RESEARCH REPORT

Effect of progressive muscular relaxation exercises versus transcutaneous electrical nerve stimulation on tension headache: A comparative study

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KEYWORDS
Lakaev Academic Stress Response Scale; progressive muscular relaxation exercises; stress; tension headache; transcutaneous electrical nerve stimulation

Abstract  Tension-type headache (TTH) is most frequent among all types of headaches. According to the International Headache Classification Subcommittee of the International Headache Society (2004), TTH occurs in 30–78% of the population. Progressive muscular relaxation exercises have been shown to reduce TTH, and home-based relaxation programmes can result in significant improvement in headaches. Transcutaneous electrical nerve stimulation (TENS) is a method of electrical stimulation that primarily aims to provide a degree of symptomatic pain relief by exciting sensory nerves and stimulating either the pain gate mechanisms or the opioid systems. The objective of this study was to compare between the effects of progressive muscular relaxation exercises and TENS on pain intensity and stress in people with TTH. Thirty patients with TTH were allocated to either Group A or Group B. Group A practised progressive muscular relaxation exercise, whereas Group B received TENS. In the latter group, TENS electrodes were placed bilaterally either on the head at the site of pain or on the occiput. The treatment was carried out for 15 minutes a day, for 7 days. Patients were assessed for pain intensity (Visual Analogue Scale) and level of stress (Lakaev Academic Stress Response Scale) before and after the intervention period. The results showed that progressive muscular relaxation exercises were effective in reducing pain as well as stress (p < 0.001). TENS, by contrast, reduced stress significantly (p < 0.001), but not pain (p = 0.233). Between-group analysis revealed that there was no statistically significant difference in reduction of pain between the two groups (p = 0.595), but the amount of stress reduction in Group A (p = 0.002) was significantly more than that in Group B. In conclusion, progressive muscular relaxation exercises were more effective in reducing stress level than TENS in patients with TTH. The effect on pain reduction was similar between the two treatment methods.

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Introduction

Tension-type headache (TTH) occurs in 35–78% of population; it is most frequent among all types of headaches and more common in women. According to the International Headache Classification Subcommittee of the International Headache Society (2004), around 44% of patients with TTH have shown limited ability to function, leading to disability and reduced quality of life [1–4].

Though not universally demonstrated, contraction of head and neck muscles can have a pathogenic role in some cases of TTH. In approximately 60% of patients with TTH, increased electromyographic activity is noted in the pericranial muscles, but headache severity has no correlation with it. One of the most prominent abnormal findings in chronic TTH is tender pericranial myofascial tissues [5,6]. Some studies have suggested that “central sensitisation” or facilitation occurs within the central nervous system, which increases excitability of neurons, making individuals more susceptible to headaches that lead to chronicity [7,8]. Additionally, stress, fatigue, and anxiety may also trigger TTH [9–12].

Regular exercise can reduce muscle tension and help alleviate symptoms related to stress and TTH. Relaxation therapy has shown beneficial effects over no treatment or placebo in TTH [13]. Progressive muscular relaxation exercises have been used successfully to decrease TTH [14–16].

Transcutaneous electrical nerve stimulation (TENS) can be an effective complement or alternative to oral analgesics. Electrical stimulation provides a degree of symptomatic pain relief by exciting low-threshold mechanoreceptors, thus stimulating either the pain gate mechanisms or the naturally occurring opioid systems. It is a noninvasive and drug-free method, and can be used transcranially for pain suppression [17–19].

Solomon and Gugliemo [17] conducted a study on the effect of TENS applied transcranially in 62 patients with migraine and tension headache. Decreased pain was reported in patients treated with TENS, according to the subjective pain intensity measured using a 0–10 scale. Tella et al [19] examined the effects of TENS on selected symptoms of headache among eight patients, aged 20–50 years, with chronic TTH. These patients were treated thrice weekly for 10 weeks using TENS, and a significant reduction in pain was reported. Whether muscular relaxation exercise is superior to TENS or vice versa in treating TTH is not clear. Using a randomized controlled design, this study aimed to compare progressive muscular relaxation exercises with TENS in reducing pain and stress in people with TTH.

Methods

Participants

Ethical approval for this study was granted by the KLE University’s Institute of Physiotherapy’s Institutional Ethics Committee (Belgaum, Karnataka, India) for reviewing short research projects on humans. Using the convenience sampling method, participants were recruited from the Physiotherapy Outpatient Department of KLE’s Dr Prabhakar Kore Hospital (Belgaum, Karnataka, India) and Medical Research Centre (MRC), Belgaum, Karnataka, India. The inclusion criteria were as follows: individuals having TTH according to the classification of the International Headache Society, and both males and females aged 19–25 years. Individuals with any other type/cause of headache were excluded from the study. The purpose of the study was explained, and a written informed consent was obtained from all participants.

Randomization

Individuals who met the inclusion criteria were randomly allocated to Group A or Group B, using opaque envelopes. The allocation was conducted by the primary investigator prior to the baseline assessment. Group A underwent progressive muscular relaxation exercises, whereas Group B received TENS.

Outcome measures

The pre- and postoutcome assessments were performed by the primary investigator who was not blinded to group allocation. Each patient was assessed on Day 1 and Day 7.

Participants were asked to rate the intensity of pain they experienced using the Visual Analogue Scale (VAS) [20,21], which is a 100-mm horizontal scale (0–no pain; 2–17 mm, mild pain; 17–47 mm, moderate pain; 47–77 mm, severe pain; 77–96 mm, very severe pain; and 96–100 mm, most severe pain imaginable). Test–retest reliability of VAS has been shown to be good, but higher among literate (r = 0.94) than among illiterate patients (r = 0.71) before and after attending a rheumatology outpatient clinic [22]. For construct validity, in patients with a variety of rheumatic diseases, the VAS has been shown to be highly correlated with a five-point verbal descriptive scale (“nil”, “mild”, “moderate”, “severe”, and “very severe”) and a numeric rating scale (with response options from “no pain” to “unbearable pain”), with correlations ranging from 0.71 to 0.78 and from 0.62 to 0.91, respectively [22]. The correlation between vertical and horizontal orientations of the VAS is 0.99 [22]. VAS is thus considered a reliable and valid tool for measuring the pain level [22,23].

Stress was measured using the Lakaev Academic Stress Response Scale (LASRS) [24,25]. Respondents were asked to rate how often they experienced stress symptoms on a five-point Likert Scale with the following anchors: 1, never; 2, rarely; 3, sometimes; 4, most of the time; and 5, all the time. The items corresponding to four factors were affective, behavioural, physiological, and cognitive. The LASRS has been shown to have sound psychometric properties and suggested to be a reliable way of measuring academic stress responses [24].

Intervention

On Day 1, the participants in both groups were assessed using VAS and LASRS. The participants of Group A practiced progressive muscular relaxation exercises. They were taught to sequentially tense and relax four groups of muscles in the body. At the same time, they were asked to pay very close attention to the feeling associated with tensing
and relaxing of the muscles. The participants were made to lie down in a comfortable position in a calm atmosphere and were asked to wear loose clothing. The four groups of muscles were as follows: Group 1—right hand and forearm (clench fist), right biceps (push down), left hand and forearm, and left biceps; Group 2—forehead (raise eyebrows), eyes (squint), and nose (wrinkle up), jaw (pull corners of mouth back), and neck (push back); Group 3—chest, shoulders, and upper back plus a deep breath, and stomach plus a deep breath; and Group 4—right thigh (lift and hold), right calf (point toes upward), and right foot (point toes downwards); same functions were performed with the left thigh, left calf, and left foot. Participants were asked to focus their attention on muscle groups, and tense the muscle group and maintain tension for a maximum period of 5–7 seconds. They were asked to focus on the feelings associated with tensing of the muscle groups. At another point of time, the tension in those muscle groups was released and the participants were asked to focus their attention on the muscle groups and relax for 30–40 seconds. The participants were asked to notice the difference between tensed and relaxed muscles. Each patient in Group A received one 15-minute session of relaxation per day, for 7 days. The participants were asked to note the difference between tensed and relaxed muscles. Each participant in Group B received TENS over the occiput. Each participant in Group B received TENS over the temporal area of the forehead, whereas those who reported pain in the occipital area were given TENS over the forehead, whereas those who reported pain in the occipital area were given TENS over the occiput. Each participant in Group B received one 15-minute session of TENS per day for 7 days.

The patients in Group B received TENS (Microstim Genius; Technomed Electronics, Perungudi, Chennai, India). A pulse rate of 4 Hz and a pulse width of 200 milliseconds were used. Electrodes were placed bilaterally either on the head at the site of pain or on the occiput [19]. The patients who had pain in the forehead were given TENS over the temporal area of the forehead, whereas those who reported pain in the occipital area were given TENS over the occiput. Each participant in Group A received one 15-minute session of relaxation per day, for 7 days. The participants were asked to routinely practise focused muscular tension—relaxation in everyday situations whenever they became stressed.

The statistical analysis was performed using SPSS software version 12, which was a demo version used by a statistician in Belgaum, Karnataka (IBM, Bangalore, India). The Chi-square test was used to check for any statistical difference in sex distribution between the two groups. Parametric unpaired t test was used to compare age between the two groups and Fischer’s exact test to compare the distribution of different subtypes of TTH. Wilcoxon signed rank test was applied to compare the levels of pain (VAS) and stress (LASRS) before and after the treatment in each group. Mann—Whitney U test was used to compare the same outcomes between the two groups at each time point. The level of significance was set at p < 0.05.

Results

Participant characteristics

A total of 42 participants were screened for eligibility, of which 36 agreed to be a part of this study. These 36 participants were then assessed and randomly allocated to one of the two groups (Group A = 19 and Group B = 17). Four participants from Group A dropped out due to personal reasons and two from Group B withdrew because they could not comply with the treatment and assessment schedule (Fig. 1).

There was no significant difference in age between the two groups (p = 0.060). Group B tended to have a higher proportion of female participants, although the difference did not reach statistical significance (p = 0.120). Patients with chronic TTH, frequent episodic TTH, and infrequent episodic TTH were included. Frequent episodic TTH was the most common. Overall, there was no significant difference in the distribution of headache subtypes between the two treatment arms (p = 0.360) (Table 1).

Within-group change over time

A comparison of the pre- and post-treatment levels of pain (VAS) revealed a statistically significant reduction in the pain level in Group A (p < 0.001) but no significant reduction in Group B (p = 0.233). Both Group A and Group B demonstrated a significant reduction in the level of stress (p < 0.001; Table 2).

Between-group differences

No significant between-group difference was observed in the level of pain at baseline (p = 0.285). By contrast, the pain level post-treatment demonstrated a significant between-group difference (p = 0.050). However, when the change scores were compared between the two groups, no significant difference was found (p = 0.595). The level of stress showed no significant between-group difference at baseline (p = 0.710). After the 7-day treatment period, the stress level demonstrated a significant between-group difference (p = 0.023). The change scores in stress also showed a significant between-group difference (p = 0.002; Table 3).

Discussion

The major finding of this study is that progressive muscular relaxation and TENS have similar effects on pain reduction, but the former treatment is superior in reducing stress in people with TTH.

TTH is one of the common medical problems and affects a large number of people; various methods are used to tackle this problem. Physiotherapy is an adjunct treatment method for TTH. In our study, the participants were young adults and had various stressors in their life, in particular stress related to education and future career. It is noteworthy that the majority of our participants are females. A Canadian study also suggested that TTH may occur in late adolescence or early adulthood, and is particularly prevalent in females [1]. In the present study, it was observed that frequent episodic TTH was most common among all the subtypes of tension headache. This is consistent with the international classification of headache disorders, which suggests that frequent episodic TTH is more prevalent than chronic TTH [2].
Our results showed that participants in Group A (progressive muscular relaxation exercises) experienced a reduction in stress and pain. Tension headaches are usually caused by stress or poor posture during study or work. This type of headache can be caused by tense neck muscles. As the muscles become tense, their microcirculation would be affected, which may then in turn lead to a vicious cycle that results in even more tension and pain. Contraction of head and neck muscles has been thought to play a pathogenic role in some patients with TTH. It is thought that “central sensitisation” or facilitation occurs within the central nervous system, which increases the excitability of neurons, making the individual more susceptible to headaches that become chronic [7,8]. Psychological stress and fatigue can be precipitating factors causing TTH [1]. The reduction in the levels of pain and stress after receiving progressive muscular relaxation may be because relaxation reduces the tension in tight muscles around the head and

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**Table 1** Comparison of characteristics of participants

<table>
<thead>
<tr>
<th></th>
<th>Sex (n)</th>
<th>Mean age (y) (mean ± SD)</th>
<th>Types of TTH (n)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>CTTH</td>
<td>FETTH</td>
</tr>
<tr>
<td>Group A</td>
<td>7</td>
<td>8</td>
<td>21.2 ± 2.4</td>
<td>0</td>
</tr>
<tr>
<td>Group B</td>
<td>3</td>
<td>12</td>
<td>19.9 ± 1.5</td>
<td>3</td>
</tr>
<tr>
<td>(p)</td>
<td>0.120</td>
<td>0.060</td>
<td>0.360</td>
<td></td>
</tr>
</tbody>
</table>

CTTH = chronic tension-type headache; FETTH = frequent episodic tension-type headache; Group A = progressive muscular relaxation; Group B = transcutaneous electrical nerve stimulation; IETTH = infrequent episodic tension-type headache; SD = standard deviation; TTH = tension-type headache.

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**Figure 1.** CONSORT flowchart. CONSORT = consolidated standards of reporting trials; TENS = transcutaneous electrical nerve stimulation.
neck, and achieves a state of mental calm by normalising the breathing pattern, reducing muscle tension, and improving microcirculation in the muscles. In a study involving 10 elderly people, Arena et al. [26] showed that relaxation therapy was beneficial in reducing overall headache, peak headache activity, and medication index. A comparative study was conducted in 40 college students to compare the effectiveness of dance movement therapy and progressive relaxation therapy with music for stress management by Chouhan & Kumar [25]. LASRS was the main outcome to measure stress levels. After 1 month of therapy, both types of treatments were found to be equally effective in reducing stress [25].

The participants in Group B (TENS) reported a significant reduction in the stress level but not in the pain level. Tella et al. [19] tested the effect of TENS on relieving symptoms of headache in eight patients, aged 20–50 years, with chronic TTH. After 10 weeks of treatment (3 treatment sessions per week), significant reduction was observed in pain and functional disability, with a significant improvement in cervical range of motion. This study concluded that application of TENS should be considered for long-term management of chronic TTH. In our study, the therapeutic effect of TENS on pain reduction was not significant. This could be due to the relatively short treatment period (7 days), compared with that demonstrated by Tella et al. [19] (10 weeks). The participant characteristics are also different. Most of our participants suffered from frequent episodic TTH, whereas chronic TTH was studied by Tella et al. [19].

Our results suggested that application of TENS can reduce the stress level, but it is not as good as progressive muscular relaxation exercises. The reduction in the stress levels following TENS treatment may be caused by sensory stimulation, which reduced muscle contraction around the head and neck. A number of studies have demonstrated the beneficial effects of TENS on pain reduction in patients with tension headache [17, 27, 28]. For example, Jay et al. [28] assessed the effectiveness of physical therapy in the treatment of chronic daily headaches. Patients showed significantly faster and greater reduction in headache throughout the 6-month follow-up period with "active" modalities such as TENS and physical therapy, compared with the "passive" modality of medication alone. Solomon and Gugliemo [17] also reported a decrease of pain in patients treated with transcranial TENS. The nonsignificant reduction in the pain level in the TENS group in our study may partially be attributed to the short treatment duration (7 days). The relatively small sample size may also explain the nonsignificant results.

This study had several limitations. The sample size was small, leading to reduced statistical power. The study did not have a no-intervention control group. Therefore, the results could demonstrate only the relative effectiveness of the two programs. To find out whether each program was indeed effective in treating TTH, further studies are required. Long-term effects of the treatment were not studied. Lastly, the outcome assessor was not blinded, which might have led to measurement bias. The positive results obtained from this study should warrant a randomized controlled trial with a larger sample size. Future studies should also assess the long-term effects of the interventions. We suggest a longer duration of treatment with more sessions in order to maximize the treatment effect.

In summary, progressive muscular relaxation exercises were more effective in reducing the stress level than TENS in patients with TTH. The degree of pain reduction was not significantly different between the two treatment methods.

**Conflicts of interest**

All contributing authors declare no conflicts of interest.

**References**


