Original Article

Effect Of Muscle Energy Technique On Craniovertebral And Shoulder Angles In Forward Head Posture

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Abstract

Purpose The aim of this study was to investigate the effect of muscle energy technique in craniovertebral angle and shoulder angle in subjects with forward head posture. **Methods** Overall, 60 participants of both genders (45 males and 15 females) with forward head posture (FHP) aged 18 - 23 years and Body Mass Index (BMI) range 18 -25 kg/m² were randomly assigned to 2 groups (A and B). Group A (n=30) received muscle energy technique in addition to conventional strengthening and stretching exercises and postural advices 3 times per week for 4-weeks. Group B (n=30) received conventional strengthening and stretching exercises and postural advices 3 times per week for 4-weeks. To assess craniovertebral angle (CVA) and Shoulder angle (SA), Photographic Posture Analysis was used. Pain intensity was evaluated with Visual analogue scale (VAS) scores, and A pressure pain algometer served to measure the pain pressure threshold (PPT). All subjects' outcomes were assessed before and after treatment. For statistical analysis, t-test was conducted to investigate the effect of treatment. **Results** A statistically significant effect ($p < 0.0001$) of treatment and time was revealed in both groups for all measured variables. Between-group analysis implied a higher improvement in post-intervention results in group A ($p < 0.05$). **Conclusion** This study indicated improvement in both groups, but adding Muscle energy technique to conventional therapy resulted in more improvement in all measured variables.

Key words: Muscle energy technique, forward head posture, craniovertebral angle, shoulder angle.

INTRODUCTION

How posture influences health is becoming more obvious. Improved posture has the potential to reduce or even eliminate several biological functions that are severely impacted by it, including back pain, headaches, mood, blood pressure, pulse, and lung capacity [1]**.** Forward head posture (FHP) is the most popular postural deformity, which affects 66% of population [2]**.** With high prevalence among university students due to long period of using computer, smartphones and faulty posture during lectures and sections with lack of awareness about proper posture among them [3]**.** Increased atlanto-occipital joint extension and decreased cervical flexion, which stretch and deteriorate the anterior cervical muscles and shorten and strengthen the posterior cervical muscles, respectively, are two characteristics of FHP. The neck's muscular imbalance puts too much strain on the joint and muscles, which results in the development of abnormalities[4]**.** Upper-crossed syndrome is brought on by a shift in the neck bone's curvature, which in turn causes a muscle imbalance and a rounded shoulder posture (RSP) [5], because the shoulder's midline and the mastoid process should be vertically aligned [6].

In the past, the traditional strengthening and stretching activities were employed to increase the craniovertebral angle, improve postural alignment, and reestablish kinesthetic awareness [7].

Recently, Muscle energy techniques (MET) used as a class of soft tissue osteopathic methods which used to reduce pain as well as improve musculoskeletal function [8]. So, this research designed to test the effectiveness of the muscular energy technique (MET) as a manual approach on CVA and SA for people with forward-head posture. **Craniovertebral angle (CVA)**: is the angle formed between a horizontal line through the spinous process of C7 and a line from the tragus of the ear angles less than 49° were considered as FHP [9]. **Shoulder angle (SA)**: is angle formed at a line between the center of the humerus and spinous process of C7 and the horizontal line through the center of the humerus and SA less than 52° [10]

Figure (1).

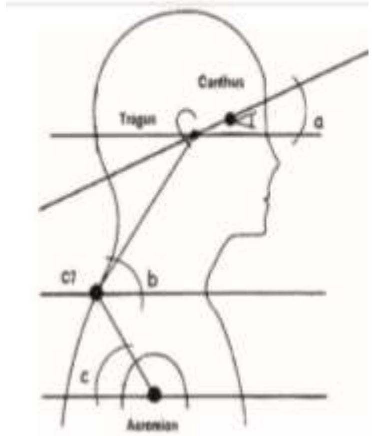


Figure (1) Angles of head and shoulder [10].
a Sagittal head, b Craniovertebral angle (CVA), c Shoulder angle (SA).

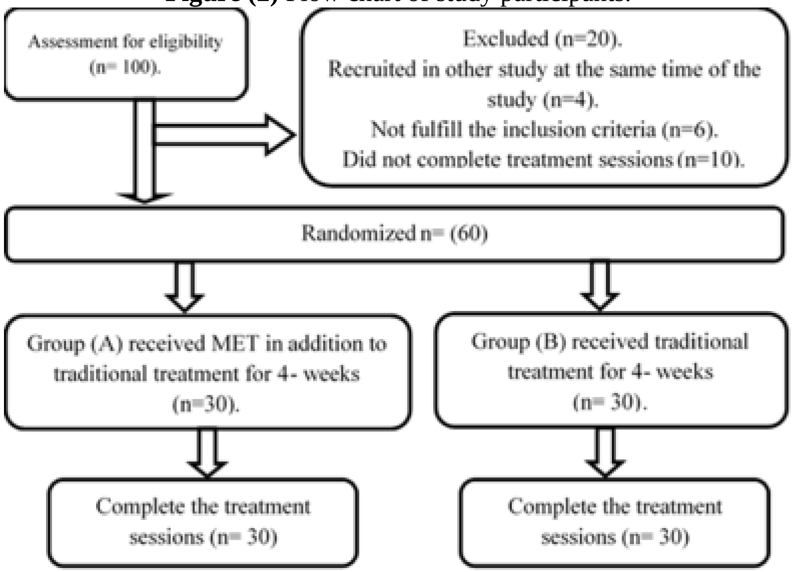
Materials and Methods

This work was intended to accurately determine effect of MET for upper trapezius and sternocleidomastoid (SCM) muscles on CVA, SA, pain and pain pressure threshold in patients with forward head posture, Students from Cairo University's faculty of physical therapy were chosen as the subjects, during the period from August 2022 to December 2022. The study protocol was approved by research ethical committee of faculty of physical therapy (NO: P.T.REC/012/003845) and registered at Clinical Trial Registry (Registry ID: NCT05642130).

Sample Size Calculation Sample size of this study was calculated by G-power analysis (version 3.1.9.2) (Franz Faul, Uni Kiel, Germany). The optimum number for this study was 60 subjects, 30 participants per group was required. This calculation was designed to reveal an effect size of 0.5 with an alpha of 0.05 and a power of 80% considering the visual analogue scale (VAS) score as the primary outcome.

Participants Sixty patients were participated in this study from both genders with forward head posture with age 18-23 years [11] and Body Mass Index (BMI) range 18-25 kg/m² [12], with a CVA equal or less than 49° [9], and SA less than 52.28° [10]. They were given a verbal and written clarification for this study. The study's intent reasoning and benefits were explained to each subject. Patients were randomly allocated into 2 equal groups: Group (A) their mean ± SD age (20.58 ± 2.02) years weight (69.01 ± 8.80) kg, height (174 ± 8.42) cm and BMI (22.54 ± 1.79) kg/m² which received MET and conventional stretching and strengthening exercises, in addition to postural advices, 3-sessions /week for 4-weeks. Group (B) their mean ± SD age (19.67 ± 1.36) years weight (68.50 ± 9.82) kg, height (171.03 ± 10.62) cm and BMI (23.28 ± 1.41) kg/m² which received conventional stretching and strengthening exercises in addition to postural advices, 3-sessions /week for 4-weeks. Outcome measures included craniovertebral angle (CVA), shoulder angle (SA), pain intensity level and pain pressure threshold that were assessed at baseline and four weeks post intervention. During assessment for eligibility twenty subjects were eliminated because ten did not complete treatment sessions and six did not meet the inclusion requirements and four were recruited for another study at the same time **Figure (2).**

Figure (2) Flow chart of study participants.



Inclusion and exclusion criteria Subjects were recruited to the study from both genders with age 18-23 years [11] if they had forward head with CVA equal or less than 49° [9] and shoulder angle less than 52.28° [10], which was determined by photogrammetry [13], there body mass index (18-25) Kg/m^2 [12]. Patients were excluded from the study if they had recent shoulder fracture, shoulder dislocation, cervical disc, cervical radiculopathy, symptoms of vertigo, dizziness, visual or auditory problems and having received physical therapy in the three months prior to the study.

Outcome measures To assess craniovertebral angle (CVA) and shoulder angle (SA), photographic posture analysis was used. Pain intensity was evaluated with visual analogue scale (VAS) scores, and A pressure pain algometer served to measure the pain pressure threshold (PPT). All subjects' outcomes were assessed before and after treatment.

Assessment Instrumentations and procedures
Photographic Posture Analysis [13] was utilized to measure CVA and SA, 50-mega pixel camera mounted on a tripod stand was used to take side views photos of the subjects with FHP[14]**,** landmarks are set on the ground to ensure that the subjects are in the same position and always at the same distance from the camera. The distance between the tripod's center and the subject's foot is measured using a tape measure at 1.5 m. The investigators adjust the height of the camera at the center of the subject dominant Shoulder, Adhesive markers were placed on tragus of the ear, spinous process of cervical spine, and anterolateral aspect of the acromion, CorelDraw graphic suites X7 software on a computer used to analyze the Pictures [9].

Pain intensity was evaluated with Visual analogue scale (VAS) scores, The VAS is a frequently used pain intensity assessment tool scale for self-reporting pain that has been proven to be valid and reliable in rehabilitation. Involving a transverse or vertical line, frequently 10 cm long. No pain" and "worst pain" are the labels at either end of the spectrum. Patients were requested to lie down and place a marker on the line at the location that most accurately described their level of pain [15]. Tenderness of the MTrP was assessed by measuring the pressure pain threshold (PPT) utilizing pressure transducer probe utilizing a pressure algometry device called a Commander Algometry (JTECH medical, Midvale, Utah, USA). When it comes to determining trigger-point sensitivity, pressure algometry is a valid and reliable method. To determine the pressure pain threshold (PPT), an algometry was placed on the trigger point, and the pressure was increased by 1 kg each second. As soon as the patient complained of pain, the pressure was measured in kilograms per centimeter squared [16]. At 60 second intervals, the process was performed three times, and the average pressure was documented as the PPT **Figure (3).**

Figure (3) Pain pressure threshold assessment

Intervention Instrumentations and procedures

Group (A) participants received muscle energy technique in form of post isometric relaxation (PIR) for upper trapezius and sternocleidomastoid muscles. Each muscle was stretched by the therapist moving the subject's head into the appropriate position. Once resistance or a barrier was felt, the position was maintained, and the subjects were instructed to isometrically contract the target muscle for 5 seconds at 20% of their maximum contraction against light resistance from the therapist. Then, the subject was instructed to relax for 5 seconds before passively stretching for 30 seconds until reaching a new barrier. Each muscle received three repetitions, 3 sessions per week, over 4-weeks period [17]. In addition to conventional strengthening and stretching exercises

PIR for upper trapezius, the patient was sitting upright on a stool. The therapist supported the patient from behind by placing one hand on the ipsilateral shoulder and the other on the side of the patient's head. The patient's head was rotated to the same side of the stretched muscle, flexed to the opposing side, then bent laterally to the opposite side. The ipsilateral hand pushed the shoulder inferiorly to lengthen the muscle until the restrictive barrier was met, then asked the patients to raise the shoulder against the hand isometrically then gently stretch the muscle until meeting a new barrier [17] **Figure (4).**

Figure (4) PIR for upper trapezius.

PIR for Sternocleidomastoid, The patient was upright and seated on a stool. The therapist stood behind the patient with her forearm on the patient's ipsilateral shoulder for stabilization, while the hands surrounded the patient's head. The head flexed laterally away from the involved side, rotated to the involved side, extended the lower cervical spine, and flexed the upper cervical spine to meet the limiting barrier. The patient was instructed to push forward against the therapist's hand isometrically, and then gently stretch the involved muscle until meeting a new barrier [17] **Figure (5).**

Figure (5) PIR for sternocleidomastoid.

Group B (control group) participants received conventional treatment as, static stretching exercise for upper trapezius and sternocleidomastoid [18]. 3 days/week over a period of 4-weeks, in addition to strengthening exercises of deep cervical flexors and scapular retractor muscles [18], 3 sets of 12 repetitions with 6 sec hold in addition to postural advices [19]. To passive stretch of upper trapezius muscle, the participant was sitting upright on a stool. The therapist supported the patient from behind, placing one hand on the patient's ipsilateral shoulder for stability and the other on the patient's head's side. The head of the individual was rotated to the same side of the stretched muscle, bent laterally to the opposing side, and moved to flexion. 30 seconds of keeping, followed by 30 seconds of relaxation [18] **Figure (6).**

Figure (6) Passive stretch for upper trapezius muscle.

Passive stretch to sternocleidomastoid Muscle (SCM), the subject sat upright on a bench. The therapist stood behind her, one hand fixing the subject’s opposing mandible and the other fixing her head, then placed her forearm on the subject's ipsilateral shoulder for support. The head was moved to extension, lateral bending to opposite side and rotation to the same side of stretched muscle, held for 30 seconds, and then relaxed for 30 seconds [18] **Figure (7).**

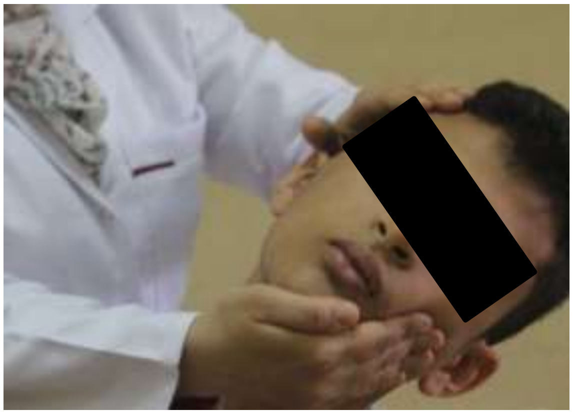


Figure (7) Passive stretch for sternocleidomastoid muscle.

Isometric strengthening exercise of deep cervical flexor muscles the subject sat on a stool. The therapist stood behind the subject, with the therapist's hand on occiput posteriorly to resist the head movement, the subject was told to tuck his head in and straighten his neck and back. As subject was instructed to tuck his head in so that his ears were aligned with the tip of his shoulders when sitting [18] **Figure (8).**

Figure (8) Isometric strengthening exercise of deep cervical flexor muscles.

Strengthening of the scapular retractor muscles, the participant sat on a chair without back support. The movement of the medial border of the scapula was gently resisted and the subject pinch them together "retraction". The subject was asked to imagine "holding a quarter between both the shoulder blades". Instructing each subject not to extend the shoulders or elevate the scapulae. The participant then stranded with his hands grasped together behind the lower back (this activity cause scapular adduction). The patient is instructed to adduct scapula and to hold the adducted position with both arms lowered downwards [18].

Postural advice was given to them, including the following: they should avoid sleeping on a foam rubber pillow; should use a chair with proper back support and an arm rest of an appropriate height to provide elbow support while working at a keyboard and computer; should avoid leaning forward while writing for an extended period at a computer or on a desk; and should avoid holding the phone by tilting the neck during prolonged phone conversations. The participants were also instructed to stretch their arm, shoulder, neck, and back muscles after every 20 to 30 minutes of work in addition to getting up and walking to silence the buzzer and restart the timer in order to reduce muscle tension. They should either refrain from carrying a bag for an extended period of time on one shoulder or distribute the bag's weight evenly across both shoulders [19].

Statistical Analysis

The Windows version of SPSS (Statistical Package for the Social Sciences) version 25 was utilized for all statistical analysis. (IBM SPSS; Chicago; Illinois; USA). Unpaired t-test was conducted for comparison of the subject characteristics between groups. Chi-squared and t test was conducted for comparison of sex distribution between groups. Unpaired t-test was conducted for comparison of CVA, SA, pain assessment, and pain pressure between groups. Paired t-test was conducted for comparison of CVA, SA, pain assessment, and pain pressure threshold (PPT) between pre and post treatment in each group. The level of significance for all statistical tests was set at $p < 0.05$.

Results

The demographic characteristics of the patients are revealed in **Table (1),** There was no substantial change among groups in age, weight, height and BMI as p-value was (0.019, 0.93, 0.26, 0.037) respectively ($p > 0.05$).

Table (1) Demographic characteristics of participants in the both groups.

	Group A	**Group B**	**t- value**	**p-value**	**Sig**
	$\bar{X}$ **± SD**	$\bar{X}$ **± SD**			
Age (years)	20.58 ± 2.02	19.67 ± 1.36	2.495	0.019	NS
Weight (kg)	69.01 ± 8.80	68.50 ± 9.82	.089	0.930	NS
Height (cm)	174 ± 8.42	171.03 ± 10.62	1.135	0.266	NS
BMI (kg/m²)	22.54 ± 1.79	23.28 ± 1.41	-2.192	0.037	NS

$\bar{X}$: Mean value SD: Standard deviation Sig: significant
t value: Unpaired t value p value: Probability value NS: Non significant

Impact of Treatment on CVA, SA, VAS and PPT

Within Group Comparison There was a substantial increase in the mean value of CVA, SA, VAS, Rt PPT and Lt PPT post-treatment in comparison with pre-treatment ($p < 0.05$) in both groups (Table 2)**.** There was a substantial decrease in the mean value of VAS post-treatment in comparison with pre-treatment ($p < 0.05$) in both groups **Table (2).**

Table (2) Comparison of Mean± SD of CVA, SA, VAS, RT PPT and LT PPT of the both groups at pre and post treatment times.

Parameters	**Group A**	**Group B**	**p-value (between groups)**
	$\bar{X}$ **± SD**	$\bar{X}$ **± SD**	
CVA			
Pre-treatment	43.64 ± 2.26	44.52 ± 1.95	0.11
Post-treatment	48.87 ± 2.76	45.97 ± 1.98	0.0001
P (within group)	0.0001	0.0001	-
SA			
Pre-treatment	46.54 ± 1.71	46.96 ± 1.78	0.35
Post-treatment	51.62 ± 1.76	48.7 ± 1.93	0.0001
P (within group)	0.0001	0.0001	-
VAS			
Pre-treatment	5.64 ± 1.38	6.1 ± 1.42	0.2
Post-treatment	1.51 ± 0.94	4.07 ± 1.3	0.0001
P (within group)	0.0001	0.0001	-
Rt PPT			
Pre-treatment	0.99 ± 0.49	1.04 ± 0.49	0.7
Post-treatment	1.7 ± 0.47	1.3 ± 0.42	0.001

P (within group)	0.0001	0.0001	-
Lt PPT			
Pre-treatment	1.1 ± 0.43	1.06 ± 0.34	0.7
Post-treatment	1.75 ± 0.6	1.3 ± 0.35	0.001
P (within group)	0.001	0.001	-

CVA: craniovertebral angle
SA: shoulder angle
VAS: Visual Analogue Scale
Rt PPT: right side pain pressure threshold
Lt PPT: left side pain pressure threshold

Between Group Comparisons

When comparing the two groups before treatment, there was no substantial difference in any of the parameters (p>0.05) (CVA, SA,VAS, RT PPT and LT PPT).When comparing groups after treatment, all variables improved significantly, while the comparison between both groups revealed a higher improvement in group A scores (p<0.000).

Discussion

A common postural variation that is usually observed in adolescents, forward head posture (FHP), has been linked to an increased risk of developing neck pain. The prevalence of FHP was observed to be around 61.3% among persons with neck discomfort who were computer users. Additionally, patients with chronic neck pain showed weakening in their deep neck flexors and experienced FHP when focused [9].

Long-term computer use demands constant strain in the neck muscles, which can quickly result in the development of a forward-head posture (FHP). The forward head requires 3.6 times as much force to maintain the same position as when standing straight because the head makes up 1/7 of the body weight [20].

In all prior studies on FHP, the impact of conventional treatment as strengthening and stretching exercises on symptoms and disease progression, such as pain, physical function, and range of motion, was explored. However, based on my research, this study was the first to look into how MET affected CVA and SA.

When comparing pretreatment CVA, SA, pain intensity, and pain pressure threshold data between groups, it was initially evident that there was no difference between the groups in any of the variables. According to the data analysis posttreatment (CVA, SA, VAS and PPT). The current study showed improvement in both groups, however adding muscular energy technique to conventional therapy led to more improvement in all evaluated variables, there was a significant effect of treatment ($p < 0.000$). To know how MET affects CVA and SA on FHP, pathogenesis should be described.

By shortening overactive muscles and inhibiting stretched ones, poor posture naturally causes FHP by creating a muscular imbalance [21], and the study aims to improve this bad posture by utilizing the effects of MET, stretching, strengthening exercises, and postural guidance [18,19].

The exercise program was employed to treat this poor posture by increase tissue flexibility and elasticity in order to restoring the proper muscle balance between agonist and antagonist muscles and improving postural alignment [22].

The neurophysiological mechanism of MET that causes more improvement may inhibit Ia, IIa, and Ib afferents from muscle spindles and Ib afferents from the Golgi tendon organ to the central nervous system. It is believed that the activity of alpha motor neurons is impacted by such a changed afferent drive. There may be a progressive return to normal activity and a reduction of pain due to an increase in muscular flexibility and resulting decrease in muscle tightness. It was suggested that stretching after an isometric contraction would normalize the function of the muscle's contractile components by equating the length of the sarcomeres in all of the engaged muscle fibers [19]. Additionally, strengthening exercises have an anabolic effect, which increases muscle strength and increases a cell's ability to withstand stress. so, it is believed that strengthening activities can effectively keep a correct posture and aid in its preservation over time [23].

The consequences of this study came in agreement with (Joshi and Poojary) **8.** Who investigated The effect of muscle energy technique and posture correction exercises on pain, function, and CVA in patients with non-specific chronic neck pain and forward head posture with a craniovertebral angle of less than 48° were separated into two groups. The MET group received muscle energy therapy along with exercises for posture correction, while the control group just received neck range of motion therapy. Three outcomes were measured: cranio-vertebral angle, function (Neck Disability Index), and pain (Numerical Pain Rating Scale). Their findings indicated that muscle energy technique should be used in the treatment of non-specific chronic neck pain in those with forward head posture since the combined effect of MET and posture correction exercises gives noticeably larger benefits than neck range of motion treatment.

It was obvious from the results of the current study that participants in both groups have showed a significant improvement in pain score ($p < 0.000$). The improvement in pain scores was higher in group A as compared with the group B ($p < 0.000$). So, according to the results of the preceding article, MET has a better impact on reducing pain and enhancing function in patients with forward head posture [24].

Authors can discuss that through, MET reduces pain by stimulating the mechanoreceptors and proprioceptors in muscles and joints as well as by inducing the body to produce its own painkillers while it is in an isometric contraction phase [25]. Isometric contractions work best when muscular tension is the main cause of dysfunction because they produce a more tolerable stretch and better relaxation [26]**.** Stretching exercises also increase the extensibility of soft tissues and the flexibility of muscles by inhibiting the Golgi tendon organ, which in turn lowers motor neuronal discharge and causes muscles to relax. This lowers trigger point pain, allowing the patient to tolerate more pressure and raising their pain threshold [27]. Additionally, postural instruction with MET reduces pain in patients with FHP [26] because it helps prevent additional damage [19]**.**

Limitations

This study was limited by the short treatment time, there was no follow-up evaluation and it did not measure the muscles activity.

Conclusion

According to the results of this study, muscle energy technique can be conceded as essential technique in treatment of forward head posture, as it improves craniovertebral angle, shoulder angle, pain intensity and pain pressure threshold in subjects with forward head posture.

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Ethical Clearance: Cleared by the Ethical Committee of Faculty of Physical Therapy, Cairo University, Cairo Egypt.

Conflict of Interest: None.

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