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Nerve Blocks

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Review History

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Scope of Policy

This Clinical Policy Bulletin addresses nerve blocks.

I. **Medical Necessity**

Aetna considers the following nerve blocks medically necessary:

A. Adductor canal block for manipulation of the knee under anesthesia and post-operative pain control after arthroscopic tibiotalar arthrodesis, anterior cruciate ligament reconstruction, total ankle arthroplasty, and total knee arthroplasty;

B. Axillary approach to brachial plexus block for post-operative pain control after surgery in the forearm, hand, and wrist;
C. Bier block for carpal tunnel surgery;
D. Celiac nerve block for the treatment of cancer/malignancy pain;
E. Cervical plexus block (superficial and deep) for post-operative analgesia after anterior cervical discectomy fusion, and for neck surgery (e.g., thyroid surgery) and regional anesthesia for carotid endarterectomy;
F. Erector spinae plane (ESP) block for post-operative pain control for breast reconstruction, lumpectomy, modified radical mastectomy, thoracic fusion, or post-operative pain control after lumbar spinal surgery, mastectomy, after resection lung mass, segmentectomy, lumbar spinal surgery, and mediastinal lymph node dissection;
G. Fascia iliaca block for acute hip fracture, and post-operative pain control following hip (including arthroscopic hip surgery) and knee surgeries;
H. Femoral nerve blocks for acute post-operative pain after knee replacement surgery;
I. Femoral-sciatic nerve block for lower limb surgeries;
J. Ganglion impar block for the treatment of chronic anorectal pain associated with radiation proctitis if member has failed conservative management (e.g., pain medication, and topical antispasmodics);
K. Genitofemoral nerve block for the treatment of chronic pelvic/suprapubic pain;
L. Inferior alveolar nerve block for refractory facial/jaw pain if member has failed conventional pain medications (e.g., NSAIDs including Toradol);
M. Infraclavicular nerve block in upper extremity surgery;
N. Intercostal nerve blocks for acute intercostal pain, and for chronic intercostal neuritis as part of a comprehensive pain management program;
O. Intercostobrachial nerve block for management of tourniquet pain during surgery;
P. Interscalene/suprascapular nerve block for pain control in shoulder surgeries;

Q. IPACK (infiltration between popliteal artery and capsule of the knee) block for pain control following ankle arthroplasty, anterior cruciate ligament repair, knee arthroscopy, medial meniscectomy, or total knee arthroplasty;

R. Lateral femoral cutaneous nerve block for meralgia paresthetica (lateral femoral cutaneous nerve entrapment) when conservative management (e.g., non-opioid analgesics or anticonvulsants such as carbamazepine, gabapentin or phenytoin) has failed; and pain control after total hip arthroplasty (THA);

S. Lumbar plexus block for post-operative pain control after THA;

T. Neuraxial/caudal block for post-operative pain management in infants and children;

U. Pecto-intercostal fascial block for management of post-operative pain after cardiothoracic surgeries;

V. Pectoral plane nerve blocks for post-operative pain control after breast cancer surgery/mastectomy;

W. Peripheral nerve blocks (continuous or single-injection) for the treatment of acute pain, or for chronic pain only as part of an active component of a comprehensive pain management program;

X. Phrenic block for the treatment of refractory hiccups when conservative methods (e.g., bilateral pressure on external auditory meatus, fasting for 24 hours, induced vomiting, lavage, and massage of hard/soft palate junction) and pharmacotherapies (e.g., benzodiazepines, chlorpromazine, gabapentin, olanzapine or muscle relaxant) have failed;

Y. Popliteal nerve block for post-operative pain control after foot and ankle surgery;

Z. Posterior tibial nerve block for post-operative pain control after foot and ankle surgery;

AA. Quadratus lumborum nerve block for post-operative pain control after abdominal surgeries, bone grafting from the iliac crest, and total hip arthroplasty;

AB. Radial nerve block for post-operative pain control after carpometacarpal joint arthroplasty and De Quervain’s tendon release;

AC. Rectus sheath block for post-operative pain control after cholecystectomy, and after cardiothoracic surgeries;

AD. Regional scalp block for post-operative pain control for craniotomy procedures;
AE. Saphenous nerve block for post-operative pain management for surgeries in the lower leg and foot;
AF. Splanchnic nerve block for the treatment of cancer/malignancy pain;
AG. Stellate ganglion block for diagnosis and treatment of sympathetically-mediated pain, and diagnosis and treatment of complex regional pain syndrome (CRPS) of the hand and arm if it is used as part of a rehabilitation program and the member has failed standard pharmacotherapies (e.g., non-steroidal anti-inflammatory drug [NSAID], topical lidocaine cream);
AH. Superior and inferior alveolar nerve block for dental/facial pain;
AI. Transversus abdominis plane (TAP) block for abdominal surgery;
AJ. Ultrasound (US)-guided celiac plexus block for inoperable pancreatic cancer and abdominal pain requiring opioid analgesics, and as a “last resort” for pain from chronic pancreatitis that are refractory to high doses of opiates;
AK. US-guided supraclavicular block as regional anesthesia during surgeries and/or post-operative pain control to the distal two-thirds of the upper extremity, or from the mid-humerus to the fingertips.

II. **Experimental and Investigational**

The following nerve blocks are considered experimental and investigational (not an all-inclusive list) because the effectiveness of these approaches has not been established:

- Adductor canal block for removal of ganglion cyst in the foot;
- Anterior cutaneous block for anterior cutaneous nerve entrapment syndrome;
- Anterior scalene/brachial plexus block for management of chronic pain;
- Auriculotemporal block for temporomandibular joint disorder;
- Axillary nerve block (block of axillary nerve) for frozen shoulder (adhesive capsulitis), bicipital tenosynovitis, chronic shoulder

pain, shoulder bursitis, or post-operative pain control after elbow surgery;

- Blocks of branches of trigeminal nerve and cervical plexus for post-operative pain control after cochlear implant;
- Calcaneal nerve block for plantar fasciitis;
- Cervical plexus block (superficial and deep) for the management of post-operative pain after clavicle open reduction and internal fixation (ORIF), after ORIF of distal radius fracture, or shoulder surgery; and for the treatment of chronic radicular pain/post-laminectomy syndrome, shoulder pain;
- Clavipectoral fascial plane block for post-op pain control after ORIF;
- Cluneal nerve block (including treatment of chronic pelvic pain);
- Erector spinae plane (ESP) block for pain management related to cervical fusion, lymph node biopsy, pain control in multiple rib fractures, post-operative pain control after cardiac procedures, laparoscopic para-esophageal repair, total hip arthroplasty, and post-operative pain control after ventral (abdominal) hernias repair (including umbilical and incisional hernias;
- Facial nerve block for the treatment of headache/neuralgia;
- Ganglion impar block for the treatment of anorectal pain associated with radiation proctitis, and testicular pain (also see CPB 0016 - Back Pain: Invasive Procedures (../1_99/0016.html));
- Genicular nerve block;
- Glossopharyngeal block for metallic taste in mouth, and post-operative pain control after endoscopic retrograde cholangiopancreatography;
- Greater auricular nerve block for headache;
- Greater occipital nerve blocks for the diagnosis and treatment of neck and upper back pain;
- Ilioinguinal nerve block for chronic pelvic pain syndrome;
- Infraclavicular nerve block for the treatment of chronic pain;
- Intellicath (a nerve-blocking device) for the treatment of chronic pelvic pain;
- Intercostal nerve blocks for the sole treatment of chronic intercostal neuritis, notalgia paresthetica;
- IPACK nerve block for post-operative pain control after foot surgery (except for ankle arthroplasty);

- Lateral branch blocks to S1, S2, S3 and dorsal ramus of L5 for chronic sacroiliac joint dysfunction and failed back syndrome
- Lateral pectoral nerve block for shoulder pain;
- Lumbar paravertebral block for post-operative pain control after transforaminal lumbar interbody fusion;
- Lumbar plexus block for post-operative pain management after a cesarean section, or after laminectomy;
- Median block for post-operative pain control after carpal tunnel release;
- Nerve block for excision of ganglion cyst in the lower extremity;
- Nerve block for hemicrania continua;
- Nerve hydrodissection for the treatment of peripheral nerve entrapment;
- Obturator nerve block for treatment of chronic pain;
- Occipital nerve block for the treatment of occipital neuralgia;
- Paravertebral nerve block for periacetabular osteotomy and diagnostic hip arthroscopy, post-operative pain management after diagnostic hip arthroscopy and periacetabular osteotomy, and treatment of chronic pain;
- PECS II block for mitral valve replacement, and post-operative pain control after shoulder surgery;
- Pectoral plane (PECS I) nerve block for post-operative pain control after cardiothoracic surgeries
- Pectoralis block for post-operative pain control after shoulder surgery;
- Pectoralis minor nerve block for pectoralis minor syndrome and thoracic outlet syndrome;
- Pedicle screw block/hardware block of spinal instrumentation;
- Pericapsular nerve group (PENG) block for all indications;
- Peripheral nerve block as sole treatment for chronic non-malignant pain;
- Peripheral nerve blocks (e.g., greater occipital (GON), supratrochlear (STN), and supraorbital (SON) nerve blocks) for the treatment of post-herpetic neuralgia, and prevention or treatment of headaches including (migraine headaches and treatment-refractory migraine in pregnancy), and for the treatment of short-lasting unilateral neuralgiform headaches;
- Popliteal nerve block for post-operative pain control after anterior cruciate ligament repair;

- Posterior femoral cutaneous nerve block for the management of pelvic pain, myofascial pain syndrome, and vaginismus;
- Pudendal nerve block for the management of chronic pelvic pain, myofascial pain syndrome, testicular pain, vaginismus, and vulvodynia/vestibulitis;
- Quadratus lumborum nerve block for post-operative pain control after lumbo-sacral fusion, and total knee arthroplasty;
- Repetitive peripheral nerve blocks for chronic non-malignant pain;
- Saphenous nerve block for the treatment of chronic pain related to osteoarthritis of the ankle and foot, and saphenous neuralgia;
- Sciatic block for the treatment of lumbar radiculopathy;
- Serratus anterior plane block for the management of post-operative pain/post-thoracotomy pain/after lung transplantation via anterolateral incision;
- Sphenopalatine nerve block for diagnosis of atypical facial pain;
- Spinal accessory neve block for the treatment of neck pain and upper back pain;
- Spinal accessory nerve block for post-operative pain control;
- Splanchnic nerve block for the treatment of abdominal pain;
- Stellate ganglion block for cervicalgia, cervical facet joint syndrome, headache, long COVID, neuropathic pain (other than CRPS), occipital and trigeminal neuralgia, phantom limb pain, post-traumatic stress disorder, and ulcerative colitis;
- Sub-occipital nerve block for sub-occipital neuralgia;
- Subscapular nerve block for the treatment of chronic upper extremity pain;
- Superficial peroneal nerve block for the treatment of chronic pain related to osteoarthritis of the ankle and foot;
- Superior hypogastric nerve block for neurogenic pelvic pain and pain relief following abdominal hysterectomy;
- Superior laryngeal nerve block for chronic cough, glottal fry, laryngeal dehydration, laryngeal hypersensitivity, and throat pain;
- Supraorbital nerve block for the diagnosis of headaches, post-operative pain control after ventriculo-peritoneal shunt placement, and treatment of temporomandibular joint (TMJ) disorder;

- Suprascapular nerve block for the treatment of adhesive capsulitis, cervical spondylosis, chronic upper extremity pain, hemiplegic shoulder pain in individuals with chronic stroke, and low back pain;
- Supratrochlear nerve block for diagnosis and treatment of headache/neuralgia;
- Sural nerve block for the treatment of foot pain including chronic pain related to osteoarthritis of the ankle and foot, and neuritis;
- Thoraco-lumbar interfascial plane (TLIP) nerve block for post-operative pain management after spine surgeries;
- Tibial nerve block before a plantar fascia injection and for the treatment of hallux rigidus;
- Trans-muscular quadratus lumborum for post-operative pain control after laparoscopic colorectal surgery;
- Transversus abdominis plane (TAP) block for post-operative analgesia following lumbar fusion, and after THA;
- Transverse thoracic block for open inguinal hernia repair, and post-operative pain control after medial sternotomy;
- US-guided erector spinae plane (ESP) block for the management of chronic myofascial pain syndrome, and post-operative pain.

Note: The use of a peripheral nerve block for pain is not a reason for a hospital stay if members have an otherwise uncomplicated out-patient procedure.

III. **Related Policies**

- CPB 0016 - Back Pain: Invasive Procedures (../1_99/0016.html)
- CPB 0462 - Migraine and Cluster Headache: Nonsurgical Management (../400_499/0462.html)
- CPB 0722 - Transforaminal Epidural Injections (../700_799/0722.html)
- CPB 0729 - Diabetic Neuropathy: Selected Treatments (../700_799/0729.html)
- CPB 0952 - Ultrasound Guidance – Selected Indications (../900_999/0952.html)

CPT Codes / HCPCS Codes / ICD-10 Codes

Celiac nerve block, Splanchnic nerve block:

Code	Code Description
CPT codes covered if selection criteria are met:	
64680	Destruction by neurolytic agent, with or without radiologic monitoring; celiac plexus
ICD-10 codes covered if selection criteria are met (not all-inclusive):	
G89.3	Neoplasm related pain (acute) (chronic)
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
R10.0	Acute abdomen
R10.10 – R10.13	Pain localized to upper abdomen
R10.30 – R10.33	Pain localized to other parts of lower abdomen
R10.811 – R10.84	Other abdominal pain
R10.9	Unspecified abdominal pain
Cervical Plexus Block:	
CPT codes covered if selection criteria are met:	
Cervical Plexus Block - no specific code	
Other CPT codes related to the CPB:	
22551 – 22552	Arthrodesis, anterior interbody, including disc space preparation, discectomy, osteophytectomy and decompression of spinal cord and/or nerve roots; cervical below C2
22554	Arthrodesis, anterior interbody technique, including minimal discectomy to prepare interspace (other than for decompression); cervical below C2
23515	Open treatment of clavicular fracture, includes internal fixation, when performed

Code	Code Description
ICD-10 codes covered if selection criteria are met (not all-inclusive):	
G89.18	Other acute postprocedural pain [Postoperative pain (POP) following neck surgery] [not covered for POP following shoulder surgery and clavicle open reduction and internal fixtation, after open reduction and internal fixation (ORIF) of distal radius fracture][not covered for POP following cochlear implant]
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
M25.511 – M25.519	Pain in shoulder
M54.10 – M54.18	Radiculopathy
M96.1	Postlaminectomy syndrome, not elsewhere classified
Clavipectoral fascial plane block:	
CPT codes not covered if selection criteria are met:	
Clavipectoral fascial plane block- no specific code	
Other CPT codes related to the CPB:	
23515	Open treatment of clavicular fracture includes internal fixation, when performed
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
G89.18	Other acute postprocedural pain
Fascia Iliaca Block:	
CPT codes covered if selection criteria are met:	
64450	Injection(s), anesthetic agent(s) and/or steroid; other peripheral nerve or branch
ICD-10 codes covered if selection criteria are met (not all-inclusive):	
G89.18	Other acute postprocedural pain
S72.001A - S72.009S	Fracture of unspecified part of neck of femur
Femoral Nerve Blocks:	
CPT codes covered if selection criteria are met:	
64447	Injection of anesthetic agent; femoral nerve, including imaging guidance, when performed
ICD-10 codes covered if selection criteria are met (not all-inclusive):	
G89.18	Other acute postprocedural pain [following knee replacement surgery]

Code	Code Description
M25.561 - M25.569	Pain in knee
Z96.651 - Z96.659	Presence of artificial knee joint [acute post-operative pain]
Femoral-sciatic nerve block:	
CPT codes covered if selection criteria are met:	
64445	Injection(s), anesthetic agent(s) and/or steroid; sciatic nerve, including imaging guidance, when performed
64446	sciatic nerve, continuous infusion by catheter (including catheter placement), including imaging guidance, when performed
64447	femoral nerve, including imaging guidance, when performed
64448	femoral nerve, continuous infusion by catheter (including catheter placement), including imaging guidance, when performed
Other CPT codes related to the CPB:	
26990 - 27299	Pelvis and hip joint
27301 - 27599	Femur (thigh region) and knee joint
27600 - 27899	Leg (tibia and fibula) and ankle joint
28001 - 28899	Foot and toes
ICD-10 codes covered if selection criteria are met (not all-inclusive):	
G89.18	Other acute postprocedural pain [POP following lower limb surgeries]
Ganglion impar block:	
CPT codes covered if selection criteria are met:	
Ganglion impar block –no specific code	
ICD-10 codes covered if selection criteria are met (not all-inclusive):	
K62.7	Radiation proctitis [Not covered for anorectal pain associated with radiation proctitis]
K62.89	Other specified diseases of anus and rectum [Chronic pain]
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
N50.811 – N50.819	Testicular pain

Code	Code Description
Inferior alveolar nerve block:	
CPT codes covered if selection criteria are met:	
64400	Injection(s), anesthetic agent(s) and/or steroid; trigeminal nerve, each branch (ie, ophthalmic, maxillary, mandibular)
ICD-10 codes covered if selection criteria are met (not all-inclusive):	
G50.1	Atypical facial pain
R68.84	Jaw pain
Infraclavicular nerve block:	
CPT codes covered if selection criteria are met:	
Infraclavicular nerve block - no specific code	
ICD-10 codes covered if selection criteria are met (not all-inclusive):	
M25.511 - M25.519	Pain in shoulder
M79.601 - M79.603, M79.621 - M79.646	Pain in arm, upper arm, forearm, hand and fingers
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
G89.21 - G89.29	Chronic pain
Intercostal Nerve Blocks:	
CPT codes covered if selection criteria are met:	
64420 - 64421	Intercostal nerve blocks
ICD-10 codes covered if selection criteria are met:	
G54.8	Other nerve root and plexus disorders [intercostal neuritis][not covered for notalgia paresthetica]
Lateral branch blocks S1, S2, S3 and dorsal ramus of L5:	
CPT codes not covered for indications listed in the CPB:	
64451	Injection(s), anesthetic agent(s) and/or steroid; nerves innervating the sacroiliac joint, with image guidance (ie, fluoroscopy or computed tomography)
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
M53.2X8	Spinal instabilities, sacral and sacrococcygeal region
M53.88	Other specified dorsopathies, sacral and sacrococcygeal region

Code	Code Description
M96.1	Postlaminectomy syndrome, not elsewhere classified [failed back syndrome]
M99.04	Segmental and somatic dysfunction of sacral region
Lumbar paravertebral block:	
CPT codes not covered for indications listed in the CPB:	
Lumbar paravertebral block -no specific code	
Other CPT codes related to the CPB:	
22630	Arthrodesis, posterior interbody technique, including laminectomy and/or discectomy to prepare interspace (other than for decompression), single interspace; lumbar
22632	each additional interspace
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
G89.18	Other acute postprocedural pain [POP following transforaminal lumbar interbody fusion]
Median Block:	
CPT codes not covered for indications listed in the CPB:	
Median Block –no specific code	
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
G89.18	Other acute postprocedural pain [POP following carpal tunnel release]
Intercostobrachial Nerve Block:	
CPT codes covered if selection criteria are met:	
64415	Injection(s), anesthetic agent(s) and/or steroid; brachial plexus
ICD-10 codes covered if selection criteria are met (not all-inclusive):	
G89.18	Other acute postprocedural pain
Interscalene/suprascapular nerve block, Anterior scalene/brachial plexus block:	
CPT codes covered if selection criteria are met:	
64415	Injection(s), anesthetic agent(s) and/or steroid; brachial plexus, including imaging guidance, when performed [not covered for Anterior scalene/brachial plexus block for chronic pain]
64416	Injection(s), anesthetic agent(s) and/or steroid; brachial plexus, continuous infusion by catheter (including catheter placement), including imaging guidance, when performed
64418	suprascapular nerve

Code	Code Description
Other CPT codes related to the CPB:	
23000 - 23929	Shoulder
25000 – 25999	Forearm and wrist surgery
26010 – 26989	Hand and fingers surgery
29805 – 29828	Arthroscopy, shoulder, surgical
ICD-10 codes covered if selection criteria are met (not all-inclusive):	
G89.18	Other acute postprocedural pain [POP following shoulder surgeries][POP following surgery in the forearm, wrist, and hand]
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
G89.21 - G89.29	Chronic pain [not covered for Anterior scalene/brachial plexus block for chronic pain]
Auriculotemporal block:	
CPT codes not covered for indications listed in the CPB:	
64400	Injection(s), anesthetic agent(s) and/or steroid; trigeminal nerve, each branch (ie, ophthalmic, maxillary, mandibular)
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
M26.601 – M26.609	Temporomandibular joint disorder, unspecified
Axillary block:	
CPT codes not covered for indications listed in the CPB:	
64417	Injection(s), anesthetic agent(s) and/or steroid; axillary nerve, including imaging guidance, when performed
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
G89.18	Other acute postprocedural pain [POP following elbow surgery]
M25.511 – M25.519	Pain in shoulder
M75.00 – M75.02	Adhesive capsulitis of shoulder
M75.20 – M75.22	Bicipital tendinitis

Code	Code Description
M75.50 – M75.52	Bursitis of shoulder
Trigeminal nerve block:	
CPT codes not covered for indications listed in the CPB:	
64400	Injection(s), anesthetic agent(s) and/or steroid; trigeminal nerve, each branch (ie, ophthalmic, maxillary, mandibular)
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
G89.18	Other acute postprocedural pain [POP following cochlear implant]
Rectus sheath block:	
CPT codes covered if selection criteria are met:	
64473	Lower extremity fascial plane block, unilateral; by injection(s), including imaging guidance, when performed
64474	by continuous infusion(s), including imaging guidance, when performed
64486	Transversus abdominis plane (TAP) block (abdominal plane block, rectus sheath block) unilateral; by injection(s) (includes imaging guidance, when performed)
64487	Transversus abdominis plane (TAP) block (abdominal plane block, rectus sheath block) unilateral; by continuous infusion(s) (includes imaging guidance, when performed)
64488	Transversus abdominis plane (TAP) block (abdominal plane block, rectus sheath block) bilateral; by injections (includes imaging guidance, when performed)
64489	Transversus abdominis plane (TAP) block (abdominal plane block, rectus sheath block) bilateral; by continuous infusions (includes imaging guidance, when performed)
Other CPT codes related to the CPB:	
33016 - 33999	Heart and pericardium
47562	Laparoscopy, surgical; cholecystectomy
47600	Cholecystectomy
92920 - 93799	Cardiovascular

Code	Code Description
ICD-10 codes covered if selection criteria are met (not all-inclusive):	
G89.18	Other acute postprocedural pain [POP after cholecystectomy] [POP following cardiothoracic surgeries]
Quadratus lumborum nerve block:	
CPT codes covered if selection criteria are met:	
Quadratus lumborum nerve block – no specific code	
Other CPT codes related to the CPB:	
22586	Arthrodesis, pre-sacral interbody technique, including disc space preparation, discectomy, with posterior instrumentation, with image guidance, includes bone graft when performed, L5-S1 interspace
27447	Arthroplasty, knee, condyle and plateau; medial AND lateral compartments with or without patella resurfacing (total knee arthroplasty)
27486 – 27487	Revision of total knee arthroplasty, with or without allograft
ICD-10 codes covered if selection criteria are met (not all-inclusive):	
G89.18	Other acute postprocedural pain [POP following abdominal surgeries] [POP following THA][POP following bone grafting from the iliac crest][Not covered for POP following Lumbo-sacral fusion and total knee arthroplasty]
Radial nerve block:	
CPT codes covered if selection criteria are met:	
Radial nerve block – no specific code	
Other CPT codes related to the CPB:	
25000	Incision, extensor tendon sheath, wrist (eg, de Quervains disease)
25447	Arthroplasty, interposition, intercarpal or carpometacarpal joints
25448	Arthroplasty, intercarpal or carpometacarpal joints; suspension, including transfer or transplant of tendon, with interposition, when performed
26530	Arthroplasty, metacarpophalangeal joint; each joint
26531	with prosthetic implant, each joint

Code	Code Description
ICD-10 codes covered if selection criteria are met (not all-inclusive):	
G89.18	Other acute postprocedural pain [POP after carpometacarpal joint arthroplasty and de Quervains tendon release]
Regional scalp block:	
CPT codes covered if selection criteria are met:	
64405	Injection(s), anesthetic agent(s) and/or steroid; greater occipital nerve
Other CPT codes related to the CPB:	
61304 – 61576	Craniectomy or craniotomy
ICD-10 codes covered if selection criteria are met (not all-inclusive):	
G89.18	Other acute postprocedural pain [POP following Craniotomy]
IPACK block:	
CPT codes covered if selection criteria are met:	
IPACK block – no specific code	
Other CPT codes related to the CPB:	
27447	Arthroplasty, knee, condyle and plateau; medial AND lateral compartments with or without patella resurfacing (total knee arthroplasty)
27570	Manipulation of knee joint under general anesthesia (includes application of traction or other fixation devices)
27700 – 27703	Arthroplasty, ankle
28001 - 28899	Foot and toes
29882	Arthroscopy, knee, surgical; with meniscus repair (medial OR lateral)
29888	Arthroscopically aided anterior cruciate ligament repair/augmentation or reconstruction
ICD-10 codes covered if selection criteria are met (not all-inclusive):	
G89.18	Other acute postprocedural pain [covered for ACL repair, ankle arthroplasty, knee arthroscopy, medial meniscectomy or TKA] [Not covered for foot surgery]

Code	Code Description
Lateral femoral cutaneous nerve block:	
CPT codes covered if selection criteria are met:	
64450	Injection(s), anesthetic agent(s) and/or steroid; other peripheral nerve or branch
Other CPT codes related to the CPB:	
27130	Arthroplasty, acetabular and proximal femoral prosthetic replacement (total hip arthroplasty), with or without autograft or allograft
27132	Conversion of previous hip surgery to total hip arthroplasty, with or without autograft or allograft
27134	Revision of total hip arthroplasty; both components, with or without autograft or allograft
27137	acetabular component only, with or without autograft or allograft
27138	femoral component only, with or without allograft
ICD-10 codes covered if selection criteria are met (not all inclusive):	
G57.10 - G57.13	Meralgia paresthetica
G89.18	Other acute postprocedural pain [POP after total hip arthroplasty (THA)]
Lumbar plexus block:	
CPT codes covered if selection criteria are met:	
64466	Thoracic fascial plane block, unilateral; by injection(s), including imaging guidance, when performed
64468	Thoracic fascial plane block, bilateral; by injection(s), including imaging guidance, when performed
64520	Injection, anesthetic agent; lumbar or thoracic (paravertebral sympathetic)
Other CPT codes related to the CPB:	
29860	Arthroscopy, hip, diagnostic with or without synovial biopsy (separate procedure)
29861	Arthroscopy, hip, surgical; with removal of loose body or foreign body

Code	Code Description
29862	with debridement/shaving of articular cartilage (chondroplasty), abrasion arthroplasty, and/or resection of labrum
29863	with synovectomy
59510	Routine obstetric care including antepartum care, cesarean delivery, and postpartum care
59514	Cesarean delivery only
59515	Cesarean delivery only; including postpartum care
63005, 63012, 63017, 63047, 63052, 63053	Laminectomy
ICD-10 codes covered if selection criteria are met (not all inclusive):	
G89.18	Other acute postprocedural pain [POP after hip arthroscopy][not covered for POP following cesarean section and laminectomy]
Neuraxial/caudal block:	
CPT codes covered if selection criteria are met:	
Neuraxial/caudal block – no specific code	
ICD-10 codes covered if selection criteria are met (not all inclusive):	
G89.18	Other acute postprocedural pain [pain management in infants and children]
Pecto-intercostal fascial block:	
CPT codes covered if selection criteria are met:	
Pecto-intercostal fascial block –no specific code	
Other CPT codes related to the CPB:	
33016 - 33999	Heart and pericardium
92920 - 93799	Cardiovascular
ICD-10 codes covered if selection criteria are met (not all inclusive):	
G89.18	Other acute postprocedural pain [POP following cardiothoracic surgeries]
Pectoral plane nerve block:	
CPT codes covered if selection criteria are met:	
Pectoral plane nerve block –no specific code	

Code	Code Description
Other CPT codes related to the CPB:	
19300 – 19307	Mastectomy procedures
19316 – 19396	Breast repair and/or reconstruction
23000 - 23929	Shoulder
ICD-10 codes covered if selection criteria are met (not all inclusive):	
G89.18	Other acute postprocedural pain [POP after breast cancer surgery/mastectomy][Not covered for POP following shoulder surgery]
Peripheral Nerve Blocks :	
CPT codes covered if selection criteria are met:	
64400 - 64450	Introduction/Injection of anesthetic agent (nerve block), diagnostic or therapeutic [not covered as sole treatment of chronic pain, for ganglion, genicular, and obturator nerve blocks for chronic pain or for repetitive peripheral nerve blocks for chronic non-malignant pain]
Other CPT codes related to the CPB:	
29897	Arthroscopy, ankle (tibiotalar and fibulotalar joints), surgical; debridement, limited
29898	debridement, extensive
ICD-10 codes covered if selection criteria are met:	
G89.11	Acute pain due to trauma
G89.12	Acute post-thoracotomy pain
G89.18	Other acute postprocedural pain
G89.21 - G89.29	Chronic pain
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
G43.001 - G43.E19	Migraines
G44.001 - G44.89	Other headache syndromes
R51.0 - R51.9	Headache

Code	Code Description
Phrenic block:	
CPT codes covered if selection criteria are met:	
Phrenic block –no specific code	
ICD-10 codes covered if selection criteria are met:	
R06.6	Hiccough [refractory]
Popliteal nerve block:	
CPT codes not covered for indications listed in the CPB:	
Popliteal nerve block – no specific code	
Other CPT codes related to the CPB:	
29888	Arthroscopically aided anterior cruciate ligament repair/augmentation or reconstruction
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
G89.18	Other acute postprocedural pain [POP after anterior cruciate ligament repair]
Posterior femoral cutaneous nerve block:	
CPT codes not covered for indications listed in the CPB:	
Posterior femoral cutaneous nerve block –no specific code	
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
M79.10 – M79.18	Myalgia
N94.2	Vaginismus
R10.2	Pelvic and perineal pain
Pudendal nerve block:	
CPT codes not covered for indications listed in the CPB:	
64430	Injection(s), anesthetic agent(s) and/or steroid; pudendal nerve
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
M79.10 – M79.18	Myalgia
N50.811 – N50.819	Testicular pain
N94.2	Vaginismus
N94.810 - N94.819	Vulvodynia/vestibulitis
R10.2	Pelvic and perineal pain

Code	Code Description
Posterior tibial nerve block:	
CPT codes covered if selection criteria are met:	
Posterior tibial nerve block – no specific code	
Other CPT codes related to the CPB:	
27650	Repair, primary, open or percutaneous, ruptured Achilles tendon
27652	with graft (includes obtaining graft)
27654	Repair, secondary, Achilles tendon, with or without graft
ICD-10 codes covered if selection criteria are met:	
G89.18	Other acute postprocedural pain [POP after Achilles tendon repair]
Chronic Pain Post Herniorrhaphy:	
CPT codes covered if selection criteria are met:	
64425	Injection, anesthetic agent; ilioinguinal, iliohypogastric nerves
ICD-10 codes covered if selection criteria are met (not all inclusive):	
K40.00 - K46.9	Hernia [abdominal cavity]
Popliteal Block:	
CPT codes covered if selection criteria are met:	
64450	Injection, anesthetic agent; other peripheral nerve or branch
Other CPT codes related to the CPB:	
27600 – 27899	Leg (tibia and fibula) and ankle joint
27814	Open treatment of bimalleolar ankle fracture (eg, lateral and medial malleoli, or lateral and posterior malleoli, or medial and posterior malleoli), includes internal fixation
28001 - 28899	Foot and toes
ICD-10 codes covered if selection criteria are met (not all-inclusive):	
G89.18	Other acute postprocedural pain [POP following hallux valgus surgery][POP following foot surgery][POP following ankle surgery]
Adductor Canal Block:	
CPT codes covered if selection criteria are met:	
64447	Injection(s), anesthetic agent(s) and/or steroid; femoral nerve, including imaging guidance, when performed

Code	Code Description
64448	femoral nerve, continuous infusion by catheter (including catheter placement), including imaging guidance, when performed
Other CPT codes related to the CPB:	
27427 – 27429	Ligamentous reconstruction (augmentation), knee
27447	Arthroplasty, knee, condyle and plateau; medial AND lateral compartments with or without patella resurfacing (total knee arthroplasty)
27486 – 27487	Revision of total knee arthroplasty, with or without allograft
27570	Manipulation of knee joint under general anesthesia (includes application of traction or other fixation devices)
27702 – 27703	Arthroplasty, ankle; with implant (total ankle)
29899	Arthroscopy, ankle (tibiotalar and fibulotalar joints), surgical; with ankle arthrodesis
ICD-10 codes covered if selection criteria are met (not all-inclusive):	
G89.18	Other acute postprocedural pain [POP following ACL reconstruction][POP following after arthroscopic tibiotalar arthrodesis] [POP following Knee manipulation under anesthesia][POP following total ankle arthroplasty and total knee arthroplasty]
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
M67.471 – M67.479	Ganglion, ankle and foot
Brachial plexus block:	
CPT codes covered if selection criteria are met:	
64415 – 64416	Injection(s), anesthetic agent(s) and/or steroid; brachial plexus, including imaging guidance, when performed
Other CPT codes related to the CPB:	
25000 – 25999	Forearm and wrist surgery
26010 – 26989	Hand and fingers surgery

Code	Code Description
ICD-10 codes covered if selection criteria are met:	
G89.18	Other acute postprocedural pain
Anterior cutaneous block:	
CPT codes not covered for indications listed in the CPB:	
Anterior cutaneous block –no specific code	
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
G57.80 – G57.83	Other specified mononeuropathies of lower limb [anterior cutaneous nerve entrapment syndrome]
G58.8	Other specified mononeuropathies [anterior cutaneous nerve entrapment syndrome]
Bier block:	
CPT codes covered if selection criteria are met:	
Bier block –no specific code	
Other CPT codes related to the CPB:	
64721	Neuroplasty and/or transposition; median nerve at carpal tunnel
ICD-10 codes covered if selection criteria are met (not all-inclusive):	
G89.18	Other acute postprocedural pain [POP following carpal tunnel surgery]
Superior and inferior alveolar nerve block:	
CPT codes covered if selection criteria are met:	
64400	Injection(s), anesthetic agent(s) and/or steroid; trigeminal nerve, each branch (ie, ophthalmic, maxillary, mandibular) [Superior and inferior alveolar nerve block]
ICD-10 codes covered if selection criteria are met (not all-inclusive):	
G50.1	Atypical facial pain [dental/facial pain]
K08.89	Other specified disorders of teeth and supporting structures [dental/facial pain]
Transversus abdominis plane (TAP) block:	
CPT codes covered if selection criteria are met:	
64486 - 64489	Transversus abdominis plane (TAP) block
Other CPT codes related to the CPB:	
22900 - 22905	Abdominal surgery

Code	Code Description
Ultrasound (US)-guided celiac plexus block:	
CPT codes covered if selection criteria are met:	
64463	Paravertebral block (PVB) (paraspinous block), thoracic; continuous infusion by catheter (includes imaging guidance)
64467	Thoracic fascial plane block, unilateral; by continuous infusion(s), including imaging guidance, when performed
64469	Thoracic fascial plane block, bilateral; by continuous infusion(s), including imaging guidance, when performed
ICD-10 codes covered if selection criteria are met (not all-inclusive):	
C25.0 - C25.9	Malignant neoplasm of pancreas [for inoperable pancreatic cancer and abdominal pain]
K86.1	Other chronic pancreatitis [for requiring opioid analgesics, and as a “last resort” for pain from chronic pancreatitis that are refractory to high doses of opiates]
US-guided supraclavicular block:	
CPT codes covered if selection criteria are met:	
64415 - 64416	Injection, anesthetic agent; brachial plexus, including imaging guidance, when performed
CPT codes not covered for indications listed in the CPB:	
76942	Ultrasonic guidance for needle placement (eg, biopsy, aspiration, injection, localization device), imaging supervision and interpretation
Calcaneal Nerve Block:	
CPT codes not covered for indications listed in the CPB:	
64450	Injection(s), anesthetic agent(s) and/or steroid; other peripheral nerve or branch
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
M72.2	Plantar fascial fibromatosis
Cluneal nerve block:	
CPT codes not covered for indications listed in the CPB:	
Cluneal nerve block –no specific code	
ICD-10 codes not covered for indications listed in the CPB (not all inclusive)::	
R10.2	Pelvic and perineal pain [chronic]

Code	Code Description
Facial Nerve Block:	
CPT codes not covered for indications listed in the CPB:	
Facial nerve block - No specific code:	
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
M54.81	
Genicular nerve block:	
CPT codes not covered for indications listed in the CPB:	
64454	Injection(s), anesthetic agent(s) and/or steroid; genicular nerve branches, including imaging guidance, when performed
64624	Destruction by neurolytic agent, genicular nerve branches including imaging guidance, when performed
Genitofemoral nerve block:	
CPT codes covered for indications listed in the CPB:	
Genitofemoral nerve block - no specific code	
ICD-10 codes covered if selection criteria are met:	
R10.2	Pelvic and perineal pain [suprapubic pain]
Greater Auricular Nerve Block:	
CPT codes not covered for indications listed in the CPB:	
Glossopharyngeal block:	
CPT codes not covered for indications listed in the CPB:	
Glossopharyngeal block – no specific code	
Other CPT codes related to the CPB:	
0397T	Endoscopic retrograde cholangiopancreatography (ERCP), with optical endomicroscopy (List separately in addition to code for primary procedure)
43260 – 43278	Endoscopic retrograde cholangiopancreatography (ERCP)
Other HCPCS codes related to the CPB:	
C7541 – C7544	Endoscopic retrograde cholangiopancreatography (ercp)
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
G89.18	Other acute postprocedural pain [POP following endoscopic retrograde cholangiopancreatography]
R43.2	Parageusia [metallic taste in mouth]

Code	Code Description
Greater Auricular Nerve Block - No specific code:	
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
R51.0 - R51.9	Headache
Lateral Pectoral Nerve Block:	
CPT codes not covered for indications listed in the CPB:	
64450	Injection(s), anesthetic agent(s) and/or steroid; other peripheral nerve or branch
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
M25.511 - M25.519	Pain in shoulder
Nerve Block For Ganglion Cyst In The Lower Extremity:	
CPT codes not covered for indications listed in the CPB:	
64447	Injection(s), anesthetic agent(s) and/or steroid; femoral nerve, including imaging guidance, when performed
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
M67.451 - M67.459	Ganglion, hip
M67.461 - M67.469	Ganglion, knee
M67.471 - M67.479	Ganglion, ankle and foot
Nerve Block For Hemicrania Continua:	
CPT codes not covered for indications listed in the CPB:	
64405	Injection(s), anesthetic agent(s) and/or steroid; greater occipital nerve
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
G44.51	Hemicrania continua
Greater occipital nerve blocks:	
CPT codes not covered for indications listed in the CPB:	
64405	Injection, anesthetic agent; greater occipital nerve
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
M47.21 - M47.24, M47.811 - M47.814	Cervical and thoracic spondylosis with or without myelopathy

Code	Code Description
M50.00 - M50.03, M51.04 - M51.05	Intervertebral disc disorder with myelopathy, cervical and thoracic region
M50.20 - M50.23, M51.24	Other intervertebral disc displacement, cervical or thoracic region
M50.30 - M50.33, M51.34 - M51.35	Other cervical, thoracic and thoracolumbar intervertebral disc degeneration
M51.44 - M51.45	Schmorl's nodes, thoracic region
M51.84	Other intervertebral disc disorders, thoracic region
M54.2	Cervicalgia
M54.9	Dorsalgia, unspecified
M96.1	Postlaminectomy syndrome, not elsewhere classified [thoracic region]
Ilioinguinal nerve block:	
CPT codes not covered for indications listed in the CPB:	
64425	Injection(s), anesthetic agent(s) and/or steroid; ilioinguinal, iliohypogastric nerves
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
R10.2	Pelvic and perineal pain
Nerve hydrodissection:	
CPT codes not covered for indications listed in the CPB:	
Nerve hydrodissection - no specific code:	
Paravertebral blocks:	
CPT codes not covered for indications listed in the CPB:	
64461 - 64463	Paravertebral block (PVB) (paraspinous block), thoracic
Other CPT codes related to the CPB:	
29860	Arthroscopy, hip, diagnostic with or without synovial biopsy (separate procedure)
S2115	Osteotomy, periacetabular, with internal fixation

Code	Code Description
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
G89.18	Other acute postprocedural pain [not covered for POP following diagnostic hip arthroscopy and periacetabular osteotomy]
G89.21 - G89.29	Chronic pain
PECS II block:	
CPT codes not covered for indications listed in the CPB:	
PECS II block –no specific code	
Other CPT codes related to the CPB:	
23000 - 23929	Shoulder
33440	Replacement, mitral valve, with cardiopulmonary bypass
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
G89.18	Other acute postprocedural pain [POP following shoulder surgery]
Pectoral plane (PECS I):	
CPT codes not covered for indications listed in the CPB:	
Pectoral plane (PECS I) – no specific code	
Other CPT codes related to the CPB:	
33016 - 33999	Heart and pericardium
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
G89.18	Other acute postprocedural pain [POP following cardiothoracic surgeries]
Pectoralis Minor Nerve Block:	
CPT codes not covered for indications listed in the CPB:	
64450	Injection(s), anesthetic agent(s) and/or steroid; other peripheral nerve or branch
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
G54.0	Brachial plexus disorders
Pedicle screw block/hardware block of spinal instrumentation:	
CPT codes not covered for indications listed in the CPB:	
Intellicath - no specific code:	
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
R10.2	Pelvic and perineal pain

Code	Code Description
Pericapsular Nerve Group (PENG) Block:	
CPT codes not covered for indications listed in the CPB:	
64447	Injection(s), anesthetic agent(s) and/or steroid; femoral nerve, including imaging guidance, when performed
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
G89.18	Other acute postprocedural pain
M25.551 - M25.559	Pain in hip
Supraorbital nerve block:	
CPT codes not covered for indications listed in the CPB:	
64400	Injection, anesthetic agent; trigeminal nerve, any division or branch [supraorbital nerve block]
Other CPT codes related to the CPB:	
62223	Creation of shunt; ventriculo-peritoneal, -pleural, other terminus
ICD-10 codes not covered for indications listed in the CPB (not all inclusive)::	
B02.23	Postherpetic polyneuropathy
G89.18	Other acute postprocedural pain [POP following ventriculo-peritoneal shunt placement]
M26.601 – M26.609	Temporomandibular joint disorder, unspecified
R51.0 – R51.9	Headache
Saphenous nerve block:	
CPT codes covered for indications listed in the CPB::	
64447	Injection(s), anesthetic agent(s) and/or steroid; femoral nerve, including imaging guidance, when performed
CPT codes not covered for indications listed in the CPB:	
64450	Injection, anesthetic agent; other peripheral nerve or branch
ICD-10 codes covered if selection criteria are met (not all-inclusive):	
G89.18	Other acute postprocedural pain
ICD-10 codes not covered for indications listed in the CPB (not all inclusive)::	
M19.071 – M19.079	Primary osteoarthritis ankle and foot
M79.2	Neuralgia and neuritis, unspecified [saphenous neuralgia]

Code	Code Description
Sciatic block:	
CPT codes not covered for indications listed in the CPB:	
64445	Injection(s), anesthetic agent(s) and/or steroid; sciatic nerve, including imaging guidance, when performed
64446	sciatic nerve, continuous infusion by catheter (including catheter placement), including imaging guidance, when performed
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
M54.16	Radiculopathy, lumbar region
Serratus anterior plane block:	
CPT codes not covered for indications listed in the CPB:	
64450	Injection(s), anesthetic agent(s) and/or steroid; other peripheral nerve or branch
ICD-10 codes not covered for indications listed in the CPB (not all inclusive:	
G89.12	Acute post-thoracotomy pain
Sphenopalatine nerve block:	
CPT codes not covered for indications listed in the CPB:	
64505	Injection, anesthetic agent; sphenopalatine ganglion
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
G50.1	Atypical facial pain
Spinal accessory nerve block:	
CPT codes not covered for indications listed in the CPB:	
Spinal accessory nerve block - no specific code:	
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
G89.18	Other acute postprocedural pain
M54.2	Cervicalgia [neck pain]
M54.6	Pain in thoracic spine [upper back pain]
Stellate ganglion block :	
CPT codes covered for indications listed in the CPB:	
64510	Injection, anesthetic agent; stellate ganglion (cervical sympathetic
ICD-10 codes covered for indications listed in the CPB (not all inclusive):	
G90.511 - G90.519	Complex regional pain syndrome I of upper limb

Code	Code Description
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
F43.10 – F43.12	Post-traumatic stress disorder (PTSD)
G50.0	Trigeminal neuralgia
G54.6	Phantom limb syndrome with pain
K51.00 - K51.919	Ulcerative colitis
M53.82	Other specified dorsopathies, cervical region
M54.2	Cervicalgia
M54.81	Occipital neuralgia
M79.2	Neuralgia and neuritis, unspecified
R51.9	Headache, unspecified
U09.9	Post COVID-19 condition, unspecified [Long-COVID]
Suboccipital nerve block:	
CPT codes not covered for indications listed in the CPB:	
Suboccipital nerve block - no specific code:	
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
M54.81	Occipital neuralgia [suboccipital]
Subscapular nerve block:	
CPT codes not covered for indications listed in the CPB:	
Subscapular nerve block - no specific code	
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
M79.621 – M79.646	Pain in upper arm, forearm, hand, fingers [chronic]
Superficial peroneal nerve block:	
CPT codes not covered for indications listed in the CPB:	
Superficial peroneal nerve block –no specific code	
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
M19.071 – M19.079	Primary osteoarthritis ankle and foot
Superior hypogastric nerve block:	
CPT codes not covered for indications listed in the CPB:	
64517	Injection, anesthetic agent; superior hypogastric plexus

Code	Code Description
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
R10.2	Pelvic and perineal pain [neurogenic]
Superior laryngeal nerve block:	
CPT codes not covered for indications listed in the CPB:	
64408	Injection(s), anesthetic agent(s) and/or steroid; vagus nerve [Superior laryngeal nerve block]
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
R05.3	Chronic cough
J38.7	Other diseases of larynx [laryngeal hypersensitivity]
Suprascapular nerve block:	
CPT codes not covered for indications listed in the CPB:	
64418	Injection, anesthetic agent; suprascapular nerve for cervical spondylosis
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
M47.812	Spondylosis without myelopathy or radiculopathy, cervical region
M54.50 - M54.59	Low back pain
M75.00 - M75.02	Adhesive capsulitis of shoulder
Supratrochlear block:	
CPT codes not covered for indications listed in the CPB:	
64400	Injection(s), anesthetic agent(s) and/or steroid; trigeminal nerve, each branch (ie, ophthalmic, maxillary, mandibular)
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
M54.81	Occipital neuralgia
R51.0 - R51.9	Headache
Sural nerve block:	
CPT codes not covered for indications listed in the CPB:	
Sural nerve block – no specific code	
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
M19.071 – M19.079	Primary osteoarthritis ankle and foot
M79.2	Neuralgia and neuritis, unspecified

Code	Code Description
M79.671 - M79.673	Pain in foot
Thoraco-lumbar interfascial plane (TLIP):	
CPT codes not covered for indications listed in the CPB:	
Thoraco-lumbar interfascial plane (TLIP) - no specific code	
Other CPT codes related to the CPB:	
22010 - 22899	Spine (vertebral column)
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
G89.18	Other acute postprocedural pain [POP after spine surgeries]
Tibial nerve block:	
CPT codes not covered for indications listed in the CPB:	
Tibial nerve block - no specific code	
64450	Injection(s), anesthetic agent(s) and/or steroid; other peripheral nerve or branch [Tibial nerve block]
Other CPT codes related to the CPB:	
20550	Injection(s); single tendon sheath, or ligament, aponeurosis (eg, plantar "fascia")
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
M20.20 – M20.22	Hallux rigidus
M72.2	Plantar fascial fibromatosis
TAP Block:	
CPT codes not covered for indications listed in the CPB:	
64486	Transversus abdominis plane (TAP) block (abdominal plane block, rectus sheath block) unilateral; by injection(s) (includes imaging guidance, when performed)
64487	Transversus abdominis plane (TAP) block (abdominal plane block, rectus sheath block) unilateral; by continuous infusion(s) (includes imaging guidance, when performed)
64488	Transversus abdominis plane (TAP) block (abdominal plane block, rectus sheath block) bilateral; by injections (includes imaging guidance, when performed)

Code	Code Description
64489	Transversus abdominis plane (TAP) block (abdominal plane block, rectus sheath block) bilateral; by continuous infusions (includes imaging guidance, when performed)
Other CPT codes related to the CPB:	
22612	Arthrodesis, posterior or posterolateral technique, single level; lumbar (with lateral transverse technique, when performed)
27130	Arthroplasty, acetabular and proximal femoral prosthetic replacement (total hip arthroplasty), with or without autograft or allograft
27132	Conversion of previous hip surgery to total hip arthroplasty, with or without autograft or allograft
27134	Revision of total hip arthroplasty; both components, with or without autograft or allograft
27137	acetabular component only, with or without autograft or allograft
27138	femoral component only, with or without allograft
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
G89.18	Other acute postprocedural pain [not covered for TAP block for post-operative analgesia following lumbar fusion and THA]
Transverse thoracic block:	
CPT codes not covered for indications listed in the CPB:	
Transverse thoracic block – no specific code	
Other CPT codes related to the CPB:	
49491 - 49525	Repair inguinal hernia
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
G89.18	Other acute postprocedural pain [POP following open inguinal hernia repair]
Ultrasound-guided erector spinae plane (ESP) block:	
CPT codes not covered for indications listed in the CPB:	
Ultrasound-guided erector spinae plane (ESP) block - no specific code	
Other CPT codes related to the CPB:	
19300 – 19307	Mastectomy

Code	Code Description
19316 – 19380	Breast repair and/or reconstruction
21603	Excision of chest wall tumor involving rib(s), with plastic reconstruction; with mediastinal lymphadenectomy
21632	Radical resection of sternum; with mediastinal lymphadenectomy
22532	Arthrodesis, lateral extracavitary technique, including minimal discectomy to prepare interspace (other than for decompression); thoracic
22534	thoracic or lumbar, each additional vertebral segment (List separately in addition to code for primary procedure)
22551 - 22552	Arthrodesis, anterior interbody, including disc space preparation, discectomy, osteophytectomy and decompression of spinal cord and/or nerve roots; cervical below C2
22554	Arthrodesis, anterior interbody technique, including minimal discectomy to prepare interspace (other than for decompression); cervical below C2
22556	thoracic
22610	Arthrodesis, posterior or posterolateral technique, single level; thoracic (with lateral transverse technique, when performed)
27130	Arthroplasty, acetabular and proximal femoral prosthetic replacement (total hip arthroplasty), with or without autograft or allograft
27132	Conversion of previous hip surgery to total hip arthroplasty, with or without autograft or allograft
27134	Revision of total hip arthroplasty; both components, with or without autograft or allograft
27137	acetabular component only, with or without autograft or allograft
27138	femoral component only, with or without allograft
32484	Removal of lung, other than pneumonectomy; single segment (segmentectomy)

Code	Code Description
32501	Resection and repair of portion of bronchus (bronchoplasty) when performed at time of lobectomy or segmentectomy (List separately in addition to code for primary procedure)
32505 – 32506	Thoracotomy; with therapeutic wedge resection (eg, mass, nodule), initial
32669	Thoracoscopy, surgical; with removal of a single lung segment (segmentectomy)
32674	Thoracoscopy, surgical; with mediastinal and regional lymphadenectomy (List separately in addition to code for primary procedure)
33016 - 33999	Heart and pericardium
38500 – 38531	Biopsy or excision of lymph node(s)
38746	Thoracic lymphadenectomy by thoracotomy, mediastinal and regional lymphadenectomy (List separately in addition to code for primary procedure)
43281 – 43282	Laparoscopy, surgical, repair of paraesophageal hernia, includes fundoplasty, when performed; with or without implantation of mesh
49491 – 49525	Repair, initial inguinal hernia
49591 – 49596	Repair of anterior abdominal hernia(s) (ie, epigastric, incisional, ventral, umbilical, spigelian), any approach (ie, open, laparoscopic, robotic), initial, including implantation of mesh or other prosthesis when performed, total length of defect(s)
62380	Endoscopic decompression of spinal cord, nerve root(s), including laminotomy, partial facetectomy, foraminotomy, discectomy and/or excision of herniated intervertebral disc, 1 interspace, lumbar

Code	Code Description
63005, 63012, 63017, 63047, 63052, 63053, 63200, 63267, 63272, 63277, 63282	Laminectomy
63030, 63040, 63042	Laminotomy
63056	Transpedicular approach with decompression of spinal cord, equina and/or nerve root(s) (eg, herniated intervertebral disc), single segment; lumbar (including transfacet, or lateral extraforaminal approach) (eg, far lateral herniated intervertebral disc)
63087 – 63091, 63102 – 63103, 63303, 63307	Vertebral corpectomy
76998	Ultrasonic guidance, intraoperative
92920 - 93799	Cardiovascular
ICD-10 codes covered if selection criteria are met:	
G89.18	Other acute postprocedural pain [POP following lumbar spinal surgery and mastectomy][POP following breast reconstruction, lumpectomy, thoracic fusion, after resection lung mass, segmentectomy, lumbar spinal surgery, and mediastinal lymph node dissection] [not covered for POP following THA and cardiac procedures] [not covered for POP following cervical fusion, lymph node biopsy, para-esophageal repair, and ventral (abdominal) hernia repair (including umbilical and incisional hernias)]
ICD-10 codes not covered for indications listed in the CPB (not all inclusive):	
M79.10 - M79.8	Myalgia [chronic myofascial pain syndrome]
S22.41XA – S22.49XK	Multiple fractures of ribs

Background

A nerve block is a form of regional anesthesia. Peripheral nerve blocks (PNBs) entail the injection of corticosteroids, local anesthetics, neurolytic agents and/or sclerosing agents into or near peripheral nerves or neve ganglion resulting in the temporary interruption of conduction of impulses in peripheral nerves or nerve trunks (somatic and sympathetic nerves). Peripheral nerve blocks attempt to block pain signals and in theory provide prolonged relief from pain.

Examples of peripheral nerve blocks include, but may not be limited to, cluneal nerve block, ganglion impar block, genicular nerve block or obturator nerve block. The cluneal nerve is a sensory nerve located in the upper portion of the buttocks, consisting of a superior, medial and inferior branch. The genicular nerve is a sensory nerve that surrounds the knee and provides innervation for the joint. An obturator nerve block is an injection of a steroid, an anesthetic or a combination of both, near the obturator nerve, which is primarily a motor nerve arising from the third and fourth lumbar nerves, with distribution to the hip and thigh; this type injection is most commonly used as part of regional anesthesia for knee surgery.

For the treatment of headache disorders, the greater occipital nerve block (GON) is the most widely used target of the peripheral nerve blocks (PNB). Other commonly targeted nerves are the lesser occipital nerve (LON) and several branches of the trigeminal nerve: the supratrochlear (STN), supraorbital (SON) and auriculotemporal (ATN) nerves (Robbins and Blumenfeld, 2017).

Peripheral nerve blocks can either be “single-injection” – refers to one-time injection of local anesthetic to the target nerve for peri-operative analgesia and/or surgical anesthesia, or “continuous” – refers to the percutaneous insertion of a catheter directly adjacent to the target peripheral nerve(s). The latter approach is to provide prolonged nerve block by continuous infusion of local anesthetic for longer procedures, as well as post-operative analgesia. Continuous PNB (cPNB) is primarily used for inpatient procedures, but can also be used in outpatients (Jeng and Rosenblatt, 2012).

Neuropathic pain is a type of pain that can result from injury to nerves, either in the peripheral or central nervous system. Neuropathic pain can occur in any part of the body and is frequently described as a hot, burning sensation. It can result from diseases that affect nerves (such as diabetes) or from trauma, or, because chemotherapy drugs can affect nerves, it can be a consequence of cancer treatment. Among the many neuropathic pain conditions some that can cause neuropathic pain of the extremities are diabetic neuropathy, reflex sympathetic dystrophy syndrome, phantom limb and post-amputation pain. Chronic pain persists over a longer period of time than acute pain and is resistant to most medical treatments. A peripheral nerve block may be performed to diagnose and/or treat neuropathic pain.

Aguirre et al (2012) stated that the most common use of cPNBs is in the peri- and post-operative period but different indications have been described like the treatment of chronic pain such as cancer-induced pain, complex regional pain syndrome or phantom limb pain. The documented benefits strongly depend on the analgesia quality and include decreasing baseline/dynamic pain, reducing additional analgesic requirements, decrease of post-operative joint inflammation and inflammatory markers, sleep disturbances and opioid-related side effects, increase of patient satisfaction and ambulation/functioning improvement, an accelerated resumption of passive joint range-of-motion, reducing time until discharge readiness, decrease in blood loss/blood transfusions, potential reduction of the incidence of post-surgical chronic pain and reduction of costs. Evidence deriving from randomized controlled trials suggests that in some situations there are also prolonged benefits of regional anesthesia after catheter removal in addition to the immediate post-operative effects. Unfortunately, there are only few data demonstrating benefits after catheter removal and the evidence of medium- or long-term improvements in health-related quality of life (QOL) measures is still lacking.

In a review on “Evidence-based interventions for chemotherapy-induced peripheral neuropathy”, Visovsky et al (2007) examined the literature on the prevention or treatment of chemotherapy-induced peripheral neuropathy (CIPN), which included pilot studies, clinical trials, systematic reviews of the literature, and case studies. The Oncology Nursing Society Putting Evidence Into Practice® (PEP) CIPN Team consisted of 2 advanced practice nurses, 2 staff nurses, and a nurse researcher. The CIPN Team chose not to include animal model-based studies because applicability and generalizability to human populations has not been established. No meta-analyses addressing the prevention or treatment of CIPN were found in the literature. The team searched Medline, the National Library of Medicine's database. Search terms included chemotherapy-induced peripheral neuropathy, peripheral neuropathy, and neuropathy. Search terms specific to known CIPN interventions also were explored, including human leukemia inhibitory factor, nerve growth factor, neurotrophin-3, exercise and chemotherapy-induced peripheral neuropathy, exercise and neuropathy, diabetes and peripheral neuropathy, vitamin E, tricyclic antidepressants (TCAs), amifostine, calcium/magnesium infusions, carbamazepine, glutathione, alpha lipoic acid, and glutamine. Other search terms were alternative therapy, complementary therapies, herbal therapies, plants-medicinal, herb(s), herbal(s), acupuncture, electric nerve stimulation, high-frequency external muscle stimulation, transelectrical nerve stimulation, spinal cord stimulation, anodyne therapy, pulsed infrared light therapy, social support, psychosocial support, educational interventions, patient education, patient safety, safety, injury, accidents, safety management, protective devices, and capsaicin. The authors concluded that CIPN remains a significant problem for patients receiving chemotherapy for cancer. At present, no interventions for CIPN can be recommended for practice. No rigorously designed studies, meta-analyses, or systematic reviews support any of the interventions discussed, and risk of harm may out-weigh potential benefits.

The American Society of Anesthesiologists Task Force on Chronic Pain Management and the American Society of Regional Anesthesia and Pain Medicine’s practice guidelines on “Chronic pain management” (2010) stated that “Peripheral somatic nerve blocks should not be used for long-term treatment of chronic pain”.

Hartemann et al (2011) stated that the prevalence of painful diabetic neuropathy (PDN) is approximately 20 % in patients with type-2 diabetes and 5 % in those with type-1 diabetes. Patients should be systematically questioned concerning suggestive symptoms, as they are not usually volunteers. As PDN is due to small-fiber injury, the 10 g monofilament pressure test as well as the standard electrophysiological procedures may be normal. Diagnosis is based on clinical findings: type of pain (burning discomfort, electric shock-like sensation, aching coldness in the lower limbs); time of occurrence (mostly at rest and at night); and abnormal sensations (such as tingling or numbness). The DN4 questionnaire is an easy-to-use validated diagnostic tool. Three classes of drugs are of equal value in treating PDN: (i) TCAs; (ii) anticonvulsants; and (iii) selective serotonin-reuptake inhibitors (SSRIs). These compounds may be prescribed as first-line therapy following pain assessment using a visual analog scale (VAS). If the initial drug at its maximum tolerated dose does not lead to a decrease in pain of at least 30 %, another drug class should be prescribed; if the pain is decreased by 30 % but remains greater than 3/10, a drug from a different class may be given in combination.

The American Academy of Neurology (AAN), American Association of Neuromuscular and Electrodiagnostic Medicine, American Academy of Physical Medicine and Rehabilitation (Bril et al, 2011) developed a scientifically sound and clinically relevant evidence-based guideline for the treatment of PDN. The basic question that was asked was: "What is the efficacy of a given treatment (pharmacological: anticonvulsants, antidepressants, opioids, others; non-pharmacological: electrical stimulation, magnetic field treatment, low-intensity laser treatment, Reiki massage, others) to reduce pain and improve physical function and QOL in patients with PDN"? A systematic review of literature from 1960 to August 2008 was performed, and studies were classified according to the AAN classification of evidence scheme for a therapeutic article. Recommendations were linked to the strength of the evidence. The results indicated that pregabalin is established as effective and should be offered for relief of PDN (Level A). Venlafaxine, duloxetine, amitriptyline, gabapentin, valproate, opioids (morphine sulfate, tramadol, and oxycodone controlled-release), and capsaicin are probably effective and should be considered for treatment of PDN (Level B). Other treatments have less robust evidence, or the evidence is negative. Effective treatments for PDN are available, but many have side effects that limit their usefulness. Few studies have sufficient information on their effects on function and QOL.

The South African Expert Panel's clinical practice guidelines for management of neuropathic pain (Chetty et al, 2012) stated that neuropathic pain (NeuP) is challenging to diagnose and manage, despite ongoing improved understanding of the underlying mechanisms. Many patients do not respond satisfactorily to existing treatments. There are no published guidelines for diagnosis or management of NeuP in South Africa. A multi-disciplinary expert panel critically reviewed available evidence to provide consensus recommendations for diagnosis and management of NeuP in South Africa. Following accurate diagnosis of NeuP, pregabalin, gabapentin, low-dose TCAs (e.g., amitriptyline) and SSRIs (e.g., duloxetine and venlafaxine) are all recommended as first-line options for the treatment of peripheral NeuP. If the response is insufficient after 2 to 4 weeks, the recommended next step is to switch to a different class, or combine different classes of agent. Opioids should be reserved for use later in the treatment pathway, if switching drugs and combination therapy fails. For central NeuP, pregabalin or amitriptyline are recommended as first-line agents. Companion treatments (e.g., cognitive behavioral therapy and physical therapy) should be administered as part of a multi-disciplinary approach. Dorsal root entry zone rhizotomy (DREZ) is not recommended to treat NeuP.

In an evidence-based guideline on “Neuropathic pain interventional treatments”, Mailis and Taenzer (2012) states that “Based on limited evidence that selective transforaminal nerve root blocks (extraforaminal root injections, periradicular steroid injections, intraforaminal oxygen-ozone injections and epidural perineural autologous conditioned serum injections can provide up to 8 to 12 weeks of relief from lumbar radicular pain, the task force cannot justify a general recommendation, but suggests that these interventions be used with caution depending on the circumstances, with full disclosure to the patient of the limited evidence and potential risks. Evidence quality: Fair; Certainty: Moderate; Strength of recommendation: Grade C (May recommend depending on circumstances. At least moderate certainty with small net benefit).

Furthermore, UpToDate reviews on “Treatment of diabetic neuropathy” (Feldman and McCulloch, 2012), “Overview of lower extremity peripheral nerve syndromes” (Rutkove, 2012), and “Epidemiology, clinical manifestations, diagnosis, and treatment of HIV-associated peripheral neuropathy” (Nardin and Freeman, 2012) do not mention the use of PNBs.

In summary, there is currently insufficient evidence to support the use of peripheral nerve blocks in the treatment of peripheral neuropathy or other indications.

The Work Loss Data Institute’s guideline on “Neck and upper back (acute & chronic)” (2013) listed greater occipital nerve block (diagnostic and therapeutic) as one of the interventions/procedures that are under study and are not specifically recommended.

In a Cochrane review, Chan et al (2014) evaluated the benefits and risks of femoral nerve block (FNB) used as a post-operative analgesic technique relative to other analgesic techniques among adults undergoing total knee replacement (TKR). These investigators searched the Cochrane Central Register of Controlled Trials (CENTRAL) 2013, Issue 1, MEDLINE, EMBASE, CINAHL, Web of Science, dissertation abstracts and reference lists of included studies. The date of the last search was January 31, 2013. These researchers included randomized controlled trials (RCTs) comparing FNB with no FNB (intravenous patient-controlled analgesia (PCA) opioid, epidural analgesia, local infiltration analgesia, and oral analgesia) in adults after TKR. They also included RCTs that compared continuous versus single-shot FNB. Two review authors independently performed study selection and data extraction. They undertook meta-analysis (random-effects model) and used relative risk ratios (RRs) for dichotomous outcomes and mean differences (MDs) or standardized mean differences (SMDs) for continuous outcomes. They interpreted SMDs according to rule of thumb where 0.2 or smaller represents a small effect, 0.5 a moderate effect and 0.8 or larger, a large effect.

These investigators included 45 eligible RCTs (2,710 participants) from 47 publications; 20 RCTs had more than 2 allocation groups. A total of 29 RCTs compared FNB (with or without concurrent treatments including

PCA opioid) versus PCA opioid, 10 RCTs compared FNB versus epidural, 5 RCTs compared FNB versus local infiltration analgesia, 1 RCT compared FNB versus oral analgesia and 4 RCTs compared continuous versus single-shot FNB. Most included RCTs were rated as low or unclear risk of bias for the aspects rated in the risk of bias assessment tool, except for the aspect of blinding. These researchers rated 14 (31 %) RCTs at high-risk for both participant and assessor blinding and rated 8 (18 %) RCTs at high-risk for one blinding aspect. Pain at rest and pain on movement were less for FNB (of any type) with or without a concurrent PCA opioid compared with PCA opioid alone during the first 72 hours post-operation. Pooled results demonstrated a moderate effect of FNB for pain at rest at 24 hours (19 RCTs, 1,066 participants, SMD -0.72, 95 % confidence interval [CI]: -0.93 to -0.51, moderate-quality evidence) and a moderate to large effect for pain on movement at 24 hours (17 RCTs, 1,017 participants, SMD -0.94, 95 % CI: -1.32 to -0.55, moderate-quality evidence). Pain was also less in each FNB subgroup: single-shot FNB, continuous FNB and continuous FNB + sciatic block, compared with PCA. Femoral nerve block also was associated with lower opioid consumption (IV morphine equivalent) at 24 hours (20 RCTs, 1,156 participants, MD -14.74 mg, 95 % CI: -18.68 to -10.81 mg, high-quality evidence) and at 48 hours (MD -14.53 mg, 95 % CI: -20.03 to -9.02 mg), lower risk of nausea and/or vomiting (RR 0.47, 95 % CI: 0.33 to 0.68, number needed to treat for an additional harmful outcome (NNTH) 4, high-quality evidence), greater knee flexion (11 RCTs, 596 participants, MD 6.48 degrees, 95 % CI ; 4.27 to 8.69 degrees, moderate-quality evidence) and greater patient satisfaction (four RCTs, 180 participants, SMD 1.06, 95 % CI: 0.74 to 1.38, low-quality evidence) compared with PCA. The authors could not demonstrate a difference in pain between FNB (any type) and epidural analgesia in the first 72 hours post-operation, including pain at 24 hours at rest (6 RCTs, 328 participants, SMD -0.05, 95 % CI: -0.43 to 0.32, moderate-quality evidence) and on movement (6 RCTs, 317 participants, SMD 0.01, 95 % CI: -0.21 to 0.24, high-quality evidence). No difference was noted at 24 hours for opioid consumption (5 RCTs, 341 participants, MD -4.35 mg, 95 % CI: -9.95 to 1.26 mg, high-quality evidence) or knee flexion (6 RCTs, 328 participants, MD -1.65, 95 % CI: -5.14 to 1.84, high-quality evidence). However, FNB demonstrated lower risk of nausea/vomiting (4 RCTs, 183 participants, RR 0.63, 95 % CI: 0.41 to 0.97, NNTH 8, moderate-quality evidence) and higher patient satisfaction (2 RCTs, 120 participants, SMD 0.60, 95 % CI:

0.23 to 0.97, low-quality evidence), compared with epidural analgesia. Pooled results of 4 studies (216 participants) comparing FNB with local infiltration analgesia detected no difference in analgesic effects between the groups at 24 hours for pain at rest (SMD 0.06, 95 % CI: -0.61 to 0.72, moderate-quality evidence) or pain on movement (SMD 0.38, 95 % CI: -0.10 to 0.86, low-quality evidence). Only 1 included RCT compared FNB with oral analgesia. These researchers considered this evidence insufficient to allow judgment of the effects of FNB compared with oral analgesia. Continuous FNB provided less pain compared with single-shot FNB (4 RCTs, 272 participants) at 24 hours at rest (SMD -0.62, 95 % CI: -1.17 to -0.07, moderate-quality evidence) and on movement (SMD -0.42, 95 % CI: -0.67 to -0.17, high-quality evidence). Continuous FNB also demonstrated lower opioid consumption compared with single-shot FNB at 24 hours (3 RCTs, 236 participants, MD -13.81 mg, 95 % CI: -23.27 to -4.35 mg, moderate-quality evidence). Generally, the meta-analyses demonstrated considerable statistical heterogeneity, with type of FNB, allocation concealment and blinding of participants, personnel and outcome assessors reducing heterogeneity in the analyses. Available evidence was insufficient to allow determination of the comparative safety of the various analgesic techniques. Few RCTs reported on serious adverse effects such as neurological injury, post-operative falls or thrombotic events. The authors concluded that following TKR, FNB (with or without concurrent treatments including PCA opioid) provided more effective analgesia than PCA opioid alone, similar analgesia to epidural analgesia and less nausea/vomiting compared with PCA alone or epidural analgesia. The review also found that continuous FNB provided better analgesia compared with single-shot FNB; RCTs were insufficient to allow definitive conclusions on the comparison between FNB and local infiltration analgesia or oral analgesia.

Bauer et al (2014) noted that pain following TKR is a challenging task for healthcare providers. Concurrently, fast recovery and early ambulation are needed to regain function and to prevent post-operative complications. Ideal post-operative analgesia provides sufficient pain relief with minimal opioid consumption and preservation of motor strength. Regional analgesia techniques are broadly used to answer these expectations. Femoral nerve blocks are performed frequently but have suggested disadvantages, such as motor weakness. The use of lumbar epidurals is questioned because of the risk of epidural hematoma. Relatively new techniques, such as local infiltration analgesia or adductor canal blocks, are increasingly discussed. The present review discussed new findings and weighted between known benefits and risks of all of these techniques for TKR. Femoral nerve blocks are the gold standard for TKR. The standard use of additional sciatic nerve blocks remains controversial. Lumbar epidurals possess an unfavorable risk/benefit ratio because of increased rate of epidural hematoma in orthopedic patients and should be reserved for lower limb amputation; peripheral regional techniques provide comparable pain control, greater satisfaction and less risk than epidural analgesia. Although motor weakness might be greater with FNBs compared with no regional analgesia, new data pointed towards a similar risk of falls after TKR, with or without peripheral nerve blocks. Local infiltration analgesia and adductor canal blockade are promising recent techniques to gain adequate pain control with a minimum of undesired side-effects. The authors concluded that FNBs are still the gold standard for an effective analgesia approach in knee arthroplasty and should be supplemented (if needed) by oral opioids. An additional sciatic nerve blockade is still controversial and should be an individual decision. Moreover, they stated that large-scale studies are needed to reinforce the promising results of newer regional techniques, such as local infiltration analgesia and adductor canal block.

An UpToDate review on “Total knee arthroplasty” (Martin et al, 2014) states that “Increasingly, patients are managed with femoral nerve blocks in order to reduce the complications and the delay in rehabilitation associated with general anesthesia and with indwelling epidural catheters. Patient-controlled analgesia (PCA) can be useful in the post-arthroplasty setting. Subsequently, oral opioid analgesics may be used. Pain control after total knee replacement has improved considerably with increasing use of multimodal pain management strategies. This typically includes “preemptive” management with acetaminophen, cyclooxygenase-2 (COX-2)-selective nonsteroidal antiinflammatory drugs (NSAIDs), femoral nerve blocks, regional anesthetics, and periarticular injections”.

Law et al (2015) compared paravertebral block (PVB) with general anesthesia/systemic analgesia, neuraxial blocks, and other PNBs. These investigators analyzed 14 RCTs from PubMed, MEDLINE, CENTRAL, EMBASE, and CINAHL up to February 2015, without language restriction, comparing PVB under sedation with general anesthesia/systematic analgesia (135 versus 133 patients), neuraxial blocks (191 versus 186 patients), and other PNBs (119 versus 117 patients). These researchers investigated pain scores, consumption of post-operative analgesia, incidence of post-operative nausea and vomiting (PONV), length of hospital stay, post-anesthesia care unit bypassing rate, time to perform blocks, intra-operative hemodynamics, and incidence of urinary retention. Joint hypothesis testing was adopted for pain and analgesics, PONV, and hemodynamic variables. All analyses were performed with RevMan 5.2.11 (Cochrane Collaboration, Copenhagen). Hartung-Knapp-Sidik-Jonkman method was used for post-hoc testing. Paravertebral block reduced PONV (nausea: RR = 0.22; 95 % CI: 0.05 to 0.93; numbers needed to treat [NNT] = 4.5; I = 15 % and vomiting: RR = 0.15; 95 % CI: 0.03 to 0.76; NNT = 8.3; I = 0 %) compared with general anesthesia/systematic analgesia (quality of evidence [QoE]: high). Compared with neuraxial blocks, PVB resulted in less post-operative nausea (RR = 0.34 [95 % CI: 0.13 to 0.91], NNT = 8.3, I = 0 %) and urinary retention (RR = 0.14 [95 % CI: 0.05 to 0.42], NNT = 7.4, I = 0 %) than neuraxial blocks (QoE: high). More time was needed to perform PVB than neuraxial blocks (standardized mean difference = 1.90 [95 % CI: 0.02 to 3.77], I = 92 %; mean difference = 5.33 minutes; QoE: moderate). However, the available data could not reject the null hypothesis of non-inferiority on all pain scores and analgesic requirements for both PVB versus general anesthesia/systematic analgesia and PVB versus neuraxial blocks (QoE: low), as well as on hemodynamic outcomes for PVB versus neuraxial blocks (QoE: moderate). This systematic review showed that PVB decreased post-operative pain scores and analgesic requirement as compared with ilio-inguinal block and transversus abdominis plane block. The authors concluded that this meta-analysis showed that PVB provides an anesthesia with fewer undesirable effects for inguinal herniorrhaphy. The choice between general anesthesia/systematic analgesia, neuraxial blocks, PVB, and other PNBs should be based on time available to perform the block and a complete coverage over the relevant structures by the blocks.

Treatment of Migraine Headaches

The American Migraine Foundation defines intractable headache as a type of headache, such as a migraine or another kind of headache that can include a combination of two or more different headache types, which is refractory to treatment. Of primary headaches (headaches that are not due to an underlying cause such as a brain tumor, infection, etc) the most common type of intractable headaches are migraines and tension headaches.

Ashkenazi et al (2010) stated that interventional procedures such as PNBs and trigger point injections (TPIs) have long been used in the treatment of various headache disorders. There are, however, little data on their effectiveness for the treatment of specific headache syndromes. Moreover, there is no widely accepted agreement among headache specialists as to the optimal technique of injection, type, and doses of the local anesthetics used, and injection regimens. The role of corticosteroids in this setting is also being debated. These investigators performed a PubMed search of the literature to find studies on PNBs and TPIs for the treatment of headaches. They classified the abstracted studies based on the procedure performed and the treated condition. These researchers found few controlled studies on the effectiveness of PNBs for headaches, and virtually none on the use of TPIs for this indication. The most widely examined procedure in this setting was greater occipital nerve block, with the majority of studies being small and non-controlled. The techniques, as well as the type and doses of local anesthetics used for PNBs, varied greatly among studies. The specific conditions treated also varied, and included both primary (e.g., migraine, cluster headache) and secondary (e.g., cervicogenic, post-traumatic) headache disorders. Trigeminal (e.g., supraorbital) nerve blocks were used in few studies. Results were generally positive, but should be taken with reservation given the methodological limitations of the available studies. The procedures were generally well-tolerated. The authors concluded that there is a need to perform more rigorous clinical trials to clarify the role of PNBs and TPIs in the management of various headache disorders, and to aim at standardizing the techniques used for the various procedures in this setting.

Levin (2010) stated that nerve blocks and neurostimulation are reasonable therapeutic options in patients with head and neck neuralgias. In addition, these peripheral nerve procedures can also be effective in primary headache disorders, such as migraine and cluster headaches. Nerve blocks for headaches are generally accomplished by using small subcutaneous injections of amide-type local anesthetics (e.g., lidocaine and bupivacaine). Targets include the greater occipital nerve, lesser occipital nerve, auriculo-temporal nerve, supra-trochlear and supraorbital nerves, spheno-palatine ganglion, cervical spinal roots, and facet joints of the upper cervical spine. The author concluded that although definitive studies examining the usefulness of nerve blocks are lacking, reports suggested that this area deserves further attention in the hope of acquiring evidence of effectiveness.

Govindappagari et al (2014) described the use of PNBs in a case series of pregnant women with migraine. A retrospective chart review of all pregnant patients treated with PNBs for migraine over a 5-year period was performed. Injections targeted greater occipital, auriculo-temporal, supraorbital, and supra-trochlear nerves using local anesthetics. Peripheral nerve blocks were performed 27 times in 13 pregnant women either in a single (n = 6) or multiple (n = 7) injection series. Mean patient age was 28 years and gestational age was 23.5 weeks, and all women had migraine, including 38.5 % who had chronic migraine. Peripheral nerve blocks were performed for status migrainosus (51.8 %) or short-term prophylaxis of frequent headache attacks (48.1 %). Before PNBs were performed, oral medications failed for all patients and intravenous medications failed for most. In patients with status migrainosus, average pain reduction was 4.0 (± 2.6 standard deviation [SD]) ($p < 0.001$) immediately post-procedure and 4.0 (± 4.4 SD) ($p = 0.007$) 24 hours post-procedure in comparison to pre-procedure pain. For patients receiving PNBs for short-term prophylaxis, immediate mean pain score reduction was 3.0 (± 2.1 SD). No patients had any serious immediate, procedurally related adverse events, and the 2 patients who had no acute pain reduction ultimately developed pre-eclampsia and had post-partum headache resolution. The authors concluded that PNBs for treatment-refractory migraine may be an effective therapeutic option in pregnancy. This was a small (n = 13) retrospective study; these findings need to be validated by well-designed studies.

An UpToDate review on “Headache in pregnant and postpartum women” (Lee et al, 2017) states that “Peripheral nerve blocks may also be effective. In a series of 13 pregnant women with migraine refractory to medication, injection of local anesthetic into one or more peripheral nerves (e.g., occipital, auriculo-temporal, supraorbital, supra-trochlear) resulted in elimination of pain in seven women, pain reduction in two women, and no response in four women. Six patients received a single injection; the other seven patients received two to five sequential nerve blocks. There were no adverse maternal or fetal effects. Given the small number of patients in this study, larger studies should be performed to better define the efficacy of this approach”.

Furthermore, UpToDate reviews on “Overview of peripheral nerve blocks” (Jeng and Rosenblatt, 2017) and "Nerve blocks of the scalp, neck, and truck: Techniques" (Rosenblatt and Lai, 2017) do not mention headache/migraine as an indication of PNBs.

Greater Occipital Nerve (GON) Blockade for Headaches

Inan et al (2015) assessed the efficacy of greater occipital nerve (GON) blockade in chronic migraine (CM) treatment in a randomized, multicenter, double-blind, and placebo-controlled study. Patients with CM were randomly divided into two groups of 42. GON blockade was administered four times (once per week) with saline in group A or bupivacaine in group B. After 4 weeks of treatment, blinding was removed; in group A, GON blockade was achieved using bupivacaine, while group B continued to receive bupivacaine, and blockade was administered once per month, then followed for 2 months. Primary endpoint was the difference in number of headache days, duration of headache, and pain scores. They noted that 72 of 84 patients completed the study. After 1 month of treatment, number of headache days had decreased from 16.9 ± 5.7 to 13.2 ± 6.7 in group A ($P = 0.035$) and from 18.1 ± 5.3 to 8.8 ± 4.8 in group B ($P < 0.001$), ($P = 0.004$, between groups); duration of headache (hour) had decreased from 24.2 ± 13.7 to 21.2 ± 13.4 in group A ($P = 0.223$) and from 25.9 ± 16.3 to 19.3 ± 11.5 in group B ($P < 0.001$), ($P = 0.767$, between groups). VAS score decreased from 8.1 ± 0.9 to 6.7 ± 1.6 in group A ($P = 0.002$) and from 8.4 ± 1.5 to 5.3 ± 2.1 in group B ($P < 0.001$), ($P = 0.004$, between groups). After blinding was removed (in 2nd and 3rd month), group A exhibited similar results like group B in 3rd month. The authors concluded that their study results suggest that GON blockade with bupivacaine was superior to placebo and was found to be effective, safe, and cost-effective for the treatment of CM.

Gul et al (2017) evaluated the efficacy of greater occipital nerve (GON) blockade in chronic migraine in a placebo-controlled, randomized study using a control group. The authors state that GON blockade with local anesthetics is an effective treatment for a group of headaches, such as cervicogenic headache, cluster headache, occipital neuralgia, and migraine. The investigators included 44 patients with chronic migraine and randomly divide the patients into two groups, as group A (bupivacaine) and group B (placebo). GON blockade was administered four times (once per week) with bupivacaine or saline. After 4 weeks of treatment, patients were followed up for 3 months, and findings were recorded once every month for comparing each month's values with the pretreatment values. The primary endpoint was the difference in the frequency of headache (headache days/month). VAS pain scores were also recorded. A total of 44 patients completed the study; no severe adverse effects were reported. Group A showed a significant decrease in the frequency of headache and VAS scores at the first, second, and third months of follow-up. Similarly, group B showed a significant decrease in the frequency of headache and VAS scores at the first month of follow-up, but second and third months of follow-up showed no significant difference. The authors concluded that their results suggest that GON blockade with bupivacaine was superior to placebo, has long-lasting effect than placebo, and was found to be effective for the treatment of CM; however, more studies are needed to better define the safety and cost-effectiveness of GON blockade in chronic migraine.

Ambrosini et al (2005) discuss their double-blind, placebo-controlled study evaluating suboccipital injection with a mixture of rapid and long-acting steroids in cluster headache. The authors state that oral steroids can interrupt bouts of cluster headache (CH) attacks, but recurrence is frequent and may lead to steroid-dependency. They note that suboccipital steroid injection may be an effective alternative. The aim of their study was to assess the preventative effect on CH attacks of an ipsilateral steroid injection in the region of the greater occipital nerve (GON). Sixteen episodic (ECH) and 7 chronic (CCH) CH outpatients were included. ECH patients were in a new bout since no more than 1 week. After a one-week run-in period, patients were allocated by randomization to the placebo or verum arms and received on the side of attacks a suboccipital injection of a mixture of long- and rapid-acting betamethasone (n=13; Verum-group) or physiological saline (n=10; Plac-group). Acute treatment was allowed at any time, additional preventative therapy if attacks persisted after 1 week. Three investigators performed the injections, while four others, blinded to group allocation, followed the patients. Follow-up visits were after 1 and 4 weeks, thereafter patients were followed routinely. Eleven Verum-group patients (3 CCH) (85%) became attack-free in the first week after the injection compared to none in the Plac-group (P=0.0001). Among them eight remained attack-free for 4 weeks (P=0.0026). Remission lasted between 4 and 26 months in five patients. A single suboccipital steroid injection completely suppresses attacks in more than 80% of CH patients. The authors state that this effect was maintained for at least 4 weeks in the majority of them.

Kashipazha et al (2014) discuss preventive effect of greater occipital nerve (GON) block on severity and frequency of migraine headaches. They conducted a randomized double-blinded controlled trial on 48 patients suffering from migraine headaches. A syringe containing 1.0 mL of lidocaine 2%, 0.5 mL of either saline (control group, N = 24) or triamcinolone 0.5 mL (intervention group, N = 24) was prepared for each patient. Patients were assessed prior to the injection, and also 2 weeks, 1 month, and 2 months thereafter for severity and frequency of pain, times to use analgesics and any appeared side effects. They found no significant differences in pain severity, pain frequency, and analgesics use between the two groups at the four study time points including at baseline, and 2, 4, and 8 weeks after the intervention. However, in both groups, the indices of pain severity, pain frequency, and analgesics use were significantly reduced at the three time points after the intervention compared with before the intervention. The authors concluded that GON block, with triamcinolone in combination with lidocaine or normal saline with lidocaine, results in reducing pain severity and frequency, as well as use of analgesics up to two months after the intervention; however any difference attributed to the drug regimens by assessing of the trend of pain characteristics changes.

Cuadrado et al (2017) discuss a double-blind, randomized, placebo-controlled clinical trial on the short-term effects of greater occipital nerve blocks (GON) in chronic migraine. The authors state that GON blocks are widely used for the treatment of headaches, but quality evidence regarding their efficacy is scarce. The authors aim was to assess the short-term clinical efficacy of GON anesthetic blocks in chronic migraine (CM) and to analyze their effect on pressure pain thresholds (PPTs) in different territories. Thirty-six women with CM were treated either with bilateral GON block with bupivacaine 0.5% (n = 18) or a sham procedure with normal saline (n = 18). Headache frequency was recorded a week after and before the procedure. PPT was measured in cephalic points (supraorbital, infraorbital and mental nerves) and extracephalic points (hand, leg) just before the injection (T0), one hour later (T1) and one week later (T2). The authors reported that the anesthetic block was superior to placebo in reducing the number of days per week with moderate-or-severe headache (MANOVA; p = 0.027), or any headache (p = 0.04). Overall, PPTs increased after anesthetic block and decreased after placebo; after the intervention, PPT differences between baseline and T1/T2 among groups were statistically significant for the supraorbital (T0-T1, p = 0.022; T0-T2, p = 0.031) and infraorbital sites (T0-T1, p = 0.013; T0-T2, p = 0.005). The authors concluded that GON anesthetic blocks appear to be effective in the short term in CM, as measured by a reduction in the number of days with moderate-to-severe headache or any headache during the week following injection. GON block is followed by an increase in PPTs in the trigeminal area, suggesting an effect on central sensitization at the trigeminal nucleus caudalis. This trial is registered at ClinicalTrials.gov (NCT02188394).

Dilli et al (2015) conducted a randomized, double-blinded, placebo-controlled study on occipital nerve block for the short-term preventive treatment of migraine. Patients with chronic and episodic migraine (more than one attack per week) were treated with either 2.5mL bupivacaine 0.5% plus 20mg methylprednisolone (n=33 patients), or with placebo (2.75mL saline and 0.25mL lidocaine 1% [n=30 patients]). An evaluation 4 weeks after the procedure did not find any significant changes in the frequency of moderate to severe headache days in either group with respect to its baseline data. The study had a small sample size and the procedure was performed once, compared to the multiple times in other studies. This study's placebo treatment included a small amount of anesthetic. The study was registered with ClinicalTrial.gov (NCT00915473).

Karadas et al (2017) evaluate the GON block in the treatment of triptan-overuse headache in a randomized comparative study. The study investigated the efficiency of a single and repeated GON block using lidocaine in the treatment of triptan-overuse headache (TOH). In the study, 105 consecutive subjects diagnosed with TOH were evaluated. The subjects were randomized into three groups. In Group 1 (n=35), only triptan was abruptly withdrawn. In Group 2 (n=35), triptan was abruptly withdrawn and single GON block was performed. In Group 3 (n=35), triptan was abruptly withdrawn and three-stage GON block was performed. All patients were injected bilaterally with a total amount of 5 cc 1% lidocaine in each stage. During follow-up, the number of headache days per month, the severity of pain (VAS), the number of triptans used, and hsCRP and IL-6 levels were recorded three times; in the pretreatment period, in the second month post-treatment, and in the fourth month post-treatment. They were then compared. The authors reported that there was a statistically significant difference in the post-treatment fourth month in comparison with the pretreatment period in Group 3 ($P<.05$). Compared to Group 1, the number of headache days, VAS, and decrease in triptan need in Group 3 was statistically significant compared to Group 2 ($P<.05$). Compared to pretreatment, in the fourth month post-treatment, both hsCRP and IL-6 levels were lower only in Group 3 ($P<.05$). They concluded that repeated GON block in addition to the discontinuation of medication has significant efficacy for TOH cases.

Blumenfeld et al (2013) provide a narrative review on expert consensus recommendations for the performance of PNB for headaches. The authors note that the American Headache Society Special Interest Section for PNBs and other Interventional Procedures convened meetings during 2010-2011 featuring formal discussions and agreements about the procedural details for occipital and trigeminal PNBs. A subcommittee then generated a narrative review detailing the methodology. PNB indications may include select primary headache disorders, secondary headache disorders, and cranial neuralgias. Special procedural considerations may be necessary in certain patient populations, including pregnancy, the elderly, anesthetic allergy, prior vasovagal attacks, an open skull defect, antiplatelet/anticoagulant use, and cosmetic concerns. PNBs described include greater occipital, lesser occipital, supratrochlear, supraorbital, and auriculotemporal injections. Technical success of the PNB should result in cutaneous anesthesia. Targeted clinical outcomes depend on the indication, and include relief of an acute headache attack, terminating a headache cycle, and transitioning out of a medication-overuse pattern. Reinjection frequency is variable, depending on the indications and agents used, and the addition of corticosteroids may be most appropriate when treating cluster headache. The authors concluded that these recommendations from the American Headache Society Special Interest Section for PNBs and other Interventional Procedures members for PNB methodology in headache disorder treatment are derived from the available literature and expert consensus. With the exception of cluster headache, there is a paucity of evidence, and further research may result in the revision of these recommendations to improve the outcome and safety of these interventions.

Santos et al (2017) discuss consensus recommendations for PNB (e.g.; GON blockade) in headaches. The authors derived at their consensus based on an “exhaustive” literature review and analysis, as well as based on their own clinical experience. The levels of evidence and grades of recommendation were defined according to the classification proposed by the Centre for Evidence Based Medicine at the University of Oxford. The authors included a published study by Ruiz Pinero et al (2015) on chronic migraine prevention utilizing GON and supraorbital nerve (SON) blockade. This was a prospective, open non-controlled study in 60 patients which included a single intervention. At 3 months, 23 patients (38.3%) had responded completely to treatment (pain-free period of at least 2 weeks), and 24 patients (40%) showed a partial response (50% reduction in pain intensity and/or days with pain during at least 2 weeks). Thirteen patients (21.7%) did not respond. Although small sample size and short-term follow up, Santos et al assigned a LOE II, Grade B recommendation and stated that GON blockade may be effective as prophylaxis for chronic migraines based on reductions in number, duration, or intensity of the attacks in the weeks or months following the intervention; however, they note that addition of corticosteroids has not been shown to increase the efficacy of anesthetic block for preventing migraines.

Santos et al (2017) also evaluated case studies involving GON blockade for symptomatic treatment of migraines. After their review of the literature of case series, the authors assigned the indication a LOE IV recommendation and state that GON blockade may be a treatment alternative for refractory episodes.

Santos et al (2017) discuss their recommendations after a literature review on GON blockade for cluster headaches (CH). The authors evaluated 2 case series (n = 19, n = 15), a retrospective study (n = 60), 2 prospective open studies (n = 14, n = 83), and 2 prospective blind studies (n = 23, n = 43). Although sample sizes were small, the authors concluded that anesthetic block of the GON is an effective treatment for CH.

In and UpToDate review on "Short-lasting unilateral neuralgiform headache attacks: Treatment" (Matharu and Cohen, 2017) state that due to the small sample size of patients studies, treatment of short-lasting unilateral neuralgiform headache with GON blockage procedures, should be considered investigational.

In an UpToDate review on "Cluster headache: Treatment and prognosis" (May, 2017) states that in some cases, GON blockade or local glucocorticoid injection are effective, at least temporarily, for patients with refractory chronic cluster headache. However, the article referenced Peres, et al (2002) study that evaluated GON block treatment for cluster headache in 14 patients. Four patients (28.5%) had a good response, five (35.7%) a moderate, and five (35.7%) had no response. The referenced article contained a small sample size.

In an UpToDate review on "Preventive treatment of migraine in adults" and "Acute treatment of migraine in adults" (Bajwa and Smith, 2017) do not mention the use of GON blockage therapy for preventive or acute treatment of migraine in adults.

Peripheral Nerve Blocks for the Treatment of Facial Pain and Headaches

Kleen and Levy (2016) stated that PNBs are an increasingly viable therapeutic option for selected groups of headache patients, particularly those with intractable headache or facial pain. Greater occipital nerve block, the most widely used local anesthetic procedure in headache conditions; adverse effects are few and infrequent. These procedures can result in rapid relief of pain and allodynia, and effects last for several weeks or months. The authors concluded that the use of nerve block procedures and potentially onabotulinum toxin therapy should be expanded for patients with intractable headache disorders who may benefit, although more studies are needed for clinical safety and effectiveness.

Treatment of Hip Fracture

Abou-Setta and colleagues (2011) reviewed and synthesized the evidence on pain management interventions in non-pathological hip fracture patients following low-energy trauma. Outcomes include pain management (short- and long-term), mortality, functional status, pain medication use, mental status, health-related quality of life (QOL), quality of sleep, ability to participate in rehabilitation, return to pre-fracture living arrangements, health services utilization, and adverse effects. Comprehensive literature searches were conducted in 25 electronic databases from 1990 to present. Searches of the grey literature, trial registries, and reference lists of previous systematic reviews and included studies were conducted to identify additional studies. Study selection, quality assessment, data extraction, and grading of the evidence were conducted independently and in duplicate. Discrepancies were resolved by consensus or third-party adjudication. Meta-analyses were conducted where data were available and deemed appropriate. In total, 83 studies were included (69 trials, 14 cohort studies). Most participants were females older than 75 with no cognitive impairment. The methodological quality of cohort studies was generally moderate; most trials were at high or unclear risk of bias. Included studies were grouped into 8 intervention categories: (i) systemic analgesia, (ii) anesthesia, (iii) complementary and alternative medicine, (iv) multi-modal pain management, (v) nerve blocks, (vi) neurostimulation, (vii) rehabilitation, and (viii) traction.

Most studies examined peri- and post-operative pain management, albeit from few perspectives such as reported pain, mortality, and adverse effects. Long-term pain was not reported, and other outcomes were reported infrequently. Nerve blockade was effective for relief of acute pain; however, most studies were limited to either assessing acute pain or use of additional analgesia and did not report on how nerve blockades may affect rehabilitation such as ambulation or mobility if the blockade has both sensory and motor effects. Acupressure, relaxation therapy, and transcutaneous electrical neurostimulation may be associated with potentially clinically meaningful reductions in pain, but further evidence is warranted before any firm conclusions are reached. While the strength of evidence is insufficient to make firm conclusions, post-operative physical therapy may improve pain control, and intravenous parecoxib, a systemic analgesic not available in North America, may be a possible alternative to traditional intramuscular injections of opiates and older non-steroidal anti-inflammatory drugs (NSAIDs). Pre-operative traction and spinal anesthesia (with or without additional agents) did not consistently reduce pain or complications in any demonstrable way compared with standard care. Although most studies reported on adverse effects, they were short-term and not adequately powered to identify significant differences. None of the included studies exclusively examined participants from institutional settings or with cognitive impairment, which reduces the generalizability of results to the overall hip fracture patient population. The authors concluded that for most interventions in this review there were sparse data available, which precluded firm conclusions for any single approach or for the optimal overall pain management following hip fracture.

Sahota et al (2014) noted that hip fractures are very painful leading to lengthy hospital stays. Conventional methods of treating pain are limited. Non-steroidal anti-inflammatory drugs are relatively contraindicated and opioids have significant side effects. Regional anesthesia holds promise but results from these techniques are inconsistent. Trials to date have been inconclusive with regard to which blocks to use and for how long; inter-patient variability remains a problem. This is a single center study conducted at Queen's Medical Centre, Nottingham; a large regional trauma center in England. It is a pragmatic, parallel arm, RCT. Sample size will be 150 participants (75 in each group). Randomization will be web-based, using computer generated concealed tables (service provided by Nottingham University Clinical Trials Unit). There is no blinding. Intervention will be a femoral nerve block (0.5 ml/kg 0.25 % levo-bupivacaine) followed by ropivacaine (0.2 % 5 ml/hr) infused via a femoral nerve catheter until 48 hours post-surgery. The control group will receive standard care. Participants will be aged over 70 years, cognitively intact (abbreviated mental score of 7 or more), able to provide informed consent, and admitted directly through the Emergency Department from their place of residence. Primary outcomes will be cumulative ambulation score (from day 1 to 3 post-operatively) and cumulative dynamic pain scores (day 1 to 3 post-operatively). Secondary outcomes will be cumulative dynamic pain score pre-operatively, cumulative side effects, cumulative calorific and protein intake, EUROQOL EQ-5D score, length of stay, and rehabilitation outcome (measured by mobility score). The authors stated that many studies have shown the effectiveness of regional blockade in neck of femur fractures, but the techniques used have varied. This study aims to identify whether early and continuous femoral nerve block can be effective in relieving pain and enhancing mobilization.

Infra-Orbital Nerve Blocks for the Management of Post-Operative Pain Following Cleft Lip Repair

In a Cochrane review, Feriani and associates (2016) evaluated the effects of infra-orbital nerve block for the management of post-operative pain following cleft lip repair in children. These investigators searched the following databases: Cochrane Central Register of Controlled Trials (CENTRAL, the Cochrane Library, Issue 6, 2015), Medline, Embase, and Literatura Latino-Americana e do Caribe em Ciências da Saúde (LILACS) from inception to June 17, 2015. There were no language restrictions. They searched for ongoing trials in the following platforms: the metaRegister of Controlled Trials; ClinicalTrials.gov (the US National Institutes of Health Ongoing Trials Register), and the World Health Organization International Clinical Trials Registry Platform (on June 17, 2015). These investigators checked reference lists of the included studies to identify any additional studies. They contacted specialists in the field and authors of the included trials for unpublished data. These researchers included RCTs that tested peri-operative infra-orbital nerve block for cleft lip repair in children, compared with other types of analgesia procedure, no intervention, or placebo (sham nerve block). They considered the type of drug, dosage, and route of administration used in each study. For the purposes of this review, the term “peri-operative” refers to the 3 phases of surgery: (i) pre-operative, (ii) intra-operative, and post-operative, (iii) and commonly includes ward admission, anesthesia, surgery, and recovery. Two review authors independently identified, screened, and selected the studies, assessed trial quality, and performed data extraction using the Cochrane Pain, Palliative and Supportive Care Review Group criteria. In case of disagreements, a 3rd review author (EMKS) was consulted. The authors assessed the evidence using Grading of Recommendations, Assessment, Development and Evaluation (GRADE). These researchers included 8 studies involving 353 children in the review. These studies reported different types of interventions (lignocaine or bupivacaine), observation times, and forms of measuring and describing the outcomes, making it difficult to conduct meta-analyses. In the comparison of infra-orbital nerve block versus placebo, there was a large effect in mean post-operative pain scores (the first primary outcome) favoring the intervention group (SMD -3.54, 95 % CI: -6.13 to -0.95; very low-quality evidence; 3 studies; 120 children). Only 1 study reported the duration of analgesia (in hours) (second primary outcome) with a difference favoring the intervention group (MD 8.26 hours, 95 % CI: 5.41 to 11.11; very low-quality evidence) and less supplemental analgesic requirements in the intervention group (RR 0.05, 95 % CI: 0.01 to 0.18; low-quality evidence). In the comparison of infra-orbital nerve block versus intravenous analgesia, there was a difference favoring the intervention group in mean post-operative pain scores (SMD -1.50, 95 % CI: -2.40 to -0.60; very low-quality evidence; 2 studies; 107 children) and in the time to feeding (MD -9.45 minutes, 95 % CI: -17.37 to -1.53; moderate-quality evidence; 2 studies; 128 children). No significant adverse events (AEs; third primary outcome) were associated with the intervention, although 3 studies did not report this outcome; 5 out of 8 studies found no unwanted side effects after the nerve blocks. Overall, the included studies were at low or unclear risk of bias. The reasons for down-grading the quality of the evidence using GRADE related to the lack of information about randomization methods and allocation concealment in the studies, very small sample sizes, and heterogeneity of outcome reporting. The authors concluded that there is low- to very low-quality evidence that infra-orbital nerve block with lignocaine or bupivacaine may reduce post-operative pain more than placebo and intravenous analgesia in children undergoing cleft lip repair. They stated that further studies with larger samples are needed; and future studies should standardize the observation time and the instruments used to measure outcomes, and stratify children by age group.

Lateral Femoral Cutaneous Nerve Blocks after Total Hip Arthroplasty

In a prospective, randomized, blinded, placebo-controlled trial, Thybo and colleagues (2016) hypothesized that an lateral femoral cutaneous nerve (LFCN) block would reduce movement-related pain after total hip arthroplasty (THA) in patients with moderate-to-severe pain. A total of 60 patients with VAS score greater than 40 mm during 30-degree active flexion of the hip on either the 1st or 2nd post-operative day after THA were included in this trial. Group A received an LFCN block with 8 ml of 0.75 % ropivacaine followed after 45 mins by an additional LFCN block with 8 ml of saline. Group B received an LFCN block with 8 ml of saline followed after 45 mins by an additional LFCN block with 8 ml of 0.75 % ropivacaine. These researchers found a difference of 17 mm (95 % CI: 4 to 31 mm; $p < 0.02$) in VAS pain score during 30-degree flexion of the hip 45 mins after the 1st block (primary outcome) in favor of group A. No other significant difference between groups regarding pain during mobilization and at rest was found. The overall non-responder rate (less than 15 mm pain reduction) was 42 %. The authors concluded that LFCN block reduced movement-related pain in patients with moderate-to-severe pain after THA. Moreover, they state that the substantial non-responder rate (42 %) limited recommendations of this block as part of a standard analgesic treatment regimen.

Liposomal Bupivacaine Peripheral Nerve Blocks for the Management of Post-Operative Pain

In a Cochrane review, Hamilton and colleagues (2016) evaluated the analgesic effectiveness and adverse effects of liposomal bupivacaine infiltration PNB for the management of patients with post-operative pain. These researchers identified randomized trials of liposomal bupivacaine PNB for the management of post-operative pain. They searched the Cochrane Central Register of Controlled Trials (CENTRAL) (2016, Issue 1), Ovid Medline (1946 to week 1 of January 2016), Ovid Medline In-

Process (January 14, 2016), Embase (1974 to January 13, 2016), ISI Web of Science (1945 to January 14, 2016), and reference lists of retrieved articles. These investigators sought unpublished studies from Internet sources, and searched clinical trials databases for ongoing trials. The date of the most recent search was January 15, 2016. Randomized, double-blind, placebo- or active-controlled clinical trials of a single-dose of liposomal bupivacaine administered as a PNB in adults aged 18 years or over undergoing elective surgery at any surgical site were selected for analysis. The authors included trials if they had at least 2 comparison groups for liposomal bupivacaine PNB compared with placebo or other types of analgesia. Two review authors independently considered trials for inclusion in the review, assessed risk of bias, and extracted data. They performed analyses using standard statistical techniques as described in the Cochrane Handbook for Systematic Reviews of Interventions, using Review Manager 5. They planned to perform a meta-analysis, however there were insufficient data to ensure a clinically meaningful answer; as such they have produced a “Summary of findings” table in a narrative format, and where possible they assessed the evidence using GRADE. These researchers identified 7 studies that met inclusion criteria for this review; 3 were recorded as completed (or terminated) but no results were published. Of the remaining 4 studies (299 participants): 2 investigated liposomal bupivacaine transversus abdominis plane (TAP) block, 1 liposomal bupivacaine dorsal penile nerve block, and 1 ankle block. The study investigating liposomal bupivacaine ankle block was a phase II dose-escalating/de-escalating trial presenting pooled data that these investigators could not use in their analysis. The studies did not report primary outcome, cumulative pain score between 0 and 72 hours, and secondary outcomes, mean pain score at 12, 24, 48, 72, or 96 hours. One study reported no difference in mean pain score during the 1st, 2nd, and 3rd post-operative 24-hour periods in participants receiving liposomal bupivacaine TAP block compared to no TAP block. Two studies, both in people undergoing laparoscopic surgery under TAP block, investigated cumulative post-operative opioid dose, reported opposing findings. One found a lower cumulative opioid consumption between 0 and 72 hours compared to bupivacaine hydrochloride TAP block and 1 found no difference during the 1st, 2nd, and 3rd post-operative 24-hour periods compared to no TAP block. No studies reported time to 1st post-operative opioid or percentage not requiring opioids over the initial 72 hours. No studies reported a health economic analysis or patient-reported outcome measures (outside of pain). The review authors sought data regarding AEs but none was available, however there were no withdrawals reported to be due to AEs. Using GRADE, these researchers considered the quality of evidence to be very low with any estimate of effect very uncertain and further research very likely to have an important impact on the confidence in the estimate of effect. All studies were at high risk of bias due to their small sample size (fewer than 50 participants per arm) leading to uncertainty around effect estimates. Additionally, inconsistency of results and sparseness of data resulted in further down-grading of the quality of the data. The authors concluded that a lack of evidence has prevented an assessment of the effectiveness of liposomal bupivacaine administered as a PNB. At present there is a lack of data to support or refute the use of liposomal bupivacaine administered as a PNB for the management of post-operative pain. They stated that further research is very likely to have an important impact on the confidence in the estimate of effect and is likely to change the estimate.

Thoracic Paravertebral Blocks in Abdominal Surgery

El-Boghdadly and associates (2016) stated that thoracic paravertebral blocks (TPVBs) have an extensive evidence base as part of a multi-modal analgesic strategy for thoracic and breast surgery and have gained popularity with the advent of ultrasound guidance. However, this role is poorly defined in the context of abdominal surgery. These investigators performed a systematic review of RCTs to clarify the impact of TPVB on peri-operative analgesic outcomes in adult abdominal surgery. They identified 20 published trials involving a total of 1,044 patients that met inclusion criteria; however there was significant heterogeneity in terms of type of surgery, TPVB technique, comparator groups and study quality. Pain scores and opioid requirements in the early post-operative period were generally improved when compared with systemic analgesia, but there was insufficient evidence for any definitive conclusions regarding comparison with epidural analgesia or other peripheral block techniques, or the benefit of continuous TPVB techniques. The reported primary block failure rate was 2.8 % and the incidence of complications was 1.2 % (6/504); there were no instances of pneumothorax. The authors concluded that TPVB appeared to be a promising analgesic technique for abdominal surgery in terms of safety and effectiveness. However, they stated that further well-designed and adequately powered studies are needed to confirm its utility, particularly with respect to other regional anesthesia techniques.

Ultrasound-Guided Forearm Peripheral Nerve Blocks for the Treatment of Digit Injuries (e.g., Phalanx Fracture or Interphalangeal Joint Dislocation)

Amini and colleagues (2016) noted that phalanx fractures and interphalangeal joint dislocations commonly present to the emergency department (ED). Although these orthopedic injuries are not complex, the 4-point digital block used for anesthesia during the reduction can be painful. Additionally, cases requiring prolonged manipulation or consultation for adequate reduction may require repeat blockade. In a case-series study, these investigators reported the findings of 4 patients who presented after mechanical injuries resulting in phalanx fracture or interphalangeal joint dislocations. These patients received an ultrasound (US)-guided PNB of the forearm with successful subsequent reduction. The authors concluded that to their knowledge, the use of US-guided PNBs of the forearm for anesthesia in reduction of upper extremity digit injuries in adult patients in the ED setting has not been described before. These preliminary findings need to be validated by well-designed studies.

Soberon and associates (2016) stated that limited data exist regarding the role of peri-neural blockade of the distal median, ulnar, and radial nerves as a primary anesthetic in patients undergoing hand surgery. In a prospective, randomized, pilot study, these researchers compared these techniques to brachial plexus blocks as a primary anesthetic in this patient population. A total of 60 patients scheduled for hand surgery were randomized to receive either an US-guided supra-clavicular, infra-clavicular, or axillary nerve block (brachial plexus blocks) or US-guided median, ulnar, and radial nerve blocks performed at the level of the mid-to- proximal forearm (forearm blocks). The ability to undergo surgery without analgesic or local anesthetic supplementation was the primary outcome. Block procedure times, post-anesthesia care unit length of stay (LOS), instances of nausea/vomiting, and need for narcotic administration were also assessed. The 2 groups were similar in terms of the need for conversion to general anesthesia or analgesic or local anesthetic supplementation, with only 1 patient in the forearm block group and 2 in the brachial plexus block group requiring local anesthetic supplementation or conversion to general anesthesia. Similar durations in surgical and tourniquet times were also observed. Both groups reported similarly low numerical rating scale pain scores as well as the need for post-operative analgesic administration (2 patients in the forearm block group and 1 in the brachial plexus block group reported numerical rating scale pain scores greater than 0 and required opioid administration in the post-anesthesia care unit). Block procedure characteristics were similar between the 2 groups. The authors concluded that forearm blocks may be used as a primary anesthetic in patients undergoing hand surgery. They stated that further research is needed to determine the appropriateness of these techniques in patients undergoing surgery in the thumb or proximal to the hand.

Genicular Nerve Block for Pain Control after Total Knee Replacement

Gonzalez Sotelo and colleagues (2017) evaluated the peri-articular distribution of genicular nerve blocks in a fresh cadaver model and described the technique in a preliminary group of patients submitted to total knee arthroplasty (TKA). In the anatomical phase, 4 genicular nerves (superior medial, superior lateral, inferior medial and inferior lateral) were blocked with 4-ml of local anesthetic with iodinated contrast and methylene blue in each (16 mls in total). It was performed on a fresh cadaver and the distribution of the injected medium was evaluated by means of a CT-scan and coronal anatomical sections on both knees. The clinical phase included 12 patients scheduled for TKA. Ultrasound-guided block of the 4 genicular nerves was performed pre-operatively and their clinical effectiveness evaluated by assessing pain after the reversal of the spinal block and at 12 hours after the block. Pain was measured using the numerical scale and the need for rescue analgesia was evaluated. A wide peri-articular distribution of contrast was observed by CT-scan, which was later evaluated in the coronal sections. The distribution followed the joint capsule without entering the joint, both in the femur and in the tibia. The pain after the reversal of the subarachnoid block was 2 ± 1, requiring rescue analgesia in 42 % of the patients. At 12 hours, the pain according to the numerical scale was 4 ± 1, 33 % needed rescue analgesia. The authors concluded that the administration of 4-ml of local anesthetic at the level of the 4 genicular nerves of the knee produced a wide peri-articular distribution. They stated that these preliminary findings in a series of 12 patients undergoing TKA appeared to be clinically effective; however, extensive case series and comparative studies with local infiltration techniques with anesthetics are needed to support these encouraging results.

Genicular Nerve Block for Pain Control of Knee Osteoarthritis

In a “Letter to the Editor”, DemIr et al (2017) presented the case of a 61-year-old woman who was referred to the authors’ tertiary physical medicine and rehabilitation outpatient clinic with a 7-year history of severe left knee pain. A 6-ml combination of 1 ml long-acting betamethasone (3.947 mg betamethasone sodium phosphate + 3 mg betamethasone acetate), 2-ml lidocaine hydrochloride 2 %, and 3-ml saline solution was distributed equally to the targeted 3 injection sites. The injectate was observed to spread around the nerves using direct US guidance. The patient was asked to keep a pain diary and record the use of any painkillers or any other conservative treatments during the following 6 months. The VAS score improved after the genicular nerve block (GNB) and dropped from 80 mm to 10 mm by week 4, and the patient reported 0 at 24 weeks. The pre-treatment Western Ontario and McMaster Universities Arthritis Index (WOMAC) sub-scores were obtained as follows: pain, 20 points; stiffness, 8 points; physical function loss, 68 points; and total WOMAC score, 96 points. In week 4, the total WOMAC score had improved to 5 points, and it decreased to 4 points at the 24-week follow-up visit. The patient stated that no requirement for any medications (paracetamol and diclofenac sodium included) for pain relief after GNB for 24 weeks. She also stated at both follow-up visits that she did not require any non-pharmacological approaches. No complications were noted during the GNB session or throughout the following 7 days. The authors stated that the main drawback of this study was that it was a single-case report of the data of a patient with no control group; thus, it was difficult to be sure that there were no placebo effects. These researchers stated that although further studies are needed to construct evidence, this initial finding suggested the safety and effectiveness of GNB with US guidance. This initial study has been an encouragement to further examine this therapeutic option in a structured fashion, including a blinded and randomized controlled group with more patients. It may be useful to consider US-guided nerve blocks for other painful joints in addition to knee OA.

Kim et al (2018) noted that recently, several studies suggested that radiofrequency ablation (RFA) of the genicular nerves is a safe and effective therapeutic procedure for the treatment of intractable pain associated with chronic knee OA. Diagnostic GNB with local anesthetic has been generally carried out before making decisions regarding RFA. Although GNB has been recently carried out together with corticosteroid, the analgesic effects of corticosteroids for treating chronic pain remain controversial. In a randomized, double-blinded study, these researchers examined the effects of combining corticosteroids and local anesthesia during US-guided GNB in patients with chronic knee OA. A total of 48 patients with chronic knee OA were randomly assigned to either the lidocaine alone group (n = 24) or lidocaine plus triamcinolone (TA) group (n = 24) before US-guided GNB. Oxford Knee Score (OKS), VAS, and Global Perceived Effect Scales (GPES; 7-point scale) were assessed at baseline and at 1, 2, 4, and 8 weeks after the procedure. The VAS scores were significantly lower in the lidocaine plus TA group than in the lidocaine alone group at both 2 ($p < 0.001$) and 4 ($p < 0.001$) weeks after GNB. The alleviation of intense pain in the lidocaine plus TA group was sustained up to 2 weeks after the procedure, in accordance with the definition of a minimal clinically important improvement. Although a similar inter-group difference in OKSs was observed at 4 weeks ($p < 0.001$), the clinical improvement in functional capacity lasted for only 1 week after the re-assessment of OKSs, in accordance with a minimal important change. No patient reported any post-procedural AEs during the follow-up period. The authors concluded that US-guided GNB, when combined with a local anesthetic and corticosteroid, could provide short-term pain relief. However, the clinical benefit of corticosteroid administration was unclear in comparison with local anesthesia alone. Given the potential adverse effects, corticosteroids might not be appropriate as adjuvants during a GNB for chronic knee OA. The authors stated that the drawbacks of this study included that the emotional state of the patients, which might affect the perception of knee pain, was not evaluated. The follow-up period was 2 months, which might be insufficient to validate the short-term effects of GNB.

Kim et al (2019) stated that recently, GNB and RFA were introduced to alleviate knee pain in patients with chronic knee OA. Both US- and fluoroscopy-guided GNBs have been used; however, whether one is superior to the other remains unknown. In a prospective RCT, these investigators compared the effectiveness of US- versus fluoroscopy-guided GNBs. From July 2015 to September 2017, a RCT was carried out to analyze the difference in the effectiveness of US- versus fluoroscopy-guided GNBs. The NRS-11, WOMAC, GPES, and complications were evaluated pre-procedure, and 1 and 3 months after GNB. A total of 80 patients were enrolled and randomly distributed to groups U (US-guided, n = 40) and F (fluoroscopy-guided, n = 40). Those who were lost to follow-up or had undergone other interventions were excluded, resulting in 31 and 30 patients in groups U and F, respectively. No differences in NRS-11 or WOMAC were observed between the 2 groups at baseline or during the follow-up period. GPES and complication rates were also similar between both groups. The authors concluded that pain relief, functional improvement, and safety were similar between groups receiving US- and fluoroscopy-guided GNBs; thus, either of the 2 imaging devices may be employed during a GNB for chronic knee pain relief. However, considering radiation exposure, US guidance may be superior to fluoroscopic guidance. It is also unclear whether there were overlapping of patients of this study with that of their 2018 study.

These investigators stated that this study had 2 main drawbacks. First, these researchers were unable to carry out double-blind randomization because of budget and personnel limitations. Given that the only pain physician was one of investigators, he could not be blinded to the type of intervention, which may constitute a confounding bias. Second, these investigators were unable to examine the patients' baseline emotional states. Subjective affect might have influenced the perception of pain severity and functional outcomes following the intervention. However, considering their exclusion of patients with neurological or psychiatric disorders during study enrollment, the authors believed that emotional factors had minimal effects on these findings.

Ragab et al (2021) noted that chronic knee OA is a frequent disease among the elderly. Intra-articular corticosteroid injection (IACSI) was commonly adopted to alleviate knee OA-related pains. Recently, GNB has emerged as a new alternative technique. These investigators examined the effectiveness of these 2 approaches when guided with US, and determined which one would offer better results. This study included 40 patients with painful chronic knee OA (9 men and 31 women, age ranged from 44 to 65 years) and were randomly assigned to 2 equal groups. Groups 1 was managed with US-guided IACSI and group 2 with US-guided GNB using a mixture of lidocaine and triamcinolone acetonide. The baseline mean VAS and OKS for the group 1 were 87.10 and 51.3, while for group 2 were 87.75 and 53.25, respectively. Follow-up values were obtained at 2, 4 and 8 weeks using VAS and OKS. The VAS score and OKS score were significantly lower in the GNB group and IACSI group at 2, and 4 weeks after the procedure ($p < 0.001$ for all), then returned near baseline values at 8 weeks. When the 2 groups were compared according to changes in VAS and OKS from baseline at 2, 4, and 8 weeks, GNB group showed significant alleviation of pain (mean reduction of 58.5, 53.3, and 9.25 points at 2, 4, and 8 weeks versus 44.9, 39.4, and 5.6 points at the IACSI groups, $p < 0.001$ at 2 and 4 weeks, $p < 0.006$ at 8 weeks). Similarly at the OKS, the GNB group showed significantly better results (33.50, 28.60, and 8.5 at GNB and 26.45, 20.10, 5.25 at IACSI. $p < 0.001$ at all periods). The authors concluded that both GNB and IACSI were effective methods to relieve chronic knee OA-related pains. When compared to each other, GNB showed more significant pain relief and functional improvement than IACSI. Moreover, these researchers stated that comparative studies with larger populations are needed to validate these findings.

The authors stated that this study had several drawbacks. First; the included number of patients was still limited (n = 40) and this could have affected the power of statistics. Second, most of included patients had different educational levels and already suffered from different co-morbidities, this could alter their subjective perception to pain improvement. Moreover, a change in emotional status of the patient (notably when long time passes after the intervention) might definitely alter their perception to long-term beneficial results of such loco-regional treatments. Third; the study lacked a control group; thus, these researchers couldn’t evaluate the placebo effect especially in the first weeks after treatment. Finally; single operator conducted all the injections.

Tan et al (2022) stated that US-guided (ULSD-g) GNB using pharmacological agents for pain control in chronic knee OA are gaining in popularity; however, there lacks a systematic review to assess the ULSD techniques and pharmacological agents used during the intervention, and to examine the knee's function post-intervention. In a systematic review, these investigators examined the clinical characteristics of patients with chronic knee OA selected for ULSD-g GNB, described the various ULSD-g techniques and pharmacological agents used to target the genicular nerves, and evaluated the primary outcomes of pain and function. These researchers looked at patients with chronic knee OA with symptoms or disease features of at least 3 months and the use of ULSD guidance for GNB using either local anesthetic agents and/or corticosteroids or alcohol. Two major electronic databases (Medline/PubMed and Embase) were searched from their inception through August 2021, without language restriction. After removing duplicates, 2 reviewers independently reviewed the abstracts of 340 records; 9 of the 10 full texts that were reviewed were selected for inclusion. A 3rd reviewer was involved in resolving disagreements. Two reviewers extracted relevant information pertaining to study types, patient characteristics, intervention details, outcome measures, and adverse effects. This was followed by independent verification for accuracy. A total of 9 studies were included with a total of 280 patients who had symptoms or disease features of at least 3 months. The National Institute of Health (NIH)'s Study Quality Assessment Tools were used for quality appraisal, of which 8 studies were at least of fair quality. All studies involved targeted at least the superior medial, superior lateral, and inferior medial genicular nerves. ULSD techniques relied on bony, soft tissue, or peri-arterial landmarks; either local anesthetic agents and/or corticosteroids or alcohol were used in the injections. Follow-up intervals for pain and functional assessments were heterogeneous, ranging from 1 week to 6 months post-procedure. Sustained improvements in both pain and knee function were observed for up to 6 months regardless of the choice of pharmacological agents. Minimal adverse effects were reported. The authors concluded that there is fair evidence to at least target the superior medial genicular nerve, inferior medial genicular nerve, and Inferior medial genicular nerve using local anesthetics, corticosteroids, or alcohol to reduce pain and to improve knee function in patients with chronic knee OA under ULSD guidance. These researchers stated that the procedure was safe; however, more research is needed to determine the optimal interventional approach.

The authors stated that this review had 2 main drawbacks. First, meta-analysis was not carried out due to heterogeneity of study designs, ULSD techniques, pharmacological agents used, and dosages administered. Second, only 1 study targeted additional genicular nerves; conclusions regarding the therapeutic blockade of these nerves could not be made.

Combined Infraclavicular-Suprascapular Blocks for Shoulder Surgery

Tran and colleagues (2017) noted that shoulder surgery can result in significant post-operative pain. Interscalene brachial plexus blocks (ISBs) constitute the current criterion standard for analgesia but may be contraindicated in patients with pulmonary pathology due to the inherent risk of phrenic nerve block and symptomatic hemi-diaphragmatic paralysis. Although US-guided ISB with small volumes (5 ml), dilute local anesthetic (LA) concentrations, and LA injection 4 mm lateral to the brachial plexus have been shown to reduce the risk of phrenic nerve block, no single intervention can decrease its incidence below 20 %. Ultrasound-guided supraclavicular blocks with LA injection postero-lateral to the brachial plexus may anesthetize the shoulder without incidental diaphragmatic dysfunction, but further confirmatory clinical trials are needed. Ultrasound-guided C7 root blocks also appeared to offer an attractive, diaphragm-sparing alternative to ISB. However, additional large-scale studies are needed to confirm their effectiveness and to quantify the risk of peri-foraminal vascular breach. Combined axillary-suprascapular nerve blocks may provide adequate post-operative analgesia for minor shoulder surgery but do not compare favorably to ISB for major surgical procedures. One intriguing solution lies in the combined use of infraclavicular brachial plexus blocks and suprascapular nerve blocks. Theoretically, the infraclavicular approach targets the posterior and lateral cords, thus anesthetizing the axillary nerve that supplies the anterior and posterior shoulder joint, as well as the subscapular and lateral pectoral nerves (both of which supply the anterior shoulder joint), whereas the suprascapular nerve block anesthetizes the posterior shoulder. The authors concluded that future randomized trials are needed to validate the effectiveness of combined infraclavicular-suprascapular blocks for shoulder surgery.

Intellicath (a Nerve-Blocking Device)

According to Endometriosis News, there is a new approach to treating chronic pelvic pain (CPP) that aims to block pain at its source in the nervous system, rather than through the use of conventional oral medications or creams. The approach targets the plexus of nerves connected with a pain area. This treatment consists of blocks directed to the plexus of nerves that serve the area, or a short-term, continuous block, lasting up to 10 days. The method supposedly leads to long-term relief, and uses Intellicath, the proprietary, patent-pending device.

Stellate Ganglion Block for Ulcerative Colitis

Zhao and colleagues (2017) examined the safety and effectiveness of stellate ganglion block for the treatment of patients with chronic ulcerative colitis (UC). A total of 120 randomly selected patients with chronic UC treated from January 2014 to January 2016 were included in this study. These patients were divided into 2 groups: (i) control group (n = 30), patients received oral sulfasalazine treatment; and (ii) experimental group (n = 90), patients received stellate ganglion block treatment. Clinical symptoms and disease activity in these 2 groups were compared before and after treatment using endoscopy. Blood was collected from patients on day 0, 10, 20 and 30 after treatment. Enzyme-linked immunosorbent assay (ELISA) was performed to determine interleukin-8 (IL-8) level. The changes in IL-8 level post-treatment in the 2 groups were compared using repeated measures analysis of variance. After treatment, clinical symptoms and disease activity were shown to be alleviated by endoscopy in both the control and experimental groups. However, patients in the control group did not have obvious abdominal pain relief. In addition, the degree of pain relief in the experimental group was statistically better than that in the control group ($p < 0.05$). Ten days after treatment, IL-8 level was found to be significantly lower in the experimental group than in the control group, and the difference was statistically significant ($p < 0.05$). In addition, AEs were significantly higher in the control group than in the experimental group, and the difference was statistically significant ($\chi2 = 33.215$, $p = 0.000$). The authors concluded that the application of stellate ganglion block is a new method for treating chronic UC – it relieved clinical symptoms in patients, reduced the level of inflammatory factors, and also had a positive impact on the disease to a certain extent. The authors stated that this study had several drawbacks – small sample size was small, and IL-8 levels in patients included into this study were not compared with healthy subjects. Thus, further studies with a larger sample size are needed.

Superior Hypogastric Nerve Block

Elkins and associates (2017) stated that pelvic neuralgias frequently cause severe pain and may have associated bladder, bowel, or sexual dysfunctions that also impact QOL. These researchers examined the etiology, epidemiology, presentation and treatment of common causes of neurogenic pelvic pain, including neuralgia of the border nerves (ilio-inguinal, ilio-hypogastric, and genito-femoral), pudendal neuralgia, clunealgia, sacral radiculopathies caused by Tarlov cysts, and cauda equina syndrome. Treatment of pelvic neuralgia includes conservative measures (e.g., lifestyle modification, pelvic physical therapy, and medications) with escalation to more invasive and novel treatments (e.g., cryoablation, nerve blocks, radiofrequency ablation, neuromodulation and neurectomy/neurolysis) if conservative treatments are ineffective.

In a randomized, double-blind, placebo-controlled, clinical trial, Rapp and colleagues (2017) examined if superior hypogastric plexus block performed during abdominal hysterectomy decreases post-operative opioid consumption and pain. A total of 68 women scheduled for total abdominal hysterectomy for a benign indication were included in this study; 20 ml of ropivacaine 7.5 mg/ml or saline was injected retro-peritoneally in the area of the superior hypogastric plexus during the hysterectomy. Subjects were individually randomized to either intervention; subjects, caregivers, and those assessing the outcomes were blinded to group assignment. The primary outcomes were post-operative opiate consumption and patients' self-assessment of pain (VAS scores); secondary outcomes were mobilization and side effects related to opiate consumption. The trial was completed with 38 women randomized to ropivacaine and 37 women randomized to saline. Analysis was performed on 35 women in the ropivaciane group and 33 women in the saline group. The post-operative opioid consumption was significantly lower in the ropivacaine group than in the placebo group (median of 55.8 and 72.4 mg, respectively, p = 0.032). The proportion of women scoring VAS less than 4 at 2 hours after block was significantly higher in the ropivacaine group (63 %) than in the placebo group (25 %) (p = 0.015). No side effects or important AEs occurred during the trial. The authors concluded that superior hypogastric plexus block is a new method in this context and a promising contribution to post-operative pain treatment following abdominal hysterectomy.

Suprascapular Nerve Block for Hemiplegic Shoulder Pain in Individuals with Chronic Stroke

In a pilot study, Jeon and associates (2014) evaluated the relative effectiveness of 3 injections methods: (i) suprascapular nerve block (SSNB) alone, (ii) intra-articular steroid injection (IAI) alone, and (iii) SSNB + IAI on relief of hemiplegic shoulder pain. These researchers recruited 30 patients with hemiplegic shoulder pain after stroke; SSNB was performed in 10 patients, IAI in 10 patients, and a combination of 2 injections in 10 patients; all were Us-guided. Each patient's maximum passive range of motion (ROM) in the shoulder was measured, and the pain intensity level was assessed with a VAS. Repeated measures were performed on pre-injection, and after injection at 1 hour, 1 week, and 1 month. Data were analyzed by Kruskal-Wallis and Friedman tests. All variables that were repeatedly measured showed significant differences in shoulder ROM with time ($p < 0.05$), but there was no difference according injection method. In addition, VAS was statistically significantly different with time, but there was no difference by injection method. Pain significantly decreased until a week after injection, but pain after a month was relatively increased. However, pain was decreased compared to pre-injection. The authors concluded that the 3 injection methods significantly improved shoulder ROM and pain with time, but no statistically significant difference was found between them.

The authors stated that the main drawbacks of this pilot study included small number of subjects (n = 10 in each group), lack of control group, and short (4-week) follow-up, and lack of control of neurodevelopmental therapy for hemiplegic patients. They stated that these limitations prevented an absolute determination of the effects of injection; broader and long-term follow-up studies are needed.

In a pilot study, Picelli and colleagues (2017) evaluated the effects of suprascapular nerve block on pain intensity, spasticity, shoulder passive ROM, and QOL in chronic stroke patients with hemiplegic shoulder pain. A total of 10 chronic stroke patients (over 2 years from onset) with hemiplegic shoulder pain graded greater than or equal to 30 mm on the VAS underwent suprascapular nerve block injection with 1 ml of 40 mg/ml methylprednisolone and 10 ml 0.5 % bupivacaine hydrochloride. Main outcome was the VAS evaluated before and after nerve block at 1 hour, 1 week, and 1 month. Secondary outcomes were the modified Ashworth scale and the shoulder elevation, abduction, and external rotation passive ROM evaluated before the nerve block and after 1 hour as well as the American Chronic Pain Association QOL Scale evaluated before and after nerve block at 1 month. The VAS significantly improved after nerve block at 1 hour ($p = 0.005$) and 1 week ($p = 0.011$). Significant improvements were found at 1 hour after nerve block in the modified Ashworth scale ($p = 0.014$) and the passive ROM of shoulder abduction ($p = 0.026$), flexion ($p = 0.007$), and external rotation ($p = 0.017$). The American Chronic Pain Association QOL Scale significantly improved at 1 month after nerve block ($p = 0.046$). The authors concluded that the findings of this pilot study supported the use of suprascapular nerve block for treating hemiplegic shoulder pain in chronic stroke patients. These preliminary findings need to be validated by well-designed studies.

Occipital Nerve Block for the Treatment of Occipital Neuralgia

Tobin and Flitman (2009) stated that occipital nerve block (ONB) is a promising treatment for headaches; however, its indications, selection criteria, and best techniques are unclear. These investigators summarized in narrative format what is known about ONBs and what needs to be learned. MD Consult and Google Scholar were searched using the terms occipital, suboccipital, block, and injection to identify relevant articles that were reviewed. This process was repeated for all additional pertinent articles identified from these articles, and so on, until no additional articles were identified. A total of 21 articles were identified. The authors concluded that ONB is an effective treatment for cervicogenic headache, cluster headache, and occipital neuralgia. While a randomized, double-blinded, placebo-controlled clinical trial is lacking, multiple open label studies reported favorable results for migraine. Two other possible uses of ONB worthy of further study are: (i) as a rescue treatment and (ii) as an adjunctive treatment for medication over-use headache. ONB may be effective for tension headache, but only under very specific circumstances. ONB is either ineffective or only effective under as yet unstudied circumstances for hemicrania continua and chronic paroxysmal hemicrania. Some practitioners use occipital nerve (ON) tenderness to palpation (TTP) or reproduction of headache pain with ON pressure (RHPONP) as selection criteria for identifying appropriate patients. While only a clinical trial can produce a definitive answer, current evidence suggested that these selection criteria are not necessary for cervicogenic headache or cluster headache. Occipital neuralgia by definition involves TTP of the ONs. Whether RHPONP or ON TTP predicts success in migraine is unclear, and may relate to whether steroids are used. A single blinded randomized controlled trial evaluating local anesthetic with steroids versus local anesthetic alone for transformed migraine reported slightly worse results with steroids, but there are several alternate explanations for this finding other than steroids being counterproductive. The technique of repetitive ONBs deserves further study. This review did not provide specific data to support the use of ONB for the treatment of occipital neuralgia.

Dach et al (2015) noted that several studies have presented evidence that blocking peripheral nerves is effective for the treatment of some headaches and cranial neuralgias, resulting in reduction of the frequency, intensity, and duration of pain. These investigators described the role of nerve block in the treatment of headaches and cranial neuralgias, and the experience of a tertiary headache center regarding this issue. They also reported the anatomical landmarks, techniques, materials used, contra-indications, and side effects of peripheral nerve block, as well as the mechanisms of action of lidocaine and dexamethasone. The authors concluded that the nerve block can be used in primary (migraine, cluster headache, and nummular headache) and secondary headaches (cervicogenic headache and headache attributed to craniotomy), as well as in cranial neuralgias (trigeminal neuropathies, glossopharyngeal and occipital neuralgias). In some of them this procedure is necessary for both diagnosis and treatment, while in others it is an adjuvant treatment.

The block of the greater occipital nerve with an anesthetic and corticosteroid compound has proved to be effective in the treatment of cluster headache. Regarding the treatment of other headaches and cranial neuralgias, controlled studies are still needed to clarify the real role of peripheral nerve block (PNB).

Hascalovici and Robbins (2017) provided demographical and clinical descriptions of patients aged 65 years old and older who were treated with PNBs for headache at the authors' institution and evaluated the safety and efficacy of this treatment. These researchers performed a retrospective, single-center, chart review of patients at least 65 years of age who received PNBs over a 6-year period. A total of 64 patients were mostly women (78 %) with an average age of 71 years (range of 65 to 94). Representative headache diagnoses were chronic migraine 50 %, episodic migraine 12.5 %, trigeminal autonomic cephalalgia 9.4 %, and occipital neuralgia 7.8 % (n = 5). Average number of headache days/month was 23. Common co-morbidities were hypertension 48 %, hyperlipidemia 42 %, arthritis 27 %, depression 47 %, and anxiety 33 %; 89 % were prescribed at least 1 medication fulfilling the Beers criteria. The average number of PNBs per patient was 4; PNBs were felt to be effective in 73 % for all headaches, 81 % for chronic migraine, 75 % for episodic migraine, 67 % for chronic tension type headache, 67 % for new daily persistent headache, and 60 % for occipital neuralgia. There were no adverse events (AEs) related to PNBs reported. The authors concluded that PNBs might be a safe and effective alternative headache management strategy for older adults. Medical and psychiatric co-morbidities, medication over-use, and Beers list medication rates were extraordinarily high, giving credence to the use of peripherally administered therapies in the geriatric population that may be better tolerated and safer.

In a prospective, open-label study, Pingree et al (2017) investigated the analgesic effects of an ultrasound (US)-guided greater occipital nerve (GON) block at the level of C2, as the nerve courses superficially to the obliquus capitis inferior muscle. Patients with a diagnosis of occipital neuralgia or cervicogenic headache were recruited for the study. Ultrasound-guided GON blocks at the level of C2 were performed by experienced clinicians according to a standardized protocol. Numeric rating scale pain scores were recorded pre-injection and at 30 minutes, 2 weeks, and 4 weeks after injection. A total of 14 injections were performed with a mean procedure time of 3.75 minutes. Anesthesia in the GON distribution was achieved for 86 % of patients at 30 minutes post-injection. Compared with baseline, numeric rating scale scores decreased by a mean of 3.78 at 30 minutes ($p < 0.001$), 2.64 at 2 weeks ($p = 0.006$), and 2.21 at 4 weeks ($p = 0.01$). There were no significant AEs reported during the study period. The authors concluded that this prospective, open-label study demonstrated successful blockade of the GON at the level of C2 using a novel US-guided technique. Significant reductions in pain scores were observed over the 4-week study period, and no AEs were reported. They stated that the results of this study provided important preliminary data for future randomized trials involving patients with occipital neuralgia and cervicogenic headache.

Spinal Accessory Neve Block for the Treatment of Neck Pain and Upper Back Pain

Taguchi et al (2000) described the radiologic anatomy for selective medial branch block for low back pain (LBP) resulting from facet joints. A groove between the mammillary process and the accessory process (M-A groove) was chosen as the target point for this nerve block. The position of M-A groove was constant on X-rays at each level of the lumbar spine. Confirming this position under the fluoroscope, the medial branch nerves can be blocked selectively. The authors concluded that this method clarified the features of LBP related to the medial branch.

Townsley et al (2011) reported the 1st description of ultrasound (US)-guided spinal accessory nerve blockade using single-shot and subsequently continuous infusion (via a peri-neural catheter) local anesthetic techniques, for the diagnosis and treatment of myofascial pain affecting the trapezius muscle. A 38-year old man presented with a 2-year history of incapacitating left suprascapular pain after a fall onto his out-stretched hand. The history and clinical examination was suggestive of myofascial pain affecting the trapezius muscle. This had been unresponsive to pharmacological therapy, physiotherapy or suprascapular nerve blockade. Following identification of the spinal accessory nerve in the posterior triangle of the neck, these investigators performed US-guided nerve blocks, first using a single injection of local anesthetic and subsequently using a continuous infusion via a peri-neural catheter, to block the nerve and temporarily relieve the patient's pain. The authors demonstrated that the spinal accessory nerve is identifiable in the posterior triangle of the neck and can be blocked successfully using US guidance. They stated that this technique can aid the diagnosis and treatment of myofascial pain originating from the trapezius muscle.

There is currently insufficient evidence to support the use of spinal accessory neve block for treatment of neck pain and upper back pain.

Ultrasound-Guided Erector Spinae Plane (ESP) Block for the Management of Post-Operative Pain

Restrepo-Garces et al (2017) noted that the erector spinae plane (ESP) block is a regional anesthetic technique involving local anesthetic injection in a para-spinal plane deep to the erector spinae muscle. Originally described for thoracic analgesia when performed at the T5 transverse process, the ESP block can provide abdominal analgesia if performed at lower thoracic levels because the erector spinae muscles extend to the lumbar spine. A catheter inserted into this plane can extend analgesic duration and can be an alternative to epidural analgesia. In this case-report, these investigators described using bilateral ESP catheters inserted at the T8 level to provide effective peri-operative analgesia for major open lower abdominal surgery.

Forero et al (2017) stated that post thoracotomy pain syndrome (PTPS) remains a common complication of thoracic surgery with significant impact on patients' quality of life (QOL). Management usually involves a multi-disciplinary approach that includes oral and topical analgesics, performing appropriate interventional techniques, and coordinating additional care such as physiotherapy, psychotherapy and rehabilitation. A variety of interventional procedures have been described to treat PTPS that is inadequately managed with systemic or topical analgesics. Most of these procedures are technically complex and are associated with risks and complications due to the proximity of the targets to neuraxial structures and pleura. The ultrasound (US)-guided ESP block is a novel technique for thoracic analgesia that promises to be a relatively simple and safe alternative to more complex and invasive techniques of neural blockade. These researchers examined the application of the ESP block in the management of PTPS and reported their preliminary experience to illustrate its therapeutic potential. The ESP block was performed in a pain clinic setting in a cohort of 7 patients with PTPS following thoracic surgery with lobectomy or pneumonectomy for lung cancer. The blocks were performed with US guidance by injecting 20 to 30 ml of ropivacaine, with or without steroid, into a fascial plane between the deep surface of erector spinae muscle and the transverse processes of the thoracic vertebrae. This para-spinal tissue plane is distant from the pleura and the neuraxis, thus minimizing the risk of complications associated with injury to these structures. The patients were followed-up by telephone 1 week after each block and reviewed in the clinic 4 to 6 weeks later to evaluate the analgesic response as well as the need for further injections and modification to the overall analgesic plan. All the patients had excellent immediate pain relief following each ESP block, and 4 out of the 7 patients experienced prolonged analgesic benefit lasting 2 weeks or more. The ESP blocks were combined with optimization of multi-modal analgesia, resulting in significant improvement in the pain experience in all patients. No complications related to the blocks were seen. The authors concluded that these findings observed in this case series indicated that the ESP block may be a valuable therapeutic option in the management of PTPS. Its immediate analgesic efficacy provided patients with temporary symptomatic relief while other aspects of chronic pain management were optimized, and it may also often confer prolonged analgesia. Moreover, these researchers stated that further studies are needed to validate these findings. This was a small (n = 7) study; and its findings were confounded by the use of multi-modal analgesia.

Yamak Altinpulluk et al (2018) noted that effective post-operative analgesia after emergency caesarean section is important because it provides early recovery, ambulation and breast-feeding. The US-guided ESP block has been originally described for providing thoracic analgesia at the T5 transverse process by Forero et al (2017). These investigators performed post-operative bilateral ESP blocks with 20 ml bupivacaine 0.25 % at the level of the T9 transverse process in a pregnant woman after caesarean section. In this report, the authors described that bilateral ESP block at T9 level provided effective and long-lasting post-operative analgesia for lower abdominal surgery. This was a single-case study.

Melvin et al (2018) stated that severe post-operative pain following spine surgery is a significant cause of morbidity, extended length of facility stay, and marked opioid usage. The ESP block anesthetizes the dorsal rami of spinal nerves that innervate the para-spinal muscles and bony vertebra. These investigators described the use of low thoracic ESP blocks as part of multi-modal analgesia in lumbosacral spine surgery. They performed bilateral ESP blocks at the T10 or T12 level in 6 cases of lumbo-sacral spine surgery: 3 lumbar decompressions, 2 sacral laminoplasties, and 1 coccygectomy. Following induction of general anesthesia, single-injection ESP blocks were performed in 3 patients while bilateral continuous ESP block catheters were placed in the remaining 3. All 6 patients had minimal post-operative pain and very low post-operative opioid requirements. There was no discernible motor or sensory block in any of the cases and no interference with intra-operative somatosensory evoked potential (SSEP) monitoring used in 2 of the cases. The authors concluded that the ESP block could contribute significantly to a peri-operative multi-modal opioid-sparing analgesic regimen and enhance recovery after lumbo-sacral spine surgery. This was a small (n = 6) study; and its findings were confounded by the use of multi-modal analgesia.

In a prospective, single-blinded, randomized, controlled clinical trial, Tulgar et al (2018) evaluated the effectiveness of ESP block (ESPB) for post-operative analgesia management in laparoscopic cholecystectomy (LC). A total of 36 patients (ASA I-II) were recruited in 2 equal groups (block and control group). Following exclusion, 30 patients were included in final analysis. Standard multi-modal analgesia was performed in Group C (control) while ESPB block was also performed in Group B (block). Pain intensity between groups were compared using Numeric Rating Scores (NRS). Also, tramadol consumption and additional rescue analgesic requirement were measured. NRS was lower in Group B during the first 3 hours. There was no difference in NRS scores at other hours. Tramadol consumption was lower in Group B during the first 12 hours. Less rescue analgesia was required in Group (?????) The authors concluded that bilateral US-guided ESPB led to effective analgesia and a decrease in analgesia requirement in first 12 hours in patients undergoing LC. This was a small study (total of 30 subjects) and its findings were confounded by the use of multi-modal analgesia.

In a single-blinded, randomized controlled study, Gurkan et al (2018) evaluated the analgesic effect of US-guided ESP block in breast cancer surgery. A total of 50 ASA I-II patients aged 25 to 65 years and scheduled for elective breast cancer surgery were included in the study. Patients were randomized into 2 groups, ESP and control. Single-shot US-guided ESP block with 20 ml 0.25 % bupivacaine at the T4 vertebral level was performed pre-operatively to all patients in the ESP group. The control group received no intervention. Patients in both groups were provided with intravenous patient-controlled analgesia device containing morphine for post-operative analgesia. Morphine consumption and NRS pain scores were recorded at 1, 6, 12 and 24 hours post-operatively. Morphine consumption at post-operative hours 1, 6, 12 and 24 decreased significantly in the ESP group ($p < 0.05$ for each time interval). Total morphine consumption decreased by 65 % at 24 hours compared to the control group (5.76 ± 3.8 mg versus 16.6 ± 6.92 mg). There was no statistically significant difference between the groups in terms of NRS scores. The authors concluded that these findings showed that US-guided ESP block exhibited a significant analgesic effect in patients undergoing breast cancer surgery. Moreover, they stated that further studies comparing different regional anesthesia techniques are needed to identify the optimal analgesia technique for this group of patients. The findings of this study were also confounded by the use of patient-controlled analgesia devices.

Hannig et al (2018) noted that post-operative pain after laparoscopic cholecystectomy can be severe. Despite multi-modal analgesia regimes, administration of high doses of opioids is often necessary. This can further lead to several adverse effects such as drowsiness and respiratory impairment as well as post-operative nausea and vomiting (PONV). This will hinder early mobilization and discharge of the patient from the day surgery setting and is sub-optimal in an early recovery after surgery setting. The ultrasound-guided Erector Spinae Plane (ESP) block is a novel truncal inter-fascial block technique providing analgesia of the thoracic or abdominal segmental innervation depending on the level of administration. Local anesthetic penetrates anteriorly presumably through the costotransverse foramina to the paravertebral space. These researchers demonstrated the analgesic efficacy of the ESP block in a case series of 3 patients scheduled for ambulatory laparoscopic cholecystectomy. They stated that these findings must be validated in future randomized controlled trials (RCTs).

The authors stated that there are several unanswered questions to address. First, the ESP block has so far only been described in case reports, and the promising results must be validated in future RCTs. Second, the optimal time for block placement should be considered. In general, this is the best achieved pre-operatively in the awake patient. About 3/4 of the patients experienced moderate-to-severe pain some time during the post-operative period. Aminority of the patients experienced excruciating pain. Third, optimal volume and concentration of local anesthetic are unknown. Previous authors have mainly used ropivacaine 0.5 % 20 ml providing analgesia for about 20 hours reducing opioid consumption to about 1/3]. A similar reduction from the expected opioid usage was observed in this 3 cases. The opioid sparing potential may be especially advantageous in the ambulatory setting, where pain and/or PONV may delay or even prevent same-day discharge. Lastly, additives like glucocorticoids can be considered, which presumably would extend block duration beyond 24 hours.

In a prospective, single-center, single-blinded, randomized controlled trial (RCT), Krishna et al (2019) examined the analgesic efficacy of bilateral ESP block compared with conventional treatment for pain after cardiac surgery in adult patients. A total of 106 patients undergoing elective cardiac surgery with cardiopulmonary bypass were included in this study. Patients were randomized into 2 groups. Patients in group 1 (ESP block group, n = 53) received US-guided bilateral ESP block with 3 mg/kg of 0.375 % ropivacaine before anesthesia induction at the T6 transverse process level. Patients in group 2 (paracetamol and tramadol group, n = 53) received paracetamol (1 gm every 6 hours) and tramadol (50 mg every 8 hours) intravenously in the post-operative period. The primary study outcome was to evaluate pain at rest using an 11-point NRS. Mann-Whitney U test was used for comparing NRS scores. The post-operative pain level after extubation and duration of analgesia during which NRS was less than 4 of 10 was compared between the groups. The median pain score at rest after extubation in group 1 was 0 of 10 until hour 6, 3 of 10 at hour 8, and 4 of 10 at hours 10 and 12 post-extubation. These were significantly less in comparison with group 2 (p = 0.0001).

Patients in group 1 had a significantly higher mean duration of analgesia (8.98 ± 0.14 hours), during which NRS was less than 4 of 10, compared with group 2 (4.60 ± 0.12 hours) (p = 0.0001). The authors concluded that ESP block safely provided significantly better pain relief at rest for longer duration as compared to intravenous paracetamol and tramadol.

Ultrasound-Guided Celiac Plexus Block

An UpToDate review on "Endoscopic ultrasound-guided celiac plexus and ganglia interventions" (Levy and Wiersema, 2019) states that "Pain relief lasting for up to 24 weeks has been observed in approximately 70 % of patients. Initial studies also suggest that EUS-CPB may also have a role in the treatment of pain related to chronic pancreatitis. However, its role is still being defined and randomized controlled studies as have been performed for pancreas cancer are lacking. Initial data suggest that in patients with moderate-to-severe pain secondary to pancreatic cancer or chronic pancreatitis, direct celiac ganglia injection is safe and effective in initial pain management. Prospective, controlled, and comparative trials are needed to confirm the safety and assess the long-term efficacy of this approach to pain management compared with conventional techniques. Until then, this approach cannot be recommended for routine practice".

IPACK Block for Pain Control Following Anterior Cruciate Ligament Repair / Total Knee Arthroplasty

Thobhani et al (2017) stated that novel regional techniques, including the adductor canal block (ACB) and the local anesthetic infiltration between the popliteal artery and capsule of the knee (IPACK) block, provide an alternative approach for controlling pain following TKA. This study compared 3 regional techniques (femoral nerve catheter [FNC] block alone, FNC block with IPACK, and ACB with IPACK) on pain scores, opioid consumption, performance during physical therapy, and hospital length of stay (LOS) in patients undergoing TKA. All patients had a continuous peri-neural infusion, either FNC block or ACB. Patients in the IPACK block groups also received a single injection 30-ml IPACK block of 0.25% ropivacaine. Pain scores and opioid consumption were recorded at post-anesthesia care unit (PACU) discharge and again at 8-hour intervals for 48 hours. Physical therapy performance was measured on post-operative days (POD) 1 and 2, and hospital LOS was recorded.

These researchers found no significant differences in the 3 groups with regard to baseline patient demographics. Although these investigators observed no differences in pain scores between the 3 groups, opioid consumption was significantly reduced in the FNC with IPACK group. Physical therapy performance was significantly better on POD 1 in the ACB with IPACK group compared to the other 2 groups. Hospital LOS was significantly shorter in the ACB with IPACK group. The authors concluded that the findings of this study demonstrated that an IPACK block reduced opioid consumption by providing effective supplemental analgesia following TKA compared to the FNC-only technique; ACB with IPACK provided equivalent analgesia and improved physical therapy performance, allowing earlier hospital discharge.

The authors stated that this study had several drawbacks. Because these investigators identified no patients who would fit the criteria to receive ACB only during the study period, this study lacked a group that received ACB only, which would allow better analysis of the contribution of the IPACK block to an ACB. Because the ACB has gained attention by providing adequate analgesia to the anterior knee while minimizing motor impairment, addition of the IPACK block could improve posterior knee analgesia without sacrificing distal motor and sensory impairment. Comparing ACB only to ACB with IPACK block should be a goal for future research. Nevertheless, no prior publications had described the effects of the IPACK block for addressing posterior knee pain following TKA, and thus the opioid-sparing effect of the IPACK block when combined with the FNC block is a novel finding. Retrospective studies may suffer from assignment bias, possibly resulting in baseline differences between groups. However, the consecutive enrollment of patients in this study may have limited selection bias. In addition, this trial was a descriptive study of the benefits of a novel approach to regional analgesia for a common surgical procedure. An investigator needs to know a clinical delta, the difference in expectation that one regional technique provides compared to another technique, to calculate sample size. Because of the novel approach of this study, such information was not available, so this study could suffer from assignment bias. However, a strength of this study is that it allowed other investigator groups to validate these findings, and when needed, to use these findings to calculate a clinical delta for the appropriate sample size needed for a prospective randomized controlled trial.

Sankineani et al (2018) noted that ACB is a peripheral nerve blockade technique that provides good pain control in patients undergoing TKA, which however does not relieve posterior knee pain. The recent technique of an ultrasound (US)-guided local anesthetic infiltration of the interspace between popliteal artery and the capsule of posterior knee (IPACK) has shown promising results in providing significant posterior knee analgesia without affecting the motor nerves. These researchers carried out a prospective study from September 2016 to March 2017 in 120 patients undergoing unilateral TKA. The initial 60 consecutive patients received ACB + IPACK (Group 1, n = 60), and the subsequent 60 patients received ACB alone (Group 2, n = 60). All patients were evaluated with visual analog scale (VAS) score for pain recorded at 8 hours, POD 1 and POD 2 after the surgery. The secondary outcome measures assessed were the range of movement (ROM) and ambulation distance. VAS score showed significantly ($p < 0.005$) better values in ACB + IPACK group compared to the ACB group. The mean ROM of knee and ambulation distance also showed significantly better values in ACB + IPACK group compared to the ACB group. The authors concluded that ACB + IPACK is a promising technique that offered improved pain management in the immediate post-operative period without affecting the motor function around the knee joint resulting in better ROM and ambulation compared to ACB alone. This was a relatively small study (n = 60 in the ACB + IPACK group); and its findings were confounded by the combined use of ACB and IPACK.

Kim et al (2019) stated that peri-articular injections (PAIs) are becoming a staple component of multi-modal joint pathways. Motor-sparing peripheral nerve blocks, such as the infiltration between the popliteal artery and capsule of the posterior knee (IPACK) and the ACB, may augment PAI in multi-modal analgesic pathways for TKA, but supporting literature remains rare. These researchers hypothesized that the addition of ACB and IPACK to PAI would lower pain on ambulation on POD 1 compared to PAI alone. This triple-blinded, randomized-controlled trial included 86 patients undergoing unilateral TKA. Patients either received (i) a PAI (control group, n = 43) or (ii) an IPACK with an ACB and modified PAI (intervention group, n = 43). The primary outcome was pain on ambulation on POD 1; secondary outcomes included numeric rating scale (NRS) pain scores, patient satisfaction, and opioid consumption. The intervention group reported significantly lower NRS pain scores on ambulation than the control group on POD 1 (difference in means [95 % confidence interval (CI)]: -3.3 [-4.0 to -2.7]; $p < 0.001$). In addition, NRS pain scores on ambulation on POD 0 (-3.5 [-4.3 to -2.7]; $p < 0.001$) and POD 2 (-1.0 [-1.9 to -0.1]; $p = 0.033$) were significantly lower. Patients in the intervention group were more satisfied, had less opioid consumption ($p = 0.005$, post-anesthesia care unit, $p = 0.028$, POD 0), less intravenous opioids ($p < 0.001$), and reduced need for intravenous patient-controlled analgesia ($p = 0.037$). The authors concluded that the addition of IPACK and ACB to PAI significantly improved analgesia and reduced opioid consumption after TKA compared to PAI alone. They stated that this study strongly supported IPACK and ACB use within a multi-modal analgesic pathway. This was a relatively small study (n = 43 in the ACB + IPACK + PAI group); and its findings were confounded by the combined use of ACB, IPACK and PAT.

Currently, there is a lack of evidence regarding the use of IPACK block following ACL repair.

Transversus Abdominis Plane (TAP) Block for Abdominal Surgery

Tsai and colleagues (2017) stated that transversus abdominis plane (TAP) block is a regional technique for analgesia of the antero-lateral abdominal wall. These investigators highlighted the nomenclature system and recent advances in TAP block techniques and proposed directions for future research. Ultrasound guidance is now considered the gold standard in TAP blocks. It is easy to acquire US images; it can be used in many surgeries involving the anterolateral abdominal wall. However, the efficacy of US-guided TAP blocks is not consistent, which might be due to the use of different approaches. The choice of technique influenced the involved area and block duration. To investigate the actual analgesic effects of TAP blocks, these researchers unified the nomenclature system and clarified the definition of each technique. Although a single-shot TAP block is limited in duration, it is still the candidate of the analgesic standard for abdominal wall surgery because the use of the catheter technique and liposomal bupivacaine may overcome this limitation.

Nerve Hydrodissection for Peripheral Nerve Entrapment

Nerve hydrodissection entails the injection of fluid (e.g., saline, dextrose water, or local anesthetic) through the nerve block needle to separate tissue planes, in order to maneuver the block needle to the desired target.

In a prospective, randomized, double-blinded, non-inferiority trial, Dufour et al (2012) tested the hypothesis that median nerve block effectiveness is not reduced when circumferential perineural hydrodissection with dextrose 5 % in water (D5W) preceded local anesthetic (LA) injection. Patients scheduled for hand surgery were randomized to receive an US-guided median nerve block at the elbow to achieve circumferential perineural spread with either 6-ml of D5W followed by 6-ml of LA (lidocaine 1.5 % with epinephrine 1:200,000) (D5W-LA group) or with 6-ml of LA alone (LA group). The primary outcome was onset time of successful anesthesia defined by a complete abolition of light touch sensation for the index finger. Data from 95 patients were analyzed: 43 in the D5W-LA group and 52 in the LA group. Non-inferiority tests were significant (all $p < 0.05$) for a critical limit of 7 mins between D5W-LA and LA groups for onset time of the primary criterion, light touch block at index finger (mean ± SD, respectively: 23.9 ± 7.4 and 22.0 ± 7.9 mins; 95 % confidence interval [CI]: -5.9 to 2.1 mins), and for cold block at index fingertip, sensory blocks at thenar eminence, and motor block. Success rate at 30 mins (defined as complete abolition for cold and light touch at index finger) was noted in 100 % and 98.1 % (95 % CI: -6 % to 10 %) and 95.2 % and 96.2 % (95 % CI: -13 % to 9 %) of patients for the D5W-LA and the LA groups. The authors concluded that performing an US-guided perineural circumferential hydrodissection with D5W into which LA was injected left nerve block outcome unchanged. The assumption that this procedure may reduce the risk of intra-vascular injection and systemic toxicity remains to be demonstrated.

Fader et al (2015) noted that symptomatic neuromas of the sural nerve are a rare but significant cause of pain and debilitation in athletes. Presentation is usually in the form of chronic pain and dysesthesias or paresthesia of the lateral foot and ankle. Treatment traditionally ranges from conservative measures, such as removing all external compressive forces, to administration of NSAIDs, vitamin B6, tricyclic antidepressants, antiepileptics, or topical anesthetics. These researchers reported a case of sural nerve entrapment in a 34-year old male triathlete with a history of recurrent training-induced right-sided gastrocnemius strains. The patient presented with numbness in the right lateral foot and ankle that had persisted for 3 months, after he was treated unsuccessfully with extensive non-operative measures, including anti-inflammatory drugs, activity modification, and a dedicated physical therapy program of stretching and strengthening. Orthopedic assessment showed worsening pain with forced passive dorsiflexion and manual pressure applied over the distal aspect of the gastrocnemius. Plain radiographs showed normal findings, but in-office US imaging showed evidence of sural nerve entrapment with edema and neuromatous scar formation in the absence of gastrocnemius or soleus pathology. Percutaneous US-guided hydrodissection of the sural nerve at the area of symptomatic neuroma and neural edema was performed the same day. The patient had complete relief of symptoms and full return to the pre-injury level of participation in competitive sports. The authors concluded that the findings of this case report showed that hydrodissection, when performed by an experienced physician, could be an effective, minimally invasive technique for neurolysis in the setting of sural nerve entrapment, resulting in improvement in clinical symptoms. This was a single-case study; its findings need to be validated by well-designed studies.

Cass (2016) stated that nerve hydrodissection is a technique used when treating peripheral nerve entrapments. It involves using an anesthetic or solution such as saline to separate the nerve from the surrounding tissue, fascia, or adjacent structures. The author concluded that there were no high-level studies to determine the need or effectiveness of hydrodissection or to establish its safety. Low-level studies showed some safety and effectiveness for the technique, but further research is needed.

Popliteal Block for Open Reduction Internal Fixation of Ankle Fracture

In a prospective randomized study, Goldstein et al (2012) compared post-operative pain control in patients treated surgically for ankle fractures who receive popliteal blocks with those who received general anesthesia alone. All patients being treated with open reduction internal fixation for ankle fractures who met inclusion criteria and consented to participate were enrolled. Patients were randomized to receive either general anesthesia (GETA) or intravenous sedation and popliteal block. Patients were assessed for duration of procedure, total time in the operating room, and post-operative pain at 2, 4, 8, 12, 24, and 48 hours after surgery using a VAS. A total of 51 patients agreed to participate in the study; 25 patients received popliteal block, while 26 patients received GETA. There were no anesthesia-related complications. At 2, 4, and 8 hours post-operatively, patients who underwent GETA demonstrated significantly higher pain. At 12 hours, there was no significant difference between the 2 groups with regard to pain control. However, by 24 hours, those who had received popliteal blocks had significantly higher pain with no difference by 48 hours. The authors concluded that popliteal block provided equivalent post-operative pain control to general anesthesia alone in patients undergoing operative fixation of ankle fractures. However, patients who receive popliteal blocks experienced a significant increase in pain between 12 and 24 hours. Recognition of this "rebound pain" with early narcotic administration may allow patients to have more effective post-operative pain control.

Goldstein et al (2013) noted that previous studies have demonstrated the efficacy of popliteal block anesthesia in decreasing post-operative narcotic administration, nausea, and LOS in patients undergoing foot and ankle surgeries. These researchers compared the amount of narcotic medication administered, the need for anti-emetic medication, post anesthesia care unit (PACU) LOS, and discharge status in patients treated surgically for ankle fractures who received popliteal blocks with those who received GETA. All patients being treated with open reduction and internal fixation for ankle fractures were randomized to receive either GETA or popliteal block. Post-operatively, data were collected on the duration of time in the PACU before discharge to home or to a hospital floor. Additional information was collection on the amount of anti-emetic and pain medication in the PACU. A total of 51 patients agreed to participate in the study. There was no significant difference between the 2 groups with regards to the need for anti-emetic medication, the amount of pain medication received in the PACU, or amount of time spent in the PACU. Patients who received a popliteal block were no more likely to be discharged to home from the PACU than those who received GETA. The authors concluded that while previous studies have demonstrated the efficacy of popliteal block in decreasing anti-emetic and pain medication administration in the PACU, these investigators found no difference in the amount of medication administered. They found that popliteal block patients were no more likely to be discharged to home than those who received general anesthesia.

Saphenous Nerve Block for Saphenous Neuralgia

Luerssen et al (1983) reported the findings of 6 patients representing 7 cases of spontaneous (non-traumatic) saphenous neuralgia secondary to entrapment of the nerve in the sub-sartorial canal. All patients complained of medial knee and leg pain. Clinical findings included tenderness over the sub-sartorial canal and sensory changes in the cutaneous distribution of 1 or both terminal branches of the saphenous nerve. The diagnosis was confirmed by saphenous nerve block in all cases. All patients were treated operatively, which resulted in symptomatic improvement. All 6 patients initially underwent external neurolysis; however, 3 patients required saphenous neurectomy for recurrent symptoms. Saphenous neuralgia should be considered in the differential diagnosis of medial lower extremity pain.

Tsai et al (2010) noted that the saphenous nerve, a branch of the femoral nerve, is a pure sensory nerve that supplies the antero-medial aspect of the lower leg from the knee to the foot. There is limited evidence of the effectiveness of US-guided techniques to block the saphenous nerve. In a retrospective, case-series study, these investigators examined the efficacy of an US-guided sub-sartorial approach to saphenous nerve block. During a 4-month period, all patients receiving a sub-sartorial saphenous nerve block for lower extremity (LE) surgery at the authors' institution had their medical records reviewed. Patient demographics and data were recorded, including block characteristics, intra-operative anesthetic management, pre-block, post-block, and post-operative pain scores, as well as post-operative analgesic dosing. Pre-operative block success was defined by minimal intra-operative analgesic administration and a pain score of 0 in the PACU not requiring analgesic supplementation. Post-operative block success was defined by reduction of pain score to 0 without need for additional analgesic dosing. A total of 39 consecutive patients were identified as receiving an US-guided sub-sartorial saphenous nerve block. Overall, this US-guided technique was found to have a 77 % success rate. The authors concluded that this case series showed that an US-guided sub-sartorial approach to saphenous nerve blockade was a moderately effective way to anesthetize the antero-medial LE. The success rate was based on stringent criteria with an end-point of post-operative analgesia. Moreover, they stated that a randomized prospective study would provide a more definitive answer regarding the efficacy of this technique for surgical anesthesia.

Supraorbital Nerve Block for Post-Herpetic Neuralgia

Yamashiro et al (1990) reported the case of a 58-year old man who had been suffering from intractable left ophthalmic post-herpetic neuralgia (PHN) for 7 years. He has also been treated for polyarteritis nodosa for 10 years. For pain relief, he was treated initially with frequent (4 times a day) stellate ganglion block (SGB) and peripheral ophthalmic nerve block for a month without relief. Then supra-orbital nerve block (SONB) with neurolytics, transcutaneous electrical nerve stimulation (TENS) and acupuncture were done with a slight relief of his pain. Recently, his pain became worse even with imipramine 75-mg and carbamazepine 100-mg a day, which relieved effectively the patient from the pain for the last 3 years. The pain was so severe to disturb his usual activities of daily living (ADL). Gasserian ganglion block with methyl prednisolone acetate 10-mg was carried out. After the block, his ADL improved markedly; 3 months after the block, he had no spontaneous pain and slight pain with light touch on the injured skin did not annoy him. Several days before the block, electric stimulation to control his pain was tested. Stimulation with the electricity (4.5 mA, 10-cycle and 400 microseconds) brought him complete relief from the pain during the stimulation. Trigeminal SEP showed no response to the stimulation of injured skin.

Ohtsuka et al (1992) noted that low -level laser therapy (LLLT) near the stellate ganglion was given for a 68-year old woman with PHN, suffering from burning pain in the right forehead for 11 years; SGB and supraorbital nerve block (SONB) with oral medication were not effective to relieve this pain. The laser irradiation induced warm sensation in her face followed by an excellent pain relief. Thermograms illustrated a remarkable increase from 30.6 degrees C to 31.5 degrees C in temperature of her right face. The irradiation near the right carotid artery also had the similar effect. The results implied that the irradiation with LLLT of the stellate ganglion and/or the carotid artery increased a facial blood flow and relieved facial neuralgia.

Eker et al (2011) stated that acute herpes zoster (AHZ) causes PHN in 48 to 75 % of patients. Nerve blocks performed in the acute phase of HZ may treat the pain and prevent PHN development. These researchers presented pain relief with modified van-Lint block in 2 cases with AHZ involving vesicles on the traces of the supraorbital and supratrochlear nerves. This study entailed 2 women, 72 and 66 years old, with AHZ involving vesicles on the traces of the supraorbital and supratrochlear nerves starting from the right peri-ocular region to the scalp presented with symptoms such as hypoesthesia, dizziness, burning, throbbing, and severe pain. Their initial VAS scores for pain were 9 and 10, respectively. Supraorbital and supratrochlear nerve blockade with modified van-Lint technique was planned, as the classical nerve block sites were covered with active vesicles. Following the nerve blocks, VAS scores of both patients decreased to 1 immediately. Vesicles were faded and scabbed, symptoms such as hypoesthesia, burning and throbbing had recovered, dizziness was relieved, and VAS scores were 4 and 5, respectively, after 1 week. VAS scores were 1 and 2, respectively, after the 2nd injection, and all symptoms were resolved, and no additional analgesic was needed during a 3-month follow-up. The authors concluded that modified van-Lint block with 5-ml 1 % lidocaine may provide successful pain relief in AHZ involving vesicles on the traces of the supraorbital and supratrochlear nerves.

Furthermore, an UpToDate review on “Postherpetic neuralgia” (Ortega, 2019) does not mention nerve block as a therapeutic option.

Suprascapular Nerve Block for Cervical Spondylosis

An UpToDate review on “Treatment and prognosis of cervical radiculopathy” (Robinson and Kothari, 2019) does not mention nerve block as a therapeutic option.

Transversus Abdominis Plane (TAP) Block for Post-Operative Analgesia Following Lumbar Fusion

Transversus abdominis plane (TAP) block is a peripheral block that entails nerves of the anterior abdominal wall. The block has been developed for post-operative pain control after gynecologic and abdominal surgery. The initial technique described the lumbar triangle of

Petit as the landmark used to access the TAP in order to facilitate the deposition of local anesthetic solution in the neurovascular plane. Other techniques include US-guided access to the neurovascular plane via the mid-axillary line between the iliac crest and the costal margin, and a subcostal access termed the “oblique subcostal” access.

Petersen and colleagues (2010) performed a systematic search of the literature and identified a total of 7 RCTs examining the effect of TAP block on post-operative pain, including a total of 364 patients, of whom 180 received TAP blockade. The surgical procedures included large bowel resection with a mid-line abdominal incision, caesarean delivery via the Pfannenstiel incision, abdominal hysterectomy via a transverse lower abdominal wall incision, open appendectomy and laparoscopic cholecystectomy. Overall, the results were encouraging and most studies have demonstrated clinically significant reductions of post-operative opioid requirements and pain, as well as some effects on opioid-related side effects (sedation and post-operative nausea and vomiting). Moreover, the authors concluded that further studies are needed to support the findings of the primary published trials and to establish general recommendations for the use of a TAP block.

Abdallah et al (2012) stated that US guidance has led a surge of interest in TAP block for post-operative analgesia following abdominal surgery. Despite or because of the numerous descriptive applications and techniques that have recently populated the literature, results of comparative studies for TAP block have been inconsistent. In a systematic review, these investigators addressed many unanswered questions, specifically the following: what are the effects of surgical procedure, block dose, block technique, and block timing on TAP block analgesia? A total of 18 intermediate-quality to good-quality randomized trials that included diverse surgical procedures were identified. Improved analgesia was noted in patients undergoing laparotomy for colorectal surgery, laparoscopic cholecystectomy, and open and laparoscopic appendectomy. There was a trend toward superior analgesic outcomes when 15-ml of local anesthetic or more was used per side compared with lesser volumes. All 5 trials investigating TAP block performed in the triangle of Petit and 7 of 12 trials performed along the mid-axillary line demonstrated some analgesic advantages; 8 of 9 trials using pre-incisional TAP block and 4 of 9 with post-incisional block revealed better analgesic outcomes. The authors concluded that although the majority of trials reviewed suggested superior early pain control, these researchers were unable to definitively identify the surgical procedures, dosing, techniques, and timing that provide optimal analgesia following TAP block. The authors concluded that the understanding of the TAP block and its role in contemporary practice remains limited.

Currently, there is a lack of evidence regarding the use of TAP block for post-operative analgesia following lumbar fusion.

Calcaneal Nerve Block for Plantar Fasciitis

Thapa and Ahuja (2014) stated that PF is the most common cause of chronic heel pain which may be bilateral in 20 % to 30 % of patients. It is a very painful and disabling condition that can affect the quality of life (QOL). The management includes both pharmacological and operative procedures with no single proven effective treatment modality. In a case-series study, these researchers managed 3 patients with PF (1 with bilateral PF). Following a diagnostic medial calcaneal nerve (MCN) block at its origin, these investigators observed reduction in verbal numerical rating scale (VNRS) in all 3 patients; 2 patients had relapse of PF pain that was managed with MCN block followed with pulsed radio frequency (PRF). All the patients were pain-free at the time of reporting. The authors concluded that this case-series study highlighted the possible role of combination of diagnostic MCN block near its origin followed with PRF as a new modality in management of patients with PF. This was a small (n = 3) study with short-term follow-up (3 months in 2 cases); and its findings were confounded by the combined use of diagnostic MCN block and PRF.

Furthermore, an UpToDate review on “Plantar fasciitis” (Buchbinder, 2020) does not mention nerve block as a management / therapeutic option.

Cervical Plexus Block for Post-Operative Analgesia for Neck Surgery and Regional Anesthesia for Carotid Endarterectomy

Pandit and associates (2007) noted that carotid endarterectomy is commonly conducted under regional (deep, superficial, intermediate, or combined) cervical plexus block (CPB), but it is not known if complication rates differ. These researchers carried out a systematic review to examine the complication rate associated with superficial (or intermediate) and deep (or combined deep plus superficial/intermediate). The null hypothesis was that complication rates were equal. Complications of interest were: serious complications related to the placement of block, incidence of conversion to general anesthesia, and serious systemic complications of the surgical-anesthetic process. These investigators retrieved 69 papers describing a total of 7,558 deep/combined blocks and 2,533 superficial/intermediate blocks. Deep/combined block was associated with a higher serious complication rate related to the injecting needle when compared with the superficial/intermediate block (odds ratio [OR] 2.13, $p = 0.006$). The conversion rate to general anesthesia was also higher with deep/combined block (OR 5.15, $p < 0.0001$), however, there was an equivalent incidence of other systemic serious complications (OR 1.13, $p = 0.273$; NS). The authors concluded that superficial/intermediate block was safer than any method that employed a deep injection. The higher rate of conversion to general anesthesia with the deep/combined block may have been influenced by the higher incidence of direct complications, but may also suggested that the superficial/combined block provided better analgesia during surgery.

Ivanec and co-workers (2008) analyzed analgesic efficacy side effects and complication rate in patients undergoing carotid surgery either under combined (deep and superficial) or superficial CPB alone. Data on 324 patients that received either combined (n = 107) or superficial (n = 216) CPB were prospectively analyzed. Data were collected on the intra-operative VAS, arterial pressure and heart rate. Analgesic efficacy was additionally assessed by the dose of supplemental 1 % lidocaine and fentanyl and time before the 1st analgesic was administered at intensive care unit (ICU). During surgery, VAS was slightly higher in the superficial group (median of 0.6, range of 0 to 3.9) than in the combined group (median of 0.4, range of 0 to 2.4; $p < 0.001$). The median supplemental lidocaine dose during the operation was higher in the superficial block group (2.4 mg/kg, range of 1.1 to 3.5) than in the combined group (2.1, range of 0.5 to 3.4 mg/kg; $p < 0.001$). Supplemental fentanyl was also higher in the superficial block group. There were no between-group differences in the time before the 1st post-operative analgesic, post-operative VAS and block-related complication rate. Accordingly combined block provided a slightly better analgesia during the surgery that was probably clinically irrelevant. There was no difference in post-operative analgesia and hemodynamic stability. The authors concluded that this was the largest prospective study in which superficial CPB was found to be as effective as combined block that was associated with a considerably higher risk of complications.

Mayhew and colleagues (2018) stated that thyroid surgery is moderately painful, but is increasingly being considered as a day-case procedure. Bilateral superficial CPB (BSCPB) provides an adjuvant technique to facilitate this approach, but there is great evidential heterogeneity in RCTs regarding its use. These researchers carried out a systematic search, critical appraisal, and analysis of RCTs. Trials examining pre-operative or post-operative BSCPB compared with control in patients undergoing thyroid surgery via neck incision were included; OR and 95 % CI were calculated for dichotomous data, while continuous data were analyzed using SMD. Primary outcome was rescue analgesic requirement in the first 24 post-operative hours. Secondary outcomes were VAS scores at 0, 4, and 24 hours, time until 1st analgesic request, intra-operative analgesic requirements, length of hospital stay, and incidence of post-operative nausea and vomiting (PONV). A total of 14 RCTs published between 2001 and 2016 including 1,154 patients were included. The overall effect of BSCPB compared with control showed a reduction in analgesic requirement (OR 0.30; 95 % CI: 0.18 to 0.51; $p < 0.00001$). There was improvement in VAS scores ($p < 0.002$) and time to 1rst analgesic requirement in the BSCPB group ($p < 0.00001$). Length of hospital stay was reduced by 6 hours by use of BSCPB. There was no significant change in the incidence of PONV with its use (OR 0.82; 95 % CI: 0.49 to 1.37; $p = 0.44$). The authors concluded that BSCPB offered analgesic efficacy in the early post-operative period for up to 24 hours following thyroid surgery, with reduced length of hospital stay, but without any beneficial effect on PONV.

Karakıs and associates (2019) noted that BSCPB is a common method used for analgesia in thyroid surgery. These investigators examined the analgesic efficacy of BSCPB in the intra-operative and post-operative periods. Patients (n = 46) undergoing thyroidectomy were randomly separated into the following 2 groups: the general anesthesia group (GA; n = 23) and the general anesthesia plus BSCPB group (GS; n = 23). The intra-operative analgesic requirement (remifentanil) and VAS score at multiple time-points during the post-operative period (after extubation, at 15 and 30 mins and 1, 2, 6, 12, 24 and 48 hours post-operation) were evaluated. Total tramadol and paracetamol consumption as well as the amount of ondansetron used was recorded. The intra-operative remifentanil requirement was significantly lower in the GS Group than in the GA Group ($p = 0.009$). The post-operative pain scores were significantly lower in the GS Group than in the GA Group at 15 ($p < 0.01$) and 30 ($p < 0.01$) mins and 1 ($p < 0.01$), 2 ($p < 0.01$), 6 ($p < 0.01$), 12 ($p < 0.01$) and 24 ($p = 0.03$) hours. The post-operative tramadol requirement was significantly lower in the GS Group than in the GA Group ($p = 0.01$). The number of patients that used ondansetron was significantly lower in the GS Group than in the GA Group ($p = 0.004$). The authors concluded that BSCPB with 0.25 % bupivacaine reduced the post-operative pain intensity and opioid dependency in thyroid surgery patients.

Furthermore, an UpToDate review on “Scalp block and cervical plexus block techniques” (Rosenblatt and Lai, 2020) states that “Superficial and deep cervical plexus blocks anesthetize the anterior and lateral neck and scalp. These blocks are particularly useful for awake carotid endarterectomy, in which neurologic monitoring of an awake patient may identify cerebral thromboembolic or ischemic events. They can also be used for postoperative analgesia for neck surgery”.

Facial Nerve Block for Migraine Headache

UpToDate reviews on “Acute treatment of migraine in adults” (Smith, 2020a), “Acute treatment of migraine in children” (Mack, 2020a), “Preventive treatment of migraine in adults” (Smith, 2020b), “Preventive treatment of migraine in children” (Mack, 2020b), and “Chronic migraine” (Garza and Schwedt, 2020a) do not mention facial nerve block as a therapeutic option.

Fascia Iliaca Block in the Emergency Room for Acute Hip Fracture and Post-Operative Pain following Hip and Knee Surgeries

In a prospective, blind, controlled, parallel trial, Aprato et al (2018) compared the fascia iliaca compartment block (FICB) and the intra-articular hip injection in terms of pain management and the need for additional systemic analgesia in the pre-operative phase of intra-capsular hip fractures. Patients greater than 65 years old with an intra-capsular hip fracture were randomized in this trial in a level-I trauma center. Patients were randomly assigned to receive either the FICB (cohort FICB) or the intra-articular hip injection (cohort IAHI) upon admission to the emergency department. The primary outcome was pain relief at 20 mins, 12 hours, 24 hours and 48 hours following the regional anesthesia, both at rest and during internal rotation of the fractured limb. The numeric rating scale (NRS) was used. Residual pain was managed with the same protocol in all patients. Additional analgesic drug administration during the 48 hours from admission was recorded. A total of 120 patients with comparable baseline characteristics were analyzed in this study: the FICB group consisted of 70 subjects, while the IAHI group consisted of 50 subjects. Pain was significantly lower in the IAHI group during movement of the fractured limb at 20 mins ($p < 0.05$), 12 hours ($p < 0.05$), 24 hours ($p < 0.05$) and 48 hours ($p < 0.05$). In the FICB cohort 72.9 % of patients needed to take oxycodone, in contrast to 28.6 % of the IAHI cohort ($p < 0.05$). In the FICB cohort 14.09 ± 11.57 mg of oxycodone was administered, while in the IAHI cohort 4.38 ± 7.63 mg ($p < 0.05$). No adverse events (AEs) related to either technique were recorded. The authors concluded that intra-articular hip injection provided better pre-operatory pain management in elder patients with intra-capsular hip fractures compared to the FICB. It also reduced the need for supplementary systemic analgesia.

In a systematic review, Steenberg and Moller (2018) examined the analgesic and adverse effects of FICB on hip fracture in adults when applied before operation. A total of 9 databases were searched from inception until July 2016 yielding 11 RCTs and quasi-RCTs, all using loss of resistance FICB, with a total population of 1,062 patients. Meta-analyses were conducted comparing the analgesic effect of FICB on NSAIDs, opioids and other nerve blocks, pre-operative analgesia consumption, and time to perform spinal anesthesia compared with opioids and time for block placement. The analgesic effect of FICB was superior to that of opioids during movement, resulted in lower pre-operative analgesia consumption and a longer time for 1st request, and reduced time to perform spinal anesthesia. Block success rate was high and there were very few adverse effects. There is insufficient evidence to conclude anything on pre-operative analgesic consumption or 1st request thereof compared with NSAIDs and other nerve blocks, post-operative analgesic consumption for pre-operatively applied FICB compared with NSAIDs, opioids and other nerve blocks, incidence and severity of delirium, and length of stay (LOS) or mortality. The authors concluded that FICB is an effective and relatively safe supplement in the pre-operative pain management of hip fracture patients.

Fadhlillah et al (2019) determined the analgesic safety and efficacy profile of single injection FICB performed peri-operatively for isolated hip fractures. Medline, Embase, Cochrane and CINAHL were searched from inception to February 2018. Inclusion criteria were: English language, adult patients (greater than 18 years old), isolated traumatic hip fracture treated with single injection FICB peri- operatively. Data were extracted into a pre-piloted form that utilized the PRISMA-P 2015 checklist. Two investigators conducted reviews independently; any ambiguity was resolved by discussion. The quality of studies was assessed using the GRADE checklist and Cochrane risk of bias tool. A random-effects model was applied. Outcomes reviewed were pain level at rest and movement, break-through analgesia and complications. Out of 3,757 citations, 8 RCTs were included involving 645 participants. Pain was significantly reduced during movements (SMD = -1.82, 95 % confidence interval [CI]: -2.26 to -1.38, $p < 0.00001$) but not at rest (SMD = -0.68, 95 % CI: -1.70 to 0.35, $p = 0.20$); FICB allowed less (break-through) supplemental analgesic (n = 57 versus n = 73), however this did not reach statistical significance ($p = 0.19$). The authors concluded that FICB was effective in controlling acute peri-operative pain in adult patients with traumatic hip fractures. The benefit was more evident during mobilization of the limb when compared to patients at rest.

An UpToDate review on “Overview of common hip fractures in adults” (Forster, 2020) states that “Initial care of the patient with a hip fracture consists primarily of providing adequate analgesia and consulting an orthopedic surgeon. Pain is often undertreated in older adults, which is inhumane and increases the risk of delirium. Intravenous opioids provide faster relief, but intramuscular or oral medications may be used. If resources are available, regional nerve blocks are highly effective at reducing pain and minimizing the sedation and other potential complications caused by opioids".

Furthermore, an UpToDate review on "Hip fracture in adults: Epidemiology and medical management" (Morrison and Siu, 2020) states that "Analgesia – Pain is often undertreated in older patients, which is inhumane and increases the risk of delirium. If resources are available, peripheral nerve blocks are highly effective at reducing pain and minimizing the sedation and other potential complications caused by opioids. Either single-injection or continuous blocks and can be used preoperatively in patients waiting for surgery, and can be continued for postoperative analgesia".

In a meta-analysis, Wang et al (2017) compared the safety and efficiency between femoral nerve block (FNB) and fascia iliaca block (FIB) for post-operative pain control in patients undergoing total knee and hip arthroplasties. These investigators carried out a systematic search in Medline (1966 to 2017.05), PubMed (1966 to 2017.05), Embase (1980 to 2017.05), ScienceDirect (1985 to 2017.05) and the Cochrane Library. Inclusion criteria: (i) Participants: Only published articles enrolling adult participants that with a diagnosis of end-stage of osteoarthritis (OA) and prepared for unilateral total knee arthroplasty (TKA) or THA; (ii) Interventions: The intervention group received FIB for post-operative pain management; (iii) Comparisons: The control group received FNB for post-operative pain control; (iv) Outcomes: VAS scores in different periods, opioids consumption, length of stay (LOS) and post-operative complications; (v) Study design: clinical RCTs were regarded as eligible in this study. Cochrane Hand book for Systematic Reviews of Interventions was used for assessment of the included studies and risk of bias was shown. Fixed/random effect model was used according to the heterogeneity tested by I2 statistic. Sensitivity analysis was conducted and publication bias was assessed. Meta-analysis was performed using Stata 11.0 software. A total of 5 RCTs including 308 patients met the inclusion criteria. The present meta-analysis indicated that there were no significant differences between groups in terms of VAS score at 12 hours (SMD = -0.080, 95 % CI: -0.306 to 0.145, p = 0.485), 24 hours (SMD =

0.098, 95 % CI: -0.127 to 0.323, p = 0.393), and 48 hours (SMD = -0.001, 95 % CI: -0.227 to 0.225, p = 0.993). No significant differences were found regarding opioid consumption at 12 hours (SMD = 0.026, 95 % CI: -0.224 to 0.275, p = 0.840), 24 hours (SMD = 0.037, 95 % CI: -0.212 to 0.286, p = 0.771), and 48 hours (SMD = -0.016, 95 % CI: -0.265 to 0.233, p = 0.900). In addition, no significant increase of complications was identified between groups. The authors concluded that there was no significant differences of VAS scores at 12 to 48 hour and opioids consumption at 12 to 48 hour between 2 groups following total joint arthroplasty. No increased risk of nausea, vomiting and pruritus was observed in both groups. These investigators stated that FNB provided equal post-operative pain control compared with FIB following total joint arthroplasty. Both of them could reduce the consumption of opioids without severe adverse effects.

In a meta-analysis, Cai et al (2019) examined the effect of FICB on pain control and morphine consumption in patients with THA. These investigators searched databases (PubMed, Embase, Cochrane Library) for eligible randomized controlled trials (RCTs) published prior to September 12, 2018. They only included THA patients who received FICB versus placebo for pain control. Risk ratios (RRs), standard MD (SMD) and 95 % CI were determined. Stata 12.0 was used for the meta-analysis. A total of 326 THA patients from 7 RCTs were subjected to meta-analysis. Overall, FICB was associated with lower visual analog scale (VAS) scores at 1 to 8 hours and 12 hours compared with placebo (p < 0.05). However, there was no significant difference between VAS at 24 hours (SMD = -0.56, 9 5% CI: -1.42 to 0.31, p = 0.206) and 48 hours after THA (SMD = -0.82, 95 % CI: -2.07 to 0.44, p = 0.204). Compared with the control group, FICB significantly decreased the occurrence of nausea (RR = 0.41, 95 % CI: 0.25 to 0.69, p = 0.010; I2 = 0.0 %). There was no significant difference in the risk of falls between the FICB and control groups (p > 0.05). The authors concluded that FICB had a beneficial role in reducing pain intensity and morphine consumption after THA. Moreover, FICB had morphine-sparing effects when compared with a control group.

Diakomi et al (2020) stated that chronic post-surgical pain (CPSP), i.e., pain persisting greater than 3 months, may appear after any type of surgery. There is a paucity of literature addressing CPSP development after hip fracture repair and the impact of any analgesic intervention on the development of CPSP in patients after hip fracture surgery. In a prospective. randomized study, these researchers examined the impact of ultrasound-guided FICB (USG-FICB) on the development of CPSP after hip fracture repair. A total of 182 patients scheduled for hip fracture surgery were included in this trial. Patients were randomized to receive a USG-FICB (FICB group) or a sham saline injection (sham FICB group), 20 mins before positioning for spinal anesthesia. The hip-related characteristic pain intensity (CPI) at 3-months post-surgery was the primary outcome measure. Presence and severity of hip-related pain at 3- and 6-months post-surgery, NRS scores at 6, 24, 36, 48 post-operative hours, total 24-hour tramadol patient-controlled analgesia (PCA) administration and timing of the 1st tramadol dose, were documented as well. FICB group presented with lower CPI scores 3-months post-operatively ($p < 0.01$), as well as lower percentage of patients with high-grade CPSP, 3 and 6 months post-operatively ($p < 0.001$). FICB group also showed significantly lower NRS scores in all instances, lower total 24-hour tramadol consumption and higher mean time to 1st tramadol dose ($p < 0.05$). The overall sample of 182 patients reported a considerably high incidence of hip-related CPSP (60 % at 3 months, 45 % at 6 months). The authors concluded that USG-FICB in the peri-operative setting may reduce the incidence, intensity and severity of CPSP at 3 and 6 months after hip fracture surgery, providing safe and effective post-operative analgesia.

Furthermore, an UpToDate review on “Lower extremity nerve blocks: Techniques” (Jeng and Rosenblatt, 2020) states that “Peripheral nerve blocks of the lower extremity are used for operative anesthesia and/or postoperative analgesia for a variety of lower extremity surgeries … Femoral nerve block is used to provide anesthesia or postoperative analgesia for surgery of the anterior thigh and knee (e.g., anterior cruciate ligament repair, patella surgery, quadriceps tendon repair) … The fascia iliaca block is an alternative to the femoral nerve block and may more reliably block the lateral femoral cutaneous nerve than the femoral block. It blocks the sensory innervation of the lateral thigh. This block does not depend on deposition of local anesthetic (LA) near an individual nerve; instead, it works by spread of the LA in a fascial plane. Therefore, this block is not performed with nerve stimulation. It can be done using ultrasound guidance or with an anatomic approach”.

Lateral Pectoral Nerve Block for Shoulder Pain

An UpToDate review on "Upper extremity nerve blocks: Techniques" (Jeng and Rosenblatt, 2020) does not mention lateral pectoral nerve block as a management / therapeutic tool.

Nerve Block for Excision of Ganglion Cyst in the Lower Extremity

An UpToDate review on "Ganglion cysts of the wrist and hand" (De Keyser, 2020) does not mention nerve block as a management / therapeutic tool.

Nerve Block for Hemicrania Continua

Guerrero et al (2012) noted that a complete response to indomethacin is needed for the diagnosis of hemicrania continua (HC). Nevertheless, patients may develop side effects leading to withdrawal of this drug. Several alternatives have been proposed with no consistent effectiveness. Both anesthetic blocks of peripheral nerves and trochlear corticosteroid injections have been effective in some case reports. In this trial, a total of 22 patients with HC were examined in a headache out-patient office. Physical examination included palpation of the SON and GON as well as of the trochlear area. In 14 patients, at least 1 tender point was detected. Due to indomethacin intolerance, at least 1 anesthetic block of the GON or SON, or an injection of corticosteroids in the trochlear area, were performed in 9 patients; 4 of them were treated with a combination procedure. All these patients experienced total or partial improvement lasting from 2 to 10 months. The authors concluded that anesthetic blocks or corticosteroid injections may be effective in HC patients showing tenderness of the SON, GON or trochlear area.

Cortijo et al (2012) noted that HC is characterized by a continuous unilateral pain, which frequently gets worse in association with autonomic symptoms. It is probably little known and under-diagnosed. Its diagnosis requires a response to indomethacin, which is not always well-tolerated. These investigators reported a series of 36 cases of HC that were treated in the headache service of a tertiary hospital. They analyzed their demographic and clinical features and the therapeutic alternatives to indomethacin. Between January 2008 and April 2012, a total of 36 patients (28 women, 8 men) were diagnosed with HC from among 1,800 (2 %) who were treated in that service. The age of onset was 46.3 ± 18.4 years. In 4 patients (11.1 %) there were pain remissions that lasted over 3 months. The baseline pain was mainly oppressive or burning with an intensity of 5.2 ± 1.4 on the verbal analogue scale. Exacerbations lasted 32.3 ± 26.1 mins, were of a predominantly stabbing nature with an intensity of 8.3 ± 1.4, and in 69.4 % of cases were accompanied by autonomic symptoms. In total, 16.7 % of the patients did not tolerate indomethacin beyond an indotest and 50 % did so with side effects. In 13 cases, at least 1 anesthetic blockade was performed in the SON or the GON or a trochlear injection of corticoids was carried out with a full response in 53.8 % and a partial response in 38.5 %. The authors concluded that HC is not an infrequent diagnosis in a headache clinic and, because it is a treatable condition, further knowledge on the subject is needed; anesthetic blockades of the SON or GON or a trochlear injection of corticoids are the therapeutic options that must be taken into consideration when indomethacin is not well-tolerated.

Androulakis et al (2016) stated that HC is a chronic headache disorder characterized by a continuous, strictly unilateral head pain accompanied by cranial autonomic symptoms, which completely responds to indomethacin; however, few alternative therapeutic options exist for the patients with this disorder who cannot tolerate indomethacin. Sphenopalatine ganglion (SPG) block has been used for the treatment of various headaches, with the strongest evidence for efficacy in cluster headache. These researchers presented the case of a 52-year old woman with a 7-year history of HC who was evaluated in their clinic for management of her headaches after she had stopped using indomethacin due to a bleeding gastro-intestinal (GI) ulcer. After failing multiple pharmacologic therapies, she was treated with repetitive SPG blocks using bupivacaine (0.6 ml at 0.5 %) twice-weekly for 6 weeks and followed by maintenance therapy. This therapeutic protocol resulted in significant improvement in her headaches, mood, and functional capacity. The authors concluded that SPG block using a local anesthetic may be an effective treatment for patients with HC, specifically for those who cannot tolerate indomethacin, or when this drug is contraindicated.

Furthermore, an UpToDate review on “Hemicrania continua” (Garza and Schwedt, 2020b) does not mention nerve block as a management / therapeutic option.

Pectoralis Minor Nerve Block for Pectoralis Minor syndrome and Thoracic Outlet Syndrome

An UpToDate review on “Overview of thoracic outlet syndrome” (Goshima, 2020) does not mention nerve block as a management / therapeutic tool.

Pericapsular Nerve Group (PENG) Block for the Management of Post-operative Pain

Giron-Arango et al (2018) stated that fascia iliaca block or femoral nerve block is used frequently in hip fracture patients because of their opioid-sparing effects and reduction in opioid-related adverse effects. A recent anatomical study on hip innervation led to the identification of relevant landmarks to target the hip articular branches of femoral nerve and accessory obturator nerve. Using this information, these researchers developed a novel ultrasound (US)-guided approach for blockade of these articular branches to the hip, the PENG (PEricapsular Nerve Group) block. The authors described the technique and its application in 5 consecutive patients.

Sandri et al (2020) examined the efficacy of the PENG block and local infiltration analgesia (LIA) combination as the only anesthesia technique for the total hip arthroplasty (THA). These researchers considered the anesthetic plan, post-operative analgesia, hospital length of stay (LOS), functional recovery, bleeding, complications and the adverse events (AEs). They reported 10 American Society of Anesthesiologists (ASA) I-II patients admitted for elective primary THA, receiving LIA during (n = 5) and at the end of surgery (n = 5). For the PENG block, these investigators used a single injection of 40-ml levobupivacaine 0.25 % and 4-mg dexamethasone. For LIA, a mixture of 0.25 % levobupivacaine, ketorolac, epinephrine, and morphine was injected into peri-articular tissues. The pain intensity was evaluated with a numeric rating scale (NRS). All patients were fully satisfied and improvement in pain relief, symptoms, and functional activity was remarkable. Intra-operative blood losses ranged 100 to 600 ml. No intra-operative complications or signs of toxicity occurred. The median duration of surgery was 59.5 ± 4.5 mins and the hospital LOS ranged between 2 and 3 days. The authors concluded that the PENG block and LIA could be hypothesized as a safe and effective anesthesia technique for the THA surgery, facilitating hip functional recovery and limit intra-operative blood losses and AEs. The main drawbacks of this study were its small (n = 5 for PENG block and LIA administered at the end of surgery) sample size; and the findings were confounded by the combined use of the PENG block and LIA.

Popliteal Nerve Block for Hallux Valgus Correction Surgery

In a prospective, randomized study, Karaarslan et al (2016) compared the efficacy, post-operative pain scores, adverse effects, additional analgesic requirements, and patient satisfaction scores of ultrasonography (US)-guided sciatic nerve block by popliteal approach with spinal anesthesia for hallux valgus correction surgery. A total of 60 patients scheduled for hallux valgus correction surgery were enrolled in this trial. Unilateral spinal block was performed on patients in the spinal anesthesia group. Popliteal block group patients received popliteal sciatic nerve block with guidance by both nerve stimulator and US. Durations of anesthetic and operative interventions and time until the initiation of surgery were recorded for both groups. Pain magnitude of the patients at the 2nd, 4th, 6th, 12th, and 24th hours following anesthetic interventions were assessed with a visual analog scale (VAS). Adverse effects such as post-operative urinary retention and post-dural puncture headache were recorded. Also, patient satisfaction was recorded. Patients were interviewed by phone for anesthetic and operative complications at 72 hours post-operatively. Spinal anesthesia group patients exhibited hypotension, bradycardia, post-dural puncture headache, and urinary retention rates of 6.6 %, 3.3 %, 10 %, and 3.3 %, respectively. Popliteal block group patients showed none of these adverse effects. Moreover, VAS scores of the patients at the 2nd, 4th, 6th, and 12th hours were significantly lower ($p < 0.001$, $p = 0.003$, $p < 0.001$, $p < 0.001$, respectively), post-operative 1st analgesic requirement times were significantly longer ($p < 0.001$), and pain satisfaction scores were significantly higher ($p < .001$) in the popliteal block group. The authors concluded that given the complications related to spinal anesthesia and its insufficiency to maintain analgesia postoperatively, they believed the preferred anesthetic method should be peripheral nerve blocks for hallux valgus correction surgeries. Level of Evidence = I.

Kir and Kir (2018) stated that post-operative pain is a frequent problem after orthopedic procedures like hallux valgus surgery. In a randomized controlled trial (RCT), these researchers examined if ankle block improves early and mid-term functional outcomes and post-operative pain management following hallux valgus surgery in patients receiving general anesthesia. This trial included 60 patients who underwent hallux valgus surgery under general anesthesia. Patients were prospectively randomized into 2 groups: general anesthesia only (group A) and ankle block added to general anesthesia (group B). Age, body-mass index (BMI), tourniquet time, duration of surgery, 1st analgesic need time, peri-operative analgesic regimen, VAS, American Orthopedic Foot and Ankle Score (AOFAS), and length of hospital stay were recorded. Independent variables were analyzed by t-test. Non-parametric data were analyzed by the Mann-Whitney U test. Patient age, demographics, and BMI were similar between the 2 groups. The average length of hospital stay was significantly longer in group A ($p < 0.01$). Group B had a longer time to 1st analgesic need than group A ($p < 0.01$). Patients in group B required less analgesic during the post-operative period. Pre-operative VAS and AOFAS scores were not statistically different between the 2 groups. The post-operative day 1 VAS score was significantly lower in group B than in group A. Follow-up visits at 3, 6, and 12 months showed significantly lower VAS and higher AOFAS scores in group B than group A. The authors concluded that ankle block added to general anesthesia may improve early and mid-term post-operative functional outcomes and post-operative pain management in patients who undergo hallux valgus surgery.

Su et al (2019) stated that adequate post-operative analgesia after hallux valgus (HV) correction surgery improves early mobilization and decreases hospital stay. Peripheral nerve block and peri-incisional local anesthetic (LA) infiltration are both widely used for pain management in orthopedic surgeries. These researchers compared the analgesic effects between the ankle block and peri-incisional infiltration technique in patients undergoing HV correction surgery. A total of 90 patients scheduled for hallux valgus correction surgery were randomly allocated into 3 groups. In group N, patients were pre-treated with tibial and peroneal nerve blocks with 8 to 10 ml of 0.25 % bupivacaine before surgery. In group P, patients received the same LA for peri-incisional infiltration pre-operatively. In group C, patients underwent surgery without regional analgesic pre-treatment. All patients had intravenous (IV) fentanyl patient control analgesia as part of multi-modal post-operative pain management. Fentanyl consumption, rest and moving pain scale, and adverse effects were evaluated at post-operative 6 hours (Poh6), Poh12, Poh24, and Poh36, respectively. Patients receiving bilateral feet surgeries were excluded in this study; 75 patients were enrolled into final analysis. The patients in group N expressed lower resting and moving pain scores at Poh6, but the pain scores turned similarly among the 3 groups following Poh12 and then. The total fentanyl consumption was significantly less in group N than in group P. The post-operative activities and mood disturbance were not significantly different between groups after Poh12 and then. The authors concluded that ankle block was better than peri-incisional LA infiltration in HV correction surgery in pain relief and fentanyl consumption.

Pre-Operative Adductor Canal Block for Post-Operative Pain Management after Anterior Cruciate Ligament Reconstruction

Runner et al (2018) stated that peripheral nerve blocks, particularly femoral nerve blocks (FNBs), are commonly performed for anterior cruciate ligament reconstruction (ACLR). However, associated quadriceps muscle weakness after FNBs is well described and may occur for up to 6 months post-operatively. The adductor canal block (ACB) has emerged as a viable alternative to the FNB, theoretically causing less quadriceps weakness during the immediate post-operative period, as it bypasses the majority of the motor fibers of the femoral nerve that branch off proximal to the adductor canal. In a prospective, single-blinded, randomized controlled trial (RCT), these researchers examined if a difference in quadriceps strength exists after an ACB or FNB for ACLR beyond the immediate post-operative period. Beyond the immediate post-operative period, these investigators anticipated no difference in quadriceps strength between patients who received ACBs or FNBs for ACR. A total of 102 patients undergoing primary ACLR using a variety of graft types were enrolled between November 2015 and April 2016. All patients were randomized to receive an ACB or FNB before surgery, and the surgeon was blinded to the block type. All patients underwent aggressive rehabilitation without functional bracing post-operatively. The time to the first straight-leg raise was reported by the patient. Isokinetic strength testing was performed at 3 and 6 months post-operatively. Data for 73 patients were analyzed. There was no significant difference in patient demographics of age, body mass index (BMI), sex, or tourniquet time between the FNB (n = 35) and ACB (n = 38) groups. The mean time to the first straight-leg raise was similar, at 13.1 ± 1.0 hours for the FNB group and 15.5 ± 1.2 hours for the ACB group (p = 0.134). The mean extension torque at 60 deg/s increased significantly for both the ACB (53.7 % ± 3.4 % to 68.3 % ± 2.9 %; p = 0.008) and the FNB (53.3 % ± 3.3 % to 68.5 % ± 4.1 %; p = 0.006) groups from 3 to 6 months post-operatively. There was also no significant difference in mean extension torque at 60 deg/s or 180 deg/s between the FNB and ACB groups at 3 and 6 months. There were no significant differences in post-operative complications (infection, arthrofibrosis, re-tear) between groups. The authors concluded that although prior studies have shown immediate post-operative benefits of ACBs compared with FNBs, with a faster return of quadriceps strength, in the current study there was no statistically or clinically significant difference in quadriceps strength at 3 and 6 months post-operatively in patients who received ACBs or FNBs for ACLR.

Bailey et al (2019) compared FNB versus ACB for post-operative pain control and quadriceps muscle function in patients undergoing ACLR with patellar tendon autograft. These researchers performed a randomized therapeutic trial of 90 patients undergoing ACLR with patellar tendon autograft comparing ACB versus FNB at 24 hours, 2 and 4 weeks, and 6 months post-surgery. Early outcome measures included average pain score and morphine equivalent units (milligrams) consumed, quadriceps surface electromyography (EMG), straight leg raise, and ability to ambulate without assistive devices. The 6-month outcome measures included knee range of motion (ROM), isokinetic knee extension peak torque, single-leg squat, and single-leg hop performance. Complications were recorded throughout the study for the development of anterior knee pain, knee extension ROM loss, deep vein thrombosis (DVT), and graft failure. Mixed-model analysis of variance and Mann-Whitney U tests were performed using an alpha of 0.05. Quadriceps surface EMG deficits were higher for FNB at 24 hours (p < 0.001) and 2 weeks (p < 0.001) when compared with the ACB group. There were no between-groups difference for subjective pain (p = 0.793) or morphine consumption (p = 0.358) within the first 24 hours of surgery. A higher percentage of patients in the ACB group met the full ambulation criteria at 4 weeks compared with the FNB group (100 % versus 84.2 %, p < 0.001). No between-group differences were observed at 6 months; however, the rate of knee extension ROM loss was higher for the FNB group versus the ACB group (21.1 % versus 5.0 %, p = 0.026), respectively. The authors concluded that ACB was as effective as FNB in providing pain control while eliciting fewer quadriceps muscle activation deficits and fewer post-operative complications. Based on previous evidence and the results of this study, these investigators recommended the use of ACB over FNB for the analgesic management of patients undergoing ACLR with patellar tendon autograft. Level of Evidence = I.

Lynch et al (2019) stated that FNB is a commonly performed technique that has been proven to provide effective regional analgesia after ACLR. The ACB uses a similar sensory block around the knee while avoiding motor blockade of the quadriceps muscles. In a prospective, double-blinded RCT, these researchers compared the efficacy of FNB versus ACB for pain control after ACLR. It was hypothesized that there would be no difference in pain levels or opioid requirements between the 2 groups. A total of 60 patients undergoing primary ACLR with bone-patellar tendon-bone autograft were randomized to receive either an ACB or an FNB pre-operatively. The primary outcomes assessed were pain levels (VAS) and narcotic requirements for 4 days after surgery. Secondary outcomes included ability to perform a straight leg raise in the recovery room and difference in thigh circumference between the operative and non-operative leg measured at 7 days post-operatively. Morphine requirements were less in the ACB group in the first 4 hours post-operatively (p = 0.02). Aside from this time interval, no differences were found between the 2 groups with regard to opioid requirements and pain scores at any other time. Similarly, no differences were noted in patients' ability to perform a straight leg raise in the recovery room (p = 0.13) or in thigh circumference at the first post-operative visit (p = 0.09). The authors concluded that the findings of this study suggested similar efficacy in peri-operative pain control with the use of an ACB for ACLR when compared with FNB. These researchers stated that the potential long-term benefit of quadriceps preservation with the ACB is worthy of future study. Level of Evidence = I.

Pre-Operative Fascia Iliaca Block for Post-Operative Analgesia Following Arthroscopic Hip Surgery

In a systematic review, Shin and colleagues (2018) provided a comprehensive review of the available evidence from randomized controlled trials (RCTs) and comparative studies on pain control after hip arthroscopy. Using the Preferred Reporting Items for Systematic Reviews and Meta-analyses guidelines, a systematic review of the literature for post-operative pain control after hip arthroscopy was performed using electronic databases. Only comparative clinical studies with level 1 to 3 evidence comparing a method of post-operative pain control with other modalities or placebo were included in this review. Case series and studies without a comparative cohort were excluded. Several methods of pain management have been described for hip arthroscopy. A total of 14 studies met the inclusion criteria: 3 on femoral nerve block, 3 on lumbar plexus block, 3 on fascia iliaca block, 4 on intra-articular injections, 2 on soft tissue surrounding surgical site injection, and 2 on celecoxib (4 studies compared 2 or more methods of analgesia). The heterogeneity of the studies did not allow for pooling of data. Single-injection femoral nerve blocks and lumbar plexus blocks provided improved analgesia, but increased fall rates were observed. Fascia iliaca blocks do not provide adequate pain relief when compared with surgical site infiltration with local anesthetic and are associated with increased risk of cutaneous nerve deficits. Patients receiving lumbar plexus block experienced significantly decreased pain compared with fascia iliaca block. Portal site and peri-acetabular injections provided superior analgesia compared with intra-articular injections alone. Pre-operative oral celecoxib, compared with placebo, resulted in earlier time to discharge and provided significant pain relief up to 24 hours. The authors concluded that peri-operative nerve blocks provided effective pain management after hip arthroscopy; but must be used with caution to decrease risk of falls. Intra-articular and portal site injections with local anesthetics and pre-operative celecoxib could decrease opioid consumption. Moreover, these researchers stated that there is a lack of high-quality evidence on this topic, and further research is needed to determine the best approach to manage post-operative pain and optimize patient satisfaction.

Behrends and associates (2018) stated that ambulatory hip arthroscopy is associated with post-operative pain routinely requiring opioid analgesia. The potential role of peripheral nerve blocks for pain control after hip arthroscopy is controversial. This trial examined if a pre-operative fascia iliaca block improves post-operative analgesia. In a prospective, randomized, double-blinded trial, a total of 80 patients scheduled for hip arthroscopy were assigned to receive a pre-operative fascia iliaca block with 40 ml ropivacaine 0.2 % or saline. Patients also received an intra-articular injection of 10-ml ropivacaine 0.2 % at procedure end. Primary study end-point was highest pain score reported in the recovery room; other study end-points were pain scores and opioid use 24 hours after surgery. Additionally, quadriceps strength was measured to identify leg weakness. The analysis included 78 patients. Highest pain scores in the recovery room were similar in the block group (6 ± 2) versus placebo group (7 ± 2), difference: -0.2 (95 % confidence interval [CI]: -1.1 to 0.7), as was opioid use (intravenous morphine equivalent dose: 15 ± 7 mg [block] versus 16 ± 9 mg [placebo]). Once discharged home, patients experienced similar pain and opioid use (13 ± 7 mg [block] versus 12 ± 8 mg [placebo]) in the 24 hours after surgery. The fascia iliaca block resulted in noticeable quadriceps weakness. There were 4 post-operative falls in the block group versus 1 fall in the placebo group. The authors concluded that pre-operative fascia iliaca blockade in addition to intra-articular local anesthetic injection did not improve pain control after hip arthroscopy but did result in quadriceps weakness, which may contribute to an increased fall risk. These researchers stated that routine use of this block cannot be recommended in this patient population.

Desmet and co-workers (2019) noted that the fascia iliaca compartment block has been promoted as a valuable regional anesthesia and analgesia technique for lower limb surgery. Numerous studies have been performed, but the evidence on the true benefits of the fascia iliaca compartment block is still limited. Recent anatomical, radiological, and clinical research has demonstrated the limitations of the landmark infra-inguinal technique. Nevertheless, this technique is still valuable in situations where ultrasound (US) cannot be used because of lack of equipment or training. With the introduction of US, a new supra-inguinal approach of the fascia iliaca has been described. Research has demonstrated that this technique led to a more reliable block of the target nerves than the infra-inguinal techniques. However, the authors concluded that more research is needed to determine the place of this technique in clinical practice.

Quadratus Lumborum Block for Hip Surgery

He et al (2018) examined the efficacy of ultrasound (US)-guided quadratus lumborum block combined with non-steroidal anti-inflammatory drugs (NSAIDs) for post-operative analgesia in patients undergoing total hip arthroplasty (THA). From January to June 2017, a total of 60 American Society of Anesthesiologists (ASA) physical status I to III patients, aged 55 to 75 years, scheduled for THA, were randomly divided into control group (group N) and quadratus lumborum block (group R); US-guided quadratus lumborum block (QLB) was implemented on the affected side at the end of operation. Then 30 ml 0.33 % ropivacaine were administrated in group R, while the control group did not receive the same block. A sufentanil patient-controlled analgesia pump was connected to the patient. The rest visual analogue score (VAS) were recorded at 0 h (T(0)), 3 h (T(1)), 6 h (T(2)), 12 h (T(3)), 24 h (T(4)), 36 h (T(5)) and 48 h(T(6)) after surgery; the VAS scores on movement were evaluated at T(4), T(5) and T(6) time-points. The consumption of sufentanil within each period time were recorded. The maximal flexion and abduction degrees of the hip joint were evaluated at 12, 24, 36 and 48 hours after operation. The number of patients for rescue pain relief by intravenous analgesia pump during 24 h and 48 h after surgery were counted in both groups. The post-operative adverse effects and overall satisfaction in the 2 groups were recorded. The VAS at rest in group R were 0.8 ± 0.4, 1.0 ± 0.3, 1.2 ± 0.5, 2.0 ± 0.5, 1.7 ± 0.4 , 1.6 ± 0.5 at T(1), T(2), T(3), T(4), T(5), T(6) respectively, and those in group N were 3.0 ± 0.7, 3.5 ± 0.9, 3.8 ± 0.9, 3.3 ± 1.1, 3.3 ± 0.7, 3.0 ± 0.7 at the same time-points. The VAS at rest were lower in group R than those in control group at all time-points (F = 203.090, 216.354, 203.956, 35.548, 96.332, 80.577, all $p < 0.01$). The VAS on movement in group R were 2.7 ± 0.9, 2.9 ± 0.7, 2.0 ± 0.6 at T(4), T(5), T(6) respectively, and those in group N were 6.0 ± 1.5, 5.8 ± 1.1, 4.5 ± 1.0. The VAS on movement were also lower in group R than those in control group(F = 154.561, 143.224, 141.479, all $p < 0.01$). The maximum flexion degrees in group R were (61 ± 12) degrees, (64 ± 10) degrees, (69 ± 15)degrees and (78 ± 19) degrees at 12, 24, 36, 48 hours after operation, and those were (45 ± 11) degrees, (49 ± 10)degrees, (52 ± 12)degrees and (60 ± 14)degrees at the same time-points. The maximum flexion degrees in group R were increased more than control group at 12, 24, 36, 48 hours after operation(F =3 4.981, 35.575, 52.106, 41.681, all $p < 0.01$). The abduction degrees in group R were (22 ± 6)degrees, (26 ± 6) degrees, (27 ± 8)degrees and (28 ± 7) degrees at 12, 24, 36, 48 hours after surgery, and those in group N were (14 ± 5) degrees, (17 ± 6) degrees, (20 ± 6) degrees and (20 ± 5) degrees. The abduction degrees in group R were increased more than those in group N (F = 58.974, 33.402, 19.151, 20.575, all $p < 0.01$). The rates of rescue analgesia for pain relief were 10 % and 16.7 % at 24 h and 48 h after operation respectively in group R, and those were 100 % and 100 % in group N. Compared to group N, the rates of rescue analgesia for pain relief in group R were significantly decreased (χ(2) = 49.091, 42.857, all $p < 0.01$). The incidences of post-operative nausea and vomiting, pruritus in group R were 3.3 % and 3.3 %, respectively, and those in group N were 23.3 % and 20.0 %. The incidences of nausea and vomiting, pruritus in group R were lower than those in group N (χ(2) = 5.192, 4.875, all $p < 0.01$). The overall satisfaction scores in group R (3.7 ± 1.0) were higher than those (1.9 ± 0.7) in the group N (t=7.841, $p < 0.01$). The authors concluded that the QLB combined with parecoxib sodium for multi-modal analgesia after THA was effective and provided satisfactory analgesia

McCrum et al (2018) examined the effect on immediate patient outcomes following hip arthroscopy with use of a pre-operative, single-shot QLB. These researchers retrospectively reviewed patients who underwent hip arthroscopy following a pre-operative QL block. These patients were matched by age and gender to patients who had not received a block; VAS pain scores immediately post-operatively and at the time of discharge were recorded. Hourly and overall opioid intake in the post-anesthesia care unit (PACU) was also recorded. Continuous data was analyzed with paired t-test, with significance being defined as $p < 0.05$. Complications in the immediate post-operative period were recorded, as was time from admission to PACU to discharge; 56 patients were included; 28 patients underwent QLB and 28 did not undergo a block. QLB patients required significantly less hydromorphone ($p = 0.010$) and oxycodone ($p = 0.001$) during their time in the PACU, and significantly fewer morphine equivalents overall and per hour in the PACU ($p < 0.001$). Despite receiving less opioid analgesia, QLB patients had significantly less pain immediately post-operatively (p = 0.026) and at the time of discharge (p = 0.015). The mean time to PACU discharge was 155 ± 49 mins, and there was no difference in time to discharge between groups (p = 0.295); 1 patient in the QLB group experienced persistent flank numbness. The authors concluded that hip arthroscopy patients who received a pre-operative QLB had less pain and a lower opioid requirement in PACU than those who did not receive a block. Level of Evidence: III (retrospective matched cohort study)

Stuart Green (2018) noted that THA is a common procedure being performed at an increasing rate in the United States. Recovering from this surgery to the extent that one can participate in criteria for discharge relies heavily on effective post-operative analgesia. Many regional anesthetic techniques are deployed in this realm. The recent utilization of QL blocks with success in other procedures warrants investigation in the THA population. A total of 20 patients received general anesthesia for elective THA; 10 cases included a pre-operative US-guided trans-muscular QLB with 30 cc 0.5 % ropivacaine; 10 cases that lacked this regional procedure. The primary outcome was length of hospital stay (LOS); secondary outcomes include total procedure time, intra-operative and post-operative fentanyl administration, and mean post-operative VAS (1 - 10); LOS was shorter in patients receiving QLB (2.9 days) versus patients not receiving QLB (5.1 days) (p value 0.0146). Intra-operative use of fentanyl was lower in patients receiving QLB (183.5 mcg) versus patients not receiving QLB (240 mcg) (p value 0.0376); PACU narcotic utilization, 24-hour VAS score, and length of operative procedure lacked statistical significance, though the study was not powered for these outcomes. The authors concluded that QL block employment in hip surgery produced significant reduction in LOS and intra-operative fentanyl use. These researchers stated that while QLB are rapidly becoming a popular option due to its quality and spread of analgesia, more adequately powered prospective research must be performed to appropriately elucidate significant trends

Bak et al (2020) noted that QLB, which is based on an easy fascial plane technique that has been reported to be effective in pain control after abdominal surgery. These investigators reported on a case involving an 83-year-old man (weight: 64 kg) who received continuous trans-muscular QLB as part of a multi-modal analgesia after hardware removal and THA.

The patient received continuous infusion of 0.2 % ropivacaine at 8 ml/h through an indwelling catheter in addition to patient-controlled analgesia (PCA) with intravenous fentanyl and oral celecoxib. The area of sensory blockade ranged from T8 to L3, and he received the 1st demand dose of fentanyl via the PCA pump at 17 hours after surgery. The patient's pain scores did not exceed 4, and no additional analgesics were required until post-operative day 5. The authors concluded that these findings suggested that trans-muscular QLB may be a suitable option for multi-modal analgesia after THA.

Kukreja et al (2019) compared analgesia and opioid consumption for patients undergoing primary THA with pre-operative posterior QLB with patients who did not receive QLB. The medical records of patients undergoing unilateral THA between January 1st, 2017 and March 31, 2018 were reviewed, and 238 patients were included in the study. The primary outcome was post-operative opioid consumption in the first 24 post-operative hours. Secondary outcomes were intra-operative, PACU, and 48-hour opioid consumption, post-operative VAS pain scores, and PACU-LOS. Primary and secondary end-point data were compared between patients undergoing primary THA with pre-operative posterior QLB with patients who did not receive QLB. For the patients who received QLB, the 24-hour total oral morphine equivalent (milligram) requirements were lower (53.82 mg ± 37.41), compared to the patients who did not receive QLB (77.59 mg ± 58.42), with $p = 0.0011$. Opioid requirements were consistently lower for the patients who received QLB at each additional assessment time-point up to 48 hours; VAS pain scores were lower up to 12 hours after surgery for the patients who received a posterior QLB, and the PACU-LOS was shorter for the patients who received QLB. The authors concluded that pre-operative posterior QLB for primary THA was associated with decreased opioid requirements up to 48 hours, decreased VAS pain scores up to 12 hours, and shorter PACU-LOS.

Saphenous Nerve Block for Post-Operative Pain Management

Andersen et al (2013) noted that local infiltration analgesia (LIA) reduces pain after total knee arthroplasty (TKA) without the motor blockade associated with epidural analgesia or femoral nerve block. However, the duration and efficacy of LIA are not sufficient. A saphenous nerve block, in addition to single-dose LIA, may improve analgesia without interfering with early mobilization. A total of 40 patients were included in this double-blind randomized controlled trial (RCT). All patients received spinal anesthesia for surgery and single-dose LIA during the operation. An ultrasound (US)-guided saphenous nerve catheter was placed post-operatively in the adductor canal at mid-thigh level. Patients were randomized into 2 groups to receive 15-ml boluses of either ropivacaine 7.5 mg/ml or saline twice daily for 2 post-operative days. Worst pain scores during movement on the day of surgery were significantly lower in the ropivacaine group (median [range] visual analog scale [VAS], 3 [0 to 7] versus 5.5 [0 to 10]; $p < 0.050$), as well as pain at rest (VAS, 2 [0 to 8] versus 4 [0 to 8]; $p = 0.032$). Break-through pain occurred later in the ropivacaine group (10.5 [range of 0.5 to 48] hours versus 3.4 [range of 0.5 to 24] hours; $p = 0.011$). All patients in the ropivacaine group were able to ambulate on the day of surgery versus 13 patients in the control group ($p = 0.004$). Fewer patients had sleep disturbance on the 1st post-operative night in the ropivacaine group ($p = 0.038$); and there were no differences in morphine consumption. The authors concluded that the combination of a saphenous nerve block with single-dose LIA offered better pain relief on the day of surgery than LIA alone.

In a prospective, cohort study, Elkassabany et al (2015) examined if the use of peripheral nerve blocks (PNBs) as part of an analgesic protocol for operative repair of tibia and ankle fractures could improve the quality of post-operative pain management and the quality of recovery (QOR). A total of 93 consecutive patients undergoing operative repair of fractures of the ankle and tibia were included in this trial. Interventions included administration of popliteal and saphenous nerve blocks, as part of post-operative analgesia regimen in some patients. Patients were labeled as the regional group or the no-regional group based on whether they received PNBs. Patient satisfaction and the quality of pain management were measured 24 hours after surgery using the Revised American Pain Society Patient Outcome Questionnaire. The QOR was measured at 24 and 48 hours after surgery using the short version of the Quality of Recovery Questionnaire (QOR-9). Satisfaction with pain management was significantly higher ($p = 0.005$) in the regional group when compared with the no-regional group. Average pain scores over 24 hours was similar between the 2 groups ($p = 0.07$). The regional group reported less time spent in severe pain over 24-hour period (40 versus 50 %, $p = 0.04$)

and higher overall perception of pain relief (80 versus 65 %, p = 0.003). Patients receiving regional anesthesia also demonstrated better QOR measured by the QOR-9 at 24 hours (p = 0.04) but not at 48 hours (p = 0.11). The authors concluded that patient satisfaction and the quality of post-operative pain management for the first 24 hours were better in patients who received PNBs as part of their post-operative analgesic regimen when compared with patients who received only systemic analgesia. Level of Evidence = II.

Jarrell et al (2018) noted that the increasing scope and complexity of foot and ankle procedures performed in an out-patient setting require more intensive peri-operative analgesia. Regional anesthesia (popliteal and saphenous nerve blocks) has been proven to provide satisfactory pain management, decreased post-operative opioid use, and earlier patient discharge. This can be further augmented with the placement of a continuous-flow catheter, typically inserted into the popliteal nerve region. These investigators examined the use of a combined popliteal and saphenous continuous-flow catheter nerve block compared to a single popliteal catheter and single-injection saphenous nerve block in post-operative pain management after ambulatory foot and ankle surgery. A prospective study was conducted using 60 patients who underwent foot and ankle surgery performed in an out-patient setting. Demographic data, degree of medial operative involvement, American Society of Anesthesiologists physical classification system, anesthesia time, and post-anesthesia care unit time were recorded. Outcome measures included pain satisfaction, numeric pain scores (NPS) at rest and with activity, and opioid intake. Patients were also classified by degree of saphenous nerve involvement in the operative procedure, by the surgeon who was blinded to the anesthesia randomization. Patients in the dual-catheter group took significantly less opioid medication on the day of surgery and post-operative day 1 (POD 1) compared to the single-catheter group (p = 0.02). The dual-catheter group reported significantly greater satisfaction with pain at POD 1 and POD 3 and a significantly lower NPS at POD 1, 2, and 3. This trend was observed in all 3 subgroups of medial operative involvement. The authors concluded that patients in the single-catheter group reported more pain, less satisfaction with pain control, and increased opioid use on POD 1, suggesting dual-catheter use was superior to single-injection nerve blocks with regard to managing early post-operative pain in out-patient foot and ankle surgery. Level of Evidence = II.

Bjorn et al (2018) stated that major ankle surgery causes intense post-operative pain, and whereas the importance of a sciatic nerve block is well established, the clinical significance of a supplemental saphenous nerve block has never been determined in a prospective, randomized, double-blind, placebo-controlled trial. These researchers hypothesized that a saphenous nerve block reduces the proportion of patients experiencing significant clinical pain after major ankle surgery. A total of 18 patients were enrolled and received a popliteal sciatic nerve block. Patients were randomized to single-injection saphenous nerve block with 10 ml 0.5 % bupivacaine with 1:200,000 epinephrine or 10 ml saline. Primary outcome was the proportion of patients reporting significant clinical pain, defined as a score greater than 3 on the numerical rating scale (NRS); secondary outcomes were maximal pain and analgesia of the cutaneous territory of the infra-patellar branch of the saphenous nerve; 8 of 9 patients in the placebo group reported significant clinical pain versus 1 of 9 patients in the bupivacaine-epinephrine group ($p = 0.003$). Maximal pain was significantly lower in the active compared with the placebo group (median, 0 [0 to 0] versus 5 [4 to 6]; $p = 0.001$). Break-through pain from the saphenous territory began within 30 mins after surgery in all cases. Sensory testing of the cutaneous territory of the infra-patellar branch of the saphenous nerve showed correlation between pain reported in the antero-medial ankle region and the intensity of cutaneous sensory block in the antero-medial knee region. The authors concluded that the saphenous nerve is an important contributor to post-operative pain after major ankle surgery, with significant clinical pain appearing within 30 mins after surgery.

Furthermore, an UpToDate review on “Lower extremity nerve blocks: Techniques” (Jeng and Rosenblatt, 2020) states that “Saphenous nerve block – The saphenous nerve can be blocked below the knee for surgery of the lower leg and ankle using an anatomic approach. Perineural catheters are not used for saphenous nerve block below the knee … Side effects and complications – The degree to which adductor canal blocks preserve the function of the quadriceps muscle, and therefore the ability to safely ambulate postoperatively, is controversial. A number of studies have reported that these blocks result in little or no quadriceps weakness, in particular compared with femoral nerve block. However, quadriceps paralysis has been reported after adductor canal block. Therefore, patients should be monitored for motor strength to reduce the risk of fall … The saphenous nerve block is useful for surgeries of the superficial, medial lower leg and provides analgesia of the medial ankle and foot”.

Serratus Anterior Plane Block for the Management of Post-Operative Pain / Post-Thoracotomy Pain

Vig et al (2019) noted that post-thoracotomy pain is one of the most severe forms of post-operative pain. Anesthetists usually manage post-thoracotomy pain with an epidural or para-vertebral block. However, both of these techniques have their limitations; US-guided inter-fascial plane block like serratus anterior plane block (SAPB) is a new concept and is proposed to provide analgesia to the hemithorax. These investigators reported their experience with 10 thoracotomy cases where this block was used as a post-operative analgesic technique. Patients undergoing pulmonary mastectomy or lobectomy received US-guided SAPB between the serratus anterior and the external intercostal muscles with 0.25 % ropivacaine, and a catheter was inserted. Post-operatively, 0.125 % ropivacaine with fentanyl (1 ug/ml) was given as infusion at 5 to7 ml/hour. Other analgesics were paracetamol and diclofenac. Fentanyl infusion at 0.25 ug/kg/hour was the rescue analgesic if pain persisted; 4 out of 10 patients required fentanyl infusion. Uncontrolled pain in 2 of these patients was at the intercostal drain site; in the 3rd patient, 2 ribs were resected; and in the 4th patient, there was poor drug spread and the catheter could not be placed in the desired plane due to poor muscle mass. The catheter was kept in-situ for a minimum of 48 hours to a maximum of 6 days after surgery. The authors concluded that SAPB could be an attractive option for post-thoracotomy analgesia.; further studies can take the help of the surgeon for catheter placement in the desired plane at the time of wound closure to ensure adequate drug spread.

Wang et al (2019) stated that reports of post-operative pain treatment after uni-portal video-assisted thoracoscopic surgery (VATS) are limited. Thoracic para-vertebral block and SAPB have been described recently in pain management after thoracic surgery. A comparison between these 2 blocks for post-operative analgesia after uni-portal VATS has not been previously reported. In a retrospective, propensity-matched study, these researchers compared the analgesic benefits of SAPB and thoracic para-vertebral block after uni-portal VATS and examined the 2 block types for non-inferiority. From December 2015 to May 2018, a total of 636 relevant records of patients who underwent uni-portal VATS under general anesthesia alone or with the addition of SAPB or thoracic para-vertebral block performed pre-operatively were identified. A propensity-matched analysis incorporating pre-operative variables was used to compare the efficacy of post-operative analgesia in 3 groups. A total of 123 patients were identified for analysis. Propensity score matching resulted in 41 patients in each group. The VAS scores were significantly lower in the SAPB group and the thoracic para-vertebral block group than in the control group at the 1st, 2nd, 4th, and 6th post-operative hours. Cumulative opioid consumption was significantly lower in the SAPB and thoracic para-vertebral block groups than in the control group at 6 hours (18.3 ± 3.1 mg, 18.7 ± 3.9 mg versus 21.5 ± 4.4 mg; $p = 0.001$) and 24 hours (43.4 ± 7.3 mg, 42.5 ± 7.7 mg versus 49.3 ± 8.8 mg; $p < 0.001$) post-operatively. The SAPB group was non-inferior to the thoracic para-vertebral block group on pain score and opioid consumption. The authors concluded that the findings of this study suggested that in patients undergoing uni-polar VATS, the addition of single-injection SAPB or thoracic para-vertebral block was associated with early analgesic benefits, including a reduction in post-operative opioid consumption and VAS score. These researchers stated that SAPB was as effective as thoracic para-vertebral block in reducing post-operative pain. Compared to thoracic para-vertebral block, SAPB is advantageous due to its relative ease of application. Moreover, they stated that although SAP block could be an effective therapeutic option for post-operative uni-polar VATS analgesia, further prospective, large-scale, randomized controlled trials are needed to examine the efficacy of and indications for SAPB.

In a randomized controlled trial, Reyad et al (2020) examined US-guided SAPB versus patient-controlled analgesia (PCA) on the emergence of post-thoracotomy pain syndrome (PTPS) after thoracotomies for thoracic tumors. This trial included 89 patients with chest malignancies, scheduled for thoracotomy were randomly allocated into 2 groups: Group A "PCA-group; n = 44" receiving patient-controlled analgesia; and group B "SAPB group; n = 45" where analgesia was provided by SAPB. The primary outcome measure was the assessment for the possible emergence of PTPS at 12 weeks. The secondary outcome measures were pain relief measured using VAS score. Quality of life (QOL) was assessed using Flanagan QOL Scale (QOLS) and activity level was assessed using Barthel Activity of daily living (ADL) score. At week 8, PTPS incidence was significantly (p = 0.037) higher in the PCA group (45 %) than in the SAPB group (24 %) with a relative risk (RR) of 1.38 and 95 % confidence interval (CI): 1.01 to 1.9; while the incidence of PTPS at week 12 was significantly (p = 0.035) higher in the PCA group (43 %) than in the SAPB group (22 %) with a RR of 2.38 and 95 % CI: 1.23 to 4.57. The need for pain therapy in PTPS patients was significantly lower in the SAPB group (17.7 %) than the PCA group (38.6 %) (p = 0.028) at week 12. Pain intensity: VAS-R and VAS-D (pain scores at rest and with activity, respectively) was comparable (p > 0.05) between both groups at 6, 12, 18 and 24 hours, however VAS was significantly higher in the PCA group at week 8 (p = 0.046) and week 12 (p = 0.032). Both groups were comparable regarding ADL and QOL scores (p > 0.05). The authors concluded that SAPB is assumed to be a good alternative for post-thoracotomy analgesia following thoracotomies. The current work hypothesized that SAPB for a week post-operatively, may reduce the emergence of PTPS and may reduce the demand for pain therapy in those patients.

Furthermore, an UpToDate review on “Thoracic nerve block techniques” (Rosenblatt and Lai, 2020) states that “Thoracic interfascial plane blocks include the Pecs I, Pecs II, serratus plane (SP), transversus thoracic muscle plane (TTMP), and erector spinae (ESP) blocks. These blocks can be utilized for superficial and deep surgery in the chest wall and axillary regions (e.g., mastectomy, cosmetic breast surgery, chest tube placement, multiple rib fractures). We suggest the use of ultrasound guidance for TPVB and the interfascial plane blocks of the chest (Grade 2C), to increase the success rate and reduce complications”.

Spinal Accessory Nerve Block for Post-Operative Pain Control

An UpToDate review on “Management of acute perioperative pain” (Mariano, 2020) does not mention spinal accessory nerve block as a management option.

Suprascapular Nerve Block for Adhesive Capsulitis and Low Back Pain

Trescot (2003) cryo-neuroablation, also known as cryo-analgesia or cryo-neurolysis, is a specialized technique for providing long-term pain relief in interventional pain management settings. Modern cryo-analgesia traces its roots to Cooper et al who developed in 1961, a device that used liquid nitrogen in a hollow tube that was insulated at the tip and achieved a temperature of - 190 degrees C. Lloyd et al proposed that cryo-analgesia was superior to other methods of peripheral nerve destruction, including alcohol neurolysis, phenol neurolysis, or surgical lesions. The application of cold to tissues creates a conduction block, similar to the effect of local anesthetics. Long-term pain relief from nerve freezing occurs because ice crystals create vascular damage to the vaso-nervorum, which produces severe endo-neural edema. Cryo-analgesia disrupts the nerve structure and creates Wallerian degeneration, but leaves the myelin sheath and endoneurium intact. Clinical applications of cryo-analgesia extend from its use in cranio-facial pain secondary to trigeminal neuralgia, posterior auricular neuralgia, and glossopharyngeal neuralgia; chest wall pain with multiple conditions including post-thoracotomy neuromas, persistent pain after rib fractures, and post herpetic neuralgia (PHN) in thoracic distribution; abdominal and pelvic pain secondary to ilio-inguinal, ilio-hypogastric, genito-femoral, sub-gastric neuralgia; pudendal neuralgia; low back pain (LBP) and lower extremity pain secondary to lumbar facet joint pathology, pseudo-sciatica, pain involving intra-spinous ligament or supra-gluteal nerve, sacroiliac joint pain, cluneal neuralgia, obturator neuritis, and various types of peripheral neuropathy; and upper extremity pain secondary to suprascapular neuritis and other conditions of peripheral neuritis. The authors described historical concepts, physics and equipment, various clinical aspects, along with technical features, indications and contraindications, with clinical description of multiple conditions amenable to cryo-analgesia in interventional pain management settings.

Furthermore, UpToDate reviews on “Treatment of acute low back pain” (Knight et al, 2020), “Subacute and chronic low back pain: Nonpharmacologic and pharmacologic treatment” (Chou, 2020a), “Subacute and chronic low back pain: Nonsurgical interventional treatment" (Chou, 2020b), and "Exercise-based therapy for low back pain" (Hartigan and Bernard, 2020) do not mention suprascapular nerve block as a management / therapeutic option.

Favejee et al (2011) stated that a variety of therapeutic interventions is available for restoring motion and diminishing pain in patients with frozen shoulder (FS). An overview article concerning the evidence for the effectiveness of these interventions is lacking. These researchers provided an evidence-based overview regarding the effectiveness of conservative and surgical interventions in the treatment of frozen shoulder. The Cochrane Library, PubMed, Embase, Cinahl and Pedro were searched for relevant systematic reviews and randomized clinical trials (RCTs); 2 reviewers independently selected relevant studies, assessed the methodological quality and extracted data. A best-evidence synthesis was used to summarize the results. A total of 5 Cochrane reviews and 18 RCTs were included studying the effectiveness of oral medication, injection therapy, physiotherapy, acupuncture, arthrographic distension and SSNB. The authors found strong evidence for the effectiveness of steroid injections and laser therapy in short-term and moderate evidence for steroid injections in mid-term follow-up. Moderate evidence was found in favor of mobilization techniques in the short- and long-term, for the effectiveness of arthrographic distension alone and as an addition to active physiotherapy in the short-term, for the effectiveness of oral steroids compared with no treatment or placebo in the short-term, and for the effectiveness of SSNB compared with acupuncture, placebo or steroid injections. For other commonly used interventions no or only limited evidence of effectiveness was found. Most of the included studies reported short-term results, whereas symptoms of frozen shoulder may last up to 4 years. The authors concluded that high quality RCTs studying long-term results are needed in this field.

Wang et al (2020) noted that SSNB is reported to treat FS effectively. However, all conclusions drawn were based on the individual study, and there are still inconsistent conclusions regarding this issue. In addition, no systematic review performed this topic. These researchers will systematically and comprehensively examine the safety and effectiveness of SSNB in treating FS. This study will incorporate studies relevant to SSNB on FS. Articles will be searched in the electronic data-bases (Medline, Embase, CINAHL, Web of Science, PsycINFO, Cochrane Library, WANGFANG, and CNKI) from inception to the present. In addition, this study will also retrieve conference proceedings and reference lists of included studies. All literature source searches will not be restricted by date and language. The Cochrane Risk of Bias Tool will be utilized to evaluate the quality of retrieved trials. Data will be collected independently by 2 authors. All collected data will be analyzed by RevMan 5.3 software. This study will synthesize the most recent published high quality trials in evaluating the safety and effectiveness of SSNB in treating FS. The authors concluded that the findings of this study may provide evidence to determine whether SSNB is effective or not in treating FS; inform policy-makers in developing appropriate guidelines for patients with FS; and guide future research concerned this issue.

Furthermore, an UpToDate reviews on “Frozen shoulder (adhesive capsulitis)” (Prestgaard, 2020) does not mention suprascapular nerve block as management / therapeutic options.

Cervical Plexus Block for Post-Operative Pain Control After Clavicle Open Reduction and Internal Fixation / Shoulder Surgery

Kline (2013) noted that treating the pain that patients experience from repair of distal clavicle fracture can be a challenge for the anesthesia provider, possibly because of the dual innervation in this region. Dual innervations of the distal clavicular region also make selecting the correct regional block difficult. The author described the first successful use of 2 separate ultrasound (US)-guided perineural catheters (combined superficial cervical plexus and selective C5 nerve root) placed for the purpose of treating distal clavicle pain and maintaining the analgesia. This technique also allowed for the preservation of distal motor control in the affected limb.

Musso et al (2017) stated that interscalene brachial plexus block is currently the gold standard for intra- and post-operative pain management for patients undergoing arthroscopic shoulder surgery. However, it is associated with block related complications, of which effect on the phrenic nerve have been of most interest. Side effects caused by general anesthesia, when this is required, are also a concern. These researchers hypothesized that the combination of superficial cervical plexus block, suprascapular nerve block, and infraclavicular brachial plexus block would provide a good alternative to interscalene block and general anesthesia. A total of 20 adult patients scheduled for arthroscopic shoulder surgery received a combination of superficial cervical plexus block (5 ml ropivacaine 0.5 %), suprascapular nerve block (4 ml ropivacaine 0.5 %), and lateral sagittal infraclavicular block (31 ml ropivacaine 0.75 %). The primary objective was to find the proportion of patients who could be operated under light propofol sedation, without the need for opioids or artificial airway; secondary objectives were patients' satisfaction and surgeons' judgment of the operating conditions; 19 of the 20 patients (95 % confidence interval [CI]: 85 to 100) underwent arthroscopic shoulder surgery with light propofol sedation, but without opioids or artificial airway. The excluded patient was not comfortable in the beach chair position and received general anesthesia. All patients were satisfied with the treatment on follow-up interviews. The surgeons rated the operating conditions as good for all patients. The authors concluded that the novel combination of a superficial cervical plexus block, a suprascapular nerve block, and an infraclavicular nerve block provided an alternative anesthetic modality for arthroscopic shoulder surgery. This study did not address the use of this novel combination for post-operative pain management.

Ho and De Paoli (2018) noted that there is a paucity of research on use of superficial cervical plexus block (SCPB) in the emergency department (ED). In a prospective, non-randomized, observational study, these researchers characterized the feasibility, safety, and potential for efficacy of US-guided SCPB in a convenience sample of ED patients presenting with painful conditions of the "cape" distribution of the neck and shoulder. Data were gathered prospectively on a convenience sample of 27 patients presenting to a community ED with painful conditions involving the distribution of the SCPB: para-cervical muscle spasm/pain (n = 8), clavicle fractures (n = 7), acromioclavicular joint injuries (n = 3), radicular pain (n = 3), and rotator cuff disorders (n = 6). Pre- and post-block 11-point verbal numeric pain scores (VNPS) were recorded, as was the incidence of any immediate complications. A retrospective chart review looked for delayed complications in the 14-day post-block period. The mean 11-point VNPS reduction was 5.4 points (62 %). There were no early serious complications and 1 case each of self-limiting vocal hoarseness and asymptomatic hemi-diaphragmatic paresis. No delayed block-related complications were found. The authors concluded that while limited by the fact that this was a non-randomized observational experience with no control group, these findings suggested that SCBP may be safe and have potential for efficacy, and warrants further evaluation in a randomized controlled trial (RCT). Again, this study did not address the use of cervical plexus block for post-operative pain management.

Hakim et al (2019) examined the safety and effectiveness of superficial cervical plexus (SCP) block in oral and maxillofacial surgical (OMFS) practice as an alternative to general anesthesia in selective cases. The total number of patients was 10, out of which 6 were male and 4 were female patients. Five patients had incision and drainage of peri-mandibular space infections, 2 patients had enucleation of cyst in the body of mandible, 1 patient had open reduction and internal fixation (ORIF) isolated angle fracture, and 2 patients had submandibular lymph node biopsies. Informed written consent were obtained from the patients after they had the procedure explained to them. Medically compromised patients and those who were excessively anxious and apprehensive, patient who did not want the procedure to be done under regional anesthesia, and patients with a history of allergy to local anesthetic were excluded. All patients had their surgical procedures under regional anesthesia (SCP block with supplemental nerve blocks) performed by the same surgeon under the supervision of anesthesiologist with continuous monitoring. SCP block with concomitant mandibular nerve and long buccal nerve block had a high success rate, low complication rate, and high patient acceptability as shown in the study. The authors concluded that SCP block anesthesia was a safe and useful anesthetic technique with the low risk of accidents and complications; therefore, a good alternative for regional anesthesia in selected cases in oral and maxillofacial surgery.

Baran et al (2020) stated that clavicle fractures occur in 35 % of shoulder girdle fractures. Surgical fixation is preferred, especially in young patients for optimal functional outcomes, while non-displaced fractures are usually treated conservatively. These investigators presented the case of a 38-year old man who was admitted to the emergency services with a fracture of the left clavicle following a fall. During the pre-operative evaluation, the patient requested to be awake during the surgery. Combined supraclavicular and superficial cervical plexus block was performed under US guidance without complications and the patient experienced no pain. The authors concluded that this technique may avoid possible complications related to interscalene brachial plexus block; and future studies are needed to confirm the safety and efficacy of this approach. Also, this study did not address the use of cervical plexus block for post-operative pain management.

Furthermore, an UpToDate review on “Anesthesia for orthopedic trauma” (Enneking et al, 2021) states that “Proximal upper extremity orthopedic injuries include clavicle fractures, acromioclavicular joint injuries, shoulder dislocations, and proximal humerus fracture. Choice of anesthetic technique – General anesthesia is required for surgery for proximal and mid clavicle fracture. The distal clavicle and the anterior superior shoulder are innervated by both the cervical plexus and the brachial plexus. Interscalene block (ISB) can be used for distal clavicle or shoulder surgery, since it may include the supraclavicular branch of the superficial cervical plexus. If a very low volume of local anesthetic (LA) solution is used for ISB to avoid phrenic nerve block, the superficial cervical plexus may be missed, and a separate injection may be required. A consequence of lower LA volume is that the superficial cervical plexus may be missed, and a separate injection may be required. In practice, general anesthesia is often preferred by patients and clinicians because the surgical field is very close to the face and airway”. The UTD review does not mention cervical plexus block as an option.

Cervical Plexus Block for the Treatment of Chronic Radicular Pain/Post-laminectomy Syndrome

In a prospective, randomized, observer-blinded study, Tran et al (2010) compared US guidance and the conventional landmark-based technique for superficial cervical plexus block (CPB). A total of 40 patients were randomly allocated to receive a block of the superficial cervical plexus using US guidance (n = 20) or the traditional landmark-based technique (n = 20). The main outcome, success, was defined as the absence of cold sensation for all 4 branches of the superficial cervical plexus at 15 mins. A blinded observer recorded success rate, onset time, block-related pain scores, and the incidence of complications. Performance time and the number of needle passes were also recorded during the performance of the block. Total anesthesia-related time was defined as the sum of performance and onset times. Success rate (80 % to 85 %) was similar between the 2 groups. Performance time was slightly longer with US (119 versus 61 sec, $p < 0.001$); however, no differences in onset and total anesthesia-related times were found. There were also no differences in the number of passes and procedural discomfort. The authors concluded that US guidance did not increase the success rate of superficial CPB compared with a landmark-based technique; additional confirmatory trials are needed.

Alilet et al (2017) stated that the value of US guidance for intermediate cervical blocks in patients undergoing carotid artery endarterectomy is poorly described. In a single-center, randomized-controlled trial (RCT), these researchers compared the efficacy of US-guided intermediate cervical block to superficial cervical block for carotid artery endarterectomies. This study was carried out in a French University Hospital, from April 2011 to March 2012. The anesthesia technique was randomly allocated to patients scheduled for carotid artery endarterectomy under regional anesthesia (ropivacaine 4.75 mg/ml): superficial cervical block in the Control group, and US-guided intermediate cervical block in the Echo group. The main outcome measure was the percentage of surgery performed without supplemental topical anesthesia; and the secondary outcomes were: rate of conversion to general anesthesia, amount of supplemental topical lidocaine and block-related complications; $p < 0.05$ was considered significant. Demographic data for the 86 patients included [mean (SD) age of 73 (11) years] did not differ between groups. Surgery was performed without supplemental topical lidocaine in 23 % and 7 % of the patients in the Echo and Control groups, respectively ($p = 0.068$). Conversion to general anesthesia for inadequate analgesia was needed in 0 and 2 patients in the Echo and Control groups, respectively. The mean dose of topical lidocaine was not different between groups. No complication directly related to a cervical block was observed. The authors concluded that US-guided intermediate CPB and superficial cervical blocks performed for carotid artery surgery appeared to provide similar results, however, this study was probably under-powered to detect any difference.

Peng et al (2020) noted that scalp nerve block has been proven to be an alternative choice to opioids in multi-modal analgesia. However, for the infra-tentorial space-occupying craniotomy, especially the sub-occipital retro-sigmoid craniotomy, scalp nerve block is insufficient. The study is a prospective, single-center, randomized, paralleled-group controlled trial. Patients scheduled to receive elective suboccipital retro-sigmoid craniotomy will be randomly assigned to the superficial CPB group or the control group. After anesthesia induction, superficial CPB will be performed under US guidance. The primary outcome is the cumulative consumption of sufentanil by the patient-controlled intravenous analgesia pump within 24 hours after surgery. Secondary outcomes include the cumulative consumption of sufentanil at other 4 time-points and numerical rating scale (NRS) pain severity score. The protocol (version number: 2.0, April 19, 2019) has been approved by the Ethics Review Committee of China Registered Clinical Trials (Ethics Review No. ChiECRCT-20190047). The findings of this study will be disseminated in peer-reviewed journals and at scientific conferences.

UpToDate review on “Scalp block and cervical plexus block techniques” (Rosenblatt and Lai, 2021) states that “Deep cervical plexus block technique – The deep cervical plexus block can be thought of as a cervical paravertebral block that targets the C2 to C4 spinal nerves. The patient is positioned supine, with the head slightly away from the side to be blocked. We suggest using ultrasound guidance for deep cervical plexus block to avoid neuraxial and vascular complications … Superficial and deep cervical plexus blocks anesthetize the anterior and lateral neck and scalp. These blocks are particularly useful for awake carotid endarterectomy, in which neurologic monitoring of an awake patient may identify cerebral thromboembolic or ischemic events. They can also be used for postoperative analgesia for neck surgery … Superficial or intermediate cervical plexus block is usually preferred, rather than deep cervical plexus block, because the more superficial blocks are easier to perform, usually more effective, and are associated with less complications than deep cervical plexus block“.

Cluneal Nerve Block for the Treatment of Chronic Pelvic Pain

An UpToDate review on “Chronic pelvic pain in adult females: Treatment” (Tu and As-Sanie, 2021) does not mention cluneal nerve block as a management / therapeutic option. Furthermore, an UpToDate review on “Overview of peripheral nerve blocks” (Jeng and Rosenblatt, 2021a) does not mention chronic pelvic pain or cluneal nerve block.

Combined Infraclavicular-Suprascapular Nerve Blocks for Post-Operative Pain Control After Arthroscopic Shoulder Surgery

In a randomized trial, Aliste et al (2018) examined combined infraclavicular-suprascapular blocks (ICB-SSBs) as a diaphragm-sparing alternative to interscalene blocks (ISBs) for arthroscopic shoulder surgery. These researchers hypothesized that ICB-SSB would provide equivalent post-operative analgesia to ISB 30 mins after surgery without the risk of hemi-diaphragmatic paralysis. Following research ethics board approval and written informed consent, participants in the ISB group received an US-guided ISB with 20 ml of levobupivacaine 0.25 % and epinephrine 5 μg·ml-1. In the ICB-SSB group, US-guided ICB (20 ml) and SSB (10 ml) were carried out using the same local anesthetic; 30 mins after the block was performed, a blinded investigator assessed the presence of hemi-diaphragmatic paralysis. Subsequently, all patients underwent general anesthesia. Post-operatively, a blinded investigator recorded pain scores at rest at 0.5, 1, 2, 3, 6, 12 and 24 hours. Consumption of intra- and post-operative narcotics was also tabulated. Compared to its ICB-SSB counterpart, the ISB group displayed non-equivalent (i.e., lower) post-operative pain scores at 30 mins (difference of the medians, -4; 99 % confidence interval [CI]: -6 to -3), required less cumulative morphine iv at 24 hours (difference of the means, -6.1 mg; 95 % CI: -10.5 to -1.6), and resulted in a higher incidence of hemi-diaphragmatic paralysis (18/20 versus 0/20 patients, respectively; $p < 0.001$). Although post-operative pain scores at 1, 2, and 3 hours appeared lower in the ISB group, the upper bounds of the 99 % CIs did not exceed the equivalence margin. The authors concluded that compared with ICB-SSB, ISB provided non-equivalent (i.e., lower) post-operative pain scores 30 mins after arthroscopic shoulder surgery. Thus, post-operative analgesia was comparable between the 2 groups.

Genitofemoral Nerve Block for the Treatment of Chronic Pelvic / Suprapubic Pain

Kothari (2007) stated that despite a multi-disciplinary approach, intractable chronic pelvic pain (CPP) is challenging to treat. Every structure in the abdomen and/or pelvis could have a role in the etiology of CPP. Management of CPP may require a combination of interventions, including pharmacological, physical and psychological therapy. Interventions suggested to-date include nerve blocks (ilio-inguinal, ilio-hypogastric, genito-femoral, hypogastric, pre-sacral) and trigger point injections, radiofrequency treatments, spinal cord stimulation (SCS), sacral root stimulation, sacral magnetic stimulation and sacral stimulation via tibial nerve. Peripheral nerve stimulation (PNS) has been particularly successful in the treatment of mononeuropathies. Indications for targeted stimulation include localized pain in non-dermatomal distribution. The epicenter of the site of pain (target) is stimulated either transcutaneously or percutaneously or via permanent neuromodulating implant. Targeted and PNS probably are under-used treatment modalities given the simplicity of the technique. The introduction of a stimulating electrode directly to the center of peripherally affected, painful areas, thereby bypassing the spinal cord and peripheral nerves is a novel simple procedure with effectiveness in the control of intractable neuropathic pain. Development of newer devices and miniaturization of electrodes will play a role in refinement and further simplification of subcutaneous neuromodulation.

Furthermore, an UpToDate review on “Chronic pelvic pain in adult females: Treatment” (Tu and As-Sanie, 2021) does not mention genitofemoral nerve block as a management / therapeutic option.

Ilioinguinal Nerve Block for Chronic Pelvic Pain Syndrome

UpToDate reviews on “Chronic prostatitis and chronic pelvic pain syndrome” (Pontari, 2021), and “Chronic pelvic pain in adult females: Treatment” (Tu and As-Sanie, 2021) do not mention ilioinguinal nerve block as a management / therapeutic option.

Infraclavicular Nerve Block for the Treatment of Chronic Pain

Day et al (2004) noted that complex regional pain syndrome type 1 (CRPS 1) is a perplexing chronic pain condition that frustrates physicians and patients alike. The etiology of the condition resides in multiple theories and diagnosis can be difficult. Therapy focuses on pain management and restoration of physical function. Conservative treatment includes both non-pharmacological and pharmacological methods. Invasive therapy centers on sympathetic and somatic blocks and may evolve to neuro-modulatory or neuraxial techniques. In patients with severe pain and extremity contractures with CRPS, often times the invasive blocks help in reduction of resting pain, but are ineffective in alleviating pain related to aggressive physical therapy. Continuous regional blockade with a percutaneous catheter is an effective, but seldom reported technique that can be used to treat both resting and movement-related pain. These investigators reviewed the results of an infraclavicular brachial plexus infusion used to treat CRPS 1 that developed in a 49-year old woman following a work-related upper extremity injury. The patient made a dramatic recovery with the infusion, which was maintained for 2 weeks. A T2 to T3 sympathetic radiofrequency (RF) thermocoagulation was then performed to maintain pain relief and the infusion was stopped. The patient returned to work and has done well over the ensuing 19 months.

Buttner and Meier (2006) stated that peripheral regional blocks are not only appropriate for intra-operative anesthesia. More and more, they become popular for post-operative analgesia after painful operations of the extremities. For this reason in this article only techniques were presented, which were suitable as well for a "single shot" block as for a continuous technique with an indwelling catheter. In detail the interscalene technique according to Meier, the infraclavicular block according to Kilka, Geiger, and Mehrkens (or alternatively according to Raj, modified by Borgeat) and the perivascular axillary brachial plexus block were described. The continuous technique of the block of the suprascapular nerve was very helpful in patients with chronic pain in the shoulder, if no surgery is performed. The authors were very interested in a praxis relevant description of the techniques including numerous "tips and tricks".

Ilfeld et al (2013) stated that there is currently no reliable treatment for phantom limb pain (PLP). Chronic PLP and associated cortical abnormalities may be maintained from abnormal peripheral input, raising the possibility that a continuous peripheral nerve block (CPNB) of extended duration may permanently reorganize cortical pain mapping, thus providing lasting relief. In a pilot study, 3 men with below-the-knee (n = 2) or below-the-elbow (n = 1) amputations and intractable PLP received femoral/sciatic or infraclavicular perineural catheter(s), respectively. Subjects were randomized in a double-masked fashion to receive perineural ropivacaine (0.5 %) or normal saline for over 6 days as out-patients using portable electronic infusion pumps. Four months later, subjects returned for repeated perineural catheter insertion and received an ambulatory infusion with the alternate solution ("cross-over"). Subjects were followed for up to 1 year. By chance, all 3 subjects received saline during their initial infusion and reported little change in their PLP; 1 subject did not receive cross-over treatment, but the remaining 2 subjects reported complete resolution of their PLP during and immediately following treatment with ropivacaine. One subject experienced no PLP recurrence through the 52-week follow-up period and the other reported mild PLP occurring once each week of just a small fraction of his original pain (pre-treatment: continuous PLP rated 10/10; post-treatment: no PLP at baseline with average of 1 PLP episode each week rated 2/10) for 12 weeks (lost to follow-up thereafter). The authors concluded that a prolonged ambulatory CPNB may be a reliable treatment for intractable PLP. These researchers stated that the findings of this pilot study suggested that a large, randomized clinical trial is needed.

Furthermore, an UpToDate review on “Upper extremity nerve blocks: Techniques” (Jeng and Rosenblatt, 2021b) states that “Infraclavicular block – The infraclavicular approach is a block of the brachial plexus at the level of the cords (lateral, posterior, and medial). Like the supraclavicular block, it provides anesthesia for surgeries of the distal two-thirds of the arm and consistently blocks the axillary and musculocutaneous nerves. Compared with supraclavicular blocks, this approach is more often used for placement of indwelling catheters since the infraclavicular site provides improved efficacy, stable positioning, and easier catheter care”. This review does not mention the use of infraclavicular block for the management of chronic pain.

IPACK Nerve Block for Post-Operative Pain Control After Knee Arthroscopy / Medial Meniscectomy

Sehmbi et al (2019) noted that adductor canal block (ACB) has emerged as an effective analgesic regional technique for major knee surgeries in the past 10 years. Its motor-sparing properties make it particularly attractive for ambulatory knee surgery, but evidence supporting its use in ambulatory arthroscopic knee surgery is conflicting. In a systematic review and meta-analysis, these researchers examined the analgesic effects of ACB for ambulatory arthroscopic knee surgeries. They carried out a comprehensive search of electronic databases for randomized controlled trials (RCTs) examining the analgesic effects of ACB compared to control or any other analgesic modality. Both minor arthroscopic and anterior cruciate ligament reconstruction (ACLR) surgeries were considered. Rest and dynamic pain scores, opioid consumption, opioid-related adverse effects, time to first analgesic request, patient satisfaction, quadriceps strength, and block-related complications were evaluated. Data were pooled using random-effects modeling. The search yielded 10 RCTs comparing ACB with placebo or femoral nerve block (FNB); these were sub-grouped according to the type of knee surgery. For minor knee arthroscopic surgery, ACB provided reduced post-operative resting pain scores by a mean difference (95 % confidence interval [CI]) of -1.46 cm (-2.03 to -0.90) ($p < 0.00001$), -0.51 cm (-0.92 to -0.10) ($p = 0.02$), and -0.48 cm (-0.93 to -0.04) ($p = 0.03$) at 0, 6, and 8 hours, respectively, compared to control. Dynamic pain scores were reduced by a mean difference (95 % CI of -1.50 cm (-2.10 to -0.90) ($p < 0.00001$), -0.50 cm (-0.95 to -0.04) ($p = 0.03$), and -0.59 cm (-1.12 to -0.05) ($p = 0.03$) at 0, 6, and 8 hours, respectively, compared to control. ACB also reduced the cumulative 24-hour oral morphine equivalent consumption by -7.41 mg (-14.75 to -0.08) ($p = 0.05$) compared to control. For ACLR surgery, ACB did not provide any analgesic benefits and did not improve any of the examined outcomes, compared to control. ACB was also not different from FNB for these outcomes. The authors concluded that after minor ambulatory arthroscopic knee surgery, ACB provided modest analgesic benefits, including improved relief for rest pain, and reduced opioid consumption for up to 8 and 24 hours, respectively. The analgesic benefits of ACB were not different from placebo or FNB after ambulatory ACLR, suggesting a limited role of both blocks in this procedure. Moreover, these investigators stated that the paucity of trials dictated cautious interpretation of these findings. They stated that future studies are needed to determine the role of ACB in the setting of local anesthetic instillation and/or graft donor-site analgesia.

Abdallah et al (2019) stated that ambulatory arthroscopic ACLR is associated with moderate pain, even when non-opioid oral analgesics such as acetaminophen and non-steroidal anti-inflammatory drugs (NSAIDs) are used. Regional analgesia (RA) could supplement non-opioid oral analgesics and reduce post-operative opioid requirements; however, the choice of regional analgesia technique ACLR remains controversial; FN, ACB, and local instillation analgesia have all been proposed and are supported by some evidence from RCTs. Consequently, RA practice in patients undergoing ACLR remains mixed. Published systematic reviews were used to identify the RA modality that would provide a balance between analgesic efficacy and associated potential risks in the setting of non-opioid multi-modal analgesic strategies. Based on the evidence available, local instillation analgesia provides the best balance of analgesic efficacy and associated risks (strong recommendation, moderate level of evidence) when used as a component of multi-modal analgesic technique in the first 24 hours after outpatient arthroscopic ACLR. In the absence of local instillation analgesia, clinicians might use ACB or FNB (weak recommendation, weak level of evidence). These recommendations have been endorsed by the Society of Ambulatory Anesthesia and approved by its board of directors.

Xin et al (2020) noted that ACB provides post-operative pain relief as effectively as FNB does, and it preserves the strength of the quadriceps femoris. However, its effect on rehabilitation after arthroscopic partial meniscectomy has not been reported. These researchers examined the effect of pre-operative ACB and FNB on the quality of rehabilitation after arthroscopic partial meniscectomy. A total of 150 patients undergoing arthroscopic partial meniscectomy were randomly allocated to the FNB group (receiving 0.3 % ropivacaine 30 ml at the thighroot-femoral nerve), the ACB group (receiving 0.3 % ropivacaine 30 ml at mid-thigh adductor canal), or the control group. The primary outcome was the Hospital for Special Surgery (HSS) knee score on the 30th post-operative day. The HSS knee score of the ACB group on the 30th day after the operation was significantly higher than those of the FNB and control groups (88.6 ±

5.3 versus 85.3 ± 6.9 and 81.2 ± 5.9, respectively; $p < 0.05$). Both the ACB and FNB groups showed excellent rehabilitation, indicating similar rehabilitation quality for both treatments. The authors concluded that ACB was similar to FNB concerning the quality of rehabilitation and pain relief after arthroscopic partial meniscectomy, while ACB had little effect on the strength of the quadriceps femoris. Level of Evidence = I.

DelPizzo et al (2020) noted that the use of RA in pediatric patients remains under-studied, although evidence suggested benefits over general anesthesia. In a meta-analysis, these researchers examined factors associated with RA use in patients under the age of 21 years undergoing ambulatory orthopedic surgery. Patients under the age of 21 who underwent anterior cruciate ligament (ACL) repair or reconstruction, knee arthroscopy (KA), or shoulder arthroscopy (SA) were identified from the NY Statewide Planning and Research Cooperative System (SPARCS) database (2005 to 2015). Frequencies of RA use (defined by FNB, spinal, epidural, caudal, or brachial plexus anesthesia) were calculated. Multi-variable regression analysis identified patient- and healthcare system-related factors associated with the use of RA. Odds ratios (OR) and 95 % CI were reported. These investigators identified 87,273 patients who underwent the procedures of interest (ACL n = 28,226; SA n = 18,155; KA n = 40,892). In the primary analysis, 14.4 % (n = 1,404) had RA as their primary anesthetic; this percentage increased for patients who had ACL or KA. When adjusting for co-variates, Hispanic ethnicity (OR 0.78; CI: 0.65 to 0.94) and Medicaid insurance (OR 0.75; CI: 0.65 to 0.87) were associated with decreased odds for the provision of RA. Further, these researchers identified increasing age (OR 1.10; CI: 1.08 to 1.11), ACL versus SA (OR 1.91; CI: 1.74 to 2.10), and sports injuries (OR 1.20; CI: 1.10 to 1.31) as factors associated with increased odds of RA use. The authors concluded that in this analysis, RA was used in a minority of patients under the age of 21 undergoing ambulatory orthopedic surgery; older age was associated with increased use while Hispanic ethnicity and lower socioeconomic status were associated with lower use.

Sinha et al (2022) stated that ACLR is one of the most frequently performed orthopedic procedures. The ability to perform ACLR on an outpatient basis is largely dependent on an effective analgesic regimen. In a prospective, randomized, controlled clinical trial, these researchers compared the analgesic effect between continuous ACB (cACB) and FNB (cFNB) during arthroscopy guided ACLR. A total of 60 ASA I/II patients for arthroscopic ACLR were recruited. Patients in Group I received cACB and those in Group II cFNB. A bolus dose of 20 cc 0.5 % levobupivacaine followed by 0.125 % 5 ml/hour was started for 24 hours. Rescue analgesia in the form of paracetamol 1 g intravenous (IV) was given. Parameters assessed were time of first rescue analgesia, total analgesic requirement in 24 hours, and painless range of motion (ROM) of the knee (15 degrees of flexion to further painless flexion). The time-to-first post-operative analgesic request (hours) was earlier in Group II (14.40 ± 4.32) than Group I (16.90 ± 3.37) and this difference was statistically significant ($p < 0.05$). The cumulative 24-hour analgesic consumption (paracetamol in g) was 0.70 ± 0.47 in Group I and 1.70 ± 0.65 in Group II ($p < 0.001$). The painless ROM (degree) was 55.67 ± 10.40 in Group I and 40.00 ± 11.37 in Group II ($p < 0.001$). The authors concluded that the findings of this study suggested that continuous ACB provided superior analgesia in patients undergoing arthroscopic ACLR when compared to continuous FNB. The authors stated that the drawbacks of this study could be the small sample size (n = 60), the anesthesiologist performing the blocks were not blinded to treatment, although they refrained from further contact with the patient. Furthermore, these investigators did not examine drug spread to popliteal fossa in cACB group (Group I).

Lateral Femoral Cutaneous Nerve Block for Post-Operative Pain Control After Total Hip Arthroplasty

Thybo and colleagues (2016) noted that peripheral regional nerve blocks are commonly used for pain management after lower extremity surgery, but motor blockade can be a significant concern. The lateral femoral cutaneous nerve (LFCN) is a purely sensory nerve from the lumbar plexus. In a prospective, blinded, randomized, placebo-controlled trial, these researchers hypothesized that an LFCN block would reduce movement-related pain after total hip arthroplasty (THA) in patients with moderate-to-severe pain. A total of 60 patients with VAS score of greater than 40 mm during 30-degree active flexion of the hip on either the 1st or 2nd post-operative day after THA were included in this study. Group A received an LFCN block with 8 ml of 0.75 % ropivacaine followed after 45 mins by an additional LFCN block with 8 ml of saline. Group B received an LFCN block with 8 ml of saline followed after 45 mins by an additional LFCN block with 8 ml of 0.75 % ropivacaine. These investigators found a difference of 17 mm (95 % CI: 4 to 31 mm; $p < 0.02$) in VAS pain score during 30-degree flexion of the hip 45 mins after the 1st block (primary outcome) in favor of group A. No other significant difference between groups regarding pain during mobilization and at rest was found. The overall non-responder rate (less than 15 mm pain reduction) was 42 %. The authors concluded that LFCN block reduced movement-related pain in patients with moderate-to-severe pain after THA.

Li and associates (2021) stated that adequate pain control after THA is essential for patient satisfaction and surgical outcome. These researchers carried out a retrospective study with before and after design in 210 elective THA patients. The control group (n = 132) received spinal anesthesia with peri-articular injection (PAI) and the treatment group (n = 78) received trans-muscular quadratus lumborum block and LFCN block in addition to spinal anesthesia and PAI. The primary outcome was VAS pain score on post-operative day (POD) 1, and secondary outcomes included VAS and opioid consumption on each POD, hospitalization cost, LOS, and discharge acuity. The mean VAS and opioid consumption (MME) were significantly lower in the treatment group than that in the control group on POD 1, with VAS difference -1.10 (95 % CI: -1.64 to -0.55), false discover rate corrected ($p < 0.001$), and MME difference -26.19 (95 % CI: -39.16 to -13.23, $p < 0.001$). A significant difference was also found for both VAS ($p = 0.007$) and opioid consumption ($p = 0.018$) on POD 2 and for opioid consumption on POD 3 ($p = 0.008$); LOS (days) in the control group versus the treatment group was 2.50 ± 1.38 versus 1.36 ± 0.95 ($p = 0.002$), and the total cost of hospitalization was over 20 % higher in the control group than that in the treatment group ($p = 0.002$). The authors concluded that the addition of trans-muscular quadratus lumborum and LFCN block in THA provided improved analgesia indicated by lower pain scores and opioid reduction and accelerated recovery with shorter hospitalization and decreased hospitalization cost.

Lumbar Plexus Block for Post-Operative Pain Control After Total Hip Arthroplasty

Fredrickson and Danesh-Clough (2015) stated that following elective THA, both continuous lumbar plexus blockade and spinal anesthesia (with adjunctive intrathecal morphine) have shown early outcome benefits over opioid analgesia and single-injection nerve block; however, the 2 techniques have not been compared in a prospective, randomized manner. These researchers examined 50 patients undergoing elective hip joint replacement; they were randomized to receive spinal anesthesia (with adjunctive intrathecal morphine 0.1 mg) or patient-controlled continuous lumbar plexus blockade. All surgery was conducted under general anesthesia. Measured outcomes included numerically rated post-operative pain, supplemental opioid consumption and indices of mobilization together with complications. Results showed that block placement time was marginally shorter for the spinal group (5 versus 7 minus, $p = 0.01$). The primary outcome, worst pain on movement/mobilization during the first 24 hours, was not statistically significantly different between groups. Patients in the lumbar plexus group were given more intra-operative opioid and rescue morphine in the post-anesthesia care unit (median = 4 versus 0 mg, $p < 0.001$), with correspondingly higher pain scores (median 5/10 versus 0/10, $p < 0.001$). Pain scores during the subsequent 24 hours were similar between groups, but more patients in the spinal group were given rescue morphine (5 versus 0, $p = 0.02$). Physiotherapy mobilization indices appeared similar between groups. More spinal group patients reported pruritus (12 versus 5, $p = 0.01$), but anti-emetic requirements, episodes of disorientation, arterial oxygen desaturation and falls were all similar between groups. Post-operative symptoms suggestive of neurological irritation or injury did not differ between groups. These researchers found that following elective hip joint replacement, compared to continuous lumbar plexus blockade, spinal anesthesia incorporating adjunctive intrathecal morphine did not result in a statistically significant difference in worst pain on movement/mobilization during the first 24 hours, although it was associated with better analgesia in the post-anesthesia care unit. Subsequently, however, these patients appeared to require more rescue morphine and more of them reported pruritus.

Johnson et al (2017) stated that debate surrounds the issue of whether peripheral nerve blockade or periarticular infiltration (PAI) should be employed within a contemporary, comprehensive multi-modal analgesia pathway for THA. These researchers hypothesized that patients treated with a continuous posterior lumbar plexus block (PNB) would report less pain and consume less opioid medication than those treated with PAI. This investigator-initiated, independently funded, 3-arm RCT performed at a single, high-volume institution compared post-operative analgesia interventions for elective, unilateral primary THA: (i) PNB; (ii) PAI with ropivacaine, ketorolac, and epinephrine (PAI-R); and (iii) PAI with liposomal bupivacaine, ketorolac, and epinephrine (PAI-L) using computerized randomization. The primary outcome was maximum pain during the morning (06:00 to 12:00) of the 1st post-operative day (POD) on an ascending numeric rating scale (NRS) from 0 to 10. Pair-wise treatment comparisons were performed using the rank-sum test, with a p value of < 0.017 indicating significance (Bonferroni adjusted). A sample size of 150 provided 80 % power to detect a difference of 2.0 NRS units. These investigators included 159 patients (51, 54, and 54 patients in the PNB, PAI-R, and PAI-L groups, respectively). No significant differences were found with respect to the primary endpoint on the morning of the first POD (median, 3.0, 4.0, and 3.0, respectively; p > 0.033 for all). Opioid consumption was low and did not differ across groups at any intervals. Median maximum pain on POD 1 was 5.0, 5.5, and 4.0, respectively, and was lower for the PAI-L group than for the PAI-R group (p = 0.006). On POD 2, maximum pain (median, 3.5, 5.0, and 3.5, respectively) was lower for the PNB group (p = 0.014) and PAI-L group (p = 0.016) compared with the PAI-R group. The PAI-L group was not significantly different from the PNB group with respect to any outcomes: post-operative opioid use including rescue intravenous (IV) opioid medication, hospital LOS, and AEs, and 3-month follow-up data including any complication. The authors concluded that in this RCT, they found a modest improvement with respect to analgesia in patients receiving PNB compared with those receiving PAI-R, but not compared with those who had PAI-L. Secondary analyses suggested that PNB or PAI-L provided superior post-operative analgesia compared with PAI-R. For primary THA, a multi-modal analgesic regimen including PNB or PAI-L provided opioid-limiting analgesia.

Gutierrez et al (2021) noted that the posterior lumbar plexus block (LPB) has been used for decades to provide acute pain management after hip surgery. Unfamiliarity with the technique and its perceived difficulty, potential risks, and possible adverse effects such as quadriceps weakness have limited broader use. The quadratus lumborum block (QLB) has been reported to be effective for post-operative pain control following hip surgery; thus, may offer another regional alternative for practitioners. These researchers hypothesized that the QLB type 3 (QLB3) can produce a non-inferior analgesic effect compared with LPB for primary hip replacement. This double-blinded, non-inferiority trial randomized 46 patients undergoing primary hip replacement to receive either QLB3 or LPB. Outcomes were examined on PACU arrival, and at post-operative hours 6, 12, and 24. The primary outcome measured was NRS pain score 24 hours after surgery. Secondary outcomes included opioid consumption, presence of quadriceps weakness at 1st post-operative physical therapy (PT) session, and time to achieve 100 feet of walking. The QLB3 did not cross the non-inferiority delta of 2 points on the NRS pain score (mean difference -0.43 (95 % CI: -1.74 to 0.87)). There were no significant differences between groups in total opioid consumption at 24 hours or in time to achieve 100 feet of walking. Quadriceps weakness at 1st PT session was less common with QLB3 (26 % versus 65 %) and time to perform the block was significantly less with QLB3 (10 mins versus 5 mins). The authors concluded that this trial supported the hypothesis that the QLB3 yielded non-inferior analgesia compared with LPB for hip replacement surgery.

Pectoral Plane Nerve Block for Post-Operative Pain Control After Breast Cancer Surgery/Mastectomy

In a prospective RCT, Neethu et al (2018) examined the analgesic efficacy of ultrasound (Us)-guided combined pectoral nerve blocks (PECS) I and II in patients scheduled for surgery for breast cancer. A total of 60 American Society of Anesthesiologists (ASA) status I to II women, aged 18 to 70 years were enrolled in this study. Patients were randomized into 2 groups (30 patients in each group), PECS (P) group and control (C) group. In group P, patients received both general anesthesia and US-guided combined PECS I and II. In group C, patients received only general anesthesia (GA). These researchers noted pain intensity at rest and during abduction of the ipsilateral upper limb, incidence of post-operative nausea and vomiting (PONV); patient's satisfaction with post-operative analgesia and maximal painless abduction at different time-intervals in both groups. There was significant decrease in the total amount of fentanyl requirement in the in P group {(140.66 ± 31.80 μg) and (438 ± 71.74 μg)} in comparison to C group {(218.33 ± 23.93 μg) and (609 ± 53.00 μg)} during intra-operative and post-operative period up to 24 hours, respectively. The time to 1st analgesic requirement was also more in P group (44.33 ± 17.65 mins) in comparison to C group (10.36 ± 4.97 mins) during post-operative period. There was less limitation of shoulder movement (pain free mobilization) on the operative site at 4 and 5 hours after surgery in P group in comparison to C group. However there was no difference in the incidence of PONV (22 out of 30 patients in group P and 20 out of 30 patients in group C) but patients in group P had a better satisfaction score with post-operative analgesia than C group having a p value of < 0.001(Score 1; 5 versus 20; Score 2; 12 versus 9; Score 3; 13 versus 1). The authors concluded that US-guided combined PECS were an effective modality of analgesia for patients undergoing breast surgeries during peri-operative period.

Versyck et al (2019) noted that surgery is the primary therapeutic intervention for breast cancer and can result in significant post-operative pain. These investigators searched the current literature and performed a meta-analysis in order to compare the analgesic efficacy of the PECS II block with systemic analgesia alone and with a thoracic paravertebral block for breast cancer surgery. Primary outcome was post-operative opioid consumption in the first 24 hours after surgery. Secondary outcomes were pain scores at 0, 3, 6, 9 and 24 hours after surgery, intra-operative opioid consumption, time to 1st analgesic request and incidence of post-operative nausea and vomiting. They identified 13 RCTs that included 815 patients. The Pecs II block significantly reduced post-operative opioid consumption (standardized mean difference [SMD]: -13.64 mg oral morphine equivalents; 95 % confidence interval [CI]: -21.22 to -6.05; p < 0.01) and acute post-operative pain at all intervals in the first 24 hours after surgery compared with systemic analgesia alone. Compared with the thoracic paravertebral block, the Pecs II block resulted in similar post-operative opioid consumption (SMD: -8.73 mg oral morphine equivalents; 95 % CI: -18.16 to 0.69; p = 0.07) and post-operative pain scores after first measurement. The authors concluded that the PECSs II block offered improved analgesic efficacy compared with systemic analgesia alone and comparable analgesic efficacy to a thoracic paravertebral block for breast cancer surgery.

Zhao et al (2019) stated that many types of regional nerve blocks have been used during anesthesia for modified radical mastectomy. In recent years, the use of pectoral nerve (PECS) block has gained importance in post-operative analgesia, but there are still controversies regarding its efficacy. There is especially no consensus on the optimal type of PECS block to be used. These researchers evaluated the analgesic efficacy of the PECS block after radical mastectomy. They searched PubMed, Embase, and the Cochrane library for RCTs for studies regarding PECS versus GA that were published prior to May 31, 2018. Outcome measures such as intra- and post-operative consumption of opioids, PONV, need for post-operative rescue analgesia, and pain scores were analyzed. After quality evaluation and data extraction, a meta-analysis was performed using Review Manager 5.3 software, and the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) system was used for rating the quality of evidence. A total of 8 RCTs and 2 cohort studies involving 993 patients were eligible. Compared with the GA group, the PECS block group effectively reduced the intra-operative and post-operative use of opioid drugs, incidence of PONV, need for post-operative rescue analgesia, and pain scores within 0 to 6 hours after surgery. However, subgroup analysis showed that PECS I block did not have a significant advantage in reducing the intra- and post-operative consumption of opioids. Results for each outcome indicator were confirmed as having a high or moderate level of evidence. The authors concluded that even considering the limitations (evaluations of efficacy in different age groups and for chronic pain were not carried out) of this meta-analysis, it can be concluded that the PECS II block is an effective anesthetic regimen in modified radical mastectomy that can effectively reduce the intra- and post-operative consumption of opioids, post-operative PONV, and the need for post-operative rescue analgesia and can alleviate early pain (0 to 6 hours) after surgery.

In a prospective, randomized, single-blinded study, Altıparmak et al (2019) compared the effects of US-guided modified PECS block and erector spinae plane (ESP) block on post-operative opioid consumption, pain scores, and intra-operative fentanyl need of patients undergoing unilateral modified radical mastectomy surgery. A total of 40 patients (ASA I-II) were allocated to 2 groups. After exclusion, 38 patients were included in the final analysis (18 patients in the PECS groups and 20 in the ESP group). Modified pectoral nerve block was performed in the PECS group and erector spinae plane block was performed in the ESP group. Post-operative tramadol consumption and pain scores were compared between the groups. Also, intra-operative fentanyl need was measured. Post-operative tramadol consumption was 132.78 ± 22.44 mg in PECS group and 196 ± 27.03 mg in ESP group (p = 0.001); NRS scores at the 15th and 30th mins were similar between the groups. However, median NRS scores were significantly lower in PECS group at the post-operative 60th min, 120th min, 12th hour and 24th hour (p = 0.024, p = 0.018, p = 0.021 and p = 0.011, respectively). Intra-operative fentanyl need was 75 mg in PECS group and 87.5 mg in ESP group. The difference was not statistically significant (p = 0.263). The authors concluded that modified PECS block reduced post-operative tramadol consumption and pain scores more effectively than ESP block after radical mastectomy surgery.

Ueshima et al (2019) noted that since the original description in 2011, the array of PECS has evolved. The PECS block in conjunction with GA can decrease an additional analgesic in peri-operative period for breast cancer surgeries. Current literature on the PECS block has reported 3 several types (PECS I, PECS II, and serratus plane blocks). The PECS I block is the same as to the 1st injection in the PECS II block. The 2nd injection in the PECS II block and the serratus plane block blocks intercostal nerves (T2 to T6) and provides an analgesic for the breast cancer surgery. However, the PECS I block (or first injection in the PECS II block) has no analgesic, because both lateral and medial pectralis nerve blocks are motor nerves. PECS block in previous reports, when added to opioid-based GA, may improve analgesia and decrease narcotic use for breast cancer surgery. Moreover, PECS block compares favorably with other regional techniques for selected types of surgery. A major limitation of the PECS block is that it could not block the internal mammary region. Thus, some studies have reported its ability to block the anterior branches of the intercostal nerve. The authors concluded that PECS block is an effective analgesic tool for the anterolateral chest; in particular, the PECS block can provide more effective analgesia for breast cancer surgery.

Senapathi et al (2019) stated that combined regional and GA are often used for the management of breast cancer surgery. Thoracic spinal block, thoracic epidural block, thoracic paravertebral block, and multiple intercostal nerve blocks are the regional anesthesia techniques that have been used in breast surgery, but some anesthesiologists are not comfortable because of the complication and side effects. In 2012, Blanco et al introduced pectoralis nerve (PECS) II block or modified PECS block as a novel approach to breast surgery. These researchers determined the effectiveness of combined US-guided PECS II block and GA for reducing intra- and post-operative pain from modified radical mastectomy. A total of 50 patients undergoing modified radical mastectomy with GA were divided into 2 groups randomly (n = 25), to either PECS (P) group or control (C) group. Ultrasound-guided PECS II block was done with 0.25 % bupivacaine (P group) or 0.9 % NaCl (C group). Patient-controlled analgesia (PCA) was used to control post-operative pain. Intra-operative opioid consumption, post-operative visual analog scale (VAS) score, and post-operative opioid consumption were measured. Intra-operative opioid consumption was significantly lower in P group ($p \leq 0.05$); VAS score at 3, 6, 12, and 24 hours post-operative were significantly lower in P group ($p \leq 0.05$); 24 hours post-operative opioid consumption was significantly lower in P group ($p \leq 0.05$). There were no complications following PECS block in both groups, including pneumothorax, vascular puncture, and hematoma. The authors concluded that combined US-guided PECS II block and GA were effective in reducing pain both intra- and post-operatively in patients undergoing modified radical mastectomy.

Lovett-Carter et al (2019) noted that several studies have evaluated the effect of PECS to improve post-operative analgesia following breast cancer surgery resulting in contradictory findings. These investigators examined the effect of PECS blocks on post-operative analgesia in women following mastectomies. They performed a quantitative systematic review in compliance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement. Articles of RCTs that compared PECS block (types I and II) to a control group in patients undergoing mastectomy were included. The primary outcome was total opioid consumption 24 hours after surgery. Secondary outcomes included pain scores and side effects. Meta-analysis was performed using the random effect model. A total of 7 RCTs with 458 patients were included in the analysis. The effect of PECS blocks on post-operative opioid consumption compared with control revealed a significant effect, weighted mean difference (WMD) (95 % CI: -4.99 (-7.90 to -2.08) mg intravenous morphine equivalents (p = 0.001). In addition, post-operative pain compared with control was reduced at 6 hours after surgery: WMD (95 % CI): -0.72 (-1.37 to -0.07), p = 0.03, and at 24 hours after surgery: WMD (95 % CI): -0.91 (-1.81 to -0.02), p = 0.04. The authors concluded that this quantitative analysis of RCTs demonstrated that the PECS block was effective for reducing post-operative opioid consumption and pain in patients undergoing mastectomy. The PECS block should be considered as an effective strategy to improve analgesic outcomes in patients undergoing mastectomies for breast cancer treatment.

Occipital Nerve Block for the Diagnosis of Occipital Neuralgia

Kapoor et al (2003) stated that occipital neuralgia (ON) syndrome can cause severe refractory headaches. In a small percentage of patients, these headaches can be devastating and debilitating, with the potential for complete relief following surgical rhizotomy. These investigators described computed tomography (CT) fluoroscopy-guided percutaneous C2to C3 nerve block for the confirmation of diagnosis of ON and for demonstrating to patients the sensory effects of intradural cervical dorsal rhizotomy before the definitive surgical procedure. A total of 17 patients with ON underwent 32 CT fluoroscopy-guided C2 or C2 and C3 nerve root blocks. Of the 17 patients, 9 (52.9 %) had ON following prior neck or skull base surgeries. On the basis of the positive results of the nerve blocks in terms of temporary pain relief, all 17 patients underwent unilateral (n = 16) or bilateral (n = 1) intradural C1 (n = 9), C2 (n = 17), C3 (n = 17), or C4 (n = 7) dorsal rhizotomies. All patients were followed-up for a mean of 20 months (range of 5 to 37 months) for assessment of pain relief; 16 patients were assessed for degree of satisfaction with and functional state after surgery. All patients had temporary relief of symptoms after percutaneous CT-guided block (positive result) and felt that occipital numbness was an acceptable alternative to pain. Immediately after surgery, all patients had complete relief from pain. At follow-up, 11 patients (64.7 %) had complete relief of symptoms, 2 (11.8 %) had partial relief, and 4 (23.5 %) had no relief; 7 of 8 (87.5 %) patients without prior surgery had complete relief of symptoms and 1 (12.5 %) patient had partial relief, as opposed to complete relief in 4 of 9 (44.4 %), partial relief in 1 of 9 (11.2 %), and no relief in 4 of 9 (44.4 %) patients with a history of prior surgery. Because of the small number of patients, this difference was not statistically significant (p = 0.110); 11 of 16 (68.8 %) patients stated that the surgery was worthwhile; 8 of 16 (50 %) patients felt they were more active and functional after surgery, whereas 25 % felt they were either unchanged or less functional than before surgery. None of the patients without a history of prior surgery reported a decreased sense of functional activity following rhizotomy. The authors concluded that CT fluoroscopy-guided percutaneous cervical nerve block was useful for the confirmation of ON, for demonstrating to patients the sensory effects of nerve sectioning, and possibly as a guide for selection of patients for intradural cervical dorsal rhizotomy. Although not statistically significant, there was a trend toward better response to rhizotomy in patients without prior head or neck surgery.

Vanderhoek et al (2013) stated that ON is a condition manifested by chronic occipital headaches and is thought to be caused by irritation or trauma to the greater occipital nerve (GON). Treatment for ON includes medications, nerve blocks, and pulsed radiofrequency ablation (PRFA). Landmark-guided GON blocks are the mainstay in both the diagnosis and treatment of ON. Ultrasound (US) is being utilized more and more in the chronic pain clinic to guide needle advancement when performing procedures; however, there are no reports on the use of US to guide a diagnostic block or PRFA of the GON. These investigators reported 2 cases in which US was used to guide diagnostic GON blocks and GON PRFA for treatment of ON. Two patients with occipital headaches were presented. In Case 1, US was used to guide diagnostic blocks of the GONs. In Case 2, US was used to guide placement of RF probes for PRFA of the GONs. Both patients reported immediate, significant pain relief, with continued pain relief for several months. The authors concluded that further study is needed to examine any difference in outcomes or morbidity between the traditional landmark method versus US-guided blocks and PRFA of the GONs.

Choi and Jeon (2016) noted that ON is defined by the International Headache Society as paroxysmal shooting or stabbing pain in the dermatomes of the GON or lesser occipital nerve. Various treatment methods exist, from medical treatment to open surgical procedures. Local injection with corticosteroid can improve symptoms, though generally only temporarily. More invasive procedures can be considered for cases that do not respond adequately to medical therapies or repeated injections. These researchers stated that the clinical presentation (i.e., tenderness over the occipital nerves) and a temporary improvement in the headache with a local anesthetic diagnostic block of the occipital nerve on the affected side confirm the diagnosis. Occipital nerve block, as an essential diagnostic tool, can also be a good treatment option for ON. Thus, the anatomy of the occipital nerve and the location of the exact target site are very important. Clinicians should keep in mind that occipital nerve block relief is not specific for ON and that false-positive results occur with migraine and cluster headaches.

Barmherzig and Kingston (2019) stated that ON and cervicogenic headache (CGH) are secondary headache disorders with occipital pain as a key feature. Due to significant phenotypic overlap, differentiating ON and CGH from primary headache disorders such as migraine or tension-type headache, or other secondary headache disorders, can be clinically challenging. These investigators reviewed the anatomy, clinical features, unique diagnostic considerations, and management approaches relating to ON and CGH. Conservative therapeutic approaches are considered 1st-line. Anesthetic nerve blocks may have a dual role in both supporting diagnosis and providing pain relief. Newer minimally invasive procedures, such as PRF and occipital nerve stimulation (ONS), represent an exciting therapeutic avenue for severe/refractory cases. Surgical interventions should be reserved for select patient populations who have failed all other conservative and minimally invasive options, to be weighed against potential risk. The authors concluded that ON and CGH represent an ongoing diagnostic challenge; and further studies are needed to consolidate efficacy regarding the comprehensive management of ON and CGH.

Furthermore, an UpToDate review on “Occipital neuralgia” (Garza, 2021) states that “The diagnosis of occipital neuralgia is considered when typical clinical features are present; the diagnosis can be confirmed when pain is transiently relieved by a local occipital anesthetic block. However, a local block is a non-specific intervention, so symptomatic relief does not indicate a specific etiology”. Moreover, occipital nerve block is listed under “Treatment”.

Peripheral Nerve Block for Post-Operative Pain Control After Arthroscopic Debridement of the Ankle

Phillips et al (2011) stated that emergency department (ED) physicians must frequently perform painful procedures on an urgent basis. These are most commonly performed using procedural sedation techniques involving parenteral sedatives and/or analgesics. Popliteal block of the sciatic nerve is a proven and safe technique used extensively in anesthesiology practice for distal lower extremity analgesia. This technique offers the advantage of relative cardiopulmonary safety, dense and prolonged analgesia, and maintenance of normal airway reflexes in patients with increased aspiration risks. These researchers examined the usefulness of sciatic nerve block in the popliteal fossa in the ED setting. They performed a retrospective analysis of all ED popliteal nerve block cases at their institution from April 2009 to April 2010. A total of 16 cases were found where popliteal block was used for pain management during procedures of the leg, ankle, and foot, including fracture reduction, splinting, irrigation, and debridement. Procedural success was defined as successful completion of the technique without the need for additional procedural sedatives, patient satisfaction, and adequate post-procedural analgesia. A high degree of satisfaction was observed in this patient population, and all procedures were successfully completed. Tibial nerve rather than common peroneal nerve stimulation correlated with success of the block. Post-procedural analgesia was excellent in all cases and predictably lasted 90 to 120 mins. The authors concluded that although limited by small numbers and its retrospective nature, this review of popliteal nerve block for painful lower extremity procedures in the ED suggested that this technique may be an attractive alternative in selected cases to parenteral procedural sedation.

Popliteal Nerve Block for Post-Operative Pain Control After Anterior Cruciate Ligament Repair

Secrist et al (2016) stated that effective pain management after anterior cruciate ligament (ACL) reconstruction improves patient satisfaction and function. In a systematic review, these investigators examined the available evidence from RCTs on pain control after ACL reconstruction. They carried out a literature review using PubMed, Medline, Google Scholar, UpToDate, Cochrane Reviews, CINAHL, and Scopus following

PRISMA guidelines (July 2014). Only RCTs comparing a method of post-operative pain control to another method or placebo were included. A total of 77 RCTs met inclusion criteria: 14 on regional nerve blocks, 21 on intra-articular injections, 4 on intramuscular/intravenous injections, 12 on multi-modal regimens, 6 on oral medications, 10 on cryotherapy/compression, 6 on mobilization, and 5 on intra-operative techniques. Single-injection femoral nerve blocks provided superior analgesia to placebo for up to 24 hours post-operatively; however, this also resulted in a quadriceps motor deficit. Indwelling femoral catheters utilized for 2 days post-operatively provided superior analgesia to a single-injection femoral nerve block. Local anesthetic injections at the surgical wound site or intra-articularly provided equivalent analgesia to regional nerve blocks. Continuous-infusion catheters of a local anesthetic provided adequate pain relief but have been shown to cause chondrolysis. Cryotherapy improved analgesia compared to no cryotherapy in 4 trials, while in 4 trials, ice water and water at room temperature provided equivalent analgesic effects. Early weight-bearing decreased pain compared to delayed weight-bearing. Oral gabapentin given pre-operatively and oral zolpidem given for the 1st week post-operatively each decreased opioid consumption as compared to placebo. Ibuprofen reduced pain compared to acetaminophen. Oral ketorolac reduced pain compared to hydrocodone-acetaminophen. The authors concluded that regional nerve blocks and intra-articular injections were both effective forms of analgesia. Cryotherapy-compression appeared to be beneficial, provided that intra-articular temperatures were sufficiently decreased. Early mobilization reduced pain symptoms. Gabapentin, zolpidem, ketorolac, and ibuprofen decreased opioid consumption. These researchers stated that despite the vast amount of high-quality evidence on this topic, further research is needed to determine the optimal multi-modal approach that can maximize recovery while minimizing pain and opioid consumption. This review did not mention popliteal nerve block.

In a prospective, comparative, multi-center study, Baverel et al (2016) defined the best anesthesia and analgesia methods for ACL reconstruction. This trial was carried out between January 2014 and April 2015. Inclusion criteria were ACL reconstruction in patients above 15 years of age performed as an out-patient surgical procedure. The anesthesia techniques analyzed were general anesthesia, spinal anesthesia and quadruple nerve blockade. The analgesic methods studied were single-shot nerve blocks, continuous nerve blocks, peri-articular and intra-articular local infiltration analgesia (LIA), non-steroidal anti-inflammatory agents (NSAIDs) and intravenous corticosteroids. The main outcome criterion was pain on a visual analog scale (VAS). The secondary outcome criteria were delayed discharge of a patient who had undergone out-patient surgery, consumption of opioids and complications for the various anesthesia techniques and analgesia methods. A total of 680 patients were included in this study, which was 63 % of the ACL reconstruction procedures performed during this period. The study population was 69 % male and 31 % female, with an average age of 30 years; 23 patients (3.4 %) could not be discharged on the day of surgery. No correlation was found with the anesthesia technique used. NSAID treatment was protective relative to delayed discharge ($p = 0.009$), while opioid consumption was a risk factor ($p < 0.01$). There were no differences in the pain levels related to the type of anesthesia. Peri-articular LIA of the hamstring tendon harvest site was effective. Intra-articular LIA did not provide better analgesia. Continuous nerve block had complication rates above 13 %. The authors concluded that all types of anesthesia were compatible with out-patient ACL reconstruction. No gold standard analgesia method can be defined based on this study's findings. However, these researchers recommended multi-modal analgesia associating peri-articular LIA or 1-shot sensory saphenous nerve block, NSAIDs and corticosteroid treatment, and cryotherapy. These investigators did not mention popliteal nerve block.

Abdallah et al (2019) noted that ambulatory arthroscopic ACL reconstruction is associated with moderate pain, even when non-opioid oral analgesics such as acetaminophen and NSAIDs are used. Regional analgesia can supplement non-opioid oral analgesics and reduce post-operative opioid requirements, but the choice of regional analgesia technique for ACL reconstruction remains controversial. Femoral nerve block, adductor canal block, and LIA have all been proposed and were supported by some evidence from randomized controlled trials (RCTs). Consequently, regional analgesia practice in patients undergoing ACL reconstruction remains mixed. Published systematic reviews were used to identify the regional analgesia modality that would provide a balance between analgesic efficacy and associated potential risks in the setting of non-opioid multi-modal analgesic strategies. Based on the evidence available, LIA provided the best balance of analgesic efficacy and associated risks (strong recommendation, moderate level of evidence) when used as a component of multi-modal analgesic technique in the first 24 hours after out-patient arthroscopic ACL reconstruction. In the absence of LIA, clinicians might use adductor canal block or femoral nerve block (weak recommendation, weak level of evidence). These recommendations have been endorsed by the Society of Ambulatory Anesthesia and approved by its board of directors. Popliteal nerve block is not mentioned.

Nguyen et al (2020) noted that infiltration between popliteal artery and capsule of the knee (IPACK) is a novel technique that can provide additional analgesic relief, although there are no studies to-date in the adolescent population. In 3 adolescent patients undergoing ACL surgery, IPACK block augmented continuous femoral nerve block by providing posterior knee analgesia with no or only minimal opioid needs in the post-anesthesia care unit and did not produce sciatic motor weakness. This was a small (n = 3) study; and its findings were confounded by the combined use of infiltration between popliteal artery and capsule of the knee block plus continuous femoral nerve block.

Posterior Femoral Cutaneous Nerve Block / Pudendal Nerve Block for the Management of Pelvic Pain, Myofascial Pain Syndrome, and Vaginismus

UpToDate reviews on “Treatment of myofascial pelvic pain syndrome in women” (Moynihan and Elkadry, 2021) and “Overview of sexual dysfunction in women: Management” (Shifren, 2021) do not mention the use of nerve block as a management / therapeutic option.

Posterior Tibial Nerve Block for Post-Operative Pain Control After Achilles Tendon Repair

In a randomized, clinical trial, Ferrer Gomez et al (2006) examined the safety and efficacy of a continuous posterior tibial nerve block (PTNB) in the ankle provided in the patient's home by elastomeric pump infusion of 0.375 % ropivacaine after ambulatory hallux valgus surgery. Patients were randomized to 2 groups of 20 each to receive either the conventional oral analgesia prescribed by these investigators after out-patient surgery (metamizole 575 mg/6 hours p.o.) or perineural analgesia with a continuous infusion of 5 ml x hour(-1) of 0.375 % ropivacaine in the posterior tibial nerve. Surgery was performed under hyperbaric spinal anesthesia with mepivacaine and an injection of 0.25 % bupivacaine into the joint. Both groups also received 50 mg/8 hours p.o. of tramadol as rescue analgesia. Assessment during visits by the home care team 12, 24, and 48 hours after surgery included the following variables: pain on a visual analog scale (VAS, 0 to 10), sleep quality, need for rescue analgesia, acceptance of the technique, side effects and adverse events (AEs). Descriptive statistics were calculated and comparisons were performed with the Mann-Whitney U test; sleep quality and need for rescue analgesia were compared by applying the Chi square statistic with a test of linear trend. The perineural analgesia group had significantly lower VAS scores at 4, 12, and 24 hours and less need for rescue analgesia. No differences in sleep quality were found ($p = 0.07$). The incidence of side effects did not differ, and there were no re-admissions. Patients expressed a high level of acceptance of the technique. The authors concluded that continuous perineural analgesia in the home setting was found to be safe and effective in these patients.

In a prospective, randomized trial, Pujol et al (2010) compared the peri-operative analgesic efficacy of 0.5 % levobupivacaine and 0.5 % ropivacaine injected in a single-dose to block the tibial and peroneal nerves for surgery using a posterior (popliteal fossa) approach. In patients undergoing hallux valgus surgery; anesthesia was provided by blocking nerves in the popliteal fossa with either 0.5 % levobupivacaine or 0.5 % ropivacaine. Variables studied were times until anesthetic block onset and reversal, need for additional sedation or peripheral block anesthetic, course of post-operative pain at 12, 24 and 48 hours and at 7 days, night-time rest, need for additional analgesia, and patient satisfaction. A total of 46 patients were enrolled. Times until onset of the sensory and motor blocks were similar in the 2 groups. For 57.1 % of the patients, the sensory and motor block lasted 24 hours after surgery, with no between-group differences. The levobupivacaine group had less pain at rest 24 hours after surgery (mean [SD] VAS score of 0.16 [0375] versus 1.17 [1.88] in the ropivacaine group; $p < 0.05$). No patient reported severe pain or required additional analgesics; none were re-admitted. More than 80 % rested well at night; and no between-group differences were observed. The authors concluded that the use of a single-dose of either levobupivacaine or ropivacaine to provide anesthesia for a popliteal approach to hallux valgus surgery was effective for controlling post-operative pain.

In a prospective, cohort study, Elkassabany et al (2015) examined if the use of peripheral nerve blocks (PNBs) as part of an analgesic protocol for operative repair of tibia and ankle fractures could improve the quality of post-operative pain management and the quality of recovery (QOR). This trial included a total of 93 consecutive patients undergoing operative repair of fractures of the ankle and tibia. Intervention was administration of popliteal and saphenous nerve blocks, as part of post-operative analgesia regimen in some patients. Patients were labeled as the regional group or the no-regional group based on whether they received PNBs. Patient satisfaction and the quality of pain management were measured 24 hours after surgery using the Revised American Pain Society Patient Outcome Questionnaire. The QOR was measured at 24 and 48 hours after surgery using the short version of the Quality of Recovery Questionnaire (QOR-9). Satisfaction with pain management was significantly higher ($p = 0.005$) in the regional group when compared with the no-regional group. Average pain scores over 24 hours was similar between the 2 groups ($p = 0.07$). The regional group reported less time spent in severe pain over 24-hour period (40 versus 50 %, $p = 0.04$) and higher overall perception of pain relief (80 versus 65 %, $p = 0.003$). Patients receiving regional anesthesia also demonstrated better QOR measured by the QOR-9 at 24 hours ($p = 0.04$) but not at 48 hours ($p = 0.11$). The authors concluded that patient satisfaction and the quality of post-operative pain management for the first 24 hours were better in patients who received PNBs as part of their post-operative analgesic regimen when compared with patients who received only systemic analgesia. Level of Evidence = II.

Alzeftawy and Elsheikh (2017) stated that peripheral nerve blocks have become an increasingly popular form of anesthesia. Pre-emptive analgesia reduces central sensitization, post-operative pain, and analgesic consumption. Different additive has been used to prolong regional blockade and improve post-operative analgesia. In a randomized, double-blind, clinical trial, these researchers examined if preemptive ankle block using combination of ropivacaine and dexamethasone would succeed in improving the post-operative analgesia after foot surgery in patients receiving general anesthesia. The study was carried out on 40 American Society of Anesthesiologists (ASA) physical Status I and II patients undergoing elective fore-foot and mid-foot surgery under general anesthesia after written informed consent and Ethical Committee approval, general anesthesia was induced as usual, the patients were breathing spontaneously, laryngeal mask airway was inserted, and anesthesia was maintained using inhalational anesthetic. Ankle block was performed before surgery using 20 ml containing 18 ml ropivacaine 0.75 % and 2 ml containing 8 mg dexamethasone in Group I and 20 ml containing 18 ropivacaine 0.75 % plus 2 ml normal saline in Group II. Evaluation of ankle block was performed by testing the motor response to electric nerve stimulation of both the posterior tibial nerve and the deep peroneal nerve. The absence of any motor responses indicated success of the block. Surgery was started in 30 mins after the block. After recovery from anesthesia, the following was measured, VAS at 1, 4, 6, 12, and 24 hours, the time to the first rescue analgesic, the analgesic requirements, and any side effects. Data were presented as means (standard deviation). Mann-Whitney U-test were used for continuous data. Student's t-test was used for normal distributed data. Patients were similar as regard to demographic data, type, and duration of surgery. Pain intensity was significantly lower in dexamethasone group ($p < 0.05$). Time to first rescue analgesic was prolonged in dexamethasone group (110 ± 3.3 mins versus 66 ± 7.9 mins; $p = 0.001$). The analgesic consumption was significantly lower in dexamethasone group. The complication was minor and self-controlled in both groups. The authors concluded that the addition of dexamethasone to ropivacaine improved pre-emptive ankle block analgesia by decreasing post-operative pain intensity and analgesic consumption with minimal post-operative complication.

Jarrell et al (2018) noted that the increasing scope and complexity of foot and ankle procedures performed in an out-patient setting require more intensive peri-operative analgesia. Regional anesthesia (popliteal and saphenous nerve blocks) has been proven to provide satisfactory pain management, decreased post-operative opioid use, and earlier patient discharge. This can be further augmented with the placement of a continuous-flow catheter, typically inserted into the popliteal nerve region. In a prospective study, these investigators examined the use of a combined popliteal and saphenous continuous-flow catheter nerve block compared to a single popliteal catheter and single-injection saphenous nerve block in post-operative pain management after ambulatory foot and ankle surgery. This trial was conducted using 60 patients who underwent foot and ankle surgery performed in an out-patient setting. Demographic data, degree of medial operative involvement, ASA physical classification system, anesthesia time, and post-anesthesia care unit (PACU) time were recorded. Outcome measures included pain satisfaction, numeric pain scores (NPS) at rest and with activity, and opioid intake. Patients were also classified by degree of saphenous nerve involvement in the operative procedure, by the surgeon who was blinded to the anesthesia randomization. Patients in the dual-catheter group took significantly less opioid medication on the day of surgery and post-operative day 1 (POD 1) compared to the single-catheter group (p = 0.02). The dual-catheter group reported significantly greater satisfaction with pain at POD 1 and POD 3 and a significantly lower NPS at POD 1, 2, and 3. This trend was observed in all 3 subgroups of medial operative involvement. The authors concluded that patients in the single-catheter group reported more pain, less satisfaction with pain control, and increased opioid use on POD 1, suggesting dual-catheter use was superior to single-injection nerve blocks with regard to managing early post-operative pain in out-patient foot and ankle surgery. Level of Evidence = II.

Quadratus Lumborum Nerve Block for Post-Operative Pain Control After Total Hip Arthroplasty

Tyagi and Salhotra (2018) stated that the quadratus lumborum block (QLB) is a newer technique that evolved from transversus abdominis plane (TAP) block. The central notion to be considered for clinical effectiveness of the block is the heterogeneity in the technique and hence the likely results. The spread of injectate following QLB depends on the approach, site of entry, and direction of needle. Broadly, the local anesthetic may track medially and caudally along the psoas muscle to affect nerves of lumbar plexus, or medially and cranially through the diaphragm into thoracic paravertebral spaces. The block may thus provide analgesia of inguinal area, hip region, and the abdominal wall depending on the precise technique of QLB used. With the trans-muscular QLB (TQLB) wherein the local anesthetic is deposited between the psoas muscle and quadratus lumborum, there is likely spread to L2/L3 vertebral area, lateral spread to lateral cutaneous nerve of thigh, and caudally under fascia iliaca. In contrast, using an intra-muscular variant of the block causes very limited spread around the quadratus lumborum, a small area of the flank and proximal lateral thigh. Thus, under the larger umbrella of a “quadratus lumborum” block, several individual variations in the technique may occur with different clinical applications.

Kinjo et al (2019) noted that the TQLB is one of the newest blocks and has been used as an effective analgesic option for various surgeries. However, it is still uncertain whether the TQLB provides beneficial analgesic outcomes for hip arthroscopic surgeries. In a retrospective cohort study, these investigators examined effects of the pre-operative TQLB on post-operative pain levels and peri-operative opioid consumption in patients who underwent out-patient arthroscopic hip surgery. Patients who underwent arthroscopic hip surgery for femoro-acetabular impingement (FAI) between June 1, 2017 and December 1, 2017 were included. All patients received general anesthesia for surgery. Two groups of patients were compared: patients who received a pre-operative TQLB, and patients who did not receive a TQLB. A total of 70 procedures (68 patients) were included in the study. Of these, 15 procedures (15 patients) received a pre-operative TQLB (TQLB group) in addition to general anesthesia, whereas the other 55 procedures (54 patients) received general anesthesia only (control group). Highest pain scores in the PACU were similar in the TQLB (6.2) group versus the control group (5.6) (95 % confidence interval [CI]: 2.08 to 0.99, p = 0.484). Pain scores decreased over time in both groups and there were no statistical differences in mean values or absolute risk differences between study groups (95 % CI: 0.19 to 0.33, p = 0.596). In addition, there were no significant differences in peri-operative opioid consumption, length of PACU stay, or the need for a rescue block in the PACU between the 2 groups. The authors concluded that the present study did not find the pre-operative TQLB to be an effective analgesic technique for patients who underwent arthroscopic hip surgery for FAI; a randomized clinical trial may further validate these results.

Rectus Sheath Block for Post-Operative Pain Control After Cholecystectomy

Kamei et al (2015) noted that single-incision laparoscopic cholecystectomy (SILC) is increasingly applied for cholecystectomy and has been reported as safe and feasible, with short-term operative outcomes equivalent to 4-port cholecystectomy. Although many investigators in randomized studies have noted the cosmetic advantages of SILC, the benefit of decreased pain in SILC remains controversial. These researchers examined the efficacy of the rectus sheath block (RSB) in SILC with respect to subjective pain. From April 2010 to March 2012, a total of 75 patients with symptomatic gallstone or gallbladder polyps were assigned to 1 of 3 groups: (i) 4-port laparoscopic cholecystectomy (n = 29); (ii) SILC (n = 15); and (iii) RSB in SILC (n = 30). They examined the operative details, length of hospital stay (LOS), and the need and usage of analgesia. Post-operative pain was recorded at 2, 6, 12, and 24 hours after surgery based on a visual analog scale (VAS). There was no difference with regard to age, ASA score, body mass index (BMI), duration of operation, or LOS among the 3 groups. A significantly lower pain score was observed in the rectus sheath block in SILC group than in the SILC group at 2 and 6 hours after operation. The pain score and need for analgesia were similar between the SILC group and the 4-port cholecystectomy group. The authors concluded that SILC using an US-guided RSB significantly reduced post-operative pain.

Gupta et al (2016) stated that as LC is not a totally pain-free procedure, with the pain being most intense on the day of surgery and on the following day. Various techniques are available for post-operative pain relief including intra-peritoneal instillation of local anesthetic and RSB, which may provide effective pain relief. These investigators compared the efficacy of pre-emptive administration (initiated before the surgical procedure) of intra-peritoneal instillation and RSB using ropivacaine for post-operative analgesia following LC. A total of 75 selected patients were randomly assigned to 3 equal groups as Group R, who received bilateral RSB with 0.25 % ropivacaine 15-ml on either side; Group I, who received intraperitoneal instillation of 0.25 % ropivacaine 50-ml, and Group C (Control group), who received only rescue analgesic on pain. These were compared regarding post-operative analgesia in terms of VAS (0 to 10 cm), Prince Henry Hospital Pain Score (0 to 3), time to 1st dose of rescue analgesic (tramadol), total rescue analgesic consumption in 48 hours, patient satisfaction scores (1 to 7) and adverse effects. The time to 1st rescue analgesic was significantly longer in Group R (16.16 ± 4.73 hours) and Group I (7.84 ± 1.34 hours) as compared to Group C (1.72 ± 0.67 hours), $p < 0.001$. Mean tramadol consumption in 48 hours for each patient was significantly less in Group R (148 ± 54.92 mg) and Group I (202 ± 33.78 mg) as compared to Group C (298 ± 22.73 mg) $p < 0.001$. Post-operative pain scores were also significantly less in Group R and Group I as compared to Group C during first 6 hours, $p < 0.05$. The difference in above parameters was also significant between Group R and Group I, $p < 0.05$. Thus; order of post-operative analgesia effect was: Group R > Group I > Group C. Rescue analgesic requirement showed a 32.21 % reduction in Group I and 50.33 % reduction in Group R as compared to Group C. Patient Satisfaction Scores (PSS) showed a significant difference among groups with acceptable PSS scores as: Group R (92 %) versus Group I (40 %) versus Group C (20%) $p < 0.001$. The authors concluded that pre-emptive administration of RSB or intra-peritoneal instillation of 0.25 % ropivacaine was found effective in providing better post-operative analgesia as compared to control group after LC. These researchers noted that among these 2 techniques, RSB was found to be superior over intraperitoneal instillation.

Iwata et al (2017) noted that several reports have examined methods to control pain following LC and have shown regional anesthesia to be an effective method. These investigators had been performing LC using simple general anesthesia (G); however, in 2013, they adapted a RSB, and in 2014, they used a combination of RSB and a subcostal transversus abdominis plane block (TAPB) on the right side. These researchers reported on the transition from G to regional anesthesia in LC and its effect on post-operative pain. They anesthetized 3 groups of patients undergoing LC: Group 1 received G (n = 32) ; group 2 received RSB (n = 28); and group 3 received a combination of RSB and TAPB (n = 31). Patients used the numeric rating scale (NRS) to record their levels of post-operative pain, and the scores were compared for each group. No significant differences were noted in NRS scores between the G and RSB groups; however, the scores in the RSB group tended to be lower. NRS scores were significantly lower in the RSB-TAPB group than in both the RSB and G groups. The authors concluded that this study showed that the combination of RSB-TAPB effectively controlled pain after LC and lowered NRS scores.

Ramkiran et al (2018) noted that pain associated with LC is most severe during the first 24 hours and the port sites are the most painful. Recent multi-modal approaches target incisional pain instead of visceral pain, which has led to the emergence of abdominal fascial plane blocks. This study examined the effects of a novel combination of 2 independently effective fascial plane blocks, namely RSB and subcostal TAPB to alleviate post-operative pain. In a prospective, randomized control, pilot study, they evaluated the effectiveness of the combination of RSB and subcostal TAPB, to compare its efficacy with that of subcostal TAPB alone and with conventional port site infiltration (PSI) in alleviating post-operative pain in patients undergoing LC. This trial included 61 patients scheduled for elective LC and distributed among 3 groups, namely Group 1: Combined subcostal TAPB with RSB (n = 20); Group 2: Oblique subcostal TAPB alone (n = 21); and Group 3: PSI group as an active control (n = 20). Combined group had significantly lower pain scores, higher satisfaction scores, and reduced rescue analgesia both in early and late post-operative periods than the conventional PSI group. The authors concluded that US-guided combined fascial plane blocks is a novel intervention in pain management of patients undergoing LC and should become the standard of care.

Jeong et al (2019) noted that pain following LC is multi-factorial and usually not effectively treated; and RSB has been proven to reduce the pain from mid-line abdominal incision and laparoscopic surgery. In a prospective, randomized, single-center trial, these investigators examined the pre-emptive analgesic effect of RSB following LC. This trial included 200 patients undergoing LC; they were randomized into pre-operative RSB (pre-RSB) or post-operative RSB (post-RSB) group. An US-guided RSB was carried out before skin incision in the pre-RSB group or after skin closure in the post-RSB group. The primary outcome was total rescue analgesic consumption at 24 hours post-surgery. The secondary outcomes were cumulated rescue analgesic consumption and post-operative pain measured by NRS at 0, 1, 2, 6, 9, 18, and 24 hours post-surgery. Total rescue analgesic consumption at 24 hours post-surgery was significantly lower in the pre-RSB group than in the post-RSB group

($p = 0.020$). The cumulated rescue analgesic consumption was significantly lower in the pre-RSB group than in the post-RSB group at 1 hour ($p = 0.023$), 9 hours ($p = 0.020$) and 18 hours ($p = 0.002$) post-surgery; NRS was significantly lower in the pre-RSB group than in the post-RSB group at 0 hour post-surgery ($p = 0.023$). The authors concluded that pre-RSB reduced the analgesic requirements in patients undergoing LC compared with the post-RSB.

Fu et al (2020) stated that pain after SILC, especially visceral pain, often troubles patients and doctors. Whether pre-emptive butorphanol can relieve visceral pain in patients undergoing SILC remains unknown. These researchers examined the efficacy of US-guided bilateral RSB and butorphanol for peri-operative analgesia in patients undergoing SILC. A total of 58 patients who met the criteria were randomly divided into 2 groups, both of which were given pre-emptive RSB. Patients were given either butorphanol 0.02 mg/kg (group B, n = 29) or sufentanil 0.1 μg/kg (group S, n = 29) as pre-emptive analgesia. The primary outcome was the cumulative frequency of rescue analgesic request within 24 hours after operation. Secondary outcomes were NRS scores (from 0 to 10) of incisional pain and visceral pain, the length of hospital stay and the incidence of post-operative adverse events (AEs). The frequency of post-operative rescue analgesic request of group S was significantly higher than that of group B ($p = 0.021$). The NRS scores for visceral pain were lower in group B at 2, 6 and 12 hours after surgery than in group S (both $p < 0.001$). The occurrence of post-operative nausea and vomiting (PONV) was significantly higher in group S. There were no significant differences between 2 groups for other outcomes. The authors concluded that butorphanol could provide sufficient visceral pain treatment following SILC than the dose of sufentanil in equal analgesic effect.

Saphenous / Superficial Peroneal / Sural Nerve Blocks for the Treatment of Osteoarthritis of the Ankle and Foot

Johnston et al (2020) described their technical and preliminary clinical experience with ultrasound (US)-guided diagnostic deep peroneal nerve (DPN) blocks for patients considering deep peroneal neurectomy. This was a retrospective analysis of US-guided diagnostic DPN blocks performed in the anterior lower leg in patients pursuing deep peroneal neurectomy for foot pain not directly attributable to the DPN. Patient age, sex, foot laterality, diagnosis, nerve block complications, location of the DPN with respect to vascular landmarks in the lower leg, pain relief from nerve block, and pain relief from neurectomy (if performed) were recorded. A total of 26 DPN blocks were performed for 25 feet, of which a majority had pain attributable to mid-foot osteoarthritis (OA) (22/25). Variable DPN locations with respect to vascular landmarks in the lower leg were observed, including lateral to the anterior tibial artery (12/25), anterior to the artery (5/25), medial to the artery (3/25), lateral to the lateral paired vein (4/25), and 1-cm lateral to the artery (1/25). After DPN blocks, patients reported pain relief in 22/25 feet. Of the 11 patients who proceeded to have a deep peroneal neurectomy, 10 reported improved foot pain. The authors concluded that diagnostic deep peroneal nerve blocks for patients considering deep peroneal neurectomy for denervation therapy should be performed in the anterior lower leg where the anterior tibial vessels serve as anatomic landmarks. Those who performed DPN blocks with US guidance should be aware of variable DPN position with respect to the vascular landmarks.

Furthermore, an UpToDate review on “Overview of the management of osteoarthritis” (Deveza, 2021) does not mention sural / peroneal nerve blocks as management / therapeutic options.

Splanchnic Nerve Block for the Treatment of Abdominal Pain

Koyyalagunta et al (2016) noted that pancreatic and other upper abdominal organ malignancies can produce intense visceral pain syndromes that are frequently treated with splanchnic nerve block (SNB) or celiac plexus neurolysis (CPN). Although commonly performed with either alcohol or phenol, there is scant literature on the comparative effectiveness, duration of benefit, and complication profile comparing the 2 agents. These investigators carried out a retrospective chart review of 93 patients who underwent SNN for cancer-related abdominal pain in order to describe patient characteristics, examine comparative efficacy, duration of benefit, and incidence of complications with alcohol versus those of phenol. Consistent with previous studies, SNN reduced reported pain scores while not significantly reducing opioid consumption. No difference in pain outcomes was found comparing alcohol versus phenol based neurolytic techniques. Celiac axis tumor infiltration and preprocedural local radiation therapy did not change the effectiveness of the procedure. These findings demonstrated that 44.57 % of patients had =30 % pain reduction while 43.54 % did not have pain reduction. Interestingly, the procedure produced significant improvements in anxiety, depression, difficulty thinking clearly, and feeling of well-being. In addition, no difference in complications was observed between the agents either. SNN was an effective and relatively safe procedure for the treatment of pain associated with pancreatic and other upper abdominal organ malignancies in this sample of patients. Choice of neurolytic agent can appropriately be left to the clinical judgment and local availability of the treating physician. The change in ancillary symptoms has a theoretical basis that supports a biopsychosocial model of pain since changes in one target area (pain) impact other related ones (depression and anxiety). Moreover, these researchers recognized the retrospective nature and the small sample size in this study. Furthermore, this study did not fully evaluate the biopsychosocial symptom burden. A recommendation for future studies is that a broader range of symptoms be assessed, including social support and interpersonal connections. By so doing, it would be possible to assess the extent to which improvement in pain and mood is also associated with improved psychosocial experiences as well.

Ahmed and Arora (2017) noted that the pain from upper GI malignancy leads to considerable morbidity; CPN and SNN are good therapeutic options. Although SNN is less frequently performed, it has an edge over CPN as it can be performed in patients with altered celiac plexus anatomy by enlarged lymph nodes. The fluoroscopy-guided SNN was carried out in 21 patients with intractable upper abdominal pain with pain intensity of greater than or equal to 7 in numerical rating scale (NRS) from upper GI cancers with distorted celiac plexus anatomy from enlarged celiac lymph nodes as observed by CT scan after positive diagnostic SNN. The demographic features, pain intensity, daily opioid dose, functional status and QOL was measured at baseline and 1 week, 1 and 3 months after the procedure. There was a significant improvement in pain intensity, opioid requirement, functional status, and physical components QOL after the neurolysis ($p < 0.05$) and this improvement had continued till 3 months. There were also more than 50 % reduction in pain intensity and significant decrease in opioid requirement in all the patients after neurolysis. The authors concluded that fluoroscopy-guided SNN resulted in significant pain relief, decrease in opioid intake, improvement in functional status, and QOL for up to 3 months in upper abdominal pain from GI cancers in patients with distorted celiac lymph node anatomy not amenable to CPN. Moreover, these researchers stated that a large randomized sham-controlled trial with adequate sample size and prolonged follow-up is needed to confirm these findings. The authors stated that limitations of study included small sample size (n = 21), non-randomized study, limited follow-up (3 months), non-sham-controlled study, non-blind study, and retrospective study.

Subscapular Nerve Block for the Treatment of Chronic Upper Extremity Pain

Tran and colleagues (2017) noted that shoulder surgery can result in significant post-operative pain. Interscalene brachial plexus blocks (ISBs) constitute the current criterion standard for analgesia but may be contraindicated in patients with pulmonary pathology due to the inherent risk of phrenic nerve block and symptomatic hemi-diaphragmatic paralysis. Although US-guided ISB with small volumes (5 ml), dilute local anesthetic (LA) concentrations, and LA injection 4 mm lateral to the brachial plexus have been shown to reduce the risk of phrenic nerve block, no single intervention can decrease its incidence below 20 %. Ultrasound-guided supraclavicular blocks with LA injection postero-lateral to the brachial plexus may anesthetize the shoulder without incidental diaphragmatic dysfunction, but further confirmatory clinical trials are needed. Ultrasound-guided C7 root blocks also appeared to offer an attractive, diaphragm-sparing alternative to ISB. However, additional large-scale studies are needed to confirm their effectiveness and to quantify the risk of peri-foraminal vascular breach. Combined axillary-suprascapular nerve blocks may provide adequate post-operative analgesia for minor shoulder surgery but do not compare favorably to ISB for major surgical procedures. One intriguing solution lies in the combined use of infraclavicular brachial plexus blocks and suprascapular nerve blocks. Theoretically, the infraclavicular approach targets the posterior and lateral cords, thus anesthetizing the axillary nerve that supplies the anterior and posterior shoulder joint, as well as the subscapular and lateral pectoral nerves (both of which supply the anterior shoulder joint), whereas the suprascapular nerve block anesthetizes the posterior shoulder. The authors concluded that future randomized trials are needed to validate the effectiveness of combined infraclavicular-suprascapular blocks for shoulder surgery.

Supraorbital Nerve Block for the Treatment of Temporomandibular Joint (TMJ) Disorder

Dupont (2003) noted that individuals with temporomandibular joint disorder (TMD) occasionally present with additional orofacial pain complaints. These can arise from dysfunction in teeth, bones, ligaments, tendons, nerves, and other structures . In a retrospective study, a group of 501 consecutive subjects with TMD complaints were evaluated for the presence of trigeminal neuritis. Very little information on the prevalence of this condition concomitant with TMDs exists in the literature. The existence of trigeminal neuritis was determined by the presence of pain when palpating trigeminal peripheral nerve branches exiting the supraorbital, infraorbital, and mental foramina in addition to the supratrochlear nerve. Each subject in this study had the involved nerves blocked with local anesthesia injections or lidocaine iontophoresis to aid in confirming the source of pain. A total of 60 subjects with TMD were found to have trigeminal neuritis; early recognition of this disorder was important because treatment was usually more successful in the acute peripheral state.

Furthermore, an UpToDate review on “Temporomandibular disorders in adults” (Mehta and Keith, 2021) states that “Interventional management for some patients – For certain patients, such as those with severe arthritis of the TMJ and patients with persistent symptoms due to internal derangement and joint pathology, interventional treatments may be offered … We prefer glucocorticoid injection rather than hyaluronic acid, and we typically use 10 mg methylprednisolone injected into the upper joint space (0.5 ml of a 20 mg/mL solution) following a local auriculotemporal nerve block using bupivacaine 0.5 % with epinephrine. There are few high-quality data demonstrating the efficacy of this approach, but in our clinical experience an injection can provide symptomatic relief of pain for up to 6 months in selected patients”.

Femoral-Sciatic Nerve Block for Lower Limb Surgeries

Bansal et al (2016) noted that peripheral nerve blocks are gaining popularity for many infra-umbilical surgeries with the development of new techniques such as US and peripheral nerve stimulator. It provides stable hemodynamic, better, and prolonged post-operative analgesia. These researchers examined the effectiveness of combined femoral and sciatic nerve block with ropivacaine alone and by adding fentanyl. This trial was performed on 100 patients scheduled for lower limb surgeries and were randomly divided into 2 groups of 50 each. In Group A, patients received 20-ml of 0.5 % ropivacaine for femoral nerve block and same dose for sciatic nerve block and in Group B, 25 µg fentanyl was added each for femoral nerve and sciatic nerve block along with ropivacaine. All hemodynamic parameters, onset and duration of sensory and motor blocks were noted. The patient characteristics were analyzed using the “Chi-square tests” and the inter-group comparison of the parametric data was performed using the unpaired t-test using software IBM SPSS 17.0. Combined femoral and sciatic nerve block provided longer duration of post-operative analgesia of approximately 12 to 13 hours. All the afore-mentioned parameters were statistically non-significant. The authors concluded that that combined femoral-sciatic nerve block using ropivacaine and fentanyl is one of the most useful yet most neglected anesthetic procedures. This could be used for lower limb surgeries without any major complications and with no drug toxicity. It could be used in critically ill patients where both GA and central co-axial block carries a high risk of mortality. This technique is safe and simple to master and slowly gaining popularity worldwide. It is having minimum hemodynamic instability and could be used in patients with valvular cardiac diseases and other cardiac ailments with fixed cardiac output, diabetic, and even patients on anti-coagulants. Although these investigators could not draw any significant difference by adding fentanyl, but as the technique and drugs used offers prolonged analgesia with negligible toxicity over other traditional techniques and drugs, so overall patient's satisfaction was better. Thus, the authors highly recommended using femoral-sciatic nerve block using ropivacaine with fentanyl for varieties of lower limb procedures.

Inferior Alveolar Nerve Block for Refractory Facial/Jaw Pain

In a prospective, randomized, double-blind study, Shadmehr et al (2017) compared the effectiveness of lidocaine with epinephrine versus lidocaine with clonidine for inferior alveolar nerve block (IANB) and hemodynamic stability (heart rate [HR], systolic blood pressure [SBP], diastolic blood pressure [DBP] and mean arterial pressure [MAP]) in patients with irreversible pulpitis. A total of 100 patients with irreversible pulpitis in mandibular molar teeth randomly received 1.8-ml of 2 % lidocaine with clonidine (15 μg/ml) or 1.8-ml of 2 % lidocaine with epinephrine (12.5 μg/ml), using a conventional IANB technique. Endodontic access cavities were prepared 15 mins after solution deposition, and all patients were required to have profound lip numbness. Success was defined as no or mild pain (VAS recording) upon endodontic access cavity preparation or initial canal instrumentation. The hemodynamic parameters were measured before, during and 5, 10 and 30 mins after administration. Finally, the collected data were subjected to independent t-test, Chi-square and Fisher's exact test using SPSS software ver20 at a significant level of 0.05. The success rates for IANB using lidocaine with epinephrine and lidocaine with clonidine solutions were 29 % and 59 %, respectively. The clonidine group exhibited a significantly higher success rate ($p < 0.05$). Five mins after drug administration, SBP and HR significantly increased in the lidocaine with epinephrine group and insignificantly decreased in lidocaine with clonidine group. The authors concluded that for mandibular molars with irreversible pulpitis, addition of clonidine to lidocaine improved the success rate of IANB compared to a standard lidocaine/epinephrine solution.

In a randomized clinical trial, Ghabraei et al (2019) compared the onset, success rate, injection pain, and post-injection pain of mental/incisive nerve block (MINB) with that of IANB using 4 % articaine in mandibular premolars with SIP. The accuracy of electrical pulp test (EPT) in determining pulpal anesthesia was also examined. This trial had 2 study arms -- MINB and IANB; injections were carried out using a standardized technique. Root canal treatment was initiated 10 mins after the injection. Success was defined as no pain or mild pain during access cavity preparation and instrumentation. Injection pain and post-injection pain (up to 7 days) were recorded. All pain ratings were performed using HP VAS. A total of 64 patients were enrolled. The success rate of MINB

(93.8 %) was higher than IANB (81.2 %); however, the difference was not significant ($p > 0.05$). The onset of anesthesia with MINB was significantly quicker, and injection pain was significantly less ($p < 0.05$), but post-injection pain was significantly higher during the first 4 days ($p < 0.001$). The accuracy of EPT in determining pulpal anesthesia was 96.88 %. The authors concluded that MINB and IANB with 4 % articaine had similar effectiveness in anesthetizing mandibular premolars with SIP; post-injection pain with MINB was higher than with IANB.

In a randomized, prospective clinical trial, Youssef et al (2021) compared the effectiveness and complications of intra-ligamentary anesthesia (ILA) with conventional IANB during injection and dental treatment of mandibular posterior teeth. A total of 72 patients (39 males, 33 females), scheduled for dental treatment of mandibular posterior teeth, were randomly allocated to ILA group (n = 35) received ILA injection or IANB group (n = 37) received the conventional IANB. The primary outcome was to evaluate pain and stress (discomfort) during the injection and dental treatment, using the numeric rating scale (NRS) from 0 to 10 (0 = no pain, 10 = the worst pain imaginable), whereas recording 24-hour post-operative complications was the secondary outcomes. Patients in ILA group reported significantly less pain during injection when compared with IANB group ($p = 0.03$), while pain during dental treatment was similar in both groups ($p = 0.2$). Patients in both groups also reported similar law values of discomfort during treatment ($p = 0.7$). Although no signs of nerve contact or any other post-operative complications were observed, 5 patients in IANB group (none in ILA group) reported temporary irritations. The authors concluded that this study showed equivalent effectiveness of both intra-ligamentary anesthesia and conventional IANB, for pain control during routine dental treatment of mandibular posterior teeth. Nevertheless, ILA showed significantly less pain during injection. No major post-operative complications in both groups were observed.

Kojima and Sendo (2022) stated that temporomandibular disorders (TMDs) are a group of disorders with symptoms that include pain and clicking sounds in the temporomandibular joint (TMJ) and restricted mouth opening. For the treatment of TMDs with trismus, these investigators suggested a new approach: jaw manipulation using the ultrasound (US)-guided IANB technique. A woman in her 60s developed TMDs and presented with severe trismus owing to pain in the TMJ. US-guided IANB was carried out with ropivacaine, which relieved the pain in the patient. Furthermore, these researchers performed jaw manipulation for trismus. Since the analgesic effect lasted for 3 days, self-training could be performed while the pain was relieved. After 5 sessions of jaw manipulation using the US-guided IANB technique, trismus significantly improved in this patient. The authors concluded that US-guided IANB can be effective in relieving TMD-related pain and trismus.

Intercostal Nerve Block for the Treatment of Notalgia Paresthetica

An UpToDate review on "Pruritus: Therapies for localized pruritus" (Fazio and Yosipovitch, 2022) states that "The best approach to the treatment of notalgia paresthetica is unclear. Topical antipruritic agents, such as pramoxine, capsaicin, or compounded topical ketamine, lidocaine, and amitriptyline, are our mainstays of treatment. We proceed to oral anticonvulsants (gabapentin or pregabalin) or injection of botulinum toxin type A when topical therapy is insufficient … Botulinum toxin A and a paravertebral nerve block have also been reported as effective in case reports. However, a placebo-controlled, randomized trial of 20 patients with notalgia paresthetica did not find a beneficial effect of botulinum toxin A treatment".

Interscalene/Suprascapular Nerve Block for Pain Control in Shoulder Surgeries (Arthroscopic or Open)

Abdallah et al (2015) interscalene block (ISB) can provide effective analgesia up to 6 hours with motion and 8 hours at rest after shoulder surgery, with no demonstrable benefits thereafter. Patients who receive an ISB can suffer rebound pain at 24 hours, but later experience similar pain severity compared with those who do not receive an ISB. The authors stated that ISB can also provide an opioid-sparing effect and reduce opioid-related side effects in the first 12 and 24 hours postoperatively, respectively. These findings are useful to inform pre-operative risk-benefit discussions regarding ISB for shoulder surgery.

In a systematic review and meta-analysis, Hussain et al (2017) concluded that there are no clinically meaningful analgesic differences between suprascapular block (SCB) and ISB except for ISB providing better pain control during recovery room stay; however, SCB has fewer side effects. These findings suggested that SCB may be considered an effective and safe ISB alternative for shoulder surgery.

In a systematic review and meta-analysis, Hussain et al (2020) stated that ISB is the acute pain management technique of choice for shoulder surgery; however, its undesirable respiratory side effects have prompted seeking alternatives. The authors concluded that for acute pain control following shoulder surgery, high-quality evidence indicated that SCB can be used as an effective ISB alternative. SCB is non-inferior for post-operative opioid consumption and acute pain, and it reduced the odds of post-block respiratory dysfunction.

In a systematic review and meta-analysis, White et al (2022) compared the analgesic effectiveness and complications rates for anterior suprascapular nerve blocks (ASSB) with ISB for arthroscopic and outpatient shoulder surgery. Only RCTs comparing the ASSB versus ISB in the context of arthroscopic shoulder surgery were eligible for inclusion. The primary outcomes included pain scores (NRS of 0 to 10) up to 24 hours post-operatively and analgesic consumption. Secondary outcomes included block complications. Meta-analysis was carried out using random-effects modeling and result certainty was determined using the GRADEpro tool. A total of 6 RCTs (709 patients) were included for analysis. ISB displayed a statistically significant reduction in pain scores by 0.40 (95 % CI: 0.36 to 0.45; $p < 0.00001$) but not morphine equivalent consumption (mean difference [MD] = 0.74 mg; 95 % CI: - 0.18 to 1.66 mg; $I2 = 60$ %; $p = 0.11$; moderate certainty) immediately in the post-operative care unit. Opioid consumption and pain scores at 6 to 24 hours were not significantly different. There was no difference in respiratory events post-block. A SSB demonstrated a significantly lower incidence of Horner's syndrome (RR = 0.17; 95 % CI: 0.08 to 0.39; $p < 0.00001$; high certainty), voice hoarseness (RR = 0.24; 95 % CI: 0.10 to 0.57; $p < 0.00001$; high certainty) and impaired respiratory function ($p < 0.00001$). The authors concluded that ASSB could be considered an appropriate analgesic option for arthroscopic shoulder surgery with potentially fewer complications than the ISB.

In a systematic review and meta-analysis, Kalthoff et al (2022) compared the effectiveness of different peripheral nerve blocks and general anesthesia (GA) in controlling post-operative pain after arthroscopic rotator cuff repair (ARCR). A total of 14 RCTs with 851 patients were included in the meta-analysis. Data from 6 different nerve block interventions were included: single-shot ISB (s-ISB; 37.8 % [322/851]), single-shot suprascapular nerve block (s-SSNB; 9.9 % [84/851]), continuous ISB (c-ISB; 17.5 % [149/851]), continuous SSNB (c-SSNB; 6.9 % [59/851]), s-ISB combined with SSNB (s-ISB+SSNB; 5.8 % [49/851]), s-SSNB combined with axillary nerve block (s-SSNB+ANB; 4.8 % [41/851]), as well as GA (17.3 % [147/851]). It remains unclear which peripheral nerve block strategy is optimal for ARCR; however, peripheral nerve blocks are highly effective at attenuating post-operative ARCR pain and should be more widely considered as an alternative over general anesthesia alone. Level of Evidence = II.

PENG (PEricapsular Nerve Group) Block for Hip Pain

Giron-Arango et al (2018) noted that fascia iliaca block or femoral nerve block is used frequently in hip fracture patients because of their opioid-sparing effects and reduction in opioid-related adverse effects. A recent anatomical study on hip innervation led to the identification of relevant landmarks to target the hip articular branches of femoral nerve and accessory obturator nerve. Using this information, these researchers developed a novel ultrasound (US)-guided approach for blockade of these articular branches to the hip, the PENG (PEricapsular Nerve Group) block. The authors described the technique and its application in 5 consecutive patients.

Del Buono et al (2020) noted that the PENG block is a novel regional technique indicated for analgesia for hip joint pain. These investigators administered PENG blocks and performed catheter insertion for continuous infusions in patients with femur fractures on hospital admission. In this case-series study, these researchers described their initial experience of pain management in 10 patients with continuous infusion and its associated AEs. The PENG block was administered with an introducer needle. The catheter was then inserted 3 cm beyond the needle tip. In 3 patients, blood aspiration through the catheter occurred. In each patient, the catheter was re-positioned 0.5 to 1.0 cm more medially. No blood aspiration or visible hematoma occurred subsequently. The presence of any vascular structure deep to the iliopsoas muscle was excluded post-operatively based on a Doppler color flow scan. The authors noted that 8 patients had femoral neck fractures, and 2 patients had intertrochanteric fractures. All 10 patients reported good pain relief. The median (inter-quartile range [IQR]) NRS score decreased from 7 (6 to 7) before the block to 2 (2 to 2.75) 20 mins after PENG catheter placement. The median (IQR) NRS score after 12, 24 and 48 hours were 2 (2 to 3), 2 (2 to 3), and 2 (0.25 to 2), respectively. Patients underwent surgery 24 to 48 hours following catheter placement. Catheters were removed by an Acute Pain Service nurse 72 hours post-insertion. These researchers highlighted the potential for intravascular catheter placement in this anatomical region. They stated that further studies are needed to confirm if this is a technical error or an associated complication of continuous PENG blocks.

Allard et al (2021) noted that regional analgesia is worth performing in the multi-modal post-operative management of hip fracture (HF) because it reduces hospital morbidity and mortality. In a comparative, observational study, these researchers compared the effectiveness and side effects of the recently described PENG block with those of the femoral block, which is considered the SOC for post-operative pain control after femoral neck fracture. This trial carried out at the Saint Antoine Hospital (Sorbonne University, Paris, France) included all patients from June to October 2019, who were coming for femoral neck fractures and who had an analgesic femoral block or PENG block before their surgery. The primary outcome was the comparison of cumulative post-operative morphine consumption 48 hours after surgery. Demographics, medical charts, and peri-operative data of 42 patients were reviewed: 21 patients before (Femoral group) and 21 patients after the introduction of PENG block (PENG group) in clinical practice. A total of 13 total hip arthroplasties (THA) and 8 hemi-arthroplasties (HA) were included in each group. Demographics were also comparable. The median, post-operative, morphine equivalent consumption at 48 hours was 10 (0 to 20) mg and 20 (0 to 50) mg in Femoral and PENG groups, respectively ($p = 0.458$). No statistically significant differences were observed in post-operative pain intensity, time to ambulation, incidence of morphine-related side effects, or hospital LOS. The post-operative muscle strength of the quadriceps was greater in the PENG group than in the Femoral group

(5/5 versus 2/5, p = 0.001). The authors concluded that in the management of hip fractures in this study, PENG block was not associated with a significant change in post-operative morphine consumption, compared to femoral block; however, it significantly improved the immediate mobility of the operated limb, making it appropriate for inclusion in enhanced recovery programs after surgery. Moreover, these researchers stated that further studies with a prospective multi-centric design and with a greater number of patients should be performed to confirm these findings.

The authors stated that one of the limitations of this study was its mono-centric and data-based design and inter-operator variability, which therefore potentially could have led to inconsistency in the efficacy of the regional anesthesia performed; thus, diminishing the power of the study. In the study by Mistry et al (2019), it was reported that the injection zone of the local anesthesia (LA) in the PENG block was very important and would influence the effectiveness of the block. Optimal injection was reflected in the US vision of a medial diffusion towards the ilio-pubic eminence. Even if the sample size was statistically calculated, another limitation of the study was the small number of patients (n = 21 in the PENG group).

Mosaffa et al (2022) noted that fascia iliaca compartment block (FICB) is a common regional analgesic strategy in hip fracture surgery; however, recently it has been suggested that FICB may not provide enough analgesia. PENG is a novel method for hip analgesia; however, its efficacy is not well established yet. In a prospective, double-blind randomized controlled clinical, these researchers examined the effect of the PENG block in the control of hip fracture pain and compared the effectiveness of the PENG compared with FICB. These investigators hypothesized that the PENG block could be a good alternative to the FICB in hip fracture analgesia. This randomized controlled clinical trial was carried out in the Imam-Hossein Hospital, Tehran, Iran; between 2018 and 2019. Hip fracture patients were randomly divided into 2 groups; Group A (n = 22) received FICB, and Group B (n = 30) received PENG block. There was no significant difference between VAS score before blocks procedure between 2 groups (p = 0.37). After 15 mins of blocks and after 12 hours of post-surgery, VAS score significantly reduced in the PENG block group compared with the FICB group (p = 0.031; p =

0.021, respectively). The first time of the analgesic consumption after surgery was significantly longer in the PENG block compared with the FCIB ($p = 0.007$). Compared with the FICB group, the total dose of morphine consumption during 24 hours significantly reduced in the PENG block ($p = 0.008$). The authors concluded that PENG block is a good method in hip fractures analgesia and provided better analgesia than FICB; however, further studies with larger sample sizes are needed to validate the effectiveness and superiority of the PENG blocks over conventional techniques. Level of Evidence = I.

Furthermore, an UpToDate review on “Approach to the adult with unspecified hip pain” (Paoloni, 2022) does not mention the PENG block as a management / therapeutic option.

Stellate Ganglion Nerve Block for the Treatment of Phantom Limb Pain

An UpToDate review on “Upper extremity amputation” (Chung and Yoneda, 2022) does not mention stellate ganglion injection/block as a management option.

Thoraco-Lumbar Interfascial Plane (TLIP) Nerve Block for Post-Operative Pain Management After Spine Surgeries

Ye et al (2021) stated that thoracolumbar interfascial plane (TLIP) block has been discussed widely in spine surgery. In a systematic review and meta-analysis, these researchers examined the safety and effectiveness of TLIP block in spine surgery. They carried out a quantitative systematic review; RCTs that compared TLIP block to non-block care or wound infiltration for patients undergoing spine surgery and took the pain or morphine consumption as a primary or secondary outcome were included. The primary outcome was cumulative opioid consumption during 0 to 24 hours following surgery. Secondary outcomes included post-operative pain intensity, rescue analgesia requirement, and AEs. A total of 9 RCTs with 539 patients were included for analysis. Compared with non-block care, TLIP block was effective in reducing the opioid consumption (WMD -16.00; 95 %CI: -19.19 to -12.81; $p < 0.001$; $I^2 = 71.6$ %) for the first 24 hours after the surgery. TLIP block significantly reduced post-operative pain intensity at rest or movement at various time-points compared with non-block care, and reduced rescue analgesia requirement ((RR 0.47; 95 % CI: 0.30 to 0.74; p = 0.001; I2 = 0.0 %) and post-operative nausea and vomiting (RR 0.58; 95 % CI: 0.39 to 0.86; p = 0.006; I2 = 25.1 %). Besides, TLIP block was superior to wound infiltration in terms of opioid consumption (WMD -17.23, 95 % CI: -21.62 to -12.86; p < 0.001; I2 = 63.8 %), and the post-operative pain intensity at rest was comparable between TLIP block and wound infiltration. The authors concluded that TLIP block improved analgesic efficacy in spine surgery compared with non-block care. Furthermore, current literature supported the TLIP block was superior to wound infiltration in terms of opioid consumption.

The authors stated that this study had several drawbacks. First, significant heterogeneity was observed in some of these findings, although sensitivity analyses were performed, these investigators did not identify the source of heterogeneity. Second, these researchers did not examine a dose-response effect of the TLIP block as the dosage used in the included studies did not provide enough variability. Third, there was significant inter-study difference in the way of reporting opioid dosages and pain scores, the diversity in the pain intensity assessment tools (VRS, NRS, VAS) and follow-up time might lead to heterogeneity and deviation in the analysis. Fourth, the sample size of included studies was relatively small, with the largest study only including 80 patients, Fifth, few studies reported the hospital LOS, the time to first analgesia request, length of PACU stay. These researchers stated that future studies should perform the analysis of TLIP block by using the above data.

In a retrospective study, Morgenstern et al (2021) examined the effectiveness in reducing post-operative pain and opioid analgesia of a novel inter-disciplinary strategy combining pre-operative TLIP block and percutaneous / endoscopic transforaminal lumbar interbody fusion surgery and determined time to 1st post-operative ambulation and hospital LOS. A total of 42 patients who underwent elective single-level percutaneous/endoscopic transforaminal lumbar interbody fusion surgery between 2015 and 2021 were divided into 2 groups: TLIP group with 17 patients who underwent TLIP block and non-TLIP group with 25 patients. Both groups received the same post-operative analgesia with morphine as patient-controlled rescue medication; VAS and Oswestry Disability Index (ODI) scores were evaluated. Statistical evaluation was performed with Student t-test. In contrast to the non-TLIP group, in the TLIP group, post-operative mean VAS back score and mean ODI score significantly decreased from 6.6 to 3.3 ($p < 0.01$) and 32.8 to 23.6 ($p < 0.01$), respectively, at hospital discharge. No differences were found between the groups at 1 month. Overall mean follow-up time was 29 ± 18 months (range of 3 to 78 months). Patients in the non-TLIP group were administered a median post-operative 24-hour morphine dose equivalent of 23 mg (range of 8 to 31 mg), while patients in the TLIP group did not require opioid analgesia ($p < 0.01$). Patients in the TLIP group started post-operative ambulation at a median of 4.1 hours (range of 2.5 to 26 hours) with a median hospital LOS of 24 hours (range of 20 to 48 hours) ($p = 0.112$). The authors concluded that TLIP block significantly improved patient outcome at hospital discharge after transforaminal lumbar interbody fusion surgery without post-operative administration of opioids. Moreover, these researchers stated that a prospective study is recommended to confirm these preliminary findings.

Tibial Nerve Block Before a First Metatarsophalangeal Joint Injection for the Treatment of Hallux Rigidus / Before a Plantar Fascia Injection

An UpToDate review on “Joint aspiration or injection in adults: Technique and indications” (Roberts, 2022) does not mention tibial nerve block as a management option.

Also, an UpToDate review on “Plantar fasciitis” (Buchbinder, 2022) does not mention the use of nerve block before glucocorticoid injection.

Adductor Canal Block Post-Operative Pain After Arthroscopic Tibiotalar Arthrodesis

Zhang et al (2022) stated that PNBs are the regional techniques in orthopedic surgeries to control post-operative pain and have early discharge from hospital; however, anesthesia protocols for foot and ankle surgeries of institutes do not include multimodal analgesics including PNBs. These researchers compared spinal anesthesia (SA) with PNB against general anesthesia (GA) with PNB for elective foot and ankle surgeries. Patients were treated for elective foot and ankle surgery under general anesthesia (using propofol, 0.05 mg/kg dezocine, and 1 % sevoflurane; GA cohort, n = 112) or spinal anesthesia (using 0.5%

bupivacaine, propofol, and 0.05 mg/kg dezocine; SA cohort, n = 132) or patients have treated for elective for foot and ankle surgery under general anesthesia (GL cohort, n = 115) or spinal anesthesia (SL cohort, n = 160) with the use of PNB (the sciatic NBs and adductor canal NBs using 0.25 % bupivacaine and 0.1 mg/kg dexamethasone). Propofol was administered in fewer amounts if anesthesia was used with the PNB. Patients of the GL cohort were transferred to ward 36 mins (mean) earlier than those of the SL cohort. None of the patients of the GL and the SL cohorts had received intra-operative opioid(s) for the management of pain. Patients of the GL and the SL cohorts have reported post-operative falls within 1 day after surgeries during movement. Patients of the SL cohort experienced more frequently difficulty with sleeping. Patients of the GL and the GA cohorts reported nausea and vomiting. Only patients of the GL cohort required usage of vasoactive drugs. The authors concluded that the findings of this study provided information to anesthesiologists and surgeons regarding anesthesia techniques for elective foot and ankle surgeries for better surgical outcomes. Level of Clinical Evidence = II.

Anterior Cutaneous Nerve Block for Anterior Cutaneous Nerve Entrapment Syndrome

Kim et al (2011) stated that meralgia paresthetica is a rarely encountered sensory mononeuropathy characterized by paresthesia, pain or sensory impairment along the distribution of the lateral femoral cutaneous nerve (LFCN) caused by entrapment or compression of the nerve as it crossed the anterior superior iliac spine and runs beneath the inguinal ligament. There is great variability regarding the area where the nerve pierces the inguinal ligament, which makes it difficult to perform blind anesthetic blocks. Ultrasound has developed into a powerful tool for the visualization of peripheral nerves including very small nerves such as accessory and sural nerves. The LFCN can be located successfully, and local anesthetic solution distribution around the nerve can be observed with US guidance. The authors noted that their successfully performed US-guided blockade of the LFCN in meralgia paresthetica suggested that this technique is a safe way to increase the success rate. Moreover, these researchers stated that further investigations are needed regarding minimum dosage of local anesthetic agent required when performing US-guided blockage of LFCN.

Furthermore, an UpToDate review on “Anterior cutaneous nerve entrapment syndrome” (Meyer, 2023) does not mention anterior cutaneous NB as a management/therapeutic option.

Auriculotemporal Nerve Block for Temporomandibular Joint (TMJ) Disorder

Zhou et al (2021) stated that TMJ “closed lock” is a clinical condition causing TMJ pain and limited mouth opening (painful locking). Recent studies suggested an increasing prevalence of degenerative joint disease associated with the onset of TMJ closed lock in adolescents and young adults. Early interventions are recommended; however, the curative effect of standard therapies remains controversial. In a retrospective study, these researchers presented an alternative method of non-surgical treatment of TMJ closed lock, and its long-term effectiveness. A total of 40 adolescents and young adults, aged 16 to 30 years, with distinct combination of symptoms of TMJ closed lock, were enrolled. Patients received anesthetic blockages of the auriculotemporal nerve, then performed mandibular condylar movement exercise for 10 mins, and subsequently received hypertonic dextrose prolotherapy in retro-discal area of TMJ. Clinical assessments at baseline and at follow-up (2 weeks, 2 months, 6 months, and 5 years) included intensity and frequency of TMJ pain, mandibular ROM, TMJ sounds, and impairment of chewing. Cone beam CT images of the TMJs revealed joint space changes in all patients and degenerative bone changes in 20 % (8/40) of the patients. The patients were diagnosed as having disc displacement without reduction with limited opening. Successful reduction of displaced disc had been achieved in the treatment; and pain at rest and pain on mastication had substantially decreased in all patients and mandibular function; and mouth opening had significantly improved since 2 weeks' follow-up. The overall success rate kept at a high level of 97.5 % (39/40) at 6 months and 5 years' follow-up. The authors concluded that the technique combining mandibular condylar movement exercise with auriculotemporal NB and dextrose prolotherapy is straightforward to perform, inexpensive and satisfactory to young patients with TMJ closed lock. Moreover, these researchers noted that drawbacks of this study included a relatively small sample size (n = 40); they stated that larger, RCTs are needed to further examine if all TMJ closed lock patients respond similarly to the treatment.

Demirsoy et al (2021) examined the effectiveness of the auriculotemporal nerve block (ATNB) technique in conjunction with non-invasive therapies for the treatment of disc displacement with reduction (DDWR) or without reduction (DDWOR) in addition to arthralgia of the TMJ. The data of 22 patients diagnosed with DDWR and DDWOR whose clinical conditions did not improve despite non-invasive treatments were analyzed. ATNB was applied to each patient during the 1st visit and re-administered at 1- and 4-week follow-up visits. Pain intensity values (0 to 10 VAS scores) were evaluated pre-ATNB and at the 6-month follow-up visit, and the maximal mouth opening (MMO) values were measured pre-ATNB and at the 1-week, 4-week, and 6-month follow-up visits. Non-invasive therapies did not make a significant difference in the outcomes between the initial visit and 1st administration of ATNB (VAS; $p = 0.913$, MMO; $p = 0.151$). However, there were significant differences in outcomes between pre-ATNB and the 1-week (MMO; $p = 0.000$), 4-week (MMO; $p = 0.000$), and 6-month (VAS; $p = 0.027$, MMO; $p = 0.000$) follow-ups. The authors concluded that ATNB may be considered as a supportive therapeutic approach in non-invasive TMJ disorder therapies.

Axillary Nerve Block for Bicipital Tenosynovitis / Shoulder Bursitis / Post-Operative Pain Control After Elbow Surgery

In a randomized trial, Wada et al (2014) assessed post-operative pain levels after arthroscopic elbow surgery under general anesthesia and examined if an axillary NB would provide additional pain management benefits compared with a portal site injection of local anesthetic. A total of 36 patients undergoing arthroscopic elbow surgery under general anesthesia were randomized to either a study group receiving axillary NB (Ax group) or a control group receiving portal site injections of local anesthetic (Lo group). During the first 48 hours following surgery, pain VAS scores (0 to 100), total amount of oral analgesics required, and patient satisfaction were evaluated. Among the 36 patients, mean pain VAS scores at rest were 37, 18, and 9 for the first 12-hour period and at 24 and 48 hours after surgery, respectively. The mean pain VAS scores during physiotherapy were 47 and 33 at 24 and 48 hours post-operatively, respectively. No intergroup differences were observed between the Ax and Lo groups at any time-point after surgery (p value range of 0.41 to 0.87). The mean number of loxoprofen tablets required during the 48-hour study period was 5.1 in the Ax group and 4.5 in the Lo group (p =

0.90). The Ax and Lo groups had mean overall patient satisfaction scores of 91 and 91, respectively (p = 0.98). The authors concluded that post-operative pain levels after arthroscopic elbow surgery could be well-managed with oral analgesics and local anesthetic; an axillary NB was not found to provide any post-operative pain control benefits. Level of Evidence = I.

UpToDate reviews on “Biceps tendinopathy and tendon rupture” (Simons and Dixon, 2023), and “Bursitis: An overview of clinical manifestations, diagnosis, and management” (Todd, 2023) do not mention axillary nerve block as a management/therapeutic option.

Bier Block for Carpal Tunnel Surgery

Volkmar et al (2021) noted that forearm tourniquets may offer decreased doses of anesthetic, shorter procedure times, and less pain compared to upper arm tourniquets. There is limited data comparing the clinical effectiveness of forearm Bier blocks to conventional upper arm Bier blocks. In a randomized, clinical trial, these researchers examined the effectiveness, complications, duration, cost, and patient satisfaction between forearm and upper arm Bier blocks during surgery. A total of 66 carpal tunnel release (CTR), ganglion excision, or trigger finger procedures were performed. Patients were randomized to 3 groups: upper arm tourniquet for 25 mins, forearm tourniquet for 25 mins, or forearm tourniquet with immediate deflation following the procedure (less than 25 mins). The effectiveness of surgical anesthesia, tourniquet discomfort, and supplementary local anesthetic administration were recorded. Pain was assessed intra-operatively and post-operatively. Patient satisfaction was assessed on the 1st post-operative day. No difference was observed between groups with respect to pain, satisfaction, or administration of supplemental medication. The tourniquet time for the group with immediate deflation following procedure was shorter by an average of 9.3 mins. Total hospital charges were 9.95 % cheaper with immediate tourniquet deflation compared to procedures where the tourniquet remained inflated for at least 25 mins. The authors concluded that the forearm Bier block was a safe, efficient, cost-effective technique for IV regional anesthesia during hand surgery, and tourniquet deflation immediately following the procedure (less than 25 mins) did not increase incidence of complications. The forearm tourniquet reduced the dose of local anesthetic; thus, the risk for systemic toxicity, with similar effectiveness as compared to the upper arm technique. Level of Evidence = II.

Erector Spinae Plane Block for Post-Operative Pain Control After Cardiac Procedures

StatPearls for “Erector spinae plane block” (Krishnan and Cascella, 2023) noted that ESP block is a relatively novel approach to pain management for a variety of surgical procedures, as well as for acute and chronic pain. It is carried out as a single injection block, or a catheter is placed for continued relief, and the procedure is most often carried out with US guidance. The ESP block can be used to deliver regional analgesia for a wide variety of surgical procedures in the anterior, posterior, and lateral thoracic and abdominal areas, as well as for the management of acute and chronic pain syndromes. The authors concluded that as the ESP block is a relatively new procedure, the vast majority of information regarding the block is from case reports and anecdotal experience.

In a systematic review and meta-analysis, King et al (2023) examined the impact of the ESP block on post-sternotomy pain and recovery in cardiac surgery patients; RCTs, cohort studies, and case-control studies were considered for inclusion. Outcomes of interest included post-operative pain, time-to-extubation, and ICU-LOS. A total of 498 studies were identified and 5 were included in the meta-analysis. The ESP block did not significantly reduce self-reported post-operative pain scores at 4 hours (-2.04; 95 % CI: -8.15 to 4.07; p = 0.29) or 12 hours (-0.27; 95 % CI: -2.48 to 1.94; p = 0.65) post-extubation, intra-operative opioid requirements (-3.07; 95 % CI: -6.25 to 0.11; p = 0.05], time-to-extubation (-1.17; 95 % CI: -2.81 to 0.46; p = 0.12), or ICU-LOS (-4.51; 95 % CI: -14.23 to 5.22; p = 0.24). The authors concluded that the ESP block was not associated with significant reduction in post-operative pain, intra-operative opioid requirements, time-to-extubation, and ICU-LOS in patients undergoing cardiac surgery. These researchers stated that the paucity of large RCTs and the high heterogeneity among studies suggested that further studies are needed to evaluate its effectiveness in cardiac surgery patients.

Erector Spinae Plane Block for Post-Operative Pain Control After Lumbar Spinal Surgery

Ma et al (2021) noted that although in recent years some RCTs have examined the analgesic effect of ESPB in spine surgery, their results are controversial. In a meta-analysis, these investigators examined the analgesic effect of pre-operative ESPB in spine surgery. The articles of RCTs that compared pre-operative ESPB with no block in terms of the analgesic effect in adult patients following spine surgery were eligible for inclusion. The primary outcome was the pain scores reported by VAS or NRS of pain at different time intervals in 48 hours after surgery. The secondary outcomes included post-operative opioid consumption, rescue analgesia requirement, opioid-related side effects and complications associated with ESPB. A total of 12 studies involving 828 patients were eligible for this study. Compared with no block, ESPB had a significant effect on reducing post-operative pain scores at rest and at movement at different time intervals except at movement at 48 hours. ESPB significantly decreased opioid consumption in 24 hours after surgery (SMD - 1.834; 95 % CI: - 2.752 to - 0.915; $p < 0.001$; $I^2 = 89.0$ %), and reduced the incidence of rescue analgesia (RR 0.333; 95 % CI: 0.261 to 0.425; $p < 0.001$; $I^2 = 0$ %) and post-operative nausea and vomiting (RR 0.380; 95 % CI: 0.272 to 0.530; $p < 0.001$; $I^2 = 9.0$ %). Complications associated with ESPB were not reported in the included studies. The authors concluded that this meta-analysis showed that ESPB was effective in decreasing post-operative pain intensity and post-operative opioid consumption in spine surgery; thus, for the management of post-operative pain following spine surgery, pre-operative ESPB was a good choice.

Peng et al (2023) stated that with the rapid development of aging population, the number of elderly patients undergoing posterior lumbar spine surgery continues to increase. Lumbar spine surgery could cause moderate-to-severe post-operative pain, and the conventional opioid-based analgesia techniques have many side effects, which are barriers to the recovery following surgery of the elderly. Previous studies have shown that ESPB could bring about favorable analgesia in spinal surgery. As far as the elderly are concerned, the analgesic and recovery effects of ESPB on posterior lumbar spine surgery are not completely clear. These investigators examined the effects of bilateral ESPB on elderly patients undergoing posterior lumbar spine surgery to improve the anesthesia techniques. A total of 70 elderly patients of both sex, who were selected from May 2020 to November 2021, scheduled for elective posterior lumbar spine surgery, and in the age of 60 to 79 years, with ASA class II to III, were divided into a ESPB group and a control (C) group using a random number table method, with 35 patients each. Before general anesthesia induction, 20-ml 0.4 % ropivacaine was injected to the transverse process of L3 or L4 bilaterally in the ESPB group and only saline in the C group. The score of NRS indicating pain at rest and on movement within 48 hours after operation, time of 1st PCA, cumulative consumptions of sufentanil within 48 hours, Leeds Sleep Evaluation Questionnaire (LSEQ) scores on the morning of day 1 and day 2 after operation, QOR-15 scores at 24 and 48 hours after operation, full diet intake times, peri-operative adverse reactions such as intra-operative hypotension, post-operative dizziness, nausea, vomiting, and constipation were compared between the 2 groups. A total of 70 patients were enrolled and 62 subjects completed the study, including 32 in the ESPB group and 30 in the C group. Compared with the C group, the post-operative NRS scores at rest at 2, 4, 6, and 12 hours and on movement at 2, 4, and 6 hours were lower, time of 1st PCA was later, sufentanil consumptions were significantly decreased during 0 to 12 hours and 12 to 24 hours after operation, LSEQ scores on the morning of day 1 and QOR-15 scores at 24 and 48 hours after operation were higher, full diet intakes achieved earlier in the ESPB group (all $p < 0.05$). There were no significant differences in the incidences of intra-operative hypotension, post-operative dizziness, nausea, vomiting, and constipation between the 2 groups (all $p > 0.05$). The authors concluded that providing favorable analgesic effects with reduced opioids consumption, bilateral ESPB for posterior lumbar spine surgery in the elderly patients could also improve post-operative sleep quality, promote GI functional restoration, and enhance recovery with few adverse reactions.

Wittayapairoj et al (2023) noted that PNBs are an important part of the multi-modal analgesia for reducing post-operative pain, opioids consumption and its side effects. A new PNB, ESPB, has shown post-operative analgesic effect in various surgical procedures such as breast, thoracic and abdominal surgery, with the limitation of the studies for spine surgery. In a double-blind RCT, these investigators examined the analgesic effect of US-guided bilateral ESPB following open lumbar spinal surgery. A total of 62 patients undergoing posterior lumbar spinal surgery were randomly allocated into 2 groups. The ESPB group (n = 31) received US-guided bilateral ESPB using 20 ml of 0.375 % bupivacaine with adrenaline 5 mcg/ml per side. The control group (n = 31) received no intervention. The same post-operative analgesia regimen was applied by oral acetaminophen 10 to 15 mg/kg every 6 hours, naproxen 250 mg twice-daily, and IV morphine via PCA device. The post-operative morphine consumption, NRS and the side effects were recorded. The bilateral ESPB group reduced the 24 h-morphine consumption by 42.9 % ($p < 0.001$), decreased overall pain score at rest by 1.4 points ($p = 0.02$), and decreased overall pain score on movement by 2.2 points ($p < 0.001$). No severe complications related to the block technique or morphine used occurred. The authors concluded that US-guided bilateral ESPB showed the effectiveness for post-operative analgesia management following open lumbar spinal surgery regarding reduced opioid consumption and pain score without any serious complications.

Fu et al (2023) stated that since the use of US-guided ESPB in 2016, the approach has been gradually applied to peri-operative analgesia in various surgeries. In recent years, more and more studies have focused on the effect of ESPB in peri-operative analgesia of lumbar spinal surgery. In a systematic review and meta-analysis, these researchers examined the safety and effectiveness of ESPB used for peri-operative pain management in lumbar spinal surgery. The PubMed, Web of Science, Cochrane Library, and Embase databases were searched for relevant articles from inception to March 2022; RCTs comparing ESPB with placebo or without ESPB in lumbar spinal surgery were included. The Review Manager 5.3 software was employed for this meta-analysis. A total of 19 RCTs with 1,381 participants were included for final analysis. The ESPB group exhibited lower intra-operative consumption of sufentanil and remifentanil, lower total opioid consumption within 24 and 48 hours after surgery, lower incidence of rescue analgesia, longer time to 1st rescue analgesic and lower number of PCA button presses compared to the control group ($p < 0.05$). Moreover, the ESPB group had significantly lower pain scores at rest and on movement within 48 hours after surgery compared with the control group ($p < 0.05$). In terms of opioid-related adverse reactions, ESPB reduced the incidence of post-operative nausea, vomiting, somnolence, and itching in comparison to the control group ($p < 0.05$). ESPB-related serious complications were not reported in included studies. The authors concluded that this meta-analysis showed that ESPB used in lumbar spinal surgery was effective in relieving post-operative pain, decreasing the peri-operative consumption of opioids, as well as decreasing the incidence of post-operative opioid-related adverse reactions.

Liu et al (20230 noted that patients undergoing lumbar spine surgery usually suffer from moderate-to-severe acute pain; ESPB has been used to relieve acute pain in various surgeries and improve post-operative outcomes. In a systematic review and meta-analysis, these researchers examined the safety and effectiveness of ESPB in patients undergoing lumbar spine surgery. This study also examined the outcomes of the ESPB compared with other regional blocks. These investigators searched PubMed, Web of Science, Cochrane library, Embase, and CINAHL databases to identify all RCTs evaluating the effects of ESPB on post-operative pain after lumbar spine surgery. The primary outcome was post-operative total opioid consumption in 24 hours. The secondary outcomes were post-operative pain scores, intra-operative opioid consumption, time to 1st rescue analgesia, number of patients requiring rescue analgesia, 1st time to ambulation after surgery, LOS, patients' satisfaction score, and post-operative side effects such as post-operative nausea and vomiting, itching. A total of 19 RCTs were included in the final analysis. Compared with no/sham block, US-guided ESPB decreased peri-operative opioid consumption including intra-operative opioid consumption: SMD = -3.04, 95 % CI: -3.99 to -2.09, p < 0.01, and opioid consumption post-operatively: (SMD = -2.80, 95 % CI: -3.61 to -2.00, p < 0.01); reduce post-operative pain at 2, 6, 12, 24, and 48 hours both at rest and movement; meanwhile shorten time to LOS: (SMD = -1.01, 95 % CI: -1.72 to 0.30, p = 0.006), decrease post-operative nausea and vomiting (RR = 0.35, 95 % CI: 0.27 to 0.46, p < 0.00001), and improve patient satisfaction (SMD = -2.03, 95 % CI: -0.96 to 3.11, p = 0.0002). However, US-guided ESPB did not shorten the time to ambulation after surgery (SMD = -0.56, 95 % CI: -1.21 to 0.08, p = 0.09). Furthermore, ESPB was not superior to other regional blocks (e.g., thoracolumbar inter-fascial plane/mid-transverse process to pleura block). The authors concluded that this meta-analysis showed that US-guided ESPB could provide effective post-operative analgesia in patients undergoing lumbar spine surgery and improve post-operative outcomes, and it deserves to be recommended as an analgesic adjunct in patients undergoing lumbar spine surgeries.

Erector Spinae Plane (ESP) Block for Post-Operative Pain Control After Mastectomy

Sharma et al (2020) stated that the ESP block is a newer technique of analgesia to the chest wall. In a prospective, single-center RCT, these researchers examined the safety and effectiveness of this block in patients undergoing total mastectomy and axillary clearance. A total of 65 patients were included; final analysis was done for 60 female patients undergoing total mastectomy and axillary clearance under general anesthesia were randomly allocated to 2 groups. Group B (block group) received US-guided ESP block at T5 level with ropivacaine (0.5 %, 0.4 ml/kg) while the control group did not receive any intervention. Post-operatively, patients in both groups received morphine via IV PCA device. Patients were followed-up for 24 hours post-operatively. The 24-hour morphine consumption was considered as the primary outcome and secondary outcomes included time to 1st rescue analgesia, pain scores at 0, 0.5, 1, 2, 4, 6, 8, 12, and 24 hours and characteristics and complications associated with block procedure. The 24-hour morphine consumption was 42 % lower in block group compared to control group [mean (SD), 2.9 (2.5) mg versus 5.0 (2.1) mg in group B and group C, respectively, $p = 0.01$]. The post-operative pain score was lower in group B versus group C at 0, 0.5, 1, 2, 4, 6, 12, and 24 hours ($p < 0.05$). A total of 26 patients in group C against 14 in group B used rescue analgesia within 1 hour of surgery ($p = 0.01$). The authors concluded that ESP block may prove to be a safe and reliable technique of analgesia for breast surgery. Moreover, these researchers stated that further studies comparing this technique with other regional techniques are needed to identify the most appropriate technique.

Sinha et al (2021) noted that Forero et al described 2 approaches of ESP block: superficial and deep to erector spinae muscle. These investigators hypothesized that the superficial technique would not lead to optimum analgesia as the drug would have to cross one more muscle layer. They compared the techniques in terms of analgesia and sensory blockade in patients undergoing modified radical mastectomy (MRM). A total of 40

ASA I/II female patients in age group 18 to 60 years undergoing unilateral MRM were included in this prospective study. Group D patients received 20-ml 0.2 % ropivacaine deep to erector spinae at the T4 level. Group S patients received 20-ml 0.2 % ropivacaine superficial to erector spinae. Sensory level of block, peri-operative opioid consumption, and adverse effects were noted. 24-hour morphine consumption was less in group D: 5.47 ± 1.1 mg and in group S was 7.66 ± 0.74 mg ($p < 0.001$). The sensory spread was more in deep group in the posterior axillary and mid axillary line. There were no reported adverse effects in either group. The authors concluded that injection of drug deep to ES muscle provided more cranio-caudal blockade of posterior and lateral chest wall, hence providing better analgesia following breast surgery. Injection of the drug superficial to the muscle led to inferior analgesia.

Eskandr et al (2022) stated that achieving adequate peri-operative analgesia can be challenging in patients undergoing breast surgeries due to the complex nerve supply of the breast and axilla. These investigators examined the effectiveness of ESP block (ESPB) in comparison to conventional regional anesthesia techniques (TPVB and PECS block). A total of 80 female patients who were scheduled for elective RMM, with ASA score I to II, and aged between 18 and 60 years, were included in the study. Patients were randomized into 4 groups, the TPVB, PECS block, ESPB, and the control group. All patients in either block groups received 25-ml bupivacaine 0.25 % with US guidance. The control group received only opioids for peri-operative pain management. The patients were observed for 48 hours after surgery for the duration of analgesia (primary outcome). ESPB has a shorter duration of analgesia than PECS block with no significant statistical difference compared with group TPVB. Morphine consumption was increased in ESPB compared to the PECS block group, with an insignificant difference compared to group TPVB. There was an insignificant difference between the groups concerning hemodynamics and complications, with 1 pneumothorax case reported in the TPVB group. The authors concluded that PECS block and ESPB represented a good alternative to TPVB for post-mastectomy analgesia with a superior analgesic effect of PECS block regarding opioid consumption, duration of the analgesia, and VAS score.

Pai and Lai (2022) noted that the analgesic effectiveness of bilateral low thoracic ESP blocks for combined major breast and abdominal surgery has not been reported. In a case-series study, these investigators examined the feasibility and effectiveness of T8 thoracic pre-incisional ESPBs in patients undergoing total radical mastectomies with axillary lymph node dissections in addition to reconstruction with abdominal deep inferior epigastric flaps. The aim was to supply dermatomal coverage to provide analgesia for T2 to L1 that formed the basis for an opioid-sparing multi-modal technique in the context of early recovery after breast surgery with deep inferior epigastric flap program.

Ahuja et al (2022) noted that several inter-fascial interfacial plane blocks have been described in patients undergoing MRM. These researchers examined the analgesic effectiveness of US-guided serratus anterior plane block and ESPB in patients undergoing MRM. A total of 80 female patients (age of 18 to 70 years) undergoing MRM were randomised into 2 groups of 40 each and were given US-guided serratus anterior plane block or ESPB with 0.4 ml/kg of 0.375 % ropivacaine in this prospective double-blind control trial. The groups were compared for the time to request of 1st dose of rescue analgesic, requirement of rescue analgesics, and patient satisfaction score. The time to request of the 1st rescue analgesia was comparable in both groups ($p = 0.056$). Post-operative pain scores at rest at 0 min were significantly lower in serratus anterior plane group as compared to ESPB group ($p = 0.03$). The intra-operative fentanyl requirement and post-operative diclofenac and tramadol requirements were comparable between the 2 groups. The number of patients requiring rescue doses of fentanyl intra-operatively and rescue analgesics post-operatively was similar in both groups. The mean patient satisfaction score was also comparable in both groups. The authors concluded that US-guided serratus anterior plane block and ESPB have comparable post-operative analgesic effectiveness after MRM.

Mohsin et al (2023) stated that post-operative pain after an MRM ranges from moderate-to-severe. PECS block has been found to be more effective than ESPB in reducing pain and the consumption of rescue analgesia in the post-operative period. In a RCT, these investigators compared the effect of ESPB and PECS block on the quality of recovery after MRM using the quality of recovery (QoR-40) score. This trial was carried out at King George's Medical University, Lucknow, India, from October 9, 2020 to October 9, 2021. After general anesthesia, patients were given blocks according to computer-generated randomization: Group I: PEC I and PEC II (PECS) blocks; Group II: ESPB; and Group III: control group (no intervention). The QoR-40 score was observed on the morning of the surgery and after 24 hours. Time to rescue analgesia and the total consumption of rescue analgesia in the first 24 hours were also observed. A total of 90 patients were included (30 in each group). In the post-operative period after 24 hours, global QoR-40 scores were 183.64 ± 6.36, 179.68 ± 6.38 and 171.37 ± 6.88 in the PECS block, ESPB and control groups ($p < 0.0001$). However, there was no statistically significant difference between the QoR scores of PECS block and ESPB group patients ($p = 0.0551$). The total requirement of rescue analgesic was significantly lower in the PECS block group (137.28 ± 31.46 mg) than in the ESPB (189.46 ± 42.98 mg) and control (229.57 ± 46.80 mg) groups ($p < 0.0001$). Time to first rescue analgesia was significantly higher in the PECS block group (6.53 ± 2.78 hours) than in the ESPB (4.05 ± 2.91 hours) and control (2.15 ± 1.51 hours) groups ($p < 0.0001$). The authors concluded that both ESPB and PECS block were effective in improving the QoR score and in reducing the consumption of rescue analgesia after MRM.

Nyima et al (2023) compared the analgesic effectiveness of ESP block with serratus anterior muscle (SAM) block in patients undergoing MRM. These researchers hypothesized that ESP block would provide better post-operative pain relief than SAM block following MRM. A total of 80 ASA I to II adult females, scheduled for MRM, were randomly allocated to receive either US-guided ipsilateral single-shot ESP or SAM block after induction in the respective planes, using 20-ml of 0.25 % ropivacaine. Both the groups received post-operative IV-PCA (morphine) for 24 hours. The primary outcome was to evaluate pain severity using a visual analog scale (VAS) score. Post-operative 24-hour opioid consumption, time to 1st opioid analgesia, hemodynamic variables, total dose of anti-emetics, and safety profile of both the blocks were also evaluated. Data analysis was performed using Statistical Package for the Social Sciences version 21.0. VAS scores were lower in the ESP block group, at rest and on movement, and the difference was statistically significant ($p < 0.05$). Post-operative morphine consumption was also significantly less in patients receiving ESP block as compared to SAM block (3.13 ± 1.44 mg versus 4.33 ± 1.69 mg; p = 0.001). The time to 1st analgesia request was significantly prolonged in the ESP group as compared to the SAM group (9.58 ± 4.11 hours versus 6.46 ± 2.95 hours; p = 0.001). No major side effects were observed in any of the study groups. The authors concluded that ESP block provided better analgesia as compared to SAM block after MRM.

Ganglion Impar Block for the Treatment of Chronic Anorectal Pain Associated with Radiation Proctitis

Gupta et al (2017) noted that patients with advanced pelvic malignancies present with pain of varying severity. Their pain can be effectively managed using a systemic pharmacologic approach, including oral administration of morphine. However, morphine can lead to constipation, which may be especially troublesome in patients with rectal carcinoma. Neurolytic blocks such as of the ganglion impar may alleviate sympathetically mediated pain and aid in decreasing opioid requirement.

Furthermore, an UpToDate review on "Coccydynia (coccygodynia)" (Foye, 2023) states that "For patients with persistent coccydynia (> 2 months), we suggest management with coccygeal injections containing local anesthetic or local anesthetic plus glucocorticoid (Grade 2C)".

Glossopharyngeal Nerve Block for Post-Operative Pain Control After Endoscopic Retrograde Cholangiopancreatography

An UpToDate review on "Overview of endoscopic retrograde cholangiopancreatography (ERCP) in adults" (Tringali et al, 2023) does not mention glossopharyngeal NB as a management option.

Median Nerve Block for Post-Operative Pain Control after Carpal Tunnel Release

An UpToDate review on "Surgery for carpal tunnel syndrome" (Hunter and Simmons, 2023) does not mention median NB as a management option.

Neuraxial/Caudal Nerve Block for Post-Operative Pain Management in Infants and Children

An UpToDate review on "Pharmacologic management of acute perioperative pain in infants and children" (Schechter, 2023) states that "Local, neuraxial, and regional analgesia are commonly and increasingly utilized components of the multimodal approach to postoperative pain management in children. For many surgical procedures, infiltration of the surgical site with a long-acting local anesthetic (LA, e.g., bupivacaine or ropivacaine) by the surgeon can provide effective postoperative analgesia for several hours after surgery. Single injection LA nerve blocks may provide analgesia for 4 to 12 hours, and in some cases through the first postoperative night. For more prolonged analgesia, continuous peripheral nerve blocks or neuraxial analgesia techniques are options. Regional analgesia techniques with LAs may be especially beneficial for children who are at increased risk of respiratory depression with opioids (e.g., children with obstructive sleep apnea, some neurologic disorders)".

PECS II Nerve Block for Post-Operative Pain Control After Shoulder Surgery

YaDeau et al (2019) noted that the pain experience for total shoulder arthroplasty (TSA) patients in the first 2 weeks after surgery has not been well-described. Many approaches to pain management have been used, with none emerging as clearly superior; it is important that any approach minimizes post-operative opioid use. In a prospective, institutional review board (IRB)-approved, observational study, these investigators determined the following: First, with the use of a long-acting nerve block and comprehensive multi-modal analgesia, what are the pain levels after TSA from day of surgery until post-operative day (POD) 14?. Second, how many opioids do TSA patients take from the day of surgery until POD 14? Third, what are the PainOUT responses at POD 1 and POD 14, focusing on side effects from opioids usage? From January 27, 2017 to December 6, 2017, a total of 154 TSA patients were identified as potentially eligible for this trial. Of those, 46 patients (30 %) were excluded (either because they were deemed not appropriate for the study, research staff were not available, patients were not eligible, or they declined to participate), and another 6 (4 %) had incomplete follow-up data and could not be studied, leaving 102 patients (66 %) for analysis.

Median pre-operative pain with movement was 7 (IQR, 5 to 9) and 13 of 102 patients used pre-operative opioids. All patients received a single-injection bupivacaine ISB with adjuvant clonidine, dexamethasone, and buprenorphine. Multi-modal analgesia included acetaminophen, NSAIDs, and opioids. The primary outcome was the NRS pain score with movement on POD 14. The NRS pain score ranged from 0 (no pain) to 10 (worst pain possible). Secondary outcomes included NRS pain scores at rest and with movement (day of surgery, and PODs 1, 3, 7 and 14), daily analgesic use from day of surgery to POD 14 (both oral and intravenous), Opioid-Related Symptom Distress Scale (which assesses 12 symptoms ranging from 0 to 4, with 4 being the most distressing; the composite score is the mean of the 12 symptom-specific scores) on POD 1, and the PainOut questionnaire on POD 1 and POD 14. The PainOut questionnaire includes questions rating nausea, drowsiness, itching from 0 (none) to 10 (severe), as well as rating difficulty staying asleep from 0 (does not interfere) to 10 (completely interferes). The median NRS pain scores with movement were 2 (IQR, 0 to 5) on POD 1, 5 (IQR, 3 to 6) on POD 3, and the pain score was 3 (IQR, 1 to 5) on POD 14. Median total opioid use (converted to oral morphine equivalents) was 16 mg (4 to 50 mg) for the first 24 hours, 30 mg (8 to 63 mg) for the third, and 0 mg (0 to 20 mg) by the eighth 24-hour period, while the most frequent number of activations of the intravenous PCA device was 0. Median PainOut scores on POD 1 and POD 14 for sleep interference, nausea, drowsiness, and itching were 0, and the median composite Opioid-Related Symptom Distress Scale score on day 1 was 0.3 (IQR, 0.1 to 0.5). The authors concluded that clinicians using this protocol, which combined a long-acting, single-injection NB with multi-modal analgesia, can inform TSA patients that their post-operative pain will likely be less than their pre-operative pain, and that on average they will stop using opioids after 7 days. These researchers stated that future research could examine what the individual components of this protocol contribute. These researchers stated that larger cohort studies or registries would document the incidence of rare complications; and RCTs could directly compare analgesic effectiveness and cost-benefits for this protocol versus alternative strategies, such as perineural catheters or liposomal bupivacaine. Perhaps most importantly, future studies could seek ways to further reduce peak pain and opioid usage on POD 2 and POD 3.

Pectoral Plane (PECS I) Nerve Block for Post-Operative Pain Control After Cardiac Surgeries

Kumar et al (2018) stated that good post-operative analgesia in cardiac surgical patients aids in early recovery and ambulation. An alternative to parenteral, para-vertebral, and thoracic epidural analgesia can be pectoralis nerve (Pecs) block, which is a novel, less invasive regional analgesic technique. These investigators hypothesized that Pecs block would provide superior post-operative analgesia for patients undergoing cardiac surgery through mid-line sternotomy compared to parenteral analgesia. A total of 40 adult patients between the age groups of 25 and 65 years undergoing coronary artery bypass graft (CABG) or valve surgeries via mid-line sternotomy under general anesthesia were enrolled in this trial. Subjects were randomly allocated into 2 groups with 20 in each group. Group 1 patients did not receive Pecs block, whereas Group 2 patients received bilateral Pecs block post-operatively. Subjects were extubated once they fulfilled extubation criteria. Ventilator duration was recorded. Patients were examined for pain by VAS scoring at rest and cough. Inspiratory flow rate was evaluated using incentive spirometry. Pecs group patients required lesser duration of ventilator support ($p < 0.0001$) in comparison to control group. Pain scores at rest and cough were significantly low in Pecs group at 0, 3, 6, 12, and 18 hours from extubation ($p < 0.05$). At 24 hours, VAS scores were comparable between 2 groups. Peak inspiratory flow rates were higher in Pecs group as compared to control group at 0, 3, 6, 12, 18, and 24 hours ($p < 0.05$). A total of 34 episodes of rescue analgesia were given in control group, whereas in Pecs group, there were only 4 episodes of rescue analgesia. The authors concluded that Pecs block was a technically simple and effective technique, and could be used as part of multi-modal analgesia in post-operative cardiac surgical patients for better patient comfort and outcome. These researchers stated that was the main drawback of this trial was its small sample size ($n = 20$ in the Pecs block group).

Furthermore, an UpToDate review on “Coronary artery bypass surgery: Perioperative medical management” (Aranki et al, 2023) does NOT mention pectoral plane (PECS I) nerve block as a management option.

Pecto-Intercostal Fascial Nerve Block (PIFB) / Rectus Sheath Nerve Block for Management of Post-Operative Pain After Cardiothoracic Surgeries

In a RCT, Hamed et al (2022) examined the analgesic efficacy of US-guided bilateral pecto-intercostal fascial plane block after open heart surgeries. A total of 70 patients aged above 18 years and scheduled for on-pump coronary artery bypass grafting (CABG) or valve replacement or both via median sternotomy were enrolled in this study. Patients were randomly allocated into 2 groups of 35 (NB group or control group). The NB group had the block carried out via 20-ml of a solution of 0.25 % bupivacaine plus epinephrine (5 mcg/ml), and the control group received dry needling. The primary outcome was the 24-hour cumulative morphine consumption. The secondary outcomes were time to the 1st analgesic request, pain score, quality of oxygenation, ICU stays, and hospital LOS. The cumulative morphine consumption in the first 24 hours was significantly lower in the NB group, with a MD of -3.54 (95 % CI: 6.55 to -0.53; p = 0.015). Furthermore, the median estimate time to the 1st analgesic request was significantly longer in the NB group than in the control group. Finally, during the post-operative period (4 to 24 hours), mean sternal wound objective pain scores were, on average, 0.58 units higher in the NB group. The authors concluded that pecto-intercostal fascial block was an effective technique in reducing morphine consumption and controlling post-sternotomy pain after cardiac surgeries. Furthermore, it may have a role in better post-operative respiratory outcomes.

Popliteal Nerve Block for Post-Operative Pain Control Following Foot Surgery

Jarrell et al (2018) stated that the increasing scope and complexity of foot and ankle procedures performed in an outpatient setting require more intensive peri-operative analgesia. Regional anesthesia (popliteal and saphenous NBs) has been proven to provide satisfactory pain management, decreased post-operative opioid use, and earlier patient discharge. This could be further augmented with the placement of a continuous-flow catheter, typically inserted into the popliteal nerve region. These investigators examined the use of a combined popliteal and saphenous continuous-flow catheter NB compared to a single popliteal catheter and single-injection saphenous NB in post-operative pain management following ambulatory foot and ankle surgery. They carried out a prospective study using 60 patients who underwent foot and ankle surgery performed in an outpatient setting. Demographic data, degree of medial operative involvement, ASA physical classification system, anesthesia time, and PACU time were recorded. Outcome measures included pain satisfaction, NPS at rest and with activity, and opioid intake. Patients were also classified by degree of saphenous nerve involvement in the operative procedure, by the surgeon who was blinded to the anesthesia randomization. Patients in the dual-catheter group took significantly less opioid medication on the day of surgery and post-operative day 1 (POD 1) compared to the single-catheter group ($p = 0.02$). The dual-catheter group reported significantly greater satisfaction with pain at POD 1 and POD 3 and a significantly lower NPS at POD 1, 2, and 3. This trend was observed in all 3 subgroups of medial operative involvement. The authors concluded that patients in the single-catheter group reported more pain, less satisfaction with pain control, and increased opioid use on POD 1, suggesting dual-catheter use was superior to single-injection NBs with regard to managing early post-operative pain in outpatient foot and ankle surgery. Level of Evidence = II.

Ma et al (2019) noted that continuous popliteal sciatic NB (CPSNB) has been used in outpatient foot and ankle surgery as a regional anesthesia method to relieve post-operative pain. Its safety and effectiveness are yet to be established. These researchers validated the effectiveness of CPSNB with regards to better pain relief and reduced analgesics consumption; and examined the safety of CPSNB. They carried out a comprehensive literature review on Web of Science, the Cochrane Library, PubMed and Embase and only included RCTs. A total of 5 RCTs that compared the safety and effectiveness of CPSNB with the single-injection popliteal sciatic nerve block group were included. The primary outcome parameters were VAS scores at post-operative 24, 48 and 72 hours. The secondary outcome parameters were amount of oral analgesics consumed, overall patient satisfaction and need of admission after surgery. A sensitivity analysis was performed to examine the consistency of the results. In comparison with the single-injection group, CPSNB was associated with a lower VAS score at post-operative 24 and 48 hours ($p < 0.05$). There were no neuropathic symptoms or infection events after the NB. However, there were several minor complications associated with the pump and catheter system, with drug leakage being the most common complication (n = 26 of 187, 13.9 %). The authors concluded that CPSNB was an effective method in pain management for outpatient foot and ankle surgery. Both methods appeared to be safe as none of the patients experienced neuropathic symptoms or infection. Level of evidence = I.

Pectoralis Block for Post-Operative Pain Control After Shoulder Surgery

An UpToDate review on “Overview of peripheral nerve blocks” (Jeng and Rosenblatt, 2023) does not mention pectoralis block.

Phrenic Nerve Block for the Treatment of Refractory Hiccups

Renes et al (2010) stated that phrenic NB can be performed and repeated if necessary for persistent hiccups, when conservative and pharmacological treatment is unsuccessful. These investigators reported the 1st description of an US-guided phrenic NB (PhNB) with a catheter, after US investigation of the bilateral diaphragm, to treat hiccups while avoiding repeated PhNBs. They reported on the case of a 36-year-old man who had persistent post-operative hiccups not responding to conservative and pharmacological treatment. Bilateral diaphragmatic US evaluation showed abnormal right-sided movement. A right-sided in-plane US-guided PhNB with catheter was carried out. Injection of local anesthetic stopped the hiccups, and a continuous infusion of local anesthetic was started for 24 hours. After discontinuation of the infusion, the hiccups recurred. Re-start of the continuous infusion of the local anesthetic via the catheter was performed, and after discontinuation 24 hours later, no further hiccups occurred. No adverse effect occurred. The authors concluded that an US-guided in-plane PhNB with catheter was feasible and avoided repeated PhNB when hiccups re-occurred; US investigation of the bilateral diaphragm should be performed before performing the NB.

Furthermore, in a review on “Hiccups in neurocritical care”, Rajagopalan et al (2021) listed phrenic nerve disruption (including local anesthetic injection) as a non-pharmacological approach for the treatment of hiccups.

Sciatic Nerve Block for the Treatment of Lumbar Radiculopathy

North et al (1996) stated that temporary NBs using local anesthetic are employed extensively in the evaluation of pain problems, especially lumbo-sacral spine disease. Their specificity and sensitivity in localizing anatomic sources of pain have never been studied formally, however, and so their diagnostic and prognostic value is questionable. There have been anecdotal reports of relief of pain by temporary NBs directed to areas of pain referral, as opposed to areas of documented underlying pathology; but there has been no study to define the frequency or magnitude of this effect. These researchers examined the specificity and sensitivity of a battery of local anesthetic NBs in a series of 33 patients with a chief complaint of sciatica, attributable in all cases to spinal disease (radiculopathy, with some clinical features of arthropathy). As determined by blinded patient analog ratings in randomized sequence, 3 different NBs were significantly more effective than control lumbar subcutaneous injection of an identical volume of 3-ml of 0.5 % bupivacaine ($p < 0.05$). Not only para-spinal lumbo-sacral root blocks and medial branch posterior primary ramus blocks (at or proximal to the pathology), but also sciatic NBs (distal or collateral to the pathology) produced temporary relief in a majority of patients. This confirmed the study hypothesis that false positive results were common, and specificity was low. For sciatic NBs, specificity was between 24 % and 36 %. Patterns of responses specific to the established diagnosis of radiculopathy (i.e., root block most effective) had sensitivities between 9 % and 42 %. Statistical analysis of clinical and technical prognostic factors revealed that the only association with pain relief by any NB was the effects of other blocks. The strongest association was between relief by sciatic NB and relief by medial branch posterior primary ramus (facet) block ($p = 0.001$, OR 16.0). There were no associations between the results of NBs and clinical findings (history, physical examination, diagnostic imaging) in these patients, chosen for their homogeneous clinical presentation and absence of functional signs. The authors concluded that these findings indicated a limited role for uncontrolled local anesthetic blocks in the diagnostic evaluation of sciatica and referred pain syndromes in general. Negative NBs or a pattern of responses may have some predictive value, but isolated, positive NBs were non-specific. This lack of specificity may, however, be advantageous in therapeutic applications.

Furthermore, an UpToDate review on “Subacute and chronic low back pain: Nonsurgical interventional treatment” (Chou, 2022) does not mention sciatic NB as a management/therapeutic option.

Stellate Ganglion Sympathetic Nerve Block for the Treatment of Long COVID

Liu and Duricka (2022) discussed their case series, in which they reported sustained positive clinical outcomes for 2 Long COVID patients after treatment with stellate ganglion blocks (SGBs), identifying the pathophysiology for their symptoms as a regional sympathetically mediated dysautonomia and suggesting that SGB could be an effective treatment for at least a subset of Long COVID patients. The authors concluded that its use in the treatment of Long COVID/post-acute sequelae of SARS-CoV-2 infection (PASC) is novel but promising. The lack of effective treatments for Long COVID/PASC makes the SGB an attractive therapeutic modality that deserves further investigation

Kirkpatrick et al (2023) reviewed the physiology of several conditions where SGBs are being examined as an adjunct treatment modality, including anosmia, post-traumatic stress disorder (PTSD), long-COVID, chronic fatigue syndrome (CFS), menopausal hot flashes, and ventricular tachyarrhythmias (VTs). Overall, the current literature supporting the use of SGBs for several esoteric conditions is limited; however, case reports to-date have shown promising evidence-based results supporting their use as an adjunctive treatment among patients with refractory symptoms to existing treatment algorithms. The authors concluded that SGB should be considered among patients with refractory symptoms for medical management in the conditions discussed in this article; however, further research is needed to delineate which patients will benefit from the use of SGB, the use of subsequent blocks and timelines in between injections, and unilateral versus bilateral blockade.

Transverse Thoracic Nerve Block for Open Inguinal Hernia Repair

Marija and Aleksandar (2020) stated that ESP block is a regional anesthesia technique, which provides visceral and somatic analgesia for abdominal surgery, during surgery and in the post-operative period. The local anesthetic is injected between the erector spinae muscle and the transverse process, and it spreads cranially and caudally into the paravertebral space, affecting the ventral and dorsal branches of the thoracic spinal nerves and the rami communicants that contain sympathetic nerve fibers. ESP block can replace thoracic epidural anesthesia and has a better analgesic effect compared to other plane blocks that are used in abdominal surgery. The authors described 6 case series of successfully performed ESP block for post-operative analgesia in various abdominal surgeries such as unilateral open inguinal hernia repair with a supraumbilical hernia, ileostomy reversal surgery, open diaphragmatic hernia repair, laparoscopic cholecystectomy, and abdominal abscess evacuation.

Furthermore, UpToDate reviews on “Open surgical repair of inguinal and femoral hernia in adults” (Griffin, 2023) and “Overview of treatment for inguinal and femoral hernia in adults” (Brooks, 2023) do not mention transverse thoracic NB as a management option.

Adductor Canal Block for Post-Operative Pain Control After Total Knee Arthroplasty

Sorensen et al (2024) noted that motor-sparing peripheral nerve blocks enhance multi-modal opioid-sparing strategies after total knee arthroplasty (TKA). These researchers hypothesized that adding a popliteal plexus block to a femoral triangle block could reduce 24-hour opioid consumption after TKA, compared with stand-alone femoral triangle block or adductor canal block. This patient- and assessor-blinded, randomized controlled trial allocated 165 patients into 3 equally sized parallel groups, receiving either: (i) popliteal plexus block+femoral triangle block, (ii) femoral triangle block, or (iii) adductor canal block. Intravenous oxycodone was administered via patient-controlled analgesia (PCA) pumps. The primary outcome was 24-hour post-operative opioid consumption. Secondary outcomes were pre-operative maximum voluntary isometric contraction and manual muscle tests of knee and ankle movement assessed before and after the nerve block procedure together with post-operative pain scores, mobilization, and 12-hour opioid consumption. These investigators reported that 24-hour post-operative intravenous oxycodone consumption varied significantly between groups ($p < 0.01$), with medians (IQR) of 6 mg (2 to 12) in the popliteal plexus block+femoral triangle block group, 10 mg (8 to 16) in the femoral triangle block group, and 12 mg (6 to 18) in the adductor canal block group. Median consumption in the popliteal plexus block+femoral triangle block group was reduced by -4 mg (95 % CI: -7.4 to -1.0, $p < 0.01$) and -6 mg (95 % CI: -8.3 to -1.3, $p = 0.01$) compared with groups of femoral triangle block and adductor canal block, respectively. No differences were found in pain scores, mobilization, or changes in pre-operative muscle strength. Post-hoc analysis showed successful 24-hour opioid-free post-operative care among 12 patients with popliteal plexus block+femoral triangle block, as compared with 2 with femoral triangle block and 6 with adductor canal block. The authors concluded that addition of a popliteal plexus block to a femoral triangle block resulted in a statistically significant reduction of 24-hour post-operative opioid consumption after TKA; however, no differences were observed in pain scores. Popliteal plexus block did not impair the lower leg muscles.

Cervical Plexus Block (Superficial and Deep) for Shoulder Pain

Tran et al (2013) stated that the sensory innervation of the clavicle remains controversial. The supraclavicular, subclavian, and long thoracic/suprascapular nerves, alone or together, may be responsible for pain transmission after clavicular fracture and surgery. Peripheral nerve blocks (PNBs) used to anesthetize the clavicle include superficial cervical plexus blocks (SCPB), interscalene blocks, and combined superficial cervical plexus-interscalene blocks. The authors concluded that future (randomized) trials are needed to determine which constitutes the best option for emergency department (fracture) and operating room (surgical fixation) settings.

Ho and De Paoli (2018) noted that although use of the SCPB by anesthesiologists for peri-operative indications is well-described, there is a paucity of research on use of SCPB in the emergency department (ED). In a prospective, observational study, these researchers examined the feasibility, safety and effectiveness of ultrasound (US)-guided SCPB in a convenience sample of ED patients presenting with painful conditions of the "cape" distribution of the neck and shoulder. Data were gathered prospectively on a convenience sample of 27 patients presenting to a community ED with painful conditions involving the distribution of the SCPB: para-cervical muscle spasm/pain (n = 8), clavicle fractures (n = 7), acromio-clavicular (AC) joint injuries (n = 3), radicular pain (n = 3), and rotator cuff disorders (n = 6). Pre- and post-block 11-point verbal numeric pain scores (VNPS) were recorded, as was the incidence of any immediate complications. A retrospective chart review looked for delayed complications in the 14-day post-block period. The mean 11-point VNPS reduction was 5.4 points (62 %). There were no early serious complications; and 1 case each of self-limiting vocal hoarseness and asymptomatic hemi-diaphragmatic paresis. No delayed block-related complications were found. The authors concluded that while limited by the fact that this was a non-randomized, observational experience with no control group, these findings suggested that SCBP may be safe and have potential for effectiveness, and warrants further evaluation in a randomized controlled trial (RCT).

Naja et al (2021) stated that myofascial pain is one of the most common causes of regional pain with no definitive treatment. In a randomized clinical trial, these researchers examined the effectiveness of deep CPB (DCPB) versus placebo injection (sham block) for the treatment of myofascial neck and shoulder pain in terms of analgesic consumption and pain during a follow-up period of 2 weeks after the block. Patients were randomly divided into 2 groups. Group I (block) received DCPB; and group II (placebo) received normal saline. A total of 66 patients were included in the study, 34 patients in the DCPB group and 32 patients in the placebo group. Two weeks after the intervention, the average pain duration was significantly lower in the DCPB group: 1.38 ± 1.39 versus 5.25 ± 1.72 for the block and placebo groups, respectively ($p < 0.0001$). Pain intensity was significantly less in the DCPB group such that 2.9 % of patients in the DCPB group had severe pain compared with 53.1 % of patients in the placebo group ($p < 0.0001$). Two weeks after receiving the block, the mean opioid consumption calculated as tramadol equivalent was 21.1 ± 44.2 mg compared with 166.1 ± 118.8 mg for the block and placebo groups, respectively. Multi-variate analysis showed that patients with a longer history of pain had a higher pain score after 2 weeks. The possibility of recovery was affected by pain duration as patients with a history of chronic pain were least affected by the block. The authors concluded that this technique could be an alternative to pharmacological and other non-pharmacological treatments for myofascial pain.

Clavipectoral Fascial Plane block for Post-Operative Pain Control After Clavicle Open Reduction and Internal Fixation (ORIF)

Vijapurkar e al (2024) noted that the clavipectoral fascial plane block (CFPB) that has been used for clavicle fracture surgeries and pain management is an emerging anesthetic technique. It has been previously used for post-operative pain management; however, it can also be used as a stand-alone anesthetic technique for clavicle fracture management. These researchers described a case of a 20-year-old man who underwent open reduction and internal fixation (ORIF) with plating for a mid-shaft clavicular fracture under a CFPB as a sole anesthetic. The authors concluded that the CFPB emerges as a promising and accessible regional anesthesia technique for effectively managing fractures of the clavicle. The use of CPFB along with supplemental analgesics like dexmedetomidine would suffice in managing the clavicular fractures. With its anatomically targeted approach and easier surgical steps, this block stands as a valuable addition to the armamentarium of pain management strategies.

Erector Spinae Block for Lumpectomy and Lymph Node Biopsy

Leong et al (2021) stated that erector spinae plane (ESP) block is a new regional anesthesia technique that provides truncal anesthesia for breast surgery. In a systematic review and meta-analysis. These investigators examined if the ESP block is effective at reducing pain scores and opioid consumption after breast surgery. This study also evaluated the outcomes of ESP blocks compared with other regional blocks. PubMed, Embase, Scopus, the Cochrane Central Register of Controlled Trials and ClinicalTrials.gov were searched. These investigators included RCTs reporting the use of the ESP block in adult breast surgery. Risk of bias was assessed with the revised Cochrane risk-of-bias tool. The GRADE approach was used to assess trial quality. A total of 13 RCTs (861 patients; 418 ESP block, 215 no blocks, 228 other blocks) were included. ESP block reduced post-operative pain compared with no block: at 0 to 2 hours (MD (95 % CI) -1.63 (-2.97 to -0.29), 6 studies, 329 patients, high-quality evidence, I2 = 98 %, p = 0.02); at 6 hours (MD (95 % CI) -0.90 (-1.49 to -0.30), 5 studies, 250 patients, high-quality evidence, I2 = 91 %, p = 0.003); at 12 hours (MD (95 % CI) -0.46 (-0.67 to -0.25), 5 studies, 250 patients, high-quality evidence, I2 = 58 %, p < 0.0001); and at 24 hours (MD (95 % CI) -0.50 (-0.70 to -0.30), 6 studies, 329 patients, high-quality evidence, I2 = 76 %, p < 0.00001). Compared with no block, ESP block also showed significantly lower post-operative oral morphine equivalent requirements (MD (95 % CI) -21.55 mg (-32.57 to -10.52), 7 studies, 429 patients, high-quality evidence, I2 = 99 %, p = 0.0001). Separate analysis of studies comparing ESP block with pectoralis nerve block and para-vertebral block showed that its analgesic effectiveness was inferior to pectoralis nerve block and similar to para-vertebral block. The incidence of pneumothorax was 2.6 % in the para-vertebral block group; there were no reports of complications of the other blocks. The authors concluded that the findings of this review showed that the ESP block was more effective at reducing post-operative opioid consumption and pain scores up to 24 hours compared with general anesthesia alone; however, it was inferior to the pectoralis nerve block and its effectiveness was similar to para-vertebral block. Moreover, these researchers stated that further evidence, preferably from properly blinded trials, is needed to confirm these findings.

StatPearls' "Erector spinae plane block" (Krishnan and Cascella, 2023) noted that ESP block is a relatively novel approach to pain management. The ESP block is a newer regional anesthetic that can provide thoracic, abdominal, and even some lower extremity analgesia. ESP blocking has been used by anesthesiologists to provide analgesia for a myriad of conditions from chronic shoulder pain to pain following hip surgery. Much of the information on the effectiveness of ESP blocking is derived from case reports and anecdotal experiences; thus, formal research is underway to examine if ESP blocks can result in a statistically significant reduction in opioid consumption, lower pain scores, and potentially hospital LOS.

Erector Spinae Block for Pain Control in Multiple Rib Fractures

Singh et al (2023) stated that pain associated with rib fractures is challenging to manage. In a randomised, single-blinded, controlled pilot study, these investigators examined the effectiveness of ESP block (ESPB) compared with thoracic epidural analgesia (TEA) for controlling pain associated with multiple rib fractures. This study was carried out on trauma patients who had 3 or more rib fractures and had been admitted at a tertiary care center. Patients were randomised into 2 groups: TEA and ESPB, from February 2019 to February 2020. In the ESPB group, a unilateral or bilateral catheter was inserted in the erector spinae space, and an infusion of 0.125 % bupivacaine was started. In the TEA group, the thoracic epidural catheter was inserted, and 0.125 % bupivacaine infusion was started. Rescue analgesia using intravenous (IV) morphine (0.1 mg/kg) was administered if the VAS score was greater than 3 for 48 hours post-operatively. The primary endpoint was total morphine consumption after administration of ESPB and TEA in patients with a rib fracture. A total of 40 patients completed the study, with 20 in each group. Total morphine consumption by patients in the ESPB group was 5.38 ± 2.6 mg per 48 hours, and by those in the TEA group was 5.22 ± 2.11 mg per 48 hours ($p = 0.883$). Thirty mins after starting the infusion, mean arterial pressure (MAP) was 64.8 ± 2.1 mmHg in the ESPB group and 57.2 ± 1.3 mmHg in the TEA group ($p = 0.00001$). The authors concluded that total morphine consumption was not statistically different in this pilot trial among the 2 groups; ESP block may provide similar analgesia with better hemodynamic stability compared to TEA in patients with multiple traumatic rib fractures.

Fitzgerald et al (2024) stated that ESPBs are often employed when treating patients with multiple rib fractures. While previous work has reported the effectiveness of ESPB as an adequate method of pain control, there has been no work comparing a continuous ESPB to "best practice" multi-modal pain control. In a retrospective, observational, cohort study, these researchers hypothesized that a continuous ESPB catheter combined with a multi-modal pain regimen may be associated with a decrease in opioid requirements when compared to a multi-modal pain regimen alone. This trial was caried out at a level 1 trauma center from September 2016 through September 2021. Inclusion criteria included patients 18 years or older with at least 3 unilateral rib fractures who were not mechanically ventilated during admission. The primary outcome was the total morphine equivalents utilized throughout the index admission. A total of 142 patients were included in this study, 71 in each cohort. Patients included had a mean age of 52.5 years, and 18 % were women. Demographic data including injury severity score, total number of rib fractures, and length of stay (LOS) were similar. While there was a trend toward a decrease in morphine equivalents in the patient cohort undergoing ESPB catheter placement, this was not found to be statistically significant (284.3 ± 244.8 versus 412.6 ± 622.2, $p = 0.5$). The authors concluded that while ESPB catheters are often used for analgesia in the setting of multiple rib fractures, there was no decrease in total opioid usage when compared with patients who were managed with a multi-modal pain regimen alone. These investigators stated that further studies comparing ESPB catheters to best practice multi-modal pain control regimens via a prospective, multi-center trial is needed to further validate these findings.

Erector Spinae Block for Thoracic Fusion

Diwan et al (2020) noted that posterior decompression and instrumentation of the cervical spine are associated with severe post-operative pain due to extensive soft tissue and muscle dissection during the surgery. In a case-series study, these researchers described bilateral continuous cervical ESPB (CESPB) placed at T1-T2 through the thoracic erector spinae plane. A series of 4 patients underwent posterior cervical decompression and stabilization for various surgical indications. The CESPB block provided intense analgesia with low requirements of anesthetic drugs in the peri-operative period and opioid-free analgesia in the post-operative period. The spread of local anesthetic was studied by performing CT contrast studies after obtaining informed consent.

Bellantonio et al (2023) stated that ESPB is a loco-regional anesthetic technique widely used in several different surgeries due to its safety and effectiveness. In a prospective, randomised-controlled, single-center study, these researchers examined the use of ESPB in spinal degenerative and traumatic surgery in Western countries and for patients of Caucasian ethnicity. Patients undergoing elective lower-thoracic and lumbar spinal fusion were randomised into 2 groups: the case group (n = 15) who received ESPB (ropivacaine 0.4 % + dexamethasone 4 mg, 20-ml per side at the level of surgery) plus post-operative opioid analgesia, and the control group (n = 15) who received opioid-based analgesia. The ESPB group showed significantly lower morphine consumption at 48 hours post-operatively, lower need for intra-operative fentanyl (203.3 ± 121.7 ug versus 322.0 ± 148.2 ug, p = 0.021), lower NRS score at 2, 6, 12, 24, and 36 hours, and higher satisfaction rates of patients (8.4 ± 1.2 versus 6.0 ± 1.05, p < 0.0001). No differences in hospital length of stay (LOS) were observed. No ESPB-related complications were observed. The authors concluded that the findings of this study confirmed the effectiveness of ESPB in spinal fusions of thoracic and lumbar spinal levels, expanding the validity of these findings to Caucasian patients and to the healthcare systems of the Western world; therefore, the extensive use of ESPB in thoracic and lumbar spine surgery is recommended.

Erector Spinae Block for Post-Operative Pain Control After Resection Lung Mass, Segmentectomy, and Mediastinal Lymph Node Dissection

Bang et al (2019) stated that the thoracic epidural block and thoracic para-vertebral block are widely used techniques for multi-modal analgesia after thoracic surgery; however, they have several adverse effects, and are not technically easy. Recently, the ESPB is a relatively simple and safe technique. In this study, a total of 3 patients were scheduled for video-assisted thoracoscopic lobectomy with mediastinal lymph node dissection. They were diagnosed with primary adenocarcinoma requiring lobectomy of lung. The continuous ESPB was carried out at the level of the T5 transverse process. The patient received the multi-modal analgesia consisted of oral celecoxib 200 mg twice-daily, IV patient-controlled analgesia (PCA; fentanyl 700 mcg, ketorolac 180 mg, total volume 100 ml), and local anesthetic (0.375 % ropivacaine 30 ml with epinephrine 1:200000) injection via indwelling catheter every 12 hours for 5 days. Furthermore, these investigators injected a mixture of ropivacaine and contrast via the indwelling catheter for verifying effect of ESPB and performed computed tomography (CT) 30 mins later. The pain score was maintained below 3 points for post-operative 5 days, and no additional rescue analgesics were administered during this period. In the CT, the contrast spread laterally from T2 to T12 deep to the erector spinae muscle. On coronal view, the contrast spread to the costotransverse ligament connecting the rib and the transverse process. In 3D reconstruction, the contrast spread from T6 to T10 to the costotransverse foramen. The authors stated that these findings showed that ESPB could be a good option as a multi-modal analgesia following lung lobectomy.

In a prospective RCT, Zhang et al (2023) examined the effects of US-guided ESPB on post-operative acute pain and chronic post-surgical pain in patients who underwent video-assisted thoracoscopic lobectomy. A total of 94 patients, who underwent elective unilateral video-assisted thoracoscopic lobotomy from August 2021 to December 2021 were randomly divided into general anesthesia group (group A, n = 46) and ESPB combined with general anesthesia group (group B, n = 48) by computer. Patient controlled intravenous analgesia (PCIA) was carried out in both groups after operation. The NRS of rest and cough pain at post anesthesia care unit (PACU), 2, 6, 12, 24 and 48 hours after operation, frequency of PCIA in 24 hours after operation, frequency of rescue analgesia, patient satisfaction, adverse reactions and complications were recorded in the 2 groups. Incidence of chronic pain at 3 months and 6 months after operation, the effect of daily life and rating of chronic pain management measures were recorded in the 2 groups. Compared with group A, rest and cough NRS score at 2, 6, 12, 24 and 48 hours after surgery, frequency of PCIA use at 24 hours after surgery, frequency of rescue analgesia were significantly decreased in group B ($p < 0.05$). There was no significant difference in NRS scores of rest and cough at PACU after operation between 2 groups after surgery at PACU ($p > 0.05$). There were no significant differences in the incidence of post-operative chronic pain between the 2 groups($p > 0.05$); the effect of post-operative chronic pain on daily life and pain management measures in group B were significantly lower than those in group A ($p < 0.05$). Compared with group A, patients in group B exhibited higher satisfaction degree, lower incidence of post-operative nausea and vomiting (PONV), and lower incidence of agitation during anesthesia recovery ($p < 0.05$). There were no pneumothorax, hematoma and toxicity of local anesthetic in the 2 groups. The authors concluded that US-guided ESPB could significantly reduce acute post-surgical pain, could not reduce the incidence of chronic post-surgical pain; but could significantly reduce the severity of chronic pain in patients who underwent video-assisted thoracoscopic lobectomy.

Erector Spinae Block for Post-Operative Pain Control After Ventral (Abdominal) Hernias Repair (Including Umbilical and Incisional Hernias)

Chin et al (2017) noted that laparoscopic ventral hernia repair is an operation associated with significant post-operative pain, and regional anesthetic techniques are of potential benefit. The ESPB performed at the level of the T5 transverse process has recently been described for thoracic surgery; and these researchers hypothesized that performing the

ESPB at a lower vertebral level would provide effective abdominal analgesia. In a pilot study, these researchers carried out pre-operative bilateral ESPBs with 20 to 30 ml ropivacaine 0.5 % at the level of the T7 transverse process in 4 patients undergoing laparoscopic ventral hernia repair. Median (range) 24-hour opioid consumption was 18.7 mg (0.0 to 43.0 mg) oral morphine. The highest and lowest median (range) pain scores in the first 24 hours were 3.5 (3.0 to 5.0) and 2.5 (0.0 to 3.0) on an 11-point NRS. These investigators also carried out the block in a fresh cadaver and assessed the extent of injectate spread using CT. There was radiographic evidence of spread extending cranially to the upper thoracic levels and caudally as far as the L2 to L3 transverse processes. The authors concluded that the ESPB is a promising regional anesthetic technique for laparoscopic ventral hernia repair and other abdominal surgery when performed at the level of the T7 transverse process. Its advantages are the ability to block both supra-umbilical and infra-umbilical dermatomes with a single-level injection and its relative simplicity.

These researchers stated that this pilot study was limited in that they only included a small number of patients (n = 4) and a single cadaver. Nevertheless these investigators have shown the potential of bilateral ESPB as an effective regional anesthetic technique in laparoscopic ventral hernia repair when performed at the T7 transverse process level. The analgesic benefit may extend to other types of painful abdominal surgery and further prospective, randomised, controlled trials are needed.

Furthermore, UpToDate reviews on “Overview of abdominal wall hernias in adults” (Brooks, 2024), “Management of ventral hernias” (Brooks and Petro, 2024), and “Care of the umbilicus and management of umbilical disorders” (Palazzi and Brandt, 2024) do not mention erector spinae block as a management / therapeutic option.

Ganglion Impar Block for the Treatment of Anorectal Pain Associated with Radiation Proctitis, and Testicular Pain

Khosla et al (2013) stated that chronic rectal pain secondary to radiation-induced proctitis is fast-becoming a leading cause of chronic pain, especially for prostate cancer (PCa) survivors. To-date, many elderly patients resort to increased opioid intake to alleviate the pain. However, this increase in opioid consumption often results in constipation and further aggravates the anorectal pain; therefore, leading to a perpetual, vicious cycle. These investigators reasoned that blocking the ganglion impar could attenuate this sympathetically maintained pain, which would result in a reduction in the consumption of opioids, lessen constipation, and lead to an improvement in the patient's quality of life (QOL). These investigators reported the case of a 73-year-old African American man with a history of PCa who presented to the pain management clinic for evaluation and treatment of his chronic anorectal pain secondary to radiation-induced proctitis. The patient underwent a ganglion impar block, using the trans-coccygeal technique, and consequently reported excellent pain relief with little or no use for opioid pain medications at a 2-month follow-up. This approach resulted in improved mobility and an increase in the patient's QOL. The authors concluded that based on this case's success, a prospective study or randomized control trial (RCT) examining the effectiveness of the ganglion impar block as a therapeutic option for chronic anorectal pain secondary to radiation-induced proctitis is needed.

Gupta et al (2013) noted that patients with advanced pelvic malignancies present with pain of varying severity. Their pain can be effectively managed using a systemic pharmacologic approach, including oral administration of morphine. However, morphine can lead to constipation, which may be especially troublesome in patients with rectal carcinoma. Neurolytic blocks such as of the ganglion impar may alleviate sympathetically mediated pain and aid in decreasing opioid requirement. However, use of a ganglion impar block may rarely be associated with side effects such as rectal puncture, neuritis, and cauda equina syndrome. The authors reported a rare neurologic complication after a fluoroscopic-guided ganglion impar block.

Yeo and Chong (2001) noted that cancer pain in the terminally ill often poses great therapeutic dilemma. Opioids, while being useful in most cases, often leaves a patient heavily sedated and constipated at high doses and sometimes, in persistent agony from cancer pain. In this case-report, an Indian woman who suffered from metastatic carcinoma of the cervix experienced tremendous pain and disability despite high doses of narcotics and membrane stabilizers. A ganglion of impar block and superior hypogastric plexus block were carried out with a neurolytic agent. The patient's pain and opioids usage were markedly reduced. The authors concluded that neurolytic nerve block could offer a great therapeutic option in selected cancer patients. This was a single-case study; and its findings were confounded by the combined ganglion of impar block and superior hypogastric plexus block.

Gupta et al (2008) stated that visceral pain in the perineal area associated with malignancies may be effectively treated with neurolysis of the ganglion impar. Since the first description of the technique of accessing the ganglion impar via the anococcygeal ligament, many techniques for ganglion impar block have been described. These researchers described a patient who was diagnosed with carcinoma of the anal canal, and was successfully given ultrasound (US)-guided ganglion impar block using a Chiba needle inserted via the anococcygeal ligament. The authors concluded that US-guided ganglion impar neurolysis was a fast, safe, and cost-effective method that could be used as a 1st-line pain relief intervention for good quality of life (QOL) in patients with perianal cancers. However, this article was retracted per the principal author (Sushma Bhatnagar)'s request.

Okcu et al (2022) stated that although it has been reported that caution should be exercised in terms of rectal perforation, as the ganglion impar is located just behind the rectum in the pre-sacral space, the authors could not find any case or images of rectal perforation occurring during ganglion impar blockade in the literature. These researchers discussed the case of a 38-year-old woman with rectal perforation that developed during ganglion impar blockade, performed by the trans-sacrococcygeal approach under fluoroscopy guidance. Wrong needle selection and the structurally short pre-sacral space of the patient may have influenced the development of rectal perforation in the patient. This study presented the 1st case and images of rectal perforation in the literature that developed during the use of ganglion impar blockade using the trans-sacrococcygeal technique. The authors concluded that in ganglion impar block applications, technically appropriate needles should be used, and care should be taken in terms of rectal perforation.

An UpToDate review on "Coccydynia (coccygodynia)" (Foye, 2024) states that "For patients with persistent coccydynia (> 2 months), we suggest management with coccygeal injections containing local anesthetic or local anesthetic plus glucocorticoid (Grade 2C)".

Furthermore, an UpToDate review on "Proctalgia fugax" (Barto and Robson, 2024) does not mention ganglion impar block as a management / therapeutic option. Moreover, this UTD review notes that "Therapies of uncertain benefit -- For patients with proctalgia fugax, we do not typically use inhaled beta-2-adrenergic agonists or interventions such as botulinum toxin injection and pudendal nerve block because randomized trials have not demonstrated their efficacy".

PEC 2 Nerve Block for Mitral Valve Replacement

In a retrospective, single-center study, Vinzant et al (2023) examined the post-operative analgesic effectiveness of single-injection pectoral fascial plane (PECS) II blocks compared to paravertebral blocks for elective robotic mitral valve surgery. These investigators reported patient and procedural characteristics, post-operative pain scores, and post-operative opioid use for patients undergoing robotic mitral valve surgery. Participants were adult patients (age of 18 years or older) admitted to the authors' hospital from January 1, 2016 to August 14, 2020, for elective robotic mitral valve repair who received either a paravertebral or PECS II block for post-operative analgesia. Subjects received an ultrasound (US)-guided, unilateral paravertebral or PECS II nerve block. A total of 123 patients received a PECS II block, and 190 patients received a paravertebral block during the study period. The primary outcome measures were average post-operative pain scores and cumulative opioid use. Secondary outcomes included hospital and intensive care unit (ICU) lengths of stay (LOS), need for re-operation, need for anti-emetics, surgical site infection (SSI), and atrial fibrillation (AF) incidence. Patients receiving the PECS II block required significantly fewer opioids in the immediate post-operative period than the paravertebral block group, and had comparable post-operative pain scores. No increase in adverse outcomes was noted for either group. The authors concluded that the PECS II block was a safe and highly effective option for regional analgesia for robotic mitral valve surgery, with demonstrated effectiveness comparable to the paravertebral block.

Furthermore, UpToDate reviews on “Management and prognosis of surgical aortic and mitral prosthetic valve regurgitation” (del Castillo and Zamorano, 2024), “Surgical procedures for severe chronic mitral regurgitation” (Pislaru, 2024), and “Overview of the management of patients with prosthetic heart valves” (Zoghbi, 2024) do not mention PEC 2 nerve block as a management option.

Quadratus Lumborum Nerve Block for Post-Operative Pain Control after Lumbo-Sacral Fusion

Wilton et al (2020) noted that lumbar spinal fusions have post-operative pain levels that could be difficult to treat. In a retrospective, single-center, pilot study, these investigators examined if using bilateral quadratus lumborum (QL) block catheters for lumbar fusions changes the patient's post-operative recovery experience by reducing opioid consumption; thus, limiting potential risks and side effects and reducing recovery time. This trial included a total of 52 surgical lumbar fusion patients. In Group A, there were 26 patients who received opioid regimens. In Group B, there were 26 patients who received bilateral QL block catheters with break-through opioid regimens. Outcome measures included 48-hour post-operative opioid use in oral MME and LOS from the PACU to hospital discharge. Group A had a mean MME of 307.62 ± 305.37 mg; whereas Group B had a statistically significant lower mean total MME of 133.78 ± 152.66 mg ($p = 0.012$, $\alpha = 0.05$). On an average, Group A required 2.3 times the MMEs than Group B. Group A had a mean LOS of 2.34 ± 1.87 days, whereas Group B had a lower mean LOS of 1.98 ± 0.51 days. This difference of 0.36 days was not statistically significant ($p = 0.522$, $\alpha = 0.05$). The authors concluded that surgical lumbar fusion patients who received the QL block catheter had a lower opioid requirement compared to standard opioid regimens; however, this trial was under-powered to detect a difference in LOS. Moreover, these researchers stated that further studies with a prospective, randomised, control design with a larger sample size are needed.

The authors stated that this trial was the 1st statistical analysis comparing QL blocks with the standard of care (SOC). As a pilot study, this analysis will potentially aid in legitimizing QL nerve blocks as a regional anesthesia treatment modality for the treatment of pain associated with lumbar fusions. These researchers stated that this study was limited by its retrospective design and small sample size (n = 26 in the QL block group). They stated that future studies at facilities with more resources may consider factoring in pain scores, baseline home opioid consumption, potential complications and number of levels fused.

Alver et al (2022) stated that quadratus lumborum block (QLB) is a fascial plane block. There is no randomized study on the effectiveness of QLB for lumbar surgery. In a randomized study, these investigators examined the effectiveness of QLB for post-operative pain management and patient satisfaction after lumbar disc herniation surgery (LDHS). A total of 60 patients with ASA score I-II planned for LDHS under general anesthesia were included. These researchers allocated the patients into 2 groups: the QLB group (n = 30) or the control group (n = 30). QLB was performed with 30-ml 0.25 % bupivacaine in the QLB group. Paracetamol 1 g IV 3 × 1 was ordered to the patients at the post-operative period. If the NRS score was 4 or higher, 1 mg/ kg tramadol IV was administered as rescue analgesia. There was a reduction in the median static NRS at 0 hour and 2 hours with QLB compared to the control group ($p < 0.05$). There was no difference in the resting NRS at any other time-point up to 24 hours. The median dynamic NRS was significantly lower at 0, 2, 4, 8, and 16 hours in the QLB group ($p < 0.05$). The need for rescue analgesia was significantly lower in the QLB group. The incidence of nausea was significantly higher in the control group. The post-operative patient satisfaction was significantly higher in the QLB group ($p < 0.05$). The authors found that the QLB was effective for pain control following LDHS.

The authors stated that this trial had several drawbacks. First, these researchers employed a single total volume of 30 ml local anesthetic, although different results may be achieved with different volumes. Second, these investigators used only an anterior approach to the QLB, creating a need to examine other approaches to the QLB for lumbar spine surgery. Third, the authors did not examine the dermatome level following the block’s application. They evaluated the effectiveness of the QLB based on the patients’ pain scores and need for rescue analgesia. These researchers stated that future, larger studies are needed to validate these findings on the effectiveness of the QLB after LDHS.

Adıguzel et al (2023) stated that the management of post-operative pain following LDHS is crucial for the quality of recovery. The effectiveness of multi-modal analgesia plans increases when inter-fascial plane nerve blocks are included. These investigators compared the analgesic effectiveness of pre-operative US-guided TLIP (thoracolumbar inter-fascial plane) nerve blocks and posterior QLBs (quadratus lumborum blocks) in patients undergoing LDHS. Patients undergoing elective LDHS under general anesthesia were randomized into 2 groups: thoracolumbar inter-fascial plane block (Group T) and posterior QLB (Group Q). Block applications were carried out 30 mins before anesthesia induction. In the post-operative period, analgesia control was provided with a PCA device. The patients' 24-hour cumulative opioid consumption was examined. Pain scores were evaluated in the 0th, 3rd, 6th, 9th, 12th, and 24th hours. The mean 24-hour cumulative morphine consumption for patients was statistically insignificant when Groups T and Q were compared (9.14 ± 7.03 mg versus 8.66 ± 6.58 mg, $p = 0.788$). Pain scores at rest and during movement as well as morphine consumption were similar between groups in the 0th, 3rd, 6th, 9th, 12th, and 24th hours ($p > 0.05$). The authors concluded that the use of TLIP blocks and posterior QLBs before anesthesia induction yielded comparable outcomes in terms of reducing post-operative analgesic consumption and enhancing the effectiveness of multi-modal analgesia in individuals undergoing single-distance lumbo-sacral spine surgery under general anesthesia.

The authors stated that this trial had several drawbacks. First, these researchers did not carry out a dermatome analysis or measure the sensory block area, which could be perceived as a constraint. However, it was worth noting that these assessments were not included in similar studies, primarily due to the nature of the surgical procedures involved, which were not conducive to such analyses. Furthermore, these investigators did not record the block performance times, although their clinical observations suggested that the identification process was quicker with the QLB. Second, contrary to the practice of some anesthetists, these researchers implemented all nerve blocks in the pre-operative block performance room, even though they could have been performed in the prone position after induction. Their objective with this approach was to shorten the operating room usage time and identify potential early complications, and they hypothesized a certain time requirement for the local anesthetic to reach the target tissue. In addition to studies examining the effects of different nerve blocks, research examining the pros and cons of the 2 time options could also be beneficial. Third, these investigators did not evaluate post-operative patient satisfaction scores or quality of recovery scores, both of which should unquestionably be included in future investigations. Furthermore, the somatosensory evoked potential (SSEP) and motor evoked potential (MEP) techniques, recently employed to mitigate nerve damage in lumbar surgeries, could potentially be employed, although it was important to note that they are not standard practice for single-level disc surgeries. Nevertheless, it is advisable to consider future research endeavors aimed at determining the potential impact of the TLIP and QLB techniques on the necessity of monitoring techniques in thoracolumbar spinal surgeries.

Drossopoulos et al (2024) noted that the introduction of minimally invasive surgery ushered in a new era of spinal surgery by minimizing the undue iatrogenic injury, recovery time, and blood loss, among other complications, of traditional open procedures. Over time, technological advancements have further refined the care of the operative minimally invasive spine patient. Moreover, pre-operative, and post-operative care have also undergone significant change by way of artificial intelligence (AI) risk stratification, advanced imaging for surgical planning as well as patient selection, post-operative recovery pathways, and digital health solutions. The authors concluded that despite these advancements, challenges persist necessitating ongoing research and collaboration to further optimize patient care in minimally invasive spine surgery. In particular, these investigators stated that paravertebral analgesia provided by the paraspinal muscular block during lumbar surgeries, including discectomies, laminectomies, and fusions, is the most frequently described application of regional anesthesia (RA) use, although feasibility has been shown in thoracic cases as well. In such cases, these paravertebral blocks have resulted in decreased intra-operative and post-operative opioid consumption without unduly burdening the patient with more pain and complications. Interestingly, there is an emerging paravertebral RA technique that uniquely provides circumferential analgesia. The QLB entails the injection of local anesthetic along the QL via anterior, lateral, and posterior approaches. Together, this provides analgesia along the entire operative scope of an anterior lumber interbody fusion. These researchers stated that although the reports of QLB on circumferential spine surgery patients were sparse, the early available evidence suggested that it is a reasonable way to provide analgesia and mitigate opioid use.

Regional Scalp Block (including Trigeminal Nerve Block) for Post-Operative Pain Control After Head and Neck Surgeries

Guilfoyle et al (2013) noted that up to 2/3 of patients reported moderate-to-severe surgical site pain after craniotomy procedures, and there is understandable reluctance to manage these symptoms with systemic opioids that may impair neurological assessment. In addition, there is a lack of consensus and evidence concerning alternative analgesia strategies for cranial neurosurgery. Regional scalp block (RSB) is an established technique that involves infiltration of local anesthetic (LA) at well-defined anatomical sites targeting the major sensory innervation of the scalp. However, the efficacy of RSB in reducing post-operative pain remains unclear. These investigators reviewed RCTs of RSB and synthesized an overall estimate of effectiveness in a quantitative meta-analysis. Medline, Embase, and the Cochrane Central Register of Controlled Trials databases were searched for all RCTs examining the effect of RSB on post-operative pain after craniotomy. Titles, abstracts, and papers were reviewed independently by 2 authors against pre-defined inclusion criteria. Two authors independently assessed the quality of included studies and extracted data on patient-reported pain scores, other analgesia requirements, and complications of RSB. Pain scores were scaled to a common 0 to 10 interval with higher scores indicating more severe pain. Meta-analysis of the pooled treatment effect was carried out with a random-effects inverse-variance weighted model; heterogeneity was quantified with the I(2) statistic. The literature search identified 138 unique citations, from which 7 RCTs with a total recruitment of 320 patients met the inclusion criteria. All studies used standard LA drugs (lidocaine, bupivacaine, or ropivacaine); in 3 studies, LA was combined with epinephrine. In 3 studies, RSB was performed pre-operatively; in the other 4 studies, it was administered post-operatively after wound closure. No complications attributable to RSB were reported. Meta-analysis found a pooled reduction in pain score at 1 hour post-operatively (n = 5 studies; mean difference, -1.61; 95 % CI: -2.06 to -1.15; p < 0.001; I(2) = 0 %). Subgroup analysis of pre-operative RSB showed significant reduction in pain scores at 2, 4, and 6 to 8 hours after surgery whereas post-operative RSB was associated with significant reduction in pain scores at 2, 4, 6 to 8 and 12 hours assessments. There was also an overall reduction in the opioid requirements over the first 24 hours post-operatively, although with significant heterogeneity among the studies (n = 6 studies; SMD, -0.79; 95 % CI: -1.55 to -0.03; p = 0.04; I(2) = 86 %). The authors concluded that published RCTs of RSB were small and of limited methodological quality; however, meta-analysis showed a consistent finding of reduced post-operative pain. This evidence supported the use of RSB for patients undergoing craniotomy.

Kunar et al (2018) stated that US-guided injection in pterygopalatine fossa is an indirect approach to block the trigeminal nerve. Trigeminal nerve block (NB) for maxillofacial surgeries may provide pre-emptive analgesia, reduce opioid consumption, and opioid-related adverse effects. In a prospective, randomised, double-blind study, a total of 60 ASA I/II patients, within the age group of 18 to 60 years scheduled for faciomaxillary surgery (fracture/pathological lesion of maxilla or mandible and cleft lip), were recruited. Subjects were allocated in either of the 2 groups: group I: general anesthesia (FENT group) and group II: general anesthesia + trigeminal NB (TNB group). Peri-operative opioid consumption and post-operative pain scores were recorded. Any adverse effects like respiratory depression and nausea were also recorded. Patients in group II required less intra-operative fentanyl top ups (1.17 ± 0.53 versus 2.70 ± 0.53) ($p < 0.05$). Post-operative opioid consumption was also less in this group (0.93 ± 0.69 versus 3.53 ± 0.68) ($p < 0.05$). The authors concluded that US-guided trigeminal NB reduced peri-operative opioid consumption in patients undergoing faciomaxillary surgery with better patient pain scores.

Smith et al (2020) noted that post-tonsillectomy pain in adults can be severe and is often poorly-controlled. Pain can lead to decreased oral intake, bleeding, longer hospital LOS, emergency department visits, dehydration, as well as weight loss. Due to persistent pain despite scheduled medications, other methods for pain control are needed. Local/regional anesthetic options have been previously studied in this population. Unfortunately, neither the injection of local anesthetics into the tonsillar fossa nor the post-operative topical application of local anesthetics to the tonsillar bed has shown effectiveness in large systematic reviews. In case-series study, these researchers reported on the post-tonsillectomy pain experience of 3 patients who were treated with peri-operative NBs placed in the pterygopalatine fossa. This represented an as-yet unexplored option for post-tonsillectomy pain control. After induction of general anesthesia, before surgical incision, a 25-G spinal needle was advanced into the pterygopalatine fossa using a supra-zygomatic, US-guided approach. Ropivacaine and dexamethasone were administered into the pterygopalatine fossa. All 3 patients experienced excellent pain control for the duration of their recovery and required 10 mg or less of oxycodone over the 2 weeks after surgery. The authors concluded that this case-series study of 3 patients provided proof of concept (POC) that use of NBs in the pterygopalatine fossa could be useful for the control of post-tonsillectomy pain. Moreover, these researchers stated that further investigation is needed to confirm these initial findings.

Wang et al (2021) stated that US-guided trigeminal NB is rarely used in orthognathic surgery, and its impact of post-operative analgesia and the auxiliary effect on hypotensive anesthesia have not been fully reported. In a prospective, controlled, single-blind, single-center study, these investigators examined the effectiveness of US-guided trigeminal NB on intra-operative anesthetic dosage and post-operative analgesia. All subjects were randomly assigned to 2 groups (n = 21/group): GEA group (general anesthesia) and TNB group (US-guided trigeminal NB [UGTNB] with general anesthesia). The primary variable was post-operative pain (visual analog scale scores, VAS scores) at post-operative 2, 4, 6, 12, and 24 hours. Satisfaction with post-operative pain management during post-operative 24 hours; the number of patients with moderate-to-severe pain (VAS score: greater than 3) at post-operative 2, 4, 6, 12, 24 hours; and the consumption of opioids and nicardipine intra-operatively, etc. were secondary variables. Data were analyzed using the unpaired t, $\chi 2$, and Wilcoxon nonparametric tests. A total of 40 patients at the Peking University School and Hospital of Stomatology between January 2019 to March 2019 were included with a mean age of 24.13 ± 5.07 years for statistical analysis, and 37.5 % were male. Compared to GEA group, the TNB group had a significantly lower VAS scores at post-operative 6 hours and 12 hours, which were 2[0,2] and 0[0,2], respectively. In addition, patients in TNB group were more satisfied with pain management at post-operative 24 hours than patients in GEA group (5[4,5] versus 4[3,5]; p = 0.03). Statistically less amounts of opioids and nicardipine in TNB group were used intra-operatively (p < 0.01). The authors concluded that UGTNB use in orthognathic surgery may improve analgesia in the 24 hours after the operation, and facilitated hypotensive anesthesia with fewer agents and fewer adverse effects post-operatively. Moreover, these researchers stated that more large, multi-center studies are needed to examine the combination of UGTNB and other non-opioid drugs, such as NSAIDs for post-operative analgesia in orthognathic surgery.

Srejic et al (2023) noted that pituitary neurosurgery executed via the trans-sphenoidal endonasal approach is often performed for pituitary adenomas. Reasons for prolonged hospital stay include post-operative headache and protracted nausea with or without vomiting. Bilateral superficial trigeminal NB of the supra-orbital V1 and infra-orbital V2 (SION) nerves performed intra-operatively as a regional anesthetic adjunct to general anesthesia were hypothesized to decrease 6 hours post-operative morphine PCA use by patients. A total of 49 patients, following induction of general anesthesia for their trans-sphenoidal surgery, were prospectively randomized in a double-blinded fashion to receive additional regional anesthesia as either a block (0.5 % ropivacaine with epinephrine 1:200,000) or placebo/sham (0.9 % normal saline). The primary endpoint of the study was systemic morphine PCA opioid consumption by the 2 groups in the first 6 hours post-operatively. The secondary endpoints included pain exposure experienced post-operatively, incidence of post-operative nausea and vomiting, and time to eligibility for PACU discharge. Of the 49 patients who were enrolled, 3 patients were excluded due to protocol violations. Ultimately, there was no statistically significant difference between morphine PCA use in the 6 hours post-operatively between the NB and placebo/sham groups. There was, however, a slight visual tendency in the NB group for higher pain scores, morphine use (p = 0.046), and delayed PACU discharge. False discovery rate corrected comparisons at each time-point and then revealed no statistically significant difference between the 2 groups. There were no differences between the 2 groups for secondary endpoints. The authors concluded that it was found that a 6-hour post-operative headache after endoscopic trans-sphenoidal pituitary surgery likely has a more complicated mechanism involving more than the superficial trigemino-vascular system and perhaps is neuro-modulated by other brain nuclei.

In a RCT, Zhang et al (2024) examined if scalp nerve block with ropivacaine could improve the quality of rehabilitation in patients after meningioma resection. This study included 150 patients who were undergoing craniotomy; they were categorized them into 2 groups -- observation group (patients received an additional regional scalp nerve block anesthesia) and control group (patients underwent intravenous general anesthesia for surgery), using the random number table method approach (75 patients in each group). The main outcome measure of the study was the Karnofsky Performance Scale (KPS) scores of patients at 3 days post-operatively, and the secondary outcome measure was the anesthesia satisfaction scores of patients after awakening from anesthesia. The application value of different anesthesia modes was studied and compared in the 2 groups. Patients in the observation group showed better anesthesia effects than those in the control group, with significantly higher KPS scores at 3 days post-operatively (75.02 versus 66.43, $p < 0.05$) and anesthesia satisfaction scores. Compared with patients in the control group, patients in the observation group had lower pain degrees at different times after the surgery, markedly lower dose of propofol and remifentanil for anesthesia, and lower incidence of adverse reactions and post-operative complications. Furthermore, the satisfaction score of the patients and their families for the treatment was higher and the results of all the outcome measures were better in the observation group than in the control group, with statistically significant differences ($p < 0.05$). The authors concluded that scalp nerve block with ropivacaine significantly improved the quality of short-term post-operative rehabilitation in patients undergoing elective craniotomy for meningioma resection. This was presumably related to the improvements in intra-operative hemodynamics, relief from post-operative pain, and reduction in post-operative nausea and vomiting.

Stellate Ganglion Block for the Treatment of Post-Traumatic Stress Disorder

Lipov et al (2013) noted that the prevalence of post-traumatic stress disorder (PTSD) has reached epidemic proportions among U.S. veterans, many of whom also have concurrent alcohol use disorder. This case report described improvements in PTSD symptom severity and memory dysfunction in a combat-exposed veteran with persistent PTSD and alcohol use disorder following 2 treatments of stellate ganglion block

(SGB). PTSD severity was measured using the PTSD Checklist, Military Version. Memory function was evaluated using the Rey Auditory Verbal Learning Test. One month after the 1st SGB, a 43.6 % reduction in PTSD severity was observed along with increases in immediate memory (50 %), recent memory (28 %), and recognition memory (25 %). Following a 2nd SGB, PTSD severity decreased by 57.7 % and memory function substantially improved, with pronounced changes in immediate memory (50 %), recent memory (58 %), and recognition memory (36 %). One year after SGB treatments, the patient has stopped drinking alcohol, continued to have sustained relief from PTSD, has improved memory function, and has become gainfully employed. The authors concluded that future studies that employ robust epidemiologic methodologies are needed to generate confirmatory evidence that would substantiate SGB's clinical utility as an adjunctive therapeutic option for PTSD.

In a randomized study, Hanling et al (2016) examined if SGB could reduce symptoms of PTSD in comparison with sham therapy in military service members. Both participants and assessors were blind; participants with PTSD received either an SGB or a sham procedure; PTSD symptoms were measured using the CAPS (Clinician-Administered PTSD Scale) and self-report measures of PTSD, depression, anxiety, and pain. Subjects underwent assessment before the procedure and at 1 week, 1 month, and 3 months after the procedure. Patients receiving sham injections were allowed to cross-over to the treatment group, and participants who maintained criteria for PTSD were allowed to receive a 2nd SGB treatment. PTSD, anxiety, and depression scores all showed improvement across time; however, there was no statistically or clinically relevant difference in outcomes between the active and control groups. Individuals who crossed-over from sham treatment to SGB similarly showed no greater improvement with the SGB treatment. Improvement in CAPS was greater with a 2nd SGB treatment than after the 1st treatment.

The authors concluded that although previous case series have suggested that SGB offered an effective intervention for PTSD, this study did not show any appreciable difference between SGB and sham treatment on psychological or pain outcomes. Moreover, these researchers stated that future studies should examine if differences in treatment methods or patient population could allow individuals with PTSD to benefit from SGB, but current evidence does not support widespread or indiscriminant clinical use of the procedure for PTSD.

In a randomized, blinded, sham-procedure, multi-center clinical trial, Olmsted et al (2020) examined if paired SGB treatments at 0 and 2 weeks would result in improvement in mean Clinician-Administered PTSD Scale for DSM-5 (CAPS-5) total symptom severity scores from baseline to 8 weeks for patients with PTSD. This study used a 2:1 SGB:sham ratio; and was carried out from May 2016 through March 2018 in 3 US Army Inter-disciplinary Pain Management Centers. Only physicians performing the procedures and the procedure nurses were aware of the intervention (but not the participants or assessors); their interactions with the participants were scripted and limited to the 2 interventions. Active-duty service members on stable psychotropic medication dosages who had a PTSD Checklist-Civilian Version (PCL-C) score of 32 or more at screening were included. Key exclusion criteria included a prior SGB treatment, selected psychiatric disorders or substance use disorders, moderate or severe traumatic brain injury (TBI), or suicidal ideation in the prior 2 months. Interventions were paired right-sided SGB or sham procedures at weeks 0 and 2. Main outcomes and measures included improvement of 10 or more points on mean CAPS-5 total symptom severity scores from baseline to 8 weeks, adjusted for site and baseline total symptom severity scores (planned a priori). Of 190 screened individuals, 113 (59.5 %; 100 male and 13 female participants; mean [SD] age, 37.3 [6.7] years) were eligible and randomized (74 to SGB and 39 to sham treatment), and 108 (95.6 % of 113) completed the study. Baseline characteristics were similar in the SGB and sham treatment groups, with mean (SD) CAPS-5 scores of 37.6 (11.2) and 39.8 (14.4), respectively (on a scale of 0 to 80); 91 (80.0 %) met CAPS-5 PTSD criteria. In an intent-to-treat (ITT) analysis, adjusted mean total symptom severity score change was -12.6 points (95 % CI: -15.5 to -9.7 points) for the group receiving SGB treatments, compared with -6.1 points (95 % CI: -9.8 to -2.3 points) for those receiving sham treatment ($p = 0.01$). The authors concluded that in this trial of active-duty service members with PTSD symptoms (at a clinical threshold and subthreshold), 2 SGB treatments 2 weeks apart were effective in reducing CAPS-5 total symptom severity scores over 8 weeks. The mild-moderate baseline level of PTSD symptom severity and short follow-up time limited the generalizability of these findings; however, the findings of this study suggested that SGB merits further trials as a PTSD treatment adjunct.

Mulvaney et al (2022) noted that US-guided SGB is an injection of local anesthetic (8 ml of 0.5 % ropivacaine) in the neck to temporarily block the cervical sympathetic trunk that controls the body's fight-or-flight response. This outpatient procedure takes less than 30 mins, and is immediately effective. In a retrospective study, these researchers examined if a left-sided SGB is effective for treating PTSD symptoms. While right-sided SGB has been extensively studied, left-sided SGB has not been formally evaluated for this indication. The hypothesis was that patients who failed to improve following a right-sided SGB will report significant improvement following a left-sided SGB. These investigators carried out a retrospective chart review for patients who received SGB for PTSD symptoms between August 2019 and March 2020. All procedures were performed at an established musculoskeletal practice by the same anesthesia/pain fellowship-trained physician. Subjects included those who underwent a left-sided SGB (LSGB) only after non-response to a right-sided SGB (RSGB). Non-response was defined as less than 10 points of improvement on a PTSD Checklist (PCL-5). Out of 205 patients, 20 did not respond to an RSGB and were included in this analysis; 10 of these patients subsequently received an LSGB, and 90 % responded favorably (PCL-5 mean improvement = 28.3 points). The authors noted that based on this sample of 205 patients receiving SGB for PTSD, they concluded that at least 4.4 % did not respond to a right-sided SGB; but did have a significant response to a left-sided SGB. Moreover, these investigators stated that further investigation is needed in a larger population.

The authors stated that this study had several drawbacks. The patients who opted to receive an LSGB after failing to respond to an RSGB returned for an LSGB at least 24 hours post-RSGB as required. This requirement limited access to treatment for the patients, who were unable to, or chose not to, return following the RSGB, which may introduce sampling bias. Data on the reasons for which patients were unable to return for an LSGB or chose to forego LSGB treatment were not documented and limit this analysis. Furthermore, the small sample size (n = 10), retrospective design, and short-term follow-up made it difficult to form generalizable conclusions. By comparing 2 different procedures on the same patients, however, these researchers were able to reliably employ self-reported symptom score comparisons between an LSGB and an RSGB. Additionally, the study suffered from a 33 % loss-to-follow-up following RSGB. Finally, because the 10 subjects in the primary analysis received both RSGB and LSGB, the possibility of an additive effect must be taken into account. Still, the data presented here provide a valuable 1st look at a potential modification of standard RSGB, as well as a foundation for future research. Moreover, these investigators stated that although the intent of this procedure is to block the cervical sympathetic chain and its associated ganglia, they could not rule out that some clinical effects may be due to anesthetic spread as well as an inadvertent block of the vagus nerve. Questions also remain surrounding lateralization. Why some PTSD patients appear to respond better to an LSGB rather than an RSGB is unclear. These findings, which showed success on the left side in a small sample, challenge existing dogma that SGB should be performed only on the right side to treat PTSD symptoms. This approach has been based in part on psycho-neurobiological models that depict sympathetic predominance (including cardiovascular regulation) within right insular function, while parasympathetic regulation has been attributed to the left insula. Several recent neuroimaging studies have also provided further evidence that such clear lateralization may be more complex than previously thought. This issue certainly warrants further investigation.

Furthermore, an UpToDate review on “Posttraumatic stress disorder in adults: Treatment overview” (Stein, 2024) states that “Stellate ganglion blockade involves injection of local anesthetic into the stellate ganglion of the sympathetic chain in the neck. Randomized trials have shown mixed results in the treatment of PTSD symptoms … Further trials investigating the use of stellate ganglion blockade as an adjunctive PTSD treatment are warranted”.

Superior Laryngeal Nerve Block for Chronic Cough, and Laryngeal Hypersensitivity

Simpson et al (2018) noted that neurogenic cough is believed to result from a sensory neuropathy involving the internal branch of the superior laryngeal nerve (SLN). In a retrospective, chart review, these researchers presented the outcomes for the treatment of neurogenic cough with localized blockade of the internal branch of the SLN. This trial included patients who underwent in-office percutaneous SLN block for treatment of neurogenic cough between 2015 and 2017. Patient demographics, indications for injection, and response to treatment were recorded and analyzed. Cough severity index (CSI) scores before and after treatment were compared. A total of 23 patients underwent percutaneous blockade of the internal branch of the SLN in the clinic setting, and 5 patients were excluded for incomplete records. The indication was neurogenic cough as a diagnosis of exclusion. The injectable substance used was a 1:1 mixture of a long-acting particulate corticosteroid and a local anesthetic. Unilateral injections were performed in 13 patients, and 5 patients underwent bilateral injections. Of the unilateral injections, 10 were left-sided. Patients underwent an average of 2.4 SLN block procedures (range of 1 to 7). Mean follow-up time post-injection was 85.4 days (7 to 450 days). Cough severity index (CSI) scores decreased significantly from an average of 26.8 pre-treatment to 14.6 post-treatment ($p < 0.0001$). The authors concluded that the SLN block was an effective treatment for neurogenic cough, with average CSI scores significantly improved following injection. Moreover, these researchers stated that further study is needed to determine the characteristics of patients' responses to treatment, long-term outcomes, and effectiveness of the procedure when compared to placebo and other accepted treatments for neurogenic cough. Level of Evidence = IV.

In a retrospective study, Dhillon (2019) described an in-office SLN block with lidocaine and steroids as an effective alternative to neuromodulators for patients with neurogenic cough. This study included 10 patients who underwent in office nerve block to the SLN for neurogenic cough. Demographic data and pre- and post-cough survey index were the measure outcomes. Follow-up was 3 to 6 months. All patients who underwent an SLN block showed significant improvement in CSI. The average number of blocks was 2.3. The mean follow-up time from the 1st SLN block was 3.4 months. The mean CSI improvement 16.30 (95 % CI: 11.44 to 21.16; $p < 0.0001$). All patients in this study completed at least 1 session of cough suppression therapy with speech language pathology (SLP). No patients were on neuromodulators at the time of the SLN block. The authors concluded that there is a role for in-office SLN block with lidocaine and steroids for patients with neurogenic cough, and could be an effective alternative to neuromodulators. Moreover, these researchers stated that further studies are needed to determine the long-term outcomes, as well as the effectiveness of the procedure when directly compared to placebo and neuromodulators for neurogenic cough.

Wamkpah et al (2022) stated that neurogenic cough affects 11 % of Americans and causes significant detriment to QOL. In a systematic review and meta-analysis, these investigators examined how procedural therapies (e.g., superior laryngeal nerve block) compared to other established pharmacologic and non-pharmacologic treatments for neurogenic cough. With the assistance of a medical librarian, a systematic review was carried out using PICOS (patients, interventions, comparator, outcome, study design) format: adults with neurogenic cough receiving any pharmacologic or non-pharmacologic treatment for neurogenic cough compared to adults with neurogenic cough receiving any other relevant interventions, or treated as single cohorts, assessed with cough-specific QOL outcomes, in all study designs and case series with 10 or more cases. Case-reports, review articles, non-human studies, non-English language articles, and unavailable full-text articles were excluded. There were 2,408 patients with neurogenic cough in this review, treated with medical therapy (77 %), speech therapy (19 %), both medical and speech therapy (1 %), and procedural therapy (3 %). The included studies ranged from low to intermediate quality. Overall, most interventions showed successful improvement in cough; however, the heterogeneity of included study designs precluded direct comparisons between intervention types. The authors concluded that this meta-analysis compared various treatments for neurogenic cough. These investigators stated that procedural therapy should be considered in the armamentarium of neurogenic cough treatments, especially in patients refractory to, or intolerant of, the side effects of medical therapy. Finally, this review showed key areas for improving neurogenic cough diagnosis, such as strict adherence to diagnostic and treatment guidelines, sophisticated reflux testing, and standardized, consistent outcome reporting.

Tipton et al (2023) stated that chronic cough is a common and debilitating problem. In a prospective, placebo-controlled study, these researchers examined the safety and effectiveness of SLN block for the treatment of neurogenic cough. Patients were recruited from an outpatient tertiary care center. Inclusion criteria included a history consistent with neurogenic cough and age of 18 years or older. Exclusion criteria included patients with untreated other etiologies of chronic cough (i.e., uncontrolled reflux) and current neuromodulating medication use. Patients were randomized into the treatment (1 to 2 ml of a 1:1 triamcinolone 40 mg: 1 % lidocaine with 1:200,000 epinephrine) or placebo (saline) group and received 2 unilateral injections at approximately 2-week intervals. Outcomes were measured primarily by the Leicester Cough Questionnaire (LCQ) and a patient symptom log including a visual analog scale (VAS) of cough severity. A total of 17 patients completed the study, including 10 in the treatment group and 7 in the placebo group; 8 (80 %) patients in the treatment group reported improvement with at least one of the injections, whereas only 1 (14.3 %) patient reported improvement in the placebo group ($p < 0.0001$). Average total LCQ scores increased in the treatment group from 10.09 to 13.15 ($p = 0.03$), with the most change occurring in the social domain. There was no statistically significant change in LCQ scores for the placebo group. There were no serious AEs. The authors concluded that an SLN block was a safe and efficacious procedure for the treatment of neurogenic cough. Moreover, these researchers stated that further studies are needed to optimize treatment protocol and assess long-term follow-up of patient outcomes. Level of Evidence = II.

Gray et al (2024) stated that SLN block consists of injection of steroid and anesthetic at the internal branch of the SLN entry site. Previous case-series studies have reported beneficial effects on neurogenic cough. SLN blocks have also recently shown benefit for para-laryngeal pain. In a retrospective review, these investigators described short-term outcomes for multiple symptoms of irritable larynx syndrome (ILS) including neurogenic cough, dysphonia related to laryngeal hypersensitivity, inducible laryngeal obstruction (ILO), para-laryngeal pain, and isolated globus. This study entailed patients from 2 centers who underwent a single SLN block for the indications listed. Variables include age, sex, indication(s), known vagus neuropathy, and patient-reported outcomes at short-term follow-up. A total of 209 patients were included (59 men, 150 women; age of 58 ± 13 years); 26 patients (12 %) had a history of a vagus nerve injury. Indications included neurogenic cough (n = 149), dysphonia related to laryngeal hypersensitivity (n = 66), para-laryngeal pain (n = 50), ILO (n = 23), and isolated globus (n = 3). Some patients had multiple indications. Significant improvements in patient-reported measures occurred after a single SLN block within 2 to 4 weeks for neurogenic cough (CSI; 25.2 ± 11.2 to 19.0 ± 12.8; $p < 0.001$), dysphonia (voice handicap index [VHI]; 10; 22.1 ± 12.2 to 18.0 ± 13.3; $p = 0.005$), and ILO (dyspnea index; 21.0 ± 14.9 to 14.7 ± 15.7; $p = 0.017$). Subjective pain improved in 23 of 39 patients with para-laryngeal pain. There was no observed improvement for isolated globus. Presence of known vagal neuropathy or therapy around the time of SLN block did not affect outcome. The authors concluded that SLN block could be an effective component of treatment for a variety of ILS symptoms; patients may experience some improvement after 1 injection. Moreover, these researchers stated that future prospective, placebo-controlled studies with longer-term follow-up and multi-parametric outcome assessment are needed. Level of Evidence = IV.

The authors stated that this study had several drawbacks. First, this was a retrospective cohort study without an available group for comparison and the study was not designed to be prospective with a control group for comparison; thus, a placebo effect could certainly have an impact on the patient-reported outcome measures. Second, patient medical co-morbidities ongoing at the time of SLN block or post-injection data capture were not accurately charted, which could also contribute to subjective changes in cough or dyspnea; hence, this was unable to be controlled for in analysis to isolate the effect of the SLN block alone. The mechanism of how SLN injection affects the nerve at the physiologic level is theorized but not understood. Third, this study focused only on the short-term outcome of a single injection for multiple indications; longer-term outcomes were not the focus of this study. Fourth, this trial was carried out at 2 centers, with potential for some heterogeneity in how the procedure was conducted. However, given the simple nature of the procedure, the multi-center nature primarily served to improve study result generalizability. Fifth, only subjective patient-reported outcome measures were available, and no quantitative cough or voice analyses were performed.

In a retrospective, single-center study, Quinton et al (2024) examined the effectiveness of bilateral SLN block in patients with refractory chronic cough. This chart review included 164 patients with refractory chronic cough who underwent bilateral SLN block at between November 2018 and September 2022. Demographics, co-morbidities, and patient-reported outcomes including pre- and post-injection LCQ scores were collected and analyzed. The cohort underwent an average of 2.97 bilateral injections (range of 1 to 22), containing either corticosteroid and local anesthetic or corticosteroid alone. Notably, 116 of 164 of patients reported an average of 67.3 % reduction in their symptoms, with the treatment effect lasting 7.60 weeks on average. The average pre- and post-injection LCQ scores were 9.70 and 13.82, respectively. A lower LCQ score represented a greater impairment of health status due to cough, and the minimum important change was 1.3 points between questionnaires. The average improvement on LCQ following bilateral SLN block was 4.11 points for this cohort. The authors concluded that the use of in-office bilateral SLN block was an effective treatment that could be used alone or in conjunction with oral medications for the treatment of refractory chronic cough. Moreover, these researchers stated that further investigations with longer follow-up, larger sample sizes, and standardized, objective measures of cough burden are needed to determine the duration of effect and long-term outcomes of this treatment modality. In addition, varying doses of corticosteroids or local anesthetic may affect outcomes, and this should be a consideration in future studies; thus, more data with collaboration between institutions will be instrumental in the development of clinical practice guidelines for the SLN block. Level of Evidence = IV.

The authors stated that this study had several drawbacks. First, the subjective nature of patient-reported outcomes limited the accuracy of our results regarding the effectiveness of bilateral SLN block for refractory chronic cough. Although these researchers incorporated the use of standardized, validated measures of cough such as the LCQ, this remains an imperfect method and does not represent an objective evaluation of cough severity. Second, some of the participants were on concurrent neuromodulators, and these investigators were unable to evaluate how this affected their data due to lack of clarity regarding discontinuation of the medication in the electronic medical record when SLN blocks were pursued. Hence, these researchers plan to continue their investigation of this therapy with a prospective study on the outcomes of neuromodulation alone compared with SLN block alone and SLN block with concurrent neuromodulation. Third, the retrospective collection of data. The authors did not have data points available for preand post-intervention analysis for each patient due to a lack of patient survey with a validated tool at each time-point, resulting in notable data loss.

Furthermore, an UpToDate review on “Evaluation and treatment of subacute and chronic cough in adults” (Weinberger and Saukkonen, 2024) does not mention nerve block as a management / therapeutic option.

Transversus Thoracic Plane Block for Post-Operative Pain Control After Medial Sternotomy

Fujii et al (2019) noted that cardiac surgery patients often experience significant pain after median sternotomy. The transversus thoracis muscle plane (TTP) block is a newly developed, single-shot nerve block technique that provides analgesia for the anterior chest wall. In a double-blind, pilot study, these researchers examined the feasibility of performing this novel block as an analgesic adjunct. All patients aged 18 to 90 years undergoing elective cardiac surgery were randomized to the block or standard care control group on admission to the ICU after surgery. Under ultrasound (US) guidance, patients in the block group received the TTP block with 20-ml of either 0.3 % or 0.5 % ropivacaine bilaterally, based on weight. The control group did not receive any injections. All blocks were performed by a single anesthesiologist, and data collection was carried out by blinded assessors. The primary feasibility outcomes were rate of recruitment, adherence, and AEs. The rate of recruitment was defined as the ratio of patients giving informed consent to the number of eligible patients who were approached to participate. Secondary outcomes included 12-hour and 24-hour NRS pain scores, 24-hour hydromorphone and acetaminophen requirements, time to extubation, time to 1st opioid administration, and patient satisfaction (on a yes/no questionnaire) at 24 hours. A total of 20 patients were approached for this study and 19 were enrolled; 8 patients received the intended intervention in each group. The recruitment rate was 95 % of all approached eligible patients, and the adherence rate to treatment group was 94 %. There were no block-related AEs. The mean (SD) NRS pain scores at rest were 3.3 (3.2) in the block group versus 5.6 (3.2) in the control group at 12 hours. At 24 hours, the pain scores were 4.1 (3.9) versus 4.1 (3.3) in the block and control group, respectively. The mean (SD) 24-hour hydromorphone administration was 1.9 (1.1) mg in the block group versus 1.8 (0.9) mg in the control group. The authors concluded that the TTP block is a novel pain management strategy post-sternotomy. The results showed a high patient recruitment, adherence, and satisfaction rate, and provided some preliminary data supporting safety. The findings of this pilot study did not show that the TTP block provided better results than standard care (with the TTP block).

Liu et al (2023) stated that the effects of the TTP block on post-operative pain have become increasingly controversial. In a meta-analysis, these investigators compared the effects of the TTP block versus no block on post-operative analgesia and side effects to examine if this new technique is a reliable alternative for pain management. PubMed, Cochrane Library, Embase, Web of Science, ClinicalTrials.gov, China National Knowledge Infrastructure, Chongqing VIP information, and Wanfang Data were searched for clinical studies examining the analgesic effect of the TTP block compared to controls. The primary outcomes included the post-operative pain scores at rest and during movement, morphine consumption in 24 hours, and the rate of PONV. A total of 11 RCTs, including 682 patients, were reviewed. The meta-analysis showed that the TTP block significantly reduced the pain scores at 0 (at rest: MD, -2.28; 95 % CI: -2.67 to -1.90) (during movement: MD: -2.09, 95 % CI: -2.62 to -1.56) and 12 hours (at rest: -1.42, 95 % CI: -2.03 to -0.82) (during movement: MD: -2.13, 95 % CI: -2.80 to -1.46) after surgery, 24-hour post-operative analgesic consumption (MD: -23.18, 95 % CI: -33.71 to -12.66), and the incidence of PONV (OR, 0.36, 95 % CI: 0.15 to 0.88). In addition, the trial sequence analysis confirmed the result of less 24-hour post-operative analgesic consumption in the TTP block group. The authors concluded that as a novel technique, the TTP block exhibited a superior post-operative analgesic effect during the early post-operative period. Moreover, these researchers stated that additional well-designed RCTs are needed.

Mansour et al (2024) noted that an association exists between cardiac surgery, performed through median sternotomy, and a considerable post-operative pain. In a prospective, randomized, comparative study, these investigators compared the effects of TTMPB and pecto-intercostal fascial plane block (PIFB) on post-operative opioid consumption among the patients who underwent open cardiac surgery. This trial was carried out in 80 patients who underwent elective on-pump cardiac surgery with sternotomy. Participants were randomly assigned to 2 groups with each group containing 40 individuals. For the TTMPB group, bilateral US-guided TTMPB was adopted in which 20-ml of 0.25 % bupivacaine was used on each side. In case of PIFB group, bilateral US-guided PIFB was adopted with the use of 20-ml of 0.25 % bupivacaine on each side. These investigators recorded the 1st time for rescue analgesia, the overall dosage of rescue analgesia administered in the first 24 hours after the operation and the post-operative complications. The PIFB group took significantly longer time to raise the 1st request for rescue analgesia (7.8 ± 1.7 hours) than the TTMPB group (6.7 ± 1.4 hours). Similarly, the PIFB group subjects had a remarkably lower “overall morphine usage” in the first 24 hours after the operation (4.8 ± 1.0 mg) than TTMPB group (7.8 ± 2.0 mg). The authors concluded that bilateral US-guided PIFB provided a longer time for the 1st analgesic demand than bilateral US-guided TTMPB in patients undergoing open cardiac surgery. Furthermore, the PIFB reported less post-operative morphine usage than the TTMPB and increased satisfaction in these patients.

Cui et al (2024) stated that pediatric patients undergoing cardiac surgery usually experience significant surgical pain. In addition, the effect of poor surgical analgesia creates a pain continuum that extends to the post-operative period. TTMPB is a novel plane block technique that can provide analgesia to the anterior chest wall; however, the analgesic role of TTMPB in pediatric cardiac surgery is still uncertain. In a systematic review and meta-analysis, these investigators examined the analgesic effectiveness of this procedure. PubMed, Embase, Web of Science, CENTRAL, WanFang Data, and the China National Knowledge Infrastructure were searched to November 2023, and the GRADE approach was followed to assess the certainty of evidence. Eligible studies enrolled pediatric patients from 2 months to 12 years of age scheduled to undergo cardiac surgery, and randomized them to receive a TTMPB or no block/sham block. A total of 6 studies that enrolled 601 pediatric patients were included. Low-certainty evidence from randomized trials showed that, compared with no block or sham block, TTMPB in pediatric patients undergoing cardiac surgery may reduce post-operative modified objective pain score at 12 hours (WMD -2.20, 95 % CI: -2.73 to -1.68) and 24 hours (WMD -1.76, 95 % CI: -2.09 to -1.42), intra-operative opioid consumption (WMD -3.83, 95 % CI: -5.90 to -1.76

μg/kg), post-operative opioid consumption (WMD -2.51, 95 % CI: -2.84 to -2.18 μg/kg), LOS in the ICU (WMD -5.56, 95 % CI: -8.30 to -2.83 hours), and extubation time (WMD -2.13, 95 % CI: -4.21 to -0.05 hours). Retrospective studies provided very-low certainty that the results were consistent with the randomized trials. The authors concluded that very low- to low-certainty evidence showed that TTMPB in pediatric patients undergoing cardiac surgery may reduce post-operative pain, opioid consumption, LOS in the ICU, and extubation time.

Fascial Plane Blocks

Coppens et al (2020) stated that thoracic epidural anesthesia is no longer considered the gold standard for peri-operative analgesia in laparoscopic colorectal procedures. In the search for alternatives, the effectiveness of the TAP block and other abdominal wall blocks such as the trans-muscular quadratus lumborum (TQL) block continues to be investigated for post-operative pain management. Most of the initial studies on TAP blocks reported positive effects; however, the amount of studies with negative outcomes is increasing, most probably due to the fact that the majority of abdominal wall blocks failed to mitigate visceral pain. The TQL block could prove attractive in the search for better post-operative pain relief after laparoscopic colorectal surgery. In several cadaveric studies of the TQL, a spread of dye into the thoracic paravertebral space, the intercostal spaces, and even the thoracic sympathetic trunk was reported. Given the advantage of possibly reaching the thoracic paravertebral space, the potential to reach nerves transmitting visceral pain, and the possible coverage of dermatomes T4 to L1, these researchers hypothesized that the TQL would provide superior post-operative analgesia for laparoscopic colorectal surgery as compared to PCA with IV morphine alone. These researchers described the protocol of a prospective, double-blind, randomized placebo-controlled trial that examine the use of TQL block for laparoscopic colorectal surgery. A total of 150 patients undergoing laparoscopic colorectal surgery will be included. Patients will be randomly allocated to 2 different analgesic strategies: a bilateral TQL with 30-ml ropivacaine 0.375 % each on both sides, administered before induction of anesthesia, plus post-operative PCA with IV morphine (TQL group, n = 75), or a bilateral TQL block with 30-ml saline each on both sides plus post-operative PCA with IV morphine (placebo group, n = 75). The primary outcome parameter will be the morphine consumption during the first 24 hours post-surgery. Secondary endpoints include pain intensity as assessed with the NRS for pain, time to return of intestinal function (defined as the time to first flatus and the time to the first post-operative intake of solid food), time to first mobilization, the incidence of post-operative nausea and vomiting during the first 24 hours, LOS on the PACU and in the hospital, the extent of sensory block at 2 time-points (admission to and discharge from the PACU), the doses of IV morphine as requested by the patient from the PCA pump, the total dosage of morphine administered IV, the need for and dose of rescue analgesics (ketamine, clonidine), free plasma ropivacaine levels after induction and at discharge from the PACU, and the incidence of AEs during treatment (in particular, signs of local anesthetic systemic toxicity (LAST)). Epidural analgesia is no longer the SOC for post-operative analgesia in laparoscopic colorectal surgery. Until now, the most effective analgesic strategy in these patients especially in an enhanced recovery program is still unknown. Several abdominal wall blocks (TAP, fascia transversalis plane block) are known to have an analgesic effect only on somatic pain. Recognizing the importance of procedure-specific pain management, these researchers aim to examine if a trans-muscular quadratus lumborum block would deliver superior pain control in comparison to PCA with IV morphine alone.

Singh et al (2024) noted that the incidence of acute post-sternotomy pain after cardiac surgery is 80 %. Pecto-intercostal fascial plane block (PIFB) adjacent to the sternum anesthetizes the anterior cutaneous branches of the inter-costal nerves and may provide effective analgesia after sternotomy. This was a prospective, double-blinded, randomized controlled, comparative trial conducted at a tertiary care center on patients of mid-line sternotomy between 18 and 65 years of age, and NYHA Class 2 and 3 for open cardiac surgery with the primary objective to examine analgesia on deep breathing after 3 hours of PIFB block bilaterally. A total of 60 patients were enrolled and randomly divided into 3 groups. PIFB was administered bilaterally before extubation, with 15 ml 0.125 % bupivacaine plain (Group B), and bupivacaine + clonidine 0.25 mcg/kg (Group B+C). Group C did not receive any intervention. All patients received acetaminophen 1 g thrice-daily and injectable tramadol 1 mg/kg as a rescue analgesic. Baseline characteristics were similar among all the groups. The Numeric Rating Scale (NRS) for pain was statistically lower ($p < 0.05$) in Groups B and B+C compared to Group C at rest, deep breathing, and coughing at 3, 6, and 12 hours after extubation. NRS on deep breathing in Groups B, B+C, and C was {(2.3, 1.5, 4.4) at 3 hours, (2.3, 1.6, 4.3) at 6 hours, (2.8, 2.1, 3.9) at 12 hours, and {(4.3, 3.5, 3.6)} at 24 hours after extubation. The peak expiratory flow-rate was the highest in Group B. Rescue analgesia was not required in Group B. The authors concluded that PIFB decreased sternotomy pain compared to the control group on deep breathing at 3 hours after block, with delayed requirement of rescue analgesia and improved respiratory mechanics in terms of peak expiratory flow rate at all time-points; however, there was no benefit from adding clonidine. These researchers stated that this trial was small and not powered for secondary outcomes. Sedation score, time to discharge from ICU, early mobilization, chronic pain, and respiratory failure were not assessed. Moreover, these researchers stated that further investigations with catheters for prolonged analgesia should be carried out.

Jayakrishnan et al (2024) noted that the ESPB is a novel regional anesthesia technique compared to the thoracic paravertebral block (TPVB) in providing post-operative pain relief in breast surgeries. Modified radical mastectomy (MRM) is a commonly performed surgery for breast cancer. In a prospective, randomized, single-center study, these researchers compared the effectiveness of ESPB and TPVB in providing post-operative pain relief following MRM. This trial was carried out in a tertiary care teaching hospital. A total of 60 ASA I-III adult patients (age of over 18 years) scheduled to undergo elective unilateral MRM for breast cancer were enrolled in the study. US-guided ESPB or TPVB with 0.25 % bupivacaine was carried out pre-operatively on the patients randomized into 2 groups, namely, the ESPB and TPVB groups. All participants received PCA for post-operative pain relief. Morphine consumption and VAS for pain were recorded at 3, 6, 12, and 24 hours post-operatively. Primarily, the mean post-operative VAS scores between the 2 groups at 3, 6, 12, and 24 hours showed no statistical significance and were comparable when matched at different time-points; however, 24-hour morphine consumption was significantly more in the ESPB group ($p = 0.035$). Duration of block performance also showed a significant difference, with ESPB taking less time to perform ($p < 0.001$). The mean age and BMI of patients and hospital LOS in both the groups were similar. The authors concluded that both ESPB and TPVB provided adequate analgesia in patients undergoing MRM; however, TPVB had better effectiveness and opioid-sparing effect when compared to ESPB. Moreover, these researchers stated that a multi-center trial with a larger sample size could provide more meaningful clinical outcomes and guide as to which modality of pain relief is better in breast surgeries.

The authors stated that the main drawback of this trial was that it was a single-center study with a small sample size (n = 60). In addition, these investigators did not examine the block's effectiveness before surgery nor the basal pain threshold of the patients. They were aware of the randomization, even though the individuals were unaware of the treatment group assignment. Another drawback was that surgeries like mastectomies, reconstructive surgeries, and so on were not included in this study. Furthermore, the outcomes of this study were only relevant to the particular local anesthetic type, concentration, and volume used. Different surgical procedures (e.g., mastectomy), block techniques, administration approaches, and use of additives may alter the results.

Luo et al (2024) noted that unilateral or bilateral anterolateral thoracotomy may result in severe acute pain in lung transplantation (LTx) recipients. Although serratus anterior plane block (SAPB) is apparently effective for pain control following open thoracic surgery, there remains a lack of evidence for the application of SAPB for post-operative analgesia following LTx. In a case-series, pilot study, these researchers described the feasibility of continuous SAPB after LTx and provided a preliminary investigation of its safety and effectiveness. After chest incisions closure was complete, all patients underwent US-guided SAPB with catheter insertion. NRS, additional opioid consumption, time to endotracheal tube removal, ICU-LOS, and catheter-related AEs were followed-up and recorded for each patient within 1 week after the procedure. A total of 14 patients who received LTx at this center from August 2023 to November 2023 were included. All patients received anterolateral approaches, and 10 (71.4 %) of them underwent bilateral LTx. The duration of catheter placement was 2 (2 to 3) days, and the resting NRS during catheter placement was equal to or less than 4. A total of 11 patients (78.6 %) were supported by extra-corporeal membrane oxygenation (ECMO) in LTx, whereas 8 patients (57.1 %) removed the tracheal tube on the 1st day after LTx. Intensive care unit (LOS was 5 (3 to 6) days, with tracheal intubation retained for 1 (1 to 2) days, and only 1 patient was reintubated. The morphine equivalent dose (MED) in the 1st week after LTx was 11.95 mg, and no catheter-related AEs were detected. The authors concluded that although continuous SAPB may be a safe and effective fascial block technique for relieving acute pain after LTx, it should be confirmed by high-quality clinical studies. These researchers noted that they did not examine the sensory loss plane due to the retrospective design. Additionally, differences in catheter placement time may lead to bias in pain assessment.

Yang et al (2024) stated that the ESPB is widely used in various thoraco-lumbar surgeries. It has unique advantages: simple and convenient operation, low safety risks, and reduced opioid use. The ESPB is used in thoracic surgery, abdominal surgery, and spinal surgery. There are also relevant research reports on post-operative analgesia during general anesthesia surgery. These investigators searched the PubMed and Web of Science data-bases to find and screen relevant studies on ESPB since 2019 and retrospectively summarized the current indications of ESPB. The methodological quality of the included studies was assessed using the Cochrane bias risk tool. The results showed that the current research on ESPB generally provides low-level clinical evidence. The complex anatomy of the erector spinae muscles is both responsible for its unique advantages and restricts its development. Few anatomical studies have clearly and completely demonstrated the diffusion relationship of local anesthetics among the anatomical structures of the erector spinal muscles. The uncontrollability of the diffusion plane prevents ESPB from being applied on a wider scale with a high level of evidence. These investigators stated that to further clarify the scope of application of ESPB and achieve the best analgesic effect, in the future, researchers should focus on the unique anatomical course and distribution of the erector spinal muscles and their fascia and nerves. It is necessary to combine anatomical, imaging, and histological methods to obtain high-quality evidence to guide clinical application.

References

The above policy is based on the following references:

1. Abdallah FW, Brull R, Joshi GP, et al. Pain management for ambulatory arthroscopic anterior cruciate ligament reconstruction: Evidence-based recommendations from the Society for Ambulatory Anesthesia. Anesth Analg. 2019;128(4):631-640.
2. Abdallah FW, Halpern SH, Aoyama K, Brull R. Will the real benefits of single-shot interscalene block please stand up? A systematic review and meta-analysis. Anesth Analg. 2015;120(5):1114-1129.
3. Abou-Setta AM, Beaupre LA, Jones CA, et al. Pain management interventions for hip fracture. AHRQ Comparative Effectiveness Reviews. Report No.: 11-EHC022-EF. Rockville (MD): Agency for Healthcare Research and Quality (US); May 2011
4. Abram SE. Neural blockade for neuropathic pain. Clin J Pain. 2000;16(2 Suppl):S56-S61.
5. Adıguzel SC, Akyurt D, Altun HB, et al. Posterior quadratus lumborum block or thoracolumbar interfascial plane block and postoperative analgesia after spinal surgery: A randomized controlled trial. J Clin Med. 2023;12(23):7217.
6. Aguirre J, Del Moral A, Cobo I, et al. The role of continuous peripheral nerve blocks. Anesthesiol Res Pract. 2012;2012:560879.
7. Ahmed A, Arora D. Fluoroscopy-guided neurolytic splanchnic nerve block for intractable pain from upper abdominal malignancies in patients with distorted celiac axis anatomy: An effective alternative to celiac plexus neurolysis - A retrospective study. Indian J Palliat Care 2017;23(3):274-281.
8. Ahuja D, Kumar V, Gupta N, et al. Comparison of the efficacy of ultrasoundGuided serratus anterior plane block versus erector spinae plane block for postoperative analgesia after modified radical mastectomy: A randomised controlled trial. Turk J Anaesthesiol Reanim. 2022;50(6):435-442.
9. Alilet A, Petit P, Devaux B, et al. Ultrasound-guided intermediate cervical block versus superficial cervical block for carotid artery

endarterectomy: The randomized-controlled CERVECHO trial. Anaesth Crit Care Pain Med. 2017;36(2):91-95.

10. Aliste J, Bravo D, Finlayson RJ, Tran DQ. A randomized comparison between interscalene and combined infraclavicular-suprascapular blocks for arthroscopic shoulder surgery. Can J Anaesth 2018;65(3):280-287.
11. Allard C, Pardo E, de la Jonquière C, et al. Comparison between femoral block and PENG block in femoral neck fractures: A cohort study. PLoS One. 2021;16(6):e0252716.
12. Altıparmak B, Korkmaz Toker M,Uysal Aİ, et al. Comparison of the effects of modified pectoral nerve block and erector spinae plane block on postoperative opioid consumption and pain scores of patients after radical mastectomy surgery: A prospective, randomized, controlled trial. J Clin Anesth. 2019;54:61-65.
13. Alver S, Bahadir C, Tahta AC, et al. The efficacy of ultrasound-guided anterior quadratus lumborum block for pain management following lumbar spinal surgery: A randomized controlled trial. BMC Anesthesiol. 2022;22(1):394.
14. Alzeftawy AE, Elsheikh NA. The effect of preemptive ankle block using ropivacaine and dexamethasone on postoperative analgesia in foot surgery. Anesth Essays Res. 2017;11(2):372-375.
15. Ambrosini A, Vandenheede M, Rossi P, et al. Suboccipital injection with a mixture of rapid- and long-acting steroids in cluster headache: A double-blind placebo-controlled study. Pain. 2005;118(1-2):92-6.
16. American Society of Anesthesiologists Task Force on Chronic Pain Management, American Society of Regional Anesthesia and Pain Medicine. Practice guidelines for chronic pain management: An updated report by the American Society of Anesthesiologists Task Force on Chronic Pain Management and the American Society of Regional Anesthesia and Pain Medicine. Anesthesiology 2010;112(4):810-833.
17. Amini R, Patricia Javedani P, Amini A, Adhikari S. Ultrasound-guided forearm nerve blocks: A novel application for pain control in adult patients with digit injuries. Case Rep Emerg Med. 2016;2016:2518596.
18. Andersen HL, Gyrn J, Moller L, et al. Continuous saphenous nerve block as supplement to single-dose local infiltration analgesia for

postoperative pain management after total knee arthroplasty. Reg Anesth Pain Med. 2013;38(2):106-111.
19. Androulakis XM, Krebs KA, Ashkenazi A, et al. Hemicrania continua may respond to repetitive sphenopalatine ganglion block: A case report. Headache. 2016;56(3):573-579.
20. Aprato A, Audisio A, Santoro A, et al. Fascia-iliaca compartment block vs intra-articular hip injection for preoperative pain management in intracapsular hip fractures: A blind, randomized, controlled trial. Injury. 2018;49(12):2203-2208.
21. Aranki S, Maltais S, Toeg HD. Coronary artery bypass surgery: Perioperative medical management. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed August 2023.
22. Ashkenazi A, Blumenfeld A, Napchan U, et al; Interventional Procedures Special Interest Section of the American. Peripheral nerve blocks and trigger point injections in headache management - a systematic review and suggestions for future research. Headache. 2010;50(6):943-952.
23. Bailey L, Griffin J, Elliott M, et al. Adductor canal nerve versus femoral nerve blockade for pain control and quadriceps function following anterior cruciate ligament reconstruction with patellar tendon autograft: A prospective randomized trial. Arthroscopy. 2019;35(3):921-929.
24. Bajwa ZH, Smith JH. Acute treatment of migraine in adults. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed February 2017.
25. Bajwa ZH, Smith JH. Preventive treatment of migraine in adults. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed May 2017.
26. Bak H, Bang S, Yoo S, et al. The continuous quadratus lumborum block for multimodal analgesia after total hip arthroplasty. Korean J Anesthesiol. 2020;73(2):158-162.
27. Bang S, Chung K, Chung J, et al. The erector spinae plane block for effective analgesia after lung lobectomy: Three cases report. Medicine (Baltimore). 2019;98(29):e16262.
28. Bansal L, Attri JP, Verma P. Lower limb surgeries under combined femoral and sciatic nerve block. Anesth Essays Res. 2016;10(3):432-436.
29. Barmherzig R, Kingston W. Occipital neuralgia and cervicogenic headache: Diagnosis and management. Curr Neurol Neurosci

Rep. 2019;19(5):20.

30. Barto A, Robson KM. Proctalgia fugax. UpToDate [online serial], Waltham, MA: UpToDate; reviewed August 2024.
31. Bauer MC, Pogatzki-Zahn EM, Zahn PK. Regional analgesia techniques for total knee replacement. Curr Opin Anaesthesiol. 2014;27(5):501-506.
32. Behrends M, Yap EN, Zhang AL, et al. Preoperative fascia iliaca block does not improve analgesia after arthroscopic hip surgery, but causes quadriceps muscles weakness: A randomized, double-blind trial. Anesthesiology. 2018;129(3):536-543.
33. Bellantonio D, Bolondi G, Cultrera F, et al. Erector spinae plane block for perioperative pain management in neurosurgical lower-thoracic and lumbar spinal fusion: A single-centre prospective randomised controlled trial. BMC Anesthesiol. 2023;23(1):187.
34. Bjorn S, Wong WY, Baas J, et al. The importance of the saphenous nerve block for analgesia following major ankle surgery: A randomized, controlled, double-blind study. Reg Anesth Pain Med. 2018;43(5):474-479.
35. Blumenfeld A, Ashkenazi A, Napchan U, et al. Expert consensus recommendations for the performance of peripheral nerve blocks for headaches–a narrative review. Headache. 2013;53(3):437-46.
36. Bril V, England JD, Franklin GM, et al; American Academy of Neurology; American Asociation of Neuromuscular and Electrodiagnostic Medicine; American Academy of Physical Medicine and Rehabilitation. Evidence-based guideline: Treatment of painful diabetic neuropathy – report of the American Association of Neuromuscular and Electrodiagnostic Medicine, the American Academy of Neurology, and the American Academy of Physical Medicine & Rehabilitation. Muscle Nerve. 2011;43(6):910-917.
37. Brooks DC. Overview of abdominal wall hernias in adults. UpToDate [online serial], Waltham, MA: UpToDate; reviewed August 2024.
38. Brooks DC. Overview of treatment for inguinal and femoral hernia in adults. UpToDate [oneline serial]. Waltham, MA: UpToDate; reviewed July 2023.
39. Brooks DC, Petro CC. Management of ventral hernias. UpToDate [online serial], Waltham, MA: UpToDate; reviewed August 2024.

40. Buchbinder R. Plantar fasciitis. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed August 2020; July 2022.
41. Buttner J, Meier G. Regional anesthesia – approaches to the brachial plexus. Anasthesiol Intensivmed Notfallmed Schmerzther. 2006;41(7-8):491-497.
42. Cai L, Song Y, Wang Z, et al. The efficacy of fascia iliaca compartment block for pain control after hip arthroplasty: A meta-analysis. Int J Surg. 2019;66:89-98.
43. Cass SP. Ultrasound-guided nerve hydrodissection: What is it? A review of the literature. 2016;15(1):20-22.
44. Chan EY, Fransen M, Parker DA, et al. Femoral nerve blocks for acute postoperative pain after knee replacement surgery. Cochrane Database Syst Rev. 2014;5:CD009941.
45. Chetty S, Baalbergen E, Bhigjee AI, et al; South African Expert Panel. Clinical practice guidelines for management of neuropathic pain: Expert panel recommendations for South Africa. S Afr Med J. 2012;102(5):312-325.
46. Chin KJ, Adhikary S, Sarwani N, Forero M. The analgesic efficacy of pre-operative bilateral erector spinae plane (ESP) blocks in patients having ventral hernia repair. Anaesthesia. 2017;72(4):452-460.
47. Choi I, Jeon SR. Neuralgias of the head: Occipital neuralgia. J Korean Med Sci. 2016;31(4):479-488.
48. Chou R. Subacute and chronic low back pain: Nonpharmacologic and pharmacologic treatment. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed August 2020a.
49. Chou R. Subacute and chronic low back pain: Nonsurgical interventional treatment. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed August 2020b; July 2023.
50. Chou R, Hashimoto R, Friedly J, et al. Pain Management Injection Therapies for Low Back Pain [Internet]. Rockville, MD: Agency for Healthcare Research and Quality; 2015.
51. Chou R, Loeser J, Owens D, et al. Interventional therapies, surgery, and interdisciplinary rehabilitation for low back pain - an evidence-based clinical practice guideline from the American Pain Society. Spine. 2009;34:1066-1077.
52. Chou R, Qaseem A, Snow V, et al. Clinical Efficacy Assessment Subcommittee of the American College of Physicians, American College of Physicians, American Pain Society Low Back Pain

Guidelines Panel. Diagnosis and treatment of low back pain: A joint clinical practice guideline from the American College of Physicians and the American Pain Society. Ann Intern Med. 2007;147:478–491.

53. Chung KC, Yoneda H. Upper extremity amputation. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2022.
54. Coppens S, Rex S, Fieuws S, et al. Trans muscular quadratus lumborum (TQL) block for laparoscopic colorectal surgery: Study protocol for a double-blind, prospective randomized placebo-controlled trial. Trials. 2020;21(1):581.
55. Cortijo E, Guerrero-Peral AL, Herrero-Velázquez S, et al. Hemicrania continua: characteristics and therapeutic experience in a series of 36 patients. Rev Neurol. 2012;55(5):270-278.
56. Cowan RP. Intractable headache. Mt Royal, NJ: American Migraine Foundation; 2016. Available at https://americanmigrainefoundation.org/understanding-migraine/intractable-headache/. Accessed September 9, 2017.
57. Cuadrado ML, Aledo-Serrano Á, Navarro P, et al. Short-term effects of greater occipital nerve blocks in chronic migraine: A double-blind, randomised, placebo-controlled clinical trial. Cephalalgia. 2017;37(9):864-872.
58. Cui Y-Y, Xu Z-Q, Hou H-J, et al. Transversus thoracic muscle plane block for postoperative pain in pediatric cardiac surgery: A systematic review and meta-analysis of randomized and observational studies. J Cardiothorac Vasc Anesth. 2024;38(5):1228-1238.
59. Dach F, Eckeli AL, Ferreira Kdos S, Speciali JG. Nerve block for the treatment of headaches and cranial neuralgias - a practical approach. Headache. 2015;55 Suppl 1:59-71.
60. David WS. Meralgia paresthetica (lateral femoral cutaneous nerve entrapment). UpToDate [online serial]. Waltham, MA: UpToDate; reviewed September 2020.
61. Day M, Pasupuleti R, Jacobs S. Infraclavicular brachial plexus block and infusion for treatment of long-standing complex regional syndrome type 1: A case report. Pain Physician. 2004;7(2):265-268.
62. De Keyser F. Ganglion cysts of the wrist and hand. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed August 2020.

63. Del Buono R, Padua E, Pascarella G, et al. Continuous PENG block for hip fracture: A case series. Reg Anesth Pain Med. 2020;45(10):835-838.
64. del Castillo AM, Zamorano P. Management and prognosis of surgical aortic and mitral prosthetic valve regurgitation. UpToDate [online serial], Waltham, MA: UpToDate; reviewed August 2024.
65. DelPizzo K, Fiasconaro M, Wilson LA, et al. The utilization of regional anesthesia among pediatric patients: A retrospective study. HSS J. 2020;16(Suppl 2):425-435.
66. DemIr Y, Guzelkucuk U, Tezel K, et al. A different approach to the management of osteoarthritis in the knee: Ultrasound guided genicular nerve block. Pain Med. 2017;18(1):181-183.
67. Demirsoy MS, Erdil A, Tümer MK. Evaluation of the efficacy of auriculotemporal nerve block in temporomandibular disorders. J Oral Facial Pain Headache. 2021;35(4):326-331.
68. Desmet M, Balocco AL, Van Belleghem V. Fascia iliaca compartment blocks: Different techniques and review of the literature. Best Pract Res Clin Anaesthesiol. 2019;33(1):57-66.
69. Deveza LA. Overview of the management of osteoarthritis. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2021.
70. Dhillon VK. Superior laryngeal nerve block for neurogenic cough: A case series. Laryngoscope Investig Otolaryngol. 2019;4(4):410-413.
71. Diakomi M, Papaioannou M, Georgoudis G, et al. The impact of fascia iliaca compartment block on chronic postsurgical pain in patients undergoing hip fracture repair. J Clin Anesth. 2020;64:109801.
72. Dilli E, Halker R, Vargas B, et al. Occipital nerve block for the short-term preventive treatment of migraine: A randomized, double-blinded, placebo-controlled study. Cephalalgia. 2015;35(11):959-68.
73. Diwan S, Koh WU, Chin KJ, Nair A. Bilateral high thoracic continuous erector spinae plane blocks for postoperative analgesia in a posterior cervical fusion. Saudi J Anaesth. 2020;14(4):535-537.
74. Drossopoulos PN, Sharma A, Ononogbu-Uche FC, et al. Pushing the limits of minimally invasive spine surgery -- From

preoperative to intraoperative to postoperative management. J Clin Med. 2024;13(8):2410.

75. Dufour E, Donat N, Jaziri S, et al. Ultrasound-guided perineural circumferential median nerve block with and without prior dextrose 5% hydrodissection: A prospective randomized double-blinded noninferiority trial. Anesth Analg. 2012;115(3):728-733.
76. Dupont JS, Jr. The prevalence of trigeminal neuritis with TMD. Cranio. 2003;21(3):180-184.
77. Eker HE, Cok OY, Aribogan A, Arslan G. Management of neuropathic pain with methylprednisolone at the site of nerve injury. Pain Med. 2012;13(3):443-451.
78. Eker HE, Yalcın Cok O, Acıl M, et al. Modified van-Lint technique for the management of postherpetic neuralgia: Case report. Agri. 2011;23(2):84-87.
79. El-Boghdadly K, Madjdpour C, Chin KJ. Thoracic paravertebral blocks in abdominal surgery - a systematic review of randomized controlled trials. Br J Anaesth. 2016;117(3):297-308.
80. Elkassabany N, Cai LF, Mehta S, et al. Does regional anesthesia improve the quality of postoperative pain management and the quality of recovery in patients undergoing operative repair of tibia and ankle fractures? J Orthop Trauma. 2015;29(9):404-409.
81. Elkins N, Hunt J, Scott KM. Neurogenic pelvic pain. Phys Med Rehabil Clin N Am. 2017;28(3):551-569.
82. Enneking K, Le-Wendling L, Ihnatsenka B. Anesthesia for orthopedic trauma. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2021.
83. Ermis MN, Yildirim D, Durakbasa MO, et al. Medial superior cluneal nerve entrapment neuropathy in military personnel; diagnosis and etiologic factors. J Back Musculoskelet Rehabil. 2011;24(3):137-144.
84. Eskandr A, Mahmoud K, Kasemy Z, et al. A comparative study between ultrasound-guided thoracic paravertebral block, pectoral nerves block, and erector spinae block for pain management in cancer breast surgeries. A randomized controlled study. Rev Esp Anestesiol Reanim (Engl Ed). 2022;69(10):617-624.
85. Fader RR, Mitchell JJ, Chadayammuri VP, et al. Percutaneous ultrasound-guided hydrodissection of a symptomatic sural neuroma. Orthopedics. 2015;38(11):e1046-e1050.

86. Fadhlillah F, Chan D, Pelosi P, Rubulotta F. Systematic review and meta-analysis of single injection fascia iliaca blocks in the peri-operative management of patients with hip fractures. Minerva Anestesiol. 2019;85(11):1211-1218.
87. Favejee MM, Huisstede BMA, Koes BW. Frozen shoulder: The effectiveness of conservative and surgical interventions – systematic review. Br J Sports Med. 2011;45(1):49-56.
88. Fazio SB, Yosipovitch G. Pruritus: Therapies for localized pruritus. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2022.
89. Feldman EL, McCulloch DK. Treatment of diabetic neuropathy. UpToDate [serial online]. Waltham, MA: UpToDate; reviewed November 2012.
90. Feriani G, Hatanaka E, Torloni MR, da Silva EM. Infraorbital nerve block for postoperative pain following cleft lip repair in children. Cochrane Database Syst Rev. 2016;4:CD011131.
91. Ferrer Gomez C, Puig Bitria R, Boada Pie S, et al. Oral analgesia versus posterior tibial nerve block for postoperative pain in ambulatory open hallux valgus surgery: A randomized clinical trial. Rev Esp Anestesiol Reanim. 2006;53(4):220-225.
92. Fitzgerald CA, Cao S, Zone AI, et al. Comparison of erector spinae plane blocks versus multimodal pain management for traumatic rib fractures: A matched cohort study. J Surg Res. 2024;294:122-127.
93. Forero M, Rajarathinam M, Adhikary S, Chin KJ. Erector spinae plane (ESP) block in the management of post thoracotomy pain syndrome: A case series. Scand J Pain. 2017;17:325-329.
94. Forster KW. Overview of common hip fractures in adults. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed August 2020.
95. Foye PM. Coccydynia (coccygodynia). UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2023; August 2024.
96. Fredrickson MJ, Danesh-Clough TK. Spinal anaesthesia with adjunctive intrathecal morphine versus continuous lumbar plexus blockade: A randomised comparison for analgesia after hip replacement. Anaesth Intensive Care. 2015;43(4):449-453.
97. Fu H, Zhong C, Fu Y, et al. Perioperative analgesic effects of preemptive ultrasound-guided rectus sheath block combined with butorphanol or sufentanil for single-incision laparoscopic

cholecystectomy: A prospective, randomized, clinical trial. J Pain Res. 2020;13:1193-1200.

98. Fu M-Y, Hao J, Ye L-H, et al, Efficacy and safety of erector spinae plane block for perioperative pain management in lumbar spinal surgery: A systematic review and meta-analysis of randomized controlled trials. J Pain Res. 2023;16:1453-1475.
99. Fujii S, Roche M, Jones PM, et al. Transversus thoracis muscle plane block in cardiac surgery: A pilot feasibility study. Reg Anesth Pain Med. 2019;44(5):556-560.
100. Garza I. Occipital neuralgia. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2021.
101. Garza I, Schwedt TJ. Chronic migraine. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed August 2020a.
102. Garza I, Schwedt TJ. Hemicrania continua. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed August 2020b.
103. Ghabraei S, Shubbar A, Nekoofar MH, Nosrat A. Anesthetic efficacy of mental/incisive nerve block compared to inferior alveolar nerve block using 4 % articaine in mandibular premolars with symptomatic irreversible pulpitis: A randomized clinical trial. Clin Oral Investig. 2019;23(2):839-845.
104. Giron-Arango L, Peng PWH, Chin KJ, et al. Pericapsular nerve group (PENG) block for hip fracture. Reg Anesth Pain Med. 2018;43(8):859-863.
105. Goldstein RY, Montero N, Jain SK, et al. Efficacy of popliteal block in postoperative pain control after ankle fracture fixation: A prospective randomized study. J Orthop Trauma. 2012;26(10):557-561.
106. Goldstein RY, Park JH, Jain S, Tejwani N. The impact of popliteal block on postoperative medication administration and time to discharge from the post-anesthesia care unit. Bull Hosp Jt Dis (2013). 2015;73(1):37-41.
107. Gonzalez Sotelo V, Maculée F, Minguell J, et al. Ultrasound-guided genicular nerve block for pain control after total knee replacement: Preliminary case series and technical note. Rev Esp Anestesiol Reanim. 2017;64(10):568-576.
108. Goshima K. Overview of thoracic outlet syndrome. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed August 2020.
109. Govindappagari S, Grossman TB, Dayal AK, et al. Peripheral nerve blocks in the treatment of migraine in pregnancy. Obstet

Gynecol. 2014;124(6):1169-1174

110. Gray AJ, Hoffman MR, Yang ZM, et al. Indications and short-term outcomes for in-office therapeutic superior laryngeal nerve block. Ann Otol Rhinol Laryngol. 2024;133(2):174-180.
111. Griffen FD. Open surgical repair of inguinal and femoral hernia in adults. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2023.
112. Guerrero AL, Herrero-Velazquez S, Penas ML, et al. Peripheral nerve blocks: A therapeutic alternative for hemicrania continua. Cephalalgia. 2012;32(6):505-508.
113. Guidelines for Chronic Pain Management: An Updated Report by the American Society of Anesthesiologists Task Force on Chronic Pain Management and the American Society of Regional Anesthesia and Pain Medicine. Anesthesiology. 2010;112(4):810-833.
114. Guilfoyle MR, Helmy A, Duane D, Hutchinson PJA. Regional scalp block for postcraniotomy analgesia: A systematic review and meta-analysis. Anesth Analg. 2013;116(5):1093-1102.
115. Gul HL, Ozon AO, Karadas O, et al. The efficacy of greater occipital nerve blockade in chronic migraine: A placebo-controlled study. Acta Neurol Scand. 2017;136(2):138-144.
116. Gupta D, Jain R, Mishra S, et al. Ultrasonography reinvents the originally described technique for ganglion impar neurolysis in perianal cancer pain. Anesth Analg. 2008;107(4):1390-1392. https://pubmed.ncbi.nlm.nih.gov/18806057/.
117. Gupta M, Naithani U, Singariya G, Gupta S. Comparison of 0.25% ropivacaine for intraperitoneal instillation v/s rectus sheath block for postoperative pain relief following laparoscopic cholecystectomy: A prospective study. J Clin Diagn Res. 2016;10(8):UC10-UC15.
118. Gupta N, Garg R, Saini S, et al. An unusual complication after ganglion impar block for chronic cancer pain management. AANA J. 2017;85(6):424-426.
119. Gurkan Y, Aksu C, Kuş A, et al. Ultrasound guided erector spinae plane block reduces postoperative opioid consumption following breast surgery: A randomized controlled study. J Clin Anesth. 2018;50:65-68.
120. Gutierrez JJP, Ben-David B, Rest C, et al. Quadratus lumborum block type 3 versus lumbar plexus block in hip replacement

surgery: A randomized, prospective, non-inferiority study. Reg Anesth Pain Med. 2021;46(2):111-117.

121. Hakim TA, Shah AA, Teli Z, et al. The safety and effectiveness of superficial cervical plexus block in oral and maxillofacial surgery as an alternative to general anesthesia in selective cases: A clinical study. J Maxillofac Oral Surg. 2019;18(1):23-29.
122. Hamed MA, Abdelhady MA, Hassan AASM, Boules ML. The analgesic effect of ultrasound-guided bilateral pectointercostal fascial plane block on sternal wound pain after open heart surgeries: A randomized controlled study. Clin J Pain. 2022;38(4):279-284.
123. Hamilton TW, Athanassoglou V, Trivella M, et al. Liposomal bupivacaine peripheral nerve block for the management of postoperative pain. Cochrane Database Syst Rev. 2016;8:CD011476.
124. Hanling SR, Hickey A, Lesnik I, et al. Stellate ganglion block for the treatment of posttraumatic stress disorder: A randomized, double-blind, controlled trial. Reg Anesth Pain Med. 2016;41(4):494-500.
125. Hannig KE, Jessen C, Soni UK, et al. Erector spinae plane block for elective laparoscopic cholecystectomy in the ambulatory surgical setting. Case Rep Anesthesiol. 2018;2018:5492527.
126. Hartemann A, Attal N, Bouhassira D, et al; Working Group on the Diabetic Foot from the French-speaking Society of Diabetology. Painful diabetic neuropathy: Diagnosis and management. Diabetes Metab. 2011;37(5):377-388.
127. Hartigan C, Bernard KK. Exercise-based therapy for low back pain. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed August 2020.
128. Hascalovici JR, Robbins MS. Peripheral nerve blocks for the treatment of headache in older adults: A retrospective study. Headache. 2017;57(1):80-86.
129. He J, Zheng XQ, Luo CH, et al. Effects and safety of quadratus lumborum block in analgesia after hip arthroplasty. Zhonghua Yi Xue Za Zhi. 2018;98(8):565-569.
130. Herring A, Price D, Nagdev A, Simon B. Superior cluneal nerve block for treatment of buttock abcesses in the emergency department. J Emerg Med. 2010;39(1):83-85.

131. Ho B, De Paoli M. Use of ultrasound-guided superficial cervical plexus block for pain management in the emergency department. J Emerg Med. 2018;55(1):87-95.
132. Hunter AA, Simmons BP. Surgery for carpal tunnel syndrome. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2023.
133. Hussain N, Costache I, Kumar N, et al. Is supraclavicular block as good as interscalene block for acute pain control following shoulder surgery? A systematic review and meta-analysis. Anesth Analg. 2020;130(5):1304-1319.
134. Hussain N, Goldar G, Ragina N, et al. Suprascapular and interscalene nerve block for shoulder surgery: A systematic review and meta-analysis. Anesthesiology. 2017;127(6):998-1013.
135. Huynh TM, Marret E, Bonnet F. Combination of dexamethasone and local anaesthetic solution in peripheral nerve blocks: A meta-analysis of randomised controlled trials. Eur J Anaesthesiol. 2015;32(11):751-758.
136. Ilfeld BM, Moeller-Bertram T, Hanling SR, et al. Treating intractable phantom limb pain with ambulatory continuous peripheral nerve blocks: A pilot study. Pain Med. 2013;14(6):935-942.
137. Inan LE, Inan N, Karadaş Ö, et al. Greater occipital nerve blockade for the treatment of chronic migraine: A randomized, multicenter, double-blind, and placebo-controlled study. Acta Neurol Scand. 2015;132(4):270-7.
138. Ivanec Z, Mazul-Sunkol B, Lovricevic I, et al. Superficial versus combined (deep and superficial) cervical plexus block for carotid endarterectomy. Acta Clin Croat. 2008;47(2):81-86.
139. Iwata M, Kuzumoto N, Kmoto K, et al. Effects of RSB and TAPB on postoperative pain in laparoscopic cholecystectomy. Masui. 2017;66(2):127-130.
140. Jarrell K, McDonald E, Shakked R, et al. Combined popliteal catheter with single-injection vs continuous-infusion saphenous nerve block for foot and ankle surgery. Foot Ankle Int. 2018;39(3):332-337.
141. Jayakrishnan S, Dua A, Kumar A. Comparison of fascial plane blocks (ESPB vs. TPVB) for pain relief following modified radical mastectomy. J Anaesthesiol Clin Pharmacol. 2024;40(3):410-415.

142. Jeng CL, Rosenblatt MA. Lower extremity nerve blocks: Techniques. UpToDate [online serial]. Waltham, MA. UpToDate; reviewed August 2020.
143. Jeng CL, Rosenblatt MA. Overview of peripheral nerve blocks. UpToDate [serial online]. Waltham, MA: UpToDate; reviewed November 2012; June 2017; July 2021a; July 2023.
144. Jeng CL, Rosenblatt MA. Upper extremity nerve blocks: Techniques. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed August 2020; July 2021b.
145. Jeon WH, Park GW, Jeong HJ, Sim YJ. The comparison of effects of suprascapular nerve block, intra-articular steroid injection, and a combination therapy on hemiplegic shoulder pain: Pilot study. Ann Rehabil Med. 2014;38(2):167-173.
146. Jeong H-W, Kim CS, Choi KT, et al. Preoperative versus postoperative rectus sheath block for acute postoperative pain relief after laparoscopic cholecystectomy: A randomized controlled study. J Clin Med. 2019;8(7):1018.
147. Johnson RL, Amundson AW, Abdel MP, et al. Continuous posterior lumbar plexus nerve block versus periarticular injection with ropivacaine or liposomal bupivacaine for total hip arthroplasty: A three-arm randomized clinical trial. J Bone Joint Surg Am. 2017;99(21):1836-1845.
148. Johnston S, Kraus J, Tutton S, Symanski J. Ultrasound-guided diagnostic deep peroneal nerve blocks prior to potential neurectomy: A retrospective review. Skeletal Radiol. 2020;49(8):1313-1321.
149. Kalthoff A, Sanda M, Tate P, et al. Peripheral nerve blocks outperform general anesthesia for pain control in arthroscopic rotator cuff repair: A systematic review and meta-analysis. Arthroscopy. 2022;38(5):1627-1641.
150. Kamei H, Ishibashi N, Nakayama G, et al. Ultrasound-guided rectus sheath block for single-incision laparoscopic cholecystectomy. Asian J Endosc Surg. 2015;8(2):148-152.
151. Kapoor V, Rothfus WE, Grahovac SZ, et al. Refractory occipital neuralgia: Preoperative assessment with CT-guided nerve block prior to dorsal cervical rhizotomy. AJNR Am J Neuroradiol. 2003;24(10):2105-2110.
152. Karadas O, Ozon AO, Ozcelik F, et al. Greater occipital nerve block in the treatment of triptan-overuse headache: A

randomized comparative study. Acta Neurol Scand. 2017;135(4):426-433.

153. Karakıs A, Tapar H, Ozsoy Z, et al. Perioperative analgesic efficacy of bilateral superficial cervical plexus block in patients undergoing thyroidectomy: A randomized controlled trial. Rev Bras Anestesiol. 2019;69(5):455-460.
154. Kashipazha D, Nakhostin-Mortazavi A, Mohammadianinejad SE, et al. Preventive effect of greater occipital nerve block on severity and frequency of migraine headache. Glob J Health Sci. 2014;6(6):209-13.
155. Khosla A, Adeyefa O, Nasir S. Successful treatment of radiation-induced proctitis pain by blockade of the ganglion impar in an elderly patient with prostate cancer: A case report. Pain Med. 2013;14(5):662-666.
156. Kim DH, Beathe JC, Lin Y, et al. Addition of infiltration between the popliteal artery and the capsule of the posterior knee and adductor canal block to periarticular injection enhances postoperative pain control in total knee arthroplasty: A randomized controlled trial. Anesth Analg. 2019;129(2):526-535
157. Kim D-H, Choi S-S, Yoon S-H, et al. Ultrasound-guided genicular nerve block for knee osteoarthritis: A double-blind, randomized controlled trial of local anesthetic alone or in combination with corticosteroid. Pain Physician. 2018;21(1):41-52.
158. Kim D-H, Lee M-S, Lee S, et al. A prospective randomized comparison of the efficacy of ultrasound- vs fluoroscopy-guided genicular nerve block for chronic knee osteoarthritis. Pain Physician. 2019;22(2):139-146.
159. Kim JE, Lee SG, Kim EJ, et al. Ultrasound-guided lateral femoral cutaneous nerve block in meralgia paresthetica. Korean J Pain. 2011;24(2):115-118.
160. King M, Stambulic T, Servito M, et al. Erector spinae plane block as perioperative analgesia for midline sternotomy in cardiac surgery: A systematic review and meta-analysis. J Card Surg. 2022;37(12):5220-5229.
161. Kinjo S, Kolodzie K, Dong K, Zhang AL. The effects of transmuscular quadratus lumborum blocks on postoperative pain in arthroscopic hip surgery: A cohort analysis. J Anesth. 2019;33(4):516-522.

162. Kir MC, Kir G. Ankle nerve block adjuvant to general anesthesia reduces postsurgical pain and improves functional outcomes in hallux valgus surgery. Med Princ Pract. 2018;27(3):236-240.
163. Kirkpatrick K, Khan MH, Deng Y, Shah KB. A review of stellate ganglion block as an adjunctive treatment modality. Cureus. 2023;15(2):e35174.
164. Kleen JK, Levin M. Injection therapy for headache and facial pain. Oral Maxillofac Surg Clin North Am. 2016;28(3):423-434.
165. Knight CL, Deyo RA, Staiger TO, Wipf JE. Treatment of acute low back pain. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2020.
166. Kojima Y, Sendo R. Jaw manipulation using ultrasound-guided inferior alveolar nerve block for trismus in temporomandibular disorders. Case Rep Dent. 2022;2022:4436893.
167. Kothari S. Neuromodulatory approaches to chronic pelvic pain and coccygodynia. Acta Neurochir Suppl. 2007;97(Pt 1):365-371.
168. Koyyalagunta D, Engle MP, Yu J, et al. The effectiveness of alcohol versus phenol based splanchnic nerve neurolysis for the treatment of intra-abdominal cancer pain. Pain Physician. 2016;19(4):281-292.
169. Krishnan S, Cascella M. Erector spinae plane block. StatPearls [Internet]. Treasure Island, FL: StatPearls Publishing: updated: June 4, 2023. Available at: https://www.ncbi.nlm.nih.gov/books/NBK545305/. Accessed November 13, 2023.
170. Krishna SN, Chauhan S, Bhoi D, et al. Bilateral erector spinae plane block for acute post-surgical pain in adult cardiac surgical patients: A randomized controlled trial. J Cardiothorac Vasc Anesth. 2019;33(2):368-375.
171. Krishnan S, Cascella M. Erector spinae plane block. StatPearls [Internet]. Last updated: June 4, 2023. Available at: https://www.ncbi.nlm.nih.gov. Accessed August 29, 2024.
172. Kukreja P, MacBeth L, Potter W, et al. Posterior quadratus lumborum block for primary total hip arthroplasty analgesia: A comparative study. Einstein (Sao Paulo). 2019;17(4):eAO4905.
173. Kumar A, Sinha C, Kumar A, et al. Ultrasound-guided trigeminal nerve block and its comparison with conventional analgesics in patients undergoing faciomaxillary surgery: Randomised control trial. Indian J Anaesth. 2018;62(11):871-875.

174. Kumar KN, Kalyane RN, Singh NG, et al. Efficacy of bilateral pectoralis nerve block for ultrafast tracking and postoperative pain management in cardiac surgery. Ann Card Anaesth. 2018;21(3):333-338.
175. Kuniya H, Aota Y, Kawai T, et al. Prospective study of superior cluneal nerve disorder as a potential cause of low back pain and leg symptoms. J Orthop Surg Res. 2014;9:139.
176. Kuniya H, Aota Y, Saito T, et al. Anatomical study of superior cluneal nerve entrapment. J Neurosurg Spine. 2013;19(1):76-80.
177. Law LS, Tan M, Bai Y, et al. Paravertebral block for inguinal herniorrhaphy: A systematic review and meta-analysis of randomized controlled trials. Anesth Analg. 2015;121(2):556-569
178. Lee M-J, Guinn D, Hickenbottom S. Headache in pregnant and postpartum women. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed August 2017
179. Leong RW, Tan ESJ, Wong SN, et al. Efficacy of erector spinae plane block for analgesia in breast surgery: A systematic review and meta-analysis. Anaesthesia. 2021;76(3):404-413.
180. Levin M. Nerve blocks in the treatment of headache. Neurotherapeutics. 2010;7(2):197-203
181. Levy MJ, Wiersema MJ. Endoscopic ultrasound-guided celiac plexus and ganglia interventions. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2019.
182. Li J, Dai F, Ona Ayala KE, et al. Transmuscular quadratus lumborum and lateral femoral cutaneous nerve block in total hip arthroplasty. Clin J Pain. 2021;37(5):366-371.
183. Lipov EG, Navaie M, Brown PR, et al. Stellate ganglion block improves refractory post-traumatic stress disorder and associated memory dysfunction: A case report and systematic literature review. Mil Med. 2013;178(2):e260-e264.
184. Liu G, Gao M, Hu Y, et al. Effects of ultrasound-guided transversus thoracic muscle plane block on postoperative pain and side effects: A systematic review and meta-analysis of randomized controlled trials. J Cardiothorac Vasc Anesth. 2023;37(5):788-800.
185. Liu H, Zhu J, Wen J, Fu Q. Ultrasound-guided erector spinae plane block for postoperative short-term outcomes in lumbar spine surgery: A meta-analysis and systematic review. Medicine (Baltimore). 2023;102(7):e32981.

186. Liu LD, Duricka DL. Stellate ganglion block reduces symptoms of Long COVID: A case series. J Neuroimmunol. 2022;362:577784.
187. Lovett-Carter D, Kendall MC, McCormick ZL, et al. Pectoral nerve blocks and postoperative pain outcomes after mastectomy: A meta-analysis of randomized controlled trials. Reg Anesth Pain Med. 2019;44:923–928.
188. Luerssen TG, Campbell RL, Defalque RJ, Worth RM. Spontaneous saphenous neuralgia. Neurosurgery. 1983;13(3):238-241.
189. Luo G, Ni T, Tao X, et al. Continuous serratus anterior plane block for postoperative analgesia following lung transplantation via anterolateral incision: A pilot study. Front Med (Lausanne). 2024;11:1438580.
190. Lynch JR, Okoroha KR, Lizzio V, et al. Adductor canal block versus femoral nerve block for pain control after anterior cruciate ligament reconstruction: A prospective randomized trial. Am J Sports Med. 2019;47(2):355-363.
191. Ma H-H, Chou TFA, Tsai S-W, et al. The efficacy and safety of continuous versus single-injection popliteal sciatic nerve block in outpatient foot and ankle surgery: A systematic review and meta-analysis. BMC Musculoskelet Disord. 2019;20(1):441.
192. Ma J, Bi Y, Zhang Y, et al. Erector spinae plane block for postoperative analgesia in spine surgery: A systematic review and meta-analysis. Eur Spine J. 2021;30(11):3137-3149.
193. Mack KJ. Acute treatment of migraine in children. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed August 2020a.
194. Mack KJ. Preventive treatment of migraine in children. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed August 2020b.
195. Mailis A, Taenzer P. Evidence-based guideline for neuropathic pain interventional treatments: Spinal cord stimulation, intravenous infusions, epidural injections and nerve blocks. Pain Res Manag. 2012;17(3):150-158.
196. Mansour MA, Mahmoud HE, Fakhry DM, Kassim DY. Comparison of the effects of transversus thoracic muscle plane block and pecto-intercostal fascial block on postoperative opioid consumption in patients undergoing open cardiac surgery: A prospective randomized study. BMC Anesthesiol. 2024;24(1):63.
197. Mariano ER. Management of acute perioperative pain. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed August 2020.

198. Marija T, Aleksandar D. Erector spinae plane block in various abdominal surgeries: A case series. Saudi J Anaesth. 2020;14(4):528-530.
199. Martin GM, Thornhill, TS, Katz JN. Total knee arthroplasty. UpToDate [serial online]. Waltham, MA: UpToDate; reviewed August 2014.
200. Matharu MS, Cohen AS. Short-lasting unilateral neuralgiform headache attacks: Treatment. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed March 2017.
201. May A. Cluster headache: Treatment and prognosis. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed March 2017.
202. Mayhew D, Sahgal N, Khirwadkar R, et al. Analgesic efficacy of bilateral superficial cervical plexus block for thyroid surgery: Meta-analysis and systematic review. Br J Anaesth. 2018;120(2):241-251.
203. McCrum CL, Ben-David B, Shin JJ, Wright VJ. Quadratus lumborum block provides improved immediate postoperative analgesia and decreased opioid use compared with a multimodal pain regimen following hip arthroscopy. J Hip Preserv Surg. 2018;5(3):233-239.
204. Mehta NR, Keith D. Temporomandibular disorders in adults. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2021.
205. Melvin JP, Schrot RJ, Chu GM, Chin KJ. Low thoracic erector spinae plane block for perioperative analgesia in lumbosacral spine surgery: A case series. Can J Anaesth. 2018;65(9):1057-1065.
206. Meyer GW. Anterior cutaneous nerve entrapment syndrome. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2023.
207. Mistry T, Sonawane KB. Gray zone of pericapsular nerve group (PENG) block. J Clin Anesth. 2019;58:123-124.
208. Mohsin MH, Verma R, Hemlata H, et al. Effect of erector spinae block and pectoralis block on quality of recovery and analgesia after modified radical mastectomy: A randomised controlled study. Sultan Qaboos Univ Med J. 2023;23(2):220-226.
209. Morozumi K, Takahashi H, Suzuki T, et al. Distal adductor canal block for administering postoperative analgesia in lower limb surgery. J Clin Anesth. 2018;44:44.
210. Morrison RS, Siu AL. Hip fracture in adults: Epidemiology and medical management. UpToDate [online serial]. Waltham, MA:

UpToDate; reviewed August 2020.

211. Mosaffa F, Taheri M, Rasi AM, et al. Comparison of pericapsular nerve group (PENG) block with fascia iliaca compartment block (FICB) for pain control in hip fractures: A double-blind prospective randomized controlled clinical trial. Orthop Traumatol Surg Res. 2022;108(1):103135.
212. Moynihan LK, Elkadry E. Treatment of myofascial pelvic pain syndrome in women. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2021.
213. Mulvaney SW, Lynch JH, Curtis KE, Ibrahim TS. The successful use of left-sided stellate ganglion block in patients that fail to respond to right-sided stellate ganglion block for the treatment of post-traumatic stress disorder symptoms: A retrospective analysis of 205 patients. Mil Med. 2022;187(7-8):e826-e829.
214. Naja AS, Madi N, Tfayli Y, et al. Deep cervical plexus block for neck and shoulder pain due to myofascial pain: A randomized clinical trial. Clin J Pain. 2021;37(2):133-139. Naja AS, Madi N, Tfayli Y, et al. Deep cervical plexus block for neck and shoulder pain due to myofascial pain: A randomized clinical trial. Clin J Pain. 2021;37(2):133-139.
215. Nardin RA, Freeman R. Epidemiology, clinical manifestations, diagnosis, and treatment of HIV-associated peripheral neuropathy. UpToDate [serial online]. Waltham, MA: UpToDate; reviewed November 2012.
216. Neethu M, Pandey RK, Sharma A, et al. Pectoral nerve blocks to improve analgesia after breast cancer surgery: A prospective, randomized and controlled trial. J Clin Anesth. 2018;45:12-17.
217. North RB, Kidd DH, Zahurak M, Piantadosi S. Specificity of diagnostic nerve blocks: a prospective, randomized study of sciatica due to lumbosacral spine disease. Pain. 1996;65(1):77-85.
218. Nyima T, Palta S, Saroa R, et al. Ultrasound-guided erector spinae plane block compared to serratus anterior muscle block for postoperative analgesia in modified radical mastectomy surgeries: A randomized control trial. Saudi J Anaesth. 2023;17(3):311-317.
219. Oh CS, Chung IH, Ji HJ, Yoon DM. Clinical implications of topographic anatomy on the ganglion impar. Anesthesiology. 2004;101(1):249-250.

220. Ohtsuka H, Kemmotsu O, Dozaki S, Imai M. Low reactive-level laser therapy near the stellate ganglion for postherpetic facial neuralgia. Masui. 1992;41(11):1809-1813.
221. Okcu M, Sencan S, Gunduz OH. Rare complication of ganglion impar blockade with the transsacrococcygeal approach: A case of rectal perforation. Turk J Phys Med Rehabil. 2022;69(1):121-124.
222. Olmsted KLR, Bartoszek M, Mulvaney S, et al. Effect of stellate ganglion block treatment on posttraumatic stress disorder symptoms: A randomized clinical trial. JAMA Psychiatry. 2020;77(2):130-138.
223. Ortega E. Postherpetic neuralgia. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2019.
224. Pai BHP, Lai YH. Feasibility and efficacy of low thoracic ultrasound-guided erector spinae plane blocks in patients undergoing radical total mastectomy with deep inferior epigastric perforator flap reconstruction. Ann Plast Surg. 2022;89(6):656-659.
225. Palazzi DL, Brandt ML. Care of the umbilicus and management of umbilical disorders. UpToDate [online serial], Waltham, MA: UpToDate; reviewed August 2024.
226. Pandit JJ, Satya-Krishna R, Gration P. et al. Superficial or deep cervical plexus block for carotid endarterectomy: A systematic review of complications. Br J Anaesth. 2007;99(2):159-169.
227. Paoloni J. Approach to the adult with unspecified hip pain. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2022.
228. Park S, Park J, Choi JW, et al. The efficacy of ultrasound-guided erector spinae plane block after mastectomy and immediate breast reconstruction with a tissue expander: A randomized clinical trial. Korean J Pain. 2021;34(1):106-113.
229. Peng J, Zhang W, Wu Y, et al. Effects of bilateral erector spinae plane block for posterior lumbar spine surgery in elderly patients. Zhong Nan Da Xue Xue Bao Yi Xue Ban. 2023;48(2):206-212.
230. Peng K, Zeng M, Dong J, et al. Ultrasound-guided superficial cervical plexus block for analgesia in patients undergoing craniotomy via suboccipital retrosigmoid approach: Study protocol of a randomised controlled trial. BMJ Open. 2020;10(2):e034003.

231. Phillips WJ, Troutman G, Lerant A. Nerve stimulator-assisted sciatic nerve block for painful procedures in the ED. Am J Emerg Med. 2011;29(9):1130-1135.
232. Picelli A, Bonazza S, Lobba D, et al. Suprascapular nerve block for the treatment of hemiplegic shoulder pain in patients with long-term chronic stroke: A pilot study. Neurol Sci. 2017;38(9):1697-1701.
233. Pingree MJ, Sole JS, O'Brien TG, et al. Clinical efficacy of an ultrasound-guided greater occipital nerve block at the level of C2. Reg Anesth Pain Med. 2017;42(1):99-104.
234. Pislaru S. Surgical procedures for severe chronic mitral regurgitation. UpToDate [online serial], Waltham, MA: UpToDate; reviewed August 2024.
235. Pontari M. Chronic prostatitis and chronic pelvic pain syndrome. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2021.
236. Prestgaard TA. Frozen shoulder (adhesive capsulitis). UpToDate [online serial]. Waltham, MA: UpToDate; reviewed August 2020.
237. Pujol E, Faulí A, Anglada MT, et al. Ultrasound-guided single dose injection of 0.5% levobupivacaine or 0.5% ropivacaine for a popliteal fossa nerve block in unilateral hallux valgus surgery. Rev Esp Anestesiol Reanim. 2010;57(5):288-292.
238. Qudsi-Sinclair S, Borrás-Rubio E, Abellan-Guillén JF, et al. A comparison of genicular nerve treatment using either radiofrequency or analgesic block with corticosteroid for pain after a total knee arthroplasty: A double-blind, randomized clinical study. Pain Pract. 2016;17(5):578-588.
239. Quinton BA, Tierney WS, Benninger MS, et al. The role of bilateral superior laryngeal nerve block in managing refractory chronic cough. Laryngoscope. 2024;134(4):1773-1777.
240. Ragab AR, Hegab S, Elnemr R, et al. Intra-articular corticosteroid injection and genicular nerve block under ultrasound guidance in pain control of knee osteoarthritis. Egypt J Radiol Nucl Med. 2021;52:196.
241. Rajagopalan V, Sengupta D, Goyal K, et al. Hiccups in neurocritical care. J Neurocrit Care. 2021;14(1):18-28.
242. Ramkiran S, Jacob M, Honwad M, et al. Ultrasound-guided combined fascial plane blocks as an intervention for pain

management after laparoscopic cholecystectomy: A randomized control study. Anesth Essays Res. 2018;12(1):16-23.

243. Rapp H, Ledin Eriksson S, Smith P. Superior hypogastric plexus block as a new method of pain relief after abdominal hysterectomy: Double-blind, randomised clinical trial of efficacy. BJOG. 2017;124(2):270-276.
244. Renes SH, van Geffen GJ, Rettig HC, et al. Ultrasound-guided continuous phrenic nerve block for persistent hiccups. Reg Anesth Pain Med. 2010;35(5):455-457.
245. Restrepo-Garces CE, Chin KJ, Suarez P, Diaz A. Bilateral continuous erector spinae plane block contributes to effective postoperative analgesia after major open abdominal surgery: A case report. A A Case Rep. 2017;9(11):319-321.
246. Reyad RM, Shaker EH, Ghobrial HZ, et al. The impact of ultrasound-guided continuous serratus anterior plane block versus intravenous patient-controlled analgesia on the incidence and severity of post-thoracotomy pain syndrome: A randomized, controlled study. Eur J Pain. 2020;24(1):159-170.
247. Robbins MS, Blumenfeld A. Information for health care professionals: Peripheral nerve blocks for headaches. Mt. Royal, NJ: American Headache Society; 2016. Available at https://americanheadachesociety.org. Accessed September 8, 2017.
248. Roberts WN, Jr. Joint aspiration or injection in adults: Technique and indications. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2022.
249. Robinson J, Kothari M. Treatment and prognosis of cervical radiculopathy. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2019.
250. Rosenblatt MA, Lai Y. Nerve blocks of the scalp, neck, and trunk: Techniques. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed February 2017.
251. Rosenblatt MA, Lai Y. Scalp block and cervical plexus block techniques. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed August 2020; July 2021.
252. Rosenblatt MA, Lai Y. Thoracic nerve block techniques. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed August 2020.
253. Runner RP, Boden SA, Godfrey WS, et al. Quadriceps strength deficits after a femoral nerve block versus adductor canal block

for anterior cruciate ligament reconstruction: A prospective, single-blinded, randomized trial. Orthop J Sports Med. 2018;6(9):2325967118797990.

254. Rutkove SB. Overview of lower extremity peripheral nerve syndromes. UpToDate [serial online]. Waltham, MA: UpToDate; reviewed November 2012.
255. Sagır O, Ozaslan S, Köroğlu A. [Application of ganglion impar block in patient with coccyx dislocation]. Agri. 2011;23(3):129-133.
256. Sahota O, Rowlands M, Bradley J, et al. Femoral nerve block intervention in neck of femur fracture (FINOF): Study protocol for a randomized controlled trial. Trials. 2014;15:189
257. Sandri M, Blasi A, De Blasi RA. PENG block and LIA as a possible anesthesia technique for total hip arthroplasty. J Anesth. 2020;34(3):472-475.
258. Sankineani SR, Reddy ARC, Eachempati KK, et al. Comparison of adductor canal block and IPACK block (interspace between the popliteal artery and the capsule of the posterior knee) with adductor canal block alone after total knee arthroplasty: A prospective control trial on pain and knee function in immediate postoperative period. Eur J Orthop Surg Traumatol. 2018;28(7):1391-1395.
259. Santos LS, Cuadrado Pérez ML, Guerrero Peral AL, et al. Consensus recommendations for anaesthetic peripheral nerve block. Neurologia. 2017;32(5):316-330.
260. Schechter W. Pharmacologic management of acute perioperative pain in infants and children. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2023.
261. Sehmbi H, Brull R, Shah UJ, et al. Evidence basis for regional anesthesia in ambulatory arthroscopic knee surgery and anterior cruciate ligament reconstruction: Part II: Adductor canal nerve block – A systematic review and meta-analysis. Anesth Analg. 2019;128(2):223-238.
262. Senapathi TGA, Widnyana IMG, Aribawa IGNM, et al. Combined ultrasound-guided Pecs II block and general anesthesia are effective for reducing pain from modified radical mastectomy. J Pain Res. 2019;12:1353-1358.
263. Shadmehr E, Aminozarbian MG, Akhavan A, et al. Anaesthetic efficacy of lidocaine/clonidine for inferior alveolar nerve block in

patients with irreversible pulpitis. Int Endod J. 2017;50(6):531-539.

264. Sharma S, Arora S, Jafra A, Singh G. Efficacy of erector spinae plane block for postoperative analgesia in total mastectomy and axillary clearance: A randomized controlled trial. Saudi J Anaesth. 2020;14(2):186-191.
265. Shifren JL. Overview of sexual dysfunction in women: Management. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2021.
266. Shin JJ, McCrum CL, Mauro CS, Vyas D. Pain management after hip arthroscopy: Systematic review of randomized controlled trials and cohort studies. Am J Sports Med. 2018;46(13):3288-3298.
267. Simons SM, Dixon B. Biceps tendinopathy and tendon rupture. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2023.
268. Simpson CB, Tibbetts KM, Loochtan MJ, Dominguez LM. Treatment of chronic neurogenic cough with in-office superior laryngeal nerve block. Laryngoscope. 2018;128(8):1898-1903.
269. Singh G, Dhiraaj S, Shamshery C, et al. To study the efficacy of ultrasound guided pecto-intercostal fascial plane block in patients undergoing midline sternotomy in open cardiac surgery: A randomized prospective comparative study. Ann Card Anaesth. 2024;27(4):301-308.
270. Singh S, Avinash R, Jaiswal S, Kumari A. Comparison of safety and efficacy of thoracic epidural block and erector spinae plane block for analgesia in patients with multiple rib fractures: A pilot single-blinded, randomised controlled trial. Indian J Anaesth. 2023;67(7):614-619.
271. Sinha C, Kumar A, Kumar A, et al. Deep versus superficial erector spinae block for modified radical mastectomy: A randomised controlled pilot study. Indian J Anaesth. 2021;65(2):97-101.
272. Sinha C, Singh AK, Kumar A, et al. Analgesic effect of continuous adductor canal block versus continuous femoral nerve block for knee arthroscopic surgery: A randomized trial. Braz J Anesthesiol. 2022;72(5):553-559.
273. Smith CR, Helander E, Chheda NN. Trigeminal nerve blockade in the pterygopalatine fossa for the management of postoperative

pain in three adults undergoing tonsillectomy: A proof-of-concept report. Pain Med. 2020;21(10):2441-2446.

274. Smith JH. Acute treatment of migraine in adults. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed August 2020a.
275. Smith JH. Preventive treatment of migraine in adults. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed August 2020b.
276. Soberon JR Jr, Crookshank JW 3rd, Nossaman BD, et al. Distal peripheral nerve blocks in the forearm as an alternative to proximal brachial plexus blockade in patients undergoing hand surgery: A prospective and randomized pilot study. J Hand Surg Am. 2016;41(10):969-977.
277. Sorensen JK, Grevstad U, Jaeger P, et al. Effects of popliteal plexus block after total knee arthroplasty: A randomized clinical trial. Reg Anesth Pain Med. 2024 Jul 16 [Online ahead of print].
278. Srejic U, Litonius E, Gandhi S, et al. Bilateral superficial trigeminal nerve blocks are not more effective than a placebo in abolishing post-operative headache pain in pituitary transsphenoidal neurosurgery: A prospective, randomized, doubleblinded clinical trial. Rev Recent Clin Trials. 2023;18(3):228-237.
279. Steenberg J, Moller AM. Systematic review of the effects of fascia iliaca compartment block on hip fracture patients before operation. Br J Anaesth. 2018;120(6):1368-1380.
280. Stein MB. Posttraumatic stress disorder in adults: Treatment overview. UpToDate [online serial], Waltham, MA: UpToDate; reviewed August 2024.
281. Stuart Green M, Ryan Hoffman C, Iqbal U, et al. Transmuscular quadratus lumborum block reduces length of stay in patients receiving total hip arthroplasty. Anesth Pain Med. 2018;8(6):e80233.
282. Su MP, Huang PJ, Tseng KY, et al. Pretreatment of ankle nerve block provides better postoperative analgesia than peri-incisional local anesthetic infiltration in hallux valgus correction surgery. Kaohsiung J Med Sci. 2019;35(3):168-174.
283. Taguchi T, Kawai S, Oda H, Kaneko K. Anatomic basis for selective nervi-spinales infiltration in the treatment of articular back pain. J Neuroradiol. 2000;27(1):25-29.

284. Talu G, Suleyman O, Talu U. Supeior cluneal nerve entrapment. Reg Anes Pain Med. 2000;25(6):648-650.
285. Tan YL, Neo EJR, Wee TC, et al. Ultrasound-guided genicular nerve blockade with pharmacological agents for chronic knee osteoarthritis: A systematic review. Pain Physician. 2022;25(4):E489-E502.
286. Thapa D, Ahuja V. Combination of diagnostic medial calcaneal nerve block followed by pulsed radiofrequency for plantar fasciitis pain: A new modality. Indian J Anaesth. 2014;58(2):183-185.
287. Thobhani S, Scalercio L, Elliott CE, et al. Novel regional techniques for total knee arthroplasty promote reduced hospital length of stay: An analysis of 106 patients. Ochsner J. 2017;17(3):233-238.
288. Thybo KH, Mathiesen O, Dahl JB, et al. Lateral femoral cutaneous nerve block after total hip arthroplasty: A randomised trial. Acta Anaesthesiol Scand. 2016;60(9):1297-1305.
289. Tipton CB, Walters R, Gudipudi R, et al. The efficacy of superior laryngeal nerve block for neurogenic cough: A placebo-controlled trial. Laryngoscope. 2023;133(11):3068-3074.
290. Tobin J, Flitman S. Occipital nerve blocks: When and what to inject? Headache. 2009;49(10):1521-1533.
291. Todd DJ. Bursitis: An overview of clinical manifestations, diagnosis, and management. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2023.
292. Toshniwal GR, Dureja GP, Prashanth SM. Transsacrococcygeal approach to ganglion impar block for management of chronic perineal pain: A prospective observational study. Pain Physician. 2007;10(5):661-666.
293. Townsley P, Ravenscroft A, Bedforth N. Ultrasound-guided spinal accessory nerve blockade in the diagnosis and management of trapezius muscle-related myofascial pain. Anaesthesia. 2011;66(5):386-389.
294. Tran DQ, Dugani S, Finlayson RJ. A randomized comparison between ultrasound-guided and landmark-based superficial cervical plexus block. Reg Anesth Pain Med. 2010;35(6):539-543.
295. Tran DQ, Elgueta MF, Aliste J, Finlayson RJ. Diaphragm-sparing nerve blocks for shoulder surgery. Reg Anesth Pain Med. 2017;42(1):32-38.

296. Tran DQH, Tiyaprasertkul W, Gonzalez AP. Analgesia for clavicular fracture and surgery: A call for evidence. Reg Anesth Pain Med. 2013;38(6):539-543.
297. Trescot AM. Cryoanalgesia in interventional pain management. Pain Physician. 2003;6(3):345-60.
298. Tringali A, Loperfido S, Costamagna G. Overview of endoscopic retrograde cholangiopancreatography (ERCP) in adults. UpToDate Inc., Waltham, MA. Last reviewed July 2023.
299. Tsai H-C, Yoshida T, Chuang T-Y, et al. Transversus abdominis plane block: An updated review of anatomy and techniques. Biomed Res Int. 2017;2017:8284363.
300. Tsai PB, Karnwal A, Kakazu C, et al. Efficacy of an ultrasound-guided subsartorial approach to saphenous nerve block: A case series. Can J Anaesth. 2010;57(7):683-688.
301. Tu FF, As-Sanie S. Chronic pelvic pain in adult females: Treatment. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2021.
302. Tulgar S, Kapakli MS, Senturk O, et al. Evaluation of ultrasound-guided erector spinae plane block for postoperative analgesia in laparoscopic cholecystectomy: A prospective, randomized, controlled clinical trial. J Clin Anesth. 2018;49:101-106.
303. Tyagi A, Salhotra R. Total hip arthroplasty and peripheral nerve blocks: Limited but salient role? J Anaesthesiol Clin Pharmacol. 2018;34(3):379-380.
304. Ueshima H, Otake H, Hara E, Blanco R. How to use pectoral nerve blocks effectively – An evidence-based update. Asian J Anesthesiol. 2019;2019(2019):1-9.
305. Vanderhoek MD, Hoang HT, Goff B. Ultrasound-guided greater occipital nerve blocks and pulsed radiofrequency ablation for diagnosis and treatment of occipital neuralgia. Anesth Pain Med. 2013;3(2):256-259.
306. Varrassi G, et al. Neural modulation by blocks and infusions. Pain Pract. 2006;6(1):34-38.
307. Versyck B, van Geffen GJ, Chin KJ. Analgesic efficacy of the Pecs II block: A systematic review and meta-analysis. Anaesthesia. 2019;74(5):663-673.
308. Vig S, Bhan S, Ahuja D, et al. Serratus anterior plane block for post-thoracotomy analgesia: A novel technique for the surgeon and anaesthetist. Indian J Surg Oncol. 2019;10(3):535-539.

309. Vijapurkar S, Sandeep G, Rajwade S, et al. Ultrasound-guided clavipectoral fascial plane block as a stand-alone anesthetic technique for clavicle fracture management: A case report. Cureus. 2024;16(5):e60244.
310. Vinzant NJ, Christensen JM, Yalamuri SM, et al. Pectoral fascial plane versus paravertebral blocks for minimally invasive mitral valve surgery analgesia. J Cardiothorac Vasc Anesth. 2023;37(7):1188-1194.
311. Visovsky C, Collins M, Abbott L, et al. Putting evidence into practice: Evidence-based interventions for chemotherapy-induced peripheral neuropathy. Clin J Oncol Nurs. 2007;11(6):901-913.
312. Vlassakov KV, et al. Local anesthetic blockade of peripheral nerves for treatment of neuralgias: Systematic analysis. Anesth Analg. 2011;112(6):1487-1493.
313. Volkmar AJ, MA, Fleury IG, et al. Safety and efficacy of forearm tourniquet compared to upper arm tourniquet for local intravenous regional anesthesia in hand surgery: A randomized clinical trial. Iowa Orthop J. 2021;41(1):177-181.
314. Wada T, Yamauchi M, Oki G, et al. Efficacy of axillary nerve block in elbow arthroscopic surgery: A randomized trial. J Shoulder Elbow Surg. 2014;23(3):291-296.
315. Wamkpah NS, Peterson AM, Lee JJ, et al. Curbing the cough: Multimodal treatments for neurogenic cough: A systematic review and meta-analysis. Laryngoscope. 2022;132(1):107-123.
316. Wang L, Wang Y, Zhang X, et al. Serratus anterior plane block or thoracic paravertebral block for postoperative pain treatment after uniportal video-assisted thoracoscopic surgery: A retrospective propensity-matched study. J Pain Res. 2019;12:2231-2238.
317. Wang X, Feng Y, Yang X, et al. Preoperative ultrasound-guided trigeminal nerve block in orthognathic surgery: A prospective study about its efficacy of intraoperative anesthetic dosage and postoperative analgesia. J Oral Maxillofac Surg. 2021;79(10):2042-2050.
318. Wang X, Sun Y, Wang L, Hao X. Femoral nerve block versus fascia iliaca block for pain control in total knee and hip arthroplasty: A meta-analysis from randomized controlled trials. Medicine (Baltimore). 2017;96(27):e7382.

319. Weinberger SE, Saukkonen K. Evaluation and treatment of subacute and chronic cough in adults. UpToDate [online serial], Waltham, MA: UpToDate; reviewed August 2024.
320. White L, Reardon D, Davis K, et al. Anterior suprascapular nerve block versus interscalene brachial plexus block for arthroscopic shoulder surgery: a systematic review and meta-analysis of randomized controlled trials. J Anesth. 2022;36(1):17-25.
321. Williams BA, Murinson BB. Diabetes mellitus and subclinical neuropathy: A call for new paths in peripheral nerve block research. Anesthesiology. 2008;109(3):361-362.
322. Wilton J, Chiu H, Codianne N, et al. Continuous quadratus lumborum block as post-operative strategy for pain control in spinal fusion surgery. Indian J Anaesth. 2020;64(10):869-873.
323. Wittayapairoj A, Wittayapairoj K, Vechvitvarakul M. Effect of bilateral ultrasound-guided erector spinae plane block on postoperative pain after open lumbar spinal surgery: A double-blind, randomized controlled trial. Eur Spine J. 2023;32(2):420-427.
324. Work Loss Data Institute. Neck and upper back (acute & chronic). Encinitas, CA: Work Loss Data Institute; May 14, 2013.
325. Xin J, Zhang Y, Li Q, et al. Adductor canal block is similar to femoral nerve block for the quality of rehabilitation after arthroscopic partial meniscectomy. Knee Surg Sports Traumatol Arthrosc. 2020;28(7):2334-2342.
326. YaDeau JT, Dines DM, Liu SS, et al. What pain levels do TSA patients experience when given a long-acting nerve block and multimodal analgesia? Clin Orthop Relat Res. 2019;477(3):622-632.
327. Yamak Altinpulluk E, García Simón D, Fajardo-Pérez M. Erector spinae plane block for analgesia after lower segment caesarean section: Case report. Rev Esp Anestesiol Reanim. 2018;65(5):284-286.
328. Yamashiro H, Hara K, Gotoh Y. Relief of intractable post-herpetic neuralgia with gasserian ganglion block using methyl prednisolone acetate and with TENS. Masui. 1990;39(9):1239-1244.
329. Yang JH, Sun Y, Yang YR, et al. The analgesic mechanism and recent clinical application of erector spinae plane block: A narrative review. J Pain Res. 2024;17:3047-3062.

330. Yeo SN, Chong JL. A case report on the treatment of intractable anal pain from metastatic carcinoma of the cervix. Ann Acad Med Singap. 2001;30(6):632-635.
331. Youssef BR, Sohnel A, Welk A, et al. RCT on the effectiveness of the intraligamentary anesthesia and inferior alveolar nerve block on pain during dental treatment. Clin Oral Investig. 2021;25(8):4825-4832.
332. Zhang J, Liu TX, Wang WX, et al. Effects of ultrasound-guided erector spinae plane block on postoperative acute pain and chronic post-surgical pain in patients underwent video-assisted thoracoscopic lobectomy: A prospective randomized, controlled trial. BMC Anesthesiol. 2023;23(1):161.
333. Zhang T, Cao Y, Xu R, et al. Spinal anesthesia with peripheral nerve block versus general anesthesia with peripheral nerve block for elective foot and ankle surgeries: A retrospective single-center study. J Foot Ankle Surg. 2022;61(4):706-712.
334. Zhang Y, He K, Chen L, et al. Role of scalp nerve block in improving the quality of rehabilitation in patients after meningioma resection: A randomized controlled clinical trial. Medicine (Baltimore). 2024;103(23):e38324.
335. Zhou H, Xue Y, Liu P. Application of auriculotemporal nerve block and dextrose prolotherapy in exercise therapy of TMJ closed lock in adolescents and young adults. Head Face Med. 2021;17(1):11.
336. Zhao HY, Yang GT, Sun NN, et al. Efficacy and safety of stellate ganglion block in chronic ulcerative colitis. World J Gastroenterol. 2017;23(3):533-539.
337. Zhao J, Han F, Yang Y, et al. Pectoral nerve block in anesthesia for modified radical mastectomy: A meta-analysis based on randomized controlled trials. Medicine (Baltimore). 2019;98(18):e15423.
338. Zoghbi WA. Overview of the management of patients with prosthetic heart valves. UpToDate [online serial], Waltham, MA: UpToDate; reviewed August 2024.

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