Pulpal-anesthesia of a mandibular first molar with irreversible pulpitis by inferior alveolar nerve block plus buccal infiltration using articaine or lignocaine

Nupur B. Bhatnagar, Shivkumar P. Mantri, Kavita A. Dube, Neelam U. Jaiswal, Vaishnavi J. Singh
Department of Conservative Dentistry and Endodontics, Hitkarini Dental College, Jabalpur, Madhya Pradesh, India

Abstract
Introduction: This study aims to compare the efficacy of a combination of an inferior alveolar nerve block (IANB) plus buccal infiltration using 4% articaine versus 2% lignocaine in achieving anesthesia of lower first molar teeth with irreversible pulpitis.
Materials and Methods: Seventy adult patients were selected. A random sequence list was employed to administer IANB plus buccal infiltration. After the onset of lip numbness, cold test and electric pulp testing were performed. Five patients, four missed blocks and one no bleeding, were excluded. Heft Parker Visual Analog Scale scores during pulp extirpation were recorded. The data of sixty-five patients were statistically analyzed using Chi-square and Mann–Whitney U-test.
Results: The success rate after lip-numbness for articaine is 91.42% and for lignocaine is 94.28%. The difference is statistically, not significant (P = 0.6425). During access, the success rate for lignocaine is 96.87%, whereas 96.96% for articaine. This difference is also not significant (P = 0.982366).
Conclusion: IANB plus buccal infiltration using articaine or lignocaine is equally effective in anesthetizing mandibular first molar with irreversible pulpitis.
Keywords: Articaine; buccal infiltration; inferior alveolar nerve block; irreversible pulpits; lignocaine

INTRODUCTION
Patients usually seek treatment for painful lower molars having irreversible pulpitis. An inferior alveolar nerve block (IANB) is the commonly used technique for achieving pulpal anesthesia of the mandibular molar. This technique involves the deposition of the local anesthetic (LA) solution in the pterygomandibular space, bathing the nerve just before it enters the mandibular foramen.\(^1\) The failure rate of an IANB ranges from 7% to 77\%.\(^2,3\) The success rate decreases further in cases of the inflamed pulp tissue.\(^1,4\)

A meta-analysis\(^5\) from 13 clinical trials, concluded that the administration of an articaine solution has an advantage over lignocaine. However, on further stratification, there was evidence of articaine superiority over lidocaine in infiltration anesthesia, but there is weak evidence of such difference in mandibular anesthesia.

Conventional injections often lead to inadequate anesthesia, and hence, the pain is too severe for an endodontist to proceed. This necessitates the administration of supplemental injections.

Rosenberg et al.\(^6\) found no significant difference between an articaine solution and a lidocaine solution when used as a supplemental infiltration after the failure of an IANB. The success rate of the supplemental buccal infiltration after
the failure of IANB, range from 62% to 84% for articaine and 29%–64.5% for lignocaine. The success rate for a combination of IANB plus buccal articaine infiltration was 82%.

Scanty comparative information exists for IANB plus buccal infiltration using lignocaine versus articaine in achieving pulpal anesthesia of lower molar teeth with irreversible pulpitis. This study aims to compare the efficacy of IANB plus buccal infiltration in obtaining pulpal anesthesia of lower molar teeth having irreversible pulpitis, using 4% articaine (Septonest; Septodont India) with 1:100,000 epinephrine and 2% lignocaine with 1:80,000 epinephrine (Lignospan special; Septodont India).

MATERIALS AND METHODS

The ethics committee of the institution approved this clinical trial. This study is a double-blind, randomized prospective study of individuals who underwent root canal treatment in lower molar teeth for irreversible pulpitis during 14 months in an endodontic clinic of a dental hospital. Participation in the study was voluntary. Patients were adequately informed regarding the required treatment. Written consent was obtained from the patients.

Patient enrolment
A total of 221 patients were screened. One hundred and fifty-one were excluded from the study. Seventy healthy adult patients, with the complaint of a painful lower molar tooth, participated in the study [Figure 1].

Sample size calculation, considering type I error of 5% and a power of 80%, showed that 70 patients would be required to detect moderate (0.3–0.5) and large (>0.5) effect sizes. For each tooth, the diagnosis of irreversible pulpitis was made from the chief complaint and the clinical examination. Pulp sensitivity was confirmed by a prolonged response with moderate-to-severe pain to cold testing and positive response to electric pulp testing (EPT). The teeth were not sensitive to percussion or palpation. Periapical radiographs and the radiographic examination revealed healthy periapical tissues.

The following inclusion and exclusion criteria were used.

Inclusion criteria
- A mandibular first molar tooth with irreversible pulpitis
- An absence of the peri-apical radiolucency on radiograph except for a widened periodontal ligament
- A vital coronal pulp on an access opening

Exclusion criteria
- The presence of the multiple carious teeth with pulpal involvement in the arch
- Presence of systemic disorders
- Sensitivity to any content (including epinephrine) of LA solution
- H/o difficulty in anesthetizing teeth
- Lactating mothers
- Pregnancy
- Use of any analgesic medication in the preceding 12 h of treatment
- Patients who reported no lip numbness following IANB administration
- Teeth with no bleeding (indicating pulp necrosis) following access cavity preparation

Then, seventy patients were randomized according to anesthetic solution employed, using the Research Randomizer program (version 4.0; Geoffrey C. Urbaniak and Scott Plous, Lancaster, PA). A random number list was generated. The patients were administered IANB plus buccal infiltration according to this list using a corresponding number on LA cartridge by an individual operator. The operator and the patient were unaware of the anesthetic solution used for IANB plus buccal infiltration.

The cartridges (35 lignocaine and 35 articaine) were masked by using opaque paper tape. Masked cartridges were numbered according to a random sequence list and marked using a permanent ink marker. This was done by one of the authors, who was not involved in administering the injections, performing the tests, and assessing the outcome.

Method
Preoperative pain scores using Heft Parker Visual Analog Scale (HPVAS) were recorded. Cold test, utilizing Endo-Frost (Coltene/Wahledent; USA), and EPT, using Digitest (Parkell Electronics division, Farmingdale, NY 11735 USA) pulp tester, were performed. An aspirating syringe (Hu-Friedy) and a 27 G needle (Septoject; Septodont India), was used to administer an IANB plus buccal infiltration. A volume of 1.5 ml of solution was used for IANB, and 0.3 ml was deposited in the mucobuccal fold adjacent to the mandibular molar for infiltration. The operator, as well as the patient, did not know which anesthetic solution was used.

The onset of lip numbness was checked, and the duration was recorded. Missed block cases were excluded if there was no onset of lip numbness within 15 min. Four such missed block cases were excluded. The tooth was isolated with the rubber dam. After 15 min of the onset of lip numbness, an EPT and cold test was performed as before. EPT was repeated after 5 min. Observations were recorded. The success of pulpal anesthesia was defined as no response to cold test and EPT.

Access preparation was done using Endo-access bur (Maillefer, Dentsply, Ballaigues, Switzerland). If there
was no bleeding, the case was excluded. One such case was excluded from the present study. Pulp extirpation was performed using a barbed broach. No pain or a weak/mild pain was recorded as a success. If the patient’s self-reported pain on HPVAS was ≥54 mm during the procedure, it was stopped, and pulpal anesthesia was considered unsuccessful. Observations were tabulated in Microsoft Excel sheet.

**Statistical analysis**

Data were analyzed using Pearson’s Chi-square test and Mann–Whitney U-test.

**RESULTS**

None of the patients reported any adverse effects associated with the LA administration or the procedure. There was no statistically significant difference for sex distribution ($P = 0.3752$), age ($P = 0.218047$), and onset of lip numbness ($P = 0.428834$) between the patients of two groups. There was no significant difference between the groups in preoperative HPVAS readings ($P = 0.718059$) as well as during access ($P = 0.4413$) HPVAS readings [Table 1 and Figure 2].

After lip-numbness, 94.28% of patients in the lignocaine group, whereas 91.42% of patients in the articaine group

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**Figure 1**: Flow diagram

**Figure 2**: (a) Age/sex/onset/visual analogue scale score in lignocaine and articaine group. (b) Success and failure in lignocaine and articaine group
group, exhibited pulpal anesthesia (negative response to EPT and cold test). This difference was not statistically significant ($P = 0.6425$). During access and pulp extirpation, the success rate in the lignocaine group was 96.87% and 96.96% for the articaine group. This difference between the groups is also not statistically significant ($P = 0.982366$) [Table 2].

**DISCUSSION**

The presence of soft-tissue anesthesia (usually measured by “lip numbness” or lack of mucosal responsiveness to a sharp explorer) does not adequately indicate pulpal anesthesia.\[^{11-14}\] However, the lack of soft-tissue anesthesia is a useful indicator that the block injection was not administered accurately for that patient. A missed block is defined as not obtaining profound lip numbness within 15–20 min following an IANB. It occurs about 5% of the time.\[^{15}\] In the present study, four patients (5.71%) had missed block, so, were not included.

Several anesthetic agents have been marketed commercially such as lignocaine, mepivacaine, bupivacaine, prilocaine, articaine, etc. Lignocaine is the most widely used agent in dentistry and considered a gold standard anesthetic solution.\[^{16}\] Despite its advantages like low allergenicity and minimal toxicity, many reports have advocated the use of articaine hydrochloride as a superior anesthetic agent.\[^{17}\] Articaine inhibits nerve impulse conduction due to the blockage of sodium channels. The addition of epinephrine causes local vasoconstriction, which in turn leads to slow absorption and thus increases the duration of action.\[^{16,18}\]

Articaine has a thiophene ring and the intramolecular hydrogen bond within its structure. As the internal hydrogen bond (between the amine nitrogen group and the ester carbonyl oxygen group) forms when articaine enters the membrane, the molecule folds on itself. Lidocaine lacks this thiophene ring. Chemical structure and not the concentration of a solution affects the anesthetic efficacy of articaine.\[^{19}\]

Anatomical variations that affect mandibular teeth anesthesia include accessory mylohyoid nerve, bifid mandibular nerve, an appearance of a retromolar foramen, a more superior than the usual position of the mandibular foramen on the ramus.

Meechan\[^{20}\] has enumerated benefits of buccal infiltration as follows: (1) technically simple, (2) more comfortable for patients, (3) in many cases obviate the presence of collateral innervation, (4) a lesser risk of intravascular injection, (5) safer in patients with clotting disorders, (6) reduce risk of needle-stick injury, and (7) preinjection application of topical anesthetic masks’ needle penetration discomfort.

In most cases, the onset of pulpal anesthesia following the conventional IANB injection usually occurs within 15–16 min.\[^{11-14}\] In some instances, onset may be delayed. Slow onset is defined as the percentage of subjects who achieved a negative response to EPT after 15 min. In mandibular teeth, slow-onset occurs about 19%–27% of the time. About 8% of patients have an onset after 30 min. In contrast to the onset of pulpal anesthesia, the onset of lip numbness usually occurs within 5–9 min. Anesthesia persists typically for approximately 2 1/2 h with 2% lidocaine with 1:100,000 epinephrine.\[^{14}\] Saraf et al.,\[^{21}\] in a comparative study, observed that articaine has a faster onset. In the present study, the mean duration of onset of lip anesthesia was 2.67 min for lignocaine and 2.51 min for the articaine group.

In the existent study, there is no statistically significant difference ($P > 0.05$) between the lignocaine and articaine groups. This result is, in agreement with the results of studies done by Rosenberg et al.,\[^{8}\] Parirokh et al.,\[^{18}\] Poorni et al.,\[^{17}\] Corbett et al.,\[^{18}\] Jung et al.,\[^{22}\] and Arrow.\[^{23}\]

Yadav\[^{24}\] in a systematic review of the anesthetic success of supplemental infiltration in mandibular molars with irreversible

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**Table 1: Comparison of age, the onset of lip numbness, preoperative and during access visual analog scale score and sex distribution of study subjects in lignocaine and articaine groups**

| Groups | 2% LI ($n = 32$) | 4% AR ($n = 33$) | Mann–Whitney U-test ($P$) |
|--------|-----------------|-----------------|--------------------------|
|        | Mean±SD         | Minimum–maximum | Mean±SD                  | Minimum–maximum |                            |
| Age    | 25.69±6.281     | 18–40           | 27.75±6.823              | 18–40           | 0.218047                  |
| Onset of lip anesthesia | 2.67±0.867 | 1–4.0 | 2.51±0.861 | 1–4.5 | 0.428834 |
| Preoperative VAS | 106.81±16.61 | 85–144 | 107.88±14.13 | 85–144 | 0.718059 |
| During access | 22.93±8.40 | 0–54 | 21.39±14.14 | 0–85 | 0.4413 |
| Sex    | Male            | Female          |                           |               |
|        | 20              | 12              |                           |               |
|        | 16              | 17              |                           |               |

**Table 2: Comparison between the groups in obtaining pulpal anesthesia after lip numbness and during endodontic access**

| Groups | After lip numbness | During access |
|--------|--------------------|---------------|
|        | Success Failure    | Success Failure |
| 2% LI  | 33 (94.28) 2 (5.71) | 31 (96.87) 1 (3.1) |
| 4% AR  | 32 (91.42) 3 (8.57) | 32 (96.96) 1 (3.03) |
| Total  | 65 (92.85) 5 (7.14) | 63 (96.92) 2 (3.07) |

Chi-square test ($P$) 0.642579 0.982366
pulpitis, concluded that none of the techniques gave 100% success. In the current study, during pulp extirpation, the anesthetic success rate was 96.87% in the lignocaine group and 96.96% for the Articaine group. Studies25,26 have shown that patients were satisfied with treatment even though moderate-to-severe pain was experienced, and patient satisfaction may be associated with the chair-side manner of the dentist or with the hope that their discomfort will be abated after the completion of the procedure.

The limitation of the present study is the sample size regulated by rigid inclusion and exclusion criteria.

CONCLUSION

Within the limitations of this study, it is concluded that IANB plus buccal infiltration is equally effective, with either 4% articaine or 2% lignocaine, in achieving pulpal anesthesia of lower first molar tooth with irreversible pulpitis.

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Conflicts of interest

There are no conflicts of interest.

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