ORIGINAL RESEARCH

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EFFECT OF TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION ON POST - OPERATIVE PAIN FOLLOWING A CARDIAC SURGERY- A PILOT STUDY

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ABSTRACT

Background: Pain has been pointed out as one of the chief concerns of patients following a cardiac surgery. Adjunctive methods of postoperative pain control that may limit narcotic side effects are of considerable interest. The study aimed to evaluate the effectiveness of Transcutaneous electrical nerve stimulation (TENS) for treatment of post-operative pain in patients who underwent cardiac surgery using a median sternotomy. In addition, we sought to compare effectiveness of TENS and SHAM (placebo) TENS on

1. Pain at rest
2. Duration Of analgesia following the intervention.

Methods: Twenty patients (8 females and 12 males) each during the 24-96hr post-operative period were a part of the study. They were randomly allocated to two groups: TENS & pharmacological analgesia (n = 10) and SHAM & pharmacological analgesia (n = 10). The Visual Analogue Scale (0-10) was used to assess the post-operative peri- incisional pain.

Results: It was seen that both TENS and SHAM TENS (P value is 0.0917) were almost equally effective in reducing peri- incisional pain following a cardiac surgery through a median sternotomy. However, the duration of analgesia following treatment with TENS was significantly greater than that with SHAM TENS.

Conclusion: Therefore both TENS and SHAM TENS can be used as a valuable strategy to alleviate post-operative suture site pain following a cardiac surgery, both clinically and statistically, but the duration of analgesia following TENS is significantly greater than that following SHAM TENS.

Key words: Transcutaneous Electrical Nerve Stimulation, TENS, Pain

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INTRODUCTION

Postoperative pain following a cardiac surgery has many aspects. It can be caused by incisions, multiple intravascular cannulations, chest tubes left after surgery, and multiple invasive procedures that patients undergo as part of their therapeutic regimen[1]. Pain has been pointed out as one of the chief concerns of patients following a cardiac surgery.[1] Pain is known to restrict effective coughing, deep breathing and early post operative mobilization.[2] As a result lung ventilation and independence in self care may not be optimal.[3]

Although narcotics and opiates may be valuable for pain control, [3] they are associated with side effects, which include respiratory depression, sedation, nausea and vomiting. Therefore, adjunctive methods of postoperative pain control that may limit narcotic side effects are of considerable interest.[4]

Transcutaneous electrical nerve stimulation (TENS) currently is one of the most commonly used forms of electro-analgesia in a number of medical and surgical conditions. [2-5] TENS has also been shown to be effective in the post-operative period of cardiac and non-cardiac thoracic surgery.[3,4] It is a form of electrical stimulation with surface electrodes which are used to modulate pain perception. A TENS unit consists of one or more electrical-signal generators, a battery and a set of electrodes. The TENS unit is small and programmable, and the generators can deliver trains of stimuli with variable current strengths, pulse rates, and pulse widths.[4]

A recent Review, Transcutaneous electrical nerve stimulation for acute pain by Walsh DM concluded that the effectiveness of TENS as a sole treatment for acute pain are impossible to make due to the limited data available and suggested that more placebo controlled trials are needed.[6] This provided the focus of the present research. The study was undertaken to evaluate if TENS would present with positive effects on post operative pain in comparison with SHAM TENS.

Thus the aim of this study was to assess the analgesic effectiveness of TENS for acute pain in adults following cardiac surgery. The objectives being; To assess the analgesic effectiveness of TENS using the Visual Analogue scale (VAS) for acute pain in adults following a cardiac surgery and to assess the duration of analgesia (in hours) following TENS for acute pain in adults following a cardiac surgery.

METHODOLOGY

The study design was a prospective experimental type. It was a Randomized Control Trial conducted in the Cardiac Surgery ward of a tertiary health care hospital. A total of 20 patients were included in this pilot study and were randomized into two groups using a randomized computer generated number list. Consent was taken from the subjects who were willing to participate in the study.

- Inclusion criteria:
  1. Subjects with peri- incisional pain ≥ 3 on the Visual Analogue Scale (VAS) on the second day post cardiac surgery using a median sternotomy. (Minimal Clinical Important Difference for VAS is = 1.7-2)
- Exclusion Criteria:
  1. Subjects having medical implants such as pacemakers.
  2. Subjects with impaired sensations, broken or damaged skin, infection at the suture site.
  3. Subjects who were apprehensive and un co-operative.

Twenty eight subjects (11 females and 17 males) each during the 24-96hour post operative period from the Cardiac surgery ward of a tertiary health care hospital were screened for the study of which twenty subjects (8 females and 12 males) who satisfied the inclusion criteria were included. All subjects underwent cardiac surgery through a median sternotomy. The surgeries included coronary artery bypass grafting (CABG) -55%, valve replacement-35% and others-10%. They had no other abnormalities or conditions that required any other surgery at the time of cardiac surgery. The analgesics the patients were on varied from patient to patient. They included T. Diclofenac (9 subjects) or T.Tramadol (11 subjects).The onset of analgesia with T.Tramadol occurs within 1 hour; peak effects occur within 2–4 hours. The mean terminal plasma elimination half-life is approximately 4–6 hours.[7]

This was a randomized one time study. The subjects were randomly subdivided into 2 groups:

Group A- TENS & pharmacological analgesia [10 subjects]

Group B- SHAM TENS & pharmacological analgesia [10 subjects]

The subjects of both groups were first familiarized with the TENS equipment and the Visual Analogue Scale. They were asked to quantify their median sternotomy pain on a 10cm line (drawn to scale) with two end points. 0- No pain at all and 10- Maximal tolerable pain.[4] The VAS was noted prior

to treatment. The reliability of the VAS has been proven to be high for the assessment of acute pain.[8]

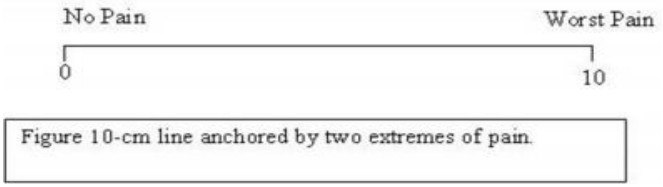


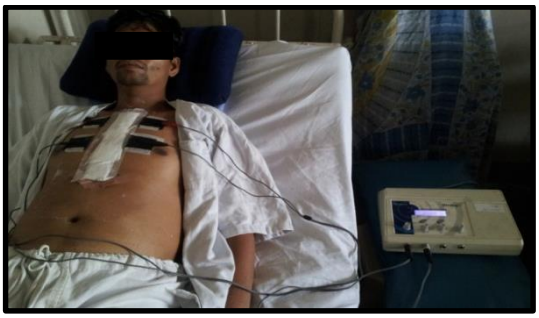
Fig 1: Visual Analogue Scale

A portable TENS unit (STRIKER) was used which provided biphasic waveform. CONVENTIONAL TENS was used (120 pulse duration).[3, 4, 9] Two sterile electrodes (first unit channel) were placed on one side of the incision and two other electrodes (second unit channel) on the other side. The electrodes were positioned 2cm away from the suture line. Electrode gel was used to reduce the impedance and the electrodes were fixed to the patient's skin using adhesive tape. The intervention was undertaken 5hrs after the intake of the analgesic, so as to avoid the peak dose effect of the analgesics (half life period = 4hrs).

Group A- Subjects were treated with high frequency stimulation (CONVENTIONAL TENS- 120pulse duration) until a strong but comfortable tingling sensation[4] was felt for 30 minutes

Group B- Subjects were treated using the same equipment except that the intensity was kept on zero (30 minutes). They were told that the electrical stimulation was silent producing no sensation and those they could confirm that the machine was on by looking at the light flashing on the machine.

Fig 2: TENS unit and electrode Placement



The patients were continuously supervised and were asked for any discomfort at timely intervals. In both groups after 30 minutes of treatment the subjects were again asked to quantify their pain using the Visual Analogue scale. They were then asked to make a note of the time for which the pain remained the same on the VAS (duration of analgesia).

OBSERVATION AND RESULTS

Table 1: Baseline characteristics of Group A and B

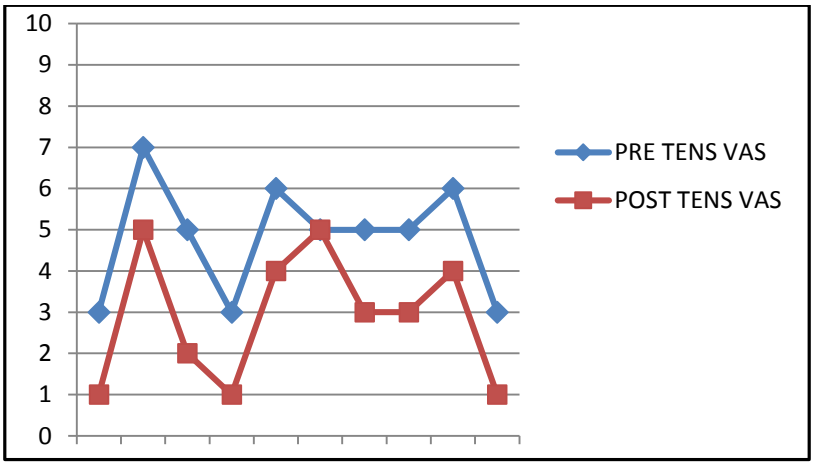
GROUP A- TENS				GROUP B- SHAM TENS			
MEAN AGE	SEX DISTRI-BUTION	SURGERY	MED	MEAN AGE	SEX DISTRI-BUTION	SURGERY	MED
51.2	M- 6 F- 4	CABG-6 VAL-3 OTHERS- 1	TRA- 6 DIC- 4	49.4	M- 6 F- 4	CABG- 5 VAL- 4 OTHERS- 1	TRA- 5 DIC- 5

M- Male; F-Female CABG- Coronary artery bypass grafting; VAL - Valvular surgeries; OTHERS- ICR, Aortic aneurysm repair TRA- Tramadol; DIC- Diclofenac

RESULTS

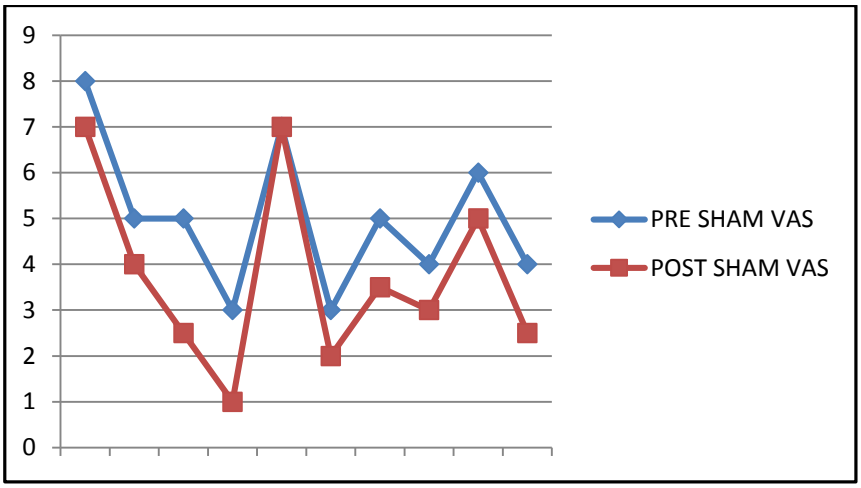
Graph Pad Instat software was used for analysis. Baseline mean of characteristics of the two groups matched; hence Parametric tests were used for analysis.

GRAPH 1: GROUP A- PRE AND POST TENS VAS COMPARISON



GROUP A- Statistically, the two tailed P value is 0.0004, considered extremely significant. (Paired T test) suggesting TENS caused a statistically significant decrease in pain.

GRAPH 2: GROUP B- PRE AND POST SHAM TENS COMPARISON



GROUP B - Statistically, the two tailed P value is 0.0002, considered extremely significant. (Paired T test) suggesting SHAM TENS caused a statistically significant decrease in pain.

Table 2: Comparison of Mean of VAS and duration of Analgesia between Group A and B

	GROUP A- Difference PRE and POST TENS VAS	Duration of Analgesia (hrs)	GROUP B- Difference PRE and POST SHAM TENS VAS	Duration of Analgesia (hrs)
MEAN	1.9	2.05	1.25	0.7

- For mean VAS difference between Group A and B, statistically, the two tailed P value is 0.0917, considered not quite significant implying both TENS and SHAM TENS were equally effective.
- For mean analgesic duration difference between Group A and B, statistically, the two tailed P value is 0.0004 considered significant implying the duration of analgesia following TENS was greater compared to SHAM TENS.

DISCUSSION

Pain is usually considered a pathological state in itself by patients, who are often happy to have its level reduced, even when the underlying pathology is unaffected. For pain to be perceived, there is usually a chain whereby peripheral receptors are stimulated by a noxious physical or chemical agent and this stimulus is carried by peripheral nerves to the spinal cord, up the spinal cord, through the brainstem so to the cerebral cortex where pain is appreciated at a conscious

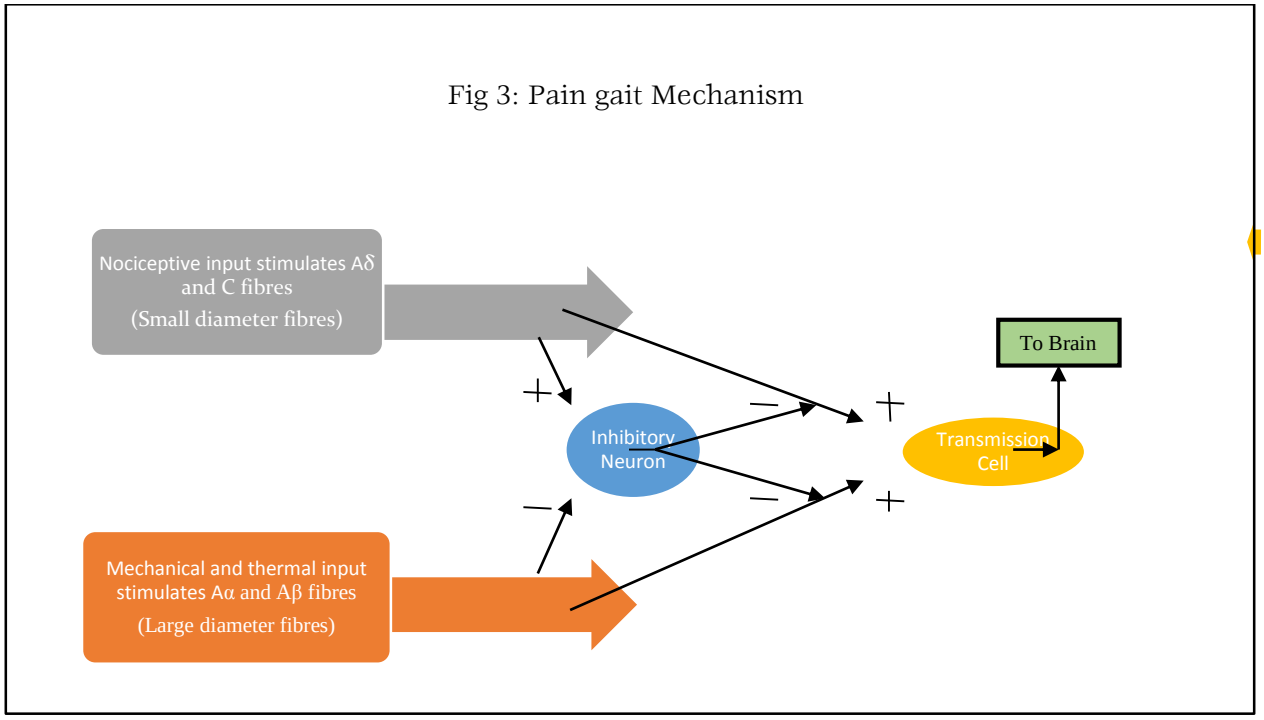
level. Nociceptive stimulus is carried to the cord along either a slow-conducting, non-myelinated C fibre or along a faster myelinated Aδ fibre.[9,10]

A reduction in the peri-incisional pain was seen in both groups TENS and SHAM TENS with no statistical difference between the two groups. Transcutaneous Electrical Nerve Stimulation is a form of electrical stimulation with surface electrodes which is used to modulate pain perception. The mechanisms proposed by which TENS produces pain relief include the following.[4]

- Pain gate mechanism postulated by Melzach & Wall in 1965
- Endogenous pain control (via endorphins, enkephalins)

Pain Gate Mechanism:- It proposes that for pain to pass through the gate, there must be an unopposed passage of nociceptive information (predominantly small diameter fibre) arriving at the synapses in the substantia gelatinosa. However if the gate is also concurrently receiving impulses produced by stimulation of thermo receptors or mechanoreceptors (transmitted via large diameter myelinated fibres), then this traffic predominates and causes pre- synaptic inhibition of the small diameter pain carrying fibres, thus causing pain relief.[11,13]

Fig 3: Pain gait Mechanism



Endogenous pain control:- Nociceptive information goes up the gate via the Lateral Spinothalamic tract. In the brain stem there is an interaction between the periaqueductal area grey matter and raphe nucleus which form a part of the descending pain suppression pathway. It blocks the release of substance P which causes pain relief.[11,12]

Conventional TENS has a high stimulation frequency (40-150 Hz) and low intensity, just above threshold. The pulse duration is short (up to 50 microseconds). The onset of analgesia with this setup is virtually immediate. Pain relief lasts while the stimulus is turned on, but it usually abates when the stimulation stops.[10]

The reduction in pain following SHAM TENS can be attributed to the proposed mechanism:

- Affective and emotional aspects of pain perception- Placebo effect[4,11]

However the duration of analgesia following treatment with TENS was significantly greater than that with SHAM TENS. In addition to the placebo effect, the mechanisms mentioned above are those by which TENS brings about pain relief resulting in the longer duration of analgesia.

However, one limitation of the study was that the sample size was very small.There was the lack of standardization of the use of analgesics during the intervention and control groups. The peak effect of the analgesics the subjects were administered varied which could be one of the reasons for differences in the duration of analgesia between the two groups. A study done by Capriano et al in 2008 inferred that TENS may be useful in reducing the need of opiates for pain control.[3]

The duration of analgesia following TENS was 2.05 hrs. The need for analgesics in those patients was reduced.

CONCLUSION

From this particular study it can be concluded that,

- Both TENS and SHAM TENS are almost equally effective in reducing suture site pain following a cardiac surgery, both clinically and statistically.
- However the duration of analgesia following TENS is significantly greater than that following SHAM TENS.

CLINICAL APPLICATION

Our Pilot study provides one more facet to the available evidence for use of TENS for relief of acute post- operative pain. The analgesia produced following TENS can help reduce the need for analgesics and the side effects associated with the same.

Further studies using a larger sample size, longer duration and different types of TENS can be done to assess the effectiveness more accurately and add to the current evidence.

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