

# Onset of Action and Duration of Efficacy of Inferior Alveolar Nerve Block Versus Single Lingual Subperiosteal Injection of 4% Articaine in Mandibular Second Molars: A Randomized Clinical Trial

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## Abstract

**Background and Aim:** Achieving adequate pulpal anesthesia could be challenging in mandibular molars. There are some disagreements about the success rate of local infiltration anesthesia with articaine as primary injection. Therefore, the aim of this study was to assess the efficacy of 4% articaine lingual subperiosteal injection as the primary injection for permanent mandibular second molars in comparison with inferior alveolar nerve block (IANB).

**Materials and Methods:** Fifteen healthy adult volunteers participated in this study. A randomized, split-mouth, single-blind design was used to allocate each side of the mandible in each patient to the test or control group. On the test side, lingual subperiosteal injection with 4% articaine and 1:100,000 epinephrine was performed for the mandibular second molar; whereas, in the control group, an IANB with 2% lidocaine and 1:80,000 epinephrine was administered. Electric pulp testing was done at baseline, and also at 5, 8, 11, 15, 20, 25, 30, 45, 60, 75, and 90 minutes after injection. Statistical analysis was carried out using t-test and Chi-square test.

**Results:** The success rate of IANB was significantly higher than that of lingual subperiosteal injection ( $P=0.0001$ ). The difference in the onset of action between the two groups was significant ( $P<0.05$ ). Anesthesia duration was  $61.0\pm 28.0$  minutes in IANB group and  $10.2\pm 12.4$  minutes in lingual subperiosteal injection group, with a significant difference between them ( $P<0.01$ ).

**Conclusion:** IANB with 2% lidocaine seems to be preferable to 4% articaine lingual subperiosteal injection due to its superior success rate, faster onset of action, and longer duration of effect.

**Key Words:** Anesthesia, Dental; Anesthesia, Local; Mandibular nerve

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## Introduction

Provision of predictable and profound pulpal anesthesia is a necessity for a successful and painless endodontic treatment. A variety of techniques and local anesthetic drugs have

been employed for this purpose [1]. Local anesthetic agents are weak bases, and are commonly synthesized in the form of hydrochloride salts in order to enhance their water solubility [2]. Inferior alveolar nerve

block (IANB) is known to be the preferred method for mandibular molar anesthesia [3]. However, it has some shortcomings, such as a high rate of insufficient depth of anesthesia ranging from 15% to 20% due to lack of reliable anatomical landmarks and variations [4]. Furthermore, severe complications including trismus, neurological lesions, hematoma, transient facial paralysis, and transient or permanent inferior alveolar nerve paresthesia have also been reported [4-6]. Hence, these drawbacks led to the development of various alternative techniques such as intra-osseous injections, periodontal ligament anesthesia, and local subperiosteal injection [7]. The local subperiosteal injection technique is typically less complex, has a higher success rate, and lower risk of postoperative complications [8]. Articaine is known as a unique local anesthetic agent since it contains both the ester group and the thiophene ring, which boost its lipid solubility, resulting in better diffusion through the nerve membranes [9].

Buccal or lingual injection of 4% articaine has been shown to be effective as a supplementary injection in many studies [10, 11]. However, there has been controversy regarding the success of 4% articaine subperiosteal injection as the main injection. Venkat Narayanan and colleagues reported that buccal/lingual subperiosteal injection of 4% articaine with 1:100,000 epinephrine yielded the same depth of anesthesia as an IANB with 2% lidocaine and 1:80,000 epinephrine [12].

Another study found that IANB with 2% lidocaine was equivalent to buccal/lingual injection of 4% articaine as the primary injection regarding the onset of action and duration of efficacy for mandibular second molar pulpal anesthesia [13]. However, to our knowledge, limited studies have investigated the effectiveness of 4% articaine lingual subperiosteal injection as the primary injection for pulpal anesthesia of mandibular

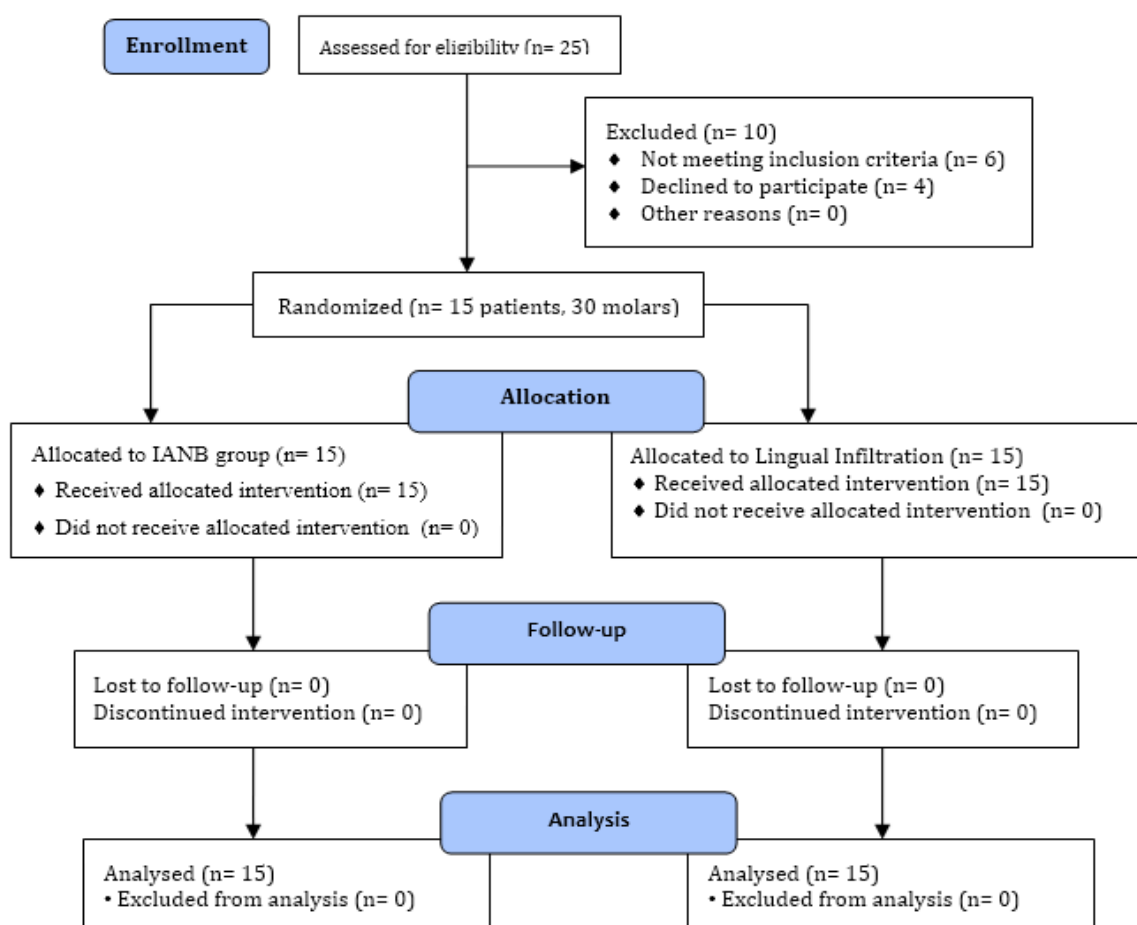
second molars.

Therefore, this study aimed to assess the effectiveness of 4% articaine lingual subperiosteal injection and compare its onset of action and duration of efficacy with the conventional IANB with 2% lidocaine in mandibular second molars.

## Materials and Methods

This single-blind, randomized, split-mouth clinical trial was carried out at the Endodontics Department of Islamic Azad University, Dental Branch, Tehran, Iran. The Ethics Committee of the Faculty of Dentistry at Islamic Azad University provided ethical approval for this study (IR.IAU.DENTAL.REC.1395.18), and the trial was registered in the Iranian Registry of Clinical Trials (IRCT2017020223620N6). This study also complied with the "Consolidated Standards of Reporting Trials" (CONSORT). The protocol of this study was explained to eligible patients prior to the injections, and all participants signed informed consent forms. As demonstrated in Figure 1, this study included 15 adult participants between 18 to 60 years who had no underlying systemic disease, or medication intake, and had sound mandibular second molars without any pulpal involvement. Allergy to local anesthetic drugs or vasoconstrictors, pregnancy, local abscess, systemic diseases, and unwillingness or inability to give informed consent were the exclusion criteria. The sample size was calculated based on a power analysis that suggested a sample size of 15 patients or greater for 0.80 statistical power.

Each mandibular quadrant of each participant was randomly assigned to one of the two groups of control for IANB with 1.8 mL of 2% lidocaine (Daroupakhsh, Tehran, Iran) and 1:80,000 epinephrine by the direct technique or test group for lingual subperiosteal injection of 1.8 mL of 4% articaine plus 1:100,000 epinephrine (Septanest, Septodont, Saint Maur-des-Fossés, France) by simple randomization. All injections



**Figure 1.** CONSORT flow diagram

were administered on the same day by the same operator who was not involved in subsequent assessments, using a standard aspirating dental cartridge syringe with a long (for IANB) or short (for lingual subperiosteal injection) 27-gauge needle (NRK, Tehran, Iran) to avoid any possible errors. Injections were performed at a rate of 1.8 mL per 60 seconds. Blinding of the operator was not possible due to the specific injection technique in each group.

The efficacy of anesthesia was evaluated by electric pulp testing (EPT). Prior to any injection, the baseline sensitivity of the respective tooth was assessed using an electric pulp tester (Gentle-Pulse vitality tester; Parkell Inc., Farmingdale, NY, USA). The tip of electric

pulp tester was placed over some toothpaste, which served as a contact medium, on the coronal third of the buccal surface of the crown. This test was repeated at 5, 8, 11, 15, 25, 30, 45, 60, 70, and 90 minutes after injections. The patient's response to gradual increase in the voltage of the electric pulp tester (zero to the maximum in 20 seconds) was reported. Similarly, the number of no-response episodes at full stimulus was reported. Effective anesthesia was described as no reaction to the pulp tester's maximal stimulation on two or more consecutive tests.

The results were analyzed using SPSS version 12.0 (SPSS Inc., Chicago, IL, USA) by the Chi-square test and t-test at a significance level of 0.05.

### Results

The study was conducted on 15 adult volunteers (30 teeth due to the split-mouth design) with a gender ratio of 53.3% male to 46.7% female, and a mean age of 23.3±3 years.

As shown in Table 1, the IANB success rate was 86.7% (13 out of 15 cases), while the success rate was 13.3% (2 out of 15 cases) for the subperiosteal injection. The success rates of the groups differed significantly (P=0.0001).

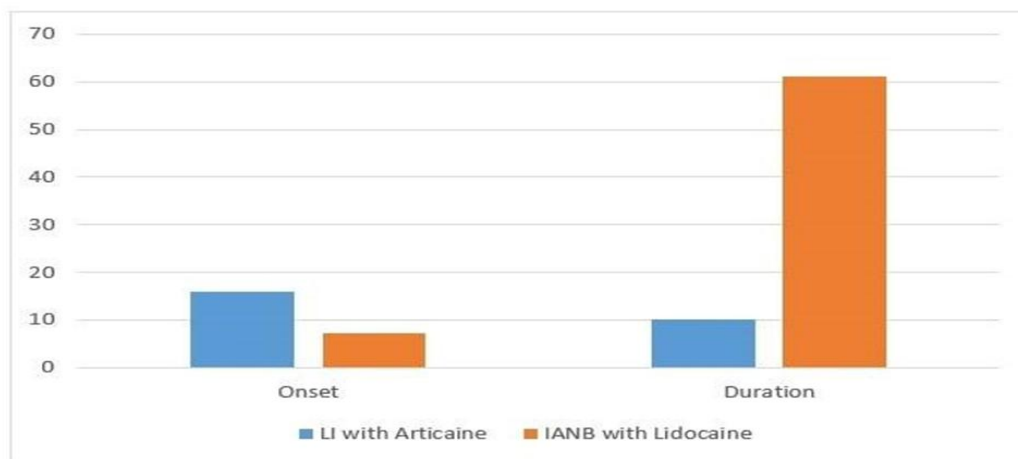
The mean time of onset of pulpal anesthesia for the IANB was 7.3±2.7 minutes; whereas it

finding an alternative to this technique is of great concern. Articaine, a unique amide local was 15.8 ± 7.8 minutes for the subperiosteal injection. The difference in the time of anesthesia onset was also significant between the two groups (P<0.05; Figure 2).

The mean duration of pulpal anesthesia was 61.0±28.0 minutes in IANB and 10.2 ± 12.4 minutes in subperiosteal injection group. The difference between the two groups in this respect was statistically significant as well (P<0.05; Figure 2)

**Table 1.** Success rate, onset of action, and duration of efficacy of mandibular second molar pulpal anesthesia in IANB and lingual subperiosteal injection groups (n=15)

Groups	Success rate (%)	Onset (minutes) (mean ± SD)	Duration (minutes) (mean ± SD)
IANB	86.7	7.3±2.7	61.0±28.0
Lingual subperiosteal injection	13.3	15.8 ± 7.8	10.2 ± 12.4
P-value	0.0001	0.001	0.0001



**Figure 2.** Comparison of onset and duration of pulpal anesthesia in mandibular second molars in inferior alveolar nerve block (IANB) and lingual infiltration (LI) groups

### Discussion

Administration of a local anesthetic agent has a pivotal role in most dental procedures. Despite the fact that IANB is the most frequent regional mandibular nerve block, it has a high failure rate due to anatomical differences in the location of the mandibular foramen and accessory innervations [14,15]. Therefore,

anesthetic agent, has a thiophene ring instead of a benzene ring, which considerably improves its lipid solubility [9]. This local anesthetic agent has shown significantly higher anesthetic potency and success rate in buccal subperiosteal injection of mandibular molars and premolars compared with lidocaine [4,7].

Although a previous study showed the superiority of IANB over buccal and lingual subperiosteal injections of articaine [13], limited controlled trials, to our knowledge, have attempted to compare the anesthetic efficacy of articaine lingual subperiosteal injection alone as the primary injection technique with IANB. This study, therefore, aimed to address this topic.

In terms of success rate and onset of action, the results of the present study showed that IANB was superior to articaine lingual subperiosteal injection as the main injection. These results were in line with those of some previous studies [5, 13]. However, our findings were contrary to those of Jung et al, [16] and Kanaa et al [17]. This inconsistency could be attributed to the proximity of the mental foramen and the buccal side of the mandibular first molar, enhancing the diffusion of anesthetic agent to reach the inferior alveolar nerve.

The current study did not support the findings of Majid and Muhammad [8] which might be due to their subjective definition of pulpal anesthesia. On the other hand, in the present study, similar to the study by Figueiredo et al. [5] absence of response to maximum voltage of electric pulp tester was considered as a sign of successful anesthesia. Use of electric pulp tester is well established in clinical practice and in local anesthetic trials [18-20]. Our findings also differed slightly from those of Monteiro et al. [21] who in spite of reporting the inadequacy of articaine subperiosteal injection as the primary injection, found a higher success rate with articaine than lidocaine. This result may be explained by the fact that all teeth evaluated in the present study were sound, unlike their study.

These findings, while preliminary, may suggest that the traditional use of IANB for mandibular second molars might be still the most suitable technique. However, given that

our findings are based on a number of limitations, the results of this study should be interpreted with caution. To begin with, the small sample size makes these findings less generalizable. Therefore, in order to confirm these results, further studies with a larger sample size are required. Evaluation of sound teeth may be another cause of error. However, it is worth mentioning that inaccuracy of electric pulp tests in teeth with pulpitis has also been reported [22,23]. Thus, to minimize pathological and anatomical differences, symptomatic teeth were excluded from this study. Another possible downside of our methodology was that the level of discomfort caused by each anesthetic agent was not evaluated in this study despite the significance of this topic.

## Conclusion

In summary, notwithstanding some limitations, our study led us to the conclusion that using IANB as a primary injection seems to be more suitable than a lingual subperiosteal injection of articaine in terms of success rate, onset of action, and duration of pulpal anesthesia.

Further investigations into this matter are strongly recommended.

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