

# Anesthetic Efficacy of the Gow-Gates Injection and Maxillary Infiltration with Articaine and Lidocaine for Irreversible Pulpitis

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## Abstract

The aim of this randomized, double-blinded study was to compare the anesthetic efficacy of 4% articaine with 1:100,000 epinephrine (AE) with 2% lidocaine with 1:100,000 epinephrine (LE) for Gow-Gates blocks and maxillary infiltrations in patients experiencing irreversible pulpitis in mandibular and maxillary posterior teeth. Forty patients diagnosed with irreversible pulpitis of a posterior tooth randomly received either AE or LE by using a Gow-Gates injection or maxillary infiltration. Endodontic access was initiated after no response to Endo-ice 15 minutes after solution deposition. Success was defined as none to mild pain on a visual analogue scale after access. Chi-square and analysis of variance statistical tests were used to analyze the data. Successful endodontic treatment substantially reduced the assessment of pulpitis pain by patients (analysis of variance,  $P < .0001$ ). Overall anesthetic success in both dental arches was 87.5%. Anesthetic success was not influenced by tooth arch ( $\chi^2$ ,  $P > .7515$ ) or gender ( $\chi^2$ ,  $P > .1115$ ). AE proved to be as effective but not superior to LE ( $P > .6002$ ). These results demonstrated the similar anesthetic effectiveness of AE and LE when used during the endodontic treatment of teeth diagnosed with irreversible pulpitis. (*J Endod* 2008;34:656–659)

## Key Words

Anesthetic, endodontics, Gow-Gates, pain, septocaine, xylocaine

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Initially introduced as Carticaine, articaine was approved for use in the United States in 2000 (1). Today articaine is marketed under the brand name Septocaine (Septodont Inc, New Castle, DE) and is available as a 4% anesthetic with 1:100,000 epinephrine (AE). AE is classified as an amide anesthetic, although it contains an additional ester group that is hydrolyzed in the blood by esterases (2). Ninety-five percent of AE is broken down in the blood, with the remainder metabolized in the liver (3). In addition to the ester group, AE differs in its composition from other amides through the presence of a thiophene ring instead of a benzene ring (2). The thiophene component increases AE lipid solubility, allowing the solution a greater capability to cross the lipid membrane of the epineurium (4).

Several studies to date have assessed AE to be a safe local anesthetic, and there have been few problems with postinjection paresthesia/dysesthesia/prolonged anesthesia (5–8). AE provides pulpal anesthesia for 60–75 minutes (4). Over the last several years Articaine use has increased in Europe and the United States (4). With a rise in use of Articaine, more research is needed to determine the efficacy of this anesthetic when compared with other anesthetics available in today's market.

Studies up to this point comparing AE with other anesthetics have used either the maxillary suprapariosteal injection for maxillary teeth or the inferior alveolar nerve (IAN) block for mandibular teeth as the 2 techniques used to administer the anesthetics (9–12). Unfortunately, anesthetic failure with an inferior alveolar injection can occur up to 25% of the time, even when administered by an experienced clinician (13). Madan et al. (14) suggested a number of reasons for this high failure rate of the IAN block including the following: (1) accessory nerve supply (mylohyoid nerve, cervical cutaneous nerve C1, C2, auriculotemporal nerve); (2) variable course of IAN; (3) variation in foramen position; and (4) bifid alveolar nerve of bifid mandibular canal. Differences between patients, their dental history, and the severity and extent of tissue inflammation might also contribute to local anesthetic failure (15).

The Gow-Gates injection was introduced into the dental literature in 1973 (16). The Gow-Gates injection uses a higher mucosal needle penetration that bypasses many of the anatomic problems associated with the IAN block. The Gow-Gates blocks almost all of the branches of the mandibular branch of the trigeminal nerve and is considered the "true mandibular block" (4). A clinical evaluation by Malamed (17) of 4275 Gow-Gates injections demonstrated a success rate in excess of 90%. The success rate of Gow-Gates injections can be explained by the inclusion of the mylohyoid and accessory nerves (18). Subsequent anesthetic studies (19–21) have reported a success rate of more than 90% for the Gow-Gates technique. In comparison, some studies of endodontic patients exhibiting symptoms of irreversible pulpitis have a success rate less than 60% for suprapariosteal injection anesthesia (22, 23). A potential problem with comparing these different studies is that the anesthesia needed to complete a routine operative procedure might not be as profound as that needed to access an irreversibly inflamed pulp. The success of the IAN block to accomplish anesthesia can vary between teeth: 5.7% for the central incisor, 38.2% for the canine, 55.3% for the first premolar, and 90.2% for the first molar (24). A recent study comparing the Gow-Gates with IAN block found no difference in pulpal and gingival anesthesia (25). However, the limitations of the conventional IAN technique make it a less accurate injection method to test anesthetics because of the possibility of an injection error. To

accurately test for anesthetic efficacy in the mandibular arch, the Gow-Gates injection should be used. The use of this injection technique will decrease injection error and more accurately test anesthetic efficacy in the mandibular arch (18–21, 26).

A commonly used dental anesthetic in the U.S. is 2% lidocaine with 1:100,000 epinephrine (LE). Information about the anesthetic effectiveness of AE and LE when used during the endodontic treatment of teeth with irreversible pulpitis is scarce. A study by Claffey et al. (12) used the IAN block to administer the anesthetic to teeth in the lower arch. However, very few studies have compared the effectiveness of AE and LE administered by using a Gow-Gates injection to teeth diagnosed with irreversible pulpitis. There is a need to compare AE and LE to ensure that the most effective local anesthetic is used to maintain patient comfort during operative procedures. Therefore, the purpose of this prospective, randomized, double-blind study was to compare the anesthetic efficacy of AE and LE in posterior teeth with symptoms of irreversible pulpitis.

## Materials and Methods

Forty-two patients participated in this randomized, double blinded study following Institutional Review Board approval. All patients included in the study were in good health without any contraindications to local anesthetic with epinephrine.

To participate in this study each patient had to present to the endodontic clinic with a symptomatic, vital, posterior tooth. Each tooth in question satisfied the criteria for a diagnosis of irreversible pulpitis. The diagnosis was determined by a prolonged, symptomatic response to cold stimuli and an intact lamina dura. The symptoms detected had to be of pulpal and not periodontal origin (22, 23).

Before treatment each patient assessed his or her initial pain on a Heft-Parker visual analogue scale (VAS) (26). 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 4 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 (27, 28).

Each patient received either 1.7 mL of AE (Septocaine) or 1.8 mL of LE (Xylocaine; Dentsply, York, PA) by using either a Gow-Gates block or maxillary infiltration. The primary investigator (M.S.) administered all the injections; he received training and calibration by experienced endodontists (K.N. and M.F.) before the commencement of the study. Each patient was assigned a random number that corresponded with 1 of the 2 anesthetic solutions. Topical anesthetic gel (20% benzocaine; Patterson Dental Supply, St Paul, MN) was placed at the injection site for 1 minute before needle insertion.

Preceding the experiment, the 2 anesthetic solutions were randomly assigned 3-digit numbers from a random number table. The random numbers were subsequently assigned to a subject designating which anesthetic solution the patient was to receive. The cartridges of anesthetic solution were "blinded" by completely masking the aluminum caps with a permanent black marker and masking the appropriate cartridges with an opaque label. The expiration date was checked on each carpule before the experiment.

The patient's contralateral canine was used as the nonanesthetized control to ensure that the Endo Ice (Hygenic Corp, Akron, OH) functioned properly and to confirm the reliability of the patient throughout the procedure.

Ten minutes after injection, the experimental tooth was tested sequentially with the Endo Ice every minute for 5 minutes. The negative control canine was tested at the 3-minute mark to test the reliability of the patient. No pulpal response with Endo-ice after 15 minutes indicated pulpal anesthesia. A positive pulpal response at the 15-minute mark indicated a missed injection, and the patient was eliminated from the study. If negative pulpal signs with cold stimuli were achieved, the experimental tooth was isolated with a rubber dam, and access was performed with a new #2 round bur (straight-line access to all pulp canals). After the access was completed, patients rated their discomfort on the modified VAS (27, 28). The block was considered successful if the subject's tooth was accessed with a pain rating no greater than that considered mild pain. Comparisons between the pain assessment with AE and LE as well as differences in the gender of the subjects and arch location of the instrumented tooth were analyzed with  $\chi^2$  tests. Regression analysis of the pulpitis pain assessed by patients before treatment was compared with the pain after treatment by using Spearman (rho) rank correlation test. All statistical tests were conducted at a significance value of  $P < .05$ .

## Results

All the subjects exhibited no response to cold stimuli before endodontic access. One patient with LE and one with AE did not have a negative response to cold stimuli at the 15-minute mark and were not included in this study. Adjunctive anesthesia was used in these patients to achieve proper patient comfort for the endodontic procedure. Anesthetic success was achieved in 87.5% of all the patients who qualified for the study. The pretreatment (analysis of variance [ANOVA],  $P > .4674$ ) and post-treatment (ANOVA,  $P > .6002$ ) pain measurements of the AE (95) and LE (80) anesthetic solutions were similar. Four anesthetic failures were observed in the mandibular arch and one in the maxillary arch; no correlation was observed between AE or LE and failure (ANOVA,  $P > .4601$ ) or between the tooth arch and failure ( $\chi^2$ ,  $P > .7515$ ).

Pulpitis pain before endodontic treatment was substantially reduced after successful treatment for both genders and tooth location (ANOVA,  $P < .0001$ ). However, the assessment of pulpitis pain was not reduced after failed treatment with both anesthetics (ANOVA,  $P > .9068$ ), as shown in Fig. 1.

The number of maxillary and mandibular teeth and male to female ratio were similar for both anesthetic groups. The demographics and arch location of the teeth are shown in Table 1. The assessments of pretreatment pain and post-treatment pain after successful endodontic therapy and failed therapy were all similar between AE and LE anesthetics, as shown in Table 1.

Analysis of the data with Spearman rank correlation (rho) for pretreatment and post-treatment pain by using the VAS found little statistical correlation between a patient's perception of pain intensity before and after treatment ( $P > .8610$ ).

## Discussion

The results of this study showed little difference in anesthetic efficacy between AE and LE in posterior, symptomatic teeth. Analysis of the data to identify the influence of gender and tooth location within the dental arch did not reveal any differences. The success of anesthesia in the mandibular arch might be attributed to the use of the Gow-Gates injection in this study. In a recent study (12), the AE anesthesia success for mandibular teeth with a diagnosis of symptomatic pulpitis was less than 25%. The present study found the AE anesthetic success for the same teeth with the Gow-Gates block was 90% (Table 1). Although all patients in both studies exhibited signs of pulpal anesthesia, it is possible that the Gow-Gates injection bypasses acces-

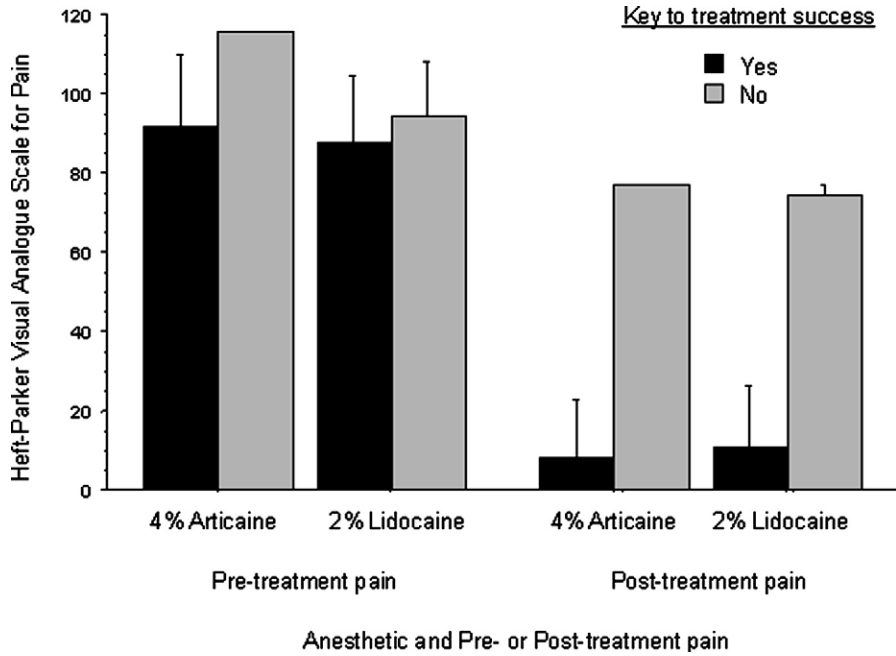


Figure 1. Bar chart of pretreatment and post-treatment pain.

sory anatomy responsible for anesthetic failure in the mandible, making it more successful than the MI.

All patients who qualified for the study exhibited a preinjection pain assessment of moderate to severe on the VAS. This preinjection pain assessment confirmed the preoperative diagnosis of irreversible pulpitis (22, 23). These symptoms are similar to those seen often in many endodontic practices. In the present study, after negative pulp signs with cold stimuli were achieved, the experimental tooth was isolated with a rubber dam, and a straight-line access was performed into the canal. The end point in this present study was each subject's self-assessment of discomfort on the VAS after canal access. Other studies have used measurements from a pulp tester (27) or heart rate (28). Measuring the blocking effects of an anesthetic with a pulp tester or heart rate is likely to be a less subjective end point than asking patients to rate their level of pain on the VAS. The main advantage of the VAS anesthetic end point used in the present study is that it directly measures the level of discomfort perceived by the patient, and this might be easier to translate to clinical endodontic practice, in comparison to pulp test or heart rate measurements. The selection of the end point for measuring the effectiveness of anesthesia treatments appears to have the po-

tential to influence the results, because of the limitations of the pulp test, heart rate measurements, and subjective variability in the severity of discomfort reported by patients.

The onset and duration of pulpal anesthesia can vary considerably between different types of anesthetics. The average duration of LE pulpal anesthesia is 2 hours and 24 minutes (29), whereas AE provides pulpal anesthesia for 60–75 minutes (4). There might be a greater risk of paresthesia and altered sensations when using longer-lasting anesthetic solutions. Lip numbness lasts longer than pulpal anesthesia (29), which might cause drooling, difficulty in eating, speaking, and the possibility of accidental self-inflicted soft tissue trauma. A high percentage of patients reported that prolonged lip anesthesia after the completion of treatment is unpleasant (30). Most local anesthetics used clinically, such as AE and LE, are relatively hydrophobic molecules that gain access to their blocking site on the sodium channel by diffusing into the cell membrane. These anesthetics block sodium channels and thereby the excitability of sensory and motor neurons; this effectively blocks pain signaling and causes numbness (31). In the future, local anesthetics may only target pain-sensing neurons and not interfere with the motor neurons that are involved in movement (32).

TABLE 1. Pretreatment and Post-treatment Values for the Articaine and Xylocaine Groups

Group	4% Articaine	2% Lidocaine	ANOVA, P Value†
Pretreatment pain*	93.1 ± 18.3	89.1 ± 16.1	.4674
Post-treatment pain (success)*	8.3 ± 14.5	10.9 ± 15.3	.6002
Post-treatment pain (failure)*	77 ± 0	74.5 ± 2.6	.4601
			$\chi^2$ , P Value‡
Gender	13 Females 7 Males	8 Females 12 Males	.1115
No. of teeth per arch/route of injection (success %‡)	10 Mandible, Gow-Gates block (90%) 10 Maxillary infiltration block (100%)	11 Mandible, Gow-Gates block (72.7%) 9 Maxillary infiltration block (88.9%)	.7515

ANOVA, analysis of variance.

\*Heft-Parker VAS, mean ± standard deviation.

†There were no significant differences ( $P > .05$ ) between the groups.

‡The block was considered successful if the subject's tooth was accessed with a pain rating no greater than that considered mild pain.

To ensure proper patient comfort, adequate anesthesia must be obtained. AE is a relatively new anesthetic distributed in the United States. There have been many claims by dentists that AE provides more effective anesthesia than other anesthetic solutions sold in the market. Although both anesthetic solutions showed a high rate of pulpal anesthesia, our study demonstrated that AE was as effective but not superior to LE. This result corroborates the other anesthetic studies to date comparing these 2 solutions (1, 12, 27, 33). In endodontics, it is imperative that profound anesthesia is obtained in symptomatic teeth before endodontic access. This study treated 10 patients in the AE group and 11 in the LE group by using the Gow-Gates block. More research is recommended with the Gow-Gates block with AE in teeth with irreversible pulpitis, so a clinician can make evidence-based decisions in the choice of a dental anesthetic.

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