Efficacy of 2% lidocaine and 4% articaine in mandibular molars with different pulp diagnoses in the mandibular technique[1]

Eficacia de la lidocaína al 2% y la articaína al 4% en molares mandibulares con diferentes diagnósticos pulpares en la técnica mandibular[1]

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ABSTRACT

Introduction: the inferior alveolar dental nerve block is the method most commonly used by endodontists to achieve local anesthesia during treatments. This study compared the efficacy of two anesthetic solutions: 2% lidocaine with 1:80,000 epinephrine and 4% articaine with 1:100,000 epinephrine in patients with different pulp diagnoses requiring endodontic treatment. ***Method:*** an interventional, randomized clinical trial. The sample included 36 patients who were treated at the postgraduate endodontics service at the Universidad de Cartagena in the year 2016. Descriptive statistics and the Chi^2 test were used for data analysis, using a limit of 0.05. ***Results:*** articaine showed a greater anesthetic effect in vestibular mucosa (88.9%) and tip of tongue (55.6%), compared with lidocaine. The rates of anesthetic success in the lidocaine and articaine groups were 5.6% and 22.2% respectively, but this difference was not statistically significant (p = 0.633). In teeth with normal pulp, the efficacy was 27.3%, and this value considerably decreased in teeth with asymptomatic and symptomatic irreversible pulpitis, with percentages of 5.8% and 12.5% respectively, although this difference was not statistically significant (p = 0.276). ***Conclusions:*** no statistically significant differences were found in the anesthetic efficacy of 2% lidocaine and 4% articaine in lower molars with vital pulp. However, articaine showed a better anesthetic success rate. No statistically significant differences were found when comparing the anesthetic efficacy in molars with normal pulp and molars with inflamed pulp—although the percentage of success in normal pulp was greater than in teeth with irreversible pulpitis.

Key words: dental pulp, pulpitis, local anesthesia, lidocaine, articaine

RESUMEN

Introducción: el bloqueo del nervio dentario inferior es el método más usado por los endodoncistas para obtener anestesia local en sus tratamientos. En este trabajo se comparó la eficacia de dos soluciones anestésicas: lidocaína al 2% con epinefrina 1:80.000 y articaína al 4% con epinefrina 1:100.000, en pacientes con diferentes diagnósticos pulpares que requirieron tratamiento de endodoncia. ***Método:*** estudio de intervención tipo ensayo clínico aleatorizado. La muestra estuvo conformada por 36 pacientes que asistieron al servicio del posgrado de endodoncia de la Universidad de Cartagena en el año 2016. Para el análisis de la información se utilizaron pruebas de estadística descriptiva y el test Chi^2. Se asumió un límite de decisión de 0,05. ***Resultados:*** la articaína mostró mayor efecto anestésico en mucosa vestibular (88,9%) y punta de lengua (55,6%), en comparación con la lidocaína. Las tasas de éxito anestésico en los grupos de lidocaína y articaína fueron 5,6% y 22,2%, respectivamente, y la diferencia no fue estadísticamente significativa (p = 0,633). En dientes con pulpa normal, la eficacia fue de 27,3% y esta disminuyó considerablemente en dientes con pulpitis irreversible tanto asintomática como sintomática, con porcentajes de 5,8% y 12,5% respectivamente, aunque esta diferencia no fue estadísticamente significativa (p = 0,276). ***Conclusiones:*** no se encontraron diferencias estadísticamente significativas en la eficacia anestésica entre la lidocaína al 2% y la articaína al 4% en molares inferiores con pulpa vital. Sin embargo, la articaína demostró tener una mejor tasa de éxito anestésico. No se encontraron diferencias estadísticamente significativas al comparar la eficacia anestésica en molares con pulpa normal y molares con pulpa inflamada (aunque el porcentaje de éxito en pulpa normal fue mayor que en dientes con pulpitis irreversible).

Palabras clave: pulpa dental, pulpitis, anestesia local, lidocaína, articaína

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INTRODUCTION

The mandibular technique is the block method most frequently used in anesthetizing mandibular molars during endodontic treatments. However, the failures reported after the use of this technique range from 10% to 81%, with higher values in teeth with inflamed dental pulp.[1, 2]

Several studies have compared lidocaine and articaine in mandibular techniques, with some showing no statistically significant differences between these anesthetic solutions, in contrast to other trials that suggest that articaine is superior in terms of degree of pulp anesthesia when compared with lidocaine.[3-5] In 2017, Aggarwal et al[6] conducted a clinical trial to evaluate the efficacy of 2% lidocaine with 1:200,000 epinephrine, 4% articaine with 1:100,000 epinephrine, and 0.5% bupivacaine with 1:200,000 epinephrine in mandibular block in patients with asymptomatic irreversible pulpitis, finding out clinical differences between articaine and the other studied solutions, but with no statistical significance.

In 2012, Kanna et al,[7] in a study in 182 patients with irreversible pulpitis in mandibular teeth, concluded that conventional mandibular block using 2% lidocaine with 1:80,000 epinephrine does not provide a pain-free endodontic procedure, and that complementary vestibular infiltration using 4% articaine with 1:100,000 epinephrine and intraosseous anaesthesia using 2% lidocaine with epinephrine provides a painless procedure with successful pulpal anaesthesia averaging 84% and 68%, respectively.

This study aimed to compare the anesthetic efficacy of 2% lidocaine with 1:80,000 epinephrine and 4% articaine with 1:100,000 epinephrine in lower molars with vital pulp in a mandibular block, and to analyze the relationship between anesthetic efficacy and diagnosis.

MATERIALS AND METHODS

This was a randomized, double-blind, parallel-controlled clinical trial. It was registered with the Department of Research of the School of Dentistry. All patients signed a written informed consent to participate. The sample included 36 subjects over 18 years of age requiring endodontic treatment in a mandibular molar with vital pulp. The researchers first standardized the criteria for pulp diagnosis, obtaining a Kappa index of 0.80. The researcher with the highest index value was calibrated, taking into account the 2009 criteria of the American Endodontic Association.[8] The clinical record of each patient was recorded, excluding those with a history of allergies to lidocaine or articaine, as well as patients in pregnancy, with contraindications to the use of epinephrine, and those using consciousness-altering medications. Sample size was calculated using the EPINFO™ software (Centers for Disease Control and Prevention, USA) and its StatCalc application. The statistical formula was used to compare two independent means, and the calculation yielded 15 subjects for each group. Considering a dropout of 10%, each group was increased to 18 patients, for a total of 36 participants.

Two local anesthetics were used: 2% lidocaine with 1:80,000 epinephrine (Roxicaína® 2%-E80, Ropsohn Therapeutics, Colombia) and 4% articaine with 1:100,000 epinephrine (Artheek® 4%-E100; Newstetic, Colombia). The anesthetic cartridges were masked by a third person who did not

belong to the research team, removing the label of the active ingredient and using colors to encode each cartridge according to the active ingredient. The cartridges were inserted in encoded envelopes, one for each group. Data analysis was done using this codification and the blinding was removed at the end of the clinical trial. In addition, the anesthetic solution that was applied to each patient was dosed, as each cartridge was externally divided into four equal parts and marked with a non-erasable marker, to ensure that each patient was applied the same amount of anesthetic solution as follows: ¾ of the cartridge were applied in the inferior dental nerve, ¼ in the lingual nerve and ¼ in the long buccal nerve.

The researchers were unaware of the solution with which each patient was anesthetized. The 36 subjects were randomly allocated to two groups using block randomization. Each subject's allocation was hidden using opaque and sealed envelopes that were delivered at the study site where the procedure was carried out on the day of each patient's consultation. An assistant was in charge of keeping the anesthetics in sealed envelopes according to the allocations. All patients received 1.8 ml of 2% lidocaine with 1:80,000 epinephrine or 4% articaine with 1:100,000 epinephrine in a unilateral mandibular technique, with anesthesia of the buccal length in a second phase in the molar region, after blood suction. All anesthetic injections were applied by the same operator, who also assessed the results and performed the clinical procedures. Soft tissue anesthesia was tested 3 minutes afterwards using the tip of a probe on the skin of the lip, the vestibular mucosa, and the tip of the tongue of the anesthetized side.

Pulp sensitivity was determined using a vitalometer (Analytic Technology, Redmond, WA, USA). The contralateral molar was evaluated with the vitalometer, in order to validate its reading and for the patient to perceive how the stimulus felt in the absence of anesthesia. This evaluation was performed 10 minutes before starting the test. In all cases, the electric pulp testing was done in the vestibular side of the mandibular molar to be treated in the anesthetized side, 5 and 10 minutes after injecting the anesthetic, to verify the degree of pulp anesthesia and to determine success according to the criteria of the clinical trial (two consecutive readings at a maximum stimulation of 80). The two vitalometer readings were followed by pulp chamber opening, recording any expression of pain by the patient during this phase; in this case, pain was measured by visual analogue scale (VAS) depending on how the subject classified this pain, considering the following ranges: 0–3: absent to mild, 4–6: moderate, 7–10: very intense. In case the pain referred by the patient was in the range of 4 to 10 (moderate to intense), an intraligamental technique was carried out in the treated molar, followed by pulp chamber access, assessing the presence of pain when using the intraligamental technique. An intrapulpal technique was used if the patient referred moderate to severe pain (VAS). The researchers collected information on the use of one or both complementary techniques in each treated subject.

All data were analyzed using the STATA® software. Descriptive statistical tests were carried out, as well as Shapiro-Wilk test, Kolmogorov-Smirnov tests, Chi^2 test and Student's test. The significance level was set at 5% ($p < 0.05$).

RESULTS

Sixteen women and 20 men participated in this study. The average age of participants was 46.5 (SD ± 15.3) years. The average age in the lidocaine group was 45.9 (SD ± 16.0) years, while in the articaine group was 47.2 (SD ± 15.0). Of the total number of patients, 18 received 2% lidocaine with 1:80,000 epinephrine and the rest 4% articaine with 1:100,000 epinephrine.

Seventeen patients (47.2%) were diagnosed with asymptomatic irreversible pulpitis. 55.6% of these (n = 10) were anesthetized with lidocaine and 38.9% (n = 7) with articaine. 30.6% of patients (n = 11) had normal pulp, and of these, 27.8% were anesthetized with lidocaine and 33.3% with articaine (Table 1).

Table 1. Distribution of the population according to pulp diagnosis

Diagnosis	Global		Lidocaine		Articaine	
	n	%	n	%	n	%
Asymptomatic Irreversible Pulpitis	17	47.2	10	55.6	7	38.9
Symptomatic Irreversible Pulpitis	8	22.2	3	16.7	5	27.8
Normal pulp	11	30.6	5	27.8	6	33.3
Total	36	100.0	18	100.0	18	100.0

Table 2 shows soft tissue anesthesia within 3 minutes of application of the solution. 86.1% of patients reported anesthesia in vestibular mucosa, 55.6% in lip skin and 50% in tongue tip. No statistically significant differences were found between the two groups that received lidocaine and articaine.

Table 2. Anesthesia of soft tissues

Soft tissue	Global		Lidocaine		Articaine	
	n	%	n	%	n	%
Lip skin						
No	16	44.4	8	44.4	8	44.4
Yes	20	55.6	10	55.6	10	55.6
Vestibular mucosa						
No	5	13.9	3	16.7	2	11.1
Yes	31	86.1	15	83.3	16	88.9
Tongue tip						
No	18	50.0	10	55.6	8	44.4
Yes	18	50.0	8	44.4	10	55.6

The frequency of successful pulpal anesthesia, determined by the vitalometer (two consecutive readings of 80), was 13.9%, being 5.6% (n = 1) for the lidocaine group and 22.2% (n = 4) for the articaine group. No statistically significant differences (p = 0.33) were observed between the anesthetic solutions assessed and the frequency of successful pulpal anesthesia determined by vitalometry (Table 3).

Table 3. Frequency of successful pulpal anesthesia determined by vitalometry

Successful pulpal anesthesia	Global		Lidocaine		Articaine		*p*-value
	n	%	n	%	n	%	
Yes	5	13.9	1	5.6	4	22.2	
No	31	86.1	17	94.4	14	77.8	0.33
Total	36	100.0	18	100.0	18	100.0	

Of the 5 patients (13.9%) in whom successful pulpal anesthesia was achieved, 27.3% (n = 3) had normal pulp, while successful pulpal anesthesia in teeth with asymptomatic and symptomatic irreversible pulpitis was achieved in 5.8% and 12.5% respectively (Table 4).

Table 4. Bivariate analysis between anesthetic success and pulp diagnosis

Anesthetic success	Pulp diagnosis								*p*-value
	AIP		SIP		NP		Total		
	N	%	n	%	n	%	n	%	
Yes	1	5.8	1	12.5	3	27.3	5	13.9	0.276
No	16	94.2	7	87.5	8	72.7	31	86.1	

AIP: Asymptomatic Irreversible Pulpitis, SIP: Symptomatic Irreversible Pulpitis, NP: Normal Pulp

Table 5 shows the average vitalometer readings at 5 minutes (mean ± SD: 47.6 ± 20.0) and 10 minutes (mean ± SD: 63.2 ± 16.6). The average vitalometry at 5 minutes was 48.0 ± 17.9 in the lidocaine group and 47.0 ± 22.3 in the articaine group. At 10 minutes, the lidocaine group had a mean ± standard deviation of 64.0 ± 14.4 and the articaine group 63.0 ± 19.0. No statistically significant differences were found in the readings at 5 minutes (p = 0.941) or 10 minutes (p = 0.806).

Table 5. Average vitalometry readings

Vitalometry	Global		Lidocaine		Articaine		*p*-value
	Mean	SD	Mean	SD	Mean	SD	
5 min	48.0	20.0	47.9	18.0	47.4	22.3	0.941
10 min	63.0	16.6	63.9	14.4	62.6	19.0	0.806

Chi squared and Student's t-test

61.1% of patients (n = 22) reported pain during the opening of the pulp chamber, with an equal distribution in both groups (n = 11; 61.1%). Table 6 shows that there were no statistically significant differences in pain incidence when administering lidocaine and articaine (p = 0.633). Pain during the opening of the chamber was evaluated through visual analogue scale (VAS). Nineteen patients (86.4%) considered it as severe pain—7 to 10 in VAS (mean ± SD: 4.9 ± 4.2, p = 0.633). 100% of the patients in the lidocaine group considered the pain to opening as severe (mean ± SD: 5.2 ± 4.4), while 72.7% (n = 8) of the articaine group classified it as such (mean ± SD: 4.7 ± 4.1). No patient considered the opening of the pulp chamber as mild pain. The data showed no statistically significant differences between the groups (p = 0.728).

Table 6. Pain to the opening of the pulp chamber

Pain to the opening of the pulp chamber	Global		Lidocaine		Articaine		*p*-value
	n	%	n	%	n	%	
No	14	38.9	7	38.9	7	38.9	0.633
Yes	22	61.1	11	61.1	11	61.1	
Pain scale during pulp chamber opening							
VAS	n	%	n	%	n	%	*p*-value
Mild (1-3)	0	0.0	0	0.0	0	0.0	0.728
Moderate (4-6)	3	13.6	0	0.0	3	27.3	
Severe (7-10)	19	86.4	11	100.0	8	72.7	
	Mean (SD)		Mean (SD)		Mean (SD)		
VAS	4.9 (4.2)		5.2 (4.4)		4.7 (4.1)		0.755

In evaluating the need for supplementary anesthesia, 22 patients (61.1%) required complementary techniques. Patients who received lidocaine and articaine required complementary anesthesia in the same proportion (61.1%; n = 11) (Table 7).

Table 7. Need for complementary anesthesia and type of complementary anesthesia used

Complementary anesthesia	Global		Lidocaine		Articaine	
	n	%	n	%	n	%
No	14	38.9	7	38.9	7	38.9
Yes	22	61.1	11	61.1	11	61.1
Type of complementary anesthesia	n	%	n	%	n	%
Intrapulpal	1	2.8	0	0.0	1	5.6
Intraligamental	10	27.8	5	27.8	5	27.8
Both	11	30.6	6	33.3	5	27.8

Of the 22 patients who needed complementary techniques, 30.6% (n = 11) required the application of two techniques (intraligamental and intrapulpal), 6 patients (33.3%) of the lidocaine group and 5 patients (27.8%) of the articaine group. The most used complementary technique was the intraligamental (27.8%; n = 10).

DISCUSSION

Several studies have compared the efficacy of 4% articaine with epinephrine and 2% lidocaine with epinephrine in mandibular or alveolar inferior dental nerve blocks, but the results have not been consistent.[3, 9] 4% articaine has proven to be more effective in achieving successful pulp anesthesia in molars after buccal infiltration;[4, 5] on the other hand, no statistically significant differences in anesthetic efficacy have been reported when comparing these two anesthetics in mandibular blocks. A clinical trial in 91 patients, published by Aggarwal et al[6] in 2017, showed that by comparing these two anesthetic solutions and 0.5% bupivacaine with epinephrine 1:200,000 in a mandibular block in patients with asymptomatic irreversible pulpitis (evaluating the anesthetic success by the absence of pain during the opening of the pulp chamber with VAS), 4% articaine was more effective (33%) than the other solutions assessed, but with no statistically significant differences.

Sood et al[9] reported that 4% articaine with 1:100,000 epinephrine was more effective in providing successful pulp anesthesia (76%) than 2% lidocaine 1:80,000 (58%) in a mandibular block in teeth with irreversible pulpitis, like in the present study, in which the data demonstrate a better effect of articaine in terms of pulp anesthesia, with values of 22.2% for articaine and 5.6% for lidocaine respectively. In evaluating pain during the opening of the pulp chamber, Sood et al[9] reported that the articaine group showed a slight increase in pain (88%) compared to the lidocaine group (82%), differing from the findings of the present study, in which both groups referred pain to pulp chamber opening in the same proportion (61%).

In 2016, Fowler et al[10] published a retrospective study to determine the anesthetic efficacy of mandibular block using 2% lidocaine with 1:100,000 epinephrine and supplementary vestibular infiltration with 4% articaine in patients with acute irreversible pulpitis. The authors reported successful pulp anesthesia in 28% of first molars and 25% of second molars during mandibular block with lidocaine. When performing an oral infiltration with articaine, the anesthetic success improved by 42% in the first molar and by 48% in the second, with no statistically significant findings. In our study, pulp anesthesia with 2% lidocaine (5.6%) and 4% articaine (22.2%) was lower than the values reported by Fowler et al,[10] considering that both solutions were used in the primary technique in each group without infiltrating with articaine in vestibular.

Yadav et al[4] conducted a clinical trial in 115 patients who had molars with irreversible pulpitis, evaluating the anesthetic success by the absence or presence of moderate pain during the opening of the chamber. The authors reported that 2% lidocaine with epinephrine 1:80,000 showed a success rate of 32%, while the success rate of 4% articaine with epinephrine 1:100,000 and buccal infiltration was 76%. These rates increased significantly in the group premedicated with ketorolac and oral infiltration with articaine (76%). The results of the present study are similar in terms of lidocaine (38.9%),

but differ in the articaine group, as Yadav et al,[4] in addition to the mandibular block, applied vestibular infiltration and premedication with ketorolac.

The superiority of 4% articaine over 2% lidocaine in mandibular block in patients with vital pulp could not be statistically verified in the present study. Both solutions presented similar behavior, although 4% articaine showed better pulpal anesthetic success rate (22.2%).

Successful pulp anesthesia is reduced in patients with asymptomatic irreversible pulpitis (5.8%), compared with normal pulp (27.3%). This can be explained by factors present in the inflamed pulp tissue, like an acid pH and the presence of inflammation mediators, which produce allodynia and hyperalgesia, contributing to a poor efficacy of anesthesia in patients with diagnoses of pulpitis.[11] The findings of the present study show that successful pulp anesthesia in mandibular molars is low (13.9%), regardless of the anesthetic solution used. This study showed that there are no statistically significant differences between the two solutions when used in a mandibular technique to control pain during the opening of the pulp chamber and that the use of complementary techniques was needed to complete the endodontic treatment.

The use of 2% lidocaine and 4% articaine has proven to be safe in terms of toxicity and associated complications,[12-15] with very low incidence of paresthesia, allergic reactions, and other complications related to the use of local anesthetics.[16-18] From the clinical perspective, the results of this report question the efficacy of pulp anesthesia after using a conventional mandibular technique.[18-21] The use of 4% articaine improved pulpal anesthesia in mandibular molars; however, it is still a very weak pulp anesthesia. The challenge dentists face today is to achieve successful pulp anesthesia in mandibular molars with diagnoses of pulp inflammation. In this regard, other studies show promising results when using articaine with buccal infiltration following inferior dental nerve block.[22-25]

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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