Anesthetic Efficacy of Three Different Volumes of 4% Articaine for Extraction of Maxillary Posterior Teeth – A Randomized Trial

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Abstract

Adequate pain control is the cornerstone of any successful surgical or dental treatment. This study was done to assess the efficacy of three different concentrations of 4% articaine: 0.6 ml, 0.9 ml and 1.2 ml in achieving anesthesia for the extraction of posterior maxillary teeth.

This study included 90 patients requiring simple or surgical extraction of their maxillary teeth. Patients were divided randomly into three groups. Patients in group 1 were administered 1.2 ml of 4% articaine. Patients in group 2 were administered 0.9 ml of 4% articaine and in group 3 patients were administered 0.6 ml of 4% articaine, all with 1:100000 epinephrine, in the mucobuccal fold above the tooth to be extracted. All extractions in the three groups were done within the same time frame and were finished in 30 minutes or less depending on whether it was a simple or a surgical extraction. All procedures including anaesthetic administration and extraction were done by the same operator. The response of each patient to the onset of anesthesia, pain perception on the numeric rating scale during the extraction procedure and the need for supplementary injection were assessed.

No statistically significant difference was found in terms of the need for supplementary injection between all three groups (p=0.889). On the numeric rating scale (NRS) no significant difference in terms of pain perception was found between the three groups. Group III had the highest mean followed by group II and finally group I.

Within the limitations of this study it can be concluded that the use of 0.6% ml of 4% articaine is enough to achieve sufficient anesthesia for the extraction of maxillary posterior teeth.

Clinical article (J Int Dent Med Res 2020; 13(1): 241-245)

Keywords: Dental extraction, Articaine, Infiltration anesthesia.

Received date: 03 August 2019 **Accept date:** 25 October 2019

Introduction

The clinical management of intraoperative pain is a crucial part of successful dental procedures[1]. With the variety of local anesthetic agents and techniques; the clinician's knowledge and choices make all the difference. The ideal local anesthetic technique before simple or surgical extraction procedures should be of rapid onset and acceptable duration. Amide local anesthetic agents are the most commonly used types with Articaine being one of the potent members of the amide group [2]. The chemical structure of Articaine gives it a higher lipid solubility due to the extra thiophene ring. This facilitates the diffusion of the LA molecules across the nerve cell membrane[2] The anesthetic technique used during extraction of posterior maxillary teeth is mainly a simple para-periosteal infiltration procedure at the apex of the tooth to be extracted [2,4]. Articaine has been reported to be potent and with a rapid onset when administered locally (infiltration anesthesia) for extraction of maxillary teeth [5,6]. The deposited volume needed for potent anesthesia in cases of local infiltration have been debatable. Volumes ranging from 0.5 mL to 2mL of local anesthetic solution have been reported [5-7].

The purpose of this study was to assess the efficacy of using three different volumes of 4% articaine: 0.6 ml, 0.9 ml and 1.2 ml in achieving anesthesia for the extraction of posterior maxillary teeth.

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Materials and methods

This study included 90 patients requiring simple or surgical extraction of their maxillary teeth (Figure 1). Ethical approval was obtained from the Ethical committee of the National Research Centre in Cairo and the study followed the Helsinki Declaration guidelines. Patients were divided randomly into three groups. Patients in group 1 were administered 1.2 ml of 4% articaine. Patients in group 2 were administered 0.9 ml of 4% articaine and in group 3 patients were administered 0.6 ml of 4% articaine, all with 1:100000 epinephrine, in the mucobuccal fold above the tooth to be extracted.

All extractions in the three groups were done within the same time frame and were finished in 30 minutes or less depending on whether it was a simple or a surgical extraction. All procedures including anaesthetic administration and extraction were done by the same operator. The pain perception on the numeric rating scale (NRS) during the extraction procedure and the need for supplementary injection were recorded (figure 2).

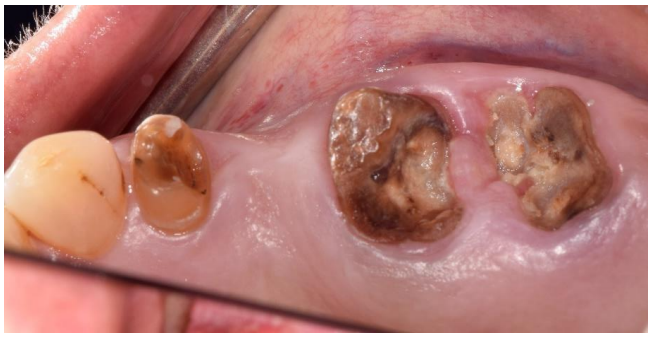

Figure 1. showing one of the included patients requiring extraction of the upper first molar

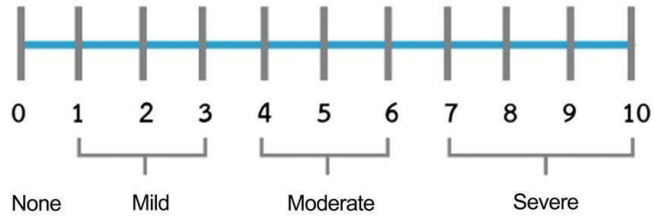

Figure 2. image of the numerical rating scale used to assess pain level.

This randomized blinded clinical trial received an ethical approval from the ethical committee at the national research centre, Cairo, Egypt. A sample size calculation was made according to a previous study with a type I error set at .05. The sample size was calculated to be 25. Written informed consents were collected from all the volunteering patients, none of which had medical conditions contraindicating the use of Articaine and epinephrine. A total of 90 patients were included in the trial divided randomly into 3 different groups; Group 1: receiving 1.2 mL Group 2: receiving 0.9mL and Group 3 receiving 0.6 mL of 4% articaine with 1:100,000 epinephrine [1](Figure – 3). [[1]Artinibsa, Inibsa Dental S.L.U., Llica de Vall- Barcelona, Spain.
[2](C-K Ject, CK Dent CO. LTD, India)]

Figures 3 and 4. Showing the used dental cartridge and needle used to deposit the anesthetic solution.

The cartridges were the same size and shape stored properly in one box. The same operator performed all the procedures using the same technique and within the same time frame – a maximum of 30 minutes' extraction procedure. The local anaesthetic 27-gauge needle [2] (Figure-4) was inserted at the depth of the sulcus at the apex of the tooth listed for extraction and advanced 4 to 7 mm until bony contact was achieved, and it was slightly retracted to provide paraperiosteal deposition. The lips and cheek were retracted by a dental mirror to apply slight tension to the tissue, and the needle inserted into the tissue at the depth of the mucobuccal fold between the mesial and distal roots of the respective tooth. The bevel of the needle was held towards the bone and the syringe was parallel to the longitudinal axis of the tooth with the tip of the needle inserted into the depth of the buccal vestibule. According to which group the patient belonged, the designated volume was deposited. No anaesthetic solution was deposited as the needle was advanced to the target site in any of the groups. An identical 0.2 mL palatal injection was performed with all the patients. The patients were unaware to which group they belonged, but the clinician had to be informed just before injection to enable proper control of the amount of LA solution deposited.

Five minutes after deposition of the anesthetic solution a dental probe was used to check the success of the anesthesia. The need for a supplementary injection during the extraction procedure was recorded, and the patients filled an NRS (Numeric Rating Scale) for the pain level during the procedure. The need for supplemental injection was recorded as a Yes/ No answer and the results of both were sent for statistical analysis.

Results

All the 90 patients included in the study completed the trial. The age ranged from 30-60 years old with a mean of 46 years old. Sixty-two of the patients were female while thirty-eight of them were males. The patient's NRS scores were gathered and the mean and standard deviation values were calculated for each group. The data was explored for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests and showed non-parametric (not-normal) distribution. Kruskal Wallis test was used to compare between the groups (more than 2 groups) in non-related samples while the Mann Whitney test was used to compare between two groups in non-related samples. The significance level was set at $p \leq 0.05$.

Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows. The need for a supplementary injection was recorded as a Yes or No answer where the need for any additional anesthetic procedures during the extraction was considered a "Yes" and not needing any a "No".

Variables		Need for Supplementary Injection	
		N	%
Group I	No	11	80%
	Yes	3	20%
Group II	No	11	73.3%
	Yes	4	26.7%
Group III	No	11	73.3%
	Yes	4	26.7%
p-value		0.889 (ns)	

Table 1. showing the frequency of Need for Supplementary Injection in the different groups. *; significant (p<0.05) ns; non-significant (p>0.05).

The results showed no statistically significant difference between Groups I, II and III where *p*=0.889. For Group I; 11 cases (80%) needed no supplementary injection and 3 cases (20%) needed a supplementary Injection, while for group II; 11 (73.3%) needed no supplementary Injection and 4 (26.7%) did, for Group III; 12 cases (73.3%) needed no supplementary Injection and 4 (26.7%) did (Table 1 and figure 5).

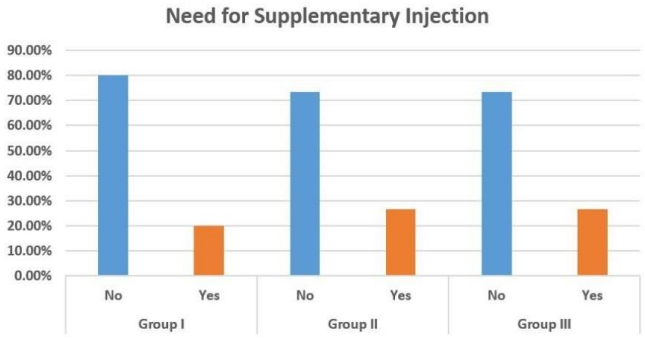

Figure 5. Bar chart representing the need for supplementary injection for the different groups.

Variables	NRS		
	Mean	SD	Median
Group I	0.8	1.78	0
Group II	0.93	1.79	0
Group III	1.27	1.83	0
p-value	0.571 (ns)		

Table 2. The mean, standard deviation (SD) and median values of NRS in different groups.*; significant (p<0.05) ns; non-significant (p>0.05).

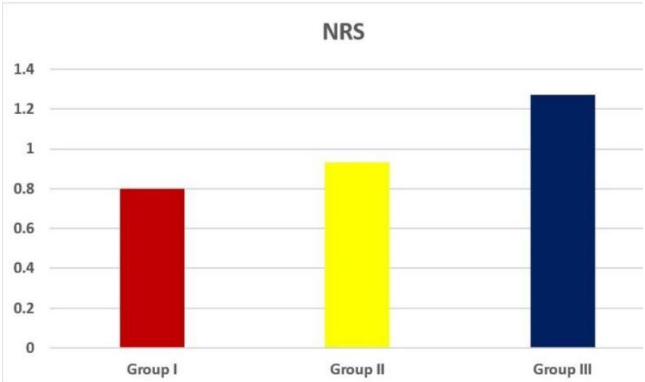

Figure 6. Bar chart representing the NRS for the different groups.

Regarding the numerical rating scale, no statistically significant difference was found between all three groups where (*p*=0.571). The

highest mean score was found in Group I, followed by Group II, while the least mean score was found in Group III (Figure 6).

Discussion

Potent local anesthetic delivery is a crucial requirement of a satisfactory dental treatment. A painless procedure is part of the positive feedback we want delivered by our patients. Different anesthetic techniques are available which depend on the anatomy of the region. Infiltration anesthesia is usually the first anesthetic option in basic maxillary procedures since it is a straight forward technique with high success rates [9– 11]. The infiltration of local anesthesia depends on the deposition of the local anesthetic solution at a point close to the apex of the tooth to be extracted and allowing it to seep through the spongy maxillary bone to reach the dental supplying nerves. The efficacy of this technique can be attributed to the smoothness, density, porosity, and thickness of the bone surrounding the maxillary teeth.[12]

Infiltration is defined as the deposition of the local anesthetic agent at or near the pulp apex to allow for the solution to seep through to reach the terminal nerve endings supplying the pulp and investing structures. When this is successful; surgical procedures within the area anesthetized can be carried out painlessly[3,4.] Articaine is an amide type local anesthetic agent which has been commonly used as a 4% concentration solution. Toxicity of articane has been reported and includes cardiac toxicity, allergic reactions and tissue toxicity. Although the specific underlying mechanisms for these are not clearly explained but they still are a possibility.[4, 13]

Reduction of the risks of toxicity are necessary and are achieved by reducing the total volume of local anesthetic solution deposited during the dental infiltration procedure. Reports on the volume of solution needed to attain acceptable analgesia during maxillary extraction procedures are limited. The results of the current study have shown that varying the anethsetic dose for maxillary infiltration from 1.2 to 0.9 to 0.6 ml had no statistically significant effect on the need for a supplementary injection or the pain score during the extraction procedure. 4% articaine solution with 1:100000 epinephrine has been reported to be a potent local anesthetic solution for dental procedures.[8] It has also been reported that 0.6 mL of 4% articaine with 1:100000 epinephrine provided satisfactory dental anesthesia for extraction of primary molar teeth.[15, 16]

Assessment of anesthetic efficacy in this study was done by analysing the need for a supplemental injection and the patient's reporting of pain during the extraction procedure according to the NRS (numeric rating scale). The NRS was described to the patients before the procedure to make them more familiar with the assessment method. A scale of 1 – 10 was used where 0 was the score given to a painless procedure and 10 the score given to the severest form of pain. Several other studies have used pain scores to evaluate the patient's pain perception [6,8,13,15,17-18]. The need for a supplemental injection was used to identify the failure of the specific volume of articaine deposited (according to the patient's group) in achieving the anesthetic effect desired. The results of the current study show that a minimum volume of 0.6 ml of 4% articaine with 1:100000 allowed for the simple or surgical extraction of maxillary posterior teeth with no significant difference for the need of supplementary injection or the patients pain score on the VAS when compared to higher volumes of 0.9 and 1.2 ml respectively.

Conclusions

Within the limitations of this study it can be concluded that buccal infiltration of 0.6 mL of 4% articaine with 1:100000 epinephrine provides satisfactory anathesia for the pulp and investing structures allowing for successful extraction of maxillary posterior teeth.

Compliance with Ethical Standards

- Funding: No funding received.
- Conflict of interest: All 3 authors declare no conflict of interest.
- Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The ethical committee of the National Research Centre – Cairo, Egypt has approved the study.
- An informed consent was obtained from all individual participants included in the study.

Declaration of Interest

The authors report no conflict of interest and the article is not funded or supported by any research grant.

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