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COMPARING THE LOCAL ANAESTHETIC EFFICACY DURING THE EXTRACTION OF IMPACTED MANDIBULAR 3RD MOLARS IN POPULATION OF JIZAN PROVINCE OF SAUDI ARABIA- A RANDOMISED PROSPECTIVE STUDY"

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ABSTRACT

Aim: To compare the local anesthetic efficacy of 2% lidocaine, 2% mepivacaine, and 4% articaine with 1:100,000 epinephrine during the surgical extraction of impacted mandibular third molars in the Jizan population of Saudi Arabia.

Materials and Methods: This randomized prospective clinical study included 180 ASA-I patients aged 20–40 years requiring surgical removal of impacted mandibular third molars. Patients were randomly allocated into three groups (n = 60 each): Group A received 2% lidocaine, Group B received 2% mepivacaine, and Group C received 4% articaine, all with 1:100,000 epinephrine. Onset and duration of anesthesia, reinjection requirement, surgical time, hemodynamic changes, return of sensation, and postoperative pain (VAS at 24 hours) were assessed. Data were analyzed using ANOVA with $p < 0.05$ considered statistically significant

Results: Articaine showed the fastest onset of anesthesia (1.9 ± 0.4 min) compared to mepivacaine (3.1 ± 0.6 min) and lidocaine (3.5 ± 0.8 min; $p < 0.001$). The duration of anesthesia was significantly longer with articaine (245 ± 12 min) than mepivacaine (185 ± 15 min) and lidocaine (172 ± 14 min; $p < 0.001$). Reinjection was least required with articaine (4%) compared to mepivacaine (10%) and lidocaine (18%). Surgical time was shortest in the articaine group (18.6 ± 2.3 min; $p < 0.05$). Postoperative pain scores were lowest with articaine (2.1 ± 0.9) compared to mepivacaine (3.9 ± 1.1) and lidocaine (4.5 ± 1.2; $p < 0.001$). Hemodynamic variations were minimal and not statistically significant between groups.

Conclusion: Articaine provided faster onset, longer duration, superior anesthetic reliability, and lower postoperative pain compared to lidocaine and mepivacaine, without significant hemodynamic risks. It can be considered the anesthetic of choice for surgical removal of impacted mandibular third molars.

***Keywords*:**Articaine, Lidocaine, Mepivacaine,Mandibular third molar surgery ,Local anesthesia efficacy

INTRODUCTION

Local anesthetics play a pivotal role in oral and maxillofacial surgery, particularly during the extraction of impacted mandibular third molars, which is one of the most frequently performed surgical procedures in dentistry. Achieving profound and long-lasting anesthesia is critical, as inadequate pain control can compromise the surgical outcome and negatively affect the patient's overall experience. Traditionally, lidocaine has been considered the gold standard anesthetic agent due to its proven efficacy, acceptable safety profile, and widespread clinical familiarity. However, in recent years, articaine has emerged as a strong alternative owing to its unique chemical structure and superior diffusion properties, which may enhance both the efficacy and the duration of anesthesia in clinical practice [1]. Comparative clinical trials have demonstrated that articaine frequently provides a faster onset of action and prolonged anesthesia compared to lidocaine. These characteristics not only contribute to improved intraoperative comfort for the patient but also reduce the frequency of supplementary injections, thereby allowing the clinician to perform surgery more efficiently[2]. Such advantages are particularly relevant in procedures like third molar surgery, where surgical difficulty, operative time, and patient anxiety are often

considerable. Reviews of pharmacological evidence have further highlighted articaine's potential to replace lidocaine as the preferred anesthetic in dental practice, primarily because of its enhanced lipid solubility, superior bone penetration, and favorable safety profile. The thiophene ring structure of articaine is thought to contribute significantly to its ability to diffuse through dense mandibular bone, a property that is particularly valuable in inferior alveolar nerve blocks [3]. This pharmacological advantage explains why articaine has often been reported as more reliable in achieving profound anesthesia in the mandible, a region where lidocaine sometimes fails to provide sufficient depth.Moreover, systematic reviews and meta-analyses have consistently suggested that articaine may deliver superior clinical outcomes for third molar extractions compared to lidocaine. These include higher success rates of anesthesia, reduced intraoperative pain, and longer duration of numbness postoperatively, which can be beneficial in minimizing immediate postoperative discomfort [4]. Such evidence provides strong support for incorporating articaine more widely into oral surgery protocols.Importantly, potency comparisons with other commonly used agents such as mepivacaine have indicated that articaine exhibits greater anesthetic efficacy. Studies comparing these agents suggest that articaine not only provides profound anesthesia but also maintains a favorable balance between effectiveness and safety, reinforcing its role as a valuable and dependable option in oral and maxillofacial surgical practice [5]. Thus, growing clinical and pharmacological evidence points to articaine as a superior alternative to traditional agents, potentially redefining anesthetic protocols for surgical extraction of impacted mandibular third molars.

MATERIALS AND METHODS

This prospective randomized clinical study was conducted in the Department of Oral and Maxillofacial Surgery after obtaining approval from the Institutional Ethical Review Board and informed consent from all participants. A total of 180 patients aged between 20 and 40 years (mean age: 28.6 ± 5.2 years) were enrolled. Only ASA-I category individuals requiring surgical extraction of impacted mandibular third molars were included. Patients with fully erupted teeth, pathological conditions such as cysts or tumors, pregnant or lactating women, those with systemic diseases, psychological disorders, allergies to local anesthetics, or any medically compromised condition were excluded.Eligible patients were randomly allocated into three equal groups of 60 participants each using a computer-generated randomization sequence. Group A received 1.8 ml of 2% lidocaine with 1:100,000 epinephrine, Group B received 1.8 ml of 2% mepivacaine with 1:100,000 epinephrine, and Group C received 1.8 ml of 4% articaine with 1:100,000 epinephrine. All injections were administered using the conventional inferior alveolar, lingual, and long buccal nerve block technique with a 27-gauge long needle. The onset of anesthesia was determined both subjectively, by numbness of the lip and tongue, and objectively, by the absence of pain upon probing with a dental explorer. If anesthesia was not achieved within 10 minutes, the injection was repeated once; persistent failure led to exclusion from the study.All surgical procedures were performed by the same experienced surgeon to eliminate inter-operator bias. A standardized approach was followed, including a triangular mucoperiosteal flap, bone guttering with rotary instruments under irrigation, tooth sectioning when required, and delivery of the tooth, followed by closure with 3-0 black silk sutures using interrupted technique. Surgical time was recorded from the initial incision until placement of the final suture.Postoperatively, patients were prescribed amoxicillin 500 mg three times daily for 5 days and paracetamol 500 mg three times daily for 5 days. They were instructed to begin warm saline rinses from the second day and sutures were removed on the seventh postoperative day. Pain was assessed after 24 hours using a Visual Analogue Scale (VAS, 0–10).Hemodynamic parameters, including systolic and diastolic blood pressure, heart rate, and oxygen saturation, were recorded at three intervals: five minutes before injection, five minutes after injection, and immediately after surgery using a multiparameter monitor. The duration of anesthesia was measured from the onset of numbness until complete recovery of sensation in the lower lip.All the collected data were compiled into a master chart and analyzed using ANOVA with G*Power software. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as percentages. A p-value of less than 0.05 was considered statistically significant. The findings of the present study were compared with those of previously published research to ensure validation and reliability.

RESULTS

A total of 180 patients (96 males and 84 females) with a mean age of 28.6 ± 5.2 years were included in the present study. The demographic distribution reflected a relatively young adult population, which is consistent with the typical age group requiring surgical extraction of impacted mandibular third molars. Analysis of clinical indications for extraction revealed that pericoronitis was the most frequent reason for surgical intervention, accounting for 38%

of the cases. This was followed by dental caries in 27% of patients, pain of odontogenic origin in 18%, periodontal pocket formation in 10%, and other causes such as root resorption in 7%. These findings are in line with existing epidemiological data, which suggest that pericoronitis and caries are the leading pathologies necessitating removal of third molars, thereby reinforcing the clinical relevance of anesthesia selection in such procedures.The evaluation of anesthetic efficacy showed marked differences among the three agents studied. The mean onset of anesthesia was found to be significantly faster in the articaine group (1.9 ± 0.4 minutes), compared to mepivacaine (3.1 ± 0.6 minutes) and lidocaine (3.5 ± 0.8 minutes), with the difference being highly statistically significant ($p < 0.001$). This rapid onset with articaine can be attributed to its high lipid solubility and superior diffusion characteristics, which enable it to penetrate nerve membranes more efficiently. In practical terms, this allowed clinicians to initiate surgery sooner, thereby improving operative workflow and reducing patient waiting time under anesthesia.In addition to rapid onset, the duration of anesthesia was markedly prolonged in patients who received articaine. The mean anesthetic duration was 245 ± 12 minutes, substantially longer than mepivacaine (185 ± 15 minutes) and lidocaine (172 ± 14 minutes), with intergroup differences again being highly significant ($p < 0.001$). This extended period of numbness ensured adequate intraoperative comfort and minimized the risk of anesthetic wear-off during surgery. The requirement for repeat injections further highlighted the reliability of articaine, which demonstrated the lowest reinjection rate (4%), compared to 10% for mepivacaine and 18% for lidocaine. Clinically, this suggests that articaine provides a more predictable and sustained anesthetic effect, reducing both the need for additional anesthetic administration and associated patient discomfort (Table 1).

Table 1. Comparison of Anesthetic Efficacy among Study Groups (1,2)

Onset of anesthesia (min)	3.5 ± 0.8	3.1 ± 0.6	1.9 ± 0.4	<0.001
Duration of anesthesia (min)	172 ± 14	185 ± 15	245 ± 12	<0.001
Repeat injection required (%)	18%	10%	4%	<0.05
Return of normal sensation (min)	165 ± 11	178 ± 13	238 ± 14	<0.001

An analysis of recovery profiles revealed differences in the return of normal sensation to the lower lip, a parameter correlating with the duration of anesthetic action. Patients who received lidocaine experienced the earliest recovery (165 ± 11 minutes), followed by mepivacaine (178 ± 13 minutes). In contrast, those administered articaine had the longest time to return of normal sensation (238 ± 14 minutes). While this extended recovery may prolong residual numbness, it also reflects the agent's capacity to provide longer postoperative analgesic coverage, which can be advantageous in minimizing immediate postoperative discomfort (Table 1)Surgical parameters also reflected the superior efficacy of articaine. Procedures performed under articaine anesthesia were completed in significantly shorter operative times (18.6 ± 2.3 minutes) compared with mepivacaine (20.2 ± 2.5 minutes) and lidocaine (21.8 ± 2.7 minutes), with the differences being statistically significant ($p < 0.05$). This reduction in surgical duration can be attributed to more profound anesthesia, which facilitated smoother intraoperative conditions, decreased the likelihood of patient movement or distress, and allowed surgeons to work more efficiently.Postoperative pain assessment provided further support for the advantages of articaine. Visual Analogue Scale (VAS) scores recorded at 24 hours post-extraction revealed that patients in the articaine group experienced the lowest levels of pain (2.1 ± 0.9), while those in the mepivacaine (3.9 ± 1.1) and lidocaine (4.5 ± 1.2) groups reported significantly higher pain scores ($p < 0.001$). These findings underscore articaine's potential to extend pain relief into the postoperative phase, thereby improving overall patient comfort and reducing the need for additional analgesic medication (Table 2).

Table 2. Surgical Parameters, Pain Scores, and Hemodynamic Findings (3,4)

Parameter	Lidocaine	Mepivacaine	Articaine	p-value
Mean surgical time (min)	21.8 ± 2.7	20.2 ± 2.5	18.6 ± 2.3	<0.05
Postoperative pain score (VAS 24h)	4.5 ± 1.2	3.9 ± 1.1	2.1 ± 0.9	<0.001
BP change (mmHg)	+5.2 ± 2.1	+4.8 ± 1.9	+5.5 ± 2.3	NS
HR change (beats/min)	+3.2 ± 1.1	+3.0 ± 1.3	+3.4 ± 1.2	NS
SpO_2 change (%)	-0.3 ± 0.2	-0.2 ± 0.3	-0.3 ± 0.2	NS

Hemodynamic monitoring during the procedures demonstrated minor increases in systolic and diastolic blood pressure as well as heart rate following anesthetic administration in all three groups. However, these variations were within physiological limits and were not statistically significant between the agents, indicating that all anesthetics were well tolerated without adverse cardiovascular effects. Oxygen saturation (SpO_2) levels also remained stable throughout the surgical procedures, with no significant intergroup differences observed. These findings reinforce the cardiovascular and systemic safety profiles of lidocaine, mepivacaine, and articaine when administered within recommended clinical dosages (Table 2).Taken together, the results of this study demonstrate that articaine consistently outperformed both lidocaine and mepivacaine in terms of onset, duration, and depth of anesthesia, as well as postoperative pain control, while maintaining a comparable safety profile. These outcomes strongly support the use of articaine as the anesthetic of choice for surgical removal of impacted mandibular third molars.

DISCUSSION

Several recent investigations have focused on comparing articaine with other anesthetics, particularly lidocaine and mepivacaine, in the context of mandibular third molar extractions and other oral surgical procedures. A randomized clinical study by Vishal et al. demonstrated that 4% articaine with epinephrine provided superior anesthetic efficacy compared with 2% lidocaine in inferior alveolar nerve blocks, with shorter onset times and more profound anesthesia, highlighting its clinical advantage in routine oral surgery [6]. These findings are supported by evidence from systematic reviews and meta-analyses, which consistently report that articaine is safe and effective for routine dental treatments and often outperforms lidocaine in terms of efficacy without an increased risk of adverse events [7]. In addition, network meta-analyses have attempted to identify the most suitable anesthetic for third molar extractions. Camps-Font et al. concluded that articaine appears to be the most effective agent for inferior alveolar nerve blocks in the context of impacted mandibular third molar surgery, thus strengthening the argument for its preferential use [8]. However, while articaine generally demonstrates superior properties, studies comparing other anesthetic agents remain relevant. For example, Visconti et al. showed that mepivacaine and lidocaine both provide effective anesthesia in patients with irreversible pulpitis, though articaine was not included in this comparison, indicating the ongoing need for direct head-to-head trials to better define relative efficacy [9].The superiority of articaine over lidocaine has been reaffirmed by multiple meta-analyses, including the systematic review by Zhang et al., which reported that articaine provides greater anesthetic efficiency in third molar surgery compared to lidocaine, particularly in terms of onset and duration [10]. More recent randomized controlled trials continue to support these findings. A split-mouth study by de Souza Santos et al. found that both lidocaine and articaine were effective for third molar extractions; however, articaine provided more consistent analgesia, thus improving patient comfort during surgery[11]. Similarly, Hassan et al. confirmed the superior performance of articaine as an inferior alveolar nerve blocking agent in patients with irreversible pulpitis, demonstrating faster onset and longer duration compared to lidocaine[12].Expanding on administration techniques, Huang et al. investigated the efficacy and safety of infiltration anesthesia with 4% articaine compared to block anesthesia with 2% lidocaine in third molar extraction. Their results suggested that articaine infiltration could achieve anesthetic outcomes comparable to, if not better than, traditional lidocaine blocks, potentially offering a less invasive approach with fewer complications [13]. Earlier studies, such as that of SierraRebolledo et al., had already indicated articaine's superior performance in inferior alveolar nerve blocks compared to lidocaine, reinforcing these findings over time[14].Importantly, comparisons between articaine and mepivacaine have also been conducted. Almeida et al. performed a randomized, double-blind, split-mouth trial and concluded that articaine was more effective than mepivacaine in third molar surgeries, providing longer-lasting anesthesia and reducing the need for reinjection, which is crucial in minimizing intraoperative complications and enhancing surgical efficiency [15]. Collectively, the body of evidence from these clinical trials and systematic reviews strongly supports the clinical preference for articaine in oral surgery. Its consistent superiority over lidocaine and mepivacaine in terms of onset, duration, and potency underscores its value as the anesthetic of choice in mandibular third molar extractions and potentially other invasive dental procedures.

CONCLUSION

Articaine showed faster onset, longer duration, and greater anesthetic reliability compared to lidocaine and mepivacaine in mandibular third molar surgeries. It also resulted in significantly lower postoperative pain scores. Hemodynamic changes were minimal and clinically insignificant, making articaine a safer and more effective choice.

DECLARATIONS

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Competing Interests
The authors have no competing interests to declare.

Informed Consent
Not applicable.

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