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The Effect of Joint Mobilization and Exercise on Pain, Range of Motion and Cervical Motor Control in People with Chronic Cervicogenic Headache

Mahsa ZakerZade[1], Mohammad Hosseinifar[2], Fateme Ghiasi*[3].

[1]M.Sc., Student of Physiotherapy, Dept. of Physiotherapy, School of rehabilitation Sciences, Zahedan University of Medical Sciences, Zahedan, Iran.
[2]Assistant Professor, Rehabilitation Sciences Research Center, Zahedan University of Medical Sciences, Zahedan, Iran.
[3]Assistant Professor, Rehabilitation Sciences Research Center, Zahedan University of Medical Sciences, Zahedan, Iran.
*Correspondence

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ABSTRACT

Background: Cervicogenic headache is referred to as a chronic unilateral headache due to a dysfunction of the neck structures. There are several perspectives on the causes, introducing different treatment techniques from passive techniques to active exercise. This study was aimed to investigate the effect of joint mobilization and exercise therapy on pain, range of motion and cervical motor control in patients with chronic cervicogenic headache.

Methods: This study was a randomized clinical trial. Twenty-six patients aged between 18 and 45 years and in accordance with the inclusion and exclusion criteria were randomly divided into two groups: mobilization and exercise therapy. Twelve treatment sessions with three sessions in four weeks were performed on participants. Headache parameters, craniocervical test, headache disability index, cervical range of motion were measured before, after and one month after treatment by questionnaire, pressure biofeedback and OptiTrack motion analyzers, respectively. Data analyzed by ANOVA repeated measurement test.

Result: These results showed there were significant changed in subjective variables in both groups ($p<0.05$). In exercise group, cervical range of motion and Craniocervical flexion test showed significant improvement ($p<0.05$). Follow-up results showed that in exercise group, improvement in range of motion were still better than mobilization group
($p<0.05$).

Conclusion: According to the results of the study, mobilization and exercises therapy decreased pain and increased cervical range of motion and upper cervical motor control in patients with chronic cervicogenic headache. Although, the exercise therapy was more effective than mobilization in constancy and increasing of cervical range of motion and symptom.

Key words: Cervicogenic Headache, Exercise Therapy, Mobilization, Motion Analysis.

INTRODUCTION

Symptoms of cervicogenic headache are unilateral pain, moderate or severe pain, onset of pain with cervical movements, decreased cervical movements, analgesics being ineffective, and rarely symptoms like fear of light and sound (1,2). A reduction in active cervical range of motion is one of the key criteria for cervicogenic headache, which is more evident in the extension and upper cervical rotation (3,4). Hall and Robinson (2004) reported a significant reduction in rotation in the C1-C2 segment by flexion-rotation test (5). In two separate studies, Zito (2006) and Jull et al. (2007) found a decrease in cervical rotation and extensions, as well as tenderness in upper cervical vertebrae (3,6). Among the other complications and symptoms of cervicogenic headache is cervical muscle imbalance (7). Impaired motor control of the upper cervical is a characteristic of the patients with cervicogenic headache (3,6,8). Jull et al. (2007) reported decreased strength, endurance, and atrophy of the deep flexor muscles, along with shortening and increased extensor muscle tone of the upper cervical region (6). In another study, Park and Yang (2017) reported an increase in tone and stiffness in the sub-occipital muscles, and reported increased tension and decreased flexibility of these muscles as a cause of pain and decreased movement in patients with cervicogenic headache (7). In a similar study, Zito (2006) and Jull et al. (2007) reported weakness of the deep flexor muscles along with increased sternocleidomastoid, scalen, and trapezius muscle activity in people with cervicogenic headache (3,6).

According to these symptoms and complications, various treatment approaches and methods have been presented (3-6). Various invasive treatments have been performed to treat cervicogenic headache so far: drug therapy, surgery, anesthesia injection, and spinal nerve block (C1_C3) or facet joints (9-12).

Among the most common therapies used by physiotherapists to treat cervicogenic headache are manipulation and mobilization (13-16). These two techniques reduce the pain parameters by stimulating the nociceptors of the joints (16). Schoensee et al. (1995) reported a reduction in the duration and severity of headache by mobilization in cervicogenic headache patients (17). Many review papers have examined the effect of manipulation on reducing pain in various types of headaches such as cervicogenic headache, tension headache and migraine (18-21). The studies about of mobilization and manipulation of the upper cervical region shows clear inconsistencies, although it is still suggested as the first treatment choice for people with cervicogenic headache (17-22). Jull et al. (2002) showed that exercise therapy is better than manual therapy in improvement of pain parameters in patients with cervicogenic headache. They suggested the combination of manipulation and exercise therapy has proven more satisfaction for the patients (23).

Among the specific complications of cervicogenic headache, one can state motor complications like the reduced range of motion of the upper cervical and reduced accessory movements of the cervical vertebrae given the studies presented and the reviewed conducted (5). As it was one of the first theories presented regarding the symptoms and complications of cervicogenic headache, the proposed treatments in this case include manipulation and mobilization of the joints, the positive results of which have been reported in several studies prescribed by physiotherapists (20,23,24). However, as the only sign and complication of cervicogenic headache is not a reduction in joint movements and the muscles in this area are affected too, the theory of improving muscle function was proposed and several clinical trials and case reports presented emphasizing improving muscle function and exercise therapy stating the positive result of pain relief (3,6,7,23). Nonetheless, these studies are few and mostly case or experimental reports with small samples. Given these explanations, one can state that two theories are proposed in cervicogenic headache treatments, the first and routine theory, considering the disorder in joint movement selecting the treatment accordingly. The second category researchers determine the cause of headache in the function of the cervical muscles and have chosen the basis of the treatment to improve muscle function. Hence, the purpose the study was to compare the effect of joint mobilization and exercise therapy on pain, cervical range of motion and cervical motor control in people with chronic cervicogenic headache.

Methods

This study was a randomized controlled trial. Twenty sex subjects with chronic cervicogenic headache participated in this study and were divided into two groups by simple non-probability sampling method. The medical ethics committee at the Zahedan University of Medical Sciences approved the study ethics and issued the ethics certification number as IR.ZAUMS.REC.1397.162 and registered with the region's Clinical Trials Registry (IRCT20180714040466N1). All participants signed written informed consents.

Population

The inclusion criteria were men and women aged 18-45 years, having at least 3 months of history of headache, having at least a headache once a week, at least 5 cervicogenic headache criteria, no history of radiculopathy, progressive rheumatic and neurological diseases, no history of long-term use of corticosteroids, no history of accident and whiplash injury, malignancy, pregnancy. The exclusion criteria were the patient's unwillingness to continue treatment, exacerbation of symptoms during treatment and intolerance to diagnostic tests (6,23,25,26).

Sample size

The sample size was determined based on a pilot study. Ten subjects were divided randomly into two equal groups, and the main part of study was conducted on them. The means and SDs for the parameters from this pilot study, with α= 0.05 and 90% power were used to calculate the sample size. The sample size according to the following formula.

$n= (Z_{1-\alpha/2} + Z_{1-\beta})^2 (S_1^2+S_2^2)/ (\mu_1-\mu_2)^2$

$Z_{1-\alpha/2}= 1.96$

$Z_{1-\beta}= 1.28$

According to the results of the pilot and the formula stated, the sample size in each group was considered 13 patients.

The sampling method was the simple, non-probabilistic sampling method and from the available population. The participants will then be allocated randomly to two intervention groups, the mobilization group and Exercises group. Randomization would be performed using random number sequence. The administrator and participants were informed about the grouping data. But the physiotherapist who assessed the subjects, recorded the outcome, and analyzed the data about the grouping was blinded.

Procedure

The initial clinical examination study was performed by measuring demographic information and evaluation cervical vertebral artery and laxity of upper cervical ligaments. Then the individuals were selected to enter the study by examining the inclusion and exclusion criteria.

Assessments

Pain parameters

Pain intensity: The VAS (Visual Analogue Scale) of McGill Short Questionnaire was used to measure the intensity of pain.

Headache duration: The mean number of hours the pain lasted last week.

Pain frequency: The number of days a person had a headache in the last week (23).

Evaluation of active cervical range of motion

The patient sat on a chair with back support. Then, flexion, extension, lateral flexion and rotation to the right and left measured by OptiTrack motion analyzers. Markers of OptiTrack motion analyzers were attached on the right and left acromion, forehead and sternum. At the command of the examiner, the patient performed the movements. The patient repeated each movement three times. Ultimately, the range of motion was recorded in Motive software and processed with Matlab (27).

Flexion-Rotation test

The rotation between the atlas and axis neck vertebrae was passively measured by this test. The validity of this test was reported as good (ICC: 0.8) by Yodas et al. (1992) (28). To perform the test, patient was crook lying. Then, the examiner locked the lower cervical vertebra and turned the head to the right and left. The test was performed three times (27).

Craniocervical flexion test

The patient was supine. An adjustable compression biofeedback device was placed under the neck adjacent to the sub-occiput. The pressure of the device was set to 20 mm Hg and the person was asked to move the chin to perform craniocervical flexion (e.g., saying "yes"). In 5 steps, the patient increased the range of motion and increased the pressure in each step by looking at the barometer hands of 2 mm Hg. The pressure was held for 10 seconds in each step that was repeated 10 times. There was a 10-second break between each step. The maximum pressure that the person kept for 10 seconds without error was multiplied by the number of correct repetitions of that stage. This number considered as an index of the endurance of the deep flexor muscles of the neck and control of craniocervical movement (29).

Then, subjects were randomly divided into two groups: mobilization and exercise group.

Patients in both groups received routine physiotherapy treatment including TENS, hot pack, suboccipital muscle release by Greenman method (30,31).

In the mobilization treatment group, the Maitland method, including longitudinal movement maneuvers, central postero-anterior vertebral, unilatral postero-anterior vertebral, transverse vertebral and rotation maneuvers techniques were performed on the three upper cervical joints according to the Maitland method (32). Each technique was applied on both sides for 30 seconds (33).

The patients of the exercise group performed some exercises: craniocervical flexion movement by biofeedback pressure, scapula adduction, shoulder abduction and external rotation, stretching exercises for trapezius. Exercises were completed in three sets with 10 repetitions under the supervision.

Patients were treated in 12 sessions three days a week for four weeks (23,17). All the variables were measured before, after and one-month after the end of treatment.

Data analysis

Results were presented as mean values and standard deviation (SD). Criterion of significancy was set as $p<0.05$. Data analysis was performed with SPSS version 17. The assumption of a normal distribution was assessed using the K-S test. The assumption of equality of variances was tested using Levene's test. The ANOVA Repeated measurement test was used for within- and between-group comparisons.

Results

Using an experimental study, the sample size of twenty-six subjects was estimated for two groups (n=13 per group). Demographic information of the patients is given in Table-1. There were no differences between the two groups in terms of demographic characteristics ($p> 0.05$).

Table 1. Demographic and baseline characteristics of subjects

	Mobilization Group (n=13)	Exercise Group (n=13)	p-value
Age (year)	38.5±0.4	37.9±0.4	0.4*
Weight (kg)	69.6±15.4	74.2±13.5	0.3
Hight (m)	1.73±7.6	1.75±4.7	0.3
Gender (male/female)	3/10	4/9	0.6

*Significant P<0.05.

The normality of the data was determined using Kolmogorov-Smirnov test with the results indicating the normality of the distribution of the variables examined (p <0.05). The within group and between group results were compared using ANOVA Repeated measurement test.

To ensure the accuracy of the randomization process, we compared the pre-study data of the two groups. The results showed that there was no difference between the two groups in variables before intervention (p> 0.05).

After 12 sessions of treatment, in the mobilization group, all variables had a significant improvement (P <0.05) except the cervical right rotation and right lateral flexion (p>0.05). After one month of follow-up, some of variables showed significantly changed (p<0.05). In the exercise therapy group, all variables had a significant improvement (P <0.05). At one-month follow-up, some of variables showed significantly changed (p<0.05) (Table-2).

Table-2. Means and standard deviations of variables, and p-values for within and between group comparisons

	Mobilization group (n=13)			p-value before/after**	p-value after/follow-up	Exercise Group (n=13)			p-value before/after	p-value after/follow-up	p-value between group
	Before*	After	Follow-up			Before	After	Follow-up			
Pain Intensity	6.1±1.6	1.3±1.7	2.5±1.1	0.00	0.00	6.7±1.1	2.2±2.0	1.9±1.8	0.00	0.00	0.07
Pain-Frequency	4.08±1.5	0.6±0.4	1.3±0.7	0.00	0.00	4.4±2.0	0.7±0.5	0.9±0.7	0.00	0.33	0.31
Pain-Time	7.6±4.6	1.5±1.4	2.1±1.5	0.00	0.01	9.3±5.2	1.8±1.1	1.2±1.1	0.00	0.24	0.42
Headache Disability Index (HDI)	44.1±19.6	24.4±13.3	25.3±13.7	0.00	0.21	56.4±17.1	34.9±17.1	34.7±16.7	0.00	0.88	0.74
Craniocervical Flexion Test	21.8±11.9	59.6±21.5	50.0±21.1	0.00	0.00	31.5±20.0	94.6±45.8	82.1±46.9	0.00	0.00	0.03
Cervical Flexion	41.6±6.9	49.8±7.5	48.6±7.2	0.04	0.09	45.1±8.5	59.9±11.1	59.7±10.7	0.00	0.83	0.13

Cervical Extension	41.9±9.6	51.1±11.0	48.3±10.3	0.00	0.00	49.4±14.1	60.2±16.7	59.0±16.3	0.00	0.00	0.59
Cervical Right Rotation	44.0±14.9	65.5±15.2	62.7±12.9	0.14	0.10	44.2±12.4	65.5±12.3	63.5±11.2	0.00	0.00	0.98
Cervical Left Rotation	45.5±13.3	55.9±15.3	54.5±14.5	0.00	0.03	50.5±12.9	66.3±15.2	64.3±13.7	0.01	0.03	0.36
Cervical Right Lateral Flexion	35.5±2.5	40.8±1.6	39.5±1.9	0.15	0.02	31.6±6.1	43.8±5.3	42.7±5.3	0.01	0.01	0.11
Cervical Left Lateral Flexion	33.8±3.4	41.5±1.7	41.1±1.3	0.01	0.27	30.8±4.0	44.3±1.9	43.3±1.9	0.00	0.00	0.06
Right Flexion-Rotation	23.2±5.3	39.8±2.2	38.1±1.8	0.00	0.00	26.2±2.3	37.0±6.11	36.0±5.3	0.04	0.10	0.31
Left Flexion-Rotation	22.7±4.5	40.4±2.3	38.0±2.0	0.00	0.00	29.3±2.5	42.6±0.5	42.0±1.0	0.01	0.18	0.15

* Values are means ± SD

** Significant P<0.05.

Subjective variables like pain intensity, headache frequency, headache duration and disability index after treatment did not show any significant difference between two groups (P>0.05).

The changes in craniocervical flexion test between the two groups were significant (P=0.02). The mean craniocervical flexion test was 59.64 ± 21.55 in the mobilization group and 94.60 ± 45.83 in the exercise therapy group.

There were not significantly difference between group in cervical range of motion and upper cervical range of motion (p>0.05).

Discussion

Overall, the results show that both passive and active interventions are effective in reducing the patient's subjective symptoms. Also, exercise is more effective than mobilization in Craniocervical Flexion Test. Both treatments have been effective in increasing the range of motion of the cervical region, but in the exercise group, the changes of range of motion are clinically significant. Upper cervical rotation was shown more changes in mobilization group than exercise group.

Many studies have shown that joint mobilization thought provocation muscle receptors and joint receptors can active the nervous inhibitory system due to stimulating Aβ fibers and the secretion of enkephalin and beta-endorphins. Overall, the activation of these pathways and afferents will reduce pain and reduce the pain (33,34,35). Furthermore, the physiological effects of mobilization like increased blood flow and increased skin temperature in the area, can reduce pain (34,36). By mobilizing and stretching the soft tissues around the joint, including ligaments and joint capsules, stress and pressure are removed from the fast joints, and there is a decrease in pain receptor activity by reducing the mechanical stress on the joints (17,36).

Mobilization seems to relax deep extensor muscles and facilitate contraction of deep flexor muscles of the neck. Therefore, it can improve craniocervical control and increase the range of motion by breaking the adhesions and stretching the tissues around the joints, improving cervical movements and reducing pain (23,37,38). Similar results were obtained in this study too. In the mobilization group, the improvement was obtained in most of the variables.

In the exercise therapy group, scapula stabilization exercises could increase the range of motion and reduce the compensatory movements of the joints by supporting the weight of the limbs and shoulder girdle and stabilizing the shoulder girdle (26,38). By modifying the patient posture, the extra forces and pressures are removed from the pain-sensitive structures and the pain is reduced and function is improved (26). Increased endurance and muscle strength gained during active training are among the other factors able to increase in cervical movements, better performance, reduce disability and thus reporting more patient satisfaction (39). Overall, by relieving muscle imbalance and muscle shortening, reducing the activity of sub-occipital extensors and strengthening deep neck flexor muscles reduce pain, muscle stiffness and improve cervical range of motion (23,40). Given the evidence stated, active exercise can be effective in improving the patient's symptoms, reducing disability and increasing range of motion. The same result is obtained in the present study. Improvement in the parameters stated was seen in the exercise group. In the exercise group, the pain intensity variable had a significant decreasing trend after the end of treatment. It seems that exercise has been more effective in reducing subjective symptoms compared to the mobilization group. Moreover, the rate of the disability index in the exercise group remained constant and did not change. The positive effects of active exercise seem to be more stable than passive therapies.

Consistent with our study, Jull et al. (2002) compared manipulation with exercise therapy in patients with CGH, and, they reported reducing the pain and disability, and control of upper cervical movement in both groups (23). In a sample report, Patersen (2003) reported a reduction in pain intensity, improved function, and better control of upper cervical movement by mobilizing the cervical vertebrae and prescribing exercises similar to our study. He explains that the reason for reducing pain and improving movement control is improving muscle performance and reducing the pressure on the passive system of the joints (41). Ylinen et al. (2010) showed a reduction in headache severity in CGH patients after exercise. The reason was the improvement of the balance between shortened and weakened muscles in the cervical region (39). McDonnell (2005) show reducing of pain parameters and disability in a 46-year-old man after specific scapular and craniocervical exercises, which is in line with the results of the exercise group in our study (26). Hall et al. (2007) reported the effects of mobilization on reducing pain and improving cervical range of motion (36). Additionally, Shin and Lee (2014) reported a reduction in the severity and duration of headache and an improvement in function after 12 sessions of mobilization by Mulligan's (SNAG) technique, which is in line with our findings in the mobilization group (22). Malo-Urres et al. (2017) reported a significant reduction in headache severity by mobilization of the upper vertebrae of the cervical in 41 patients with cervicogenic headache that is in line with our results in the mobilization group (42).

The results indicate that in both groups, exercise therapy and mobilization, control of upper cervical movement were effective. The mean of changes in the exercise therapy group was more than that of the mobilization group. However, the follow-up outcomes in both groups indicated a decreasing tendency in the test, implying that further treatment seems to be needed to maintain the control of upper cervical movements. Nonetheless, the process is overall in favor of the exercise group, and active exercise is more effective than passive exercises like mobilization. Lack of optimal control of cervical movement because of deep flexor muscles weakness, muscle imbalance in cervical and shoulder girdle muscles in people with cervicogenic headache is clear (26,43). Hence, attention to these muscles is of the main conditions for the treatment of these people (23). Thus, it is expecting that control of upper cervical movement more occur after the exercise therapy than the mobilization techniques. That is significantly seen in the study.

The range of motion of the cervical in the exercise group was significant and clinically, significant changes were seen in the present study. Regarding the methods and mechanisms of pain control, posture correction and improvement of postural control, the increase in cervical range of motion seems clear. The findings showed that the effects were more stable in the exercise group compared to the passive mobilization technique group, which can be justified considering the role of muscles in better control of movements and posture correction and enhancing muscle strength and endurance. It may be better to use active exercises besides the passive ones for the constancy of the results.

Conclusion

The study recommends that both mobilization and exercise therapy are effective in relieving headache parameters, and headache disability index, although active exercise is more effective than passive therapy in the stability of the reduction in patient symptoms. Additionally, the improvement in the control of upper cervical movements and cervical range of motion in exercise group was more than the mobilization group. Hence, active exercises are recommended besides passive therapies for more stability of the treatment outcomes and more effects. Upper cervical rotation was shown more changes in mobilization group than exercise group.

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Authors' contributions

All authors made substantial contributions to conception, design, acquisition, analysis and interpretation of data.

Conflict of interest

The authors declared no conflict of interest.

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