Original Article

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Comparison of lidocaine with articaine buccal injection in reducing complications following impacted mandibular third molar surgery: a split-mouth randomized clinical trial

Amin Naghipour[1], Mohammad Esmaeelinejad[2], Seyed Vahid Dehnad[2], Anahita Shahi[3], Alireza Jarrahi[1]

[1]Student Research Committee, School of Dentistry, Semnan University of Medical Sciences, Semnan, Iran
[2]Department of Oral and Maxillofacial Surgery, School of Dentistry, Semnan University of Medical Sciences, Semnan, Iran
[3]Department of Periodontology, School of Dentistry, Semnan University of Medical Sciences, Semnan, Iran

Background: Complications following impacted third molar surgery significantly affect patients' quality of life during the immediate postoperative period. This study aimed to achieve the proper anesthesia method by comparing the effect of the application of lidocaine alone with the application of lidocaine and articaine simultaneously in reducing the complications during and following impacted mandibular third molar surgery.
Methods: The study design was a split-mouth double-blind randomized clinical trial. The study was conducted on 13 patients (26 samples) referred for elective surgical removal of bilateral impacted mandibular third molar with similar difficulty on both sides. Each patient underwent similar surgical procedures on two separate appointments. Each patient randomly received 2% lidocaine for conventional inferior alveolar nerve block and 4% articaine for local infiltration before the surgery on one side (group A) and 2% lidocaine alone (for both block anesthesia and infiltration) before the surgery on the other side (group B). Intraoperative and postoperative variables for both groups were established and statistically analyzed.
Results: The findings showed that pain on the first day after surgery in group A was significantly lower than that in group B. The patients in group A mentioned experiencing less discomfort following the surgery. The increased horizontal swelling on the first and third days following surgery and oblique swelling on the seventh day in patients in group B were statistically significant.
Conclusion: Choosing an appropriate anesthetic drug for oral surgery, specifically impacted third molar surgery, is dependent on the clinician's opinion, however; it seems that the combination of lidocaine and articaine may control the patient's pain significantly better than lidocaine alone.

Keywords: Lidocaine; Local Anesthesia; Pain; Third Molar.

INTRODUCTION

Third molar surgery is one of the most common procedures performed by oral and maxillofacial surgeons and general dentists. The impacted third molar surgical extraction involves traumatic manipulation of bone, joint, and muscle tissues [1]. Pain, swelling, and trismus are common complications associated with mandibular third molar surgical removal, all of which are the results of

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Corresponding Author: Mohammad Esmaeelinejad, Department of Oral and Maxillofacial Surgery, School of Dentistry, Semnan University of Medical Sciences, Semnan, Iran
Tel: +98 23 33 34 07 86 Fax: +98 23 33 33 17 29 E-mail: esmaeelnejad@gmail.com

secondary tissue inflammation due to injury. These symptoms severely affect patients' quality of life during the immediate postoperative period [2].

Pain, trismus, and swelling managements require clinical and pharmacological strategies to reduce further adverse outcomes and improve postoperative patient comfort. Proper local anesthesia (LA) technique is the most important method to reduce the incidence of pain during the surgical process [3]. With sufficient LA induction, the time of the surgery becomes shorter, consequently reducing the traumatic procedures. To achieve a successful LA induction, two factors should be considered: type of local anesthetics and injection technique [4].

Recently, articaine is widely used in dentistry. Fat solubility in parallel with its potency (one and a half times that of lidocaine) has made this anesthetic popular among dentists and surgeons [5]. Articaine has a higher diffusion rate and can be diffused in soft and hard tissues more reliably than other anesthetics [6].

Inferior alveolar nerve block (IANB) is the most widely used injection technique for LA of the mandible in surgical procedures, although IANB is not always successful in pulpal anesthesia and the rate of its failure is reported to be between 10% and 39% in experimental studies [7]. Previous studies have not shown a clear difference between the effects of articaine and 2% lidocaine when used for IANB or periodontal ligament or infiltration injections, although articaine seems to induce a long-term pulpal anesthesia compared to lidocaine [8]. El-Kholey (2013) also conducted a relevant study on infiltration anesthesia for the extraction of mandibular molars. They investigated the effectiveness of 1.8 ml of A100 (4% articaine) with that of 3.6 ml of this solution through buccal infiltration to extract the impacted third molar. Thirty adult patients with two symmetrically impacted teeth underwent surgical extraction of impacted mandibular third molar in two separate appointments. He concluded that buccal infiltration of 4% articaine with epinephrine 1:100,000 (3.6 ml) could be effective in the extraction of mandibular first molars [9]. In a similar investigation, the efficacy of 4% articaine was evaluated in pain reduction during third molar surgery. The study confirmed that this anesthetic is efficient in the extraction of third molars [10,11].

The important goal is to ensure the maximum comfort of the patient during and after the surgery [12]. Perioperative pain reduces the patient's cooperation and then prolongs the surgery [6]. Consequently, the rate of postoperative edema and discomfort also increase [13]. Efforts to achieve complete intraoperative anesthesia have been the subject of several previous studies. Therefore, to achieve a suitable LA method for third molar surgical removal, we conducted a comparative study of the two injection methods and their perioperative and postoperative complications and pain. This study aimed to compare the efficacy of articaine with that of lidocaine buccal injection in reducing the postoperative complications of mandibular impacted third molar surgery.

METHODS

This split-mouth double-blind clinical trial was conducted at the Faculty of Dentistry, Semnan University of Medical Sciences, Semnan, Iran, during 2019.

According to a similar study [14], the onset of anesthesia beginning was 99.2 ± 10.54 seconds, and considering 95% confidence interval and 90% power, the sample size was estimated to be 26 (PASS 11, NCSS, LLC, Kaysville, Utah, USA). The study population comprised 26 samples (13 patients) aged between 20 and 35 years. The patients were included if they met the following inclusion criteria:

- Patients who were candidates for mandibular third molar surgical removal; these teeth were categorized in Group C according to Pell & Gregory's classification [15] and had an extraction difficulty of grades 7–10 according to Pederson's scale [16].
- Patients with systemic conditions classified as class 1 according to the American Society of Anesthesiologists' guidelines.

- Patients who cooperated during the follow-up period.

The exclusion criteria included the following:

- Patients with acute or chronic inflammation in the periapical view of the second molar
- Patients with existing systemic problems
- Pregnant patients
- Patients with a specific intraoperative problem, including bone fractures or damage to the second molar or the inferior alveolar nerve
- Patients with insufficient follow-up for re-examination
- Patients with neurological diseases in which the patients are taking antipsychotic drugs
- Patients who are contraindicated to either articaine or lidocaine

The withdrawal criteria were as follows:

- Patients who request to withdraw from the study
- Patients with allergic reactions appearing in the first surgery

1. Measuring the variables

The pain was one of the variables of the current study and was assessed using the visual analog scale (VAS) [6]. The patients had to have no pain at the surgical site preoperatively (zero pain score is considered), and the highest pain was considered 100 mm. Other measurements were as follows:

- The maximal mouth opening (MMO) was calculated by measuring the distance from the incisal edge of the maxillary central incisor to the incisal edge of the mandibular central incisor when the mouth was opened as widely as possible using a digital caliper (Mitutoyo, Illinois, USA).
- Facial width was calculated to evaluate the swelling in three dimensions by a piece of thread and was subsequently measured using a ruler.

The three dimensions to measure the swelling were as follows:

1. Horizontal distance: The distance between the oral commissure to the junction of the ear lobe on the same side while the piece of thread followed the cheek convexity.
2. Vertical distance: The distance between the outer canthus of the eye to the mandibular angle of the same side while the piece of thread followed the convexity of the face.
3. Oblique distance: The distance between the oral commissure and the mandibular angle on the same side while the piece of thread followed the possible convexity of the face [17].

- Surgery duration, duration of initiating anesthesia, and the number LA cartridges used during the surgical process were other variables assessed in the current study.

Preoperative measurements, including pain, swelling, and trismus, were also assessed on days 1, 3, and 7 and recorded postoperatively. All the measurements were assessed by two experts who were blinded to the group allocation, and the mean of the calculations was established in the chart.

2. Surgical procedure

Each patient underwent surgery in two separate appointments with an interval of 4 weeks. Block randomization was performed to divide the two sides of the patients (26 cases) into two experimental groups by a dentist who was blinded to the group allocation. In group A cases (one side of a patient), 2% lidocaine with 1:100,000 epinephrine (Darou Pakhsh Pharmaceutical MFG Co., Tehran, Iran) was used for IANB and 4% articaine with 1:200000 epinephrine (Darou Pakhsh Pharmaceutical MFG Co., Tehran, Iran) for local infiltration. In group B cases (the other side of each patient), 2% lidocaine with 1:100,000 epinephrine (Darou Pakhsh Pharmaceutical MFG Co., Tehran, Iran) was applied for both IANB and local infiltration. IANB was performed according to the conventional method. The LAs for local infiltration were directly injected at the root apex area of the third molar and distal to the second molar (Fig. 1).

Each patient received a total of 2.7 ml of LA in the first place. A total of 1.8 ml LA was injected for IANB and 0.9 ml for local infiltration. If the patient complained of any pain during the operation, additional LA was

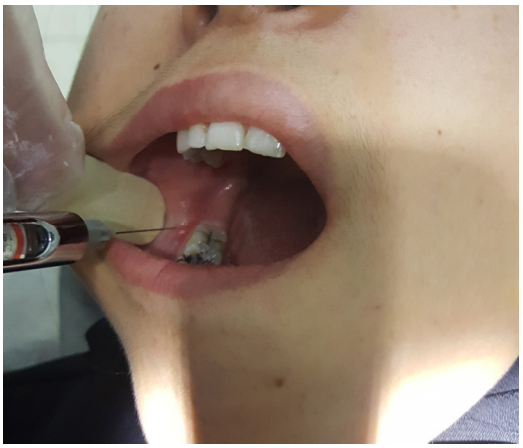

Fig. 1. The figure shows the injection of 4% articaine as local infiltration distal to the second molar.

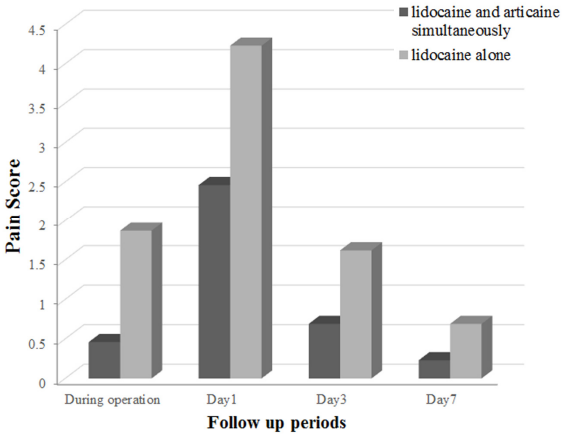

Fig. 2. The figure shows the chart of experienced pain established by the patients.

Table 1. Demographic data of participants

Participant	Age	Sex	Marital status	Lidocaine alone injection side	Simultaneous local anesthetics injection side
1	20	Female	Married	Left	Right
2	26	Male	Married	Right	Left
3	20	Female	Married	Left	Right
4	27	Female	Married	Left	Right
5	26	Male	Single	Right	Left
6	22	Male	Single	Right	Left
7	32	Female	Married	Right	Left
8	24	Female	Married	Left	Right
9	20	Female	Single	Left	Right
10	21	Female	Single	Left	Right
11	28	Male	Married	Right	Left
12	29	Male	Single	Right	Left
13	22	Female	Single	Right	Left

injected conventionally. Before surgery, the time it took for the patient to report the initial symptoms of LA was recorded. After LA was achieved, an envelope flap was created, and the bone was exposed. The bone was removed using a surgical handpiece (NSK, Nakanishi Inc., Japan) and a tungsten-carbide round bur No. 7 (Hager & Meisinger GmbH, Germany), and the tooth was sectioned if necessary. The tooth was subsequently luxated and extracted using a surgical elevator. After the tooth was extracted, the tooth cavity was examined to ensure that there was no remaining part of the tooth or follicle. The cavity was irrigated with normal saline, and subsequently, the flap was put back to its place and stitched using a simple interrupted absorbable suture. For all patients, amoxicillin (500 mg q 8 h) for 7 days and codeine/acetaminophen (10 mg/325 mg q 6 h) for 48 h were prescribed. The pain intensity sheet (VAS), which indicates the pain during the surgery, was filled by the patient after the surgery.

Surgical treatment was performed by one oral and maxillofacial surgeon with 97% repeatability at the clinic.

3. Ethical consideration

The procedures followed the ethical standards of the responsible committee of Semnan University of Medical Sciences with the ethical code of IR.SEMUMS.REC. 1397.158 and with the Declaration of Helsinki of 1975 that was revised in 2000. This project was also registered to Iranian Registry of Clinical Trials with the ethical code of IRCT20181226042135N1.

4. Statistical analyses

Data were analyzed using descriptive statistics (number and percentage) and diagrams using the Statistical Package for the Social Sciences version 26 (International Business Machines Corporation, Armonk, NY). Paired t-test and Wilcoxon tests were used to describe numerical variables. $P < 0.05$ was considered statistically significant.

RESULTS

A total of 17 patients were investigated in the present study. Four patients were excluded from the study considering their absence in follow-up sessions or second surgery, and finally, 13 patients (26 cases) entered the study. The mean ± standard deviation of the patients' age was 24.38 ± 3.92 years. The minimum and maximum ages of participants were 20 and 32 years, respectively. There were 8 female and 5 male patients (Table 1).

The findings showed that pain in group A was significantly lower than that in group B on the first day following surgery ($P = 0.03$), while there was no significant difference between the two groups in terms of pain level in other days (Fig. 2).

The results of the postoperative swelling of the patients in the two groups in three dimensions are shown in the charts (Fig. 3). The horizontal swelling in the first day following surgery was significantly lower in group A than that in group B ($P = 0.024$). There was no significant relationship in other cases.

The MMO of the patients was significantly higher in group A in the third and seventh days after surgery than that in group B ($P = 0.018$ and $P = 0.012$, respectively) (Table 2).

The mean times of onset of LA were 52.69 s in group A and 60.15 s in group B. The total durations of surgery were 6.2 ± 4.01 min in group A and 6.24 ± 1.77 min in group B. These data were not statistically significant. The number of injected cartridges during the surgeries in group A was less than that in group B, and the findings were not statistically significant (2.03 ± 0.157 vs. 2.11 ± 0.219 cartridges).

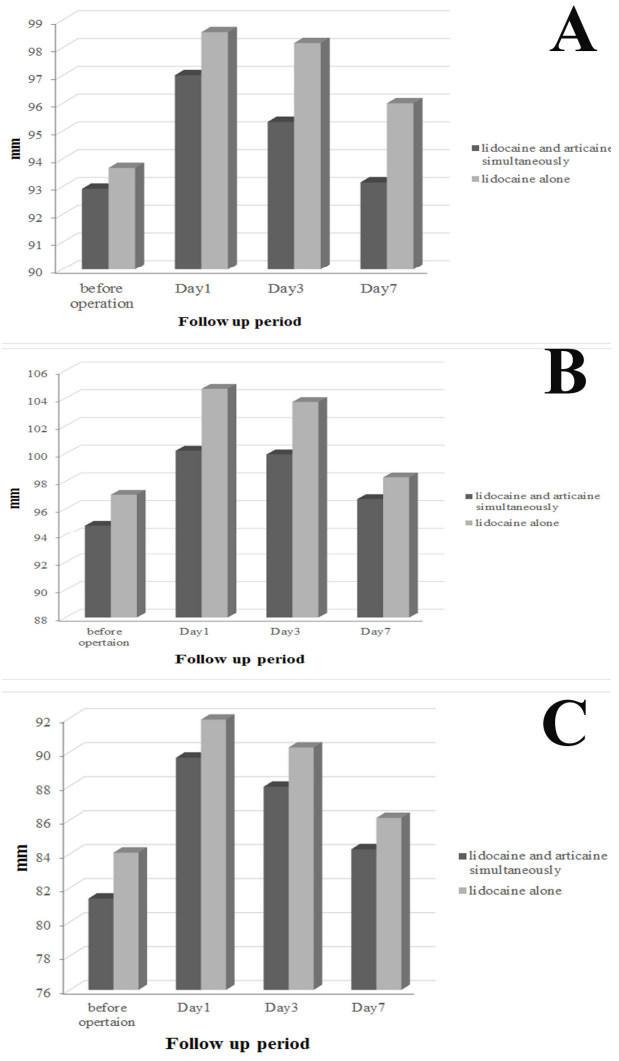

Fig. 3. The figure presents the charts of postoperative swelling in two groups. (A) Assessment of postoperative edema in the vertical dimension during the follow-up period is shown. (B) Assessment of postoperative edema in the horizontal dimension during the follow-up period is shown. (C) Assessment of postoperative edema in the oblique dimension during the follow-up period is shown.

Table 2. Distribution of limitation of maximum mouth opening between the groups during the follow-up period

Experimental groups (mean ± standard deviation)			
Follow-up time	Group A	Group B	P value
Day 1	17.1 ± 8.5 mm	15.9 ± 5.3 mm	0.964
Day 3	14.7 ± 8.4 mm	9.4 ± 4.5 mm	0.018
Day 7	9.5 ± 6.6 mm	4.6 ± 5.7 mm	0.012

DISCUSSION

Third molar surgical extraction is one of the most common oral surgeries and, similar with other surgeries, is associated with several complications, including hemorrhage, ecchymosis, infection, swelling, pain, dry socket, and trismus [18]. Considering the possibility of pain and swelling following the third molar surgery, various studies have been conducted on the effective factors in reducing the complications of impacted wisdom tooth surgical extraction. These studies have investigated the use of analgesics [19], anti-inflammatory drugs [2], and mouthwashes [20], although there is no consensus on a unique method. The present study was conducted as a split-mouth clinical trial to investigate the efficacy of two local anesthetics used as buccal infiltration to reduce the pain and other complications following impacted mandibular third molar surgery.

The findings of the present study indicated that the pain in group A was lower than that in group B during the surgery and all the following days. However, this difference was statistically significantly lower on the first day after surgery. Whatever the less pain the patient experience, their cooperation is improved. Higher cooperation of the patient leads to more precise surgery and fewer complications. Complications such as trismus and postoperative edema are directly associated with the manipulation of the tissue [21]. Longer surgical period and consequently more manipulation may lead to more severe complications. As the findings of the current study showed the lower pain experience in group A, facial edema was significantly less in group A than in group B during the follow-up period, and these data were significant on the first day statistically. Moreover, the trismus rate was significantly lower in surgical cases, and 4% articaine was used for buccal infiltration on the third and seventh days following surgery. Although better results were observed in group A, there were no significant differences between the two groups in terms of the time of onset of anesthesia, frequency of cartridges injected, and the duration of surgery. The cases in group A needed fewer cartridges to be injected than group B participants. As fewer cartridges are injected, less chance of an overdose is possible. Although these findings were not significantly different, it is valuable in medically compromised patients and drug interaction cases.

Mittal et al. (2018) compared the effectiveness of 4% articaine with that of 2% lidocaine in surgical extraction of the impacted mandibular third molar. They concluded that 4% articaine had a faster onset than 2% lidocaine did, and 4% articaine induced longer duration of anesthesia than 2% lidocaine did [14].

Regarding the effect of articaine and lidocaine, Ashraf et al. (2013) conducted a study on the effect of articaine against lidocaine in the form of block anesthesia and infiltration in teeth with irreversible pulpitis. They reported a lower success rate for buccal injection after insufficient IANB with lidocaine (29%) than articaine (71%) in mandibular first or second molars [8]. Therefore, consistent with the present study, articaine infiltration anesthesia has played an important role in reducing pain after surgery. The 4% articaine infiltration anesthesia plays an effective role in reducing pain on the first day after treatment, and the patient has a more pleasant experience of treatment and will most likely have less stress for subsequent treatments.

In another similar article, Rebolledo et al. (2007) published a comparative study aiming to determine the effectiveness of 4% articaine anesthesia with IANB of 2% lidocaine during surgical removal of impacted mandibular third molar. This split-mouth study was conducted on 30 patients with symmetrically impacted mandibular wisdom teeth. Despite the favorable clinical effects of 4% articaine, there was no significant difference between the two LAs in terms of intraoperative pain, the onset of anesthesia, and the volume of anesthetic solution used and the need for re-anesthesia. The duration period of anesthesia was significantly higher in 4% articaine anesthesia than that in 2% lidocaine [22]. This study showed that although statistical analysis did not show a significant difference between the two LAs, 4% articaine

had a better clinical performance than 2% lidocaine. This study did not investigate the effectiveness of these two types of LAs in reducing complications despite the current study.

The meta-analysis studies on the safety of articaine showed that this anesthetic is more effective in the first molar region, and the pain following the injection is negligible. It is more safe and effective than lidocaine in dentistry procedure when applied as infiltration injection [23].

The present study, which was conducted on 13 individuals aged 20 to 35 years with impacted mandibular third molar, unlike similar studies, investigated more variables such as trismus, swelling, the total time of the surgery process, and the number of cartridges used. Moreover, the patient's pain, unlike other studies, was assessed during surgery and on the first, third, and seventh days after surgery. It should also be noted that the patients aged older than 20 years had been chosen because the impacted wisdom tooth, which has not grown until the age of 20 years, no longer grows into the mouth, and the age range of younger than 35 years has also been chosen because the increased bone density after the age of 35 years makes the surgery difficult, and postoperative periodontal problems of the second molar outweigh the benefits of surgery (if there are no problems). Articaine + lidocaine recipients experienced significantly less pain during the study, specifically on the day after surgery, compared to lidocaine recipients, although they generally had less swelling and trismus compared to the lidocaine group.

In conclusion, administering articaine and lidocaine simultaneously may lead to less pain on the day following surgery of impacted third molar. This combination of LAs may also influence the postoperative edema experienced on the first, third day, and the seventh days after surgery. Therefore, it is recommended to use both articaine and lidocaine injections in the surgical extraction of the mandibular third molar to reduce postoperative complications.

AUTHOR ORCIDs

Amin Naghipour: https://orcid.org/0000-0003-4776-422X
Mohammad Esmaeelinejad: https://orcid.org/0000-0002-9068-9758
Seyed Vahid Dehnad: https://orcid.org/0000-0001-6296-9974
Anahita Shahi: https://orcid.org/0000-0002-5082-496X
Alireza Jarrahi: https://orcid.org/0000-0001-6302-6839

AUTHOR CONTRIBUTIONS

Amin Naghipour: Formal analysis, Investigation, Writing - original draft
Mohammad Esmaeelinejad: Conceptualization, Project administration, Supervision, Writing - review & editing
Seyed Vahid Dehnad: Methodology, Visualization, Writing - review & editing
Anahita Shahi: Data curation, Investigation, Writing - review & editing
Alireza Jarrahi: Data curation, Investigation, Writing - original draft

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REFERENCES

1. Esparza-Villalpando V, Chavarria-Bolaños D, Gordillo-Moscoso A, Masuoka-Ito D, Martinez-Rider R, Isiordia-Espinoza M, et al. Comparison of the analgesic efficacy of preoperative/postoperative oral dexketoprofen trometamol in third molar surgery: a randomized clinical trial. J Craniomaxillofac Surg 2016; 44: 1350-5.
2. Lim D, Ngeow WC. A comparative study on the efficacy of submucosal injection of dexamethasone versus methylprednisolone in reducing postoperative sequelae after third molar surgery. J Oral Maxillofac Surg 2017; 75: 2278-86.
3. Saxena P, Gupta SK, Newaskar V, Chandra A. Advances in dental local anesthesia techniques and devices: an update.

Natl J Maxillofac Surg 2013; 4: 19-24.
4. Ogle OE, Mahjoubi G. Local anesthesia: agents, techniques, and complications. Dent Clin North Am 2012; 56: 133-48.
5. Nizharadze N, Mamaladze M, Chipashvili N, Vadachkoria D. Articaine-the best choice of local anesthetic in contemporary dentistry. Georgian Medical News 2011: 15-23.
6. Sharifi M, Karimaghaee A, Iranmanesh F, Sheikhfathalahi M. Comparison of the anesthetic efficacy of articaine infiltration versus lidocaine inferior alveolar nerve block in pulp therapy of lower primary molars. J Mash Dent Sch 2017; 41: 305-16.
7. Mikesell P, Nusstein J, Reader A, Beck M, Weaver J. A comparison of articaine and lidocaine for inferior alveolar nerve blocks. J Endod 2005; 31: 265-70.
8. Ashraf H, Kazem M, Dianat O, Noghrehkar F. Efficacy of articaine versus lidocaine in block and infiltration anesthesia administered in teeth with irreversible pulpitis: a prospective, randomized, double-blind study. J Endod 2013; 39: 6-10.
9. El-Kholey KE. Infiltration anesthesia for extraction of the mandibular molars. J Oral Maxillofac Surg 2013; 71: 1658.e1-5.
10. Colombini BL, Modena KC, Calvo AM, Sakai VT, Giglio FP, Dionísio TJ, et al. Articaine and mepivacaine efficacy in postoperative analgesia for lower third molar removal: a double-blind, randomized, crossover study. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006; 102: 169-74.
11. Lima-Júnior JL, Dias-Ribeiro E, de Araújo TN, Ferreira-Rocha J, Honfi-Júnior ES, Sarmento CF, et al. Evaluation of the buccal vestibule-palatal diffusion of 4% articaine hydrochloride in impacted maxillary third molar extractions. Med Oral Patol Oral Cir Bucal 2009; 14: E129-32.
12. Mehra P, Reebye U, Nadershah M, Cottrell D. Efficacy of anti-inflammatory drugs in third molar surgery: a randomized clinical trial. Int J Oral Maxillofac Surg 2013; 42: 835-42.
13. de Souza AM, Horliana AC, Simone JL, Jorge WA, Tortamano IP. Postoperative pain after bupivacaine supplementation in mandibular third molar surgery: splint-mouth randomized double blind controlled clinical trial. Oral Maxillofac Surg 2014; 18: 387-91.
14. Mittal J, Kaur G, Mann HS, Narang S, Kamra M, Kapoor S, et al. Comparative study of the efficacy of 4% articaine vs 2% lidocaine in surgical removal of bilaterally impacted mandibular third molars. J Contemp Dent Pract 2018; 19: 743-8.
15. Alling CC 3rd, Catone GA. Management of impacted teeth. J Oral Maxillofac Surg 1993; 51: 3-6.
16. Yuasa H, Kawai T, Sugiura M. Classification of surgical difficulty in extracting impacted third molars. Br J Oral Maxillofac Surg 2002; 40: 26-31.
17. Gay-Escoda C, Gómez-Santos L, Sánchez-Torres A, Herráez-Vilas JM. Effect of the suture technique on postoperative pain, swelling and trismus after removal of lower third molars: a randomized clinical trial. Med Oral Patol Oral Cir Bucal 2015; 20: e372-7.
18. Miloro M, Ghali GE, Larsen PE, Waite P. Peterson's principles of oral and maxillofacial surgery. vol. 1. Hamilton: BC Decker Inc. 2004.
19. Haraji A, Lasemi E, Zareh R, Nateghi Z. Comparison of naproxen-azithromycin combination with piroxicam-azithromycin combination in prevention of complications after impacted third molar extraction. J Mashad Dent Sch 2009; 33: 207-14.
20. Hasheminia D, Moaddabi A, Moradi S, Soltani P, Moannaei M, Issazadeh M. The efficacy of 1% betadine mouthwash on the incidence of dry socket after mandibular third molar surgery. J Clin Exp Dent 2018; 10: e445-9.
21. Alcântara CE, Falci SG, Oliveira-Ferreira F, Santos CR, Pinheiro ML. Pre-emptive effect of dexamethasone and methylprednisolone on pain, swelling, and trismus after third molar surgery: a split-mouth randomized triple-blind clinical trial. Int J Oral Maxillofac Surg 2014; 43: 93-8.
22. Sierra Rebolledo A, Delgado Molina E, Berini Aytés L, Gay Escoda C. Comparative study of the anesthetic efficacy

of 4% articaine versus 2% lidocaine in inferior alveolar nerve block during surgical extraction of impacted lower third molars. Med Oral Patol Oral Cir Bucal 2007; 12: 139-44.

23. Katyal V. The efficacy and safety of articaine versus lignocaine in dental treatments: a meta-analysis. J Dent 2010; 38: 307-17.