Failure of locoregional anesthesia in dental practice. Review of the literature

Araceli Boronat López [1], Miguel Peñarrocha Diago [2]

(1) Dentist and student of the Master of Oral Surgery and Implantology
(2) Assistant Professor of Oral Medicine. Valencia University Medical and Dental School. Director of the Master of Oral Surgery and Implantology. University of Valencia. Valencia (Spain)

Correspondence:
Dr. Miguel Peñarrocha Diago.
Facultad de Medicina y Odontología.
Universidad de Valencia.
C/ Gascó Oliag, 1.
46020 Valencia.
E-mail: miguel.penarrocha@uv.es

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ABSTRACT
Correct identification of the causes of dental anesthetic failure is essential in order to adopt the required measures for successful anesthesia. A review is made of the factors implicated in locoregional anesthesia failure, such as a bifid inferior alveolar nerve, retromolar foramen associated to accessory innervation, double or accessory mental foramen, the relation between the infiltration technique and bone density, accessory innervation in the case of the mylohyoid nerve and first cervical branches, cross innervation of the incisors, inactivity in the presence of tissue inflammation, inactive anesthetic solutions, an incorrect technique, and subjective perception on the part of particularly anxious patients. The therapeutic options available in the event such problems are encountered in routine clinical practice are commented.

Key words: *Dental anesthesia, failures.*

RESUMEN
Una identificación correcta de la causa de los fracasos en la anestesia dental es esencial con el fin de tomar las medidas adecuadas para conseguir el éxito en la anestesia. En este artículo se revisan los factores implicados en un fallo anestésico como son el nervio dentario inferior bífido, el agujero retromolar asociado a una inervación accesoria, el agujero mentoniano doble o accesorio, la relación entre técnica infiltrativa y la densidad ósea, las inervaciones accesorias en el caso del nervio milohioideo y primeras ramas cervicales, la inervación cruzada en los incisivos, la inactividad ante la inflamación tisular, soluciones anestésicas inactivas, una técnica incorrecta y la subjetividad en los pacientes muy ansiosos. Se comentan las opciones terapéuticas a realizar si se nos plantea uno de estos problemas en la práctica habitual.

Palabras clave: *Anestesia dental, fracasos.*

INTRODUCTION

Local anesthesia constitutes routine practice for the dental professional, and all technically correct anesthetic procedures performed with an appropriate anesthetic must be effective. However, Vinckier (1) has estimated failure rates of 10% for inferior alveolar nerve block and 7% for the rest of anesthetic procedures. Wong and Jacobsen (2) in turn report that inferior alveolar nerve injections using the conventional technique fail in 5-15% of cases.

Many factors contribute to anesthetic failure, including both operator (choice of anesthetic technique) and patient (anatomical, pathological or psychological) related factors. If symptoms of anesthesia are not identified after a prudent period of 10-15 minutes following the anesthetic procedure, then anesthetic failure can be assumed.

METHOD

The present study examines the most common causes of locoregional anesthesia failure in dental practice, with a review of all the publications and articles indexed in the Medline literature database, and found in the known Spanish journals, over the past 25 years.

RESULTS

Anomalous anatomical variants and anatomical relations

Anatomical variations can be found in the cranial region, and constitute the principal cause of dental anesthesia failure.

-Bifid inferior alveolar nerve

A double or bifid inferior alveolar nerve represents a possible cause of failure in inferior alveolar nerve block (3,4). In 0.4% of cases the inferior alveolar nerve presents two or even three trajectories through accessory foramina containing small sensory nerve fibers. Langlais et al. (5), in a series of 6000 panoramic X-rays, recorded 57 bifid canals (0.95%), while Sanchis et al. (6) obtained 7 images suggestive of a bifid canal in a series of 2012 panoramic X-rays. Nortjé et al. (7), in 3612 patients, identified 33 bifid canals (0.9%), of which 20 were bilateral and 13 unilateral. These findings indicate that bifid canals are not so unusual, though in any case the prevalence is in the range of 1% (3,5,8).

Oliver (4) defines the inferior alveolar nerve in a position apical and lingual to the third and second molar, and posteriorly vestibular to the roots of the premolars until the nerve emerges from the mental foramen. Rajchel and Ellis (9) found the greatest distance from the cortical zone vestibular to the mandibular canal between the first and second molar, with vestibular displacement of the nerve at second molar level towards the mental foramen. Goaz and White (10) radiologically observed the high- or low-lying position of the mandibular canal, while Zoógrafos et al. (11) studied 700 panoramic X-rays, with the description of three types of mandibular canal distributed as follows in order of increasing frequency: type III (canal below the mandibular margin); type II (canal between the apexes of the second molar and the mandibular margin); and type I (canal in intimate contact with the apexes of the first and second molar). Lastly, according to Nortjé et al. (7), the mandibular canal varies with age, becoming located in a higher position after 60 years of age.

-Retromolar foramen

The presence of a retromolar foramen with or without the existence of a bifid mandibular nerve was investigated by Sutton, who identified nerve fibers in the mentioned foramen. Likewise, Pyle et al. (12), in a series of 249 Afro-Americans and 226 Caucasians, reported a 7.8% prevalence of the foramen, without significant differences in terms of race or sex. Sawyer and Kiely (13) studied 234 adult mandibles and recorded a 7.7% prevalence of the retromolar foramen without differences between males and females. This anatomical variant provides accessory innervation that causes mandibular block to fail.

-Accessory mental foramen

This foramen is located apical or proximal to the mental foramen, and also contains mental nerve fibers (4). The data concerning its existence are contradictory. Thus, while Shanklad (14) reported a 6.62% prevalence of accessory mental foramina in 138 mandibles, Parameswaran and Udayakumar (15) recorded a much smaller percentage (2.5%), and Grover and Lorton (16) found no such accessory foramina in a series of 5000 panoramic X-rays. Sawyer et al. (17), in four population groups, investigated the frequency/race ratio a smaller percentage of this anatomical variant being observed in American Caucasians and Asian Indians (1.4% and 1.5%, respectively).

-Bone density

Some patients, particularly those of advanced age, present an increased bone density in the mandibular teeth, thus leading to deficient anesthesia when using periapical infiltration techniques (2). The opposite applies in children, where infiltrative approaches are more commonly used due to the lower existing bone density.

-Accessory innervations

The mylohyoid nerve is a mandibular branch of the trigeminal nerve that supplies motor innervation to the mylohyoid and digastric muscles. However, it may also possess a sensory component, thereby providing accessory innervation and causing inferior alveolar nerve block failure (18).

Innervation corresponding to the first cervical branches may also be present, with fibers reaching gingival, bone and dental areas in the posterior molar region.

-Nerve anastomoses

Contralateral innervation of the anterior teeth can cause anesthetic failure in both the upper jaw and mandible.

Yonchak et al. (19), in a series of 38 patients, evaluated the percentage of nerve anastomosis upon anesthetizing the inferior alveolar nerve unilaterally and bilaterally (Table 1). The authors found that cross innervation can cause an important number of central and lateral incisor anesthetic failures (significant difference). Rood (20) attributed this situation to crossing of the inferior alveolar nerve and accessory innervation of nerves such as the buccal or facial nerve and cervical plexus.

Table 1. Efficacy of mandibular block for assessing cross innervation of anterior sector teeth (3).

	Unilateral	Bilateral
Central incisor	39%	66%
Lateral incisor	50%	74%
Canine	68%	76%

- Inflammation and infection

Inflammation, with infection, are also causes of anesthetic failure, particularly in situations of pulpitis or apical periodontitis (21). Infection generates an acid pH that interferes with anesthetic dissociation, while inflammation can induce a primary area of hyperesthesia, which in turn increases patient sensitivity (2).

Nusstein et al. (22), applying conventional anesthetic techniques to teeth with irreversible pulpitis, required intrabony anesthesia as complementary measure in 81% of the lower teeth and in 12% of the upper teeth. According to Potonick and Bajrovic (23), even when the technique is correctly performed, the presence of inflammation causes anesthesia to fail in 30-45% of cases. In the event of such failure, block techniques involving anesthetic solution injection at a distance from the inflammatory site are required, with the avoidance of infection spread (24).

Vandermeulen (25) recommends avoiding repeated anesthetic administration in cases of inflammation and infection, since tachyphylaxis may result (anesthetic reaction becoming increasingly weaker).

- Ineffective anesthetic

Despite correct performance of the technique, good anesthesia will prove elusive if the anesthetic solution used is defective. Some defective solutions may result in certain drug batches, or in anesthetics which are rarely used. It is therefore necessary to check the expiry date of the product involved (2).

Storage of anesthetics at over 37ºC will lead to anesthetic failure, particularly in the case of plastic cartridges (26). In addition, the pressure of injection plays a role, particularly in the case of intraligamentous procedures (27) – with the risk of carpule fracture upon injection, and resulting failure to inject the anesthetic solution.

- Incorrect technique

When referring to incorrect technique performance, special mention should be made of mandibular block. If injection is too low, lingual anesthesia will result, with deficient anesthesia of the teeth and bone structures. If injection is too deep, the solution may be deposited in the parotid space, with anesthesia and temporary paralysis (until the anesthetic is reabsorbed) of the facial nerve but no anesthesia of the mandibular nerve. If injection is too mesial, the solution will be instilled in the pterygoid muscle, with deficient anesthesia secondary to incorrect block, and trismus. In the case of an excessively superficial injection, the anesthetic solution is deposited in the pterygomandibular space – distant from the mandibular foramen – and inadequate anesthetic performance results. When injecting high up, the solution is deposited in the sigmoid notch or condylar neck, without resulting anesthesia. Lastly, intravascular injection does not afford good anesthetic results, and may moreover cause systemic complications (2).

It is also important to take into account that the anatomy varies with age and development of the facial structures. If a line is traced tangential to the occlusal surface of the last molar, Spix's spine in adults is seen to be located one centimeter above the mentioned line, in children at the level of the line (i.e., lower than in the adult), and in edentate individuals at a point higher than in adults. In edentulous patients it is important to keep the plane horizontal in order to avoid instilling anesthetic solution below the mandibular foramen.

- Anxious patients

Particularly anxious patients pose a challenge for dental treatment. Anxiety and fear can cause a patient to refer pain once anesthesia has been achieved. Early identification of this problem, a meticulous technique, and sedation, can help in such situations (2).

Anesthetic response varies among individuals. In effect, 1% of the population may refer no response at all, while another 1% may refer an extraordinary effect, and 70% tend to respond as expected.

DISCUSSION

In the event of anesthetic failure, the underlying cause should be identified, as this will make it easier to ensure a sufficient anesthetic effect. Inferior mandibular block applying the direct technique is the most widely employed approach. However, in cases involving bifid canals, for example, it is advisable to perform a higher anesthetic technique, such as that proposed by Gow-Gates, since it effectively anesthetizes all mandibular nerve branches following injection at a single point (24,28,29). In cases of retromolar foramina, the problem can be solved by instilling a few drops of anesthetic solution in the anomalous retromolar region, or by adopting the same approach as in patients with a bifid canal (high mandibular block). In patients presenting accessory innervation, failure is to be expected in 10-20% of cases if only the inferior alveolar nerve is blocked, without associated reinforcement of the first molar lingual (due to the mylohyoid nerve) and of the treatment tooth vestibular (for the cervical branches)(24,30).

If good anesthesia is not achieved in the upper jaw, particularly in the region of the incisors, the possible existence of nerve anastomosis should be considered, with the instillation of anesthetic solution in the contralateral side (24).

Many authors attribute locoregional anesthesia failure to a lack of knowledge or experience on the part of the dental professional (i.e., technician, rather than technical, failure); consequently, an incorrect technique can only be avoided with full knowledge of the anatomy and mechanisms of anesthetic effect.

REFERENCES

1. Vinckier F. What is the cause of failure of local anesthesia?. Rev Belge Med Dent 2000;55:41-50.
2. Wong MK, Jacobsen PL. Reasons for local anesthesia failures. J Am Dent Assoc 1992;123:69-73.
3. Grover PS, Lorton L. Bifid mandibular nerve as a possible cause of inadequate anesthesia in the mandible. J Oral Maxillofac Surg 1983;41:177-9.
4. Granollers M, Berini L, Gay C. Variaciones de la anatomía del nervio dentario inferior. Revisión bibliográfica. Anales de Odontoestomatología 1997;1:24-9.
5. Langlais RP, Broodus R, Glass BJ. Bifid mandibular canals in panoramic radiographs. J Am Dent Assoc 1985;110:923-6.
6. Sanchis JM, Peñarrocha M, Soler F. Bifid mandibular canal. J Oral Maxillofac Surg 2003;61:422-4.
7. Nortjé CJ, Farman AG, Grotepass FW. Variations in the anatomy of the inferior dental mandibular canal: A retrospective study of panoramic radiographs from 3612 routine dental patients. Br J Oral Surg, 1977;15:171-2.
8. Wyatt WM. Accessory mandibular canal: literature review and presentation of an additional variant. Quintessence Int 1996;27:111-3.
9. Rajchel J, Ellis E, Fonseca RJ. The anatomical location of the mandibular canal its relationship to the sagittal ramus asteotomy. Int J Adult Orthodon Orthognath Surg 1986;1:37-47.
10. Goaz PW, White SC, eds. Oral radiology principles and interpretation. St. Louis: Mosby; 1987. p.174-99.
11. Zografos J, Kolokoudias M, Papadakis E. The types of the mandibular canal. Hell Period Stomat Gnathopathoprosopike Cheir 1990;5:17-20.
12. Pyle MA, Jasinevicius TR, Lalumandier JA, Kohrs KJ, Sawyer DR. Prevalence and implications of accessory retromolar foramina in clinical dentistry. Gen Dent 1999;47:500-3.
13. Sawyer DR, Kiely ML. Retromolar foramen: a mandibular variant important to dentistry. Ann Dent 1991;50:16-8.
14. Sakland WE. The position of the mental foramen in Asian Indians. J Oral Implantol 1994;20:118-23.
15. Parameswaran A, Udayakumar P. Bifid root and root canal in mandibular second premolar and its management: a case report. Fed Oper Dent 1990;1:25-7.
16. Grover PS, Lorton L. Bifid mandibular nerve as a possible cause of inadequate anesthesia in the mandible. J Oral Maxillofac Surg 1983;41:177-9.
17. Sawyer DR, Kiely ML, Pyle MA. The frequency of accessory mental foramina in four ethnic groups. Arch Oral Biol 1998;43:417-20.
18. Bennett S, Towsend G. Distribution of the mylohyoid nerve: anatomical variability and clinical implications. Aust Endod J 2001;27:109-11.
19. Yonchack T, Reader A, Beck M, Meyers WJ. Anesthetic efficacy of unilateral and bilateral inferior alveolar nerve blocks to determine cross innervation in anterior teeth. Oral Surg Oral Med Oral Pathol 2001;92:132-5.
20. Rood JP. The nerve supply of the mandibular incisor region. Br Dent J 1977;143:227-30.
21. Fleury AA. Local anesthesia failure in endodontic therapy. The acute inflammation factor. Compendium 1990;11:210-4.
22. Nusstein J, Reader A, Nist R, Beck M, Meyers W. The anesthetic efficacy of the intraosseous injection in irreversible pulpitis. J Endodon 1996;22:196.
23. Potocnik I, Bajrovic F. Failure of inferior alveolar nerve block in endodontics. Endod Dent Traumatol 1999;15:247-51.
24. Peñarrocha M, Martínez JM, Sanchís JM, eds. Anestesia local en Odontología. Valencia: Colección odontológica; 1999. p.249-61.
25. Vandermeulen E. Pain perception, mechanisms of action of local anesthetics and possible causes of failure. Rev Belge Med Dent 2000;55:29-40.
26. Meechan JG, Donaldson D, Kotlicki A. The effect of storage temperature on the resistance to failure of dental local anesthetic cartridges. J Can Dent Assoc 1995;61:143-8.
27. Meechan JG, McCabe JF, Carrick TE. Plastic dental local anaesthesic cartridges: a laboratory investigation. Br Dent J 1990;169:54-6.
28. Budenz AW, Osterman SR. A review of mandibular anesthesia nerve block techniques. J Calif Dent Assoc 1995;23:27-34.
29. Gow-Gates GA. Mandibular conduction anesthesia: A new tecnique using extraoral landmarks. Oral Surg Oral Med Oral Pathol 1973;36:321-8.
30. Sillampää M, Vuori V, Lehtinen R. The mylohyoid nerve and mandibula anesthesia. Int J Oral Maxillofac Surg 1988;17:206-7.