Nonpharmacological treatment for migraine: incremental utility of physical therapy with relaxation and thermal biofeedback

DA Marcus¹, L Scharff², S Mercer³, DC Turk³

University of Pittsburgh Medical Center¹, Pain Evaluation and Treatment Institute, Pittsburgh, PA, USA; School of Physiotherapy², University of Otago, Dunedin, New Zealand; Department of Anesthesiology³, University of Washington, Seattle, WA, USA

The role of muscular abnormalities in chronic headache as either a contributing cause or an effect is unclear. Cervical musculoskeletal abnormalities have been linked clinically to tension-type headaches. Muscular tightness and tenderness are reported in about 70% of chronic migraine or tension-type headache sufferers (1, 2). Clinical complaints of muscle tenderness are supported by the increased electromyographic activity in frontalis and cervical muscles in both migraine and tension-type headache (3). Recent studies, however, have called the causal role of chronic muscle tension in tension-type headache into question. For example, Zwart et al. (4) reported no decrease in headache in six tension-type headache sufferers after administration of botulinum toxin to paralyze neck muscles.

Clinical examination has identified mechanical abnormalities in both migraine and tension-type headache subjects when assessing range of motion measures (1). Watson and Trott (5) used passive accessory intervertebral mobility testing to reliably identify postural and mechanical abnormalities in a group of headache patients and a nonheadache control group. Abnormal joint findings were identified in 50% of controls and in all of the headache patients, with head pain reproduced in 40% of the headache patients.

In a preliminary study, the presence of both muscular and joint pathology was assessed in 90 chronic headache patients evaluated at a headache clinic (6). Latent or active myofascial trigger points were identified in the head of 6.7% patients, in the neck of 77%, and in the shoulder of 51%. Active myofascial trigger points were recorded in 15% with migraine and in 9% with tension-type headache. Eighty-six percent of migraine patients and 70% of tension-type headache patients had abnormal mechanical findings. The identification of anomalous musculoskeletal characteristics in chronic headache sufferers has led to the investigation of several different treatments for these abnormalities. Physical therapy (PT) (7) and chiropractic treatment (8) have demonstrated effectiveness in tension-type headache, suggesting an important clinical role of cervical musculoskeletal abnormalities. Lockett and Campbell (9) evaluated a 12-week aerobic program in 11 migraine patients compared with an inactive control group. Migraineurs demonstrated a significant reduction in headache in comparison to controls.

The findings of studies reporting the benefit of chiropractic manipulation, PT, and exercise in chronic headache are inconclusive because of the small sample sizes and the lack of adequate control groups. In addition, there have been no published reports of the efficacy in migraineurs of a PT program designed to treat frequently identified musculoskeletal abnormalities. Given the similarity of muscular and joint assessment findings in tension-type headache and migraine sufferers, it might be expected that PT treatment would result in a similar response in both types of headache patients.

One type of nonmedical treatment that has been demonstrated to be effective in treating migraine patients is the combination of relaxation training techniques with thermal biofeedback (10, 11). Approximately 50% of patients treated with this...
approach report a reduction in headache by at least half. Some patients who fail to improve with traditional treatments or with relaxation and biofeedback may experience significant headache relief with multidisciplinary treatment, including PT (12). The extent to which physical therapy individually contributes to this success is unknown.

The goals of the present project were twofold: (i) evaluation of effectiveness of physical therapy in treating chronic migraine, and (ii) evaluation of any cumulative benefits of combining PT with relaxation and thermal biofeedback (RTB). Because it is impossible to develop a plausible placebo PT treatment, the RTB treatment was used as conventional treatment with which to compare the effects of PT. In the second study, the utility of PT as an adjunct treatment to RTB was investigated. Individuals from the first study who had failed to report headache improvement with either PT or RTB were offered the alternative treatment, that is, subjects who did not report at least a 50% reduction in headache after PT were offered RTB and vice-versa. This cross-over approach allowed for an investigation of the utility of: (i) using PT to treat RTB “failures”, and (ii) “priming” RTB subjects with PT treatment.

STUDY 1

Methods

Subject assessment

Subjects, recruited through newspaper advertisements and posters placed in the university community, were females aged 18 to 45 years, and qualified for a diagnosis of migraine with or without aura according to the criteria of the International Headache Society (IHS) (13). Only women were included because of the 3:1 female to male ratio in the prevalence of migraine (14). Subjects were also required to suffer from migraines at least once per week, or on a total of 5 days per month. Exclusion criteria included the use of daily preventive headache medications or frequent (more than 3 days per week) use of abortive medications.

Subjects were independently evaluated by a board-certified neurologist and a clinical pain psychologist. The following self-report inventories were also administered by the psychologist: The West Haven-Yale Multidimensional Pain Inventory (MPI) (15) assesses the psychosocial and behavioral aspects of pain in relation to an individual’s perceptions of pain intensity, life impact, responses of significant others, and performance of common activities. The MPI is a 60-item, self-report inventory with items scored on a range of 0 (none) to 6 (extreme reports). The MPI has been demonstrated to have good reliability and validity (15), and has also been used previously in headache patient samples (16, 17).

The Center for Epidemiological Studies depression scale (CES-D) (18) is a 20-item questionnaire developed by the Center for Epidemiological Studies of the National Center for Health Statistics. This scale measures depressive symptomatology with an emphasis on affective symptoms. The CES-D was developed for use with community rather than psychiatric samples. It has excellent psychometric properties and has been used with headache patients (16). A score of 16 or greater has been suggested to represent clinically significant depressive symptoms.

Subjects randomized to physical therapy treatment underwent an evaluation by a licensed physical therapist prior to the initiation of treatment. This examination included assessments for postural, myofascial, and mechanical abnormalities.

Posture was assessed by comparing the patient’s normal standing posture to a standard ideal midline posture. Mild abnormalities included forward head position or deviation from normal spine curvature. A moderate abnormality was scoliosis of ≤20 degrees and severe abnormality was scoliosis >20 degrees or leg-length discrepancy.

Myofascial evaluations utilized criteria established by Travel and Simons (19) to identify latent and active trigger points. Trigger points required the presence of taut bands, a local twitch response, and muscles tender and firm to palpation. Trigger points were coded as latent if they failed to refer pain and active if they referred pain.

Mechanical abnormalities were evaluated using criteria established by Jull et al. (20). Joint range of motion was measured both actively and passively, and measurements were determined using a goniometer. Cervical synovial joint abnormalities required the presence of abnormal quality of movement/resistance and abnormal end feel. Joint abnormalities were recorded as mechanical if symptomatic pain was not reproduced. They were recorded as cervicogenic if symptomatic pain was reproduced.

Following enrollment in the study, subjects maintained daily headache and medication use diaries, and were instructed not to change medications throughout their involvement. Headache severity was recorded four times each day. Two weeks of diary recordings were used to calculate a baseline Headache Index (HI). The HI is equivalent to mean headache severity over the 2-week recording period. The HI has been utilized as a measure of headache activity in many studies (10).
Table 1. Demographic and headache characteristics.

<table>
<thead>
<tr>
<th>Table 1. Demographic and headache characteristics.</th>
<th>Education level</th>
<th>PT group</th>
<th>RTB group</th>
</tr>
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<tbody>
<tr>
<td>Mean age in years (SD):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total group (n=69)</td>
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<td>4</td>
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<td>11</td>
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<td>15</td>
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<td>Working part time</td>
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<td>14</td>
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<td>Homemaker</td>
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<td>Years suffered from migraine (SD):</td>
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<td></td>
<td></td>
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<tr>
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<td></td>
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<tr>
<td>RTB group (n=39)</td>
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<tr>
<td>Migraine without aura and tension-type headache</td>
<td>5</td>
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<td>Pretreatment headache index (SD):</td>
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<tr>
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</tr>
<tr>
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</table>

Treatment

Subjects were randomized to receive one of two nonmedication headache treatments. One group received PT and the other received relaxation/thermal biofeedback (RTB). Subjects in both groups attended four weekly one-hour treatment sessions.

Physical PT

The PT treatment was designed to address abnormalities in posture, muscles, and joints. This treatment included the following: postural correction to achieve proper alignment of the head and spine; cervical range of motion exercises of the neck and shoulder girdle musculature; isometric strengthening exercises of the neck; active self-mobilization exercises of the cervical spine, such as retraction and suboccipital range of motion exercises; a general whole body stretching and reconditioning program; flare management techniques, including the use of heat and ice for exercises and pain flares, positional distraction, oscillatory movements, and trigger point treatment.

Proper exercise technique was also included, such as the avoidance of overstretching and ways of modifying the home exercise program during pain flares. Subjects were instructed to perform their exercise program twice daily, with each session lasting about 30 min.

Relaxation/RTB

RTB consisted of training in progressive muscle relaxation (21), breathing exercises, and thermal biofeedback. Treatment included the following: (i) education regarding the pathophysiology of headache and the rationale for relaxation training as a treatment for headache, and training in deep-breathing exercises. (ii) The third and fourth sessions comprised thermal biofeedback training in which subjects were trained to increase their fingertip temperatures through the use of imagery and the relaxation methods they had previously been taught.

Subjects were given homework assignments to practice skills they had learned in treatment twice daily, and were provided with audiotapes of relaxation exercises and portable thermal biofeedback devices. Home practice sessions were 20 to 30 min each.

After completing either treatment, pretreatment questionnaires were repeated. A HI was calculated from the last 2 weeks of diaries, and a change score was calculated as follows:

\[
\text{Change score} = \left(\frac{\text{Pretreatment HI} - \text{Posttreatment HI}}{\text{Pretreatment HI}}\right) \times 100
\]

Subjects achieving a significant improvement in headache (as indicated by a change score of 50% or greater reduction) were considered treatment successes (22). No additional treatment was offered to these individuals, and follow-up headache recordings were obtained at 3, 6, and 12 months following treatment. Subjects who were considered treatment failures were offered additional treatment in study 2.

Results

Subject characteristics

A total of 88 women enrolled in the study. Fifteen dropped out after evaluation and before treatment began (10 had been assigned to PT, 5 to RTB). There
Physical therapy treatment of migraine

was a difference in the number of women who dropped out before treatment began because of the difference in secretarial follow-up for subjects who did not show up for their first treatment sessions (RTB no-shows were more likely to be rescheduled). Four women dropped out of the study after beginning the treatment (3 from PT and 1 from RTB). The majority of dropouts cited time constraints as the reason for leaving the study. A total of 69 women completed treatment (81.2% of the original sample). There were no significant differences between study completers and dropouts on age, headache characteristics, or questionnaire scores. Subject age ranged from 20 to 58 years, with a mean of 37.0 (SD=10.9). A diagnosis of migraine with aura was assigned to 21 women, migraine without aura to 33; combined diagnoses of both migraine without aura and tension-type headache were assigned to 15. Thirty women were randomized into PT, and 39 into RTB. Demographic and headache characteristic information is provided for both treatment groups as well as the entire study sample in Table 1. There were no statistically significant differences between the two treated groups on any of the demographic or headache characteristics.

Self-report inventory scores

The pretreatment scores on five subscales of the MPI (Pain Intensity, Pain Interference, Life Control, Affective Distress, and General Activity Level) and the pretreatment CES-D score were compared to determine if the treatment groups were equivalent on these measures. A MANOVA showed no significant differences ($F[7,24]=1.78, p=0.14$). The scores for both groups were comparable to previously published MPI and CES-D scores for treatment-seeking headache patients (16, 23).

Of the 30 women treated with PT, 29 evaluation reports were available (one evaluation was missing from the medical chart). Postural, myofascial, and mechanical abnormalities for these women are listed in Table 2. These findings were similar to reports of PT evaluations with treatment-seeking headache patients (16, 23).

Treatment outcome

Clinically significant improvement in headache (50% or better reduction in HI score) was achieved in only 13% of the PT group ($n=4$). Mean HI decreased from 2.50 to 2.11 after PT treatment, representing an overall mean decrease of only 15.6%. In contrast, 51% of the women in the RTB group experienced significant headache reduction ($n=20$), with a mean HI decrease from 2.59 to 1.52 (41.3%). A repeated measures ANOVA compared pretreatment and posttreatment HI by group, and revealed a significant main effect for time ($F[1]=28.80, p<0.001$) and a significant time x treatment group interaction ($F[1]=6.63, p<0.01$). All of the subjects tended to improve; however, those in the RTB demonstrated a significantly greater degree of change in HI score. This was also reflected in a chi-square comparison of clinical improvement, with a larger proportion of RTB subjects considered clinically improved ($\chi^2(1)=11.34, p<0.001$).

All four PT treatment successes had abnormal findings in at least three out of four categories of postural, myofascial, mechanical head, and mechanical neck abnormalities. Twenty-one of the treatment failures also met this criteria. A chi-square test was conducted comparing the presence of severe abnormalities (including moderate or severe postural abnormalities, active trigger points, or cervicogenic mechanical abnormalities) to clinically significant improvement. No relationship was identified ($\chi^2(1)=1.05, p=0.32$).

Self-report inventory score changes

A mixed-model MANOVA was used with the pretreatment and posttreatment scores of five subscales of the MPI (Pain Intensity, Life Interference, Life Control, Affective Distress, and General Activity Level) and CES-D score as the dependent variables, and treatment group as the independent variable. Complete information was available for 48 women (70% of the sample). Six women returned incomplete information, and information was missing from 15 women who chose not to participate in study 2 (see below). The MANOVA was significant for the main effect of treatment group ($F(6,41)=3.12, p<0.01$), and also
revealed a significant group x time interaction (F(6,41)=2.67, p<0.03). The RTB group demonstrated a significantly greater degree of improvement in comparison to the PT group in the pretreatment to posttreatment comparison. Follow-up repeated measures ANOVAs revealed significant group x time interactions in the Pain Intensity, Pain Interference, and Life Control subscales of the MPI, as well as a trend in the affect scale. Fig. 1 illustrates the score changes for both groups.

Long-term follow-up

Subjects who had achieved a 50% or more improvement in their HI scores were followed-up at 3, 6, and 12 months after treatment to determine if changes were maintained over time. The treatment successes consisted of four women who had completed PT (13%) and 20 women who had completed RTB (51%). Fig. 2 presents the mean HI for each group, and the number of responses at each follow-up. Treatment success was maintained for both groups, with neither group returning to baseline headache levels up to 1 year after treatment. No between-groups analysis was performed on these data because of the small sample size in the PT group; however, the effect of time in the RTB group was significant (F(4,64)=10.57, p<0.001).

STUDY 2

Methods

Subjects who did not achieve a significant reduction in headache (those with a HI change less than 50%) in study 1 were offered the treatment that they had not previously received. Of the 19 women who did not improve after the RTB, 11 (57.9%) chose to begin PT, and 19 of the 26 women who did not improve after PT were treated with RTB (73.1%). Individuals who chose to enter study 2 were compared with those who declined on demographic, headache, and pretreatment questionnaire scores, and the only significant differences were in age (t(67)=1.96, p<0.05) and headache duration (t(67)=2.61, p<0.01). Study 2 decliners were significantly younger, with a shorter headache duration. The difference in the proportion of women who chose not to enter study 2 in either treatment group was not statistically significant (x^2(1)=2.14, p = 0.29).

Assessment and treatment procedures identical to those described in Study 1 were used. Musculoskeletal features were similar to those identified in subjects who were initially treated with PT in study 1. After completion of the second treatment, subjects were instructed to maintain headache diaries for the following 4 weeks. As in study 1, psychological questionnaires were repeated after treatment, and follow-up headache recordings were obtained at 3, 6, and 12 months after completing treatment.

Results

Subject characteristics

There was no significant group difference in initial pretreatment HI (t(28)= -0.41, p=0.97) or in HI at posttreatment of study 1 (t(28)= -0.42, p=0.68). Nor was there any difference between the two groups in duration of headache (t(28)= 0.25, p=0.81). Pretreatment self-report inventory scores for the two treatment groups were compared via a MANOVA using the same six scales of the MPI described in study 1 and the CES-D score as dependent variables. There was no significant difference by treatment group (F(7,10)= 0.82, p=0.60).

Treatment outcome

After treatment was completed, a HI was calculated from the posttreatment diaries and compared with the pretreatment HI. A repeated measures ANOVA demonstrated a significant effect of time (F(1)= 9.30, p<0.05) with no interaction (or
order of treatment presentation) effect. It should be noted, however, that power for the interaction comparison was quite low (1-β=0.1) Subjects significantly improved with treatment in both groups. Mean HI at the end of the second phase was equivalent in the treatment groups: 1.77 (SD=1.8) for PT and 1.76 (SD=1.8) for RTB. Forty-seven percent of the PT group (n=9) and 50% of the RTB group (n=6) were clinically improved. The difference in the proportion of subjects who had achieved clinical improvement was not significant ($\chi^2(1)=0.09$, p=0.77). The majority of subjects (7 out of 11, or 63.6%) had met criteria for abnormalities in at least three out of four musculoskeletal categories. The presence of severe musculoskeletal abnormalities was not related to treatment outcome.

Long-term follow-up

Subjects were followed-up at 3, 6, and 12 months after treatment. The mean HIs for each treatment phase and follow-up are presented in Fig. 3. Group A represents those patients who initially showed no significant improvement with RTB in study 1 and were then treated with PT. Group B represents patients who failed to improve with PT in study 1 and were then treated with RTB. A mixed model ANOVA revealed a significant effect of time ($F(5,5) = 7.77$, p=0.02), with no group or interaction effect.

Conclusions

The results of both of these studies support the use of nonpharmacological treatment, especially RTB, for migraine. An RTB approach would be recommended as a first-line nonmedication treatment because of its demonstrated effectiveness in about half of migraineurs. PT did not achieve this same level of efficacy as a first-line treatment, but proved to be a useful adjunctive treatment for those women who had failed to achieve significant headache relief after RTB treatment. Therefore, PT may be recommended as a second-line treatment for those migraineurs who fail to achieve adequate headache improvement with RTB.

All subjects in this study qualified for a diagnosis of migraine headache using IHS criteria. These women exhibited demographic information and psychological variables similar to typical headache populations. Overall, 55% of subjects demonstrated significant improvement in HI after treatment. This effect was maintained in a 1-year follow-up.

Musculoskeletal abnormalities were discovered in the majority of women given PT evaluations. Despite the presence of these abnormalities, PT treatment failed to result in significant improvement when used as the sole treatment. Clinically significant improvement occurred in only 13% of the PT group, with a mean decrease in HI of 15.6%. These results are similar to medication placebo (12-13%) (24, 25) or other control conditions (15%) (26).

The 51% and 50% improvement rates experienced by the RTB group in both studies were comparable to the results of similar treatment research (10, 24). Of those subjects who did not experience significant headache relief after RTB, 47% reported significant improvement after the addition of PT. Thus, although PT itself appeared to be an ineffective treatment, it may be a useful approach to use when an initial course of RTB fails to result in headache improvement.

RTB focused on reducing levels of muscle tension, whereas PT was designed to improve range of motion, flexibility, and posture. RTB also appeared to result in changes of affect and perceptions of pain impact and life control that were not achieved by subjects treated with PT, as reflected by the MPI and CES-D scores. A number of studies have demonstrated that an important predictor of successful treatment outcome from pain rehabilitation is the development of sense of self-efficacy or self-control (27-29). This sense of control may also be a key ingredient in the self-management of migraine (30). For some patients, this perceived control plus muscle relaxation is sufficient to produce significant improvement, explaining the success of RTB alone. PT treatment, without the additional development of self-control skills, proved ineffective in the present study.

For some individuals, the sense of control gained through RTB treatment may be necessary, but not sufficient. For this latter group, PT was necessary following RTB. The PT treatment may have added muscle flexibility that improved individual's abilities to use the relaxation exercises effectively.

The results of this study are limited by relatively brief follow-up of treatment failures in study 1. They began their second treatment 1 month after...
failing to achieve success with the first treatment. It is possible, then, that some of the success noted in study 2 represents a delayed effect from the treatment received in study 1. In addition, those women who participated in study 2 were a select group who consented to additional treatment. This self-selection may make them different from those women who did not choose to proceed with additional treatment. The power was too low to detect actual differences in order of treatment presentation in study 2, and future studies implementing cross-over designs may be able to identify which subjects are more likely to benefit from such multidisciplinary treatments.

Additional research is necessary to investigate our findings of a lack of an association between muscular abnormalities and treatment outcome. Despite the findings with our sample, it is plausible that there may be subgroups of migraine sufferers for whom muscular factors play a more prominent role. Larger scale studies are needed to examine this, and future research may find it useful to match treatments to patients with specific musculoskeletal abnormalities. In addition, this study suggests that additional emphasis should be given to fostering a sense of control in migraine patients, regardless of the nonpharmacological treatments used. Perhaps adding self-control feedback to a PT treatment program would affect the improvement rate.

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References