Comparative Evaluation of 1.8 mL and 3.6 mL of 2% Lidocaine with 1:200,000 Epinephrine for Inferior Alveolar Nerve Block in Patients with Irreversible Pulpitis: A Prospective, Randomized Single-blind Study

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Abstract

Introduction: There is a decrease in the anesthetic efficacy of inferior alveolar nerve blocks in patients with irreversible pulpitis. It was hypothesized that the increasing the volume of anesthetic solution may improve the success rates of dental pulp anesthesia in patients with pulpal pain. **Methods:** Fifty-five adult volunteers, actively experiencing pain, participated in this prospective, randomized, single-blind study. The patients were divided into 2 groups on a random basis and received an inferior alveolar nerve block with either 1.8 mL or 3.6 mL of 2% lidocaine with 1:200,000 epinephrine. Endodontic access preparation was initiated after 15 minutes of the initial IANB. Pain during treatment was recorded using the Heft-Parker visual analog scale (HP VAS). The primary outcome measure, and the definition of "success," was the ability to undertake pulp access and canal instrumentation with no or mild pain (HP VAS score <55 mm). Statistical analysis was performed using the chi-square test. **Results:** All patients included in the final analysis had profound lip anesthesia. There were no significant differences in sex, age, or preoperative pain scores of the experimental groups. IANBs of 1.8 mL lidocaine with epinephrine had a success rate of 26%, whereas the administration of 3.6 mL had a 54% success rate. The difference was statistically significant. **Conclusions:** Increasing the volume of 2% lidocaine to 3.6 mL improved the success rate as compared with 1.8 mL but did not give a clinical success rates of 100%. *(J Endod 2012;38:753–756)*

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Key Words

Inferior alveolar nerve block, irreversible pulpitis, lidocaine, volume of anesthetic solution

The inferior alveolar nerve block (IANB) is the most commonly used technique for achieving pulpal anesthesia for posterior mandibular endodontic procedures (1–7). The IANB may provide successful anesthesia in 70% of teeth with uninflamed pulps, but the success rate drastically decreases to 30% or even less in patients with irreversible pulpitis (1–10). The literature suggests the activation of nociceptors by inflammatory mediators such as prostaglandins as a major cause of the increased incidence of the failure of IANBs in patients with irreversible pulpitis (9) although the mechanisms of local anesthetic failure are still not fully understood. Various methods have been suggested in the past to increase the success rate of IANBs in patients with irreversible pulpitis, including supplemental infiltrations (4), preoperative administration of analgesics (6), the use of different local anesthetic solutions (10), intraosseous and periodontal injections (9), a repeat IANB (9), and the use of different techniques of providing IANBs (3, 5, 9).

IANB involves the deposition of local anesthesia solution in the pterygomandibular space, bathing the inferior alveolar nerve just before it enters the mandibular foramen (11). Various authors and textbooks have recommended the administration of 1.5 to 2.2 mL of local anesthetic solution in the pterygomandibular space (11–14). This volume of local anesthetic solution was chosen on the basis of reported volumes of the pterygomandibular space (11). Murphy and Grundy (15) estimated the volume of the pterygomandibular space to be approximately 2.0 mL. Kohler et al (16) suggested from a clinical observation that two 1.8-mL cartridges (3.6 mL) more adequately fill the pterygomandibular space. Madrid et al (17) reported that the "volume of the pterygomandibular space is quite superior to the value usually reported in the dental literature." Some authors have suggested increasing the amount of local anesthetic solution in order to increase the anesthetic success. Yared and Dagher (18) evaluated the degree of anesthesia after the administration of 3.6 mL of 2% lidocaine solutions with either 1:50,000, 1:80,000, or 1:100,000 for the inferior alveolar nerve in healthy volunteers. They compared their results retrospectively with the results of Dagher et al (19) (using 1.8 mL of 2% lidocaine solutions) and found statistically higher success rates with the 3.6-mL volume. Wali et al (20) reported that increasing the volume to 3.6 mL of 2% lidocaine with 1:50,000 epinephrine did not result in more successful pulpal anesthesia when compared with 1.8 mL of 2% lidocaine with 1:100,000 in uninflamed pulps. Vreeland et al (1) compared 1.8 mL of 2% lidocaine with 1:100,000 epinephrine, 3.6 mL of 2% lidocaine with 1:200,000 epinephrine, and 1.8 mL of 4% lidocaine with 1:100,000 epinephrine in uninflamed pulps and found no significant differences in anesthetic success or failure among the 3 solutions.

There is very limited literature regarding the effect of increasing the amount of 2% lidocaine solution on anesthetic success in inflamed pulps. The purpose of the present prospective, randomized, single-blind study was to comparatively evaluate the anesthetic efficacy of 1.8 mL and 3.6 mL of 2% lidocaine with 1:200,000 epinephrine in patients with irreversible pulpitis.

Materials and Methods

Fifty-five adult volunteer subjects were selected from a dental emergency department and were included in this prospective, randomized, single-blind study. Sample size determination was based on a level type 1 error at 0.05 and b level type 2 error of 0.20. A power calculation and results from a previous study (4) indicated that a sample size of 44 subjects would give 80% power to detect a 15% difference in the success rate of the test groups. The success was defined as the ability to undertake pulp access and canal instrumentation with no or mild pain (Heft-Parker visual analog scale [HP VAS] score <55 mm). We assumed a dropout rate of approximately 10% and enrolled at least 25 subjects in each group. The subjects were actively experiencing pain and were in good health, and none were taking any medication that would alter pain perception as determined by oral questioning and a written questionnaire. An ethical clearance was taken from the departmental review committee, and informed written consent was obtained from each subject. Preoperative radiographs were obtained. The inclusion criteria for the study were active pain in the mandibular first or second molar (>54 mm on the Heft-Parker visual analog scale [HP VAS] of 170 mm), a prolonged response to cold testing with an ice stick and an electric pulp tester, the absence of any periapical radiolucency on radiographs except for a widened periodontal ligament, a vital coronal pulp on access opening, American Society of Anesthesiologists class I or II medical history, and the ability to understand the use of pain scales.

The treatment procedure and the use of pain scales were explained to the patients. Patients marked their pretreatment pain on the 170-mm HP VAS (21). The millimeter marks were removed from the scale, and the scale was divided into 4 categories: "no pain" corresponded to 0 mm; "faint, weak, or mild" pain corresponded to 1 to 54 mm; "moderate" pain corresponded to 55 to 114 mm; and "strong, intense, and maximum possible" pain corresponded above 114 mm (10).

The patients were randomly allocated to 2 treatment groups with the help of a simple random generator. Twenty-seven patients received standard IANB injections using 1.8 mL of 2% lidocaine with 1:200,000 epinephrine (Xylocaine; AstraZencea Pharmaceutical Products, Bangalore, India), whereas 28 patients received 3.6 mL of 2% lidocaine with 1:200,000 epinephrine. The solution was injected by the same clinician (first author) via a 5-mL disposable syringe (Dispo Van, Faridabad, India) with a 31-mm 24-G needle (Adis; Albert David Ltd, Mandideep, India). After reaching the target area, aspiration was performed, and the solution was deposited at a rate of 1 mL/min.

After 15 minutes, each patient was asked whether his/her lip was numb. If profound lip numbness was not recorded, the block was considered unsuccessful, and the patients were excluded from the study. The patients were asked to rate their pain on the HP VAS after 20 minutes of the initial IANB. A conventional access opening was initiated after isolation with a rubber dam. Patients were instructed to raise their hand if any pain was felt during the procedure. In case of pain during the treatment, the procedure was stopped, and patients were asked to rate the pain on the HP VAS. Success was defined as no pain or weak/mild pain during endodontic access preparation and instrumentation (HP VAS score <55 mm).

The findings were recorded on a Microsoft Excel sheet (Microsoft Office Excel 2003; Microsoft Corporation, Redmond, WA) for statistical evaluation by using the program BioEstat (version 4.0; Mamiraua Institute, Belem, Brazil). Age and initial and postinjection pain of the subjects were summarized by using means and standard deviations. Multiple comparison analysis of variance (Kruskal-Wallis) and *t* tests were used to determine significant differences at $P < .05$. The anesthetic success of all groups was compared by using nonparametric chi-square tests.

Results

Fifty-five adult volunteer subjects, 24 men and 31 women, with an average age of 30 years, ranging from 23 to 37 years, participated in this prospective, randomized, single-blind study. The age, sex, and initial and 15-minute postinjection pain of all the patients are presented in Table 1. The distribution of teeth for the 1.8-mL and 3.6-mL IANB groups is presented in Table 2. There was no statistical difference between age, sex, initial pain, and the distribution of teeth ($P > .05$). All patients included in the study had profound lip anesthesia after 15 minutes. All patients reported a significant decrease in active pain after local anesthesia ($P < .05$). The postinjection pain HP VAS scores of the different groups were insignificant ($P = .88$).

The comparison of the percentage of patients with successful anesthesia ("no pain" or "weak/mild" pain during endodontic access preparation and instrumentation) is presented in Table 3. The 1.8-mL group had a 26% success rate (7/27 patients), and the 3.6-mL group had a 54% success rate (15/28 patients). There was a significant difference between the groups ($P < .05$). None of the techniques had a 100% success rate.

Discussion

Effective pain management is an important aspect of treating endodontic painful conditions. IANBs provide local anesthesia for mandibular molar teeth by depositing the solution in the pterygomandibular space (11). Because of the anatomic location of the mandibular foramen and the bony prominence of the linguale, the position of the needle may be limited (15). However, it has been shown that a very accurate position of the needle near the nerve is not very important in the success of IANBs (15). The injections given with the guidance of ultrasound did not produce any significant improvement in the success of IANBs (15).

In the present study, the anesthetic success of 1.8 mL and 3.6 mL of 2% lidocaine with 1:200,000 epinephrine was comparatively evaluated. The 1.8-mL IANB had a 26% success rate. The success rate was similar to that reported by various previous studies (3–10). The 3.6-mL IANB had a 54% success rate, which was significantly higher than the 1.8-mL IANB group. Some authors have advocated the use of more than one standard cartridge (1.8 mL) while administering an IANB. Yared and Dager (18) found statistically higher success rates with the 3.6-mL volume as retrospectively compared with 1.8 mL of 2% lidocaine solution. It has been shown that small myelinated nerves are blocked more quickly and effectively than large mylinated nerves (22). To completely block nerve conduction, it is important to bathe a certain amount of nerve length in the anesthetic solution (23). De Jong (24) has suggested that least 10 mm of the nerve must be exposed to an adequate volume and concentration of an anesthetic solution to prevent salutatory conduction. Potoćnik and Bajrović (3) suggested that an adequate volume of anesthetic solution must be applied to the 3 internodal lengths of the largest fiber. Because the longest internodal spans in the human inferior dental nerve have been found to be 1.8 mm (8),

TABLE 1. A Comparison of Age, Sex, and Initial and Postinjection Pain

	1.8-mL IANB	3.6-mL IANB
Age	30 ± 9 y; range, 23-35 y	31 ± 8 y; range, 25-37 y
Sex	10 men 17 women	14 men 14 women
Initial VAS pain score (mm)	104 ± 24	98 ± 32
VAS pain score 15 min after IANB injection (mm)	7 ± 4	10 ± 4

There was no significant difference ($P > .05$) between the groups.