Comparative Evaluation of Efficacy of 2% Lidocaine and 4% Articaine in Paediatric Patients during Needle Insertion by Conventional and Alternative Technique of Local Anesthesia

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Abstract:
Background: Local anesthesia is an essential part of many dental procedures, particularly in pediatric patients who may be fearful or anxious during treatment. Two of the most commonly used local anesthetics are 2% lidocaine and 4% articaine, but there is ongoing debate about which one is more effective. Additionally, the technique used for administering local anesthesia can also impact pain perception during needle insertion. This topic aims to compare the efficacy of 2% lidocaine and 4% articaine, as well as to evaluate the pain perception of pediatric patients during needle insertion using both conventional and alternative techniques of local anesthesia.

Methodology: A total of 180 pediatric patients were included in the study, and they were randomly assigned to receive either 2% lidocaine or 4% articaine using either conventional or alternative techniques. The study included pediatric patients aged 4-12 years, who required dental treatment involving local anesthesia assigned to the following groups:

- Group 1: 2% lidocaine with conventional technique of local anesthesia;
- Group 2: 2% lidocaine with alternative technique of local anesthesia;
- Group 3: 4% articaine with conventional technique of local anesthesia;
- Group 4: 4% articaine with alternative technique of local anesthesia.

Outcome assessed were onset and duration of anesthesia.

Results: The results showed that the use of 4% articaine was more effective in increasing the duration of anesthesia and a faster onset than 2% lidocaine, regardless of the technique used. Additionally, the alternative technique was found to be less painful than the conventional technique.

Conclusion: This study provides important insights into the use of local anesthesia in pediatric patients and highlights the potential benefits of using 4% articaine and alternative techniques for reducing pain and discomfort during needle insertion.

Keywords: Efficacy, Lidocaine, Articaine, Pain perception, Pediatric patients, Needle
INTRODUCTION

Pain and apprehension are obnoxious feelings and arousing experiences, which are strongly associated with traumas to tissues.[1] Increasing pain and nervousness during Dental treatment is a prime concern for pediatric Dentist. It is universally agreed that Dental treatment is most fear causing procedure especially in children [2].

The purpose of the local anaesthesia is to ease discomfort and agony. The task of administering local anaesthetic to children in paediatric dentistry causes the most concern; nevertheless, pain and anxiety might reduce the effectiveness of anaesthesia in young patients [3]. This apprehension of anesthesia is often commenced as a behavior management problem, due to that a few pediatric patients shows panic-stricken behavior and poor handling skills in anticipation of uneasiness [4].

Technology is an effective tool that paediatric dentists can use to lessen any pain or discomfort that may arise during the application of local anaesthesia. All patients experience pain and suffering even after receiving tropical anesthesia [4]. Some topical anesthetics function well, while others are ineffective but the literature reports their effectiveness without consistent results. The factors include; human variations, dissimilarity in the topical anesthesia procedures and concentrations [5] and time duration during Local anesthetic application may allow the child to become more frightened. There are reported literature that LA can produce systemic toxicity on prolonged use [6]. Therefore, the need exist to develop a better topical system or needle insertion techniques to reduce pain and discomfort in pediatric dental patients. The proper use of LA has been studied broadly in literature[7].

In 1976, a brand-new amide local anaesthetic called articaine HCl was developed. It has certain additional benefits in addition to clinical actions that are similar to those of lidocaine. This is the sole amide LA containing a thiophene ring, and articaine appears to be an ester-bonded amide LA that is extensively used. Because of this, articaine can be found in the liver and plasma (where it is hydrolyzed by plasma esterase) (hepaticmicrosomal enzymes) [8]. Although it also appears to be an amide LA with a regularly used ester bond, articaine is a methyl ester hydrochloride. This is the only amide LA with a
thiophene ring, and it is intended to be a widely used ester-bonded amide LA. As soon as amide LAs enter the bloodstream, they continue to circulate and are active until they reach the liver, when hepatic microsomal enzymes break them down. Unlike other amide LAs, which only undergo liver-based biotransformation, articaine undergoes biotransformation in both the liver and the plasma. Use of alternate technique can reduce the discomfort of children and allow the clinician to administer LA. Lee and Lee in their study compared the alternate technique to conventional technique of infiltration and found considerable disparity on the subject of the pain response between the substitute inclusion which was less painful as compared to the conventional.

No study up till now has been accomplished to evaluate the responses in children and the time period of anesthesia in them during administration of local anesthesia in a form of 4% articaine (1: 200 000 epinephrine) and 2% lidocaine (1 : 100 000 epinephrine) via conventional and alternative technique. Hence the present study was conducted to explore the research question, “Is there a distinction in efficacy and pain perception between “Conventional technique” and “Alternative technique” with Lidocaine and articaine as anesthetic agents?”

MATERIALS AND METHODS

The present study was conducted in the Department of Pedodontics and Preventive Dentistry, Peoples College of Dental Sciences and Research Centre, Bhopal. A randomized controlled, parallel design experiment was carried out among children of aged 4 to 12 years undergoing dental procedures requiring local anesthesia. Ethical approval was obtained from Institutional Ethical Committee of Maharaj Vinayak Global University, Jaipur. Children between 4 to 12 years, of both genders requiring dental treatment to be performed under local anesthesia formed the study subjects. A power analysis was performed with a difference of 20% to consider the smallest effect of clinical relevance to differentiate between the 2 major groups for efficiency and pain. The study yielded a power of 86% to yield statistically significant results. An attrition rate of 20% was established and inclusion of 180 children was planned.

Inclusion criteria:

1) Males and females, of 4 to 10 years old. The lower limit of the selected age group reflects the articaine’s manufacturer recommendation of minimum patient’s age of four years at LA agent administration. The upper limit of the age group was
determined in consideration to the required restorative care of mandibular molars.

2) In accordance to the widely recognized health status classification of the American Society of Anesthesiology (ASA), the participants were categorized as ASA I (healthy) or ASA II (mild, well-controlled systemic illness) for inclusion in this trial.

3) Subjects were chosen from those planned for restorative dental procedure of their deciduous lower molars requiring use of local anesthetic.

4) Children were chosen from those known to be co-operative for the required dental intervention and not in need of any advanced behavior management modalities, for instance inhalation (Nitrous Oxide and Oxygen) or oral sedation.

**Exclusion Criteria:**

1) Patients that required treatment on teeth other than primary molars.

2) Patients that required non-restorative dental procedures such as extraction or extensive pulp therapy (pulpectomy).

3) Child dental patients that were uncooperative for dental care (Frankl 1 and 2) or those that may have required advanced behavior management 19 modalities such as inhalation or oral sedation. This exclusion criteria were selected to prevent analgesic or sedative agents from distorting the subject’s perception of the procedure.

Each patient was assigned randomly to the two treatment groups i.e. conventional and alternative group.

**Study groups:** The patients were further alienated into two groups on the source of the Anaesthetics agent used i.e. 2% Lignocaine - 2 % lidocaine cartridges with 1:100000 epinephrine

4% Articaine - 4 % articaine cartridges with 1:100000 epinephrine

**Group A:** Conventional group (n = 90): further divided into two group (n= 45) each: i) 2% Lignocaine (A1) and ii) 4% Artcaine (A2)

**Group B:** Alternative technique fir 90): (n = 90): further divided into two group (n= 45) each: i) 2% lignocaine (B1) and 4% artcaine (B2)

**Data Collection:**

Children between the ages of 4 and 12 who underwent dental operations needing local anaesthesia were included in the study. Two groups of patients were randomly separated. On the basis of the type of anaesthesia employed, the patients in each group were further split into two groups. The traditional method involved
buccal penetration and an inferior alveolar block, where the mucosa was dried with cotton at the injection site. About 30 seconds prior to insertion, a topical anaesthetic gel (15 percent Lidocaine topical aerosol USP) was administered to the injection site. To gently release the medicine, the mucosa was stretched, and the needle tip was carefully placed at the injection site. For the alternative treatment, the anesthetic was quickly and gently pulsated or pushed into the free tissue at the inoculation site that had been cleaned and dried over the needle’s tip to a depth of 1 to 1.5 mm. A few drops of the solution were released as the needle tip pierced the tissue, and then it was pushed forward to the proper depth to continue releasing anaesthesia. Before the introduction of this procedure, topical anaesthetic gel was not permitted. The maximum advised dose was maintained at 5 mg/kg.

Outcomes assessed: Effectiveness of local anesthesia in term of onset and duration of anesthesia, Pain perception and Physiological parameters

Data analysis: SPSS 25.0 Version was employed for statistical analysis. One way ANOVA was used for judgment of difference between mean values of 2 groups.

RESULTS

The study assessed and compared the efficacy of commonly used anesthetics among pediatric patients in 2 different techniques. 21,19,18 and 22 procedures were of extraction in A1, A2, B1 and B2 group respectively. On comparison between groups for Onset of anaesthesia, the least time taken for anaesthetic effect to set in was for B2 followed by B1, A2 and A1 respectively, which was highly significant at p<0.001. It can seen that alternative technique using articaine demonstrated greater efficacy among paediatric patients requiring dental treatment with anaesthesia. (Table1)

B2 group had the longest duration of anesthesia (Table 2) Conventional technique with articaine began anaesthetic effect in 178.60 ± 7.405 seconds as compared to lignocaine with 182.200 ± 8.0667 seconds , which was significant at p = 0.006. Alternative technique with articaine began anaesthetic effect in 177.022 ± 5.658 seconds as compared to lignocaine with 175.756 ± 6.335 seconds, which was not significant at p = 0.320. Between same anaesthetic agents, alternative technique showed better result for articaine than lignocaine at p<0.001. Lignocaine in the alternative technique performed better than conventional technique, 171.244 versus 165.466 which was significant at p=0.004.
Table 1: Comparison between groups for onset of anaesthesia

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean ± S.D (in seconds)</th>
<th>95% Confidence Interval of mean</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower bound</td>
<td>Upper bound</td>
</tr>
<tr>
<td>A1</td>
<td>183.200 ± 8.066</td>
<td>180.7765</td>
<td>185.6235</td>
</tr>
<tr>
<td>A2</td>
<td>178.600 ± 7.405</td>
<td>176.3752</td>
<td>180.8248</td>
</tr>
<tr>
<td>B1</td>
<td>177.022 ± 5.658</td>
<td>175.3221</td>
<td>178.7223</td>
</tr>
<tr>
<td>B2</td>
<td>175.755 ± 6.335</td>
<td>173.8520</td>
<td>177.6591</td>
</tr>
</tbody>
</table>

ANOVA test = 9.912; df = 3; p<0.001 ** (Highly significant)

Table 2: Comparison between groups for duration of anaesthesia

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean ± S.D (in minutes)</th>
<th>95% Confidence Interval of mean</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower bound</td>
<td>Upper bound</td>
</tr>
<tr>
<td>A1</td>
<td>165.4667 ± 10.3870</td>
<td>144.00</td>
<td>175.00</td>
</tr>
<tr>
<td>A2</td>
<td>189.3556 ± 5.2921</td>
<td>180.00</td>
<td>196.00</td>
</tr>
<tr>
<td>B1</td>
<td>171.2444 ± 8.1048</td>
<td>156.00</td>
<td>179.00</td>
</tr>
<tr>
<td>B2</td>
<td>223.7111 ± 9.3289</td>
<td>212.00</td>
<td>237.00</td>
</tr>
</tbody>
</table>

ANOVA test = 429.164; df = 3; p<0.001 ** (Highly significant)

DISCUSSION

The study was done to compare the efficacy of 2% lidocaine & 4% Articaine in relieving pain perception of pediatric patients by conventional and Alternative technique of LA.

The best natural placeholder is an asymptomatic baby tooth. When various
treatment options cannot keep a baby tooth alive until its natural exfoliation or fall out, extraction is considered a last resort. In the case of unrecoverable crown build-up or insufficient root length, tooth removal is usually indicated. Tooth removal are the most common oral surgical treatment, and they require extensive pain management to elicit patient involvement and manage anxiety.

One of the most critical aspects that affects the effectiveness of any operational or surgical procedure is pain management. There are several strategies for controlling pain, the most prevalent of which is the use of LA drugs in dental treatment. In paediatric dentistry, LA is usually administered with the goal of reducing discomfort by behavioural, technical, and pharmaceutical measures. As a result, pain control in the dental operatory eliminates undesirable behaviour by relieving pain and suffering [9].

Lidocaine complex has preserved its position because the most extensively used anesthetic as a result of it fits many of the factors for a superb anesthetic. The relevancy and safety of this anesthetic are valid by scientific knowledge demonstrating its effectiveness, marginal allergic potential, and low toxicity. As a result, it absolutely was dubbed the “gold standard” against that all newer agents area unit measured [10]. Articaine is not a brand-new medication. In earlier, largely German literature, articaine was known as articaine, carticaine, or HOE 40 045. Because it possesses a thiophene moiety instead of the normal benzene group, Articaine is unique among existing amide LA. Unlike other amide LA, articaine undergoes biotransformation in the liver and plasma, allowing it to be removed from the body more quickly.

Despite also appearing to be an amide LA with an ester bond that is widely used, articaine is a methyl ester hydrochloride. This is the only ester-bonded amide LA that has a thiophene ring, and it will be widely used. When amide LAs enter the bloodstream, they stay active and travel throughout the body until they reach the liver, where hepatic microsomal enzymes break them down. Unlike other amide LAs, which are only biotransformed in the liver, articaine is biotransformed in both the liver and the plasma.

Articaine is known for having a stronger local anaesthetic effect. When statistically compared to other LA, the existing data suggests that articaine is similarly, if not more, effective. The findings of the current study agreed with those of Monteiro et al [11] and Leith et al. [12] who found that discomfort after syringe insertion was
less in the alternative approach than in the normal Local Anesthetic technique. The results of this study differed from those of Arrow et al. [13] who found that analgesic efficacy for buccal infiltration with articaine was 71% and lidocaine was 64%.

When Ram and Amir tested articaine 4 % with 1:200,000 epinephrine and lidocaine 2 % with 1:100,000 epinephrine, they discovered that articaine was more effective with a longer lasting numbing effect. [14] Articaine, according to Leith et al. (12) is an effective and safe substitute to lidocaine for usage in children. In compared to traditional approaches, alternative techniques were considerably superior in reducing pain (FLACC score= 0.26), according to the findings of this study. Both groups had statistically significant results. (Groups Lignocaine and Articaine).

Potocnik et al. directly observed 4 % articaine inhibited nerve transmission better than 2 % lidocaine in a rat somatic sensory conduction investigation. According to Brandt et al., articaine were 3.81 times higher probable anesthetic effect when administered through infiltration [15]. Results reported inception & extent of anesthesia. There alternative approach had the longest anesthetics effect, with 4 % articaine lasting 223.711 minutes, followed by articaine in the traditional technique, and then lignocaine in the alternative and conventional techniques, with p<0.001 significance. When it came to the onset of anesthesia, there were substantial disparities between articaine and lidocaine.

When compared to lidocaine, articaine lasted substantially longer and had a quicker onset. LA drugs’ duration of action may be predominantly determined by their amount of binding affinity and the higher the protein binding of a certain drug, the longer the sodium channel is blocked and the longer the duration of unconsciousness. Lidocaine and articaine have recorded protein-binding values of 65 and 95 %, respectively. Even though the anesthetic solution was been various concentrations: articaine 4 % and lidocaine 2 %, no difference could be seen. Authors also noted that the alternative method can lessen the perception of pain and comfort in paediatric patients when comparing the alternative and traditional infiltration strategies. The alternative method would involve the dentist pulling or pushing the free, dry, and clean tissues just above the injection site over the needle’s tip. An element of operator bias cannot be ruled out as the examinations and procedures were done by a single investigator. But this error was addressed by continuous calibration of the examiner through out the study. The study results
Efficacy of 2% Lidocaine ….

may not be generalizable to the wider population due to the specific population of pediatric patients included in the study or the specific technique of anesthesia used. But as the we ensured that the study’s inclusion criteria were clearly defined, this limitation could be overlooked.

CONCLUSION

The efficiency of alternative technique in relieving pain among the pediatric patients was significantly greater in comparison to the Conventional Technique. Onset of anesthesia was faster with 4% articaine delivered through alternative technique along with duration of anesthetic procedure. The significantly better performance of the alternative technique in relieving pain among the pediatric patients were seen in both 2% Lignocaine and 4% articaine.

REFERENCES


