Superior position of the mandibular foramen and the necessary alterations in the local anaesthetic technique: a case report

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VERIFIABLE CPD PAPER

PRACTICE

IN BRIEF

- Provides an overview of inferior dental block (IDB) techniques and reasons for failure.
- Focuses on anatomical variation and accessory innervation as reasons for local anaesthesia failure with reference to a case study.
- Alternative IDB techniques are discussed, namely the Akinosi and Gow-Gates techniques.

The inferior alveolar nerve block or inferior dental block (IDB) is one of the most common techniques of delivering dental anaesthesia, with several million being administered each year. When conventional techniques fail the dentist should have the skills and confidence to use alternative techniques to achieve anaesthesia. The aim of this paper is to discuss the possible reasons for failure, with particular reference to local anatomy. The benefit of alternative techniques is highlighted by the use of an interesting case study, involving a superior position of the mandibular foramen.

INTRODUCTION

The inferior alveolar nerve block or inferior dental block (IDB) is one of the most common techniques of delivering dental anaesthesia, with several million being administered each year.[1] Good dental anaesthesia is essential for delivering pain-free dentistry and the highest quality of patient care. Varying success rates have been reported and the possible reasons for failure include:[2]

- Poor anaesthetic technique
- Anatomical variations
- Presence of acute infections
- Patient immaturity
- Inability to introduce the needle to the appropriate site
- Reduced patient pain threshold.

Two techniques of delivering IDBs are taught at undergraduate level in the UK: the direct technique, also known as the Halstead technique, and the indirect technique. The key features of these techniques are summarised in Table 1.

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While the direct and indirect techniques will provide effective local anaesthesia in the vast majority of cases, they do not allow for all eventualities, for example, variation in the location of the mandibular foramen. Two alternative approaches, namely the Akinosi technique and the Gow-Gates technique, may therefore be utilised, either at the outset, where variations in local anatomy have been recognised, or following a failed conventional attempt at achieving anaesthesia.

Each of these techniques and their potential applications will be described in more detail. To highlight the clinical relevance, the following case study highlights a scenario whereby the Akinosi technique was utilised to achieve effective local anaesthesia before removal of a lower third molar.

CASE STUDY

A 28-year-old Caucasian female with no relevant past medical history was referred to a primary care-based specialist in oral surgery for the surgical removal of an impacted lower right third molar, owing to a history of recurrent pericoronitis. Clinically, this tooth was partially erupted with an inflamed operculum and the tooth appeared to be distoangularly impacted. A dental panoramic tomograph (Fig. 1) confirmed that the lower right third molar was indeed distoangularly impacted. In addition, the position of the mandibular foramen and resulting

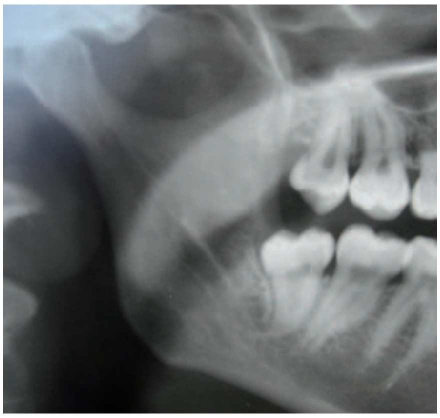

Fig. 1 A right ¼ dental panoramic tomography demonstrating a radiolucent band with corticated margins ascending almost the entire length of the ascending ramus to the condylar neck

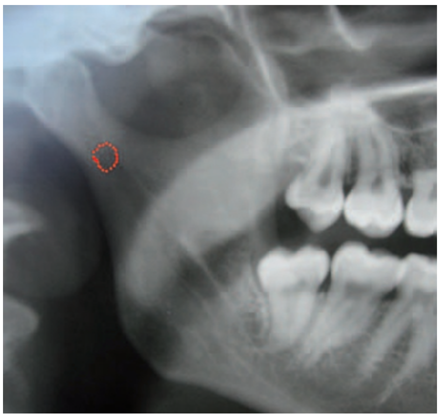

Fig. 2 Suspected position of the mandibular foramen demonstrated (dotted red circle)

path of the mandibular canal was noted to be unusual. A radiolucent band with corticated margins was noted to ascend almost the entire length of the ascending ramus to the condylar neck. It was agreed that this was most likely to represent the mandibular canal with a superiorly positioned mandibular foramen (Fig. 2). However, a grooving of the medial aspect of the ramus of the mandible may also have explained this appearance, with the mandibular foramen itself lying in a normal position just above the occlusal plane. It was felt unnecessary to confirm the true position of the mandibular foramen with a CT scan.

At the time of treatment a direct technique IDB was administered using 2.2 ml of 2% lignocaine with 1:80000 adrenaline. After approximately five minutes, no signs of inferior alveolar nerve anaesthesia were achieved. The Akinosi technique was then utilised to deliver a further 2.2 ml of 2% lignocaine with 1:80,000 adrenaline. Subsequently, complete anaesthesia of the inferior alveolar nerve was achieved within approximately two minutes. We suspect the more superior positioning of the Akinosi technique delivered the local anaesthetic solution closer to the mandibular foramen, although we cannot rule out the possibility that the anaesthesia achieved was as a delayed effect of the direct technique nerve block. Surgical removal of 48 was completed uneventfully.

DISCUSSION

The mandible is one of the most variable bones in the body. Geographically two of the most variable measurements are the height (superoinferiorly) and the width (anteriorposteriorly) of the ascending ramus.[3] Dental nerve blocks are based on anatomic norms and statistical averages of nerve pathways and bone structure. Any variation from the 'average patient' can result in failed anaesthesia, as suggested in our case study. Anatomic variations that could predispose to IDB failure include:[1]

- A wide flaring mandible
- A wide ramus mandibularis in the anterior-posterior direction
- A long ramus mandibularis in the superior-inferior direction
- Bulky musculature or excess adipose tissue
- An abnormal position of the mandibular foramen.

The case study discussed shows an abnormal position of the mandibular foramen. The position of the mandibular foramen has been found to vary but is predominantly located on the medial surface of the ramus, at a midpoint anteroposteriorly and two thirds of the way down a line joining the coronoid process to the angle of the mandible.[4] The position changes in relation to the occlusal

Table 1 Summary of the inferior dental nerve block (IDB) techniques

IDB technique	Specific indications	Technique details	Anaesthesia achieved
Direct conventional or 'Halstead'	Conventional technique	Thumb on coronoid notch	Inferior alveolar nerve
		Another finger on posterior mandibular border	Lingual nerve
		Long (35 mm) 27 gauge needle	
		Approach from the lower premolars of the opposite side	
		Puncture site: a position lateral to the pterygomandibular raphe and medial to the thumb (ramus) at a level half-way up the thumbnail (1 cm above the occlusal plane of the molars)	
		Needle inserted until bony contact, usually 20-25 mm	
Indirect conventional	Conventional technique	Similar to direct technique	Inferior alveolar nerve
		Needle is initially positioned over the molars of the same side	Lingual nerve
		Needle advanced 10-15 mm	
		Needle swung over to the premolars of the opposite side	
		Needle advanced further until bony contact is achieved as in the direct technique	
Akinosi	Nervous patients	Mouth closed	Inferior alveolar nerve
	Trismus or ankylosis	Cheek retracted	Lingual nerve
	Large tongues	Long (35 mm) 27 gauge needle	Long buccal nerve
	Superior position of mandibular foramen anticipated	Puncture site: the retromolar mucosa, parallel to the maxillary occlusal plane to the level of the maxillary mucogingival junction	
		Advanced ~25 mm until the hub is at the level of the distal aspect of the upper second molar tooth	
		No bony contact end point	
Gow-Gates[11] (high mandibular block)	Superior position of mandibular foramen anticipated	Mouth open wide	Inferior alveolar nerve
		Neck extended in a similar position to the palatal injection	Lingual nerve
		Mandible held in a similar fashion to the Inferior dental block	Long buccal nerve
		Two planes are imagined for needle orientation	In some cases, the auriculotemporal nerve
		Alpha plane – passes through the corners of the mouth and the lower border of the tragus of the ear	
		Beta plane – contains the tragus in its relationship with the side of the face. This assesses the divergence of the mandibular ramus and the needle should be parallel to this plane	
		Approach from the opposite corner of the mouth	
		Needle slide across the mesio-palatal cusp of the maxillary second molar on the injection side	
		Puncture site: just distal to the maxillary second molar	
Modified Gow-Gates technique[17]		Extraoral palpation of the condyle	Same as conventional Gow-Gates
		Intraoral palpation of the angle between the coronoid process and the coronoid notch	
		At the level of the sigmoid notch, the needle penetrates the mucosa, tangent to the posterior border of the coronoid process, and is advanced toward the fingertip placed on the condylar head until bony contact is achieved	

plane with age, for example, children having a lower position and older edentulous patients a higher position. A study of lateral cephalometric radiographs showed the mandibular foramen to be ~4 mm below the occlusal plane at 3-years-old, rising to the level of the occlusal plane at 9-years-old and to ~4 mm above the occlusal pane in adulthood.[5]

A dental panoramic tomograph can be useful in predicting the site of the mandibular foramen. This factor alone is not justification for an exposure[6] but if a radiograph has already been exposed then the information should be utilised.

Occasionally, variations in the position of the mandibular foramen can be overcome by subtly altering conventional approaches to dental local anaesthetic techniques. For example, a direct IDB technique with a slightly elevated point of entry was successfully utilised to achieve local anaesthesia in the case shown in Figure 3, despite the mandibular foramen clearly lying in a more superior position than would normally be expected. However, in more extreme cases two further approaches, the Akinosi technique and the Gow Gates technique, may be considered.

The Akinosi technique, also known as the Vazirani-Akinosi or the closed mouth technique, was first described in 1960.[7] In a single injection, anaesthesia of the inferior alveolar, lingual and buccal nerves is achieved. This technique requires the patient to have their mouth closed which forms a position of muscular and aponeurotic relaxation, permitting a nearly painless injection to be made.[8] The tissue is also of a rather loose areolar type in this area which allows for easy accommodation of the solution without pain.[8] It is useful with nervous patients, those with trismus or ankylosis and those with large tongues interfering with the standard direct or indirect techniques. A lower incidence of positive aspirations has been reported with the Akinosi technique (2%) compared to the standard technique (22%).[9]

Figures 4, 5 and 6 demonstrate the approach required. With the mouth closed the dentist retracts the tissues of the cheek. A long (35 mm) needle is advanced into the retromolar mucosa, parallel to the maxillary occlusal plane but at a height coincident with the mucogingival junction. In contrast to other inferior dental

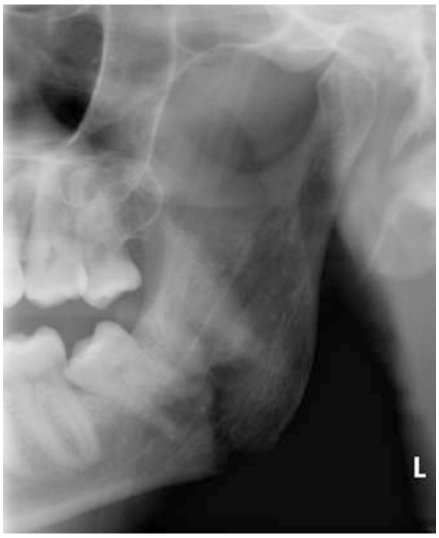

Fig. 3 A left ¼ dental panoramic tomography demonstrating a superior position of the mandibular foramen. Anaesthesia was achieved with a direct IDB technique with a slightly elevated point of entry

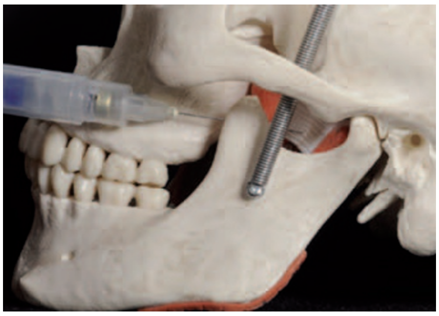

Fig. 4 Akinosi technique. Observe the lack of a bony contact

nerve block techniques, the Akinosi technique does not rely on bony contact as the end point. Rather the needle is advanced until the hub is at the level of the distal aspect of the upper second molar tooth, the needle having entered the tissues to a depth of approximately 25 mm.

The Gow-Gates technique, also known as the high mandibular block, was developed in 1947 but not presented in the literature until 1973.[10] In a single injection, anaesthesia of the inferior alveolar nerve, lingual nerve, long buccal nerve, possibly the auriculotemporal nerve and other accessory nerves is achieved. The target area for deposition of local anaesthetic, in this technique, is the latero-anterior surface of the condylar neck, just below the insertion of the lateral pterygoid muscle. This local anaesthetic deposition site offers several advantages over the standard technique's deposition site, inside the pterygomandibular triangle. There is a lower incidence of positive aspirations and

Fig. 5 Akinosi technique demonstrated clinically. Observe the mouth closed position

Fig. 6 Akinosi technique. Observe the position of the syringe parallel to the maxillary occlusal plane and with the hub adjacent to the distal aspect of the upper second molar tooth

hence intravascular injections, possibly due to the relatively avascular nature of the site which only has a few small vessels, in comparison to the pterygomandibular triangle which has the inferior alveolar nerve, vein and artery and the pterygoid plexus.[11,12] This reduced vascularity also reduces the need for a vasoconstrictor,[13] particularly useful when vasoconstrictor use should be limited due to medical conditions. Penetration of the medial pterygoid muscle is avoided and hence incidents of post injection trismus are reduced.[11,12]

For experienced operators high success rates have been achieved[14] but for inexperienced operators high failure rates have been reported.[15] This is likely to be due to difficulties with appropriate visualisation and alignment of the extraoral reference planes and the intraoral puncture points, which have been described as 'impossible' by some authors.[16,17] Zandi *et al.* describe a device that facilitates the Gow-Gates technique to unfamiliar practitioners to achieve higher success rates.[15] Shinagawa demonstrated an alternative Gow-Gates technique, with altered reference planes, which gives an effective injection site.[17] The conventional and 'altered reference planes' techniques are described in Table 1 and illustrated in Figures 7 and 8.

The success rates of these alternative techniques (Akinosi and Gow-Gates) are not significantly different to standard IDB techniques although the onset of pulpal anaesthesia is slower, due to the thicker nerve bundle at more proximal positions.[18,19] When specifically looking at irreversible pulpitis, the Gow-Gates technique has given significantly higher success rates compared to the standard IDB.[20] The Akinosi technique and buccal-plus-lingual infiltrations technique had statistically similar success rates to the conventional IDB technique with irreversible pulpitis.[20] There is no difference in pain on injection between standard IDB, Akinosi and Gow-Gates techniques.[18]


Fig. 7 Gow-Gates technique. Observe the deposition of the anaesthetic close to the head of the mandibular condyle


Fig. 8 The Gow-Gates technique demonstrated clinically

As a point of interest, a further IDB technique is available which utilises an extra-cranial approach. This involves a point of entry inferomedial to the lower border of the mandible just anterior to the angle and via the sigmoid notch.[2] However, this approach is not recommended for dentists, with the risk of intracranial deposition of solution resulting from incorrect needle position.

Accessory innervation may also be a cause of failed local anaesthesia, particularly of a mandibular molar. Sutton studied the innervation of mandibular teeth and listed the following as involved nerves: mylohyoid, transverse cervical, facial, buccal, auriculotemporal, great auricular, posterior superior alveolar and lingual.[21] Studies into the presence of accessory foramen in the mandible have shown that the average mandible has 36 foramen[22] with the largest accessory foramen being located on the lingual surface in an area superior to the genial tubercles.[23] Dissections and clinical studies have indicated that the mylohyoid nerve may enter some of these foramen to provide innervation to the mandibular teeth[22] and it has also been shown that, other than the inferior alveolar nerve, the mylohyoid nerve has the greatest incidence of involvement of innervation of mandibular teeth.[21]

The mylohyoid nerve is a mixed nerve providing motor innervation to the mylohyoid and anterior digastric muscles and sensory innervation to the teeth and a small area of the chin, although this is highly variable.[24] The mylohyoid nerve is usually anaesthetised during the IDB as it branches from the inferior alveolar nerve just before the mandibular foramen. However the position of branching is variable and the mylohyoid branch may escape anaesthesia, especially with shielding from the pterygomandibular fascia and sphenomandibular ligament.[25] If profound anaesthesia is not achieved from an IDB then it may be necessary to provide an additional mylohyoid nerve block. To achieve this, a simple infiltration of the soft tissues over the distal lingual root surface of the tooth requiring treatment or just under the lingual mucosa in the area of the tooth has been reported as successful.[26,27] An infiltration in the retromolar area also achieves this effect and additionally anaesthetises any accessory mandibular nerves entering the foramen at the coronoid process.

The problem of accessory innervation is reduced when using the Gow-Gates technique because the local anaesthetic is deposited at a deeper site than the standard IDB technique and more proximally along the nerve. This allows the mandibular division of the trigeminal nerve to be anaesthetised before it separates into its branches and hence the accessory branches are anaesthetised.

Alternative local anaesthetic techniques, in addition to nerve blocks, include intraligamentary, intraosseous and intrapulpal techniques. More recently infiltrations with articaine have become popular and a buccal infiltration in the mandible has been shown to be as effective as an IDB or able to achieve anaesthesia when an IDB fails.[28]

Complications of delivering local anaesthetic can be divided into general and local. General complications, for example psychogenic reactions (for example, fainting), and toxicity relate to all local anaesthetic techniques and are beyond the scope of this publication. Local or anatomically related complications can be divided into the following types: injuries to blood vessels, trauma to muscles and injuries to nerves.

The Akinosi and Gow-Gates techniques have a more superior anaesthetic deposition site than the standard IDB, with a closer proximity to the maxillary artery and therefore an increased risk of vascular injury. In order to decrease the risk of intravascular injection an aspiration in two planes technique has been suggested.[29] Aspirating before and after rotating the needle 45 degrees prevents the vessel wall occluding the needle tip, thus giving a more accurate aspiration. The temporalis and medial pterygoid muscles are the most commonly damaged during the standard IDB. The more superior position of the Gow-Gates technique increases the possibility of the lateral pterygoid muscle being involved although, as previously mentioned, incidents of trismus are reduced due to avoidance of the medial pterygoid muscle. Nerve damage following inferior dental nerve blocks is rare, estimated to occur perhaps once in a full-time practitioner's career.[30] 70% of these injuries are to the lingual nerve and high concentration solutions such as 4% articaine should be avoided.[30]

CONCLUSION

In the few situations where the standard IDB technique fails to achieve sufficient anaesthesia, alternative techniques such as the Akinosi and Gow-Gates techniques can be utilised. They give effective anaesthesia via a non-painful injection with some advantages over the standard techniques, such as eliminating accessory innervation. These alternative techniques can be used when a superior position of the mandibular foramen is anticipated or demonstrated radiographically.

Clinical images produced with the kind help of Heather Cowie and Medical Photography, Lauriston Building, NHS Lothian.

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