Effect of Bupivacaine on Postoperative Pain for Inferior Alveolar Nerve Block Anesthesia after Single-visit Root Canal Treatment in Teeth with Irreversible Pulpitis

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Abstract

Introduction: Pain control after root canal treatment is of great importance in endodontic practice. The aim of the present study was to investigate the effect of a long-acting anesthetic (bupivacaine) on postoperative pain and the use of analgesics after root canal treatment.

Methods: In a randomized double-blinded clinical trial, 60 patients (30 per group) having first or second mandibular molars with irreversible pulpitis randomly received either 0.5% bupivacaine with 1:200,000 epinephrine or 2% lidocaine with 1:80,000 epinephrine as the anesthetic solutions for inferior alveolar nerve blocks. After single-visit root canal treatment, each patient recorded their pain score on a visual analogue scale at 6, 12, 24, 36, 48, and 72 hours after treatment. Data were analyzed by Mann-Whitney, χ², Cochrane Q, and t tests as well as Pearson correlation analysis.

Results: The results indicate that patients who received bupivacaine had significantly lower pain scores at 6 and 12 hours after root canal treatment compared with the patients who received lidocaine (P < .05). The use of analgesics in the bupivacaine patients was significantly lower than in the lidocaine group (P < .05).

Conclusions: Patients who received bupivacaine as the anesthetic agent for single-visit endodontic treatment of irreversible pulpitis in mandibular molars had significantly less early postoperative pain and used fewer analgesics than those who had lidocaine as the anesthetic. (J Endod 2012; 38:1–5)

Key Words

Bupivacaine, IANB, lidocaine, long acting anesthesia, one visit, postoperative pain, root canal treatment, single visit

Pain control during and after root canal treatment is an important aspect of endodontic practice (1). Numerous articles have been published regarding the prevalence of postendodontic pain as well as the effect of various medications, irrigants, root canal preparation techniques, and the number of treatment visits (2–16).

Several strategies have been described for controlling pain after root canal treatment (1). The prescription of analgesics before commencing root canal treatment (7), occlusal reduction (1, 5), prescription of analgesics on the basis of a flexible plan, and the use of long-acting anesthetics (17) have all been advocated.

Decision-making in modern endodontic practice should be based on evidence-based investigations (18). A search of the PubMed database for evidence-based investigations on the effect of long-acting anesthetic solutions and the prevalence of postoperative pain after root canal treatment revealed a lack of investigations with a high level of evidence. Most articles regarding postoperative pain have shown the effect of long-acting anesthetics on pain control after tooth extraction (19–23). Two articles that investigated the effect of long-acting anesthetics on pain control after root canal treatment had several shortcomings such as inadequate sample size, they included both maxillary and mandibular teeth with various pulp and periradicular conditions, and they investigated pain after root canal preparation, root canal filling, or periradicular surgery (2, 3). In addition, the individuals who participated in those studies were mostly women, and their gender might have influenced the results (24). Therefore, the aim of this study was to compare the postoperative pain and analgesic use after single-visit root canal treatment of acute irreversible pulpitis with either bupivacaine (a long-acting anesthetic) or lidocaine.

Materials and Methods

This study was approved by the Ethics Committee of Kerman University of Medical Sciences in Iran (no. KA/90-225). The sample size calculation, which was based on an error of α = 0.05 and power at 0.8 pairs, indicated that ideally a sample size of 38 in each group would be required.

The following inclusion and exclusion criteria were used for this study. The exclusion criteria were the presence of any systemic disorders that prevented administration of lidocaine and bupivacaine as the anesthetic agents, sensitivity to either lidocaine with 1:80,000 epinephrine or bupivacaine with 1:200,000 epinephrine, gastric diseases, the presence of a periapical radiolucency, pregnancy, having a tooth not suitable for restoration, having serious periodontal disease that rendered the tooth unsuitable for endodontic treatment, patients with spontaneous pain who needed emergency treatment, patients who had used any type of analgesic medication during the preceding 12 hours before the treatment, and teeth with a necrotic, infected pulp or swelling.

Inclusion criteria included healthy patients having a first or second mandibular molar tooth with acute irreversible pulpitis and normal periapical radiographic appearance without sensitivity to percussion.

The clinical diagnosis of acute irreversible pulpitis was confirmed by a response to an electric pulp test (Element Diagnostic Unit; SybronEndo, Glendora, CA) and a prolonged exaggerated response (> 10 seconds) with moderate-to-severe pain to a cold test (Roeko Endo-Frost; Roeko, Langenau, Germany) after the stimulus had been removed.
Seventy-five 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 April to December 2011. Informed consent of all subjects or their parents (for patients younger than 18 years old) was obtained 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 2 groups of 38 patients each. To randomize the patients, each patient was assigned a number. The numbers in each group were written on paper, and each one was kept in a separate sealed opaque envelope. Each patient was asked to choose one of the envelopes and was assigned to one of the groups on the basis of the number. To be double-blinded regarding the type of anesthetic solution, all inferior alveolar nerve block (IANB) injections were administered by a postgraduate student, and then another postgraduate student performed the root canal treatment. Before administering anesthesia, a visual analogue pain scale (VAS) was given to each patient to rate their pain level. Five minutes after administration of 1 cartridge of anesthetic with either 2% lidocaine with 1:80,000 epinephrine (Percaine; Darupakhsh, Tehran, Iran) or 0.5% bupivacaine with 1:200,000 epinephrine (Inibscain Plus; Inibsa, Madrid, Spain), each patient was asked whether they had any signs of soft-tissue anesthesia. If the patient did not report profound lip numbness, then the IANB was considered to be inadequate, and the patient was excluded from the study. If the patient reported adequate anesthesia, the tooth was isolated with a rubber dam, and endodontic treatment was commenced. Root canal preparation was performed after electronic root canal measurement with a Root ZX (Morita Corporation, Kyoto, Japan). The working length of each root canal was set at 1 mm less than the radiographic apex, and this was confirmed with a periapical radiograph. Any teeth where the working length had been overestimated, where instruments had inadvertently been placed beyond the working length, or where the root canal filling extended beyond the working length were excluded from the study. A 1.5% solution of sodium hypochlorite was used as an irrigant between each instrument during root canal preparation. The root canals were instrumented initially to file size no. 15, followed by the use of Gates Glidden drills sizes 2 and 3 to prepare the coronal portion of the canals. RaCe rotary instruments (FKG Dentaire, La Chaux-de-Fonds, Switzerland) were then used to complete the root canal preparation to a size 30/0.04 file. The smear layer was removed by irrigating with 17% ethylenediaminetetraacetic acid (Asia Chimi Teh, Tehran, Iran), followed by irrigation with normal saline. The root canals were then dried and filled with gutta-percha and AH26 (Dentsply DeTrey, Konstanz, Germany) root canal cement.

Patients were instructed to complete a VAS pain score to rate their pain at 6, 12, 24, 36, 48, and 72 hours after root canal treatment (14, 25). The following criteria were outlined for the patients to rate their pain: 0, no pain; 1–3, mild pain; 4–6, moderate pain; 7–9, severe pain.

The patients were instructed that they could use analgesics (ibuprofen 400 mg every 6 hours) if they felt pain; however, they were also required to record the number of analgesic tablets on their VAS forms. The patients were also requested to complete a form to evaluate the effect of the analgesic medication (5): 0, none or mild pain that does not require analgesic medication; 1, moderate pain that was fairly well-controlled with analgesic medication and did not interfere with sleep or daily activities; 2, unbearable pain that was not controlled with analgesic medication and interfered with daily activities.

All patients were monitored for 1 week after the procedure.

Data were analyzed by Mann-Whitney, χ², Cochrane Q, and t tests as well as Pearson correlation analysis to compare qualitative and quantitative data between the 2 groups.

**Results**

A total of 75 patients participated in the study initially, but 15 were excluded for the following reasons: 5 patients were excluded because adequate pulp anesthesia could not be obtained (3 female lidocaine, 1 male bupivacaine, 1 female bupivacaine), 3 patients had root canal cement extruded through the apical foramen (2 female lidocaine, 1 female bupivacaine), 2 patients had instruments extended beyond the working length (2 male lidocaine), in 2 patients the pulps were not exposed (1 male lidocaine, 1 female bupivacaine), and 3 patients did not return their VAS forms (2 male bupivacaine, 1 female lidocaine). The remainder of the 60 patients (34 female and 26 male) completed the study, with each group having 30 patients each. None of the patients reported any side effects up to 1 week after root canal treatment. The average age of the patients in the lidocaine group was 26.9 ± 8.4 years and 26.8 ± 7.8 years in the bupivacaine group. In the lidocaine group, 15 patients were male and 15 were female, whereas in the bupivacaine group 11 patients were male and 19 were female. Both groups showed no significant differences between age and gender (P > .05). Table 1 summarizes the general characteristics and demographic data of the patients in this study.

Overall at all time intervals, almost two thirds of the patients had no postoperative pain (60.5% overall: bupivacaine 58.26%, lidocaine 41.74%). The remainder had mild pain (28.1% overall: bupivacaine 44.55%, lidocaine 55.45%), moderate pain (8.9% overall: bupivacaine 18.75%, lidocaine 81.25%), or severe pain (2.5% overall: bupivacaine 22.22%, lidocaine 77.78%) (Fig. 1). There was no significant difference between gender and the level of postoperative pain in both the lidocaine and bupivacaine groups (P > .05). Spearman correlation analysis showed no correlation between age and postoperative pain in this study (P = .230, r = 0.226).

Cochrane Q test of the patients’ pain levels showed that the lidocaine group patients had significantly more postoperative pain after root canal treatment (P < .05), although this had significantly decreased by 72 hours. In contrast, the patients in the bupivacaine group reported no significant differences in pain throughout the 72 hours of the study (Fig. 2) (P > .05).

The patients who received bupivacaine as the anesthetic agent reported significantly lower postoperative pain levels at 6 and 12 hours compared with the patients who had received lidocaine (P < .05). There was no significant difference in postoperative pain between the bupivacaine and lidocaine groups at other time intervals (P > .05), although the trend shown by the raw data indicated less pain with bupivacaine.

A total of 40 analgesic tablets were taken by patients in the bupivacaine group, whereas the patients in the lidocaine group consumed

**Table 1. Demographic and Clinical Features of the Patients**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Bupivacaine (n = 30)</th>
<th>Lidocaine (n = 30)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16–39</td>
<td>28</td>
<td>27</td>
<td>&gt;.05</td>
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<tr>
<td>40–59</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>11</td>
<td>15</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>Female</td>
<td>19</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Teeth</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First mandibular molar</td>
<td>16</td>
<td>15</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>Second mandibular molar</td>
<td>14</td>
<td>15</td>
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</table>
71 tablets (Fig. 3). Analysis of medication consumption on postoperative pain relief on the basis of the investigation by Rosenberg et al (5) was in favor of bupivacaine ($P < .05$).

**Discussion**

The results of this study have shown that patients who received bupivacaine as the anesthetic agent reported significantly less pain during the early postoperative periods (6 and 12 hours) after root canal treatment for acute irreversible pulpitis compared with those who received lidocaine ($P < .05$). They also tended to have less pain at the later time intervals, although this was not significant.

Attar et al (7) used 3 different pain scales (Heft-Parker, Category, and VAS) and reported high correlations between each scale. Therefore, in the present study, the VAS was used to assess pain experienced by the patients. Several investigations have used 4 categories of pain ratings on the VAS after root canal treatment (14, 25). In the present study, criteria for different levels of pain rate were described for the patients to assist them when completing the VAS forms.

Patients were asked to record their pain rate during the first 72 hours after root canal treatment. Genet et al (26) reported that most patients with severe postoperative pain reported that their pain had reduced to a mild level during this period of time. A systematic review and meta-analysis on pain after root canal treatment reported that during the first 2 days after treatment, the amount of pain rate substantially decreased (15). The results of the present study have shown that nearly 80% of the patients were free of pain by 3 days after the root canal treatment.

Another meta-analysis and systematic review reported that the frequency of pain in patients after single-visit root canal treatment was significantly lower than in patients who received multiple-visit endodontic treatment (16). Therefore, all teeth in this study were treated in a single appointment.

Interestingly, a systematic review of single-visit root canal treatment concluded that patients might take more analgesics compared with when the treatment is provided during multiple visits (27). The results of the present study have shown that the overall consumption of analgesic medication was lower in the bupivacaine group; these patients reported significantly less pain that needed medication ($P < .05$).

In the present study ibuprofen was prescribed as a medication for patients with pain after root canal treatment. One might argue that prescribing analgesics might influence the study’s results. However, several factors were considered when designing this study. First, ethical practice indicates that rescue medication should be prescribed for patients to use if they feel pain after root canal treatment. Second, if patients who received medication after treatment had been excluded from the study, then the protocol would not have followed what typically happens in day-to-day clinical practice. Furthermore, one of the exclusion criteria was gastric diseases because ibuprofen was prescribed for all patients to ensure that the same medication was used by all patients. This meant that the same effects would be experienced by all patients, and the number of tablets used could be compared for each group. Third, previous investigations have either prescribed or allowed patients to use medication if they felt pain to evaluate the influence of either procedures or medications on patients’ pain (5, 10, 13, 14).

One of the strategies suggested for pain control after root canal treatment is to use a long-acting anesthetic such as bupivacaine (17). The rationale for this is to block the barrage of nociceptive impulses during a longer period of time to prevent central hyperalgesia at the early stage of inflammation after root canal treatment (17). The long-acting efficacy of bupivacaine is directly related to the site of injection (28–30). It has been stated that bupivacaine has a longer duration of anesthesia when used for IANB injections than when used for infiltration injections in the maxilla (28, 30). In an investigation of infiltration injections for maxillary lateral incisors and molars,
bupivacaine and lidocaine had similar anesthetic duration for maxillary molar teeth, but bupivacaine had significantly shorter duration of anesthesia than lidocaine for maxillary lateral incisors (29). Hence, in this study, mandibular molars were treated, and the anesthetic solutions were used for IANB injections.

There has been a lack of high-level evidence investigations of the effect of bupivacaine on postoperative pain after root canal treatment. Previous studies have not been well-designed, with teeth in both the maxillary and mandibular arches being included, as well as teeth with various pulp conditions (pulpitis and infected canals), various endodontic procedures (root canal preparation, periapical surgery), the patients were mostly women, and the studies had small sample size in each group (2, 3). All of these confounders can influence the study results (24, 31, 32). Hence, to avoid such confounders in the present study, only mandibular molar teeth with acute irreversible pulpitis and an absence of periapical disease without tenderness to percussion were included.

Previous investigations on postoperative pain incidence after root canal treatment have reported a wide variety of pain from 3%–58% in either single-visit or multiple-visit endodontic treatment (33). In the present study, the overall highest incidence of postoperative pain was 18.33% at 6 hours after single-visit root canal treatment, which is lower than the 29% reported in a previous investigation (26). Most of the patients who had moderate-to-severe pain were in the lidocaine group rather than the bupivacaine group (33.33% versus 3.33%). It has been shown that most patients report the highest postoperative pain levels in the early stages after root canal treatment. As time passed, the number of patients with moderate-to-severe pain decreases, and the number of patients with mild or no pain increases (15). The same pattern of pain was observed in the present study.

A survey of Ontario dentists in 2007 reported that bupivacaine was not often used as an anesthetic agent; only 0.68% of all anesthetic cartridges used per year were bupivacaine (34). One of the main disadvantages of using bupivacaine as the anesthetic agent for dental practice
is the long duration of the anesthesia (35). In the present study, overall 24 patients (40%) felt no pain at 6 hours after root canal treatment. From these, 79.2% of them were in the bupivacaine group, and 20.8% were in the lidocaine group (P < .05). This indicates patients have an option to choose between having no pain or long duration of anesthesia, provided the dentist has explained the advantages and disadvantages to them before treatment.

Although there was no single factor involved in postoperative pain, it has been shown that the presence of preoperative pain and sensitivity to percussion (mechanical allodynia) before treatment are the most consistent predictors for pain after root canal treatment (28). Long-acting anesthesia has been recommended if these predictors are found in patients requiring root canal treatment. The results of the present study have shown that even in patients free of spontaneous pain and sensitivity to percussion before starting treatment, there was a significantly lower pain rate after root canal treatment reported by the patients who had been anesthetized with bupivacaine (P < .05). Therefore, it seems rational to recommend the use of bupivacaine as one of the main strategies for pain control even in the absence of preoperative pain and sensitivity to percussion.

Bupivacaine has some shortcomings that practitioners should be aware of when considering its use. These include slow onset of action (36), lower success rates of anesthesia in IANB (36), toxic effects on the central nervous system, and potential cardiovascular effects (28).

An investigation on the effect of bupivacaine and lidocaine on prostaglandin E2 production showed that bupivacaine significantly increased prostaglandin E2 gene expression at 48 hours after oral surgery (37). This suggests that more pain might be felt after 2 days by patients who receive bupivacaine for root canal treatment. However, the results of the present study as well as other previous investigations (2, 3) have not shown any increased levels of pain 48 hours after root canal treatment (Fig. 2).

In conclusion, the use of bupivacaine for IANB injections can significantly reduce postoperative pain compared with lidocaine in the early postoperative periods after root canal treatment of acute irreversible pulpitis. Bupivacaine was also associated with less pain in the later time periods, although this was not significant.

Acknowledgments

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References