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Strength of scapular stabilizers in shoulder pain male population with and without scapular dyskinesis

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ABSTRACT

Background and aim

A majority of the chronic shoulder pain population suffer from scapular dyskinesis. In scapular dyskinesis the scapular stabilizers i.e., the serratus anterior, middle trapezius and lower trapezius muscles are most likely to undergo weakness. The isometric strength testing of the scapular stabilizers will provide an objective measure of assessment and if the scapular dyskinesis has any additive effect on the strength of scapular stabilizers in shoulder pain population. Thus, the aim of the study is to measure the strength of scapular stabilizers in shoulder pain population with and without scapular dyskinesis.

Methods

100 shoulder pain subjects were recruited and divided into two groups. Group 1consisted of 50 subjects without scapular dyskinesis and Group 2 consisted of 50 subjects with scapular dyskinesis as assessed by Scapular Dyskinesis Test (SDT). Strength of serratus anterior (SA), middle trapezius (MT) and lower trapezius (LT) were measured in both the groups.

Results

Independent t-test was used for between group analyses. Group 2 subjects were found to have statistically significant weak serratus anterior muscle, weak middle trapezius muscle and weak lower trapezius muscle ($p<0.05$) as compared to Group 1 subjects.

Conclusion

The shoulder pain patients with scapular dyskinesis hadweak serratus anterior, middle trapezius and lower trapezius as compared to shoulder pain patients without scapular dyskinesis.

Keywords: Scapular dyskinesis, Shoulder pain, Scapular stabilizers, Muscle strength

INTRODUCTION

Shoulder pain is one of the most prevalent musculoskeletal conditions which affect the general population [1]. A strong association has been found between the shoulder pain and dysfunction of the scapula [2, 3, 5]. Scapula is positioned on the thorax and its proper positioning is essential to

provide stability, movement and optimum muscular performance for the shoulder join [2-4]. As the scapulothoracic joint is not a true anatomical joint and the scapula is held on thorax with the help of the scapular muscles making it more vulnerable to undergo abnormal position and function [9]. Inappropriate or faulty kinematics of the scapula leads to inefficient functioning of the shoulder complex resulting in the decline of neuromuscular performance and leading to predisposition to further injuries of the glenohumeral joint [8, 9, 10]. This altered scapular motion and position has been referred to as scapular dyskinesis [8]. It is more likely to occur because of the disturbed force couple of the scapular stabilizers as the scapular stabilizers undergo weakness and cannot provide the supportive base for the appropriate functioning of the glenohumeral joint [5]. Thus, the scapular movements are characterized by reduced upward rotation, posterior tilting and increased internal rotation in scapular dyskinesis [9]. It has been estimated that scapular dyskinesis occurs in 68-100% of patients with shoulder pathologies [6]. However, it is not known yet whether the shoulder pain triggers the scapular dyskinesis or the dyskinesis of the scapula causes the shoulder pain pathology [7].

Coupling of the upper, middle and lower trapezius with serratus anterior is required for the stabilization of the scapula [5]. Cools et al [2] and Paine et al [9] reported that the scapular stabilizers particularly middle trapezius, lower trapezius and serratus anterior were relatively weak in subjects with altered position of the scapula. It is well established that the rotator cuff muscles undergo weakness in shoulder pain and has been investigated objectively as well [12] but there is paucity of objective data on scapular stabilizers' strength in shoulder pain population. However it has been theorized that in shoulder pain the scapular stabilizers are found to be weak [5, 9]. But there is a lack of literature to support the same.

Scapular dyskinesis is reported in normal population as well but the strength of scapular stabilizers are not found to be affected in normal population with scapular dyskinesis when compared to population without scapular dyskinesis, concluding that scapular dyskinesis has no additional effect on the strength of scapular stabilizers [7]. Therefore, it is imperative to investigate if the same holds true in population with shoulder pain or not i.e., whether scapular dyskinesis has any additive effect on scapular stabilizers' strength in population with shoulder pain, as well as there is a need of studies which can support the concept of weak scapular stabilizers in scapular dyskinesis by evaluating them using objective measures like dynamometer which is much easily available in clinical set up as compared to the electromyographic equipment.

Thus the aim of the current study was to evaluate the strength of the scapular stabilizers i.e., serratus anterior (SA), middle trapezius (MT) and lower trapezius (LT) in shoulder pain population with and without scapular dyskinesis.

MATERIALS AND METHODS

A cross-sectional study was conducted after the approval from the Institutional Ethical Committee.100 male individuals recruited in the study. The purpose and procedure of the study were explained to the participants and they were requested to sign an informed consent. After signing informed consent form within age of 18-40 years, NPRS<7, shoulder elevation range of motion>140 degrees [7, 13, 14]. Subjects were excluded if they have bilateral symptoms, subjects diagnosed with adhesive capsulitis, any history of major trauma, any systemic disease, BMI > 32 [12, 15]. Participants with shoulder pain were divided into two groups on the basis of Scapular dyskinesis test. The participants with no dyskinesis were kept in group1 and participants with dyskinesis present were kept in group 2. Then strength of serratus anterior, middle trapezius and lower trapezius was measured in both the groups.

SCAPULAR DYSKINESIS TEST (SDT) [14-16]

SDT is a dynamic assessment method for scapular dyskinesis and has been found to be a reliable and valid to be used in clinical settings. The test requires the participants to remove their shirts in order to visualize the scapular movement. The participants were then asked to perform 5 repetitions of each flexion and abduction on both sides with weights in their hands and thumb facing towards the ceiling. The weights were given according to their body weight i.e., 1.5 KG if the body weight was $\leq$ 68.1 KG or 2.5 KG for $\geq$ 68.1

KG. The movements were videotaped from the posterior aspect to record the presence of scapular dyskinesis [14].

Scapular dyskinesis was said to be present if the participant's scapula demonstrated prominence of the inferior angle/ medial border/ elevation of the superior body or if there was presence of scapular dysrhythmia which is demonstrated by elevation or protraction of the scapula early or excessively, staggered movement of scapula while elevation or bringing down the arm or sudden descent of scapula while taking the arm down [14] (Figure 1).



Figure 1: Scapular Dyskinesis (prominent inferomedial border) on the left side while doing loaded shoulder flexion

STRENGTH TESTING OF SA, MT AND LT

Strength of serratus anterior, middle and lower trapezius was measured by using a hand held dynamometer (Saehan manual muscle tester, Sunrise dealers, Aggarwal Plaza, Pitampura, New Delhi) was used and the accuracy was given by manufacturer was ±2%. The readings were noted in Newton (N).

PROCEDURE FOR THE TESTING OF MUSCLE STRENGTHS [17, 18]

Muscle strength testing was performed by asking the participant to put his maximum effort through the dynamometer which was resisted by the examiner. As described by Bohannon [19], a "make test" was performed by the participants. Three readings were taken and the average was recorded. The average strength of the muscles were normalized by dividing it by the participant's body weight (N) to avoid the influence of various anthropometric measures on the muscle strength [7].

STRENGTH OF SERRATUS ANTERIOR

The patient was positioned supine lying with shoulder and elbow in 90 degree of flexion. This position was derived from Kendall and colleagues' [18] study in which they gave resistance over the closed fist of the participant but in that position the placement of dynamometer was not stable and this position used in this study has been found to be reliable in a study done by Michener and co-workers [25]. The dynamometer was placed against the elbow of the patient i.e., ulna over the olecranon process. The resistance through the dynamometer was employed along the axis of the humerus while the subject was asked to push against the dynamometer towards the ceiling. The position of patient and the dynamometer is depicted in figure 2 [17].



Figure 2: Strength testing of Serratus Anterior muscle by using dynamometer

STRENGTH OF MIDDLE TRAPEZIUS

The position of patient and the dynamometer placement is depicted in figure 3. The participant was in prone lying with head turned to any side and the shoulder of the testing side in 90 degrees of abduction at shoulder joint and elbow flexed to 90 degrees. Before application of resistance the scapula was positioned in midrange for generation of maximum effort as described by optimal length-tension relationship [25]. The midrange position was identified by moving the scapula through the available range and then the midpoint was selected. The participants were asked to maintain the midrange throughout the testing procedure. For the testing of middle trapezius, the dynamometer was placed over the spine of the scapula in-between the acromion and the spine of the scapula. The resistive force via the dynamometer was applied along the humerus long axis parallel to the ground [10, 25].

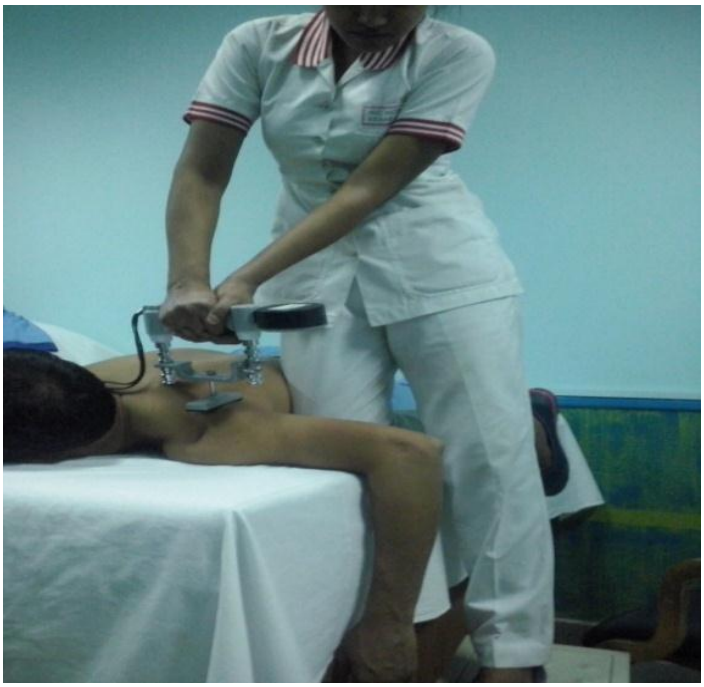

Figure 3: Strength testing of Middle Trapezius muscle by using dynamometer

STRENGTH OF LOWER TRAPEZIUS

Position of patient and dynamometer placement shown in figure 4. Placement of the dynamometer was same as for the testing of MT over the spine of scapula. The position of patient was prone lying, shoulder in 140 degrees of elevation and shoulder external rotation so that the thumb faces up and the resistance was applied along the humeral long axis in superolateral direction [10, 25].



Figure 4: Strength testing of Lower Trapezius muscle by using dynamometer

STATISTICAL ANALYSIS

The data were analysed by using SPSS 21 windows for significant difference between the groups. Independent t-test was used for between group comparisons.

RESULTS AND DISCUSSION

The mean ± SD age was 31.85 ± 5.25 years and 33.90 ± 4.7 years for Group 1 and 2 respectively. The mean ± SD of BMI was 23.4 ± 1.7 for Group 1 and 23.5 ± 1.9 for Group 2. The demographic data is depicted in Table 1. Statistically significant difference was found between the two groups for the strength of SA, MT and LT at p value 0.05 levels (Table 2).

Table 1: Demographic data

	GROUP 1	GROUP 2
Age (years) (Mean ± SD)	31.85 ± 5.25	33.90 ± 4.7
BMI (Kg/ cm square) (Mean ± SD)	23.4 ± 1.7	23.5 ± 1.9

Table 2: Result Table

	Group 1	Group 2	t- value	Sig.(p value)
Normalized strength of SA	1.4±0.77	0.89±0.38	3.50	0.001
Normalized strength of MT	1.27±0.66	0.98±0.37	2.18	0.036
Normalized strength of LT	1.20±0.71	0.90±0.40	2.072	0.046

DISCUSSION

This study aimed to evaluate the strength of SA, MT and LT in shoulder pain population with and without scapular dyskinesis. The strengths were assessed by using dynamometer to get the objective measures. The current study hypothesized that significant statistical differences in the strengths of SA, MT and LT would exists between the two groups i.e., shoulder pain population with scapular dyskinesis and shoulder pain without scapular dyskinesis. According to the results of the present study a significant difference between the two groups was seen for the strength of all the three muscles i.e., SA, MT and LT. This study was a first attempt to evaluate the strengths of SA, MT and LT in shoulder pain patients with and without scapular dyskinesis.

Various studies have mentioned that scapular dyskinesis is a common finding among people with shoulder pain due to a variety of shoulder pathologies such as impingement syndrome, rotator cuff tears, glenoid labrum tears and instability [5]. Many individuals with scapular dyskinesis suffer from subacromial impingement because upon elevating the arm, the scapula experiences an increase in upward rotation and anterior tilt causing the anterior part of the acromion to move forward and downwards thus reducing the subacromial space [19]. Thus scapular dyskinesis is a common entity in shoulder pain population but whether scapular dyskinesis is adaptive or pathologic is not well understood [7]. Various studies have indicated that there is muscle weakness of the scapular stabilizers as well as muscular imbalance in scapular dyskinesis [2, 7-9]. It has been seen that employing rehabilitation programs to restore the scapular muscle imbalance restored the strength of the rotator cuff as well in overhead athletes with shoulder pain [20, 21]. This is further supported by the fact that on repositioning of the scapula by stabilizing and retracting the scapula externally by the examiner caused reduced symptoms and improved strength of the rotator cuff in individuals with scapular dyskinesis [22, 23]. Thus concluding that the scapular dyskinesis is further predisposing the rotator cuff muscles to undergo weakness and if the scapular stabilizers are strengthened it will improve the strength of the rotator cuff as well [22, 23].

The results of the current study are in accordance with the work of Paine and coworkers [9] in which the altered position of the scapula has been linked with weak scapular stabilizers, also supported by several other authors [4, 6].

The proposed pathomechanics of scapular dyskinesis has been linked with altered activation pattern of the upper and lower trapezius with serratus anterior leading to abnormal positioning of the scapula, altered scapulohumeral rhythm and dysfunction of the shoulder complex [2, 4, 5, 8, 10]. The serratus anterior and lower trapezius are the most commonly weak or inhibited muscles of the scapulothoracic joint that may lead to abnormal movement [2, 4, 5, 8, 10]. Therefore, many studies have focused on restoration of the recruitment pattern of the scapular stabilizers in their rehabilitation program [2, 4, 5]. This is further supported by many of the electromyographic studies' data which showed altered recruitment pattern of the scapular stabilizers in shoulder pain population [2, 4, 5].

Though scapular dyskinesis is a prevalent condition in shoulder pain but it has also been found to be present in asymptomatic population as well [7]. But the strength evaluation studies in asymptomatic population did not reveal any significant deficit in the strength of the scapular stabilizers and indicated the presence of scapular dyskinesis as a movement dysfunction only [7]. The results of the current study provides evidence that in symptomatic individuals the scapular dyskinesis is not just a movement dysfunction but there is alteration in the strength of the scapular stabilizers as well.

The testing position for LT and MT in the current study employed the resistance on the spine of the scapula and not on the proximal wrist as mentioned by Seitz and colleagues [24] for manual muscle testing. This position has been supported by many researchers and found it to be more efficient when testing the strength with dynamometer [7, 17, 18]. Michener and coworkers [25] reported in their study that placement of dynamometer directly over the scapula was reported as a valid measure when compared with electromyography while assessing the strength of lower trapezius.

In the current study only male subjects were recruited as most of the females patients might feel uncomfortable in exposing their back and allowed it to be videotaped which was required for the evaluation of scapular dyskinesis and could lead to

inappropriate ratio of male to female affecting the homogeneity of the sample.

The stage of pathology, chronicity of the symptoms and patient's perception of pain were all secondary variables which could not be controlled.

Limitations

1. The result of the study cannot be able to generalised to female population.
2. EMG of the muscles was not done.
3. Only isometric strength was taken.

Future Research

Influence of other factors such as neck pain, forward head posture and inflexibility of other shoulder muscles should also be seen on scapular dyskinesis and the strength of scapular stabilizers.

Conclusion

It can be concluded that the strength of the SA, MT and LT is reduced in scapular dyskinesis in shoulder pain population when compared to people without scapular dyskinesis.

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