Effects of Bilateral Upper-Limb Exercise on Trunk Muscles

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Abstract. We recommend the following movements for low back pain patients dependent on their stage of impairment. In the early stage of exercise, the pull-down exercise in a sitting position with handgrip width adjustments for exercise of the front muscles. With advance of stage, the handgrip width can be narrowed and the exercise can start in the standing position. For the back muscles, pull-up movement can be performed in a sitting position in the early stage, and pull-up movement in a standing position can be performed in subsequent stage. The handgrip width does not influence the pull-up exercises.

Key words: Bilateral upper-limb exercise, Trunk muscle activities, Low back pain.

INTRODUCTION

Muscle activities of the trunk during upper-limb movements are thought to be important for maintaining postural stability1). Previous researches reported on effects of posture1) effects of movement direction2), and effects of arm speed3) on trunk muscle activities. These researchers focused mainly on the timing of muscle activities during movements, however, there is no report describing the effect of load applied to the trunk muscles. One possible cause of low back pain can be imbalance of front and back muscle activities. The unbalanced muscles increase muscle spasm by overuse and limited relaxation, and fall into a vicious circle of pain. To treat such muscle imbalance, trunk muscle activities with various upper extremity movements need to be examined and ranked with magnitude of trunk muscle activities.

The purpose of this study was to examine the effect of bilateral upper-limb movements on trunk muscle activities, especially effect of posture, effect of direction of movement, and effect of position of handgrip. We believe our objective results may help understanding of trunk activities during upper-limb movements, and may provide suggestions for the clinical treatment of low back pain.

METHODS

Ten healthy adults volunteers (5 female and 5 male, aged 26.2 ± 8.7 years old) participated in this study. Muscle activities were recorded from the rectus abdominis, the obliquus externus abdominis, the trapezius, the latissimus dorsi, and the erector spinae via Neuropack8 electro-myography (NHON KOHDEN Inc., Japan). After reducing skin impedance, two recording electrodes were attached a little distal to the middle of target muscle at 1.5 cm intervals. EMG was normalized by isometric maximum voluntary contraction of each muscle. Subjects were asked to perform three upper-limb movements with the assist of MOFLEX, a functional exercise machine (PROXOMED Inc.,...
Germany). This equipment enable subjects to move eccentrically and concentrically at constant speed with variable resistance. The speed of the movement was set at 0.3 m/sec. After the subject became comfortable with the movement, EMG was recorded at the sampling rate of 2000Hz for 5 seconds. The three movements consisted of pull-down in a standing position (Fig. 1), pull-up in a standing position (Fig. 2), and pull-down in a sitting position (Fig. 3). The width between grips was changed to 15 cm, 60 cm, 75 cm, 100 cm for the third movement. Means and standard deviations of each muscle activity (%MVC) during six conditions were calculated. Data exceeding two standard deviations were removed from the analysis.

RESULTS

During pull-down in the standing position, the rectus abdominis and the obliquus externus abdominis showed more than 30% of MVC. The trapezius and the muscles spinae showed 20% or more muscle activity for the pull-up movement in the standing position. Especially, the trapezius indicated more than 50% of muscle activity during the pull-up movement. For pull-down in the sitting position, muscle activity presented similar to the first movement, but muscle activity of the latissimus dorsi increased dependent on the width between grips the greater the grip width, the greater the muscle activity, whereas muscle activity of the rectus abdomimus decreased (Table 1).

DISCUSSION

We examined electric activities of the muscles, but our results may extrapolate to muscle strength, since a linear relationship between muscle strength and muscle electrical activity was confirmed if the load is moderate\(^4\). The movement used in this research did not exceed 50% of maximal voluntary contraction.

Effect of posture

During the pull-down movement, both rectus abdominis and obliquus externus abdominis showed high activity, although the standing position showed higher activities than the sitting position. Erector spinae also increased activity in the standing position, so we believe that the standing position requires more muscle activity to maintain posture in
upper-limb activity.

**Effect of movement direction**

In comparison of pull-down and pull-up in the standing position, pull-down required more muscle activities of the rectus abdominis and the obliquus externus abdominis, whereas pull-up required muscle activities of the erector spinae and the latissimus dorsi. Both front muscles and back muscles showed muscle activity during pull-down and pull-up movement; front muscles were dominant during pull-down movement, and back muscles were dominant in pull-up movement.

**Effect of handgrip width**

As the distance of handgrip width increased, a greater latissimus dorsi activity and a lesser rectus abdominis activity were observed. We believe that in order to pull down the functional bar, isometric contraction is required in the direction of adduction, and internal rotation movement simultaneous with shoulder joint extension movement.

**Application for clinical settings**

Both pull-down and pull-up showed muscle activity in the back muscles, but the activity was higher in the pull-up movement, so the pull-up movement could be used for the advanced stage of back muscle treatment, and the pull-down exercise could be used in the earlier stage. The front muscles act more in the trunk flexion which accompanies the pull-down movement. It is guessed that the muscle activities of the back muscles were seen in the trunk extension of the pull-up movement. Movement in the standing position could also be applicable to the advanced stage, since the standing position requires more activity to stabilize the pelvis. To control activity in abdominal muscles, the position of the handgrip could be used.

**REFERENCES**


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<th>Rectus abdominis</th>
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