



Original Research Article

## **Analgesic Effects of Modulated Frequency Transcutaneous Electrical Nerve Stimulation in the Relief of Pain after Abdominal Surgery - A Randomized Controlled Trial**

Ajay Thakur, Sukumar S

Asst. Prof., Nitte Institute of Physiotherapy, Nitte University, Mangalore, India- 575018

Corresponding Author: Sukumar S

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### **ABSTRACT**

**Background and Objectives:** Transcutaneous electrical stimulation (TENS) is an effective method of postoperative physical therapy. The objective of this study was to determine the efficacy of modulated frequency TENS on relieving incision pain related to physical therapy after abdominal surgery. **Methods:** A clinical, randomized, prospective study was undertaken with 45 patients who presented a pain score  $\geq 3$  on the visual analog scale (VAS) were allocated in three groups. Subjects in group one received modulated TENS, second group received low frequency TENS, and third group treated with conventional physical therapy without TENS. TENS was given for 20 minutes and Pain was evaluated using a visual analog scale (VAS) before treatment on day one and after application of TENS in the five consecutive post operative days.

**Results:** statistical comparison of Modulated TENS with Low TENS the values ( $P= 0.370$ ), shows that both the groups equally effective in reducing pain. But when control group is compared with modulated TENS and low TENS it signifies that the results obtained is significant  $P=0.01$ , which suggests that when compared to control group both the experimental group is significant. The inferential statistical results of post intervention pain score indicates both the TENS groups ( Modulated TENS & Low TENS) were more effective in reducing pain much faster as compared to the control group.

**Conclusions:** This study revealed that there was a relief in pain in all the 3 groups but frequency modulated TENS showed a faster pain relief over a short span of time as compared to the other two groups.

**Keywords:** Transcutaneous electrical nerve stimulation (TENS), modulated frequency, Acu TENS, visual analog scale (VAS), abdominal surgery, postoperative pain.

### **INTRODUCTION**

Post operative pain over incision site and related dermatomal areas is common among patients who had undergone abdominal and thoracic surgeries. <sup>[1]</sup> Pain due to post operative tissue damage may lead to reduction in functional abilities,

altered pain perception and difficulty in breathing. <sup>[2]</sup> There are several studies have done on severity of post operative pain and treatment for related dysfunction due to pain.

Patient undergone abdominal and cardiothoracic surgeries were treated

commonly by pharmacological agents, wound care and splinting (elasticized abdominal binder), infrared radiation, different types of TENS were used to reduce pain. Relaxed breathing exercises, forced expiratory techniques, postural correction positioning were used to improve the breathing pattern and oxygenation. [3]

Transcutaneous electrical nerve stimulation was effectively used by the physical therapists to treat pain and pain related neuro-muscular dysfunction. [4] It is a safe [5] and effective method of treating pain compared to opioid and nonopioid analgesic medication. [6] There are several researchers were recommended the TENS for its therapeutic use of pain reduction in post operative pain. [7-9]

Alka Chandra et al suggested TENS can be used adjunct with epidural analgesia for acute post operative pain in patients of posterolateral thoracotomies. [10] Another research concluded that transcutaneous electrical nerve stimulation (TENS) along with post-operative medications to be safe and effective in alleviating post-operative pain and in improving patient recovery. [11]

TENS induced pain relief may also improve the respiratory functions and functional mobility of the patients after abdominal or cardiothoracic surgeries. [12-14] A prospective randomized control study on effectiveness of TENS in post thoracotomy subjects concluded that improvement in spirometric respiratory function and arterial blood gases. [15] These extra effects may play a major role in reducing the duration of hospital stay of post surgical patients. [16]

There are various types of TENS which used to treat pain and related neuromusculoskeletal dysfunction. Different studies were also concluded that all types of TENS application was effective in pain management. Hamza et al states that use of TENS at mixed (2-100Hz) frequencies of stimulation produced a slightly greater

opioid sparing effect than either low (2Hz) or high (100Hz) frequencies alone. [17] However, a review study was concluded that Seven of the nine active controlled studies found no difference in analgesic efficacy between High Frequency (HF) TENS and Low Frequency (LF) TENS. [18]

Past few decades' conventional low and high frequency TENS along with other pharmacological and physical therapy intervention were used to treat post surgical pain. The stimulation parameters were fixed specifically in the low and high frequency TENS. If both low and high frequency parameters were combined together by making modulation of frequency from low to high the effects may be maximized.

Application of modulated frequency TENS, [19] intensity as high as the subject could tolerate, and electrodes placed on either side and parallel to the incision may produce combined effects of low and high frequency TENS. So, this prospective randomized control study was conducted to know the effectiveness of modulated frequency TENS on reducing post surgical abdominal pain.

## **MATERIALS AND METHODS**

Forty five patients, who underwent abdominal surgery on the first postoperative day, were selected from the population group satisfying the inclusion criteria from the patients of the department of Surgery of K.S Hegde Charitable hospital, Mangalore, India. Inclusion criteria were patients with upper abdominal surgery, Patients age 25 – 50 Years at the time of the study, Patients with post abdominal incision pain, Pain score  $\geq 3$  measured by the visual analogic scale (VAS) on the first postoperative day, both gender, Patient willingness to participate and the patients which were excluded were Cardio respiratory diseases, Patients aged above 50 Years, Hemoptysis, Abnormal skin sensation, Psychiatric illness.

Patients were randomly allocated in three groups according to the computer-generated randomization schedule prepared before commencement of the study. First and second group were considered to be interventional group and third group was control group.

**Informed consent:**

45 subjects with post abdominal surgery were explained briefly about the treatment procedure and possible benefits of intervention before signing written informed consent.

**Pre intervention assessment:**

Post abdominal surgery incision pain was assessed on day one before treatment using visual analog scale. Visual Analog Scale is an 11 point numerical qualitative outcome measure with high inter and intra rater reliability. The visual analog scale, graded from zero to 10, in which zero means no pain, and 10 awfully severe pain was used for the objective evaluation of pain.

**Intervention selection:**

15 patients in the first group were treated with combination of modulated or mixed frequency (4Hz-150Hz) TENS, injectable Tramadol drug 50 mg i.v 8 hourly in a day and physical therapy for 5 consecutive days.

[19] Subjects (15 Patients) in the second group were treated with the combination of low frequency (4 Hz) TENS, injectable Tramadol drug 50 mg i.v 8 hourly in a day and physical therapy for 5 days. [17,20]

Another 15 subjects in third group were treated with the combination of usual hospital care, injectable Tramadol drug 50 mg i.v. 8 hourly in a day and physical therapy for 5 consecutive days without having intervention of TENS

**Intervention procedure:**

TENS was given using Gem Stim combo apparatus; model GM320TE which is a battery operated TENS. To apply TENS, the type of incision was not taken into consideration. Two sterile electrodes

(first unit channel) were placed on one side of the incision and the other two electrodes (second unit channel), on the other side of incision. The electrodes were positioned 1 cm away from the suture line. The intensity was adjusted individually based on patient tolerance between 10–30 mA generating a perceptible tingling sensation without significant muscle contraction. Treatment was given for 20 minutes through 4 electrodes placed around the surgical incision twice after 4 and 8 hours after surgery.

After the treatment with TENS in first and second group the patient's incision site was protected by wound splints. Physical therapy treatment like deep breathing exercises, mobility training exercises were carried out with supervision. All subjects in the three groups were received 50 mg of Tramadol every 8 hours to control pain after surgery. This treatment procedure was carried out for five consecutive post operative days. The post intervention Pain intensity was assessed using visual analog scale at end each day treatment for five days.

**ANALYSIS AND RESULTS**

*Statistical methods:*

Categorical data was described in frequency and percentiles and qualitative and quantitative data was described in form of mean and standard deviation. A repeated measure of ANOVA was used for within and between groups comparison among different groups and Bonferoni test was selected for multiple comparisons among three groups.

**RESULTS**

There are 11 male and 4 female with mean age of 34.66 were treated with modulated TENS, again 11 male and 4 female with mean age of 33.66 were received low TENS, and 12 male and 3

female with the mean age of 34.66 were received conventional physiotherapy treatment other than modulated and low TENS.(Table 1). Pre and post intervention pain score among individual groups had shown that there is significant difference in the mean scores. However, the 5<sup>th</sup> post operative day post intervention pain score in modulated frequency (1.00) and low frequency group (1.00) was far better than pain score in the control group (2.86). Initial two post operative day pain score in modulated frequency and low frequency TENS showed similar pain reduction, but later days the subjects received modulated TENS mean score shown further reduction compared to the low frequency TENS. (Table 2)

**Table 1: Characteristics of the patients with abdominal incision pain**

Group	Variables	Mean ± S.D. N (%)	
Modulated TENS	Age	34.6667 ± 5.52484	
	Gender	Male	11 (73.33%)
		Female	04 (26.67%)
Low TENS	Age	33.6667 ± 5.72796	
	Gender	Male	11 (73.33%)
		Female	04 (26.67%)
Control group	Age	34.6667 ± 5.52484	
	Gender	Male	12 (80%)
		Female	03 (20%)

The post hoc analysis for multiple comparisons between the groups showed that modulated and low TENS effectively reduced pain compared to the conventional treatment. Mean difference of pain score (0.367) between modulated and low TENS had shown that there is no statistically significant difference in the treatment. Mean difference (0.7667) between low TENS and

conventional treatment had shown there is a significant difference in the reduction. Instead, there was very high significant difference (1.133) between the modulated frequency and conventional treatment in the management of post operative pain. When compared the Modulated TENS with Low TENS the values shows it's not significant P= 0.370, states that both the groups equally effective in reducing pain. But when control group is compared with modulated TENS and low TENS it signifies that the results obtained is significant P=0.00, which suggests that when compared to control group both the experimental group is significant.(Table 3)

**Table 2: Descriptive statistics of pre and post intervention pain score among three groups**

Descriptive Statistics				
	Groups	Mean	Std. Deviation	N
POD1B	Modulated TENS	7.6667	.61721	15
	Low TENS	7.4667	.63994	15
	Control group	7.4000	.50709	15
	Total	7.5111	.58861	45
POD1	Modulated TENS	5.6000	.82808	15
	Low TENS	5.8667	.99043	15
	Control group	6.2000	.67612	15
	Total	5.8889	.85870	45
POD2	Modulated TENS	4.1333	.74322	15
	Low TENS	4.4667	1.12546	15
	Control group	5.3333	.81650	15
	Total	4.6444	1.02593	45
POD3	Modulated TENS	2.8000	.77460	15
	Low TENS	3.3333	.97590	15
	Control group	4.4667	.74322	15
	Total	3.5333	1.07872	45
POD4	Modulated TENS	1.8000	.77460	15
	Low TENS	2.4667	.99043	15
	Control group	3.5333	.83381	15
	Total	2.6000	1.11600	45
POD5	Modulated TENS	1.0000	.65465	15
	Low TENS	1.6000	.63246	15
	Control group	2.8667	.74322	15
	Total	1.8222	1.02888	45

**Table 3: Intergroup comparison of visual analog scale score among subjects in three groups using post hoc analysis**

(I) Groups	J(Groups)	Mean Difference (I-J)	Std. Error	95% Confidence Interval		Sig.
				Lower Bound	Upper Bound	
Modulated TENS	Low TENS	.3667	.23322	-.9482	.2149	.370
Low TENS	Control Group	.7667*	.23322	-1.3482	-.1851	.006
Modulated TENS	Control Group	1.1333*	.23322	.5518	1.7149	.000

## DISCUSSION

The post operative pain over incision site and difficulty in performing activities due to pain are relatively common among patient undergone abdominal surgeries. Pharmacological and conventional physical therapy interventions were commonly used to treat the post abdominal surgical pain. Transcutaneous electrical nerve stimulation with low or high frequency without any modulation was usually selected for pain reduction in post surgical patients. There are several research studies were done to document the effects of low frequency TENS and the study results also shown positive effects of low TENS. The modulated frequency TENS has the properties to produce the non-painful regulated sensory-motor stimulation which may make a patient comfortable in receiving electrical mode of intervention.

This present study results have shown the further evidence for the therapeutic effectiveness of low Frequency TENS in reducing pain. This also correlates with the study results of which were also suggested low frequency TENS is an effective therapeutic modality in post operative incisional pain. The strong evidence of modulated TENS for pain reduction in post surgical pain suggesting that even modulated frequency TENS is an effective alternative treatment method. The results of multiple comparison of this study evidencing that modulated frequency is a better therapeutic tool like low frequency TENS. Moreover, these results also strongly correlate with previous study results of Rakel B, et al. who has done study on modulated TENS in the management of post abdominal surgical pain. <sup>[19]</sup>

## CONCLUSION

The inferential statistical results of post intervention pain scores among three groups indicates both the TENS groups

(Modulated TENS & Low TENS) were more effective in reducing pain much faster as compared to the control group. The final outcome of this study revealed that there was a relief in pain in all the 3 groups but frequency modulated TENS showed a faster pain relief over a short span of time as compared to the other two groups.

### *Further scope:*

Further study can be conducted using Modulated frequency mode of TENS for muscle reeducation immediate after joint replacement surgeries as the modality has no side effects and has a huge property in reducing pain and improving sensory-motor control.

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