Original Article

Comparative Evaluation of Anesthetic Efficacy of 4% Articaine Using Buccal Infiltration Technique and Periodontal Ligament Injection Technique for Extraction of Primary Mandibular Molars: An *In vivo* Study

Shivani Kapoor, Tanu Nangia, Mousumi Goswami

ITS Dental College, Hospital, and Research Centre, Greater Noida, Uttar Pradesh, India

Abstract

Introduction: Dental anxiety is patient's psychological response to the dental environment. Local anesthetic injection is the most anxiety-causing procedure for children in dentistry, especially the inferior alveolar nerve block (IANB) which is the most commonly used injection technique for achieving local anesthesia of mandibular molars. The various alternatives explored for IANB are intra-ligamentary technique/periodontal injection technique and buccal infiltration. **Aim:** The aim of this study was to compare the effectiveness of articaine hydrochloride 4% with adrenaline 1:100,000 for the extraction of mandibular primary molar teeth using buccal infiltration injection and intraligamentary injection. **Materials and Methods:** The present study was conducted on 30 children in the age group of 5–10 years requiring bilateral extraction of primary mandibular molars. The patients were randomly selected and divided into two groups. Group 1 received anesthesia using buccal infiltration injection technique and Group 2 received anesthesia using intraligamentary injection both containing 4% articaine with 1:1,00,000 adrenaline. **Results:** The success rate of buccal infiltration and intraligamentary injection using 4% articaine with mean sound, eye, and motor scores (± standard deviation) was found to be statistically nonsignificant, i.e., 3.07 for buccal infiltration and 2.97 for intraligamentary injection technique with $P = 0.835$ ($P > 0.05$). **Conclusion:** There is no significant difference between buccal infiltration technique and intraligamentary injection technique for the extraction of primary mandibular molars using 4% articaine with 1:1,00,000 adrenaline.

Keywords: Articaine, buccal infiltration, extraction, intraligamentary injection

Introduction

Dental anxiety has been a concern in children for many years. Local anesthetic injection is the most anxiety-causing procedure for children in dentistry.[1] Pain and anxiety can reduce the efficacy of anesthesia in pediatric patients. Hence, painless dental treatment is of major interest in pediatric dentistry. To ensure successful pain relief, a sound knowledge of local anesthetic solutions and appropriate application of local anesthetic techniques are mandatory.

The inferior alveolar nerve block (IANB) is the most commonly used injection technique for achieving local anesthesia in mandibular molars, although studies have shown failure rates of 44%–81%.[2] The major complications seen with IANB include paraesthesia, needle breakage, lingual nerve paralysis, trismus, hematoma, soft-tissue injury, and most commonly postanesthetic traumatic ulcers, especially in pediatric patients.[3] There is a constant quest and ongoing research to develop a more efficient technique for delivering local anesthesia to achieve the optimal and desired effects. Various supplemental techniques such as the intraosseous,

Address for correspondence: Dr. Tanu Nangia, ITS Dental College, Hospital and Research Centre, 47, Knowledge Park III, Greater Noida - 201 308, Uttar Pradesh, India.
E-mail: dr_tanunangia@yahoo.co.in

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intraligamentary, and infiltration injection techniques have been studied to enhance the success of anesthesia.[4]

A technique called the periodontal ligament (PDL) injection (intra-periodontal or intraligamentary) has been employed for many years, primarily as a means of achieving complete anesthesia in a tooth where regional block anesthesia failed to provide it.[5] It is a preferred route of anesthesia, especially for mandibular teeth wherein a minimal amount of anesthesia is deposited at the operating site. This technique allows the deposition of the agent at the operating site and also requires minimal anesthetic dose for the treatment.

Another alternative method for anesthetising the primary molar teeth is using infiltration injection. Easier application, lesser rate of anesthesia in soft tissues, and shorter anesthetic time are among the advantages of infiltration technique as compared to the block method.

Hence, the present study was undertaken to compare and evaluate the anesthetic efficacy of buccal infiltration technique and intraligamentary technique using 4% articaine for extraction of primary mandibular molars.

Materials and Methods

The present study was conducted in a sample of 30 patients who reported to the Department of Pedodontics and Preventive Dentistry, ITS Dental College, Hospital and Research Center, Greater Noida, for bilateral extraction of primary mandibular molars. Before conducting the study, ethical clearance from the Institutional Ethics Committee was taken.

Calculation of the sample size

The minimum number of samples in each group was calculated by using "G-POWER SOFTWARE" (version 3.0, Erdfelder, Faul and Buchner, 1996). It was done for f-test and Means: The difference between two dependent means (matched pairs) was chosen.

The ILT was administered with intraligamentary injection (GDC) using cartridge containing articaine hydrochloride 4% with adrenaline 1:100,000 (Septanest, Septodont, France) and a 30G extra short disposable needle (Septoject, Septodont France).

Thirty children aged 5–10 years, whose bilateral primary mandibular molars were indicated for the extraction were selected and randomly divided into Group 1 and Group 2. This particular age was selected as this is a stage of mixed dentition and the children under this age group undergoes an enormous surge of intellectual development[5] and since the criteria for the pain assessment in the present study was based on the sound, eye, and motor scores which are used to evaluate the efficiency of pain control during the anesthetic procedure,[6] observing changes in patients behavior during dental treatment, for example, facial expressions, moaning, body movements plays a very important role for the assessment of pain response. Therefore, this age group is feasible for the subjective evaluation of pain response during extraction. Children were selected using the simple random sampling method wherein they were asked to select a ball from a container containing balls that were either yellow or green in color. Those who selected green balls were kept in Group 1 and ones who selected yellow balls were kept in Group 2.

During the first appointment, the extraction of the primary molar on the unilateral side was done using the injection technique which was randomly selected by colored balls. The extraction of the molar on the contralateral side was carried out after 1 week, and the same procedure was repeated using an alternative injection technique.

Group 1 children received buccal infiltration injection containing 4% articaine with 1,1:00,000 adrenaline. The cheek was retracted so that the mucobuccal fold of the offending tooth became taut. The needle was oriented toward the bone and the mucous membrane and penetrated mesial to the tooth to be anesthetized. The needle was advanced so that it would be directed between the roots of the tooth. Using a 27G needle, 1.5 ml of 4% articaine with 1:1,00,000 adrenaline was then administered.

Group 2 children received intraligamentary injection containing 4% articaine with 1:1,00,000 adrenaline. 0.8 mL of 4% articaine with 1:1,00,000 adrenaline was administered. The injection was inserted through the gingival sulcus into the PDL space. The bevel of the needle faced the alveolar wall. The tip of the needle passed along the root surface until it met resistance. Resistance to injection while the lever of intraligamentary injection was depressed indicated the correct location of the needle in the PDL, approximately at a depth of 2–3 mm. The angle of the bevel permitted insertion of the needle into the PDL to the required depth. The sites chosen for injection were the mesiobuccal, distolingual, mesial, and distal aspects of the gingival sulcus. A minimum deposition of 0.2 ml articaine was administered at each of these sites.

30 s after the administration of local anesthetic (LA), the objective symptoms were assessed using a blunt probe. The profoundness of the anesthesia was assessed objectively while retracting the gingiva and during the application of forceps to the tooth. Sound eye motor (SEM) scale was used to assess the pain at the time of injection, at the time of blunt probe application and at the time of extraction by an operator blinded to the study. A single experienced pediatric dentist recorded the SEM score for all the participants during the entire course of the study.

After taking informed consent from the parents, extraction was carried out. If the patient experienced pain at any given time during the extraction, the procedure was abandoned and extraction was carried out after administrating routine inferior alveolar nerve and lingual block. Postextraction instructions were given to the patient and analgesic was prescribed to the patient. Antibiotics were prescribed if required. Space maintainer was given wherever indicated.

Results

The present study was carried out over a sample of 30 patients out of which 16 were males and 14 were females requiring extraction of bilateral primary mandibular molars i.e., 60 primary mandibular molar teeth amongst which one patient did not report for the extraction of the contralateral tooth. The mean age of patients participating in the study was 7.2 years with a standard deviation (SD) of 1.03 and the mean SEM score of 30 patients was 3.01, with a SD of 1.86 [Table 1] and maximum percentage of SEM score category of 2–3 was found to be maximum in 42.4% patients [Table 2].

The mean age of overall sample of 30 patients is 7.22 years, with a SD of 1.03.

The mean SEM score of overall sample of 30 patients is 3.01, with a SD of 1.86.

When sound, eye, and motor scores were compared between both the study groups, none of the scores were significant different ($P > 0.05$). This implies that both Group 1 and Group 2 had similar sound, eye, and motor scores [Table 3].

When sound, eye, and motor scores were compared between both genders, the sound and eye scores had no significant difference ($P > 0.05$), however, Motor scores were significantly different ($P < 0.05$). The motor score was significantly higher in males than females. This implies that Motor Score was significantly higher in Males as compared to Females [Table 4].

This implies both Group 1 and Group 2 had similar SEM score ($P > 0.05$). When the overall SEM score was compared between both the groups, the difference was statistically not significant scores [Table 5].

Table 1: Mean age and SEM score for overall sample size

	Age	Sound	Eye	Motor	SEM
n	59	59	59	59	59
Mean	7.220	1.17	0.73	1.12	3.02
SEM	0.1342	0.116	0.093	0.106	0.242
Median	7.000	1.00	1.00	1.00	3.00
SD	1.0309	0.894	0.715	0.811	1.862
Range	4.0	3	2	3	7
Minimum	5.0	0	0	0	0
Maximum	9.0	3	2	3	7

SD: Standard deviation, SEM: Sound eye motor, SEM: Standard error of the mean

Table 2: Frequency table

SEM score category	Frequency (%)	Valid percent	Cumulative percent
0-1	13 (22.0)	22.0	22.0
2-3	25 (42.4)	42.4	64.4
4-5	14 (23.7)	23.7	88.1
6-7	7 (11.9)	11.9	100.0
Total	59 (100.0)	100.0	

SEM: Sound eye motor

Table 3: Comparison between Group 1 and Group 2

	Group	*n*	Mean rank	Sum of ranks
Sound	Group 1	29	34.07	988.00
	Group 2	30	26.07	782.00
	Total	59		
Eye	Group 1	29	26.24	761.00
	Group 2	30	33.63	1009.00
	Total	59		
Motor	Group 1	29	31.86	924.00
	Group 2	30	28.20	846.00
	Total	59		

	Sound	Eye	Motor
Mann-Whitney U	317.000	326.000	381.000
Wilcoxon W	782.000	761.000	846.000
Z	−1.886	−1.798	−0.926
P	0.059	0.072	0.354

Discussion

Pain is defined as an unpleasant sensory or emotional experience arising from actual or potential tissue damage. In general, patients commonly described dental procedures as painful and unpleasant.[7] Therefore, for good pediatric dental care, pain control is important and necessary. Research has identified dental injection as the highest-ranked source of pain during dental procedures. Any change in patient behavior during dental treatment (e.g., facial expressions, crying, and body movement) plays a very important role in pain assessment. Thus, in order to get a correct subjective evaluation of pain, we used SEM scale.

SEM scale was used to record the reaction of the child at the time of injection, during gingival retraction and during the extraction of the primary mandibular molars and the overall SEM scale for the two groups, i.e., Group 1(buccal infiltration) and Group 2 (intraligamentary technique) were compared, and it was noted that both Group 1 and Group 2 had similar sound, eye, and motor scores [Table 3]. It was observed that for sound score among the two study groups, In Group 1 (buccal infiltration), Score 1 was found to be highest among the children whereas Group 2 (intraligamentary technique) showed equivalence of Scores 0 and 1 [Graph 1].

For comparison of an eye score among Group 1 and Group 2, it was observed that the majority of the children among Group 1 had Score 0 in comparison to Score 1 in Group 2 [Graph 1]. In a comparison of motor score among the two groups, Group 1 (buccal infiltration) and Group 2 (intraligamentary technique) Score 1 was found to be highest among both the groups [Graph 1]. Thus, the findings of our study imply that in both Group 1 and Group 2 when overall SEM score was compared between both the groups, the difference was statistically not significant scores [Table 5], and both the techniques can be used as an alternative to conventional IANB

Table 4: Comparison between two genders

	Gender	*n*	Mean rank	Sum of ranks
Sound	Male	31	32.05	993.50
	Female	28	27.73	776.50
	Total	59		
Eye	Male	31	31.61	980.00
	Female	28	28.21	790.00
	Total	59		
Motor	Male	31	34.29	1063.00
	Female	28	25.25	707.00
	Total	59		

	Sound	Eye	Motor
Mann-Whitney U	370.500	384.000	301.000
Wilcoxon W	776.500	790.000	707.000
Z	−1.016	−0.826	−2.283
P	0.310	0.409	0.022* (significant)

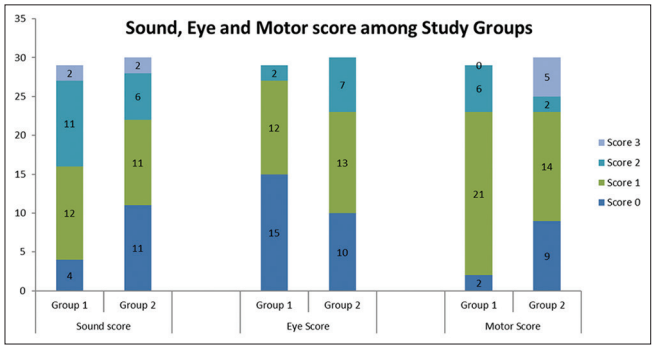
*$P<0.05$

Table 5: Intergroup comparison of the standard error of the mean score between both study groups

Group statistics					
	Group	*n*	Mean	SD	SEM
SEM	Group 1	29	3.07	1.462	0.272
	Group 2	30	2.97	2.205	0.403

	t-test for equality of means			
	t	df	*P*	Mean difference
SEM	0.209	57	0.835	0.102

SD: Standard deviation, SEM: Sound eye motor, SEM: Standard error of the mean



Graph 1: Intergroup comparison of sound, eye, motor scale scores.

technique for the extraction of primary mandibular molars with articaine as an anesthesia of choice. The result of our study is in accordance with the study conducted by Rathi *et al*.[8] who concluded that for pediatric patients age 7–12 years, single buccal infiltration with 4% articaine with 1:100,000 epinephrine is more effective compared to 2% lidocaine with 1:80,000 epinephrine for primarly molar extraction. Our results are also in accordance with the study conducted by Pradhan *et al*.[9] who concluded that the intraligamentary injection technique can be used effectively to anesthetize mandibular molars, as a primary technique for extraction of mandibular posterior teeth. Another study conducted by Sharan *et al*.[10] concluded that ILT with articaine can be an alternative to IANB for extraction of primary mandibular molars.

Use of articaine in children

Articaine (4-methyl-3-[2-(propylamino)-propion amido]-2-thiophene-carboxylic acid, methyl ester hydrochloride) is an amide-type local anesthetic agent that differs from other local amide anesthetics due the presence of thiophene ring. It also contains an ester group, so that hydrolyzation occurs in the plasma by non-specific cholinesterases and is primarily excreted through the kidneys.[11] Articaine inhibits nerve conduction similar to other local anesthetic agents by reversibly binding to the α-subunit of the voltage-gated sodium channels within the nerve's internal cavity.

Jakobs *et al*.[12] in a study stated that in 3–12-year-old children, serum concentrations of articaine were comparable to those in adults, with maximum concentrations of a 2% solution significantly lower than that of a 4% one. Adewumi *et al*.[13] stated that the most common adverse reactions of articaine reported to be prolong numbness and soft tissue injuries, mainly occurring in children younger than seven. According to Sixou and Barbosa-Rogier,[14] Articaine injection in children aged 4–16 years was able to provide successful anesthesia for a high proportion of deciduous and permanent teeth, though the success was significantly higher in the maxillary teeth. Leith *et al*.[1] in a study concluded that articaine achieves successful pain control while reducing the volume administered and is advocated as a safe and effective alternative to lidocaine for use in children. Elheeny[15] in a study concluded the efficient and secure use of articaine hydrochloride 4% with epinephrine 1:100,000 to treat children between the ages of 3 and below 4-year-old. Therefore, the available literature on articaine for use in children shows that it is safe and effective for clinical procedures in children of all ages.

Conclusion

Within the limitations of the study, it can be concluded that there is no statistically significant difference between buccal infiltration technique and intraligamentary injection technique for the extraction of primary mandibular molars, and both the techniques can be used as an alternative to the gold standard IANB. The use of articaine as an anesthetic agent of choice is based solely on the personal preference of the clinician.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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