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Anesthesia: Essays and Researches

Review Article

A basic review on the inferior alveolar nerve block techniques

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Abstract

The inferior alveolar nerve block is the most common injection technique used in dentistry and many modifications of the conventional nerve block have been recently described in the literature. Selecting the best technique by the dentist or surgeon depends on many factors including the success rate and complications related to the selected technique. Dentists should be aware of the available current modifications of the inferior alveolar nerve block techniques in order to effectively choose between these modifications. Some operators may encounter difficulty in identifying the anatomical landmarks which are useful in applying the inferior alveolar nerve block and rely instead on assumptions as to where the needle should be positioned. Such assumptions can lead to failure and the failure rate of inferior alveolar nerve block has been reported to be 20-25% which is considered very high. In this basic review, the anatomical details of the inferior alveolar nerve will be given together with a description of its both conventional and modified blocking techniques; in addition, an overview of the complications which may result from the application of this important technique will be mentioned.

Key words: Complications, inferior alveolar nerve block, techniques

INTRODUCTION

The inferior alveolar nerve block, a common procedure in dentistry, involves the insertion of a needle near the mandibular foramen in order to deposit a solution of local anesthetic near to the nerve before it enters the foramen, a region where the inferior alveolar vein and artery are also present.[1] The pterygoid plexus is located posterior and superior to this area. Many techniques and associated modification have been published regarding this nerve block and failure of anesthesia has been reported to be mainly due to technical errors in the local anesthetic administration technique by the dentist/surgeon and not because of the anatomical variations that my present in some patients. Some operators may fail to identify the anatomical landmarks useful in applying the inferior alveolar nerve block and rely instead on assumptions as to where the needle should be positioned. The failure rate of inferior alveolar nerve block has been reported to be 20-25%.[2] In this basic introductory review, simplified basic information related to the inferior alveolar nerve anatomy and its different available blocking techniques was collected from the available literature with an overview of some of the techniques related complications.

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BASIC ANATOMY

Branches of the mandibular nerve

The mandibular division of the trigeminal exits the skull through the foramen ovale and then divides into the anterior and posterior divisions with the main nerve trunk below the foramen. The trunk gives two branches, namely a) the nerve to medial pterygoid muscle and b) a meningeal branch which goes back to the cranium through the foramen spinosum; this branch is also called the nervus spinosus.[1] The mandibular nerve then divides in to two divisions, anterior and posterior. The anterior division of the mandibular nerve has mainly motor branches and the motor nerves of this division comprise the nerve to the temporalis muscle, nerve to the lateral pterygoid, and nerve to masseter muscles. The buccal nerve is the sensory branch of the anterior division (also known as the long buccal nerve and the buccinators nerve). The buccal nerve does not supply the buccinators muscle, but this muscle gets its innervation from the facial nerve. The posterior division of the mandibular nerve is mainly sensory. Branches of the posterior division are the lingual nerve, inferior alveolar nerve, and auriculotemporal nerve. The inferior alveolar nerve divides into two terminal braches, the mental and incisive nerves. The motor nerve for the posterior division is the nerve which serves the mylohyoid muscle and anterior belly of digastric. The mylohyoid nerve is considered to be a mixed nerve when it supplies the skin over the mental protuberance and may also provide sensory innervation to the mesial root of the mandibular first molar. The branches of the mandibular nerve innervate the structures involved in mastication, mucosa, teeth, salivation, speech, and also taste sensations.[3] The branches of the mandibular nerve are shown in Figure 1. Many previous reports have described variations in the normal anatomy of the mandibular nerve. Communications exist between the inferior alveolar and the auriculotemporal nerves and also between the mylohyoid and lingual nerves.[4,5] Another communication occurring between the inferior alveolar nerve and the nerve to the lateral pterygoid muscle has also been reported.[6] These above rare anatomical variations may help to explain why some local anesthetic techniques often fail.

Location of the mandibular foramen

The use of the inferior alveolar nerve block and failure of anesthesia could be explained by a lack of operator awareness of the anatomical location of this foramen, especially since the location of the mandibular foramen may vary between people.[7] Successful inferior alveolar nerve block is related to the deposition of local anesthetic material very close to the nerve before it enters the mandibular foramen. Some researchers have shown that anesthesia of the inferior alveolar nerve block can also be achieved by the deposition of anesthetic material in the pterygomandibular space as the result of diffusion of the material toward the area of the mandibular foramen.[8] This technique is diffusion dependent and aims to avoid the large vessels in the area of the foramen. Many studies have discussed the location of the mandibular foramen.[2,9-14] Its location has been studied in relation to the anterior-posterior dimensions of the ramus of the mandible, the height of the ramus and changes of these dimensions with age, and also the foramen's position in relation to the occlusal plane. Thangavelu *et al*., have shown that the position of the mandibular foramen is not at the center in the anterior-posterior dimension of the ramus, but it is around 2.75 mm posterior to the midpoint of the width of the ramus.[2] They have also shown that the foramen is located at a distance of 19 mm from the coronoid notch and is either level with or below the occlusal plane. The foramen is also located 3 mm above the midpoint of an imaginary line running from the sigmoid notch to the inferior border of the

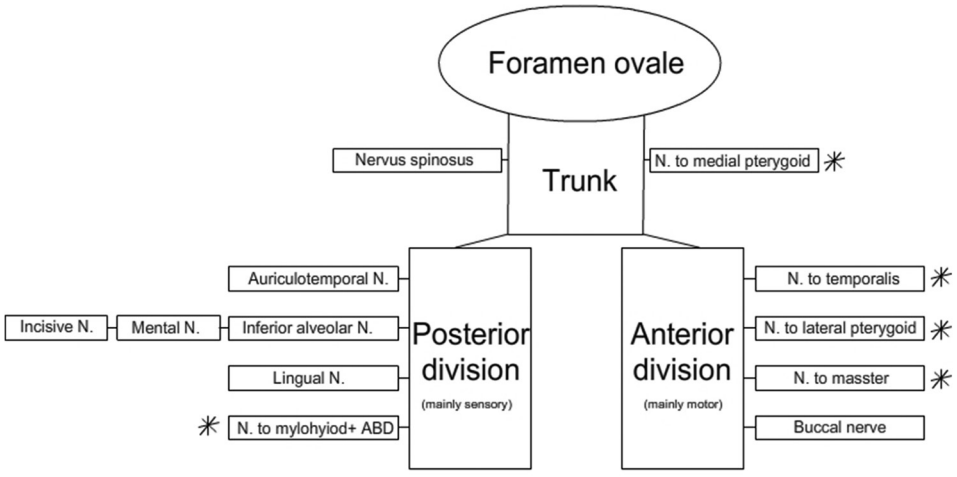

Figure 1: Branches of the mandibular nerve. *Motor branches. ABD = Anterior belly of digastrics

mandible.[2] Other studies on location of the mandibular foramen have shown that the foramen can be at the center of anterior-posterior width of the ramus,[7] 2.08-2.56 mm behind the midpoint of anterior-posterior dimension[15] or on the posterior third quarter of the anterior-posterior width.[16] The relation of the mandibular foramen to the occlusal plane has been reported to vary with age with most studies reporting its location below the occlusal plane in adults. In young children however, the foramen can be found below the occlusal plane and at the occlusal plane level in older children.[13] The foramen can also be superior to its normal anatomical location.[17] Although published reports point to some differences in the location of the mandibular foramen, these differences are not large and the deposition of local anesthetic solution can overcome these differences by diffusion. Figure 2 shows the common location of the mandibular foramen in relation to the ramus height and width, to the occlusal plane, and to the target area of the conventional inferior alveolar nerve block technique. The illustrated location could vary between ethnic groups.

Techniques employed

Many techniques for blocking the inferior alveolar nerve have been described in the literature and each has its own advantages and disadvantages. Although there are some techniques which are commonly used worldwide, still some of the new modified published techniques unknown to dentists. Although some of these techniques may not be of interest to some dentist it is worth knowing about their presence.

The conventional inferior alveolar nerve block

The inferior alveolar nerve block is the most common technique used in dentistry. Despite its importance, it is associated with a failure rate of 15-20% a figure which represents the highest percentage of all clinical failures achieved using local anesthesia.[1] The conventional method of blocking the inferior alveolar nerve involves the insertion of the dental needle near the area of the mandibular foramen, where the inferior alveolar nerve is located before it enters the foramen. Some important landmarks need to be recognized by the operator in order to reduce the percentage of failure following the use of this technique. Radiographs are usually available for most patients before treatment and many dentists concentrate on problems related to the dentition and jaw as seen in these radiographs, but may not use them to estimate the location of the mandibular foramen and other bony landmarks used in the inferior alveolar nerve block. Many studies have shown that the mandibular foramen can easily be located on orthopantomogram (OPG) radiographs.[12,18,19]

Location of landmarks for conventional inferior alveolar nerve block

The general anatomical landmarks of the mandible that the operator should be aware of and which can be used in the inferior alveolar nerve block include the coronoid process and notch, the anterior and posterior border of the mandible, the sigmoid notch, and also the condyle [Figure 3].[1,20,21] The most important clinical landmarks used in the location of the inferior alveolar nerve block are the coronoid notch and the pterygomandibular raphe. The preferred site of needle insertion lies between these two landmarks and the point of insertion is determined by simple measurements. The insertion point is on an imaginary line drawn from the deepest part of the pterygomandibular raphe to the coronoid notch.[1] The location of the insertion point on this line is one quarter the distance towards the pterygomandibular raphe above the occlusal plane of the lower teeth; the syringe barrel should be located at the opposite site at the premolars teeth during injection [Figure 4].

Approach to needle insertion

The needle is inserted into a stretched mucosa and a few drops of local anesthetic solution are deposited in the area; a topical anesthetic, such as 20% benzocaine, can be applied if required before insertion. Penetration with the needle is continued until bony resistance is felt. Touching the bone with needle should be done very gently as this causes pain by touching the periosteum.[22] The needle

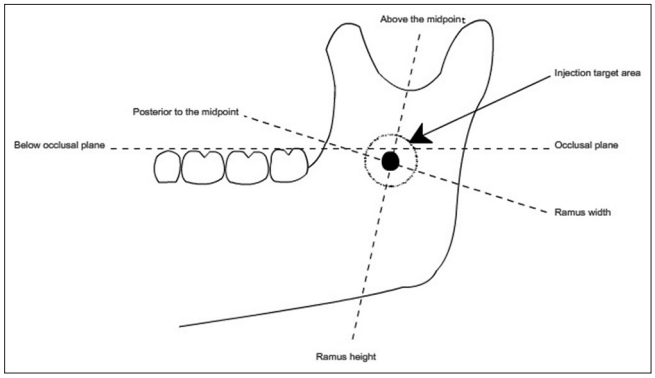

Figure 2: Common location of the mandibular foramen in adults

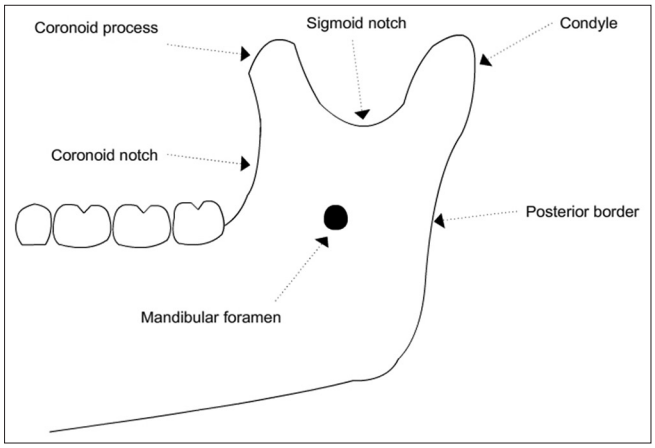

Figure 3: Anatomical landmarks of the mandibular ramus

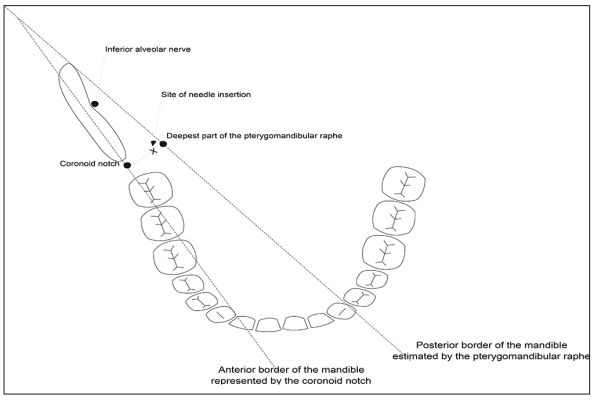

Figure 4: Main landmarks and needle insertion site for the inferior alveolar nerve block

can be damaged when toughing the bone making it bend like a hook, a result which can cause pain when the needle is withdrawn. The needle should be withdrawn 2 mm and then aspiration is performed before the local anesthetic is deposited. The penetration depth of the needle usually ranges from 19 to 25 mm; insertion of the needle more than 25 mm may indicate that its position is more posterior towards the posterior border of the mandible. A premature touch of the bone indicates an anterior position of the needle. Aspiration is mandatory before deposition of the local anesthetic solution and the injection should be very slow. Needle deflection may occur during insertion and this is mainly due to the one side bevel and resistance encountered from the tissues. This problem of needle deflection can be overcome by needle rotation technique or using nondeflecting needle.[23]

Modifications of inferior alveolar nerve block

Many alternative approaches to the inferior alveolar nerve bock technique have been described in the literature, all of which aim to achieve a high success rate, reduce the risk of intravascular injections and finally, avoid damage to the nerve.

1. The alternative technique described by Thangavelu *et al.*, 2012.[24] With the patient's mouth opened fully, the needle is inserted 6-8 mm above an imaginary midpoint between the upper and lower occlusal planes and 8-10 mm posterior to the anterior border of the ramus, while the barrel of the syringe is located between the canine and premolar. The needle is advanced to the bone and then the barrel is adjusted to the midline and the needle is kept very close to the medial surface of the ramus. The author of this technique advises multiple touch of the bone of the medial surface of the ramus during insertion. The recommended insertion depth ranges from 21 to 24 mm. The needle location is changed closer to the mandibular foramen by moving the barrel again, to the opposite side. The authors reported no complications and no positive aspiration during the use of this technique, and claim a success rate of 95%. However, this technique seems to be traumatic to the periosteum than does the conventional inferior alveolar nerve block, largely because it involves multiple bone touches and redirection of the syringe on two occasions.
2. The Thangavelu *et al*., 2012 technique using the internal oblique ridge[25] Thangavelu *et al*., also reported the use of the internal oblique ridge as the only landmark for another alternative approach to the inferior alveolar nerve block technique. In this technique the thumb is placed over the retromolar area and its edge indicates the location of the internal oblique ridge. The insertion point of the needle will then be 6-8 mm above the midpoint of the thumb and 2 mm posterior to the internal oblique ridge. The syringe barrel is positioned at the area of the lower premolars teeth in the opposite side. The depth of penetration is 15-20 mm, at which point the bone is touched. The lingual nerve is anesthetized during the procedure, and the success rate is reported to be 95%.
3. The novel technique of Boonsiriseth *et al.*, 2012[26] This technique employs a long, 30 mm needle whose insertion point is the same as that used in the conventional method, but the barrel of the syringe is located at the occlusal surface of the teeth on the same side of injection. The insertion depth is controlled by a rubber stop on the needle. There is no bony contact of the needle with the ramus and the technique is mainly dependent on the insertion point and depth. The advantages of this technique include a reduction in pain and risk of traumatizing the nerve. The authors of this technique claim that it reduces the risk of systemic complications although there were positive aspirations in some cases (5%), a fact which means that the occurrence of systemic complications is not ruled out by the use of this technique.
4. The new approach of Palti *et al*., 2011 for inferior alveolar nerve block[20] This technique aims to identify some easy to find landmarks to locate the mandibular foramen and involves identification of the mesiobuccal groove and middle point of the mesial slope of the distolingual cusp of primary second molar or permanent first molar. Two wires are used in this technique, one passing through the mesiobuccal groove and midpoint of the mesial slope in one side of the mandible, while the other is passed over the occlusal plane on the opposite side; the intersection of the two wires indicates the location of the mandibular foramen. This technique needs further clinical studies in order to confirm its effectiveness.
5. Suazo Galdames *et al*., inferior alveolar nerve block through the retromolar triangle[27] This technique involves the deposition of local anesthetic solution at the retromolar triangle which is a triangular area located near to the distal side of the lower third molar and is formed by the fork in the temporal crest, located

in the internal surface of the mandibular ramus, and distal surface of the last mandibular molar. The bone at this area is perforated by a variable number of holes of varying sizes which allow for the passage of the buccal artery that anastomoses with the inferior alveolar vessels in the mandibular canal. Deposition of local anesthetic solution at this area can reach the inferior alveolar nerve through this communication between the retromolar triangle and the mandibular canal. The success rate of this technique was reported to be 72% with an onset time of 10 min. This technique is reported to be valuable in case of patients with blood disorders where use of the conventional inferior alveolar nerve block can present problems.

6. Nooh and Abdullah modified indirect technique[28] This technique is a modified version of Malamed's indirect technique.[1] In this technique the needle is inserted 1.5 cm above the occlusal plane with syringe barrel located at the premolars area in the opposite site. After touching the bone, the syringe is then moved to the same side of injection and the needle then advanced while it is in contact with bone to a distance of 30-34 mm. The authors claimed that this technique has a lower failure rate (1%), lower positive aspiration, and lower incidence of complications.
7. Injection in to the pterygomandibular space. The technique of Takasugi *et al*.[8] This technique is based on the presence of a space between the medial pterygoid muscle and deep tendon of temporalis muscle near the anterior border of the ramus of the mandible. The method is also referred to as the anterior inferior alveolar nerve block technique. In this technique the needle is inserted at a point at the lateral side of the pterygomandibular raphe, approximately 10 mm above the occlusal plane. The barrel of the syringe is positioned in the opposite side at the mandibular first molar. The location of the barrel is based on the average angles predicated by computed tomography (CT) images. The depth of needle insertion is only 10 mm. Advantages of this technique include a reduction in the risk of nerve injury or intravascular injection; the success rate is however, reported to be only 75% and the onset time ranges from 4 to 9 min. Radiographic studies by Okamoto *et al*., on the diffusion of local anesthetic in the anterior technique revealed that the local anesthetic solution spread rapidly in the pterygomandibular space and also reached the inferior alveolar nerve from the site anterior to the mandibular foramen, a region containing no large vessels or nerves.[29,30]
8. Other alternative techniques: Other available techniques target the mandibular nerve branches rather than only the inferior alveolar nerve; these include approaches described by Gow-Gates, Vazirani/Akinosi's closed mouth, and Fischer's three stage technique;[24,25] all three techniques need a highly skilled operator and are rarely used by dentists in Saudi Arabia, but may be a common practice in other countries.

COMPLICATIONS

Complication related to the inferior alveolar nerve block vary from being common to rare, and include pain and trismus produced by tearing the mucosa during insertion or even by the withdrawal of the needle,[31,32] needle breakage at that point of injection,[33] and facial paralysis caused by deposition of the anesthetic solution in the parotid region, a problem which mainly occurs when the needle is directed more posterior toward the posterior border of the mandible.[34,35] Hematoma may also develop due to the damage of blood vessels in the area to be anesthetized, as well as following the intravascular injection of anesthetic solution. Other reported complications include ptosis and extraocular muscles paralysis,[36] aphonia,[37] necrosis of the skin of the chin,[38] diplopia, and abducent nerve palsy.[39,40] Some rare complications include a reduction in visual acuity and atrophy of the optic nerve. It has been also reported recently that inferior alveolar nerve block could be a factor in third molar agenesis.[41]

CONCLUSION

Although many techniques for inferior alveolar nerve block have been described in the literature, most dentists still use the conventional block approach. Selecting the most suitable technique needs the dentist to be knowledgeable and fully aware of the various steps involved. Similarly, the advantages and disadvantages of each approach need to be recognized and taken into account, as indeed do the indications related to their implementation.

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