Peripheral Nerve Blocks

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These are useful adjuvants to general anesthesia in the pediatric patient. There are advantages to peripheral blocks.

(a) The target nerves can be blocked.

(b) Associated motor blockade is minimized.

(c) A lower amount of local anesthetic is utilized.

(d) Potential for urinary retention is minimal.

(e) It can be used in areas where a central neuroaxial block cannot always be used e.g., head and neck.

Selecting the local anesthetic for peripheral blocks:

Lidocaine, mepivacaine and bupivacaine are commonly used for peripheral blocks. The longer acting local anesthetics are preferred since they provide longer duration of postoperative pain relief. Adding a small amount of bicarbonate (1 ml /20 ml of local anesthetic) reduces the pain on injection and can enhance the speed of onset of the local anesthetic block.[1] The addition of epinephrine may decrease vascular absorption and extend the duration of the block.

Nerve Stimulator:

Most peripheral nerve blocks are performed in children who are either moderately sedated or under general anesthesia. A peripheral nerve stimulator may be useful for locating the nerve to be blocked. It is clearly not a substitute for anatomic knowledge but an adjunct for locating the nerve in an unconscious or heavily sedated patient.

Surface mapping for peripheral nerves, particularly motor nerves can be helpful in identifying the location of these nerves prior to performing the block.[2] A higher amperage is required to surface map motor nerves. We will address peripheral nerve blocks in children based on the anatomical regions to be blocked.

HEAD & NECK BLOCKS

The scalp is innervated by two groups of nerves (i) the first division of the trigeminal nerve that divides into the supraorbital and supratrochlear nerves that supply the anterior part of the scalp and (ii) cervical root C_2 that supplies the posterior part of the scalp.[3]

Supraorbital & supratrochlear blocks

Indications: Pain relief for scalp excisions[4], frontal craniotomies, frontal ventriculo-peritoneal shunts.[5]

Technique: With the patient supine, the supraorbital notch is palpated. After careful preparation of the skin, a 27-G needle is inserted into the supraorbital notch perpendicularly; 1 to 2 ml of bupivacaine (0.25% with 1:200,000 epinephrine) is injected after careful aspiration to prevent intravascular placement. To block the supratrochlear nerve, the needle is withdrawn to the skin level and directed medially towards the tip of the nose; 1ml. of bupivacaine(0.25% with 1:200,000 epinephrine) is injected.

Complications: Due to the loose areolar tissue of the eyelid, gentle pressure should be applied to the supraorbital area, which prevents the dissection of local anesthetic and the formation of ecchymosis.

Greater Occipital Nerve Block

Indications: Treatment of occipital pain following posterior fossa surgery and posterior shunt revisions. It is also useful for treating chronic pain secondary to occipital neuralgia.[3]

Anatomy: The posterior neck and head is innervated by the cervical spinal nerves. The dorsal rami of C2 end in the greater occipital nerve, which provides cutaneous innervation to the major portion of the posterior scalp.

Technique: With the patient's head turned to one side, or with the patient prone, the occipital artery is palpated at the level of the superior nuchal line. (Fig 2). The occipital nerve is located medial to the occipital artery. 2 ml of bupivacaine (0.25% with 1:200,000 epinephrine) is injected to form a skin wheal.

Complications: Rare. Caution has to be exercised to prevent intravascular placement.

Infraorbital Block

Anatomy: This is the termination of the second division of the trigeminal nerve. This is entirely sensory. The nerve emerges in front of the maxilla through the infraorbital foramen and divides into four branches; the inferior palpebral, the external nasal, the internal nasal and the superior labial. These branches innervate the lower eyelid, the lateral inferior portion of the nose and its vestibule, the upper lip and the mucosa along the upper lip and the vermilion.

Indications: Postoperative pain relief in cleft lip repair [6;7]; reconstructive procedures of the nose including septal reconstruction[8] and rhinoplasty and in patients undergoing endoscopic sinus surgery[9]

Technique: An intraoral approach and an extraoral approach can be used. We prefer the intraoral approach. (Fig 3) After palpating the infraorbital foramen, the upper lip is folded back. A 27-G needle is inserted through the buccal mucosa approximately parallel to the maxillary second molar. With the tip of the needle at the level of the infraorbital foramen, and, after careful aspiration, 0.05 to 1 ml of local anesthetic (0.25% bupivacaine with epinephrine 1:200,000) is injected into the space.

Complications: Pressure has to be applied to the area since there is loose adventitious tissue that can lead to ecchymosis and swelling. Care has to be taken to prevent direct injection into the orbit or eye.

Great Auricular nerve block

Indications: Provides postoperative pain relief in patients undergoing mastoid-ectomy[10;11] and otoplasty. A significant advantage is a reduction in postoperative nausea and vomiting in patients undergoing this block compared to the intravenous opioids.[10]

Anatomy: This supplies the sensory innervation to the mastoid and the external ear. It is a branch of the superficial cervical plexus. The great auricular nerve is derived from superficial cervical plexus (C3) The great auricular nerve has been described by McKinney and is often described as McKinney's point.[12] The great auricular nerve wraps around the belly of the sterno-cleidomastoid at the level of the cricoid cartilage and emerges to supply the area of the mastoid and the external ear.

Technique: The cricoid cartilage is identified. A line is drawn from the superior margin of the cricoid laterally to the posterior border of the sterno-cleidomastoid muscle. 2 – 3 ml of bupivacaine (0.25% with 1:200,000 epinephrine) is injected superficially at this point. (Fig 4)

Complications: If the needle is placed deep there is a chance that a deep cervical plexus block can ensue with added complications including Horner's syndrome, phrenic nerve block, or unintended sub-arachnoid block. A small erythematous area can be seen at the site of injection.

Intercostal Nerve Block

Anatomy: These are derived from the ventral rami of the 1st thoracic through 12th thoracic nerves. There are four branches ; the gray rami communicans; posterior cutaneous branch; a lateral cutaneous branch; and a cutaneous branch that supplies the midline of the chest.

Technique: It can be blocked either at the paravertebral or in the mid-axillary line. After the low margin of the rib is located, the skin is retracted cephalad and a needle is inserted perpendicular to the skin over the rib and advanced until the rib is encountered. A distinct pop may be felt as the needle enters the neurovascular sheath. After negative aspiration, local anesthetic is injected into the space.

Complications: Pneumothorax has been reported with intercostal blocks. Toxicity from local anesthetic absorption from the site is higher than in any other location.[13] A third complication is a high sub-arachnoid block associated with a posterior paravertebral approach.

Inguinal Block: (ilioinguinal & iliohypogastric block)

Indications: Used for procedures in the inguinal area including hernia repair and orchidopexy.

Anatomy: The inguinal area is innervated by the sub-costal nerve (T12), iliohypogastric and ilioinguinal nerves(derived from L1). After piercing the internal oblique approximately 2 – 3 cm medial to the anterior superior iliac spine, the nerve then travels between the internal oblique and external oblique aponeurosis where it accompanies the spermatic cord to the genital area.

Technique: A 27-G needle is inserted at a 45-degree angle at a point one quarter of the way from the anterior superior iliac spine and the umbilicus at the level of the inguinal ligament. Two distinct 'pops' are felt as the needle enters the external and internal oblique muscles. About 10 ml of bupivacaine (0.25% with 1:200,000 epinephrine) is injected into the space. Care must be taken not to enter the peritoneum.

Complications: Intraperitoneal injection; intravascular placement.

Penile Block

Indications: This is useful for procedures on the external genitalia including circumcision [14] urethral dilatation, and hypospadias repair. Even though a caudal block is ideally suited for these procedures, there are certain contraindications like spinal dysraphism and lack of parental consent.

Anatomy: The pudendal nerve and the pelvic plexus supply the penis. There are two dorsal nerves that run along side the dorsal artery that separate at the level of the symphysis pubis to innervate the penis.

Technique: Two common techniques used include (I) Ring Block: A ring of local anesthetic without epinephrine is injected at the base of the shaft of the penis. (ii) Dorsal nerve block: A point 1-cm above the symphysis pubis is identified. A 27-G needle is inserted at a 30-degree angle. After aspiration 4 ml of local anesthetic without epinephrine is injected.

Complications: Hematoma formation, compromised blood flow to the penis and intravascular injection.

Lower Extremity Blocks

The major use of nerve blocks of the lower extremity in pediatric patients is for managing postoperative pain and as an adjunct to general anesthesia

Sciatic Nerve Block

Anatomy: The sciatic nerve arises from the L_4 through S_3 roots of the sacral plexus, passes through the pelvis, and becomes superficial at the lower margin of the gluteus maximus muscle. It then descends into the lower extremity in the posterior aspect of the thigh, supplying sensory innervation to the posterior thigh as well as to the entire leg and foot below the level of the knee except for the medial aspect, which is supplied by the femoral nerve. All blocks are performed with the aid of a nerve stimulator to elicit a motor response in the foot. A newer approach to the sciatic nerve using a lateral approach to the popliteal fossa has been described.[15] This offers the additional advantage of being able to provide the block in a supine patient and is particularly helpful in the pediatric patient.

Approach of Labat (Posterior Approach)

Technique. The patient is placed in the lateral decubitus position lying on the non-operative leg. The leg to be blocked is flexed and the lower leg is extended . A line is drawn from the posterior superior iliac spine to the greater trochanter of the femur. Another line is drawn from the greater trochanter to the coccyx. The first line is bisected, and a perpendicular line is drawn from that point to the second line; the point at which it intersects the second line is the site of needle insertion. A 22-gauge insulated needle is advanced in the perpendicular plane until it strikes bone. It is possible for the needle to pass through the sciatic notch without either encountering bone or causing a paresthesia. In that case, the needle is redirected in a cephalad direction until bone is encountered. A motor paresthesia is then sought using an organized grid-like approach, fanning medially to laterally. Under general anesthesia, dorsiflexion or plantar flexion of the foot is desired to locate the nerve. A dose of 0.5 ml/kg of bupivacaine (0.25% with epinephrine 1:200,000) is recommended for children older than 6 months of age. If the sciatic nerve block is

used in conjunction with a femoral nerve block, consideration should be given to diluting the local anesthetic concentration further to limit the injected dose to 2-3 mg/kg of bupivacaine.

Lateral Popliteal Sciatic Nerve Block

This approach to the sciatic nerve can be performed with the patient in the supine position and can provide postoperative analgesia in patients undergoing surgery to the foot and knee.[16] It has the advantage of preserving hamstring function and allows early ambulation with crutches.

Anatomy: The popliteal fossa is a diamond shaped area located behind the knee. It is bordered by the biceps femoris laterally, medially by the tendons of the semitendinosus and semimembranosus muscles, and inferiorly by the heads of the gastrocnemius muscle. The sciatic nerve, after its formation from the L_4 through S_5, innervates all areas of the leg and foot below the knee except the antero-medial cutaneous area of the leg and foot, which are supplied by the femoral nerve. The sciatic nerve divides into two branches, the larger tibial nerve located medially and the common peroneal nerve located laterally. The nerves are together at the apex of the popliteal fossa where they are in close proximity to each other and are enclosed in a connective tissue sheath for a few more centimeters before dividing into the component nerves.

Technique: After induction of general anesthesia, the lower leg is elevated on a pillow. The biceps femoris tendon is palpated. The tendon is then traced upwards for about 3 to 5 cm. A 22 G insulated needle is inserted anterior to the tendon in a horizontal plane with a cephalad angulation (Fig 5). A nerve stimulator is attached to the sheathed needle and with low voltage stimulation (0.2 to 0.5 mV), the foot is observed for plantar flexion (tibial nerve) or dorsiflexion (common peroneal nerve). On injection of a test dose of 1 ml bupivacaine (0.25 % with epinephrine 1:200,000), the twitching is abolished. This confirms correct placement of the needle; 5-10 ml of additional local anesthetic are then injected. In adult studies, it has been shown that the duration of a sciatic nerve block is longer than an ankle block or subcutaneous infiltration and provides excellent postoperative analgesia.[16]

Complications: Intraneural injection must be avoided. Using a low voltage nerve stimulator ensures proper placement of the needle. It is rare to see intravascular placement of the needle with this approach. Intravascular injection may be avoided with incremental injection with frequent withdrawal.

Femoral Nerve Block

A femoral nerve block is particularly useful in patients with a fractured femoral shaft so that transport, x-ray, and other minor surgical manipulations are not painful.

Anatomy: The femoral nerve is located immediately lateral to the femoral artery and deep to both the fascia lata and fascia iliaca.[17-19]

Technique: A blunt 22-gauge B-bevel needle or alternatively a caudal needle is advanced lateral to the pulsation of the femoral artery. Two fascial planes can be located by a distinct "pop" that is felt as the needle traverses these fascial planes. The nerve is blocked by depositing an appropriate volume (5-10 ml) of local anesthetic lateral to the femoral pulse and deep to the fascia iliaca Repeated aspiration and incremental injection should be used to avoid injection into the femoral artery.

Complications: Due to the close proximity of the nerve to the femoral artery, it may be preferable to avoid this technique in patients who are on anticoagulants or who may have blood dyscrasias. Intravascular injection may be avoided with incremental injection with frequent withdrawal.

Lateral Femoral Cutaneous Nerve

Anatomy: The lateral femoral cutaneous nerve arises from the L_2 and L_3 roots of the lumbar plexus. It emerges from the lateral border of the psoas muscle and passes obliquely under the fascia iliaca to enter the thigh 1 to 2 cm medial to the anterior superior iliac spine. The nerve innervates the lateral aspect of the thigh Blockade is also indicated for supplementation of femoral and sciatic nerve blocks to provide relief of tourniquet pain. It is also suitable for anesthetizing the lateral aspect of the thigh as a donor site for small skin grafts, fascia iliaca grafts, or muscle biopsy for muscular disorders [17;20]

Technique: A point approximately 2-cm caudal and 2 cm medial to the anterior superior iliac spine is located. A B-bevel needle or a caudal needle is then advanced through the skin and then through the fascia lata. A distinct pop is felt at this point. Two to 10 ml of local anesthetic, depending on the size of the child, are deposited in a fan-like fashion.

Complications: It is rare to see any complications associated with a lateral femoral cutaneous nerve block. However, care has to be taken to avoid an intraneural placement of the local anesthetic solution. Intravascular injection may be avoided with incremental injection with frequent withdrawal.

Fascia Iliaca Block

This block is particularly useful in children to provide unilateral anesthesia or analgesia of the lower extremity. The block has been reported to be less reliable in adults than in children. It produces blockade of the femoral, lateral femoral cutaneous and obturator nerves with a single injection of local anesthetic.

Anatomy: The fascia iliaca and iliacus muscle binds this compartment superficially, superiorly it is bound by the iliac crest, and posteriorly by the psoas muscle. It has the advantage of producing blockade without requiring the needle to be in the close proximity to any major nerves or blood vessels.

Technique. The injection is made approximately 1 cm inferior to the junction of the outer and middle thirds of the inguinal ligament. As the needle is inserted in a perpendicular angle of about 75 degrees to the skin, two characteristic “pops” are felt as the needle pierces the fascia lata and then the fascia iliaca . Digital pressure is exerted distally to the site during the injection and for a short time afterwards, and the swelling produced in the groin by the volume of local anesthetic is massaged to promote proximal flow of the drug. A volume of 0.3-0.5 ml/kg is sufficient in most cases.

Complications: Due to the larger volume that is required to provide an adequate block, care has to be taken to not exceed the maximum dosage of the local anesthetic. Intravascular injection may be avoided with incremental injection with frequent withdrawal.

Ankle block.

Block of the nerves of the foot at the ankle is a technique that is valuable to produce both surgical anesthesia and postoperative analgesia for procedures on the foot. If a tourniquet is being used, one can use an Esmarch® at the level of the ankle rather than the standard thigh or calf tourniquet

Anatomy & technique: There are five nerves that have to be blocked to provide an adequate ankle block. (i) Deep peroneal nerve (L_4, L_5, S_1, S_2) innervates the web space between the great and second toes. It is blocked at the level of the ankle crease in the lower part of the leg, by inserting a 25-gauge needle through the skin until it contacts the tibia 5 ml of local anesthetic are injected and then an additional amount as the needle is being withdrawn. (ii) Superficial peroneal nerve (L_4, L_5, S_1, S_2) innervates the medial and lateral aspects of the dorsum of the foot. It is blocked immediately above the talocrural joint. It can be blocked by subcutaneous infiltration of local anesthetic from the anterior border of the tibia to the lateral malleolus. (iii) saphenous nerve, which innervates the skin over the medial malleolus. It is blocked by subcutaneous infiltration around the great saphenous vein at the level of the medial malleolus. (iv) tibial nerve (L_4, L_5, S_1, S_2, S_3) lies posterior to the posterior tibial artery and divides into the medial and lateral plantar branches, which innervate their respective aspects of the sole of the foot. It is blocked at the level of the medial malleolus.(v) sural nerve is blocked at the lateral aspect below the lateral malleolus

Complications: It is very rare to see complications from an ankle block. However, the use of vasoconstrictors in the block solution can cause necrosis of the toes. Care should be taken to avoid the use of an ankle block in patients who may have compromised blood flow to the lower extremity.

CONCLUSION: Regional anesthesia can be used for most pediatric surgical procedures. Caution has to be exerted since most patients are under general anesthesia and paresthesias cannot be obtained. Dosing of local anesthetic with limits set on maximum doses should be part of the routine when a choice of regional technique is considered.

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