2017

EMG of serratus anterior, upper, middle, and lower trapezius during glenohumeral abduction in a patient with scapular dyskinesia: a case study

Tyler Bentrup  
*University of North Dakota*

Byron Flett  
*University of North Dakota*

Joshua Sorvig  
*University of North Dakota*

Follow this and additional works at: [https://commons.und.edu/pt-grad](https://commons.und.edu/pt-grad)

Part of the [Physical Therapy Commons](https://commons.und.edu/pt-grad)

**Recommended Citation**

[https://commons.und.edu/pt-grad/658](https://commons.und.edu/pt-grad/658)

This Scholarly Project is brought to you for free and open access by the Department of Physical Therapy at UND Scholarly Commons. It has been accepted for inclusion in Physical Therapy Scholarly Projects by an authorized administrator of UND Scholarly Commons. For more information, please contact zeinebyousif@library.und.edu.
EMG of Serratus Anterior, Upper, Middle, and Lower Trapezius during Glenohumeral Abduction in a Patient with Scapular Dyskinesia: A Case Study

by

Tyler Bentrup, SPT
Bachelor of Science in Biology,
University of Missouri- St. Louis, 2015

Bryon Flett, SPT
Bachelor of Science in Kinesiology
Western Washington University, 2015

Joshua Sorvig, SPT
Bachelor of Science in General Studies
University of North Dakota, 2016

A Scholarly Project Submitted to the Graduate Faculty of the

Department of Physical Therapy
School of Medicine

University of North Dakota

in partial fulfillment of the requirements for the degree of

Doctor of Physical Therapy

Grand Forks, North Dakota
October, 2017
This Scholarly Project, submitted by Tyler Bentrup, Bryon Flett, and Joshua Sorvig 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)
<table>
<thead>
<tr>
<th>Title</th>
<th>EMG of Serratus Anterior, Upper, Middle, and Lower Trapezius during Glenohumeral Abduction in a Patient with Scapular Dyskinesia: A Case Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department</td>
<td>Physical Therapy</td>
</tr>
<tr>
<td>Degree</td>
<td>Doctor of Physical Therapy</td>
</tr>
</tbody>
</table>

In presenting this Scholarly Project in partial fulfillment of the requirements for a graduate degree from the University of North Dakota, I agree that the Department of Physical Therapy shall make it freely available for inspection. I further agree that permission for extensive copying for scholarly purposes may be granted by the professor who supervised my work or, in his/her absence, by the Chairperson of the department. It is understood that any copying or publication or other use of this Scholarly Project or part thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and the University of North Dakota in any scholarly use which may be made of any material in this Scholarly Project.

Signature: [Signature]

Date: 10-24-17
TABLE OF CONTENTS

LIST OF FIGURES ........................................................................................................... 5
LIST OF TABLES ............................................................................................................... 6
ABSTRACT ....................................................................................................................... 7

CHAPTER
I. INTRODUCTION ...................................................................................................... 8
II. METHODS ............................................................................................................... 10
III. RESULTS ............................................................................................................. 10
IV. DISCUSSION .......................................................................................................... 21
IV. LIMITATIONS ......................................................................................................... 22

REFERENCES ............................................................................................................. 23
LIST OF FIGURES

Figure 1. Ratio of EMG Activity of Right Upper Extremity During Glenohumeral Abduction ............................................................. 13

Figure 2. Ratio of EMG Activity of Left Upper Extremity During Glenohumeral Abduction ............................................................. 14
LIST OF TABLES

**Table 1.** Ratios of Serratus Anterior EMG to Trapezius EMG During Slow Speed Abduction ........................................................................... 11

**Table 2.** Ratios of Serratus Anterior EMG to Trapezius EMG During Moderate Speed Abduction ............................................................. 12

**Table 3.** Ratios of Serratus Anterior EMG to Trapezius EMG During Fast Speed Abduction ................................................................. 12
ABSTRACT

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

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 exerts a significant amount more of energy than the right lower trapezius.

Conclusion. This study may demonstrate the importance of bilateral lower trapezius muscular strength training in order to counteract the anterior tilt motion performed by the serratus anterior in patients with non-symptomatic scapular dyskinesia.
CHAPTER I

INTRODUCTION

Scapular dyskinesia has been a well studied topic over the past couple of decades with the influence behind it being the prevalence of shoulder pain and the correlation with poor scapular kinetics. In one study by Hillary, et al (2017), they determined that in patients with scapular dyskinesia are not any more likely to have pain due to their abnormal mechanics. Other purposes for studies have been to determine which muscles accomplish different functions on the scapula, including appropriate EMG ratios comparing the upper trapezius to the lower trapezius and each of those muscles to the serratus anterior (Tomonobu, 2014). Therefore, with scapular dyskinesia not being an absolute cause of pain, and proper EMG ratios of different muscles already being researched this study’s purpose is to look at a single subject with scapular dyskinesia and determine which muscles were causing the abnormal movement of the scapula during shoulder abduction.

Purpose

The purpose of this pilot study was to analyze scapular biomechanics in a single subject experiencing abnormal movement patterns in the left scapula with bilateral shoulder abduction in a slow, moderate, and fast biomechanical speed. Scapular dyskinesia has been a widely researched topic in physiotherapy as
research has shown that many individuals experience minimal to no symptoms with this diagnosis.
CHAPTER II

METHODS

EMG activity was recorded using a Noraxon™ TeleMyo2400 G2 telemetry unit with a sampling rate of 1 kHz. This was transmitted to a TeloMyo PC interface card connected to a laptop computer which then stored all the data. Data analysis was performed using the MyoResearch XP 1.07 software. 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 muscles tested were the right and left sided upper trapezius, middle trapezius, lower trapezius and serratus anterior in the same subject. A video camera was used to record the shoulder abduction motion. The video camera was synced to the EMG data collection. The subject performed the abduction motion at three different speeds (slow, moderate, fast) in time with a metronome.
CHAPTER III

RESULTS

Tables 1 through 3 show the ratio of serratus activity to trapezius activity during the three different abduction 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 abduction motion the left serratus anterior is weaker than the right serratus anterior, at least in comparison to the right serratus anterior. Figures 1 and 2 compare the same EMG activity in graphic form. In all cases the left serratus anterior muscle does not appear to elicit the same level of activity (as compared to the lower trapezius) as does the right serratus anterior muscle.

Table 1. Ratios of Serratus Anterior EMG to Trapezius EMG During Slow Speed Abduction (Mean EMG Amplitude shown in microvolts)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>L Serratus (109): L Upper Trapezius (146) =</td>
<td><strong>.747</strong></td>
</tr>
<tr>
<td>L Serratus (109): L Middle Trapezius (65.7) =</td>
<td><strong>1.66</strong></td>
</tr>
<tr>
<td>L Serratus (109): Lower Trapezius (161) =</td>
<td><strong>.677</strong></td>
</tr>
<tr>
<td>R Serratus Anterior (113): R Upper Trapezius (122) =</td>
<td><strong>.926</strong></td>
</tr>
<tr>
<td>R Serratus Anterior (113): R Middle Trapezius (51.6) =</td>
<td><strong>2.19</strong></td>
</tr>
<tr>
<td>R Serratus Anterior (113): R Lower Trapezius (33.7) =</td>
<td><strong>3.35</strong></td>
</tr>
</tbody>
</table>
Table 2. Ratios of Serratus Anterior EMG to Trapezius EMG During Moderate Speed Abduction (Mean EMG Amplitude shown in microvolts)

<table>
<thead>
<tr>
<th>Ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td>L Serratus Anterior (221): L Upper Trapezius(210) = 1.05</td>
</tr>
<tr>
<td>L Serratus Anterior(221): L Middle Trapezius(103) = 2.15</td>
</tr>
<tr>
<td>L Serratus Anterior(221): L Lower Trapezius(335) = 0.66</td>
</tr>
<tr>
<td>R Serratus Anterior (210): R Upper Trapezius(200) = 1.05</td>
</tr>
<tr>
<td>R Serratus Anterior(210): R Middle Trapezius(75.5) = 2.78</td>
</tr>
<tr>
<td>R Serratus Anterior(210): R Lower Trapezius(66.1) = 3.18</td>
</tr>
</tbody>
</table>

Table 3. Ratios of Serratus Anterior EMG to Trapezius EMG During Fast Speed Abduction (Mean EMG Amplitude shown in microvolts)

<table>
<thead>
<tr>
<th>Ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td>L Serratus Anterior (225): L Upper Trapezius(209) = 1.08</td>
</tr>
<tr>
<td>L Serratus Anterior(225): L Middle Trapezius(109) = 2.06</td>
</tr>
<tr>
<td>L Serratus Anterior(225): L Lower Trapezius(390) = 0.577</td>
</tr>
<tr>
<td>R Serratus Anterior (215): R Upper Trapezius(206) = 1.04</td>
</tr>
<tr>
<td>R Serratus Anterior(215): R Middle Trapezius(66.8) = 3.22</td>
</tr>
<tr>
<td>R Serratus Anterior(215): R Lower Trapezius(79.1) = 2.72</td>
</tr>
</tbody>
</table>
Ratio of EMG Activity of Right Upper Extremity During Glenohumeral Abduction

Figure 1. Ratio of EMG Activity of Right Serratus Anterior to Trapezius Muscles at Three Different Speeds of Abduction.
Figure 2. Ratio of EMG Activity of Left Serratus Anterior to Trapezius Muscles at Three Different Speeds of Abduction.
CHAPTER IV
DISCUSSION

This pilot study compared EMG activity in the left and right serratus anterior, left and right upper trapezius, left and right middle trapezius, and left and right lower trapezius throughout full shoulder abduction. 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 shoulder abduction. The subject in the 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 increased impairment (“winging scapula”) at 50% of normal shoulder flexion and abduction. Scapular dyskinesis was present throughout entire motion during both elevation and depression as well as with all three varying shoulder abduction velocities. At all speeds of shoulder abduction, the serratus anterior on the left side showed a decreased amount of EMG activity in comparison to the lower trapezius. This finding would be consistent with an expected scapular winging on the left side.
CHAPTER V
LIMITATIONS

There were several limitations that need to be considered when analyzing this case study. A maximal voluntary contraction (MVC) was only recorded on one side (left) of the subject, which limited the possible analysis of this subject's EMG data. With only one side obtained, the experimenters were unable to use this baseline and compare the left side to the right side of the subject on any data analysis. Without being able to truly compare left to right sides of the subject, the experimenters had to instead compare the ratios of muscle activity from either side. The serratus anterior muscle activity was used as the nominator and same side trapezius as the denominator to make the ratio of EMG muscle activity which then could be compared side to side.

Future studies should gather this baseline MVC in order to truly compare the left and right side of the subject in question. This was also a case study and so only involved one patient 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.

Electrode placement was done by three different researchers using standardized points for all the muscles involved in the study. With three separate researchers applying the electrodes there could have been human error on electrode placement from side to side and electrode to electrode.
REFERENCES


