Effect of Preoperative Pain on Inferior Alveolar Nerve Block

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The present study tested the hypothesis that the amount and severity of preoperative pain will affect the anesthetic efficacy of inferior alveolar nerve block (IANB) in patients with symptomatic irreversible pulpitis. One-hundred seventy-seven adult volunteer subjects, actively experiencing pain in a mandibular molar, participated in this prospective double-blind study carried out at 2 different centers. The patients were classified into 3 groups on the basis of severity of preoperative pain: mild, 1–54 mm on the Heft-Parker visual analog scale (HP VAS); moderate, 55–114 mm; and severe, greater than 114 mm. After IANB with 1.8 mL of 2% lidocaine, endodontic access preparation was initiated. Pain during treatment was recorded using the HP VAS. The primary outcome measure was the ability to undertake pulp access and canal instrumentation with no or mild pain. The success rates were statistically analyzed by multiple logistic regression test. There was a significant difference between the mild and severe preoperative pain group (P = .03). There was a positive correlation between the values of preoperative and intraoperative pain (r = .2 and .4 at 2 centers). The amount of preoperative pain can affect the anesthetic success rates of IANB in patients with symptomatic irreversible pulpitis.

Key Words: Inferior alveolar nerve block; Preoperative pain; Central sensitization; Hyperalgesia; Irreversible pulpitis.

Successful local anesthesia is a critical aspect in alleviating pain during endodontic procedures. However, it is very difficult to achieve a 100% anesthetic success rate in nerve-block anesthesia.1 Moreover, the local anesthetic solutions are even less effective in patients with irreversible pulpitis, especially in symptomatic mandibular molars.1,2 Various studies have shown a poor anesthetic success rate using single inferior alveolar nerve block with 1.8 mL of local anesthetic solution.1–3 A possible explanation for the decrease in success rates of inflamed pulp might be the activation of nociceptors by inflammation.1 The barrage of painful stimuli, along with tissue damage, alters and modulates the peripheral and the central pain pathways.4–6 The inflammatory mediators reduce the threshold for activation of peripheral nociceptors to a point that a minor stimulus now may fire these neurons.1 The continuous firing of peripheral nociceptors causes neuroplastic changes in the dorsal horn, leading to an increase in dorsal horn neuron discharge rate and the size of the receptive field of A-delta fibers.1,4,7 The combined effect of these factors will cause hyperalgesia and allodynia.

The presence of preoperative pain can affect the local anesthetic success rates and postoperative pain. Arqueta-Figueroa et al8 evaluated the anesthetic efficacy of 4%
irreversible pulpitis (86.9%). Henry et al.9 reported that pulpitis (64.2%) than in patients with asymptomatic significantly less in patients with symptomatic irreversible mandibular posterior teeth. The success rate was symptomatic and asymptomatic irreversible pulpitis in articaine with 1 : 100,000 epinephrine in patients with 136 Inferior Alveolar Nerve Block and Preoperative Pain Anesth Prog 62:135–139 2015 significant postoperative pain. Yoldas et al.10 evaluated most patients with symptomatic necrotic teeth had dealing with the evaluation of anesthetic efficacy of...subject.

The methodology was similar to previous studies of various anesthetic solutions in patients with asymptomatic/symptomatic pulpitis. The inclusion criteria for the study were active pain in the mandibular first or second molar (>0 mm on the HP VAS of 170 mm),11 a prolongation response to cold testing with an ice stick and an electric pulp tester, the absence of any periapical radiolucency on radiographs except for a widened periodontal ligament, a vital coronal pulp on access opening, American Society of Anesthesiologists class I or II medical history, and the ability to understand the use of local anesthetic solution, patients who were pregnant or breast-feeding, a history of known or suspected drug abuse, and patients taking any drugs that could have affected the pain perception. Patients having active pain in more than 1 mandibular molar were excluded from the study. The treatment procedure and the use of pain scales were explained to the patients. The millimeter marks were removed from the scale, and the scale was divided into 4 categories: “no pain” corresponded to 0 mm; “faint, weak, or mild” pain corresponded to 1 to 54 mm; “moderate” pain corresponded to 55 to 114 mm; and severe pain corresponded to greater than 114 mm and included “strong, intense, and maximum possible” pain.2 The patients were classified into 3 groups on the basis of preoperative pain (mild: 1–54 mm on HP VAS; moderate: 55–114 mm; and severe: greater than 114 mm). The patients were given an alpha-numeric code. The diagnosis of preoperative pain was done by one of the authors, and the clinician was blinded to rest of the clinical procedures.

The patients received inferior alveolar nerve block injections using 1.8 mL of 2% lidocaine with 1 : 200,000 epinephrine using a direct Halsted approach. The area of injection was dried using sterile gauze, and topical anesthesia of 20% benzocaine was applied using a sterile cotton tip applicator for 60 seconds. The solution was injected via a 5-mL disposable syringe with a 31-mm 24-G needle. After reaching the target area, aspiration was performed, and the solution was deposited over a period of 120 seconds. No anesthetic solution was deposited during needle insertion and placement. After needle withdrawal, the subjects were asked to rate the solution deposition pain on another 170-mm HP VAS. The solution deposition and the endodontic treatment were performed by the same clinician, who was blinded to the initial diagnosis of preoperative pain. Only the codes and the primary/secondary outcomes were recorded. The code was broken only after completion of the study.

After 15 minutes, each patient was asked whether his or her lip was numb. If profound lip numbness was not recorded, the block was considered unsuccessful, and the...MATERIALS AND METHODS

This study was carried out at 2 centers in different cities (SGT Dental College, Gurgaon, India, and SB Dental College, Chennai, India). One-hundred eighty-two initial adult patients (90 at SGT and 92 at SB center) participated in this multicenter, randomized, double-blinded trial. The primary outcome (endpoint) was defined as “success or failure,” which was indicated as the ability of the clinician to undertake pulp access and canal instrumentation until the apical third with no or mild pain (HP VAS score <55 mm). The solution deposition pain on HP VAS was taken as a secondary outcome of the trial. The sample size calculation consisted of α-level type I error of .05 for a single-tailed test and β-level type II error of .20. A power analysis indicated that a sample size of 81 subjects would give 80% power to detect a 25% difference in the success rates. A dropout rate of 10% was assumed, and 30 subjects were enrolled in each group at both centers (90 at SGT and 92 at SB centers, respectively). An ethical clearance was taken from the departmental review committee (reference no. SBDCECM105/13/27), and informed written consent was obtained from each subject.

The methodology was similar to previous studies dealing with the evaluation of anesthetic efficacy of...correlation to local anesthesia success.
patients were excluded from the study. A conventional access opening was initiated after isolation with a rubber dam. Patients were instructed to raise their hand if any pain was felt during the procedure. In the case of pain during the treatment, the procedure was stopped, and patients were asked to rate the pain on the HP VAS. Success was defined as no pain or weak/mild pain during endodontic access preparation and instrumentation (HP VAS score <55 mm).

The findings were recorded on a Microsoft Excel sheet (Microsoft Office Excel 2003; Microsoft Corporation, Redmond, Wash) for statistical evaluation by using the program BioEstat (version 4.0; Mamiraua Institute, Belem, Brazil). Age, gender, and solution deposition pain of the subjects were summarized by using means and standard deviations. Multiple comparison analysis of variance (Mann-Whitney U) and t tests were used to determine significant differences at \( P < .05 \). The anesthetic success rates were compared using multiple logistic regression tests. Odds ratios with 95% confidence intervals were calculated.

**RESULTS**

One-hundred seventy-seven adult volunteer subjects, 91 men and 86 women, with an average age of 42 years (range, 24–52 years), participated in this prospective clinical study. Of the original 182 patients, 1 patient from the moderate preoperative pain group, 3 patients from the severe preoperative pain group at the SGT center, and 1 patient from the severe preoperative pain group at the SB center did not have profound lip numbness at 15 minutes and were excluded from the study. All patients included in the study had profound lip anesthesia after 15 minutes. The age, gender, and mean solution deposition pain of all the patients are presented in Table 1. There was no statistically significant difference between the groups \( P > .05 \).

The comparison of percentage of patients with successful anesthesia at individual centers (“no pain” or “weak/mild” pain during endodontic access preparation and instrumentation) is presented in Table 2. Patients with mild preoperative pain had 33% (9 of 30 patients at the SGT center, 11 of 30 patients at the SB center) and patients with moderate preoperative pain had 29% (7 of 29 patients at the SGT center, 10 of 31 patients at the SB center) success rates. The patients with severe preoperative pain presented the lowest success rate of 16% (3 of 27 patients at the SGT center, 6 of 30 patients at the SB center). There was a statistically significant difference between the success rates of mild and severe preoperative pain groups \( P = .03 \), odds ratio = 2.67, 95% confidence interval = 1.093 to 6.504; Table 3). Overall, the success rate was 25% (46 of 177 patients). Patients with severe preoperative pain experienced significantly more solution deposition pain than other groups \( P < .05 \).

The correlation plot between the absolute values of preoperative and intraoperative pain scores is shown in the Figure. There was a positive correlation coefficient between the 2 values \( r = .2 \) at SGT and \( r = .4 \) at SB.

**DISCUSSION**

The combined success rate in the present study was 25%. This was comparable with previous studies evaluating 1.8–2.2mL of 2% lidocaine in patients with symptomatic pulpitis but was significantly less than studies evaluating asymptomatic patients.\(^2\)\(^{-}\)\(^4\)\(^{-}\)\(^12\)\(^{-}\)\(^15\) Patients with symptomatic irreversible pulpitis present with lower pain thresholds and increased response to nociceptive stimuli.\(^16\) The alteration and/or modulation of signal processing is a contributing factor to this hyperalgesia and allodynia.\(^1\)\(^5\) At the peripheral level, inflammatory mediators activate and potentiate the activity of certain receptors such as TTX-resistant channels and TRPV1 channels.\(^17\)\(^{,}18\) The TRPV1 channels are activated by either direct stimulation or posttranslational modulation by arachidonic acid metabolites.\(^17\)\(^{,}18\) The local acidosis, which is present as a sequel of pulpal inflammation, directly activates the

| Successful anesthesia obtained at SGT center | 9 of 30 patients (30%) | 7 of 29 patients (24%) | 3 of 27 patients (11%) |
| Successful anesthesia obtained at SB center | 11 of 30 patients (37%) | 10 of 31 patients (32%) | 6 of 30 patients (20%) |

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**Table 1.** Comparison of Age and Gender of Patients

| Center SGT Age, y (mean, SD)* | 37.7, 7.4, range 24–51 | 40 men, 46 women |
| Center SB Age, y (mean, SD)* | 45.4, 7.4, range 25–52 | 51 men, 40 women |

* There was no statistically significant difference between the groups \( P > .05 \).
TRPV1 activity. The sensitization of TRPV1 channels may lead to a reduction in the firing threshold of the channel activation (from 42°C to body temperature). This will lead to spontaneous and/or pulsating pain. The TTX-resistant channels and TRPV1 channels are difficult to anesthetize, and they make the nerve less sensitive to commonly used local anesthetic agents. This can explain the peripheral mechanism behind the reduction in the success rate of anesthesia in patients with symptomatic pulpitis as compared with asymptomatic pulpitis.

In the present study, the effect of amount/severity of preoperative pain on anesthetic efficacy was evaluated as “success” or “failure” during endodontic management of symptomatic mandibular molars using 1.8 mL of 2% lidocaine with 1:200,000 epinephrine. The amount of preoperative pain affected the anesthetic success rates (which was measured as no or mild pain during endodontic procedures) in the mild versus severe preoperative pain groups. There was a weak positive correlation between the absolute preoperative pain scores and intraoperative pain scores. The results imply that patients with active pain associated with symptomatic irreversible pulpitis have a poor success rate and that the failure rate increases with an increase in the severity of preoperative pain. The patients with severe preoperative pain had the lowest success rates in the present study.

Table 3. Logistic Regression Analysis of the Combined Anesthetic Success Rates of Both Centers

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<thead>
<tr>
<th></th>
<th>Mild vs Severe</th>
<th>Mild vs Moderate</th>
<th>Moderate vs Severe</th>
</tr>
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<tbody>
<tr>
<td>Odds ratio</td>
<td>2.68</td>
<td>1.264</td>
<td>2.108</td>
</tr>
<tr>
<td>95% confidence interval</td>
<td>1.093 to 6.504</td>
<td>0.581 to 2.750</td>
<td>0.851 to 5.221</td>
</tr>
<tr>
<td>Z statistics</td>
<td>2.156</td>
<td>0.593</td>
<td>1.613</td>
</tr>
<tr>
<td>Significance level</td>
<td>$P = .03$</td>
<td>$P = .554$</td>
<td>$P = .107$</td>
</tr>
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Central sensitization produces an exaggerated central nervous system response to even gentle peripheral stimuli, leading to hyperalgesia. Woolf reported that application of brief, low-frequency burst-of-action potentials by the activation of nociceptors increased the synaptic efficacy in nociceptive neurons in the dorsal horn of the spinal cord. The author also noted that central sensitization remained active even after the end of conditioning stimuli or that it may require only a very low level of nociceptor inputs to sustain it. Khan et al evaluated mechanical pain thresholds in patients with irreversible pulpitis and compared the values with their contralateral teeth. The authors reported that the mechanical pain thresholds of teeth with irreversible pulpitis were reduced by 77% compared with contralateral control teeth. Moreover, the normal teeth contralateral to the symptomatic teeth had lower mechanical thresholds than those observed in healthy volunteers, suggesting the activation of central sensitization.

In the present study, patients with severe preoperative pain presented with significantly higher solution deposition pain than other test groups. Overall, almost 74% of patients had moderate to severe solution deposition pain. McCartney et al retrospectively analyzed 102 inferior alveolar nerve block in patients with irreversible pulpitis, using 1.8–2.2 mL of 2% lidocaine with 1:100,000 epinephrine. The authors reported that 66% to 73% of patients experienced moderate to severe pain during solution deposition. Although several studies evaluating the solution deposition pain in healthy volunteers have reported a much lower incidence of moderate to severe pain, the higher incidence of pain in patients with irreversible pulpitis suggests the activation of central sensitization.

Linear correlation chart between Heft-Parker visual analog scale value of preoperative pain and intraoperative pain. (a) Center SGT ($r = .2$). (b) Center SB ($r = .4$).
the present study could be attributed to the preoperative pain/anxiety of the patients.25–27

In conclusion, the amount of preoperative pain affects the anesthetic success of inferior alveolar nerve block of 1.8 mL of 2% lidocaine with 1 : 200,000 epinephrine. There was a positive correlation between the values of preoperative pain and intraoperative pain.

REFERENCES