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COMPARISON OF CONVENTIONAL PHYSICAL THERAPY AND MULLIGAN MOBILIZATION TECHNIQUE IN THE TREATMENT OF CERVICOGENIC HEADACHE

ORIGINAL ARTICLE

ABSTRACT

Purpose: The aim of this investigate the effectiveness of the conventional physical therapy and Mulligan mobilization technique in the treatment of Cervicogenic Headache (CH) and to compare the effectiveness of these two methods.

Methods: A total of 40 patients with CH were randomized into conventional physical therapy group (Group 1, n=20) and Mulligan mobilization group (Group 2, n=20). Neck lordosis, range of motion (ROM), Cervical Performance Tests, Visual Analogue Scale (VAS), Neck Disability Index, Beck Depression Scale measurements were recorded at baseline and at two weeks after the treatment.

Results: VAS, Neck Disability Index and Beck Depression Scale decreased and ROM, cervical performance and lordosis angle increased significantly in both groups (p=0.010).

Conclusions: Both treatments were found to have positive effects on radiological and clinical findings of CH, but Mulligan mobilization technique was found to be more effective in all evaluations except neck extension and right lateral flexion ROM measurements.

Keywords: Exercise Therapy, Headache, Musculoskeletal Manipulations, Neck Pain, Physical Therapy Modalities

SERVİKOJENİK BAŞ AĞRISI TEDAVİSİNDE KONVENSİYONEL FİZİK TEDAVİ İLE MULLIGAN MOBİLİZASYON TEKNİĞİNİN KARŞILAŞTIRILMASI

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Bu çalışmanın amacı Servikojenik Baş Ağrısı (SBA) tedavisinde konvansiyonel fizik tedavi ve Mulligan mobilizasyon tekniğinin etkinliğini araştırmak ve bu iki yöntemin etkinliğini karşılaştırmaktır.

Yöntem: SBA'lı toplam 40 hasta konvansiyonel fizik tedavi grubu (Grup 1, n=20) ve Mulligan mobilizasyon grubu (Grup 2, n=20) olarak randomize edildi. Boyun lordoz açısı, eklem hareket açıklığı (EHA), Servikal Performans Testleri, Visuel Analog Skalası (VAS), Boyun Özür İndeksi, Beck Depresyon Ölçeği ölçümleri tedavi öncesi ve tedaviden iki hafta sonra kaydedildi.

Sonuçlar: Grup içi karşılaştırmada; VAS, Boyun Özür İndeksi ve Beck Depresyon Ölçeği her iki grupta da anlamlı olarak azaldı; EHA, servikal performans testleri, lordoz açısı ise anlamlı olarak arttı (p=0,010). Gruplar arası karşılaştırmada; servikal ekstansiyon ve sağ lateral fleksiyon hariç tüm boyun EHA değerleri grup 2'de servikal performans testi, boyun lordoz açısı daha fazla arttı. Ayrıca VAS, Boyun Özür İndeksi ve Beck Depresyon Ölçeği değerleri Grup 2'de daha fazla azaldı.

Tartışma: Her iki tedavinin de SBA'nın radyolojik ve klinik bulguları üzerinde olumlu etkileri olduğu ancak Mulligan mobilizasyon tekniğinin boyun ekstansiyon ile sağ lateral fleksiyon ROM ölçümü dışındaki tüm değerlendirmelerde daha etkili olduğu bulundu.

Anahtar Kelimeler: Egzersiz Tedavisi, Baş Ağrısı, Kas-İskelet Sistemi Manipülasyonları, Boyun Ağrısı, Fizik Tedavi Yöntemleri

INTRODUCTION

Cervicogenic headache (CH) is one of the common secondary headaches caused by the disorder of the neck region structures (1). The incidence of CH in chronic headaches is 15-20%. It is also known to affect 0.4-2.5% of the general population with females being four times more affected than men (2, 3). There may be a history of trauma as well as prolonged neck flexion or poor static postures in its etiology (3). Although the pathophysiology of CH is not fully explained, it is related to the connection between the nerves arising between the first three cervical vertebrae and the trigemineal nerve (2, 4). CH are thought to arise from musculoskeletal impairments. It is stated that these impairments originate from the joints, muscles, ligaments and other soft tissues in the neck. Some authors are supported atlantoocipital joint, atlantoaxial joint, C2-C3 zygapophysial joint, C2-C3 intervertebral disc, upper cervical spinal nerves and their roots, skeletal muscles and connective tissue in the region as a possible cause of impairment due to the etiology and pathophysiology of CH (3, 5). In the clinic of the disease, unilateral headache from the neck to the eye can be encountered, along with tenderness in the occipital region or upper back cervical muscles, decreased and painful cervical joint movement, and anxiety (6).

Treatments include invasive or non-invasive techniques (7). Physical therapy from noninvasive techniques is used for symptomatic treatment. Patients with CH can benefit from physical therapy techniques such as exercise, ultrasound (US), transcutaneous electrical nerve stimulation (TENS), manuel therapy (2, 6, 8). In patients with CH, joint mobility limitation, poor posture, muscle flexibility, muscle strength and endurance are evaluated and the exercise program is tailored to the patient's needs. In order to correct cervical retraction and to increase neck joint angle, early neck ROM exercises should be started in the early period. Afterwards, isometric neck exercises to increase neck muscle strength, and dynamic endurance training to reduce patient pain and increase function are applied. Also, sensorimotor exercise should include progressive exercises on the unsupported surface to improve postural and reflective stabilization. The last step in the rehabilitation program of patients with CH should be to improve functional activity (3, 9, 10). Hotpack, is a superficial warming agent, and US, warms the deep tissues, are effective in reducing pain (11, 12). TENS is transdermal electrical nerve stimulation to relieve pain and its role in pain reduction is explained by Gate Control Theory (13). The combination of Hotpack, US, TENS and exercises is a widely used treatment for neck pain and semptoms (12), but the effects of this combination have not yet been studied in CH. Mulligan mobilization technique in the treatment of CH which is a special form of manual therapy applied by trained physiotherapists is used to increase joint movement, pain relief, correction of biomechanics. Sustained Natural Apophyseal Glide (SNAG) technique and traction in the upper cervical region from Mulligan mobilization are important applications in the treatment of headache in reducing joint pain and increasing ROM. SNAG is the abbreviation for natural apophysial shifts in zygapophysial joint. Another technique is traction in the upper cervical region is a mild traction applied in extension to treat headaches caused by biomechanical problems. This methods effective on zygapophysial, atlantooccipitalis and atlantoaxialis joints (14).

CH is common in clinical practice seen and routinely treated, but limited research and experts lack of consensus by is one of the subjects (6, 15) and the effectiveness of its techniques has not yet been determined (3). To the best of our knowledge, there are only a few studies in the literature regarding the effectiveness of Mulligan mobilization technique in patients with CH (16-18). Two of these studies compared Mulligan mobilization with the placebo group (17, 18) while the other study compared it with another mobilization technique (16). However, there is no study on the effectiveness of only conventional physical therapy consisting of hot pack, US, TENS and exercise therapy. In addition, in these studies, the effectiveness of Mulligan mobilization was evaluated only with limited clinical measures of pain and functionality. Therefore, in this study, we investigated the effectiveness of the conventional physical therapy and Mulligan mobilization technique used in CH separately on clinical and radiological measurements of the cervical region and compared the effectiveness

of these two methods. The hypothesis of the study was that Mulligan mobilization was more effective than conventional physical therapy in patient with CH.

METHODS

Study design and recruitment of patients

This is a prospective, randomized controlled and pretest–posttest design study. Participants were randomized based on the generated random number for the order of arrival according to the simple randomisation method. The study was approved by Inonu University Malatya Clinical Research Ethics Committee (2016/200). The study was conducted in accordance with the principles of the Declaration of Helsinki and supported by Inonu University Scientific Research Projects Unit (2017/925). At the beginning of the study, patients were informed about the study and their written consent was obtained.

Patients diagnosed with CH by a doctor from Departments of Neurology in Malatya Training and Research Hospital, were screened for eligibility criteria from August 2017 and January 2018. The patients were treated in department of Physical Therapy and Rehabilitation in Malatya Training and Research Hospital. For patients to be eligible, they had to present with a diagnosis of CH according to the diagnostic criteria developed by the International Headache Society (19). Inclusion criteria were as follows: 18-70 years patients with neck pain and unilateral headache that begins and spreads in the neck frontotemporal area at least 5 times during the last 3 months, a minimum average pain intensity of 3 (0–10 scale), limited cervical ROM, tenderness in at least one of the joints of the upper cervical spine (C1-C3). Exclusion criteria were as follows: Specific disorders of the cervical spine, such as disc prolapse, spinal stenosis, post-operative conditions, history of severe trauma, instability, spasmodic torticollis, as well as peripheral nerve entrapment, fibromyalgia, inflammatory rheumatic diseases, severe psychiatric illness and and pregnancy. Patients with headache other than CH, surgery for CH, taking medication for headache, recent history of myocardial infarction, cardiac pacemaker, malignancy history, active infection, metal implant or prosthesis were also excluded.

40 participants (5 males, 35 females) aged 19-69 years with CH meeting these criteria were randomly selected and divided into two equal groups, Group 1 and Group 2, based on the order of arrival.

Outcome measures

At the beginning, demographic information of patients such as age, gender, body mass index (BMI), education, occupation and marital status were questioned. In addition, patients were evaluated from neck lordosis angle, ROM, Cervical Performance Test, VAS, Neck Disability Index and Beck Depression Scale Pre-treatment (PreT) and Post-treatment (PostT).

For neck lordosis angle, lateral radiographs were taken with Siemens Multix digital radiography device (Siemens AG Healthcare Sector, Erlangen, German). It was measured by Cobb method (20).

Neck ROM was measured using universal goniometer (Baseline Evaluation Instrument®, Fabrication Enterprises, Inc., White Plains, NY, ABD) using pivot, fixed arm and movable arm reference points determined according to Kendall-Mc Creary criteria (21).

Cervical muscle performance test, holding time in cervical flexion, extension right and left lateral flexion positions were measured with a chronometer. In the cervical flexion muscle performance test, the patient was instructed to raise the head and hold it while maintaining the chin tuck position. In the cervical extension muscle performance test, the patient was asked to raise the neck while in the prone position. In addition, in the cervical lateral flexion muscle performance test, the patient was asked to raise the neck while lying on the side. The patient rested between each test. All tests were repeated three times and the average of the tests was recorded. Based on the time the patient was able to hold the position, the assessment was as follows: 20-25 sec: functional, 10-19 sec: moderately functional, 1-9 sec: poor functionality, and 0 sec: non-functional. Evaluation of performance tests; 20-25 sec. movement functional, 10-19 sec. movement moderately functional, 1-9 sec. weakly functional, 0 sec dysfunctional (22).

VAS was evaluated in 3 ways as activity, rest and night. They were asked to score between 0-100

(22).

Neck Disability Index is a questionnaire developed to evaluate the functional impairment of neck pain. It consists of 10 parts: pain severity, personal care, load bearing, reading, headache, attention, work, driving, sleeping, and entertainment. There are 6 cases in each section; it is scored between 0-5 (0: best case, 5: worst case). The patient was asked to mark the most appropriate option. Rating is between 0-50. 0-4 points indicate that there is no insufficiency, 5-14 points mean mild insufficiency, 15-24 points mean moderate insufficiency, 25–34 points serious insufficiency and ≥35 points complete insufficiency. This was explained to the patients (22).

The mental state of the patients was evaluated with the Beck Depression Scale. The scale consists of 21 categories and each has four options. Each item has between 0 and 3 points. The total score ranges from 0 to 63 0-9 points are defined as minimal depressive symptoms, 10-16 points are defined as mild depressive symptoms, 17-29 points are defined as moderate depressive symptoms, 30-63 points are defined as severe depressive symptoms (22).

Interventions

Group 1 was applied conventional physical therapy techniques including Hotpack, US, TENS and exercise for 5 consecutive days for 2 weeks. 20 min Hotpack application (Chattanooga Medical Suplly Inc, Chattanooga, TN), 5 min right and 5 min left, US (Chattanooga Medical Suplly Inc, Chattanooga, TN) with 1-1.5 watts / cm^2 dosage was performed in trapezius muscle, upper cervical and occipitovertebral region, which is the most painful cervical region in a sitting position supported by a pillow. Conventional type TENS (Chattanooga Medical Suplly Inc, Chattanooga, TN) with a frequency of 50 Hz and a current transition time of 100 µs was applied to the neck area. Immediately after physical therapy agents, 10 repetitions all-round neck ROM and isometric exercises were performed.

In Group 2 was applied only Mulligan mobilization tecniques including SNAG and traction in the upper cervical region every other day for 3 days for 2 weeks. SNAG technique was performed with the patient sitting upright in a chair. The physiotherapist stabilized the occiput with the index, middle, and ring fingers of one hand while placing the little finger on the C2 spinous process. After placing the hands in this way, the head forearm stabilized by the support and gently push the spinosus process ventrally with the other hand. With this maneuver, C2 slides forward under C1, and therefore C1 moves forward relative to the skull (Figure 1). Upper cervical traction was performed with patient laying supine with the neck in a neutral posture. The physiotherapist placed the proximal part of his forearm under the cervical spine so that the radial border was tucked under the base of the occipital bone. The fingers of the other hand were placed over the patient's chin. The therapist applied traction through pronating the forearm and simultaneously imposed pressure over the chin to provide a translator component so that it was a combination of translation and rotation of the forearm. The force applied to the occiput and chin was equal (Figure 1). Physiotherapist made the movements for 10 seconds in each glide with a rest time of 30 seconds in between and 10 repetitions.

Figure 1. Mulligan mobilization tecniques

(A: SNAG, B: Traction in the upper cervical region)

Statistical Analysis

Statistical analysis was performed with IBM SPSS Statistics version 22.0 statistic package. The minimum required sample size for the study was calculated using G*Power Software (Version 3.0.10 University of Dusseldorf, Germany). The smallest sample size with 0.80 effect size, 5% type I error, 80% statistical power conditions was calculated at least 10 patients in each group. However, in order to increase the power of the research, a treatment group of 20 and

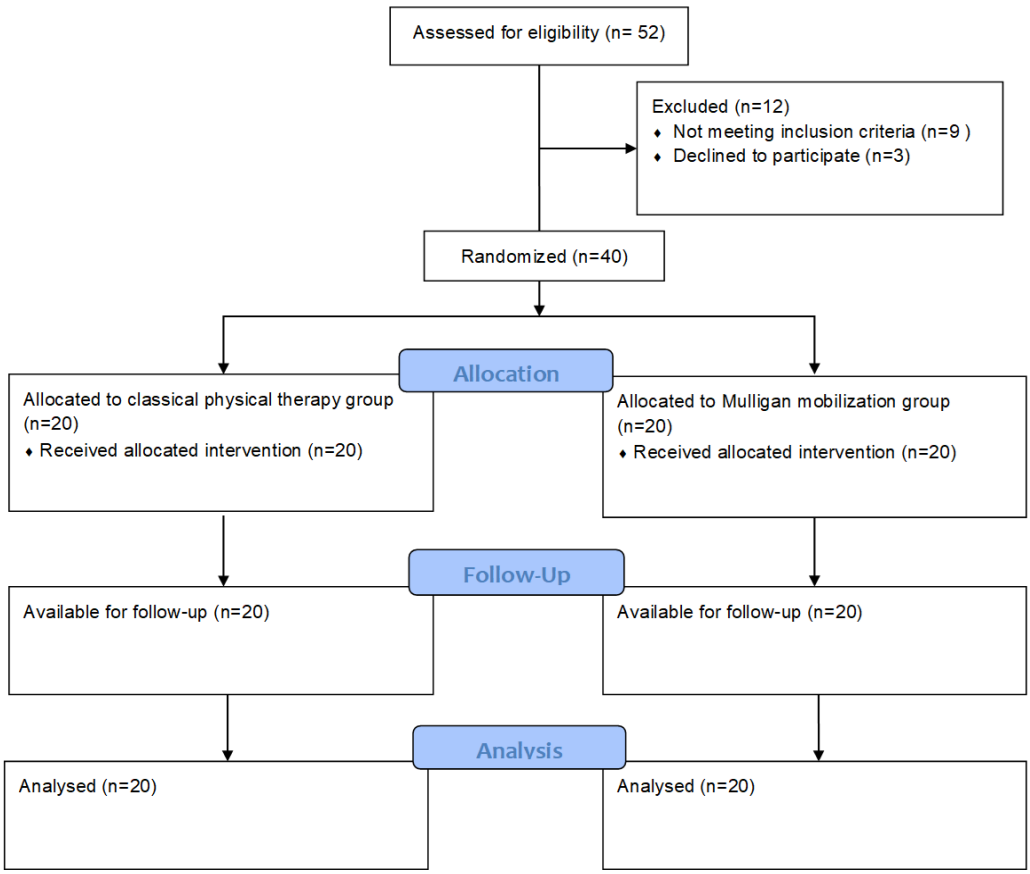

Figure 2. Flow diagram of the study

Table 1. Demographic Distribution of Patients

		Group 1	Group 2	P
Gender	Female	17 (85%)	18 (90%)	0.999
	Male	3 (15%)	2 (10%)	
Age, years		51 (19-69)	40 (23-64)	0.159
BMI, kg/m²		28 (21-34)	26 (21-32)	0.150
Working Condition	Working	3 (30%)	7 (70%)	0.518
	Retired	1 (50%)	1 (50%)	
	Houswife	13 (54.2%)	11 (45.8%)	
	Student	3 (75%)	1 (25%)	

a control group of 20 were randomly selected among 40 patients based on volunteering.

Normality distribution for all continuous variables was evaluated with the Shapiro-Wilk test. It was found that the data were not normally distributed. In the statistical evaluation of this study, the data were summarized by number % (percentage) or median (min-max). Mann Whitney-U Test was used to compare two independent groups in terms of quantitative variables. Wilcoxon Test was used to compare pre-test and post-test evaluations. p <0.05 was considered statistically significant.

RESULTS

A total of 52 patient were eligible to participate in the study. However, 12 patient refused to paticipate to the study were then excluded, thus totaling a sample of 40 patient with CH (Figure 2).

Demographic Findings

There was no significant difference between

groups in terms of gender distribution, mean age, BMI, occupational distribution (Table 1).

Clinical and Radiological Findings

When both groups were evaluated for VAS, the decrease in pain symptoms was more prominent in Group 2 with Mulligan mobilization. Neck extension and right lateral flexion were equally increased in both groups. Neck flexion, left lateral flexion and right-left rotation values were higher in Group 2. The increase in the measurement of cervical performance tests in both groups was found to be more prominent in Group 2 (Figure 3).

The decrease in Neck Disability Index and Beck Depression Scale measurement in both groups were found to be more significant in Group 2. When the increase in neck lordosis angle was compared in both groups, a more significant increase was observed in Group 2 (Figure 4).

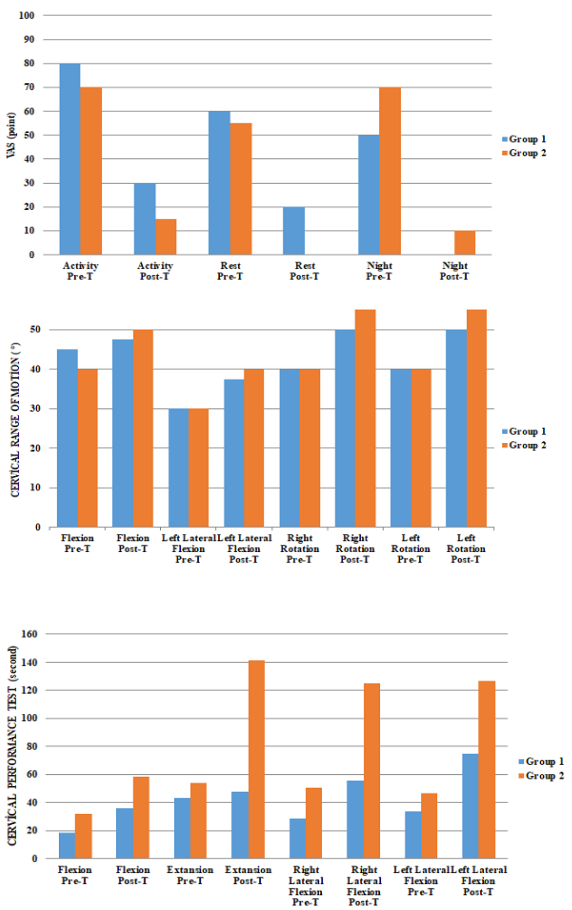

Figure 3. Comparison of VAS, cervical ROM and performance tests in Pre-treatment (Pre-T) and Post-treatment (Post-T) of Group 1 and Group 2 separately

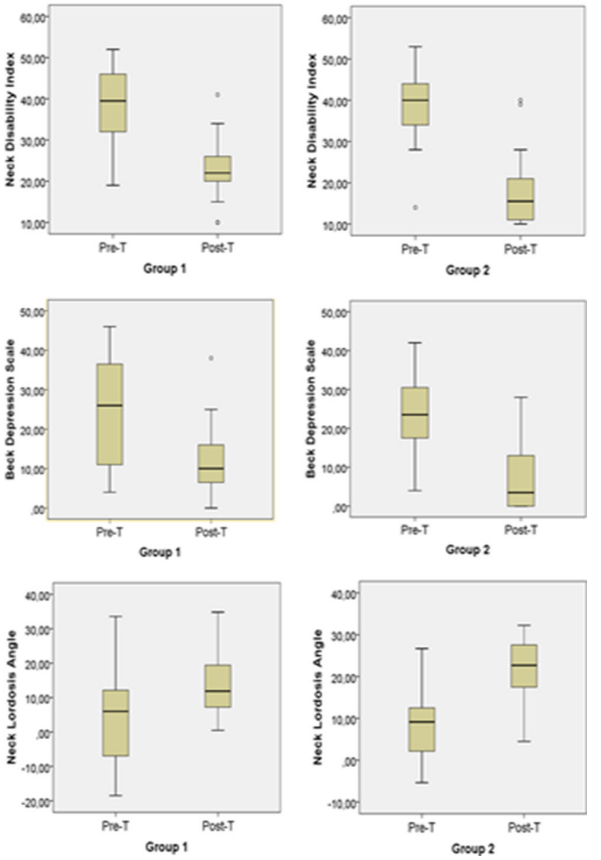

Figure 4. Group 1 and 2; Comparison of Neck Disability Index, Beck Depression Scale, Neck Lordosis Angle separately in Pre-treatment (Pre-T) and Post-treatment (Post-T)

DISCUSSION

The aim of this study is to investigate the effectiveness of the conventional physical therapy and Mulligan mobilization technique used in the treatment of CH separately on clinical and radiological measurements of the cervical region and compared the effectiveness of these two methods. We concluded that VAS, ROM, cervical performance test, neck lordosis angle, Neck Disability Index and Beck Depression Scale were significantly effective in both groups. In addition, Mulligan mobilization significantly improved VAS, neck lordosis angle, Neck Disability Index and Beck Depression Scale. The result shows that both treatments are scientifically suitable for CH, but Mulligan mobilization technique is more effective.

CH accounts for 15-20% of headaches that affect approximately 50% of the population (2). Racicki (3), reported that CH occurs in all age groups and is more common in women. In our

sample, which made up our study, Racicki's study supports the fact that the number of female patients was higher than the number of male patients. In addition, the age range of the patients in our study was from a young patient of 16 years old to an elderly patient of 70 years old.

CH with a complex pathophysiology includes nociceptive, neuropathic, referred pain. This pain associated with trigeminal afferent and efferent impulses from the upper cervical nerves of the nucleus trigeminocervicalis (23). Bronford (24) attributed the effect of manual therapy and exercise in CH to the relationship between the sensitization of the trigeminocervical nucleus and the activation of descending inhibitory pathways. Due to the predominance of peripheral input in the upper cervical region in CH, mobilizations of this region are recommended. Upper cervical traction in Khalil (25) study and SNAG application in Hall (18) and Shin (17) studies showed positive effects on pain. In addition, among the studies on exercise, McDonnell (26) found that spinal stabilization with lower abdominal and upper cervical flexion, shoulder flexion for the latissimus dorsi muscle, shoulder abduction and lateral flexion exercises for the pectoralis major/minor muscle were effective in pain in CH. In our study, we recorded improvement in pain in patients who applied SNAG and upper cervical traction from Mulligan mobilization, as did Khalil, Hall and Shin. In addition, we noted that the conventional physiotherapy consisting of hotpack, US, TENS and isometric-ROM exercise, which was recommended but no study on this subject in the literature, was effective in relieving pain, but Mulligan mobilization was better. Because of this result, we think that the use of Mulligan mobilization, which is non-invasive and has immediately hypoalgesia effect, is highly probable that it is due to a non-opioid mechanism of action, should be encouraged in the clinic, based on the therapist's assessment, findings and clinical judgment.

ROM is valuable in the diagnosis and evaluation of many diseases (27). The limitation in the range of motion of the cervical spine, which distinguishes CH from other headaches, is considered a reasonable biological marker for the diagnosis of CH, although its reliability and validity have not been confirmed in larger studies (28). Zito (29) emphasized that the musculoskeletal disorder in CH is mainly related to joint dysfunction and limited joint movement accompanied by pain. Khalil (25) improved neck rotation with upper cervical traction, while Hall (18) improved neck rotation with SNAG application. Jull (9) recorded improvement in all neck joint movements with low-dose endurance exercises in the cervicoscapular region. In our study, an improvement was observed in the range of motion of the joint in the group that was applied hotpack, US, and TENS in addition to isometric-ROM exercises. However, better improvement was noted in the Mulligan mobilization group in neck flexion, left lateral flexion, and right rotation. Based on the importance of rotational tests in the evaluation of CH, it can be said that Mulligan mobilization is a more acceptable treatment for CH, especially with excessive increase in rotational movements.

When cervical region muscles are evaluated in patients with neck pain, it has been shown in many studies that there is a relationship between pain and insufficient endurance (30, 31). In fact, an electromyographic study emphasized the importance of early fatigue finding due to the decrease in the endurance of the muscle rather than its strength (32). In CH with neck pain, we have not encountered any study in the literature on cervical performance testing. In our study, it was noted that there was an increase in both the Mulligan mobilization group and the conventional physiotherapy group in the neck flexion, extension, right and left lateral flexion performance test, which we performed to evaluate the functionality due to muscle performance. In this sense, we contributed to the literature by showing the effect of Mulligan mobilization and conventional physiotherapy in CH.

The International Headache Society emphasized that one finding of radiographic evaluation in CH is the change in cervical lordosis, which shows abnormal posture. Zito said in his study that changes in cervical lordosis and anterior position of the head were associated with neck-related headaches (29). Fortner (33) reported in the case report that reduction in cervical lordosis or kyphosis in CH may be biomechanical markers and that neck traction combined with cervical extension exercise is effective in gaining the normal lordosis angle. In our study, we eval-

uated neck lordosis with Cobb angle in CH, and we found that lordosis decreased and even went into kyphotic posture in these patients. This finding supports Zito and Fortner. We think that the musculoskeletal structures affected in the neck region also cause deterioration in the basic biomechanical balance, and abnormal changes in the neck lordosis cause neck pain and headache. In addition, in our study, similar to Fortner's approach, an improvement was observed in lordosis in both the conventional physical therapy group including head extension exercise and the Mulligan mobilization group containing traction, but this improvement was better in the Mulligan group.

Although there is a relationship between neck pain severity and neck disability, these two parameters should be considered and measured separately because pain affects each individual differently. In CH with neck pain-induced headache, Dunning (34) used a Neck Disability Indeks in a study comparing upper cervical-thoracic manipulation and C1-C2/T1-T2 mobilization+craniocervical flexion exercise. While it was almost 19 points before the treatment in both groups, it decreased to 11 points in the manipulation group and 6 points in the mobilization+exercise group after 4 weeks of treatment, improving disability. Khalil (25) noted that CD decreased from 46 points to 25 points after treatment in the Mulligan group where he applied upper cervical traction. In another study by Adham (35), Mulligan, using the SNAG technique from mobilization, recorded a 67% change in NDI with a 20 point decrease from 30 points. In our study, while neck disability was 40 points in both groups at the beginning of the treatment, it decreased above 20 points in the conventional physiotherapy group and below 20 points in the Mulligan mobilization group after the treatment. We think that this improvement in the Mulligan group is due to the greater increase in pain and joint range of motion compared to the conventional group.

Pourahmadi (36) stated that the patient's muscle endurance was reflected in his functionality and quality of life, and therefore led to depressive symptoms. In addition, it is stated in some sources that it is not clear whether the pain precedes the depression, occurs after the depression, or is a comorbid condition. However, while depression may be the result, not the cause, of such headaches, it is thought that depression and such headaches may have a common biological basis. It is known that the prevalence of depression in chronic headache is over 50%. The effect of botulinum toxin type A treatment on depression in CH by Karatas (37) et al. was evaluated with the Beck Depression Scale. Treatment has been shown to reduce depression in CH. There is no study in the literature on the effects of conventional treatment and Mulligan mobilization on depression in CH. In our study, both treatments were found to be effective on the level of depression, while Mulligan mobilization was noted to be more effective in treatment in this sense. We think that the reason why this improvement is more significant in Mulligan mobilization is due to the better improvement in pain and functionality in this group.

Evidence today has shown that CH is a multidimensional musculoskeletal disease, but it is controversial in its therapeutic applications (3, 34). Although Racicki (3) reports that methods such as conventional physical therapy and manuel therapy are recommended, there are few studies in the literature regarding the effectiveness of Mulligan mobilization technique in patients (16-18). There are no specific studies on conventional therapy, which is routinely called combined Hotpack, US, TENS, and exercise, in the treatment of musculoskeletal patients. Only Farina et al. (38) on TENS, Ylien (10) on neck isometric, stretching and endurance exercises, McDonnell (26) on neck, scapulothoracic and lumbar exercises, Jull (9) on isometric craniocervical flexion, scapular retraction and stretching exercises in CH emphasized its impact. In addition to all these exercises, they also stated the importance of neck ROM and isometric exercises in the early period to correct cervical retraction and increase neck joint angle. In this study, in accordance with the literature, Mulligan mobilization technique was applied to one group and conventional physical therapy consisting of only hotpack, US, TENS and isomeric-ROM exercises was applied to the other group. Although it was effective in both groups in the treatment of CH, Mulligan mobilization was more effective. However, we think that more studies are needed in the literature on this subject.

The limitations of this study can be summarized as the fact that the treatments were in the wide age range of the study sample, the long-term effects of the study were not investigated, and the home program was not given to the groups. Our study evaluated the efficacy of conventional physical therapy and only Mulligan mobilization for each group and compared the effectiveness of these two methods in CH. We think that further studies should be conducted with in different age groups, longer follow-up periods by giving home programs in order to increase the effectiveness of treatment.

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Conflict of Interest: Authors declare that there is no conflict of interest.

Author Contributions: Concept – Research consists of MAD's doctoral thesis; Design – MAD, EK; Supervision – EK, DO; Resources and Financial Support – MAD, EK, ME; Materials – ME, DY; Data Collection and/or Processing – MAD, DY, SO; Analysis and/or Interpretation – MAD, EK, ME, DY; Literature Research – MAD, ME, DY; Writing Manuscript – MAD, SO; Critical Review – EK, DO.

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