Anesthetic Efficacy of Articaine and Lidocaine for Incisive/Mental Nerve Block

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Abstract

Introduction: The incisive/mental nerve block (IMNB) could be an alternative to the inferior alveolar nerve block in the mandibular anterior teeth. The effectiveness of articaine has not been tested in IMNB. **Methods:** This prospective randomized double-blind crossover study compared the anesthetic efficacy of 0.6 mL 4% articaine and 2% lidocaine, both with 1:100.000 epinephrine administered as IMNB to 40 volunteers in two sessions. Pulpal anesthesia of lateral incisor through premolars was tested with an electric pulp tester. The injection and postoperative pain were evaluated by using visual analog scales. The onset (time from the end of injection to the absence of pulpal response) and duration of pulpal anesthesia (time recorded before two positive responses to the pulp tester) and the anesthesia success (two consecutive readings of 80 without response and onset ≤10 minutes) were measured. **Results:** Articaine provided a higher success rate ($p < 0.001$) of anesthesia than lidocaine for the lateral incisor (32.5%), the canine (55%), and the first (72.5%) and second (80%) premolars and a faster onset ($p < 0.05$) for canine and increased duration ($p < 0.05$) of anesthesia for premolars. The median duration of premolars anesthesia was 10 and 20 minutes, respectively, with lidocaine and articaine. There were no differences in pain scores between the solutions ($p > 0.05$). **Conclusions:** Articaine promoted higher anesthesia success and longer duration of anesthesia than lidocaine for most of the teeth after IMNB although anesthesia success could be considered clinically appropriated only for premolars. The volume of local anesthetic used in the present study may not be appropriate for procedures lasting longer than 10 minutes. *(J Endod 2010;36:438–441)*

Key Words

Articaine, incisive/mental nerve block, lidocaine, local anesthetics

The incisive/mental nerve block usually provides effective anesthesia for premolars (1, 2) and canines (1) in more than 50% of the cases. The degree of success of this technique is shown to be higher in the premolars and decreases in the canine and lateral incisor (1, 2). A similar finding is observed in inferior alveolar nerve blocks, and the explanation for this fact is the position of sensory nerve fibers for each tooth in different depths in the nerve bundle, with increased difficulty of local anesthetic to reach the most inner fibers (3–5).

Although the solution deposition inside or outside the foramen does not influence the duration of pulp anesthesia and the degree of discomfort, the success is lower for canine and second premolars when the injection is given outside the foramen (1). Articaine, an amide with a heterocyclic thiophene ring, has been shown to provide higher success levels than lidocaine for infiltration anesthesia in permanent mandibular molars (6–8). It also could be a useful alternative for mandibular first molars anesthesia because it has a faster onset and a similar success rate when compared with inferior alveolar nerve block (9). The effectiveness of articaine has not been tested in an incisive/mental nerve block.

The aim of the present prospective, randomized, double-blind, crossover study was to compare the efficacy of articaine and lidocaine, both with epinephrine 1:100,000, in obtaining pulp anesthesia of mandibular premolars, the canine, and the lateral incisor after incisive/mental nerve block.

Material and Methods

This study was approved by the ethical committee of the Piracicaba Dental School, University of Campinas (CAAE–0025.0.167.000-07), and written informed consent was obtained from every subject. The number of volunteers was set at 40 based on a power calculation that indicated that a sample size of 39 volunteers would provide 80% power to detect a difference of 30% in the success rate, assuming a significance level of 5%. The volunteers (20 men and 20 women) aged from 18 to 35 years presented with mandibular premolars, canines, and lateral incisors, all responsible to the pulp tester. Exclusion criteria included pregnancy, systemic disease, intake of medicines other than contraceptives, history of allergy to the components of the local anesthetic solutions, local anesthesia in the region at least 1 week before the experiment, caries, large restorations, periodontal disease, or a history of trauma or sensitivity in the target teeth.

Volunteers randomly received two incisive/mental nerve blocks according to the technique described by Malamed (10) at 2 separate appointments spaced at least 2 weeks apart in a repeated-measures design. The injections were performed by a single

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trained operator and consisted of 0.6 mL 2% lidocaine (Alphacaine; DFL Industria e Comercio Ltda, Rio de Janeiro, RJ, Brazil) or 4% articaine (Articaine, DFL Industria e Comercio Ltda), both with 1:100,000 epinephrine.

At the beginning of each appointment and before any injection, the right mandibular lateral incisor, the canine, and the first and second premolar were tested 3 times by using a pulp tester (Analytic Technology Corp, Redmond, WA) to determine baseline response. After isolation of the teeth with cotton rolls and drying them with gauze, fluoride gel was applied to the probe tip and placed midway between the gingival margin and the incisal or occlusal edge of the teeth to be tested (according to the manufacturer's guidelines). The left mandibular canine was used as a control to ensure that the pulp tester was operating properly and that the volunteers were responding accurately during the study. The current rate was set up to increase from no output (0) to the maximum output (80) at 30 seconds. The number at initial sensation was recorded, and the mean value of the 3 readings was considered to be the baseline threshold. Every 2 minutes after injection, the same teeth were tested until there was no response to the maximum output of the pulp tester and then every 10 minutes until two consecutive responses to the pulp tester were obtained. All the pulp testing was performed by a trained person who was blinded to the anesthetic solutions administered.

After the injection, volunteers were asked to record the pain associated with the local anesthetic injection procedure (needle insertion and anesthetic solution deposition) on a 100-mm visual analog scale (VAS) ranging from 0 = "no pain" to 100 = "unbearable pain." The postoperative pain was recorded by volunteers on another VAS after the returning to normal sensation in the soft tissue.

The parameters evaluated were lip anesthesia onset (the time from the end of the injection to the beginning of lip numbness to palpation), duration of lip anesthesia (the time from the beginning to the end of lip numbness to palpation), onset of pulpal anesthesia (the time from the end of injection to the first of two consecutive readings of 80 without response), duration of pulpal anesthesia (the time from the onset of pulpal anesthesia to the time recorded before two positive responses to the pulp tester were obtained), and anesthetic success (two consecutive readings of 80 without response and onset of pulpal anesthesia $\leq$10 minutes).

The onset of lip numbness was assessed by asking the volunteers to palpate the lip and report when lip numbness occurred. Volunteers were instructed to palpate the inferior lip at each time of electric pulp testing and every 10 minutes subsequently to the end of pulp testing until return to normal sensation. Twenty-four hours after the injection, the volunteers were also asked about discomfort or complications of the anesthetic procedure.

Data were analyzed with BioEstat (version 5.0; Mamirauá Institute, Belem, PA, Brazil). The Wilcoxon matched pairs signed rank test was used to analyze the onset and duration of pulp anesthesia, the duration of soft-tissue anesthesia, and the pain associated to injection and postoperative pain; the log-rank test was used to analyze anesthesia success. The significance level was set at 5%.

Results

No statistically significant differences ($p > 0.05$) were found between sexes (data not shown) regarding any of the studied parameters. The results for onset and the duration of lip and pulpal anesthesia (lateral incisor, canine, first and second premolar) are presented in Table 1. The percentages of volunteers with no response to the maximal output of the electric pulp test in the lateral incisor, the canine, and the first and second premolars are shown in Figure 1.

Higher success rates were observed for the lateral incisor ($p = 0.0008$), the canine ($p < 0.0001$), and the first ($p < 0.0001$) and second ($p < 0.0001$) premolars with the use of articaine. All volunteers reported lip numbness after articaine and lidocaine incisive/mental nerve block at the first registration point (2 minutes after the end of injection).

There was no significant difference between the solutions regarding the onset of pulpal anesthesia for the first premolar ($p = 0.286$) and the second premolar ($p = 0.4534$). Considering the canine, articaine solution provided faster onset of anesthesia ($p = 0.0431$). The onset and duration of anesthesia for the lateral incisor were not analyzed because of the low incidence of successful anesthesia for this tooth.

The 4% articaine with 1:100,000 epinephrine solution provided increased duration of soft tissue ($p = 0.0174$) and pulpal anesthesia for the first ($p = 0.0253$) and second premolars ($p = 0.0108$). No significant difference between the solutions was found for the duration of anesthesia in the canine ($p = 0.1441$). The duration of pulpal anesthesia was measured only for the teeth presenting at least 10 minutes of anesthesia (two consecutive readings of 80 without response).

VAS (Fig. 2) associated with local anesthetic injection varied between 1 and 71 mm for lidocaine and between 1 and 70 mm for articaine; the postoperative VAS varied from 0 to 25 mm for lidocaine and 0 to 34 mm for articaine. The scores of pain associated with local anesthetic injection were higher than the postoperative pain scores for both solutions tested ($p < 0.05$). There was no significant difference ($p > 0.05$) between the solutions regarding the injection pain and postoperative pain. No discomfort or complication other than pain was related by any of the volunteers in the following 24 hours after the anesthetic injection.

Discussion

Anesthesia success and duration may vary considerably depending on the type and volume of anesthetic solution, the technique, and the site of injection (6, 11–14). The influence of the injected volume has been shown on the percentage of anesthesia success as well as on the duration of anesthesia (13, 14). In the present study, the side of injection was standardized to avoid any variability including the unanesthetized canine of the contralateral side of the mandible used to verify the proper function of the electric pulp test and the response of the volunteers.

Although many authors suggest the use of 1.0 to 1.5 mL of local anesthetic for incisive/mental nerve block (15–17), in the present study a smaller volume of local anesthetic was used as suggested by Malamed

TABLE 1. Anesthesia Success rate (%), Onset, and Duration (in minutes) of Soft Tissue and Pulpal Anesthesia (Median [Lower-Upper Quartiles]) After Incisive/Mental Nerve Block With Lidocaine and Articaine Solutions

	Solution	Lateral Incisor	Canine	First Premolar	Second Premolar	Lip
Onset of anesthesia (min)	Lidocaine	—	8 (5–9)	4 (2–6)	3 (2–4.5)	2
	Articaine	—	5* (4–6)	4 (2–4)	2 (2–4)	2
Duration of anesthesia (min)	Lidocaine	—	10 (10–20)	10 (10–20)	10 (10–20)	156 (135.5-184.25)
	Articaine	—	10 (10–20)	20* (10–30)	20* (10–32.5)	165* (145.75-198.5)

*Statistically significant difference ($p < 0.05$) between both solutions considering the same tooth.

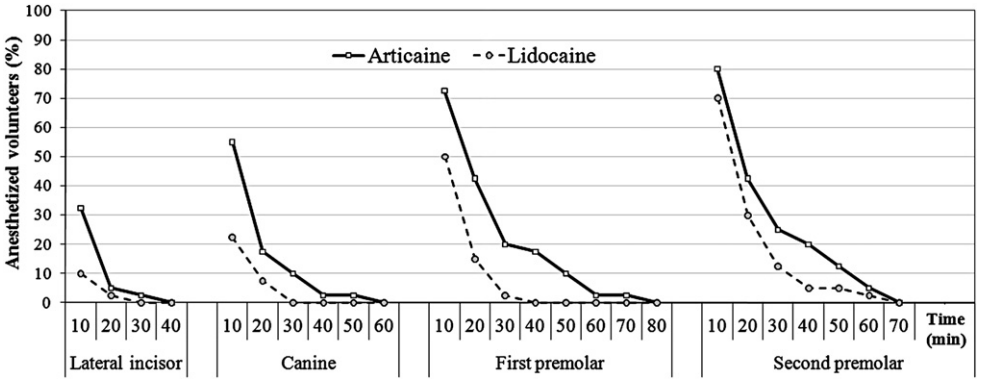

Figure 1. The percentage of volunteers with no response to electric pulp testing at maximal setting (80 reading) at 10-minute intervals (from 0 to 80) after incisive/mental nerve block.

(10) to investigate anesthesia success of the two solutions under this condition. The higher anesthesia success for posterior teeth (premolars) is in agreement with other studies for incisive/mental nerve block (1, 2, 18) and also studies for inferior alveolar nerve block (19, 20). Probably, the close proximity of the injection site to the premolars could have influenced the results of the present study. In addition, it is possible that the position of the posterior-teeth nerve fibers, which are located in the periphery of the nerve bundle, could be responsible for the higher anesthesia success.

The percentages of anesthesia success obtained in the present study for premolars, 50 to 70%, were similar to those obtained by Joyce and Donnelly (1) for the first premolar when 0.9 mL 2% lidocaine with 1:100,000 epinephrine was deposited outside the mental foramen. Larger volumes may lead to increased degrees of success for these teeth such as 90% to 100% when using 1.8 mL 2% lidocaine with 1:100,000 epinephrine (18) and 81.8% when using 2 mL 2% lidocaine with 1:80,000 epinephrine (2). Therefore, the volume of local anesthetic and probably the concentration of epinephrine may influence the degree of success of the injections. Additionally, the definition of anesthesia success may vary among the studies. Although Joyce and Donnelly (1) defined success as one 80 μA reading (maximal electric pulp tester stimulation) without sensation, Whitworth et al (2) defined success as two consecutive 80 μA readings without sensation. Nist et al (18) used 2% lidocaine with 1:100,000 epinephrine and considered the anesthesia success when two consecutive 80 μA readings were obtained during 60 minutes after injection. The present study considered two consecutive readings of 80 μA without response (a minimum of 10 minutes of pulpal anesthesia) and onset of pulpal anesthesia $\leq$10 minutes.

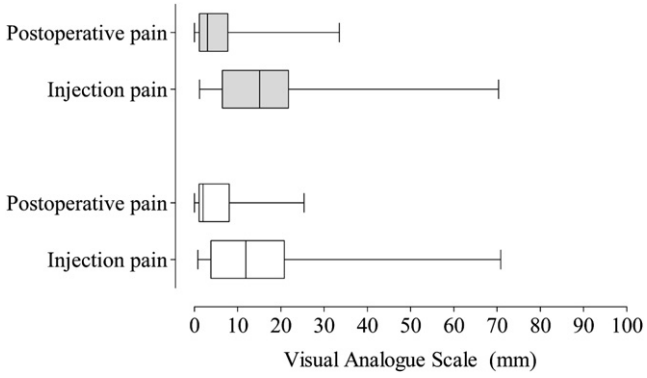

Figure 2. The scores of injection pain and postoperative pain after incisive/mental nerve block with lidocaine (white bars) or articaine (gray bars). Central line = median; box = 1st and 3rd quartiles; whisker = minimum and maximum values.

For teeth localized further from the mental foramen, the influence of the volume is even more pronounced. Considering canine, the anesthesia success with lidocaine associated to epinephrine was 58% and 22.5%, respectively, for Joyce and Donnelly (1) and the present study, whereas for the lateral incisor 45%, 38.5%, and 10% of anesthesia success was obtained by Nist et al (18), Whitworth et al (2), and our study, respectively. Otherwise, the use of 0.6 mL articaine provided increased percentages of anesthesia success, which was comparable to that obtained by these authors with lidocaine in higher volumes. Thus, incisive/mental nerve block with 0.6 mL articaine could be a reasonable alternative for premolars anesthesia. However, considering the canine and the lateral incisor, the anesthesia success rates are not acceptable for both anesthetic solutions when 0.6 mL is used.

Some studies showed similar anesthetic effects for articaine and lidocaine considering mandibular posterior teeth with noninflamed (21) and inflamed (22, 23) pulps after an inferior alveolar nerve block. However, in the present study, articaine provided higher anesthesia success than lidocaine considering all observed teeth. A higher degree of success with articaine in relation to lidocaine has also been seen in mandibular posterior teeth after infiltration in this region (6, 7, 24). These results could be explained by differences in the anesthesia techniques used and anesthetic diffusion profile. Although in the inferior alveolar nerve block the anesthetic solution is injected near the nerve, the infiltration in the posterior region of the mandible requires diffusion through the cortical plate. In the incisive/mental nerve block, the local anesthetic may reach the nerve directly through the mental foramen or also diffuse through the cortical plate. Therefore, the increased diffusion of articaine, resulting in a better bone penetration (9), could explain the differences of anesthetic efficacy between inferior alveolar nerve block and infiltration or incisive/mental nerve block. The ability of articaine to diffuse through soft tissue and bone better than other anesthetics is probably because of its thiophene group, which increases its liposolubility (25, 26).

The results for the onset of pulpal anesthesia obtained in our study for premolars were within the range reported by Robertson et al (7), Corbett et al (8), and Jung et al (9) after the infiltration of 1.8 mL, 1.7 mL, and 1.8 mL of 4% articaine, respectively, with 1:100,000 epinephrine in the buccal region of mandibular first molar. The results obtained with lidocaine were shorter in the present study probably because of the injection near the mental foramen, whereas Robertson et al (7) injected in the first molar region. The distance from the mental foramen could have less influence in the articaine performance because this anesthetic seems to have a better penetration than lidocaine. These authors (7) obtained

pulpal onset (mean ± standard deviation) of 4.7 ± 2.4 minutes and 4.3 ± 2.3 minutes for the first and second premolar, respectively with articaine and 6.1 ± 3.1 minutes and 6.9 ± 6.6 minutes with lidocaine for the same teeth. Our results were 4.2 ± 2.1 minutes and 3.4 ± 2.2 minutes for articaine and 4.5 ± 2.1 minutes and 3.6 ± 1.8 minutes for lidocaine, respectively, for the first and second premolar. Articaine provided a shorter anesthesia onset for canine teeth in the present study, which could also be explained based on the higher liposolubility and ability to diffuse to the axons that innervate this tooth, which are placed inner in the nerve bundle. However, no difference concerning anesthesia duration was found between the solutions for the canine, whereas articaine provided longer-lasting anesthesia for premolars. These findings could be related to the small volume used in this study.

Another interesting observation is the time when the percentage of volunteers anesthetized begins to decrease. In the studies of Nist et al (18) and Whitworth et al (2), it started 15 to 30 minutes after the injection, whereas in our study it started in 10 minutes as shown in Figure 2. This difference could also be related to the difference of volumes of local anesthetic injected in these studies, 1.8, 2.0, and 0.6 mL, respectively. These findings suggest that the volume used in our study, although recommended in the literature (10), may not be appropriate to maintain anesthesia for procedures demanding more than 10 minutes of pulpal anesthesia. In contrast, the duration of soft-tissue anesthesia was long lasting, with more than 2.5 hours for both solutions, with extended duration after the use of articaine. Usually, the lip numbness is not required and often undesired because it disturbs normal daily activities, such as eating, drinking, and speaking. However, gingival anesthesia could be important when postoperative pain in soft tissue is anticipated, such as in surgical procedures. Despite causing lip numbness, the incisive/mental nerve block does not cause lingual anesthesia, as usually verified in the inferior alveolar nerve block.

No difference was found between the solutions in relation to the injection and postoperative pain. Considering VAS values less than 30 mm as mild pain, from 30 mm until 60 mm as moderate pain, and more than 60 mm as severe pain, 87.5% of the volunteers in both groups rated injection pain as mild and 10% as moderate, whereas the postoperative pain was rated as mild with the exception of one volunteer in the articaine group who rated postoperative pain as moderate. These data are in agreement with the literature (1, 18), which reports injection pain varying from none to moderate, with mild or no pain after the discontinuation of anesthesia. The use of VAS pain scale has been shown such as a reliable assessment tool to evaluate the level of pain in studies comparing different local anesthetics solutions (27).

No postoperative complications, other than pain, were reported by volunteers in the present study. Robertson et al (7) observed bruising and swelling in 4% and 5% of volunteers for articaine and lidocaine, respectively, after infiltration of one cartridge of these solutions as buccal infiltration in the mandibular first molar. The absence of complications in our study probably is related to the small volume used. Further studies are necessary to establish the appropriate volume of articaine to provide pulpal anesthesia lasting more than 10 minutes after an incisive/mental nerve block.

Conclusion

Articaine promoted higher anesthesia success and duration of anesthesia than lidocaine for most of the teeth after an incisive/mental nerve block. The volume of local anesthetic used in the present study may not be appropriate for procedures lasting longer than 10 minutes.

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