Anesthetic Efficacy of Gow-Gates Nerve Block, Inferior Alveolar Nerve Block, and Their Combination in Mandibular Molars with Symptomatic Irreversible Pulpitis: A Prospective, Randomized Clinical Trial

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Abstract

Introduction: The purpose of this prospective, randomized clinical trial was to evaluate the anesthetic efficacy of the Gow-Gates nerve block (GGNB), the inferior alveolar nerve block (IANB), and their combination for mandibular molars in patients with symptomatic irreversible pulpitis. **Methods:** One hundred fifty patients diagnosed with symptomatic irreversible pulpitis of a mandibular molar were selected. The patients randomly received 2 GGNB injections, 2 IANB injections, or 1 GGNB injection plus 1 IANB injection of 1.8 mL 2% lidocaine with 1:80,000 epinephrine. Access cavity preparation was initiated 15 minutes after injections. Lip numbness was a requisite for all of the patients. Success was specified as no or mild pain on the basis of Heft-Parker visual analog scale recordings during access cavity preparation or initial instrumentation. Data were analyzed with the chi-square, Kruskal-Wallis, and analysis of variance tests. **Results:** The success rates of anesthesia were 40%, 44%, and 70% for the GGNB, IANB, and GGNB + IANB groups, respectively. There was no statistically significant difference in the success rate of anesthesia between the GGNB and IANB groups ($P > .05$). The anesthesia success rate for the GGNB + IANB group was significantly different from those of the GGNB and IANB groups ($P < .05$). **Conclusions:** A combination of GGNB and IANB could improve the efficacy of anesthesia in mandibular molars with symptomatic irreversible pulpitis, but it would still require supplemental anesthesia. Further research may be needed to confirm the results of this study. *(J Endod 2018;44:384–388)*

Key Words

Gow-Gates, inferior alveolar nerve block, local anesthesia, molar, pulpitis

Significance

A combination of a Gow-Gates nerve block and an inferior alveolar nerve block can be helpful for clinicians to improve the efficacy of anesthesia in mandibular molars with symptomatic irreversible pulpitis.

Effective local anesthesia is an important initial step in the management of patients with painful pulpitis. However, achieving profound anesthesia is a great challenge in mandibular molars, particularly in teeth with symptomatic irreversible pulpitis (1).

The Gow-Gates nerve block (GGNB) was first introduced as a true alternative approach to anesthetize the mandibular nerve in 1973. The target area for the deposition of local anesthetic solution is the lateral aspect of the anterior portion of the condylar neck where the mandibular nerve exits through the foramen ovale (Fig. 1*A*). Therefore, all the branches of the mandibular nerve, including the auriculotemporal, lingual, buccal, and mylohyoid nerves, are anesthetized (2). However, clinical studies have reported failure rates ranging from 10%–65% for GGNB in mandibular posterior teeth with irreversible pulpitis (3–5).

The inferior alveolar nerve block (IANB) is the most widely used technique to achieve local anesthesia for endodontic treatment of mandibular teeth. The target area for the deposition of local anesthetic solution is the pterygomandibular space where the inferior alveolar nerve enters the mandibular foramen (Fig. 1*B*). Therefore, other branches of the mandibular nerve, including the lingual, buccal, and mylohyoid nerves, are not anesthetized because they are above the mandibular foramen. The anesthetic efficacy of this technique, compared with GGNB, is controversial (3). However, clinical studies have reported failure rates ranging from 30%–81% for IANB in mandibular posterior teeth with irreversible pulpitis (6–8).

The most probable explanation for the decrease in the success rate of local anesthesia in teeth with inflamed pulps can be the activation and sensitization effect of inflammation on the nociceptors and stimulation of a greater number of nerve fibers (9–12), resulting in a barrage of impulses from the inflamed pulp to the brain through more than a thousand unmyelinated sensory C fibers (13, 14). Therefore, it is hypothesized that deposition of local anesthetic solution at 2 different sites along the nerve trunk results in the exposure of a greater length of the nerve to the local anesthetic solution, thus increasing the number of voltage-gated sodium channels exposed to local anesthetic solution, resulting in improved efficacy of local anesthesia.

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0099-2399/$ - see front matter

https://doi.org/10.1016/j.joen.2017.10.008

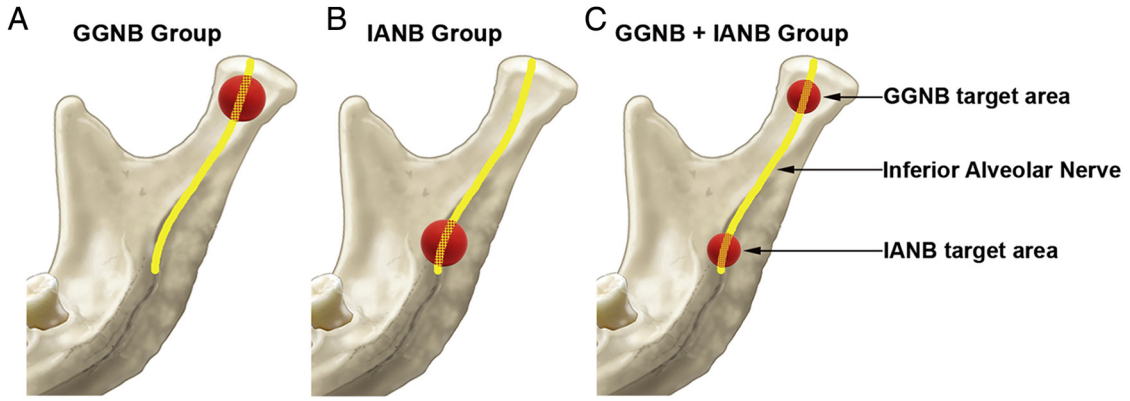

Figure 1. A schematic illustration of the injection target areas in the 3 groups: *(A)* 3.6 mL, *(B)* 3.6 mL, and *(C)* 1.8 mL of anesthetic solution was deposited at each of the injection target areas.

The combination of GGNB and IANB may result in the exposure of a greater length of the inferior alveolar nerve to the local anesthetic solution and subsequently increases the efficacy of anesthesia. However, there are no studies on the efficacy of a combination of GGNB and IANB in patients with irreversible pulpitis. Thus, the purpose of this prospective, randomized clinical trial was to compare the anesthetic efficacy of GGNB, IANB, and GGNB in association with IANB for mandibular molars with symptomatic irreversible pulpitis. The null hypothesis tested was that no difference would be found between the success rates of the 2 nerve block techniques and their combination.

Materials and Methods

One hundred fifty adult patients participated in this prospective, randomized clinical trial. All of the subjects were emergency patients of the Dental Clinic of Isfahan University of Medical Sciences, Isfahan, Iran. Criteria for inclusion in the study consisted of age over 18 years, active pain in a mandibular molar, a lingering response to cold testing with cold spray (Endo-Frost; Coltene-Whaledent, Langenau, Germany), absence of any periapical radiolucency on radiographs (except for a widened periodontal ligament with an intact lamina dura), a vital pulp at access cavity preparation, and the ability to understand the use of pain scales. Criteria for exclusion from the study consisted of an allergy to local anesthetics; pregnancy; the use of any medications such as sedatives, antianxiety, antidepressants, or analgesics that might influence pain assessment; a history of significant medical problems; the presence of active pathosis in the area of injection; and the inability to give written informed consent. Therefore, each patient had a mandibular molar with a clinical diagnosis of symptomatic irreversible pulpitis.

The research was conducted in full accordance with the World Medical Association Declaration of Helsinki. The ethics committee of the university approved the protocol of the study with number 395437, and the study was registered at the clinical trials website (http://www.clinicaltrials.gov) with number NCT03117491. Written informed consent was also approved by the ethics committee and was obtained from each patient before treatment.

Each patient assessed his or her initial pain on a Heft-Parker visual analog scale (HP-VAS) (15). This scale is a horizontal marked line ranging from 0–170 mm. The patients placed a mark on the scale where it best described their pain level. The scale was divided into 4 categories with various descriptive terms. The no pain, mild pain, moderate pain, and severe pain choices were described by 0-mm, 1- to 54-mm, 55- to 113-mm, and 114- to 170-mm divisions, respectively. Patients with moderate or severe initial pain were included in the study.

The patients were randomly assigned to 3 groups of 50 each using random number generator software (Random Allocation Software; M. Saghaei, Isfahan, Iran): GGNB, IANB, and GGNB + IANB.

Before each injection procedure, the mucosa was dried, and a topical anesthetic agent (20% benzocaine; Ultradent Products Inc, South Jordan, UT) was applied to the injection site using a cotton tip applicator and left in place for 1 minute. All of the injections were administered using 2% lidocaine with 1:80,000 epinephrine (2% Persocaine-E; Daroupakhsh, Tehran, Iran), a standard aspirating dental injection syringe, and a 27-G 31-mm needle (CK Ject; CK Dental, Kor-Kyungji-do, Korea). A single operator (M.S.) performed all of the injections.

In the GGNB group (Fig. 1*A*), each patient received two 1.8-mL cartridges of 2% lidocaine with 1:80,000 epinephrine using the conventional GGNB technique. The patient was placed in the supine position with the neck extended and the mouth open as wide as possible. The injection site was the soft tissue just distal to the maxillary second molar at the height of its mesiopalatal cusp. The needle was placed through the mucosa of the injection site and inserted along an imaginary line between the 2 extraoral landmarks at the lower border of the intertragic notch and the corner of the mouth. The needle was advanced slowly until bony contact was felt at the lateral region of the condyle neck (target area) or until a penetration depth of approximately 25 mm was reached. If contact was not felt, the needle was withdrawn and redirected at another angle. After bony contact, the needle was withdrawn slightly, aspiration was performed, and the anesthetic solution was deposited over a period of 1 minute. The patient was asked to keep his or her mouth wide open for a further 1 minute. The second GGNB injection was performed immediately after the first one in the same way as described previously.

In the IANB group (Fig. 1*B*), each patient received two 1.8-mL cartridges of 2% lidocaine with 1:80,000 epinephrine using the conventional IANB technique. The patient was placed in the supine or semisupine position with an open mouth. The injection site was the soft tissue over the medial surface of the ramus, lateral to the pterygomandibular raphe. The coronoid notch on the anterior border of the ramus was touched by the thumb, and the posterior border of the ramus was touched by the first or second finger of the noninjecting hand. The line between the finger and the thumb determined the height of the injection site. The syringe was kept parallel to the mandibular occlusal plane and directed from the premolars on the opposite side. The needle was placed through the mucosa of the injection site and then advanced slowly until bony contact was felt. Then, the needle was withdrawn slightly, aspiration was performed, and the anesthetic solution was

deposited over a period of 1 minute. The second IANB injection was performed immediately after the first one in the same way as described earlier.

In the GGNB + IANB group (Fig. 1*C*), each patient received one 1.8-mL cartridge of 2% lidocaine with 1:80,000 epinephrine using the conventional GGNB technique and one 1.8-mL cartridge of 2% lidocaine with 1:80,000 epinephrine using the conventional IANB technique as described previously.

Profound lip numbness was considered as a subjective criterion for nerve block achievement. The patient was asked for lip numbness 15 minutes after the injection. If profound lip numbness was not achieved, the nerve block was indicated as missed, and the patient was excluded from the study. In the GGNB group, 1 patient was excluded from the study as a result of a lack of profound lip numbness and replaced with another patient.

One operator performed all of the injections, and 15 minutes after the injection, each tooth was isolated using a rubber dam, and access cavity preparation was initiated. The operator who performed the access cavity preparation was blinded to the injection technique. The patients were instructed to rate any pain experienced during preparation of the access cavity or placement of the initial file in the same way by the operator performing the injections. If the patient felt pain, the treatment was immediately suspended, and the patient recorded the severity of pain by using the HP-VAS. The success of the anesthesia was defined as the tooth without pain or with mild pain according to the HP-VAS scores (HP-VAS $\leq$54). For patients indicating moderate or severe pain, intraligamentary and/or intrapulpal injection was administered and the endodontic treatment proceeded.

Statistical Analysis

Data were analyzed with SPSS, Version 22 (IBM Corp, Armonk, NY). Comparisons among the 3 groups for the success of anesthesia and sex differences were made using the chi-square test; the initial pain was analyzed using the Kruskal-Wallis test, and age was analyzed with one-way analysis of variance. Using data from a previous study (16), we estimated that a sample size of 50 patients in each group was required to detect a difference of 25% in the success rate of anesthesia between the groups, with an alpha risk of .05 and a power of 80%. Statistical significance was defined at $P < .05$.

Results

A total of 150 patients, 52 men and 98 women, with an age range of 18–64 years and a mean of 36 $\pm$ 10 years participated in this study. Baseline variables for the GGNB, IANB, and GGNB + IANB groups are presented in Table 1. There were no significant differences in age, sex, or initial pain among the 3 groups ($P > .05$).

The success rates of anesthesia were 40%, 44%, and 70% for the GGNB, IANB, and GGNB + IANB groups, respectively (Fig. 2). There was

TABLE 1. Baseline Variables for the 3 Groups

Variable	GGNB	IANB	GGNB + IANB	*P* value*
Total subjects	50	50	50	
Age (y)	18–55	18–64	18–56	.566
Sex				.402
Women	34	29	35	
Men	16	21	15	
Initial pain†	105 (29.0)	104 (30.1)	112 (33.3)	.334

GGNB, Gow-Gates nerve block; IANB, inferior alveolar nerve block.
*There were no significant differences between the 2 groups ($P > .05$).
†Mean (standard deviation).

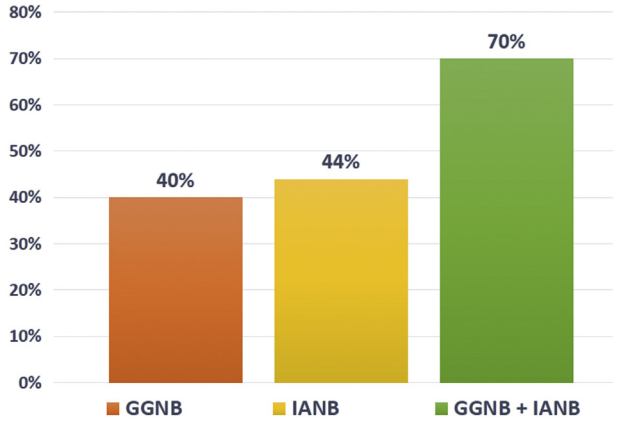

Figure 2. Success rates of anesthesia for the GGNB, IANB, and GGNB + IANB groups.

no statistically significant difference in the success rate of anesthesia between the GGNB and IANB groups ($P > .05$). The success rate of anesthesia in the GGNB + IANB group exhibited a statistically significant difference from the GGNB and IANB groups ($P < .05$).

Discussion

The results of this study indicated that a combination of GGNB and IANB techniques increased the success rate of anesthesia for symptomatic mandibular molars compared with the success rate of each technique alone. Age, sex, and initial pain of patients (baseline variables) were not significantly different among the 3 groups. Thus, the variables had no effect on the results (Table 1). In addition, all of the teeth had moderate or severe initial pain, a lingering response to cold testing, and a vital coronal pulp tissue on access preparation, which indicated the diagnosis of symptomatic irreversible pulpitis for the teeth.

In the present study, the success rate of anesthesia was evaluated by measuring the severity of pain during access cavity preparation or placement of the initial file using the HP-VAS; other tests with an electric pulp tester were not performed. This was based on the results of Nusstein et al (6), who used an electric pulp tester for measuring the severity of pain for teeth with irreversible pulpitis. They showed that 42% of patients who showed a negative response to electric pulp testing after administering anesthesia still had pain during treatment and required another injection.

Some clinical studies have reported that increasing the volume of the anesthetic solution improves the success rate of IANB (17–19), whereas others have reported no beneficial effects (20–25). However, to avoid the confounding factor of anesthetic solution volume, all of the patients received the same volume of the anesthetic solution, consisting of two 1.8-mL cartridges of 2% lidocaine with 1:80,000 epinephrine.

The success rate of GGNB has been reported to range from 35%–90% in mandibular posterior teeth with symptomatic irreversible pulpitis (3–5). In the present study, we evaluated the success rate of GGNB in 50 patients using 3.6 mL 2% lidocaine with 1:80,000 epinephrine in symptomatic mandibular molars and found it to be 40%. Moreover, the success rate of IANB has been reported to range from 19%–70% in mandibular posterior teeth with symptomatic irreversible pulpitis (6–8), and it was 44% under the conditions of this study. Differences in the results might be attributed to the type and the volume of local anesthetic solution, sample size, and clinician experience.

In this study, the success rates of GGNB and IANB techniques exhibited no significant difference. Our results are consistent with those of

studies that indicated no significant differences in the anesthetic efficacy of GGNB and IANB techniques (26–29). However, our results do not coincide with those of other studies indicating that the anesthetic efficacy of the GGNB technique is superior to that of the IANB technique (4, 30–33). Differences in the results might be attributed to the type and the volume of local anesthetic solution, type of treatment (root canal treatment or tooth extraction), condition of the pulp (normal or inflamed), and clinician experience.

In the present study, none of the GGNB and IANB techniques given alone provided profound anesthesia in patients with irreversible pulpitis. These results are consistent with those of other studies concluding that the mandibular block techniques (GGNB, IANB, and Vazirani-Akinosi nerve block techniques) given alone could not provide acceptable success rates in patients with irreversible pulpitis, and all of them required supplemental anesthesia (3, 4). Click et al (3) evaluated the anesthetic efficacy of GGNB (60 patients) and Vazirani-Akinosi (38 patients) techniques using 3.6 mL 2% lidocaine with 1:100,000 epinephrine in symptomatic posterior teeth. They reported a success rate of 35% for GGNB and 16% for Vazirani-Akinosi techniques. Aggarwal et al (4) studied the anesthetic efficacy of GGNB (25 patients), IANB (22 patients), and Vazirani-Akinosi (24 patients) techniques using 2.2 mL 4% articaine with 1:100,000 epinephrine in symptomatic mandibular molars. They reported success rates of 52%, 36%, and 41% for GGNB, IANB, and Vazirani-Akinosi techniques, respectively.

The pterygomandibular space is a part of the infratemporal fossa, which is filled by loose connective tissue suspended in various fascial planes. The volume of this space has been estimated to be approximately 2 mL (34). The target area for both GGNB and IANB injections is located in this space, and anesthetic solution fills the space. However, the solution might escape from the pterygomandibular space through the hiatus where the internal maxillary artery enters this space between the sphenomandibular ligament and the condyloid process (35). We found that injecting 3.6 mL anesthetic solution at 2 different sites in the pterygomandibular space was more successful than injecting at only 1 site. Berns and Sadove (35) reported that anesthetic solution migrated in the pterygomandibular space depending on the path of least resistance, which is determined by fascial planes and structures encountered and not necessarily by needle tip placement. They claimed that solution deposition does not always follow a predictable path, and it may take an uncontrollable erratic course away from the path of the inferior alveolar nerve. Therefore, a possible explanation for our finding is that deposition of anesthetic solution at 2 different sites of the pterygomandibular space is more likely to cause the anesthetic solution to follow a path to the inferior alveolar nerve. Another explanation is that, when a certain volume of anesthetic solution is deposited at 2 different sites along the nerve trunk (Fig. 1*C*), the length of nerve exposed to anesthetic solution might be greater than when the same volume of anesthetic solution is deposited at 1 site (Fig. 1*A* and *B*).

Kohler et al (36) reported a higher success rate for GGNB when the anesthetic volume was increased from 1.8–3.6 mL (18%–82%). However, we found that only a 1.8-mL GGNB injection in combination with a 1.8-mL IANB injection increased the success rate of anesthesia. This may be because of the fact that deposition of anesthetic solution at 2 different sites of the pterygomandibular space has a better chance of following a path to the inferior alveolar nerve. Moreover, deposition of local anesthetic solution at 2 different sites along the inferior alveolar nerve compared with deposition of local anesthetic solution at 1 site might result in a greater length of nerve exposed to anesthetic solution.

The results of this study support the hypothesis that deposition of local anesthetic solution at 2 different sites along the nerve trunk blocks transmission of pain impulses better than deposition of local anesthetic solution at 1 site. Therefore, it would be helpful for clinicians to use a combination of 2 different local anesthesia techniques to increase the success rate of anesthesia. However, even though the success rate of the combination technique was 70%, supplemental injections such as intraligamentary, intraosseous, or intrapulpal injections may still be needed.

The present study was a prospective, randomized clinical trial. The patient and the operator performing the access cavity preparation were blinded to the study groups. However, because of the clinical setting of the study, the operator performing the injections was not blinded to the groups. Hence, a possible limitation of the present study is that it was not double-blind.

In conclusion, a combination of GGNB and IANB could improve the efficacy of anesthesia in mandibular molars with symptomatic irreversible pulpitis, but it would still require supplemental anesthesia. Further research may be needed to confirm the results of this study.

Acknowledgments

Supported by Isfahan University of Medical Sciences Research grant no. 395437.

The authors would like to thank Saba Moshkforoush for her help as a research assistant.

The authors deny any conflicts of interest related to this study.

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