EMG of Serratus Anterior, Upper, Middle, and Lower Trapezius during Glenohumeral Abduction in a Participant with Scapular Dyskinesia: A Case Study

Daniel Garcia
*University of North Dakota*

Trevor Roppel
*University of North Dakota*

Mekenzie Scheresky
*University of North Dakota*

Shane Omdahl
*University of North Dakota*

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EMG of Serratus Anterior, Upper, Middle, and Lower Trapezius during Glenohumeral Abduction in a Participant with Scapular Dyskinesia: A Case Study

by

Daniel Garcia
Bachelor of Science Degree in Kinesiology and Health Promotion
University of Wyoming, 2015

Trevor Roppel

Mekenzie Scheresky
Bachelor of General Health Studies
University of North Dakota, 2017

Shane Omdahl
Bachelor of General Health Studies
University of North Dakota, 2017

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EMG of Serratus Anterior, Upper, Middle, and Lower Trapezius during Glenohumeral Abduction in a Participant with Scapular Dyskinesia: A Case Study

Dan Garcia, Shane Omdahl, Trevor Roppe, and Mekenzie Scheresky

Abstract

- Introduction: The purpose of this case study was to examine the differences in muscle activation between the upper trapezius, middle trapezius, lower trapezius and serratus anterior in a participant with scapular dyskinesia.
- Methods: EMG activity was recorded using a Noraxon TeleMyo2400 G2 telemetry unit with a sampling rate of 1 kHz on the aforementioned muscles.
- Results: In comparing UE ratios of EMG activity, it appears that the left lower trapezius showed decreased activity compared to the right lower trapezius. The left serratus anterior showed decreased activity relative to the trapezius muscle activity. The decreased activity in the left serratus anterior would help explain the scapular winging that occurred in the subject during shoulder elevation.
- Conclusion: The results of this study indicate that the subject showed increased EMG activity in the left lower trapezius and decreased in the left serratus anterior that might explain the scapular winging. The use of EMG and video may be a useful diagnostic tool for clinicians to identify specific muscle firing patterns.

Methods

- The EMG activity was recorded using a Noraxon TeleMyo DTS telemetry unit with a sampling rate of 1 kHz which was transmitted to a TeleMyo DTS recorder interface connected to a laptop computer.
- Data analysis was performed using the Noraxon Myomuscle software, version 3.8.
- The muscles that were monitored bilaterally were the: 1) serratus anterior, 2) upper trapezius, 3) middle trapezius and 4) lower trapezius. Before applying the electrodes, the skin was cleansed with isopropyl alcohol. The electrodes were placed in accordance with standardized lead positions. A video camera was used to track the shoulder motion.
- Using the Noraxon software, an ensemble average of EMG activity for each of the muscles was created during shoulder motion at each of the three speeds.

Discussion

- Based on previous studies, the researchers in this study hypothesized the test subject would display decreased serratus anterior EMG activity on the left side causing an anterior tilt and "winged" scapula with shoulder adduction.
- The test subject under study was a male aged 20-30 years of age with no current complaints of scapular pain but had previous trauma to his clavicle 3 years prior. Upon visual examination, the patient displayed moderate scapular winging on the left at rest. With motion impairment "scapular dyskinesis" was present during the latter portion of adduction at all tested speeds. The EMG data showed decreased upper trapezius and serratus anterior activity on the left, especially with functional speeds of 180 deg/sec and 270 deg/sec. EMG activity was also increased in the left middle and lower trapezius compared to the right at all speeds. The decreased level of EMG activity of the serratus anterior and upper trapezius relative to middle and lower trapezius muscles would indicate a rotational imbalance between the serratus anterior and trapezius muscles during shoulder adduction.
- The clinical implication of this finding would indicate a need for selective strengthening of the serratus anterior and upper trapezius muscles to regain a normal balance of the scapular muscles.

Results

- The graphs show the activation ratios between serratus anterior and trapezius muscles during bilateral adduction at multiple speeds.
- In all cases the ratio of the left serratus anterior to left lower trapezius is below the ratio for the same muscles on the right side of the body.

Conclusions

- The results of this study showed an imbalance in EMG activity between the serratus anterior and upper trapezius compared to middle and lower trapezius on the shoulder presenting with scapular dyskinesia during adduction from 180 degrees to 0.
- The left serratus anterior and upper trapezius presented with decreased activation during adduction. Therefore, strengthening of the left serratus anterior and upper trapezius would be indicated to restore the muscle balance.

References

This Scholarly Project, submitted by Daniel Garcia, Trevor Roppel, Mekenzie Scheresky, Shane Omdahl in partial fulfillment of the requirements for the Degree of Doctor of Physical Therapy from the University of North Dakota, has been read by the Advisor and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

(Graduate School Advisor)

(Chairperson, Physical Therapy)
PERMISSION

Title EMG of Serratus Anterior, Upper, Middle, and Lower Trapezius during Glenohumeral Abduction in a Patient with Scapular Dyskinesia: A Case Study

Department Physical Therapy

Degree Doctor of Physical Therapy

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Signature

Date 12/6/2018

Trevor Roppel

[Signature]

[Signature]

[Signature]
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ABSTRACT

Introduction and Purpose. The purpose of this case study was to examine the differences in muscle activation between the upper trapezius, middle trapezius, lower trapezius and serratus anterior in a participant with scapular dyskinesia.

Methods. EMG activity was recorded using a Noraxon™ TeleMyo DTS telemetry unit with a sampling rate of 1 kHz. EMG data was recorded during three different speeds of shoulder abduction. Four scapular muscles were monitored bilaterally during the experiment. The muscles that were monitored included the upper trapezius, middle trapezius, lower trapezius and serratus anterior. The subject was also captured on video using the NiNox 125/250 FPS camera system.

Results. In comparing UE ratios of EMG activity, it appears that the left lower trapezius showed more EMG activity than the right lower trapezius. The left serratus anterior showed decreased activity relative to the trapezius muscle activity. The decreased activity in the left serratus anterior would help explain the scapular winging that occurred in the subject during shoulder elevation.

Conclusion. The results of this study indicate that the subject showed increased EMG activity in the left lower trapezius and decreased in the left serratus anterior that might explain the scapular dyskinesia. The use of EMG and video may be a useful diagnostic tool for clinicians to identify specific muscle firing patterns.
CHAPTER I
INTRODUCTION

Introduction

Scapular dyskinesia is defined as an altered movement or position of the scapula.\textsuperscript{1} The degree of scapula dyskinesia has been classified as none, subtle, and obvious based on the presence of scapula winging or dysrhythmia during shoulder movement. Although scapular dyskinesia has been proposed to be a cause of shoulder pain, a recent study found that the presence of scapula dyskinesia does not appear to be related to the presence of shoulder pain.

Purpose

The purpose of this study was to analyze scapular biomechanics in a single subject experiencing abnormal movement patterns in the left scapula. The subject was a young, fit male with obvious scapular winging during shoulder abduction. Manual muscle testing of the scapular muscles did not reveal any obvious weakness. Electromyography (EMG) was used to try and determine if there were any scapular muscle imbalances between the involved (left) scapular muscles and the normally functioning right scapular muscles. In addition, if the EMG analysis revealed any muscle imbalance, we would develop an exercise protocol to address the imbalance.
CHAPTER II
METHODS

EMG activity was recorded using a Noraxon TeleMyo DTS telemetry unit with a sampling rate of 1 kHz. The EMG data was recorded from the muscles using the Noraxon Model 546 DTS EMG sensor system which transmitted the EMG data to a Noraxon Model 580 DTS receiver connected to a laptop computer which stored the collected data. The EMG data was analyzed using the Noraxon MR3 Myomuscle software program. The Noraxon Myovideo system, using a NiNox 125/250 camera system was used to record the shoulder abduction exercises. The video camera was synced to the EMG data collection.

The muscles tested were the right and left sided upper trapezius, middle trapezius, lower trapezius and serratus anterior on the same subject. Before applying the EMG electrodes the skin was abraded and cleaned with isopropyl alcohol. Blue Sensor (model M-00-S) surface electrodes were used to pick up the EMG activity. The electrodes were placed on the skin, parallel to the muscle fiber orientation and followed standard, recommended placement sites. The EMG electrodes were placed as follows:

**Upper Trapezius**: 1/2 distance from C7 to the tip of the acromion process.

**Middle Trapezius**: 1/2 distance from medial border of scapula (root) to spinous process (about T3).

**Lower Trapezius**: 2/3 distance from root of scapula spine to T8, about 5 cm down from root.

**Serratus Anterior**: with shoulder flexed to 180, place electrodes over muscle belly at level of inferior scapular spine, anterior to the latissimus dorsi.
The subject performed the abduction and adduction motion at four different speeds, in time with a metronome at 30, 45, 60 and 90 beats per minute. The subject repeated each motion three times during the course of the experiment. EMG data and video data was collected for each motion.
CHAPTER III
RESULTS

Figures 1 and 2 show the activation ratios between serratus anterior and the trapezius muscles during bilateral shoulder adduction at multiple speeds. Speeds of 180 deg/sec and 270 deg/sec produced the most significant scapular winging in the involved (L) shoulder. The involved shoulder presents with decreased EMG activity of the serratus anterior and upper trapezius muscles compared to the uninvolved shoulder (R). Regarding the middle and lower trapezius, the graphs indicate increased EMG activity during adduction at speeds of 180 deg/sec and 270 deg/sec in the L shoulder.

Figures 1 and 2 show the ratio of serratus activity to trapezius activity during the two different adduction speeds. In all cases the ratio of the left serratus anterior to left lower trapezius is below the ratio for the same muscles on the right side of the body. This would indicate that during the adduction motion the left serratus anterior shows less EMG activity than the right serratus anterior.
Figure 1. Ratio of EMG Activity of Shoulder Stabilizers during 45 bpm of active adduction
Figure 2. Ratio of EMG Activity of Shoulder Stabilizers during 60 bpm of active adduction
CHAPTER IV

DISCUSSION

Based on previous studies, the researchers in this study hypothesized that the test subject would display decreased serratus anterior EMG activity on the left side causing an anterior tilt and "winged" scapula with frontal plane shoulder movements.

The test subject under study was a male aged 20-30 years of age with no prior complaints or symptoms of scapular pain or trauma. Upon visual examination, the patient displayed moderate scapular winging on the left at rest. With motion a "scapular dyskinesia" impairment was present during the latter portion of adduction at all tested speeds. The EMG data showed decreased Upper Trap and Serratus activity on the left, especially with functional speeds of 180 deg/sec and 270 deg/sec. EMG activity was also increased in the left middle and lower trapezius compared to the right at all speeds. The decreased level of EMG activity of the serratus anterior and upper trapezius relative to middle and lower trapezius muscles would indicate a relational imbalance between the serratus anterior and trapezius muscles during shoulder adduction from 180 to 0 degrees. The clinical implication of this finding would indicate a need for selective strengthening of the serratus anterior and upper trapezius muscles to regain a normal balance of the scapular muscles.
CHAPTER V
LIMITATIONS

There were several limitations that need to be considered when analyzing this case study. First, electrode placement was done by four different researchers using standardized points for all the muscles involved in the study. With four separate researchers applying the electrodes there could have been human error on electrode placement from side to side and electrode to electrode.

Another limitation of this study is that it was a case study and only included one participant with scapular dyskinesis. More subjects would be required in future research to properly analyze the process and muscle imbalances possibly involved in scapular dyskinesis of the general population. Another limitation of this study is that our participant has had previous injuries to his left scapula and clavicle. The injuries this participant sustained to his left upper extremity were a shoulder separation and a clavicle fracture. These injuries could have affected the position of his scapular stabilizers which could have affected the muscular activity in the muscles themselves. Future studies would need to compare participants with scapular dyskinesis with and without previous injuries to the scapula or shoulder to see if their EMG activity are similar.
REFERENCES


