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Comparison of the Effectiveness of Infraorbital Anesthesia Using 4% Articaine Associated with 1:100,000 and 1:200,000 Epinephrine

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• Conflicts of interest: none declared.

Abstract

Objective: To compare the anesthetic efficacy of 4% articaine associated with epinephrine concentrations of 1:100,000 and 1:200,000, using the infraorbital nerve block approach. **Material and Methods:** This is a double-blind cross-sectional study conducted with 40 volunteers. Pulpal anesthetic parameters such as latency, duration, and success rates were evaluated using a pulp tester device, which emits electrical discharges ranging from 0 to 80 μA in 20 seconds. Soft tissue anesthesia (vestibular gum) was evaluated by pressing a wooden toothpick into the gingival region used in the approach. Finally, parameters related to pain after anesthesia were evaluated. **Results:** We found no statistically significant differences between anesthetic solutions for pulp and soft tissue regarding latency period. The anesthetic solution containing 1:100,000 epinephrine presented a significantly longer effect duration than 1:200,000 epinephrine regarding pulpal anesthesia of maxillary central incisors, first maxillary premolar, and second maxillary premolar. As for vestibular gum, we found no statistically significant differences between the solutions. Regarding pain at injection, the two anesthetic solutions showed no statistically significant differences. **Conclusion:** 4% articaine with 1:100,000 epinephrine presented significantly longer pulpal anesthesia duration in some dental elements when compared to 1:200,000 epinephrine.

Keywords: Local Anesthetics; Articaine; Epinephrine.

Introduction

Local anesthetics are drugs that provide certified safety for patients, as well as intraoperative and postoperative pain management.[1,2] After administration, local anesthetics incur minimal tissue irritation rates and rare toxicity events. Articaine is an important local anesthetics within the amide group, available for dental use in Europe since 1976, but commercialized in Brazil only up from 1999.[1]

Articaine contains a thiophene ring in its molecular structure, which enhances the lipid solubility of the drug and its capacity to penetrate through the membrane and nerve sheaths, enabling its binding to the specific receptor site on sodium channel proteins.[3] This local anesthetic also exhibits a high degree of plasma protein binding, providing a greater adherence to specific receptors, which may explain its longer anesthetic effect duration.[4] Although classified as amide, articaine molecules contain an ester group, which makes its biotransformation to occur in both the plasma (by cholinesterase enzymes) and the liver (by microsomal enzymes), conferring it a shorter plasma half-life when compared to other anesthetics.[5]

Articaine formulations available in Brazil, contains an adrenergic vasoconstrictor that provides better intraoperative management by improving anesthetic quality and effect duration, as well as bleeding control epinephrine. Articaine hydrochloride is found at 4% associated with epinephrine vasoconstrictor at 1:100,000 and 1:200,000.[1,6,7]

Epinephrine in different concentrations alter vasoconstrictors ratio, but some authors found no significant differences regarding anesthetic efficacy and effect duration, showing that, in reduced concentrations, vasoconstrictors are applicable in daily dental care.[7-10] Conversely, similar studies reported better clinical performance when articaine is associated with epinephrine at higher concentrations.[11-13] These findings indicate the need for expanding knowledge on the use of the two anesthetic solutions in some anesthetic block approaches still lacking in the literature.

This study sought to compare the anesthetic efficacy of 4% articaine associated with 1:100,000 and 1:200,000 epinephrine for infraorbital nerve block.

Material and Methods

This study was approved by the Research Ethics Committee of the School of Sciences of the Santa Casa de Misericórdia de Vitória under opinion no. 3,225,550. All volunteers agreed to participate in the study by signing an informed consent form (ICF).

This is a split-mouth double-blind study. Each anesthetic solution was administered on one side of the maxilla, following the sequence randomized prior to the beginning of the study. Forty dentistry students at the Escola Superior São Francisco de Assis, Santa Teresa - ES, were selected to participate, according to the sample size calculated by a previous study with similar research method.[6,14]

The study sample was composed of dentistry students classified as ASA I by the American Society of Anesthesiology Physical Status Classification System, and who had previously

undergone local anesthesia without complications. Individuals with asthma (who present a higher risk of allergic reactions to the antioxidant present in the anesthetic solution), users of continuous medications, pregnant and lactating women, and individuals with caries, periodontal disease, history of trauma, or sensitivity in the dental elements involved in the anesthetic approach were excluded.

Anesthetic procedures

One of the following local anesthetic solutions was administered in each evaluation session: 4% articaine hydrochloride with 1:100,000 epinephrine (Articaine®– DFL Química e Farmacêutica Ltda.) or 4% articaine hydrochloride with 1:200,000 epinephrine (Articaine®– DFL Química e Farmacêutica Ltda.).

Before anesthesia, the dental elements required for the infraorbital technique were tested by electrical stimulus applied with the pulp tester device according to manufacturer instructions. Each dental element was measured three times, and their arithmetic mean was considered the baseline threshold of pulp response.

Before performing the anesthetic techniques, topical anesthesia was administered with 5% lidocaine (Generic - EMS) by pressing a sterile gauze on the puncture point for two minutes. Infraorbital anesthesia was performed using a 27G x 32 mm needle at about 5 mm from the bottom of the vestibule, toward the maxillary second premolar. The needle was inserted parallel to the long axis of the tooth, at a 20 mm depth, until reaching the infraorbital foramen entrance.

Evaluation of anesthetic parameters

After anesthetic injection, dental elements were tested with electrical stimulus every two minutes until no painful sensation was detected at maximum stimulus, determining anesthetic success (anesthesia range) and latency period. Once dental elements reached anesthetic effect, electrical stimulus was performed every 10 minutes until the device read two consecutive painful sensation at the maximum stimulus, determining anesthesia duration.

Soft tissue anesthesia (vestibular gum) was evaluated by pressing a blunt-tip wooden toothpick into the gingival region during dental elements evaluation.

Pain at injection was evaluated using a pain scale[15] filled out by volunteers, indicating the intensity of pain felt during anesthetic injection from zero to ten – zero indicating no pain and ten the worst possible pain.

Results were initially evaluated for normal distribution (Shapiro Wilk test) and equality of variances (Levene's test), and then compared using the paired Wilcoxon test or Mann-Whitney U test for not meeting normality requirements. Data expressed in frequency distribution tables were compared by Fisher's exact tests or Chi-square, accordingly. All analyses were conducted using the 8.1.0 GraphPad Prism statistical package®, and significance level was set at 5% (=0.05).

Results

Eighty infraorbital anesthetic techniques were performed altogether: 40 using 4% articaine with 1:100,000 epinephrine (ART100) and 40 using 4% articaine with 1:200,000 (ART200) epinephrine.

Table 1 shows the success rates in pulp and soft tissue for each dental element involved in the infraorbital technique according to anesthetic solution.

Table 1. Anesthetic success indexes according to anesthetic solution and dental element.

		Anesthetic solutions		p-value (Fisher's exact or chi-square test)
		ART100	ART200	
Pulp anesthetic success	MCI	8 (20.0%)	5 (12.5%)	0.3632
	MLI	14 (35.0%)	14 (35.0%)	>0.9999
	MC	34 (85.0%)	34 (85.0%)	>0.9999
	1MPM	37 (92.5%)	35 (87.5%)	0.7119
	2MPM	38 (95.0%)	35 (87.5%)	0.4315
Vestibular gum anesthetic success	MCI	32 (80.0%)	34 (85.0%)	0.5562
	MLI	34 (85.0%)	38 (95.0%)	0.2633
	CM	38 (95.0%)	39 (97.5%)	>0.9999
	1MPM	39 (97.5%)	39 (97.5%)	>0.9999
	2MPM	39 (97.5%)	40 (100%)	>0.9999

MCI (maxillary central incisor); MLI (maxillary lateral incisor); MC (maxillary canine), 1M1P (maxillary first premolar); 2M2P maxillary second premolar; ART100 (articaine hydrochloride with 1:100,000); ART200 (articaine hydrochloride with 1:200,000).

We found no statistically significant differences (Chi-square or Fisher's exact tests, p>0.05) between anesthetic solutions regarding anesthetized teeth and soft tissues (success rate). The success rate of the two anesthetic solutions showed no significant differences when considering all dental elements (Chi-square, p=0.4061), with ART100 reaching 65.5% and ART200 61.5%. For vestibular gingival tissue, ART100 reached a success rate of 91% and ART200 of 95% (Chi-square, p=0.1169) regardless of the dental element.

Regarding pulp latency for duly anesthetized elements, ART100 reached a mean value of 3.3 minutes and ART200 of 2.7 minutes. As for soft tissue duly anesthetized, mean latency was 2.2 minutes for both solutions.

Table 2 shows the results of pulpal and soft tissue anesthesia duration. Zero value was attributed to elements that did not achieve anesthesia.

Regarding pulpal anesthesia duration, the ART100 anesthetic solution presented a significant longer effect duration than the ART200 solution for maxillary central incisors (MCI), first maxillary premolar (1MPM), and second maxillary premolar (2MPM). For ART100, the mean pulpal anesthesia duration index for properly anesthetized elements was 37.4 minutes regardless of the dental element, significantly

higher than that of ART200, equal to 25.3 minutes (p<0.0001, Mann-Whitney test). We found no statistically significant differences regarding anesthesia duration for vestibular gingival tissue of any dental element involved (p>0.05). For ART100, the overall soft tissue anesthesia duration index of properly anesthetized elements was 77 minutes regardless of the dental element, significantly higher than that of ART200, equal to 62.4 minutes (p=0.0094, Mann-Whitney test).

Table 2. Anesthesia duration mean value (±standard deviation) according to anesthetic solution and dental element.

		Anesthetic solutions	
		ART100	ART200
Effect duration on pulp tissue (min)	MCI	5.75 (±12.79)^{A}	1.75 (±5.00)^{B}
	MLI	9.00 (±14.46)^{A}	5.25 (±8.20)^{A}
	MC	33.0 (±27.29)^{A}	25.0 (±19.5)^{A}
	1MPM	38.25 (±26.97)^{A}	22.5 (±17.10)^{B}
	2MPM	36.5 (±24.45)^{A}	23.25 (±15.8)^{B}
Effect duration on vestibular gums (min)	MCI	61.0 (±59.17)^{A}	49.5 (±41.2)^{A}
	MLI	68.25 (±61.39)^{A}	60.75 (±41.0) ^{A}
	MC	72.25 (±57.04)^{A}	64.0 (±39.90)^{A}
	1MPM	74.75 (±53.11)^{A}	57.75 (±35.40)^{A}
	2MPM	74.25 (±52.96)^{A}	63.0 (±39.60)^{A}

Different superscripted letters indicate statistically significant differences between columns (intergroup comparison) for each dental element – paired sample Wilcoxon test.
MCI (maxillary central incisor); MLI (maxillary lateral incisor); MC (maxillary canine), 1M1P (maxillary first premolar); 2M2P maxillary second premolar ART100 (articaine hydrochloride with 1:100,000); ART200 (articaine hydrochloride with 1:200,000).

Figure 1 shows results regarding pain at local anesthetic injection, indicating no statistically significant differences (p=0.6028, paired Wilcoxon test) between the two solutions.

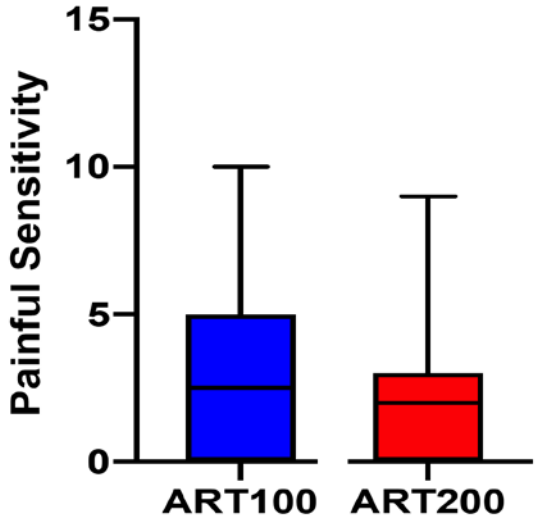

Figure 1. Painful sensitivity (11-point pain scale) at anesthetic solution injection. Larger center bar = median; boxes = 1st and 3rd quartiles; tabs = maximum and minimum values. ART100 (articaine hydrochloride with 1:100,000); ART200 (articaine hydrochloride with 1:200,000).

Discussion

The study was conducted with dentistry students who had previously undergone local anesthesia. No clinical procedure was performed alongside anesthesia, which enabled us to analyze pulpal anesthesia duration for waiving anesthetic complementation despite unsuccessful dental elements.

We found similar values for pulp latency period, corroborating those reported by other authors[9–11,13] who employed the same anesthetic solutions in inferior alveolar nerve block. ART100 and ART200 showed no significant differences regarding pulpal anesthetic success, regardless of the dental element. This finding such as those reported by De Morais *et al.*[9] and Moore *et al.*,[10] both using the same anesthetic solutions than ours in inferior alveolar nerve block.

Regarding the infraorbital approach, central and lateral incisors reached a low success rate, corroborating Berberich *et al.* and Meechan.[16,17] This may be explained by the cross innervation in the anterior maxilla, accessory innervations, or even the distance between these elements and the infraorbital technique puncture point. The ART100 solution presented a higher overall pulpal anesthesia duration index than ART200, similar to that found by Tortamano *et al.*[11] when evaluating the same anesthetic solutions in inferior alveolar nerve block. On the other hand, other studies[9,10,13] approaching inferior alveolar nerve block found no differences in pulpal anesthesia duration.

We found no significant difference between solutions regarding mean latency in vestibular gums. The results corroborate those reported by Lasemi *et al.*,[7] who employed these same solutions for inferior alveolar nerve block, but for lower lip anesthesia, differing from the site evaluated in our study. Regarding vestibular gums anesthesia duration, ART100 reached a higher overall index than ART200. These data differ from those found by previous studies,[7,9,13] possibly due to the use of different anesthetic techniques.

Finally, anesthetic solutions presented no significant difference when considering pain at injection, corroborating the results reported by other studies[2,18,19] comparing the same solutions in different anesthetic techniques. Berberich *et al.*[16] employed the same anesthetic technique as ours with different anesthetic solutions and reported a single case of pain, evidencing a low pain index – similar to our study.

Conclusions

The anesthetic solutions of 4% articaine with 1:100,000 and 1:200,000 epinephrine delivered similar performances for the infraorbital nerve block technique regarding pulp tissue and vestibular gum latency period and success rate. The solution containing 4% articaine with 1:100,000 epinephrine presented a longer anesthetic duration than 1:200,000 epinephrine especially in pulp.

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Mini Curriculum and Author's Contribution

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