A study to evaluate activation of the lower trapezius muscle during varied forms of Kendall exercises

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Abstract
Background - The trapezius muscle, a dynamic structure plays a crucial role in maintaining proper shoulder mechanics and is often considered a source of weakness and dysfunction in patients.

Objectives - To evaluate the activation pattern of lower trapezius muscle during varied forms of kendall exercises, so that it can help clinicians to design an efficient shoulder rehabilitation program.

Design - A Cross Sectional Observational Study

Method - The muscle activation pattern of lower trapezius muscle of 50 individuals, aged 20 to 30 years was measured using surface EMG for maximum voluntary isometric contraction against manual resistance during which EMG activity of lower trapezius muscle was assessed in shoulder at 75°, 90°, 125°, and 160° of abduction with arm externally rotated and manual resistance was applied at the distal forearm. A repeated measure ANOVA was then performed.

Results - Means of lower trapezius showed highest muscle fiber activation at 160° abduction. Then ANOVA was applied and calculated using Graphpad Version 3.10. Obtained values: p = 0.5139, F = 0.7675.

Conclusion - There was no significant difference in activation of lower trapezius muscle at any angle of arm abduction.

Keywords - Electromyography; Kendall exercises; Arm Abduction, Shoulder Rehabilitation

Introduction

The shoulder moves in a complicated manner during elevation, involving all of the joints at the shoulder complex, to facilitate optimal placement of the hand for function. During elevation, glenohumeral motion occurs around the stable base of the scapula, with that stability provided by the scapulothoracic muscles. In addition these muscles also dynamically position the scapula for efficient glenohumeral motion (Paine and Voight, 1993).

The trapezius muscle plays a crucial role in maintaining proper shoulder mechanics and is often considered a source of weakness and dysfunction in patients. The trapezius muscle is a dynamic structure, which is called upon to play multiple roles in maintaining glenohumeral joint stability and functional outcomes. As the humerus is abducted, the three portions of the trapezius (upper, middle, and lower) act along with the serratus anterior to concentrically control upward rotation of scapula. A dysfunction or weakness in this muscle may lead to muscle imbalance, decreased muscle endurance and altered scapulohumeral rhythm, which in turn might lead to shoulder impingement, muscle fatigue, instability of the glenohumeral joint and postural changes (Fuglevand et.al., 1993; Lehman et.al., 2004).

Past research has used electromyography (EMG) to investigate the muscle activation patterns and muscle fatigue of the shoulder musculature in functional activities. Lower trapezius muscle is often targeted in shoulder rehabilitation due to its contribution in maintaining proper shoulder kinematics and stabilization. Studies have shown that therapeutic exercises aimed at strengthening of separate portions of the trapezius can ultimately improve scapulohumeral rhythm. Several authors recommend different positions for the lower trapezius muscle strengthening; thereby it is very important to know which position will have the maximum activation of the muscle. Moseley et.al. (1992) indicated that rows, horizontal abduction, scaption, and shoulder flexion being the optimal exercises for lower trapezius. Ekstrom studied 10 different exercises at high intensity (85-90% of one repetition maximum) and identified overhead arm raise in standing and shoulder external rotation at 90° of abduction were optimal exercises for lower trapezius. Interestingly, one exercise examined was a 90° horizontal abduction exercise based on Kendall’s position. Activation was not highest among the exercises, but was substantial. The intensity of exercise makes any generalization to the rehabilitation population difficult and examining a single Kendall position limits the knowledge of its effectiveness.

The purpose of this study was to investigate the muscle activation patterns of the lower trapezius during four specific therapeutic exercises using positions described by Florence Kendall (Kendall et.al. 1980). By identifying the most effective positioning criteria in targeting the lower trapezius muscle, clinicians will be better able to design a more efficient and centered rehabilitation program. The purpose of the study was to evaluate the activation pattern of lower trapezius muscle during four specific therapeutic exercises using positions described by Florence Kendall.

Methodology

Cross sectional observational study was performed on 50 healthy individuals at Shri K. K. Sheth Physiotherapy College. The subjects were selected by simple random sampling. Inclusion criteria were (1) Normal Individuals (BMI 18 to 24.9 kg/m²) (2) Between ages of 20 to 30 years (3) Both Gender – Males and Females. Subjects were excluded (1) Those who had participated in consistent resistive weight training within the
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past 6 months, (2) Those with History of previous Neck, Back, or Shoulder Pain and/or Trauma. (3) Those with any associated Musculoskeletal or Neurological disorder affecting the Study.

Prior to the commencement of the study, consent had been taken from all the subjects. Muscle activation pattern of lower trapezius muscle was measured using surface EMG during Maximum Voluntary Isometric Contraction (MVIC) at four different angles of arm abduction. Subject lie prone with arm abducted and externally rotated such that thumb is pointing towards ceiling. Each subjects was shown and practiced the four testing positions, i.e. 75°, 90°, 125°, and 160° of shoulder abduction wherein they were supposed to perform Maximum Voluntary Isometric Contraction.

Active Electrode was placed perpendicular to vertebral column at the level of inferior angle of scapula, 3-4 cm (2 fingers breath) lateral to the spinous process of 7th dorsal vertebrae. Reference Electrode was placed 3cm distal to it. With the subject prone on the plinth, goniometer was used to move the arm into one of the four positions of arm abduction; 0° was defined as the subject having the arm completely adducted against the thigh. The glenohumeral joint was used as base for the goniometer. Electromyography activity of MVIC of lower trapezius muscle was assessed at each of the four positions against the manual resistance being applied at the distal forearm and the subject was asked to raise their arm against it. Three trials at each position were taken with the MVIC for 5 seconds and 5 seconds rest between each repetition.

Figure 2 Method of recording MVIC of lower trapezius muscle at varied Kendall’s positions

Data Analysis

Mean of the highest measure obtained at each position was taken and then standard deviation was calculated. A single factor repeated ANOVA was performed for each aspect of trapezius studied.

Graph 1: lower trapezius activation at various angles

Results

Out of 50 subjects tested, 18 were males and 32 were females. ANOVA was applied and calculations done using Graphpad Version 3.10, Obtained values of p = 0.5139 and F = 0.7675 is considered non significant and thus the variation obtained among column means is by chance.

Discussion

The results of the study showed that lower trapezius muscle demonstrated no significant level of difference of activation at any of angle of arm abduction. These findings are congruent with that advocated by Paula et al., that patterns of increasing and decreasing activity were nearly equally present in individuals, consequently resulting in no significant increase in the group mean value between 90° and 140°.

While lower trapezius demonstrated the greatest activation at 160°, this position was not significantly greater than the other three positions; 75°, 90° and 125° of arm abduction. Activation at 125° was lower than all other angles for the lower trapezius muscle. This findings are contrary to Elissa Kinney et.al., (2007) who suggested greatest amount of lower trapezius activation is during 90° and 125° of arm abduction. However Kendall (1980) advocated 160° angle of arm abduction will target the lower trapezius muscle maximally, since the overhead arm position will target lower fibers optimally. Ekstrom (2003) showed that lower trapezius showed maximal activation at 125° as the muscle fibers have been estimated to run at that angle. Moseley et. al., conducted a fine wire EMG study of trapezius muscle and found optimal position for lower trapezius activation was horizontal arm abduction (90°).

Data from this investigation provides baseline information regarding muscle activation of the lower trapezius during horizontal abduction. The variability in patterns of EMG activity reported in this study may explain the apparent contradiction in reports of lower trapezius activity among preceding investigations. Previous authors report increasing activity of the lower trapezius at increased humeral elevation angles, decreasing activity after 90°, or activity changes being dependent on the plane of elevation. In the present study, patterns of increasing and decreasing activity were nearly equally present in individuals, consequently resulting in no
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significance. Thus the probable reason being that as the angle of elevation increases the contribution from the serratus anterior and upper trapezius muscle increases, thus there is combine role of these muscles in the upward rotation of scapula as the arm elevation increases, causing no significant increase in the lower trapezius muscle firing with arm elevation.\(^\text{10}\)

These findings can be generalized to strengthening in the clinical setting. When clinicians are formulating rehabilitation programs for patients with shoulder, neck and back problems. It may provide some insight into the rehabilitation of patients with shoulder pathology in clinical setting, causing clinicians to question the effectiveness of exercises that have been considered the standards of practice for quite some time by many.

The limitations of the study were small sample size, temperature could not be controlled and only one muscle lower trapezius was analyzed. The study can be in future conducted by involving the simultaneous EMG recording of Maximum Voluntary Isometric Contraction of all three, upper trapezius, lower trapezius, and serratus anterior muscle in Kendall’s positions.

**Conclusion**

The investigation suggests that for shoulder rehabilitation program, lower trapezius muscle strengthening at any angle of shoulder abduction (750, 900, 1250, or 1600) would lead to equal amount of lower trapezius muscle activation.

**Clinical implication**

As there is no significant difference in activation pattern of Lower Trapezius between any of the angle of arm abduction, thus any of the four position can be used for an efficient rehabilitation program.

**References**

17. Travis Beck,. Applications of Surface Electromyography in Strength and Conditioning.