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Effect of the Foot Placements on the Latissmus Dorsi and Low Back Muscle Activities during Pull-down Exercise

Won-gyu Yoo[1)]

[1)] *Department of Physical Therapy, College of Biomedical Science and Engineering, Inje University and Elderly Life Redesign Institute: 607 Obangdong, Gimhae, Gyeongsangnam-do 621-749, Republic of Korea. TEL+82 55-320-3994; FAX:+82 55-329-1678*

Abstract. [Purpose] The purpose of this study was to examine the effects of foot placement on the latissmus dorsi and low back muscles activities during pull-down exercise. [Subjects] For this study, we recruited 10 male volunteers. [Methods] The subjects performed pull-down exercises with 4 foot placement conditions. The activities of the latissmus dorsi and L4 paraspinal muscles were measured. [Results] The activities of the latissmus dorsi muscles significantly increased in the order of conditions 1 and 2 < condition 4 < condition 3. The activities of the L4 paraspinal muscles were significantly different, with the activities of conditions 1 and 2 being greater than those of conditions 3 and 4. [Conclusion] We suggest that the selection of foot placement is an important factor for the effective strengthening of the latissmus dorsi.

Key words: Foot placement, Latissmus dorsi, Pull-down exercise

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INTRODUCTION

The latissmus dorsi muscle contributes to shoulder adduction, internal rotation, and extension, and it directly connects the upper extremity and trunk[1, 2)]. Because of its importance, researchers have investigated the merits of several exercise methods and instruments for the activation of the latissmus dorsi[3)]. Representative exercises for strengthening the latissimus dorsi are pull down, pull up, and rowing exercises. Previous studies which investigated the latissmus dorsi muscle activation have reported that it depends on grip width, expert instruction, and forearm orientation[3–5)]. Signorile et al.[5)] reported that a wide handgrip position produces a greater latissmus dorsi muscle activation than other handgrip positions. Sperandei et al.[6)] investigated three positions of pull down, the scapular plane, the frontal plane using a V-shaped bar, and the behind the neck position. Clinical studies have also used different methods for the measurement of latissmus dorsi[4, 5)]. Pull down in the standing position and body lifting in the seated position have commonly been used to activate the latissmus dorsi[4–6)]. However, no study has investigated the effect of foot placement on the latissmus dorsi and low back muscle activities during pull-down exercise. Therefore, the purpose of this study was to examine the effects of foot placement on the latissmus dorsi and low back muscle activities during pull-down exercise.

E-mail: won7y@inje.ac.kr

SUBJECTS AND METHODS

The study subjects were 10 males aged 20–27 years (23.2 ± 3.2 years, mean±SD) whose average height and weight were 175.6 ± 2.3 cm and 66.2 ± 4.6 kg, respectively. The subjects had no history of musculoskeletal disorders or pain associated with the upper extremity in the past 6 months. The EMG data were collected using a Biopac MP150WSW (Biopac System, Santa Barbara, CA, USA). Surface electrodes were placed at an oblique angle over the latissmus dorsi muscle on the right side, approximately 4 cm below the inferior tip of the scapula and midway between the spine and lateral edge of the torso, and for the L4 paraspinal muscle on the right side 2 cm, laterally from the L4 spinous process. The subjects performed pull-down exercises with 4 foot placement conditions. Condition 1 was standing with their feet one shoulder-width apart, condition 2 was standing with their feet 120% shoulder-width apart, condition 3 was standing with the right foot placed anteriorly and the left foot posteriorly one shoulder-width apart, and condition 4 was standing with the left foot placed anteriorly and the right foot posteriorly one shoulder-width apart. From the standing position, subjects grasped the two bar of pulley. Subjects then tried to pull-down with their arms, caudally, without flexing the elbow or depressing the shoulder. The exercise load was the 50% of the body weight[7)]. Each isometric exertion was maintained for 5 seconds, and the middle of three seconds was used for further analysis. Data were normalized as percentages of the maximal voluntary isometric contractions value against normalized data. Statistical analysis was performed using one-way repeated measures analysis of variance (ANOVA). The Bonferroni

correction was performed to identify specific differences between multiple pairwise comparisons among the 4 conditions. The results were considered significant for values of $p < 0.05$, and SPSS version 18.0 (SPSS, Chicago, IL, USA) was used for the statistical analyses.

RESULTS

The activities of the latissmus dorsi muscles significantly increased in the order of conditions 1 (45.9 ± 13.3%) and 2 (42.9 ± 12.3%) < condition 4 (52.0 ± 12.0%) < condition 3 (56.2 ± 10.2%) ($p<0.05$). The EMG activities of the L4 paraspinal muscles were significantly different, with the activities of condition 1 (46.2 ±16.0%) and condition 2 (49.5 ±19.6%) being significantly greater than those of condition 3 (33.8 ±11.7%) and condition 4 (36.5 ±15.5%) ($p<0.05$).

DISCUSSION

This study investigated the effects of foot placement on the latissmus dorsi and low back muscle activities during pull-down exercise. Our results show that the activities of the latissmus dorsi muscles significantly increased in the order of conditions 1 and 2 < condition 4 < condition 3. Condition 3 was standing with the right foot placed anteriorly and the left foot posteriorly one shoulder-width apart. The latissmus dorsi is a very broad muscle that originates at the lower six thoracic vertebrae, the lumbodorsal fascia, the sacrum, and the blade of the ilium; it inserts, along with the teres major, on the medial edge of the humerus[1–3]. A previous study showed that extension of the ipsilateral leg generates gluteus maximus activity, which tightens the thoracolumbar fascia. The stress of the thoracolumar fascia is transmitted to the ipsilateral latissmus dorsi[8]. Our results also show that the activities of the L4 paraspinal muscles were significantly different, with conditions 1 and 2 being significantly higher than those of conditions 3 and 4. According to recent reports, continuous exercise training with poor posture or method can result in low back pain[7–9]. Subjects with LBP have been shown to have altered trunk muscle activation patterns which are activated highly in L4-L5 level back muscles[10]. Foot placement is associated with the size of the base of support (BOS) of the body[9]. Pull-down exercise requires anterior-posterior translation along the line of the center of gravity of body[9]. Therefore, we suggest that the selection of foot placement is an important factor for effective strengthening of the latissmus dorsi.

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