Local anaesthetics in dentistry: A series

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DS Moodley

ABSTRACT

Failure in local anaesthesia in dentistry is not uncommon with failure rates ranging approximately between 15% and 30%, especially for the inferior alveolar nerve block (IANB). In fact of all the nerve blocks which may be administered in the human body the IANB has the highest failure rate (Malamed, 2012). Therefore, the aim of this series of articles is the discuss some of the causes of failure in local anaesthesia and make recommendations so as to minimize the experience. Current trends like computer controlled local anaesthetic delivery, reversal of soft tissue anaesthesia for patient comfort and "needle free" anaesthesia will be discussed.

INTRODUCTION

In Dentistry, failure of local anaesthetics is not uncommon and is in fact a feature of dental practice.[1,2] Clinical success of local anaesthetics ranges roughly between 75% and 90 %.[1,3,4] The inferior alveolar nerve block records the highest failure rate compared with all other nerve blocks in the human body.[5] Despite the problems in achieving local anaesthesia in Dentistry, there are few studies that have attempted to determine the mechanisms for these failures.[3] In clinical practice incomplete anaesthesia can lead to a painful experience for the patient as well as being a frustrating encounter for the clinician, leading to about 10% of cases having to be postponed. An understanding of the reasons for failure could help to reduce its occurrence. Thus, the aim of this article is to discuss some of the possible causes of failure in local anaesthesia in Dentistry and to make recommendations which may minimize the problem.

FAILURE OF LOCAL ANAESTHETICS

Lack of success in obtaining complete anaesthesia in dentistry may be related to anatomical, physiological or psychological factors. Anatomical variations at the site of the injection, infection or inflammation at the injection site and medical or psychological problems with which the patient may present, can affect the anaesthetic outcome (patient related factors). Choice of anaesthetic agents, the use of vasoconstrictors and experience of the operator may also influence the success of local anaesthesia, factors related to the operator.

DS Moodley: *PhD, MSc, PDD Aesthet. BDS, FICD*. Department of Restorative Dentistry, Faculty of Dentistry, University of the Western Cape, Cape Town, South Africa. Private Bag X1, Tygerberg, 7505. Tel: 021 9373090 E-mail: dmoodley@uwc.ac.za

ACRONYMS

IANB: inferior alveolar nerve block
SI: supplemental infiltration

EFFECT OF ANATOMICAL CAUSES FOR ANESTHETIC FAILURES

An understanding of the variations in innervation to the teeth would help improve the dentist's ability to induce profound local anaesthesia.[6,7] The trigeminal nerve supplies sensory function to both the maxillary and mandibular teeth. The inferior alveolar nerve, a branch of the posterior division, supplies sensation to all the mandibular teeth on one side as well as to the mucosa of the lower lip and skin over the chin. However, simply blocking this nerve through the traditional inferior nerve block does not guarantee complete pulpal numbness in 30% of the patients.[8] Using ultrasound-guided technique, Hannan *et al.*[8] showed that a direct hit on the nerve does not guarantee complete pulpal anaesthesia in spite of obtaining 100% lip numbness. Thus, complete lip numbness does not necessarily indicate complete pulpal anaesthesia of the mandibular teeth and the accuracy of needle placement is not the primary reason for pulpal anaesthetic failure with this block. Accessory or supplementary nerve supply to the mandibular teeth, in addition to that from the inferior alveolar nerve, may be a plausible explanation for failed anaesthesia in mandibular teeth.[9] Only 5.4% of patients have no accessory canals while the majority (81%) of patients have between two to six accessory canals.[10] Gupta *et al.*[11] found accessory foramina in the mandible in 94% of their cases. It may seem that having no accessory canals may be an exception as more often accessory canals can be found in the mandible. When these accessory canals transmit nerve fibres, local anaesthesia may fail as these branches passing through the accessory canals may provide an "escape pathway" for sensation. In addition to the inferior alveolar nerve in the mandible, the lingual nerve, the long buccal nerve, the nerve to mylohyoid, the auriculotemporal nerve and the cervical nerves have been implicated as possible accessory suppliers of sensation to the mandibular teeth.[2,12] The auriculotemporal nerve, a branch of the anterior division of the mandibular nerve,

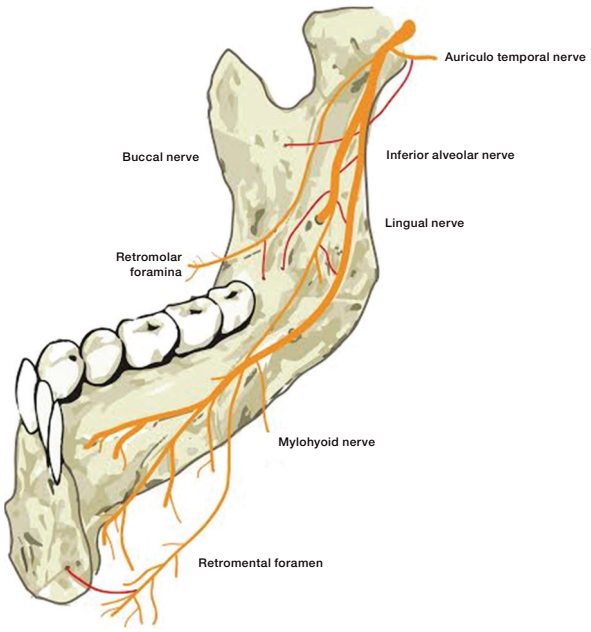

Figure 1: Diagrammatic representation of accessory nerve supply to the mandible

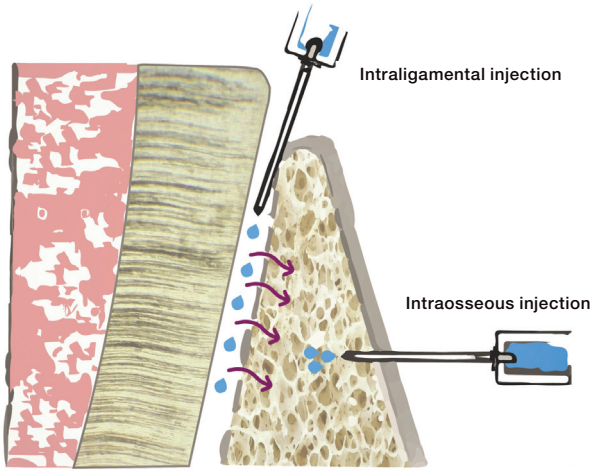

Figure 2: Diagrammatic representation showing intraligamental and intraosseous injections.

may send out filaments as it loops around the condyle.[13] These may enter the lower jaw through a foramen located slightly above the mandibular foramen to supply the mandibular molar teeth (Figure 1). In this instance the dentist will need to inject slightly higher than the traditional inferior alveolar nerve target to be able to block the auriculotemporal nerve as well. Foramina present in the retromolar region may also provide entry points for filaments of the long buccal branch of the inferior alveolar nerve supplying innervation to the mandibular teeth (Figure 1). A long buccal block or mandibular buccal infiltration may be necessary for complete anaesthesia in such cases.[2]

The mylohyoid nerve originates as a small posterior branch of the inferior alveolar nerve before the latter enters the mandibular foramen.[12] The branch runs along the mylohyoid groove on the medial surface of the mandible to supply the mylohyoid and the anterior belly of the digastric muscles. Some sensory fibres could enter the mandible through the retromandibular foramina and provide innervation to premolar, canine and incisor teeth and occasionally the first mandibular molar.[13] The presence of both Aδ fibres (afferent) and Aα fibres (efferent) in this nerve confirms its mixed nature.[14] Studies indicate the mylohyoid nerve as an alternate ''escape route'' for pain in the mandibular teeth.[12] To overcome accessory innervation from the mylohyoid nerve, the clinician can deposit anaesthetic solution higher in the pterygomandibular space or infiltrate on the lingual surface of the mandible adjacent to the tooth[3] so as to block the nerve as it enters the mandible on the lingual aspect.

In the upper jaw the greater palatine and nasopalatine nerves may send sensory innervation to the maxillary teeth in which instance blocking of these nerves by injecting palatally will provide complete anaesthesia to the maxillary teeth.[2]

SUPPLEMENTAL INJECTIONS

Occasionally traditional techniques of anaesthesia like infiltration and regional block injections may not provide successful anaesthesia especially in endodontics for the so-called inflamed pulp (hot tooth) or irreversible pulpitis. According to the American Association of Endodontics, a recent systemic review to evaluate the anaesthetic success rates of the inferior alveolar nerve block (IANB) injection technique alone or along with supplemental infiltration (SI) technique when used for pulpal anaesthesia of mandibular posterior teeth with irreversible pulpitis, indicated that none of the techniques gave 100% success rate.[15] When inferior alveolar nerve block alone was used only 14-39% success rate was obtained but when supplemental injections were included, success was significantly increased to 50-65% for irreversible pulpitis.[15]

The term intra-ligamentary or periodontal ligament anaesthesia may be misleading as the anaesthetic injected into the periodontal ligament provides pulpal anaesthesia by penetrating the cancellous bone through natural perforations (Figure 2). The anaesthetic fluid spreads along the outer surface of the alveolar plate and under the periosteum, moving into crestal marrow spaces along vascular channels and not through the periodontium by travelling down the length of the ligament, as was previously assumed.[16,17] Some authors suggest that placing the bevel of the needle to face the alveolar wall increases the efficacy[18] while Malamed[19] advocates that the bevel should face the root as this allows easier advancement of the needle. It is thus now recommended to commence with the bevel facing the root to facilitate penetration and then to rotate the needle to face the bone to increase efficacy.[20] The success rate when periodontal injection is used as a supplement to conventional IANB is 78%.[17]

Intra-osseous injection consists of introducing the local anaesthetic directly into periradicular cancellous bone via specialized systems like Stabident (Fairfax Dental, USA) and X-Tip (X-Tip Technologies, USA). Success rates for conventional inferior alveolar nerve block with supplemental intraosseous injections ranged from 80% with the first injection and increased to 98% with a second intraosseous injection.[21] Intra- osseous injection can provide profound anesthesia for 60 minutes when used as a supplement in cases of failed IANB.[17]

In approximately 5-10% of mandibular posterior teeth with irreversible pulpitis, supplemental injections, even when repeated, do not produce profound anaesthesia; pain persists when the pulp is entered.[22] This is an indication

for an intrapulpal injection. Onset is usually immediate and no special syringes or needles are required. The disadvantage is that the injection is painful.

CONCLUSION

Accessory nerve supply especially to the mandibular teeth seems to provide an "escape" route for pain and may contribute to failed anaesthesia in the dental chair. In these instances, the dental clinician needs to block these accessory nerve supplies to ensure complete anaesthesia for their patients.

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