Chapter 30: Regional Anesthesia: Head and Neck Blocks

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INTRODUCTION

FOCUS POINTS

1. Hand and neck blocks can be used to relieve pain and supplement general anesthesia in infants and children undergoing head and neck surgery.[1,2] Block selection depends on the surgical approach. Most anesthesiologists have limited opportunity to perform these blocks since major surgery of the face and neck is relatively uncommon and local infiltration is often used for most minor procedures.[3,4]
2. Local infiltration provides a circumscribed area of anesthesia in the immediate vicinity of injection and large volumes of local anesthetic may be required. A nerve block on the other hand provides a larger area of anesthesia for a relatively small volume of local anesthetic.
3. Most children have an inherent fear of needles, particularly around the facial area. This precludes its use in young children (and in some older children!) without sedation or general anesthesia.
4. The anatomical landmarks are relatively constant in adults but structural changes that occur during growth of a child results in some variability. A thorough understanding of the anatomical relationship of the nerve to be blocked is essential since the anatomy of the head and neck is compact and the cranial and cervical nerves are close to vital structures. Inadvertent injection into these blood vessels carries a significant risk of toxicity.

DEVELOPMENT OF THE SKULL 5

A newborn's facial configuration differs from that of an adult. Ossification is incomplete and many bones are still in several elements united by fibrous tissue or cartilage. The face below the orbits, including the mandible, accounts for about one-half of the skull in adults. In the newborn the air sinuses are rudimentary, the mandible and maxillae are small, the teeth are absent, and thus the face below the orbit makes up only one-eighth of the skull.

The orbit in newborns is large and almost circular. The supra-orbital notch is near the middle of the supra-orbital margin in adults, whereas it lies more medial in the newborn. The maxilla is small, the distance between the alveolar ridges is short, and the infraorbital foramen is millimeters from the inferior orbital ridge.

The mandibular ramus also varies with age. At birth the angle of the mandible is small (obtuse) and develops with progressive growth of the mandible. In the child, before tooth eruption, the mental foramen is closer to the alveolar margin. When the teeth erupt the mental foramen descends to halfway between the margins, and in adults with the teeth preserved, the mental foramen is somewhat closer to the inferior border of the mandible.[6]

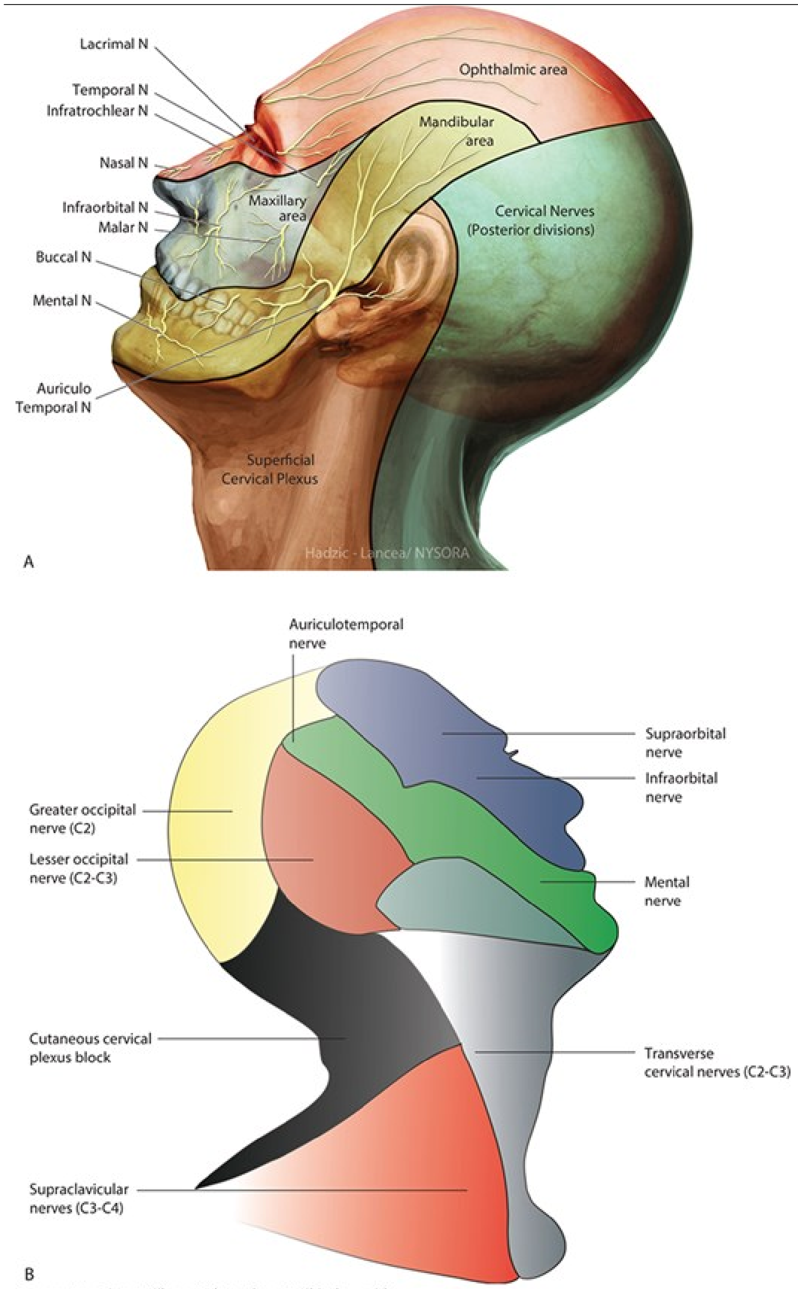
INNERVATION OF THE FACE

Briefly, the innervation of the head, face, and neck is best understood if one considers the embryological development as the face forms around the primitive mouth or stomodeum. Initially, the stomodeum is surrounded caudally by the mandibular arch (supplied by the mandibular division of the trigeminal nerve), laterally on each side by the maxillary processes (supplied by the maxillary division of the trigeminal nerve), and rostrally by the forebrain capsule, which develops the frontonasal process (supplied by the ophthalmic division of the trigeminal nerve) that eventually forms the nose. The two maxillary processes grow inward and join together below the primitive nose to form the upper margin of the mouth.

Thus in the mature face, the forehead, eyebrows, upper eyelids, and nose are supplied by the ophthalmic division of the trigeminal nerve. The lower eyelids, cheek, and upper lip are supplied by the maxillary division, while the lower lip, chin, and mandibular and temporal regions are supplied by the mandibular division (Figure 30-1A). All these nerves may be blocked proximally to provide anesthesia in the sensory distribution of that particular nerve. Disproportionate growth of the cranial cavity in humans causes these dermatomal distributions to be distorted cranially, with the result that some skin innervated by the cervical plexus is drawn up over the angle of the mandible and posteriorly over the occipital area and the scalp as far as the vertex (Figure 30-1B).

Figure 30-1

Innervation of the head and neck: (A) Distribution of the the branches of the trigeminal nerve (Reproduced with permission, from Hadzic A. *Hadzic's Textbook of Regional Anesthesia and Acute Pain Management*, 2nd ed. 2017. https://accessanesthesiology.mhmedical.com. Copyright © McGraw Hill LLC. All rights reserved). (B) Sensory distribution of the cervical plexus and innervation of the lateral aspect of the face and scalp (Reproduced with permission, from Hadzic A, eds. *Hadzic's Peripheral Nerve Blocks and Anatomy for Ultrasound-Guided Regional Anesthesia*, 2nd ed. 2012. https://accessanesthesiology.mhmedical.com. Copyright © McGraw Hill LLC. All rights reserved).



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Risks

Specific complications peculiar to regional anesthesia in this area are more likely to occur with deep blocks and usually involve damage to adjacent structures or spread to the central nervous system by direct or vascular injection.[7–9] Convulsions or extensive neuraxial anesthesia will require urgent resuscitation.

To date, complications have only been described in adults and include transient loss of consciousness, convulsions, and reversible blindness as a result of injection of small volumes of local anesthetic into the vertebral or carotid artery or one of their branches. Local anesthetic could also spread into the neuraxis by direct penetration of either the foramina of the skull or the dura to produce total brainstem anesthesia.[9]

Deep nerve blocks of the head and neck in children should only be attempted by experts for specific indications, preferably under imaging or radiological control. Superficial nerve blocks on the other hand are blocks of the terminal branches of these deep nerves. Although these blocks reduce the field of anesthesia, they are relatively simple to perform and carry a low risk.

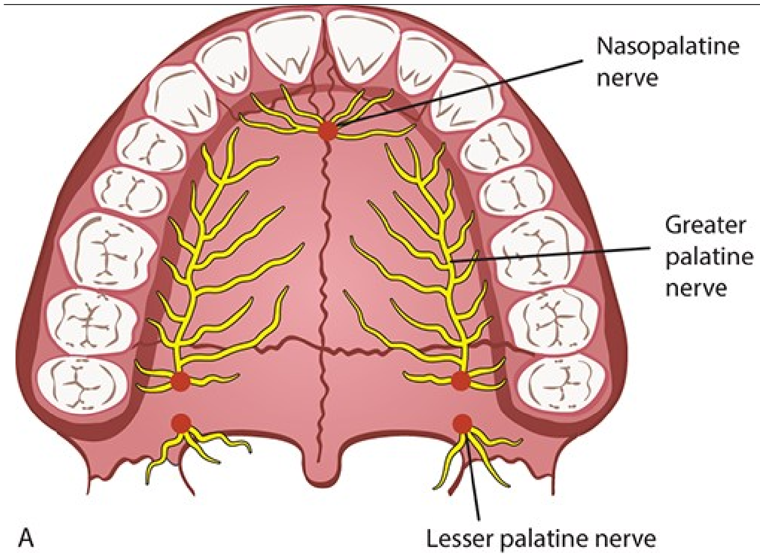
Local anesthetic toxicity is dependent on the age of the patient, the agent used, the dose given, the use of a vasoconstrictor, and the site of injection: Maximum safe dose for commonly used local anesthetic agents have been described (lignocaine 3 mg/kg with epinephrine 6 mg/kg; bupivacaine 2 mg/kg; ropivacaine 3 mg/kg). Slow injection of fractionated doses with intermittent aspiration reduces the risk of toxicity. Most blocks of the head and neck can be achieved using less than 1.5 mL. The finest-gauge needle available should be used to reduce the risk of bruising and to avoid permanently marking the face.

Surgery of the Palate

The maxillary division of the trigeminal nerve (V2) provides sensory innervation to the hard and soft palate, upper jaw and maxillary sinus, back of the nasal cavity, and upper dental arch. Terminal branches of the maxillary division include the greater and lesser palatine nerves and nasopalatine nerve that provides intraoral innervation to the hard and soft palate (Figure 30-2A).[10–16]

Figure 30-2

(A) Terminal branches of the maxillary division of the trigeminal nerve and innervation of the soft and hard palate. (B) Needle insertion for the greater palatine nerve block is 1cm medial to the junction of the maxillary second and third molars (Reproduced with permission, from Hadzic A. *Hadzic's Textbook of Regional Anesthesia and Acute Pain Management*, 2nd ed. 2017. https://accessanesthesiology.mhmedical.com. Copyright © McGraw Hill LLC. All rights reserved).

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The maxillary division after leaving the foramen rotundum traverses the pterygopalatine fossa and passes forward and laterally to reach the floor of the orbit by the infraorbital fissure. The palate can be blocked proximally using a suprazygomatic approach,[12–15] or distally as it emerges from the greater palatine foramen as the greater palatine nerve on the hard palate.

With the patient supine and head in the neutral position, the needle is inserted perpendicular to the skin at the angle formed by the superior edge of the zygomatic arch and the posterior rim of the orbital ridge. The needle is advanced till bony contact with greater wing of sphenoid is made. This depth will vary from 15 to 25 mm depending on the size of the infant or child. Once bony contact is made the needle is redirected toward the philtrum and advanced 15 to 20 mm into the fossa after “walking off” the sphenoid. After a negative aspiration for blood 0.15 mL/kg local anesthetic can be injected. Ultrasound can be used to confirm correct placement within the fossa by directing an infrazygomatic-placed probe toward the fossa.[16]

Alternatively the *greater palatine nerve*, a terminal branch of the maxillary division, courses from the pterygoid ganglion through the greater palatine fossa and emerges from greater palatine foramen. The greater palatine foramen lies medial to the second molar or just anterior to the junction of the hard and soft palate in those infants who do not yet have molar teeth Figure 30-2B. Local anesthetic inserted superficially at this location will block the nerve as it emerges from the foramen. Advancing the needle into the foramen risks intraneural injection or nerve compression in the confined space.

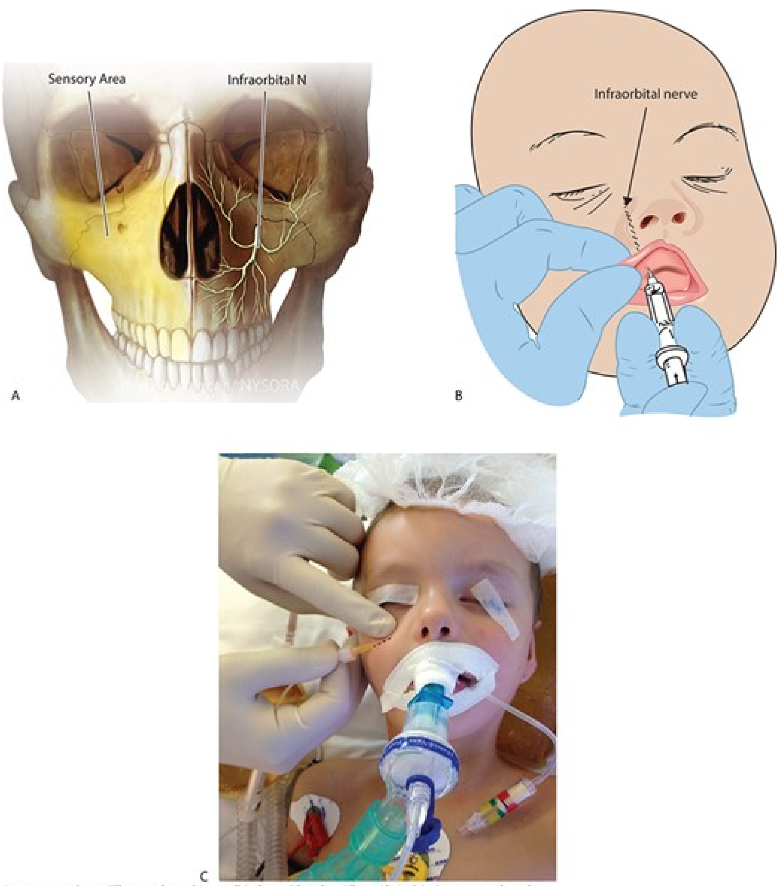
SURGERY OF THE LIPS

Upper Lip

The *infraorbital nerve, also a branch of the maxillary division of the trigeminal nerve*, supplies sensory innervation to the skin and mucous membrane of the upper lip and lower eyelid, the cheek between them and to the alae of the nose (Figure 30-3A). Infraorbital nerve blocks have proved useful in neonates,[17] infants, and older children undergoing cleft lip repair.[18–21] Perioperative analgesia without risk of respiratory depression can be provided. Two approaches to the infraorbital nerve have been described in children: (i) the *intraoral approach* and (ii) the extraoral approach in neonates and infants.

Figure 30-3

(A) Sensory area of the intraorbital nerve (Reproduced with permission, from Hadzic A. *Hadzic's Textbook of Regional Anesthesia and Acute Pain Management*, 2nd ed. 2017. https://accessanesthesiology.mhmedical.com. Copyright © McGraw Hill LLC. All rights reserved). (B) Intraoral approach to the infraorbital nerve block. Needle insertion point is into the mucosa at the gingivolabial junction at the level of the canine tooth and directed toward the infraorbital foramen. (C) Extraoral approach to the infraorbital nerve block. The infraorbital foramen in palpated and the needle is introduced over this area until bony contact in achieved (Reproduced with permission, from Hadzic A. *Hadzic's Textbook of Regional Anesthesia and Acute Pain Management*, 2nd ed. 2017. https://accessanesthesiology.mhmedical.com. Copyright © McGraw Hill LLC. All rights reserved).



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In intraoral approach,[18–21] after lifting the upper lip and cleaning the mucosa, a fine needle is inserted under and into the gingivolabial fold at the level of the canine tooth (if present) and directed upward and outward toward the infraorbital foramen (Figure 30-3B). The infraorbital foramen, more easily palpable in older children, lies just below the orbital rim on a line drawn caudad through the center of the pupil. When the tip of the needle is palpable in the area of the foramen, 0.5 to 1.5 mL of local anesthetic can be deposited at the foramen opening after prior aspiration. It is not necessary to enter the foramen as this may result in nerve damage by compression in the narrow infraorbital canal. Penetration of the flimsy orbital floor and damage to the orbital contents is another potential danger of entering the foramen.

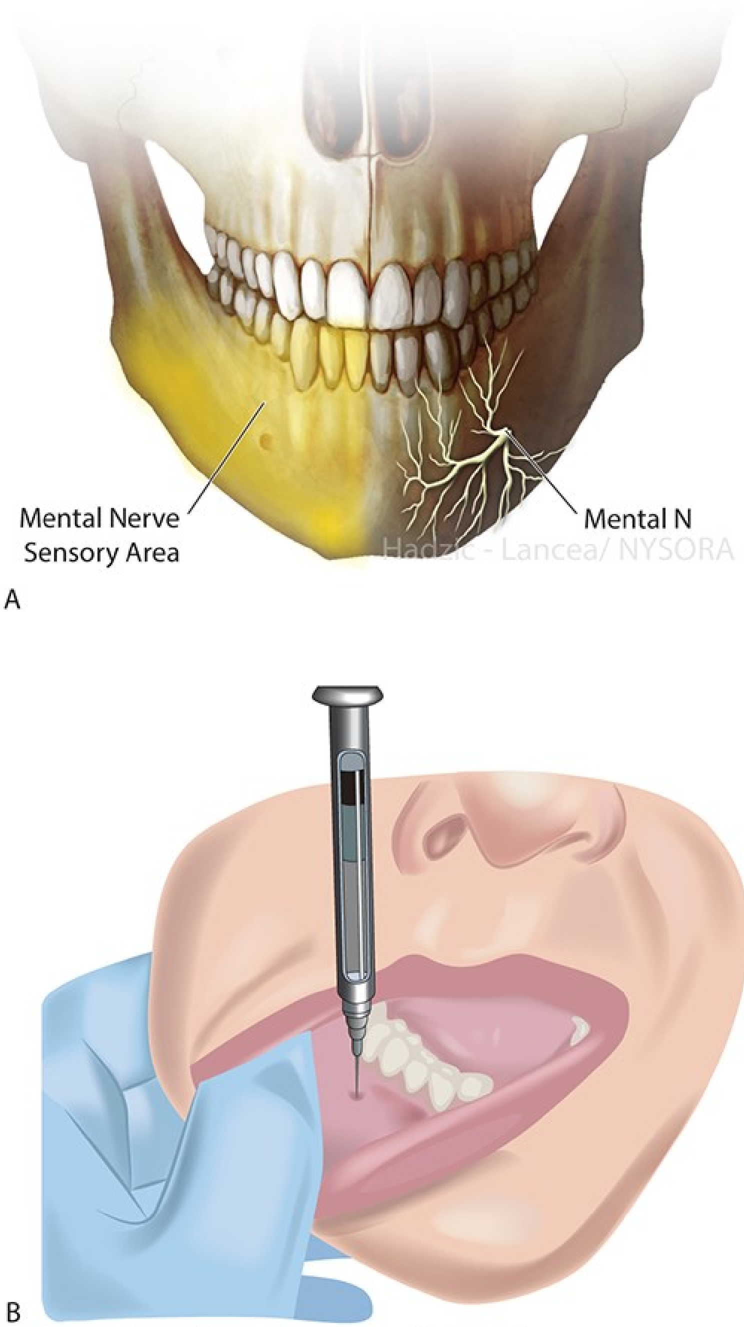
Extraoral approach[17] will depend on whether the infraorbital foramen is palpable or not. The foramen is palpable in older children and lies approximately 0.5 cm below the junction of the medial and middle thirds of the lower orbital rim. A fine needle is introduced vertical to the skin at this point until bone contact is made Figure 30-3C. A successful block can be achieved if the local anesthetic is placed in the vicinity of the foramen. The foramen is not easily palpable in neonates and small infants. In this age group a simple measurement made from the angle of the mouth to the palpebral fissure can be used. This is approximately 30 to 32 mm in term neonates. The infraorbital foramen will lie at the coordinates of half that distance (15 to 16 mm) from the palpebral fissure and quarter of that distance (7.5 to 8 mm) from the alae nasi.[17]

Lower Lip

The mandibular division of the trigeminal nerve V3 gives off several major branches: the buccal nerve, lingual nerve, inferior alveolar nerve, and the auriculotemporal nerves. The mental nerve, a terminal branch of the inferior alveolar nerve, emerges through the mental foramen in the mandible to provide sensory innervation to the lower lip and chin (Figure 30-4A). The position of the mental foramen varies with age. It lies more caudad on the mandibular ramus in children with teeth but is close to the alveolar margin in infants and neonates.[6] Retract the lower lip, and after cleaning over the midpoint of the mandible in a vertical line with the infraorbital foramen, the nerve can be blocked as it emerges from the mental foramen by infiltrating 0.5- to 1.0-mL local anesthetic (Figure 30-4B). The apex of the root of the second premolar can serve as an alternative landmark in children older than 2 years.

Figure 30-4

(A) Sensory area of the mental nerve (Reproduced with permission, from Hadzic A. *Hadzic's Textbook of Regional Anesthesia and Acute Pain Management*, 2nd ed. 2017. https://accessanesthesiology.mhmedical.com. Copyright © McGraw Hill LLC. All rights reserved). (B) The mental nerve is blocked by inserting the needle into the buccal fold along the vertical line drawn from the intraorbital foramen or at the second premolar.



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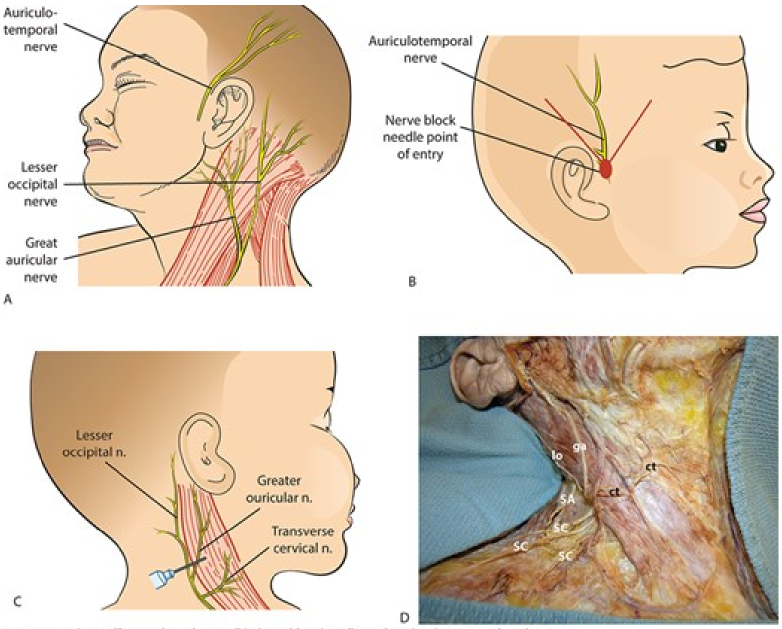
Surgery of the Ear

The nerve supply to the pinna is complex. The pinna is supplied by both the cervical plexus and the trigeminal nerve. Branches of the cervical plexus, the greater auricular nerve, and the lesser occipital nerve supply the posterior surface of the ear and the lower third of its anterior surface. The superior two-thirds of the anterior surface of the pinna is supplied by the auriculo-temporal branch of the mandibular division of the trigeminal nerve (Figure 30-5A).

Figure 30-5

(A) Nerve supply to the ear. (B) Lateral view of the head illustrating the course of the auriculotemporal nerve as well as needle entry point. (C) Lateral aspect of the head showing the location of the greater auricular and lesser occipital nerves proximally. The nerves can be blocked together at the midpoint of the posterior border of the sternocleidomastoid muscle. (D) Superficial cervical plexus branches (Reproduced with permission, from Hadzic A, eds. *Hadzic's Peripheral Nerve Blocks and Anatomy for Ultrasound-Guided Regional Anesthesia*, 2nd ed. 2012. https://accessanesthesiology.mhmedical.com. Copyright © McGraw Hill LLC. All rights reserved). Ct, transverse cervical; ga, greater auricular; lo, lesser occipital; sc supraclavicular. Note the spinal accessory nerve (SA) and its proximity to the proximal blockade of the greater auricular and lesser occipital nerves.



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Successful postoperative analgesia has been described for children undergoing otoplasties or surgical correction of "bat ears."[22–26] Blockade of the greater auricular, lesser occipital, and auriculo-temporal nerves provide more prolonged analgesia than local infiltration.

The cervical plexus supply to the ear can be blocked at various points; the more distal the block, the more localized the area of blockade. The choice of block may also be influenced by the ability to identify the landmarks in children of different ages. For example, in infants the posterior border of the sternocleidomastoid may be difficult to identify in their relative short neck. A more peripheral block might be preferred in this age group. Irrespective of age the muscular landmarks should be delineated before sedating or anesthetizing the child to facilitate the accurate placement of the block.

The *auriculotemporal nerve* can be blocked by infiltration between the pinna and lateral corner of the eye as the nerve ascends over the posterior aspect of the zygoma behind the superficial temporal artery (Figure 30-5B).

The *greater auricular nerve* and lesser occipital nerves can be blocked proximally as they emerge at the midpoint of the posterior border of the sternocleidomastoid (Figure 30-5C); more distally where the nerves lie more superficially by infiltration from the angle of the mandible to the mastoid process; or over the mastoid process posterior to the ear.

It is worth noting that the accessory nerve provides the motor innervation to the trapezius and lies very close to the cervical plexus (Figure 30-5D). It emerges at the junction of the upper and middle third of the posterior border of the sternocleidomastoid and may also be blocked when the more proximal approach is used, particularly in young children. The child (or parent) should be warned about the inability to shrug their shoulder after the block.

Surgery to Eyelid

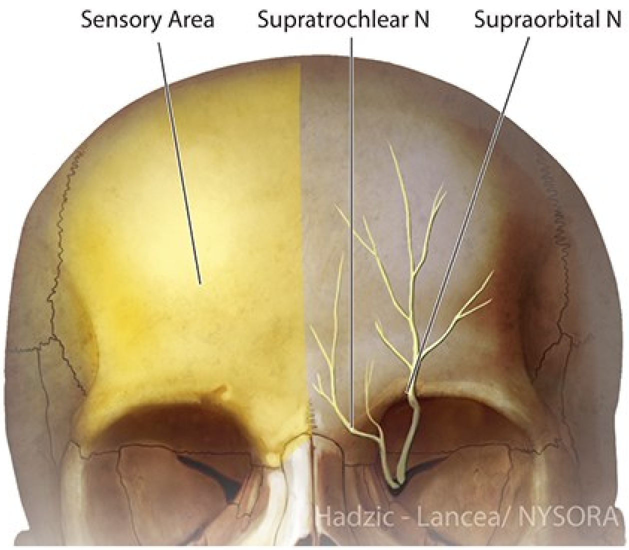
The sensory supply to the lower eyelid is provided by the infraorbital nerve. The upper eyelid is supplied medially by the supratrochlear nerve and laterally by the lacrimal and zygomaticofacial branches of the maxillary division of the trigeminal nerve.

Surgery of the Forehead

The sensory innervation of the forehead and scalp to the vertex is provided by the supraorbital and supratrochlear nerves (Figure 30-6A).[27] These are terminal branches of the ophthalmic division of the trigeminal nerve (V1). The lateral aspect of the forehead and temporal region is supplied by the auriculotemporal (mandibular division) and zygomaticotemporal nerves (maxillary division of trigeminal nerve). Blockade of these nerves is simple and can be used for minor surgical procedures in this area (eg, removal of cysts, suture of lacerations, etc). When combined with blocks of other sensory nerves to the scalp (occipital, greater auricular), they provide excellent analgesia for craniofacial surgery.

Figure 30-6

(A) Sensory area of the supratrochlear and supraorbital nerves (Reproduced with permission, from Hadzic A. *Hadzic's Textbook of Regional Anesthesia and Acute Pain Management*, 2nd ed. 2017. https://accessanesthesiology.mhmedical.com. Copyright © McGraw Hill LLC. All rights reserved). (B) The supraorbital and supratrochlear nerves can be blocked using the single injection technique or by blocking each nerve individually as shown here.



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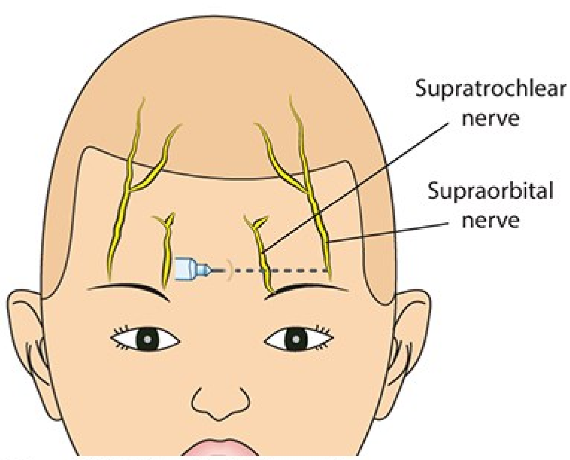

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The *supraorbital nerve* can be blocked as it emerges from the orbit through the supraorbital notch, although Beer et al have shown that this is not always true and the nerve may emerge a variable distance along and above the supraorbital rim.[27] The majority of exit points are asymmetrical. In older children the supraorbital notch lies in the same vertical plane as that of the pupil and infraorbital foramen but is slightly more medial in neonates and infants (Figure 30-6B).

The *supratrochlear nerve* emerges from the superomedial angle of the orbit and runs up the forehead parallel to the supraorbital nerve. The technique for blocking this nerve is the same except the needle is inserted in the medial portion of the orbital rim just lateral to the root of the nose. It is best to block these nerves by infiltrating 1 to 2 mL local anesthetic solution between skin and bone above the eyebrow to reduce the risk of periorbital hematoma formation. The two nerves can be blocked simultaneously using a single-needle insertion in midbrow above the root of the nose and infiltrating 1 to 2 mL local anesthetic laterally, along the supraorbital rim. Infiltration occurs over this location from lateral to medial (Figure 30-6B).

The *zygomaticotemporal nerve* can be blocked by subcutaneous infiltration as it emerges from the anterior aspect of the zygomatic arch.

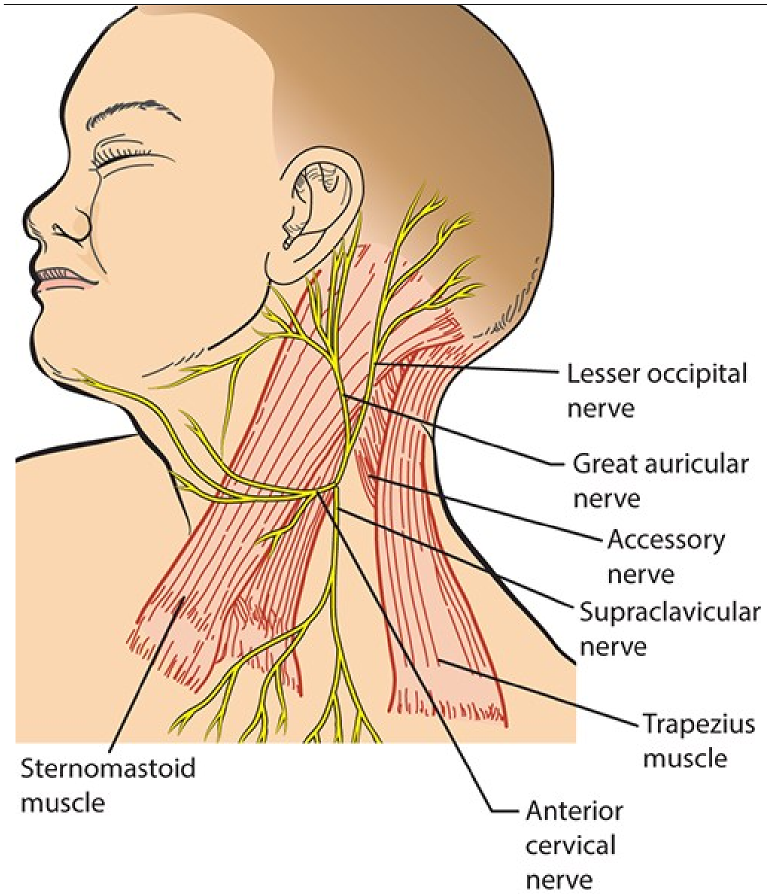
Surgery of the Neck

The anterolateral aspect of the neck is supplied by the anterior primary rami of the cervical plexus (Figure 30-1B). These emerge as four distinct nerves from the posterior border of the sternocleidomastoid muscle at its midpoint. The lesser occipital and greater auricular nerves supply the ear and the skin over the angle of the mandible. The anterior cutaneous nerve supplies the skin from chin to suprasternal notch and the supraclavicular nerve supplies the inferior aspect of the neck and clavicle as far as the second rib, laterally over the deltoid, and posteriorly to the spine of the scapula.

All four branches can be blocked by introducing a fine-gauge needle perpendicular to the skin and infiltrating 1 to 2 mL local anesthetic solution at the midpoint of the posterior border of the sternocleidomastoid and along the middle third of the posterior border of the sternocleidomastoid (Figure 30-7).[28,29] The depth of insertion, usually 0.5 to 1 cm, will vary according to the age of the patient and the extent of subcutaneous fat. Avoid puncturing the external jugular vein as it crosses the sternocleidomastoid close to this point. Theoretically these nerves could be blocked individually but it is usual to block all four branches and also the accessory nerve if the deep fascia is penetrated.

Figure 30-7

Superficial cervical plexus emerges from the midpoint of the posterior border of the sternoicleidomastoid muscle. All four nerves can be blocked at this point.



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Successful block of the superficial cervical plexus results in analgesia corresponding to the C2–4 dermatomes and can be used for both major and minor surgical procedures such as thyroid surgery and excision of thyroglossal cysts, branchial arch anomalies, or lymph node biopsy. In a recent report, it was considered a safer alternative than general anesthesia for a cervical lymph node biopsy in a child with a large mediastinal mass.[28] In the event of anatomical distortion by a large mass of nodes (lymphoma, tuberculosis) or cystic hygroma, the superficial cervical block is probably best avoided. Placement of internal jugular or subclavian venous catheters could also be made more comfortable for awake children by using a superficial cervical plexus block.

STELLATE GANGLION BLOCK

Indications for stellate ganglion block do not frequently arise in children, but the role of steliate ganglion block in chronic pain in children still needs to be defined.[29–35] Clinical syndromes unrelated to pain have been managed with stellate ganglion blockade. These include the Romano–Ward and Jervell–Lange–Nielson syndromes both characterized by prolonged QT interval and life-threatening cardiac dysrhythmias.[31,32]

The block is performed with the child in the supine position with the neck extended by placing an appropriate-sized towel or pillow beneath the shoulders. Chassaignac's tubercle, the anterior tubercle of the transverse process of the sixth cervical vertebra, is defined at the level of the cricoid cartilage and immobilized between the second and third fingers (Figure 30-4). With the same fingers the carotid artery is retracted laterally along with the anterior border of the sternocleidomastoid muscle. A fine-gauge needle can be inserted perpendicularly through the skin toward the sixth transverse process. After bony contact is made, the needle is withdrawn slightly and after negative aspiration 0.15 to 0.2 mL/kg local anesthetic can be injected slowly.

INFILTRATION

Local infiltration is most commonly used for minor surgery or when lacerations are sutured in the conscious child.[36–39] It sometimes involves multiple potentially painful injections. A simple nerve block such as those described earlier can reduce the number of injections, while increasing the field of anesthesia and reducing local tissue distortions.

However, there are a number of simple maneuvers that can make infiltration anesthesia less painful.[38,39] These include the use of fine-gauge needles, injecting warm buffered local anesthetic solution slowly into the sides of the laceration rather than through intact skin after the application of topical tetracaine.

Scalp infiltration is commonly used before craniotomy[35,36] to prevent the potentially detrimental hemodynamic response to scalp incision and reflection. A 0.125% concentration of bupivacaine with 1:400000 epinephrine is as effective as a 0.25% bupivacaine solution with 1:400000 epinephrine in reducing hemodynamic responses. The lower concentration produces lower blood levels and would therefore be safer to use for scalp lacerations if large volumes are required. Simple blocks to the nerves innervating the scalp would further reduce the risk.

CONCLUSION

Superficial nerve blockade of the face and neck is a relatively unexplored area in pediatric anesthesia. Regional anesthesia in this area of the body is challenging but a technically satisfying addition to the pediatric anesthesiologist's repertoire to provide excellent long-lasting analgesia for certain surgical procedures. Lack of knowledge or imagination should not put a limit on their potential benefit.

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