Comparative Evaluation of the Efficacy of 4% Articaine and 2% Lignocaine During Orthodontic Extraction: A Randomized, Double-Blind Study

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ABSTRACT

Background: Local anaesthetics block the peripheral nerves and are used to prevent pain, during surgical and dental procedures. The primary object of this investigation was to compare and evaluate the efficacy of 4% Articaine hydrochloride with 1:100000 adrenaline and 2% Lignocaine hydrochloride with 1:80000 adrenaline during orthodontic extraction of maxillary first premolar.

Methods: This prospective randomized, double-blind study was conducted from February 2013 to September 2014 on 43 patients less than 40 years of age requiring bilateral maxillary first premolar extractions for orthodontic purposes. Each patient was randomly assigned to receive either 2% lignocaine hydrochloride or 4% articaine hydrochloride for premolar extraction of one side and another solution was administered for the premolar extraction of contralateral side spaced 1 to 3 weeks apart. In each patient, the difference in the pain levels, onset of anesthesia and duration of anesthesia was assessed on the administration of lignocaine hydrochloride and articaine hydrochloride.

Results: There was statistically no significant difference in pain levels between orthodontic extraction of maxillary first premolar between the Articaine and Lignocaine groups. (p>0.05). The Articaine group had an earlier onset of anaesthesia after buccal infiltration and palatal infiltration as compared to the lignocaine group. The mean duration of anaesthesia was longer in the articaine group as compared to the highly significant lignocaine group.

Conclusions: Articaine can be used as a suitable alternative to lignocaine in the extraction of maxillary premolars for orthodontic reasons with clinical advantages like faster time of onset, longer duration, and greater diffusing property over lignocaine.

Key Words: Local anaesthetic, Lignocaine hydrochloride, Articaine hydrochloride, Orthodontic Extraction, Prospective study, Double-blind study

INTRODUCTION

Ever since the introduction of synthetic local anesthetic agents in surgical practice, clinically adequate pain control with minimum side effects has been the goal and desirable prerequisite for painless procedures.1 The ability to provide safe, effective local anesthetic is the cornerstone of successful clinical and surgical practice. Local anesthetics form the backbone of pain control techniques in dentistry.2

The history of local anaesthesia dates back to 1859 when cocaine was isolated by Niemann. Since the introduction of cocaine local anaesthesia (1886), and the subsequent development of procaine (1904) and other related type anaesthetics, dentistry has prided itself on being as close to “painless” as possible. In the late 1940s a new group of local anaesthetic compounds, the amide was introduced. The initial amide local anaesthetic, lidocaine (Xylocaine), revolutionized pain control. A new class of local anaesthetic was synthesized in 1943 called Lidocaine. It was marketed under the proprietary name Xylocaine and successfully replaced procaine. Lidocaine was found to have faster action of action, longer duration of anaesthesia as compared to the esters.3

In 1969, Carticaine was first prepared by Rushing and colleagues and had its generic name changed to Articaine when it entered clinical practice in Germany in 1976 as a local anesthetic.4 Articaine differs from the previous amide local

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anaesthetic in being derived from a thiophene ring instead of the usual benzene ring which gives the molecule better diffusion properties as compared to lidocaine. It contains an additional ester group that is quickly hydrolyzed by plasma esterase which gives Articaine an elimination half-life of approximately 90 minutes.5,6

The objective of this study was to evaluate the anaesthetic efficacy of 4% Articaine HCl with 1:100000 adrenaline and 2% Lignocaine HCl with 1:80000 adrenaline in bilateral extraction of maxillary premolars for orthodontic purposes and also to compare both local anaesthetic agents for the difference in the pain levels, onset for of anaesthesia and duration of anaesthesia.

MATERIALS AND METHODS

This prospective randomized, double-blind study was conducted on 43 patients (28 females and 15 males), aged less than 40 years who reported bilateral orthodontic extractions of upper premolar teeth to the Department of Oral and Maxillofacial Surgery, from February 2013 to September 2014.

Inclusion and exclusion criteria
The participants were selected under the following criteria - age less than 40 years, American Society of Anesthesiologists Grade-I patients (a healthy individual with no systemic disease), having cooperative behaviour for dental treatment under local analgesia. But the participants - were excluded from the study under the following criteria - Medically compromised patients, pregnancy, history of allergy to lidocaine/articaine or any of the constituents in local anaesthetic solutions, age more than 40 years, and children below the age of reasoning infection/ inflammation near the site of injection, smokers, alcoholics.

50 cartridges each containing 1.8 ml of 2 % lignocaine hydrochloride with 1:80,000 epinephrine and 50 cartridges each of 1.7 ml of 4 % articaine hydrochloride with 1:1,00,000 adrenaline or 1.8 ml of 2% lignocaine hydrochloride with 1:80,000 adrenaline was administered in the buccal vestibule using a self-aspiring syringe with 30-G needle ( {.31mm × 25mm} DEJECT disposable needle 30G -L ). The injection target site was centred over the buccal root apices of the maxillary premolar. The lip was gently retracted, and the needle was placed gently into the alveolar mucosa (needle insertion phase) with a bevel directed towards the bone and was advanced within 2-3 seconds until the needle was estimated to be at or just superior to the apices of the tooth (needle placement phase). The anaesthetic solution the time to anaesthetic effect on the buccal and palatal side was recorded as the time elapsed from the full withdrawal of needle until the patient indicated the first evidence of Vincent’s sign objectively. Subjective confirmation was done with a standard probe every 30 seconds until no response was recorded for 10 minutes on the buccal and palatal side using a stopwatch in minutes. Palatal infiltration was administered 10 minutes after buccal infiltration when it was observed that palatal anaesthesia was not achieved with buccal injection. If the patient complained of pain on the buccal or palatal side then the need for re-anaesthesia was considered. After palatal injection patient was again asked to mark the VAS scale to record the pain on palatal injection. The onset of palatal anaesthesia was checked on every 30 seconds till 10 minutes until no response was observed. After the successful anaesthesia had been achieved the tooth was extracted using a standard forceps’ technique under sterile aseptic conditions and a pressure pack was placed. Post-operative instructions were given and only analgesics (Tab. Ibugecic plus TDS × 3 days) was prescribed. The duration of anaesthesia was recorded as the time from initial pain perception of the anaesthetic effect to the moment in which the
effect began to fade. Patient marked fliers distributed to them representing the loss of intensity of heaviness (+ + + + + + to -), as the time elapsed from 30 minutes to 6 hours, after extraction, of 15-minute interval. This was also confirmed by a telephone conversation with the patient. Postoperative complications if present were observed.

**STATISTICAL ANALYSIS**

The data were entered in the Microsoft Excel spreadsheet 2013. The student’s unpaired t-test analysis was performed using IBM SPSS Version 24.0 (Armonk, NY: IBM Corp.). The VAS scores by t-test were calculated. P-value <0.05 was considered statistically significant.

**RESULTS**

Table 1 illustrates the age distribution among males and females. Out of 43 patients included in the study, 34.9% of patients were male and 65.1% of patients were females. 14 patients in the male group were in the age group of 10-15 years and 1 in the age group of 15-20 years. 11 patients in the female group were in the age group of 10-15 years, 8 in the age group of 15-20 years of age, and 9 in 20 – 25 years of age.

Pain on buccal and palatal injections was compared between blue (Articaine group) and green (Lignocaine) groups using Paired T-test. Table 2 shows that there was statistically no significant (p-value>0.05) difference between the Blue (Articaine) and Green (Lignocaine) groups for pain on injection on the buccal and palatal sides.

The mean for the onset of anaesthesia was calculated by paired T-test. Table 3 shows the mean onset of anaesthesia after buccal infiltration in the green (lignocaine) group which was 2.19 minutes as compared to the blue (articaine) group which was 1.56 minutes and the difference was statistically significant (p-value<0.05). Mean onset of anaesthesia after palatal infiltration in the green group (lignocaine) was 1.27 minutes as compared to that of the blue group (articaine) which was 0.93 minutes and the difference was statistically significant (p-value<0.05).

The mean duration of anaesthesia was compared in both groups using a paired “t” test. Table 4 illustrates the mean duration of anaesthesia of 193.67 minutes with the green (lignocaine) group and 254.95 minutes with the blue group (articaine) group. The difference was statistically significant (p-value<0.05) giving the inference that the blue (articaine) group has a longer duration of anaesthesia compared with the green (lignocaine) group.

**DISCUSSION**

Lignocaine is, today the ‘Gold Standard’ local anaesthetic agent against which all new local anaesthetics are compared. Lignocaine 2% combined with a vasoconstrictor in a 1:100,000 concentration provides reliable and profound pulpal anaesthesia for approximately 60 minutes with a duration of soft tissue anaesthesia ranging from 3 to 5 hours. Lignocaine is also supplied as a 2% solution with 1:50,000 epinephrine. Although this concentration may be useful to provide surgical hemostasis by local infiltration, its routine use for primary operative or surgical anaesthesia should be avoided because of the possibility of an acute epinephrine reaction, which may often manifest as hypertension or tachycardia in susceptible patients. In 1969, Rusching et al., synthesized Articaine hydrochloride with the name of articaine and in 1976 it was marketed in Germany. The pharmacological characteristics of this anaesthetic are responsible for its main advantages concerning other local anaesthetics and include a substitution of the aromatic ring that increases the lipid solubility of the drugs as well as potency (1.5 times greater than of the lignocaine).

No difference was observed in the intensity of pain on injection on buccal infiltration in both groups. However, palatal infiltration in both groups was more painful than their buccal counterparts. These results were by the findings of Malamed et al., who found no significant difference in VAS pain scores between subjects receiving articaine with epinephrine and those receiving lignocaine with epinephrine.

Onset and duration periods must be considered when comparing two or more local anaesthetic agents. An ideal agent must have a shorter onset and should last for a sufficient time to allow the completion of the desired procedure.

In our study mean onset of anaesthesia after buccal injection had a significant difference between articaine and lignocaine groups. The lignocaine group had higher mean onset of anaesthesia as compared to the articaine group suggesting a shorter onset of action in the articaine group. Costa et al. reported a higher mean onset for lignocaine (2.8 minutes), followed by 4% articaine with 1:200000 epinephrine (1.6 minutes) and 4% articaine with 1:100000 epinephrine (1.4 minutes).

Kambalimath et al. also reported similar results with a mean onset time of 4% articaine as 2-3 minutes when compared to 3 minutes for the lignocaine group. Similar findings were reported by Colombini et al. and Rebolledo et al. Shorter mean onset of anaesthesia in articaine group could be attributed to smaller dissociation constant (pKa = 7.8) of articaine as compared to lignocaine which has greater dissociation constant (pKa = 7.9).

In this study, the mean duration of anaesthesia achieved with the articaine group was longer than that achieved with the
lignocaine group. Similar results were reported by Rebolledo et al., Sreekumaret al., and Bansal et al.12,8,13 The duration of the effect of an anaesthetic depends upon its degree of protein binding. The injection site or concentration of vasconstricctor present in the anaesthetic solution also affects the duration of the effect of the local anaesthetic among other factors. Among all amide local anaesthetics, Articaine has the highest protein binding percentage. This in turn implies a longer duration of the anaesthetic effect.

Further controlled clinical trials with similar local anaesthetic agents in other areas of the oral cavity in the form of infiltration and nerve block are necessary to evaluate the safety and efficacy of articaine.

**CONCLUSION**

The efficacy of 4% articaine with 1:1, 00,000 epinephrine based on the Visual Analogue Scale was better than 2% lignocaine with 1:80,000 epinephrine, indicating that articaine provides adequate analgesia for the procedure to be performed. The efficacy of 4% articaine with 1:100,000 epinephrine was found to be comparable to 2% lignocaine with 1:80,000 epinephrine. The Onset of anaesthetic action of 4% Articaine with 1:100,000 epinephrine was found to be shorter than 2% lignocaine with 1:80,000 statistically significant epinephrine. 4% Articaine with 1:100,000 epinephrine was found to have a longer duration of action than 2% lignocaine with 1:80,000 epinephrine thus adding to the patient comfort after the extractions by increasing the pain-free duration. This difference was statistically highly significant. Thus Articaine can be used as a suitable alternative to lignocaine in the extraction of maxillary premolars for orthodontic reasons with clinical advantages like faster time of onset, longer duration, and greater diffusing property over lignocaine. Thus more studies in the future with a larger sample size must be performed where the difficulty of extraction and complications are recorded in addition to evaluation of the efficacy of the Articaine over lignocaine.

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**Author’s contribution**

Dr. Meenu Jain: Concepts, design of the study, investigation, and statistical analysis. Dr. Namrata Dogra: Definition of intellectual content, and statistics. Dr. Manish Gupta: Manuscript editing and review of literature. Dr. Seema Grover: Writing results.

**REFERENCES**

Table 1: Age distribution among males and females

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<th>10-15 years</th>
<th>15-20 years</th>
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<tbody>
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<td>14</td>
<td>1</td>
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<td>15</td>
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<td></td>
<td>56.0%</td>
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<tr>
<td>Female</td>
<td>11</td>
<td>8</td>
<td>9</td>
<td>28</td>
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<td></td>
<td>44.0%</td>
<td>88.9%</td>
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<td>65.1%</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>9</td>
<td>8</td>
<td>43</td>
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<td>100.0%</td>
<td>100.0%</td>
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</table>

Table 2: Mean pain ratings for each group (VAS) (Buccal and Palatal injection)

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Mean difference</th>
<th>T-test value</th>
<th>P-value</th>
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</thead>
<tbody>
<tr>
<td>VAS – Buccal Blue</td>
<td>43</td>
<td>2.09</td>
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<td>-0.12</td>
<td>-0.597</td>
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<td>VAS – Buccal Green</td>
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<td>2.21</td>
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<td>VAS – Palatal Blue</td>
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<td>3.31</td>
<td>1.77</td>
<td>0.08</td>
<td>0.257</td>
<td>0.799*</td>
</tr>
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<td>VAS – Palatal Green</td>
<td>36</td>
<td>3.22</td>
<td>1.61</td>
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</tbody>
</table>

Note:*p>0.05- Non significant

Table 3: Mean onset of anaesthesia (in minutes) after buccal and palatal infiltration in both green (lignocaine) and blue (articaine) groups.

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Mean difference</th>
<th>T-test value</th>
<th>P-value</th>
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<tbody>
<tr>
<td>The onset of Anaesthesia – Buccal (Blue)</td>
<td>43</td>
<td>1.56</td>
<td>0.67</td>
<td>-0.63</td>
<td>-3.433</td>
<td>0.001**</td>
</tr>
<tr>
<td>The onset of Anaesthesia - Buccal (Green)</td>
<td>43</td>
<td>2.19</td>
<td>0.93</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The onset of Anaesthesia – Palatal (Blue)</td>
<td>37</td>
<td>0.93</td>
<td>0.52</td>
<td>-0.34</td>
<td>-2.860</td>
<td>0.007**</td>
</tr>
<tr>
<td>The onset of Anaesthesia - Palatal (Green)</td>
<td>37</td>
<td>1.27</td>
<td>0.64</td>
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</tbody>
</table>

Note:**p<0.01- Highly Significant

Table 4: Mean duration of Anaesthesia of Articaine and Lignocaine in minutes

<table>
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<th>Duration of Anesthesia (in min)</th>
<th>Number</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Mean difference</th>
<th>T-test value</th>
<th>P-value</th>
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</thead>
<tbody>
<tr>
<td>Blue</td>
<td>43</td>
<td>254.95</td>
<td>43.55</td>
<td>61.28</td>
<td>11.218</td>
<td>0.000***</td>
</tr>
<tr>
<td>Green</td>
<td>43</td>
<td>193.67</td>
<td>40.29</td>
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</table>

Note:**p<0.001- Very Highly Significant

Figure 1: VAS Scale.