Comparison of the Local Anaesthetic Effect of 4 % Articaine and 2 % Lidocaine Administered Using Inferior Alveolar Nerve Block Technique in Primary Mandibular Molar Extractions

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ABSTRACT

BACKGROUND

Lidocaine, a time-tested drug which is used as the most common local anaesthetic for dental practice worldwide. The use of articaine in dentistry has widely increased in the recent years. Articaine is said to have superior penetration into both soft tissue and bone. Alveolar nerve block is technique sensitive and nerve injury is more when compared to local infiltration technique. We wanted to compare the anaesthetic efficacy of 4 % articaine with 1:100000 epinephrine by buccal and lingual infiltration along with 2 % lidocaine with 1:100,000 epinephrine, in primary mandibular molar extraction.

METHODS

Seventy children of age group 8 - 10 years indicated for primary mandibular molar extractions were distributed into two groups, comprising of 35 children in each group. One group received 4 % articaine with 1:100000 epinephrine via local infiltration and the second group received 2 % lidocaine with 1:100000 epinephrine via Inferior alveolar nerve block. Following administration of local anaesthesia, effectiveness of the local anaesthetic agents was evaluated by assessing the onset and duration of anaesthesia and intraoperative pain scores during extraction. Statistical analysis was carried out using Mann Whitney test and Student t test.

RESULTS

Onset and effectiveness of local anaesthesia are same and there is no statistical difference. Articaine with buccal and lingual infiltration showed shorter duration of action in comparison to lignocaine with inferior alveolar nerve block.

CONCLUSION

Articaine for buccal and lingual infiltration when compared with lignocaine administered as inferior alveolar nerve block has no difference in the onset and effectiveness. Articaine also has shorter duration of action. So, it can be considered as an alternative to Inferior Alveolar Nerve Block in paediatric dentistry. Post extraction complications like lip and tongue bite can be avoided in children.

KEY WORDS

Articaine, Lidocaine, Buccal and Lingual Infiltration, Inferior Alveolar Nerve Block, Primary Mandibular Molar Extractions

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BACKGROUND

Pain management is an important aspect of dentistry, especially in paediatric dentistry.[1] Local anaesthesia is one of the strategies for pain management. Lignocaine is considered as the "gold standard" anaesthetic agent. It has a rapid onset of action, ability to produce profound anaesthesia, has intermediate duration of action and greater potency.

Lidocaine was produced by Lofgren in 1943, which is considered as the first modern local anaesthetic agent. Lidocaine was available in the market since 1948. Even though other amide local anaesthetics found application for clinical purposes which include mepivacaine (1957), prilocaine (1960) and bupivacaine (1963) lignocaine is the most widely accepted local anaesthetic in dentistry worldwide. Articaine chemically known as 4-Methyl-3-[[1-oxo-2-(propylamino) propyl] amino]-2-thiophenecarboxylic acid methyl ester is another anaesthetic agent from the amide family with a half-life of 20 min. It is more soluble in lipids, compared to lidocaine, due to the presence of a thiophene ring in its chemical structure. Additionally, articaine has strong affinity for proteins, making its penetration possible through the bone. Plasma cholinesterase hydrolyses articaine and excretion takes place mainly in the kidneys.[2]

Articaine was marketed in dentistry in 1977 which was originally synthesized as carticaine.[2] Carticaine was synthesised by Rusching et al. in 1969 with a molecular weight of 320.84. Since then extensive investigations are being carried out to study the properties of articaine.[3] Clinical trials with different study designs have compared articaine mainly with lidocaine. The controversies in literature pertaining to articaine's alleged neurotoxicity are paraesthesia and prolonged numbness after dental procedures. There is no conclusive evidence in literature regarding the neurotoxicity of articaine.[4]

Local anaesthetic failure is evident in about 10 % of inferior alveolar nerve block administration and 7 % of local anaesthesia cases in total.[5] The failure of anaesthesia may be due to many factors including technical errors or anatomic or pathologic variations. Anaesthetic failure can be assumed if symptoms of anaesthesia cannot be identified over a period of 10 - 15 minutes after administering the local anaesthetic agent.[6]

The inferior alveolar nerve block has been reported as having the highest level of patient discomfort compared with other injection techniques.[7] However, apart from the more difficult nature of this injection technique compared to the infiltration technique, it is associated with some complications, the most common of which is injury to the venous plexus and formation of haematoma.[8] Some other complications of the inferior alveolar nerve block technique include trauma due to mastication, infection, trauma to sensory and motor nerves, trismus and in rare cases fracture of the needle in tissues.[8-10] The child's behaviour in the dental operatory can be influenced by his experience during treatment which can have an effect on further visits.[11] Thus a less traumatic means of local anaesthesia in the mandibular posterior region among children would be a useful adjunct in the treatment of these teeth.

Malamed et al described that the use of 4 % articaine by infiltration technique has certain advantages over inferior nerve block injection.[12] The benefits of infiltration include; it is not technique sensitive, is more comfortable for patients, haemostasis can be achieved when needed, obviates collateral innervations, and the risk of damage to nerve trunks can be avoided.[13] In addition, patients with clotting disorders can be given infiltration so that unwanted internal bleeding can be avoided. As buccal infiltration with articaine has shorter duration of action, it is not recommended for long procedures. Also, a supplemental injection will be required for lingual anaesthesia during certain procedures like extraction where lingual soft tissues have to be manipulated.[14]

In paedodontic practice, local anaesthesia is required in most of the dental procedures like extractions and pulp therapies. The child will become fearful from the sight of the needle to the thoughts of pain associated with the insertion of needle which further increases the child's anxiety. [1] The present study was undertaken to compare the effectiveness of local anaesthesia achieved using infiltration of 4 % articaine along with 1:100000 epinephrine with that achieved by the application of inferior alveolar nerve block with 2 % lignocaine with 1:100,000 concentration of epinephrine in deciduous mandibular molars indicated for extraction. Considering the difficulty and possible complications of inferior alveolar nerve block, the use of infiltration anaesthesia with articaine can be considered as an alternative to the nerve block technique especially in children.

Objectives

1. To evaluate the effectiveness of 4 % articaine by local infiltration when compared to 2 % lidocaine by inferior alveolar nerve block techniques in primary mandibular molar extractions.
2. To compare the onset of anaesthesia, intra operative pain and duration of anaesthesia of 4 % articaine with 1:100,000 epinephrine and 2 % lidocaine with 1:100,000 epinephrine.

METHODS

This in vivo prospective study was conducted in the Department of Paedodontics and Preventive Dentistry, after due approval from the Institutional review board, Yenepoya Dental College, Yenepoya University, Mangalore, India and Yenepoya University Ethics Committee, Yenepoya University, Mangalore, India.

Inclusion Criteria

1. Grossly decayed primary mandibular molars indicated for extraction with not less than half of the root length present.
2. Children falling in the Frankl behaviour rating scale of 3 and 4.

Exclusion Criteria

1. Allergies to local anaesthetics or sulphites.
2. History of significant medical conditions.
3. Under any medications.
4. Presence of abscess, sinus opening.

In this study healthy 70 male and female children aged 8 to 10 years, who were candidates for extraction of primary mandibular molars and fulfilling the inclusion criteria were selected. Intra oral periapical radiograph of the tooth to be extracted was made to rule out any periapical pathology. Informed consent was obtained from their parents and the procedure was explained to them both verbally and in written form.

Materials

1. Topical anaesthetic: Precaine-B [20 % Benzocaine]
2. 4 % articaine cartridges with 1:100000 epinephrine [SEPTANEST®-Articaine HCl. 4 % with Epinephrine 1:100,000 Injection made by Septodont, France.]
3. 2 % lidocaine cartridges with 1:100000 epinephrine [LIGNOSPAN®-Lignocaine HCL 2 % with Epinephrine 1:100000 Injection made by Septodont, France.]

70 subjects were randomly allocated to either group A (n = 35) who received 1.5 ml of 2 % lignocaine with 1:100000 epinephrine via inferior alveolar nerve block or group B (n = 35) who received 1.5 ml of 4 % articaine with 1:10000 epinephrine via buccal and lingual infiltration. The effectiveness of 2 % lignocaine and 4 % articaine were assessed based on the following criteria.

Criteria for Assessment

1. *Onset of Anaesthesia* - The child was seated comfortably on the dental chair, followed by the application of topical anaesthetic (Precaine B 20 % Benzocaine) using a cotton swab over the injection site one minute before the injection. In group A 1.5 ml of 2 % lignocaine solution was administered using inferior alveolar nerve block technique. In group B 1.5 ml of 4 % articaine solution after withdrawing the solution into a 26-gauge disposable syringe was administered using buccal and lingual infiltration. Beginning of anaesthetic effect was measured in seconds after administering the anaesthetic. This was based on gingival probing (objective sign). Probing was done on the gingiva around the tooth to be extracted using a blunt ended William's periodontal probe. Initially probing was carried out at 30 seconds after injection and checked every 15 seconds thereafter using a stopwatch until the patient reported complete absence of pain. The patient was asked for subjective symptoms like numbness of tongue, numbness of lower lip and buccal mucosa at the corresponding site of injection.

2. *Pain Perception* - Using Visual Analog Scale (VAS) pain perception was judged subjectively by the patient. The 10 cm VAS scale ranged from "no pain" (smiley face = 0) to "Unbearable pain" (frowning face = 10). The child was instructed to point at the face as per his / her experience during extraction. Subsequently pain score was recorded corresponding to the smiley selection by the patient.

3. *Duration of Anaesthesia* - Duration of anaesthesia was recorded as the time period lapsed from the onset of anaesthesia to the time at which the anaesthetic effect started to wear off. The patient was asked to report the time of initiation of loss of numbness or experience of initial pain following the procedure through a telephonic conversation. The patient was instructed not to take the prescribed analgesic until the initiation of pain and informing the investigator.

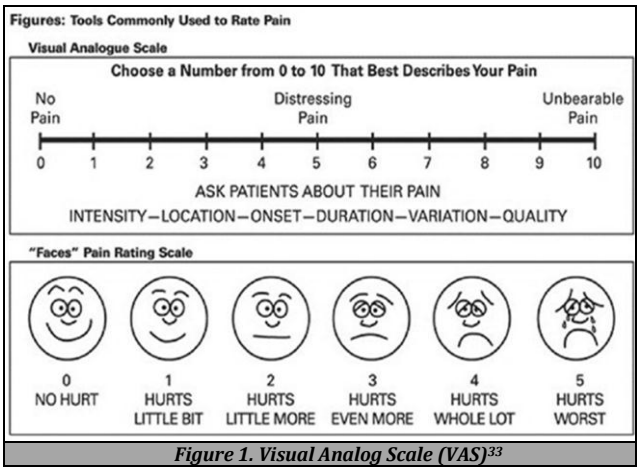

Figure 1. Visual Analog Scale (VAS)[33]

Statistical Analysis

Data analysis was done using Statistical Package for the Social Sciences software version 22. Statistical test carried out was Student t test and Mann-Whitney U test.

RESULTS

After collecting data, the following parameters were evaluated-

- Onset of action
- Intraoperative pain
- Duration of action

Onset of Action

According to Student t test the mean onset value of group A was 183 seconds and that for group B was 172 seconds. There was no significant difference between the groups. (p = 0)

Local Anaesthetic	N	Mean	Standard Deviation	95 % Confidence Interval for Mean		t Test P Value
				Lower Bound	Upper Bound	
4 % Articaine	35	183.00	20.84	175.84	195.16	.000
2 % Lidocaine	35	172.00	20.84	164.84	179.16	

Table 1. Time of Onset in Articane Group and Lidocaine Group

Intra Operative Pain

For intra operative pain the mean VAS score was 0.77 (SD = 0.73) in both group A and group B. There was no significant difference between the groups (p = 1).

Duration of Anaesthesia

The mean value for duration of anaesthesia of group A was 91.37 minutes (SD = 22.87) and group B was 124.63 minutes (SD = 26.99). Group A had a shorter duration of action. This difference was statistically significant (p = 0).

Local Anaesthetic	N	Mean	Standard Deviation	95 % Confidence Interval for Mean		t Test P Value
				Lower Bound	Upper Bound	
4 % Articaine	35	91.37	22.87	83.52	99.23	.000
2 % Lidocaine	35	144.63	29.99	134.33	154.93	

Table 2. Duration of Anaesthesia in Articaine Group and Lidocaine Group

DISCUSSION

Asymptomatic primary tooth is considered as the best natural space maintainer. Extraction of a primary tooth is considered as the last treatment option when other treatment modalities fail to preserve the tooth until its natural exfoliation or shedding. In such cases wherein there is a non-restorable crown structure or inadequate root length mostly extractions are recommended followed by rehabilitation with a space maintainer. Extractions are the most frequently performed oral surgical procedure mostly in adults and less frequently in children which mandates complete pain control in order to gain patient's cooperation and to manage patient's anxiety.

Pain control during any operative or surgical procedure is one of the most important factors which determines the success of a treatment. There are various methods used to control pain among which use of local anaesthetic agents is the most commonly employed technique in dental practice.[15] The administration of local anaesthesia in paediatric dentistry always focuses on alleviating pain by means of behavioural, technical and pharmacologic strategies. Thus the control of pain eradicates unwanted behaviour in the dental operatory by alleviating pain and discomfort.

Local Anaesthetics (LA) are those agents which upon topical application or local administration cause reversible loss of sensory perception, especially of pain, in a circumscribed region of the body.[16]

Ideal Requirements for Local Anaesthetics to Work Efficiently

- Should have high intrinsic activity, which can produce complete anaesthesia.
- Faster onset.
- Duration of anaesthesia (30 to 60 min for standard dental treatment) should be adequate.
- Systemic toxicity at a minimal level.
- Efficacy-toxicity ratio should be high.
- Serious adverse effects incidence should be low.[17]

Lidocaine hydrochloride has maintained its status as the most widely used local anaesthetic as it meets many of the requirements of an ideal local anaesthetic to a great extent. The scientific evidence has proved the efficacy, low allergic potential, and reduced toxicity have confirmed the importance and safety of this local anaesthetic. Thus, it became labelled as the gold standard to which all newer agents are compared. Despite lidocaine being the benchmark, numerous reports have advocated the use of articaine hydrochloride as a superior anaesthetic agent, primarily based on its enhanced anaesthetic potency, which is 150 % higher than that of lidocaine, along with other advantages.[18]

Articaine, which is chemically 4-methyl-3 (2-[propylamino] propionamido) 2-thiophene carboxylic acid, is the only amide local anaesthetic which has a thiophene ring and an additional ester ring. Lipid solubility which is an intrinsic quality of local anaesthetic potency permits better penetration of the anaesthetic through the nerve membrane and surrounding tissues. The duration of anaesthesia was described in terms of binding of anaesthetic molecules to the nerve membrane. The stronger the bond, the slower the rate of anaesthetic release from its corresponding receptor sites, thus the duration of action will be enhanced.[18]

Even though many studies have shown that articaine is equally effective both in nerve block and infiltration, the present study compared the effectiveness of articaine through infiltration in the mandibular region during extraction of deciduous molars. Infiltration technique is more preferable because of various factors like lesser depth of penetration of needle, minimal technical errors, easier application and shorter duration of action.[19] Possible variations in anatomical landmarks during the administration of nerve block can also be avoided.

In a study, Arali et al.[20] suggested that the buccal infiltration of articaine can be an alternative for the inferior alveolar nerve block technique with lidocaine in the treatment of mandibular deciduous molars with irreversible pulpitis. However, apart from buccal infiltration an additional lingual infiltration was required for anaesthetizing the lingual mucosa during extraction.

Monteiro et al[21] evaluated 50 adult patients with irreversible pulpitis of mandibular first molars in a double-blind clinical trial. Evaluation of patients' pain with an electric pulp tester showed that the success rate of articaine was significantly higher than that of lidocaine. In another study, Hosseini et al[22] evaluated the effectiveness 2 % Lidocaine containing 1:80000 of epinephrine and 4 % articaine containing 1:100000 concentration of epinephrine. The success rates of the anaesthetic techniques were evaluated with cold test and visual analogue scale. Despite the higher success rate of anaesthesia in the articaine group (66.6 %) compared to that in the lidocaine group (56.5 %), the difference was not statistically significant.

Katyal et al.[23] carried out a meta-analysis and reported that the success of the anaesthetic technique with articaine in adults and in children over 4 years of age was higher than that of lidocaine. Also, they concluded that articaine had higher post-injection pain compared to lidocaine, but pain scores were negligible clinically which was in agreement with the current study. Tortamano et al.[24] showed that the initiation of anaesthesia and its duration in the inferior alveolar nerve block with 4 % articaine containing 1:100000 concentration of epinephrine was higher than that of 2 % lidocaine containing 1:100000 epinephrine.

Arrow et al.[25] carried out a study on 57 adolescent 11 - 13 years of age to evaluate the success of lidocaine with 1:80000 concentration of epinephrine and 4 % articaine in the buccal infiltration technique for restorative procedures of posterior mandibular teeth. Although the success rate of articaine was higher than that of lidocaine (71 % vs. 64 %), the difference was not statistically significant.

Bartlett et al[26] carried out a review on the success of inferior alveolar nerve block anaesthetic technique with 2 % lidocaine compared to the buccal infiltration of 4 % articaine and reported that the success rates of lidocaine and articaine

were 55.6 - 69.2 % and 65.4 - 70.4 %, respectively, concluding that the success of infiltration of articaine was almost similar to that of inferior alveolar nerve block technique with lidocaine.

Kandasamy et al.[27] and Leith et al.[28] in their studies concluded that 4 % articaine has faster onset when compared to 2 % lidoacine using either local infiltration or neve block techniques. But the present study demonstrated that both groups did not have any statistical significance in terms of onset of anaesthesia. This may be because of the fact that in this study we compared two different local anaesthetic solutions using different techniques of administration.

The pain scores obtained from the visual analogue scale showed that it was clinically and statistically not significant. This was in accordance with the findings of Wright et al.[29] and Oulis et al.[30]

Many comparative studies between articaine and lidocaine have shown that articaine has longer duration of action when compared to lidocaine. In the present study 2 % lidocaine demonstrated longer duration of action when compared to 4 % articaine. This may be due to the fact that one group received 4 % articaine using buccal and lingual infiltration whereas the other group received 2 % lidocaine using inferior alveolar nerve block technique.

Hillerup et al.[31] stated that there is a distinct neurotoxicity of 4 % articane. However, Malet et al.[32] even showed in vitro that articaine is less toxic than lidocaine when incubated with human neuroblastoma cells.

Allergic reactions were not reported in any of the participants both in articaine and lidocaine groups. However, any local anaesthetic with epinephrine is contraindicated in patients with known sulfite sensitivity (such as some asthmatics with allergic-type asthma). Use in children under 4 years of age is not recommended, since no data exist to support such usage.[12]

The observations from the study recommends the use of 4 % articaine with buccal and lingual infiltration as an alternative to 2 % lidocaine with inferior alveolar nerve block in primary mandibular molar extractions.

Limitations of the Study

This research can be conducted on a larger scale by including a wider age group and an increased sample size. Moreover, as pain threshold varies in an individual; in addition to the measurement of pain other parameters could have been included for the study.

CONCLUSIONS

Within the limits of this study, it can be concluded that articaine with buccal and lingual infiltration in comparison with lidocaine by inferior alveolar nerve block is equally effective in terms of onset and reduced intraoperative and postoperative pain. Articaine also has shorter duration of action which was statistically significant. Considering the difficulty in administering inferior alveolar nerve block, nerve injury and post extraction complications like lip and tongue biting, articaine with buccal and lingual infiltration can be used as an alternative to inferior alveolar nerve block for extractions in paediatric patients.

Data sharing statement provided by the authors is available with the full text of this article at jemds.com.
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