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Comparison of the Forward Head Posture on Scapular Muscle Contributions During Shoulder Flexion of Predominant Arm in Women with Forward Head Posture

Aydin Valizadeh,[1] Reza Rajabi,[2] Farhad Rezazadeh,*[3] Azam Mahmoudpour,[2] Shirin Aali[3]

1. Department of Physical Education, Faculty of Education and Psychology, University of Mohaghegh Ardabili, Ardabil, Iran
2. Department of Sport Medicine, Faculty of Physical Education and Sport Sciences, Tehran Universiy, Tehran, Iran
3. Department of Sport Medicine, Faculty of Physical Education and Sport Sciences, Kharazmi University, Tehran, Iran

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*Corresponding author at:
Department of Sport Medicine, Faculty of Physical Education and Sport Sciences, Kharazmi University, Tehran, Iran.
E-mail:
rezazade.farhad@gmail.com

Abstract

***Background*:** Because of the corrigibility of forward head posture (FHP), the recognition of the relationship between this deformity and scapular rotator muscles may be influential on scapular muscle activities in detection of better way to improve movement disorders. Therefore, the aim of this study was to compare the serratus anterior, upper and lower trapezius muscle contributions during shoulder flexion without weight in women with and without FHP.

***Materials and Methods*:** In this case-control study was carried out on 18 women with FHP and 14 healthy subjects who were matched. EMG muscle activities were recorded during shoulder flexion and abduction. The value of each muscle divided on total muscle values to calculate contribution ratio and independent *t*-test was used to compare contributions between groups.

***Results*:** There was a significant decrease in serratus anterior muscle activity ratio (p=0.002) and a significant increase in upper trapezius muscle activity ratio (p=0.001) between subjects with and without FHP. There was not also significant difference in contribution of lower trapezius muscle.

***Conclusion*:** Contribution of the serratus anterior muscle in individuals with forward head posture is less than healthy subjects. The contribution of upper trapezius muscle also in individuals with FHP is greater than healthy subjects.

Introduction

Forward head posture is one of the most common types of poor postures that are associated with shoulder pain [1, 2]. Despite, forward head is a risk factor for impingement syndrome of shoulder and sub acromial region which has great role in the development of pain-related occupational injuries that varies between 8% and 41% depend on exposure rate to injury [3-5]. Considering muscular imbalance of shoulder girdle, impairs neuromuscular control and cause abnormal movement pattern for elevation of upper extremity, the hypothesis suggests the relationship between forward head and stabilizer muscles of scapula. Serratus anterior and trapezius muscles play a major role in creating and controlling the movements of scapula and leads to upward rotation, external rotation and posterior tilt of scapula as a paired force [6-8].

Thigpen et al. compared combination of scapular motion and activity of serratus anterior, upper and lower trapezius muscles in healthy subjects and patients with forward head posture and rounded shoulder [3]. The researchers' findings suggest that the normal activity of the serratus anterior and trapezius muscles is an important factor for forward head posture [9, 10]. Also Weon et al. evaluated the effect of simulated forward head posture on the upward rotators of the shoulder in sitting position with isometric flexion in sagittal plane [11].

Many researches have been made to assess the effect of head, chest and shoulder posture on shoulder muscles strength and kinematics. However, no study has been done yet to evaluate the effects of head posture on rotator muscles activity during shoulder flexion that is an important risk factor in the development of shoulder pain in computer users and overhead activities. Also, because of the correction of forward head abnormalities by exercise therapy, understanding the relationship between these abnormalities and activity of scapular rotator muscles may be effective in improving shoulder pain and movement disorders. However, there are a few literatures in this area.

Thus; the assumption of this research project is that the activities required shoulder flexion such as working with computer leads to functional impairment of scapula rotator muscles. Therefore, this study aimed to address the existing gap in comparing the effects of forward head posture on activity of Serratus anterior, upper and lower trapezius muscles during dominant shoulder flexion in women with forward head posture and healthy counterparts.

Materials and Methods

This case-control study was carried out on 32 women with and without forward head posture in the corrective exercises laboratory of Tehran University in 2011. The cases were selected from available population of students living in the dormitories of Tehran University and using the results of a preliminary study to determine sample size base on variance of parameters achieved from 5 person, so 18 women with FHP and 14 healthy women matched base on the height, weight, age and dominance of the upper limb were selected. Inclusion criteria for patients were: a normal posture for the healthy group and FHP for patients. The exclusion criteria include pain feel in the neck and shoulder, neck and chest fracture, structural or functional scoliosis and increased kyphosis, history of neuromuscular disease, cardio-respiratory problems and constant participation in sportive activities. Research information provided in written form and all volunteers signed a consent form. Demographic information including age, height, weight and dominant arm of subjects was collected by examiner.

To ensure no pain during the measurement visual analog scale was used so that if the numeric value was greater than 3, the subject was excluded from the test [12]. New York test was used to detect abnormalities such as forward head, kyphosis, scoliosis, and rounded shoulders in frontal and sagittal views. If any of these abnormalities except head forward was seen in an individual, she was excluded from further analysis. Then, using a goniometer forward head angle (craniovertebral angle) was measured while the subject asked to stand in a comfortable position and do three neck flexion and extension, then maintain head in a comfortable position. Examiner standing in the right side of the subject, adjusting fixed arm of the goniometer perpendicular to the ground and the removable arm on spinous process of Seventh cervical vertebra and tragus then the angle between removable arm and the line parallel with ground through the seventh vertebra was recorded as forward head angle. If the angle was in the range of 42.7±1.5 degree the subject classified in FHP group and the angle range of 52.6±1.9 considered as normal head posture [13]. EMG activity recorded by the researcher using device (Model ME6000) manufactured by Mega Electronics Ltd of Finland. In this study, three channels of sixteen available channels, was used to record the EMG activity of the muscles, with the ×305 gain and sampling rate was 2000 Hz. Data analyzed with Megavin software. Also the beginning and end of arm flexion was determined with electro goniometer. After apreliminary description of test procedure to subject, skin at the electrodes sites was shaved, abraded, and cleaned with alcohol before the attachment of the electrodes to reduce skin impedance and obtain the best fixation. Recording electrodes were fixed using adhesive tape and positioned parallel to the direction of the muscle fibers and the reference electrode using conducting gel. Electrodes installed using bipolar method and center to center distance between the electrodes was 30 mm. Electrode positioning followed recommendations by the previous studies (Fig. 1) [14]. Data normalized with maximal voluntary contraction (MVC) of each muscle. In order to record the MVC of serratus anterior muscle subjects sat on a chair in a vertical position, with out leaning back and the arm was held at an angle of 125 degrees. Examiner applied resistance on elbow to prevent arm flexion and on the lower angle of scapula in order to prevent rotation of the scapula. MVC for upper trapezius muscle achieved in former sitting position with the shoulder flexed at 125 degrees and for the trapezius with the shoulder abducted at 90 degree, the neck tilted to the same side and rotated to the opposite side. In order to prevent head extension and arm abduction the examiner applied resistance on occiput and top of elbow respectively. MVC for lower trapezius muscle achieved in prone position on a bed, arm was over head and along with lower trapezius fibers, also examiner applied a resistance on elbow to avoid from elevation and on low back to prevent separation from bed [14, 15]. In order to record the EMG activity of the muscles, subjects stood with palm in contact with the body raising and lowering arm in full rang in sagittal plane without elbow flexion in four seconds in steady speed that controlled with metronome [16]. EMG signal processing was done in 3-second windows (i.e. the first and last two seconds of the 7-second of MVC recording were excluded for each studied task). EMG amplitude values are represented by the RMS for tasks. Finally, electromyographic activity of serratus anterior, upper and lower trapezius muscles during flexion, divided to three seconds of maximal voluntary isometric contraction of the muscles, then normalized as a percentage of maximum voluntary isometric contraction. To determine the relative contribution of each muscle in arm flexion normalized EMG activity of each muscle divided to sum of EMG activity of all three muscles. The Kolmogorov-Smirnov test was used for normality of distribution. Independent *t*-test was used to compare the muscles' EMG activity between groups. A 5% level ($p \leq 0.05$) was used to determine statistical significance. Data analyzed in SPSS-15 software.

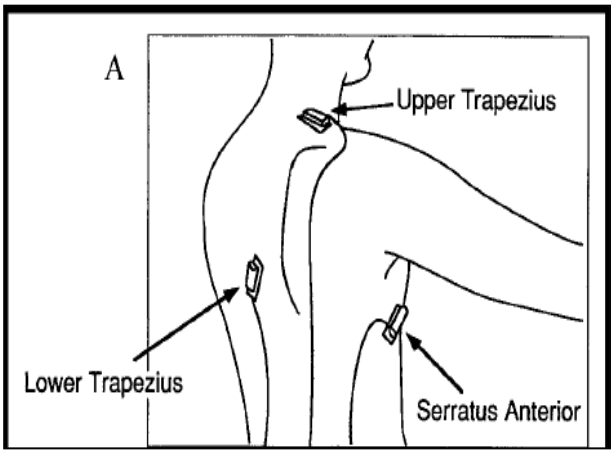

Figure 1. Electrode sites for serratus anterior, upper trapezius and lower trapezius muscles

Table 1. Demographic values of subjects (Mean±SD)

Groups	Head forward angles (degree)	Age (yrs)	Height (cm)
Healthy subjects	52.6±1.9	26±2.5	162.7±6.1
Head forward group	42.7±1.5	25.2±1.1	163.9±6.3

Table 2. The comparison of RMS values of normalized EMG activity of each muscle between two groups (Mean±SD)

Groups	Serratus anterior	Upper trapezius	Lower trapezius
Healthy subjects	45±7	34±9	20±9
Head forward group	36±7	48±9	16±7
p-Value	0.002*	0.001*	0.14

* Significant p-values according to the analysis of variance

Results

Demographic values of subjects including age, weight, height and head forward angles are presented in table 1. The results of the RMS values of normalized EMG activity of upper and lower trapezius and serratus anterior muscles in relation to the sum EMG activity of all three muscles in patients with forward head posture and healthy ones are presented in table 2. The data analysis showed that there was significant difference in the relative contribution of normalized EMG activity of upper trapezius and serratus anterior muscles to the sum activity of all three muscles in patients with forward head posture, where as no significant difference was found between two groups in the lower trapezius (Table 2).

Discussion

This study's results demonstrate that serratus anterior and upper trapezius muscles contribution during prominent arm flexion between women with and without forward head posture were influenced. The contribution of serratus anterior in patients with forward head posture was decreased. Also, the upper trapezius muscle contribution in patients with forward head showed increased EMG activity, whereas there was no significant difference in the contribution of lower trapezius between two groups.

This result is in agreement with McLean and Weon et al., who reported that head forward posture alters the length and tension of upper trapezius muscle during shoulder upward rotation [11, 17]. Upper trapezius muscle is agonist of scapula upward rotation and antagonist of levator scapula muscle. So, enhancing tension of levator scapula leads to prevent scapular upward rotation. Therefore, to overcome increased tension due to forward head posture, the upper trapezius should be more active. The results of the present study also confirm this fact. The upper trapezius muscle has higher recruitment with maximal activity level compared to other muscles. Also, because of quick response and increased muscle tension, it can be said in addition to its role as a scapular rotator, it tends to have short length as a postural muscle with high level of activity [18]. It is also possible that biomechanical changes of cervical spines due to forward head posture cause changes in muscle EMG activity. Torque of cervical flexors increases in patients with forward head posture. Therefore, to counteract this imbalance, cervical extensor muscles show more activity. The results of this study are consistent with an increase in upper trapezius muscle activity [11]. In contrast, results of this study are in disagreement with Ludewig and Cook who demonstrated that there was no significant difference between serratus anterior, upper and lower trapezius muscles EMG activity with respect to the position of head 0, 25 and 50 degrees angles during arm elevation in scapular plane [3-6]. The differences should be sought in the selection of movement patterns and cervical flexion. Mcquade et al. expressed that different movement patterns with arm elevation create different scapular movements [19]. The movement patterns of this study were arm flexion without weight over the entire range of motion of head forward posture while in other research scapular movement patterns on scapular plane with different head flexion angles. Despite Weon reported increased lower trapezius muscle activity during isometric exercise with loading over arm in the sagittal plane [11], we did not reach such a conclusion in the present study. This is likely due to elevation movement pattern (movement plane, loading and maximum isometric contraction) [15]. Sahrmann observed that the Kinematic changes of scapular movement associated with an imbalance of muscle forces [20].

In this regard, Ludewig and Thigpen evaluated the combination of shoulder and scapula joint motions in patients with shoulder impingement syndrome and disorders during functional activities in scapular plane with related muscle activities. They concluded that upper and lower trapezius and serratus anterior muscles EMG activities at all loading times and phases are altered, which is similar to pattern obtained in the present study [3, 15].Thus, high level activity of upper trapezius and lower level activity of serratus anterior have a great role in causing pain. Decreased serratus anterior muscle activity can be due to decreased scapular upward rotation which is a mechanical risk factor of impingement syndrome due to reduction in subacromial space and increased pressure [21, 22], or the lack of stability in the shoulder area. It is believed that to maintain stability of humeral head in center of shoulder joint has an important role. Therefore, any disorders in this mechanism cause to faulty movement of humeral head during functional activities. So, shoulder girdle stability is required for arm joint stability. One of the important factors help to

maintain the stability of the shoulder joint is coupled scapulothoracic joint forces, including the trapezius and serratus anterior muscles. At the beginning phase of arm elevation which rotation axis located in spine of scapula, upper fibers of serratus anterior have primary role. When axis of rotation reaches to acromio-clavicular, upper and lower trapezius contribution activities reduced and serratus anterior activity increased. Reduction of serratus anterior activity in the lower part is another main points discussed in literature which have a key role in the second half of arm elevation [23].

Reduction serratus anterior EMG activity is a mechanism preventing shoulder pain or result of an abnormal motion of shoulder [23, 24]. The only muscle which has potentially a great role in all three scapular rotation is serratus anterior, thereby the decrease in serratus anterior EMG activity can leads to alter shoulder motion complex. Meanwhile, because of reduction in relative contribution of serratus anterior in patients with forward head posture compare to healthy ones, it is expected that the contribution of other muscles is altered. Therefore, increase in other muscles contribution cause to decrease serratus anterior contribution [15, 25]. Contribution of the serratus anterior muscle in individuals with forward head posture is lower than healthy subjects. The results of this study revealed that serratus anterior contribution in individuals with FHP is lower than healthy subjects and the contribution of upper trapezius in forward head posture group is higher than healthy group. Therefore, restoring normal function of upper trapezius and serratus anterior muscles play an important role in correcting forward head posture.

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Authors' Contributions

All authors had equal role in design, work, statistical analysis and manuscript writing.

Conflict of Interest

The authors declare no conflict of interest.

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