

## *Evaluation of Analgesic Efficacy of Transcutaneous Electrical Nerve Stimulation in Acute and Chronic Pain: A Prospective Audit*

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### **Abstract**

**Introduction:** Transcutaneous Electrical Nerve Stimulation (TENS) has been shown to be successful in treating acute as well as chronic pain. But, it has been greatly underused especially for acute pain. Current prospective audit was conducted to evaluate the efficacy of TENS in acute and chronic pain conditions and to evaluate its efficacy on various components of pain.

**Method:** Fifty patients suffering from acute and chronic pain were included in the audit. All the parameters of TENS were set and intensity kept at minimum, which was then increased gradually to maximum tolerability. Intermittent therapy was given for all but postsurgical pain, for which continuous therapy was used.

**Result:** Pain relief was better after the treatment in both the groups ( $p < 0.001$ ), but was found to be even better in acute pain group ( $p < 0.001$ ). Improvement in limitation of movements, mood and capacity to work was found to be better in chronic pain patients, whereas greater reduction in the need for other analgesics was observed in patients with acute pain. The best results in both groups were obtained at TENS frequency of 100 Hz and pulse rate of 10 waves/seconds. The effect of TENS on sympathetic system was not very impressive.

**Conclusion:** TENS resulted in best pain relief with frequency of 100Hz and pulse rate of 10 waves/sec. TENS resulted in better pain relief, reduction in duration of pain, and requirement of other conventional analgesics in acute compared to chronic pain patients hence it should be utilized for acute pain conditions more often.

**Keywords:** Analgesic effect; Transcutaneous Electrical Nerve Stimulation; Acute and chronic pain groups; Prospective Audit

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### **Introduction**

Pain has been one of the greatest suffering of human being affecting day to day life. Several methods have been used, but no single form of treatment, either surgical or non-surgical, has been found to be universally effective in all types of pain. Opioids are associated with several unwanted side effects like respiratory depression, histamine release, nausea, vomiting, reduced gut mobility, Central Nervous System (CNS) depression, tolerance and physical dependence. Nerve blocks are effective, but they are invasive, expensive and painful requiring special expertise, and equipments like nerve

stimulator and ultrasound and it may be associated with nerve damage and local anesthetic toxicity.

Interest in Transcutaneous Electrical Nerve Stimulation (TENS) started after discovery of “Gate control theory of pain” by Melzack and Wall in 1965 [1]. TENS is a well known analgesic modality. Its advantages include simplicity, ease of use, minimal side effects and proven safety [2]. Occasional side effects seen with TENS are allergic dermatitis and mild erythema at the site of application. Use of sufficient gel prevents these complications.

Satisfactory relief of chronic pain remains a major ongoing problem for pain physicians. TENS has been mostly tried as a last resort after failure of conventional analgesics. It is used for neuropathic pain, chronic low back pain [3], osteoarthritis of knee [4], myofascial pain, trigeminal neuralgia [2], sciatica [5], post-herpetic neuralgia [6] and angina pectoris [7]. As more and more information is available about TENS now, it can even be used as a first line therapy in majority of painful conditions [2]. TENS is effective in acute pain also, but it is very much underused. It has been shown to be successful in treating postoperative pain in abdominal surgeries like laparoscopic cholecystectomy [8], thoracic surgery [9] and micro laryngeal surgery [10]. Postoperatively, it significantly reduces the requirement of conventional analgesics [11]. This prospective audit was conducted to evaluate the efficacy of TENS on acute and chronic pain conditions, sympathetic nervous system activity and to compare the effect of TENS on various components of pain in both the groups.

## Method

After obtaining institutional ethical committee clearance and patient's consent, fifty patients between 15-75 years of age and having pain were included in this prospective audit. Equal numbers of patients having acute and chronic pain were included. Patient having cardiac pacemaker, pregnancy, acute infection, recent thrombosis, hemorrhage in the application site and those requiring application of electrode near carotid sinus were excluded from the audit. Patients were evaluated regarding type, nature, severity, duration of pain and

treatment taken for it before applying TENS. The data were recorded according to our pain score (Table1). Patients were explained in detail about the procedure, pain scoring system used in our audit.

Patients were positioned ensuring maximum comfort and proper exposure of the part of application. The chosen site for TENS application was cleaned to reduce impedance. After marking the electrode placement points “Active Probe” was placed over the area having maximum pain. The “Base Probe” was applied within 10 cm of “Active Probe”. Base line vital parameters like Pulse Rate (PR), Blood Pressure (BP) and Respiratory Rate (RR) were noted. All the parameters of TENS (according to the site, severity and type of pain) were set and intensity kept at minimum (zero). After switching the equipment on, initially the body resistance was measured. Then gradually the intensity was increased till the patient felt maximum yet comfortable stimulation. Intermittent therapy was given for 20-30 minutes over a period of 7-10 days in three sittings. First sitting included 1-3 days of therapy, second sitting 4-6 days and third sitting 7-9 days of therapy. This particular regimen was used for all but postoperative pain. Continuous therapy was used for postoperative pain in cholecystectomy patients. In the postoperative period electrodes were placed about one inch away from skin incision. Therapy was continued for 72 hours. Patients were taught about increasing or decreasing the intensity according to the degree of pain. Patients were allowed to ask for rescue analgesia in case pain relief was not adequate even after adjusting the intensity of TENS to its maximum intensity. Pain scoring was done according to a predesigned pain scoring system (Table-1). Vital parameters were checked again at the end of the therapy. Parameters like patient's resistance, pulse, basic frequency and intensity were noted for all the three sittings.

All the continuous variables are described using mean and standard deviation. Firstly, the difference of pre-post therapy outcome measures was compared between the acute and chronic group patients using unpaired t-test. Also, over all pain relief and result were compared between groups using unpaired t-test and Mann Whitney and U test respectively. To assess the

effect of TENS on various continuous outcome measures, the paired t-test was used separately for each group of patients whereas for comparison of ordinal outcome measures over different visits Friedman test followed by multiple comparisons were used separately for each group. The difference of pre-post therapy outcome measures was also compared for different

TENS pulses and frequencies using one way Analysis of Variance (ANOVA). Further, over all pain relief and result was compared among different TENS pulses and frequencies using ANOVA and Kruskal Wallis test respectively. All statistical analysis was done using STATA 9. The p-values less than 0.05 were regarded as statistically significant.

**Table 1:** Methods used for assessment of various parameters during the study

| <b>Pain Scoring System</b>       |                                                                                                                                                                     |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Parameters</b>                | <b>Grading</b>                                                                                                                                                      |
| Intensity of pain                | 0-None, 1-Mild, 2-Moderate, 3-Severe                                                                                                                                |
| Duration of pain                 | 0-None, 1-Sometimes, 2-Most of the day, 3-Day & night                                                                                                               |
| Limitation of movement           | 0-Free, 1-Free but painful, 2-Limited, 3-Almost impossible                                                                                                          |
| Need for medications             | 0-None or rarely non-opioid analgesics, 1-Occasional non-opioid analgesics, 2-Regular non-opioid analgesics, 3-Opioids.                                             |
| Mood and capacity of works       | 0-Normal, 1-Normal but unable to concentrate fully on work, 2-Depressed, affected by pain, tired, almost unable to work, 3-Deeply affected by pain, unable to work. |
| <b>Pain Intensity</b>            |                                                                                                                                                                     |
| <b>Points</b>                    | <b>Pain intensity</b>                                                                                                                                               |
| 11-15                            | Severe pain with marked disability                                                                                                                                  |
| 6-10                             | Moderate pain                                                                                                                                                       |
| 2-5                              | Mild pain                                                                                                                                                           |
| 0-1                              | No pain                                                                                                                                                             |
| <b>Efficacy</b>                  | <b>Improvement in pain scoring</b>                                                                                                                                  |
| Excellent                        | Reduction of pain score by 8 or more points or complete cure.                                                                                                       |
| Good                             | Reduction of pain score by 5-7 points.                                                                                                                              |
| Moderate                         | Reduction of pain score by 3-4 points                                                                                                                               |
| Poor                             | Pain score remained the same or reduced by 1-2 points                                                                                                               |
| <b>Assessment of pain relief</b> |                                                                                                                                                                     |
| <b>Pain relief</b>               | <b>Criteria</b>                                                                                                                                                     |
| 100%                             | No complain of pain                                                                                                                                                 |
| 75%                              | Occasional mild pain                                                                                                                                                |
| 50%                              | Analgesics required occasionally in lesser amount                                                                                                                   |
| 25%                              | Only slight reduction of pain                                                                                                                                       |
| 0%                               | No relief                                                                                                                                                           |

## Results

Table 2 depicts the descriptive characteristics in the acute and chronic pain groups. There was no statistical difference between the groups except the percentage of pain relief, which was significantly better in acute pain group (p value <0.001). Table 3 depicts the comparison of hemodynamic variables and total pain score between the two groups before and after the TENS therapy. There was no statistical significant difference in the PR, systolic BP or diastolic BP between the pre and post TENS therapy measurements. But the total pain score was significantly lesser after the treatment in both the groups (p

value <0.001). Pain relief, as such, was good in both the groups but was found to be better in acute pain group. In acute pain group, 5 patients got 100% relief, 9 got 75% relief, 7 got 50% relief and 4 got 25% relief. Whereas in chronic pain group, only 2 patients got 100% relief, 7 got 75%, 8 got 50% and 8 got 25% of pain relief. The overall analgesic efficacy of TENS therapy in acute pain group was excellent in 40% patients, good in 28%, moderate in 20% and poor in 12% of the patients. While in chronic pain group, it was found to be excellent in 32%, good in 40%, moderate in 24% and poor in only 4% of the patients

**Table 2:** Descriptive statistics for Acute and chronic group patients

| Variable                      | Acute pain group |            | Chronic pain group |           | p value |
|-------------------------------|------------------|------------|--------------------|-----------|---------|
|                               | No               | Mean±SD    | No                 | Mean±SD   |         |
| Age (Years)                   | 25               | 45.5±15.3  | 25                 | 43.2±12.5 | 0.563   |
| Sex (M:F)                     | 25               | 13:12      | 25                 | 13:12     | 1.000   |
| HR pre-therapy                | 25               | 90.3±5.4   | 25                 | 88.6±7.5  | 0.362   |
| HR post-therapy               | 25               | 87.3±3.7   | 25                 | 85.5±5.4  | 0.175   |
| SBP pre-therapy               | 25               | 130.4±11.4 | 25                 | 129.6±8.9 | 0.783   |
| SBP post-therapy              | 25               | 127.6±9.1  | 25                 | 127.7±7.3 | 0.966   |
| DBP pre-therapy               | 25               | 86.8±7.8   | 25                 | 86.6±6.5  | 0.922   |
| DBP post-therapy              | 25               | 84.3±5.6   | 25                 | 84.1±5.2  | 0.896   |
| TENS intensity1               | 25               | 8.5±1.6    | 25                 | 8.4±1.8   | 0.836   |
| TENS intensity 2              | 25               | 8.5±1.6    | 25                 | 8.6±1.6   | 0.826   |
| TENS intensity 3              | 25               | 8.5±1.6    | 25                 | 8.5±1.5   | 1.000   |
| Percentage of Pain relief     | 25               | 0.7±0.2    | 25                 | 0.5±0.2   | 0.0009* |
| Total pain score pre-therapy  | 25               | 10.5±1.8   | 25                 | 11.1±1.7  | 0.231   |
| Total pain score post-therapy | 25               | 4.2±2.8    | 25                 | 5.5±2.8   | 0.107   |

. HR: Heart rate, SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, TENS: Transcutaneous Electrical Nerve Stimulator.

**Table 3:** Comparisons of hemodynamic parameters and total pain score pre and post therapy in acute and chronic groups

|    | Acute Pain Group |              |          | Chronic Pain Group |              |          |
|----|------------------|--------------|----------|--------------------|--------------|----------|
|    | Pre-therapy      | Post-therapy | p values | Pre-therapy        | Post-therapy | p values |
|    | Mean±SD          | Mean±SD      |          | Mean±SD            | Mean±SD      |          |
| HR | 90.3±5.4         | 87.3±3.7     | 0.026    | 88.6±7.5           | 85.5±5.4     | 0.100    |

|                  |            |           |         |           |           |         |
|------------------|------------|-----------|---------|-----------|-----------|---------|
| SBP              | 130.4±11.4 | 127.6±9.1 | 0.342   | 129.6±8.9 | 126.7±7.3 | 0.213   |
| DBP              | 86.8±7.8   | 84.3±5.6  | 0.199   | 86.6±6.5  | 84.1±5.2  | 0.139   |
| Total pain score | 10.5±1.8   | 4.2±2.8   | 0.0001* | 11.1±1.7  | 5.5±2.8   | 0.0001* |

HR: Heart rate, SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure

The improvement in duration of pain was better in acute pain group (Table 4). Pain was abolished in 20% of patients in acute pain and only 8% in patients with chronic pain. Improvement in limitation of movements and mood and capacity to work was found to be better in chronic pain patients, whereas greater reduction in need for other analgesics was observed in patients with acute pain. Table 5 depicts the response of TENS in various painful conditions in both the groups. TENS has been found to be highly effective in shoulder hand syndrome (100%), chronic neuralgia (100%), myofascial pain (100%), arthritis (50%), Frozen shoulder (50%), scar pain (50%), trigeminal neuralgia (33%). TENS also gave good pain relief in causalgia (100%), phantom limb pain (100%), cervical spondylitis (50%), arthritis (50%), frozen shoulder (50%), post herpetic neuralgia (50%), scar pain (50%), cancer pain (33%), chronic backache (33%) and trigeminal neuralgia (33%) in chronic pain group. The effect of TENS therapy was found to be poor in cancer pain (33%) in chronic pain group giving no pain relief. But in other cases it gave excellent to moderate pain

relief. In acute pain group, TENS was ineffective in acute headache (1 patient), soft tissue injury (1 patient), and muscle spasm (1 patient). But on the other hand TENS gave excellent pain relief in tension headache (66%), acute headache (40%), wry neck (100%), muscle spasm (66%), sciatica (60%) and good pain relief in acute headache (20%), sciatica (40%), and postoperative pain (80%). The response to TENS therapy was best in patients with chronic nerve pain, myo-facial pain and shoulder hand syndrome in the chronic pain group. In acute pain group, the best response was observed for patients with wry neck and sciatica. It is worth highlighting that out of 5 patients having acute pain postoperatively (after cholecystectomy), 80% of them had good analgesia and thus the concomitant intake of other analgesics could be reduced by 50%. The best results in both groups were obtained at TENS frequency of 100 Hz and pulse rate of 10 waves/seconds.

No patient had any side effects from TENS therapy. The acceptability of this therapy, by the patients, was excellent

**Table 4:** Comparison of medians of various outcome measures based on our predesigned scale in acute and chronic pain groups

| Variables | Acute pain group |                       |                       |                       |         | Chronic pain group |                       |                       |                       |         |
|-----------|------------------|-----------------------|-----------------------|-----------------------|---------|--------------------|-----------------------|-----------------------|-----------------------|---------|
|           | Pre-therapy      | 1 <sup>st</sup> visit | 2 <sup>nd</sup> visit | 3 <sup>rd</sup> visit | p value | Pre-therapy        | 1 <sup>st</sup> visit | 2 <sup>nd</sup> visit | 3 <sup>rd</sup> visit | p value |
| Pain      | 3                | 2                     | 1                     | 1                     | <0.001* | 3                  | 2                     | 1                     | 1                     | <0.001* |
| Duration  | 3                | 2                     | 1                     | 1                     | <0.001* | 3                  | 2                     | 2                     | 1                     | <0.001* |
| LOM       | 2                | 1                     | 1                     | 1                     | <0.001* | 2                  | 2                     | 1                     | 1                     | <0.001* |
| MED       | 2                | 2                     | 1                     | 1                     | <0.001* | 2                  | 2                     | 1                     | 1                     | <0.001* |
| MCW       | 2                | 1                     | 1                     | 1                     | <0.001* | 2                  | 1                     | 1                     | 1                     | <0.001* |

LOM: limitation of movement, MED: Need for medication, MCW: Mood and capacity to work.

**Table 5:** Showing response of TENS in various pain conditions in different number of patients

| <b>Chronic pain conditions</b> |                       |                  |             |                 |             |
|--------------------------------|-----------------------|------------------|-------------|-----------------|-------------|
|                                | <b>Total patients</b> | <b>Excellent</b> | <b>Good</b> | <b>Moderate</b> | <b>Poor</b> |
| Cancer Pain                    | 3                     | 0                | 1           | 1               | 1           |
| Cervical spondylitis           | 2                     | 0                | 1           | 1               | 0           |
| Shoulder hand syndrome         | 1                     | 1                | 0           | 0               | 0           |
| Causalgia                      | 1                     | 0                | 1           | 0               | 0           |
| Chronic backache               | 3                     | 0                | 1           | 2               | 0           |
| Chronic neuralgia              | 2                     | 2                | 0           | 0               | 0           |
| Trigeminal neuralgia           | 3                     | 1                | 1           | 1               | 0           |
| Arthritis                      | 2                     | 1                | 1           | 0               | 0           |
| Frozen shoulder                | 2                     | 1                | 1           | 0               | 0           |
| Myofascial pain                | 1                     | 1                | 0           | 0               | 0           |
| Post herpetic neuralgia        | 2                     | 0                | 1           | 1               | 0           |
| Scar Pain                      | 2                     | 1                | 1           | 0               | 0           |
| Phantom limb pain              | 1                     | 0                | 1           | 0               | 0           |
| <b>Acute Pain Conditions</b>   |                       |                  |             |                 |             |
| Tension Headache               | 3                     | 2                | 0           | 1               | 0           |
| Acute Headache                 | 5                     | 2                | 1           | 1               | 1           |
| Wry Neck                       | 1                     | 1                | 0           | 0               | 0           |
| Soft tissue injury             | 3                     | 0                | 0           | 2               | 1           |
| Muscle spasm                   | 3                     | 2                | 0           | 0               | 1           |
| Sciatica                       | 5                     | 3                | 2           | 0               | 0           |
| Postoperative pain             | 5                     | 0                | 4           | 1               | 0           |

## Discussion

It was observed in our audit that more number of patient responded to TENS therapy in the chronic pain group, but the excellent effect of TENS therapy was observed only in more number of patients in the acute pain group. The quantitative aspect of pain was better tackled for acute pain whereas; patients with chronic pain benefitted more in affective and functional aspect. This audit emphasizes that TENS is an acceptable mode of analgesia not only for chronic but also for

acute pain conditions and it can be used early in the course rather than as a last resort. TENS is found to provide better pain relief in acute pain conditions where it is mostly underused.

We tried to assess the pain relief by using a very comprehensive pain scoring system, using five different subjective criteria for proper evaluation of analgesic effect. These criteria included intensity of pain, duration of pain, limitation of movements, requirement of other analgesic drugs, and mood and capacity of work. Our pain scoring system is simple and covers the sensory,

affective as well as the evaluative aspects of pain [12]. There are several scoring systems to evaluate pain like Visual Analogue Scale (VAS), McGill Pain Questionnaire (MPQ) etc. VAS is simple, but it is unidimensional, measuring only intensity of pain. MPQ is multi-dimensional evaluating the quantitative and qualitative aspects of pain and has wide applicability. But, it is very complicated for regular use and it measures sensory aspect more than affective and evaluative aspects of pain.

TENS has been tried for treatment of angina pectoris not responding satisfactorily to medical and surgical treatment [13]. TENS seems to have anti-ischemic and anti-anginal effects probably due to reduced sympathetic activity [13]. In all the types of patient where we used TENS, vitals were checked before and after TENS sessions. We didn't find any major reduction of hemodynamic parameters after TENS therapy in our study. We found 11-15 beats/min reduction in PR in only 4% of patients in acute and chronic pain groups, whereas maximum reduction of BP was by 6-10mmHg only in 12% and 36% in acute and chronic pain group respectively. Sanderson JE et al. found no significant change in hemodynamic parameters during Valsalva maneuver, cold stimulus over face, or head up tilt while using TENS [14]. But they did find significant reduction of diastolic BP during isometric exercise.

We found that patient tend to utilize specific frequencies and PR to control their pain conditions. In our study 100 Hz frequency was used by 12 (48%) and 22 (88%) patients in acute and chronic pain groups respectively. By doing so 3 (18.9%) and 2 (9.09%) patients in acute and chronic pain groups had 100% pain relief. Whereas, pulse rate of 10 waves/min resulted in 100% pain relief in 3 (37.5%) and 2 (13.3%) patients in acute and chronic pain groups respectively. This finding corroborates the findings found by Melzac and Wall [1]. They reported that high frequency (between 40-100 Hz) and low intensity TENS selectively activated the large diameter afferent fibers (A $\beta$ ) resulting in closing of "pain gates" in the spinal cord. Similarly, Mannheimer C et al. in a study in rheumatoid arthritis patients found that analgesic efficacy of 70 Hz TENS

and 3-70 Hz TENS were better while that of 3 Hz TENS was poorer [15].

We found improvement in limitation of movements among many of our patients undergoing TENS therapy. Complete improvement without any limitation of movement was seen in 7 (30.4%) and 5 (26%) patients in acute and chronic pain groups respectively, while 10 (43.4%) and 13 (52%) patients in acute and chronic pain groups had good improvement. Sternbach RA et al. during their follow up study found that patients on TENS showed significantly increased activity at the end of the year compared to control group [16].

We observed that 9 (36%) patients in acute pain group didn't require supplemental analgesics (nonsteroidal anti-inflammatory analgesics, opioids, nerve blocks etc.) after taking TENS therapy and they could be completely weaned off from the conventional analgesics they were on and another 9 (36%) patients had considerable reduction in analgesic requirement, whereas in chronic pain category 6 (24%) patients could be weaned off from other analgesics and 10 (40%) patients had good reduction (more than 50%) in analgesic requirement. This could be because of the gate control mechanism and endorphins release by TENS. Similarly, Solomon et al. used TENS for postoperative pain management and found that narcotic analgesic consumption was significantly less in TENS group [17].

With regard to mood and capacity of work, 8(32%) patients in chronic pain group were in the best of their mood and 12 (48%) patients had good improvement in mood and capacity of work after TENS therapy. In acute pain group, 11 (44%) of patients were in best of their moods and 8(32%) of the patients had good improvement in their mood. On the other hand, 6(24%) patients in acute pain group and only 3(12%) patients in chronic pain group had absolutely no improvement in the mood. Mogra F et al. found that mood, behavior and functional capacity to work improved markedly in many patients in their study [12]. Scherder et al. in their study on patients with Alzheimer's disease found that patients who underwent short term TENS therapy (30 min a day) felt less dejected, gloomy, irritable, and more cheerful, active and alert

[18]. These patients became more interested in increased social contacts and daily activities.

We found that degree of pain relief was better in acute pain category compared to chronic conditions with TENS therapy. In acute pain group 5 (20%) and 9 (36%) patients had 100% and 75% pain relief respectively with TENS, whereas in chronic pain category 2 (8%) and 7 (28%) had the similar degree of relief. We also found significant association of TENS therapy and reduction of duration of pain. Pain was completely abolished in 5 (20%) cases and another 15 (60%) patients had significant reduction in duration of pain in acute pain group. Whereas, in the chronic pain group only 2 (8%) patients had complete relief of pain and 11 (44%) patients had significant reduction in duration of pain. Continuous type of TENS therapy would have been better in these type of patients. But admission is needed for this facility.

While evaluating overall analgesic efficacy of TENS, it was found that overall analgesic effect was excellent in 10 (40%) patients, good in 7 (28%) patients, moderate in 5 (20%) patients, and poor in 3 (12%) patients in Acute pain group. Whereas, 8 (32%) patients had excellent, 10 (40%) patients had good, 6 (24%) patients had moderate, and 1 (4%) patient had poor overall analgesic efficacy in chronic pain group. The median pain score, duration of pain relief, limitation of movements, reduction in use of analgesics and mood and capacity to work were found to be reduced over different follow up visits. The posthoc analysis revealed significant reduction in all of the pain variables between any of the follow up visits in acute group. The same pattern was observed also for chronic group patients with respect to all the outcome measures. The posthoc analysis revealed significant reduction in pain variable medians between any of the follow up visits in chronic group. The quantitative aspect of pain was better improved in acute pain group, whereas patients of chronic pain group had more benefit in affective and functional aspects of pain (Table 4).

Fishbain et al. also reported that long-term use of TENS improves not only pain but other outcome variables (e.g., return to work, social activities, and need for other therapies) [19]. Mogra F et al. found that overall effect of TENS was good

in 148 (50.7%) patients, moderate in 71 (24.3%) patients, and poor in 73 (25%) patients [12]. In another study Shealy and Maurer found good overall effect in 80% of in acute pain patients, whereas in chronic pain group 25% patients had complete relief, and in 55% patient's medication could be appreciably reduced [20].

In acute pain group, compared to other conditions, analgesic response for wry neck and sciatica was found to be the best (Table 5). Out of 5 patients of sciatica, 3 had excellent and 2 had good relief. This was because of early initiation of therapy. Out of 3 cases of muscle spasm, 2 had excellent and 1 had poor relief. Out of 3 of our patients with tension headache, 2 had excellent and 1 had moderate relief with TENS therapy. The effect of TENS therapy in acute backache varied from excellent to poor in almost equal number of cases. It may be because of pathological variation of the individual cases. The efficacy of TENS was not good in patients with soft tissue injury.

We treated 5 cases of postoperative pain (cholecystectomy) by continuous TENS therapy for 72 hours. Of them 4 had good and 1 had moderate pain relief? In 4 patients who had good pain relief, dose of conventional analgesics could be reduced by 50%. In a study, after thoracotomy procedures, 23% of the patients in an active TENS group required no parenteral opioids during the first 24 h postoperatively [21]. In contrast, all of the patients in the sham group needed opioid analgesics after thoracic surgery. In another post-thoracotomy study, TENS-treated patients had significantly lower pain scores, shorter stays in the recovery room, and better tolerance of chest physical therapy on both the first and second postoperative days [22]. This result is quite significant and TENS should be utilized more for this indication. Reducing the intake of other analgesics could be advantageous in avoiding the side effects of opioids and NSAIDs especially during postoperative period where the pain is quite intense and more amount of drugs are needed. In chronic pain group best result was obtained in chronic nerve pain, myofascial pain, and shoulder hand syndrome (Table 5). Both the cases of chronic peripheral nerve pain had excellent pain relief. Although chronic pain relief after TENS therapy has

been alleged to result from a “placebo” effect (e.g., chronic low back pain) [23], other studies in diabetic patients with peripheral neuropathy have demonstrated analgesic efficacy that clearly exceeded the placebo effect [24]. Our patient of hand and shoulder syndrome had excellent pain relief. We found excellent pain relief with TENS therapy in a patient with chronic myofascial pain. Analgesic effect of TENS was good to excellent in arthritis, frozen shoulder, and scar pain. But patients with cancer pain in the chronic pain group didn’t respond very well to TENS therapy. The inconsistent analgesic responses to TENS therapy may be related to factors like variable stimulation sites [25], frequencies [26], Intensities [27], and durations of electrical stimulation, as well as the patient’s psychological profile [28].

## Conclusion

TENS is an effective mode of analgesia with negligible side effects and had good acceptability. TENS resulted in best pain relief with frequency of 100Hz and pulse rate of 10 waves/sec. TENS resulted in better pain relief, reduction in duration of pain, and reduced requirement of other conventional analgesics in acute compared to chronic pain patients. Patient in chronic pain group had better improvement in limitation of movement, mood and capacity of work with TENS therapy. Both the groups had good overall analgesic efficacy with TENS, but, the quantitative aspect of pain relief was better in patients in acute pain group, whereas the patients in the chronic pain group were benefited more in affective and functional aspects of pain. TENS is a simple, effective, cheaper mode of analgesia with higher patient acceptance and has good efficacy in acute and chronic pain conditions. This modality of analgesia should be more extensively utilized in both acute as well as chronic pain groups. Moreover it should be used early in the course.

## References

1. Melzack R, Wall PD. Pain mechanisms: a new theory. *Science*. 1965; 150(3699):971-9.
2. Singla S, Prabhakar V, Singla RK. Role of transcutaneous electric nerve stimulation in the management of trigeminal neuralgia. *J Neurosci Rural Pract*. 2011; 2(2):150-2.
3. Milne S, Welch V, Brosseau L, Saginur M, Shea B, Tugwell P, et al. Transcutaneous electrical nerve stimulation (TENS) for chronic low back pain. *Cochrane Database Syst Rev*. 2001;(2):CD003008.
4. Osiri M, Welch V, Brosseau L, Shea B, McGowan J, Tugwell P, et al. Transcutaneous electrical nerve stimulation for knee osteoarthritis. *Cochrane Database Syst Rev*. 2000 ; (4):CD002823.
5. Ghoname EA, White PF, Ahmed HE, Hamza MA, Craig WF, Noe CE. Percutaneous electrical nerve stimulation: an alternative to TENS in the management of sciatica. *Pain*. 1999; 83(2):193-9.
6. Kolšek M. TENS - an alternative to antiviral drugs for acute herpes zoster treatment and postherpetic neuralgia prevention. *Swiss Med Wkly*. 2012; 141:w13229.
7. Fanciullo GJ, Robb JF, Rose RJ, Sanders JH Jr. Spinal cord stimulation for intractable angina pectoris. *Anesth Analg*. 1999; 89(2):305-6.
8. Silva MB, de Melo PR, de Oliveira NM, Crema E, Fernandes LF. Analgesic Effect of Transcutaneous Electrical Nerve Stimulation after Laparoscopic Cholecystectomy. *Am J Phys Med Rehabil*. 2012; 91(8):652-7.
9. Freynet A, Falcoz PE. Is transcutaneous electrical nerve stimulation effective in relieving postoperative pain after thoracotomy? *Interact Cardiovasc Thorac Surg*. 2010; 10(2):283-8.
10. Toyota S, Satake T, Amaki Y. Transcutaneous electrical nerve stimulation as an alternative therapy for microlaryngeal endoscopic surgery. *Anesth Analg*. 1999;89(5):1236-8.
11. Bjordal JM, Johnson MI, Ljunggreen AE. Transcutaneous electrical nerve stimulation (TENS) can reduce postoperative analgesic consumption. A meta-analysis with assessment of optimal treatment parameters for postoperative pain. *Eur J Pain*. 2003; 7(2):181-8.
12. Magora F, Aladjemoff L, Tannenbaum J, Magora A. Treatment of pain by transcutaneous electrical stimulation. *Acta Anaesthesiol Scand*. 1978; 22(6):589-92.

13. Hautvast RW, DeJongste MJ, ter Horst GJ, Blanksma PK, Lie KI. Angina pectoris refractory for conventional therapy--is neurostimulation a possible alternative treatment? *Clin Cardiol*. 1996; 19(7):531-5.
14. Sanderson JE, Tomlinson B, Lau MS, So KW, Cheung AH, Critchley JA, et al. The effect of transcutaneous electrical nerve stimulation (TENS) on autonomic cardiovascular reflexes. *Clin Auton Res*. 1995; 5(2):81-4.
15. Mannheimer C, Carlsson CA. The analgesic effect of transcutaneous electrical nerve stimulation (TENS) in patients with rheumatoid arthritis. A comparative study of different pulse patterns. *Pain*. 1979;6(3):329-34.
16. Sternbach RA, Ignelzi RJ, Deems LM, Timmermans G. Transcutaneous electrical analgesia: a follow-up analysis. *Pain*. 1976; 2(1):35-41.
17. Solomon RA, Viernstein MC, Long DM. Reduction of postoperative pain and narcotic use by transcutaneous electrical nerve stimulation. *Surgery*. 1980; 87(2):142-6.
18. Scherder EJ, Bouma A, Steen AM. Effects of short-term transcutaneous electrical nerve stimulation on memory and affective behaviour in patients with probable Alzheimer's disease. *Behav Brain Res*. 1995;67(2):211-9.
19. Fishbain DA, Chabal C, Abbott A, Heine LW, Cutler R. Transcutaneous electrical nerve stimulation (TENS) treatment outcome in long-term users. *Clin J Pain*. 1996; 12(3):201-14.
20. Shealy CN, Maurer D. Transcutaneous nerve stimulation for control of pain. A preliminary technical note. *Surg Neurol*. 1974;2(1):45-7.
21. Rooney SM, Jain S, Goldiner PL. Effect of transcutaneous nerve stimulation on postoperative pain after thoracotomy. *Anesth Analg*. 1983;62(11):1010-2.
22. Warfield CA, Stein JM, Frank HA. The effect of transcutaneous electrical nerve stimulation on pain after thoracotomy. *Ann Thorac Surg*. 1985; 39(5):462-5.
23. Deyo RA, Walsh NE, Martin DC, Schoenfeld LS, Ramamurthy S. A controlled trial of transcutaneous electrical nerve stimulation (TENS) and exercise for chronic low back pain. *N Engl J Med*. 1990;322(23):1627-34.
24. Kumar D, Marshall HJ. Diabetic peripheral neuropathy: amelioration of pain with transcutaneous electrostimulation. *Diabetes Care*. 1997; 20(11):1702-5.
25. Chen L, Tang J, White PF, Sloninsky A, Wender RH, Naruse R, et al. The effect of location of transcutaneous electrical nerve stimulation on postoperative opioid analgesic requirement: acupoint versus nonacupoint stimulation. *Anesth Analg*. 1998; 87(5):1129-34.
26. Hamza MA, White PF, Ahmed HE, Ghoname EA. Effect of the frequency of transcutaneous electrical nerve stimulation on the postoperative opioid analgesic requirement and recovery profile. *Anesthesiology*. 1999; 91(5):1232-8.
27. Wang B, Tang J, White PF, Naruse R, Sloninsky A, Kariger R, et al. Effect of the intensity of transcutaneous acupoint electrical stimulation on the postoperative analgesic requirement. *Anesth Analg*. 1997;85(2):406-13.
28. Lampl C, Kreczi T, Klingler D. Transcutaneous electrical nerve stimulation in the treatment of chronic pain: predictive factors and evaluation of the method. *Clin J Pain*. 1998;14(2):134-42.