



**Research Article**

**EFFICIENCY OF TENS IN CONTROLLING PAIN DURING SEPARATION USING TWO DIFFERENT ORTHODONTIC SEPARATORS**

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**ABSTRACT**

Pain is the most commonly cited negative effect of orthodontic treatment and is of major concern to patients as well as clinicians. Pain control during orthodontics is therefore an important aspect of patient compliance. The present study was carried out to assess the efficiency of transcutaneous electrical nerve stimulation (TENS) in controlling pain during orthodontic separation. Thirty subjects were equally assigned to three groups -intraoral group, extraoral group, and control group. In each group, Kesling separators were placed mesial and distal to the left maxillary first molar and elastomeric separators on the right side. A scientific medical system physio-multi TENS STIM -2CH was used to deliver the electric current. Visual analog scale (VAS) was used to assess the pain. In all the 3 groups left sides (Kesling separator) mean VAS score was more than the right side (elastomeric separator) means VAS score. There was no statistically significant difference between intraoral TENS and extraoral TENS group. The TENS subjects reported significantly less pain than the control subjects. The present study suggests that TENS is an effective non-pharmacologic method of controlling post- separation orthodontic tooth pain.

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**INTRODUCTION**

Pain is perhaps even older than mankind. There is a reason to believe that it is inherent in any life linked with consciousness. Evidence indicates that man has suffered this affliction since his beginning, for one finds testimony to the existence of pain in the chronicles of all races (Fulop Miller) [1]. The International Association of the Study of Pain has defined pain as "an unpleasant sensory and emotional experience with actual or potential tissue damage or described in terms of such damage" [2]. Orthodontic tooth movement requires application of force to the tooth which generally causes pain. The general perception of patients is that orthodontic treatment and pain are inseparable and go hand in hand. There are reports that one of the discouraging factors for seeking orthodontic treatment is the individual's fear for the related pain and discomfort [3-6].

It is imperative that pain control during orthodontic treatment should be considered an important aspect of orthodontic mechanotherapy. The control of pain in orthodontic treatment should include adjusting the forces to a level below the pain threshold. Unfortunately such low forces would have very little if any effect on the tooth movement. To alleviate the pain and discomfort, clinicians have tried different approaches.

Anti-inflammatory drugs remain the most preferred method but lack of an appropriate protocol for their administration after orthodontic appointments is considered to be a major drawback requiring attention in future research. The non-pharmacological approaches include, having patients to chew on something fairly hard for example – a plastic wafer, analgesic chewing gums, transcutaneous electrical nerve stimulation (TENS), low-level laser therapy (LLLT), vibratory stimulation and magnetic force field [7-15].

Orthodontic separation forms the first step in fixed orthodontic mechanotherapy wherein space is created mesial and distal to the first molars to accommodate bands. Placement of separators (brass wire, elastomeric, spring type steel separators) results in painful experience in almost all the patients. Although many non-pharmacological methods are available, one non-invasive, cost effective method of pain control is TENS. Unfortunately, few clinical studies have evaluated the use of electrical stimulation during orthodontic procedures and some of these have been conducted on an empirical basis. Even though, Acetaminophen is a widely used analgesic during orthodontic treatment as it doesn't interfere with orthodontic tooth movement, there is now increasing and convincing epidemiological evidence from a range of independent studies implicating paracetamol use in the etiology of asthma and other allergic diseases [16-18]. It is the putative risk factor not only for the development of asthma due to bronchospasmodic action, but also causes anaphylactic

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shock [19]. The purpose of the present investigation was: (1) To evaluate the efficiency of transcutaneous electrical nerve stimulation (TENS), in controlling pain associated with tooth separation using two different separators. (2) To assess the effects of location and duration of TENS therapy during orthodontic separation. (3) To assess the time course of tooth pain following placement of separators.

## **MATERIALS AND METHODS**

Thirty patients selected for comprehensive orthodontic treatment at C.K.S Teja Dental College, Tirupati, were included in this study.

### **Inclusion Criteria**

1. Age group between 18 to 25yrs.
2. Presence of second molars and second bicuspid since separating elastics had to be fixed on the first molars.
3. Subjects with non- extraction treatment plan.
4. Subjects with proper interproximal contacts present mesial and distal to the maxillary 1<sup>st</sup> molar.
5. Subject with no clinical signs of gingival inflammation.

### **Exclusion Criteria**

1. Use of any medication that could interfere with results before procedure and during the procedure.
2. Patients with cardiac arrhythmias and pacemakers (especially of the demand type).
3. Patients with dermatological lesions e.g. dermatitis, eczema.
4. Patients allergic to electrodes, gels and tapes.
5. Epileptic patients.

Subjects (n = 30) were randomly and equally assigned the following groups using stratified random sampling method: Group 1- TENS intraoral, Group 2- TENS extra-oral, Group 3- control group with equal distribution of males (5) and females (5). In each group, 2 different types of separators were placed. Maxillary left side received Kesling separators and right side, elastomeric separators. Separators were placed mesial and distal to the first permanent maxillary molar. Placebo effects were not taken into consideration in this study as it has been proved by previous studies that there was no significant difference in visual analogue scale (VAS) scores between the placebo and control groups at any time [10,22,23].

### **Apparatus**

A Physio-Multi TENS STIM -2CH (**Fig 1**) was used to deliver the electric current. Current intensity of this apparatus will be typically in the range of 0-50 mA (milli amperes), though some machines may provide outputs up to 100 mA. Although this is a small current, it is sufficient because the primary target for the therapy is sensory nerves, and so long as sufficient current is passed through the tissues to depolarize these nerves, the modality can be effective. To be clinically effective, it is suggested that the TENS machine should cover the range from about 2-150 pps or Hertz (Hz) pulse frequency. The duration (width) of each pulse was 400  $\mu$ sec (microseconds). The reason that such short duration pulses were used to achieve these effects is that the targets are the sensory nerves which tend to have relatively low threshold (i.e they are quite easy to excite) and that they will respond to rapid change of electrical state. There is generally no need to apply a prolonged pulse in order to force a sensory nerve to depolarize, therefore stimulation for less than millisecond is

sufficient. This machine is a dual channel output i.e two pairs of electrodes can be used simultaneously. Widespread and diffuse pain presentations can be usefully treated with a 4 electrode (2 channels) system.

The VAS was used to assess the pain. It consists of horizontal 10 cm scale with description of "no pain" on the left side and "severe pain" on the right side of scale. It is a direct pain scaling method in which the subjects evaluate the level of pain by making a mark on a continuous line. The advantages of using the VAS over observational, self report, behavioral, physiological or verbal rating scales, are the higher sensitivity, reproducibility, and reliability of direct scaling technique [24-28]. The VAS is also a valid and reliable method of measuring discrete pain, being able to discriminate between small changes in pain intensity [29]. These Scales have proven sensitive to both pharmacological and non- pharmacological methods of alleviating pain [30]. It also allows the use of parametric statistical tests [31]. They are less reliable in measuring absolute discomfort at any particular moment than in measuring changes in pain over time, as was done in the present investigation [11].

### **Methodology of TENS Application**

Approval of all the subjects participating in the study was obtained on appropriate consent forms. Subjects receiving TENS therapy were informed that they would assess a pain reduction device that would deliver a mild electric current. Both groups were informed that the current intensity was very small and that they would feel a very slight tingling sensation. Control subjects were informed that they were participating in a study to assess the discomfort experienced during orthodontic treatment.

For all subjects Kesling separators made with 0.020" Australian stainless steel wire were placed on the left side maxillary arch mesial and distal to the maxillary first molar. On the right side elastomeric separators were placed mesial and distal to the maxillary first molar (**Fig 2**). For those subjects in the extraoral groups, electrodes were placed bilaterally over the subjects zygomatic arches (**Fig 3**). The electrodes were held in position with plasters. The TENS unit was set to deliver a current frequency of 60 Hz with an intensity of 50 mA. The duration of each session was 15 minutes. It was applied for four days (1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> day). For the intraoral group, current was applied directly to the teeth by placing one pen electrode on the crown of each tooth and the other electrode on the palatal mucosa adjacent to the tooth (**Fig 4**). The TENS unit was set to a current frequency of 60 Hz with an intensity of 50 mA. The first and second molars and the second premolar on each side of the arch received 6 seconds of treatment current each time. It was repeated on the either side immediately after the placement of the separators for four days.

Following separator placement each subject was given VAS scoring slip. Patients were instructed to evaluate their pain at 8 pm after the dinner by marking the spot on the line they believed to best represent the pain they were experiencing at the time. The VAS score is the distance from the left border of the line to the point of the subject's mark, measured to the nearest millimeter. Subjects were also instructed to make each evaluation independently, hence every day the sheet was collected then a new form for the next day was given to the subject to minimize the error.

Subjects in all the three groups were instructed to report every 24 hrs for periodic check up. Any missing separators are replaced immediately and the subjects were instructed not to take any kind of analgesics. The subjects in control group received no treatment procedure.

**Analysis of Data**

Mean and standard deviation were calculated for each variable. Student 't' test was conducted between the means of the right and left sides VAS score to identify the significant differences and analysis of variance (ANOVA) test was performed to compare the mean between groups and between days. Post hoc test (Tukey) was also performed for multiple comparisons between the groups and the days (p<0.05).

**RESULTS**

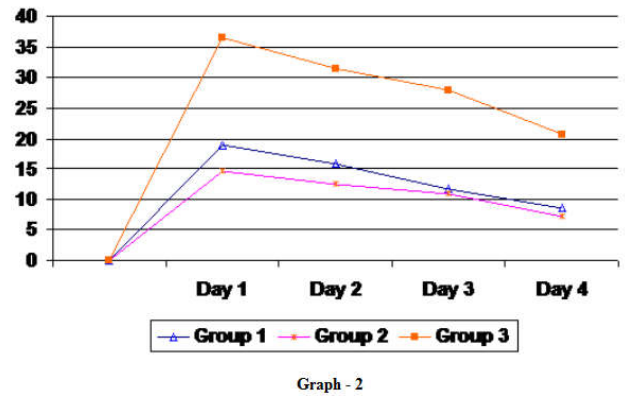
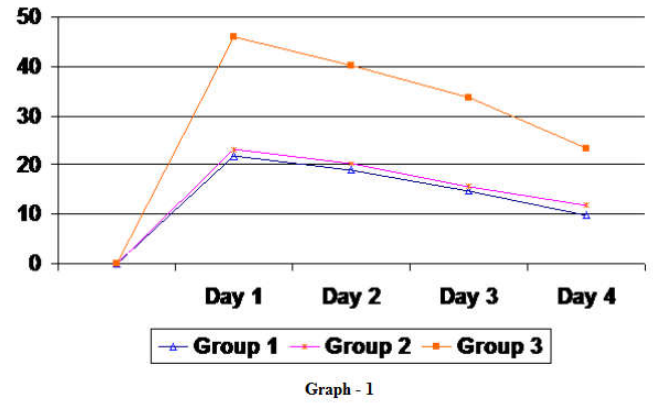
The mean VAS scores for the different groups at the various assessment periods are shown in Table 1.

The pain scores of subjects who received TENS therapy were significantly less than those of controls with both types of separators (p<0.05). The levels of discomfort were found to be significantly different between controls and TENS subjects on all four days. The mean VAS scores with Kesling separators was more than elastomeric separators, but the difference was not statistically significant in TENS groups (p>0.05). Statistically significant difference between the separators was seen in control subjects (p<0.05).

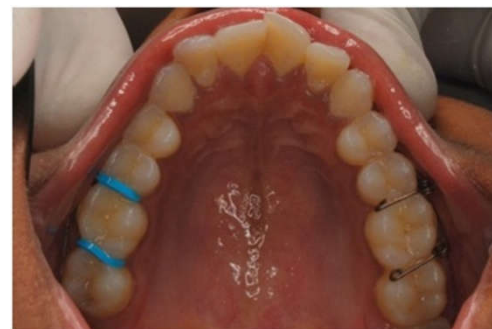
Comparison of VAS scores between groups revealed statistically significant difference between TENS groups and controls on all four days (p<0.01) for both the separators. The difference between intraoral TENS and extra-oral TENS groups was not statistically significant across the time intervals (p>0.05). Comparison of mean values of VAS scores within the groups using both the separators showed statistically significant difference between first day and the fourth day (p<0.01). The Graph 1 shows the comparison of mean pain scores among the three groups using Kesling separators and Graph 2 shows the comparison with elastomeric separators.

**Table 1** Comparison of mean values of VAS scores between groups

Groups	Day 1	Day 2	Day 3	Day 4
TENS Intraoral Group (n=10)				
Kesling separator				
Mean ± SD				
Elastomeric separator	21.8 ± 8.53	18.9 ± 7.92	14.7 ± 5.79	9.8 ± 4.63
Mean ± SD	19 ± 4.78	15.8 ± 6.08	11.8 ± 4.75	8.5 ± 3.92
TENS Extraoral Group (n=10)				
Kesling separator				
Mean ± SD	23.3 ± 8.24	20.3 ± 7.11	15.7 ± 4.99	11.8 ± 5.3
Elastomeric separator	14.6 ± 9.46	12.5 ± 7.89	10.9 ± 6.15	7.3 ± 4.24
Mean ± SD				
Control Group (n=10)				
Kesling separator				
Mean ± SD	46 ± 10.4	40.2 ± 9.48	33.6 ± 8.99	23.4 ± 7.09
Elastomeric separator				
Mean ± SD	36.4 ± 9.9	31.4 ± 9.61	27.9 ± 10.35	20.7 ± 8.97



**Fig 1** TENS unit with Electrodes



**Fig 2** Intraoral view of Separators



Fig 3 Extraoral application of TENS using Electrodes



Fig 4 - Intraoral application of TENS using pen electrode

## DISCUSSION

Electrical stimulation has been used as a therapeutic modality from the time of Roman Empire [32]. A comprehensive overview concerning the use of peripheral electrical stimulation for pain relief has been written by Woolf [33].

TENS generates short, low amplitude electrical impulse that travels between two electrodes placed on the skin. The signal from the electrical stimulation of beta fibers (larger nerve fibers for pressure and touch) reaches the central nervous system before the signals from the slower A and C fibers (smaller nerve fibers for pain). Thus, the beta impulse blocks or "closes the gate" to the pain impulses. The electric impulse also stimulates the production of a local analgesic (beta endorphin) and/ or substance "P" in the nerve cells and of serotonin in the brain, raising the patient's pain tolerance [34]. The first dental application of TENS was for the treatment of myofascial pain dysfunction syndrome [35]. Mumford [36] assessed the effects of TENS on the pain threshold of electrically stimulated tooth pulp and results demonstrated a higher pain perception after TENS application. First controlled experimental design of TENS application was carried out by Hansson and Ekholm [23] on out patients attending an emergency dental clinic.

Roth and Thrash (1986) [11] assessed for TENS effect on periodontal pain associated with orthodontic separation and suggested that TENS was an effective non-pharmacological method of controlling pain.

Abdulhammed *et al* (1989) [37] assessed the efficiency of TENS in children during placement of a rubber clamp and found significant increase in tooth pain threshold.

Weiss and Carver (1994) [38] reported that TENS reduces the pain associated with debonding and further suggested that it can be used during proximal stripping and incisor recontouring procedures.

Shasikumar and Anup (2009) [39] demonstrated decreased pain thresholds in young patients during initial stages of alignment by extra-oral TENS.

In the present study, no statistically significant difference was found between genders in the subsequent pain responses. Earlier reports by Jones (1984)[ 40], Fernandes *et al* (1998)[41], Ngan *et al* (1989)[42], Bondemark *et al* (2004)[43] seem to agree with this finding. Few studies claim that females reported more pain/discomfort than males [44,45].

In all the 3 groups, left sides (Kesling separator) mean VAS score was more than the right side (elastomeric separator) means VAS score. Kesling separator was more painful than the elastomeric separators but the difference was statistically non significant ( $p > 0.05$ ). Hoffman WE (1972)[46] and Bondemark L (2004)[43] reported that both types of separators caused pain of mild to moderate intensity, with Kesling being more tolerable than elastomeric, but the difference found was not statistically significant. The results show that pain was high in control group than in TENS group. Within the TENS groups, no significant difference was observed with either of separators.

The time of onset was between zero and 1<sup>st</sup> day/ 24 hours. The pain after placing separator was more on day 1 and day 2. This pain lasted for the 2<sup>nd</sup> and 3<sup>rd</sup> day and disappeared between 3<sup>rd</sup> and 4<sup>th</sup> day. These findings are similar to the clinical observations reported by Burstone (1962)[47], Hoffman (1972)[46], Roth and Thrash (1986)[11] and by Bondemark L (2004)[43].

The reliability of patients in recording discomfort precisely and at the requested times could not be verified. Nevertheless this study confirms previous findings that the intensity of pain is greatest in 24 hrs. The results also indicate that discomfort was significantly less at every time interval for those who used TENS.

***Though our study Supports the use of TENS to Alleviate pain, it Presents few Limitations.***

1. As compared to aligning and leveling simulation of orthodontic treatment using separators placement may cause less pain.
2. This design did not consider the response variability inherent in studies using separate treatment and control groups.
3. Influence of personality characteristics such as neuroticism and introversion - extroversion on perception of discomfort by patients was not evaluated.

## CONCLUSION

The present study showed that, pain scores were high in control group than in TENS group. Pain was perceived to be more with Kesling separators than with elastomeric separators but the difference was not statistically significant. TENS is effective in reducing the pain after placement of orthodontic

separators. This study provides valuable information concerning the analgesic properties of peripheral electrical stimulation and should help establish a useful baseline for future clinical studies of the efficacy of electrical stimulation during orthodontic procedures. The TENS as a treatment modality to control pain during orthodontic tooth separation has the advantage of being non-invasive, easy to administer and having no adverse tissue reactions. It is worthwhile to look into its potential applications into orthodontics. Future investigations should focus on blinded, randomized control trials, comparing pharmacological and non pharmacological approaches.

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