Chapter 4

Anatomy Applied to Block Anesthesia for Maxillofacial Surgery

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Additional information is available at the end of the chapter

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Abstract

Anatomy is a basic knowledge that every clinician must have; however, its full management is not always achieved and gaps remain in daily practice. The aim of this chapter is to emphasize the most relevant aspects of head and neck anatomy, specifically related to osteology and neurology for the application of regional anesthesia techniques. This chapter presents a clear and concise text, useful for both undergraduate and graduate students and for the dentist and maxillofacial surgeon. The most relevant aspects of the bone and sensory anatomy relevant for the realization of regional anesthetic techniques in the oral and maxillofacial area are reviewed, including complementary figures and tables. The anatomy related to the techniques directed to the three major branches of the trigeminal nerve (ophthalmic nerve, maxillary nerve, and to the branches of the mandibular nerve) will be approached separately.

Keywords: clinical anatomy, anatomy for anesthesia, maxillofacial surgery

1. Introduction

Anatomy is a basic knowledge that every clinician must have; however, its full management is not always achieved and gaps remain in daily practice. Knowledge of the precise topography and distribution area of the trigeminal nerve and its branches is required to provide precise and useful anesthesia. Even more, during diverse types of surgery, it is very important to know the distribution area of the trigeminal nerve in order to predict the anesthetic area and avoid pain.

The aim of this chapter is to emphasize the most relevant aspects of head and neck anatomy, specifically related to osteology and neurology, for the application of regional anesthesia techniques.

This text includes the most relevant aspects of the bone and sensory anatomy, relevant for the realization of regional anesthetic techniques in the oral and maxillofacial area.

2. General principles

The maxilla has fine external and porous corticals, with thickening in certain areas that generally do not reach thicknesses greater than 1 mm. This allows that anesthetic solution deposited through the buccal vestibules infiltrate into the maxillary bone, anesthetizing the maxillary teeth and their adjacent tissues (periodontium and gingival mucosa). However, the thickness of the palatal corticals is much greater, impeding the same infiltrative effect. This forces us to consider anesthetic block of the nerve trunks before they are introduced to the maxilla, for most effective anesthetic and of more extensive sectors.

For its part, the jaw usually has a greater thickening even of all its cortical, reaching easily the 3 mm (basilar rim reaches thicknesses of up to 5 mm) [1]. These anatomical characteristics of the mandible should be considered to decide the anesthetic technique to be used, the latency time, and the required anesthetic concentration.

After the respective trigeminal branches are introduced into the maxilla and jaw and emit the branches that innervate the dental tissues, the terminal branches emerge into the skin and innervate the specific areas of the face, giving rise to the different trigeminal dermatomes [2] (see **Figure 1**).

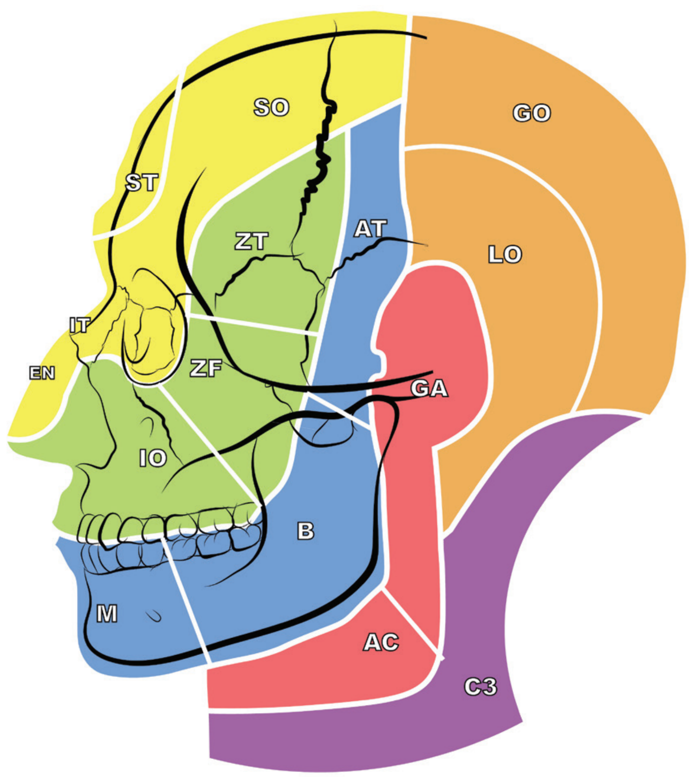

Figure 1. The major sensory dermatomes of the head and neck. B, buccal nerve; EN, external (dorsal) nasal nerve; IO, infraorbital nerve; IT, infratrochlear; ST, supratrochlear nerve; M, mental nerve; SO, supraorbital nerve; Zf, zygomaticofacial nerve; ZT, zygomaticotemporal nerve. Adapted from: Simplified Facial Rejuvenation. 1st ed. Heidelberg: Springer; 2008.

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3. Ophthalmic division

The ophthalmic nerve (V1) is the smallest of the three divisions of the trigeminal nerve. The V1 branches into the frontal, nasociliary, and lacrimal nerves as it approaches the superior orbital fissure. It supplies branches to the cornea, ciliary body, and iris; to the lacrimal gland and conjunctiva; to the upper part of the mucous membrane of the nasal cavity; and to the skin of the eyelids, eyebrow, forehead, and upper lateral nose.

a. The frontal nerve is the largest division of the branches of the V1, courses outside and superolateral, and divides into the supratrochlear and supraorbital nerves within the orbit. The supratrochlear nerve supplies the conjunctiva and the skin of the upper eyelid and ascends dividing into branches to supply the skin of the lower forehead near the midline. The supraorbital nerve courses between the levator palpebrae muscle and orbital roof and exited the supraorbital notch or foramen; it innervates the upper eyelid, the mucous membrane of the frontal, the galea aponeurosis, and the orbicularis oculi. It ascends to the forehead, dividing into a smaller medial and a lateral branch, which supply the skin of the scalp nearly as far back as the lambdoid suture.

b. The nasociliary nerve is more deeply placed in the orbit. The sensory root from the nasociliary nerve passes to the globe through the short ciliary nerves and conveys sensation to cornea and globe. At the level of the fissure, the nasociliary nerve gently ascends to reach the medial part of the orbit, where it gives rise to the anterior and posterior ethmoidal nerves and infratrochlear nerve. The anterior ethmoidal nerve gives off two branches, the internal nasal and external nasal nerves. The internal nasal nerve innervates the mucous membrane of the anterior part of the nasal septum and the lateral wall of the nasal cavity. The external nasal branch innervates the skin over the apex and the *ala* of nose. The posterior ethmoidal nerve supplies the ethmoidal and sphenoidal sinuses. The infratrochlear nerve gives sensitive innervation to the skin of the eyelids and bridge of the nose, conjunctiva, and also to the skin of the lacrimal sac and caruncle.

c. The lacrimal nerve is the smallest of the three division of the V1 and conveys sensation from the area in front of the lacrimal gland.

Anesthetic considerations:

- The anesthetic block of the first division of the trigeminal nerve is useful for the execution of procedures on the territories innervated by the terminal branches.
- The supraorbital, supratrochlear, and infratrochlear nerves can be easily anesthetized through the location of the supraorbital notch or foramen (see **Figure 2**).
- The supraorbital foramen is located 29 mm lateral to the midline (25–33 mm) and 5 mm below the upper margin of the supraorbital rim (range, 4–6 mm) [3]. This supraorbital notch is readily palpable in most patients and when injecting this area, it is prudent to use the free hand to palpate the orbital rim to prevent inadvertent injection into the globe. The supratrochlear nerve is located medial to the supraorbital nerve at the supraorbital rim and emerges between the trochlea and the supraorbital foramen located 16 mm lateral to

the midline (range, 12–21 mm) and 7 mm below the upper margin of the supraorbital rim (range, 6–9 mm) [3]. The infratrochlear nerve can be blocked injecting local anesthetic solution at the junction of the orbit and the nasal bones.

- The external nasal nerve emerges 5–10 mm from the nasal midline at the osseous junction of the inferior portion of the nasal bones (the distal edge of the nasal bones) and can be blocked subcutaneously at the osseous-cartilaginous junction of the distal nasal bones (see **Figure 3**).

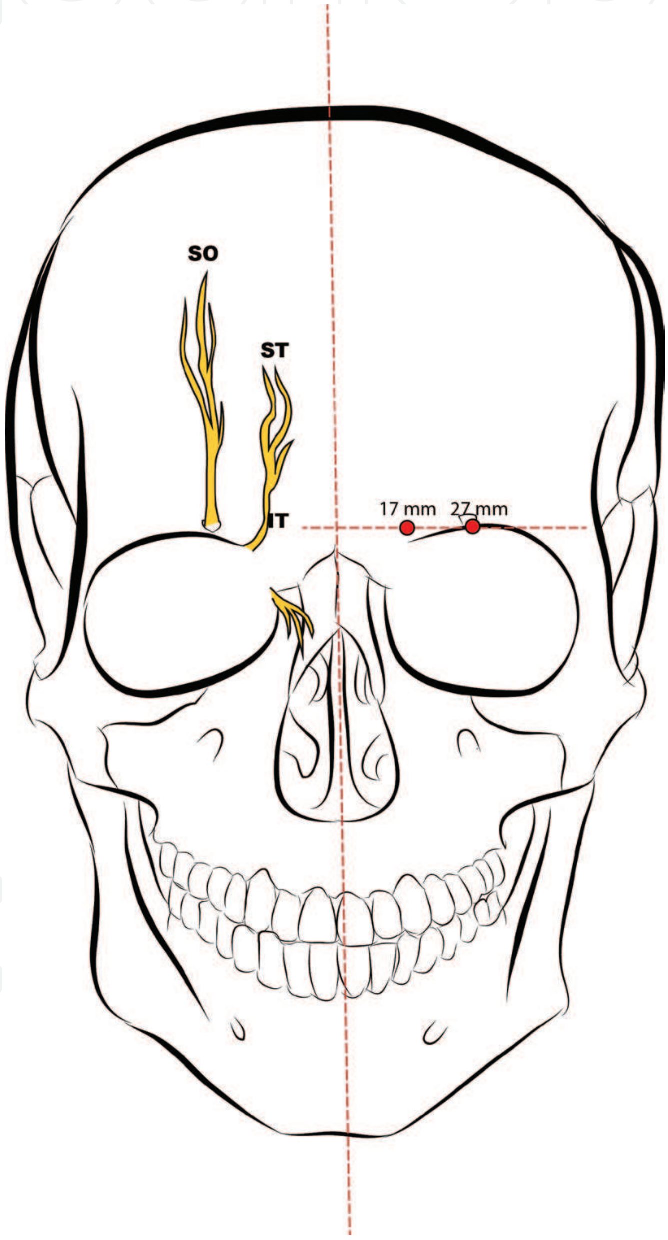

Figure 2. Points to anesthetic block of the supraorbital and supratrochlear nerves. Adapted from: Simplified Facial Rejuvenation. 1st ed. Heidelberg: Springer; 2008.

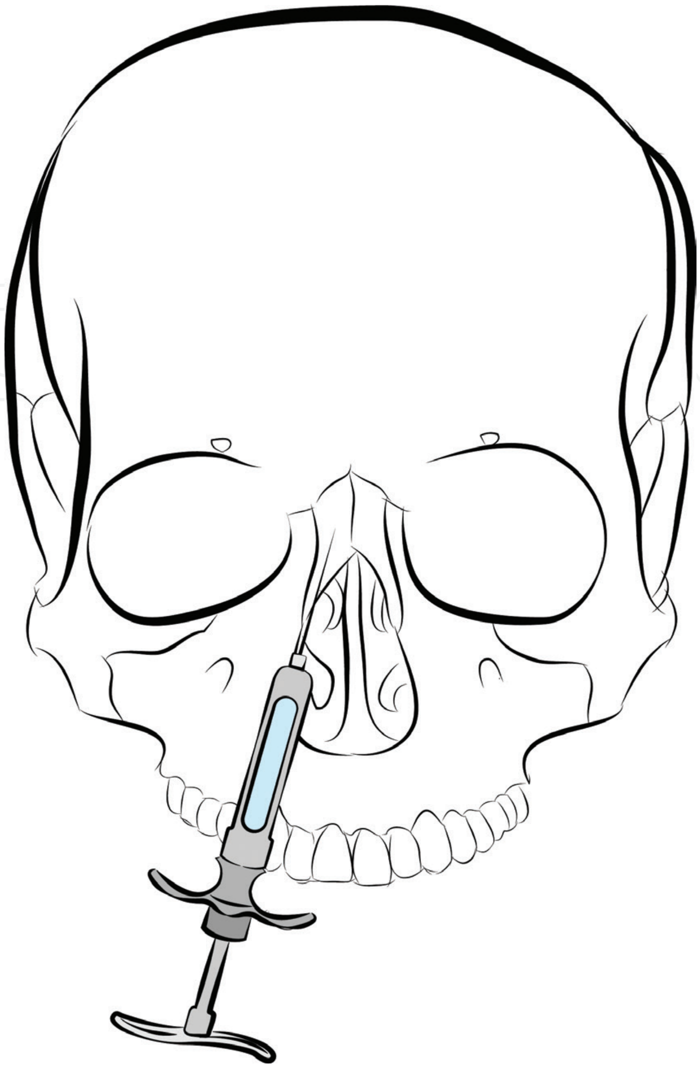

Figure 3. Anesthetic block of external nasal branches.

4. Maxillary division

The maxillary nerve (V2), the intermediate division of the trigeminal nerve, is purely sensory in function. The V2 gives innervation to all structures in and around the maxillary bone and the mid-facial region, including the skin of the mid-facial regions, the lower eyelid, side of the nose, and upper lip; nasopharyngeal mucosa, maxillary sinus, soft and hard palate, palatine tonsil, maxillary teeth, and periodontal tissues [3].

The maxillary nerve leaves the endocranium through the foramen rotundum, located in the greater wing of the sphenoid bone, to enter the pterygopalatine fossa (PPF).

The PPF is a pyramidal space located between the pterygoid bone posteriorly, the perpendicular plate of the palatine bone anteromedially, and maxilla anterolaterally. It opens laterally into the medial part of the infratemporal fossa through the pterygomaxillary fissure and superiorly through the medial part of the inferior orbital fissure into the orbital apex. The fossa also communicates posterolaterally with middle cranial fossa through the foramen rotundum, posteromedially with foramen lacerum through the vidian canal, medially with the nasopharynx through the palatovaginal canal, inferomedially with the oral cavity through the palatine foramina, and medially with nasal cavity through the sphenopalatine foramen.

The V2, after entering the PPF, gives off ganglionic branches to the pterygopalatine ganglion (PPG). It then deviates laterally just beneath the inferior orbital fissure, giving rise to the zygomatic nerve and posterosuperior alveolar nerve.

Anesthetic considerations:

- The zygomatic nerve enters the orbit through the inferior orbital fissure, where it divides into zygomaticotemporal and zygomaticofacial nerves. These nerves give innervation to the skin on the temporal area and on the prominence of the cheek, respectively (see **Figure 1**).
- The zygomaticofacial nerve is blocked by injecting the inferior lateral portion of the orbital rim, and the zygomaticotemporal nerve is blocked by placing the needle on the concave surface of the posterior lateral orbital rim (see **Figure 4**).

In the posterior aspect of the maxillary tuberosity, one to three small holes, 1–2 mm in diameter, can be clearly seen, which are located between 10 and 25 mm above the alveolar rim and behind the second or at the height of the third upper molar. These holes are continued with small ducts or grooves that run through the posterolateral wall of the maxillary sinus until reaching the dental apices. It contains the posterosuperior alveolar vessels and nerves; it is destined to the superior molars, premolars, and neighboring tissues.

The posterior superior alveolar nerve arises from the maxillary nerve before penetrating into the infraorbital canal in the PPF and descends anteriorly and inferiorly to pierce the infratemporal surface of the maxillary sinus (see **Figure 5**). After entering the maxillary sinus, the nerves pass forward under the mucosa of the maxillary sinus, supplying afferent innervation to these membranes. It also supplies a branch to the upper gum and the adjoining part of the cheek [3].

The middle superior alveolar nerve leaves the infraorbital nerve (ION) in the infraorbital groove, the posterior part of the infraorbital canal. It runs down and forward in the lateral wall of the maxillary sinus and ends in small branches which link up with the superior dental plexus, supplying small rami to the upper premolar teeth [4] and first molar (**Table 1**).

The pterygopalatine ganglion gives rise to: from the lower surface the greater and lesser palatine nerves; from the medial surface the sphenopalatine nerve and pharyngeal branch; and from the superior surface the orbital branch.

The palatine nerves are distributed over much of the roof of the mouth, the soft palate, the amygdala, and the nasal mucosa. The major palatine nerve descends through the greater palatine canal, which begins at the lower end of the PPF, it passes through this duct, and inside, it

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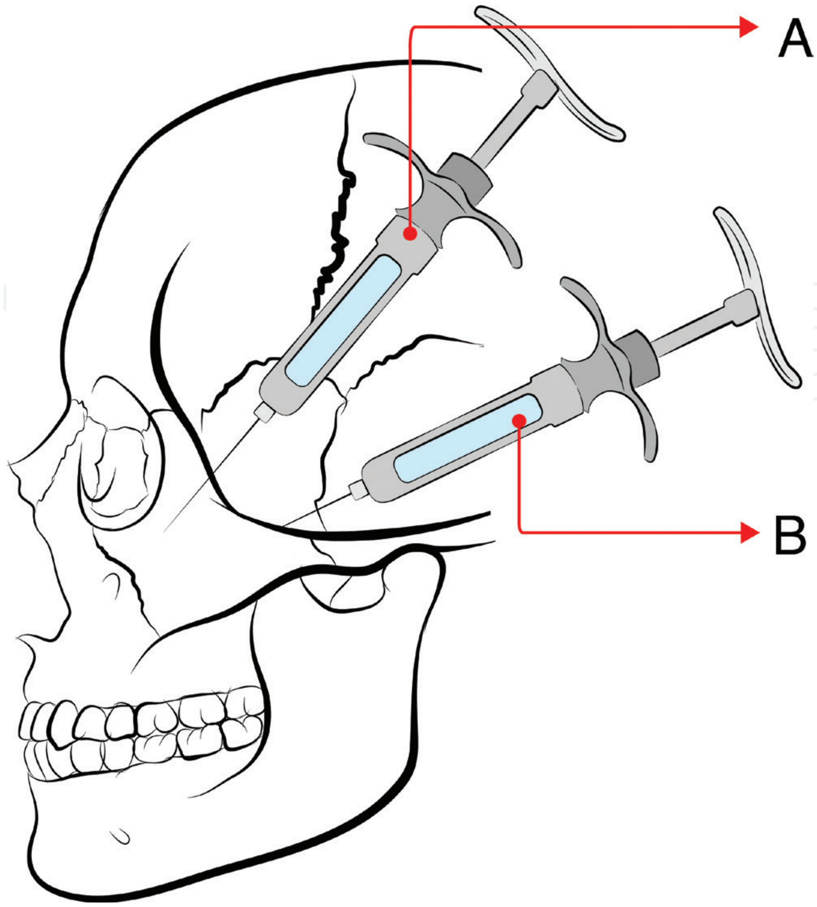

Figure 4. Image showing the needle directions for block technique of (A) zygomaticofacial nerve and (B) zygomaticotemporal nerve (copyright of authors).

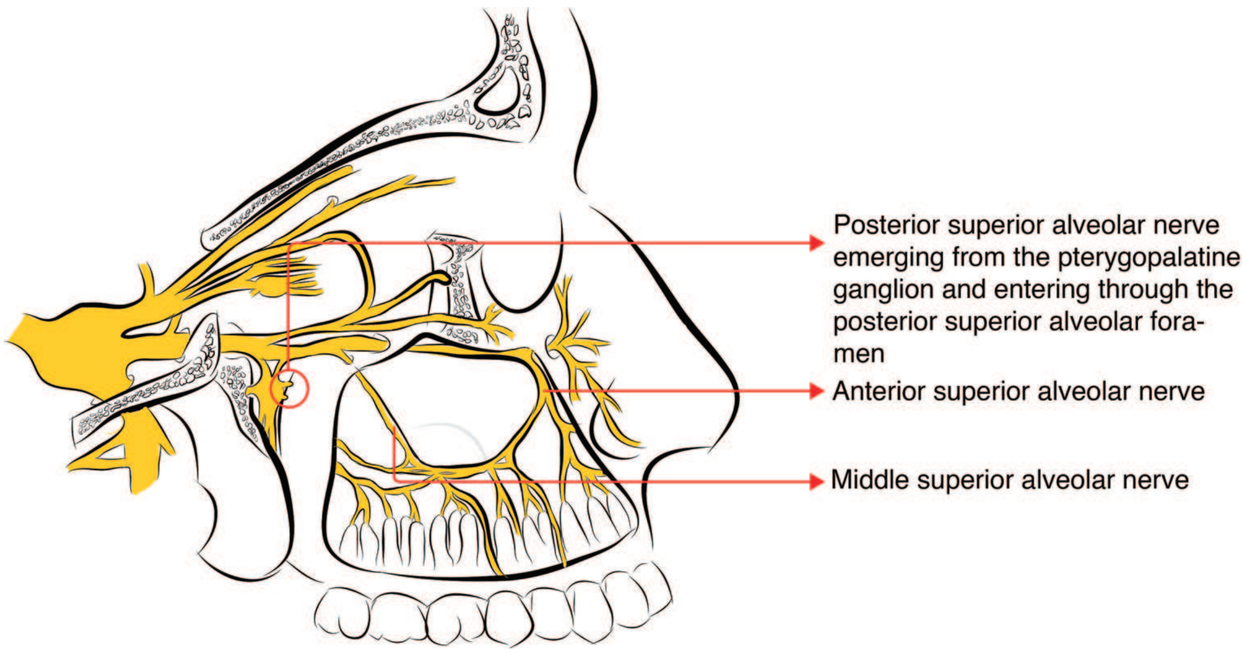

Figure 5. Image showing the posterior superior alveolar nerve anatomy entering at maxillary bone, true 3–4 holes in the tuberosity (copyright of authors).

Anesthetized nerves	• Posterior superior alveolar nerve (local anesthetic reaches the nerve at its one to three entry holes in the posterior aspect of the maxillary tuberosity)
Anesthetized areas	• Pulp of the superior molar dental pieces (excepting the mesiobuccal root of the maxillary first molar, which can be innerved by superior middle alveolar nerve or by the Auerbach plexus) • Vestibular gingival mucosa and periodontium of the abovementioned dental pieces • Vestibular layer of the alveolar ridge
Anatomical references	• 2 cm cephalic to the alveolar ridge • 2 cm ventral to the maxillary tuberosity
Patient/operator position	• Maxillary occlusal plane positioned perpendicularly to the floor • Operator positioned from 9 to 10 o'clock
Local anesthetic volume required	1.8 mL
Needle required	• Short or long needle, 25 G
Needle direction	• From caudal to cephalic in 45° • From lateral to medial • From ventral to dorsal, without loss contact with tuberosity bone
Needle puncture depth	15 mm

Table 1. Posterior superior alveolar nerve block technique.

runs down, forward, and inward, and appears in the mouth through the major palatine foramen of the maxillary. It communicates with the filaments of the nasopalatine nerve, a branch of the sphenopalatine nerve [3].

The lesser palatine nerves, after leaving the PPF, descend and appear in the mouth through a lesser palatine foramen in the palatine bone and give branches to the uvula, tonsil, and soft palate. These nerves anastomose with branches of the glossopharyngeal nerve to form a tonsillar plexus around the palatine tonsil [3].

The nasopalatine nerve, the largest of the nasal branches of the PPG, travels through the sphenopalatine foramen, located just below the sphenoid sinus, enters into the nasal cavity and reaches the nasal septum. It then runs anteroinferiorly between the periosteum and mucous membrane of the nasal septum, supplies a few filaments to the nasal septum, exits the nasal

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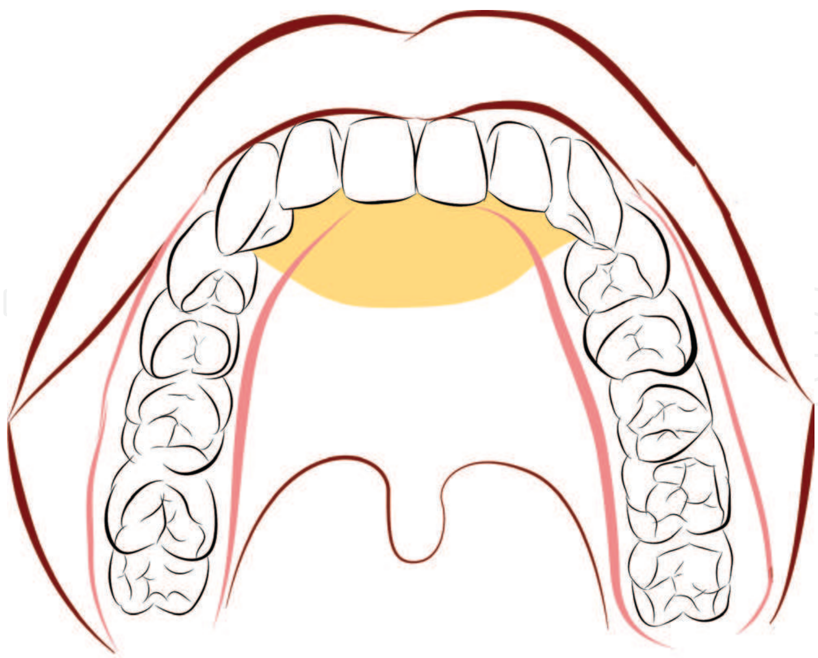

Figure 6. Image showing the palatal mucosal area innervated by nasopalatine nerve (copyright of authors).

cavity through the incisive foramen, and ends by supplying the mucosa of the anterior part of the hard palate [3] (see **Figure 6**).

Other nasal branches include medial and lateral posterior superior nasal nerves. The lateral posterior superior nasal branches innervate the mucosa of the posterior part of the superior and middle nasal conchae and the lining of the posterior ethmoidal sinuses. The medial posterior superior nasal branches supply the mucosa of the posterior part of the roof and of the nasal septum.

The anterior palatine canal, also called nasopalatine, presents a Y-shape and is formed by the union of two lateral canals excavated in the palatine apophyses of the jaws, one to each side of the nasal septum, in the anterior area of the nasal floor, where they converge in one. With a top-down and back-to-front direction, its total length varies between 8 and 20 mm. Its mouth end in the palate is made through a depression or fovea, the anterior palatine foramen or incisor foramen, which may have an oval, triangular, rectangular, or racket shape, with a major axis of approximately 1 cm and a width of 5 mm. While the nasal holes that initiate this duct are located approximately 15–20 mm behind the piriform notch, the incisive foramen is located between 4 and 10 mm behind the alveolar ridge, under a thickening of the palatal mucosa, called the incisive papilla (**Table 2**).

The palatine canal, which leads to the descending palatine artery, a venous vessel and the major palatine nerve, it is an access route to the pterygomaxillary fossa from the oral cavity. The maxillary nerve block via the greater palatine canal technique will anesthetize all the terminal branches of the maxillary nerve with a single injection.

Anesthetized nerves	• Nasopalatine nerve bilaterally (both side nerves confluence in the midline forming the incisive papilla)
Anesthetized areas	• Palatine mucosa from canine to canine • Underlying hard tissues (mucoperiosteum)
Anatomical references	• Incisal papilla, located in the midline 5 mm posterior to the inter-incisal space between superior central incisors
Patient/operator position	• Maxillary occlusal plane positioned perpendicularly to the floor • Operator positioned from 9 to 10 o'clock
Local anesthetic volume required	0.5 mL
Needle required	• Short needle, 25 G
Needle direction	• From caudal to cephalic in 75° • Ventral to dorsal
Needle puncture depth	10 mm

Table 2. Nasopalatine nerve block technique.

The greater palatine canal is formed by the union of two excavated channels, one in the maxilla and another in the vertical sheet of the palatal bone. From the palate, its direction is outward, backward, and upright (inclinations of 5–10°, 15–20°, and 60–70°, respectively), with a length varying between 10 and 22 mm, depending on the facial biotype.

The greater palatine canal emerges onto the oral cavity trough the greater palatine foramen. This foramen has an oval shape, with a larger diameter that can easily reach 5 mm. It is located in the angle that forms the horizontal portion of the palatine bone and the inner side of the maxillary alveolar ridge. In the soft tissues that cover it, a mild depression is observed, and this is an important aspect that can help in the appropriate location of the foramen for anesthetic purposes. Its posterior border lies approximately 1 cm in front of the hook of the pterygoid process and 5–6 mm in front of the border between hard and soft palate, which translates clinically as a change in the coloration of the palatal mucosa. The location of the palatine foramen in relation to the molars varies with age and individual characteristics, being able to be in front or distal to the third molar or—less frequently—between this and the second molar [4]; in young individuals who do not yet have the third molar, it is located in front of the distal side of the second; and in children less than 12 years old, it is usually in front of the distal face of the first molar (**Table 3**).

After entering the PPF, the V2 then turns medially as the infraorbital nerve (ION), passing through the inferior orbital fissure to enter the infraorbital groove, from where the anterior

Anesthetized nerves	• Maxillary division of the trigeminal nerve and all of its branches (local anesthetic reaches the maxillary nerve at the pterygopalatine fossa)
Anesthetized areas	• Pulp of dental pieces of the ipsilateral hemimaxilla • Periodontium and alveolar bone related to the abovementioned dental pieces • Palatine mucosa of the ipsilateral hemimaxilla • Skin of the ipsilateral lower eyelid, lateral wall of the nasal pyramid, cheek, and superior lip without crossing the midline
Anatomical references	• 10 mm medial to the distal surface of the second molar • Alternatively, 15 mm lateral to the palate midline can be used as reference (useful in the edentulous patient, where dental references are lost) • 3.5 mm anterior to the limit between soft palate and hard palate
Patient/Operator position	• Cervical hyperextension, maxillary occlusal plane positioned perpendicularly to the floor • Maximum mouth opening • Operator positioned from 9 to 10 o'clock
Local anesthetic volume required	1.8 mL
Needle required	• Long needle, 25 G
Needle direction	• From caudal to cephalic • From ventral to dorsal • From medial to lateral
Needle puncture depth	30–35 mm

Table 3. Maxillary nerve block technique via the greater palatine canal.

and middle superior alveolar nerves arise. The long axis of the infraorbital canal is directed forward, down, and medially through its canal lying progressively below the floor of the orbit and in the roof of the maxillary sinus, until it emerges in the face through the infraorbital foramen.

The anterior superior alveolar nerve leaves the lateral side of the ION just prior to the infraorbital exit through the foramen. It traverses the canal in the anterior wall of maxillary sinus and divides into branches supplying incisor and canine teeth. In the absence of middle superior alveolar nerves, which happens in approximately 70% of cases [4], the anterior superior alveolar nerve emits a few posterior branches, which join with branches of the posterior superior alveolar nerve to form a nervous plexus also called the Auerbach dental plexus, which is distributed through the lateral wall of the maxillary sinus and innervates the premolars and the mesiobuccal root of the first molar [1] (see **Figure 7**).

The infraorbital nerve (ION) is the terminal branch of the maxillary nerve, and after emerging onto the face, it divides onto its terminal branches: inferior palpebral, nasal, and superior labial branches [5], which supply the skin and conjunctiva of the lower eyelid, the lateral skin of the nose, the movable part of the nasal septum and vestibule of the nose, the skin over the cheek and upper lip, and the related oral mucosa [5].

The infraorbital notch or foramen is the facial or anterior opening of the infraorbital canal. In a generally oval shape, its major axis is oblique downward and outward, with a maximum length of 6 mm. Due to the final orientation of the infraorbital canal, the foramen has a superior cutting edge, which is notorious, whereas its lower border is imperceptible, being confused with the anterior aspect of the maxilla, which at this point forms the canine fossa.

The infraorbital foramen is single in 90–97% of the cases [4]. Several authors have also described the presence of an accessory infraorbital foramen through which a branch of the ION passes. A recent systematic review showed that the frequency of skulls containing the

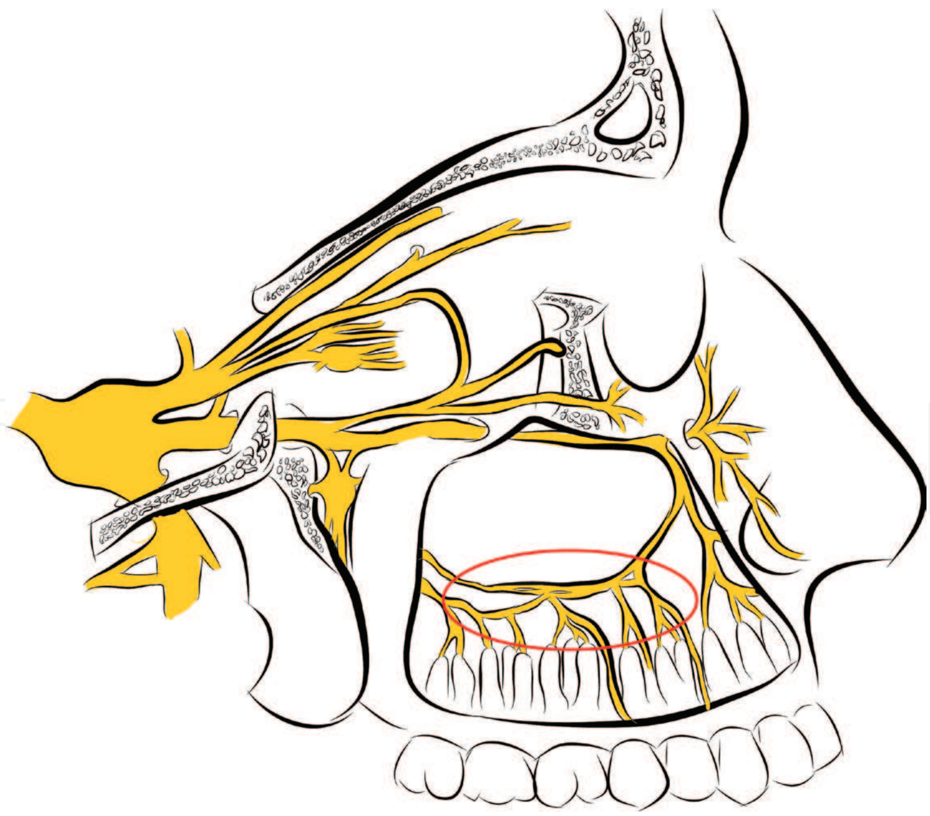

Figure 7. Image showing the anatomical alternative with Auerbach's plexus (circle) (copyright of authors).

accessory infraorbital foramen ranged from 0.8 to 27.3%, with a mean frequency of 16.9 ± 8.6%, being more frequent in left side of the skull [6]. This is important because a partial nerve blockade during anesthesia can lead to an insufficient blockage of the ION.

In a study by Hu et al. [5], the accessory infraorbital foramen was found in 14% of the cases, and the nerve component that exited through the accessory infraorbital foramen was either the inferior palpebral branch, or the external nasal branch.

The topography of both the canal and the infraorbital foramen is of special importance in the practice of anesthesia of the anterior superior alveolar nerves and the infraorbital nerve branches.

To properly locate the infraorbital foramen, we must consider that *it* is normally located within 1 cm of the inferior border of the orbital rim [3, 7].

In the lateral sense, it is located at the junction of the inner third and the middle third of the infraorbital rim. It also corresponds to an imaginary vertical line drawn downward from the supraorbital notch, joining the infraorbital and mental foramen.

A successful infraorbital nerve block will anesthetize the infraorbital cheek, the lower palpebral area, the lateral nasal area, and superior labial regions (see **Figure 8**).

The aforementioned infraorbital nerve blocks provide anesthesia to the lateral nasal skin but do not provide anesthesia to the central portion of the nose. An external nasal nerve of the block will supplement nasal anesthesia by providing anesthesia over the area of the cartilaginous nasal dorsum and tip (**Table 4**).

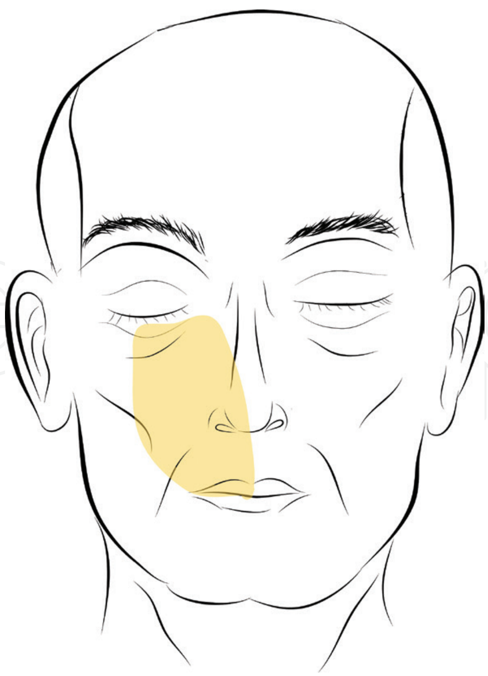

Figure 8. Image showing area innerved by infraorbital nerve (copyright of authors).

Anesthetized nerves	• Anterior superior alveolar nerve
	• Middle superior alveolar nerve
	• Infraorbital nerve and its branches:
	  • Inferior palpebral nerve
	  • Lateral nasal nerve
	  • Superior labial nerve

Anesthetized areas	• Pulp of dental pieces including from central incisors to second premolars • Gingival mucosa vestibular to the abovementioned dental pieces • Wing of the nose skin • Inferior eyelid • Ipsilateral superior lip
Anatomical references	• Union of internal third and lateral two-thirds of the inferior orbital rim • Intraoral technique: bottom of the oral vestibule in relation with the ipsilateral first premolar
Patient/operator position	• Maxillary occlusal plane positioned perpendicularly to the floor • Operator positioned from 9 to 10 o'clock
Local anesthetic volume required	0.9–1.2 mL
Needle required	• Long needle, 25 G for intra-oral technique • Short needle, 25 G for extra-oral technique
Needle direction	• From ventral to dorsal • From medial to lateral • From caudal to cephalic
Needle puncture depth	16 mm for intraoral technique

Table 4. Infraorbital nerve block technique.

5. Mandibular division

The mandibular division (V3) is the largest branch of the trigeminal nerve. It supplies the teeth and gums of the mandible, the skin in the temporal region, part of the auricle, the lower lip, and the lower part of the face. The V3 also contains motor fiber to innervate the muscle of mastication, the mylohyoid, the anterior belly of the digastric muscle, tensor veli palatini, and tensor tympani muscle [1].

The V3 is made up of two roots: a large, sensory root, which proceeds from the lateral part of the trigeminal ganglion and emerges almost immediately through the foramen ovale of the sphenoid bone and a small motor root that passes below the trigeminal ganglion and unites with the sensory root just outside the foramen ovale. This trunk it later splits into a small anterior and a large posterior division.

Branches from the anterior division provide motor innervation to the muscles of mastication, and sensory innervation to the mucous membrane of the cheek and buccal mucous membrane of the molars.

The anterior division of V3 runs under the lateral pterygoid and then emerges between its two heads to become de buccal nerve, the only sensory component of the anterior division. Under the lateral pterygoid, this nerve gives off several motor branches; the deep temporal nerves, the masseter, and lateral pterygoid nerves.

At the level of the occlusal plane of the mandibular molars, the buccal nerve crosses in front of the anterior border of the ramus and enters the cheek through the buccinator muscle. It gives innervation to the skin of the cheek, the buccal gingiva of the mandibular molars, and the mucobuccal fold in that region [1].

The posterior division of V3 gives rise to sensory branches and one motor branch. It descends downward and medially to the lateral pterygoid muscle, at which points it branches into the auriculotemporal, lingual, and inferior alveolar nerves.

The auriculotemporal nerve provides sensitive innervation to the skin over the helix and tragus of the ear, the external auditory meatus, the posterior portion of the temporomandibular joint, and the skin over the temporal region.

The lingual nerve provides general sensation to the anterior two-thirds of the tongue and sensory innervation to the mucous membranes of the floor of the mouth and the lingual gingiva of the mandible.

The inferior alveolar nerve descends medial to the lateral pterygoid muscle and lateroposterior to the lingual nerve, to the region between the sphenomandibular ligament and the medial surface of the mandibular ramus, where it is introduced into the mandibular canal at the level of the mandibular foramen. Immediately before the inferior alveolar nerve enters the mandibular foramen gives off a motor branch, the mylohyoid nerve, which supplies the mylohyoid muscle and anterior belly of the digastric muscle. Nevertheless, some fibers of the mylohyoid nerve could enter into mandibula through the retromandibular foramina and provide innervation to premolar, canine, and incisor teeth [4, 8].

The inferior alveolar nerve travels anteriorly through the mandibular canal and gives off branches to the teeth, which may form a plexus between the trunk of the nerve and the roots of the teeth. The dental branches of the inferior alveolar nerve supply the molar, premolar, canine, and incisors teeth. The inferior alveolar nerve emerges in the mental foramen where it divides into the terminal branches: the incisive and mental nerve.

The mental nerve, pure sensory, leaves the interior of the mandible to supply the skin of the chin and lower lip, the mucosa of the lip, and the adjacent gum.

A continuation of the mandibular canal, the mandibular incisive canal, is a normal structure that typically extends closer to the mandibular midline after the mental nerve emerges through the mandibular foramen [9, 10]. The mandibular incisive nerve travels within this canal and forms a nerve plexus via dental branches to supply innervation to first bicuspid, canine, and lateral and central incisors.

Given that the mandibular bone is very thick, an anesthetic technique with successful nerve block of the V3 branches requires knowledge of the location of the mandibular bone repairs that allows the deposition of the anesthetic in areas close to the nerve trunks before they enter or after they leave the mandibular canal.

The mandibular foramen is located in the medial surface of the mandibular ramus and is the entrance to the mandibular canal, excavated in the thickness of the mandible. This foramen acquires relevance in oral surgery since it is a critical point for the nerve block anesthesia of the inferior alveolar nerve. It has the appearance of a wide cleft, limited from the anterior side by a bony plate called the lingula of the mandible or spine of spix [8] (see **Figure 9**).

The lingula can be palpated through the mucosa of the oral cavity. It shows the way, where one should point the needle, when anesthetizing the inferior alveolar nerve [8].

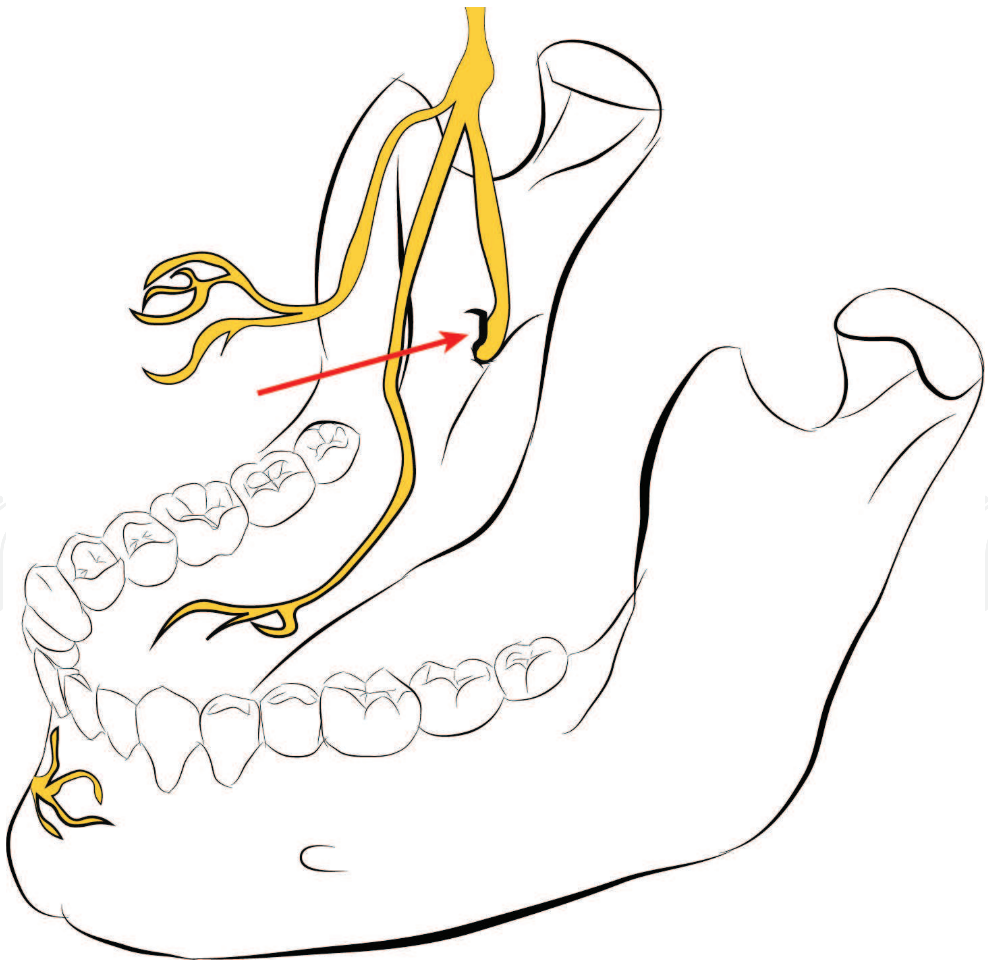

Figure 9. Image showing distribution of buccal, lingual, and inferior alveolar nerves at mandibular lingula or spine of spix level (arrow) (copyright of authors).

The location of the inferior alveolar foramen would be equidistant from the four edges of the mandibular ramus, although it is usually observed closer to the mandibular notch and to the posterior edge of the mandibular ramus [8]. In the vertical direction, the distance between the hole and the occlusal plane is correlated with the patient's age: as the individual grows, the mandibular foramen moves cranially and positions itself in the center of the corpus [8]. In very young individuals, the mandibular foramen is located approximately at the level of the occlusal plane [11].

In the mentioned foramen, the nerve lies anteriorly and medially to the inferior alveolar artery. Such a configuration occurs in 60% of the cases. In 20%, the nerve is located laterally, and in 10%, posteriorly to the artery. In 10%, the nerve is placed independently to the artery [8] (**Table 5**).

Anesthetized nerves	• Inferior alveolar nerve (local anesthetic reaches the nerve at its entry to the mandibular canal through the inferior alveolar foramen, in the medial surface of the mandibular ramus) • Buccal nerve • Lingual nerve
Anesthetized areas	• Pulp of the dental pieces of the ipsilateral hemimandible • Vestibular and lingual mucoperiosteum of the ipsilateral hemimandible • Anterior two-thirds of the tongue • Floor of the mouth mucosa • Skin of the ipsilateral inferior lip and chin
Anatomical references	• 1 cm dorsal to the anterior edge of the mandibular ramus • Pterygomandibular raphe (clinical manifestation of the pterygomandibular ligament) • 1 cm cephalic to the mandibular occlusal plane
Patient/operator position	• Mandibular occlusal plane positioned parallel to the floor while the patient makes a maximal mouth opening • Operator positioned from 9 to 10 o'clock for the left hemimandible block (right-handed operator) • Operator facing the patient for the right hemi-mandible block (right-handed operator)
Local anesthetic volume required	1.5 mL
Needle required	• Long needle, 25 G
Needle direction	• From ventral to dorsal • From medial to lateral (placing the body of the syringe in contact with the contralateral corner of mouth)
Needle puncture depth	20–25 mm

Table 5. Inferior alveolar, buccal, and lingual nerve block techniques.

The mandibular canal travels through the thickness of the mandible; first, close to the medial surface and then maintained equidistant and, at the anterior end, approach the external osseous table. The mental canal has an upward, backward, and lateral outward direction at an angle of 45° to the mandibular bone plane. As a consequence of this, the mental foramen regularly rounded and with a diameter of 3–5 mm has an acute lower anteroinferior border, whereas the posterosuperior half is confused with the bone plane of the mandibular body. The mental foramen may usually be found on the vertical line drawn downward from the supraorbital notch and lies below the level of premolar teeth (see **Figure 10**).

The mental foramen has many anatomical variations not only in its size and shape but also in its location and direction of the opening [9]. In a study by Kqiku et al. [12], the most common position of the mental foramen investigated—using anatomical dissection—was between the first and second mandibular premolars in 37.75% of the cases and 27.5% in line with the long axis of the second mandibular premolar.

These anatomical dispositions require that the approach of the mental foramen for anesthetic purposes consider the direction of the needle from back to front and from top to bottom. In an anteroposterior sense, the location of the mental foramen is in front of the second premolar or between both premolars, at a height—in the young adult—equidistant between the basilar border and the alveolar ridge (**Table 6**).

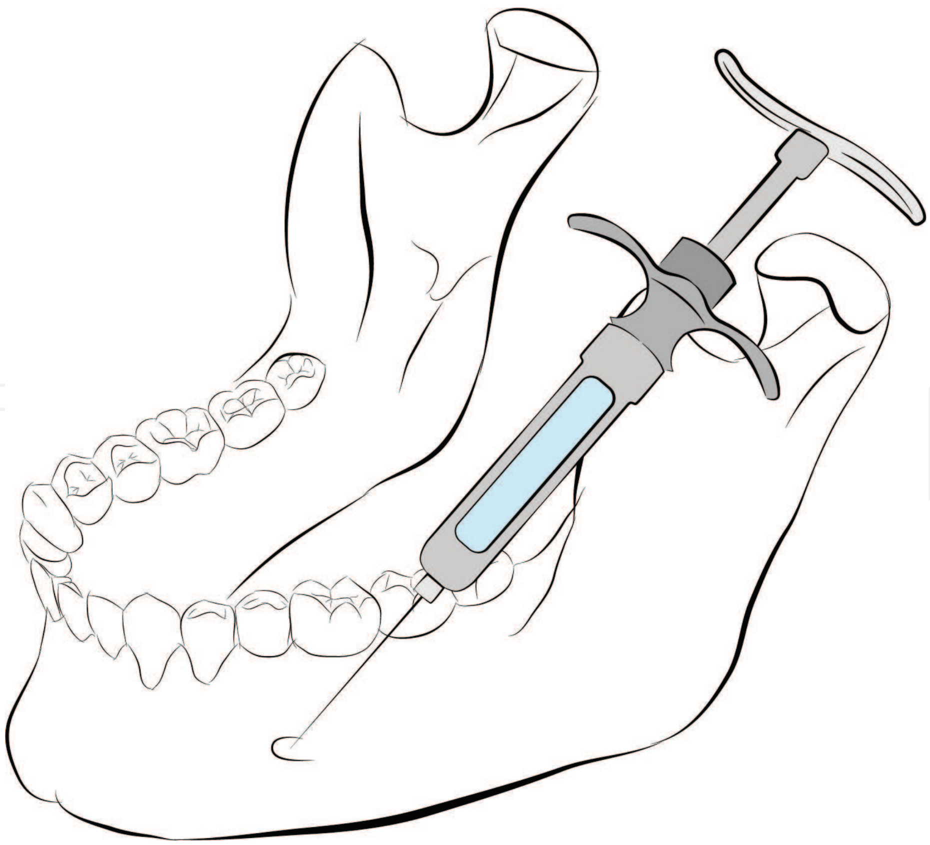

Figure 10. Image showing the needle direction for a successful mental anesthesia (copyright of authors).

Anesthetized nerves	• Mental nerve, terminal branch of the inferior alveolar nerve
Anesthetized areas	• Pulp of the dental pieces from inferior second premolar to inferior central incisor • Vestibular mucoperiosteum of the abovementioned dental pieces • Skin of the ipsilateral inferior lip and chin
Anatomical references	• Almost bottom of the oral vestibule (more precise in the lip internal face), puncture site located between the apices of the inferior first and second premolars
Patient/operator position	• Mandibular occlusal plane positioned parallel to the floor, mandibular rest position • Operator facing the patient, approximately positioned at 8 o'clock
Local anesthetic volume required	0.6 mL
Needle required	• Short or long needle, 25 or 27 G
Needle direction	• From dorsal to ventral • From cephalic to caudal • From lateral to medial
Needle puncture depth	23–25 mm

Table 6. Mental nerve block technique.

Branches of the cervical plexus could provide an additional innervation of the mandibular region. The great auricular nerve arises from the cervical plexus and provides sensory innervation of the skin over the parotid gland, the mastoid process, and the outer ears. Consequently, a separate infiltration of the great auricular may be needed to achieve total analgesia of the mandibular region when conventional anesthesia fails [4].

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