A comprehensive review of regional anesthesia for head and neck surgery

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Abstract
Head and neck surgery encompasses a wide range of procedures from common tonsillectomy to major head and neck cancer resections requiring free flap reconstruction. Anesthetic management of these procedures relies predominately on general anesthesia; however, regional anesthetic techniques are available that can be used for both the primary anesthetic and analgesia, or in combination with general anesthesia. Traditionally most of these blocks were done blindly using anatomical structures, but with more availability of ultrasounds, these blocks are easier to perform, and with less complications. In this review, we will discuss the anatomical and ultrasound-guided approaches to regional anesthetic techniques that can be used in head and neck surgeries for primary intraoperative management, or in combination with general anesthesia for perioperative pain management. A discussion of outcomes studies of the different nerve blocks and potential complications associated with block placement will be highlighted.

Keywords: Greater and lesser occipital nerve blocks, Supraorbital and supratrochlear nerve, Infratrochlear nerve block, Mandibular nerve block, Mental nerve block, Superficial cervical plexus nerve, Glossopharyngeal nerve block, Recurrent and superior laryngeal blocks

Head and neck surgery encompasses a wide range of procedures from common tonsillectomy to major head and neck cancer resections requiring free flap reconstruction. Anesthetic management of these procedures relies predominately on general anesthesia; however, regional anesthetic techniques are available that can be used for both the primary anesthetic and analgesia, or in combination with general anesthesia. Traditionally most of these blocks were done blindly using anatomical structures, but with more availability of ultrasounds, these blocks are easier to perform, and with less complications. In this review, we will discuss the anatomical and ultrasound-guided approaches to regional anesthetic techniques that can be used in head and neck surgeries for primary intraoperative management, or in combination with general anesthesia for perioperative pain management. A discussion of outcomes studies of the different nerve blocks and potential complications associated with block placement will be highlighted.

Regional anesthetic techniques and considerations for head surgery

The greater occipital nerve (GON)

The GON is a sensory nerve that arises from the medial branch of the dorsal ramus of the C2 spinal nerve (Fig. 1). It innervates the muscles at the back of the head, arises between the obliquus capitis inferior and the trapezius fascia just inferior to the superior nuchal ridge along with the occipital artery. The greater occipital nerve becomes more superficial as it pierces the trapezius fascia just inferior to the superior nuchal ridge along with the occipital artery. It supplies the medial aspect of the posterior scalp from the EOP to the mastoid process on the superior nuchal line closer to the occiput. The GON can be blocked using anatomic landmarks, or by ultrasound guidance. Anatomically, the occipital artery can be palpated approximately one-third the distance from the EOP to the mastoid process on the superior nuchal line closer to the occiput. The nerve is medial to the artery. The injection site is 2 cm inferior and 2 cm lateral to the EOP. It may be blocked using a 11/2 inch 25- or 27-G needle, and 1–3 mL of local anesthetic (0.25% or 0.5% ropivacaine or bupivacaine) injected after aspiration. First perform a subcutaneous injection (localize the skin with 0.5 mL of 2% lidocaine using a 27-G needle), then perform a continuous injection with intermittent aspiration as you insert your 11/2 inch 25- or 27-G needle deeper into the muscle while fanning out superior, medially and inferior. Occasionally, the entire length of the needle may be inserted and it is fine if you hit the skull while injecting. Apply pressure and gently rub the area in a circular motion to allow for dissipation of the local anesthetic around the nerve, to provide hemostasis if inadvertently intravascular injection occurs.

The greater occipital nerve can also be blocked using ultrasound guidance. Ultrasound guidance allows for visualization of the nerve and vessels, thus preventing direct injection into them and minimizing nerve injury. There are 2 areas where the GON can be blocked. The first location is by placing a linear probe at the level of the superior nuchal line in a transverse plane with the probe slightly lateral to the EOP. Another approach is placing the same probe on the spinous process of the atlas just lateral to the EOP. Another approach is placing the same probe on the spinous process of the atlas just lateral to the EOP. The probe is then moved posteriorly and inferiorly, and the occipital artery can be identified. The greater occipital nerve can then be identified by using the bony landmarks and the suboccipital triangle (Fig. 2). The greater occipital nerve becomes more superficial as it pierces the trapezius fascia just inferior to the superior nuchal ridge along with the occipital artery. It supplies the medial aspect of the posterior scalp from the EOP to the mastoid process on the superior nuchal line closer to the occiput. The nerve is medial to the artery. The injection site is 2 cm inferior and 2 cm lateral to the EOP. It may be blocked using a 11/2 inch 25- or 27-G needle, and 1–3 mL of local anesthetic (0.25% or 0.5% ropivacaine or bupivacaine) injected after aspiration. First perform a subcutaneous injection (localize the skin with 0.5 mL of 2% lidocaine using a 27-G needle), then perform a continuous injection with intermittent aspiration as you insert your 11/2 inch 25- or 27-G needle deeper into the muscle while fanning out superior, medially and inferior. Occasionally, the entire length of the needle may be inserted and it is fine if you hit the skull while injecting. Apply pressure and gently rub the area in a circular motion to allow for dissipation of the local anesthetic around the nerve, to provide hemostasis if inadvertently intravascular injection occurs.

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process of C2 then moving the probe laterally to identify the obliquus capitis inferior muscle of the neck. The GON is an hypoechoic structure visualized just below the caudate border of the semispinalis muscle, and
crossing the obliquus capitis inferior muscle from lateral to medial (Fig. 4)\(^5\).

**The lesser occipital nerve (LON)**

The LON arises from the ventral primary rami of the C2 and C3 nerves (Fig. 5). The nerve passes superiorly along the posterior border of the sternocleidomastoid muscle (SCM), dividing into the cutaneous branches that innervate the lateral portion of the posterior scalp and the cranial surface of the pinna of the ear (Fig. 6)\(^10\). The LON as with the greater occipital nerve can be blocked to diagnose and treat occipital neuralgia and cervicogenic headaches (headaches that arise from bony structures or soft tissues of the neck). Occipital neuralgia is a headache characterized by pain that is isolated to sensory fields of the greater or LONs\(^11\). The LON lies two-third along the superior nuchal line closer to the mastoid process. Anatomically, the LON can be blocked 5 cm lateral and 1 cm inferior to the EOP\(^7\). However, local anesthetic can spread to the LON while performing the GON block at
the C2 spinous process when using ultrasound guidance. Place a linear probe on the spinous process of C2 then moving the probe about 5 cm laterally to identify the attachment point of the SCM on the mastoid, the LON lies along the posterior border of the muscle (Fig. 7). The block can be performed using an out-of-plane technique with an 11/2 inch 25- or 27-G needle. Inject 1–2 mL of local anesthetic (0.25% or 0.5% ropivacaine or bupivacaine) after aspiration. Ultrasound-guided occipital nerve blocks appear to be relatively safe, effective, and an easy procedure for both the diagnosis and treatment of occipital neuralgia secondary to direct visualization of the greater occipital nerve and LON. It prevents direct injection into the nerves, minimizing nerve injury, and also prevents injection into the greater occipital artery and the vertebral artery. Use ultrasound whenever feasible.

Outcome studies on head blocks
Greater occipital nerve blocks has been shown to be effective in the short-term for treatment of chronic migraine by reducing the frequency and severity of headaches\cite{12,13}. Cuadrado and colleagues randomized 18 women to a GON block with bupivacaine 0.5% and 18 women to a sham procedure with normal saline. Result showed that anesthetic block was superior to placebo in reducing the number of days per week with moderate or severe headache or any headaches\cite{12}. In a metanalysis, Tang et al showed that although GON can reduce the number of headache days and alleviate pain, it had no significant effect on the duration of headache per 4 weeks for migraine patients\cite{13}. LON block have
also been shown to be helpful in treating occipital neuralgia in the short-term but had no significant benefit at 6 months postinjection\cite{14}. Overall, there is evidence showing the effectiveness of head blocks in reducing pain thus allowing for a reduction in the use of nonsteroidal anti-inflammatory drugs and its hepatic complications; opioid use which leads to less complications such as postoperative nausea and vomiting (PONV), sedation, and constipation.

Complications of head blocks
Complications of head and scalp blocks are rare due to the superficial locations of the nerves. However, intravascular injection and spinal spread of local anesthetic are potential complications. Always aspirate prior to injection to avoid intravascular injection. The vertebral and greater occipital arteries are in close proximity (lateral) to the GON. The spinal cord is medial and deep to the muscles, and in children with prior spine surgeries extreme caution should be taken to remain subcutaneously during injection to avoid a total spinal anesthetic and respiratory compromise.

Regional anesthetic techniques for facial and oral surgeries

Supraorbital and supratrochlear nerve block
The supraorbital and supratrochlear nerves are terminal branches of the frontal nerve, a branch of the ophthalmic nerve (V1) from the trigeminal nerve (Fig. 8). The supraorbital nerve can be blocked by palpating the supraorbital notch (located at the middle portion of the superior orbit, 2–3 cm from the midline of forehead) and directing the needle to the medial brow (Fig. 9). Injecting 1–2 mL of 0.5% ropivacaine or bupivacaine is enough to block the nerve, providing sensory loss around the eyebrow, upper eyelid, and lower forehead. The supratrochlear nerve can be blocked by palpating the notch and depositing local anesthetic (2–3 mL) in a medial and lateral direction to capture lateral supraorbital fibers. Ultrasound guidance can also be used to block both nerves. A linear probe is placed in a transverse position above the orbital rim and local anesthetic is deposit next to the nerve (Fig. 10)\cite{5}. The full area of sensory loss for both nerves includes the frontal scalp, forehead, bridge of nose, and the upper eyelid. Thus, the block can be used for surgeries such as frontal sinus, cosmetic nasal surgery, ophthalmic, frontal craniotomies, and awake craniotomy\cite{16,17}. It can also be used to treat supraorbital and supratrochlear neuralgia and migraine headaches\cite{18,19}.

Infraorbital nerve block
The infraorbital nerve is a branch of the maxillary nerve (V2) derived from the trigeminal nerve. It is in the infraorbital foramen, which is below the inferior orbital rim, about 3 cm from midline of the face, aligned with both the pupil and supraorbital notch (Fig. 11). Injecting 2–3 mL of 0.5% ropivacaine or bupivacaine is sufficient to provide analgesia for the cheek, upper

**Figure 9.** Demonstration of supraorbital nerve block (A) and supratrochlear nerve block (B), advance needle subcutaneously after palpating the supraorbital notch and directing the needle to the medial brow.

**Figure 10.** Ultrasound image of supraorbital nerve block. A linear probe is placed in a transverse position above the orbital rim and local anesthetic is deposit next to the nerve. SON indicates supraorbital nerve.

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**Figure 11.** Ultrasound image of infraorbital nerve block. A linear probe is placed in a transverse position above the orbital rim and local anesthetic is deposit next to the nerve.
lip, the floor of the orbit, and lateral aspect of the nose\cite{16}. The block is indicated for wound closures (cleft palate), abscess drainage, dental procedures, or pain relief. There are 2 common approaches to blocking the nerve (intraoral or extraoral). The extraoral approach carries the highest risk of globe penetration. When performing the block, it is important to place a finger at the infraorbital notch to avoid injecting into the orbit directly. This technique will guide the trajectory of the needle (1.5-inch 25-G needle). The safest approach is the intraoral approach. Once again leave your finger on the infraorbital notch, retract the check with thumb of the noninjecting hand and then insert the needle into the buccal mucosa above the second bicuspid tooth and direct it superiorly into the canine fossa. Aspirate first, and then inject local anesthetic (Fig. 12)\cite{5}. Placing a finger over the infraorbital foramen helps prevent direct injection into the eye. An ultrasound-guided block can also be done with a high frequency linear probe (hockey stick) and injecting local anesthetic bilaterally using an in-plane technique (needle aligned parallel to the ultrasound beam) as seen in Figure 13\cite{5}.

Sphenopalatine

The sphenopalatine ganglion (SPG) arises from the maxillary (V2) branch of the trigeminal nerve (Fig. 14). Several studies have shown blockade of the ganglion is effective in treating migraine headaches, other facial pain syndromes, and for postoperative pain after endoscopic sinus surgery\cite{21-23}. The SPG is also known as the pterygopalatine ganglion, containing autonomic, motor, and sensory nerves. It provides sensation to the hard palate, soft palate, tonsils, nasal and pharyngeal mucosa, and posterior portion of the nasal septum\cite{20}. Thus, this block can be used in combination with the infraorbital nerve block for cleft palate surgery, septoplasty and nasal laceration. The block can be done using a transnasal or transoral approach post induction and intubation. The transnasal approach entails using a cotton swab to place local anesthetic into the back of the nose (posterior border of middle turbinate), in addition, the anterior ethmoid nerve can also be blocked using a similar approach by placing a swab anterior-superiorly in the nose (Fig. 15). The anterior ethmoid nerve is a branch of the nasociliary nerve and it provides sensory innervation to the anterior portion of the nasal cavity\cite{24}. The anterior ethmoid nerve block in combination with the SPG block is useful for nasal surgery such as septoplasty and rhinoplasty in awake or asleep patients. The transoral approach to the SPG is performed by using a small gauge needle (1.5-inch 25-G needle) to inject 1–2 mL of 0.5% ropivacaine or bupivacaine with epinephrine at the groove between the first and second upper molars where the greater palatine foramen lies (Fig. 16)\cite{17}. This approach is typically more painful and technically difficult, with uncertainty in spread of local anesthetic to the ganglion.

Mandibular nerve block

The mandibular nerve (V3) is the largest branch of the trigeminal nerve (Fig. 17). It exists from the cranium through the oval foramen and divides into the posterior trunk which becomes the auriculotemporal, lingual, and inferior alveolar nerve, mental nerve, and the anterior branch which supplies motor fibers to the temporalis, masseter, pterygoids, mylohyoid, and also sensory fibers to the buccal nerve\cite{17,24}. The mandibular nerve can be used to provide anesthesia for dental procedures that involves the mandibular teeth, gingiva of the mandible, and the lower lip. It can be blocked using landmark structures or ultrasound guidance. There are several landmark techniques that can be used to block the nerve. These includes the supraperiosteal technique, periodontal ligament injection, intrapulpal anesthesia, intraseptal
The inferior alveolar nerve can be blocked as it travels on the medial aspect of the ramus of the mandible before entry into the

common techniques with inferior been the most used (Fig. 18). Vazirani-Akinosi closed-mouth mandibular block is also an acceptable approach; however, it is contraindicated in patients with an infection or inflammation involving the pterygomandibular region or maxillary tuberosity. The other techniques mentioned above can be used but are less effective with more potential complications than the Gow-Gates technique or the IANB block.

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Figure 14. Sphenopalatine ganglion and its neural connections in a sagittal view of the nasopharynx. Reproduced with permission from Robbins et al[20] (under the Copyright Clearance Center License number 4851980889049). Copyright John Wiley and Sons, Hoboken. All permission requests for this image should be made to the copyright holder.

Figure 13. Ultrasound guided block of infraorbital nerve using a high frequency linear probe (hockey stick) in an out-of-plane technique. ION indicates infraorbital nerve.
mandibular foramen, or after emerging through the foramen ovale. The needle entry point is between the coronoid and condylar processes of the ramus of the mandible. The nerve is bordered by the zygomatic arch above, and the mandibular notch below the tragus of the ear (Fig. 19)[24].

Deposition 2–5 mL of 0.5% bupivacaine after aspiration, this is enough to block the mandibular teeth on side of injection, buccal and lingual hard and soft tissue, and lower lip.

Another option is the Gow-Gates technique; it is a useful alternative to the IANB technique. Advantages include its low failure rate and its low incidence of positive aspiration. The target area for this technique is the neck of the condyle below the area of insertion of the lateral pterygoid muscle. Needle insertion site is just distal to the maxillary second molar at the level of the mesiolingual cusp. Advance the needle through soft tissue ~25 mm until contact is made with bone. Once contact is made with bone, withdraw the needle 1 mm, and aspirate. Deposition of 1–2 mL of local anesthetic after aspiration is enough to provide...
a complete block of ipsilateral mandibular bone to midline, hard and soft tissue of buccal and lingual aspect, anterior two-thirds of tongue, floor of mouth, skin over zygoma, posterior aspect of cheek, and temporal region on side of injection[17,24].

The mandibular nerve can also be blocked using ultrasound guidance. A linear probe is placed superior to the mandible or below the zygoma and anterior to the mandibular condyle in a transverse orientation on the same side of surgery. The mandibular nerve is identified as an ovoid to round hyperechoic structure medial to the alveolar artery and vein (Fig. 20). Using an out-of-plane technique with a needle (1.5-inch 25–G needle) inserted superiorly, inject 2–5 mL of local anesthetic (0.25% or 0.5% ropivacaine or bupivacaine) near the nerve after negative aspiration.

Mental nerve block

The mental nerve arise from the largest branch of the trigeminal nerve, the mandibular nerve (V3). It exits the mental foramen and divides into three branches that innervate the molar and premolar teeth, lower lip, and chin (Fig. 21)[5,27]. The block can be performed with an intraoral or an extroral (percutaneous) approach. Intraorally, retract the lower lip and apply a topical anesthetic to the base of the first bicuspid at the inferior labial sulcus for about 1 minute. Then insert a 27-G needle using a 1 mL syringe in the area of the second premolar and direct the needle anterior and inferior orientation. Extroral approach involves injecting local anesthetic 1 cm lateral to the mental foramen using a 1.5-inch 25-G needle and directing the needle laterally and medially[28]. Avoid intraforaminal injection by withdrawing the needle if the patient reports paresthesia, this will help reduce risk of permanent nerve injury. Ultrasound guidance is also useful when doing the block. With a 10–12 MHz linear transducer in an oblique transverse position, beginning scanning in a cephalad direction from the inferior border of the mandible until you find the mental foramen; the hypoechoic cleft/shadow within the hyperechoic line (Fig. 22)[29]. Following negative aspiration to avoid the mental branch of the inferior alveolar artery, inject 2–3 mL of 0.5% ropivacaine or bupivacaine. This will provide adequate analgesia for surgeries involving laceration repair, mandibular surgery and cases involving lower lip, chin, and the lower molars.

Outcome studies on facial nerve blocks

Scalp blocks such as supraorbital nerve, supratrochlear nerve, zygomaticotemporal, and auriculotemporal blocks have been shown to be helpful during awake craniotomy and frontal craniotomy[24,30]. In a prospective study, 53 patients who underwent awake craniotomy had scalp block done with blockade of the supraorbital, supratrochlear, zygomaticotemporal, auriculotemporal, greater occipital, and LONs using a mixture of 2% lidocaine and 0.75% ropivacaine, including 5 μg/mL of epinephrine. Heart rate and blood pressure after head pinning and skin incision, and incidence of severe pain on emergence from anesthesia were accessed. The heart rate and blood pressure were marginally increased as compared to baseline. Nineteen percent of the patients complained of incisional pain at emergence from anesthesia. They concluded that scalp block with a mixture of
lidocaine and ropivacaine seems to provide effective and safe anesthetic management in patients undergoing awake craniotomy, thus reducing the use of postoperative opioids\cite{31}. In a study by Ilhan and colleagues, 26 patients diagnosed with migraines were injected with 1% lidocaine at supraorbital and infraorbital nerve localizations and clinical results were evaluated after 6 months of follow-up. They concluded that injecting 1% of lidocaine to supraorbital and infraorbital nerve for 3 times prevents the acute migraine episodes effectively during the 6-months of follow-up without having any significant side effects\cite{19}.

SPG block has been shown to be effective in treating acute migraine headaches. In a retrospective case series, 55 patients with acute migraine headaches underwent a block with 2 mL of 2% lidocaine in each nostril. Rapid relief of headaches observed at 15 minutes and 2 hours, and treatment effect was sustained at 24 hours after procedure in most patients\cite{22}. Mandibular nerve block has been shown to be effective in reversing the trismus caused by pain and muscle spasm prior to intubation\cite{32} and it has also been shown to be safe and useful in patients with irreversible pulpitis\cite{33,34}. In a large systematic review, with 16 studies meeting the eligibility criteria, the efficacy of IANB was determined by comparing articaine versus lidocaine. A significant difference was observed; higher success with articaine (risk ratio, 0.76; 95% confidence interval, 0.63–0.88) in the mixed treatment comparison analysis. The probability of success for each treatment was 73% for articaine, 57% for prilocaine, 55% for mepivacaine, 53% for bupivacaine, and 12% for lidocaine. They concluded that articaine can increase the IANB success rate in patients with irreversible pulpitis\cite{34}. Ultrasound-guided mental nerve block is shown to be effective in treating post-herpetic neuralgia in a case series of 3 patients. Good outcomes with no adverse effects was shown when mental block was done with ultrasound\cite{35}. On the basis of multiple evidences, as shown above, facial nerve blocks are effective in reducing pain thus allowing for faster recovery time, a reduction in perioperative opioid use, and less complications such as PONV, excessive sedation, and constipation.

Complications of facial nerve blocks

Common complications include transient diplopia due to paralysis of the superior oblique muscle of the eye, ptosis, ecchymosis at the puncture site, hematoma, intravascular injection of local anesthetic, and nerve injury from direct puncture to nerve. Aspiration before injection of local anesthetic and the use of a diluted anesthetic solution with 1:100,000 or 1:200,000 epinephrine is usually considered safe to prevent toxic plasma drug levels and limit intravascular injection.

Regional anesthetic techniques for neck surgeries and airway management

Superficial cervical plexus block

The superficial cervical plexus (C2–C4) combines to form these terminal branches—the lesser occipital, greater auricular,
transverse cervical, and supraclavicular nerves (Fig. 23). They emerge from behind the posterior border of the SCM\textsuperscript{[17,36]}. The superficial cervical plexus provides sensory distribution from the mandible to the clavicle (anterolateral neck, anteauricular, and retroauricular areas), and can be performed bilaterally for midline neck surgeries such as thyroidectomy, and multiple parathyroidectomy. Other procedures include thyroglossal cyst removal, carotid endarterectomy, lateral neck dissections, lymph node biopsy, and awake internal jugular central line placement. The block can be done using landmark structures such as the SCM or by ultrasound guidance. Using landmarks, identify the posterior border of the SCM. At the midway point between the clavicle head and the mastoid process attachment, inject 5–10 mL of 0.5% ropivacaine or bupivacaine superficially to the deep cervical fascia using a 1.5-inch 25-G needle. This technique will effectively block the superficial cervical plexus. By ultrasound guidance, the plexus is visualized as a small collection of hypoechoic oval structures deep and partially lateral to the posterior border of the SCM (Fig. 24).\textsuperscript{[35]}

Glossopharyngeal nerve (GPN) block

The GPN supplies sensory innervation to the oropharynx, vallecula, and posterior third of the tongue (Fig. 25). It is part of the group of nerve blocks needed to provide adequate anesthesia for awake intubation. The GPN provides sensation for the gag reflex, thus blocking it will helps facilitate endotracheal intubation from direct laryngoscopy and also for passage of nasotracheal tube through the posterior pharynx\textsuperscript{[36,38]}. There are 2 approaches to blocking the GPN. The first approach is the intraoral approach, which needs adequate mouth opening to
accomplish the block. Inject 2–5 mL of 2% lidocaine using a 22- or 25-G needle submucosally at the caudal aspect of the posterior tonsillar pillar where it crosses the palatoglossal arch (Fig. 26). Bilaterally blocks is needed. Blockade can also be done submu-

cosally by directly placing a soaked gauze with local anesthetic in

the same area for 5–10 minutes or by spraying local anesthetic in

the area. This method will reduce the risk of intravascular

injection but its less effective as an injection\cite{36}. The second

approach is the peristyloid technique, which involves depositing

local anesthetic posterior to the styloid process where the
glossopharyngeal nerve lies. This technique is generally not

recommended for temporary nerve blocks for anesthesia of the

oropharynx. It is a difficult block to do even under fluoroscopy

and can cause bilateral vagal nerve paralysis if bilateral peristy-

loid GPN is done. The patient is placed in the supine position with

head in a neutral position, the styloid process is palpated just

posterior to the angle of the jaw, a 25-G 1.5-inch needle is placed
directly contacting the styloid process (1–2 cm deep). The needle

is then angled posteriorly and walked off the styloid process, as

soon as contact is loss, 5–7 mL of 2% lidocaine can be injected

after negative aspiration\cite{38}. The GPN block must be done with

careful aspiration with small incremental dose of local anesthetic
due to the presence multiple vessels in the palatoglossal arch

especially the internal carotid artery which is near the nerve.

There is also a high risk of local anesthetic toxicity leading to

seizures from injection into vasculature\cite{36}.

**Superior and recurrent (transtracheal) laryngeal nerve blocks**

The superior and recurrent laryngeal nerves (RLNs) are branches

of the vagus nerve that innervate the larynx (Fig. 27). The

superior laryngeal nerve (SLN) is blocked as it passes inferiorly
to the greater cornu of the hyoid bone, where it splits into the

internal and external branches of the nerve. The SLN provides

sensory innervation of laryngeal structures above the vocal cords—

differentiation, posterior surface of the epiglottis, and the base of the

tongue\cite{36}. It also provides brainstem mediated airway reflexes

such as the glottic closure reflex and coughing from the efferent

fibers of the vagus nerve\cite{38}. The block should be done bilaterally
to accomplish adequate analgesia for awake intubation, broncho-

scopy or a laryngoscopy\cite{5,17}. The block is done with the patient in

Figure 25. Glossopharyngeal nerve and it anatomic innervations. Reproduced

with permission from public domain access Gray and Carter\cite{37}, illustrator

Henry Vandyke Carter, plate 793.

Figure 26. Intraoral approach to glossopharyngeal nerve block. Injecting in the
caudal aspect of the posterior tonsillar pillar.

Figure 27. Anatomic innervation of the larynx highlighting the superior laryngeal
nerve (blue rectangle) and recurrent laryngeal nerve (red rectangle). Reproduced
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a supine position with the neck extended to expose the hyoid bone. The hyoid bone is gently palpated, using a 25-G needle with 3 mL syringe, 2 mL of 2% lidocaine is injected after the needle is withdrawn 1 mm after contact with the greater horn of the hyoid bone (Fig. 28). Ultrasound guidance can also be used to perform this block by placing a linear probe in a transverse plane on the neck to identify the hyoid bone which is a hyperechoic curved rim with shadowing below. A slight tilt of the probe laterally will display the greater cornu of the hyoid bone. At this location, an injection of local anesthetic can be performed by directing the needle slightly below the greater cornu using an in-plane method, 1–2 mL of 2% lidocaine can be injected after negative aspiration (Fig. 29)[36].

The RLN can be blocked using a transtracheal or translaryngeal approach. The RLN innervates the glottis and the trachea; thus, it is useful when performing an awake intubation, bronchoscopy, and laryngoscopy[17,38]. Direct infiltration of the RLNs is contraindicated because it can cause upper airway obstruction due to bilateral vocal cord paralysis since motor and sensory fibers run together. A transtracheal approach entails palpating the cricothyroid membrane then placing a 20-G peripheral venous catheter with local anesthesia (4 mL of 4% lidocaine) into the space while aspirating with a 5 mL syringe until a “pop” is felt and air bubbles return, confirming position within the trachea (Fig. 30). The needle is removed, leaving the catheter in place to provide immediate access to the airway[36]. Before injecting the local anesthetic, the patient is asked to take a deep breath as the local anesthesia is injected[17]. Sometimes it may be difficult to palpate the cricothyroid membrane, thus the use of ultrasound guidance is beneficial in this scenario. The block can be performed by placing a linear probe in a parasagittal position on the neck, and then tilting the probe until you see the cricoid cartilage (caudate) and thyroid cartilage (cephalad). The space in between the two cartilages is the cricothyroid membrane. Thus, the membrane lies between the caudal border of the thyroid cartilage and the cephalad border of the cricoid cartilage[38]. After finding the membrane, turn your probe to a transverse position, you will see the reverberation artifacts (A lines) at tissue air interface below the membrane. The needle is inserted into this space as depicted in Figure 31. Always aspirate first to confirm you get air bubbles which indicate you are through the membrane and inside the trachea[5,36]. The RLN can also be blocked below the cricothyroid membrane by spraying local anesthetic via the injection
In a retrospective chart review of 23 patients who underwent in-office bilateral SLN block before awake intubation, the ultrasound-guided approach reduced postoperative respiratory compromise, opioid utilization, and the need for sedation. Both methods preserved the motor function of the RLNs, mild to no paralysis, hoarseness (blockade of vagus nerve, RLN, and SLN), and aspiration risk. Horner syndrome (facial numbness, ptosis, miosis, anhidrosis), and phrenic nerve block (voice hoarseness) are self-limiting as the complications. We believe it is important to add ultrasound-guided nerve blocks to the enhanced recovery after surgery protocols that

Outcome studies on neck and airway nerve blocks

Superficial cervical plexus block in combination with deep cervical plexus block have been shown to be effective as primary anesthetic and analgesia for cervical endarterectomy; however, there was no reduction in 30-day postoperative incidence of stroke, myocardial infarction or death as compared with general anesthesia.[40][41]. The nerve block does reduce postoperative respiratory compromise, opioid utilization, and reduces surgical and anesthesia time.[41]. Superficial cervical plexus block has also been shown to provide adequate analgesia for thyroidectomy. A study by Shih et al.[42], concluded that bilateral superficial cervical plexus was effective in reducing the amount of general anesthetic required during a thyroidectomy, and also reduced the postoperative pain in the first 24 hours after surgery. A randomized controlled study comparing ultrasound-guided superficial cervical plexus block to landmark technique, found ultrasound-guided block was more effective in reducing pain both intraoperatively and postoperatively in patients undergoing thyroidectomy.[43]. Similarly, Gürkan et al.[44] study concluded that US-guided bilateral superficial cervical plexus block reduces postoperative opioid consumption following thyroid surgery.

SLN block has been shown to be effective and safe in treating chronic neurogenic cough short term[45] and for awake intubation[46]. In a retrospective chart review of 23 patients who underwent in-office percutaneous SLN block for treatment of neurogenic cough between 2015 and 2017, cough severity index scores decreased significantly from an average of 26.8 pretreatment to 14.6 posttreatments (P < 0.0001)[49]. A prospective study of 50 patients, a combination of bilateral glossopharyngeal nerve block, bilateral SLN block, and RLN block before awake fiberoptic intubation using 2% lidocaine showed good efficacy and safety. Ninety percent of patients were quite comfortable during and even after awake fiberoptic intubation[46]. In a Korean randomized single-blind prospective study with 60 patients, nerve blocks of bilateral SLN and transtracheal RLN for fiberoptic-guided nasotracheal intubation showed a significant shorter time to intubation and better patient comfort as compared with jet nebulization of the airway with local anesthetic[47]. In both airway studies, the use of airway blocks effectively reduce the amount of opioids use intraoperatively and it can be assumed that side effects related to opioid use were also reduced. Most importantly, patient satisfaction were higher in nerve block groups with injection.

In a clinical trial by Ortega Ramirez and colleagues, looking at 100 patients undergoing upper GI endoscopy, they compared GPN blocks to topical anesthesia in providing adequate tolerance during the procedure. They concluded that GPN blocks provided greater comfort and reduced the need for sedation as compared with topical anesthesia[48]. Based on multiple evidences, as shown above, neck and airway blocks are effective in reducing pain and discomfort associated with neck surgeries, awake intubation, and endoscopy. Thus, neck and airway blocks allow for faster recovery time, a reduction in perioperative opioid use, and less complications such as PONV, excessive sedation, and aspiration risk.

Complications of neck and airway blocks

Complications of superficial cervical plexus block include intravascular injections, nerve damage, Horner syndrome (facial numbness, ptosis, miosis, anhidrosis), and phrenic nerve block (voice hoarseness). Horner syndrome and voice hoarseness are self-limiting as the local anesthetic wears off. Complications associated with airway blocks (GPN, RLN, SLN) includes intravascular injections, nerve damage, airway obstruction (RLN) from bilaterally vocal cord paralysis, hoarseness (blockade of vagus nerve, RLN and SLN), dysphagia (GPN), and local anesthetic toxicity leading to seizure.

Conclusion

Regional anesthesia for head and neck surgeries entails blocking various nerves for primary anesthetic, or as analgesia in combination with general anesthesia for surgical procedures, airway management, and the treatment of migraines and facial neuralgias (Table 1). Traditionally most of these blocks were done blindly using anatomical structures, but with more availability of ultrasounds, these blocks are easier to perform, and with less complications. We believe it is important to add ultrasound-guided nerve blocks to the enhanced recovery after surgery protocols that
**Regional anesthesia for surgical procedures.**

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Summary of nerve blocks for surgical procedures:

have been established. Utilization of the blocks may be a powerful adjunct in the opioid crisis by limiting perioperative opioid utilization and its complications.

**Assistance with the images**

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