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Effects of joint manipulation in the upper cervical spine on the signs and symptoms of subjects with headache: a blind, clinical trial

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Background: There is a relationship between headaches and dysfunctions in the upper cervical spine and joint manipulation in this region can be a useful tool for returning tissue mobility and improving the symptoms of these individuals. **Objective:** to evaluate the effects of 3 sessions of manipulation of the upper cervical spine on pain, cervical mobility, Neck Disability Index (NDI) and the Migraine Disability Assessment (MIDAS) questionnaire of individuals with headache. **Methods:** 13 volunteers (28.1 ± 6.7 years) with headache participated. Initially, they filled in a pain diary for 4 weeks. After this period, the volunteers answered the NDI questionnaire and MIDAS. Then, the movements of the cervical spine were measured with the aid of a tape measure, with the volunteer seated. Subsequently, the intervention was performed (3 sessions with an interval of 7 days between them), with the volunteer in the supine position and the global maneuver for the upper cervical spine was applied bilaterally. At the end of the intervention, they were reassessed for cervical mobility and for the NDI and MIDAS questionnaires. After that period, they answered the pain diary again for another 4 weeks (follow up). The statistical analysis consisted of the Kolmogorov-Smirnov normality test followed by ANOVA tests with post hoc and tukey or paired Student's t test with a significance level of 5%. **Results:** There was a significant improvement after the cervical mobility intervention, in the MIDAS and NDI questionnaires. The pain parameters, assessed by the pain diary, were significantly reduced during the intervention and remained in the follow up. **Conclusion:** the intervention was effective in reducing the signs and symptoms of individuals with headache.
Keywords: Cervical Spine; Osteopathic Medicine; Tensional Headache; Pain.

BACKGROUND

Headaches are among the most common diseases and, according to the World Health Organization, a large part of the population has been or will be affected by this symptom. However, the minority of people with headache disorders worldwide are adequately diagnosed by a health care provider and, therefore, headaches have been underestimated, under-recognized and under-treated throughout the world[1]. Headache can be defined as any pain that is felt in the head segment and can be classified as primary (when pain is not a symptom of another pathology) or secondary to another disease. Among primary conditions, migraine and tension-type headache are the most common and disabling[2]. The latter is the most common form of headache, both in adults and adolescents[3]. In addition, tension-type headache can cause substantial levels of disability for patients and their families as well as for society as a whole due to the high prevalence in the general population[4].

Regarding pain, studies have shown that the cervical spine shows hyperalgesia responses in children with headache[5], and they also suffer from neck pain[6] and that this is a negative prognostic factor for headache. Thus, some authors suggest an evaluation of the cervical spine when the subject has headache[7].

The diagnostic criteria formulated by the international cervicogenic headache study group include: unilateral headache without changing sides; pain occurring with movement of the neck; pain during head support in an unconventional position and / or external pressure on the upper cervical or occipital region; restriction of cervical mobility; ipsilateral neck, shoulder and arm pain[8]. In fact, cervical disorders have traditionally been linked to different types of headaches[9]. For example, reduced neck mobility has been found in subjects suffering from cervicogenic headache[10] and chronic tension-type headache (CTTH), but not in subjects with migraine[11].

Thus, it is important that the evaluation and intervention in the cervical spine are part of the approach of the patient with cervicogenic headache. Mayoralas et al.[12] assessed the cervical mobility of children with and without headache and found that those who had headache showed less cervical mobility for flexion, extension and right and left inclinations, but not for rotation, when compared to children without headache. Fernandez de las Penãs et al.[11] found decreased cervical mobility in adults with CTTH. The treatment of this type of headache is challenging[2].

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Medications, physiotherapy resources and also osteopathy can be used to prevent painful crises and treat primary headaches. Among osteopathic resources, joint manipulation stands out, a non-invasive treatment technique that consists of a short-range, high-speed impulse that, if applied to the vertebra, aims to increase joint range of motion (ROM)(13) and generate a neurophysiological stimulus, which occurs by correcting the central facilitation(14).

The basic principle of joint manipulation is to treat somatic dysfunction, which can be defined in different ways, by different authors(15-20). All definitions suggest that there is a decrease in mobility and neurophysiological changes (alteration of sensitivity, motor and biochemical) in dysfunctional tissue.

As an effect of joint manipulation an increase in the range of articular movement and correction of central facilitation are expected, with a consequent improvement in motor control of the symmetry of the muscles innervated by the manipulated metameric level(15), and an increase in the pressure pain threshold (PPT) in tissues innervated by the manipulated metameric level(21).

The relationship of the cervical spine to the head can be explained by the convergence of afferent nerve fibers from regions of the head (dura mater, and mucous membranes) and from the cervical spine to the trigeminal caudal nucleus(22). According to the same authors, it is possible that nociceptive afferences originating in cervical structures may influence the excitability in the trigeminal caudal nucleus, promoting the maintenance of headache.

Anatomically, the afferent fibers of the trigeminal nerve and the 3 upper cervical nerves converge with 2nd order sensory neurons in the dorsal horn of the spinal cord of the upper cervical spine. This convergence is the anatomical basis for the clinical observation that patients with cervicogenic headache may experience headache in tissues innervated by these cervical and trigeminal levels(23).

The upper cervical spine also has a direct relationship with the upper cervical ganglion (ganglion of the sympathetic nervous system) which is located at the level of the C1 and C2 vertebrae. It is a large ganglion and the post-ganglionic fibers depart from it through cephalic arterial branches to form the internal carotid sympathetic plexus and enter the cranial cavity. It also sends arterial branches to the external carotid artery and gray branches to the anterior branches of the four upper cervical spinal nerves(24).

Due to the close relationship between the upper cervical spine and the cephalic segment, as explained, the objective of the present study was to evaluate the immediate and late effects of 3 joint manipulation sessions on the upper cervical spine on the frequency and intensity of headache, the cervical mobility and the neck disability index of subjects with headache.

METHODS

Thirteen volunteers, of both genders, participated in the study, 11 of which were female (28.7 ± 7.0 years old; 66.1 ± 15.1 Kg; 1.66 ± 0.10 meters and Body Mass Index of 23.7 ± 3.8 Kg/m^2) and 2 were male (24.5 ± 3.5 years; 79.5 ± 13.4 Kg; 1.77 ± 0.10 meters and Body Mass Index of 25.2 ± 4.4 Kg/m^2). All volunteers signed an informed consent form and the project was approved by the Einstein University Human Research Ethics Committee with number 16-03/268.

Inclusion criteria were age between 18 and 40 years and the presence of headache according to MIDAS (Migraine Disability Assessment) questionnaire. Exclusion criteria were subjects: with the presence of tumors of any kind; who were under continuous treatment for headache and depression; having undergone any surgical procedure on the skull and/or cervical; Klein and/or Sharp-Pursen tests positive; patients with systemic, neurological or rheumatological diseases, osteoporosis, rhinitis and / or sinusitis; and who were undergoing orthodontic treatment. The research (evaluation and intervention) was carried out at the physiotherapy clinic of the Faculdades Integradas Einstein de Limeira/SP.

Procedures

Four weeks before starting the treatment protocol, all volunteers filled out a diary of pain to complement the diagnosis. This diary was used to calculate the intensity of the headache; the frequency of headache (calculated by dividing the number of days with headache by the number of weeks analyzed, days/week) and the pain index (calculated by the number of mild crisis x 1 + number of moderate crisis x 2 + number of severe crisis x 3)(12).

After filling in the pain diary, all volunteers underwent an initial assessment, in which they answered the questionnaire called neck disability index (provides information on how neck pain affects a subject's ability to perform activities of daily living) and the MIDAS questionnaire, which presents five questions regarding headache episodes and what is the impact of these episodes on work and activities of daily living.

Then, the cervical spine movements were measured with the aid of a tape measure. For this assessment, the individual remained comfortably seated on a chair with the trunk supported on the back of the chair, feet on the floor and hips and knees in 90º flexion.

In this position, the range of motion of flexion, extension, right and left inclination and right and left head rotation were measured. To assess head flexion and extension, the volunteer was instructed to lower his head, trying to rest his chin on his chest (flexion) and raise his head as much as possible and look at the ceiling (extension). At the maximum amplitude of each movement described above, with the tape measure, the distance from the chin to the sternal notch was measured (in centimeters).

The inclination movements (to the right and left) were measured, asking the volunteer to tilt the head and neck to the right or left, taking the ear towards the homolateral shoulder. With the tape measure, the distance from the earlobe to the most lateral region of the acromion was measured (in centimeters). Rotation movements to the right and to the left were performed by asking the volunteer to rotate the head, bringing the chin towards the shoulder, without compensation. With the measuring tape, the distance from the mentum to the most lateral region of the acromion was measured, in centimeters. It should be noted that the evaluator remained alert for movement compensations that could occur, especially at the level of the shoulder girdle and, if it happened, the measurement was discarded and a new collection was performed.

After the evaluations described above, the volunteers underwent an intervention protocol that consisted of applying a joint manipulation maneuver of the upper cervical spine, performed bilaterally. The purpose of this technique is to unspecifically fit the occipital joints with C1 and C1 with C2, in rotation. For this purpose, the volunteers were positioned in supine position on a stretcher. The researcher remained standing, at the height of the volunteer's head, on the side to be manipulated.

The cephalic hand made contact with the opposite side of the volunteer's skull, leaving the sternocleidomastoid muscle between the third and fourth fingers. The caudal hand made global contact with the volunteer's skull on the same side that the researcher was on: fifth finger below the mandibular region, fourth finger on the mandibular region, third finger on the maxilla, second finger on the zygomatic bone and first finger on the temporal bone. The researcher tilted his torso over the volunteer's head, leaving his forearms aligned on the axis of the volunteer's spine, and maintained a neutral flexion-extension position and placed the rotation parameter to the opposite side (70-80 degrees) and a small contralateral inclination (figure 1).

Then, the researcher sought the restrictive barrier with a small axial traction movement. When this barrier was found, an impulse was applied in a helical direction, increasing rotation and traction. The same procedure was repeated on the other side. If cavitation did not occur in the first maneuver, a maximum of two more maneuvers were attempted. If there was no cavitation after the third attempt, the segment was considered to be manipulated.

Figure 1. Positioning of the researcher and the volunteer for the application of the manipulation maneuver of the upper cervical spine.

Two more interventions were carried out, with an interval of 7 days between them. At the end of the third intervention, measurements of cervical mobility were performed, in the same way as the initial assessment.

Seven days after the last session, the volunteer returned to the clinic only for a final reassessment, which included filling the neck disability index, the MIDAS questionnaire, delivering the pain diary, in addition to assessing cervical spine mobility (to assess the late effect of the technique). At this stage, the volunteers received a new pain diary and filled it in for a month after treatment to evaluate the follow-up.

Statistical analysis

It was used the Instat software version 3.0. Initially, the Kolmogorov-Smirnov normality test was performed. As the data presented a normal distribution, ANOVA tests followed by the post hoc were applied for the comparison in the different evaluation periods (previous month, during the intervention and follow-up) and the paired T test for the comparison before and after the intervention. In all analyzes, a critical level of 5% (p <0.05).

RESULTS

Pain diary

Regarding the pain diary, the frequency of headache crisis, the pain index and the intensity of pain during headache crisis were evaluated before (previous month), during interventions and follow up (4 weeks after the end of proposed treatment).

It can be seen in Table 1 that there was a significant reduction in the frequency of headache crisis during the intervention and in the follow up (from 7 ± 3.4 crisis in the previous month to 3.5 ± 1.8 crisis during the intervention and 2.5 ± 1.7 crisis one month after the last intervention). There was no significant difference between the periods during the intervention and follow up, which means that the effects of the manipulation were maintained for at least one month after treatment.

Table 1 shows that, in the month prior to treatment, the pain index was 14.2 ± 6.7. There was a significant reduction in this index during the intervention (7.2 ± 4.6) and in the follow up (5.8 ± 4.0). There was no significant difference between the period during the intervention and follow up, indicating that results of the treatment remained one month after the end of the it.

Regarding the number of crises, it can be seen in Table 1 that, during the intervention period and in the follow-up, there was a significant reduction in the number of moderate crises, which went from 3.5 ± 2.5 crises/month (previous month) to 1.7 ± 1.5 crises/month (during the intervention) and 1.4 ± 1.4 crises (follow up). There was a significant reduction in the number of mild crises in the follow-up (0.1 ± 0.3 weak crises/month) when compared to the previous month (1.8 ± 2.0 weak crises/month). With regard to severe crises, there was no significant difference between the different assessment periods (1.8 ± 1.2 in the previous month, 1.0 ± 1.2 during treatment and 1.0 ± 0.9 in follow up).

Table 1. Mean values ± standard deviation of the pain diary referring to the frequency of headache crisis, pain index and number of crisis (mild, moderate and severe) in the different evaluation periods: Previous month (one month before starting the intervention); during the intervention and follow up (one month after the end of the intervention), n = 13.

	Month before	During intervention	Follow-up
Crisis frequency	7.0 ± 3.4	3.5 ± 1.8*	2.5 ± 1.7*
Pain index	14.2 ± 6.7	7.2 ± 4.6*	5.8 ± 4.0*
Number of crisis			
Mild	1.8 ± 2.0		0.1 ± 0.3*
Moderate	3.5 ± 2.5	1.7 ± 1.5*	1.4 ± 1.4*
Severe	1.8 ± 1.2	1.0 ± 1.2	1.0 ± 0.9

***Note:** p <0.05 in relation to the previous month.

Range of motion of the cervical spine

Regarding the mobility of the cervical spine, Table 2 shows the amplitude of the flexion, extension, right and left lateral inclination, right and left rotation. There was a significant improvement after the 3rd intervention session in the flexion movements, right lateral inclination and right and left rotation. 7 days after the end of the intervention, only the flexion and rotation movements to the left differed significantly from the pre-intervention period.

Table 2. Mean ± standard deviation of the cervical range of motion (cm) of flexion, extension, right lateral inclination (IR) and left lateral inclination (LI) and right rotation (RR) and left rotation (LR), before the intervention, after the 3rd session and 7 days after the last intervention session, n = 13,

	Pre	Post 3rd Session	Post 7
Flexion	3.3 ± 2.0	2.0 ± 1.5*	1.9 ± 1.5*
Extension	19.6 ± 2.3	19.8 ± 2.1	19.7 ± 1.9
RI	10.8 ± 2.2	9.5 ± 1.8*	9.7 ± 2.3
LI	10.7 ± 2.4	9.8 ± 1.8	10.1 ± 1.9
RR	10.3 ± 2.1	9.4 ± 2.2*	8.7 ± 2.5
LR	10.9 ± 1.8	9.3 ± 2.0*	9.6 ± 2.2*

***Note:** * p <0.05 in relation to the pre-intervention period.

Questionnaires

Regarding the questionnaires used in the study, it can be seen in Table 3, that there was a significant reduction in the score of the neck disability index, demonstrating that the proposed protocol was effective in reducing the functional limitation that the group had before treatment.

Table 3. Mean ± SD of the scores of the Neck Disability Index (NDI) and Migraine Disability Assessment (MIDAS) questionnaire (general score, frequency of pain and intensity of pain) before the intervention and 7 days after the last intervention session, n = 13.

Questionnaires	Pre	Post 7	p
NDI	12.4 ± 6.0	7.4 ± 5.8*	0.0115
MIDAS Overall score	19.7 ± 21.1	8 ± 9.8*	0.0057
MIDAS Pain frequency	21.3 ± 11.5	9.2 ± 5.1*	0.0016
MIDAS Pain intensity	7.5 ± 1.5	5.6 ± 2.4*	0.002

***Note:** * p <0.05 in relation to pre-intervention period.

The MIDAS questionnaire, specific for headache, was also applied before and after the interventions. It was found that, after the proposed treatment, there was a significant reduction in the 3 indexes evaluated. The volunteers showed a significant reduction in the general score of the questionnaire, a reduction in the frequency of headache crisis, as well as in the intensity of the pain of these crisis.

DISCUSSION

The volunteers probably had decreased cervical mobility, as found Zito, Jull and Story[25], who evaluated volunteers who had cervicogenic headache, migraine with aura and control volunteers and found less ROM of cervical flexion and extension, in addition to dysfunction of the upper cervical joint and a higher incidence of pain and muscle stiffness in the cervical region in symptomatic volunteers.

There was an increase in the range of motion of flexion and head rotation after intervention, results that agree with Zwart[26], screened volunteers with headaches of different types and restricted head movement, assessed the effects of 3 interventions with joint manipulation on the range of movement of the head and found increased flexion and right and left rotation movements. Both studies found significant improvement in ROM especially in flexion and right and left rotations and not in inclinations. The most significant improvement for cervical rotations can be justified by the anatomy of the joint between C1 and C2, which presents the articular facets with a 20º inclination in the transverse plane, which allows for wider rotation movements than at other cervical levels[27].

The increase in amplitude was probably due to the way the manipulation was performed, in which the therapist took the joint, passively, up to the movement barrier and then performed a quick and short movement, passing the restrictive barrier, but not crossing the anatomical barrier, thus restoring the amplitude that was limited.

There was a decrease in the intensity and frequency of headache, a decrease in disability due to neck pain and a decrease in the MIDAS score after intervention. These results agree with several authors[28-31].

Gross et al.[28] concluded that joint manipulation applied to the cervical spine is more effective than massage and transcutaneous electrical stimulation in decreasing pain and improving the function of volunteers with cervicogenic headache.

Molina[29] developed a literature review on the efficiency of joint manipulation of the upper cervical spine on the dysfunction of these joints and headache. Efficacy was considered good when measured during and immediately after treatment and moderate from 3 to 6 months after the intervention.

Nilsson, Christensen and Hartvigsen[30] compared the effects of joint manipulation and the use of low-intensity laser in the upper cervical region associated with deep friction massage therapy on the pain of volunteers with headache and concluded that both interventions reduce the frequency of symptoms and that manipulation was more effective in decrease in pain intensity.

Jull et al.[31] evaluated the effects of isolated joint manipulation, low-load exercises and the combination of the two, for 6 weeks, in volunteers diagnosed with cervicogenic headache and found a decrease in the frequency and intensity of the headache in the three groups evaluated, with the results remaining until 12 months after treatment.

These results were probably due to the neurological relationship between the upper cervical spine and the head, via the trigeminocervical nucleus, due to the relaxation of the suboccipital muscles and the consequent decrease in tension in the dura mater because of the connection between these structures and also because of the greater possibility of biomechanical adaptation of volunteers in response to chronic pain and access of joint manipulation to pain modulators[32].

Joint manipulation should be encouraged in the treatment of tension headache, but it still needs to be proven effective[33], although it proves to be more efficient than massage and equivalent to the drugs normally prescribed[34]. This type of maneuver can have an effect on muscle activity by stimulating mechanoreceptors and deep muscles, interfering with the excitability of the alpha motoneuron[35], besides being able to interfere in the descending pain inhibition pathways, generating analgesia[36].

The trigeminocervical nucleus, which probably received interference from the maneuvers, is responsible for receiving nociceptive stimuli from the cranial, mandibular and cervical region[37], therefore, this is one of the ways in which manipulation in the upper cervical spine interfered with the symptoms of the cranial region. Other therapeutic proposals also used this route, such as the use of anesthetic block in the C1-C2 and C2-C3 zygapophyseal joints, which generated an immediate reduction in headache[38].

Another route of action was the probable relaxation of the deep muscles, which would decrease the tension in the cranial dura mater due to the continuity between the posterior minor rectus muscle of the head and the atlanto-occipital membrane, which is closely related to the dura mater[39].

There may also have been analgesia induced by joint manipulation via attenuation of somatosensory cortical responses[36].

In this sense, the manipulation applied to the upper cervical spine had an effect on the two approaches proposed by Lederman[32] for osteopathic management of chronic pain, facilitating the adaptation of volunteers in face of the demands that are imposed on the cervical spine during daily activities, as well as interfering in pain through the action in the somatosensory cortical pathways.

This study presents, as limitations, the non-use of a control or placebo group to compare the effects of the interventions, as well as not using a gold standard assessment to quantify ROMs of the head.

CONCLUSION

In view of the experimental conditions performed, it can be concluded that 3 sessions of manipulation of the upper cervical spine reduced the frequency of headache crisis, as well as the pain index and intensity, as well as the disability generated by the headache (MIDAS) and the NDI. In addition, it improved the range of motion of the cervical spine, especially for the flexion and rotation movements to the right and left in subjects with headache complaints.

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