A Prospective, Randomized, Double-blind Comparison of Articaine and Lidocaine for Maxillary Infiltrations

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Abstract

The purpose of this prospective, randomized, double-blind crossover study was to evaluate the anesthetic efficacy of 4% articaine with 1:100,000 epinephrine and 2% lidocaine with 1:100,000 epinephrine in maxillary lateral incisors and first molars. Eighty subjects randomly received, in a double-blind manner, maxillary lateral incisor and first molar infiltrations of one cartridge of 4% articaine with 1:100,000 epinephrine or 2% lidocaine with 1:100,000 epinephrine at two separate appointments spaced at least 1 week apart. In maxillary lateral incisors, articaine exhibited a significantly higher anesthetic success rate of 88% when compared with a 62% success rate with lidocaine. In maxillary first molars, articaine had a similar success rate to lidocaine (78% vs 73%), and there was no significant difference between the two solutions. In conclusion, a maxillary infiltration of 4% articaine with 1:100,000 epinephrine statistically improved anesthetic success when compared with 2% lidocaine with 1:100,000 epinephrine in the lateral incisor but not in the first molar. *(J Endod 2008;34:389–393)*

Key Words

Articaine, infiltration, lidocaine, maxillary

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Maxillary infiltration anesthesia is a common method to anesthetize maxillary teeth. Previous studies (1–13) have evaluated the success of maxillary infiltrations using the electric pulp tester. Using a volume of 1.8 mL or less and various anesthetic formulations, pulpal anesthetic success (obtaining maximum output with an electric pulp tester) ranged from 64% to 100%.

Articaine has been reported to provide improved local anesthetic activity (14). Many studies have evaluated articaine and found it to be a safe and effective local anesthetic agent (15–25). Repeated clinical trials have failed to show that articaine is statistically superior to lidocaine in inferior alveolar nerve block anesthesia (16–17, 20–21, 25). Infiltration anesthesia in the maxilla has shown an equivalent effect for articaine, prilocaine, and lidocaine (4–6, 17) except for one study by Costa et al. (11), which showed a prolonged duration with articaine. However, in buccal infiltration of the mandibular first molar, 4% articaine with 1:100,000 epinephrine resulted in a higher success rate than using 2% lidocaine with 1:100,000 epinephrine (26, 27).

The efficacy of 4% articaine with 1:100,000 epinephrine in providing pulpal anesthesia when administered to human maxillary teeth needs further investigation to ensure its appropriate clinical use. The purpose of this prospective, randomized, double-blind, crossover study was to compare the degree of pulpal anesthesia obtained with 4% articaine with 1:100,000 epinephrine and 2% lidocaine with 1:100,000 epinephrine in maxillary lateral incisors and first molars.

Materials and Methods

Eighty 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, pregnancy, a history of significant medical conditions, taking any medications that may affect anesthetic assessment, active sites of pathosis in area of injection, and inability to give informed consent. The Ohio State University Human Subjects Review Committee approved the study, and written informed consent was obtained from each subject.

Using a crossover design, 40 subjects received two sets of maxillary lateral incisor infiltrations and 40 subjects received two sets of maxillary first molar infiltrations at two separate appointments spaced at least 1 week apart. For each lateral incisor or first molar, the two sets of injections consisted of using one cartridge of 2% lidocaine with 1:100,000 epinephrine and one cartridge of 4% articaine with 1:100,000 epinephrine.

With the crossover design, 80 infiltrations were administered for both the lateral incisor and first molar, and each subject served as his/her own control. Twenty maxillary right lateral incisors and 20 maxillary left lateral incisors were used. Twenty maxillary right molars and 20 maxillary left molars were used. The same side chosen for the first infiltration was used for the second infiltration. The same tooth was used at both visits for each anesthetic solution. The contralateral canine was used as the control to ensure that the pulp tester was operating properly and that the subject was responding appropriately. A visual and clinical examination was conducted to ensure that all teeth were free of caries, large restorations, crowns, and periodontal disease and that none had a history of trauma or sensitivity.

Before the injections, at both appointments, the experimental tooth and the contralateral canine (control) were tested three times with the electric pulp tester (Analytic Technology Corp, Redmond, WA) to obtain baseline information. The teeth were iso-

lated with cotton rolls and dried with an air syringe. Toothpaste was applied to the probe tip, which was placed in the middle third of the facial or 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 the maximum output (80). Trained personnel who were blinded to the anesthetic solutions administered all preinjection and postinjection tests.

Before the experiment, the two anesthetic solutions were randomly assigned six-digit numbers from a random number table. The random numbers were assigned to a subject to designate which anesthetic solution was to be administered at each appointment.

Under sterile conditions, the lidocaine and articaine cartridges were masked with opaque labels, and the cartridge caps and plungers were masked with a black felt-tip marker. The corresponding six-digit codes were written on each cartridge label. All anesthetic solutions were checked to ensure that the anesthetic solution had not expired. The infiltration injections were administered using the standard masked cartridges and an aspirating syringe equipped with a 27-G 1½-in needle.

Before the injection, each subject was shown a visual analog scale (VAS) and was asked to rate the pain for each phase of the injection including needle insertion, needle placement, and deposition of solution. A Heft-Parker VAS (28) was used in this study (Fig. 1). Immediately after the infiltration, each subject rated the pain for each injection phase on the VAS. The VAS was a 170-mm line with various descriptive terms. The subjects placed a mark on the scale where it best described their pain level. To interpret the data, the VAS was divided into the following four categories. No pain corresponded to 0 mm on the scale. Mild pain was defined as greater than 0 mm and less than or equal to 54 mm. Mild pain included the descriptors of faint, weak, and mild pain. Moderate pain was defined as greater than 54 mm and less than 114 mm. Severe pain was defined as equal to or greater than 114 mm. Severe pain included the descriptors of strong, intense, and maximum possible.

Before each injection, 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. A standard maxillary infiltration injection was administered with an aspirating syringe and a 27-G 1½-in needle (Sherwood Medical Co, St. Louis, MO). The target site was centered over the root apex of the maxillary lateral incisor or between the mesiobuccal and distobuccal root apices of the maxillary first molar. The needle was gently placed into the alveolar mucosa (needle insertion phase) with the bevel toward bone and advanced until the needle was estimated to be at or just above the apex of the lateral incisor or the apices of the first molar (needle placement phase). The anesthetic formulation was deposited over a period of 1 minute (solution deposition phase). All infiltrations were given by the senior author (GE).

The depth of anesthesia was monitored with the electric pulp tester. At 1 minute after the infiltration injection, pulp test readings were obtained for the experimental tooth (first molar or lateral incisor) and the contralateral maxillary canine. The testing continued in 3-minute cycles for a total of 60 minutes. At every third cycle, the control tooth, the contralateral canine, was tested by an inactivated electric pulp tester to test the reliability of the subject (ie, if the subject responded positively to an inactivated pulp tester then they were not reliable and could not be used in the study).

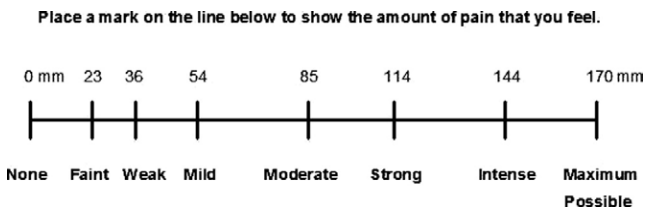

Figure 1. The Heft-Parker Visual Analog Scale (VAS) used for the assessment of pain. The millimeter demarcations were not shown on the patient's VAS.

TABLE 1. The Onset of Pulpal Anesthesia (minutes ± standard deviation)

	Articaine	Lidocaine
Lateral incisor*	2.5 (±1.22)	3.0 (±1.73)
First molar†	3.3 (±2.35)	3.7 (±2.29)

*Lidocaine, $n = 25$; articaine, $n = 35$.
†Lidocaine, $n = 29$; articaine, $n = 31$.

All subjects were asked to complete postinjection surveys after each infiltration administered (160 injection surveys). The subjects rated pain in the injection area using the same VAS as previously described immediately after the numbness wore off and again each morning on arising for 3 days. Patients were also instructed to describe and record any problems, other than pain, that they experienced.

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 two consecutive 80 readings with the pulp tester were obtained within 10 minutes after the infiltration. With a nondirectional alpha risk of 0.05 and a power of 80%, a sample size of 40 subjects per tooth group was required to show a difference in anesthetic success of ±25%.

The data were analyzed statistically. Group comparison between the articaine and lidocaine formulations for anesthetic success was analyzed by using the exact McNemar test. Between-group comparisons of needle insertion, needle placement, and solution deposition pain and postoperative pain were made by using analysis of variance with a Tukey-Kramer multiple-comparison test. Comparisons were considered significant at $p < 0.05$.

Results

For the lateral incisor, 25 men and 15 women ranging in age from 20 to 36 years, with an average age of 25 years, participated in this study. For the first molar, 21 men and 19 women ranging in age from 20 to 33 years with an average age of 24 years participated.

The onset of pulpal anesthesia is listed in Table 1. Table 2 shows the percentages of successful pulpal anesthesia. There was a statistically higher success rate for the articaine solution versus the lidocaine solution for the maxillary lateral incisor. For the maxillary first molar, there was no significant difference in anesthetic success between solutions. The incidence of pulpal anesthesia (80 readings across time) for the two anesthetic solutions is presented in Figures 2 and 3.

The pain of injection is presented in Table 3. There were no significant differences between the two anesthetic solutions for any phases of the injection. Postinjection pain scores are presented in Table 4. There was a significant difference between the two anesthetic solutions when subjective numbness wore off. There were no significant differences between solutions for days 1 through 3. The only reported postinjection complications were bruising and slight swelling in the area of the

TABLE 2. Percentages and Number of Subjects Who Experienced Anesthetic Success

	Articaine	Lidocaine
Lateral incisor*	88% (35/40)	62% (25/40)
First molar†	78% (31/40)	72% (29/40)

*There was a significant difference ($p < 0.05$) between the solutions.
†There was no significant difference ($p > 0.05$) between the solutions.