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The Relationship Between Thoracic Kyphosis Curvature, Scapular Position and Posterior Shoulder Girdle Muscles Endurance

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Abstract: One of the parts that has an important role in creating an ideal posture in upper body, is shoulder girdle. It is believed that the position of scapula has direct correlation with its stability, strength and endurance of muscles in this area. Therefore any change or dislocation of this bone that is seen in some kinds of abnormalities, might affect shoulder girdle muscles especially their stabilator function. Sixty four girls who had no regular exercise, pain and injury experience in their shoulder and spine with average of age (20.43 ± 0.99), height (162.76 ± 3.55) and weight (53.32 ± 5.11) were recruited. The degree of thoracic kyphosis was measured using a flexible ruler and scapula protraction was calculated with Diveta method and endurance of posterior shoulder girdle muscles was measured using a clinical test. Results showed a significant correlation between thoracic kyphosis degree and scapula protraction ($r= 0.40$, $p<0.05$) and endurance of posterior shoulder girdle muscles($r= -0.40$, $p<0.05$). Also, there was a significant negative correlation between scapula protraction and endurance of posterior shoulder girdle muscles($r= -0.37$, $p<0.05$). Conclusion: we concluded that, when thoracic kyphosis curvature increases, scapula bones move away from their normal position and endurance of posterior shoulder girdle muscles decreases.

Key words: Thoracic kyphosis · Scapula protraction · Posterior shoulder girdle muscles · Muscular endurance

INTRODUCTION

Posture can be defined as the position of all the body segments observed at a specific moment. Adequate posture occurs when the body is kept in balance with the least expenditure of energy possible. Under such conditions, muscles work more efficiently and ideal positions are allocated to the thoracic and abdominal organs [1]. Inadequate posture consists of poor interrelations between parts of the body. These imperfect interrelations cause muscle tension and shortening, which makes appropriate joint movements more difficult to achieve. Incorrect movements cause injuries to the musculoskeletal system and limit the ability to perform daily activities. The prevalence of postural problems is associated with pain. So that, these constant pressures Causes Non-anatomical adaptability in the body structures especially the spinal column [2].

The spinal column is the master axis of the whole muscular and skeletal system; all the other systems and tracts of the human body are organized around it. It is one of the first structures embryos develop, forming the appendices that, in their turn, give rise to the limbs and other body segments. Therefore, diseases that affect the spinal column structure and function may affect the whole body. Biomechanically speaking, the spinal column influences and is influenced by positioning and stress of the pelvic and scapular belts and upper and lower limbs, respectively. The thoracic spine can be a source of pain and dysfunction for many individuals especially in adaults across the life span. Pain in this region has been associated with reduced quality of life and functional capacity. Hyperkyphosis is common posture problems among children and adolescents [3, 4, 5]. Mainly hyperkyphosis develop because of unsuitable postural habits. In this situation, the pectoralis muscles including minor and major pectoralis, serratus anterior and latissimus dorsi, become tight and short, contrastly erector spinae, rhomboids and trapezius become stretched and weak. Also, unsuitable posture with hyperkyphosis and forward shoulders, cause disorder in function of shoulder girdle joints. Inward rotators muscles, serratus anterior and lower trapezius might be shorten. In these individuals therefore both shoulders and upper thoracic

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spine motions become limited [6, 7]. To correct and prevent the problems, researches use remedial and corrective exercise protocols as in studies which have been yet done, for example the effect of the strengthening exercises for trunk extensor muscles were measured among older women and the results indicated that when the back muscles become more strong, thoracic kyphosis will be reduced [2]. Some studies indicate that trunk extensor muscles strength is an important factor in thoracic kyphosis degree variation [3, 2], It has been stated that when these muscles become more strong, the angle of kyphosis will be reduced [8]. Accordingly, strengthing exercise protocols to treat this problem have been recommended [2].

Upper back muscles such as (lavator, rhomboids, trapezius) have an important role in structure and motions of spine [9]. Theoretically it can be expected any change in the spinal curvature, like a hyperkyphosis, might changes length and strength of trunk extensor muscles. It is believed that the scapula position has the direct correlation with scapula stability, strength and endurance of muscles of this area. It is also belived that if the position of these bones changes, which can be seen in some abnormalities, it will affect the performance of shoulder girdle muscles specially scapula stabilization muscles too [10].

Round shoulder, thoracic kyphosis abnormalities and forward head might make scapula dislocation from its original site. In this position, to get suitable position of retraction, scapula consumes much more muscular energy [11] and according to Mottram [8] weakness of muscles between scapula, makes them move away from spine. However there is not much information about inter relationship of hyperkyphosis, scapula position and the endurance of shoulder girdle muscles. Available studies are more focused on the position of scapula among injured subjects and athletes. An indirect study Raphael, *et al.* [12] indicated a correlation between the strength of upper limbs muscle and thoracic kyphosis degree, however in their study did not report which muscles were measured and which method was used.

The aim of this study was to determine if there is any correlation between thoracic kyphosis degree, scapula protraction and posterior shoulder girdle muscles endurance.

MATERIALS AND METHODS

Participants: Sixty four girls between the age of 20-24 years old were recruited for this study. Relevant questionnaire and letter of satisfaction was distributed among the volunteers to provide demographic information about the age, medical and athletic records if agreemented. Then, the subjects who had physical problems in shoulder girdle such as: Fracture, dislocation, surgery, bone injury, pain and postural abnormalities like forward head, round shoulder were eliminated from study as a exclusion criteria. Also subjects who had not any regular exercise (3 or more than 3 times during a week), championship and professional activities experience were set as inclusion criteria. Hence subjects who were (±2 SD) taller and heavier than the means were excluded from the study to reduce the height and weight effect on the outcome.

Instruments: Thoracic kyphosis was measured using a flexible ruler and Diveta [9] method was used to measure scapula protraction (Figure 1).

Endurance of posterior shoulder girdle muscles in this study was considered as the ability of these muscles to keep natural position of scapula in abduction motion and outward rotation of arm during a long time. To measure endurance of posterior shoulder girdle muscles, we used rehabilitation and clinical test [13, 14]. The individual lied on the floor in prone position as forehead was on the pad to keep neck in the natural position. Then he/she took 2-kilogram dumbbells with straight elbow and arms in 90' abduction position and also outward rotation, they moved their hands away from floor parallel to the surface of the floor. The time between taking the dumbbells parallel to the floor surface until those dumbbells become close to the floor and attache it, was considered an endurance of muscles degree (Figure 2). (It should be said that the distance between hands and the floor was equal for all subjects and we put two pads over the hands not to carry dumbbells up more, as a result, the situation was similar for all the subjects).

Statistics: Parametric analysis was performed as the kyphosis, scapula protraction and posterior shoulder girdle muscles endurance data was normally distributed. The correlation between thoracic kyphosis, scapula protraction and posterior shoulder girdle muscles endurance was computed by Pearson's product moment. All statistical analyses were performed using the statistical package of SPSS for Windows version 15. A level of $p<0.05$ was chosen as the maximum level for statistical significance for all analyses.

A/B = scapula protraction

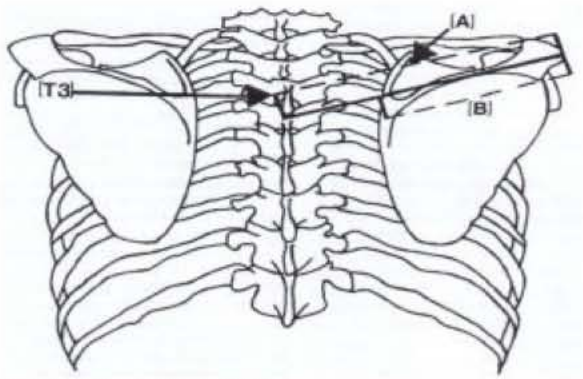

Fig. 1: The method of measuring scapula protraction degree

Fig. 2: The method of measuring posterior shoulder girdle muscles endurance

RESULTS

Mean and standard deviation of subjects profile, including age, height and weight and the study variables including Thoracic kyphosis, scapular protraction and posterior shoulder girdle muscle endurance are presented in Table 1. Acording to Table 2, there is a significant correlation between thoracic kyphosis degree and scapula protraction ($r= 0.40$, $p<0.05$) and endurance of posterior shoulder girdle muscles($r= -0.40$, $p<0.05$). Also, there is a significant negative correlation between scapula protraction and endurance of posterior shoulder girdle muscles($r= -0.37$, $p<0.05$).

Table1: Descriptive information of study variables(n= 64)

Variable	M	SD
Age (years)	20.43	0.99
height (cm)	162.76	3.55
Weight (kg)	53.32	5.11
Thoracic kyphosis (dg)	46.61	11.03
Scapula protraction (cm)	1.54	0.15
Muscle endurance (s)	37.31	17.77

Table 2: Correlation of thoracic kyphosis degree with study variables (n= 64)

TK	Variable	R	P value
	Scapula protraction	0.40	0.001
	Posterior shoulder girdle muscles endurance	-0.40	0.001
SP	posterior shoulder girdle muscles endurance	-0.37	0.002

TK = Thoracic kyphosis, SP = scapula protraction, R = correlation

A/B = scapula protraction

DISCUSSION

It has been hypothesized that changes in sagital plane posture, specifically thoracic kyphosis and forward-head posture, result in changes in the resting position of the shoulder complex [15]. The results of this study indicate that an increase in thoracic kyphosis curvature causes an increase in scapula protraction degree and a decrease in posterior shoulder girdle muscles endurance. This finding can be explained by the increased prominence of the ribs dorsally and the increased anteroposterior diameter of the thorax evident in subjects with a mid-thoracic curve. The angulation of scapula and/or the clavicle must increase to accommodate the greater anteroposterior thoracic diameter [15, 11, 1].

The scapulothoracic joint is one of the least congruent joints in the body. No actual bony articulation exists between the scapula and the thorax, which allows tremendous mobility in many directions, including protraction, retraction, elevation, depression and rotation. The scapula is as a base for muscle attachment. The muscles that stabilize the scapula attach to the medial border of the scapula, thereby controlling its position. This musculature controls scapular motion mainly through synergistic cocontractions and force couples, which are paired muscles that control the movement or position of a joint or a body part. So, because of the lack of bony attachment in scapulothoracic joint, any change in the thoracic curvature and stabilizer muscles performance causes change of natural scapular position and scapulohumeral rhythm [1, 11]. In this regard, there are many researches showing that in subjects with hyperkyphosis abnormality, shoulder abdaction range of motion and subacromial space are reduced. These authors suggested that the changes may be explained by alterations in scapular kinematics during humeral abduction movement and change in scapula natural position such as scapula protraction increase at resting. So that, in subjects of with hyperkyphosis abnormality during humeral abduction, posterior tilt and upward rotation of the scapula and ability of scapular stabilizer muscles for keeps scapula in natural position reduced [14, 2, 16]. Also they stated that subacromial space decrease in this patents may be attributed to the less posterior tilting of the scapula and scapula protraction increase [17, 18, 16].

This study results are in agreement with the clinical literature describing increased scapular protraction with thoracic kyphosis. Hence, Kibler *et al*., (1997) and Kendall *et al*., (1993) believed thoracic kyphosis or neck lordosis can result in excessive protraction of the scapula so that impingement occurs with elevation and excessive muscular energy will be required to achive the proper position of retraction on the thoracic wall [11, 1]. Also, Culham *et al*., (1994) investigated spinal and shoulder complex posture. In this study thoracic spine and shoulder complex posture were measured in 57 women over the age of 50. Results indicated that the protraction of scapula in the transverse plan was significantly greater than in subjects with an increase in curvature of the thoracic spine [15]. On the other hand, Mottram (1997) believed that the weakness of scapula stabilizer muscles causes atrophy and increases of the muscles length between scapula and spine makes scapula move away from spine(protracted) [8]. Diveta *et al*., (1990) have stated that weakness of the scapula retractor muscles, such as the upper trapezius, lower trapezius and rhomboid muscles causes scapular abduction or a "forward shoulders" posture to increase during relaxed standing [9]. SO that, Con Hrysomallis (2011) investigated the effectiveness of strengthening and stretching exercises for the postural correction of abducted Scapular. Correlational studies have failed to detect a significant association between muscle strength and scapular position but found a significant relationship between muscle length and scapular position. Prospective intervention studies have shown that stretching the anterior chest muscles on its own or in combination with strengthening the scapular retractors can alter the position of the scapula at rest in individuals with abducted scapulae [19]. Also, Allegrucci *et al*., (1994) and Stewart *et al*., (1995) in their researches showed that By affecting the position of the scapula and the length of the posterior shoulder girdle muscles, The hyperkyphosis has a detrimental effect on the shoulder. In this position the scapula becomes Abducted, therefore the muscles holding it close to the spine become lengthened. Existing imbalance allows the shortened muscles to be activated more easily and causing an abnormal pattern of movement around the muscularly controlled shoulder [20, 21].

CONCLUSION

According to our findings, we can conclude that thoracic kyphosis has a significant correlation with scapula protraction and the endurance of posterior shoulder girdle muscles. Whenever thoracic kyphosis curvature increases, scapula bones moves away from its position and endurance of posterior shoulder girdle muscles decreases. So, we should consider the position and distance of scapulaes, the strength and endurance of posterior shoulder girdle muscles as significant variables among the persons who have hyperkyphosis problem. Therefore, when dealing with hyperkyphosis abnormalities, we recommend strengthening of posterior shoulder girdle muscles (scapulas retraction exercise) in addition to strengthening of back extensor muscles and the traction of anterior shoulder girdle muscles.

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