Comparative Study of the Anesthetic Efficacy of Articaine and Lignocaine in Mandibular First Molars

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Abstract

Pain control is an important part of dentistry and particularly of tooth extractions and surgical procedures. The achievement of successful local anesthesia is a continual challenge in dentistry. Not all conventional inferior alveolar nerve blocks (IANB) result in successful anesthesia. The purpose of this randomized controlled trial was to compare the effectiveness of 4% articaine with 1:100,000 epinephrine mandibular infiltration with that of 2% lignocaine with 1:100,000 epinephrine conventional IANB in mandibular posterior teeth. Using independent study design, a total of 64 patients, 18-59 yrs old, requiring tooth extractions of mandibular first molars randomly received either 1.8ml of articaine buccal and lingual infiltration or 1.8ml of lignocaine IANB. Anesthesia was determined using Heft – Parker Visual Analog Scale (VAS) and Wong – Baker Faces Pain Scale (FPS). Anesthetic efficacy was considered successful if the patients felt no pain or mild pain (VAS < 54mm and FPS of 0-4) during extraction. According to VAS, 84.4% of articaine infiltration and 87.5% of lignocaine IANB were successful (p=0.719) and the success rate determined by FPS were 90.6% and 84.4% respectively (p=0.453). There were no statistically significant differences (p>0.05). The onset of subjective lip numbness and the injection discomfort of articaine and lignocaine groups were not significantly different (p>0.05). In conclusion, infiltration anesthesia with 4% articaine for mandibular first molars can be a useful alternative for clinicians because it has a similar success rate compared with lignocaine IANB.

Introduction

In dentistry, the ability to provide a patient with clinically adequate pain control was a concern of dentists throughout the world. For most surgical procedures, dentists are able to manage operative pain & discomfort by using intraoral administration of local anesthetics. Thus, local anesthesia and its administration techniques are integral parts of management of painful dental procedures.

Although local anesthesia for the extraction of mandibular posterior teeth has principally been obtained through the administration of inferior alveolar nerve block (IANB), not all IANB injections result in successful pulpal anesthesia (Claffey et.al., 2004). Clinical studies have found failure of 44% to 81% with the IANB (Nusstein et.al., 1998). Anesthetic failure after conventional IANB may be caused by several factors such as technical errors, presence of limitation of mouth opening and collateral innervations (Pogrel et. al.,1997 ; Yonchak et.al., 2001).Therefore, many studies have developed considerable interest in inducing mandibular pulpal anesthesia by means of administering buccal infiltration (BI) injection of anesthetic solution adjacent to molars.

The efficacy of infiltration anesthesia for
mandibular molars has been considered inadequate because the mandible has dense, thick cortical bone at that region. Haas et al. (1990) reported that BI of lignocaine or prilocaine solution was not very effective for pulpal anesthesia in adult mandibular posterior teeth. Recently, articaine hydrochloride has been claimed to be efficacious for anesthesia of mandibular pulp and lingual soft tissue by BI, as well as palatal soft tissue anesthesia by means of maxillary labial infiltration because of its superior diffusion through bony tissue (Haas et al., 1990). The superiority of 4% articaine with epinephrine over 2% lignocaine with epinephrine after mandibular infiltration was confirmed by the work of Kanaa et al. (2006). Robertson and colleagues (2007) also found that 4% articaine has 75%-87% anesthetic success in mandibular molars when administered via BI. These results show that BI can be as effective as IANB in anesthetizing the pulp of mandibular molars by using articaine. However, neither study compared the effectiveness of the two methods directly in the extractions of mandibular molars.

The purpose of this study was to compare the efficacy of articaine infiltration anesthesia to the efficacy of conventional lignocaine IANB of the same dose in the extractions of mandibular first molars.

**Material and Methods**

This study was approved by the Ethical Board of the University of Dental Medicine, Yangon and written informed consent was obtained from each subject. Sixty-four patients (28 men and 36 women) between 18 and 59 years of age who needed to have extraction of at least one lower first molar tooth were enrolled in this study. All patients were good in health as determined by a health history and oral questioning. Exclusion criteria included any reported allergy to local anesthetic agents, unstable cardiovascular disease, pregnancy, apical abscess and neurological disorders with sensory disturbance.

The study was designed as a randomized controlled clinical trial. Total 64 patients were equally and randomly divided into 2 groups, articaine group and lignocaine group. At the appointment, the 64 patients randomly allocated either conventional inferior nerve block (IANB) of 1.8 ml of 2% lignocaine with 1:100,000 epinephrine or buccal and lingual infiltration anesthesia of 4% articaine with 1:100,000 epinephrine for extraction of mandibular first molar. Randomization was performed by the lottery method.

Before the injection, each patient was given a hybrid visual analog scale (Heft- Parker VAS) and faces pain scale (Wong – Baker FPS). This VAS consisted of a 170 mm horizontal line with demarcations at each end with words such as “no pain” and “the worst pain imaginable”. Faces pain scale (FPS) consisted of a series of facial expressions drawing to illustrate a spectrum of pain intensity.

![Figuer 1. Visual Analog Scale (Heft – Parker VAS)](image)
The subject was informed of the rating scales to be utilized and asked to mark a separate VAS and FPS to rate the pain they experienced at each stage of the infiltration injection, epithelial attachment breaking and tooth extraction. Using the VAS, the patient indicated the intensity of pain by marking a line on a horizontal scale. The VAS score was determined by measuring the distance in mm from the left end of the line to the point that the patient indicated.

Anesthetic injection was administered by the investigator. For the articaine infiltration anesthesia, 1.8 ml of 4% articaine with 1:100,000 epinephrine (Articaine 1:100,000; DFL, Brazil) was given by using infiltration method (1.6 ml of cartridge for the buccal infiltration and 0.2 ml of cartridge for lingual infiltration) with a dental aspirating syringe fitted with (27 G, 21 mm) disposable short needle at a rate of 1.8 ml per 60 seconds. The mandibular buccal infiltration was administered at mucobuccal fold adjacent to the selected lower first molar bisecting the approximate location of the mesial and distal roots. The needle was gently placed into the alveolar mucosa and was advanced until the needle was estimated to be at or just above the roots of the first molar. The lingual infiltration was administered to the lingual gingival adjacent to the extracted tooth.

For the lignocaine nerve block, 1.8 ml of 2% lignocaine with 1:100,000 epinephrine (Alphacaine 1:100,000; DFL, Brazil) was given by using conventional IANB method (0.9 ml of cartridge for inferior alveolar nerve, 0.45 ml of cartridge for lingual nerve and 0.45 ml of cartridge for long buccal nerve) with a dental aspirating syringe fitted with (27 G, 30 mm) disposable long needle at a rate of 1.8 ml per 60 seconds.

Following the completion of anesthetic injection, the patient received a post injection pain survey with VAS. The onset of lip numbness was also recorded. After 10-15 minutes of LA injection, detachment of epithelial attachment by probing on both buccal and lingual sides was done and extraction performed. If the patient felt pain, the treatment was immediately stopped and the patient rated their discomfort using the VAS and FPS. The success of anesthesia was defined as the ability to extract the tooth without pain or mild pain (VAS score of 0 to ≤ 54 mm and FPS score of 0 to ≤ 4). In anesthetic failure case, tooth extraction was continued by using additional conventional IANB with 2% lignocaine.

Data were analyzed by Chi-square, Fisher’s exact test and Student’s t test, performed using a statistical analysis package (SPSS 15.0 software).

**Results**

The study was performed over a one year period. 36 women (56.25%) and 28 men (43.75%) with a
mean age of 39.38 years (range, 18-59 years) were included. There were no significant differences (p>0.843) between the two groups. The distribution of teeth and diagnosis of teeth are outlined in Table 1 and 2. There were no significant differences (p>0.073) between the two groups.

No significant difference was noted in injection discomfort between articaine mandibular infiltration (mean VAS 9.72 mm) and lignocaine IANB (mean VAS 11 mm) in 64 patients (p=0.734) (Fig.3). All patients reported lip numbness after articaine mandibular infiltration and lignocaine IANB, with a mean onset of 3.07 minutes (SD, 2.37 minutes) and 3.26 minutes (SD, 2.15 minutes), respectively.

The anesthetic success determined by extraction pain (VAS) is presented in Table 3. The success rate of articaine mandibular infiltration was 84.4% and that of lignocaine IANB was 87.5%. There was no significant difference (p=0.719) between the two groups. The percentage of successful anesthesia in the two study groups determined by extraction pain (VAS score) are summarized in Table 3.

According to the FPS, 29 out of 32 patients (90.6%) achieved successful anesthesia after articaine mandibular infiltration and 27 out of 32 patients (84.4%) had anesthetic success after lignocaine IANB (FPS= 0 to 4). The failure rate were 9.4% (3 out of 32 patients) and 15.6% (5 out of 32 patients) for articaine and lignocaine groups respectively (FPS= > 4). Statistical analysis value showed that there was no significant difference among study groups (p= 0.453) (Fig.4).

The mean duration of soft tissue anesthesia was 134 minutes (SD, 62.55 minutes) after articaine mandibular infiltration and 181.67 minutes (SD, 47.06 minutes) after lignocaine conventional nerve block. The difference was not significant (p= 0.253) (Fig.5).

Table (1) Distribution of extracted teeth for articaine and lignocaine groups

<table>
<thead>
<tr>
<th></th>
<th>Articaine Group</th>
<th>Lignocaine Group</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower left first molar</td>
<td>9</td>
<td>16</td>
<td>25</td>
</tr>
<tr>
<td>Lower right first molar</td>
<td>23</td>
<td>16</td>
<td>39</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>32</td>
<td>64</td>
</tr>
<tr>
<td>p = 0.073</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Table (2) Relation between Diagnosis of extracted teeth and study groups

<table>
<thead>
<tr>
<th></th>
<th>Articaine Group</th>
<th>Lignocaine Group</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute exacerbation of chronic pulpitis</td>
<td>1</td>
<td>3.1%</td>
<td>0</td>
</tr>
<tr>
<td>Chronic apical periodontitis</td>
<td>27</td>
<td>84.4%</td>
<td>25</td>
</tr>
<tr>
<td>Chronic periodontitis</td>
<td>3</td>
<td>9.4%</td>
<td>5</td>
</tr>
<tr>
<td>Chronic irreversible pulpitis</td>
<td>1</td>
<td>3.1%</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>100.0%</td>
<td>32</td>
</tr>
<tr>
<td>p=&gt;0.10</td>
<td></td>
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</tbody>
</table>
Figure 3. Mean VAs (mm) for injection discomfort

Table (3) Comparison of the percentage of successful anesthesia in two study groups determined by extraction pain (VAS score)

<table>
<thead>
<tr>
<th>VAS</th>
<th>Articaine Group</th>
<th>Lignocaine Group</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-54 mm (success)</td>
<td>27</td>
<td>84.4%</td>
<td>28</td>
</tr>
<tr>
<td>&gt; 54 mm (Fail)</td>
<td>5</td>
<td>15.6%</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>100.0%</td>
<td>32</td>
</tr>
</tbody>
</table>

P = 0.719

Figure 4. Comparison of anesthetic success determined by extraction pain (FPS)

P = 0.453
Discussion

This study was conducted to compare the local anesthetic efficacy of two techniques, 4% articaine mandibular infiltration versus 2% lignocaine conventional IANB in the extraction of mandibular first molars. The patients’ age (p=0.843), gender (p=1.000), tooth type and diagnosis (Table 1 and 2) were not significantly different between the two study groups. Therefore, there were no significant differences of demographic data of the patients among these study groups and the effect of age, gender and diagnosis would be minimized between the two groups.

Pain of anesthetic injection may be influenced by site of the injection, use of topical anesthesia, injection rate, injection volume, the type of the solution used due to its acidic pH (Malamed, 2004). Previous studies have reported that the inferior alveolar block injection yielded significantly more discomfort than local infiltration injection (Kaufman et.al., 2005; Sharaf, 1997). In the current study, anesthetic injection pain for articaine infiltration group resulted in a mean pain VAS of 9.92mm and 11.00mm for lignocaine IANB. Both mean values were in the mild pain category. Statistical analysis of anesthetic injection discomfort found no significant differences between the two solution groups (p=0.723). Corbett et.al., (2008) reported that the injection pain of articaine buccal infiltration (BI) and lignocaine IANB were in mild pain categories. Although BI cannot be directly compared to our pain measurement scale for the reason as we used 1.2 ml of 1.8 ml cartridge for the buccal infiltration and 0.6 ml of cartridge for lingual infiltration, the values found in this study correlate to the “mild” pain levels found in Corbett study.

Reporting of subjective lip numbness was similar after infiltration and IANB. The mean onset of lip numbness was 3.07 minutes (range 1-10 minutes) for articaine infiltration and 3.26 minutes (range 2-10 minutes) for lignocaine IANB. Several studies have examined the anesthetic efficacy with the aid of pulp tester. Although all subjects felt profound lip numbness, pulp testing revealed that subjects did not always have pulpal anesthesia because the onset of successful pulpal anesthesia started after 5 to 15 minutes of injection (Jung et.al., 2008). Thus, lip numbness only indicated soft tissue anesthesia but did not guarantee successful pulpal anesthesia (Mikesel et.al., 2005). These results suggest that a period of 5 to 15 minutes should elapse before commencing a potential painful procedure.

In the present study, the successful anesthesia in two study groups determined by extraction pain (VAS) was shown in Table 3. Comparing the articaine infiltration data with the lignocaine IANB data, of the 64 patients, 27 (84.4%) experienced anesthetic success after articaine infiltration compared with 28 (87.5%) after the IANB. The failure rates were 5 (15.6%) and 4 (12.5%) for articaine and lignocaine groups respectively. Success was defined as extraction discomfort of no or mild pain (VAS = 0 - ≤ 54mm) and failure was defined as moderate or severe pain (VAS > 54mm). No statistically significant difference was noted between the techniques (p=0.719). Our findings corroborate those of
Corbett et al. (2008) who also conducted a clinical study evaluating articaine infiltration technique and lignocaine IANB by using electric pulp tester.

According to FPS definition, 29 patients (90.6%) experienced anesthetic success after articaine infiltration compared with 27 patients (84.4%) after the lignocaine IANB. There was no statistically significant difference in anesthetic success of the two groups (p=0.453) (Figure 4).

We found that articaine infiltration was as effective as lignocaine IANB in the extraction of mandibular first molars. A possible mechanism of articaine is that it has better bone penetration efficacy. Articaine contains a thioephene ring instead of benzene ring like other amide local anesthetics, which may allow the molecule to diffuse more readily. This speculation is corroborated by the claims that articaine is able to diffuse through soft and hard tissues more reliably than other local anesthetics and that maxillary buccal infiltration of articaine provides even a palatal soft tissue anesthesia (Haas et al., 1990).

There are possible mechanisms of action by which buccal infiltration of articaine achieves its effect as an alternative to regional block methods in the first molar region. It may be assumed that infiltration through to the inferior alveolar nerve canal and blocking the inferior alveolar nerve distal to that point or infiltration through the mental foramen to produce a modified mental and incisive nerve block (MINB).

These possibilities can be tested in clinical investigation. Meechan and colleagues (2011) conducted a trial in which they compared buccal infiltration with lingual infiltration of the same dose of anesthetic whether this blockade was the result of infiltration through the cortex to the mandibular canal or entry into the canal via the mental foramen. In this investigation, healthy adult participants received either a buccal or a lingual infiltration of 1.8 ml of 4% articaine with 1:100,000 epinephrine opposite to the mandibular first molar. The results of this study showed that the buccal infiltration for the first molars, first premolars and lateral incisors, was more successful (P < .001) than the lingual infiltration only. This is evidence that the mental foramen is important in the mechanism of action of a buccal infiltration at the mandibular first molar. But the lingual infiltration only cannot access the mental foramen and any effect would be caused by diffusion through the cortex.

Martin and coworker (2011) showed that dose dependent effectiveness of BI anesthesia of 4% articaine with 1:100,000 epinephrine at the mandibular first molar. The 1.8 mL provided anesthesia in 50% of the cases and 3.6 mL provided anesthesia in 70% of the cases. Hence, it can be suggested that additional dose of articaine may provide more anesthetic success in mandibular infiltration.

The mean duration of soft tissue anesthesia was 134 minutes (SD, 62.55 minutes) after articaine mandibular infiltration and 181.67 minutes (SD, 47.06 minutes) after lignocaine conventional nerve block. Although the duration of soft tissue anesthesia of two group were not statistically difference, articaine infiltration group had rapid anesthetic wear off. Articaine benefits from short plasma half-life compared with other amide local anesthetics (Mikesell et al., 2005; Malamed et al., 2005) and when gives as an infiltration should circumvent the possible concentration related neurotoxicity associated with regional blocks methods.

In addition, articaine infiltration technique may be preferred in certain patients such as those suffering from hemophilia in order to reduce the chances of dangerous hemorrhage. Trismus and nonsurgical paresthesia as a result of damage from the needle to the inferior alveolar or lingual nerves is avoided. Articaine infiltration anesthesia does not required the specialized equipment needed for intraosseous delivery and less destructive to the periodontium that follows intraigmentary injections.
Conclusion
Anesthetic efficacy of 4% articaine with epinephrine mandibular infiltration was similar to that of an IANB using 2% lignocaine with epinephrine in extraction of mandibular first molars. Thus, articaine mandibular infiltration method can be useful alternative to 2% lignocaine IANB in achieving anesthesia of mandibular first molar extraction.

References


