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CHAPTER 1

Local Anesthesia of the Face

Cerrene N. Giordano and Anthony M. Rossi

DEFINITION

- Local or regional anesthesia involves the injection or application of a medication to a specific area of the body to minimize procedural-related pain.
- Various types of local anesthesia exist including topical, infiltrative, nerve block, and tumescent.
- The number of office-based procedures utilizing local anesthesia continues to rise, particularly in the dermatologic setting.
- In-office procedures performed under local anesthesia have reduced recovery time, decreased cost, and improved safety relative to those performed under general anesthesia or intravenous sedation.

ANATOMY

- Effective local anesthesia for the face, particularly with peripheral nerve blocks, requires a complete understanding of the underlying nervous anatomy.
- The 11 branches of the trigeminal nerve (cranial nerve V) and 2 branches of the cervical plexus (C2, C3) are primarily responsible for the cutaneous sensory innervation of the face and neck (FIG 1).
- The trigeminal nerve is divided into three main components—V1 (ophthalmic nerve), V2 (maxillary nerve), and V3 (mandibular nerve) with further smaller divisions.
  - V1 is composed of the supraorbital, supratrochlear, infratrochlear, external nasal, and lacrimal nerve branches and is primarily responsible for the sensory innervation of the upper eyelids, glabella, forehead, dorsal nose, and anterior portion of the scalp.
  - V2 is composed of the zygomaticotemporal, zygomaticofacial, and infraorbital branches and supplies innervation to the central face including the lower eyelids, medial cheeks, temples, lateral nasal sidewall and alar rim of the nose, and the upper cutaneous and mucosal lip.
  - V3 is composed of the auriculotemporal, buccal, and mental nerves and innervates the lateral and lower halves of the face including the preauricular region, portions of the anterior ear, jawline, chin, and lower lip.
- The supraorbital, infraorbital, and mental nerves exit their respective foramen all located in the midpupillary line.
- Cervical nerves C2 and C3 form the great auricular and lesser occipital nerves that complete the innervation of the lateral and anterior neck, the ear, and the postauricular scalp.

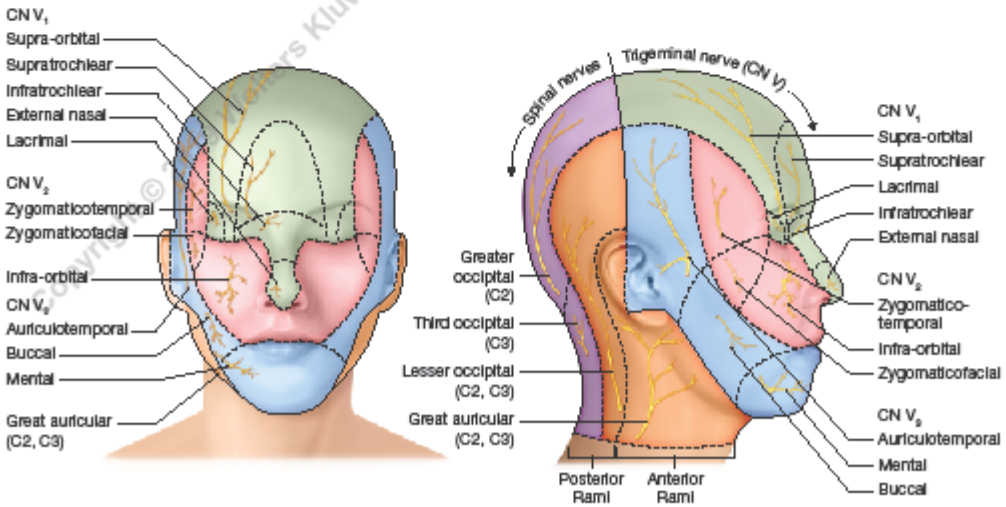

FIG 1 • Trigeminal and cervical plexus nerve distribution.

- The great auricular and lesser occipital nerves emerge from Erb point in the posterior cervical triangle, located approximately at the midpoint of the posterior border of the sternocleidomastoid muscle.
- The greater occipital (C2) and third occipital (C3) nerves supply the posterior scalp and neck.

MECHANISMS OF ACTION

- All local anesthetics share a similar molecular structure composed of a hydrophilic amine and a lipophilic aromatic ring linked together by an intermediate chain that classifies the agent as an ester or amide.
- Both esters and amides cause reversible inhibition of voltage-gated sodium channels within affected nerves, thereby blocking depolarization and inhibiting action potential propagation and ultimately sensation.[1]
- Esters, such as tetracaine, procaine, and chloroprocaine, are hydrolyzed by plasma cholinesterases and excreted by the kidneys (Table 1).
- In contrast, amides such as lidocaine, mepivacaine, and bupivacaine are metabolized by microsomal enzymes in the liver.[2]
- The structural components of the local anesthetic agent determine various parameters for clinical efficacy.
  - The lipid solubility of the aromatic ring influences the diffusion and potency of the product, with more lipid-soluble molecules possessing greater diffusion through the nerve cell membrane resulting in higher potency.
  - Agents that are highly protein-bound have a longer duration of action as they possess a stronger affinity for the sodium-gated ion channels.
  - Speed of onset is determined by the drug dissociation constant (pKa), defined as the pH at which the ionized and nonionized forms of the drug are present in equal amounts.
    - All local anesthetics have a pKa higher than physiologic pH.
  - The closer the pKa is to physiologic pH, the more nonionized form of the medication is present, and the more rapidly the drug penetrates the nerve cell membrane creating its clinical effect.
- Ropivacaine is a newer amide anesthetic that has been shown to have a rapid onset and longer duration of action compared to lidocaine.

NATURAL HISTORY

- The Inca populations were the first to discover the pain-reducing property of the *Erythroxylum coca* plant.[2]
- In the late 1880s, cocaine was isolated from the plant and used initially in ophthalmologic surgeries.
- Safer alternatives were developed early in the 20th century followed by widespread acceptance within the medical community.
- Lidocaine was the first amide anesthetic to undergo clinical testing in the 1940s, with a faster onset, longer duration, and lower toxicity compared to the ester formulations available at the time.

PATIENT HISTORY AND PHYSICAL FINDINGS

- Eliciting relevant patient history and performing a physical exam prior to the use of any anesthetic agent are crucial to ensure patient safety and minimize complications.
- Patient history
  - Determine medication allergies and prior exposure to injectable or topical anesthetics.
  - Obtain an up-to-date list of the patient's medications including over-the-counter herbs and agents to avoid potential interactions, particularly with drugs metabolized through the liver.
  - A detailed medical history should be elicited, with particular attention to cardiac, renal, liver, and neurologic diseases.
- Relative contraindications
  - Hypersensitivity to the agent (particularly esters)
  - Application of a topical agent to the skin with impaired barrier function
  - G6PD (glucose-6-phosphate dehydrogenase) enzyme deficiency with the use of EMLA (eutectic mixture of local anesthetics)
  - Significant cardiac or hepatic disease
  - Use of class I antiarrhythmic (tocainide, mexiletine)

Table 1 Anesthetics Used for Local Infiltration

Anesthetic	Onset (min)	Duration (min)		Max Recommended Dose (Adults)	
		Without Epinephrine	With Epinephrine	Without Epinephrine	With Epinephrine
Amides					
Articaine	2–4	30–120	60–240	5.0 mg/kg or 350 mg	7.0 mg/kg or 500 mg
Bupivacaine	2–10	120–240	240–480	2.5 mg/kg or 175 mg	3.0 mg/kg or 225 mg
Etidocaine	3–5	200	240–360	4.5 mg/kg or 300 mg	6.5 mg/kg or 400 mg
Lidocaine	<1	30–120	60–400	4.5 mg/kg or 300 mg	7.0 mg/kg or 500 mg
Mepivacaine	3–20	30–120	60–400	6.0 mg/kg or 400 mg	7.0 mg/kg or 550 mg
Prilocaine	5–6	30–120	60–400	7.0 mg/kg or 400 mg	10.0 mg/kg or 600 mg
Esters					
Chloroprocaine	5–6	30–60	N/A	11.0 mg/kg or 800 mg	14.0 mg/kg or 1000 mg
Procaine	5	15–90	30–180	10.0 mg/kg	14.0 mg/kg
Tetracaine	7	120–240	240–480	2.0 mg/kg	2.0 mg/kg

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- Use of EMLA in infants under 1 month of age (increased risk of methemoglobinemia)
- Lidocaine is pregnancy category B; however, *lidocaine is excreted in breast milk*; therefore, caution is advised for use in breast-feeding mothers.
- Ocular exposure with EMLA should be avoided due to the presence of sodium hydroxide and the potential for alkaline injury.
- Caution is advised with concomitant use of EMLA and certain methemoglobinemia-inducing medications such as acetaminophen, anesthetics (prilocaine and benzocaine), anticonvulsants, antimalarials, nitrates, sulfonamides, and aniline dyes.

- Physical examination
  - Ensure there is no skin breakdown or signs of infection or inflammatory lesions in areas where the agent will be applied/injected.
- Selection of agent
  - Based on the anticipated procedure, the anesthetic is selected by taking into account the need for topical vs injectable modality, duration of the agent, and location of the procedure.
  - The level of preprocedure patient anxiety should also be assessed and may determine the agent and application type used.

SURGICAL MANAGEMENT

- Facial anesthesia is necessary for a variety of different cutaneous procedures, including skin biopsies, excisions, Mohs micrographic surgery, surgical reconstruction, and laser and light-based therapies for facial resurfacing, scar revision, or lesion ablation.
- The decision to use an anesthetic and the selection of the agent is dependent partially on the type of procedure performed and the anticipated degree of discomfort.
- Facial nerve blocks are commonly implemented for ablative laser resurfacing of the entire face; however, there are reports of regional cutaneous nerve blocks for larger pigmented or vascular facial lesions as well.
- Regional nerve blocks hold the advantage of minimizing significant tissue distortion, using less total volume of medication, and less patient discomfort, but they are more challenging to administer.
- Tumescent anesthesia is a form of local anesthesia using large volumes of highly dilute anesthetic delivered subcutaneously, first described by Dr. Jeffrey Klein in the 1980s.
  - It can be used alone or with various levels of sedation based on the intended procedure.
  - While there is a wide range of usages for tumescent anesthesia, face and neck uses generally include liposuction, face and neck lifts, dermabrasion, and full-face laser resurfacing.
  - Lower volumes of fluid are infiltrated into the face (100–150 mL per side) when compared with body infiltration, so the concentration of lidocaine may be higher for facial procedures.[3]

Preoperative Planning

- Obtain an accurate patient weight to calculate the maximum allotted anesthetic dose especially for procedures requiring larger volumes.
- Lidocaine toxicity is dose dependent, and it is critical to remain below the calculated maximum dose.
- It is also important to take into consideration individual patient characteristics as frail, elderly patients or those with underlying liver malfunction may require lower dosages.
- The maximum allotted dose of plain lidocaine for an adult patient is 4.5 mg/kg for whom the addition of epinephrine allows for up to 7 mg/kg[4] (see Table 1).
- The WiMP formula may also be used for ease of calculating maximum allotted dosages as long as the patient's weight, maximum dosage, and percentage concentration of the agent are known.[5]
  - V (mL) = (weight (kg) × 0.1 × maximum dose (mg/kg))/percentage concentration

Positioning

- Positioning is key to establishing both patient and provider comfort during the procedure.
- Ideally, the patient should be comfortably seated on the exam table with the table leaning back and the feet propped up to minimize a vasovagal reaction.
- The patient's head should be firmly rested against the back of the table to allow for stabilization and minimize sudden movements when the needle is injected.
- It is best when injecting if the patient's eyes are closed so they do not unintentionally pull away if they visualize the needle.
- For the surgeon, the table needs to be at an appropriate height, and the patient needs to be positioned closer to the surgeon's side of the table to avoid excessive bending or reaching.
- The patient's skin is held taut by either the surgeon's nondominant hand or an assistant.
- The surgeon's nondominant hand may be used to stabilize the dominant hand during the injection. Alternatively, the surgeon may rest a few fingers of his or her dominant hand on other parts of the patient's face to stabilize self.
- If an assistant is present, care must be taken to ensure the assistant is far enough from the anticipated injection target to avoid accidental needlestick injury should a sudden movement occur.
- Additionally, the surgeon should be positioned so the needle is facing away from critical anatomic structures such as the globe of the eye to avoid an accidental puncture with unanticipated patient movement.

Approach

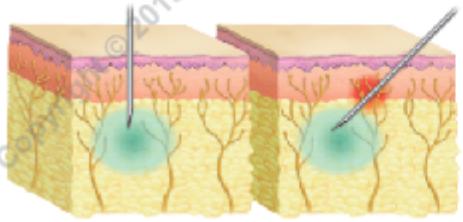
- Topical agents
  - The topical anesthetic agents encompass a wide variety of noninvasive, painless products, which are commonly used prior to minimally invasive cosmetic procedures.
  - Topical lidocaine and EMLA (eutectic mixture of local anesthetics) are the two most commonly used topical agents.
  - Lidocaine is available in many formulations including cream, viscous solution, jelly, ointment, spray, and patches.
  - Due to its unique liposomal delivery system to enhance penetration through the stratum corneum, lidocaine 4% cream (LMX-4, Ferndale Laboratories, Ferndale, MI) has the advantage of ease of application without occlusion, more rapid onset compared to EMLA (Astra Pharmaceuticals, Westborough, MA), and availability without a prescription.

- EMLA is a eutectic mixture of 2.5% lidocaine and 2.5% prilocaine hydrochloride. EMLA is applied to intact skin, under occlusion, for a minimum of 1 hour to facilitate absorption.
- The depth of anesthesia is directly proportional to the duration of time the product is left in place, with maximum clinical anesthesia achieved at 2 to 3 hours and clinical effect remaining around 1 to 2 hours post removal of product.[6]
- EMLA is safe for use in pediatric and adult populations, and the dosing is largely based on weight and surface area. The manufacturer recommends a dose of 2 g of EMLA per 10 cm^6 for 2 hours. The maximum recommended dose is 60 g applied to 400 cm^6 of normal skin.
- Caution with either product should be exercised with use over large surface areas as prolonged application, large surface area, occlusion, and high concentrations increase the risk for cardiotoxicity and central nervous system toxicity.

- Injectable agents
  - Lidocaine and bupivacaine are the two most commonly used injectable agents. Lidocaine has a rapid onset of action, generally less than 1 minute, and lasts on average from 30 to 120 minutes, longer with the addition of epinephrine.[4]
  - Bupivacaine is a slower-acting agent, with a 2- to 10-minute onset; however, it has one of the longest durations of action, lasting 120 to 240 minutes without epinephrine. Because of the longer duration of action, bupivacaine is commonly used in lengthy surgical procedures, but its risk of cardiac and neurologic toxicity remains a concern.
  - Ropivacaine and levobupivacaine are two newer amide anesthetics that have a similar duration of action to bupivacaine with fewer cardiotoxic and central nervous system effects and less pain on injection when compared to lidocaine with epinephrine.
- Infiltrative anesthesia may be combined with other forms of anesthesia such as topical, nerve block, or tumescent for larger or more complex cutaneous procedures.
- Smaller needle sizes, such as 30 or 32 gauge, should be used, and needles should be replaced frequently to reduce pain on injection.
- Additions to injectable anesthetics such as epinephrine, hyaluronidase, and bicarbonate that can enhance efficacy and/or improve patient comfort will be discussed in another section.

Local Infiltration

- Prep the surrounding skin with an antiseptic agent such as alcohol, Betadine, or chlorhexidine immediately prior to injection.
- Stretch the surrounding skin and stabilize the needle with the nondominant hand.
- Quickly pierce the skin with the tip of the needle at a 90-degree angle (**TECH FIG 1**).
  - Injection through an enlarged pore or follicle may minimize patient-perceived pain.
- Aspirate the needle prior to product infiltration to avoid intravascular injection and minimize risk for toxicity.[4]



TECH FIG 1 • Piercing the skin at a 90-degree angle irritates fewer nerve fibers, thereby reducing injection pain.

- Advance the needle tip deep/subdermally first and deposit about 0.5 mL of anesthetic agent.
- Be sure to inject slowly as rapid infiltration and cutaneous distention contribute to increased pain.
- Pause for about 30 seconds, and move the needle more superficially while injecting more volume.[7]
- The needle may be slightly withdrawn and advanced subcutaneously in a fanlike fashion to continue anesthetizing while minimizing the number of painful injection points.
- Once that region is complete, the needle may be fully withdrawn from the skin and reinserted within 1 cm of the blanched border to continue injecting along the established area.[7]
- Anterograde injection is recommended to keep the wheal before the needle tip to minimize further pain of the needle.[7]
- For larger excisions, it is generally recommended to perform a ring block with infiltrative anesthesia around the outside of the ellipse, and supplemental anesthesia may be added centrally only where needed upon testing of the area.
  - Using a longer needle to inject deep into the fascial plane or having additional syringes on hand intraoperatively may be necessary for supplementation based on the depth of the procedure planned.
- The lowest possible dose to achieve an anesthetic effect should be used to avoid toxicity.

TECHNIQUES

TECHNIQUES

Facial Nerve Blocks

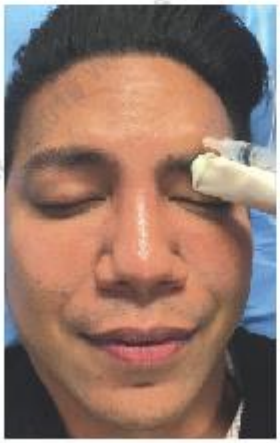
- There are a number of facial nerve blocks that can be performed, including supraorbital, supratrochlear, infraorbital, infratrochlear, mental, zygomaticofacial, zygomaticotemporal, and external nasal. The most commonly used are supraorbital, supratrochlear, infraorbital, and mental.
- Many authors cite the use of 4% articaine hydrochloride with epinephrine as the preferred agent for facial nerve blocks, but 1% lidocaine with or without epinephrine or mixtures of 1% lidocaine and 0.25% bupivacaine may also be used.
- Generally, 3-mL syringes with small-gauge needles such as 25 or 30 are used to reduce pain. Occasionally, longer needles such as 30 mm may be used to ensure product deposition at the targeted foramen.

Supraorbital and Supratrochlear Nerves

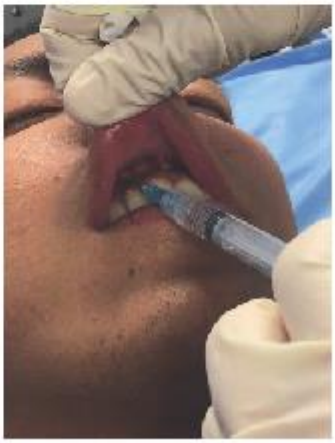
- The supraorbital foramen is located in the mid-pupillary line and is palpated along the orbital rim.
  - The needle is inserted perpendicular to the skin above the foramen and advanced until contact is achieved with the supraorbital ridge, with care not to enter the foramen and cause damage to the nerve (**TECH FIG 2**).
- The supratrochlear nerve can be blocked with periosteal injection at the medial eyebrow and nasal root junction, about 1 cm medial to the supraorbital foramen.
- About 0.5 to 3 mL of anesthetic solution is deposited periosteally to each location after negative aspiration.

Infraorbital Nerve (Video)

- The percutaneous approach for the infraorbital nerve involves palpation of the infraorbital foramen, located in the mid-pupillary line about 1 cm lateral to the ipsilateral nasal ala.[5] The patient may feel a slight discomfort with palpation, which assists in identification.
  - The injection is placed 1 cm inferior to the foramen, and the needle is tangentially directed and slowly advanced upward until the approximate location of the foramen is reached.
  - A small wheal (approximately 0.2 mL) of anesthesia can be placed subdermally prior to advancing the needle to minimize pain.
  - Alternatively, topical anesthetic agents can be used to reduce injection-related pain.
    - After negative aspiration, a 0.5- to 2.5-mL bolus of anesthetic solution is very slowly deposited just outside of the foramen.
    - It may be helpful for the injector to leave a finger of the nondominant hand pressed over the foramen for ease of location/identification.
  - Extreme caution is advised to avoid needlestick injury.
    - The infraorbital nerve has a slower onset of anesthesia, so it is recommended that this nerve is anesthetized first.[5]
- The intraoral approach to the infraorbital nerve (**TECH FIG 3**) involves first locating the foramen by gentle palpation of the overlying skin as described above.
  - The area is then marked and/or the injector's finger is kept in place as a guide.
  - A small wheal (approximately 0.2 mL) of anesthesia is placed in the mucobuccal fold over the second premolar.
  - The needle is then advanced further upward toward the marked foramen, remaining parallel to the long axis of the second premolar until the foramen is reached.
  - After negative aspiration, a 0.5- to 2.5-mL bolus of anesthetic is slowly placed just outside of the foramen.



TECH FIG 2 • Supraorbital nerve block.



TECH FIG 3 • Intraoral approach to infraorbital nerve block.