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Original Article

The effects of visual biofeedback using ultrasonograpy on deep trunk muscle activation

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Abstract. [Purpose] The objective of this study is to investigate the effect of visual biofeedback using ulatrasonography on the functional improvement of deep trunk muscle. [Subjects and Methods] This study selected ten healthy people without orthopedic history and information on the study. The average ages, heights, and weights were 22.70 ± 2.06 years old, 171.15 ± 9.18 cm, and 66.86 ± 8.88 kg in the experimental group, respectively. The abdominal drawing-in maneuver were executed for subjects through monitoring the status of muscle contraction using ultrasonic waves. And motor control exercises were performed during 6 weeks, 20 minutes/day and three times/week. We collected the data using electromyography MP150 system (BIOPAC system Inc., CA, USA) in order to measure trunk muscle activation. [Results] The subjects showed significant improvements in Internal oblique abdominis and lumbar multifidus muscle after intervention. [Conclusion] Visual biofeedback training using ultrasonography might be effective in improving function of the deep trunk muscle.
Key words: Visual biofeedback, Ulatrasonography, Deep trunk muscle

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INTRODUCTION

It is known that core stability can enhance the muscles located nearby abdomen, lumbar spine and pelvis[1)] and play important role to improve balance ability and trunk stabilization[2)]. Core muscles are composed of the muscles of nearby abdomen and pelvis, such as rectus abdominis, external/internal oblique abdominis, transverse abdominis, erector spinae, quadratus lumborum, multifidus, gluteus medius[3)]. Those muscles are playing an important role providing stabilization during moving legs and arms. Among them, it is known that transverse abdominalis and multifidus provide spinal stabilization to deep muscles[4)]. In order to strengthen core muscles, various methods of exercises such as swiss ball[1)] and bridge exercise[5)] are used. But the lack of studies and definite evidences are founded whether those methods are effective to deep muscles such as transverse abdominalis and multifidus. ADIM is a kind of exercise technique to increase intra-abdominal pressure by pulling lower abdomen without moving spine and pelvis[6)], and possible to contract transverse abdominalis and multifidus selectively, which is utilized for spinal stabilization exercise[7)]. Lee et al.[6)] reported the muscle activation of trunk muscles is increased when back pain patients who are instable on lumbar spine exercise ADIM, and Chon et al.[8)] reported the muscle activation of deep core muscles is increased when the patients perform ADIM including dorsiflexion. But in the review of preceding research, most studies are executed on muscle activation of deep muscle by simply applying ADIM. Therefore, the purpose of this study was to investigate the effects of visual biofeedback using ultrasonography on muscle activity of the deep trunk muscle in healthy adults.

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SUBJECTS AND METHODS

This study selected ten healthy people without orthopedic history. Information on the study and written informed consent according to the ethical standards of the Declaration of Helsinki were provided to all subjects prior to their participation, and all agreed to participate in the project. The average ages, heights, and weights were 22.70 ± 2.06 years old, 171.15 ± 9.18 cm, and 66.86 ± 8.88 kg in the experimental group, respectively.

The ADIM (abdominal Drawing-in Maneuver) are executed for subjects through monitoring the status of muscle contraction using ultrasonic waves. And motor control exercises are performed during 6 weeks, 20 minutes/a day and three times/a week.

Ultrasonic measurement for the thick of transverse abdominal muscle is executed by positioning the probe to the center of upper parts on iliac crest at central midaxillary line in the right. And in order to reduce measurement error, we selected an expert who is 5 years more experienced in ultrasonic measurement field.

We firstly asked the subject to pose putting a pillow under the head, bending hip and knee joint to 60 degrees, and taking crook-lying position, and adjust monitor position for them to watch the ultrasonic image (achieve CST, V2U Healthcare, Pte, Ltd., Singapore) at ease. During the exercise, therapist gives instructions orally to the subject "please make your abdomen constriction like drawing your belly with the utmost effort while breathing as usual[9)], and subject execute the exercise by checking on his transverse abdominal muscle contraction via the monitor. Total time of exercise are 20 minutes; allowing the subject to rest for 10 minutes after contraction of transverse abdominal muscle for 10 minutes.

We collected the data using electromyography MP150 system (BIOPAC system Inc. CA, USA) in order to measure trunk muscle activation. We measured electrical activities by using electromyogram electrode attached to the area of muscular fiber and pressing muscle parts following the direction of muscle texture in order to find the positions[10)].

The attached locations of surface electrodes were as follows11): (1) for rectus abdominis: 5 cm from top of belly, (2) for Internal oblique abdominis: the middle point between belly line and ASIS, (3) for Internal oblique abdominis: in the center of the triangle formed by a horizontal line between the anterior superior iliac spine of the innominate and the umbilicus, midline, and the inguinal ligament, (4) for lumbar multifidus: 2 cm lateral to the spinous process at the L4–L5 interspace.

We executed bridge exercise to measure muscle activity at reference voluntary contraction of each muscle[12)]. After we collected the data value for 5 seconds at maximal voluntary isometric contraction of each muscle, and used the amount of average electromyographic signals reference voluntary contraction (%RVC) during only 3 seconds excluding 2 of beginning and 1 of latter part from total 5. Average value was obtained from 3 times of measurements.

RESULTS

The subjects showed significant improvements in Internal oblique abdominis and lumbar multifidus muscle after intervention ($p<0.05$) (Table 1).

Table 1. The within-group and between-group comparisons for the outcome measures (unit: % RVC)

	EG (n=10)
Rectus abdominis	
Pre-test	10.6 ± 4.0[a]
Post test	12.2 ± 3.7
Change value	1.6 ± 6.4
External oblique abdominis	
Pre-test	12.6 ± 2.8
Post test	13.8 ± 3.9
Change value	1.2 ± 3.6
Internal oblique abdominis	
Pre-test	16.8 ± 4.9
Post test	22.0 ± 4.3**
Change value	5.2 ± 4.5
Lumbar multifidus	
Pre-test	17.0 ± 7.4
Post test	23.9 ± 2.9**
Change value	6.9 ± 6.1

EG: visual biofeedback group using ultrasonography
[a]Mean ± SD. *p<0.05, **p<0.01

DISCUSSION

In this study, we compared and analyzed the muscle activation for trunk muscle activation, especially surface muscle of rectus abdominis, external oblique abdominis, and deep muscles of Internal oblique abdominis, lumbar multifidus using visual feedback of ADIM which conduct targeting health adults. As like the above, in the preceding research by using visual feedback, Kim et al.[13] showed the subject's contraction exercise of pelvic floor muscle through visual feedback can increase muscular activation in transverse abdominis and its thickness is thicker. Also, Park et al.[14] report breathing exercise using visual feedback can increase pulmonary function and respiration muscle activation significantly. Recently, this visual biofeedback is used to care the stroke patients. Lee et al.[15] report that visual perception and sitting balance are improved when visual biofeedback training is conducted for stroke patients. The current study has some limitations. First, the small sample size may have influenced the results. Second, the absence of follow-up after the end of the intervention does not allow for determination of the durability of the effect of this therapy. Further studies, including a long-term follow-up assessment, are needed to evaluate the long term benefits of visual biofeedback therapy.

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