4% Articaine Buccal Infiltration Versus 2% Lignocaine Inferior Alveolar Nerve Block for Pulpal Anaesthesia in Mandibular First Molars

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ABSTRACT

The aim of the quasi-experimental study was to assess and compare anaesthetic efficiency of 4% articaine buccal infiltration (BI) and 2% lignocaine inferior alveolar block (IANB) for pulpal anaesthesia in mandibular first molars. Thirty-nine participants with healthy 1st molar teeth on both sides of the mandible who came for root canal treatment of adjacent teeth were recruited for the trial. All participants received 2% lignocaine IANB on 1st visit and 4% articaine BI on 2nd visit and the appointment was given at least 1 week apart. Pulpal anaesthesia onset and duration were checked by an electric pulp tester. The result showed that 4% of articaine BI secured 53.8% successful pulpal anaesthesia in mandibular first molar teeth while 2% of lignocaine IANB did 61.5%, and this difference was not statistically significant. The onset time of pulpal anaesthesia showed no significant difference between these two methods. But, the duration of pulpal anaesthesia was significantly shorter in articaine BI than in lignocaine IANB. It can be concluded that 4% articaine BI is a safe and effective method for pulpal anaesthesia in mandibular first molar teeth. But it should be used considering its shorter duration.

Keywords: Articaine buccal infiltration, Lignocaine inferior alveolar block, Mandibular first molars, Pulpal anaesthesia.

1. Introduction

Pain is a great concern in Endodontics, and successful anaesthesia can significantly reduce fear and anxiety about dental treatment procedures [1]. Profound anaesthesia in the mandible is quite challenging because of thicker cortical bone [2]. To deal with this challenge, selecting the right anaesthetic solution and the proper technique is a matter of utmost importance. Logically, a good anaesthetic should provide quicker onset of anaesthesia and provide adequate duration to complete the task with minimum or negligible adverse effects and complications.

Till now, the choice of anaesthesia for mandibular molar is inferior alveolar nerve block (IANB) with 2% Lignocaine. Lignocaine, an amide local anaesthetic with rapid onset and intermediate duration of action, now has become the gold standard in local anaesthesia to which all new local anaesthetics are compared [3]. Articaine, a recently popular local anaesthetic, is classified as amide but possesses both amide and ester characteristics. It contains a thiphene aromatic ring rather than benzene, making it more liposoluble and tissue penetrable. This feature allows articaine to diffuse through soft and hard tissues more reliably than other local anaesthetics [4]. Like Lignocaine, Articaine is a well-tolerated, safe, and effective local anaesthetic in clinical dentistry [5]. The plasma half-life of articaine is only 27 minutes and lignocaine is approximately 90 minutes [2]. A shorter half-life is always preferable because it will eliminate from the body rapidly after action, and the chance of developing systemic toxicity will be less. But articaine does not provide any advantage over lignocaine when used for inferior alveolar nerve block [6].

From a technical standpoint, IANB is one of the most challenging injection techniques with the highest failure rate, up to 50% in mandibular posterior teeth [7]. Per-operative and post-operative complications are also common [8]. So, searching for simpler, safer, and easier alternatives is an issue of concern to researchers in this field.

Various techniques are advocated in the literature, such as intraosseous injections, intraligamentary, intrapulpal
injection, and buccal infiltration to supplement or replace IANB [9], [10]. Buccal infiltration (BI) is a simpler, minimally invasive, and easier technique than IANB and other available alternatives [11]. It does not require specialized equipment like intraosseous injection (drilling) and intraligamental injection (pressure syringe). It is less bone and periodontal tissue destructive and avoids large bacteremia following intraligamentary injections [12], [13]. Post-injection complications are minimal; only slight tenderness and swelling are reported [14].

In buccal infiltration (BI), anaesthetic is simply placed below the submucosa near the tooth’s apex, and diffusion of anaesthetic occurs through the underlying bone to the root apex. But in the case of the mandibular posterior region, cortical bone is thick. Thick cortical bone prevents sufficient diffusion of anaesthetic. So current gold standard anaesthetic Lignocaine fails to produce enough pulpal anaesthesia in the posterior mandible when buccal infiltration is given [15]. As articaine has better bone penetration capability due to the thiophene ring, it is expected to produce more successful anaesthesia than lignocaine when buccal infiltration is given in the posterior mandible.

Previous clinical studies on 4% articaine primary buccal infiltration show mixed results. It can secure 40% to 87% successful anaesthesia in mandibular first molar [11], [15]–[20]. Jung et al. [17] claimed articaine buccal infiltration provides a significantly quicker onset of anaesthesia than lignocaine IANB. But these results should be interpreted with caution. The demographic perspective of the study population, tooth condition, anaesthesia onset measuring time, and anaesthesia measuring tools are different from author to author. Demography is vital because cortical bone thickness varies among age, sex, racial and ethnic background [21], [22]. Except, for Corbett et al. [11], no one measured the duration of anaesthesia for articaine BI. But the duration of anaesthesia is also very important for selecting anaesthesia for restorative and endodontic work. Poorni et al. [18], Subbiya et al. [19], Monteiro et al. [20] evaluated anaesthetic success in the symptomatic tooth using a Visual analogue scale (VAS), which is a subjective tool.

An objective evaluation of anaesthesia is more acceptable than a subjective VAS scale. Electric pulp tester (ETP) provides more objective measurement and negative response in maximum output (10/10) on two consecutive tests at least 2 minutes apart and provides guarantee (~99%) of successful pulpal anaesthesia in non-pulpitic teeth [23], [24]. No objective test can guarantee anaesthesia in the symptomatic tooth [24].

To our best knowledge, to date, no data is available comparing the efficiency of 4% articaine BI and 2% lignocaine IANB in mandibular first molar teeth from the perspective of the Bangladeshi population. Hence, this quasi-experimental study aims to verify the anaesthetic efficiency of 4% articaine buccal infiltration over 2% lignocaine IANB in mandibular first molar teeth in a sample of the Bangladeshi population using a more objective tool (electric pulp tester).

2. Materials and methods

This clinical study was designed as a quasi-experimental study and prior to the commencement of the study approval was taken from the Institutional Review Board of Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh. The study was conducted from March 2021 to February 2022 at the Department of Conservative Dentistry and Endodontics at Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka. Using data from a previous study [17] sample size of 39 was calculated keeping a 5% level of significance and 80% power of the test. 39 participants (20 males and 19 females) between 18-50 years of age with healthy 1st molar teeth on both sides of the mandible who came for root canal treatment of adjacent teeth (2nd molar, 2nd premolar) were recruited for the study. Exclusion criteria were an abnormal response to an electric pulp test, apical pathology, and infection, allergy to local anaesthetic, American Society of Anaesthesiology classification III and above illness, pregnancy, and lactation. After explaining the details, written consent was obtained from each participant.

Two anaesthetic methods (2% lignocaine IANB in 1st visit, 4% articaine BI in 2nd visit) were given in respect to healthy 1st molar adjacent to the diseased tooth on two consecutive appointments at least one week apart. As multi-visit root canal treatment was planned for patients’ diseased teeth, the visit schedule was planned and executed to work for both study and treatment. At each visit, the anaesthetic trial was given first in respect to the healthy 1st mandibular molar; then, their expected treatment was given. Treatment was not a part of the study.

At each visit before starting the study, normal response to EPT was checked and compared with the contralateral first molar tooth to establish a baseline reading. All EPT were done at the mesiobuccal cusp tip in the presence of a conducting medium-toothpaste. The mesiobuccal cusp tip was chosen because it responds in the lowest current level than other places [25]. Before the electric pulp test, teeth were isolated with a cotton roll and dried with an air syringe in all cases.

At 1st visit, one cartridge (1.7 ml) 2% lignocaine with 1:10000 epinephrine was injected as inferior alveolar nerve block (IANB). After injecting anaesthesia, EPT was then repeated every 2 minutes intervals for 20 minutes period to check the onset of pulpal anaesthesia on the mesiobuccal cusp tip. The anaesthesia was considered successful if the participant didn’t respond to a maximum output of EPT (10) at least two consecutive time points 2 minutes apart. Negative reading in EPT cross-checked with contralateral first molar. It was regarded as unsuccessful if successful anaesthesia didn’t occur within 20 minutes observation period.

If anaesthesia occurred, EPT was then repeated every 5 minutes to check the duration of anaesthesia. A positive reading below 10 in 2 consecutive times was considered the end of anaesthesia. The duration was checked until positive reading or 60 minutes after the onset of anaesthesia, whichever came first. In addition to the objective anaesthesia assessment, patients were asked to report lip
numbness when started (different feelings, numbness, or tingling).

At 2nd visit, one cartridge (1.7 ml) 4% articaine with 1:100000 epinephrine was injected as buccal infiltration (BI) in mucobuccal fold adjacent to apex of the tooth. After injecting, pulpal anaesthesia onset, duration, and lip numbness were recorded as before. After giving anaesthesia at each visit, EPT results were observed and recorded by the separately trained observer who remained blind about the anaesthetic drug and technique used. Patients were kept blind also.

The data were analyzed using the SPSS software version 26.0 (IBM, Armonk, New York). Test of normality: Kolmogorov–Smirnov test and Shapiro–Wilk test were done for continuous quantitative variables like time of onset and duration of pulpal anaesthesia, time of onset of lip numbness, and the results were significant. So, these data were not normally distributed. Non-parametric Wilcoxon Signed Rank Test was done for these variables. McNemar’s test was done for categorical nominal data: the success of pulpal anaesthesia and the success of lip numbness. The result of significance was expressed as a p-value.

### 3. Result

Among 39 participants, 53.8% showed successful pulpal anaesthesia following 4% articaine buccal infiltration (BI) compared with 61.5% following 2% lignocaine inferior alveolar nerve block (IANB). This difference was not statistically significant (Table I). The mean onset time of pulpal anaesthesia for articaine BI and lignocaine IANB was 6.57 ± 2.20 minutes and 9.25 ± 4.16 minutes, respectively. Though articaine BI showed a little bit quicker onset of anaesthesia, this difference was not statistically significant (Table II). The duration of pulpal anaesthesia following articaine BI was 24.52 ± 6.87 minutes. This was significantly shorter than lignocaine IANB which lasted up to 50.21 ± 12.89 minutes (Table II).

While considering lip numbness, all participants reported lip numbness after 4% articaine BI, whereas 8 participants (20.5%) did not report lip numbness after lignocaine IANB. This difference was statistically significant (Table III). The onset time of lip numbness was significantly quicker for articaine BI than lignocaine IANB (Table IV).

### 4. Discussion

The present study showed that 4% articaine BI secured 53.8% successful pulpal anaesthesia in mandibular first molar teeth. In comparison, 2% lignocaine IANB secured 61.5% success, with no statistically significant difference between these two. These findings confirm the works of Corbett et al. [11] and Jung et al. [17]. They found no statistically significant difference, but the success rate varies. Jung et al. [17] reported 54% success for articaine BI, similar to our study. Martin et al. [14] also claimed similar (50%) success when one cartridge articaine was used. Kanaa et al. [13], Corbett et al. [11], Robertson et al. [16] found 64.5%, 70.4% and 87% success respectively. Differences in study populations and anaesthetic success evaluation time may be account for this difference. Corbett et al. [11], Kanaa et al. [15] included participants aged 20–30 years in their trial, and both evaluated anaesthetic success up to 30 minutes. Our age range was wider, ranging from 18–50 years, and evaluating time was 20 minutes. Robertson et al. [16] claimed 87% success and included participants aged 18–60 years, but their success evaluation time was 60 minutes after injection, which increased success so high. When considering the success rate of lignocaine IANB, our finding was similar to Corbett et al. [11] as they claimed 55.6% success. Jung et al. [17] found a lower success rate (43%) and explained that this lower rate might be due to anatomic variations.

### Table I: Comparison of Pulpal Anaesthetic Success in Between 4% Articaine BI and 2% Lignocaine IANB (N = 39)

<table>
<thead>
<tr>
<th>Variables</th>
<th>4% articaine BI Success (%)</th>
<th>2% lignocaine IANB Success (%)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Success of pulpal anaesthesia</td>
<td>Yes 53.8% (21)</td>
<td>61.5% (24)</td>
<td>0.581 (&gt;0.05)</td>
</tr>
<tr>
<td></td>
<td>No 46.2% (18)</td>
<td>38.5% (15)</td>
<td></td>
</tr>
</tbody>
</table>

Note: McNemar’s test p-value <0.05 is considered statistically significant.

### Table II: Comparison of Time of Onset and Duration of Pulpal Anaesthesia in Between 4% Articaine BI and 2% Lignocaine IANB (N = 39)

<table>
<thead>
<tr>
<th>Variables</th>
<th>4% articaine BI Time of onset (mean ± Sd.) min</th>
<th>2% lignocaine IANB Time of onset (mean ± Sd.) min</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of onset of pulpal anaesthesia</td>
<td>6.57 ± 2.20</td>
<td>9.25 ± 4.16</td>
<td>0.06 (&gt;0.05)</td>
</tr>
<tr>
<td>Duration of pulpal anaesthesia</td>
<td>24.52 ± 6.87</td>
<td>50.21 ± 12.89</td>
<td>0.001 (&lt;0.05)*</td>
</tr>
</tbody>
</table>

Note: Wilcoxon Signed Rank Test, *p-value <0.05 is considered statistically significant.

### Table III: Comparison of Success Rate of Lip Numbness in Between 4% Articaine BI and 2% Lignocaine IANB (N = 39)

<table>
<thead>
<tr>
<th>Variables</th>
<th>4% articaine BI Success (%)</th>
<th>2% lignocaine IANB Success (%)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Success of lip numbness</td>
<td>Yes 100% (39)</td>
<td>79.5% (31)</td>
<td>0.008 (&lt;0.05)*</td>
</tr>
<tr>
<td></td>
<td>No 0% (0)</td>
<td>20.5% (8)</td>
<td></td>
</tr>
</tbody>
</table>

Note: McNemar’s test, *p-value <0.05 is considered statistically significant.

### Table IV: Comparison of Time of Onset of Lip Numbness in Between 4% Articaine BI and 2% Lignocaine IANB (N = 39)

<table>
<thead>
<tr>
<th>Variables</th>
<th>4% articaine BI Time of onset (mean ± Sd.) sec</th>
<th>2% lignocaine IANB Time of onset (mean ± Sd.) sec</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of onset of lip numbness</td>
<td>89.46 ± 35.41</td>
<td>138.32 ± 61.04</td>
<td>0.000 (&lt;0.05)*</td>
</tr>
</tbody>
</table>

Note: Wilcoxon Signed Rank Test, *p-value <0.05 is considered statistically significant.
Onset time and duration are crucial for selecting anaesthesia for dental treatment. When considering onset, we found mean onset time of pulpal anaesthesia was $6.57 \pm 2.2$ minutes and $9.25 \pm 4.16$ minutes for articaine BI and lignocaine IANB, respectively, with no significant statistical difference. Jung et al. [17], Corbett et al. [11], Martin et al. [14], and Robertson et al. [16] reported mean onset time of pulpal anaesthesia of articaine BI was 6.6 minutes, 6.8 minutes, 5.4 minutes, 4.2 minutes, respectively. Our findings fall within this range. Jung et al. [17], Tortamano et al. [26]. Corbett et al. [11] found that the mean onset time of lignocaine IANB was 9.7 minutes, 8.7 minutes, and 5.7 minutes, respectively. Our finding was consistent with them. So, articaine BI can secure pulpal anaesthesia a little bit quicker than lignocaine IANB, but this slight difference is not significant.

While evaluating the duration, we found that articaine BI produced a significantly shorter duration of pulpal anaesthesia. The mean duration of 4% articaine BI was $24.52 \pm 6.87$ minutes, and for lignocaine IANB, it was $50.21 \pm 12.89$ minutes. To our knowledge, we found no study comparing the duration of these two methods. Some authors measured duration separately from different perspectives. Corbett et al. [11] measured the duration of articaine BI and found the mean duration was $21.6 \pm 7.9$ minutes. Kanaa et al. [15] claimed that the maximum possible duration for articaine BI was 28 minutes. This finding is similar to ours. However, Oliveira et al. [27] claimed articaine infiltration produces a longer duration of anaesthesia. This contradicts our result. They checked articaine in the maxilla, which is structurally different from the mandible. The maxilla is a spongy bone with a thinner cortical plate that allows diffusion of an adequate volume of anaesthetic. The anaesthetic drug remains in the site of action for a prolonged period because it contains vasoconstrictor. However, mandible has a denser cortical plate which does not allow adequate diffusion of anaesthetic. As articaine has increased bone diffusion capacity, a certain amount can diffuse, which causes the onset of anaesthesia, but this amount may not be sufficient to prolong the duration. Tortamano et al. [26] compared the duration of IANB in different anaesthetic agents and found the mean duration of lignocaine IANB was $61.8 \pm 15.5$ minutes. Our findings are close to it. The slight difference is due to our duration evaluation time being up to 60 minutes after onset. Nevertheless, nearly 50% IANB block lasted more than 60 minutes in our study. In the IANB procedure, an anaesthetic drug is deposited in proximity to the inferior alveolar nerve. When lignocaine with vasoconstrictor is correctly deposited, it ensures adequate volume and concentration, which is the reason for a longer duration. So, lignocaine IANB is suitable for works that need a more prolonged duration of anaesthesia. Due to the shorter duration, articaine BI may not be appropriate for works that take longer than 30 minutes. In those cases, another dose or supplemental methods may help.

Lip numbness is a subjective symptom that varies highly. Articaine BI produced 100% lip numbness. It is due to the deposition of local anaesthetic in the first molar region, and it is not very far from the mental foramen. So, diffusion of anaesthesia towards the mental foramen produces lip numbness in every BI case. Lignocaine IANB could not secure lip numbness in 8 (20.5%) cases. Pulpal anaesthesia did not occur in these eight participants. 31 participants reported lip numbness after lignocaine IANB, but pulpal anaesthesia occurred in 24 participants. From this, we can conclude that the absence of lip numbness indicates pulpal anaesthesia failure, but the presence of lip numbness cannot guarantee pulpal anaesthesia. The same is true for articaine BI, where 100% lip numbness occurred, but pulpal anaesthesia success was 53.8%. So, even after lip numbness, the onset of pulpal anaesthesia should be checked. We found that articaine BI produces a significantly quicker onset of lip numbness than lignocaine IANB. Lip numbness started at 89.46 sec (1.49 minutes), and 138.32 sec (2.31 minutes) after injection of articaine BI, and lignocaine IANB respectively. However, pulpal anaesthesia occurs at 6.57, and 9.25 minutes respectively. So, clinicians should wait up to 10 minutes before starting any restorative and endodontic work.

5. Conclusion

4% articaine BI is a safe and effective method for pulpal anaesthesia in mandibular first molar teeth. But it should be used considering its shorter duration.

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Conflict of Interest

Authors declare that they do not have any conflict of interest.

Ethical clearance

Ethical clearance was taken from Intuitional Review board (IRB) of Bangabandhu Sheikh Mujib Medical University, Shahbag, Dhaka-1000, Bangladesh. (No. BSMMU/2021/2425, Date:18.03.2021).

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