Comparison of the success rates of four anesthetic solutions for inferior alveolar nerve block in patients with irreversible pulpitis. A prospective, randomized, double-blind study

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ABSTRACT

Introduction: This study compared the efficacy of four anesthetic solutions for inferior alveolar nerve block (IANB) in patients with irreversible pulpitis. **Material and Methods:** This prospective, randomized, double-blind study included 60 adult volunteers. The patients were randomly divided into four groups of 15 and received conventional IANB as follows: Group ART - 2 cartridges of 4% articaine with 1:100,000 epinephrine; Group LID - 2 cartridges of 2% lidocaine with 1:100,000 epinephrine; Group PRI - 2 cartridges of 3% prilocaine with 0.03 IU felypressin; and Group MEP - 2 cartridges of 2% mepivacaine with 1:100,000 epinephrine. Access was begun 10 minutes after IANB, and patients were instructed to rate any pain felt during the endodontic procedure. The success of IANB was defined as access and instrumentation of root canals with no pain. If the patient felt any pain, the treatment was discontinued immediately and the anesthetic procedure was classified as unsuccessful. **Results:** The chi-square test was used to analyze results ($\alpha = 5\%$). There was no significant difference ($p > 0.05$) in the efficacy of IANB between the ART (53.33%), PRI (46.66%), and MEP (53.33%) groups. However, the success rate in the LID group was statistically lower (20%) than in the other groups ($p < 0.05$). **Conclusion:** None of the anesthetic solutions had an acceptable success rate for IANB in patients with irreversible pulpitis. The solution of 2% lidocaine with 1:100,000 epinephrine had the worst rate when compared to the other groups.

Keywords: Endodontics. Pulpitis. Anesthesia. Local.

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Introduction

In dentistry, clinical procedures are decisive in eliminating pain, and the effectiveness of local anesthesia is a critical factor in handling emergency situations in endodontics.[1] Pain control often begins with the application of a local anesthetic solution. According to Veering,[2] the dental anesthetics most often used, among those available in the market, are lidocaine, prilocaine, mepivacaine, bupivacaine, and articaine.

Inferior alveolar nerve block (IANB) is an injection technique routinely used for the local anesthesia of mandibular teeth during clinical procedures. However, this technique is not always successful for pulp anesthesia.[3] Clinical studies in endodontics[4-7] have reported failure rates ranging from 15 to 35% in the anesthesia of mandibular teeth. Success rates are poorer among patients with pulpitis.[8-14]

Several mechanisms have been described to explain the failure of local anesthesia, e.g. anatomic variations with crossover and accessory innervations,[4,15] and a decrease in local pH.[8,15] However, the most plausible explanation for the low success rates obtained in patients with pulpitis may be the activation of nociceptors by inflammation.[16,17] Inflammatory mediators reduce the threshold of nociceptor activation to such a low level that even minimal stimuli can activate them.[16,17,18]

Several studies have been conducted with the aim of comparing the efficacy of different anesthetic solutions during endodontic procedures for different reasons. However, to the knowledge of the authors, no study so far has compared the four anesthetic solutions used in this study for IANB in molars with irreversible pulpitis. Therefore, the objective of the present study was to compare the efficacy of the four anesthetic solutions most frequently used in dentistry for inferior alveolar nerve block, namely articaine, lidocaine, prilocaine, and mepivacaine, in patients with irreversible pulpitis.

Material and Methods

This prospective, randomized, double-blind study included 60 adult volunteers recruited at the Dental Emergency Department of the Catholic University of Campinas, São Paulo, Brazil.

The participants were experiencing pain in a mandibular molar and were in good health. They had no allergy to local anesthetic solutions or sulfites, no systemic diseases, were not pregnant or unable to respond to pain, and were not taking any medication that could interfere with pain perception, as determined by oral interview and written questionnaire. The study protocol was approved by the Research Ethics Committee of the Catholic University of Campinas, and written informed consent was obtained from each participant.

The following inclusion criteria were taken into consideration: Active pain in a mandibular molar; prolonged response to cold testing with Endo-Ice (Maquira, Maringá, Brazil); absence of any periapical radiolucency on radiographs, except for a widened periodontal ligament; and vital coronal pulp upon access.

Patients were randomly divided into four groups of 15, according to the type of solution used: Group ART - 2 cartridges of 4% articaine with 1:100,000 epinephrine (DFL, Rio de Janeiro, Brazil); Group LID - 2 cartridges of 2% lidocaine with 1:100,000 epinephrine (DFL, Rio de Janeiro, Brazil); Group PRI - 2 cartridges of 3% prilocaine with 0.03 IU felypressin (DFL, Rio de Janeiro, Brazil); and Group MEP - 2 cartridges of 2% mepivacaine with 1:100,000 epinephrine (DFL, Rio de Janeiro, Brazil).

A topical anesthetic (EMLA cream, Astra Zeneca, São Paulo, Brazil), an eutectic mixture of 2.5% lidocaine 2.5% and prilocaine, was passively placed at the IANB injection site for 1 minute using a cotton tip applicator. All patients received standard IANB injections using two masked cartridges of one of the anesthetic solution tested. The solution was injected by the same clinician using self-aspirating syringes (Septodont, Saint-Maur-des-Fosses, France) and 27-gauge long needles (Septoject, Septodont). After reaching the target area, aspiration was performed, and 1.8 mL of solution (1 cartridge) was deposited at a rate of 1 mL/min. After 1 minute, another 1.8 mL was deposited, also at a rate of 1 mL/min. Five minutes after the second cartridge was used, patients were asked whether their lips were numb. If profound lip numbness was not recorded at this time, the block was classified as unsuccessful, and the patient was excluded from the study. Teeth considered as adequately anesthetized were isolated with a rubber dam, and access was performed.

Patients were instructed to report any pain felt during the procedure. In the presence of pain, the

treatment was discontinued immediately, and the anesthetic procedure was classified as unsuccessful. IANB success was defined as access and complete instrumentation of root canals with no pain.

Results were analyzed using the chi-square test. Significance was set at $p = 0.05$ ($\alpha = 5\%$).

Results

Sixty adult patients (41 women and 19 men) aged 19 to 57 years old participated in this study. The rates of success and failure obtained in each group are shown in Figure 1.

No statistically significant differences were found between the ART, PRI, and MEP groups ($p > 0.05$). However, the success rate in the LID group was statistically lower ($p < 0.05$) than that found in the other three groups.

Discussion

Efficient anesthesia is extremely important to ensure patient comfort during endodontic procedures. Several studies have evaluated the efficacy of local anesthetic solutions for teeth with irreversible pulpitis.[1,8-14,19] Corbett et al[20] sent a questionnaire to 506 dentists in the United Kingdom and found that the anesthetic solution most often used was lidocaine with epinephrine, followed by prilocaine with felypressin. According to Malamed,[21] articaine has become the second drug of choice for local anesthesia in the United States since its introduction in 2000. Gaffen and Hass[22] conducted a study with 8,058 dentists in Ontario, Canada, and found that the anesthetic solutions most frequently used in dental clinics were lidocaine, articaine, mepivacaine, and prilocaine. However, our review of the literature did not yield any clinical studies that compared the four anesthetic solutions used in this study for IANB in molars with irreversible pulpitis.

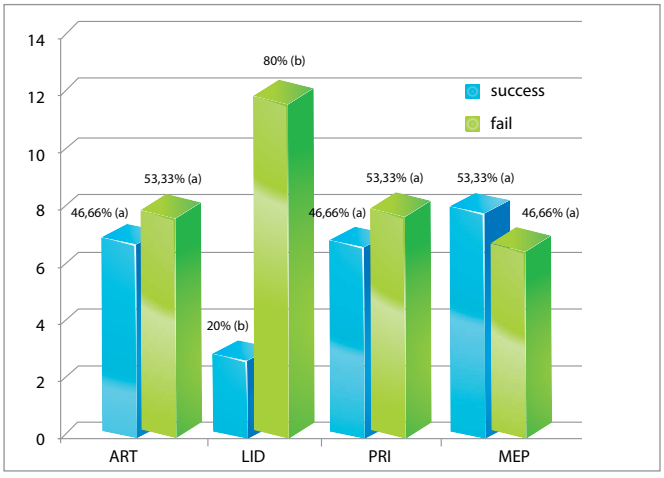

Figure 1. Success and failure rates obtained in the four study group. Different letters indicate the presence of significant differences ($p < 0.05$). ART = articaine + epinephrine; LID = lidocaine + epinephrine; PRI = prilocaine + felypressin; MEP = mepivacaine + epinephrine.

As part of our protocol, a topical cream (EMLA, Astra Zeneca, São Paulo, Brazil), an eutectic mixture of local anesthetics, was applied before the injection, which is in accordance with other clinical studies that have shown that EMLA is superior to benzocaine or lignocaine as a topical anesthetic.[23]

To achieve IANB, 3.6 mL (2 cartridges) of anesthetic solution were injected, as advocated by other authors.[24,25] The decision to use two injections was based on the low success rate reported in the literature for anesthetizing the pulp of mandibular teeth with irreversible pulpitis using only one cartridge.[12,14,26]

Endodontic procedures was initiated after 10 minutes of initial inferior alveolar nerve block, based on the findings of Lai et al,[27] who observed an onset time of 10 to 15 min after injection for mandibular anesthesia.

In this study, the presence or absence of pain was used to evaluate the efficacy of anesthetic solutions. Aggarwal et al[28] and Claffey et al[10] classified the success of IANB of mandibular teeth with irreversible pulpitis as the absence of pain or presence of only mild pain according to a visual analog scale (VAS). The success criterion employed in our study was the total absence of pain during access and instrumentation of the root canal system, because this is the purpose of local anesthesia in endodontic treatment.

In this study, IANB success rates for molars with irreversible pulpitis ranged from 20 to 53.33%, a finding that is in agreement with rates reported in the literature, which range from 19 to 56%.[10-14,29,30,31] Moreover, there were no statistically significant differences between the articaine (ART), prilocaine (PRI), and mepivacaine (MEP) groups. Although several other authors have also reported the absence of significant differences between lidocaine and other anesthetic solutions, using different techniques in clinical

conditions,[8,19,25,32] in our study the lidocaine group had a statistically lower success rate (20%) when compared with the rates found for the other three groups. Our result is similar to the 19-26% success rates found by Bigby et al,[31] Nusstein et al,[13] Reisman et al,[12] and Claffey et al,[10] but lower than the 50-56% rates reported by Cohen et al[14] and Kennedy et al[11] - all these studies used lidocaine in teeth with irreversible pulpitis. The success criterion used in this study, namely total absence of pain during access and instrumentation, may explain our low success rate.

Finally, according to our results, IANB in mandibular molars with irreversible pulpitis was not clinically successful. Complementary techniques using supplemental buccal,[33] periodontal ligament[34] or intraosseous[35] injections should be assessed with the aim of increasing success rates and providing more comfort to patients and convenience to dentists.

Conclusion

The results of this study showed that the four anesthetic solutions under evaluation did not achieve an acceptable IANB success rate for mandibular molars with irreversible pulpitis. When compared to other solutions, 2% lidocaine with 1:100,000 epinephrine had the worst rate.

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