Effectiveness of transcutaneous electrical nerve stimulation and interferential electrotherapy in adhesive capsulitis

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ABSTRACT

A total of 50 subjects were randomly allocated to receive (i) transcutaneous electrical nerve stimulation (n=25) (ii) interferential electrotherapy (n=25). Subjects in groups (i) and (ii) received 10 sessions of the respective treatment. Each subject's score on Range of Motion, Constant Murley Assessment and visual analogue scale were recorded at baseline, post-treatment session and subsequent follow-up sessions. In both the transcutaneous electrical nerve stimulation and interferential electrotherapy groups, the Range of Motion, Constant Murley Assessment score increased and the visual analogue scale score decreased significantly (both \( p < 0.0001 \)), and significant difference was found between the 2 intervention groups (all \( p < 0.05 \)). The observed improvement was well maintained in both intervention groups at least until the 6-month follow-up session. Both transcutaneous electrical nerve stimulation or interferential electrotherapy are effective in treating frozen shoulder patients. Interferential therapy is more effective in reducing pain intensity and restoring shoulder function for people with adhesive capsulitis.

Keywords: adhesive capsulitis, interferential therapy, transcutaneous electrical nerve stimulation

INTRODUCTION

Adhesive capsulitis, also known as frozen shoulder, is one of the most frequent pathologies in the middle-aged population. The aetiology of frozen shoulder is unclear, possibly involving a non-specific chronic inflammatory reaction of subsynovial tissue and resulting in capsular and synovial thickening, but the problem affects the function of the glenohumeral joint. It usually results in pain, decreased range of motion, and muscle weakness. Persistent shoulder pain and compromised mobility may cause difficulty in performing activities of daily living or even lead to disability.

Transcutaneous electrical nerve stimulation (TENS) is a non-invasive technique in which a low-voltage electrical current is delivered through wires from a small power unit to electrodes located on the skin. TENS is often used to treat pain in variety of acute and chronic musculoskeletal conditions. Recent reports, however, suggest that the absorption of calcific deposits in the shoulder muscle tendons is accelerated by low frequency TENS therapy and may be related to increased microcirculation in the region of the stimulation. Although no controlled studies were identified to document those hypotheses, the most consistent and extensive pain relief appears to occur with stimulation of the acupuncture points thought to be associated with shoulder pain.

Interferential electrotherapy (IFE) is a common physiotherapeutic treatment modality used in Western countries. Its high carrier frequency (around 4000 Hz) produces lower impedance to the skin and allows deeper penetration into tissue. IFE predominately excites large-diameter nerve fibres and reduces the transmission of nociceptive signals through small-diameter nerve fibres to the spinal dorsal horn by presynaptic inhibition, thus achieving pain modulation in the higher centre. Some studies have shown that IFE is
effective in the management of various pain conditions\textsuperscript{17-19}, but not much work has been done on shoulder conditions. The aim of the study is to find out whether TENS or IFT is effective in per arthritis shoulder.

**MATERIAL AND METHODS**

**Study Design:**

The study is comparative in nature in which the effectiveness of TENS vs. Interferential therapy is seen in Periarthritis shoulder.

**Research Setting**

The study was performed in the Department of Physiotherapy and Rehabilitation (Shri Guru Ram Das Institute of Medical Science and Research), Vallah, Amritsar.

**Participants**

Male & females subjects of Shri Guru Ram Das Institute of Medical Sciences and Research, Vallah, Amritsar formulated the population for this study. Representative sample of 70 males & females with unilateral shoulder affection who volunteered to participate were taken, out of whom 50 samples who met the inclusion criteria were taken as experimental group. 25 patients are in group I which are given interferential therapy and 25 patients are in group II which are given transcutaneous electrical nerve stimulation. Inclusive criteria were patients of Age Group 40-60 yrs who reported localized pain over one shoulder, experienced night pain and had restricted active and passive shoulder motions. Exclusive criteria included Age Group Below 40 and above 60 , history of trauma, fractures, previous shoulder surgery, cervical or thoracic pain syndrome, complex regional pain syndrome, malignancies, on anticoagulant therapy, Psychic patient, Hyper mobile joint or had received acupuncture treatment to the painful shoulder in the past 6 months. Written consent was obtained from all subjects. The study was approved by the local ethics committee. The subjects were randomly allocated into: (i) the IFE group (n = 25); (ii) TENS group (n = 25)

**Interventions**

**INTERFERENTIAL THERAPY (IFT) GROUP**

The subjects in this group received IFE treatment for 10 sessions over 4 weeks. The patient is positioned comfortably and the skin is prepared, washed and any skin lesion insulated with petroleum jelly. An IFE machine delivered current swept from 80 to 120 Hz, and 4 suction-type electrodes were placed around the shoulder region used in two pairs, (quadripolar technique is applied) each pair being indicated by the colorings of the wire from the machine. The electrodes of each pair are placed diagonally opposite one another in such a way that the interference effect is produced in the tissues where it is required, which is very deep. The patient is warned that he will feel a tingling sensation which should not be too uncomfortable or burning.

The intensity of the stimulation was adjusted to just below the pain threshold and the stimulation lasted for 20 minutes.

**TRANSCUTANEOUSELECTRICALNERVESTIMULATION (TENS) GROUP**

All the subjects in this group received TENS treatment for 10 sessions over a 4-week period (2-3 times a week) The skin in the treatment area was first sterilized with an isopropyl alcohol skin wipe. Conductive rubber electrodes covered with a conductive gel in order to gain good skin contact re placed on the patient's skin. The electrodes can be bandaged onto the patient or fixed with adhesive tape. Four electrodes are placed for the treatment of periarthritis, we used high frequency TENS in our study. The intensity of the stimulation was adjusted to a tolerance level of just below the pain threshold. Large main units are available to produce the current, but often small unit made to be placed in the patient's pocket and utilizing batteries are preferred.

Pulses of around 0.2 ms at about 100Hz are given at intensities that provoke gentle contraction. The patient should feel a tingling pins and needle sensation. This stimulates the high threshold 'A' delta and 'C' fibres leads to release of endogenous opioids afferents which reduces pain. It is applied to acupuncture points but is sometime applied to motor points of muscles. The intensity of the stimulation was adjusted to a tolerance level of just below the pain threshold. The needle was retained for 20 min, and was manually lifted and thrusted every 10 min.

**OUTCOME MEASURES**

**Range of motion**

Goniometry is measurement of angles created at human joint by the bones of the body. The instrument used for this Measurement is known as Goniometer. The patient joint is placed in a starting position of Zero degree then permit the patients to move the joint through available range of motion and measure the angle. Goniometric measurements are recorded in numerical table and range of motion measured.
CONSTANT MURLEY ASSESSMENT (CMA) SCORE

The CMA score is a reliable and valid instrument for assessing overall shoulder function, with low inter-rater and intra-rater error rates (16-17). It is a 100-point scale that is composed of 4 domains: (i) pain (15-point), (ii) activities of daily living (20-point), (iii) range of motion (40-point), and iv) power (25-point) (16-18). The higher the score the better the overall functional performance and vice versa.

VAS (Visual Analog Scale)

VAS is a pain rating scale. Allows the patient visually gauge the amount of pain along a solid 10 cm line. Patient is asked to mark his/her pain status on the line provided

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>No pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>severe pain</td>
</tr>
</tbody>
</table>

Examiner should consistently use the same pain rating scale when assessing or reassessing patient to increase consistent results.

DATA ANALYSIS

An experimental design consisting males and female subjects were taken for the study. The responses were recorded for the dependent variable - ROM and pain. The responses were recorded in the condition of pre-treatment and post-treatment. The qualitative data was worked upon by using the Software Analyze-It for MS-Excel. Manually related test and unrelated t-test was used to compare the correct responses for the TENS and Interferential therapy.

THE LEVEL OF SIGNIFICANCE WAS SET AT 0.05 FOR ALL ANALYSES. THE SIGNIFICANT LEVEL P 0.05 WERE CONSIDERED

CHARACTERISTICS OF THE DATA PRESENTED THROUGH TABLES AND GRAPHS

- Pre and post ROM, CMA score and VAS was analyzed by using mean and standard deviation presented in tables.
- The related t test and unrelated t test was used to find out any significant difference between pre and post-test, ROM, CMA score and Visual Analog Scale (VAS). Statistical procedure and their formula are

\[
\text{Means} = \frac{\sum X}{n}
\]

Standard Deviation S.D.

\[
\sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}
\]

Related t-test

\[
t = \frac{\Sigma d}{\sqrt{\frac{\Sigma \Sigma d^2 - (\Sigma \Sigma d)^2}{n-1}}}
\]

Unrelated t-test

\[
t = \sqrt{\frac{(\frac{\Sigma x_1^2}{n_1} - \frac{(\Sigma x_1)^2}{n_1}) + (\frac{\Sigma x_2^2}{n_2} - \frac{(\Sigma x_2)^2}{n_2})}{n_1 - 1 + n_2 - 1}} \times \frac{1}{\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}
\]

RESULTS

Visual analogue scale (Figure 1)

Table 1 shows the distribution of pain scores measured by visual analog scale in patients treated with (IFT) and (TENS).

<table>
<thead>
<tr>
<th></th>
<th>Pre Treatment Reading</th>
<th>Post Treatment Reading</th>
<th>t value</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>S.D.</td>
<td>S.E.</td>
<td>Mean</td>
</tr>
<tr>
<td>IFT</td>
<td>7.50</td>
<td>±0.83</td>
<td>0.18</td>
<td>2.15</td>
</tr>
<tr>
<td>TENS</td>
<td>7.70</td>
<td>±0.73</td>
<td>0.16</td>
<td>5.10</td>
</tr>
</tbody>
</table>

Table 1

Scores of Visual Analog Scales (VAS) in patients treated with IFT and TENS.
In patients treated with IFT, pre-treatment VAS score was 7.50 and after the treatment the score was reduced at 2.15, showing highly significant differences (p 0.0001) between the pre and post score (t=29.44). In patients treated with TENS, pre-treatment VAS score was 7.70 and after the treatment the score was reduced to 5.10, showing highly significant differences (p 0.0001) between the pre and post score (t=13.17).

**Table 2**

<table>
<thead>
<tr>
<th>Scores Differences</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean S.D. S.E.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IFT 5.35 ±0.81 0.18</td>
<td>10.25</td>
<td>0.0001</td>
</tr>
<tr>
<td>TENS 2.60 0.80 0.20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**RANGE OF MOTION**

*Flexion*

Table 3 shows the distribution of scores of range of Motion (ROM) of flexion in patients treated with IFT and TENS (Figure 2). In patients treated with IFT, pre treatment ROM score was 72.00 and the post treatment score was increased by 148.50 showing highly significant differences (p 0.0001) between the pre and post score (t=22.09). In patient treated with TENS, pre treatment ROM score was 71.50 and post treatment score was increased to 99.00 showing highly significant differences (p 0.0001) between the pre and post score (t=15.64).

**Table 3**

<table>
<thead>
<tr>
<th>Pre Treatment Reading</th>
<th>Post Treatment Reading</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>S.D.</td>
<td>S.E.</td>
<td>Mean</td>
</tr>
<tr>
<td>IFT 72.00 21.73 4.86</td>
<td>148.50 12.99 2.90</td>
<td>22.09</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>TENS 71.50 22.60 5.05</td>
<td>99.00 18.04 4.03</td>
<td>15.64</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Table 4 shows the mean differences of scores of range of motion of flexion in patients treated with IFT and TENS. The patients treated with IFT shows higher mean difference (76.50) than in patients treated with TENS. (27.50) showing highly significant differences (p≤0.0001) between them (t=12.62).
Table 4

Mean differences of scores of range of motion of flexion in patients treated with between IFT and TENS

<table>
<thead>
<tr>
<th></th>
<th>Scores Differences</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>S.D.</td>
<td>S.E.</td>
<td></td>
</tr>
<tr>
<td>IFT</td>
<td>76.50</td>
<td>15.48</td>
<td>3.46</td>
</tr>
<tr>
<td>TENS</td>
<td>27.50</td>
<td>7.86</td>
<td>1.76</td>
</tr>
</tbody>
</table>

Table 5

Scores of Range of motion for abduction in patients in treated with IFT and TENS

<table>
<thead>
<tr>
<th></th>
<th>Pre Treatment Reading</th>
<th>Post Treatment Reading</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>S.D.</td>
<td>S.E.</td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>IFT</td>
<td>74.45</td>
<td>22.56</td>
<td>5.05</td>
<td>154.0</td>
</tr>
<tr>
<td>TENS</td>
<td>78.00</td>
<td>20.35</td>
<td>4.55</td>
<td>104.00</td>
</tr>
</tbody>
</table>

Table 6 shows the mean difference of scores of range of motion of abduction in patients treated with IFT and TENS. The patients treated with IFT shows higher mean difference (78.75) than patients treated with TENS (26.00) showing highly significant differences (p 0.0001) between them (t=11.78).

Table 6

Mean differences of scores of range of motion of abduction in persons treated with IFT and TENS

<table>
<thead>
<tr>
<th></th>
<th>Scores Differences</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>S.D.</td>
<td>S.E.</td>
<td></td>
</tr>
<tr>
<td>IFT</td>
<td>78.75</td>
<td>18.27</td>
<td>4.09</td>
</tr>
<tr>
<td>TENS</td>
<td>26.00</td>
<td>8.21</td>
<td>1.84</td>
</tr>
</tbody>
</table>

EXTERNAL ROTATION

Table 7 shows the distribution of scores of Range of motion (ROM) of external rotation in patients treated with IFT and TENS (Figure 4). In patients treated with IFT, pre-treatment range of motion (ROM) score was (21.75) and post treatment score was increased to (65.50) showing highly significantly differences (p 0.0001) between the pre and post score (t=22.45). In patient treated with TENS, pre treatment ROM score was (23.00) and post-treatment score was increased to 34.00 showing highly significant differences (p 0.0001) between the pre and post score (t=10.34).
CONSTANT MURLEY ASSESSMENT SCORES

In the TENS group, the average CMA scores improved significantly, from 65.5 at the baseline to 86.0 in the post-treatment session (the mean improvement was 31.5%; p < 0.0001). The subjects in the IFE group showed improvement, with their CMA scores having increased from 59.6 (SD 15.4) at the baseline to 84.9 (SD 8.4) in post-treatment session (the mean improvement was 42.2%, p < 0.0001).

DISCUSSION

These findings demonstrated that TENS or IFE successfully alleviated shoulder pain and improved shoulder function for people with frozen shoulder but the patient which are given interferential therapy responded more to treatment. Ten sessions of TENS or IFE produced increase in the ROM and decrease in the VAS scores, however, significant difference (p < .0001) was found between the 2 active treatment groups. The observed improvements in pain and shoulder functions were comparable to similar previous studies.

Our results are consistent with those reported by Marchand et al., Palmer et al., Basbaum & Field, Melzack & Wall, Johnson and Tabasam, Somers and Somers. They suggested that the substantia gelatinosa in the dorsal horn of the spinal cord acts as a gate control system. Activation of the large diameter myelinated fibres subserving touch, pressure and vibration is thought to facilitate the pre-synaptic inhibition of substantia gelatinosa cells on the transmission cells in the dorsal horn, thus reducing pain transmission. TENS is supposed to excite predominantly these fibres, which may reduce the output of the transmission cells, thus reducing the perception of heat pain.

This is the study to compare the effects of IFE or TENS for people suffering from frozen shoulder. Our findings demonstrated that 10 sessions of IFE produced an increase in CMA scores, Range of motions and a reduction in VAS scores. This is contrast to the negative findings of using IFE for treating shoulder disorders, as reported by Van der Heijden et al. The different results obtained in the 2 studies could be partly explained by the variation in patient selection and the choice of parameters. Van der Heijden et al. delivered IFE at 4 KHz with a frequency modulated between 60 and 100 Hz via 2 reusable hypoallergenic self-adhering electrodes. The present study delivered IFE at 80–120 Hz with suction cup electrodes.

Table 7

<table>
<thead>
<tr>
<th>Pre Treatment Reading</th>
<th>Post Treatment Reading</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>S.D.</td>
<td>S.E.</td>
<td></td>
</tr>
<tr>
<td>IFT</td>
<td>21.75</td>
<td>1.67</td>
<td>65.50</td>
</tr>
<tr>
<td>TENS</td>
<td>23.00</td>
<td>2.47</td>
<td>34.00</td>
</tr>
</tbody>
</table>

Table 8 shows the mean difference of scores of ROM in patients treated with IFT and TENS. The patients treated with IFT shows higher mean differences (43.75) than in patients treated with TENS (11.00) showing highly significant differences (p 0.0001) between them (t=14.75).

Table 8

<table>
<thead>
<tr>
<th>Scores Differences</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>S.D.</td>
<td>S.E.</td>
</tr>
<tr>
<td>IFT</td>
<td>43.75</td>
<td>8.72</td>
</tr>
<tr>
<td>TENS</td>
<td>11.00</td>
<td>4.76</td>
</tr>
</tbody>
</table>
Despite the wide use of IFE for managing different painful conditions, the analgesic mechanism of IFE is unclear. It is believed that the mechanisms might be similar to those in transcutaneous electrical nerve stimulation\(^3\). The resulting current of IFE has a frequency that is modulated between 1 and 100 Hz, which is supposed to produce pain reduction through the gate control theory. This stimulates cutaneous sensory nerves and causes slight vasodilation, which may enhance the analgesic effects. The weaknesses of the present study include a less number of subjects. Better statistical data can be obtained by taking more subjects. Study was limited to small area that is physiotherapy and rehabilitation department of SGRDIMSR.

In conclusion, the TENS or IFE was effective at reducing pain intensity and restoring shoulder function for people with frozen shoulder. The improvement after 10 sessions of either TENS or IFE was significant. Interferential therapy is more applicable in the treatment of patients suffering from periarthritis than Transcutaneous Electrical Nerve Stimulation.

REFERENCES


