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Effect of isometric horizontal abduction on pectoralis major and serratus anterior EMG activity during three exercises in subjects with scapular winging

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ABSTRACT

The aim of this study was to determine the effect of isometric horizontal abduction using Thera-Band during three exercises (forward flexion, scaption, and wall push-up plus) in subjects with scapular winging by investigating the electromyographic (EMG) amplitude of the pectoralis major, serratus anterior and the pectoralis major/serratus anterior activity ratio. Twenty-four males with scapular winging participated in this study. The subjects performed the forward flexion, scaption, and wall push-up plus with and without isometric horizontal abduction using Thera-Band. Surface EMG was used to collect the EMG data of the pectoralis major and serratus anterior during the three exercises. Two-way repeated analyses of variance with two within-subject factors (isometric horizontal abduction condition and exercise type) were used to determine the statistical significance of pectoralis major and serratus anterior EMG activity and the pectoralis major/serratus anterior EMG activity ratio. Pectoralis major EMG activity was significantly lower during forward flexion and wall push-up plus with isometric horizontal abduction, and serratus anterior EMG activity was significantly greater with isometric horizontal abduction. Additionally, the pectoralis major/serratus anterior activity ratio was significantly lower during the forward flexion and wall push-up plus with isometric horizontal abduction. The results of this study suggest that isometric horizontal abduction using Thera-Band can be used as an effective method to facilitate the serratus anterior activity and to reduce excessive pectoralis major activity during exercises for activating serratus anterior.

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1. Introduction

The serratus anterior is the primary muscle used to stabilize the medial border and inferior angle of the scapula and to prevent winging and anterior tilting of the scapula (Escamilla et al., 2009; Neumann, 2002). Accordingly, weakness, fatigue, and abnormal muscle firing patterns of the serratus anterior can cause shoulder dysfunctions that deviate from the normal scapulohumeral rhythm (Madeleine et al., 2008), as well as glenohumeral and scapulohumeral muscle imbalance (Cools et al., 2004; Hallström and Kärholm, 2006). Especially, scapular winging can result from weakness of the serratus anterior itself without nerve involvement, even though the most common cause is injury of the long thoracic nerves that innervate the serratus anterior (Dvir and Berne, 1978; Martin and Fish, 2008). Therefore, the serratus anterior is a focus of

therapeutic exercise protocols for the prevention and rehabilitation of scapular winging.

Many previous studies have investigated diverse exercises to determine the most effective exercise to elicit serratus anterior activity including open and closed kinetic chain exercises (Cook et al., 2007; Decker et al., 1999; Hardwick et al., 2006; Ludewig et al., 2004; Martins et al., 2008; McClure et al., 2004). Of these diverse exercises, forward flexion has been routinely included in shoulder rehabilitation programs (Ellenbecker, 2006; McCann et al., 1993) and is reported to induce serratus anterior activity greater than 40% of maximal isometric voluntary contraction (Wattanaparakomkul et al., 2011). Furthermore, the scaption and push-up plus were found to consistently elicit serratus anterior activity greater than 20% of maximal isometric voluntary contraction (Decker et al., 1999). Thus, these exercises have been recommended for increasing serratus anterior activation. Decker et al. (1999) also reported that the plus phase of push-up plus induces the highest average serratus anterior activation as compared to a number of other exercises used in the study. Especially, the wall push-up plus is commonly advocated because this modified push-up plus is believed to be a less demanding exercise for clinical use, and it is generally recommended to patients who cannot

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