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Gender differences between muscle activation and onset timing of the four subdivisions of trapezius during humerothoracic elevation

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ABSTRACT

The aim of this study was to provide a description of gender differences of the normal muscle activation patterns of the four subdivisions of the trapezius (clavicular, descending, transverse, ascending) during arm elevation. Surface EMG was collected from these four subdivisions from twenty-two healthy subjects (12 females, 10 males) during arm elevation in the scapular plane. Percent activation (RMS) of each subdivision was compared between genders across arm angles and elevation phase and onset time of each subdivision was compared between genders. Females demonstrated significantly higher % activation levels for each subdivision ($p < .05$), except transverse trapezius ($p = .36$). A statistically significant difference for onset time was observed between gender for the descending trapezius, with a slower onset time for females ($p < .05$). Findings from this study support the theory that subdivisions within descending trapezius are preferentially activated and demonstrate that gender differences are present within the fourth subdivision of trapezius. As subjects were without shoulder pathology, the observed gender differences may be explained by normal motor control variations. However, as coordinated activation of trapezius is required for normal shoulder motion, it is recommended to include all four subdivisions of trapezius and address gender differences in future studies.

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1. Introduction

The trapezius muscle is widely studied in biomechanical research focusing on the shoulder and shoulder pathologies as it is a prime mover of the scapula (Johnson, Bogduk, Nowitzke, & House, 1994; Johnson & Pandyan, 2005; Kimura, Sato, Ochi, Hosoya, & Sadoyama, 2007) and frequently impacted by fatigue and myalgia as a consequence of repetitive work (Kimura et al., 2007; Larsson, Sogaard, & Rosendal, 2007; Szucs, Navalgund, & Borstad, 2009). Various studies have demonstrated the significant role of coordinated trapezius muscle activation for normal shoulder motion and imbalances in muscle activation or timing within the subdivisions of this muscle have been proposed to lead to altered kinematics of the shoulder complex (Cools, Witvrouw, Declercq, Danneels, & Cambier, 2003; Moraes, Faria, & Teixeira-Salmela, 2008; Wadsworth & Bullock-Saxton, 1997). Though the trapezius is traditionally divided into three anatomical and functional subdivisions, a small number of studies have demonstrated that a subdivision of the descending trapezius, with fibers inserting onto the clavicle, are independently activated from fibers which insert onto the acromion (Falla & Farina, 2008b; Holtermann & Roeleveld, 2006; Jensen & Westgaard, 1995) (Fig. 1A and B). With insertions on different bony segments of the shoulder girdle, these subdivisions of descending trapezius are likely to activate independently based on mechanical demands.

Describing the normal activation patterns of all four subdivisions of trapezius is necessary before the effects of altered activation patterns on shoulder kinematics can be considered. Jensen and Westgaard report that activation within different regions of the descending trapezius is dependent on arm position (Jensen & Westgaard, 1995) and functional movement of the arm results in different activation levels between the trapezius fibers that insert onto the clavicle, the acromion, and the scapular spine (Jensen & Westgaard, 1997). These observations led the authors to conclude that the descending trapezius is subdivided into functional regions that selectively activate based on the mechanical demands of the task. This theory of selective or preferential activation has been supported by subsequent studies (Falla & Farina, 2008b; Holtermann & Roeleveld, 2006; Holtermann et al., 2008; Samani & Madeleine, 2008). Falla and Farina (2008a) reported that regions within the descending trapezius independently activate during sub-maximal contractions in different planes of motion. In a study by Holtermann et al. (2008), half of the subjects were able to isolate and activate the descending trapezius and two subjects were able to selectively activate the clavicular fibers of the descending trapezius independent of the acromial fibers. Despite evidence of preferential activation of subdivisions

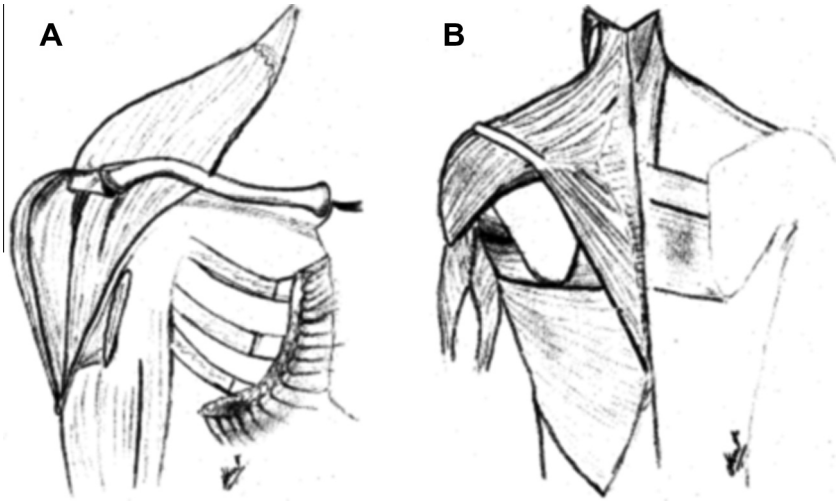

Fig. 1. (A) An anterior view of the fibers of trapezius inserting onto the posterolateral aspect of the clavicle, opposite of the anterior deltoid muscle. (B) A posterior view of the broad trapezius muscle, inserting onto the scapula.

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