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Comparative study of two needle models in terms of deflection during inferior alveolar nerve block

Esther Delgado-Molina [1], Meritxell Tamarit-Borràs [2], Leonardo Berini-Aytés [3], Cosme Gay-Escoda [4]

[1] DDS. Professor of the Master of Oral Surgery and Orofacial Implantology. School of Dentistry of the University of Barcelona
[2] DDS. Professor of the Master of Oral Surgery and Orofacial Implantology. School of Dentistry of the University of Barcelona
[3] DDS, MD, PhD. Professor of Oral and Maxillofacial Surgery. Professor of the Master of Oral Surgery and Orofacial Implantology. Dean, School of Dentistry of the University of Barcelona
[4] DDS, MD, PhD. Chairman and Professor of Oral and Maxillofacial Surgery. Director of the Master of Oral Surgery and Orofacial Implantology. School of Dentistry of the University of Barcelona. Oral and Maxillofacial Surgeon of the Teknon Medical Center, Barcelona (Spain)

Correspondence:
Centro Médico Teknon
C/Vilana 12
08022 Barcelona, Spain
cgay @ bell.ub.es

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Abstract

Objectives: The purpose of this study is to determine the possible differences in deflection between two needles of same length and external gauge but with different internal gauges during truncal block of the inferior alveolar nerve. The initial working hypothesis was that greater deflection may be expected with larger internal gauge needles.

Study design: Four clinicians subjected 346 patients to inferior alveolar nerve block and infiltrating anesthesia of the buccal nerve trajectory for the surgical or conventional extraction of the lower third molar. A nonautoaspirating syringe system with 2 types of needle was used: a standard 27-gauge x 35-mm needle with an internal gauge of 0.215 mm or an XL Monoprotect® 27-gauge x 35-mm needle with an internal gauge of 0.265 mm. The following information was systematically recorded for each patient: needle type, gender, anesthetic technique (direct or indirect truncal block) and the number of bone contacts during the procedure, the patient-extraction side, the practitioner performing the technique, and blood aspiration (either positive or negative).

Results: 346 needles were used in total. 190 were standard needles (27-gauge x 35-mm needle with an internal gauge of 0.215 mm) and 156 were XL Monoprotect®. Incidence of deflection was observed in 49.1% of cases (170 needles) where 94 were standard needles and 76 XL Monoprotect®. Needle torsion ranged from 0º and 6º.

Conclusions: No significant differences were recorded in terms of deflection and internal gauge, operator, patient-extraction side, the anesthetic technique involved and the number of bone contacts during the procedure.

Key words: *Anesthetic needle, external gauge, internal gauge, deflection, truncal block.*

Introduction

Truncal block of the inferior alveolar nerve is one of the most frequent anesthetic techniques in oral surgery. No common criteria exist to determine the gauge and length of the needle to be used. Needle deflection is defined as the curvature or deviation of needles as a result of tissue resistance during insertion (1,2). Dental needles generally have an external gauge that ranges from 0.3 to 0.5 mm (30-gauge and 25-gauge needles respectively) showing greater resistance to deflection as the gauge increases (3). Factors connected with deflection are: metal alloy (3,4) and amount of silicon, gauge, length and bevel orientation (8,9). According to Allen (10-25), gauge dental needles are the most appropriate needles for the inferior dental nerve block injections as they are sufficiently rigid not to break, less likely to deviate from the penetration direction and can easily penetrate to the inferior dental nerve target depth.

Regarding needle length, some authors such as Kronman et al. (7), Malamed (11), and Bedrock et al. (12), recommend longer needles (more than 30 mm) for the truncal block of the inferior alveolar nerve to avoid needle breakage. Gay-Escoda et al. (1,2,13,l4), agree with this statement as long needles facilitate removal if necessary, as one third of the needle is visible. However, other authors mentioned by Malamed (11), such as Barker and Davies prefer the use of short needles as the path before bone contact is no longer than 25 mm. These authors argue that a lower incidence of deflection is expected with same gauge but short-length needles due to intratissue resistance.

The aim of this study is to evaluate the differences in deflection between two needles of same length and external gauge but with different internal gauges during truncal block of the inferior alveolar nerve. The initial working hypothesis was that greater deflection may be expected with larger internal gauge needles.

Materials and Methods

Four operators with similar dental training (graduates in dentistry and third-year residents in oral surgery) performed a total of 346 truncal blocks of the inferior alveolar nerve in 346 patients (114 males and 232 females) using a nonautoaspirating syringe system Uniject K® (Hoechst AG, Frankfurt, Germany) and two types of needle: a standard 27-gauge x 35-mm needle with an internal gauge of 0.215 mm or an XL Monoprotect®(manufactured by Sofic, Mazamet, France, and distributed by Laboratorios Inibsa, Barcelona, Spain) 27- gauge X 35-mm needle with an internal gauge of 0.265 mm.

Inferior alveolar nerve block was performed, followed by surgical or conventional extraction of a lower third molar using the direct or indirect truncal technique. In both cases the needle was advanced until bone contact was established, followed by slight withdrawal (1 mm) and aspiration; in the event of negative aspiration, the anesthetic solution was slowly injected (1,2).

To ensure good anesthesia of the surgical area, infiltrating anesthesia was also performed in the vestibular region innervated by the buccal nerve. Submucosal injection was made in the vestibular fundus of the region of the lower second and third molar, using 1 of the 2 needle types: standard or XL Monoprotect®, both with a 30-gauge external gauge and length of 25 mm but with different internal gauges (0.115 and 0.165 mm, respectively).

Thus, 2 needles were used with each patient: a long needle for the truncal technique and a short needle for the infiltration of the territory innervated by the long buccal nerve. The cartridges contained 1.8 mL of the anesthetic solution (4% articaine with 1:100,000 epinephrine).

The following data were systematically recorded for both truncal block of the inferior alveolar nerve and infiltrating anesthesia of the long buccal nerve: needle type, patient gender, anesthetic technique (direct or indirect truncal block) and the number of bone contacts during the procedure, the operator performing the technique, the patient-extraction side and blood aspiration (either positive or negative).

The chi-square and Student t-tests were used to analyze the qualitative and quantitative variables, respectively.

Results

A total of 346 patients (114 males and 232 females) were subjected to truncal block of the inferior alveolar nerve. The total incidence of deflection was 49.1% (Table 1).

Of the needles used, 190 (54.9%) presented the standard internal gauge of 0.215 mm, whereas 156 needles (45.1%) had an internal gauge of 0.265 mm.

No significant differences ($p<0.05$) were observed on correlating the incidence of deflection to the internal gauge of the needles. Likewise, no significant differences were recorded on deflection with the truncal anesthetic technique used, the number of changes in orientation and bone contacts, the operator performing the procedure, and patient-side of extraction.

The relative risk of deflection with both needle types was calculated, taking into account the internal gauge. There was no increase in the relative risk associated with the use of either the direct or indirect technique or with the use of either a greater or smaller internal needle gauge.

However, when assessing the operator side and the truncal technique used, smaller needles showed an increased risk of deflection when used for the anesthesia of the ipsilateral positioning of the operator with respect to the extraction side and anesthetic techniques. In contrast, with needles with larger internal gauges, the relative risk of deflection remained the same in both sides (Table 2).

Table 1. Study sample description and general results.

Total No. of Patients	346 (114 males y 232 females)
Total No. of standard needles: ·27G x 35 mm. · Internal gauge: 0.215 mm	190 (54.9%)
Total No. of XL Monoprotect® needles: ·27G x 35 mm. · Internal gauge: 0.265mm	156 (45.1%)
Total deflection incidence	170 (49.1%)
Standard needle deflection incidence	94 (49.5%)
XL Monoprotect® needle deflection	76 (48.7%)
Standard needle torsion range	0º-2º
XL Monoprotect® needle torsion range	0º-6º

Table 2. Risk and relative risk of deflection according to anesthetic technique, operator side and type of needle used.

ANESTHETIC TECHNIQUE	DIRECT		INDIRECT	
OPERATOR SIDE	Ipsilateral	Contralateral	Ipsilateral	Contralateral
Deflection risk with standard needles	0.6	0.4	0.3	0.6
Deflection risk with XL Monoprotect® needles	0.4	0.5	0.4	0.6
Relative risk of deflection with standard needles in the ipsi-late-ral side of the operator			**2**	
Relative risk of deflection with standard needles in the contralateral side of the operator			0.7	
Relative risk of deflection with XL Monoprotect® needles in the ipsilateral side of the operator			1.2	
Relative risk of deflection with XL Monoprotect® needles in the contralateral side of the operator			0.8	

Discussion

Robison et al. (4), cited Aldous who conducted the first in vitro study to determine the degree of needle deflection for inferior alveolar nerve using two tissuelike substances, hydrocolloid and frankfurters that portrayed clinical conditions. Aldous concluded that differences were observed between needles with different external gauges as needle deflection is inversely related to needle diameter. Deflection was greater with 30-gauge needle versus 25-gauge needles. However, Robison et al. (4), reported no deflection differences between the latter gauge and 27-gauge and 30-gauge needles and criticize the research of Aldous for using an insufficient sample size as only two planes were considered when determining deflection and, therefore, the distribution of needles used was not equitable. Robison et al. (4), although imitated Aldous' study design, used a bigger sample where bevel orientation and gauge, as well as needle thickness, were previously determined; they also analysed the needle performance in three planes. They concluded that external gauges do not influence deflection.

In this context, Cooley et al. (3), justified in their study that the internal gauge may influence the incidence of deflection as the use of similar external gauges facilitates rotation. On the other hand, Wittrock et al. (15), found that the internal gauge in 30-gauge needles was a variable parameter among manufacturers. This would explain the difference in performance of needles of the same external gauge but from different manufactures. No statistically significant differences were observed on contrasting the two groups of needles with different internal gauges used in our study.

As mentioned before, needle deflection may be influenced by the type of alloy used in needle manufacturing (3,4). In the in vitro study conducted by Cooley et al. (3), lesser deflection was reported with 27-gauge versus 30-gauge needles. Although no statistically significant

differences were observed, the authors attributed an important role on the part of the alloy used by the manufacturer. Likewise, Wittrock et al. (15), consider that the material used in needle manufacturing is a determinant factor for deflection. Furthermore Robison et al. (4), reported in an in vitro study that no statistically significant differences were found in terms of deflection with needles of 25 mm length and 25-27- and 30-gauge needles from different manufacturers. They also reported that a group of 25-gauge needles from a specific manufacturer was found to show lesser deflection due to the metal alloy used and not the needle gauge. In our study, this comparison was not made as all needles included in the analysis were from the same manufacturer.

Regarding needle length and deflection, Kronman et al. (7), prefer to use short needles (less than 30 mm) during truncal block of the inferior alveolar nerve as lesser deflection was observed in their study. A specific needle length is needed for the effective truncal anesthesia of the inferior alveolar nerve in order to facilitate bone contact prior to the injection of local anesthetic solution and further spread of the anesthetic solution into the pterygomandibular space. Delgado et al. (16), reported that the mean needle depth at contact with the mandibular ramus was 20.72 mm while Kronman et al. (7), concluded that the mean needle depth was 21.96 mm. As a safety measure, a third of the needle should be visible in order to facilitate removal in the event of needle breakage (1,2,13,14). Thus, authors such as Gay-Escoda et al. (1,2,13,14), recommend the use of long needles (35 mm) for the truncal block of the inferior alveolar nerve. On the other hand, Bedrock et al. (12), argue that factors such as needle reuse, inappropriate anesthetic technique or a sudden movement of the patient or the operator can cause needle breakage.

According to an in vitro study conducted by Hochman et al. (9), showed that anesthetic technique used during truncal block of the inferior alveolar nerve may affect needle deflection. Robison et al. (4), and Davidson (17), agree with this point. Thus, Hochman et al. (9), introduce a new anesthetic technique known as a "bidirectional rotation insertion technique". This technique seeks to produce a more accurate, linear needle tracking through tissues and to neutralize the force vectors that act on the needle bevel that make the needle shaft bend. The needle is rotated between the thumb and index finger 180 degrees in each direction. The type of rotation used is analogous to techniques that have been described for endodontic file instrumentation. In the study, the authors concluded that the bidirectional rotational insertion technique reduces substantially the force required to push the needle to penetrate tissues compared with the usual linear technique as a reduction of force penetration in the range of 40% to 50% was reported. However, truncal block (both direct and indirect and linear insertion) was the technique used in our analysis. No statistically significant differences were observed; thus anesthetic technique was not a determinant factor for evaluating needle deflection.

Smith (18), showed that bevel tip design of a needle will influence the path the needle takes as it penetrates through substances of varying densities and concluded that bevel shape of the needle tip will influence needle deflection. Davidson (17), also agrees with these findings. However, Forrest (19), relates deflection to the incorrect bevel orientation in the course of truncal block of the inferior alveolar nerve. In our study, no statistically significant differences were reported in terms of deflection and bevel orientation as bevel shape was the same for the two types of needles used. Furthermore, it is necessary to point out that all operators performed the same bevel orientation as explained on the Materials and Methods section.

In conclusion, the present study found no statistically significant differences in terms of needle deflection and internal gauge, the anesthetic technique used, the clinician performing the procedure or the operator side. Consequently, our initial working hypothesis can be rejected, because no increased deflections were observed for greater internal gauges.

However when analysing the patient-extraction side and the anesthetic technique used, smaller internal gauges showed an increased risk of deflection when used for the anesthesia of the ipsilateral positioning of the operator. This may be attributed to the forced position of the operator's hand in the course of the anesthesia of the ipsilateral side which increases deflection. In order to compensate the deflection, the patient should turn to the operator. We consider that deflection was affected by operator performance and not by the internal gauge used.

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