EMG ACTIVATION PATTERNS OF FOUR PARTS OF THE TRAPEZIUS MUSCLE

1 Kimberly A. Szucs, 2 John D. Borstad
1Department of Occupational Therapy, Duquesne University, Pittsburgh, PA, USA; szucska@duq.edu
2Physical Therapy Division, The Ohio State University, Columbus, OH, USA

INTRODUCTION

The broad trapezius muscle inserts on the clavicle and scapula and is important for movement of the segments of the shoulder complex. Historically, the trapezius has been divided into three anatomical and functional divisions, the upper, middle, and lower trapezius [1]. Fibers of upper trapezius originate on the superior nuchal line of the cranium and ligamentum nuchae and insert on the lateral third of the clavicle and acromion (Figure 1A). Middle trapezius originates at C7 and T1 and inserts on the acromion and scapula spine. Fibers of lower trapezius originate below T1 and insert on the scapula spine [1] (Figure 1B). The upper and lower trapezius work synergistically with the serratus anterior muscle to upwardly rotate the scapula. Based on the insertion of the upper trapezius fibers on the lateral third of the clavicle it is suggested that these fibers act to elevate and retract the clavicle [1].

Most shoulder studies include muscle activation and timing for the acromial fibers of upper trapezius [2, 3, 4] and have not attempted to describe the activation patterns of the specific fibers that insert on the clavicle. Because fibers of upper trapezius insert onto two different bony segments, it is possible that these fibers have separate mechanical demands during arm elevation. Several studies have demonstrated that the upper portion of the trapezius muscle is not uniformly activated, lending support to the theory that regions within this portion of the muscle are selectively activated based on the mechanical requirements of the task [5, 6]. During an isometric abduction contraction, the lower fibers of trapezius have higher initial discharge rates compared to the upper fibers [5]. The activation levels in the fibers of trapezius that insert onto the clavicle are higher compared to the scapular fibers during elevation in the coronal plane [6]. Additionally, a recent study demonstrated that some individuals are able to selectively activate the clavicle and acromial portions of the trapezius muscle independent of the lower portions [7].

Because imbalances in muscle activation or timing between synergistic force couples can contribute to altered kinematics of the shoulder complex [2], it is necessary to describe the normal muscle activation patterns of the four anatomical subdivisions of trapezius.

METHODS

A Delsys Bagnoli 8-channel EMG system (Delsys Inc., Boston, MA) was used to record raw surface EMG signals from the 4 parts of trapezius (clavicle, upper, middle, and lower subdivisions), and anterior deltoid muscles. This system is differentially amplified and has an input impedance of \( >10^{15} \Omega//0.2pF \). Data were pre-amplified x10 and sampled at 1200 Hz using MotionMonitor. Bipolar Ag-AgCl parallel bar electrodes were taped to the skin overlying the muscle belly in parallel with the direction of the muscle fiber. Sensors were applied at the following locations (Figure 2):

1. Clavicular fibers of Trapezius: 20% lateral to the midpoint between the origin and insertion of the fibers [7].
2. Upper Trapezius: Halfway along a line between the acromioclavicular joint and the seventh cervical spinous process [8]
3. Middle Trapezius: Midway on a horizontal line between the root of the spine of scapula and the third thoracic spinous process [8]
4. Lower Trapezius: Medial and superior to an oblique line between the root of the spine of scapula and the 8th thoracic spinous process [8]

Because imbalances in muscle activation or timing between synergistic force couples can contribute to altered kinematics of the shoulder complex [2], it is necessary to describe the normal muscle activation patterns of the four anatomical subdivisions of trapezius.

Maximum voluntary contractions were collected for each muscle. The same method was used for the clavicular and acromial parts of upper trapezius. EMG data were collected at a rate of 1200 Hz while subjects actively elevated their arm in the scapular plane. Data were collected from 25 healthy subjects. Each extremity was tested separately. EMG data were reduced to every 15° of arm elevation. Raw EMG data were full wave rectified and filtered with a 100Hz low pass fourth-order zero lag Butterworth filter. Separate MVCs for each muscle were calculated with a custom computer program in Matlab.

For a descriptive analysis, the elevation phase of arm motion was broken into 15° phases. The mean percent change in muscle activation was calculated for each phase for each...
null