The Effect of 2 Injection Speeds on Local Anesthetic Discomfort During Inferior Alveolar Nerve Blocks

Marcelo Rodrigo de Souza Melo,* Mark Jon Santana Sabey,* Carla Juliane Lima, DDS,† Liane Maciel de Almeida Souza, DDS, PhD,‡ and Francisco Carlos Groppo, DDS, PhD§

*Undergraduate Student, †Former Graduate Student, and ‡Chairman Professor, Dentistry School of Sergipe, Federal University of Sergipe, Brazil, and §Chairman Professor, Dentistry School of Piracicaba, University of Campinas, São Paulo, Brazil.

This randomized double-blind crossover trial investigated the discomfort associated with 2 injection speeds, low (60 seconds) and slow (100 seconds), during inferior alveolar nerve block by using 1.8 mL of 2% lidocaine with 1 : 100,000 epinephrine. Three phases were considered: (a) mucosa perforation, (b) needle insertion, and (c) solution injection. Thirty-two healthy adult volunteers needing bilateral inferior alveolar nerve blocks at least 1 week apart were enrolled in the present study. The anesthetic procedure discomfort was recorded by volunteers on a 10-cm visual analog scale in each phase for both injection speeds. Comparison between the 2 anesthesia speeds in each phase was performed by paired *t* test. Results showed no statistically significant difference between injection speeds regarding perforation ($P = .1016$), needle placement ($P = .0584$), or speed injection ($P = .1806$). The discomfort in all phases was considered low. We concluded that the 2 injection speeds tested did not affect the volunteers' pain perception during inferior alveolar nerve blocks.

Key Words: Inferior alveolar nerve block; Injection speed; Lidocaine; Local anesthesia; Pain.

Dental anxiety and pain experience, frequently associated with local anesthesia, are the 2 major causes for noncompliance with dental care. Mucosal needle perforation and solution injection have been linked to fear reports. Thus, painless local anesthetic administration is an essential factor to reduce stress in dental treatments.^{1–6}

Local anesthetic injection is also commonly related to medical emergencies in dental offices⁴ and it is important to control anxiety and fear to avoid such occurrences.^{5,6}

Discomfort during inferior alveolar nerve block (IANB) has been reported.⁷ For this reason, this technique has

been studied and the injection steps divided to identify the moment most associated with pain. Those steps are mucosa perforation, needle placement, and solution injection.¹

Slow injection speeds have been neglected by dentists who usually consider the slow injection as a loss of time. Others may feel that completing the injection as quickly as possible will shorten the period of injection discomfort. However, it is important to establish an optimal speed for local anesthetic administration to allow for minimally traumatic local anesthesia.^{4,7}

Different injection speeds of local anesthetics are related in literature. Malamed⁴ indicates 1 mL/min, approximately 100 seconds, to inject a single cartridge (1.8 mL), whereas Kanaa et al⁷ and Whitworth et al⁸ indicate 1 cartridge/min (1.8 mL/min) as recommended injection speed.

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Address correspondence to Dr Liane Maciel de Almeida Souza, Universidade Federal de Sergipe, Hospital Universitário, Departamento de Odontologia, Rua Cláudio Batista, s/n—Bairro Sanatório, Aracaju, SE, Brasil, CEP 49060-100; odontoliu@gmail.com.

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The aim of this trial was to determine the injection step in local anesthesia administration that is most associated with discomfort and to correlate the pain perception with 2 injection speeds during IANB.

METHODS

This randomized, double-blind crossover trial was performed to evaluate the pain during IANB delivered with 2 different injection speeds, considered as “low” (60 seconds) and “slow” (100 seconds) speeds according to previous studies.^{4,7,8} The study was conducted in the Dentistry School at Federal University of Sergipe, Aracaju-Sergipe, Brazil, during 12 months, and it was approved by the Ethics Committee in Research of Federal University of Sergipe protocol 0053.0.107.000-10.

Patients of both genders, aged from 18 to 40 years, were eligible for the trial. All volunteers were healthy, American Society of Anesthesiologists physical status I, and with stable vital signs evaluated at the preoperative visit. Patients who were pregnant, who had odontophobia, or who reported allergy to any of the local anesthetic components were excluded from the trial. Patients who used antihistamines, cimetidine, illicit drugs, or any other prescription or over-the-counter medication that interferes with pain sensitivity were also excluded.

All volunteers signed the research consent and received instructions about the study from one researcher, who defined the order and sides of the IANBs by using random allocation software. A second researcher was responsible for the IANBs. This operator was trained to deliver the anesthetic solutions at the prescribed speeds and was not involved in assessing outcomes. In order to accurately control the injection speed, a chronometer was positioned for the second researcher out of sight of the volunteer.

Before all procedures, all volunteers submitted to chlorhexidine gluconate 0.12% mouthwash for 1 minute. Mucosa was dried with gauze and topical anesthetic (20% benzocaine) was applied with a cotton swab for 1 minute before needle puncture. Local anesthesia procedure was performed according to the speed and side previously defined.

Before the injections, patients were instructed to rate the pain experience for each one of the following injection steps during the IANB injection: (a) mucosa perforation, (b) needle insertion to the target site, and (c) anesthetic solution deposition.

Injections were given with standard dental aspirating syringes (Integra Miltex) fitted with 45-mm/27-gauge dental needles (Unoject; DFL). The local anesthetic needle was inserted midway between the internal oblique

ridge and the pterygomandibular raphe and advanced until bone contact. Negative aspiration was achieved before depositing 1.8 mL of solution over either 60 or 100 seconds. No anesthetic solution was deposited during needle penetration towards the target site. After needle withdrawal, volunteers were asked to self-record the discomfort associated for each injection step on a 10-cm visual analog scale (VAS) with endpoints tagged as “no pain” (0 cm) and “unbearable pain” (10 cm).

IANBs were administered on each side with only 1 injection speed. The interval between the 2 injections was 1 week. The solution deposition speeds were 60 and 100 seconds per cartridge with 1.8 mL of 2% lidocaine with 1 : 100,000 epinephrine (Alphacaine 100; DFL) on each side. After anesthesia, dental procedures were performed according to the necessary treatment.

Statistical analysis was performed by using the BioEstat (Fundação Mamirauá) statistical package. The level of significance was set at 5%. Differences in pain perception regarding age and between genders were verified by Mann-Whitney test. Paired *t* test was used to observe possible influence of sides and the differences of pain between the 2 anesthesia speeds. The data distribution was observed by both Shapiro-Wilk and Kolmogorov-Smirnov tests. The similarity of variances was tested by Levene's test. Analysis of variance with Tukey or Bonferroni post hoc methods was also used to verify possible differences among the 3 injection steps. A *P* value $\leq .05$ was considered significant.

RESULTS

Thirty-two adult volunteers (13 men and 19 women), 18–31 years old, underwent bilateral IANBs for dental treatment. The mean time recorded for the anesthesia procedure in the 60-second speed group was 61 ± 3 seconds and the mean time in the 100-second speed group was 100 ± 5.5 seconds.

No statistically significant differences ($P = .2658$) between the ages of men (23.0 ± 3.4 years) and women (21.6 ± 2.8 years) were observed. In addition, there were no statistically significant differences between genders regarding pain perception considering each injection step, except for the solution injection, which showed higher ($P = .0302$) VAS values for females (2.04 ± 0.51 cm) than males (0.67 ± 0.21 cm) during the 60-second injection only.

The Figure shows the VAS values for each injection step for both speeds of injection. Pain perception by VAS was generally evaluated as low. The pain classification (low, moderate, and severe) of VAS values was adapted from Collins et al.⁹ VAS values presented

Visual analog scale (VAS) mean ($\pm$ SD) observed during the injection steps for 60- and 100-second speed groups.

normal distribution and similar variances after data transformation.

Despite a statistically significant increase in pain in the subgroup of female volunteers related to the injection step of the anesthetic over 60 seconds, overall, there was no statistically significant difference between the studied injection speeds for the mucosa perforation ($P = .1016$), needle insertion ($P = .584$), or local anesthetic injection ($P = .1806$).

The most painful injection step was the needle insertion to target site for both injection speeds ($P = .0244$ to 60 seconds and $P = .0086$ to 100 seconds). The pain measured by VAS scale during mucosa perforation and anesthetic solution deposition was not significantly different between the 2 groups.

DISCUSSION

Pain is an individual sensation influenced by a number of factors altering its perception. It is reported that older individuals report less pain than younger ones.^{10,11} In the present study, the subjects age range was restricted in order to reduce the influence of this variable.

Difference in pain perception between genders is controversial in the literature. This trial showed women presenting more discomfort than men during the solution injection only at the 60-second speed of injection. Studies have found pain perception differences between gender during dental anesthesia, where females tolerated less pain than males.^{3,10,11} However, other authors have not found differences.^{1,7,8,12}

The IANB has been associated with pain and discomfort. For the actual mucosa perforation, Nusstein and Beck,¹¹ in a retrospective study of 1635 IANBs, reported an incidence of moderate-to-severe pain ranging from 14 to 22% of blocks. For needle placement

to the target site, in 2006 Nusstein et al¹³ reported that 22–56% of the subjects experienced moderate to severe pain. For the solution deposition at the target site, various authors^{1,14–16} have reported that the incidence of moderate to severe pain ranged from 14 to 52%.

This study observed differences in pain intensity among injection steps inside the groups. The needle insertion was the injection step most associated with pain in both the 60- and 100-second speed groups. This result correlates with other studies in which this injection step was reportedly most related with discomfort.^{1,13,17}

McCartney et al¹ evaluated pain felt in the 3 injection steps of IANB injections using 2% lidocaine with 1 : 100,000 epinephrine in 102 emergency patients with irreversible pulpitis. The authors observed that the administration of 0.2–0.4 mL of anesthetic solution during needle placement did not significantly reduce needle placement pain compared with administering no anesthetic solution during needle placement.

The use of topical anesthesia in this study did not eliminate mucosa perforation pain. McCartney et al,¹ Nusstein and Beck,¹¹ Nakanishi et al,¹⁸ and Meechan et al¹⁹ reported that 20% benzocaine was not completely effective in reducing mucosa perforation pain for the IANB in asymptomatic patients. It may be that the most important aspect of using topical anesthetic agents is not its clinical effectiveness, but rather the psychological effect on the patient who feels the clinician is doing everything possible to prevent pain.¹ Martin et al²⁰ found that if patients thought they were receiving topical anesthetic, whether they did or not, they anticipated less pain during the injection.

Injection speed has been shown to influence the pain of intraoral injections. Many studies compared slow and rapid injections and found that slow injections were associated with less discomfort than rapid injections.^{1,5–8,21–23} Slow injections are considered safer in cases of intravenous injections of anesthetic solutions, limiting cardiovascular alterations and anesthetic peak concentrations.⁴

Kanaa et al⁷ in 2006 investigated discomfort and efficacy related to 60-second (slow) and 15-second (rapid) IANBs using 2.0 mL of 2% lidocaine with 1 : 80,000 epinephrine in securing mandibular first molar, premolar, and lateral incisor pulp anesthesia in 38 healthy adult volunteers. Episodes of maximal stimulation (80 μ A) without sensation on electronic pulp testing were recorded. Injection discomfort was self-recorded by volunteers on a 100-mm VAS. Slow IANB was more comfortable than rapid IANB. Slow IANB also produced more episodes of no response to maximal pulp stimulation than rapid IANB in molars (220 vs 159 episodes), premolars (253 vs 216 episodes), and lateral incisors (119 vs 99 episodes).

The results of the present trial demonstrate that with the exception of a statistically significant increase in pain associated with the 60-second speed in female versus male participants for the solution injection step, overall there were no significant differences in any of the 3 steps for either of the 2 speed groups when evaluated as a whole. The increased pain in female volunteers associated with the solution injected over 60 seconds may represent the threshold for the maximum speed of injection above which both male and female volunteers might experience increased injection pain. Because the overall pain levels at any of the steps were relatively low, the statistically significant increased pain in females for this step may not be a clinically significant difference. These data relate to the IANB and do not necessarily pertain to the pain associated with any other injection techniques.

In conclusion, although females experienced significantly more pain than males during the 60-second solution injection step, overall, the pain associated with the IANB injection over 60 seconds was not clinically different from that of the injection over 100 seconds. The 60-second injection for the IANB may save a few seconds of time for the dentist without increasing the discomfort of the injection.

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