Anesthetic Efficacy of 4 % Articaine During Extraction of the Mandibular Posterior Teeth by Using Inferior Alveolar Nerve Block and Buccal Infiltration Techniques

Khalid E. El-Kholey^{1,2}

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Abstract

Introduction The study was designed to evaluate the anesthetic efficacy of 4 % articaine with 1:100,000 epinephrine (A100) in infiltration and inferior alveolar nerve block (IANB) anesthetic techniques for the pain control during extraction of the mandibular posterior teeth.

Methods This prospective randomized single-blind clinical trial included 100 patients needing extraction of at least two mandibular molars. Patients received either infiltration in the buccal vestibule opposite to the first molar supplemented with lingual infiltration or standard IANB with A100. For assessment of depth of anesthesia obtained by the two anaesthetic techniques, presence or absence of pain during the extraction were rated using the visual analog scale.

Results Fifty patients received infiltration anesthesia and fifty patients were anesthetized by IANB. The success rate of pain-free extraction after buccal infiltration was 94 %, whereas by using IANB with the same anesthetic it was 92 %. No statistical differences were detected in the success rates between the two anesthetic techniques ($P = 0.15$).

Conclusions Buccal Infiltration can be considered a good option during extraction of the mandibular molar and premolar teeth of course, with supplemental lingual anesthesia.

Keywords Articaine · Mandibular molars · Infiltration · Nerve block · Extraction

Introduction

Providing effective pain control is one of the most important aspects of dental care. Infiltration anesthesia is the common method used to anesthetize maxillary teeth with an adequate rate of success. However, only recently infiltration with an articaine formulation has been used to anesthetize mandibular first molars with promising results [1–3].

Mandibular molars are usually anesthetized by regional blockade of the inferior alveolar nerve. Unfortunately, the reported failure rates for the inferior alveolar nerve block are commonly quite high, that may be related to absence of consistent anatomical landmarks. This difficulty of obtaining high success rate of pain control after traditional Inferior alveolar nerve block led to development of alternative techniques such as Gow-Gates mandibular nerve block, Akinosi-Vazirani closed-mouth nerve block, intraligamentary injections, and intraosseous anesthesia. Although, those techniques have some advantages over the inferior alveolar block, they have some limitations, contraindications, and disadvantages [4–6]. However, it would be beneficial if similar results could be achieved by simpler options such as the infiltration technique.

A number of studies have shown the superiority of 4 % articaine to 2 % lidocaine, both with 1:100,000 epinephrine when used as primary buccal infiltration of the mandibular first molar [7–10]. Additional studies compared the depth of pulpal anesthesia in the mandibular molars obtained after buccal infiltration by articaine to that obtained after the inferior alveolar nerve block (IANB) with 2 %

✉ Khalid E. El-Kholey
Alkoley@hotmail.com

¹ Ain-Shames University Hospitals, Cario, Egypt

² Present Address: Oral Surgery Department, Ibn Sina College for Medical Studies, Jeddah 21418, Saudi Arabia

lidocaine and found a similar success rate for both of them [9, 11]. Moreover, other studies clearly demonstrated that articaine by buccal infiltration in the mucobuccal fold of the first mandibular molar can provide more successful anesthesia to mandibular teeth when administrated alone or as a supplement to the IANB with lidocaine or articaine [12, 13]. However, none have compared IANB with buccal infiltration, both with articaine during extraction of mandibular molars and premolars.

The null hypothesis of the present study was that the infiltration of A100 in the buccal vestibule of the lower first molar will be as effective as IANB with A100 during extraction of the mandibular posteriors. The aim was to compare the anesthetic efficacy of 4 % articaine with epinephrine (1:100,000) in achieving anesthesia during extraction of mandibular molar and premolar teeth. The primary outcome measure was a pain-free extraction.

Materials and Methods

Study Design and Patient Selection

This prospective, randomized, single-blind clinical study was performed at the Oral Surgery Department, Dentistry program, Ibn Sina College for Medical Studies, Jeddah, Saudi Arabia. This study followed the Declaration of Helsinki on medical protocol and ethics and the regional Ethical Review Board of Ibn Sina College for Medical Studies approved the study. Details of the treatment were discussed with the patients and an informed consent agreement was signed by them.

The inclusion criteria were the presence of at least two mandibular molars in the same side that are indicated for extraction with agreement of patient to extract more than one tooth in the same visit under local anesthesia.

The exclusion criteria comprised loose teeth with severe bone loss, or very small remaining roots just attached to the soft tissues. This in addition to any patients with allergy to the local anesthetics, were pregnant, had significant medical conditions, patients younger than 18 years, were taking any medications that could affect pain assessment, or had active sites of infection in the area of injection.

Using data from a previous study [8], a power calculation dictated that 50 subjects in each treatment group would provide a 90 % chance of detecting a 25 % difference in success rates, assuming a significance level of 5 %.

Treatment Protocol

One hundred patients from the outpatients who visited Ibn Sina dental clinic in the period from September 2012 to March 2014 were divided into 2 groups by using a simple

randomization procedure. For allocation of the subjects, a computer-generated list of random numbers was used with a randomization ratio of 1:1 by using random allocation software (version 1.0, May 2004). One blinded nurse enrolled all participants and assigned them to each of the anesthetic technique to determine which technique to be used at each appointment. Only the random numbers were recorded on the data-collection sheets to further blind the experiment. For all the patients, the anesthetic used was 4 % articaine with 1:100,000 epinephrine (Ubistesin forte, 3 M Espe, Germany), but administrated by different technique in the two groups. Group I consisted of patients who received a buccal infiltration in the mucobuccal fold adjacent to mandibular first molar supplemented with a lingual infiltration. Group II consisted of subjects who received standard IANB of A100.

After the usual preparation of the site of injection and application of topical anesthesia, the anesthetics were administrated as follows:

1. For the patients in the group I, 1.5 mL of A100 was administrated in depth of the mucobuccal fold opposite to the mandibular first molar. For the lingual soft tissue anesthesia, 0.3 mL of the same anesthetic was deposited under the lingual mucosa opposite to the tooth to be extracted or at the most posterior one, in case of multiple teeth extraction.
2. All patients of group II received a standard IANB injection with 1.5 mL of A100, then 0.3 mL was used for long buccal injection in the mucobuccal fold distal to the tooth to be extracted.

Additional 0.3 mL of the same anesthetic would be infiltrated if needed for weak lingual soft tissue anesthesia, to supplement weak buccal soft tissue anesthesia obtained by IANB or for purpose of hemostasis.

After 10 min, the patients were asked whether they were having lip numbness. Patients who did not report lip numbness were excluded from the study. In those who reported lip numbness, objective signs of anesthesia were investigated by a deep prick of buccal and lingual mucosa using a sharp needle to confirm the depth of anesthesia. Upon confirmation of the profound anesthesia and depending on the treatment plan of the patient, any molar or premolar teeth in that side planned to be extracted were removed at the same visit by the same anesthesia. The extraction of the molars was started by separating the roots using a surgical bur. After complete separation of the roots, straight grooved elevators (No 301 and No 34S) were used for adequate luxation before their picking up from the sockets using the forceps. This procedure was followed in all the molars extraction as most of the molars were badly decayed or had insufficient tooth structure and also to standardize the procedures for all the patients. Regarding

the premolar. The extractions were finished after adequate luxation with same elevators. If the patient felt pain, or any discomfort was noticed during any step of the surgery, the procedure was stopped and the anesthesia was considered failure.

Assessment of Anesthetic Efficacy

The following parameters were reported:

1. Total volume of anesthetic solution used during the surgery (in mL).
2. Quality of the anesthesia provided by the two anesthetic techniques during the surgery and evaluated by the surgeon, according to a modification of the method described by Sisk [14]. This was based on a 3-point category rating scale: 1 = no discomfort reported by the patient during the surgery; 2 = any discomfort reported by patient during the surgery, without the need for additional anesthesia; and 3 = any discomfort reported by patient during the surgery, with the need of additional anesthesia.
3. Difficulty of the surgery according to the surgical trauma, rated by the surgeon at the completion of each extraction, according to a 3-point category rating scale: 1 = easy; 2 = normal; 3 = complicated [14].
4. Subjective intraoperative pain evaluation: Before the extraction, each patient was instructed on how to rate any pain that may be felt during the extraction using a Heft-Parker visual analog scale (VAS) [15]. VAS used was a 170-mm line with various descriptive terms. The subjects placed a mark on the scale where it best described their pain level. To interpret the data, the VAS was divided into the following 4 categories: no pain corresponded to 0 mm on the scale; mild pain was defined as >0 and <54 mm, which included descriptors of faint, weak, and mild pain; moderate pain was defined as >54 and <114 mm; severe pain was defined as ≥ 114 and included the descriptors of strong, intense, and maximum possible. Subjects recorded the pain scores immediately after the surgery.

Pain-free treatment was defined as no pain felt by the patient or discomfort noticed during the surgery. If any patient felt pain during the surgery and the reported pain on VAS was >0 mm during his pain assessment, the technique was considered unsuccessful. Those patients who experienced pain during the extraction categorized as failure of pain-free treatment, and managed according to the best local practice, with further supplementary injections as needed.

Analysis was undertaken in SPSS version 15 for Windows (SPSS Inc, Chicago, IL), and the significance level was set at $P \leq 0.05$.

Results

One hundred patients were recruited to participate in this study. Table 1 shows the distribution of the study population on the basis of sex, mean age, and total number of the teeth extracted. There were no significant differences in age, gender, and reason of extraction between the two groups. Table 2 shows the distribution and number of the molar and premolar teeth extracted during the study.

The mean total volume of anesthetic used during the surgery in the two groups was not significantly different. When infiltration anesthesia was used, it was 1.9 mL, and when IANB used, it was 2 mL (Table 3).

The mean scores attributed to quality of anesthesia were very close to 1, and a score of 3 was not attributed to any surgery, strongly suggesting that patients felt no discomfort during all of the surgeries irrespective of the anesthetic technique used. Regarding difficulty of extraction for the different patients, there were no statistically significant difference in the surgeon's mean rating of surgical difficulty between patients of the two groups, irrespective of the anesthetic technique used (Table 3).

The percentage of patients with successful anesthesia depending on criteria cited before was 94 % for the patients receiving infiltration anesthesia. For group II that received IANB it was 92 %. However, there was no significant difference between the two anesthetic techniques in rate of success ($P = 0.15$, Table 3).

Discussion

Lidocaine hydrochloride has maintained its status as the most widely used local anesthetic in dentistry since its introduction. Proven efficacy, low allergenicity, and minimal toxicity through clinical use and research have confirmed the value and safety of this drug. Thus, it became labeled the gold standard to which all new local anesthetics are compared. Despite the gold standard status of lidocaine hydrochloride, numerous reports have advocated the use of articaine hydrochloride as a superior anesthetic agent, primarily on the basis of its enhanced anesthetic potency, which is 1.5 times greater than that of lidocaine, with faster onset and increased success rate [16]. Articaine, classified as an amide anesthetic, has increased liposolubility and potency because of presence of a thiophene ring. According to some authors, its ability to diffuse can produce

Table 1 Summary of data of patients and reason for extraction

Value	Infiltration with 4 % articaine (n = 50)	IANB with 4 % articaine (n = 50)	<i>P</i> value
Age (mean + SD years)	32.2 ± 7.7	30 ± 6.8	0.26
Male (male/female)	30/21	25/24	0.34
Total number of teeth extracted during the study (molar/premolar)	100/60	100/53	0.16

Table 2 Distribution of molar and premolar teeth extracted during the study

Number of teeth extracted	First molar	Second molar	First premolar	Second premolar
Infiltration anesthesia	50	50	35	25
IANB	50	50	31	22

Table 3 Total volume of anesthetic used, difficulty of surgery, and number and percentage of the patients successful anesthesia

Variables measured and anesthetic technique	Infiltration	IANB	<i>P</i> value
Total volume of anesthetic (mean ± SD mL)	1.9 ± 0.14	2 ± 0.14	0.50
Difficulty of surgery	1.20 ± 0.40	1.26 ± 0.44	0.26
Anesthetic success n (%)	47 (94 %)	46 (92 %)	0.15

n number of patient, *SD* standard deviation

pulpal anesthesia in mandibular teeth after infiltration anesthesia [17, 18].

Although articaine shows no advantage over lidocaine as an inferior dental nerve block [19] articaine buccal infiltrations have been reported to have a higher anesthetic success rate in molars and premolars than lidocaine [3, 10]. However, none have compared IANB with buccal Infiltration, both with articaine during extraction of mandibular molars and premolars.

The results of the present trial indicate that buccal infiltration of articaine produced success rates similar to that of IANB of articaine for pain control during extraction of lower molar and premolar teeth. The definition of successful anaesthesia in the present study was similar to that employed by Kanaa et al. [20] in that success was defined as pain-free treatment. This is different to other studies that defined successful anaesthesia as an absence of response to the pulp test reading of 80 [21]. Absence of response to electrical pulp testing up to reading of 80 is considered as one of important signs for successful anesthesia for the teeth with vital pulp. However, subjective symptoms as lip numbness and absence of pain during the treatment are more practical and easily applicable methods to test efficacy of the anesthesia, especially when the tooth or teeth to be extracted are non-vital, no electric pulp tester available, or to avoid false results that may occur with the electric pulp tester [22, 23].

Our results demonstrated higher success rate for both infiltration and block techniques than results of a study that used A100 for achieving pulpal anesthesia in the mandibular molars with the same techniques [8]. Percent of

patients with successful anesthesia in our study after buccal infiltration and IANB anesthesia was in the range of 92–94 %, while percentage of anesthetic success in the above mentioned study ranged from 65 to 69 % for the buccal infiltration anesthesia. On the other hand, success rate after IANB in same study was in the range of 69–75 %.

The likely difference in the anaesthetic success rates between our study and the previous study may be related to the type of the treatment done. We depended solely on a pain-free extraction as the criterion of success in the present study. Previous study considered absence of pain during the gaining of access to the pulp chamber and also during pulp extirpation as a criterion of success. In the light of the fact that, root canal therapy in a vital pulp is capable of producing intense, sharp pain if performed under less than adequate anesthesia. This intense pain during these procedures is due to direct manipulation of the myelinated A-delta and the unmyelinated C-afferent sensory neurons that requires a high degree of local anesthesia. It also has been shown that obtaining anaesthesia for extraction procedures on teeth with irreversible pulpitis is simpler and more successful than procedures such as pulp extirpation [24].

Some studies showed good percentage of pulpal anesthesia in the lower premolars after buccal infiltration of A100 in the first molar area. Robertson et al. [10] found that anaesthetic success rate for the lower first and second premolar (depending on absence of response to electric pulp tester of 80 readings) was 86 and 92 % respectively. In another study [26], the percent of successful pulpal

anaesthesia for the first premolar was 77.3 %. Successful extraction of 60 premolar teeth performed after buccal first molar infiltration anesthesia in the current study reflects the good results of achieved pulpal anesthesia in the premolars after same buccal infiltration technique in those previous studies.

The exact mechanism of action by which buccal infiltration of articaine at the area of lower first molar achieves its effect to anesthetize the lower posterior teeth is not known. Meechan [25] in his article about the use of infiltration anesthetic technique to anesthetize mandibular teeth in adults mentioned that the likely mechanisms might be related to infiltration through the inferior alveolar nerve canal, blocking the inferior alveolar nerve distal to that point or infiltration through the mental foramen to produce a modified mental incisive nerve block. Recently, Currie et al. [26] published a study in April 2013 that concluded that mandibular first molar infiltration with articaine achieved its effect via a combination of modified mental and incisive nerve block and articaine diffusion through the mandibular bone to the tooth apices in this region, producing a field block anesthesia. This last study [26] and fact that articaine is able to diffuse through soft and hard tissues more reliably than other local anesthetics [9] may help in explaining how the articaine injected buccal to the lower first molar was used successfully by the author of this current work for the surgical removal of impacted lower wisdom [27].

Meechan [1] in his article on infiltration anesthesia in the mandible has mentioned benefits which include: infiltration is technically simple, it is more comfortable for patients, can provide hemostasis when needed, in many cases obviates the presence of collateral innervations, and avoids risk of potential damage to nerve trunks. In addition, infiltration techniques may be preferred in some patient groups such as those suffering from clotting disorders to avoid unwanted internal bleeding. However, a buccal infiltration with articaine is not without some shortcomings as its short duration of action may be a disadvantage in long procedures. Also a supplemental injection will be needed for lingual anesthesia in case of extraction or any procedure in which, lingual soft tissues will be manipulated.

Conclusions

Although Infiltration and IANB were equally effective, buccal infiltration of the lower first molar by 4 % articaine could be used as a good option for extraction of the mandibular posterior teeth, of course, with supplemental lingual anesthesia.

Further study with a larger number of patients and different age range may be useful in providing more data on this extensively investigated technique.

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Compliance with Ethical Standards

Conflict of interest The author denies any conflicts of interest related to this study.

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