Efficacy of Articaine versus Lidocaine in Supplemental Infiltration for Mandibular First versus Second Molars with Irreversible Pulpitis: A Prospective, Randomized, Double-blind Clinical Trial

Michael R. Shapiro, DMD, MS,[*†] *Neville J. McDonald, BDS, MS,*[*] *Richard J. Gardner, DDS, MS,*[*‡] *Mathilde C. Peters, DMD, PhD,*[*] *and Tatiana M. Botero, DDS, MS*[*]

Abstract

Introduction: Profound pulpal anesthesia is difficult to achieve in mandibular molars with irreversible pulpitis (IP). However, there are no published randomized controlled clinical trials comparing the success of supplemental buccal infiltration (BI) in mandibular first versus second molars with IP. The purpose of this prospective, randomized, double-blind study was to compare the efficacy of 4% articaine with 2% lidocaine for supplemental BIs in mandibular first versus second molars with IP after a failed inferior alveolar nerve block (IANB). This study's sample was combined with data from a previous trial. **Methods:** One hundred ninety-nine emergency subjects diagnosed with IP of a mandibular molar were selected and received an IANB with 4% articaine. Subjects who failed to achieve profound pulpal anesthesia, determined by a positive response to cold or pain upon access, randomly received 4% articaine or 2% lidocaine as a supplemental BI. Endodontic access was begun 5 minutes after infiltration. Success was defined as less than mild pain during endodontic access and instrumentation on the Heft-Parker visual analog scale. **Results:** There was a 25% IANB success rate with 4% articaine. The success rate for articaine supplemental BI in first molars was 61% versus 63% for second molars ($P > .05$). The success of lidocaine in first molars was 66%, but for second molars it was 32% ($P = .004$). **Conclusions:** The success rate for IANB with 4% articaine was 25%. Articaine and lidocaine had similar success rates for supplemental infiltration in first molars, whereas articaine was significantly more successful for second molars. However, because BI often did not provide profound pulpal anesthesia, additional techniques including intraosseous anesthesia may still be required. *(J Endod 2018;■:1–6)*

Key Words

Articaine, inferior alveolar nerve block, infiltration, irreversible pulpitis, lidocaine, mandibular molars

Significance

Mandibular molars with irreversible pulpitis present challenges in achieving profound pulpal anesthesia. This study showed that buccal infiltration with articaine significantly improves success rates for mandibular second molars. Articaine and lidocaine showed similar success rates for mandibular first molars.

One of the most difficult situations dentists routinely face is a patient who presents a mandibular molar with symptomatic irreversible pulpitis (IP). Frequently called a "hot" tooth, such teeth often present a significant challenge in achieving adequate pulpal anesthesia. Three studies investigated mandibular posterior teeth with IP using an inferior alveolar nerve block (IANB) and supplementary techniques after IANB failure (1–3). They found that achieving complete pulpal anesthesia is often difficult for the clinician. Even for subjects with healthy asymptomatic mandibular molars, IANB has a significant failure rate of 10%–39% (1–4). Unfortunately, the success rate of IANB in mandibular molars with IP drops to approximately 24% (4, 5).

Despite theoretical advantages, clinical studies of the Gow-Gates and Vazirani-Akinosi techniques have shown no difference in success rates (6). As an alternative, supplemental injections can be used including buccal infiltration (BI), periodontal ligament (PDL) injections (7), intraosseous injection (IO), local infiltration, and intrapulpal injections.

A relatively easy, safe, and comfortable alternative to conventional IANB is a mandibular BI injection, which, despite the thicker cortical plate, has been shown to be effective for mandibular molar anesthesia in asymptomatic patients (8). Several studies have used 4% articaine BI as a supplemental infiltration for mandibular molars with IP (1–3, 9). As a representative example, Ashraf et al (1) showed a success rate of 29% with 2% lidocaine BI, whereas there was 71% success using articaine. However, a

From the *Department of Cariology, Restorative Sciences, and Endodontics, University of Michigan School of Dentistry, Ann Arbor, Michigan; †Private Practice Limited to Endodontics, West Bloomfield, MI; and ‡Private Practice Limited to Endodontics, Ann Arbor, MI.

Address requests for reprints to Dr Tatiana M. Botero, School of Dentistry, University of Michigan, 1011 N University Rm. 2309, Ann Arbor, MI 48109-1078. E-mail address: tbotero@umich.edu

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nonsupplemented IANB (either by 4% articaine or 2% lidocaine) was successful only 14% of the time (1).

Rogers et al (5) published the first randomized, double-blind, clinical trial of the efficacy of BI of 4% articaine versus 2% lidocaine when articaine was used for IANB. They found 4% articaine to be significantly more effective than 2% lidocaine, with success rates of 62% and 37%, respectively.

The studies by Ashraf et al (1) and Roger et al (5) also found apparent differences in success between first and second molars. Rogers et al found that the success rate of approximately 62% for articaine was similar for first and second molars. However, the success rate for lidocaine dropped significantly from 53% to 18% in first versus second molars. In contrast, Ashraf et al found that infiltration for second molars was more effective than for first molars.

Because no study has yet compared the success rate of supplemental anesthesia in first and second molars in a randomized, double-blind clinical trial, the purpose of this prospective clinical trial was to determine whether there is a difference in the pulpal anesthetic efficacy of 68 mg articaine (with 0.017 mg epinephrine) and 34 mg lidocaine (with 0.017 mg epinephrine) using supplemental infiltration for first or second mandibular molars. In addition, the study combines the results of this study with those of Rogers et al (5) in order to increase the sample size and, thus, the power function of statistical tests.

Materials and Methods

Prestudy Phase

To determine the appropriate sample size for this study, an a priori power analysis was conducted based on relevant information in the study by Rogers et al (5), which found no statistically significant difference (ie, $P > .05$) between the success of articaine and lidocaine in first molars and no statistically significant difference between the success of articaine in first and second molars. nQuery ± nTerim 3.0 software (Statistical Solutions, Boston, MA) was used to performed power calculations using the Fisher exact test. A sample size of 100 subjects was planned in order to yield a combined sample size of 200.

The study was approved by the Institutional Review Board at the University of Michigan, Ann Arbor, MI (IRB00001999) and registered on Clnicaltrials.gov (NCT01496846) (Supplemental Figs. 1 and 2 are available online at www.jendodon.com). Rogers et al's (5) clinical protocol was followed.

The volunteer subjects were patients of record at the University of Michigan School of Dentistry who had pain in a mandibular molar. The same operator (M.R.S.) provided screening, diagnosis, and anesthesia. However, a separate operator often conducted the actual root canal treatment. The patient's medical history was reviewed to ensure no contraindications to dental treatment or the local anesthetic.

To qualify for the study, subjects had to meet the accepted American Association of Endodontics diagnostic criteria for a mandibular first or second molar with symptomatic IP (10). Specifically, each patient had to have a history of greater than moderate pain in a lower first or second molar as measured by the Heft-Parker visual analog scale (VAS) (11) and lingering sensitivity to cold upon testing with Endo-Ice (1,1, 1, 2 tetrafluoroethane; Hygenic Corp, Akron, OH). Exclusion criteria included molars with an apical radiolucency or that were necrotic upon endodontic access.

Following Rogers et al's protocol (5), each patient was asked to rate his or her pretreatment, postinjection, and posttreatment pain on a Heft-Parker VAS by touching an iPad (Apple Inc, Cupertino, CA) screen with a pain scale labeled with pain descriptors. In addition to "no pain," the HP-VAS data were collapsed into 3 categories for ease of reporting. No pain corresponded to 0 mm. Mild pain was operationally defined as a rating >0 mm and ≤54 mm. This range included the descriptors faint, weak, and mild pain. Moderate pain was operationally defined as >54 mm and <114 mm. Severe pain was defined as ≥114 mm. The latter range included the following descriptors: strong, intense, and maximum possible (11).

To standardize the administration of anesthesia from patient to patient, all anesthesia was delivered using the Midwest Comfort Control Syringe (Dentsply Professional, Des Plaines, IL). The syringe allows the operator to select from a predetermined rate of anesthesia determined by the technique of administration (eg, block, infiltration, palatal, PDL, or intraosseous).

The study's flowchart is shown in Figure 1. After a 60-second application of topical benzocaine (20%; Centrix, Shelton, CT), all study subjects received an initial IANB of 1.7 mL 4% articaine with 1:100,000 epinephrine (Articadent; Dentsply Pharmaceutical, York, PA). The IANB involved a 27-G needle on the block setting of the Comfort Control Syringe. The needle insertion was performed slightly lateral to the middle portion of the pterygomandibular raphe to contact bone with the needle bevel directed toward the bone, slightly withdrawn, and aspirated, and the solution was deposited with the Midwest Comfort Control syringe at a rate of 0.02 mL/s.

IANB effectiveness was assessed 15 minutes postinjection by questioning the patient about lip numbness. If the patient did not show profound lip numbness, the block was considered missed, and the patient was excluded from data analysis. If the patient reported lip numbness, the study proceeded to cold testing (Fig. 1). The inflamed tooth as well as the adjacent molar and premolar were cold tested with Endo-Ice using a size #3 saturated cotton pellet on the coronal third of the mesiobuccal line angle of the molars and the coronal third on the buccal side of the premolars. A positive cold response on the inflamed molar was considered a failed block, at which point the patient received a randomly assigned supplemental BI. After a negative cold response, the tooth was isolated with a dental dam, and before initiating access, subjects were instructed to report, during access, any pain felt beyond mild discomfort (VAS rating >54 mm). IANB success was operationally defined as the ability to access and instrument the tooth with no pain or not more than mild pain. Subjects who experienced pain beyond the established criteria for success were considered to have had a "failed block." These subjects were randomly assigned to a supplemental infiltration treatment (Fig. 1).

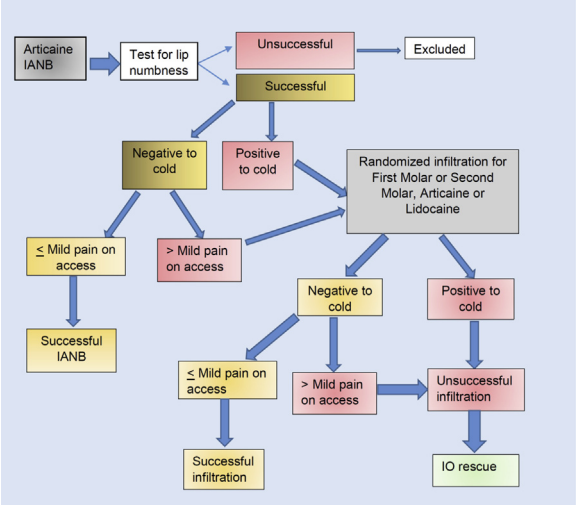

Figure 1. The study flowchart; this figure depicts the flow of patients through the study.

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