Open Peer Review on Qeios

Comparative Study Between the Efficacy of 4% Articaine Infiltration and 2% Lidocaine Nerve Block as Local Anesthetic Agents for Painful Dental Procedures in Children Aged 6-18 Years

Shaifali Agarwal[1], Neerja Singh[2], Subash Singh[2], Alok Singh[3], Vinay Umale[3], Rohit Kulshrestha[4]

1 Saraswati Dental College and Hospital
2 Babu Banarsi Das College of Dental Sciences
3 Yogita Dental College
4 Terna Dental College and Hospital

Funding: No specific funding was received for this work.

Potential competing interests: No potential competing interests to declare.

Abstract

Objective: To assess and compare the efficacy of 4% articaine as buccal infiltration and 2% lidocaine as a nerve block for painful dental procedures in the maxillary and mandibular arch.

Study design: The study was carried out in 40 children (6 to 12 years) who needed local anesthesia for the dental treatment. The subjects were randomly divided into two groups (A & B) based on the arch involved. Group A and group B consisted of 20 individuals randomly receiving lignocaine nerve block and articaine infiltration at an interval of 1 week in the maxillary arch and mandibular arch, respectively. Pain during the administration of anesthetic agents, intra-operative pain, and the onset of anesthesia was recorded for both the arches.

Result: Pain during the administration of anesthetic agent was more with nerve block than infiltration in both maxillary arch (p=0.001) as well as mandibular arch (p=0.06). Intra-operative pain was similar for both the anesthetic agents in both the arches. Articaine showed a significantly shorter onset of anesthesia in both the arches.

Conclusion: Efficacy of 4% articaine with infiltration and 2% lidocaine with nerve block was found to be similar. Hence, articaine infiltration can be used as an alternative to the lignocaine nerve block.

Shaifali Agrawal[a], **Neerja Singh**[b], **Subash Singh**[c], **Alok Singh**[d], **Vinay Umale**[e], and **Rohit Kulshrestha**[f]

[a] *Senior Lecturer, Department of Pedodontics and Preventive Dentistry, Saraswati Dental College, Lucknow, India*

[b] *Head of the Department, Department of Pedodontics and Preventive Dentistry, Babu Banarsi Das College of Dental Sciences, Lucknow, India*

[c] *Reader, Department of Pedodontics and Preventive Dentistry, Babu Banarsi Das College of Dental Sciences, Lucknow, India*

[d] *Senior Lecturer, Department of Orthodontics and Dentofacial Orthopedics, Yogita Dental College, Khed Maharashtra*

India.

[e] *Senior Lecturer, Department of Orthodontics and Dentofacial Orthopedics, Yogita Dental College, Khed Maharashtra India.*

[f] *Senior Lecturer, Department of Orthodontics and Dentofacial Orthopedics, Terna Dental College, Navi Mumbai, Maharashtra India.*

[*]Corresponding author: Rohit Kulshrestha, Senior Lecturer, Department of Orthodontics and Dentofacial Orthopedics, Terna Dental College, Navi Mumbai, Maharashtra India. Email: kulrohit@gmail.com

Keywords: Articaine, Lignocaine, Local anesthetic agent.

Introduction

One of the important aspects of the successful treatment in pediatric dentistry was pain management. If a child experiences pain during the dental procedure, he/she might develop reluctance or phobia towards future dental treatment. Local anesthesia prevents discomfort, eliminates pain, and renders the dental treatment to be carried out effectively and comfortably. Local anesthesia can be defined as loss of sensation in a circumscribed area of the body caused by depression of excitation of nerves endings or inhibition of conduction process in peripheral nerve [1]. The introduction of the local anesthetic agent was a boon that has revolutionized the field of dentistry.

In 1943, the first amide local anesthetic lidocaine hydrochloride was synthesized and was considered as the “gold standard” for comparison with other anesthetic drugs.[2] Lidocaine had minimal adverse drug reactions and was considered to be the safest anesthetic agent but in the case of unintentional intravascular injections plasma concentration of the drug increased leading to systemic toxicity.[3] Other drawbacks like limited diffusibility, need for multiple injections and complex biotransformation have led to the discovery of an agent that had fewer advantages over lidocaine.

Articaine was the only amide local anesthetic agent that had a thiophene ring instead of a benzene ring, which accords to its lipid solubility. Articaine had an ester linkage rendering the drug to undergo biotransformation not only in the liver but also in plasma, consequently reducing its half-life and systemic toxicity in the blood. Recent evidence showed that buccal infiltration with articaine produced palatal and lingual anesthesia, thus, eliminating the need for block anesthesia and multiple injections which were uncomfortable and painful to children.

Despite its popularity, articaine was not routinely used as an anesthetic agent by clinicians in their practice. The study described in this article was formulated to compare the anesthetic efficacy of 4% articaine as buccal infiltration with 2% lidocaine as a nerve block to contribute to a more profound knowledge about the quality of articaine as a local anesthetic agent.

Materials and Method

The study was conducted on 40 children referred to the Department of Pedodontics and Preventive Dentistry, Babu Banarasi Das College of Dental Sciences (BBDCODS). Clearance was obtained from the institutional ethical committee of BBDCODS, Lucknow. Children of both the gender (male and female) with an age group of 6-12 years (mean age 10.2), requiring pulp therapy or extraction categorized as ASA Class I and Frankl III and IV were included in the study. Any behaviour management techniques were not used during the study. Individuals who were known allergic to the local anesthetic agent to be used and the presence of soft tissue infection near the proposed injection site were excluded from the study. Previous dental history was taken and the patients who had their first visit to the dentist were included in the study. Written informed consent was obtained from the parents/ guardian before the treatment. Additionally, assent was taken from children above seven years of age [4].

The subjects were randomly divided into two groups based on arch involved: Group A & Group B. Group A consisted of 20 patients randomly receiving 4% articaine as infiltration (Articaine Hydrochloride 4% with Epinephrine 1:100,000 infiltration-Septodont) and 2% lidocaine as nerve block (Lidocaine Hydrochloride 2% with Epinephrine 1:80,000-Xicaine) in the maxillary arch at an interval of 1 week and Group B consisted of 20 patients randomly receiving the two anesthetic agents (4% articaine infiltration or 2% lidocaine nerve block) in the mandibular arch at an interval of 1 week. The procedure was performed by two investigators; investigator 1 performed the administration and recorded the pain and investigator 2 observed the entire procedure. In the first appointment, the patients falling into either Group A or Group B were randomly selected to receive either lidocaine nerve block or articaine infiltration. In the second appointment, the local anesthetic agent not used previously was then administered.

The concerned area where the anesthetic solution must be deposited was dried with gauze piece followed by application of topical anesthetic agent Lidocaine Topical Aerosol USP (Nummit Spray) – ICPA Health Products Ltd. 1.7 ml of either of the anesthetic solution was deposited at a rate of 1.8 ml/min. All the anesthetic injections were administered by a single operator with 27-gauge needle. To determine the pain experienced during the deposition of anesthetic solution, subjects were asked to rate the pain immediately after the lidocaine nerve block or articaine infiltration, on the visual analog scale pain scale by the subjective method. Anesthetic efficacy was assessed by having the subject rate the intra-operative pain following the treatment procedure on the VAS. Each subject placed a mark on the scale where it best described their pain level.

Statistical analysis

The results are presented in frequencies, percentages, and mean ± SD. The Chi-square test was used to compare categorical variables between the groups. The Unpaired t-test was us to compare continuous variables between the groups. The p-value<0.05 was considered significant. All the analysis was carried out on SPSS 16.0 version (Chicago, Inc., USA

Result

Forty children with mean age 11.15±3.97 years in the maxillary arch and 11.80±4.22 years in the mandibular arch were included in the study.

Pain on injection

Pain during the administration of anesthetic agents according to the visual analog pain rating scale was more with lidocaine as nerve block than articaine as infiltration in both the groups (Table 1,2). The difference between the pain score in group A was statistically significant (p=0.001)

Intra-operative pain

Pain score during treatment was similar with articaine infiltration and lidocaine nerve block in both the groups (group A= maxillary arch; group B= mandibular arch) (Table 3, 4)

The onset of anesthesia

A statistically significant difference was found in the onset of anesthesia between lidocaine and articaine in Group A (p=0.0009) and Group B (0.0001). (Table 5,6)

Discussion

Lignocaine was the gold standard anesthetic agent used in dentistry to date due to its minimal toxicity and better efficacy [5]. Hence, lignocaine was used in the study for comparison. However, clinical studies have reported that anesthetic failure by lignocaine nerve block especially during inferior alveolar nerve block can occur up to 25% of the time [6]. Meechan suggested that poor operator technique, variations in the position of the foramina, accessory innervations, accuracy of the injection, and variable course of the inferior alveolar nerve might explain why local anesthesia does not work in all cases. The low success rate of inferior alveolar nerve block has been observed (23% and 39%) in studies conducted by Claffey et al and Aggarwal et al respectively during the treatment of patients with irreversible pulpitis [6][7]. Infiltrations were easier to perform, did not require perforation of cortical bone, were comfortable to the patient and operator, and avoid lingual numbness and possible damage to the nerve. Thus, to achieve anesthesia, infiltrations can be used as a primary injection technique or as a supplemental injection to enhance the effectiveness of primary injection. Recent evidence has shown that the use of articaine in dentistry can be an effective measure to provide local anesthesia either by block or by infiltration [8]. Articaine, an amide with an additional ester group, and its chemical structure made the drug more fat-soluble and enhances its ability to diffuse through hard and soft tissues, which made it a useful anesthetic agent in dentistry.

Four percent articaine with 1:100,000 epinephrine has been found to produce successful anesthesia as suggested by the

study of Lima et al where they administered articaine through buccal vestibule without palatal injection during the extraction of impacted maxillary third molar [9]. Kanna D et al found buccal infiltration with 4% articaine to be more effective than buccal infiltration with 2% lidocaine in securing mandibular first molar anesthesia [10]. In a study conducted by Silva-Junior et al, a combination of buccal infiltration of 2% articaine and inferior alveolar nerve block of 2% lidocaine with epinephrine 1:100,000 showed increased efficacy during impacted mandibular third molar surgery in comparison to a combination of buccal infiltration of 2% lidocaine and inferior alveolar nerve block of 2% lidocaine [11]. Hence, based on the finding of the above studies supporting articaine's efficacy when administered as infiltration, it was selected in this study as a local anesthetic agent for comparing its efficacy with lidocaine. Not all studies agree on articaine's ability as infiltration to produce better anesthetic properties than lignocaine nerve block. Studies conducted by Sharman et al [5] and Kambalimath et al [2] showed equal efficacy of articaine infiltration and lidocaine nerve block in securing anesthesia during treatment procedures. On the other hand, Abdul wahab et al compared six different local anesthetic agents and found that articaine was the only one that has better pulpal anesthesia than lignocaine after mandibular infiltration [12]. Thus, the mixed findings on the efficacy of articaine pointed to the need for further search which led us to formulate our study with the purpose to compare the anesthetic efficacy of 2% lignocaine nerve block with 4% articaine infiltration for dental procedures in children.

The anesthetic was effective if the procedure could be performed without any pain. Pain measurement was difficult to be established because its perception and intensity were multifactorial which encompasses sensorial and effective factors. In the present study, evaluation of pain was done by Visual Analogue Scale (VAS) which provided a validated and meaningful measure of anesthetic efficacy. VAS, a 10 cm metric scale with the two endpoints labeled as "no pain" and "worst pain ever" for assessing individual pain perceptions in which patient was asked to rate the scale according to intensity of pain experienced by them. VAS is methodologically sound, conceptually simple, easy to administer, and unobtrusive to the respondent.

Pain score during the administration of anesthetic solutions was more with 2% lignocaine as nerve block than 4% articaine as infiltration in the maxillary arch, which was statistically significant (p=0.001), and the pain score was more with lignocaine in the mandibular arch (p=0.06) but not statistically significant. Similar results were obtained by Chopra et al [8] in which pain score after administration of lignocaine as nerve block was more when compared to articaine as infiltration during pulp therapy of mandibular primary molars. Srinivasan et al [13] and Kanaa et al [14] reported articaine buccal infiltration to be more comfortable than lidocaine infiltration in the maxillary teeth with irreversible pulpitis. Contrary to the results obtained, Mikesell et al [15], Poorni et al [16], and Sara Ghadimi et al [17] reported no difference in the discomfort experienced by the patients during the administration of articaine as infiltration and lidocaine as a nerve block for the routine treatment procedures in the mandibular arch. Higher pain score with lignocaine nerve block than articaine infiltration may be explained by the fact that the depth of penetration is more in a block than infiltration, and for the nerve block additional palatal/lingual injections were required to achieve anesthesia on buccal as well as lingual/palatal side which was uncomfortable to patients whereas single injection of articaine buccal infiltration also produced lingual/palatal anesthesia.

The intra-operative pain score obtained was the same for both the solutions (4% articaine infiltration and 2% lignocaine block) in the maxillary (p=1.00) and mandibular arch (p=1.00) respectively, which suggests that articaine infiltration alone could provide similar comfort during treatment to lignocaine group where both buccal and palatal/lingual injections were given. The above results are per the study conducted by Sherman et al and Poorni et al in which a similar pain score was observed for buccal infiltration of 4% articaine with 1:100,000 epinephrine and 2% lidocaine with 1:100,000 epinephrine as nerve block during treatment procedures in the mandibular and maxillary arch. The anesthetic success rate as suggested by Peng et al [18], Hassan et al[19], Luqman et al [20], and Bansal S et al was found to be similar for buccal infiltration of articaine and conventional buccal plus palatal injections of lidocaine during the extraction of permanent maxillary premolar and molar. Contradictory to the above results, Chopra et al and Muhammad Zain et al [21] reported high pain scores with lignocaine nerve block as compared to articaine as infiltration for pulp therapy in mandibular molars. Arali and Mytri [22] and Sara Ghadimi et al [17] also reported significantly better patient behavior with articaine during dental treatment. In a systematic review by Virginia Powell articaine infiltration was found to be 2.44 times more likely to produce successful pulpal anesthesia than lidocaine nerve block. Significantly less pain score was observed with 4% articaine in a study conducted by Kumar et al {m/23/} during the extraction of maxillary molars as determined by Faces Pain Scale-Revised.

Statistical analysis of the data obtained from the present study suggests that articaine can be successfully used through the infiltration method as a local anesthetic agent for pulp therapy and extraction procedures in children. The present study also provided an insight that due to the similar efficacy of articaine as infiltration and lignocaine as a nerve block, single infiltration of articaine can be used as an alternative for achieving anesthesia to conventional buccal plus lingual/palatal injections of lignocaine.

Conclusion

Based on observations made during the study and their analysis, the following conclusions have been drawn:

1. Buccal infiltration of 4% articaine was better tolerated by children during administration in both maxillary and mandibular arch.
2. Lidocaine 2% as nerve block and articaine 4% as buccal infiltration are equally effective local anesthetic agents in both the arches during the treatment.

The present study indicated that with the use of 4% articaine as buccal infiltration, dental treatment can be performed without the need for palatal/lingual nerve block. Hence, it can be suggested that buccal infiltration of 4% articaine can be a useful alternative to 2% lidocaine as a nerve block during treatment procedures in dentistry especially pediatric dentistry.

Tables

Table 1. Comparison of Visual Analogue Scale (VAS) Score after deposition between Lidocaine and Articaine in Group A (maxillary arch)

VAS	Lidocaine (n=20)		Articaine (n=20)		p-value
	No.	%	No.	%	
No pain	0	0.0	2	10	
Mild	16	80	17	85	0.001*
Moderate	4	20	1	5	

Table 2. Comparison of VAS (Visual Analogue Scale) after deposition between Lidocaine and articaine in Group B (mandibular arch)

VAS	Lidocaine (n=20)		Articaine (n=20)		p-value
	No.	%	No.	%	
No pain	1	5.0	1	5.0	
Mild	14	70.0	19	95.0	0.06
Moderate	5	25.0	0	0.0	

Table 3. Comparison of intra-operative VAS (Visual Analogue Scale) score between Lidocaine and Articaine in Group A (Maxillary arch)

VAS	Lidocaine (n=20)		Articaine (n=20)		p-value
	No.	%	No.	%	
No pain	15	75.0	15	75.0	
Mild	4	20.0	4	20.0	1.00
Moderate	1	5.0	1	5.0	

Table 4. Comparison of intra-operative VAS (Visual Analogue Scale) score between Lidocaine and articaine in Group B (Mandibular arch)

VAS	Lidocaine (n=20)		Articaine (n=20)		p-value
	No.	%	No.	%	
No pain	18	90.0	18	90.0	1.00
Mild	2	10.0	2	10.0	

Table 5. Comparison of onset of anesthesia between Lidocaine and articaine in Group A (maxillary arch)

Groups	Onset of anesthesia in seconds (Mean±SD)
Lidocaine	87.45±11.90
Articaine	73.30±12.79
p-value	0.0009*

Table 6. Comparison of onset of anesthesia between Lidocaine and articaine in Group B (mandibular arch)

Groups	Onset of anesthesia in seconds (Mean±SD)
Lidocaine	84.70±8.56
Articaine	70.95±6.14
p-value	0.0001*

Statements and Declarations

- The authors declare that they have no competing interests. All authors state that there is no conflict of interest.
- No funding was given for this study.

Author contributions

SA, NS carried out the research work in gathering the articles for the study, thought of the concept and drafted the manuscript. SS, AS, VU participated in the structuring the article, defined the intellectual content and performed the statistical analysis. RK and SA both did the clinical work, gathered the data and participated in its design. SS and RK coordinated and helped to draft the final manuscript. All authors were part of the manuscript preparation, editing and reviewing. They all read and approved the final manuscript.

References

1. ^*Malamed SF. Handbook of local anesthesia. Elsevier Health Sciences; 2004 Jun 8.*
2. a, b*Kambalimath DH, Dolas RS, Kambalimath HV, Agrawal SM. Efficacy of 4% Articaine and 2% Lidocaine: A clinical study. Journal of maxillofacial and oral surgery. 2013 Mar;12(1):3-10.*
3. ^*Kaushik JS, Narang M, Agarwal N. Informed consent in pediatric practice. Indian pediatrics. 2010 Dec;47(12):1039-46.*
4. ^*Srinivasan MR, Poorni S, Nitharshika Y, Diana D, Duraivel D. Articaine buccal infiltration versus lignocaine inferior alveolar block for pulpal anaesthesia in mandibular second premolars–Randomized control double blinded clinical trial. Journal of Pierre Fauchard Academy (India Section). 2017 Jun 1;31(2-4):79-83.*
5. a, b*Sherman MG, Flax M, Namerow K, Murray PE. Anesthetic efficacy of the Gow-Gates injection and maxillary*

infiltration with articaine and lidocaine for irreversible pulpitis. Journal of endodontics. 2008 Jun 1;34(6):656-9.

6. [a, b]*Aggarwal V, Jain A, Debipada K. Anesthetic efficacy of supplemental buccal and lingual infiltrations of articaine and lidocaine following an inferior alveolar nerve block in patients with irreversible pulpitis. J Endod 2009; 35:925–9*
7. [^]*Chopra R, Marwaha M, Bansal K, Mittal M Evaluation of Buccal Infiltration with Articaine and Inferior Alveolar Nerve Block with Lignocaine for Pulp Therapy in Mandibular Primary Molars. J Clin Pediatr Dent. 2016; 40(4):301-5*
8. [a, b]*Lima Júnior JL, Dias-Ribeiro E, de Araújo TN, Ferreira Rocha J, Honfi Júnior ES, Sarmento CF, Seabra F, Sousa MD. Evaluation of the buccal vestibule-palatal diffusion of 4% articaine hydrochloride in impacted maxillary third molar extractions.*
9. [^]*Kanaa MD, Whitworth JM, Corbett IP, Meechan JG. Articaine and lidocaine mandibular buccal infiltration anesthesia: a prospective randomized double-blind cross-over study. Journal of endodontics. 2006 Apr 1;32(4):296-8.*
10. [^]*Geraldo Prisco da Silva-Junior, Liane Maciel de Almeida Souza, and Francisco Carlos Groppo, Comparison of Articaine and Lidocaine for Buccal Infiltration After Inferior Alveolar Nerve Block for Intraoperative Pain Control During Impacted Mandibular Third Molar Surgery. Anesth Prog, 2017; 64:80–84.*
11. [^]*Abdulwahab M, Boynes S, Moore P, Seifikar S, Al-Jazzaf A, Alshuraidah A, Zovko J, Close J. The efficacy of six local anesthetic formulations used for posterior mandibular buccal infiltration anesthesia. The Journal of the American Dental Association. 2009 Aug 1;140(8):1018-24.*
12. [^]*Srinivasan N, Kavitha M, Loganathan CS, Padmini G. Comparison of anesthetic efficacy of 4% articaine and 2% lidocaine for maxillary buccal infiltration in patients with irreversible pulpitis. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology. 2009 Jan 1;107(1):133-6.*
13. [^]*Kanaa MD, Whitworth JM, Meechan JG. A comparison of the efficacy of 4% articaine with 1:100,000 epinephrine and 2% lidocaine with 1:80,000 epinephrine in achieving pulpal anesthesia in maxillary teeth with irreversible pulpitis. J Endod. 2012 Mar; 38(3):279-82.*
14. [^]*Mikesell P, Nusstein J, Reader A, Beck M, Weaver J. A comparison of articaine and lidocaine for inferior alveolar nerve blocks. Journal of endodontics. 2005 Apr 1;31(4):265-70.*
15. [^]*Poorni S, Veniashok B, Senthilkumar A D, Indira R, Ramachadran S. Anaesthetic efficacy of four percent articaine for pulpal anesthesia by using inferior alveolar nerve block and buccal infiltration techniques in patients with irreversible pulpitis: A prospective randomized double-blind clinical trial. J Endod. 2011; 37: 1603–160.*
16. [^]*Ghadimi S, Shahrabi M, Khosravi Z, Behroozi R. Efficacy of articaine infiltration versus lidocaine inferior alveolar nerve block for pulpotomy in mandibular primary second molars: A randomized clinical trial. Journal of dental research, dental clinics, dental prospects. 2018;12(2):97.*
17. [a, b]*Peng M, Zhu ZM, Yang XM. Feasibility of permanent maxillary tooth removal using articaine anesthesia without palatal injection. Hua xi kou qiang yi xue za zhi= Huaxi kouqiang yixue zazhi= West China journal of stomatology. 2008 Aug 1;26(4):416-8.*
18. [^]*Hassan S, Shah A, Dar M, Hakeem T, Teli Z. Comparison of Articaine and Lidocaine Used as Dental Local Anesthetics-A Research Article. IOSR-Journal Dent Med Science. 2015; 14:8 123-128.*
19. [^]*Luqman U, Majeed Janjua OS, Ashfaq M, Irfan H, Mushtaq S, Bilal A. Comparison of articaine and lignocaine for uncomplicated maxillary exodontia. J Coll Physicians Surg Pak. 2015 Mar; 25(3):181-4.*

20. ^*Zain M, SU RK, Sikandar H, Shah SA. Comparison of Anaesthetic Efficacy of 4% Articaine Primary Buccal Infiltration Versus 2% Lidocaine Inferior Alveolar Nerve Block in Symptomatic Mandibular First Molar Teeth. Journal of the College of Physicians and Surgeons--pakistan: JCPSP. 2016 Jan 1;26(1):4-8.*
21. ^*Veena Arali, Mytri P. Anaesthetic Efficacy of 4% Articaine Mandibular Buccal Infiltration Compared To 2% Lignocaine Inferior Alveolar Nerve Block in Children with Irreversible Pulpitis. J Clin Diagn Res. 2015 Apr; 9(4): ZC65–ZC67.*
22. ^*Kolli NK, Nirmala SV, Nuvvula S. The effectiveness of articaine and lidocaine single buccal infiltration versus conventional buccal and palatal injection using lidocaine during primary maxillary molar extraction: a randomized control trial. Anesthesia, essays and researches. 2017 Jan;11(1):160.*