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The success rate of bupivacaine and lidocaine as anesthetic agents in inferior alveolar nerve block in teeth with irreversible pulpitis without spontaneous pain

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Objectives: Achieving adequate anesthesia with inferior alveolar nerve blocks (IANB) is of great importance during dental procedures. The aim of the present study was to assess the success rate of two anesthetic agents (bupivacaine and lidocaine) for IANB when treating teeth with irreversible pulpitis. ***Materials and Methods:*** Sixty volunteer male and female patients who required root canal treatment of a mandibular molar due to caries participated in the present study. The inclusion criteria included prolonged pain to thermal stimulus but no spontaneous pain. The patients were randomly allocated to receive either 2% lidocaine with 1:80,000 epinephrine or 0.5% bupivacaine with 1:200,000 epinephrine as an IANB injection. The sensitivity of the teeth to a cold test as well as the amount of pain during access cavity preparation and root canal instrumentation were recorded. Results were statistically analyzed with the Chi-Square and Fischer's exact tests. ***Results:*** At the final step, fifty-nine patients were included in the study. The success rate for bupivacaine and lidocaine groups were 20.0% and 24.1%, respectively. There was no significant difference between the two groups at any stage of the treatment procedure. ***Conclusions:*** There was no difference in success rates of anesthesia when bupivacaine and lidocaine were used for IANB injections to treat mandibular molar teeth with irreversible pulpitis. Neither agent was able to completely anesthetize the teeth effectively. Therefore, practitioners should be prepared to administer supplemental anesthesia to overcome pain during root canal treatment. (*Restor Dent Endod* 2015;40(2):155-160)

Key words: Anesthesia; Bupivacaine; Cold test; Inferior alveolar nerve block; Irreversible pulpitis; Lidocaine

Introduction

Patients desire and expect to receive dental treatment, particularly root canal procedures, without any pain.[1] Numerous investigations have been performed to determine the best methods and drugs for successful anesthesia during dental procedures. The inferior alveolar nerve block (IANB) injection has long been the method of choice for many clinicians for anesthesia when treating mandibular molar teeth.[2-19] However, high number of instances of inadequate anesthesia following IANB administration with various anesthetic agents and techniques has resulted in the need for continuing investigations in this field.

Laboratory investigations have suggested that bupivacaine would be the anesthetic

agent of choice for teeth with severely inflamed pulps because it acts more effectively over Tetrodotoxin (TTx) resistance channels compared to lidocaine.[20] Several investigators have reported the use of bupivacaine to achieve anesthesia in mandibular molars with IANB injections.[11,21-24]

It is generally accepted that achieving anesthesia in teeth with irreversible pulpitis is significantly more difficult than for the teeth with clinically normal pulp.[1,2] However, only one investigation has been performed to compare bupivacaine and lidocaine for IANB in teeth with irreversible pulpitis.[11] That study examined the success of anesthesia by electric pulp tester (EPT) after administration of either 2% lidocaine with 1:100,000 epinephrine or 0.5% bupivacaine with 1:200,000 epinephrine as anesthetic solutions. This experiment showed that the patients who received the latter anesthetic solution had significantly higher number of positive responses to EPT compared to the lidocaine group. In contrast, in the same patients after commencing access cavity preparation, the number of patients who had no or mild pain during the root canal treatment procedure in the bupivacaine group was lower than the number of the patients who received lidocaine as the anesthetic agent, although the difference was not significant.[11]

Previous investigation comparing bupivacaine and lidocaine evaluated the success rate of IANB in patients with spontaneous and moderate to severe pain, and in need of emergency treatment.[11] The clinical response to bupivacaine and lidocaine for IANB injections in terms of anesthesia success in patients with spontaneous and moderate to severe pain might be different to the response in patients who have irreversible pulpitis with only prolonged pain following thermal stimulus.[3,10] Hence, the aim of the present investigation was to compare these anesthetic agents for IANB when treating teeth with no spontaneous pain but with prolonged pain following thermal stimulus.

Materials and Methods

This study was approved by the Ethics Committee of Kerman University of Medical Sciences in Iran (No. KA/90/336-1). Sample size calculations required up to 30 patients in each group to detect a difference of 30% in the success rate of anesthesia between groups with a power of 0.8.

The following inclusion and exclusion criteria were employed for this study:

- Inclusion criteria: Healthy patients over 18 years old who had a first or second mandibular molar tooth in need of root canal treatment with irreversible pulpitis. The clinical diagnosis of irreversible pulpitis was confirmed by a positive response to an electric pulp tester (The Element Diagnostic Unit: SybronEndo, Glendora, CA, USA) and a prolonged response more than 10 seconds with moderate to severe pain to a cold test (Roeko Endo-Frost, Roeko, Langenau, Germany) applied with a size 2 cotton pellet.
- Exclusion criteria: Presence of systemic disorders, sensitivity to lidocaine with 1:80,000 epinephrine, sensitivity to bupivacaine, presence of widening of the periodontal ligament space, presence of a periapical radiolucency, lactation, pregnancy, and/or using any type of analgesic medication in the preceding 12 hours before the treatment, teeth that were unsuitable for restoration, teeth with full crowns, and teeth associated with spontaneous severe pain that needed emergency treatment.

Sixty patients were eligible to participate in this prospective, randomized double blind study. All patients were treated in the postgraduate clinic of the Endodontic Department of Kerman Dental School in Iran from February 2011 to February 2012. Informed consent was obtained from all subjects who participated in this study after the nature of the procedure and the possible discomforts and risks had been fully explained. All patients who agreed to participate in the study were randomly divided into two groups of 30 patients each.

Before administering the anesthesia, the patients were asked to rate their pain using a Heft-Parker visual analogue pain scale (VAS) following a cold test. The VAS scores were divided into four categories. No pain corresponded to 0 mm, mild pain was defined as being > 0 mm and ≤ 54 mm, moderate pain was defined as being > 54 mm and < 114 mm, and severe pain was defined as being ≥ 114 mm.

Patients were randomly assigned to the groups by selecting a sealed opaque envelope with the group number concealed inside it. Two clinicians performed the clinical procedures, one administered the IANB injection and the other prepared the endodontic access cavity 15 minutes following the injection. Only the clinician who administered the anesthetic solution was aware of the type of anesthetic technique used. After applying a topical anesthetic agent (20% Benzocaine, Premier, Philadelphia, PA, USA) at the site of IANB injection, a side-loading cartridge syringe (Dena Instruments, Forgeman Instruments Co., Sialkot, Pakistan) was used to administer the injections. The syringe was equipped with a blood aspiration device and a thumb ring. A 27 gauge, 38 mm needle (Nik Rahnama Kar Co., Tehran, Iran) was fitted to the syringe. In all patients, aspiration was performed with needle withdrawn 1 - 2 mm when bone contact was established following needle insertion and also based on a standard IANB method. After obtaining a negative blood aspiration, 1.8 mL of the anesthetic agent was injected. In one group, 2% lidocaine with 1:80,000 epinephrine (Darupakhsh, Tehran, Iran) was used, while in the other group, 0.5% bupivacaine with

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1:200,000 epinephrine (Inibsacain Plus, Inibsa, Madrid, Spain) was used.

Fifteen minutes after administering anesthesia, the teeth were again tested with same pulp sensibility cold test and the patients were asked to rate their pain using the Heft-Parker VAS. After isolating the teeth with rubber dam, endodontic access cavity preparation was started. Access cavity preparation was only commenced in patients who reported lip numbness following administration of the anesthetic. The patients were instructed to rate any pain experienced during each step of access cavity preparation (within dentin, when entering the pulp chamber, or when an endodontic instrument was inserted into the root canals) on the Heft-Parker VAS. No or mild pain (faint, weak, and mild pain) were considered as success, whereas moderate and severe pain were considered as failure of anesthesia. If a patient reported sensitivity to the cold test before starting the access cavity preparation or at any time during subsequent treatment, then another method of anesthesia, such as an periodontal ligament injection or intrapulpal injection, was employed in order to continue the treatment.

Data were analyzed by chi square test and Fischer's exact test. The comparisons were considered significant if $p < 0.05$.

Results

One patient in the lidocaine group was excluded from the study because of the patient's desire not to remain in the study during access cavity preparation. The remaining 59 patients were included in the study (Table 1). All patients in both groups reported lip numbness following IANB anesthesia. No significant difference was found between gender and age of the patients in the lidocaine and bupivacaine groups. Success rate of anesthesia for patients in the bupivacaine and the lidocaine groups were 20% and 24.1%, respectively ($p > 0.05$). Table 2 shows the success of anesthesia at different stages of the treatment. Despite different success rates between the anesthetic agents at various stages of the endodontic procedure (cold test 15 minutes after anesthesia, penetration into dentin, penetration into the pulp chamber and root canal instrumentation), the results showed no significant difference between the two groups at any stages of the study and treatment.

Discussion

This study compared the success rate of 2% lidocaine with 1:80,000 epinephrine or 0.5% bupivacaine with 1:200,000 epinephrine as an IANB injection in mandibular molar teeth with irreversible pulpitis and found any significant difference between them. Previous studies investigating the success rate of IANB anesthesia following the usage of either bupivacaine or lidocaine have reported varying results.[11,21,22] Fernandez *et al*. reported a significantly higher success rate of IANB in the lidocaine group compared to bupivacaine for second mandibular molars, whereas Sampaio *et al*. reported no significant difference between the two groups.[11,21] The results of the present study was in

Table 1. Demographic features of the patients

Anesthetics	Age (Mean ± SD)	Gender	
		Male	Female
Bupivacaine	26.7 ± 8.6	9	21
Lidocaine	26.7 ± 7.2	15	14

Table 2. Success and failure rates at various stages of access cavity preparation and the root canal treatment

Success & Failure rate	Step of the procedure / Group									
	15 min		Dentine		Pulp		Instrumentation		Final success	
	B	L	B	L	B	L	B	L	B	L
Success	100 (30)	89.7 (26)	80 (24)	57.7 (15)	41.7 (10)	73.3 (11)	60 (6)	63.6 (7)	20 (6)	24.14 (7)
Failure	0 (0)	10.3 (3)	20 (6)	42.3 (11)	58.3 (14)	26.7 (4)	40 (4)	36.4 (4)	80 (24)	75.86 (22)
Total	30	29	30	26	24	15	10	11	30	29

The success and failure rates were presented in percentages (%). The numbers in the parentheses were the number of the patients.
B, Bupivacaine; L, Lidocaine.

accordance with the Sampaio *et al*. study on mandibular molars with irreversible pulpitis as there was no significant difference between bupivacaine and lidocaine.[11] The confusing results among these studies may be attributed to the differences in the status of the pulp in these studies. While the study of Sampaio *et al*. and the present study investigated the effects on mandibular molars with irreversible pulpitis, Fernandez *et al*. tested teeth with normal pulps in first mandibular molar teeth.[11,21]

In the present study, despite no response to the cold test in all the teeth that received bupivacaine as the anesthetic agent, only 20% had no or mild pain during access cavity preparation. Previous investigations have shown that a negative response to cold and electric pulp tests cannot guarantee success of an IANB injection during access cavity preparation.[2-4,11] In the present study, similar to previous studies, a cold pulp test was used to evaluate anesthesia before starting the access cavity preparation.[3,4,25] Previous investigations that have used bupivacaine as the anesthetic agent for IANB have used an EPT to evaluate the efficacy of anesthesia.[11,21-23] Both methods have been used to evaluate success of anesthesia in both normal and diseased pulps.[2,3,11,26,27]

In a previous investigation, most of the patients in the bupivacaine group (80%) reported positive response to the EPT 10 minutes after administering anesthesia, whereas in the present study all patients reported no response to the cold test.[11] This difference might be resulted from the difference between the type of stimulus (EPT versus cold), the inclusion criteria (including patients with spontaneous pain versus patients without spontaneous pain), the different volume of anesthetic agents used (3.6 mL versus 1.8 mL) and the time for evaluating the patients' response after administering the anesthesia (10 minutes versus 15 minutes).

Sampaio *et al*. reported a higher (but not significant) success rate in the bupivacaine group (80%) compared to the lidocaine group (62.9%) for IANB injections, whereas the lidocaine group (24.14%) showed a slightly higher success rate compared to the bupivacaine group (20%) in the present study.[11] One of the reasons might be the difference between the inclusion criteria of these studies. In their study, Sampaio *et al*. included patients with moderate to severe spontaneous pain that needed emergency treatment, whereas the present study included only patients with irreversible pulpitis without spontaneous pain.[11] It has been reported that bupivacaine is more effective on TTx-resistance sodium channels than lidocaine.[20] Since in teeth with spontaneous pain, the presence of some types of TTx-resistance sodium channels is more prominent on the nociceptive fibers, bupivacaine can be expected to be more effective than lidocaine.[28,29]

Overall the success rate of anesthesia in Sampaio *et al*. investigation was higher than the present study.[11] One of the reasons might be the higher volume of anesthetic agent used in their investigation (3.6 mL) compared to the present study (1.8 mL). A recent investigation reported that increasing the volume of anesthetic agent may improve success rate of anesthesia in mandibular molar teeth with irreversible pulpitis.[16] However, another investigation reported no significant difference among patients when different volume of anesthetic agents were used.[30]

Bupivacaine has several drawbacks as an anesthetic agent. One of the major concerns regarding the use of bupivacaine is its potential for adverse effects on cardiovascular systems.[31] In addition, the longer duration of anesthesia may not be a desirable feeling for some patients.[32-34] Several studies have reported less post-operative pain following the use of bupivacaine for IANB.[32-35] Hence, one of the strategies for controlling post-operative pain following root canal treatment is to use a long-acting anesthetic agent such as bupivacaine.[1] The results of the present study showed that bupivacaine did not improve the success rate of IANB anesthesia when used as a primary anesthetic agent. Therefore, clinicians can choose the anesthetic agent based on the results of the diagnostic evaluation of each case. If the patient has a history of pre-operative spontaneous pain and sensitivity to percussion, then bupivacaine can be considered for the IANB as these symptoms are predictors for post-operative pain.[31] However, if these symptoms are not present, lidocaine can be chosen as they have the anesthetic effect without the long acting effect of soft tissue anesthesia following the treatment.

Based on the definition of various stages of the pulp and the periapical diseases, patients may present with symptomatic or asymptomatic irreversible pulpitis.[36,37] In the present study, only the patients diagnosed to have asymptomatic irreversible pulpitis with no spontaneous pain but prolonged pain following the use of food and liquids with cold or hot temperature were included. The reason for including only the teeth with asymptomatic irreversible pulpitis was due to the conflicting results of previous investigations when premedication with NSAIDs was used for evaluating their effect of anesthesia success.[3,10,26,38,39] In fact, the investigations that included patients with spontaneous pain reported no significant difference in anesthesia success when the patients were premedicated with NSAIDs, whereas studies that included patients without spontaneous pain reported significantly higher success when the NSAIDs premedication was used.[3,10,26,38,39] As the same bias may influence the success rate of anesthesia again, only patients that had irreversible pulpitis but no spontaneous pain were included in the present study. In our opinion, investigators should notice the possible bias and design their future research with careful inclusion criteria for various conditions of pulpal diseases in order to provide more reliable results. In the

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present study, one of the patients was excluded because she preferred not to complete the Heft-Parker VAS form during the endodontic procedure. Therefore, despite the endodontic treatment was performed for the patient, she had not been asked to rate her pain during the treatment.

Conclusions

This study showed no difference in success rates of anesthesia when bupivacaine and lidocaine were used for IANB injections to treat mandibular molar teeth with irreversible pulpitis. Neither agent was able to completely anesthetize the teeth effectively. Therefore, practitioners should be prepared to administer supplemental anesthesia to overcome pain during root canal treatments.

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Conflict of Interest: No potential conflict of interest relevant to this article was reported.

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