

# Comparative Evaluation of the Effectiveness of Different Pain-alleviating Methods before Local Anesthetic Administration in Children of 6 to 12 Years of Age: A Clinical Study

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## ABSTRACT

**Background and aim of the study:** Pediatric patients are apprehensive regarding having dental treatment mainly because of painful local anesthetic (LA) injections. Various techniques like transcutaneous electrical nerve stimulation (TENS), topical anesthetic agents, and vibrator device are introduced to reduce discomfort before LA administration. Therefore, the present study aimed to compare and evaluate the effectiveness of TENS, 2% lignocaine gel, eutectic mixture of lignocaine and prilocaine (EMLA), and vibrating device before LA injections in alleviating pain in pediatric patients.

**Materials and methods:** Sixty healthy children aged 6 to 12 years who required LA injections for dental procedures were selected and divided into four groups with 15 patients in each group. Wong-Baker's facial pain rating scale (WBFPRS) and face, legs, activity, cry, and consolability scale (FLACC) are used for pain perception which are tabulated, and statistically analyzed.

**Results:** The test results demonstrated that the TENS group has shown the least mean WBFPRS and FLACC score, followed by vibrator devices, EMLA gel, and lignocaine gel.

**Conclusion:** The newly introduced TENS apparatus showed encouraging results, hence can be used as a safe and reliable technique to be used in pediatric dentistry.

**Keywords:** 2% Lignocaine, Eutectic mixture of lignocaine and prilocaine, Pain scales, Transcutaneous electrical nerve stimulation, Vibrator.

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## INTRODUCTION

The main concern of the pediatric dentist is to achieve the cooperation of the child in the dental clinic during various pediatric procedures. Administering anesthesia to pediatric patients proves to be the most challenging part of the process. The real fear of the child during a pediatric procedure is painful local anesthetic (LA) injections. The mere sight of needle and syringes cause psychological trauma to the child and thus interferes with the behavior management of a child. Reducing the fear of pain during LA injections gains the confidence of the child toward the dentist, thus achieving the cooperation of the child during treatment.

Various techniques are available to reduce discomfort during LA injections. Transcutaneous electrical nerve stimulation (TENS) works on the principle of gate control theory given by Melzack and Wall in 1965. Shane and Kessler in 1967 first described its use in various fields related to medicines.<sup>1</sup> Transcutaneous electrical nerve stimulation directly stimulates the nerves by electrical impulses of short duration and small amplitude for pain reduction during LA injections.<sup>2</sup> Transcutaneous electrical nerve stimulation proved to be more comfortable and beneficial in reducing pain and anxiety during LA injections.

Topical anesthetic agents are commonly used before the administration of LA injections. Nakanishi et al. found that the site of injection plays an essential role in the efficacy of topical anesthetic agents. 2% lignocaine gel produces surface anesthesia; however, it has a limited capacity of penetrating deep into tissues.<sup>2</sup> A cutaneous topical anesthetic which was first used in dermatology in the 1980s, eutectic mixture of lignocaine and prilocaine (EMLA) – “a

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1:1 mixture of 2.5% prilocaine and 2.5% lidocaine”. The first trial to administer EMLA cream in the mucosal surface was first described by Holst and Evers.<sup>3</sup>

The vibration device is also a technique in reducing pain during LA administration, and it works on the principle of gate control theory of pain. Inhibitory interneurons in the spinal cord get stimulated by touch and vibratory stimuli which restricts the information carried by A-δ and C fibers to second-order neurons of the spinal cord.<sup>4</sup> Thus, pain stimuli get eliminated. Hence, this study was aimed to compare and evaluate the effect of various pain alleviating techniques such as the application of a topical anesthetic gel, TENS, and vibration device in reducing pain among pediatric patients requiring anesthesia during routine dental procedures.

## MATERIALS AND METHODS

### Materials

The apparatus used was the TENS apparatus with two electrode rods, 2% lignocaine gel, EMLA gel, and a vibrator device. Diagnostic instruments, LA syringe, and povidone–iodine solution (Fig. 1).

Wong–Baker’s facial pain scale and FLACC scale were used for pain perception.

### Methods

Written consent was obtained from parents explaining the procedure to them in the local language before beginning with the process.

### Sample

6 to 12 years of children visiting the Department of Pedodontics and Preventive Dentistry, ACPM Dental College, Dhule, requiring the need for local anesthesia were considered for the study.

### Sample Size

A total of 60 subjects requiring the need for LA injections were selected randomly for the study upon fulfilling the following criteria.

### Inclusion Criteria

- Children who are never exposed to TENS, EMLA jelly, lignocaine jelly, and vibrator device.
- Children who require LA injections and in whom parental consent was obtained.

### Exclusion Criteria

- Children with epileptic disorder.
- Children with a history of cardiac and bleeding disorder.
- Immature children who cannot understand the concept of pain.
- Physically and mentally challenged children.
- Children with unknown skin allergies.

### Study Design

Sixty children were randomly divided into four groups with 15 children in each group requiring the need for local anesthesia before the procedure.

Group I: Children received TENS stimuli.

Group II: Children received 2% lignocaine gel.

Group III: Children received EMLA gel.

Group IV: Children received vibration stimuli.

### Group I (TENS Group)

Transcutaneous electrical nerve stimulation unit comprises a control unit and electrode pads (Fig. 2). The electrode pads can be applied extraorally, which was a cumbersome method, time-consuming, and patient cooperation was required. Thus, it was modified using electrode rods, which can be applied intraorally (Fig. 3).

The site of needle insertion was gently swabbed with povidone–iodine. Electrode rods are wrapped with cotton and moistened with water. Transcutaneous electrical nerve stimulation electrodes rods are placed intraorally on the mucous membrane over the site of needle insertion. The amplitude and frequency of the TENS unit were adjusted until the child felt a warm, twitching sensation. The LA solution was then deposited, and a TENS stimulation was maintained until the deposition of the solution into the tissue (Fig. 4).

### Group II (Lignocaine Group)

At the injection site, 2% lignocaine gel was applied for 2 minutes, and then the LA solution was deposited (Fig. 5).

### Group III (EMLA Group)

Eutectic mixture of lignocaine and prilocaine gel was applied at the injection site for 3 to 5 minutes, and the LA solution was then deposited (Fig. 6).

### Group IV (Vibrator Group)

A vibrating device was placed extraorally on the same side to the site of injection. The device was placed along the inferior border of the mandibular ramus for mandibular injections. The device was set against the zygomatic arch for maxillary injections. Amplitude was gradually increased from 0 to 2 modes until the patient feels the twitching sensation. Local anesthetic solution was deposited until vibration mode was maintained until the deposition of the solution into tissues (Fig. 7).

2% lignocaine with 1:80,000 adrenaline is used in each group. Pain assessment was done using Wong–Baker’s Facial Pain Scale (Fig. 8) and face, legs, activity, cry, and consolability scale (FLACC) (Table 1) after administration of LA solution in all the four groups.

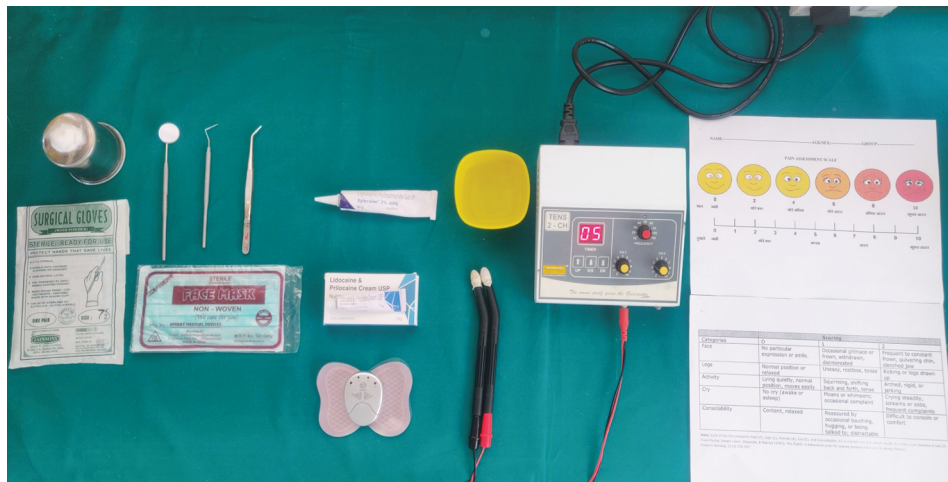


Fig. 1: Armamentarium used

## OBSERVATION

### Wong–Baker’s facial pain scale

In this, the rate of discomfort was asked from child on a 0 to 10 score with a smiling child at one end and a tearful child at the other. The distance along the scale from the smiling child was taken as the pain score (Fig. 9).

### FLACC Scale

In this scale, the operator observes the level of discomfort from 0 to 2 in each of the 5 categories, and the scale was scored in a range of 0 to 10.

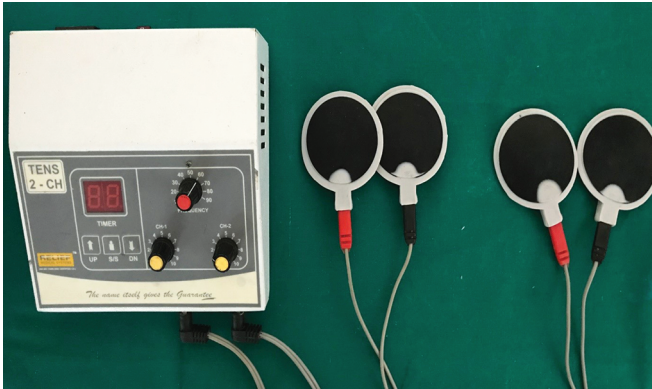


Fig. 2: TENS apparatus with extraoral electrode pads

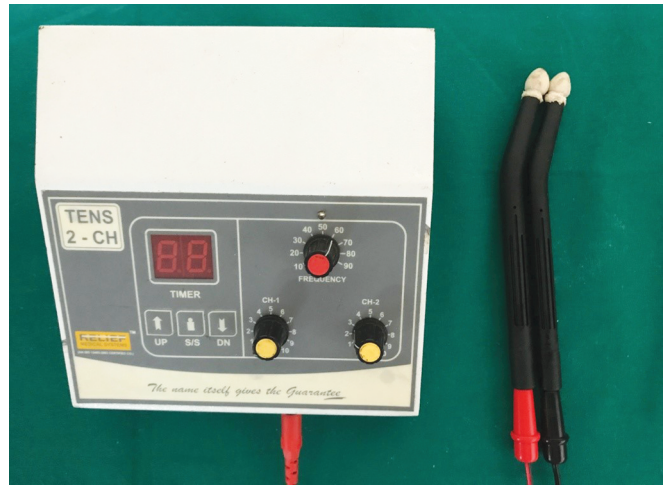
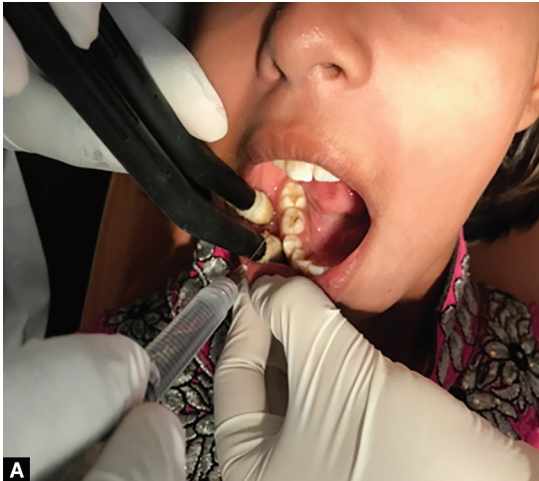
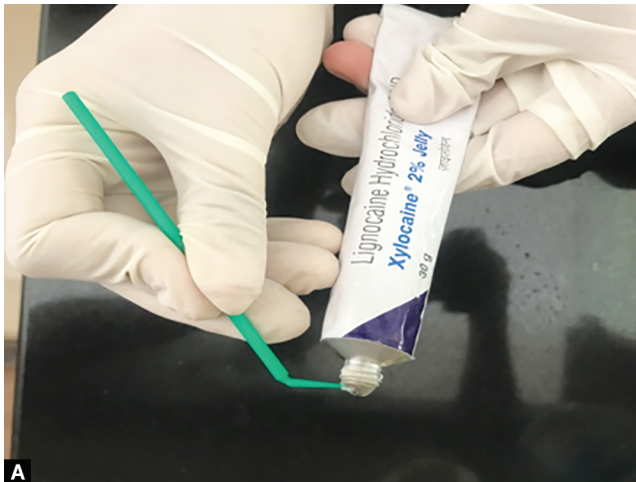


Fig. 3: Modification of TENS electrode



Figs 4A and B: Application of TENS electrodes in group I



Figs 5A and B: 2% lignocaine jelly application in group II

## RESULTS

The values were subjected to the statistical analysis in which the ANOVA test was performed. Most significant pain reduction was observed in the TENS group with Wong–Baker faces mean pain score of 2.4 followed by vibration group with a mean pain score of 3.2, then EMLA group with a mean score of 4.13, and lastly 2% lignocaine jelly with 6.4 mean scores (Fig. 10 and Table 2).

Similarly, minimum pain felt in the TENS group with FLACC scale mean pain score of 1.47 followed by vibration group with a mean pain score of 1.80 then EMLA group with a mean score of 2.27, and lastly 2% lignocaine jelly with a mean score of 5.4 (Fig. 11 and Table 3).

The result obtained was statistically significant with  $p = <0.05$ , suggesting the TENS application to be more effective in reducing pain sensation.

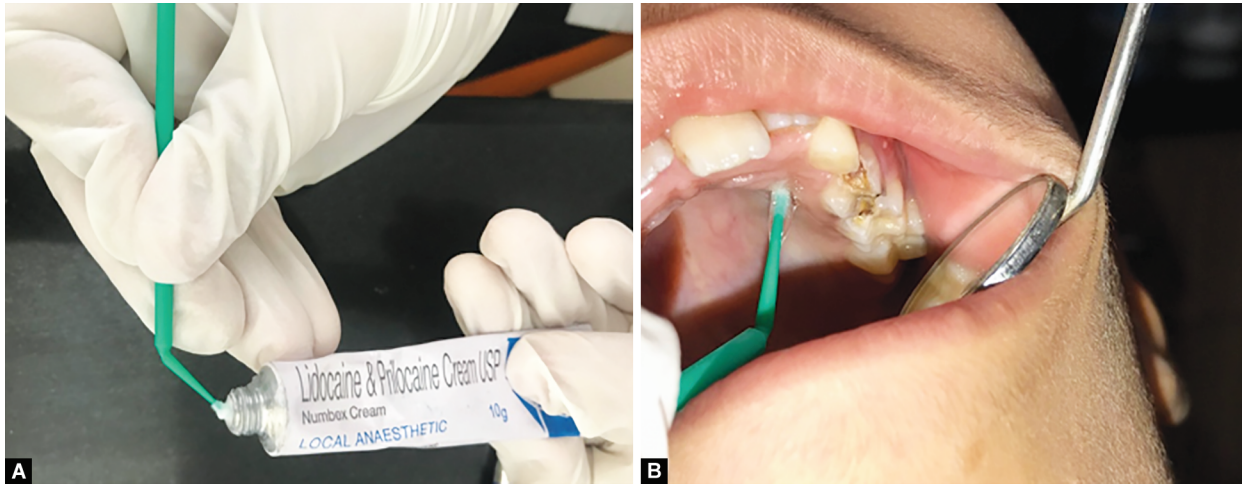
## DISCUSSION

Pain is the most undesirable aspect of pediatric dentistry, which can lead to significant uncooperative behavior of the child in the dental office. By reducing the pain associated with LA administration, the patient can get maximum comfort and satisfaction. The primary aim of all clinicians is to give painless LA. Continuous research has

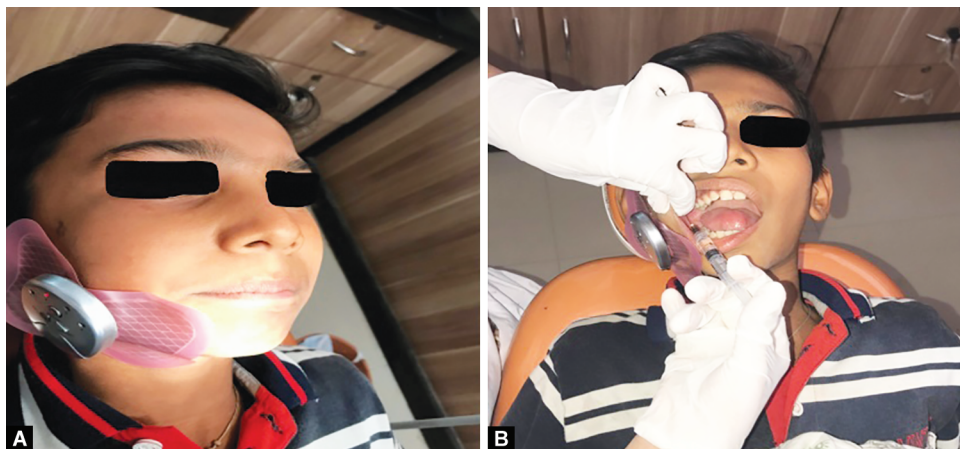
been carried out for newer methodologies and techniques which can make dental treatment under LA more comfortable.<sup>2</sup>

To decrease the pain and discomfort caused by injections, various alternatives are available such as topical anesthetic application or application of TENS and vibration stimuli.

In the present study, a comparison of this pain alleviating method was made before the LA administration. Transcutaneous electrical nerve stimulation have been shown to significantly reduce pain and discomfort. Transcutaneous electrical nerve stimulation works on the principle of “gate control theory” which states that there is a gateway in the spinal cord’s dorsal horn which regulates the transmission of pain messages that are then sent to (ascending pathways) and (descending pathways) higher brain levels for central processing, thereby decreasing perception of pain. Some postulated mechanisms of TENS-mediated pain relief include stimulating endorphin release in the spinal cord.<sup>5,6</sup> Transcutaneous electrical nerve stimulation stimulates large-diameter nerve fibers with a lower threshold to electrical activity than smaller diameter fibers.<sup>7</sup> Nociceptive fibers (A-delta and C-fibers) have a higher threshold of activation than mechanoreceptive fibers (A-beta fibers). Melzack and Wall proposed that it would be possible to selectively stimulate mechanoreceptive fibers by titrating the amplitude of electrical currents delivered across the mucosal surface.<sup>8</sup>



Figs 6A and B: EMLA gel application in group III



Figs 7A and B: Vibrator device placement in group IV

Name:.....Age/Sex.....Group:.....

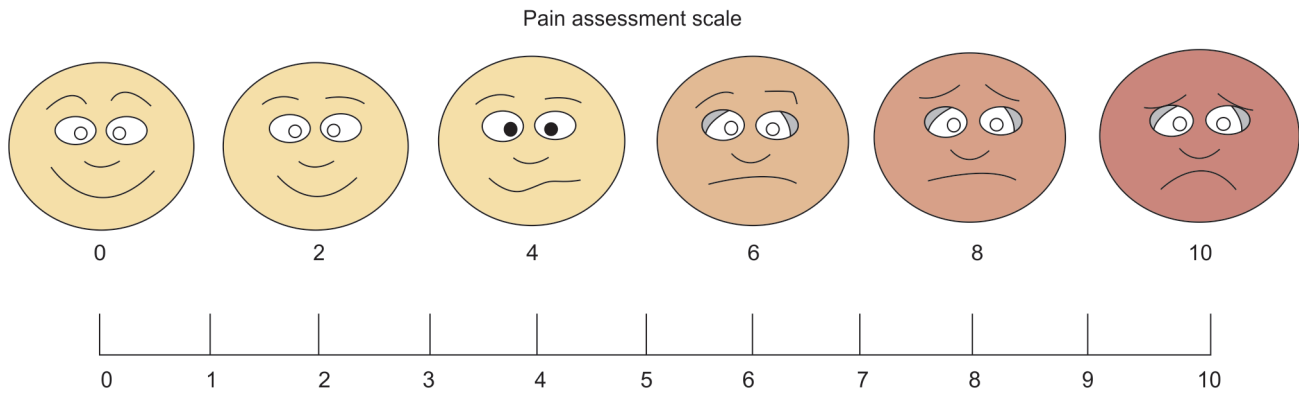


Fig. 8: Wong-Bakers faces rating scale

Table 1: FLACC scale

Category	Scoring		
	0	1	2
Face	No particular expression or smile	Occasional grimace or frown, withdrawn, disinterested	Frequent to constant quivering chin, clenched jaw
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 (awake or asleep)	Moans or whimpers; occasional complaint	Crying steadily, screams or sobs, frequent complaints
Consolability	Content, relaxed	Reassured by occasional touching, hugging or being talked to, distractible	Difficult to console or comfort



Fig. 9: Self-evaluation by a child using Wong-Baker faces rating scale

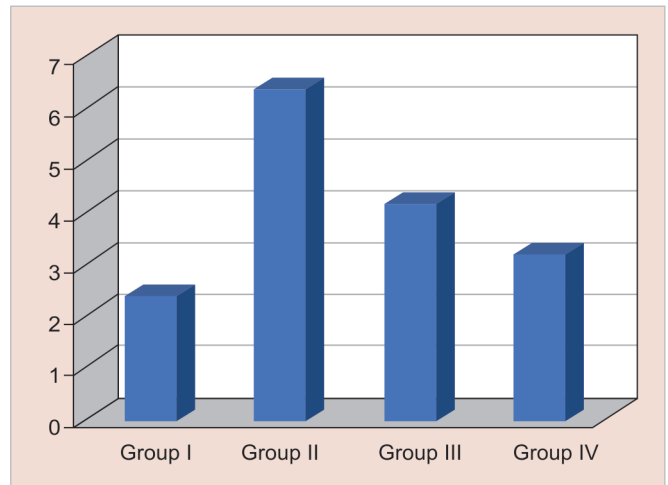


Fig. 10: Comparison of mean Wong-Baker faces pain rating scale scores for pain between different study groups

The advantages of TENS are:

- It is a non-invasive and safe technique.
- It is a standalone technique for the various minor pediatric procedure like extraction, restorative procedures, and pulp capping.

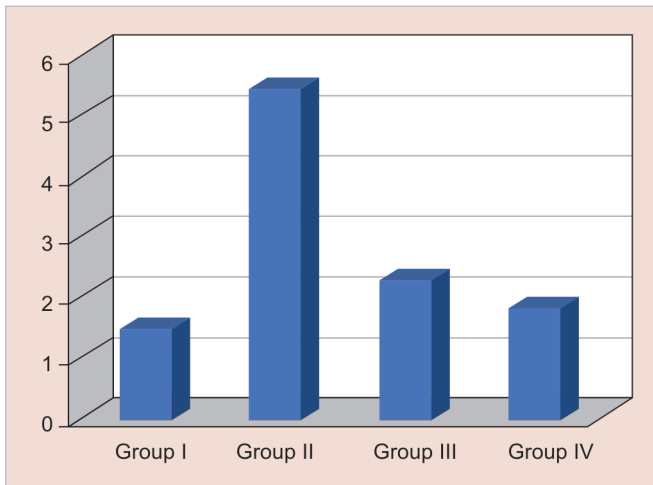
Quarnstrom Fred conducted a study using TENS for pediatric procedures where no pain was felt during extraction.<sup>9</sup> A study

conducted by Bishop TS using TENS on pediatric patients where restorative procedures were carried and reported success of 92.8%.<sup>10</sup> Segura et al. also reported minimum pain with TENS in the 7 to 12 years of age group during restorative procedures.<sup>11</sup> Clark et al. also reported successful endodontic procedures with TENS.<sup>12</sup>

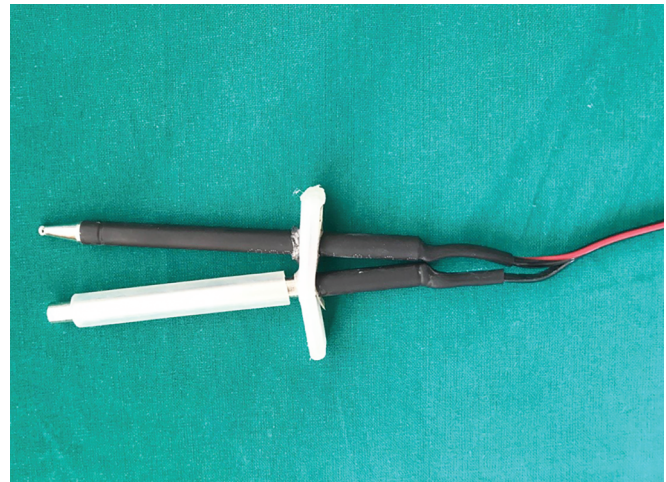
The only limitation of this study was that the pen electrodes were bulky, and handling of the TENS unit requires the need of the

**Table 2:** Comparison of mean WBFPRS scores for pain between different study groups

	N	Mean	Std. deviation	Std. error	95% confidence interval for mean		Minimum	Maximum
					Lower bound	Upper bound		
1	15	2.40	2.293	0.592	1.13	3.67	0	6
2	15	6.40	2.746	0.709	4.88	7.92	2	10
3	15	4.13	2.326	0.601	2.85	5.42	0	8
4	15	3.20	1.971	0.509	2.11	4.29	0	6
Total	60	4.03	2.743	0.345	3.32	4.74	0	10



**Fig. 11:** Comparison of mean FLACC scores for pain between different study groups



**Fig. 12:** Modification of pen electrodes

**Table 3:** Comparison of mean FLACC score for pain between different study groups

	N	Mean	Std. deviation	Std. error	95% confidence interval for mean		Minimum	Maximum
					Lower bound	Upper bound		
1	15	1.47	1.407	0.363	0.69	2.25	0	5
2	15	5.40	3.180	0.821	3.64	7.16	2	10
3	15	2.27	1.534	0.396	1.42	3.12	0	4
4	15	1.80	1.424	0.368	1.01	2.59	0	5
Total	60	2.73	2.530	0.327	2.08	3.39	0	10

second operator. To overcome this, pen electrodes were modified to be used for a single operator (Fig. 12).

Its use in children with epileptic disorders, central nervous system disorders such as trigeminal neuralgia, congenital heart disease, and children with pacemakers is contraindicated.

The use of vibrating devices is another technique in reducing the pain of LA injections. It works on the principle of the gate control theory of pain and stimulates A-beta nerve fiber input from a vibration stimulus which would inhibit smaller fiber A-delta and C fiber (nociceptive) input from a transmucosal needle injection.<sup>4</sup> It was suggested that vibrating devices generate a distractive environment that causes the brain cells to relay the vibrations, thus giving room for anesthesia delivery. A study conducted by Blair finds the same results using Vibraject in children.<sup>13</sup> However, a massager-like device using extraoral vibrating stimuli is the first of its kind used in the present study for reducing pain and discomfort in children during LA administration.

### Advantages

- Extraoral vibration makes child-friendly device becomes more comfortable for the child and renders effective dental care.
- From the aspect of child pain management, this device contributes both physiologically and psychologically useful tools.

The only disadvantage of the vibrator is the first quiver after placement at the desired location.

Topical anesthetics reversibly block nerve conduction near their site of administration by targeting free nerve endings in the mucosa which causes transient loss of sensation in a particular area. Nerve impulse conduction is stopped by lowering nerve cell membrane permeability to sodium ions, possibly by competing with calcium-binding sites that control the permeability of sodium. This change in permeability lowers depolarization and raises the excitability threshold until the ability to produce an action potential is lost.<sup>14</sup>

Eutectic mixture of lignocaine and prilocaine is a commercial anesthetic agent that has got acceptance by dental clinicians. The EMLA cream proves to be effective in reducing pain during ultrasonic scaling, rubber-dam clamp placement, and subgingival tooth preparation.<sup>15</sup> Disadvantage of EMLA cream is it gives an unusual sensation of taste.

2% lignocaine has a limited capacity of penetrating deep into the tissue. Though the discomfort due to surface penetration is minimized, at greater depths of penetration, they are ineffective.

There are various faces rating scales for young children were introduced. The Wong–Baker faces pain rating scale is simple, easy to understand, and has shown a positive correlation. In several studies, it has been used for assessing pain in children and adults. FLACC scale is a good and reliable scale as trained observer notices the behavioral expression of child and assess the child pain reaction for pain assessment. Hence, in the present study, Wong–Baker faces pain rating scale and FLACC scale were used.

## CONCLUSION

It can be concluded that TENS proved to be more effective, comfortable, and it significantly reduces pain during LA administrations. Transcutaneous electrical nerve stimulation prove to be a safe, reliable, and practical technique to be used in pediatric dentistry.

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