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Research Article

The Efficacy of Articaine Single Buccal Injection for Maxillary Premolars Extraction: A Randomized Clinical Study

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Abstract

Background: The palatal injection is the most frequently used painful injection, but there is evidence that articaine 4% administered through buccal injection alone can extract maxillary teeth painlessly. ***Objective***: A comparative study is conducted to evaluate the anesthetic efficacy of articaine 4% buccal without palatal injection for extraction of maxillary premolars compared to lidocaine 2% buccal and palatal injection. ***Methods***: A randomized, single-blinded clinical trial was carried out involving 200 patients, of whom 104 were females and 96 were males, who were indicated for extraction of maxillary premolar teeth. The patients were randomly divided into two groups: Group A, control group: The maxillary premolar tooth extraction was performed under buccal and palatal infiltration anesthesia with 1.8 mL of 2% lidocaine hydrochloride with 1:80,000 epinephrine. Group B, a study group, extracted the maxillary premolar's teeth under buccal anesthesia without palatal infiltration anesthesia with articaine hydrochloride 1.8 mL, 4% with 1:100,000 epinephrine. The outcome variable was the pain experienced during the extraction using the Visual Analogue Scale (VAS). ***Results***: Statistical analysis showed that the difference in pain perception during extraction by VAS scores was statistically non-significant between the control and the study groups. ***Conclusions***: The painful palatal injection in the extraction of maxillary premolars can be overcome by using only a buccal injection of articaine 4%.

Keywords: Articaine, Bicuspid, Extraction, Lidocaine, Palatial injection.

فعالية حقنة واحدة من الأرتيكائين في الشدق لقلع الضواحك الفكية: دراسة سريرية عشوائية

الخلاصة

الخلفية: الحقن الحنكي هو الحقن المؤلم الأكثر استخداما، ولكن هناك أدلة على أن اعطاء ارتيكائيين 4٪ من خلال حقن الشدق وحده يمكن من قلع أسنان الفك العلوي دون ألم. **الهدف**: تم إجراء الدراسة لتقييم فعالية التخدير باستخدام أرتيكائين 4٪ في الشدق بدون حقن حنكي لقلع الضواحك الفكية مقارنة بحقن ليدوكائين 2٪ في الشدق والحنك. **الطريقة**: تم إجراء تجربة سريرية عشوائية أحادية التعمية شملت 200 مريض، منهم 104 من الإناث و 96 من الذكور، الذين تم تحديدهم لقلع أسنان الضواحك الفكية. تم تقسيم المرضى عشوائيا إلى مجموعتين: المجموعة الضابطة: تم إجراء قلع الضواحك الفكية تحت التخدير الشدقي وتخدير تسلل الحنك مع 1.8 مل من 2٪ ليدوكائين هيدروكلوريد و 1: 80000 ادرينالين. مجموعة الدراسة، استخرجت أسنان الضواحك الفكي تحت التخدير الشدقي دون تخدير تسلل الحنك مع أرتيكائين هيدروكلوريد 1.8 مل، 4٪ مع 1: 100000 ادرينالين. كان متغير النتيجة هو الألم الذي حدث أثناء الاستخراج باستخدام المقياس التناظري المرئي. وتم تحليل البيانات باستخدام اختبار t غير المزاوج. أظهر التحليل الإحصائي أن الفرق في إدراك الألم أثناء القلع بواسطة درجات المقياس التناظري المرئي كان غير ذي دلالة إحصائية بين المجموعة الضابطة ومجموعات الدراسة. **الاستنتاجات**: يمكن التغلب على الحقن الحنكي المؤلم في قلع الضواحك الفكية باستخدام 4% أرتيكائين بحقن الشدق فقط .

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INTRODUCTION

Pain management is one of the most important aspects of patient satisfaction and safety. The use of local anesthetics is crucial to the practice of pain management in dentistry [1]. There are several different local anesthetic medications available for this purpose. Patients often avoid getting local anesthetic injections because of the discomfort and anxiety they cause. As a result, providing painless treatment is one of dentistry's primary responsibilities. Many studies have tried to find a medication that is both less dangerous and more effective [2]. A palatal infiltrate, or block, is required for the extraction of maxillary teeth. Injections into the palate are painful. Despite the palatally administered surface anesthetic before injection, several individuals still experienced pain. Injections into the palate are quite painful due to the close binding of the mucosa to the underlying periosteum and the high number of nerve endings in the area. Mucoperiosteum displacement is another factor that can cause pain [3]. Patients typically have the worst experience receiving injections in the palatal region. It is recognized as the most painful dental procedure and a true cause of dental phobia [4]. Fear of needles prevents about 5% of the population from getting necessary dental care [5]. Due to the presence of a thiophene ring, articaine differentiates from the other amide local anesthetics. The thiophene ring facilitates diffusion across the lipid-rich neuronal membrane to reach target receptors, making the molecule more lipid-soluble [6]. Because of the chemical characteristics of articaine as a local anesthetic and the consistently thin architecture of the maxillary bone, palatal anesthesia can be achieved through buccal infiltration [7]. This study aimed to determine whether 4% articaine infiltration with a single buccal infiltration is comparable to 2% lidocaine using the conventional approach (buccal and palatal injection) to extract maxillary premolars.

METHODS

Ethical approval and consent to participate

Protocol number 414121 of this study was authorized by the Research Ethics Committee of the University of Baghdad College of Dentistry. All principles of the Declaration of Helsinki were used to deal with patients. All patients understood the protocol of treatment and signed an informed consent sheet. No animals were used in this study.

Study design

A randomized, single-blinded clinical trial was conducted between February and December 2022 at the Department of Oral and Maxillofacial Surgery at the College of Dentistry, University of Baghdad, and Almamon Specialized Dental Centre in Baghdad. The protocol was registered at ClinicalTrials.gov (identifier: NCT05951907). The sample size included two hundred patients who met the study's inclusion criteria. Two groups of 100 patients were randomly assigned using a randomization program found at https://www.graphpad.com. Group A was the control group in which the extraction of the maxillary premolar's teeth was carried out under buccal and palatal infiltration anesthesia with 1.8 mL cartridges of 2% lidocaine hydrochloride and 1:80,000 epinephrine (Huons, Korea). Group B, a study group in which the maxillary premolar's teeth were extracted under buccal without palatal infiltration anesthesia with 1.8 mL cartridges of 4% articaine hydrochloride and 1:100,000 epinephrine (Artheek, Colombia), The flow chart of the experiment is explained in Figure 1.

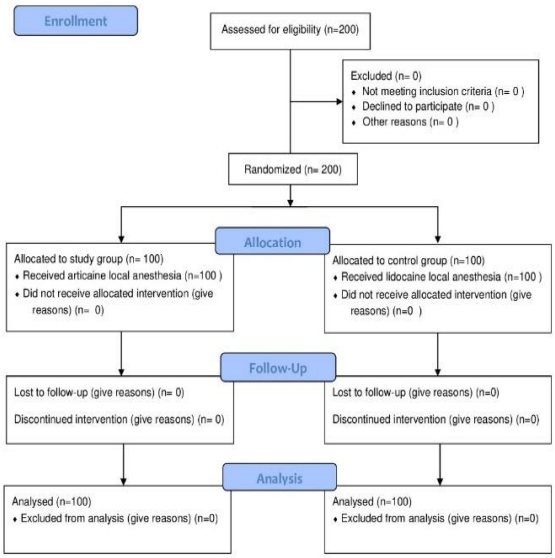

Figure 1: The flow chart of the experiment.

Sample size determination

G Power 3.1.9.7 for Windows (Heinrich-Heine University, Dusseldorf, Germany) was utilized for the sample size calculation. Using the following parameters: α err prob 0.05, power (1-β err prob) 0.95, and effect size d 0.5, an a priori sample size calculation was performed. The sample size calculation resulted in 176 patients, with 88 patients in each group. Even so, to address the attrition inherent in prospective research, the sample size was inflated by 12%. It was decided to include 200 patients, divided into two groups of 100 for each control and study group.

Inclusion and exclusion criteria

Patients older than 18 years old, both genders, and patients who indicated extraction of one of the unrestorable maxillary premolars were included in this study. The excluded patients from this study were allergic patients to any local anesthetics used, pregnant patients, patients with mobile teeth, patients with uncontrolled systemic diseases, patients on medication affecting pain assessment like opioids, patients with periapical lesions, and patients who required flap design and bone removal.

Blinding

All participants were unaware whether they were part of the control or study groups. An online randomization program randomly assigned patients to either Group A (the control group) or Group B (the study group).

Surgical procedure

Patients in the control group had infiltration with 2% lidocaine in 1.8 ml. After inserting the needle in the buccal vestibule above the accused tooth, approximately 1.5 mL of local anesthetic solution was given slowly before the syringe was carefully removed. Palatal infiltration involves injecting around 0.3 mL of solution through a needle placed at the junction of the palate's horizontal and vertical regions. In the study group, patients received a total of 1.8 mL of 4% articaine via an infiltration technique, with the local anesthetic solution injected the entire length of the cartridge buccally without palatal injection. Probing the marginal gingiva around the tooth at 60 seconds, 120 seconds, and 180 seconds post-injection was used to assess the onset of anesthesia in both groups. Failure to induce local anesthesia during these periods indicates a failed procedure, necessitates a second cartridge, and excludes the patient. The tooth extraction procedure started with the buccal and palatal gingiva being separated. The tooth was luxated mesially and distally with a straight elevator, and finally, the tooth was extracted with forceps. The difficulty of extracting these teeth was noted to be low.

Data collection

In all the patients, the demographic data, age and gender, and distribution of the extracted teeth were recorded, and the number of minutes spent on extracting was registered. A visual analogue scale rated both groups' pain levels during the extraction, a VAS scale from 0 to 10, in which zero is no pain and ten is the worst.

Study variables

It was found that injecting 4% articaine hydrochloride with 1:100,000 epinephrine without injecting it into the palate and 2% lidocaine hydrochloride with 1:80,000 epinephrine injected buccally and palatally were the most important predictors of maxillary premolar extraction. Extraction duration in minutes, tooth distribution, and demographic information such as age and gender were also recorded. The difference between the two groups' levels of pain during extraction, as measured by a pain VAS scale ranging from 0 (no pain) to 10 (unbearable pain), was one of the outcome variables.

Statistical analysis

Statistical Package for Social Research was used for descriptive analysis and presentation (SPSS version 22, Chicago, Illinois, USA). Frequency, percentage, mean±SD, Shapiro Wilk test, Chi-square, unpaired *t*-test; p-values<0.05 were considered statistically significant.

RESULTS

Two hundred patients participated in this study; 48 percent were males and 52 percent were females, ranging in age from 18 to 72 years. Concerning the distribution of demographic characteristics between the two groups in this study, a non-significant difference was reported in age and gender distribution (Table 1).

Table 1: The differences in age and gender distribution between the two groups

Variables	Control group	Study group	*p*
Gender, *n*(%)			
Female	50(50)	54(54)	0.571
Male	50(50)	46(46)	
Age (year)	39.76±14.17	40.51±13.81	0.705

Values are presented as mean±SD and number (%).

The distribution of the extracted maxillary premolars in the whole sample size between both the study and control groups of this study is explained in Figure 2. Concerning pain during extraction (VAS), scores showed no significant difference between the study and control groups. In contrast, the extraction duration showed a significant difference between the study and control groups, as explained in Table 2.

Table 2: The differences in the extraction pain (VAS) and duration between the two groups

Variables	Control group	Study group	*p*
Pain (VAS)	1.2±1.58	1.24±1.72	0.864
Duration (min)	6.42±2.89	5.5±1.92	0.009

Values were presented as mean±SD; VAS: visual analogue scale.

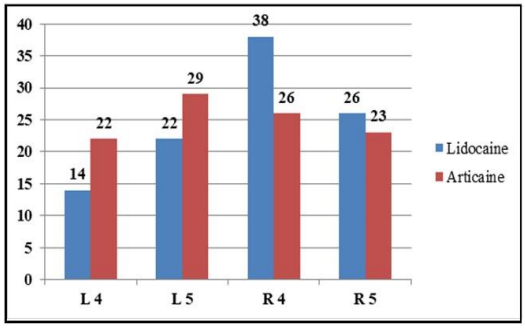

Figure 2: The extracted teeth distribution. (L4: upper left first premolar, L5: upper left second premolar, R4: upper right first premolar, R5: upper right second premolar).

The result of this study showed a non-significant difference concerning pain during extraction among

genders. The descriptive and statistical tests are shown in Table 3. The pain during extraction (VAS) scores recorded a non-significant difference among ages for the ≤40 age group and the >40 age group. The descriptive and statistical test of pain during extraction among ages is shown in Table 4.

Table 3: The differences in the pain during extraction (VAS) among gender.

Variables	Male	Female	*p*
Pain (VAS) (mean±SD)	1.02±1.21	1.4±1.96	0.095

(VAS: visual analog scale; SD, Standard deviation.

Table 4: The differences in the pain during extraction (VAS) among age.

Variables	≤40	>40	*p*
Pain (VAS) (mean±SD)	1.31±1.67	1.1±1.63	0.373

VAS: visual analog scale, SD: Standard deviation.

DISCUSSION

Local anesthesia is a fundamental component of dental pain management strategies. For the treatment and management of pain, local anesthetics are the safest and most efficient medications available. However, for most patients, getting these drugs is part of their appointment with the dentist that causes them the most pain and anxiety. The needle is the most frightening aspect of administering local anesthetics [8]. Scientific studies have demonstrated that fear of dental injections causes 5% of the population to avoid necessary dental care [5]. The most painful method of anesthetic infiltration is palatal injection. Although techniques to reduce palatal injection pain have been suggested, they are not yet in widespread use [9]. Due to the considerable nerve supply and close connection of the palatal mucosa to the underlying periosteum, the palatal injection has traditionally been considered the most painful of any injection in the oral cavity [10]. Instead of the needle piercing the mucosa, the mucoperiosteum displacement seems to be the source of this pain [11,12]. This study assessed patients' pain levels during extraction using the visual analogue scale (VAS 0-10), a widely used self-reported measure of pain. The scale measures are assumed to have a continuous range from zero (no pain) to ten (unbearable pain). which is difficult to measure directly. In this study, a non-significant difference was found between the VAS scores of people who had an extraction with an injection of articaine in the buccal area and those who had the same procedure with lidocaine in the buccal and palatal areas. The scores of VAS ranged from 0 to 7 in both groups, with the mean pain rating (VAS) scores in the articaine treated group being 1.240 and 1.200 for the lidocaine (control group). Close results by Darawade *et al*. (2014) [13] reported that the statistical analysis in their study showed little difference (VAS) in pain rating for test and control sites. However, all individuals in the lidocaine group needed palatal anesthesia. Moreover, other studies [5,14-15] found no statistically significant difference in the visual analogue scale (VAS) scores for permanent maxillary tooth removal between the two injection forms, and all patients rated both extractions as "acceptable." Furthermore, Uckan *et al*. (2006) [12] reported that there was no statistically significant difference between permanent maxillary tooth removal with a palatal injection of 4% articaine HCl with 1:100,000 epinephrine (97.5%) and without a palatal injection of 4% articaine HCl with 96.8%, as measured by (VAS) and (FPS) scores. According to research performed by Luqman *et al*. [16] which includes 194 patients, there were no statistically significant changes in VAS scores between the groups that received articaine buccal injections and those that received lidocaine buccal and palatal injections during the extraction of maxillary molars, premolars, and incisors. The articaine group had the lowest mean (VAS) score in the premolar area. In 2012, Kanaa *et al*. [17] showed that buccal infiltrations with 4% articaine and 2% lidocaine with 1:80,000 epinephrine generated equal degrees of pain-free treatment. According to another investigation on treating irreversible pulpitis in the maxilla, the tooth extraction group had a higher success rate for pain-free treatment than the pulp extirpation group. To reduce patient suffering during exodontia, the authors suggest using 4% articaine for buccal infiltration of maxillary teeth that can be extracted without palatal infiltration. The patient experience can be greatly enhanced by recommending its use in all cases of simple maxillary exodontia. Since articaine is the only amide LA with a thiophene ring, making it more lipid-soluble, it stands to reason that it would perform better in buccal infiltration than lidocaine did in this trial. Articaine's greater lipid solubility allows it to diffuse more effectively into soft tissues, leading to a greater intraneural concentration, wider longitudinal spreading, and more effective conduction blockage than other anesthetics. Articaine, a thiophene derivative, blocks ionic channels at far lower concentrations than lidocaine, a benzene derivative; this matched the results of numerous other investigations [18,19]. Results from the current investigation conflicted with the findings of Özeç *et al*. [20], who included that an anesthetic of 4% articaine HCl in the palatal tissues following buccal injection could not be detected. Another study that contradicts these findings is that conducted by Mittal *et al*. [21], which found that articaine did not produce sufficient palatal anesthesia during the extraction of primary maxillary molars. When patients were divided into two groups based on gender in the present study, there was no statistically significant difference in VAS values between genders when the injection type was ignored. Many studies [22,23] reported significant statistical differences with higher VAS scores in the female group than in the males, explaining the low pain threshold of females compared to males. Another outcome measured in this study was pain scores according to age. There were

non-significant statistical differences in VAS scores among ages. This outcome agrees with [22], who reported the same records. While Somuri *et al*. [14] mentioned that all individuals in the lignocaine group experienced no pain during extraction, three individuals in the articaine group, aged 21, 26, and 28, reported mild discomfort. In the current study, there was a significant statistical difference in the extraction duration between the two groups. The mean was 6.42 for the lidocaine group and 5.50 for the articaine group. The records show that the extraction under the articaine group takes slightly less time than the lidocaine group, which could be explained by the fact that articaine has a quicker onset, a longer duration of action, and a larger diffusing property. This fact is close to other studies that reported the fast onset and high success rate of anesthesia with articaine [24,25]. In 2018, a study by Gazal [6] indicated that patients who received articaine buccal infiltration before tooth extraction reported a quicker beginning time of anesthetic effect than those who received mepivacaine buccal infiltration. The outcomes of this study disagree with that reported by Bataineh *et al*. [23], who found a statistically insignificant difference in the extraction duration between the two groups and suggested that extraction difficulty was comparable.

Limitations of the study

The limitations of the current study were that it was not a split-mouth technique due to time limitations and difficulty in data collection. Moreover, the operator was not blinded to the type of anesthesia (single-blinded study).

Conclusion

Articaine 4% buccal infiltration can be used for the extraction of permanent maxillary premolar teeth successfully without the need for palatal injection, and buccal infiltration with 4% articaine is just as effective as the "gold standard" of buccal and palatal infiltration with 2% lidocaine.

Conflicts of interest

There are no conflicts of interest.

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Data sharing statement

Supplementary data can be shared with the corresponding author upon reasonable request.

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