

Comparison of 4% Articaine Versus 2% Lidocaine for Tooth Extraction of Mandibular Molars

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KEYWORDS

Articaine, lidocaine, tooth extraction, molar, Kabul

ABSTRACT

Teeth extraction requires a painless procedure with minimal dosage and needle insertions. Articaine possesses unique chemical structure incorporating a thiophene moiety, which augments its lipophilicity, and an ester group that is conducive to plasma biotransformation. This study was conducted to compare efficacy of 4% articaine and 2% lidocaine for extraction of mandibular molars at Stomatology Teaching Hospital, Kabul. This prospective cohort study included 60 patients (30 in each group) who were referred for extraction of lower molar teeth. Data were collected using pre-structured checklist and analyzed using SPSS version 21.0. Independent t-test was used to compare onset and duration of anesthesia, statistical significance set at $p < 0.05$. Most of the participants (65%) were male, with mean age of 34.81 ± 12.12 years. Onset of anesthesia in patients administered with articaine was on average 97 sec, whereas in lidocaine-administered patients it was 158.5 sec ($p < 0.001$). Duration of anesthesia in articaine administered group (236.4 min) was significantly longer than in lidocaine administered group (164.4 min) ($p < 0.001$). Onset of anesthesia with articaine was faster than with lidocaine, and duration of anesthesia with articaine was longer than with lidocaine. Therefore, articaine is recommended for the extraction of mandibular molars.

INTRODUCTION

Pain control during tooth extraction using nerve blocks is a well-established local anesthesia technique that is widely used in oral surgery. Effective pain management and adequate anesthesia are essential in oral surgical procedures, as they influence patient comfort, procedural success, and overall treatment experience. Previous research in oral surgery has emphasized the importance of evaluating pain-related outcomes following dental procedures [1]. Articaine was initially developed in 1969 by Rusching under the name of carticaine, with a molecular weight of 284.4 g/mol. It became recognized as an unparalleled local anesthetic in dentistry and was introduced as a new local anesthetic by the Ames Group in 1976, which was

later converted to articaine [2]. This local anesthetic has similar effects to lidocaine but is an effective and safe option for dental extraction surgeries owing to its appropriate onset and duration of action. It is also safe for use in paediatric patients, readily available on the market, and extensively used in various dental surgical procedures [2, 3].

The selection of appropriate local anesthetic agents for performing procedures comfortably and efficiently is crucial, primarily relying on clinical considerations of the onset and duration of anesthesia. Another important aspect of local anesthesia is the pharmacokinetic properties of local anesthetic agents, including their absorption, distribution, and metabolism. Articaine undergoes biotransformation by liver enzymes in the plasma and is then metabolized. Notably, approximately 5 to 10 percent of this drug remains unchanged, and the rest is excreted by the kidneys. Another important characteristic of this anesthetic agent is its good tissue absorption and excellent diffusion properties [4].

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Several studies in different countries have compared the efficacy of articaine versus lidocaine; a study by Malamed et al. (2000) reported that patients who received articaine had better tolerance and clinical efficacy than those who received lidocaine [5]. A systematic review and meta-analysis reported that the duration of anesthesia with articaine was longer than that with lidocaine (mean difference = 68.86 min) and the onset of anesthesia was shorter than that with lidocaine (mean difference = -15.10 sec) [6]. Another study by Thomas et al. (2023) also reported that 4% articaine demonstrated superior anesthetic efficacy compared to 2% lidocaine [7]. Likewise, a similar study by Haider et al. (2023) showed that 4% articaine was clinically more effective than 2% lidocaine [8]. Additional studies have also indicated that 4% articaine infiltration is more effective than 2% lidocaine [9-11]. Since similar research has not been conducted in Afghanistan and 4% articaine is not widely used among Afghan dentists, it is important to evaluate whether its efficacy in this population is comparable to that reported in other settings. Therefore, this study was conducted at the Stomatology Teaching Hospital to assess the effectiveness of 4% articaine compared to 2% lidocaine for the extraction of mandibular molars. Beyond addressing the local evidence gap, the findings of this study have broader clinical significance, as they may contribute to evidence-based decision-making in the selection of local anesthetics. In particular, the results may help improve anesthetic efficacy and enhance patient comfort during mandibular molar extractions. Furthermore, this study may provide valuable insights to guide local clinical practice and inform policy decisions regarding the adoption and use of articaine in Afghanistan.

MATERIALS AND METHOD

This prospective cohort study was conducted at the Stomatology Teaching Hospital of Kabul University of Medical Sciences. Ethical approval was obtained from the Institutional Review Board of Kabul University of Medical Sciences (643:07/01/2020), and informed consent was obtained from all patients prior to enrollment in the study. Patients with indications for mandibular molar extraction (extensive dental caries, preapical pathology, failed previous treatment, and non-restorable tooth) and aged 18 year and above who were referred to the oral surgery clinic were included in this study. Those who were sensitive to local anesthesia, pregnant, had acute infections, or had prolonged dental extractions exceeding 60 min were excluded from the study.

The sample size was calculated using online software, assuming 90% power, a 99% confidence level, and a 1:1 allocation ratio between the intervention and control groups. Based on previous findings, the mean onset time of anesthesia was 56 seconds for the articaine group and 75 seconds for the lidocaine group, with a standard deviation of 14 seconds [12]. The minimum required sample size was estimated to be 34 participants (17 per group). However, to increase statistical power and enhance the reliability of the findings, the final sample size was expanded to 60 participants (30 per group).

The data were collected using a pre-structured checklist, which captured sociodemographic information as well as relevant clinical characteristics of the procedure. Patients who visited the oral surgery clinic on even days received articaine, while those who visited on odd days received lidocaine. Among those who received 4% articaine with epinephrine 1:100,000, 30 individuals were selected; 30 individuals who received 2% lidocaine with epinephrine 100,000 were selected as the control group. Each patient was examined, and the tooth was extracted by an oral surgeon. The same oral surgeon performed the surgery and examination. An equal amount of anesthetic (1.8 milliliters) was administered to both groups using the Standard Technique: The needle is inserted lateral to the pterygomandibular raphe, approximately 6-10 mm above the occlusal plane of the mandibular teeth. The needle is advanced until bone is contacted near the mandibular foramen. After aspiration, the anesthetic is injected with a 27-gauge long needle [13].

The onset of anesthesia was defined as the time interval from needle withdrawal until the first objective sign of anesthesia, assessed by the presence of Vincent's sign (numbness of the ipsilateral lower lip), which is considered a clinical indicator of successful inferior alveolar nerve block. Although Vincent's sign reflects soft tissue anesthesia, it was used as the primary objective measure of onset in this study. Patients were examined at 30-, 15-, and 10-second intervals to detect its occurrence.

The duration of anesthesia was defined as the time from onset of anesthesia until complete return of normal sensation, indicating recovery of soft tissue anesthesia. Patients were assessed at 60-, 30-, 15-, and 5-minute intervals to record the duration of anesthesia. Patient discomfort was evaluated clinically based on verbal reporting and behavioral response during the procedure. Patients were

blinded to the type of local anesthetic administered to reduce bias in subjective reporting.

Statistical Package for Social Science (SPSS), version 21.0, was used to analyze the data. An independent t-test was used when appropriate to compare the onset and duration of anesthesia effects. Statistical significance was set at $p < 0.05$.

RESULTS

Approximately two-thirds of the patients were male (65%, 39 individuals) and 35% (21 individuals) were female. The gender distribution was similar in both the groups. The mean age of patients was 34.81 ± 12.12 years. The average age in the lidocaine group was 34.36 ± 12.10 years, while in the articaine group, the average age was 35.26 ± 12.33 years (Table 1).

Table 2 shows a comparison between articaine and lidocaine. The onset of anesthesia among patients in articaine group was approximately one and a half

minutes, while among patients in lidocaine group, it was about two and a half minutes, and this difference was statistically significant ($p < 0.001$). The duration of anesthesia in the articaine group was significantly longer than lidocaine group ($p < 0.001$). The duration of the surgical procedure in both groups was similar ($p = 0.493$).

Table 1 Characteristics of study participants by type of anesthetic agents

	Lidocaine		Articaine		Total	
	n	%	n	%	n	%
Sex						
Male	19	48.7	20	51.3	39	65.0
Female	11	52.4	10	47.6	21	35.0
Age, mean $\pm$ SD	34.36 $\pm$ 12.10		35.26 $\pm$ 12.33		34.81 $\pm$ 12.12	
< 20	3	50.0	3	50.0	6	10.0
20-29	10	52.6	9	47.4	19	31.7
30-39	8	50.0	8	50.0	16	26.7
40-49	4	50.0	4	50.0	8	13.3
≥ 50	5	45.5	6	54.5	11	18.3

Table 2 Distribution of anesthesia onset and duration by type of anesthetic agents

Anaesthetic Type	Unit	N	Mean	Standard Deviation	Median	Range	P-value
Onset of Action	Seconds						< 0.001
Lidocaine		30	158.5	17.3	160	135-210	
Articaine		30	97.0	19.7	90	75-150	
Duration of Action	Minutes						< 0.001
Lidocaine		30	164.4	22.1	160	110-200	
Articaine		30	236.4	20.1	230	210-275	
Duration of Surgery	Minutes						0.493
Lidocaine		30	14.4	9.6	11	8-60	
Articaine		30	13.3	3.7	12	8-25	

DISCUSSION

In this study, the efficacy of 4% articaine and 2% lidocaine for mandibular molar extraction was assessed in terms of onset time and duration of anaesthesia. The results demonstrated that 4% articaine had a faster onset of action (97 sec) compared to 2% lidocaine (158.5 sec), and a longer duration of anaesthesia (236.4 min vs. 164.4 min). These findings indicate that articaine provides superior clinical efficacy under the conditions of this study.

A systematic review and meta-analysis by Yant et al. (2020) reported that the duration of anesthesia with 4% articaine was longer than that with 2% lidocaine, and the onset of anesthesia was shorter with articaine than with lidocaine [14]. A study by Sierra et al. (2007) in Spain, using a randomized double-blind clinical trial with 30 patients

undergoing tooth extraction, found that 4% articaine had better onset and duration of action than 2% lidocaine. The duration of action for 4% articaine was 220.86 min and that for 2% lidocaine was 168.20 min ($p = 0.003$). The onset of action of 4% articaine (56.0 sec) was better than that of 2% lidocaine (75.0 sec); however, this difference was not statistically significant [12]. A similar study from India, with 20 patients undergoing tooth extraction, found that the onset of action with 4% articaine was on average 58.5 sec compared to 177 sec with 2% lidocaine ($p < 0.005$). The average duration of action was 72 min with articaine and 49 min with lidocaine ($p < 0.005$) [15]. Another study from India compared 4% articaine with 2% lignocaine on 70 patients revealed that the onset of anesthesia with articaine was shorter than lignocaine (56.57 sec versus 88.26 sec) [16].

Another study from India on 60 patients found that the duration of anesthesia with articaine was longer

and the onset was shorter than that with lidocaine (duration 196.8 min vs 175.9 min and 81 sec vs. 84 sec), but the difference was not statistically significant [17]. Other studies have also found that the average duration of anesthesia with articaine is longer than that with lidocaine. The average onset of anesthesia with articaine was shorter than that with lidocaine, but the differences were not statistically significant [18-21]. Our findings are similar to those of previous studies. However, in some studies, only clinical differences were observed with no statistical significance. This discrepancy may be attributed to the small sample sizes of those studies and variability in clinical conditions (e.g., degree of inflammation, presence of infection, and tooth pathology).

Similar studies have demonstrated that articaine is more effective than lidocaine in terms of pain relief and anesthesia onset. A study by Thomas et al. (2023) reported that patients who received 4% articaine experienced less pain during surgery compared to those who received 2% lidocaine [7]. An umbrella review also indicated that 4% articaine is more effective than 2% lidocaine for local anesthesia in teeth with irreversible pulpitis [22]. Additionally, a systematic review comparing 4% articaine with 2% lidocaine for anesthesia in cases of irreversible pulpitis found that articaine demonstrated superior efficacy, including lower pain scores, faster anesthesia onset, and fewer adverse events [23].

In considering the use of 4% articaine versus 2% lidocaine, it is important to evaluate the potential benefits and risks associated with each anesthetic agent. The enhanced efficacy of 4% articaine may lead to improved surgery performance, as patients typically experience less pain and discomfort during procedures, facilitating smoother and more efficient surgical outcomes. From the patient's perspective, reduced pain during surgery can significantly enhance overall satisfaction and positively influence their perception of the treatment experience. However, the prolonged effects of anesthesia associated with 4% articaine should also be taken into account; longer-lasting numbness may impact postoperative activities, including difficulties with eating, speaking, or maintaining oral hygiene. Conversely, while 2% lidocaine may result in quicker recovery from anesthesia, it may not provide the same level of pain relief, potentially affecting both surgical performance and patient comfort. Therefore, a careful evaluation of the benefits and risks of both anesthetic agents is essential for optimizing patient care and outcomes.

The findings of this study have important clinical implications for mandibular molar anesthesia, where achieving adequate block can be challenging. Inferior alveolar nerve block with lidocaine may show delayed onset or insufficient anesthesia, particularly in inflamed or anatomically variable cases. In contrast, the faster onset and longer duration observed with 4% articaine suggest it may be a more reliable option for mandibular molar extractions. Its better diffusion may improve anesthetic success, reduce the need for repeat injections, and enhance procedural efficiency. In the local context of Afghanistan, where lidocaine is most commonly used, these results support considering articaine as an alternative, especially in complex cases, to improve pain control and patient comfort.

This study has several strengths and limitations that should be considered. As one of the first clinical comparisons of 4% articaine and 2% lidocaine in the Afghan population, it addresses an important gap in the literature and provides locally relevant evidence. The comparative design with equal group allocation and standardized data collection enhances the reliability and clinical applicability of the findings. However, the single-center design and relatively modest sample size may limit the generalizability of the results. Additionally, the population-specific nature of the study may affect the external validity of the findings. Therefore, further multi-center studies with larger and more diverse populations are recommended to confirm and extend these results.

CONCLUSION

In summary, the administration of 4% articaine for mandibular molar extraction demonstrated faster onset and longer duration of anaesthesia compared to 2% lidocaine. Based on these parameters, articaine showed more favorable anaesthetic performance under the conditions of this study. These findings suggest that 4% articaine may offer clinical advantages in procedures requiring inferior alveolar nerve block. However, prolonged anaesthetic effects should be considered, as they may result in extended postoperative numbness and associated inconvenience. Further studies with larger and more diverse populations are recommended to confirm these findings and to evaluate additional clinical outcomes and potential adverse effects.

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DECLARATION OF INTEREST

Authors declare no conflict of interest.

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