



4% lidocaine versus 4% articaine for inferior alveolar nerve block in impacted lower third molar surgery

Kiatanant Boonsiriset¹, Sittipong Chaimanakarn¹, Prued Chewpreecha¹, Natee Nonpassopon¹, Manop Khanijou¹, Bushara Ping², Natthamet Wongsirichat¹

¹Department of Oral & Maxillofacial Surgery, Faculty of Dentistry, Mahidol University, Bangkok, Thailand

²Faculty of Odonto-Stomatology, University of Health Sciences of Cambodia (UHS), Cambodia

Background: No study has compared lidocaine with articaine, each at a concentration of 4% and combined with epinephrine. The purpose of this study was to compare the effectiveness of 4% lidocaine with that of 4% articaine, with a concentration of 1:100,000 epinephrine added to each, in an inferior alveolar nerve block for surgery on impacted lower third molars.

Method: This study was conducted at the Faculty of Dentistry, Mahidol University in Bangkok, Thailand. The randomized, single-blind, comparative split-mouth study was carried out in patients with symmetrically impacted lower third molars, as identified on panoramic radiographs. Each patient underwent surgery for the removal of the lower third molars by the same surgeon under local anesthesia at two separate visits, 3 weeks apart. The onset and duration of local anesthesia, intra-operative pain, surgical duration, and number of additional anesthetics administered were recorded.

Results: The subjective and objective onset of action for the local anesthetics showed statistically significant differences ($P < 0.05$). However, the intra-operative pain, surgical duration, duration of local anesthesia, and number of additional anesthetics administered did not show statistically significant differences.

Conclusion: The use of 4% articaine for the inferior alveolar nerve block was clinically more effective in the onset of subjective and objective anesthesia as compared with the use of 4% lidocaine. Based on the pain scores from the visual analogue scale, 4% lidocaine provided more analgesia during the procedure, and patients noted less intra-operative pain than with 4% articaine; however, the difference was not clinically significant.

Keywords: Alveolar Nerve, Inferior; Articaine; Lidocaine; Nerve Block; Third Molar; Visual Analog Scale.

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INTRODUCTION

Since becoming clinically available in 1948, lidocaine hydrochloride has gained popularity as the first amide local anesthetic drug used in dentistry. After more than a decade of clinical use and several research studies, lidocaine has proven more effective, less allergenic, and less toxic as compared with other local anesthetics.

Therefore, it has become the “gold standard” local anesthetic [1].

In many previous studies, researchers have tried to manipulate the physical and chemical properties of local anesthetics to improve their effectiveness when used for the inferior alveolar nerve (IAN) block. Researchers have compared different types and volumes [2-4] of local anesthetics and have modified the concentration of the buffering agent in the local anesthetic cartridge. Previous

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Corresponding Author: Natthamet Wongsirichat, Department of Oral & Maxillofacial Surgery, Mahidol University, 6 Yothi Street, Rachathewee, District, Bangkok, 10400, Thailand

Tel: +66814509454 Fax: +6622007844 E-mail: natthamet.won@mahidol.ac.th

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studies have commonly reported on the onset, duration of action, and success rate of pulpal anesthesia observed with the different methods [5-11].

In 1969, a new local anesthetic drug, manufactured under the name “articaine,” was introduced in dentistry and became “articaine” in 1984 [1]. Articaine was first available in Germany in 1975 and was introduced to the North American market (Canada) in 1983. In 2000, 4% articaine with 1:100,000 epinephrine was approved for use in the United States [1].

Numerous recent publications have confirmed that articaine has superior efficacy as compared with that of lidocaine. Malamed [1] reported that articaine has 1.5 times more induction potency and a longer duration of action than lidocaine. However, the conclusion that 4% articaine is superior to 2% lidocaine in effectiveness appears biased because the concentrations are different.

Ping et al. [2-4] studied the efficacy and hemodynamic changes of high concentration (4%) lidocaine and 2% lidocaine; however, no studies have compared 4% lidocaine with 4% articaine.

Therefore, the aim of this study was to evaluate the efficacy of a high concentration (4%) of standard lidocaine compared with that of 4% articaine for the surgical removal of lower impacted third molars.

MATERIALS AND METHODS

This controlled, randomized, prospective, and split-mouth study was performed at the Department of Oral and Maxillofacial Surgery, Faculty of Dentistry at Mahidol University in Bangkok, Thailand. Approval for the protocol of this study was granted by the Committee in the Ethics of Research in Human Dentistry and Pharmacy of Mahidol University, Institutional Review Board (Protocol No. MU-DT/PY-IRB 2015/021.0206).

Twenty-three patients meeting the eligibility criteria listed in Table 1 were enrolled in this study, and informed consent was obtained from each individual.

The patients had similar bilateral lower third molars, and we randomly divided them into two groups as follows:

1. In the study group, 1.7 ml of 4% lidocaine with 1:100,000 epinephrine was injected through the pterygomandibular space for the IAN block in the impacted lower third molar surgery.
2. In the comparative group, 1.7 ml of 4% articaine with 1:100,000 epinephrine was injected through the pterygomandibular space for the IAN block in the impacted lower third molar surgery.

The IAN block injections were performed by the same dentist on both sides, and the same surgeon operated on the impacted lower third molars.

Table 1. Eligibility criteria for patient selection (inclusion and exclusion criteria)

Inclusion Criteria	Exclusion Criteria
1. Impacted third molars symmetrically positioned on both sides of the mandible	1. Systolic blood pressure (> 140 mmHg, < 90 mmHg)
2. At least one healthy lower first or second molar on both sides (i.e. without caries or restoration)	2. Diastolic blood pressure (> 90 mmHg, <60 mmHg)
3. Consent provided for the study	3. Heart rate (>100 bpm, < 60 bpm)
4. Aged between 18 and 45 y	4. Pregnancy or current lactation
5. Non-smoker and not an alcoholic	5. Cardiovascular problems, renal and/or liver failure, or other serious medical condition
6. Bilateral impacted lower third molars, which require flap opening, bone removal, and tooth separation during the operation	6. Allergy to local anesthetics
7. Ability to understand and carry out the instructions given by the investigators	7. Facial deformities that may interfere with the injections, surgery, or evaluation
	8. Swelling and/or infection associated with the third molar site
	9. Any medication within 5 d prior to surgery that would alter the patient’s perception of pain (analgesic, antidepressants, etc.)
	10. Inability to follow the instructions or cooperate during the study

Note: y, years; bpm, beats per minute; d, days.

SURGICAL METHOD

The patients were injected with either 4% lidocaine or 4% articaine (both with 1:100,000 epinephrine) as local anesthetic for the IAN block in the surgical removal of the impacted lower third molars. The local anesthetics were prepared immediately before the injections were administered.

The 4% lidocaine with 1:100,000 epinephrine was prepared by withdrawing 0.02 ml of epinephrine bitartrate using a micropipette and inserting it into a 2 ml ampule containing 40 mg/ml of lidocaine (Jayson Pharmaceuticals Ltd; Dhaka, Bangladesh). For the injection, 1.7 ml was drawn from the ampule to equal the quantity of 4% articaine with 1:100,000 epinephrine (Ubistesin Forte 3M ESPE, Seefeld, Germany) that was used for the comparison in this study.

Initially, 1.7 ml of the local anesthetic was administered to each patient for the IAN and lingual nerve block. Ten minutes after the injection, the intensity of pain on probing was measured. A second injection of the same anesthetic was administered if the pain persisted. If the patient still experienced pain on probing ten minutes after the second injection, the patient was excluded from the study.

After confirming adequate numbness from the IAN and lingual nerve blocks, another 0.3 ml of the same anesthetic was administered for the buccal nerve block, using the same standard surgical procedure. One of the patient's impacted third lower molars was then surgically removed. After 3 weeks, the patient underwent the same procedures for the opposite molar.

The comprehensive pain measurement was performed using the standard visual analogue scale (VAS) at each step. Postoperatively, each patient was instructed to complete a patient record form to evaluate the duration of the local anesthesia, as indicated by recovery of sensation to the lower lip. The patient also recorded any unfavorable events that occurred postoperatively.

The measurements recorded were:

1. Type of impaction.
2. Subjective onset and objective onset of anesthetic effect, indicated by an absence of pain to the pinprick test on the canine vestibule and molar lingual vestibule mucosa.
3. Pain assessment: The 100 mm VAS was used for measuring pain during the procedure.
4. Duration of local anesthesia: On the patient report form, each patient recorded the time that lapsed from the subjective onset of anesthesia to the time when the numbness of the lower lip wore off.
5. Additional injections of anesthetic drugs required (in numbers).
6. Incidence of postoperative (severe) adverse effects. Postoperatively, patients were administered 500 mg paracetamol (1 tablet every 4-6 h as necessary for pain) and 500 mg amoxicillin (1 capsule, 4 times a day, before a meal and before bed), orally for 5 d.

The statistical analysis of the subjective and objective onset of anesthesia, anesthetic duration, surgical time, and VAS value of intra-operative pain was performed using the paired t-test. Fisher's exact test was used to analyze the statistical difference in the number of additional anesthetic injections administered in the groups.

RESULTS

Initially, 23 patients were included in the study. One participant was withdrawn when he did not attend the second surgical appointment. Therefore, the final sample included 22 patients with a mean age of 21 years. No adverse events were detected during surgery or in the postoperative period.

Fig. 1 shows the types of molar impaction identified on panoramic radiographs, and all patients had bilaterally symmetric impactions.

As shown in Table 2, the onset of local anesthesia with 4% articaine was significantly more rapid in both subjective and objective onsets than that with 4% lidocaine. Moreover, 4% articaine had a longer anesthetic

duration than 4% lidocaine, although the difference was not statistically significant. Additionally, there was no significant difference in the surgical time between the 4% articaine and 4% lidocaine groups.

The intensity of intra-operative pain was rated on the

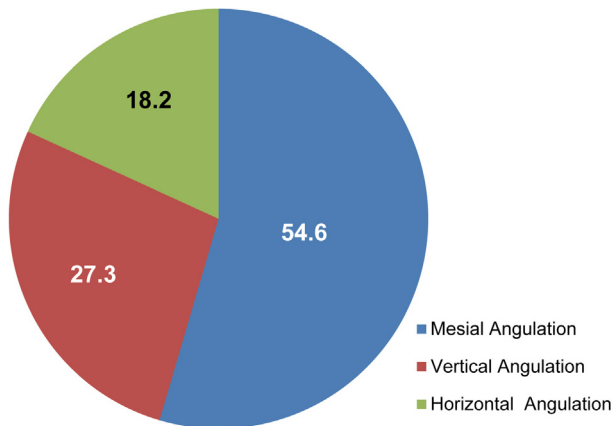


Fig. 1. Types of lower third molars of the patients studied in this study are shown.

0-100 mm VAS by the patients, and the results showed that patients in the 4% articaine group experienced more pain than those in the 4% lidocaine group. During suturing, the 4% lidocaine group experienced more pain than the 4% articaine group; however, the difference was not statistically significant (Table 3).

The difference in the number of cases requiring additional anesthetic injections between the two groups at each step was not statistically significant even though more patients in the 4% articaine group required additional anesthetic injections than in the 4% lidocaine group (Table 4).

DISCUSSION

A previously published study used a 3-4 week interval between the first and second surgeries for patients with

Table 2. Comparisons among subjective onset, objective onset, and duration of anesthesia and surgical time

Measurement	4% Articaine	4% Lidocaine	P-value
Subjective onset (s)	134.86 ± 69.26	253.95 ± 154.10	0.003*
Objective onset (min)	7.28 ± 2.73	10.05 ± 3.43	0.003*
Duration of anesthesia (min)	287.55 ± 82.79	258.82 ± 81.76	0.221
Surgical time (min)	19.46 ± 5.44	17.76 ± 7.05	0.053

Note: s, second; min, minute

Table 3. Comparison of the intensity of intra-operative pain on the visual analog pain scale (0-100 mm)

Step of measurement	4% articaine	4% lidocaine	P-value
Drug addition	27.48 ± 20.48	23.64 ± 17.62	0.450
Soft tissue incision	14.61 ± 21.41	7.48 ± 15.33	0.195
Bone removal	10.98 ± 13.43	5.36 ± 6.59	0.067
Tooth sectioning	9.07 ± 15.17	4.73 ± 8.02	0.122
Tooth elevation	20.55 ± 17.53	14.89 ± 17.71	0.257
Suturing	0.25 ± 0.84	1.27 ± 2.50	0.069
Immediate post-op	4.68 ± 12.66	1.45 ± 3.03	0.248

Note: post-op, post operation

Table 4. Comparison of the number of cases requiring additional anesthetic during the procedure

Procedure	4% Articaine (N=22)	4% Lidocaine (N=22)	P-value
Repeated IANB	2	2	1.000
Soft tissue incision	1	0	1.000
Bone removal	2	0	0.488
Tooth sectioning	4	3	1.000
Tooth elevation	0	0	0
Suturing	0	0	0

Note: IANB, Inferior alveolar nerve block

bilateral lower third molar surgery [3,4,12]. Therefore, we chose a 3-week interval between the surgeries in this study so that postoperative sequelae of the local anesthetic injection, such as pain and numbness, were reduced.

Our results showed that 4% articaine and 4% lidocaine, with the same concentration of vasoconstrictor (1:100,000 epinephrine) had similar clinical efficacy in lower third molar surgery. The main difference between the groups was in the subjective and objective onset of anesthesia, with 4% articaine demonstrating a more rapid onset than 4% lidocaine. These results are similar to those from the study by Rebolledo et al. [13] that reported a mean anesthetic latency of 75.04 s (\pm 14.8) and 56.03 s (\pm 9.76) for the lidocaine and articaine groups, respectively. However, the difference observed between the two anesthetic solutions was not statistically significant [11]. Many previous studies have confirmed that the onset of anesthesia for articaine was faster than that with lidocaine. However, these studies used 2% lidocaine in comparison with 4% articaine [11,13]. In our study, the quicker onset of anesthesia with articaine than that with lidocaine, when the same concentrations of anesthetic and vasoconstrictor were used, was statistically significant. This difference in the two anesthetic solutions of the same concentration appears to be a more reliable comparison.

A factor that can influence the onset of anesthetic action is protein binding. Higher levels of protein binding could lead to a higher potency of neuroplasm blockage. Other factors that might have an effect on anesthetic duration include the dose administered, vascularity at the site of injection, and concentration of vasoconstrictor [14,15]. Administering the local anesthetic closer to the nerve could also provide a greater effect and longer duration of anesthesia than administering it a further distance from the nerve during the nerve block procedure [16,17].

Articaine has one of the greatest protein binding percentages of all the amide local anesthetics; therefore, it has a longer anesthetic effect [18]. Numerous previous studies have confirmed that 4% articaine has a longer duration of anesthetic effect than 2% lidocaine, and the

difference is statistically significant [11,19-21]. As shown in this study, 4% articaine also exhibits a longer duration of anesthesia than 4% lidocaine; however, the difference was not statistically significant. The main difference in this study from previous studies is the use of an increased concentration of lidocaine, from 2% to 4%, along with the vasoconstrictor.

To determine the degree of anesthesia, intra-operative VAS measurements were used to compare the efficacy of the local anesthetics. Most previous studies have shown patients who were administered 4% articaine experienced less intra-operative pain than those who received 2% lidocaine [1,13]. However, this study showed that the 4% lidocaine group experienced less intra-operative pain than the 4% articaine group, though the difference was not statistically significant. Therefore, dentists could apply 4% lidocaine for use in clinical practice.

Moreover, another notable finding was the requirement of additional local anesthesia during surgery. A previous study demonstrated the necessity of additional local anesthesia when 2% lidocaine was used during surgical procedures [13]. However, this study showed that the articaine group required additional anesthesia more than the lidocaine group during the procedure, although the difference was not statistically significant. Therefore, the procedure could be performed by dentists using either 4% lidocaine or 4% articaine with similar efficacy.

Additionally in this study, the surgical time was not statistically different between the two local anesthetic groups.

In conclusion, the IAN block using 4% articaine was found to be more clinically effective in subjective and objective onsets of anesthesia than with using 4% lidocaine. The VAS measurements showed that 4% lidocaine provided a more adequate analgesia for the lower third molar surgery and less intra-operative pain than those observed with 4% articaine; however, no clinically significant difference was found between the two groups.

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ETHICS APPROVAL: This study was approved by the Committee in the Ethics of Research in Human Dentistry and Pharmacy of Mahidol University, Institutional Review Board (Protocol No. MU-DT/PY-IRB 2015/021.0206).

NOTES: There are no financial or other issues that might lead to conflict of interest.

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