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The Effect of Muscle Energy Technique on Headache, Upper Cervical Rotation and Deep Upper Cervical Muscle Thickness in Cervicogenic Headache (Randomized Clinical Trial)

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Abstract

Background: Cervicogenic headache (CGH) is a disabling condition associated with musculoskeletal impairment of the cervical region. There is limited evidence for the efficacy of muscle energy technique (MET) on CGH.
Objectives: The present study aimed to assess the effect of MET on CGH patients.
Methods: In this single-blinded, randomized, controlled study, thirty subjects with CGH aged 18 - 55years were randomly assigned into two groups, intervention group (MET in cervical muscles + infrared (IR) radiation) and control group (IR). Both groups received these interventions for 6 sessions, 3 times a week for two weeks. Outcome measures included headache index, upper cervical rotation range of motion (ROM), and deep upper cervical muscles thickness.
Results: In the intragroup analysis, the headache index and upper cervical rotation ROM were significantly different in the two groups ($P < 0.05$), but in the intergroup analysis, only left upper cervical rotation ROM was significantly different ($P < 0.05$). Additionally, all muscles thickness had no significant difference in intragroup and intergroup analyses ($P > 0.05$). The effect size was large in the MET group than that in the control group for ROM and headache index ($d > 0.7$), but this was less than medium for muscle thickness in the two groups ($d < 0.5$).
Conclusions: MET + IR is a suitable and durable approach for CGH treatment and increase of upper cervical rotation ROM rather than IR alone, but this approach cannot change the muscles thickness significantly in 2 weeks.

Keywords: Cervicogenic Headache, Muscle Energy Technique, Headache Index, Deep Muscle, Thickness

1. Background

Cervicogenic headache is a type of frequent intermittent headache affecting the community (1), with prevalence estimated to comprise 14 - 18% of all chronic headaches (2, 3).

Musculoskeletal impairment of the cervical region such as motor control changes in muscle, including pain and tenderness, weakness, atrophy or spasm, and movement restriction (active and passive physiological movements) due to neck pain and headache, exhibits itself in CGH (4-6); in particular, upper cervical rotation limitation was seen in previous studies as an important critical diagnosis of this kind of headache (7, 8). ROM restriction can produce pain and cause muscle imbalance, muscle structure change exhibiting itself in the form of weakness or atrophy, and changes on the articulating surface (9).

Many treatments have been proposed to treat CGH, but in recent studies, manipulation and therapeutic exercise have suggested the best procedure for CGH treatment (10, 11). However, the manipulation of the upper cervical region may lead to serious complications (12); therefore, the best alternative method may be the use of MET for neck mobilizations and muscle strengthening. MET is safe and risk-free technique that is easy-to-use, and it is a useful and effective therapeutic exercise owing to active participation of the patient in performing it.

MET could have considerable positive effects on decreased abnormal muscle tone, normal joint function restoration and pain reduction (13, 14). This method involves the voluntary contraction of a subject's muscles in a precisely controlled direction, against a counterforce load of operator for corrective muscular force (9, 14). MET could be used to manage patients with many kinds of symp-

toms (15), including restricted ROM and pain in Atlanto-axial joint (16), neck pain (17), upper trepezius myofascial trigger points (MTrPs) (18), subocipital tenderness (19), tension type headache (TTH) (20), low back pain (21) and lumbopelvic pain (22). Nevertheless, in the CGH, this technique as always been used in combination with other manual techniques (23). Currently, according to search of this study team, the effect of MET on CGH patients has not been specifically studied in a clinical trials study.

Longus Capitis (LCap), Rectus Capitis Posterior Major (RCPM) and Obliquus Capitis Superior (OCS) are the deep upper cervical muscles synergy in stability of the upper cervical region that are supposed to be impaired in CGH (4, 5, 24).

2. Objectives

Therefore, this novel study aimed to assess the MET effects on the headache index, cervical rotation ROM and thickness of deep upper cervical muscles by ultrasonography in CGH patients.

3. Methods

A single-blinded randomized controlled trial (RCT) study was conducted in the motor control laboratory of Iran University of Medical Sciences (School of Rehabilitation Sciences) from 20/01/2017 to 20/07/2017 (six months).

The participants, from neurology or physiotherapy clinics in Tehran, or by becoming aware through the advertisements given at the university, referred to the research team. The patients suffering from a headache received necessary information about the research, and then they were examined.

3.1. Inclusion and Exclusion Criteria

Male and female subjects aged 18 - 55 years entered in this study met the inclusion criteria defined by the Cervicogenic Headache International Study Group (CEHISG), including unilateral headache (without side shift) related by pain, movement and sustaining position of neck started from the occiput spread to the tempro-frontal region for more than 3 months, pain and tenderness at the upper cervical segments palpation, as well as pain and movement restriction in cervical region, especially in the upper cervical rotation (5, 7, 25).

Other types of headache, including migraine, tension type, other serious headaches, history of head and neck trauma or surgery, deformity in spine, pregnancy, CGH patients with mixed headache or laxity of alar ligaments and vertebra basilar artery insufficiency and patients with a history of physiotherapy at least 3 months prior to the study were not included. The selected patients were randomly divided into two groups: intervention or control group to compare the effect of MET to IR in 6 sessions (third times a week, one day in between) in a 2-week treatment period (Box 1).

Box 1. Flowchart of Study

Flowchart
Participants informed and examined (n = 120)
Screening inclusion and exclusion criteria (n = 32)
Final cases selection (n = 30) and baseline data collection
Randomization to 2 groups (Intervention and control group)
Two weeks treatment (3 times in weeks) for each group
Follow up: end of the second week and 2 weeks later

3.2. Randomization

Restricted randomization method (Random allocation rule) was used for randomization in this study (26). Researchers according to a similar study conducted by Rezasoltani et al. (27) determined a total sample size of 30 subjects. Then, the code of subjects was written in paper, according to gender distribution of CGH prevalence that was 4:1(2), women's code was written in blue paper (24 subjects) and men's code in red paper (6 subjects) and drawings were made (15 persons per group).

3.3. Outcome Measurements

3.3.1. Headache Index

The headache examination tools included questions concerning headache intensity (Visual Analogue Scale (VAS) from 0 to 25, zero indicating no headache, and 25 indicating the maximum headache, frequency (headache repetitions in month), and duration of headache (hours of headache) in each attack (7, 28). The subjects were evaluated in three times at the beginning of the first session, after the end of the sixth session and two weeks after the end of the treatment.

3.3.2. Upper Cervical Rotation Test

This test was measured in a supine position by a goniometer (29). The average range of this motion is 44 - 45 degrees, but if the range is reduced to less than 32 - 33 degrees, the upper cervical rotation test will be positive (30). The within day and between days reliability for this variable measurement in 15 CGH patients was excellent and intraclass correlation coefficient (ICC) was 0.88 to 0.93; this test was measured before and after the first session, at the end of the third session and after the sixth session.

3.3.3. Ultrasonography

The thickness of the muscles (anterior-posterior dimension) by an ultrasound device (SONOACE R7- 2014 from SAMSUNG MEDISON manufacturer- made in South Korea) with a bandwidth frequency of 9 - 12 MHz (resolution frequency) and online B mode images by a linear probe was measured. For ultrasound evaluation of the RCPM and OCS muscles, the subjects sat on the chair with their head in a neutral position (31) and at the distance between the occiput and C2; these muscle images were taken. LCap muscle imaging, in a supine position (32) at the C3-C4 level in the anterior cervical part in both sides was carried out (Figures 1 and 2). Each muscle was scanned in four sessions: before and after the first session, end of the third session and end of the sixth session, and all muscle measurements were performed three times in one session, and an average value was used. An expert physiotherapist in musculoskeletal ultrasonography performed all the measurements. The within day and between days reliability of measuring the thickness of the muscles in 15 subjects (10 healthy and 5 CGH subjects) was excellent (ICC > 0.80).

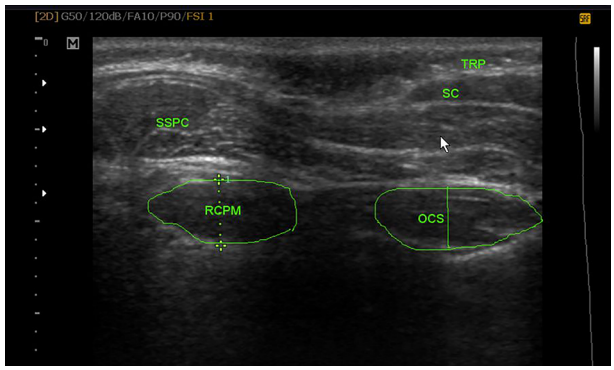

Figure 1. US view at C1-C2 level. TRP, trapezius muscle; SC, splenius capities muscle; SSPC, semispinalis capitis muscle; OCS, obliquus capitis superior muscle; RCPM, rectus capitis posterior major muscle.

3.4. Interventions

An expert physiotherapist performed all the interventions during the study, and the blinded assistant recorded the results of the measurements.

3.4.1. Infrared Radiation

In this study, IR was given to both intervention and control groups for general relaxing of the cervical region. In the relaxed prone position on the bed, by hands under the forehead and closed eyes, IR from a single flame light (a power of 250 W and voltage 230 - 250 V) was adjusted perpendicular to the exposed upper cervical region at a distance of 45 centimeters, for 15 minutes.

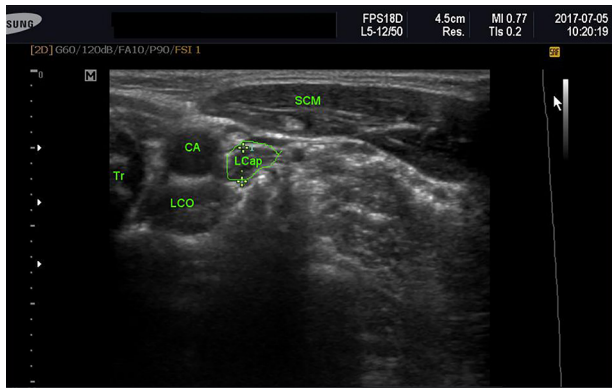

Figure 2. US view at the level of C4. LCap, longus capities muscle; SCM, sternocleidomastoid muscle; LCo, longus colli muscle; CA, carotid artery; Tr, trachea.

3.4.2. Muscle Energy Technique

All the techniques were performed in a supine position, and the line of the subject's look was toward the contraction side in hold time of contraction and toward the opposite side in the relaxation phase. Additionally, the contraction force was 20% - 30% of maximal voluntary contraction, and each technique was repeated three times, and then it was carried out for the opposite side.

1- To correct the upper cervical rotation ROM limitation: The therapist first bent the upper cervical region about 30 to 45 degrees then took it to the rotation elastic barrier. In this position, the patient was asked to contract her agonist muscles and hold the contraction for 5 to 7 seconds. Then, she was asked to relax her muscles. After complete relaxation; the head was taken to the new barrier.

2- To correct the upper cervical flexion ROM limitation: one hand of the therapist was placed below the occiput and the other hand under the chin. The patient's head was bended to the elastic barrier of the flexion motion. In this position, the patient was asked to contract her upper cervical extensor muscles for 5 to 7 seconds. Then she was asked to relax her muscles. After complete relaxation, the head was taken to the new barrier for flexion.

3- To correct the upper cervical extension ROM limitation: the patient's head was extended to the elastic barrier of the upper cervical extension. In this position, the patient was asked to contract upper cervical flexor muscles (nodding) and held for 5 to 7 seconds. Then, she was asked to relax her muscles. After complete relaxation; the head was taken to the new barrier.

4- To correct the upper cervical lateral bending ROM limitation: the patient's neck was bended to the elastic barrier of the lateral bending. In this position, the patient was asked to contract her muscles for 5 to 7 seconds, and then

she was asked to relax her muscles. After complete relaxation, the head was taken to the new barrier to the lateral bending (13, 14).

3.5. Ethical Consideration and Control Bias

The Ethics Committee of Iran University of Medical Sciences approved this research (Ethical Code: 9211342209), and the study was registered in the Iranian Registry of Clinical Trials (IRCT2015031421459N1).

This study was safe for the participants and had no adverse effects on them. The informed consent form was signed by the subjects prior to the inclusion in the study. The patients in the control group after the follow-up period (2 weeks after the last session) received MET and other manual treatments for headache treatment.

Randomization, concealed allocation, as well as blinding of the patients, the research assistant who recorded the outcome measures and the data analyzer were used to minimize bias. However, blinding the physiotherapist who performed the interventions was impossible.

3.6. Data Management and Analysis

The SPSS Ver.16.0 software was used for statistical analysis. Descriptive analysis was performed for the demographic variables, and the means and standard deviations (SD) of the parameters were described. The Shapiro-Wilk test was used to check normal data distribution. Repeated measures, ANOVA, and one-way ANOVA were used to analyze intragroup (pre vs. post in each group) and intergroup (intervention vs. control) comparisons.

The level of statistical significance was considered $\alpha = 0.05$ and the power of the test was assumed to be more than 80%. Effect sizes were calculated using Cohen's d due to the equal number of samples in the two groups.

4. Results

Thirty-two people were selected as CGH patients after exact examination, but two persons withdrew, and randomization was performed in 30 subjects (15 subjects: 12 females and 3 males) participated per group. Table 1 presents the demographic values of variables. All variables had normal distribution; therefore, the parametric test was used for analysis. In the intergroup comparison for characteristic variables at baseline, the initial values in both groups were not significantly different, and the two groups were similar in age, height, weight, BMI, upper cervical rotation ROM, and headache index ($P > 0.05$) (Table 1).

Table 1. Baseline Characteristics of the Participants

Variables	Intervention Group, Mean ± SD	Control Group, Mean ± SD	P Value
Age, year	29.93 ± 8.53	28.87 ± 11.25	0.72
Height, cm	165.73 ± 7.14	162.40 ± 9.57	0.29
Weight, kg	64.03 ± 10.59	63.03 ± 13.82	0.82
BMI (body mass index), kg/m^2	23.26 ± 3.02	23.70 ± 3.89	0.73
Left upper cervical rotation	28.40 ± 3.66	29.66 ± 5.28	0.45
Right upper cervical rotation	29.33 ± 5.03	29.20 ± 5.17	0.94
Headache index	45.77 ± 22.20	40.92 ± 22.67	0.55

4.1. Headache Index

Headache index showed a significant decrease from the beginning to the end of treatment sessions in both groups ($P < 0.05$), but there was no significant difference between the groups in the treatment process and the repeated measure test ($P = 0.056$). In the follow-up, after two weeks of treatment, this improvement continued in the intervention group and had a significant change with the baseline ($P < 0.05$) but in the control group, although significant, it did not improve headache. In the study of effect size, the Cohen's d value between the groups was calculated 0.70 after two weeks (baseline and end of the last session) and was 0.40 after 4 weeks (baseline and two weeks after the last session). The intragroup effect size (baseline and last session) was 1.12 and 0.87 for intervention and control groups, respectively. This value was obtained 1.17 and 0.67 for intervention and control groups for the baseline and the follow-up period (2 weeks after the last session), respectively (Table 2).

4.2. Upper Cervical Rotation ROM

The left side upper cervical rotation in the intervention group significantly increased before and after the treatment in the first session ($P = 0.001$) between the first and the end of the third session ($P = 0.001$), and between the first and the end of the sixth session ($P = 0.001$). Nevertheless, in the control group, despite the ROM increase, the changes were not significant among the four time measurements ($P > 0.05$). Moreover, the change trend in this variable in the intergroup comparison had a significant difference ($P = 0.031$). The effect size was less than 0.5 in the intergroup comparison, but in the intervention group, in four-time measurements, it was obtained between 1.09 and 1.43 but in the control group, it was calculated 0.18 to 0.38.

Table 2. Repeated Measurement Results for HI and Upper Cervical Rotation ROM

Variables	Intervention Group, Mean ± SD	Control Group, Mean ± SD
Headache index		
Assessment 1	45.77 ± 22.20	40.92 ± 22.67
Assessment 2	28.03 ± 18.45	16.60 ± 14.61
Assessment 3	24.62 ± 22.70	33.40 ± 20.53
Within group P value	0.004	0.005
Between group P value	0.056	
Left upper cervical ROM		
Assessment 1	38.40 ± 3.66	39.67 ± 5.287
Assessment 2	41.27 ± 4.16	40.00 ± 4.536
Assessment 3	40.93 ± 4.04	40.73 ± 4.114
Assessment4	42.73 ± 3.05	41.07 ± 4.496
Within group P value	0.00	0.228
Between group P value	0.031	
Right upper cervical ROM		
Assessment 1	39.33 ± 5.03	39.20 ± 5.17
Assessment 2	41.80 ± 4.36	40.67 ± 4.77
Assessment 3	42.07 ± 4.49	41.07 ± 5.36
Assessment4	42.47 ± 3.35	41.07 ± 4.81
Within group P value	0.00	0.021
Between group P value	0.448	

In the right side upper cervical rotation, in the intervention group, ROM increasing was significant before and after the first session (P = 0.001), between first and third sessions (P = 0.002) and first and sixth sessions (P = 0.001).This variable also had significant changes in the control group, so that the P values between measurements before and after the first session, first and third sessions, and first and sixth sessions were 0.009, 0.014, and 0.017, respectively. However, there was no significant difference between the two groups in increasing the right side upper cervical rotation ROM (P > 0.05).

In computing the effect size between the two groups, Cohen's d was smaller than 0.2, but in the within groups, in the intervention group, this value was between 0.98 and 1.09 and in the control group, it was 0.69 to 0.77 (Table 2).

4.3. Muscles Thickness

Four-time LCAP muscle thickness measurements in both sides were not significantly different in intragroup and intergroup comparisons (P > 0.05).

The effect size for this variable in comparing between the groups was less than 0.2, and this value in the intervention and control groups was 0.23 to 0.55, and less than 0.2, respectively.

In the left and right RCPM muscles, although there was no clear trend in decreasing or increasing thickness, there was no significant difference between group and intragroup changes from the beginning to the end of the treatment (P > 0.05). In the study of the effect size, in the intergroup comparison, Cohen's d was less than 0.2, and in the intragroup comparison, it was less than 0.5 for both groups.

The thickness of OCS muscle in the left side between the first and fourth measurements in the intervention group decreased significantly (P = 0.017). In addition, in the control group, the thickness change between the first and second and between the first and third measurements was significant (P < 0.05). Overall, the changes between the two groups were not significant (P > 0.05). The effect size in the intergroup comparison was less than 0.5 and in the intragroup, it was 0.7 and 0.65 in the intervention and control groups, respectively.

OCS muscle thickness on the right side between the second and fourth measurements in the intervention group decreased significantly (P = 0.033). No significant changes were observed in the control group, but the change was not statistically significant in the two groups (P > 0.05) (Table 3). In examining the effect size, this value was less than 0.5 in the intergroup and intergroup comparison. Figure 3 schematically represents the process of variation of variables by the group.

5. Discussion

The results of this study suggest that MET is an effective technique in improving the CGH symptoms.

5.1. Headache Index and ROM Improvement

In this study, headache index showed a significant change from the beginning to the end of treatment sessions in both groups, but this change was more stable in the intervention group, so that the headache improvement trend continued up to two weeks after the end of treatment.

Difference in the effects of two treatment methods (IR or MET) in the two groups is the cause of the difference in sustainability of the effects of treatment between the groups.

In the control group, only IR modality was used that was superficial heat, and its effects were improving blood

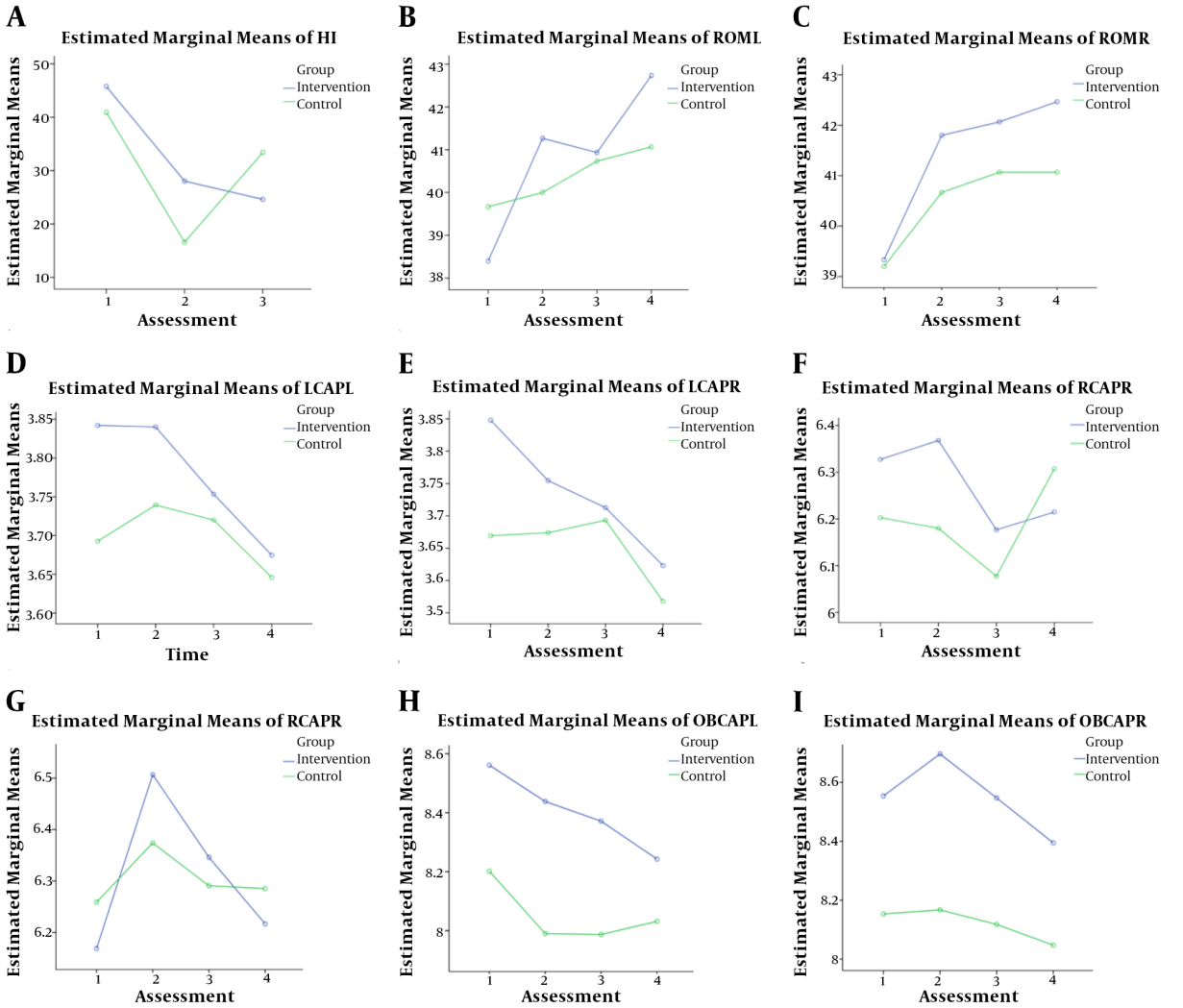

Figure 3. In each number, the upper line shows the variable changes in the intervention group and the lower line exhibits changes in the control group, A is the headache index, B and C are the left and right upper cervical rotation ROM changes, D and E are Longus capitis muscle on left and right sides, F and G are Rectus capitis muscle on left and right sides, and H and I are Obliquus capitis superior muscle on left and right sides.

circulation, metabolism and oxygenation to the tissues, removing the excreted substances from the treatment area, and increasing endorphin levels; thereby decreasing stiffness and fatigue (33). Furthermore, it can reduce muscle spasm and pain and cause general relaxation (34), being consistent with the study conducted by Gale et al. reporting an approximately 50% decrease of the intensity of pain in patients with chronic low back pain (35). Although, the effects of this modality are short-lived with no improvement in strength, ROM and muscle control and stability, MET has durable effects on motor control that can reduce abnormal tone of the muscles, strength the muscles, increase soft tissue extensibility through active and passive stretching, and improve the ROM and stability of the joints (13, 14). Therefore, the expected stable improvement in CGH symptoms in the intervention group seems reasonable.

Furthermore, upper cervical rotation ROM on both sides increased in both groups, but this increase was significant in left not on the right side in comparison between two groups. However, by examining the effect size, in the intervention group, this effect was better on the two sides than that in the control group. Therefore, it can be claimed that in ROM increasing, MET with IR was more effective than IR alone and more involvedness in the left muscles was possible, causing these muscles to respond to MET ap-

Table 3. Repeated Measurement Results for Muscles Thickness

Variables	Intervention Group, Mean ± SD	Control Group, Mean ± SD
LCAPL		
Assessment 1	3.84 ± 0.45	3.69 ± 0.41
Assessment 2	3.84 ± 0.41	3.74 ± 0.36
Assessment 3	5.75 ± 7.78	3.72 ± 0.30
Assessment 4	3.67 ± 0.24	3.65 ± 0.30
Within group P value	0.341	0.165
Between group P value	0.325	
LCAPR		
Assessment 1	3.85 ± 0.45	3.67 ± 0.36
Assessment 2	3.75 ± 0.40	3.67 ± 0.34
Assessment 3	3.71 ± 0.37	3.69 ± 0.22
Assessment 4	3.62 ± 0.30	3.57 ± 0.42
Within group P value	0.072	0.688
Between group P value	0.704	
RCPML		
Assessment 1	6.33 ± 0.56	6.20 ± 0.74
Assessment 2	6.37 ± 0.67	6.18 ± 0.66
Assessment 3	6.18 ± 0.55	6.08 ± 0.70
Assessment 4	6.21 ± 0.48	6.31 ± 0.92
Within group P value	0.263	0.395
Between group P value	0.401	
RCPMR		
Assessment 1	6.17 ± 0.67	6.26 ± 1.19
Assessment 2	6.51 ± 0.62	6.37 ± 1.11
Assessment 3	6.35 ± 0.56	6.29 ± 1.13
Assessment 4	6.22 ± 0.63	6.29 ± 1.08
Within group P value	0.104	0.784
Between group P value	0.086	
OCSL		
Assessment 1	8.56 ± 0.698	8.20 ± 1.15
Assessment 2	8.44 ± 0.514	7.99 ± 1.06
Assessment 3	8.37 ± 0.566	7.99 ± 1.04
Assessment 4	8.24 ± 0.627	8.03 ± 1.04
Within group P value	0.026	0.082
Between group P value	0.372	
OCSR		
Assessment 1	8.55 ± 0.66	8.15 ± 1.41
Assessment 2	8.70 ± 0.87	8.17 ± 1.52
Assessment 3	8.55 ± 0.71	8.12 ± 1.12
Assessment 4	8.39 ± 0.50	8.05 ± 1.20
Within group P value	0.061	0.760
Between group P value	0.721	

Abbreviations: LCAPL, left longus capitis muscle; LCAPR, right longus capitis muscle; OCSL, left obliquus capitis muscle; OCSR, right obliquus capitis muscle; RCPML, left rectus capitis muscle; RCPMR, right rectus capitis muscle

plication better than noninvolved muscles.

Nevertheless, the findings of the present study regarding MET treatment is supported by many studies suggesting that MET can reduce the pain, muscle tenderness and improve the cervical ROM in asymptomatic and neck pain patients (9, 17, 19, 36, 37). The effects of MET were stronger than those of static stretching (38) and ischemic compression on upper trepezius MTrPs (18) and sham manipulation (39).

Furthermore, MET was equally effective with manual pressure release in pain reduction, muscle tenderness and ROM increase (40), but the effectiveness of MET was lower than that of manipulation in the cervical region (41). In the MTrPs treatment, in the upper trapezius muscle, greater improvements in pain and cervical lateral flexion ROM were detected in favor of the neuromuscular inhibition technique that MET was as part of this technique (42). Therefore, in the present study, MET by reducing pain, and tenderness in this area, caused a decrease in the patient's headache, being in line with the study by Quinn et al. in which headache frequency was reduced with application of MET with combination by four massage techniques treatment on neck and shoulder muscles in chronic TTH (43). Furthermore, the immediate improvement in headache was reported in manual therapy (pressure release, MET, or soft tissue techniques) compared to placebo treatment (ultrasound)on the cervical muscles in chronic TTH (44). Although, in the study by Youssef et al. comparing the upper cervical mobilizations to massage therapy that MET for cervical paravertebral musculature was one element of massage in management of CGH, headache intensity, frequency, duration and active cervical ROM showed significant improvement in each treatment group, but significant differences in all measured variables were seen in favor of mobilization techniques (23). In the Youssef's study, MET was performed as general in the flexor muscles and their antagonistic muscles for 5 minutes, which due to combination of the effect of MET with other techniques of massage in this study, its effectiveness is not certain; however, in the present study, the effect of MET was assessed separately, and reduction in pain and cervical ROM increment was demonstrated clearly.

5.2. Muscle Thickness

In addition to the improvement in headache and ROM in this study, with slight ignorance, in all three muscles on both sides, the thickness was decreased. This is similar to Sadria et al. study that reported increase in active ROM of cervical lateral flexion, decrease in pain intensity and decrease in upper trapezius muscle thickness, when MET was applied on the upper trapezius muscle groups (45).

Unfortunately, no other studies were found about the effect of MET on cervical muscle thickness. Although muscles thickness decreased in the current study, it did not follow a consistent pattern and was not significant in intra- and intergroup comparison, but this reduction in thickness according to effect size was clear in LCAP and left OCS muscles. In this regard, it could be stated that upper cervical rotation ROM that its limitation was one of the diagnosis criteria of CGH, impaired owing to these muscles impairment (hyper-tonicity or inhibition). Although, in this study, MET in combination with IR corrected and relaxed the impairment of these muscles, the effect was not statistically significant.

Perhaps a short treatment period cannot change the thickness of the muscles, and prolongation of the treatment course or follow-up is needed to determine the clear changes in the thickness of the muscles; or possibly based on the theory of "muscle fiber type change" according to the previous study that stated fiber type changed from slow to fast fiber in the dorsal and ventral muscles in cervical dysfunction (46); this may occur in these cases, but no changes in muscle thickness are made.

As stated above, MET is an efficient technique in restoration of normal function of joint and muscle, decrease of passive congestion and ultimately reduction of pain symptoms. In this study, MET on the agonist and antagonist deep neck flexor, extensor, rotator and lateral bending muscles may be the cause of muscle relaxation owing to autogenic and reciprocal inhibition mechanisms activated during the isometric contraction. In addition, activation of muscle and joint mechanoreceptors during the MET process leads to pain descending modulation, nociceptive inhibition, and ultimately MET hypoalgesic effects (47). Furthermore, changes in muscle tone/ extensibility, and increase in viscoelasticity and tolerance to stretch and reflex relaxation are the physiological mechanisms behind the ROM increment in MET application (13).

It can be argued that all of these changes following MET application ultimately lead to improved muscle setting and correction contraction pattern, impaired by pain and dysfunction in the cervical region; therefore, improving in cervical motor control is one of the important reasons for headache relief.

5.3. Limitations and Recommendations

Intervention in this study was limited to two groups and a two-week period; therefore, this research team recommends future studies increase duration of treatment period to obtain better and durable results in headache symptoms, muscle thickness and improvement stability and motor control dysfunction of this region.

5.4. Conclusion

The results of this study could support evidence of the benefits of MET in the cervical region for CGH treatment, but it seems that MET combined with IR improving CGH and upper cervical rotation ROM is better than IR alone, and had more durable effects on headache symptoms decrement. Although MET with IR did not change deep neck muscles thickness in two weeks, it was suggested as a safe and useful technique to treat CGH in order to increase ROM and relieve pain effects.

Footnotes

Authors' Contribution: Study concept and design: Omolbanin Abaspour and Mohammad Akbari; acquisition of data: Omolbanin Abaspour; analysis and interpretation of data: Omolbanin Abaspour and Mohammad Akbari; drafting of the manuscript: Omolbanin Abaspour and Mohammad Akbari; critical revision of the manuscript for important intellectual content: Asghar Rezasoltani and Amir Ahmadi; statistical analysis: Omolbanin Abaspour; administrative, technical, and material support: Asghar Rezasoltani and Amir Ahmadi; study supervision: Mohammad Akbari

Clinical Trial Registration Code: IRCT2015031421459N1.

Conflict of Interests: There was no conflict of interests.

Ethical Approval: The Ethics Committee of Iran University of Medical Sciences approved this research (Ethical Code: 9211342209), https://res.iums.ac.ir.

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Informed Consent: The informed consent form was signed by the subjects prior to the inclusion in the study.

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