# Effects of Two Different Anesthetic Solutions on Injection Pain, Efficacy, and Duration of Soft-Tissue Anesthesia with Inferior Alveolar Nerve Block for Primary Molars

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***Objectives:*** *The purpose of the study was to compare the efficacy, injection pain, duration of soft tissue anesthesia, and postoperative complications of two different anesthetics (2% lidocaine with 1:80,000 epinephrine and 3% plain mepivacaine) in pediatric patients in inferior alveolar nerve block (IANB) administered by a computer-controlled delivery system (CCDS).* ***Study Design:*** *The study was conducted as a randomized, controlled-crossover, double-blind clinical trial with 60 children requiring bilateral pulpotomy or extraction of primary mandibular molars. A CCDS was used to deliver 3% mepivacaine to 1 primary tooth and 2% lidocaine to the contralateral tooth with an IANB technique. Severity of pain and efficacy of anesthesia were evaluated using the Face, Legs, Activity, Cry, Consolability Scale, and comfort and side effects were assessed using a questionnaire. Data were analyzed using the Mann–Whitney U, Wilcoxon t, and Fisher exact tests.* ***Results:*** *Patients receiving 2% lidocaine experienced significantly less pain during injection than those receiving 3% mepivacaine, and no significant differences were found in the pain scores during treatments or in postoperative complications between the two anesthetics. The mean durations of anesthesia for 3% mepivacaine and 2% lidocaine were 139.68 minutes and 149.10 minutes, respectively.* ***Conclusions:*** *Plain mepivacaine and 2% lidocaine were similarly effective in pulpotomy and the extraction of primary mandibular molars. Although the use of 3% mepivacaine provided a shorter duration of anesthesia than 2% lidocaine, both solutions showed similar results in terms of postoperative complications.*

*Key words: injections, pain, primary teeth*

## INTRODUCTION

Injection pain, inadequate or incomplete anesthesia/analgesia and soft-tissue injury are among the complications of local anesthesia in pediatric dental care. Considering that pain is a major etiological factor in the development of both dental anxiety and dental behavior-management problems, research in the areas of pain prevention and management during dental treatment is of great importance, particularly for pediatric dentistry.[1-3]

One new technique aimed at reducing injection pain and anxiety during intraoral injection is the use of computer-controlled delivery systems (CCDSs) developed as alternatives to the conventional syringe.[4] First introduced into dentistry in 1997, CCDSs have a number of reported advantages, including application of a more comfortable injection, even in tissues with low elasticity; a more sensitive, tactile, and ergonomic handpiece; and a non-threatening design that resembles a pen, making it particularly useful in pediatric patients who are afraid of conventional needles.[4-6] Studies have reported low pain levels with computer-controlled injection, and both adult and child patients who have received dental anesthesia with both traditional syringes and CCDSs have stated that they would choose the CCDS for future dental injections.[6-8]

CCDS has been recommended for various types of injections, including infiltration, intraosseous, intraligamentary, and nerve-block injections.[7-9] Inferior alveolar nerve block (IANB) is the most frequently used technique for achieving local anesthesia for restorative and surgical procedures in mandibular primary and permanent molars.[10] The main advantage of IANB injection is the depth of the anesthesia.[11] The ability to anesthetize all molars, premolars, and canines on the side of the injection makes it possible to treat multiple teeth in the same quadrant at one appointment.[12] However, IANB also includes some disadvantages, especially for pediatric patients.

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As soft-tissue anesthesia lasts significantly longer than pulpal anesthesia, dental patients who receive local anesthetic during treatment usually leave the dental office with residual soft-tissue numbness, and many children cannot cope with this problem. Therefore, soft-tissue injury caused by inadvertently biting or chewing tissue following inferior alveolar nerve injection occurs more frequently in pediatric patients than in adults. The problem of soft-tissue injury following local anesthesia may be resolved by selecting a local anesthetic solution with an appropriate duration for the length of the treatment procedure.[13] Application of local anesthetics with shorter durations reduces the risk of lip and cheek biting; moreover, long-acting local anesthetics are not recommended either for children or physically or mentally disabled patients, as the prolonged effect increases the risk of soft-tissue injury.[14]

Mepivacaine is an amide local anesthetic that has been widely used in dental treatment. It is considered an important anesthetic agent due to its mild vasodilating properties; it is also capable of promoting profound local anesthesia. Plain mepivacaine is most frequently used by general practitioners performing simple restorative procedures in pediatric patients in order to prevent postoperative tissue injury related to unnecessary numbness, because mepivacaine without a vasoconstrictor produces a short period of soft-tissue anesthesia. Mepivacaine provides 20–40 minutes of pulpal anesthesia and 2–3 hours of soft-tissue anesthesia, whereas lidocaine–epinephrine, the most widely used local anesthetic in both dentistry and medicine, provides 60 minutes of pulpal anesthesia in ideal circumstances and 3–5 hours of soft-tissue anesthesia.[14] Unlike mepivacaine, lidocaine causes vasodilatation; thus, it is commonly used with epinephrine to slow down absorption by vascular structures and increase the duration of local anesthesia.[12,15]

In the reviewed literature, few studies have compared the efficacy and duration of plain mepivacaine to long-acting local anesthetics. Replogle *et al* [16] examined the effect of intraosseous injection and reported that the depth and duration of anesthesia with plain mepivacaine was less than that of lidocaine with epinephrine in adult patients. However, Wright et al.[17] found no difference among mepivacaine, prilocaine, and articaine in terms of efficacy during probing, rubber-dam placement, or drilling in pediatric dental patients. Çalış et al.[18] concluded that mepivacaine and lidocaine have similar local anesthetic effects in sedated pediatric patients undergoing exodontia. Another study found that the efficacies of articaine and mepivacaine are similar, but found that soft-tissue anesthesia lasts longer with articaine than with mepivacaine.[19]

To the best of our knowledge, no published study has compared the use of 2% lidocaine with epinephrine and 3% plain mepivacaine in pulpotomy treatment and extraction of primary molar teeth with IANB. Therefore, this prospective, randomized, double-blind study aimed to compare 2% lidocaine with 1:80,000 epinephrine and plain mepivacaine as local anesthetics delivered by CCDS to primary molar teeth requiring pulpotomy or extraction in terms of anesthetic efficacy, injection pain, duration of soft-tissue anesthesia, postoperative complications, and clinical properties.

## MATERIALS AND METHOD

The study protocol was approved by the Ethics Committee of Kocaeli University (#94/2012) and written consent was obtained from parents and patients prior to the treatment. Based on data from a previous study,[20] a minimum sample size of 24 subjects for per group (total of 48) was calculated using the G*Power software program (Ver. 3.1.9.2; power 0.80, $\alpha$=0.05, $\beta$=0.20). Therefore, taking into account possible requirements for additional anesthesia or other events, this study was conducted with 60 children aged 6–12 years who were the first to meet the inclusion criteria and agree to participation from among those patients applying for routine dental treatment to Kocaeli University's Pediatric Dentistry Clinic.

Patients who required similar procedures (extraction or pulpotomy) bilaterally on primary molars with similar operative difficulties and demonstrated positive or definitely positive behavior (Frankl scale 3 or 4) during pretreatment behavioral assessment were included.[21] Patients with allergies to local anesthetics or sulfites, a history of significant medical conditions or dental treatment, or a site of active pathosis in the area of injection were excluded, as well as those taking any medication that might affect anesthetic assessment.

The study was conducted using a randomized, controlled, crossover, double-blind study design. Patients were divided into two groups according to the treatment procedures (Group I: Pulpotomy Group; Group II: Extraction Group) and two subgroups according to anesthetic solutions (2% lidocaine with 1:80,000 epinephrine or 3% plain mepivacaine). The local anesthetic used in a patient at the first appointment was randomly selected using a computer-generated list. At least a 1-week interval was maintained between similar treatments on the left and right primary mandibular molar teeth of each patient using the two different anesthetics. In total, 120 operative procedures (60 pulpotomies, 60 extractions) were performed and 120 injections (60 with lidocaine 1/80,000 and 60 with plain mepivacaine) were carried out. All injections were administered by CCDS (Sleeper ONE, Dental Hi Tec, France) using the IANB technique. A single practitioner who had 6 months of experience using the CCDS performed all injections and operations and a single rater who was not the practitioner evaluated the anesthetic solutions. A dental assistant put the anesthetic solution in the device, so both the practitioner and the rater were blinded to the local anesthetic solution being tested.

The "tell-show-do" technique was used for all patients. Injections were described to the children using reframing techniques (i.e., using euphemistic phrases such as "putting the tooth to sleep"). None of the patients required a sedative or any other pharmacological therapy to receive dental treatment.

Local anesthetic solutions were kept at room temperature for 30 minutes prior to use. Prior to treatment, the injection site was dried with a cotton tip applicator and a topical anesthetic (Hurricaine, Beutlich, 1541 Shields Drive Waukegan IL 60085, USA) was applied for 60 seconds. A CCDS (Sleeper ONE, Dental Hi Tec, BP 30051, 49308 Cholet–Cedex, France) was used to deliver the anesthesia, in accordance with the injection technique and time recommended by the CCDS manufacturer. Accordingly, local anesthetic agents (0.9 ml per injection) were administered using the CCDS's "slow" setting employing the IANB technique. The average time required per injection was 46 seconds. Patients were asked to open their mouth as wide as possible. The operator positioned the ball of his thumb intraorally on the coronoid notch of the anterior border of the ramus and the fingers on the posterior border of the ramus extraorally and gently inserted the CCDS needle between the internal oblique ridge and the pterigomandibular raphe. Upon contact with bone, the needle was

withdrawn approximately 1 mm to prevent subperiosteal injection and the solution was deposited after negative aspiration.

The Face, Legs, Activity, Cry, Consolability (FLACC) Behavioral Pain Assessment Scale was used to objectively evaluate children during the anesthesia injection and operative procedures.[22]. The FLACC scale comprises five parameters (1: Face; 2: Legs; 3: Activity; 4: Crying; 5: Consolability), each of which is given a pain score of 0–2, for a total behavioral pain score in the range of 0–10, as follows: 0=relaxed and comfortable (no pain); 1–3=mild discomfort; 4–6=moderate pain; and 7–10=severe discomfort and/or pain (Table 1).

Behavioral parameters were recorded for five stages of pulpotomy [1: use of the high-speed handpiece on enamel (HSHP); 2: use of the low-speed handpiece on dentine (LSHP); 3: removal of coronal pulp (RCP); 4: placement of matrix band (PM); and 5: tooth restoration (TR)] and three stages of extraction [1: during probing on the vestibular and palatal sides of the gingival sulcus for anesthesia control (P); 2: gingival elevation and elevation (GE); and 3: extraction (E) ].

The first 10 patients' injections and operative procedures on both sides of the mandible were videotaped to establish intra-rater reliability. In addition, evaluations of injection pain and operative procedures were carried out by the rater and another experienced pediatric dentist to establish inter-rater reliability.

At the end of both treatment appointments, parents were informed about possible postoperative complications (pain, lip or tongue biting, bleeding, and hematoma) and were advised to call if any of these were observed. They were also given forms and asked to record the levels (none, mild, moderate) of any complications observed, as well as the time at which their children reported that the feeling of numbness disappeared. The forms were retrieved at subsequent appointments and the data obtained were used to assess postoperative complications.

Statistical analysis was performed using a commercially available software program (SPSS 20.00; SPSS, Chicago, IL). Intra- and inter-rater agreement were assessed using Kappa test values (κ), with values of >0.81, 0.80–0.61, 0.60–0.41, 0.40–0.21, and <0.20 denoting perfect, substantial, moderate, fair, and slight agreement, respectively. Normality of distribution was evaluated using the Kolmogorov–Smirnov test. Differences in anesthesia efficacy and injection pain between groups were evaluated with the Mann–Whitney U and Wilcoxon t tests. Differences between genders were analyzed with the Monte Carlo chi-square and Fisher exact tests. In all cases, the level of significance was set at $p<.05$.

## RESULTS

The study was conducted with 60 children ranging in age from 6 to 12 years. The mean age of children undergoing pulpotomy (16 girls, 14 boys) was 7.5±0.8 years, whereas the mean age of children undergoing extraction (19 girls, 11 boys) was 9.93±1.3 years. Based on the repeated assessment of videotaped images, Kappa values showed substantial inter-rater (κ=.798) and substantial intra-rater agreement (κ=.778).

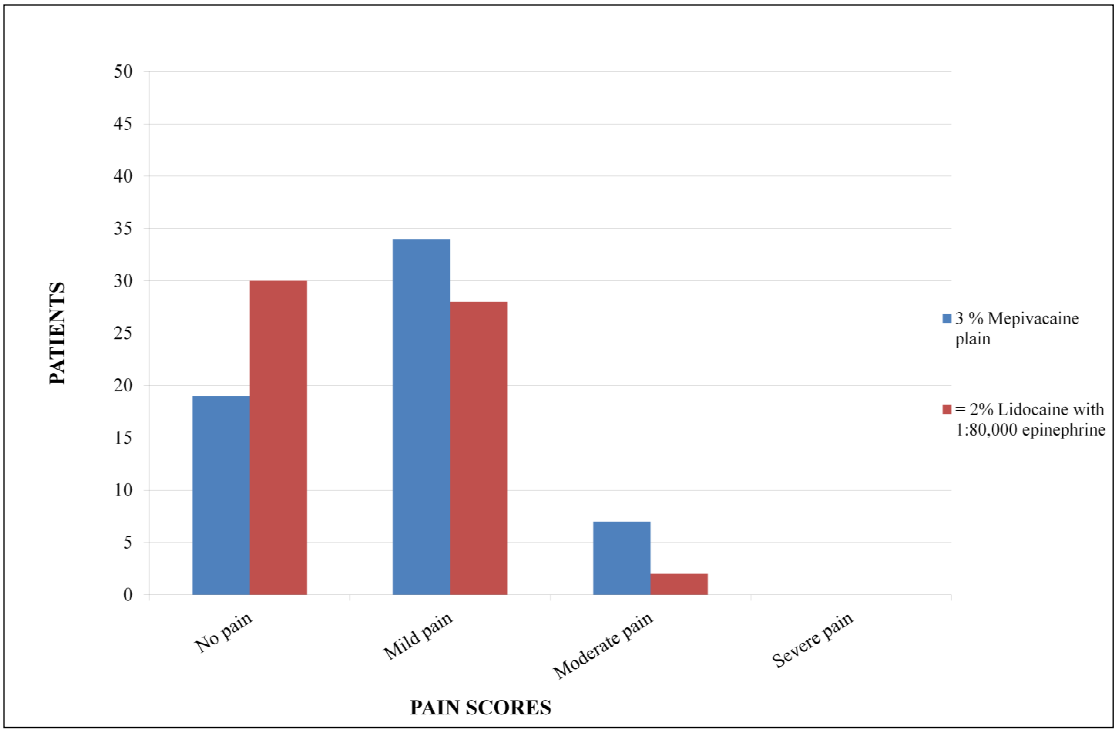
Pain-related behavior differed significantly between the subgroups during the administration of the local anesthetic agent, as the patients receiving 2% lidocaine with 1:80,000 epinephrine showed less pain during injection than those receiving plain mepivacaine ($p=.015$; Graph 1). Half of the patients (30/60) receiving 2% lidocaine with 1:80,000 epinephrine showed no pain, 28 showed mild pain, and 2 showed moderate pain. By comparison, 19 of 60 subjects receiving plain mepivacaine showed no pain, 34 showed mild pain, and 7 showed moderate pain. None of the subjects receiving either anesthesia showed severe discomfort or pain. Although injection pain was statistically different between mepivacaine and lidocaine, there was no statistically significant difference in pain scores during injection in the 'mild' or 'moderate' pain between two materials ($p=0.275$, $p=0.084$).

Pain scores did not vary significantly by anesthetic agent during any stage of the pulpotomy procedure ($p=.317$; Graph 2). Of those patients receiving 2% lidocaine with 1:80,000 epinephrine, 19 showed no pain and 11 showed mild pain during HSHP; 17 showed no pain and 13 showed mild pain during LSHP; 17 showed no pain and 13 showed mild pain during RCP; 25 showed no pain and 5 showed mild pain during PM; and 25 showed no pain, 4 showed mild pain, and 1 showed moderate pain during TR. By comparison, of the patients receiving plain mepivacaine, 10 showed no pain and 20 showed mild pain during HSHP; 15 showed no pain, 14 showed mild pain, and 1 showed moderate pain during LSHP; 15 showed no pain, 10 showed mild pain, and 5 showed moderate pain during RCP; 21 showed no pain, 6 showed mild pain, and 3 showed moderate pain during PMB; and 29 showed no pain and 1 showed moderate pain during TR. Notably, among patients treated with 2% lidocaine with 1:80,000 epinephrine, moderate pain or discomfort was observed only during the final stage of pulpotomy, and no severe discomfort or pain was observed during any stage. On the other hand, with plain mepivacaine, moderate discomfort or pain was observed in all stages of pulpotomy except HSHP, but no severe discomfort or pain was observed during any stage. While there was

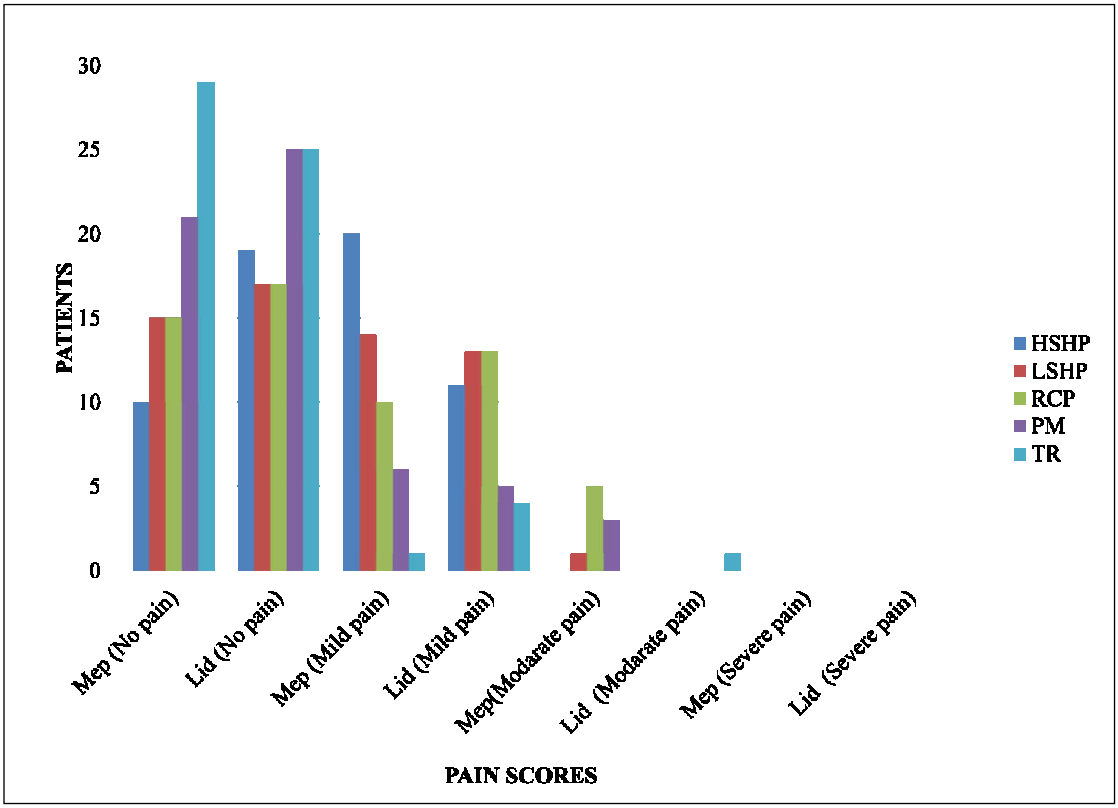
**Table 1: FLACC Behavioral Pain Assessment Scale**

| CATEGORIES | 0 | 1 | 2 |
|---|---|---|---|
| **Face** | No particular expression or smile | Occasional grimace or frown; withdrawn, disinterested | Frequent to constant frown, clenched jaw, quivering chin |
| **Legs** | Normal position or relaxed | Uneasy, restless, tense | Kicking or legs drawn up |
| **Activity** | Lying quietly, normal position, moves easily | Squirming, shifting back and forth, tense | Arched, rigid, or jerking |
| **Cry** | No cry | Moans or whimpers, occasional complaint | Crying steadily, screams or sobs; frequent complaints |
| **Consolability** | Content, relaxed | Reassured by occasional touching, hugging or being talked to; distractable | Difficult to console or comfort |

**Graph 1: Pain scores during injection**




**Graph 2: Pain scores during the stages of pulpotomy. (HSHP: High speed hand piece, LSHP: Low speed hand piece, RCP: Removal of coronal pulp, PM: Placement of matrix band, TR: Tooth restoration) (Mep= 3% Mepivacaine plain, Lid = 2% Lidocaine with 1:80,000 epinephrine)**



a positive correlation between children who expressed pain during the injection and those exhibiting pain during the LSHP/RCP in the mepivacaine group (p=0.031, p=0.027), in the lidocaine group, there was no correlation in pain scores between injection and any stages. Additionally, in the mepivacaine group, there was a correlation in pain scores between RCP and HSHP/LSHP/PM stages (p=0.013, p=0.000, p=0.006); in the lidocaine group, the only correlation in pain scores were between LSHP and HSLP (p=0.001), and RCP and PM stages (p=0.000).

Similar to the pulpotomy procedure, pain scores did not vary significantly by anesthetic agent during any stage of the extraction procedure (p=.529; Graph 3). Of those patients receiving 2% lidocaine with 1:80,000 epinephrine, 28 showed no pain and 2 showed mild pain for P; 21 showed no pain and 9 showed mild pain for GE; and 10 showed no pain, 13 showed mild pain, 6 showed moderate pain, and 1 showed severe discomfort or pain for E. By comparison, of the patients receiving plain mepivacaine, 24 showed no pain and 6 showed mild pain for P; 18 showed no pain and 12 showed mild pain for GE; and 10 showed no pain, 11 showed mild pain, 8 showed moderate pain, and 1 showed severe discomfort or pain for E. There was a positive correlation in pain scores between injection and P/GE stages in the mepivacaine group (p=0.028, p=0.014) and between injection and GE stage in the lidocaine group (p=0.012). Additionally, there was a positive correlation in pain scores between GE and E stages in the mepivacaine group (p=0.003), and between the GE and P stages in the lidocaine group (p=0.025).

None of the patients reported postoperative complications severe enough to require clinical treatment. In the pulpotomy group, three patients treated using 2% lidocaine with 1:80,000 epinephrine and four patients treated using plain mepivacaine reported mild pain, while one patient treated using plain mepivacaine reported moderate pain. In the extraction group, seven patients treated using 2% lidocaine with 1:80,000 epinephrine and nine patients treated using plain mepivacaine reported mild pain, while four patients treated using plain mepivacaine reported moderate pain. Differences in postoperative pain did not vary significantly between the two anesthetics (p=.130).

There were no significant differences in postoperative lip or tongue biting, bleeding, or hematoma between the two anesthetics. Lip biting was experienced only in one patient treated using 2% lidocaine with 1:80,000 epinephrine and one patient treated using plain mepivacaine, both of whom were in the extraction group. In terms of bleeding, no statistically significant difference was observed between the two anesthetic solutions (p=.164). None of the patients required any surgical procedure for hemostasis; however, five patients treated using 2% lidocaine with 1:80,000 epinephrine and eight patients treated using plain mepivacaine required a change in sponge to obtain hemostasis but the difference between the two groups was not statistically significant (p=.102). No patient in any group reported hematoma, swelling, or infection.

The duration of anesthesia was shorter with 3% mepivacaine than with 2% lidocaine- epinephrine (p=.035). The mean duration of anesthesia was 139.68 minutes for 3% mepivacaine and 149.10 minutes for 2%lidocaine-epinephrine (Table 2).

With regard to the differences in findings for gender, the present study found no significant differences in levels of pain during injection or treatment.

**Graph 3: Pain scores during the stages of extraction procedure. (Mep= 3% Mepivacaine plain, Lid = 2% Lidocaine with 1:80,000 epinephrine)**

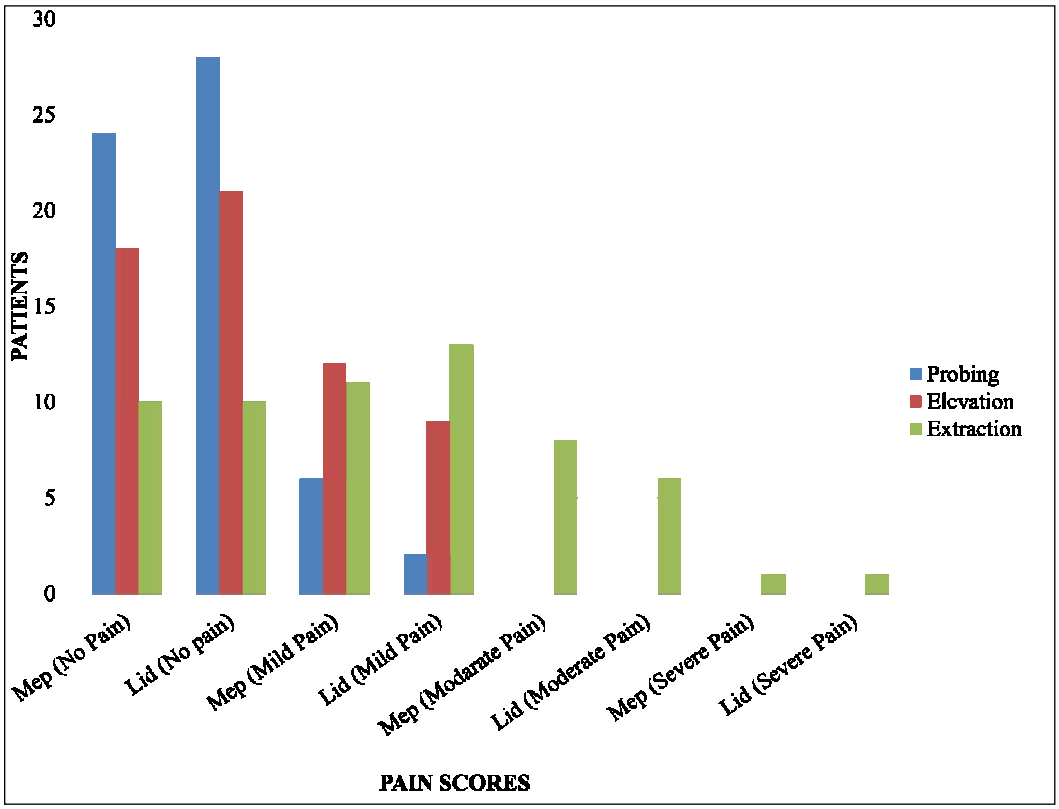


**Table 2: Duration of Soft-Tissue Anesthesia (Minutes)**

| | Maximum | Minimum | Mean | Standard Deviation | P Value |
|---|---|---|---|---|---|
| 2% Lidocaine with 1:80,000 epinephrine | 285 | 111 | 149.10 | 49.08 | P(1)= .035 |
| 3% Mepivacaine plain | 215 | 80 | 139.68 | 45.76 | |

(1)- Wilcoxon t test

## DISCUSSION

Pulpotomy and extraction are commonly performed procedures in children. Pulpotomy involves the removal of the coronal pulp tissue of a primary tooth without removing the pulp tissue in the root canal.[23] This is followed by applying pulp medicament over the radicular pulp tissue and placing a final restoration on the pulpotomized tooth. SCC steel crowns have long been considered the gold standard for the final restoration of pulpotomized primary molars[24,25]; however, the demand for a more esthetic alternative has increased for adults and children alike in recent years.[26] Studies on the efficacy of tooth-colored and bonded restorations in pulpotomized primary molars have shown promising results as alternative materials.[27,28] In this study, resin-based composite was chosen as an esthetic restorative option for pulpotomized teeth. Injection pain, postoperative complications, and the effectiveness of two anesthetic solutions (plain mepivacaine and 2% lidocaine/epinephrine) with IANB anesthesia were evaluated through the pulpotomy and extraction procedures.

Successful anesthesia is technique-sensitive, and a number of factors contribute to failure of local anaesthesia.[29] These may be related either to the patient or the operator.[12] Ajarmah et al.[30] reported that operator experience is an important factor for IANB. The success rate for IANB injections is more than 90%.[31,32] The subjective signs and symptoms of anesthesia include tingling or numbness of the lower lip, which indicates anesthesia of the mental nerve, a terminal branch of the IAN. These signs and symptoms are good indicators that the IAN is anesthetized, although they are not reliable indicators of the depth of the anesthesia.[13] In this study, to reduce anesthesia failure, an experienced pediatric dentist performed the anesthesia, and all patients showed profound lip numbness. Yılmaz et al.[33] performed the anesthesia control for the pulpotomy by probing the tooth buccally and lingually using a periodontal probe. In our study, it was performed only in the extraction group. In pulpotomy, it was not performed to avoid damaging the gingiva or periodontal ligament. In the extraction procedure, 28 subjects showed 'no pain' with lidocaine, and 24 subjects showed 'no pain' with mepivacaine for probing. Although, 2 subjects with lidocaine, and 6 subjects with mepivacaine showed 'mild pain', which they displayed by a facial expression associated with pain, there were no leg or other movements. In addition, they did not complain about pain during the procedure. Therefore, viewing the periodontal probe may have caused the facial expression, which appeared as a reflex against any potential pain.

The present study found that plain mepivacaine and 2% lidocaine (1:80,000 epinephrine) performed similarly when delivered as IANB anesthesia by a CCDS for primary mandibular molars requiring extraction or pulpotomy. Although these results are consistent with the findings of Cohen et al.[34] and McLean et al.,[35] who found that 3% mepivacaine and 2% lidocaine performed similarly as IANB agents in adults. However, the measurement of efficacy of anesthesia in their studies was performed only by assessing pulpal anesthesia with dichlorodifluoromethane and a pulp tester, without any clinical treatment. To the best of our knowledge, no clinical study has yet compared the efficacy of plain mepivacaine and 2% lidocaine for pulpotomy and extraction of teeth with IANB in pediatric patients. Çalış et al.[18] reported that mepivacaine and lidocaine have similar local anesthetic effects in sedated pediatric patients undergoing exodontia. In that study, the authors evaluated only the postoperative pain and hemodynamic effects of anesthetic solutions in sedated children. Thus, it is difficult to assess differences in anesthetic effects reported in their study and our own. In the present study, both solutions allowed completion of the pulpotomy and extraction procedures. Subjects did not require any additional anesthesia. In the lidocaine group, only one patient showed 'moderate pain', and in the mepivacaine group, nine patients showed 'moderate pain' in different stages of pulpotomy. All the FLACC scores for 'moderate pain' were less than "5." Additionally, in the pulpotomy/mepivacaine group, there was a positive correlation between injection and pain in the LSHP/RCP stages. In the lidocaine group, there was no correlation in pain scores between injection and any of the stages. In other words, the subjects who showed higher pain during the injection with mepivacaine, showed higher pain scores during the pulpotomy. The increased rate in 'moderate' pain in pulpotomy/mepivecaine may have been a result of dental anxiety.

In the extraction group, there was a positive correlation in pain scores between injection and P/GE stages in the mepivacaine group and between injection and P stage in the lidocaine group. As mentioned above, viewing sharp-edged objects as injector, elevator or the periodontal probe may have caused the facial expression, which appeared as a reflex against any potential pain. This may have resulted fake 'mild pain' scores during P/GE stages. Additionally, of those patients whose tooth was extracted, 6 showed 'moderate' and 1 showed 'severe discomfort' in the lidocaine group and 8 showed 'moderate' and 1 showed 'severe discomfort' in the mepivacaine group. It is possible that the children interpreted the pressure required for extraction as a type of pain or discomfort, which would explain why they did not show any moderate pain during the probing or elevation but did during the extraction procedure.

Studies comparing the same anesthetic solutions with and without vasoconstrictors have reported less pain with plain anesthetic solutions, possibly because of their higher pH levels.[36,37] In a clinical study with different mepivacaine solutions, Oikarinen *et al* [36] found more frequent pain on injection with low-pH solutions than with high-pH ones, as well as more frequent pain with the addition of a vasoconstrictor than with plain solutions. In the present study, pain during injection was greater with the plain mepivacaine than

with the 2% lidocaine with the vasoconstrictor epinephrine, which appears to conflict with the findings of Oikarinen et al.; in fact, the findings were similar with regard to pH, as the pH of plain mepivacaine is 4.5, while that of lidocaine with a vasoconstrictor is in the range of 5–5.5. In contrast to our study, Nusstein *et al* [38] reported no significant differences between 2% lidocaine–epinephrine and 3% mepivacaine in terms of pain on needle insertion and solution deposition. Considering that the injection site is also an important factor for injection pain and that their study was conducted using a palatal-anterior superior alveolar injection, the authors speculated that the non-elastic nature of palatal tissue might play more of a role in palatal injection pain than the pH of the anesthetic solution. In the present study, as in some previous researches,[6,39] pain upon needle insertion and solution deposition were evaluated together. With the exception of differences in subjective characteristics of patients or operator delivery, this study controlled for other factors that might affect pain upon needle insertion and solution deposition using a CCDS. Notably, in the present study, although mepivacaine was more painful during injection than lidocaine, this difference was only among the subjects who showed no pain compared to moderate and mild pain. There was no statistical difference between subjects with mild or moderate pain.

In this study, the duration of anesthesia was determined to be from the onset of paresthesia until its disappearance. Accordingly, the mean duration of anesthesia was 139.68 minutes for 3% mepivacaine and 149.10 minutes for 2% lidocaine–epinephrine. This finding is in agreement with that of most authors, indicating that epinephrine as a vasoconstrictor extends the duration of anesthesia[33,40]; however, mean duration for both anesthetic agents was less than previously reported.[34] Two factors may account for the findings of this study regarding the duration of soft-tissue anesthesia; that is, information on duration of anesthesia was provided by parents, who may not have had accurate information, and the disappearance of the sensation of numbness might not have been similarly defined by all children.

In contrast to expectations, in this study, it was found that the anesthetic solution had no effect on postoperative complications. Odabas *et al* [19] reported that there was no statically significant difference in adverse events such as accidental lip and/or cheek injury between articaine with epinephrine and mepivacaine. In contrast, Yılmaz *et al* [33] investigated the use of articaine and prilocaine in children and found that both the type of anesthetic and the method of administration affected the frequency of post-procedural adverse events, the most common of which was self-inflicted trauma. The authors attributed the differences in self-inflicted injury to differences in the duration of local anesthesia. The difference in findings reported by Yılmaz [33] and by Odabas [19] and the present study may be due to the differences in the ages of the participating children (6–8 years for Yılmaz et al., 7–13 years for Odabas and 6–12 years for the present study). The ability of children to successfully cope with soft-tissue numbness may increase with age, resulting in decreases in accidental lip/cheek injuries, even with longer-lasting soft-tissue anesthesia.

In the present study, a clinical difference in bleeding between the two anesthetic solutions resulted in a greater need for changes in sponges following extraction with mepivacaine than with 2% lidocaine with epinephrine, but the difference between the two materials was not statistically significant, it may be the result of limited subject number. The lidocaine/epinephrine was expected to have less bleeding compared to mepivacaine, given that epinephrine is effective in preventing or minimizing blood loss during surgical procedures.[40] Although a decline in tissue-level epinephrine has also been reported to produce a rebound vasodilatory effect that may lead to postoperative bleeding and potential interference with wound healing,[40] the present study found no problems related to hemostasis with either 2% lidocaine with 1:80,000 epinephrine or mepivacaine.

With regard to the differences in findings along gender lines, the present study found no significant differences in levels of pain during injection or treatment reported by boys and girls, which is in line with the findings of a previous study.[41]

## CONCLUSION

1. Plain mepivacaine and 2% lidocaine with 1:80,000 epinephrine administered by IANB anesthesia via CCDS were similarly effective for both primary mandibular molar extraction and pulpotomy.
2. Pain during injection was greater with 3% mepivacaine than with 2% lidocaine with 1:80,000 epinephrine, and the duration of anesthesia was shorter with mepivacaine than with lidocaine.
3. Plain mepivacaine and 2% lidocaine with 1:80,000 epinephrine showed similar results in terms of postoperative complications.

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