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ORIGINAL PAPER

Comparison of Effects Exerted by 4% Articaine Buccal Infiltration and 2% Lidocaine Inferior Alveolar Nerve Block on Pain Perception and Behavioral Feedback of Children during Pulp Treatment of Mandibular Second Primary Molars

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ABSTRACT

Background: *One of the most impressive factors discouraging many people from seeking dental treatment is the fear of experiencing pain during dental procedures. Thus, the use of an effective method for pain control is vital in this regard. Articaine, which has an additional ester and thiophene groups that increase its biosolubility and permeability compared to older anesthetic agents, can be more effective on inducing anesthesia during dental treatment. Given the inconsistent currently available information on this concept, the present study was designed to compare the efficacy of articaine with that of lidocaine on pain control during pulp treatment of deciduous molar.*

Methods and materials: *In this cross-sectional study, 38 patients who needed pulpotomy in both mandibular second molar of primary teeth were randomly divided into two groups, using the Randlist software. In the first meeting, infiltration with articaine 4% (epinephrine 1/100 000) was performed for all patients in group 1 on the left side of the mandible. At the next appointment, inferior alveolar nerve block was done with lidocaine 2% on the right side of the mandible (epinephrine 1/80 000). Notably, for*

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all patients in the second group, the first injection was performed on the right second primary molar with articaine 4% (epinephrine 1/100 000), and inferior alveolar nerve block was also done with lidocaine 2% on the left side of the mandible (epinephrine 1/80 000).

Results: *Of the 38 patients included in the current study, 10 (26.3%) subjects in the lidocaine group and nine (23.6%) in the articaine group complained of pain during their dental treatment procedures, but this difference was not statistically significant.*

Conclusion: *According to the findings of this study, buccal infiltration of 4% articaine had a comparable anesthetic outcome to that of 2% lidocaine for inferior alveolar nerve block in pulp treatment of the second primary mandibular molars.*

Keywords: articaine, lidocaine, pulpotomy, pain.

INTRODUCTION

Controlling the pain during dental procedures is one of the pivotal aims of all professionals working in this field (1). Pain control in pediatric dentistry is of great importance because adverse childhood experiences give rise to further fear and anxiety in adolescence (2). Moreover, pain management is one of the most momentous aspects of behavioral guidance in children undergoing dental treatment (3). In this regard, the most common method for this purpose is applying local anesthesia to block the peripheral nerves and to prevent the transmission of pain during dental procedures (4). Dental anesthetic materials include lidocaine, bupivacaine, etidocaine, articaine, and mepivacaine. Lidocaine, as the safest and most commonly used anesthetic agent, was discovered in 1942 (5, 6). After the introduction of lidocaine, it became the most frequently used local anesthesia in medicine and dentistry fields, replacing procaine, and it has maintained this status in many countries up to now. Today, it is considered as the "gold standard" and all new local anesthetics are usually compared with it.

Articaine is an amide anesthetic drug with rapid onset (45 to 90 seconds) and short acting time (10 to 20 minutes), but when combining it with epinephrine, its effect could last for a longer time. Noteworthy, it is the single local anesthetic drug that contains thiophene and an additional ester group; therefore, its biotransformation could be simultaneously done in plasma and liver due to esterase enzyme and microsomal enzymes, respectively. Subsequently, such a collaboration eliminates the half-life of articaine to 20 minutes and slumps some adverse effects like overdose (7). Early types of articaine cartridges in Canada contained methyl paraben preservatives. Although it was shown that parabens were less likely to cause allergic reactions, methyl paraben has been removed from articaine cartridge in North American states. Articaine has also a good diffusion, so it can be passed through soft and hard tissue more reliably compared to the other anesthetic drugs used in dentistry (9, 8). Moreover, it has a strong adhesion to proteins, which allows a greater penetration into the bone (10, 11).

The conventional method to reach pupal anesthesia in the primary mandibular molar is inferior alveolar nerve block (IANB). However, one of the most prevailing complaints after this injection is soft tissue damage in the tongue, cheek or lip, which is caused by unwanted biting of soft tissue due to numbness. Therefore, it is rational to seek an alternative for it.

Although intraligament injection has been proposed as a substitute, given the possibility of enamel hypoplasia in permanent teeth as a sequel of it, using intraligament injection in children is not completely approved yet (7, 11).

Infiltration, another technique which has been proposed as an alternative, has some advantages over block such as a shorter course of soft tissue numbness and an easier injection method (12).

Because of dense cortical bone of mandible, which could consequently be a considerable barrier against anesthetic drugs distribution in infiltration technique (13), the use of articaine, which has a better diffusion into soft and hard

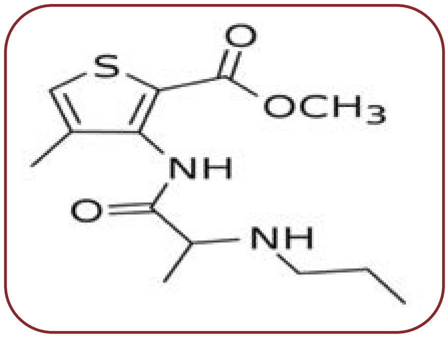

FIGURE 1. Articaine structure

tissues, can lead to a more effective anesthesia (14).

Methemoglobinemia is one of the possible side effects of articaine used in high dosage. Accordingly, such reaction ostensibly comes after an intravenous injection of drug and no case of such reactions has been reported up to now following articaine injection for a usual dental procedure. Notably, the use of articaine in patients with idiopathic or congenital methemoglobinemia as well as those with anemia, heart or respiratory failure is contraindicated, because it could ingenerate hypoxia (ASA IV and III). Another contraindication is a proven allergy to sulfur-containing drugs. In this regard, a case of allergic reaction to articaine in the dental office has been recently reported (1). Figure 1 illustrates the structure of articaine.

Given all the above-mentioned reasons, this study was conducted with the aim of comparing the effects of buccal infiltration with 4% articaine and those of inferior alveolar nerve block with 2% lidocaine on pain perception and behavioral feedback of children during pulp treatment of mandibular second primary molars. ❑

MATERIALS AND METHODS

In this study, sampling was performed using the simple random method for four months, from October 2017 to the end of December 2017, among pediatric patients who were referred to the Dentistry Faculty of Tabriz University of Medical Sciences, Iran.

In order to determine the sample size, we considered the results of a similar study (5) that used average pain rate in SEM (sound, eye, and motor) and Wong-baker (faces pain rating) scale to assess pain in the articaine group (16±2.46) and lidocaine group (19±5). Afterwards, 38 patients were selected based on $\alpha=0.05$, power=80% and fault=10%.

Inclusion criteria: 1) children with both primary second molars of mandible needing pulpotomy, whose radiographic symptoms confirm requisite of pulp therapy; 2) children with no inflammatory lesions (abscesses, fistulas) in the buccal mucosa of their second primary mandibular molars; 3) children in the age group of 4-6 years old; 4) children who were ranked 3 or 4 on Frankl scale; 5) children who had no medical problems with local anesthesia; 6) children who were physically and mentally healthy; 7) children who had no spontaneous pain in the above-mentioned teeth.

Exclusion criteria – Children whose second primary molars were necrotic or had spontaneous pain or nocturnal pain, irreversible pulpit along with radiographic symptoms such as internal or external root resorption, and PDL widening or hyperemic pulp were excluded from this study.

Injection method – Subjects were randomly divided into two equal groups using Randlist software. In order to eliminate possible interfering factors, this study was done in a split mouth manner. In the first meeting, infiltration was performed with 4% articaine and epinephrine 1/100 000 (Artinibsa, Inibsa, Barcelona, Spain) for all patients in group 1 on their second primary molar of left side. During the next session, inferior alveolar nerve block with lidocaine 2% along with epinephrine 1/80 000 (DaruPakhsh, Tehran, Iran) was done on the right side.

For all patients included in the second group, the first injection for IANB was done with lidocaine 2% and epinephrine 1/80 000 (DaruPakhsh, Tehran, Iran) on the left side, and in the next appointment, infiltration of 4% articaine with epinephrine 1/100 000 (Artinibsa, Inibsa, Barcelona, Spain) was performed on the right side.

Infiltration technique – The needle tip was placed in the buccal vestibule and then directed to the apex of the tooth and about one-third to one-fourth of the cartridge had slowly discharged (5).

Inferior alveolar nerve block technique – The thumb of non-operating hand was placed on the occlusal surface of intended side and protruded toward the inner oblique ridge of ramus and then placed in touch with retromolar pad. The syringe was directed between the two mandibular primary molars of opposite side and the needle was then pushed forward until hitting the bone, then the injection was slowly done (15). After three to five minutes, treatment was started, and numbness in the lower lip indicated that anesthesia has begun (1).

Anesthesia was assessed by a pediatric dentist in both groups by observing each child's reaction during performing the dental procedure using SEM scale and Wong-baker faces pain rating scale.

All injections have been performed by a pediatric dentistry who was resident in Pediatric dentistry Department of Tabriz University of Medical Sciences.

SEM pain scale – SEM pain scale is known as one of the behavioral evaluation scales by which the observer can determine the severity of the pain based on the child's pain related symptoms received from his/her voice, eyes, and body movements. Then, the observer records a number for each child. In this research, pain ranking for all participants via this scale has been done by a pedodontist who was blinded to the study.

Cases who were ranked as 2, 3, and 4 based on this scale were then considered as non-anesthetized items in the checklist (18, 17, 16). Table 1 shows SEM pain scale.

In this study, VAS (visual analogue scale) has been also used to measure participants' pain level; VAS diagram is a line with a length of 100 mm, which a smiling or no hurt face is at zero millimeters and "hurts worst" face is at the end of the line. The severity of pain should be expressed by participant by referring to a point between these two faces (19).

While using this scale to prevent counting error by child, a non-graded version (Wong-baker) including six faces – "no hurt, hurts a little bit, hurts a little more, hurts even more, hurts a lot, and hurts worst" – was applied. Before injecting, all participants received explanations about the scale in order to choose the exact face related to their pain sensation during pulpotomy. Faces placed in positions marked by numbers 2, 4, 6, 8, and 10 were then considered as painful (17). Figure 2 shows the Wong-baker scale.

Statistical methods – Data obtained in this study were analyzed using descriptive statistical methods (percentage of frequency, mean, and standard deviation). McNamara test was also used to compare the effectiveness anesthetic agents in both groups via SPSS 17 software. P <0.05 was considered as the statistically significant level.

Ethical aspect of study – Prior to applying anesthesia, written informed consents were taken from the parents of each patient. The parents did not get charged for this research and patients were explained that they could withdraw from the study at any time they wanted.

This study has been approved by the ethical committee of Tabriz University of Medical Sciences with the registration number of IR.TBZMED.REC.1396.967 and has also been registered in IRCT with the registration code of IRCT20100125003168N5. ❑

FIGURE 2. Wong-baker scale

RESULTS

A total of 48 children of both genders aged 4 to 6, with a mean age of 3.5 years old, were evaluated in this study, but 10 children who had no cooperation or were not referred for the second appointment were excluded from the study.

In this study, there was no statistically significant difference in terms of gender.

Based on SEM scale, in the articaine group, 10 (26.3%) patients reported pain during dental procedure, and 28 (73.3%) no pain, while in the lidocaine group, nine (23.6%) patients reported pain and 29 (76.6%) no pain. Bar chart 1 illustrates the number of cases who experienced pain according to SEM scale.

According to Wong-baker (VAS) scale, in the articaine group, 16 (42.1%) patients reported pain and 22 (57.8%) no pain, while in the lidocaine group, 20 (52.8%) patients reported pain and 18 (47.3%) no pain. Bar chart 2 shows the number of cases who experienced pain according to VAS scale.

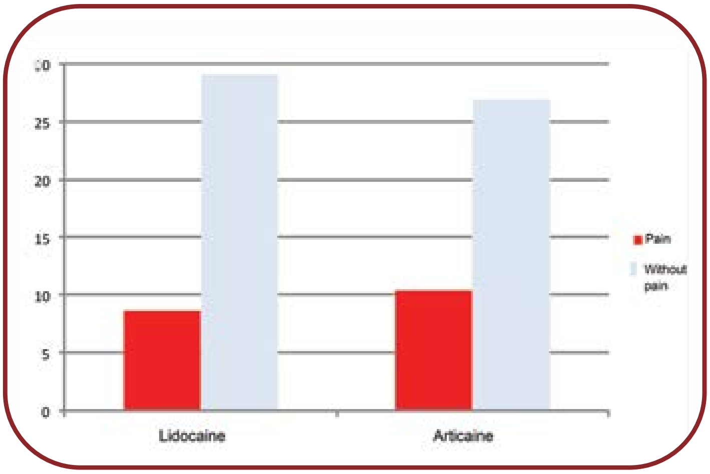

FIGURE 3. The number of cases with or without experience of pain according to SEM scale

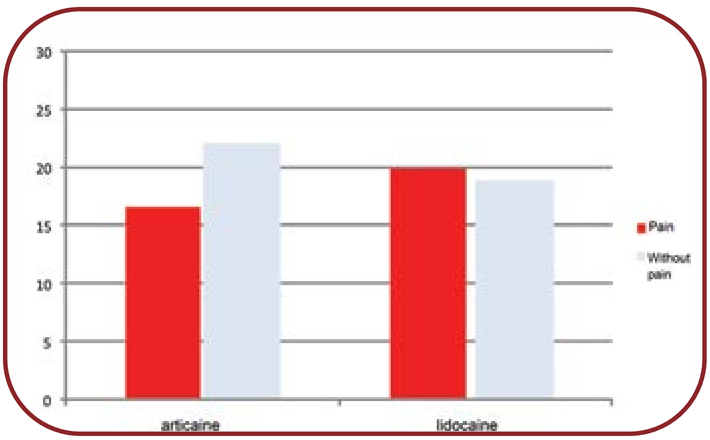

FIGURE 4. The number of cases with or without experience of pain according to VAS scale

Based on results of the chi-square test, there was no statistically significant difference between these two groups. ❑

DISCUSSION

The main purpose of this study was to compare the anesthetic effectiveness of infiltration technique using 4% articaine with that of IANB with 2% lidocaine in primary second mandibular molar that required pulpotomy.

Regarding the shortcomings of IANB, which is commonly used to provide anesthesia in the mandibular area, in this study we attempted to evaluate the efficacy of infiltration method in order to substitute it, if we could reach the desired sequel. Furthermore, considering the dense mandibular cortical bone, which could be considered as a strong barrier against anesthetic materials, articaine was preferred for infiltration technique in this study due to its better diffusion into the hard tissue (11, 14).

Articaine has some exclusive pharmacological features like replacing the aromatic chain with the typhoid one, which soars its lipid solubility and strength compared to lidocaine, consequently leading to a more rapid spread around nerves (14, 20).

Moreover, articaine has a good tissue diffusion, so it can be released from soft and hard tissues more reliably compared to other anesthetics (9, 8). Also, it has a strong bond to proteins, which allows better penetration into the bone (11, 10).

Inferior alveolar nerve block technique has some demerits such as the possibility of intravascular injection if aspiration is done, which exposes patients to higher risks of overdose, trismus, and hematoma. In addition, this technique is difficult and has a relatively higher failure rate in getting desired anesthesia compared to other methods (14, 2).

Considering the limitations of this study such as small sample size and unique sampling location, we concluded that anesthesia was provided by 4% articaine infiltration in the second primary mandibular molars and IANB with 2% lidocaine, which are similar in terms of their success rates. Thus, it could be nearly rational to switch toward infiltration technique with articaine in the mandibular area.

A literature review revealed some similar recent reports in this field. The results of a study performed by Donohue in 1993 showed that the infiltration method could provide a favorable anesthesia in the first primary mandibular molar for restoration, pulp therapy, and extraction (21).

In another study conducted by Arrow in 2012, the efficacy of articaine 4% infiltration was compared with that of lidocaine 2% IANB for the restoration of primary mandibular molars. Although the success rate in the articaine group was slightly higher than lidocaine (71% *vs* 64%), this difference was not statistically significant (22), which literally confirmed our findings.

In 2013, Tortamano *et al*. evaluated the onset and duration of pulpal anesthesia using articaine 4% and lidocaine 2% for IANB. Finally, they came to the result that the articaine group had a rapid onset and a longer pulpal anesthesia (23),

TABLE 1. SEM pain scale

Observations	Comfort	Mild discomfort	Moderate discomfort	Severe discomfort
Sound	No sound	Nonspecific pain-related sounds (possible pain)	Verbal complaints: its loud	Verbal complaints: shouting, crying
Eye	No sign	Dilated eyes without tears (anxiety sign)	Tears – sudden eyes movement	Crying – tears cover the face
Motor	Relaxed body and hand status	Muscular contraction contraction in the hands	Sudden body and hand movement	Hand movements for defense, such as turning the head to the opposite side

which could be considered as a confirmation of the higher potency of articaine, as mentioned earlier.

In the same line, Jung's study, which overhauled pulp sensitivity via a pulp tester, concluded that infiltration with 4% articaine had a more rapid onset and an equal efficacy in pulpal anesthesia versus IANB with lidocaine 2% (24).

In 2010, a study conducted by Katyal (25), which compared the efficacy of articaine to that of lidocaine in the mandibular and maxillary teeth, through infiltration and IANB techniques, it was indicated that articaine was more successful in development of anesthesia in the first mandibular and maxillary teeth.

In 2014, Nydegger (26) compared the effectiveness of three anesthetics materials, including articaine, lidocaine, and perlocaine, in the infiltration method for the first permanent mandibular molar. The results of this study showed a success rate of 55% for articaine, 33% for lidocaine, and 32% for perlocaine, which featured an immense efficacy of articaine in the infiltration technique, and especially in the denser bone of the mandible.

Unlike the aforementioned studies, Sharaf *et al* (27) investigated 80 children aged between three and nine years old using two different methods of infiltration and IANB for various dental procedures, including restoration, pulp therapy, and extraction on the first primary mandibular molar. The authors found that the effectiveness of infiltration in pulp therapy was much lower than IANB. However, these two types of injections had the same results for extractions and restorations. Correspondingly, although this finding is in discordance with ours, in Sharaf's study, the type of anesthetic agent was not considered as an impressive factor on infiltration efficacy.

Similarly, in a study by Oulis, who investigated the efficacy of infiltration on pulpotomy, restoration, and extraction of primary mandibular molars, it was shown that infiltration did not provide favorable anesthesia for pulpotomy and extraction (28). Moreover, the anesthetic agent in this study was lidocaine, which reportedly had less penetration to the cortical bone of the mandible compared to articaine.

The different results obtained from SEM and VAS scales in our study can probably be due to the fact that in VAS, children reported pain even during injection, while in SEM, a pedodontist recorded each child's reaction during dental procedures.

It should be noted that the sample size, techniques of applying anesthesia and dosage of epinephrine, background disease, site of injection, and patients' age can all affect the heterogeneity of results obtained in various studies.

CONCLUSION

According to results of this study, buccal infiltration of 4% articaine has a comparable anesthetic outcome with 2% lidocaine IANB for pulp treatment of the second primary mandibular molars. However, further studies are needed to replace this method in the mandibular area. ❑

Conflicts of interest: none declared.

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