

COMPARISON OF PECTORALIS MAJOR AND SERRATUS ANTERIOR MUSCLE ACTIVITIES DURING DIFFERENT PUSH-UP PLUS EXERCISES IN SUBJECTS WITH AND WITHOUT SCAPULAR WINGING

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ABSTRACT

Park, K-M, Cynn, H-S, Kwon, O-Y, Yi, C-H, Yoon, T-L, and Lee, J-H. Comparison of pectoralis major and serratus anterior muscle activities during different push-up plus exercises in subjects with and without scapular winging. *J Strength Cond Res* 28(9): 2546–2551, 2014—To examine the differences between men with and without scapular winging in the electromyographic (EMG) amplitude and activity ratio between the pectoralis major (PM) and serratus anterior (SA) during 3 push-up plus exercises: (a) the standard push-up plus (SPP), (b) the knee push-up plus (KPP), and (c) the wall push-up plus (WPP), and to determine which exercise induced the lowest PM/SA ratio in each group. Twenty-eight men participated in this study (13 scapular winging group: age, 21.8 ± 2.1 years; 15 control group: age, 23.3 ± 2.0 years). Surface EMG of the PM, SA, and activity ratio between the PM and SA were collected during 3 push-up plus exercises, and the EMG data were expressed as a percentage of the reference voluntary contraction (%RVC). The normalized PM activity for subjects in the scapular winging group was significantly greater than that in the control group (79.16 ± 6.65 %RVC vs. 39.66 ± 6.19 %RVC, $p \leq 0.05$). The normalized SA activity was significantly lower in the scapular winging group compared with the control group (39.80 ± 4.09 %RVC vs. 56.28 ± 3.81 %RVC, $p \leq 0.05$) and was significantly decreased in the following order: SPP > KPP > WPP; 77.09 ± 5.12 %RVC > 39.48 ± 3.38 %RVC > 27.55 ± 3.07 %RVC, $p < 0.016$). The PM/SA EMG ratio was significantly greater in the scapular winging group compared with that in the control group across all exercises and was significantly lower during SPP than that during KPP and WPP in both groups (1.13 ± 0.58

vs. 0.53 ± 0.25 for SPP, 3.50 ± 2.07 vs. 0.92 ± 0.63 for KPP, 4.04 ± 3.13 vs. 1.19 ± 0.66 for WPP, $p < 0.016$). Greater PM activity was found in the scapular winging group, and the SPP is an optimal exercise for subjects with scapular winging, where maximum SA activation with minimal PM activation is desired.

KEY WORDS decreased serratus anterior activity, increased pectoralis major activity, modified push-up plus exercises, scapular dysfunction

INTRODUCTION

Musculoskeletal factors of scapular dysfunction include continuous abnormal posture (30), repetitive movements deviating from normal scapulohumeral rhythm (22) or glenohumeral, and scapulothoracic muscle imbalance (3,9). In particular, scapular winging, which is a subtype of scapular dysfunction has 2 common causes: (a) denervation of the long thoracic nerve causing difficulty in active shoulder flexion above 120° or (b) weakness of the serratus anterior (SA) muscle in theory.

The SA, which maintains components of normal 3-dimensional scapular movements (18,24), is one of the most important factors for preventing winging and anterior tilt of the scapula (7,26). Serratus anterior abnormal muscle firing patterns caused by muscle weakness or fatigue are associated with painful shoulder conditions such as subacromial impingement and scapular winging (17,20). Therefore, many therapeutic exercise protocols for the SA activity have been investigated for prevention and rehabilitation of scapular dysfunction.

Standard push-up plus (SPP) shows the highest average SA activation as compared with other SA activation exercises and has been recommended to effectively elicit SA muscles (2,5,10,23). In addition, modifications to the SPP are commonly recommended, including the knee push-up plus (KPP), elbow push-up plus, and wall push-up plus (WPP). This is because these alternatives are believed to limit the amount of weight bearing during the exercise and are especially suggested in the

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