Effectiveness of Frequency Modulated Transcutaneous Electrical Nerve Stimulation (TENS) on Post Incision Pain Following Abdominal Surgery: A Prospective, Randomized, Placebo Controlled Study

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ABSTRACT

To evaluate the effectiveness of modulated frequency transcutaneous electrical nerve stimulation (TENS) on relieving pain after abdominal surgery. The study population was comprised of 60 subjects aged between 25 to 50 years. To evaluate the effectiveness of modulated frequency VAS was measured five times and compared between the experimental and control group. There was a difference in median pain score over a period of time (P < 0.001) between the groups expect at base line (P = 0.854). This study revealed that there was a relief in pain between the subjects over a short span of time. Hence the TENS after abdominal surgery is beneficial for the subjects with abdominal surgery incision. Since, the treatment has no observable side effects, and the pain-reducing effect persisted for 5 days, it is advisable for the subjects.

Surgical procedures cause, inevitably, tissue damage, may it be by direct visceral manipulation, through the incision itself, and by the use of surgical retractors that help expose the surgical field. Pain after surgery causes discomfort to the patient, preventing the patient from relaxing, leading to shallow breathing, and hindering the patient's movements in bed.

Pain is an important negative influence in the postoperative evolution of abdominal surgeries, especially those in the upper abdomen, even using analgesic drugs. Transcutaneous electrical stimulation can be used in the postoperative hospital routine as adjuvant to conventional analgesia.

Introduction

Pain has been described as "an unpleasant experience which we associate with tissue damage or express in terms of tissue damage, or both." The International Association for the Study of Pain described pain as “An unpleasant sensory & emotional experience associated with actual or potential tissue damage, or described in terms of such damage”. Transcutaneous Electrical Nerve Stimulation (T.E.N.S.) is a seemingly simple piece of therapeutic apparatus that is increasingly being used in the control and management of pain.  

Pain can be modified by cognitive manipulation, change of mood, or by various physical means, such as opiates, analgesics or other agents which act on the peripheral or central nervous systems. T.E.N.S. is a noninvasive technique of electrical stimulation of the peripheral nervous system. It has recently emerged as a distinct therapeutic modality in the control of both acute and chronic pain.

Transcutaneous electrical stimulation stimulates nerve fibers that send signals to the brain, which the thalamus interprets as pain. The impulses transmitted transcutaneously stimulate myelinated A fibers, which transmit proprioceptive ascendant information. These fibers are sensitive to interrupted biphasic and monophasic waves, such as those delivered by TENS. The effects of TENS follow the "Gate Theory" postulated by Melzack et al., in 1965, in which the superstimulation of type A fibers block the entrance of stimuli conducted by type C fibers in the gates of the gelatinous substance, the posterior horn of the spinal cord, and the transmission cells.

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more effective physical therapy maneuvers in the postoperative period.

Methods:
The study was approved by Ethical committee of Nitte University, Mangalore and signed informed consent was obtained by all the patients. Sixty patients, who underwent abdominal surgery on the first postoperative day, and presented a pain score ≥ 3 on the visual analog scale (VAS), were randomly assigned to any of the 2 groups. The randomization occurred in the order, in which the patients were enrolled in the study according to the computer-generated randomization schedule prepared before commencement of the study. Before the treatment patients were explained well about TENS and the procedure. All the patients were advised that TENS treatment did not preclude the administration of analgesics. After the operation both the two groups of patients were given a standard medication using intravenous patient controlled analgesia (PCA), i.e. Tramadol.

Subjects 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 aged 25 – 50 Years at the time of the study. Patients with post abdominal incisional pain. Pain score ≥ 3 measured by the visual analog scale (VAS) on the first postoperative day. Both sex. Patient willingness to participate and the patients which were excluded were Cardio respiratory diseases, Patients aged above 50 Years, Hemoptyosis, Abnormal skin sensation, Psychiatric illness.

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. All subjects received 50 mg of Tramadol every 8 hours to control pain after surgery. Pain was assessed before the treatment i.e. before application of TENS on the first post operative day and after application of TENS 24, 48, 72, 96 and 120 post operative hours (POH) through a visual analogue scale (VAS).

Experimental Group: Modulated TENS
In this group 30 patients were given modulated TENS (4Hz-150Hz, Pulse width of 120 µsec). Injectable Tramadol drug 50 mg IV, 8 hourly was given for 5 days for the management of post abdominal incisional pain.

Control Group: Control group
In this group 30 patients were given injectable Tramadol drug 50 mg IV, 8 hourly for 5 days without having intervention of TENS.

Results:
Statistical analysis was performed using IBM SPSS 21 and Medcalc 12 software’s. All recorded data were taken for analysis including those of patients who were discharged.

The study population comprised of 60 subjects aged between 25 to 50 years. To evaluate the effectiveness of modulated frequency, pain score was measured five times and compared between the experimental and control group.

Table 1

<table>
<thead>
<tr>
<th>Postoperative period</th>
<th>Group 1. Frequency Modulated TENS Group 2. Control TENS Group (n=10)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>POD 1 (Before TENS)</td>
<td>Mean±SD</td>
<td>Mean±SD</td>
</tr>
<tr>
<td>POD 2 (After TENS)</td>
<td>7.8±0.42</td>
<td>7.3±0.48</td>
</tr>
<tr>
<td>POD 3 (After TENS)</td>
<td>4.9±0.87</td>
<td>6.6±0.51</td>
</tr>
<tr>
<td>POD 4 (After TENS)</td>
<td>4.1±0.87</td>
<td>5.6±0.51</td>
</tr>
<tr>
<td>POD 5 (After TENS)</td>
<td>2.2±0.63</td>
<td>3.4±0.51</td>
</tr>
</tbody>
</table>

The mean pain intensity did not differ between the groups on POD1, before he application of TENS, 7.2±0.42 for the active TENS group versus 7.3±0.48 for the control group. Following the assigned treatment, the mean score on the VAS in the active TENS group decreased significantly after TENS application compared to control group on POD1 (p<0.0001), POD2 (p<0.0002), POD3 (p<0.0002), POD4 (p<0.0001) and POD5 (p<0.0001).

There was a difference in median pain score over a period of time (P < 0.001) between the groups expect at base line (P = 0.878).

Table 2. Mean pain scores for frequency modulated TENS and control group

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In the above graph when comparing the experimental and control group the differences before treatment of TENS on the 1st post operative day is compared to the 5th post operative day, there was a pain reduction on all the 5 post operative days as compared to the control group.

Discussion: Studies investigating frequency-modulated TENS are few. Ekstrom et al. investigated the effect of peripheral nerve stimulation using frequencies modulating at 85 610 pps or 85620 pps for 2-, 6-, or 15-second time periods. All modulated frequencies produced reductions in the C-fiber–evoked flexion reflex response. However, controlled studies on healthy participants exposed to experimentally induced pain failed to detect differences in hypalgesia between different settings of frequency-modulated interferential therapy and compared with constant-frequency interferential therapy. Desantana et al. reported that TENS alternating between 4 pps for 1 day and 100 pps for 1 day delayed opioid tolerance to repeated TENS application in rats when compared with 4 pps or 100 pps ad-ministered independently. Recently, a new TENS-like device has appeared with sequentially modulated frequency (1 to 39 Hz) and width (10 to 40 ms). This frequency of rhythmic electrical modulation system has been shown to generate changes in the H-reflex amplitude over and above that seen with constant frequencies. The putative differential effects of constant, modulating, and alternating frequencies have been attributed to different mechanisms in the spinal cord. Wang et al. reported that electro acupuncture that alternated between 2 pps and 100 pps, each lasting for 3 seconds, generated greater antinociceptive responses in rats than 2 pps and 100 pps applied simultaneously to the right and left hind legs, respectively.

There is some evidence that alternating (switching) frequency between preset upper and lower frequency limits affects nervous system response. Hamza et al. reported that TENS alternating between 2 pps and 100 pps in a 3-second period produced greater postoperative morphine-sparing effects than either 2 pps or 100 pps frequencies alone. They used 100 women undergoing major gynecological procedures in 4 groups who were given free-access to patient-controlled analgesia (PCA) delivering 2 to 3 mg intravenous boluses of morphine with a lockout interval of 10 minutes.

The aim of this study was to investigate the effect of frequency modulated TENS on post incision pain following abdominal surgery. To this the effect of 4Hz -150Hz were investigated over a period of 5 days. Active frequency modulated TENS significantly reduced pain intensity when compared to the control group. To our knowledge, this is the first study to show the effectiveness of frequency modulated TENS in reducing pain on post incision pain following abdominal surgery.

Conclusions: This study revealed that there was a relief in pain between the subjects over a short span of time. Hence, TENS is beneficial for the subjects with abdominal surgery incision. Since, the treatment has no observable side effects, and the pain-reducing effect persisted for 5 days, it is advisable for the subjects.

References: