ORIGINAL RESEARCH

A Comparative Evaluation of Pain Experience and Time of Onset of 2% Lignocaine and 4% Articaine in Inferior Alveolar Nerve Block among Pediatric Population: A Clinical Study

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Abstract

Aim: The objective of this research was to conduct a comparison and evaluate the pain perception and time of onset of 2% lignocaine 1:80,000 epinephrine with 4% articaine 1:100,000 epinephrine in the pediatric population.

Materials and methods: A split-mouth randomized control trial was conducted on 50 children aged 9–14 years who required inferior alveolar nerve block (IANB) anesthesia for bilateral dental treatment in the mandibular arch. The time of onset was recorded when no sensation was reported even when maximum electrical stimulus was applied in an electric pulp testing (EPT). The pain perception was assessed using a visual analog scale (VAS) rated by the patient for subjective symptoms and face, legs, activity, cry, and consolability (FLACC) scale for objective pain rated by the operator.

Results: The mean onset of time, pain—VAS, and FLACC score decreased by 1.31, 12.07, and 18.39%, respectively in 4% articaine as compared to 2% lignocaine but the difference did not reach statistical significance ($p > 0.05$), that is, found to be statistically the same.

In conclusion, it can be inferred that the utilization of 4% articaine is as potent as 2% lignocaine solution but showed slightly better onset of anesthesia and pain experience among the children although the findings were not statistically significant.

Clinical significance: Local anesthesia (LA) is one of the main methods of pain management in pediatric practice which makes it essential to choose an LA agent with a shorter time of onset and less pain on administration.

Keywords: Articaine, Face, legs, activity, cry, and consolability scale, Lignocaine, Pain perception, Time of onset, Visual analog scale.

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Introduction

In pediatric dentistry, fear and anxiety are recurring feelings and the subject of concern as emotions influence a child's behavior and play an important role in the perception of pain. One of the main methods to prevent pain in dentistry is the administration of local anesthesia (LA) but it is also probably the most delicate and difficult procedure and produces the greatest negative response in pediatric dental treatment.

An appropriate choice of LA agents is based on knowledge of the properties and clinical features of each agent. Lidocaine was introduced in the late 1940s and became the most common dental LA and because of its safety and effectiveness, it also became the gold standard for comparison among newer agents.[1] Articaine, the newest amide LA, was introduced in 1969. Articaine stands out as the sole amide LA featuring a distinctive thiophene ring, enhancing its liposolubility, along with an additional ester ring. In terms of physicochemical properties, articaine closely resembles widely utilized LA, except for the absence of an aromatic ring. Its notable attributes include efficient tissue penetration, high diffusibility, and a substantial plasma protein binding rate of around 95%.[2]

local anesthesia (LA) for treatments in a child's mandibular posterior teeth can be principally obtained with the administration of an inferior alveolar nerve block (IANB). It is one of the most common table techniques of LA administration and produces intense pain.[3] An ideal anesthetic agent should have a short onset period and should last long enough to allow the completion of a determined procedure.[4] The time of onset is the time interval between completion of anesthetic agent administration to achieving profound anesthesia which can be assessed by performing an electric pulp test (EPT).

Evaluating pain perception in children is a multifaceted process influenced by physiological, psychological, behavioral, and developmental factors, making it a challenging assessment. The measurement of pain intensity primarily relies on three methods—self-report, behavioral, and physiological measures. Although self-report measures are considered the most accurate and valid, their effectiveness is contingent on the child's age and experience, as the ability to articulate pain improves with growing age and accumulated experiences.[5] Pain in the present study was recorded using the visual analog scale (VAS) rated by the patients based on their subjective pain

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and the face, leg, activity, cry, consolability (FLACC) scale scored by the operator evaluating the objective pain experienced by the patient.

Therefore, the aim of this study was to compare and evaluate the pain experience and time of onset of 2% lignocaine and 4% articaine in IANB among the pediatric population.

Materials and Methods

A randomized controlled trial with a split-mouth design was carried out in the Department of Pedodontics of the college and ethical approval was obtained from the Institutional Review Board. Fifty children aged 9–14 years requiring IANB for bilateral dental treatment in the mandibular arch participated in the study. The procedure to be done for the study was explained by the principal investigator to the parents/guardians and a written consent was obtained. Children with no previous experience of dental anesthesia, a history of allergies to LA, and a medical history were included while patients medically compromised, having soft tissue infection, and those unable to communicate were excluded from the study.

For randomization, two envelopes were made and labeled types A and B. Cartridges of both the anesthetic agents of 2% lignocaine hydrochloride 1:80,000 epinephrine (Lignospan Standard, Septodont, Canada) and 4% articaine hydrochloride 1:100,000 epinephrine (Septanest, Septodont, France) were checked for expiration dates and covered with an opaque label in order to mask the identity of anesthetic agent. The cartridge of lignocaine was placed in type A while articaine was placed in type B envelopes by an external independent party to which the operator was blinded.

During the first visit, the children explained the procedure of EPT, anesthesia administration, and VAS that they would have to rate. The side of the mandibular arch to be treated was selected randomly or based on the patient's preference for the treatment required. EPT was performed as an initial procedure to record the baseline vitality and threshold of the concerned tooth. To perform EPT the experimental tooth and the contralateral canine tooth were selected and tested with EPT (Averon, Ekaterinburg, Russia). The teeth were isolated using cotton rolls and dried with a gauze piece. Toothpaste was applied to the tip of the EPT probe and was placed midway between the gingival margin and the occlusal or incisal edge of the tooth. The number associated with the initial sensation after the application of the electric current was recorded.

The site of LA administration was dried using a gauze piece and a topical anesthetic agent (Lignospan-O Mfd by Septodont, India) was applied using cotton earbud for 60 seconds. A cartridge from one of the envelopes was randomly selected for utilization. The LA agent was administered with the standard technique of IANB and on completion of the injection postneedle withdrawal from the mouth the stopwatch was started. After 30 seconds, the patient was questioned for subjective symptoms and EPT was done. Every 30 seconds this procedure was repeated until no sensation was reported by the patient even when maximum electrical stimulus was applied. This time was recorded as the time of onset of anesthesia. After the anesthesia was profoundly acted the children were shown a picture of the VAS and asked to rate their experience of pain during LA administration on a 100 mm line from 0 to 100 marking.

The treatment required for the patient was performed according to the standard protocols. The patient was observed for any pain and their objective symptoms were evaluated by the operator based on the child's behavior and activity during treatment being done using the FLACC scale. On completion of the procedures, parents were informed about the duration of the LA effect and precautions to be taken to prevent oral injuries of the anesthetized tissues.

The patient's second appointment was spaced 1 week apart. The same process was followed with another anesthetic agent not utilized in the previous appointment and was administered on the contralateral side from that of the initially selected one.

All the collected data was tabulated and statically analysis was performed on Statistical Packages for the Social Sciences (SPSS) software (Windows version 22.0).

Results

The time of onset of 2% lignocaine and 4% articaine ranged from 2.15 to 4.38 and 2.10–4.25 minutes, respectively with mean [± standard error (SE)] 3.02 ± 0.08 and 2.98 ± 0.08 minutes and median 3.19 and 3.10 minutes, respectively. The mean time of onset slightly lowered in 4% articaine group compared to 2% lignocaine group (4% articaine < 2% lignocaine) (Table 1 and Fig. 1). Comparing the difference in the mean time of onset of two groups, student's *t*-test showed similar ($p > 0.05$) time of onset between the two groups [3.02 ± 0.08 and 2.98 ± 0.08, mean difference = 0.04 ± 0.11, 95% confidence of interval (CI): −0.19–0.27, $t = 0.35$, $p = 0.729$) though it lowered by 1.31% in 4% articaine compared to 2% lignocaine (Table 1 and Fig. 1). Thus the difference in time of onset was statistically insignificant.

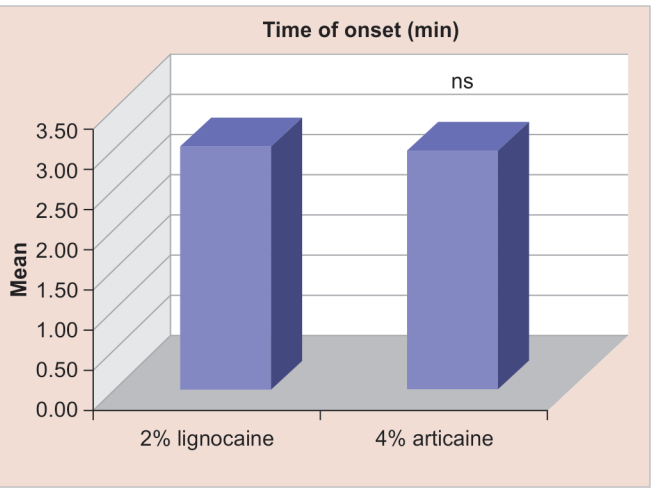

Fig. 1: Comparison of the difference in the mean time of onset between two groups; nonsignificance $p > 0.05$ compared to 2% lignocaine

Table 1: Time of onset (minute) of two groups

2% lignocaine (n = 50)	*4% articaine (n = 50)*	*Mean difference*	*t-value*	*p-value*
3.02 ± 0.08	2.98 ± 0.08	0.04 ± 0.11	0.35	0.729

The time of onset of the two groups was summarized in mean ± SE and compared by student's *t*-test (*t*-value)

The VAS score of 2% lignocaine and 4% articaine ranged from 12 to 90 and 10–100, respectively with a mean (±SE) of 46.72 ± 2.79 and 41.08 ± 2.85, respectively, and a median of 44 and 40, respectively. Like, time of onset, the mean VAS score also lowered marginally in 4% articaine group compared to 2% lignocaine group (4% articaine < 2% lignocaine) (Table 2 and Fig. 2). Comparing the difference in mean VAS score of two groups, Student's *t*-test showed similar ($p > 0.05$) VAS score between the two groups (46.72 ± 2.79; 41.08 ± 2.85, mean difference = 5.64 ± 3.99, 95% CI: −2.29–13.57, $t = 1.41$, $p = 0.161$) though lowered by 12.07% in 4% articaine group compared to 2% lignocaine group (Table 2 and Fig. 2) the result was not statistically significant.

The FLACC score of 2% lignocaine and 4% articaine ranged from 0 to 6 and 0–7, respectively with a mean (± SE) of 1.74 ± 0.26 and 1.42 ± 0.25, respectively, and both median 1. Like, both time of onset and VAS score, the mean FLACC score also lowered marginally in the 4% articaine group compared to 2% lignocaine group (4% articaine < 2% lignocaine) (Table 3 and Fig. 3). Comparing the difference in mean FLACC score of two groups, student's *t*-test showed similar ($p > 0.05$) FLACC score between the two groups (1.74 ± 0.26 and 1.42 ± 0.25, mean difference = 0.32 ± 0.36, 95% CI: −0.40–1.04, $t = 0.89$, $p = 0.376$) though lowered by 18.39% in 4% articaine group compared to 2% lignocaine group (Table 3 and Fig. 3) the results was statistically insignificant.

The overall result of the present study can be concluded as, although the mean onset of time, pain (VAS), and FLACC score decreased by 1.31, 12.07, and 18.39%, respectively in 4% articaine compared to 2% lignocaine but the difference did not reach statistical significance ($p > 0.05$), that is, found to be statistically the same.

Discussion

An ideal anesthetic agent should have a short onset period and should last long enough to allow the completion of a determined procedure.[4] In this study, the time of onset was the time interval between completion of administration of the anesthetic agent to no response of the concerned tooth to EPT which was in agreement with studies done by Malamed et al.,[2] and Donaldson et al.[6]

Bjorn stated electricity is the preferred stimulus in dental anesthetic studies, due to its precision of control and measurement, ease of application, ability to adjust to physiological circumstances more than any other stimuli, and repeated use without damage to the pulp tissue. The EPT has been used as an indicator of the effectiveness of local anaesthesia during operative procedures (A˚ gren & Danielsson 1981, Kaufman et al. 1984, Montagnese et al. 1984, Vreeland et al. 1989, Nist et al. 1992, Certosimo & Archer 1996, Costa et al. 2005, Fernandez et al. 2005, Mikesell et al. 2005, Modaresi et al. 2005, Branco et al. 2006, Goodman et al. 2006, Kanaa et al. 2006a,b, Lai et al. 2006, Meechan et al. 2006, Modaresi et al. 2006).[7] This presumption originated from the research of Bjorn, the initial investigator to associate the absence of pain during operative and pulpectomy procedures with the absence of any response to the highest output of a pulp tester. In this study, the use of the pulp tester reading of 80 signaling maximum output was selected as a criterion for the onset of pulpal anesthesia which was similar to the studies of Dreven et al.,[8] Certosimo and Archer.[9] Other authors like Mikesell et al.[10] and Claffey et al.[11] used numbness of the lower lip to determine the onset of the anesthetic effect unlike Kambalimath et al.,[1] Minu et al.[12] who used objective symptoms using gingival probing for determination of time of onset.

Table 2: VAS (score) of two groups

2% lignocaine (n = 50)	*4% articaine (n = 50)*	*Mean difference*	*t-value*	*p-value*
46.72 ± 2.79	41.08 ± 2.85	5.64 ± 3.99	1.41	0.161

The VAS score of the two groups was summarized in mean ± SE and compared by student's *t*-test (*t*-value)

Table 3: FLACC (score) of two groups

2% lignocaine (n = 50)	*4% articaine (n = 50)*	*Mean difference*	*t-value*	*p-value*
1.74 ± 0.26	1.42 ± 0.25	0.32 ± 0.36	0.89	0.376

The FLACC scores of the two groups were summarized in mean ± SE and compared by student's *t*-test (*t*-value)

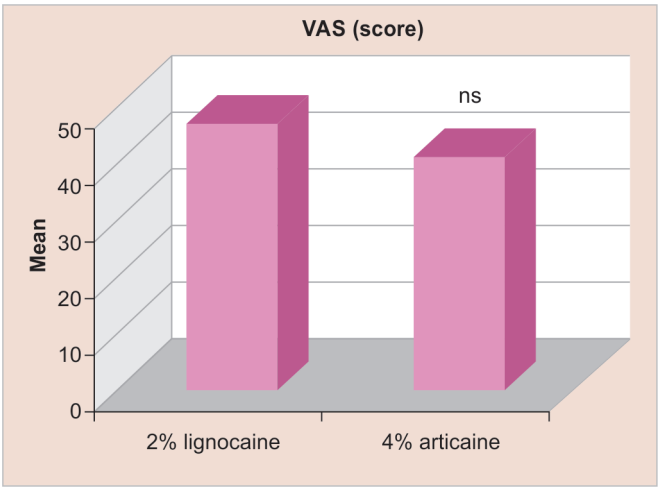

Fig. 2: Comparison of the difference in mean VAS score between two groups; nonsignificance $p > 0.05$ compared to 2% lignocaine

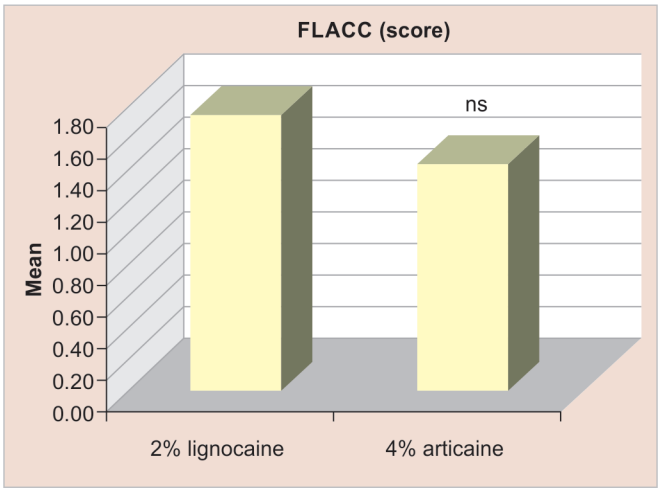

Fig. 3: Comparison of the difference in mean FLACC score between two groups; nonsignificance $p > 0.05$ compared to 2% lignocaine

On analyzing the time of onset of anesthesia of two groups, the values were lowered by 1.31% in 4% articaine compared to 2% lignocaine but the difference was statistically insignificant. Based on the findings, a study involving children was conducted by Arrow for children aged 11–13 years to evaluate the success of 2% lidocaine and 4% articaine and concluded that while the effectiveness of articaine was superior to that of lidocaine (71 vs 64%), the disparity did not reach statistical significance. Minu et al.[12] in their study demonstrated that both lignocaine and articaine groups did not have any statistical significance in terms of the onset of anesthesia. In the contrary to the results of the present study, Tortamano et al.[13] found that the time of onset for articaine was significantly higher compared to lignocaine in IANB injections.

A robust correlation exists between the perception of pain and behavioral issues in the dental context. Effectively assessing children's pain necessitates the evaluation of multiple dimensions of the experienced pain. Given that pain is a highly individual and multidimensional phenomenon, self-reporting typically emerges as the most effective assessment method. In the pediatric population, it is advantageous to employ a composite measure that encompasses both self-reported (subjective) and observational (objective) pain assessments.[14]

Various pain assessment scales have been used in children including the VAS, faces pain scale, Wong–Bakers faces pain scale, Heft–Parker VAS, for the recording of subjective pain while the FLACC scale, behavior-modified pain scale, and sound eye motor scale were used for assessing objective pain during LA administration and dental treatment procedures. In the present study, the VAS, and FLACC scales were used for pain assessment.

The VAS was first introduced in 1921 in the field of psychology to measure the well-being of individuals. Woodforde and Merskey were the first to report the use of the VAS pain scale with descriptive extremes. It is a unidimensional, continuous, single-item scale for measurement of pain intensity which has been widely used in diverse populations.[15] A study by Khatri et al.[16] supports the utility of obtaining child self-reporting of pain and found that VAS was an appropriate tool used for the assessment of pain among children aged 3–14 years. The extensive utilization of this method is attributed to its simplicity and versatility across diverse populations and settings. It has undergone validation, demonstrating sensitivity to fluctuations in a patient's pain experience. Notably, it is rapid, easily comprehensible, and conducive to use with children. Additionally, it circumvents the imprecise use of descriptive language for pain, facilitating a meaningful comparison of measurements over time. Thus in this study, VAS was used for pain perception.[17]

On quantifying the VAS scores of the two groups, a decrease of 12.07% was recorded in the 4% articaine group compared to the 2% lignocaine group but the result was not statistically significant. In accordance with the present study authors like Wright et al.,[18] Oulis et al.,[19] compared 2% lignocaine and 4% articaine for pain perception using the VAS scale and found no significant difference in the scorings while Afsal et al.[20] found the VAS score for 4% articaine was less compared to 2% lignocaine, but not statistically significant. Studies conducted by Mikesell et al.,[10] Kanaa et al.,[21] found results pertaining to VAS score to be against the analysis of the present study as they found the VAS scores to be higher in the 4% articaine group than the 2% lignocaine group although the result was not statistically significant.

The FLACC scale was developed in 1997 at the University of Michigan, Ann Arbor, Michigan, United States of America, as a simple measure of pain behaviors possessing the attributes necessary to facilitate easy assimilation into clinical practice. It can be detected and graded by an observer, is reliable, and valid with children and those with cognitive impairments in an age range of 0–18 years. The FLACC scores correlated better with the children's assessment of pain intensity. The scale has demonstrated robust interrater reliability and validity in assessing pain following surgery, trauma, malignancy, and various other disease processes in infants and children.[22] In this study the operator rated the FLACC scale for assessment of pain perception in children during the dental procedure being performed to evaluate the effectiveness of anesthetic solutions.

In this study, FLACC scores declined for 4% articaine by 18.39% compared to 2% lignocaine although the results were statistically insignificant. In a similar study, Kolli et al.[23] found the mean FLACC score to be higher in the 2% lignocaine group, compared to 4% articaine, but they found a statistically significant difference for the obtained values. In contrast to the finding of the current study, Bahrololoomi and Rezaei[24] found the mean FLACC scores of 4% articaine to be higher than 2% lidocaine although the difference was not statistically significant. The overall result of the present study can be concluded as, although the values of time of onset, VAS, and FLACC score decreased in 4% articaine compared to 2% lignocaine the difference was not able to reach statistical significance ($p > 0.05$). The study conducted by Donaldson et al.,[6] Kambalimath et al.,[1] and Bansal et al.[25] was in accordance with the present study where they concluded that time of onset and pain perception (VAS) was less for 4% articaine group than 2% lidocaine group but not statistically significant. Kolli et al.[23] in their study concluded that the pain rated by the patient and pain rated by operator using FLACC showed lesser scores for 4% articaine than 2% lignocaine which was in favor of the present study. In contradiction to the present study, Jayalakshmi et al.[26] concluded that the time of onset of 4% articaine was higher than that of 2% lignocaine, the pain perception was the same, similarly Bahrololoomi and Rezaei[24] found the mean FLACC scores of 4% articaine to be higher.

Results from the present study found 4% articaine to have a better time of onset and pain perception than 2% lignocaine anesthetic solution. The onset of LA is directly influenced by the corresponding pKa value—a smaller pKa value is associated with shorter latency. Accordingly, in theory, 4% articaine with a pKa value of 7.8 would at least present a shorter latency than 2% lignocaine. Results of the present study coincide with this assumption as the onset of 4% articaine was faster than 2% lignocaine.[27] Another factor is the protein binding capacity of the anesthetic agent where the higher the protein binding level higher the potential of neuroplasm blockage and faster onset.[28] Less pain perception in 4% articaine solution can be attributed to the presence of a thiophene ring in its molecule which increases the lipid solubility of the solution making its tissue penetration easier.[29] Thus 4% articaine is appropriate for clinical use and is comparable to other commercially available LA agents and can be effectively used in children. Also, it showed lesser pain perception scores hence, can provide a pain-free dental experience.

Conclusion

It can be concluded that 4% articaine is appropriate for clinical use is comparable to other commercially available LA agents and can be effectively used in children. Also, it showed lesser pain perception scores hence, can provide a pain-free dental experience. The sample size in this study was small, therefore, to arrive at a definitive conclusion more clinical trials with a larger sample size for evaluation of pain experience and time of onset of 2% lignocaine

and 4% articaine in inferior alveolar nerve block in the pediatric population should be conducted.

Clinical Significance

Local anesthesia (LA) is one of the main methods of pain management in pediatric practice which makes it essential to choose an LA agent with a shorter time of onset of anesthesia and less pain perception which results in better cooperation and a positive experience for the patient.

References

1. Kambalimath DH, Dolas RS, Kambalimath HV, et al. Efficacy of 4% Articaine and 2% Lidocaine: a clinical study. J Maxillofac Oral Surg 2013;12(1):3–10. DOI: 10.1007/s12663-012-0368-4
2. Malamed SF, Gagnon S, Leblanc D. A comparison between articaine HCl and lidocaine HCl in pediatric dental patients. Pediatr Dent 2000;22(4):307–311.
3. Arrow P. A comparison of articaine 4% and lignocaine 2% in block and infiltration analgesia in children. Aust Dent J 2012;57(3):325–333. DOI: 10.1111/j.1834-7819.2012.01699.x
4. Costa CG, Tortamano IP, Rocha RG, et al. Onset and duration periods of articaine and lidocaine on maxillary infiltration. Quintessence Int 2005;36(3):197–201.
5. Srouji R, Ratnapalan S, Schneeweiss S. Pain in children: assessment and non-pharmacological management. Int J Pediatr 2010;2010:474838. DOI: 10.1155/2010/474838
6. Donaldson D, James-Perdok L, Craig BJ, et al. A comparison of Ultracaine DS (articaine HCl) and Citanest forte (prilocaine HCl) in maxillary infiltration and mandibular nerve block. J Can Dent Assoc 1987;53(1):38–42.
7. Lin J, Chandler NP. Electric pulp testing: a review Int Endod J 2008;41(5):365–374. DOI: 10.1111/j.1365-2591.2008.01375.x
8. Dreven L, Reader A, Beck M, et al. An evaluation of the electric pulp tester as a measure of analgesia in human vital teeth. J Endod 1987;13(5):233– 238. DOI: 10.1016/s0099-2399(87)80097-3
9. Certosimo AJ, Archer RD. A clinical evaluation of the electric pulp tester as an indicator of local anesthesia. Oper Dent 1996;21(1):25–30.
10. Mikesell P, Nusstein J, Reader A, et al. A comparison of articaine and lidocaine for inferior alveolar nerve blocks. J Endod 2005;31(4):265–270. DOI: 10.1097/01.don.0000140576.36513.cb
11. Claffey E, Reader A, Nusstein J, et al. Anesthetic efficacy of articaine for inferior alveolar nerve blocks in patients with irreversible pulpitis. J Endod 2004; 30(8):568–571. DOI: 10.1097/01.don.0000125317.21892.8f
12. OV MM, HT RH, Bhat SS, et al. Comparison of the local anaesthetic effect of 4% Articaine and 2% Lidocaine administered using inferior alveolar nerve block technique in primary mandibular molar extractions. J Evolution Med Dent Sci 2021;10(1):13–19. DOI: 10.14260/jemds/2021/3
13. Tortamano IP, Siviero M, Lee S, et al. Onset and duration period of pulpal anesthesia of articaine and lidocaine in inferior alveolar nerve block. Braz Dent J 2013;24(4):371–374. DOI: 10.1590/0103-6440201302072
14. Alzahrani F, Duggal MS, Munyombwe T, et al. Anaesthetic efficacy of 4% articaine and 2% lidocaine for extraction and pulpotomy of mandibular primary molars: an equivalence parallel prospective randomized controlled trial. Int J Paediatr Dent 2018;28(3):335–344. DOI: 10.1111/ipd.12361
15. Hawker GA, Mian S, Kendzerska T, et al. Measures of adult pain: Visual analog scale for pain (VAS pain), numeric rating scale for pain (NRS pain), McGill pain questionnaire (MPQ), short-form McGill pain questionnaire (SF-mpq), chronic pain grade scale (CPGS), short form- 6 bodily pain scale (SF-36 bps), and measure of intermittent and constant osteoarthritis pain (ICOAP). Arthritis Care Res (Hoboken) 2011;63(Suppl 11):S240–S252. DOI: 10.1002/acr.20543
16. Khatri A, Afsal MM, Kalra N, et al. Hemodynamic changes in pediatric dental patients using 2% lignocaine, buffered lignocaine, and 4% articaine in pediatric dental procedures. J Oral Res Rev 2021;13(2):81. DOI: 10.4103/jorr.jorr_19_20
17. Poorni S, Veniashok B, Senthilkumar AD, et al. Anesthetic 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(12):1603–1607. DOI: 10.1016/j.joen.2011.09.009
18. Wright GZ, Weinberger SJ, Marti R, et al. The effectiveness of infiltration anaesthesia in the mandibular primary molar region. Pediatr Dent 1991;13(5):278–283.
19. Oulis CJ, Vadiakas GP, Vasilopoulou A. The effectiveness of mandibular infiltration compared to mandibular block anaesthesia in treating primary molars in children. Pediatr Dent 1996;18(4):301–305.
20. MM A, Khatri A, Kalra N, et al. Pain perception and efficacy of local analgesia using 2% lignocaine, buffered lignocaine, and 4% articaine in pediatric dental procedures. J Dent Anesth Pain Med 2019;19(2):101–109. DOI: 10.17245/jdapm.2019.19.2.101
21. Kanaa MD, Whitworth JM, Corbett IP, et al. Articaine and lidocaine mandibular buccal infiltration anesthesia: a prospective randomized double-blind cross-over study. J Endod 2006;32(4):296–298. DOI: 10.1016/j.joen.2005.09.016
22. Jaskowski SK. The FLACC: a behavioral scale for scoring postoperative pain in young children. AACN Nurs Scan Crit Care 1998;8(1):16.
23. 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. Anesth Essays Res 2017;11(1):160–164. DOI: 10.4103/0259-1162.186589
24. Bahrololoomi Z, Rezaei M. Anesthetic efficacy of single buccal infiltration of 4% articaine compared to routine inferior alveolar nerve block with 2% lidocaine during bilateral extraction of mandibular primary molars: a randomized controlled trial. J Dent Anesth Pain Med 2021;21(1):61–69.
25. Bansal SK, Kaura S, Sangha PK, et al. Comparison of anesthetic efficacy of 4% articaine versus 2% lignocaine. Indian Journal of Dental Sciences 2018;10(2):92.
26. Jayalakshmi PS, Soumithran CS, Kinra PK, et al. Comparative evaluation of local anesthetic action of articaine witth lignocaine. Journal of Current Research. 2017;9(10): 60611–60613.
27. Ghosh A, Basu S, Maity C, et al. Efficacy of 4% articaine with 1: 100,000 adrenaline as an effective alternative for achieving anesthesia during dental extraction. Indian Journal of Dental Sciences 2019;11(4):189.
28. Boonsiriseth K, Chaimanakarn S, Chewpreecha P, et al. 4% lidocaine versus 4% articaine for inferior alveolar nerve block in impacted lower third molar surgery. Journal of dental anesthesia and pain medicine 2017;17(1):29–35.
29. Becker DE, Reed KL. Local anesthetics: review of pharmacological considerations. Anesth Prog 2012;59(2):90-101. DOI: 10.2344/0003-3006-59.2.90