Anesthetic Comparisons of 4% Concentrations of Articaine, Lidocaine, and Prilocaine as Primary Buccal Infiltrations of the Mandibular First Molar: A Prospective Randomized, Double-blind Study

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Abstract

Introduction: Studies have shown the superiority of 4% articaine with 1:100,000 epinephrine over 2% lidocaine with 1:100,000 epinephrine when used as a primary buccal infiltration of the mandibular first molar. A study using other 4% anesthetic formulations may help determine the role of concentration in the increased efficacy of 4% articaine. The authors conducted a prospective randomized, double-blind, crossover study comparing the pulpal anesthesia obtained with 4% concentrations of articaine, lidocaine, and prilocaine formulations as primary buccal infiltrations of the mandibular first molar. **Methods:** Sixty asymptomatic adult subjects randomly received a primary mandibular buccal first molar infiltration of 1.8 mL 4% articaine with 1:100,000 epinephrine, 4% lidocaine with 1:100,000 epinephrine, and 4% prilocaine with 1:200,000 epinephrine in 3 separate appointments. An electric pulp tester was used to test the first molar for anesthesia in 3-minute cycles for 60 minutes after the infiltrations. Successful anesthesia was defined as 2 consecutive 80/80 readings. **Results:** The success rate for the 4% articaine formulation was 55%, 33% for the 4% lidocaine formulation, and 32% for the 4% prilocaine formulation. There was a significant difference between articaine and both lidocaine ($P = .0071$) and prilocaine ($P = .0187$) formulations. **Conclusions:** A 4% articaine formulation was statistically better than both 4% lidocaine and 4% prilocaine formulations for buccal infiltration of the mandibular first molar in asymptomatic mandibular first molars. However, the success rate of 55% is not high enough to support its use as a primary buccal infiltration technique in the mandibular first molar. *(J Endod 2014;40:1912–1916)*

Key Words

Articaine, infiltration, lidocaine, mandibular, prilocaine

A number of studies have shown the superiority of 4% articaine with 1:100,000 epinephrine over 2% lidocaine with 1:100,000 epinephrine when used as a primary buccal infiltration of the mandibular first molar (1–3) and as a supplemental buccal infiltration of the first molar after an inferior alveolar nerve block (4, 5).

The exact mechanism of articaine's increased efficacy is not known. Borchard and Drouin (6) found that a lower concentration of articaine was sufficient to block the action potential when compared with other amide anesthetics. Potocnik et al (7), in a study of sensory nerve conduction in rats, found that both 2% and 4% articaine concentrations were superior to 2% lidocaine in blocking nerve conduction. It may be that factors other than the concentration are responsible for articaine's clinical efficacy. For instance, the unique chemical structure of articaine (the thiophene ring), which is not possessed by other local anesthetic agents, may facilitate better diffusion of the anesthetic solution (8). One study suggested that it is the intramolecular hydrogen bond that gives articaine its favorable properties (8). A study using other 4% anesthetic formulations may help in determining the role of concentration in the increased efficacy of 4% articaine.

No study has compared the anesthetic success of a 1-cartridge volume of 4% articaine, 4% prilocaine, and 4% lidocaine formulations in a mandibular buccal infiltration of the first molar. The purpose of this prospective randomized, double-blind, crossover study was to compare the degree of pulpal anesthesia obtained with 1.8 mL 4% articaine with 1:100,000 epinephrine, 4% lidocaine with 1:100,000 epinephrine, and 4% prilocaine with 1:200,000 epinephrine as a primary buccal infiltration in the mandibular first molar. We also recorded the pain of injection and postoperative pain.

Materials and Methods

Sixty adult subjects participated in this study. All subjects were in good health and were not taking any medication that would alter pain perception as determined by a written health history and oral questioning. Exclusion criteria were as follows: younger than 18 or older than 65 years of age; allergies to local anesthetics or sulfites; history of significant medical conditions (American Society Anesthesiologist classification 2 or higher); taking any medications (over-the-counter pain-relieving medications, narcotics, sedatives, or antianxiety or antidepressant medications) that could affect anesthetic assessment; active sites of pathosis in the area of injection; and inability to give informed consent. Females were questioned regarding pregnancy and were not allowed

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to participate if pregnant, suspected a pregnancy, trying to become pregnant, or lactating. The Ohio State University Human Subjects Review Committee approved the study, and written informed consent was obtained from each subject.

Using a crossover design, all 60 asymptomatic subjects received 3 injections consisting of a single, primary mandibular first molar infiltration using 1.8 mL 4% articaine with 1:100,000 epinephrine (Articadent; Dentsply Pharmaceutical, York, PA), 4% prilocaine with 1:200,000 epinephrine (Citanest Forte, Dentsply Pharmaceutical), and 4% lidocaine with 1:100,000 epinephrine (Central Ohio Compounding Pharmacy, Columbus, OH) in 3 separate appointments spaced at least 1 week apart. Each subject received only 1 infiltration at each appointment.

With the crossover design, 180 infiltrations were administered for the mandibular first molar, and each subject served as his or her own control. Ninety infiltrations were administered on the left side, and 90 infiltrations were administered on the right side. The same side chosen for the first infiltration was used again for the second and third subsequent infiltrations. The test tooth chosen for the experiment was the mandibular first molar. The mandibular contralateral canine was used as the control to ensure that the pulp tester was operating properly and that the subject was responding appropriately. Visual and clinical examinations were conducted before subject inclusion to ensure that all test teeth were free of caries, large restorations, crowns, and periodontal disease and that none had a history of trauma or sensitivity.

Before the injection at all 3 appointments, the experimental tooth and the contralateral canine (control) were tested 2 times with the electric pulp tester (Kerr; Analytic Technology Corp, Redmond, WA) to ensure tooth vitality and obtain baseline information. The teeth were isolated with cotton rolls and dried with an air syringe. Toothpaste (Crest Prohealth, Proctor & Gamble Co, Cincinnati, OH) was applied to the probe tip, which was placed in the middle third of the buccal surface of the tooth being tested. The value at the initial sensation was recorded. The current rate was set at 25 seconds to increase from no output (0) to maximum output (80). Trained personnel, who were blinded to the anesthetic formulations, administered all preinjection and postinjection tests.

Before the experiment, the 3 anesthetic formulations were randomly assigned 6-digit numbers from a random number table. Each subject was randomly assigned to each of the 3 anesthetic formulations to determine which formulation was to be administered at each appointment. A master list with the 6-digit numbers and the order in which the subject received the anesthetic formulations was accessible to a research assistant who prepared the anesthetic formulations for injection. Only the random numbers were recorded on the data collection sheets to further blind the experiment.

Under sterile conditions and depending on the anesthetic formulation required for the appointment, either 1.8 mL 4% articaine with 1:100,000 epinephrine (Articadent) or 1.8 mL 4% prilocaine with 1:200,000 epinephrine (Citanest Forte) formulations were loaded by trained personnel into a separate, sterile 5-mL Luer-Lok disposable syringe (Becton-Dickinson & Co, Rutherford, NJ) by aspirating the standard cartridge contents into an appropriate 6-digit, labeled syringe. All anesthetic solution cartridges were checked to ensure that the anesthetic solution was not expired. Each 4% formulation contained either 72 mg articaine with 18 μg epinephrine or 72 mg prilocaine with 9 μg epinephrine. Robertson et al (2) found that on average the anesthetic solution expressed from a cartridge was 1.76 mL regardless of whether the label read 1.8 or 1.7 mL. We used anesthetic cartridges for the commercial preparations but controlled the final volume of 1.8 mL because we used 5-mL syringes.

For the 4% lidocaine formulation, syringes were prepared as follows: under sterile conditions, 1.8 mL 4% lidocaine (Central Ohio Compounding Pharmacy, Columbus, OH) was drawn into a sterile 5-mL Luer-Lok disposable syringe using a 30- G needle (Becton-Dickinson & Co); 18 μg epinephrine was drawn from a 1-mL ampule of 1:1000 epinephrine (Abbott Laboratories, North Chicago, IL) using a calibrated micropipette (Sherwood Medical, St Louis, MO), and this was added to the syringe. The 1:1000 epinephrine ampules were only used once. The 4% lidocaine formulation contained 72 mg lidocaine with 18 μg epinephrine and was prepared by a trained research assistant.

The infiltrations were administered using the syringes equipped with a 27-G 1¼-inch needle (Monoject; Sherwood Services, Mansfield, MA). Before the infiltration, each subject was instructed on how to rate the pain for each phase of the injection including needle insertion, needle placement, and deposition of anesthetic solution using a Heft-Parker visual analog scale (VAS) (9). The VAS was divided into 4 categories. No pain corresponded to 0 mm. Mild pain was defined as >0 mm and ≤54 mm. Mild pain included the descriptors of faint, weak, and mild pain. Moderate pain was defined as >54 mm but <114 mm. Moderate pain included the descriptor moderate. Severe pain was defined as ≥114 mm. Severe pain included the descriptors strong, intense, and maximum possible. During each phase of the injection, the principal investigator informed the subject when each phase of the injection was completed. Immediately after the infiltration, the subject rated the pain for each injection phase on the VAS.

Before each injection, the mucosa was dried with gauze, and 0.2 mL topical anesthetic gel (20% Benzocaine; Patterson Dental Supply, Inc, St Paul, MN) was passively placed with a cotton tip applicator for 60 seconds at the injection site. The injection target site was centered over the buccal root apices of the mandibular first molar. The lip was gently retracted, and the 27-G needle was gently placed into the alveolar mucosa (needle insertion phase) with the needle bevel directed toward the bone and was advanced within 2–3 seconds until the needle was estimated to be at or just superior to the apices of the tooth (needle placement phase). The anesthetic solution was deposited over a period of 1 minute (solution deposition phase). All infiltrations were given by the senior author (B.N.).

The depth of anesthesia was monitored with an electric pulp tester. At 1 minute after the infiltration, the mandibular first molar was tested. At 3 minutes, the first molar and the contralateral mandibular canine were tested. The testing continued in 3-minute cycles for a total of 60 minutes. At every third cycle, the control tooth (ie, the contralateral canine) was tested by an inactivated pulp tester to test the reliability of the subject. If the subject responded positively to an inactivated pulp tester, then he or she was not considered reliable and was not used in the study. No subjects were eliminated for this reason.

All subjects were asked to complete postoperative pain surveys after each appointment using the VAS as previously described immediately after the numbness wore off and again each morning upon rising for the next 3 days. They were asked to rate the pain in the area of the injection. Subjects were also instructed to describe and record any problems, other than pain, that they experienced after the injections.

No response from the subject at the maximum output (80 reading) of the pulp tester was used as the criterion for pulpal anesthesia. Anesthesia was considered successful when 2 consecutive 80 readings with the pulp tester were recorded.

Each anesthetic formulation was randomly tested using an Orion Star A111 pH Tester (Thermo Scientific, Beverly, MA). Before each sample was tested, the pH tester was calibrated using pH buffers (NIST Traceable Solution; OAKTON, Vernon Hills, IL). Cartridges of anesthetic were randomly sampled for 4% articaine and 4% prilocaine. The 4% lidocaine solution and the epinephrine (1:1000) solution were each randomly sampled separately and then as a proportionately mixed solution.