Research paper: The Effect of Suboccipital Myofascial Release Technique on Cervical Muscle Strength of Patients With Cervicogenic Headache

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ABSTRACT

Purpose: To determine whether Myofascial Release (MFR) technique in upper cervical region is more effective than using conventional exercises to improve cervical muscle strength in patients with cervicogenic headache. Design: Randomized Controlled Trial. Setting: An outpatient physical therapy clinic, University of social welfare and rehabilitation science, Iran.

Methods: We conducted a prospective, randomized controlled, and single blinded trial on 34 patients with cervicogenic headache, aged 15-75 years, which assigned randomly to exercise group (n=17, mean(SD) age=38(11.31) years) and suboccipital myofascial release group (n=17, mean(SD) age=38.88(9.38) years). Ten treatment sessions, 6 times a week for each group were applied. Outcome measures were isometric cervical muscle strength (flexors, extensors, right and left rotators and lateral flexors) measured by force gauge.

Results: Statistical analysis (paired t test) revealed a significant improvement in cervical muscle strength after treatment in the MFR and exercise groups compared with before treatment ($P<0.05$). Based on ANCOVA results, pretest scores as controlling factor, no significant difference was found between two groups after 10 treatment sessions with regard to all variables ($P>0.05$) except cervical flexors strength ($P=0.021$) and cervical left rotators strength ($P=0.031$).

Conclusion: Pain and myofascial stiffness can be an impediment for full muscle interference in contraction and application of suboccipital MFR and common exercises can be effective techniques in restoring cervical muscle strength, especially in cervical rotatory movements.

Keywords:

Myofascial release, Exercise, Cervicogenic headache, Muscle strength

1. Introduction

Cervicogenic Headache (CGH) is a secondary and often unilateral headache that is known by referring pain from soft or hard cervical structures to occipital, temporal, frontal and sometimes pre-orbital regions [1-3]. The prevalence of CGH in the general population is approximately 0.4%-2.5% and 4 times more in women than men [4]. Cervicogenic headache accounts for 15%-20% of all chronic headaches [4, 5]. According to reports, at least 7 million people suffer from CGH that wastes millions of daily work and productions [6, 7]. Based on the last version of Cervicogenic Headache International Study

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Group (CHISG), CGH is characterized by pain with neck movement or improper sustained positions, myofascial pain and stiffness and limited Range of Motion (ROM) in cervical spine. One of the major diagnostic problems is the overlap of cervicogenic headache with migraine and tension type headache [3, 8].

The problem is usually caused by clinical signs and symptoms, which vary between individuals and also during the disease course [9]. However, it has been known that tip-top clinical test has high sensitivity and specificity for diagnosing CGH in upper cervical Flexion-Rotation Test (FRT) [10-13]. Nevertheless, there are some fascial connections between suboccipital muscles with dura mater and C2 vertebra [14]. Presumably, fascial restriction in one part of the body causes unusual stress in another parts of the body due to fascial continuity. So fascial restriction in this region can limit the normal movement of muscles between fascial plates in different directions in suboccipital region [15, 16]. Fascia is a soft tissue component of the connective tissue system that percolate the human body [17], also it has been considered as a fibrous collagenous tissue that is part of the body tensional force transmission system [18].

Myofascial Release (MFR) is a therapeutic technique that applies gentle pressure and stretching (in both forms of direct and indirect approaches) intended to restore optimal length, to decrease severity of pain, and to accelerate the release of fascial restrictions caused by stress, strain, repetitive use, and traumatic or surgical scarring [19-21]. There are a number of studies on MFR and its effects like ROM increase, improving joint biomechanics, increase in extensibilities of soft tissues and significant decrease in pain and muscles tone [16, 19, 22, 23]. Based on common upper crossed syndrome, suboccipital myofascial stiffness is symmetric with the weakness of deep cervical flexors muscles and vice versa in individuals with forward head posture and chronic neck pain and head pain [15, 24]. Gwendolen expressed that patients with neck pain demonstrate reduced electromyographic activity of the deep cervical flexor muscles during craniocervical flexion test [25].

Apparently, pain and stiffness of suboccipital myofascial structures reduce forceful deep cervical flexors muscle strength so releasing this stiffness can be a justified way for improving neck muscle flexors. The cause of difference may be neural inhibition due to the pain felt during isometric tests or dynamic tests of muscle and joints. If the pain is the main cause of reduced cervical muscle strength, the implications for therapy should be focused on treating the pain. Although a lot of interventions like massage, exercises therapy, physiotherapy, electrotherapy and spinal mobilization are used for CGH treatment [26-29], MFR has not been studied specifically about suboccipital for CGH. So the purpose of current study was to compare the effect of MFR technique in the upper cervical region with common exercises on cervical muscle strength in subjects with CGH.

2. Materials and Methods

Study design

This experimental study was a single blind Randomized Controlled Trial (RCT) to determine the efficacy of suboccipital myofascial release technique on cervical muscle strength compared to conventional exercises in patients with CGH.

Study subjects

A total of 52 patients with CGH (between 15 and 75 years old) participated in this study. They had been recruited either by referral from general practitioners or through calling in clinical and general centers located in Tehran. The study subjects were selected by convenience sampling method. The participants who met the inclusion criteria underwent a physical examination of cervical spine for baseline assessment, which included manual palpation of the upper cervical joints. Eventually, 34 subjects were allowed to participate in the study. All subjects signed an informed consent form approved by the Ethics Committee of University of Social Welfare and Rehabilitation Sciences.

Inclusion criteria

The inclusion criteria were as follows: 1. Neck pain referring unilaterally to suboccipital region [30]; 2. The pain and restriction in C1-C2 rotation by craniocervical FRT [13]; 3. Intensifying headache by manual pressure to upper cervical muscles and joints, and 4. Experiencing headache at least once per week for the last 6 months.

Exclusion criteria

Exclusion criteria were as follows: 1. Having bilateral headaches (typifying tension headache); 2. Intolerance to craniocervical FRT; 3. Presence of autonomic system symptoms like vertigo, dizziness and visual impairment; 4. Intense specific neck pain as disk herniation, canal stenosis or cervical spondylosis; 5. Any condition that might contraindicate MFR technique in upper cervical region, and 6. Physiotherapy for headache in the last 6 months.

Measurement

A series of headache-associated measures and physical tests of the cervical spine were taken at baseline for both groups. The major outcome measures were cervical muscle strength including flexors, extensors, right and left rotators and right and left lateral flexors which were measured before and immediately after treatment sessions by force gauge. The average value of the two repetitive measurements with an interval of 15-20 s (expressed as kg/cm^2) was taken for data analysis of the cervical muscle strength [31].

Procedure

The patients were randomly assigned to a control (exercise) group (n=17, mean(SD) age=38(11.31) years) and an experimental (MFR) group (n=17, mean(SD) age=38.88(9.38) years). We employed block randomization method so as to keep the numbers in each group very close at all times. Table 1 presents physical characteristics of the subjects in each group. The treatment regimens for the control group comprised low load endurance exercises to train muscle control of the cervicoscapular region [25, 32, 33].

The first stage consisted of specific exercises in order to address the impairment in deep neck flexor muscles found in CGH. Craniocervical flexion exercises, performed in supine lying, aimed at targeting the deep neck flexor muscles which have an important supporting function for the cervical region [9, 32]. The subjects were first taught to do a slow and controlled craniocervical flexion. Then they were trained to hold progressively increasing ranges of craniocervical flexion using feedback from an air-filled pressure sensor placed behind the neck. In home exercises, subjects were asked to lie down in supine position with knee flexion and two or three roll of towel under the head to be at the same level of the trunk. Then the subjects were instructed to perform craniocervical flexion up to middle distance of full flexion of chin for the first 4-5 sessions and after that, when the pain and tightness of subcranial tissues decrease, craniocervical flexion was done over the whole distance of chin flexion. The scapular muscles, especially the serratus anterior and lower trapezius, were exercised initially in the prone lying position.

First subjects were trained using inner range holding exercises of scapular adduction and retraction. Training of these cervicoscapular muscles was also incorporated into postural correction exercises which were done regularly throughout the day in sitting position. The subjects were trained to sit with a natural lumbar lordosis while gently adducting and retracting their scapulae and slowly flexing their craniocervical spine to contract the deep neck flexors. Subsequently, low level rotatory isometric resistance exercises were used to train the co-contraction of cervical flexors and extensors [24, 32]. All participants received these exercises. No additional verbal encouragements were given during the exercises. All exercises were performed as count of 7 s and subjects were instructed to do all exercises daily with 15 repetitions (twice a day). Frequency of treatment was every day for the exercise group. They attended "clinical center" for checking of their exercise performance by physiotherapist three times per week. They also could be taught active muscle stretching exercises to address any muscle tightness.

The patients in the experimental group were treated by MFR technique in upper cervical region as described by regimen in different studies (Figure 1). In this regimen, before the main intervention, the therapist flex the Metacarpophalangeal (MP) and extend interphalangeal (IP) joints, by placing them under the middle joints of cervical (C4-C5), and hold them for 1-2 minutes; thus the cervical segment was moved passively with some rotation by the therapist. For the application of the main technique, subjects were asked to lie down in supine position with knee flexion and two or three roll of towel were placed under the head of the subjects to level the trunk with head.

Therapist sat on a stool at the head of the table. Elbows and supinated forearms were on the table. The subjects were asked to lift their head off the table. The tips of the first three fingers positioned into the soft tissue inferior to the arc of atlas. The fingers were stabilized in a flexed position -about 45° at the MP and Proximal InterPhalangeal (PIP) joints. The subjects were asked to rest their head back down so that their fingertips are over the suboccipital soft

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Figure 1. Suboccipital myofascial release technique

tissues and their finger pads rest tightly against the inferior aspect of the atlas. As the position is felt to be comfortable, some soft tissue reactions will occur, characterized by local softening sensations followed by an increase in the weight of the head (There is no additional traction during this phase and it takes around 3 minutes). This phase is repeated 3 times in each session. At the end, for more releasing, suboccipital traction will commence.

For this phase, subject lies supine with head supported and therapist places the three middle fingers just caudal to the nuchal line, lifts the finger tips upward while resting the hands on the treatment table, and then applies a gentle cranial pull, causing a long axis traction. The procedure was performed for 2 to 3 minutes. Subjects in each group received 10 physiotherapy treatment sessions. Treatment frequency was 6 times per week for the MFR group and every day for the exercise group. Moreover, three times per week they refer to clinical center for checking of their exercise performance by the physiotherapist.

Reliability

We used 10 symptomatic volunteers (n=10, Mean(SD) age=35.80(11.80) years) and assessed intra-tester reliability of the Economical Digital Force Gauge (Series DS2 Up to 220 lbf capacity). For this purpose, at first the examiner measured the average value of isometric muscle strength of the two repetitive measurements with an interval of 20-30 s in subjects and then after 30 minutes repeated the measurement randomly in the subjects by using the same procedure to reduce the memory effect.

Data analysis

Statistical analysis was conducted using SPSS 23. The baseline characteristics of the two groups were compared using univariate analyses. In methodological assessment for detecting the intra-reliability of pressure algometer, Intraclass Correlation Coefficient (ICC) was used for absolute reliability and Standard Error of Measurement (SEM) for assessing relative reliability with a confidence level of 95%. Alpha and power of study were set at 0.05 and 0.80, respectively for each analysis. Normal distribution of collected data were examined by Kolmogorov–Smirnov test (K-S).

Independent t test for continuous measures and Mann-Whitney test for discrete (ordinal scale) measures were used to determine any difference in different variables between two groups before the treatment. Paired t tests for continuous measures and Wilcoxon test for discrete (ordinal scale) measures were used to determine any significant difference between pretreatment and posttreatment measurements in each group. Analysis of covariance (ANCOVA) was calculated to determine the significance of differences between the control and the experimental groups in posttest variable scores, with pretreatment scores used as covariates in the analysis. For valid application of the ANCOVA, the test for homogeneity of regression coefficient was performed.

3. Results

The participant flow diagram provided in Figure 2 reports the numbers and timing of randomization assignment, interventions, and measurements for each group. The ICC was more than 0.90 for repeated measures of the force gauge. It demonstrates high intra-tester reliability for the measurement of cervical muscle strength (Table 2). Statistical analysis (the Independent t test) revealed no significant (P>0.05) difference in demographic variables (age, weight, height, BMI) and cervical muscle strength as a clinical outcome measure between the two groups (Table 3). The result of paired t test showed a significant improvement (P<0.05) in all clinical outcome measures scores after 10 treatment sessions in the control and experimental group compared with pretreatment scores except cervical

Table 1. Demographic data of the subjects (Mean±SD)

Variable	Exercise Group (n=17) Mean±SD	MFR Group (n=17) Mean±SD
Age (y)	38±11.31	38.88±9.38
Weight (kg)	67.82±7.53	67.88±7.80
Height (cm)	166.35±7.52	170.52±5.68
Gender	Male (n=5) Female (n=12)	Male (n=9) Female (n=8)
Body mass index (kg/m²)	24.52±2.55	23.36±2.62

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Table 2. Reliability of force gauge

Variable	ICC	SEM
Force gauge (flexors)	0.98	3.21
Force gauge (extensors)	0.97	3.57
Force gauge (right rotators)	0.96	5.77
Force gauge (left rotators)	0.97	4.71
Force gauge (right lat. flexors)	0.95	5.46
Force gauge (left lat. flexors)	0.96	4.45

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Table 3. Independent sample t test: Group comparing for pretreatment status

Variable	Myofascial Release (Experimental)	Exercise (Control)	P
	Mean±SD	Mean±SD	
Age, y	38±11.31	38±11.31	0.80
Weight, kg	67.82±7.53	67.82±7.53	0.98
Height, cm	166.35±7.52	166.35±7.52	0.07
BMI, kg/m^2	24.52±2.55	24.52±2.55	2.00
Force gauge (Neck flexors)	59.58±22.70	54.94±24.25	0.56
Force gauge (Neck extensors)	64.72±20.64	64.05±29.02	0.93
Force gauge (Neck right rotators)	52.05±28.86	43.76±18.33	0.39
Force gauge (Neck left rotators)	53.47±27.21	50.11±25.06	0.86
Force gauge (Right lat. flexors)	52.00±24.45	48.82±18.69	0.67
Force gauge (Left lat. flexors)	56.45±25.25	52.64±20.22	0.72

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Table 4. Paired t test for cervical muscle strength in the subjects

Variable	Group	Before Treatment (Mean±SD)	After Treatment (Mean±SD)	P
Cervical flexors strength	MFR	59.58±22.70	61.76±21.11	0.049
	Exercise	54.94±24.25	62.00±22.13	0.016
Cervical extensors strength	MFR	64.72±20.64	67.00±22.50	0.357
	Exercise	64.05±29.02	74.52±19.33	0.063
Cervical right rotators strength	MFR	52.05±28.86	56.35±29.11	0.011
	Exercise	43.76±18.33	47.58±16.84	0.032
Cervicalleft rotators strength	MFR	53.47±27.21	57.00±27.03	0.025
	Exercise	50.11±25.06	58.47±21.41	0.019
Cervical Right lat. flexors strength	MFR	52.00±24.45	55.05±23.93	0.014
	Exercise	48.82±18.69	55.29±19.91	0.004
Cervical left lat. Flexors strength	MFR	56.45±25.25	59.47±26.90	0.014
	Exercise	52.64±20.22	57.58±16.84	0.007

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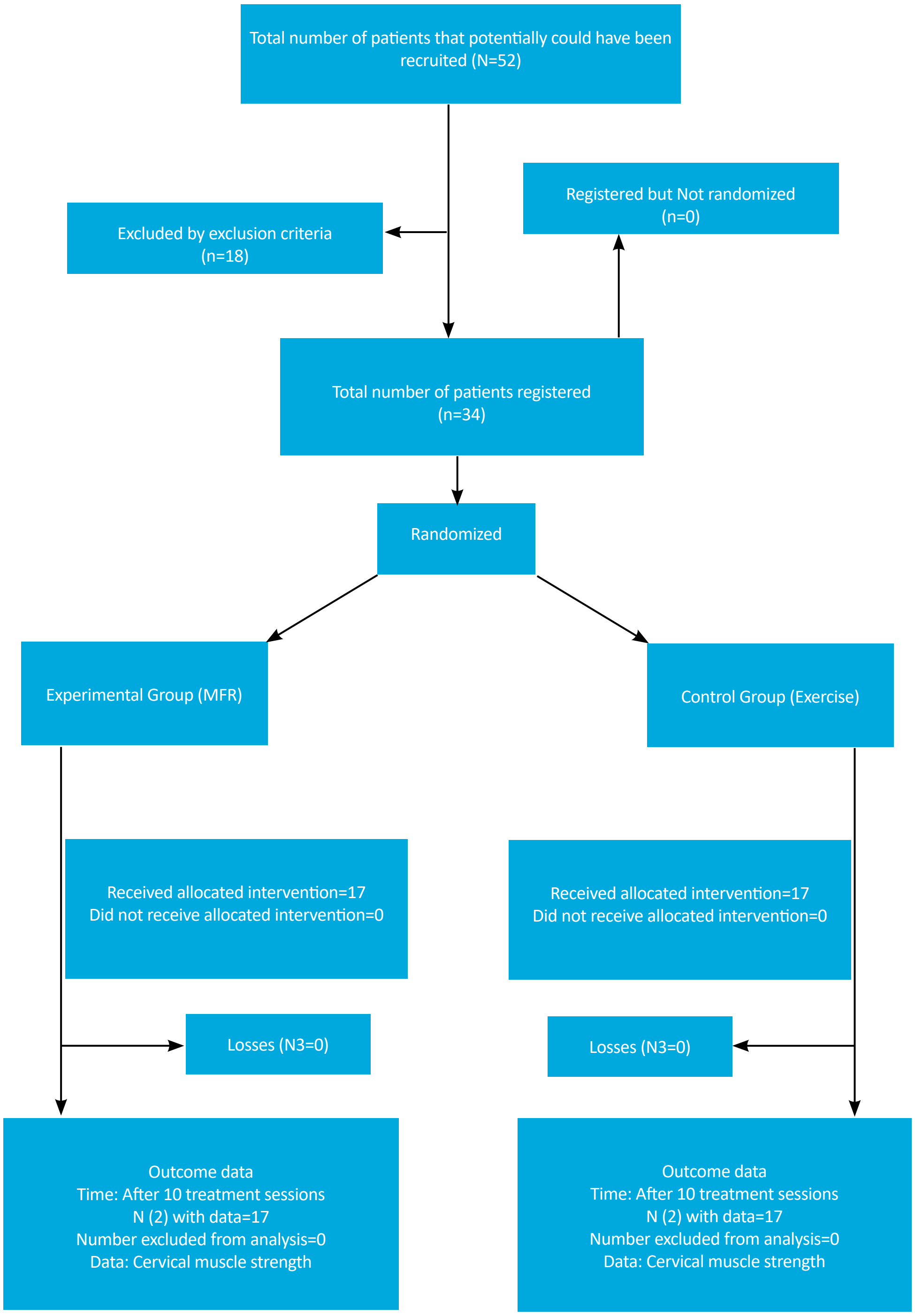

Figure 2. Flow diagram for randomized studies

extensors strength in both MFR group (P=0.357) and exercise group (P=0.063) (Table 4). The findings of ANCOVA showed no significant difference between the control and experimental group after 10 treatment sessions on cervical muscles strength with pretreatment scores as the covariate, except cervical flexors strength (P=0.021) and neck left rotators strength (P=0.031) (Table 5) (Figure 3).

4. Discussion

CGH is identified by neck pain and dysfunction, typically of the upper cervical spine, although the specific etiology is still unknown. It is associated with cervical musculoskeletal dysfunction and muscle imbalance with characteristic patterns of muscle weakness and tightness . A multi-modal physiotherapy interventions including modalities, manual therapy, and therapeutic exercise are recommended in pa-

Table 5. ANCOVA test for comparing change variables onset treatment between two groups (MFR and Exercise)

Variable	Sum Square	df	Mean Square	F	P
Neck flexors strength	162.24	1	162.24	5.92	0.021
Neck extensors strength	536.35	1	536.35	2.69	0.111
Neck right rotators strength	1.62	1	1.62	0.052	0.821
Neck left rotators strength	172.08	1	172.08	5.10	0.031
Neck right lat. flexors strength	92.56	1	92.56	2.19	0.149
Neck left lat. flexors strength	5.15	1	5.15	0.154	0.697

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tients with CGH [16]. Recently MFR as a new technique is applied in different musculoskeletal disorders. MFR is being used to treat patients with a wide variety of problems, but there is little research to support its efficacy especially on subjects with CGH.

The results of this study showed a significant improvement in cervical muscle strength, especially right and left rotators after 10 treatment sessions compared with pre-treatment score in both exercise and MFR groups. Results in flexors, rotators and lateral flexors muscle strength in exercise group were more significant than MFR group but we found no significant result for cervical muscle strength in both groups (P>0.05).

Possible mechanisms about physiological effects of MFR and suboccipital traction as complementary intervention for improving cervical muscle strength include restoration of length of the subcranial, upper trapezius and sternocleidomastoid muscles sarcomeres and reduction of pain and sensitization mechanisms associated with TrPs and tight myofascial bands as an impediment in demonstration of true muscle strength [34].

The restoration of length and strength of the myofascial tissue will take the pressure off the pain sensitive structures such as nerves and blood vessels, as well as restoring performance and mobility of the joints and muscles [35]. Our finding is in accordance with other studies showing short

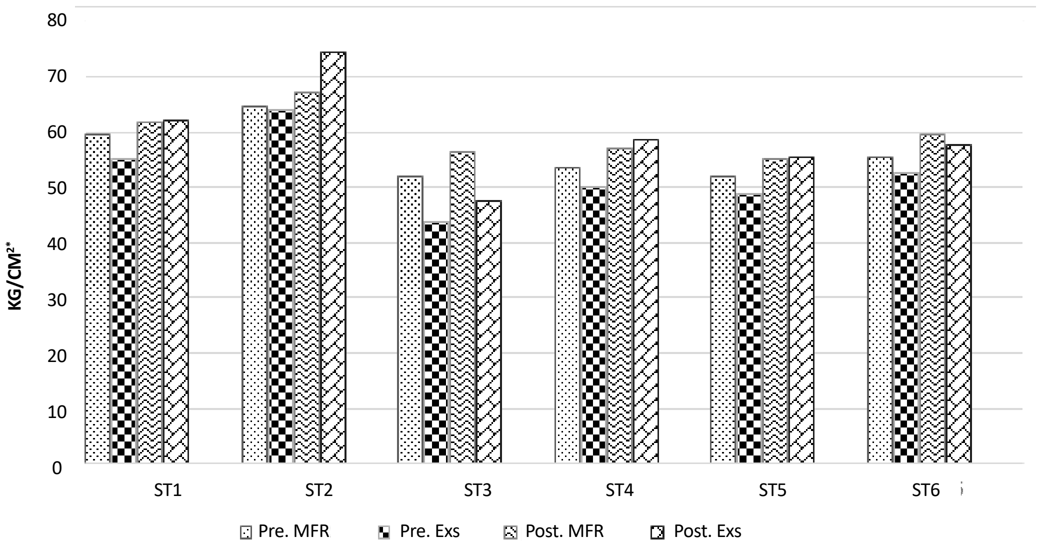

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Figure 3. Pretest and posttest measurements for cervical muscle strength in both group before and after treatment

ST 1: flexion strength ST 2: extension strength

ST 3: right rotation strength ST 4: left rotation strength

ST 5: right lat. flexors strength ST 6: left lat. flexors strength term effects of massage or exercise treatment in patients with CGH. It was assumed that pain-relieving interventions would improve cervical function, as several studies have reported higher strength following passive treatments. Levoska et al. [36] found that stretching and massage 3 times a week for 5 weeks increased maximal isometric cervical strength by 17% in extension and 14% in lateral flexion and neck pain sensation decreased significantly.

Ylinen et al. [37] found 10% increase in neck flexion and rotation and 7% in neck extension strength in women with chronic neck pain who were doing stretching exercises twice a week. Jordan et al. [38] found that performing massage and manual traction therapy twice a week for 6 weeks would increase isometric neck flexion 15% and neck extension strength 24% [38].

Gwendolen Jull (2002) studied the effect of exercise on performance in the craniocervical flexion muscle test and demonstrated that the interventions inclusive of manual therapy with exercises and exercises alone, were both significantly different from those without exercise (manual therapy and control) at week 7 and at month 12 (P=0.001 for all) [32, 39]. César Fernandez (2013) explained that manual therapy targeted to activate TrPs in the sternocleidomastoid muscle may be useful in reducing headache and neck pain intensity and increasing motor performance of the deep cervical flexors muscles [40]. Unfortunately, there are few studies focusing on the effectiveness of MFR technique in patients with CGH. It seems that MFR cannot improve muscle fiber sizes but may increase motor performance by reducing pain and central sensitization of upper cervical myofascial structures.

Pain and myofascial stiffness can be an impediment for full muscle contribution in contraction and based on findings of this study, MFR and exercise are effective interventions for improvement of cervical muscle strength especially right and left rotators and cervical flexors in individuals with CGH. Using either of the treatments depends on the clinical decisions of the practitioner and patient's values, but it appears that combined treatment of MFR and exercise are more useful than the use of MFR or exercise alone. Studies with larger sample sizes and assessing by muscle's sonography or EMG-activation and examining long-term effects are recommended.

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Conflict of Interest

The authors declared no conflicts of interest.

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