ORIGINAL ARTICLE

Effect of fentanyl on the success of inferior alveolar nerve block for teeth with symptomatic irreversible pulpitis: a randomized clinical trial

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ABSTRACT

Aim: *The purpose of this prospective, randomized, double-blind study was to evaluate the effect of adding fentanyl to lidocaine 2% with epinephrine 1:80,000 on the success of the inferior alveolar nerve block in mandibular molar teeth with symptomatic irreversible pulpitis.*

Methodology: *100 healthy adult patients with diagnosis of symptomatic irreversible pulpitis in one of the mandibular molar tooth were selected and randomly divided in two groups of 50 patients each. In the first group (fentanyl group), 0.25 ml of a cartridge of 1.8 ml of 2% lidocaine with 1:80,000 epinephrine solution was drained and the same amount from 50µg/ ml fentanyl solution was added to the cartridge. In the second group (non-fentanyl group) 0.25 ml of a cartridge of 1.8 ml of 2% lidocaine with 1:80,000 epinephrine solution was drained and the same amount from saline solution was added to the cartridge. Each group received two cartridges of prepared soloution with inferior alveolar nerve block injection technique. Access cavity preparation started 15 minautes after injection and after confirming the lip numbness. Success defined as no pain or mild pain on the basis of Heft-Parker visual analog scale during access cavity preparation or initial instrumentation. Data were analyzed by T-test and Chi-square*

Results: *The success rate of inferior alveolar nerve block injection was 58% for Fentanyl group and 46% for Non-Fentanyl group. There was no significant difference between the two groups (P=0.23).*

Conclusions: *The addition of fentanyl to lidocaine 2% with epinephrine 1:80,000 did not increase the success rate of the inferior alveolar nerve block in mandibular molar teeth with symptomatic irreversible pulpitis*

KEYWORDS *Inferior alveolar nerve, nerve block, Lidocaine, Fantanyl, Pulpitis*

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Introduction

Deep anesthesia is an important factor during root canal treatment procedures. However, some factors during endodontic treatments can make obtaining appropriate anesthesia challenging (1). Inferior alveolar nerve block is the standard technique for anesthesia of posterior mandibular teeth. Failure in this technique is a considerable clinical problem during root canal treatment particularly in teeth with irreversible pulpitis (1). The failure rate for inferior alveolar nerve block in asymptomatic molar teeth is 10-39% (2-5). The success rate of this technique is reduced to 24% for molar teeth with irreversible pulpitis (4, 6). Several hypotheses have been developed to explain the reduced effectiveness of local anesthesia in inflamed teeth. These hypotheses include the reduction in pain threshold of inflamed tissues, hyperalgesia, the reduction in penetration of the basic form of the anesthetic molecules from the neural membrane as a result of reduced pH in tissues, the increase in anesthetic-resistant TTX-R sodium channels, and the reduction in pain threshold of patients as a result of anxiety (7-10). Different studies have proposed different methods for increasing the chance of success in inferior alveolar nerve blocks, such as increasing the volume of the local anesthetic solution, increasing the concentration of epinephrine, alternative local anesthetic solutions, alternative injection sites, supplemental injection techniques, increasing injection time, buffered anesthetic solutions, and premedication with non-steroid anti-inflammatory drugs (NSAIDs) or sedatives (11-19). Several studies have evaluated the effects of adding different therapeutic agents to local anesthetic solutions. These drugs include NSAIDs, opioids, anti-anxiety drugs and anesthetics (20-23).
Fentanyl is a potent synthetic opioid which is used as an analgesic agent and also an additive drug for local and general anesthesia (24). Fentanyl is 50-100 times more potent than morphine and is thus more effective in lower serum concentrations (25). The effectiveness of fentanyl combined with its low rate of side effects has garnered attention to this opioid agent (26). The onset of fentanyl is quick and duration of action is short (24).
To the authors' knowledge, no previous study has been performed on the effects of addition of fentanyl to 2% lidocaine solutions in success rate of inferior alveolar nerve blocks in molar teeth with symptomatic irreversible pulpitis. Therefore, the aim of this study was to evaluate the success rate of local anesthesia by inferior alveolar nerve block using lidocaine 2%+fentanyl solution for teeth with symptomatic irreversible pulpitis.

Materials and Methods

100 healthy adult individuals who have attended for emergency treatment to the Endodontics Department of Isfahan Dental School have participated in this study. Individuals under 18 years, those with a history of systemic diseases, pregnant women, patients with allergy to local anesthetic drugs or sulphites, patients taking drugs affecting the evaluation of anesthetics, those with active pathoses in the injection site, and those unable for informed consent were excluded from the study.
The Research Ethics Committee in Isfahan University of Medical Sciences approved the protocol for this study (IR.MUI.RESEARCH.REC.1398.430). This clinical trial has been registered in the Iranian Registry for Clinical Trials (IRCT20191114045441N1). Informed consent was obtained from all participants.
Inclusion criteria was presence of one vital mandibular first molar with moderate to severe pain and elongated response to cold test with Endo-Frost cold spray (Coltene-Whaledent, Langenau, Germany). Teeth without a response to cold test, or with necrotic coronal pulp tissues during access cavity preparation, or with periapical lesions were not included. Therefore, each patient had one mandibular first molar with clinical diagnosis of symptomatic irreversible pulpitis.
The permitted injection dose for fentanyl for a 50 kg adult human was calculated

according to the Pain Assessment and Management Initiative as 0.5 to 1 mL. In this study, the lower threshold (0.5 mL) was used. In both study groups, 0.25 mL of the solution in 1.8 mL anesthetic solutions cartridges containing 2% lidocaine+1:80,000 epinephrine (Darupakhsh, Iran) was removed using an aspirating syringe. In the fentanyl group, 0.25 mL of 50 µg/mL fentanyl solution (Abureihan, Tehran, Iran) was then added to the anesthetic cartridge. In order for proper mixing, the anesthetic cartridge was reversed for 5 times. In the control group, 0.25 mL of normal saline was added to the anesthetic cartridge and the cartridge was reversed for 5 times for proper mixing. At first, the patients marked their preoperative pain levels on the Heft-Parker Visual Analogue Scale (HP-VAS) (27). This visual scale for measurement of pain levels is a 10-cm scale divided into four segments: no pain (0 cm), mild pain (1-3 cm), moderate pain (4-6 cm), and severe pain (7-10 cm) (27). Patients with moderate to severe pain were included in this study.

A trained dental assistant prepared the anesthetic solutions immediately before injection and coded them based on randomized blocks. In each group, two cartridges of the prepared solutions were injected after aspiration using the inferior alveolar nerve block technique. All of the anesthetic injections were performed by one operator. The operator and the patient were blinded to the components of each anesthetic cartridge. All of the injections were made using standard aspirating dental syringes with 31 mm gauge 27 needles. Anesthesia of the lower lip was considered as the indicator for success of the inferior alveolar nerve block. 15 min after injection, if anesthesia was obtained in the lower lip and chin, the therapeutic treatment was performed. Otherwise, the patient was excluded from the study and required treatment was performed after supplementary injection techniques. In case of presence of pain during access cavity preparation and initial file insertion, the treatment procedure was suspended and the patients were asked to mark their pain levels on HP-VAS. This marked the end of the study for that particular patient. Success was defined as no pain or mild pain during access cavity preparation and initial file insertion and failure was defined as presence of moderate or severe pain in each of these stages.

Statistical Analysis

The data pertaining to preoperative pain and success rate of inferior alveolar nerve block were statistically analyzed using SPSS (version 20, IBM Corporation, Armonk, NY, USA). Comparison between fentanyl and control groups for success of inferior alveolar nerve block was analyzed

Table 1
Age distribution

Group	Number	Minimum	Maximum	Mean	standard deviation
fentanyl	50	18	52	33.14	11.68
Control	50	18	55	31.06	9.89

Table 2
Sex distribution

Group		Number	Percentage
fentanyl	Man	27	54
	Woman	23	46
Control	Man	23	46
	Woman	27	54

using chi-square test, while preoperative and intraoperative pain were compared using t-test. Level of significance was set at 0.05.

Results

100 adult individuals (50 men and 50 women) with an age range of 18-55 were enrolled in this study. variables for fentanyl and control groups are shown in tables 1 and 2.

Mean age and sex distribution were not significantly different between the two groups (p=0.339 and p=0.424, respectively).

Mean preoperative pain was 6.28 in the fentanyl group and 6.74 in the control group. T-test revealed that no statistically significant difference was observed between preoperative pain in the fentanyl and control groups (p=0.375).

Mean intraoperative pain in the fentanyl group and control group were 3.48 and 4.08, respectively. The mean recorded intraoperative pain in the fentanyl group was lower than that of the control group. Based on t-test, however, the difference was not statistically significant (p=0.417) (table 3).

Success rate of the inferior alveolar nerve block was 58% in the fentanyl group and 46% in the control group. Although the success rate in the fentanyl group was higher than in the control group, this difference was not statistically significant according to chi-square test (p=0.23) (table 4).

Discussion

Based on the findings of this study, addition of fentanyl to lidocaine cartridges increased the effectiveness of inferior alveolar nerve block in mandibular molars with symptomatic irreversible pulpitis. The basic parameters of the participants (age, sex, and preoperative pain) were not significantly different between the study groups and thus these variables did not alter the results.

The standard anesthetic technique for mandibular posterior teeth is inferior alveolar nerve block. However, this technique has a high failure rate particularly for teeth with symptomatic irreversible pulpitis. The present findings confirmed the results of previous studies reporting low success rate of inferior alveolar nerve block for teeth with symptomatic irreversible pulpitis (4, 6). In the present study, the success rate of the anesthetic injection for teeth with symptomatic irreversible pulpitis was 46%. A number of studies have assessed the effects of addition of therapeutic agents to the original local anesthetic. These additives include NSAIDs, opioids, anti-anxiety drugs, and anesthetics (20-23). Addition of opioids to local anesthetic agents can provide several benefits. Among different opioids, fentanyl with its high analgesic effects 50-100 times more potent than morphine), its anesthetic and sedative properties, and its lower rate of side effects compared to its effectiveness, is an appropriate choice. Fentanyl is a potent synthetic opioid used as analgesic medication and also in combination with other drugs for local and general anesthesia (24). Fentanyl is 50 to 100 times more potent than morphine and will therefore provide acceptable effects in lower serum concentrations (25).The effectiveness of fentanyl in combination with its low rate of side effects has garnered attention to this opioid agent (26). The onset of fentanyl is quick and duration of action is short (24). Intravascular injection of fentanyl is usually applied for general anesthesia, local anesthesia, and pain control (28).Intrathecal application of fentanyl is used as a component of spinal anesthesia and its epidural injection is used for epidural anesthesia and analgesia. Due to its high fat solubility, fentanyl's effects are more localized compared with morphine (29). Fentanyl is used for emergency pain control (usually in the form of nasal spray), control of chronic pain (e.g., in patients with cancer, in the form of skin patches) and quick pain control (in the form of sublingual tablets) (30-31).Other major applications of fentanyl include pre-anesthetic sedation in operative rooms and sedation for intubated patients (25).

The action mechanism of fentanyl is similar to other opioid drugs. Fentanyl affects

Table 3
Pain distribution in patient (according to HP-VAS)

Group		Number	Minimum	Maximum	Mean	Standard deviation
Preoperative pain	fentanyl	50	0	10	6.28	2.95
	Control	50	3	10	6.74	2.16
Intraoperative pain	fentanyl	50	0	10	3.48	3.7
	Control	50	0	10	4.08	3.66

Table 4
Success rate

Group		Success	Unsuccessful	Total
fentanyl	Number	29	21	50
	Percentage	58	42	100
Control	Number	23	27	50
	Percentage	46	54	100
Total	Number	52	48	100
	Percentage	52	48	100

a subgroup of opioid receptors which are primarily in the brain (in the neuroanatomic structures for feelings, pain, and speech). Fentanyl is a mu-selective opioid agonist which can also activate other opioid receptors such as delta and kappa receptors, leading to its analgesic effects (21). The most common side effects of fentanyl include sleepiness, confusion, malaise, xerostomia, diarrhea, nausea, constipation, and sweating (25). Although fentanyl is more potent that morphine, nausea occurs less frequently after fentanyl administration compared with morphine (32). Injection of fentanyl provides a quick action onset within the first minutes and peaking at the second minutes (33). Additionally, by using the low dosage of fentanyl in this study, the probability of side effects was extremely low. However, any experienced side effect will resolve quickly and the patients will be able to be dismissed without the need for a companion.

De Pedro-Muñoz and Mena-Álvarez evaluated the effect of submucosal injection of tramadol as an adjunct injection technique on success rate of inferior alveolar nerve block with 4% articaine+1:100,000 epinephrine solution in teeth with irreversible pulpitis. Their findings indicated that submucosal injection of tramadol prior to the inferior alveolar nerve block injection significantly increased its success rate (34).

Aksoy and Ege assessed the effectiveness of submucosal injection of tramadol as a complementary injection technique for inferior alveolar nerve block in teeth with symptomatic irreversible pulpitis. They concluded that submucosal administration of tramadol did not significantly influence the success rate of inferior alveolar nerve block in teeth with symptomatic irreversible pulpitis (35).

Rodríguez-Wong et al. analyzed the effect of adding tramadol to mepivacaine 2%+1:100,000 epinephrine solution on success rate of inferior alveolar nerve block in molars with symptomatic irreversible pulpitis. Based on their findings, although the success rate of inferior alveolar nerve block was improved by addition of fentanyl, no significant difference was observed between the two study groups (36). Bigby et al. evaluated the effect of addition of meperidine to 2% lidocaine+1:100,000 epinephrine solution on success rate of inferior alveolar nerve block for molars with symptomatic irreversible pulpitis and reported that adding meperidine does not significantly enhance the success rate of inferior alveolar nerve block (21). The findings of these two studies were consistent with the present findings indicating that addition of opioids to local anesthetic solutions does not significantly improve the success of inferior alveolar nerve block.

Conclusions

Based on the findings of the present study, addition of fentanyl to lidocaine anesthetic cartridges improved the effectiveness of inferior alveolar nerve block. However, this increase was not statistically significant.

Clinical Relevance

Failure in IANB technique is a considerable clinical problem during root canal treatment particularly in teeth with irreversible pulpitis. Addition of fentanyl to lidocaine anesthetic cartridges improved the effectiveness of IANB.

Conflict of Interest

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

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