Effect of a Multi-Air-Cushion Biofeedback Device (MABD) on Shoulder Muscles during the Dynamic Hug Exercise

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Abstract. [Purpose] We developed a multi-air-cushion biofeedback device (MABD) to assist the dynamic hug exercise, and investigated the effects of MABD on the shoulder muscles during the dynamic hug exercise. [Subjects] Twelve males aged 22–32 years were recruited. [Methods] We measured the right side serratus anterior, lower trapezius, and upper trapezius muscle activities during the dynamic hug exercise with and without MABD. [Results] The serratus anterior and lower trapezius muscles activities significantly increased during the dynamic hug exercise with MABD compared to without it. The upper trapezius muscle significantly decreased during the dynamic hug exercise with MABD compared to without it. [Conclusion] The results suggest that the dynamic hug exercise with MABD is an effective scapular stability exercise.

Key words: Biofeedback, Dynamic hug exercise, Scapular stability

INTRODUCTION

Shoulder discomfort is one of the most common types of clinical musculoskeletal problems1). The scapula is an important link between the trunk and the upper extremities and it also provides proximal stability for functional activity of the upper extremities2). A change in the scapular position and motion influences the change in muscle length attached to the scapula and eventually causes shoulder pathologies such as impingement1, 2). Lin JJ et al.3) reported that increased upper trapezius muscle activity is caused by scapular elevation and inferior angle tipping. Another study showed that lower trapezius weakness is produced by an anterior tilt of the scapula4). The proper alignment and muscle balance of the scapula is essential for acquiring stability of the shoulder girdle and functional shoulder movement5). In recent reviews, the dynamic hug exercise was recommended for effective strengthening of the scapulothoracic musculature5, 6). We developed a multi-air-cushion biofeedback device (MABD) for assisting the performance of the dynamic hug exercise. In the present study, we investigated the effects of MABD on shoulder muscle activities during the dynamic hug exercise.

SUBJECTS AND METHODS

Twelve males, aged 22–32 years with a mean height and weight of 172.5 ± 6.7 cm and 68.2 ± 6.8 kg, respectively, participated in this study. The subjects had no history of musculoskeletal disorders or pain associated with the upper extremity in the past 6 months. EMG signals were collected for 30 seconds, sent to the data acquisition unit of a MP150 system (Biopack System, Santa Barbara, CA, USA), and expressed relative to the maximum voluntary contraction (MVC). The surface electrodes were attached to the right upper trapezius, right lower trapezius, and right serratus anterior muscles. We developed a multi-air-cushion biofeedback device (MABD) for assisting the performance of the dynamic hug exercise. The MABD consists of three 15 × 10 cm air cushions and a 100 × 100 cm back support board with containing pressure detecting sensors (AP-series pressure sensor, Keyence, Japan). Visual feedback was provided to each participant by linking the pressure sensors to display devices. The three air cushions were positioned over the left and right scapulas and the cervical spine and were attached to the back support board. The air-cushion positions are adjustable by Velcro on the support board. The pressure sensors are able to sense increased pressure over the baseline. The subjects were instructed to maintain the pressure based on the air pressure data of the initial standard leaning posture. They performed the dynamic hug exercise with and without MABD. The test order was randomized. The dynamic hug exercise horizontally adducts the humerus until the hands touch together. The subjects performed the dynamic hug exercise using a pulley station. The axis of the pulley was placed at the level of each subject’s acromion by inserting plastic plates under his feet. The subjects stood with their feet shoulder-width apart, elbows flexed at 90° and internally rotated at 90°, and with the shoulders abducted at 90°. The subjects pushed the handle using horizontal shoulder adduction and elbow extension6). The Statistical Package (SPSS, Chicago, IL, USA)
was used to conduct paired t-tests to analyze the significance of differences in the dynamic hug exercise with and without MABD. The level for statistical significance was α, chosen as 0.05.

RESULTS

The serratus anterior muscle activity significantly increased during the dynamic hug exercise performed with MABD (39.8±15.9%) compared to without MABD (33.2±16.0%) (p<0.05). The lower trapezius muscle activity significantly increased during the dynamic hug exercise performed with MABD (28.8±9.2%) compared to without MABD (19.0±12.2%) (p<0.05). The upper trapezius muscle significantly decreased during the dynamic hug exercise performed with MABD (18.1±8.8%) compared to without MABD (26.5±9.0%) (p<0.05).

DISCUSSION

We investigated the effects of MABD on the shoulder muscles during the dynamic hug exercise. The serratus anterior and lower trapezius muscles activities significantly increased during the dynamic hug exercise with MABD. The serratus anterior and lower trapezius muscles are the major scapulothoracic muscles associated with normal scapular alignment and functional stability and mobility. Previous researchers have suggested exercises for selective activation of the serratus anterior and lower trapezius for therapeutic assessment of shoulder rehabilitation. Decker et al. described the dynamic hug as a combined movement involving horizontal shoulder adduction and scapular protraction. In recent reviews, the dynamic hug exercise was recommended for strengthening the scapulothoracic musculature. Biofeedback, in particular, has been reported to be an effective intervention for re-educating posture and reducing altered activation of the upper trapezius muscles. In the present study, the upper trapezius muscle activity significantly decreased during the dynamic hug exercise performed with the MABD compared to the same exercise without MABD. Higher activation of the upper trapezius has been observed in patients with shoulder disorders, and previous research has suggested that inhibition of the upper trapezius effectively restores the normal pattern of the scapulothoracic muscles. The MABD changes the dynamic hug exercise, which is an open chain exercise, to a closed chain exercise. Tucker et al. investigated scapular muscle activities in closed kinetic chain exercises and showed that these could affect the scapular muscle activities in symptomatic subjects. The dynamic hug exercise with MABD also provides a labile support for the left and right scapular and cervical spine. Recently, de Oliveira et al. suggested that a labile surface enhances the activities of the scapulothoracic muscles. Therefore, our opinion is that performance of the dynamic hug exercise the MABD would help to improve scapular stability during the dynamic hug exercise.

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