Comparison of two needle models in terms of bevel deformation during truncal block of the inferior alveolar nerve

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Almendros-Marqués N, Delgado-Molina E, Tamarit-Borrás M, Berini-Aytés L, Gay-Escoda C. **Comparison of two needle models in terms of bevel deformation during truncal block of the inferior alveolar nerve.** Med Oral Patol Oral Cir Bucal 2007;12:E317-22.
© Medicina Oral S. L. C.I.F. B 96689336 - ISSN 1698-6946

Received: 15-07-2006
Accepted: 23-02-2007

Indexed in:
-Index Medicus / MEDLINE / PubMed
-EMBASE, Excerpta Medica
-SCOPUS
-Indice Médico Español
-IBECS

ABSTRACT

Objectives: To evaluate the differences in terms of bevel deformation between two types of needle of the same length and external caliber, but with different internal diameters, during truncal block of the inferior alveolar nerve. Study design: Four operators performed truncal block of the inferior alveolar nerve and infiltrating anesthesia of the buccal nerve for the extraction of a lower third molar in 266 patients. The truncal block was carried out using a standard 27G x 35 mm needle with an internal caliber of 0.215 mm, or a 27G x 35 mm XL Monoprotect® needle with an internal caliber of 0.265 mm. The infiltrating anesthesia was made with a Monoprotect® or XL Monoprotect® needle, both with a caliber of 30G and a length of 25 mm, but with different internal calibers (0.215 and 0.265 mm, respectively). The type of needle used, the anesthetic technique and the number of bone contacts was established during the procedure, the operator working side, the side of the tooth to be removed, the operator in charge of the intervention and the presence of bevel deformation after the anesthetic technique were collected for each patient. Results: A statistically significant association was observed between bevel deformation and the operator performing the truncal block, while a statistically significant association ($p<0.05$) was recorded between bevel deformation and the operator performing the infiltrating technique, the internal caliber of the needle and the number of bone contacts. Conclusions: There are no differences between the Monoprotect® needles and the XL Monoprotect® needles in terms of bevel deformation. Any such deformation can be attributable to physical-mechanical aspects such as the force with which the operator inserts the needle in the tissues – an aspect that in turn conditions the intensity of needle impact upon bone.

Key words: *Truncal block, infiltrating anesthesia, dental needle.*

RESUMEN

Objetivos: Evaluar las posibles diferencias existentes en cuanto a la deformación del bisel de dos tipos de aguja de igual longitud y calibre externo, pero de distinto diámetro interno, durante el bloqueo troncal del nervio dentario inferior. Diseño del estudio: Cuatro operadores de similar formación quirúrgica realizaron el bloqueo troncal del nervio dentario inferior y la anestesia infiltrativa del nervio bucal para proceder a la extracción quirúrgica o convencional del tercer molar inferior en 266 pacientes. Para efectuar el bloqueo troncal se utilizó en todos los casos un sistema de jeringa no auto-aspirante (Uniject K®; Hoechst AG, Frankfurt, Alemania) y dos tipos de aguja: una aguja Monoprotect® de 27G x 35 mm con un calibre interno de 0.215 mm (Sofic SA, Mazamet, Francia) o una aguja XL Monoprotect® de 27G x 35 mm con un calibre interno de 0.265 mm (Sofic SA, Mazamet, Francia). Para hacer la anestesia infiltrativa del nervio bucal se utilizó el mismo tipo de jeringa y otros dos tipos de aguja: la Monoprotect®o la XL Monoprotect®, ambas con un calibre de 30G y 25 mm de longitud, diferenciándose en su calibre interno (0.215 y 0.265 mm, respectivamente) (Sofic SA, Mazamet, Francia). En cada paciente fue recopilada de forma sistemática la siguiente información: el tipo de aguja, la técnica anestésica utilizada (troncular directa o indirecta) y el número de veces que se había contactado con el hueso durante ésta, el lado de trabajo del operador, el lado del diente a extraer, el operador que hizo la intervención quirúrgica, así como la presencia o ausencia de deformación del bisel tras la técnica anestésica. Resultados: Para la técnica troncular, sólo se observó una asociación estadísticamente significativa entre la deformación de los biseles de las agujas y el operador que efectuó la técnica anestésica, mientras que para la técnica infiltrativa, se encontró una asociación estadísticamente significativa ($p<0,05$) entre la deformación de los biseles de las agujas y el operador que efectuó la técnica anestésica, el calibre interno de la aguja y el número de contactos óseos. Conclusiones: No existen diferencias entre las agujas Monoprotect® y las agujas XL Monoprotect® en cuanto a la deformación de su bisel, sino que la existencia de esta deformación obedece a aspectos físico-mecánicos como la fuerza con la que el operador introduce la aguja en los tejidos, que a su vez condicionará la intensidad del impacto de la aguja sobre el hueso.

Palabras clave: *Anestesia troncular, anestesia infiltrativa, aguja de anestesia.*

INTRODUCTION

The needles used for locoregional anesthesia in dental practice are defined by the formula aG b x c mm, where “a” indicates the number corresponding to the external caliber or diameter; “b” is the measure in mm of this caliber; and “c” is the length of the needle shaft in mm. The smaller the caliber number, the greater the external diameter of the needle (1).

A number of needles have been introduced on the market, such as the XL Monoprotect® needle (Sofic SA, Mazamet, France), maintaining the external diameter of conventional needles but affording a 2.06- and 1.52-fold greater internal luminal diameter for 30G (intraligamentous and periapical techniques) and 27G needles (paraapical and truncal techniques), respectively (1).

The needles used for dental anesthesia must have a bevel allowing easy soft tissue penetration while minimizing the risk of vascular or nerve puncture. Short (45º) and long beveled needles (7º to 15º) are available – blood vessel penetration being easier with the latter. In our setting, the needles currently marketed by the principal manufacturers have a triple bevel (1). Chikhani et al. (2) prefer to use thick (27G) and short beveled needles (45º) for truncal block of the inferior alveolar nerve. The greater external caliber of these short beveled needles (45º) makes it easier for them to slide over the surface of the nerve in the event contact is established with the latter. In comparison, fine needles with long bevels are more prone to penetrate the nerve.

However, after studying sciatic nerve anesthesia in an animal model, authors such as Rice et al. (3) argue that when short beveled local anesthesia needles produce nerve injuries, these are more serious than when using long beveled needles. Moreover, such lesions are more frequent and take longer to heal, because an increased area of nerve tissue is affected.

On the other hand, and in addition to caliber and length, the angle formed by the bevel and needle shaft conditions needle deflection upon insertion into soft tissues. Non-deflecting needles are therefore advised, i.e., needles in which the tip coincides with the center of the needle shaft lumen (1).

The initial working hypothesis is that needles of lesser internal diameter suffer less bevel deformation during the anesthetic technique, due to their increased metal thickness. The present study evaluates the differences in terms of bevel deformation between two types of needle of the same length and external caliber, but with different internal diameters, during truncal block of the inferior alveolar nerve, and during infiltrating anesthesia of the branches of the buccal nerve that innervate the vestibular zone in the region of the lower third molar.

MATERIALS AND METHODS

Four operators with similar dental training (graduates in dentistry and second and third year residents of the Master of Oral Surgery and Orofacial Implantology, School of Dentistry of the University of Barcelona, Spain) performed a total of 266 truncal blocks of the inferior alveolar nerve in 266 patients between January and October, 2004. A non-aspirating syringe system was used in all cases (Uniject K®; Hoechst AG, Frankfurt, Germany) and two types of randomly designated needle: a Monoprotect® 27G x 35 mm needle with an internal caliber of 0.215 mm (Sofic SA, Mazamet, Francia), or a 27G x 35 mm XL Monoprotect® needle with an internal caliber of 0.265 mm (Sofic SA, Mazamet, France; distributed by Laboratorios Inibsa, Barcelona, Spain).

Truncal block was carried out via the direct or indirect technique, followed by surgical or conventional extraction of a lower third molar. In both techniques the needle was inserted until bone contact was established, followed by needle tip withdrawal (about 1 mm) to perform the blood aspiration maneuver. The needles were inserted with the bevel oriented towards the bone, taking as reference the mark on the needle shaft indicating bevel location.

In all cases, and to ensure correct anesthesia of the surgical field, infiltrating anesthesia was subsequently performed via submucosal injection at vestibular level of the lower second and third molars using the Monoprotect® or XL Monoprotect® needle on a randomized basis – both presenting a caliber of 30G and a length of 25 mm, and with an internal caliber of 0.215 and 0.265 mm, respectively. Three infiltrations were made, with blood aspiration maneuvering in each of them.

Thus, two needles were used in each patient: a long needle for truncal anesthesia of the inferior alveolar nerve, and a short needle for infiltration of the territory innervated by the buccal nerve. The cartridges contained 1.8 ml of anesthetic solution (4% articaine and adrenalin 1:100,000)(Laboratorios Inibsa, Barcelona, Spain).

In both truncal block of the inferior alveolar nerve and infiltrating anesthesia of the buccal nerve, the following information was systematically collected: the type of needle used; the anesthetic technique (direct or indirect truncal block) and the number of times bone contact was established during the procedure; the operator working side; the side of the tooth to be removed; the operator in charge of the intervention; and the presence or absence of bevel deformation after the anesthetic technique. Bevel deformation was assessed by examining each of the used needle tips with a stereomicroscope (40x/100x)(Olympus Optical Co., Ltd, Hamburg, Germany). Bevels presenting any kind of deformation were classified as non-preserved bevels. Figure I shows a Monoprotect® needle with non-preserved bevel after truncal block of the inferior alveolar nerve (100X). Figure II shows a XL Monoprotect®needle with non-preserved bevel after truncal block of the inferior alveolar nerve (40X).

The chi-square and Student t-tests were used for comparing qualitative and quantitative variables, respectively. Statistical significance was considered for $p<0.05$. The SPSS version 11.5 statistical package for Microsoft Windows was used throughout (license of the University of Barcelona).

RESULTS

A total of 266 patients were subjected to truncal anesthesia of the inferior alveolar nerve, followed by infiltrating anesthesia of the buccal nerve as a prior step to surgical or conventional extraction of a lower third molar. Table 1 describes the type and number of needles used in the study.

No statistically significant association was observed between bevel deformation and the surgical experience of the operator, the working side, ipsi- or contralateral positioning of the operator with respect to the side of extraction, the truncal technique used (direct or indirect), the internal caliber of the needle or the number of bone contacts recorded on performing truncal anesthesia of the inferior alveolar nerve. However, a statistically significant association ($p<0.05$) was observed between bevel deformation and the operator performing the anesthetic technique (Table 2).

Fig. 1. Monoprotect® needle with non-preserved bevel after truncal block of the inferior alveolar nerve (100X).

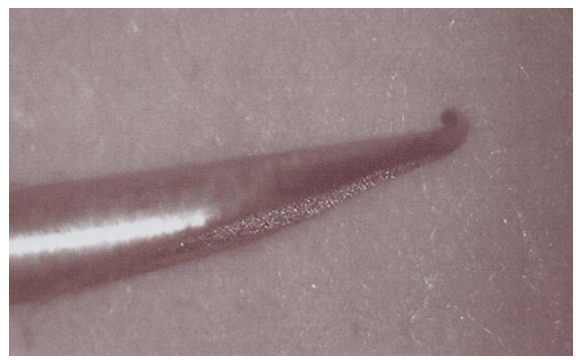

Fig. 2. XL Monoprotect® needle with non-preserved bevel after truncal block of the inferior alveolar nerve (40X).

In the case of the infiltrating technique, no statistically significant association was found between bevel deformation and the surgical experience of the operator, the working side, and the ipsi- or contralateral positioning of the operator with respect to the side of extraction. In contrast, a statistically significant association ($p<0.05$) was observed between bevel deformation and the operator performing the anesthetic technique, the internal caliber of the needle and the number of bone contacts (Table 3).

DISCUSSION

Damage to the lingual nerve during extraction of an impacted lower third molar is attributable to different intraoperative factors – one of which is the timing of the mandibular truncal block. The lesion can be caused by direct puncture, or indirectly by tearing of the nerve when the needle – deformed at the tip because of bone contact – is withdrawn from the injection site. The tearing caused by a deformed needle can affect not only the lingual nerve but also other tissues surrounding the injection site – thus favoring the development of postoperative swelling and trismus.

At the moment of needle tip impact upon mandibular bone during truncal block of the inferior alveolar nerve, needle deflection may occur instead of actual deforma-

Table 1. Sample description.

Anesthetic technique			
	Truncal	Infiltrating	Total
Monoprotect®	- 27G x 35 mm - Internal caliber: 0.215 mm - 150 needles	- 30G x 25 mm - Internal caliber: 0.215 mm - 150 needles	300
XL Monoprotect®	- 27G x 35 mm - Internal caliber: 0.265 mm - 116 needles	- 30G x 25 mm - Internal caliber: 0.265 mm - 116 needles	232
Total number of needles	266 long needles	266 short needles	532

Table 2. Bevel deformation and experience, operator, working side, operator side, type of needle, anesthetic technique and number of bone contacts during truncal anesthesia of the inferior alveolar nerve. (*) Statistically significant differences ($p<0.05$). R2 (second year resident dentists). R3 (third year resident dentists).

Variables		Preserved bevel	Non-preserved bevel
Expertise	R_2 R_3	28 93	44 101
Operator *	1 2 3 4	27 22 24 48	44 42 35 24
Working side (tooth to be removed)	Right Left	94 27	101 44
Operator side	Ipsilateral Contralateral	68 53	78 67
Type of needle	Monoprotect® XL Monoprotect®	65 56	85 60
Anesthetic technique	Direct truncal Indirect truncal	104 17	116 29
Number of bone contacts	1 2 3 4	78 41 1 1	89 53 2 1
Total		121 (45.5%)	145 (54.5%)

Table 3. Bevel deformation and experience, operator, working side, operator side, type of needle, anesthetic technique and number of bone contacts during infiltrating anesthesia of the buccal nerve. (*) Statistically significant differences ($p<0.05$). R2 (second year resident dentists). R3 (third year resident dentists).

Variables		Preserved bevel	Non-preserved bevel
Expertise	R_2 R_3	34 78	37 117
Operator *	1 2 3 4	34 16 26 36	37 48 33 36
Working side (tooth to be removed)	Right Left	78 34	117 37
Operator side	Ipsilateral Contralateral	65 47	79 75
Type of needle *	Monoprotect® XL Monoprotect®	56 56	94 60
Number of bone contacts*	0 1 2 3	6 74 20 12	3 87 36 28
Total		112 (42.1%)	154 (57.9%)

tion. According to Stacy, (4) this phenomenon depends on orientation of the needle bevel at the time of bone contact. Thus, if the bevel faces the bone surface, inward deflection will result, while if the bevel is oriented medially, deflection predominantly will be outwards. According to this author, the importance of deflection is that outward twisting of the bevel could tear the neurovascular bundle of the inferior alveolar nerve and lingual nerve upon withdrawing the anesthesia needle. He therefore prefers to perform truncal block of the inferior alveolar nerve with the bevel oriented towards the bone. On the other hand, authors such as Davidson (5) prefer to orientate the needle bevel medially, in order to facilitate deflection towards the bone surface and thus ensure increased anesthetic efficacy. This author argues that tissue resistance upon the bevel conditions needle deflection towards the non-beveled side. In our study, the needles were inserted with the bevel oriented towards the bone, and taking as reference the mark on the needle shaft indicating bevel location.

A number of investigators have indicated the possibility of nerve damage secondary to trauma produced by the local anesthetic needle, (2-4,6-9) despite the fact that such damage should normally be regarded as a secondary etiological factor in patients with sensory alterations of the lingual nerve following the surgical extraction of impacted lower third molars. In effect, the primary causes are scalpel incision, manipulation with different surgical instruments including rotary elements, and lingual flap separation with a Howarth elevator or any other instrument. (10-12) In this context, Selander et al. (13) have experimentally demonstrated that trauma caused by the needle could inflict perineural, nerve fiber and blood vessel damage. These authors suggest that such nerve damage may be reduced by adopting short beveled needles (45°). However, they make no mention of the hazard posed by bevel deformation at the time of needle withdrawal. Rice and Mc Mahon (3) have shown that the nerve damage produced by long beveled needles (9-15°) is less severe than the injury caused by short beveled needles, since the damage-inflicting area of a long beveled needle is smaller than that of a short beveled needle.

On the other hand, Brooke (14) and Stone and Kaban (15) attribute an important role on the part of the anesthesia needle in the appearance of postoperative trismus due to direct puncture of the internal pterygoid muscle, which could be increased if the needle bevel suffers deformation after the bone contact inherent to truncal block of the inferior alveolar nerve.

In principle, anesthesia needles of increased internal caliber could be expected to show increased susceptibility towards bevel deformation, due to the lesser metal thickness between the internal and external diameters of the needle. These characteristics on the other hand would increase flexibility and reduce needle fracture risk compared with a needle of lesser internal caliber, which would be more rigid. However, in our study, bevel deformation proved more frequent with needles of lesser internal caliber (standard 0.215 mm) and greater metal thickness in application to both the truncal (58.6% of altered needles) and infiltrating technique (61.0% of altered needles).

In this study contradictory results were obtained in terms of bevel deformation. In effect, the latter should be related to the number of impacts of the needle upon bone, though curiously the largest number of deformations in our series corresponded to the infiltrating anesthesia technique, where bone contact is normally not established. Hence deformation was not significantly associated to the number of bone contacts.

In our study, bevel deformation appears to be attributable to operator-related factors, since one surgeon was clearly seen to concentrate the largest number of non-deformed bevels in both the mandibular and infiltrating technique. In fact, operator number 4 respectively preserved 48 and 36 intact bevels after these two techniques, while operator 2 preserved only 22 and 16 intact bevels after performing the same techniques.

In this context, it could be postulated that the surgical experience of the operators conditions bevel deformation of the anesthesia needles. However, no statistically significant association was observed between operator experience and the number of deformations in either anesthetic technique, since the surgeon with the greatest expertise (operator 2) was precisely the one who produced the largest number of deformations.

Likewise, no statistically significant association was recorded between bevel deformation and the working side, ipsi- or contralateral positioning of the operator with respect to the extraction side in both anesthetic techniques, or the truncal approach adopted (direct or indirect).

Although no bone contacts should be expected during infiltration of the buccal nerve, such contacts were recorded by the operators. Indeed, there were more deformed bevels than non-deformed needles with this technique. This could be explained by the limited thickness of the tissues at vestibular level, which facilitates bevel-bone contact if the operator is not extremely careful. On the other hand, since three punctures were made with the same needle (anterior margin of the ascending ramus of the mandible, vestibular fundus at the level of the third molar destined for extraction, and vestibular fundus of the first molar), the probability of bone impact (and therefore of deformation) is greater.

In our study, no patient suffered sensory alterations of the lingual nerve or inferior alveolar nerve despite a 54.5% incidence of deformed bevels during truncal block of the inferior alveolar nerve. Such sensory alterations are mainly attributable to maneuvers such as raising of the lingual flap during surgical extraction of the third molar, or to direct iatrogenic action upon the nerve on applying the scalpel or rotary instruments to the tissues (lingual nerve damage). (10)

In conclusion, the results of our study indicate no differences between the Monoprotect® needles and the XL Monoprotect® needles in terms of bevel deformation. In effect, any such deformation was seen to be attributable to physical-mechanical aspects such as the force with which the operator inserts the needle in the tissues – an aspect that in turn conditions the intensity of needle impact upon bone. Our initial working hypothesis is thus rejected.

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