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A Comparison of Abdominal Muscle Thicknesses Measured by Ultrasonography between the Abdominal Drawing-in and Straight Leg Raise Maneuvers

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Abstract. [Purpose] This study compared and analyzed the ultrasonograms of deep abdominal muscles (transverse abdominis muscle, internus oblique abdominal muscle, external oblique abdominal muscle) in the Active Straight Leg Raise (ASLR) and Abdominal Drawing-In Maneuver (ADIM) to identify more effective clinical diagnosis methods. [Subjects and Methods] The study was conducted by performing ASLR and ADIM movement in sequence. The subjects were 37 healthy subjects and we measured the thicknesses of deep abdominal muscles (transverse abdominis muscle, internus oblique abdominal muscle, external oblique abdominal muscle) on ultrasonograms taken during ASLR and ADIM for comparison and analysis. In order to assess the relations among the deep abdominal muscles on the same side as measured during ASLR and ADIM, a correlation analysis was carried out. The independent t-test was conducted to identify the differences in thicknesses of same side muscles as measured during ASLR and ADIM. [Results] The results show that each muscle on the same side during ASLR and ADIM had high level of correlations except during ASLR and ADIM the right EO. Also, for the muscle thickness of the same side muscles, only the right EO showed a significant differences. [Conclusion] ADIM is a complicated and difficult movement to measure. ASLR also enables the measurement of deep abdominal muscles; therefore, it could be used to elevate the efficiency of clinical diagnosis. We anticipate that ASLR will be used more for the measurement of deep abdominal muscles.
Key words: Ultrasonograms, Deep abdominal muscles, ASLR and ADIM

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INTRODUCTION

One of main causes of chronic lower back pain is poor control of paravertebral muscles. In most studies, the deep muscles have been measured using electromyographic (EMG) examination, but this method is difficult to perform for clinical use, and it is expensive and uncomfortable, and has risks of infection[1, 2)]. Therefore, Rehabilitative Ultrasound Imaging (RUSI) is being presented as an alternative approach for assessing motor control deficits and for giving to give feedback in exercise therapy[3, 4)].

The method of measuring the deep abdominal muscles using RUSI requires performance of the Abdominal Drawing-In Maneuver (ADIM), which is widely used in measurements of the deep abdominal muscles the transversus abdominis muscles (TrA), internal oblique muscles (IO), and external oblique muscles (EO)[5)]. In addition, ADIM plus specific ultrasound guided exercise has been suggested as a good method for reducing the pain of patients with chronic lower back pain and for increasing the activities of deep abdominal muscles[6)]. However, ADIM which is performed in with performing the maneuver, which requires supine hook-lying posture has disadvantages including difficulty education on the posture and its practice, and inability to measure unable to understand the movements.

The Active Straight Leg Raise (ASLR) has been suggested as an alternative maneuver for measuring the deep abdominal muscles with RUSI. It has been reported to have clinical diagnostic value and validity in the assessment of the motor control deficits of patients with unilateral lumbopelvic pain[7)]. The ASLR is easier to understand than ADIM, and it is considered to be a method that is easy to perform. In this study, used in we compared and analyzed ultrasonograms of during ADIM and ASLR which are for RUSI measurements of deep abdominal muscles to identify the method with the highest level efficiency clinical application.

SUBJECTS AND METHODS

Subjects

The subjects were 37 undergraduate students who were selected from among 45 volunteers attending a university located in Cheonan city. The selected subjects were those

Table 1. The results of the correlation analysis

Correlation coefficient (r)		ASLR					
		TrA(left)	TrA(right)	IO(left)	IO(right)	EO(left)	EO(right)
ADIM	TrA (left)	0.9**					
	TrA (right)		0.9**				
	IO (left)			0.9**			
	IO (right)				0.8**		
	EO (left)					0.8**	
	EO (right)						0.2

TrA; Transverse abdominal muscle, IO: Internal oblique muscle, EO: External oblique muscle. ** = p<0.01

Table 2. Comparison of muscle thicknesses between ASLR and ADIM

	Contracted ASLR(n=37) (M ± SD)	Contracted ADIM(n=37) (M ± SD)
TrA (left)cm	4.4 ± 1.6	4.5 ± 1.4
TrA (right)cm	4.2 ± 1.3	4.4 ± 1.3
IO (left)cm	8.9 ± 2.2	9.3 ± 2.3
IO (right)cm	8.7 ± 2.3	9.3 ± 2.2
EO (left)cm	4.2 ± 1.7	3.9 ± 1.2
EO (right)cm	6.6 ± 1.5*	4.3 ± 1.2

TrA; Transverse abdominal muscle, IO: Internal oblique muscle, EO: External oblique muscle. *: independent t-test value, *= p<0.05

who gave their consent to participation in the study, who had no orthopedic problem affecting the trunk, and no chronic back pain.

Methods

The sonogram device used in this study was a Logiq sonography system (α-200, Samsung-GE Medical Systems Inc., Seongnam, Korea) employing a 7.5 MHz linear transducer. At the state of rest, TrA, IO and EO were measured, then ADIM and ASLR were performed in sequence. The measurement was repeated 3 times for each posture, and were performed on the left and right sides. Subjects were given 1 minute of resting time after measurement of each maneuver. For ADIM, subjects were asked to adopt a position that would minimize lumbar lordosis by flexing the hip and knee joints at 40–80 degree in the supine position. Then, they were asked to pull the lower abdomen up as much as possible when exhaling to achieve maximum contraction. After achieving maximum contraction, the bilateral deep abdominal muscles were measured. For ASLR, the subjects were asked to lie in the supine position with their lower extremities straight on a standard plinth, hands resting on the chest, and elbows on the plinth. The feet were positioned 20 cm apart prior to the subject being asked to raise the lower extremity 5 cm off the plinth without bending the knee[8]. Ten seconds after lifting the right leg about 5 cm from the plinth, the bilateral deep abdominal muscles were measured in the same manner as for ADIM[7]. For both postures, the transducer was placed 25 mm form the side between the 12th rib and the iliac crest for measurement. After sonographic measurement, the thicknesses of TrA, IO and EO were measured on a line drawn vertical to a horizontal line drawn 1.5 cm from the muscle–fascia junction at the bilateral ends of the image[9].

Statistical analysis was performed using SPSS 15.0 for Windows. Pearson correlation coefficients were calculated to analyze the relationships of same side muscle thicknesses as measured during ASLR and ADIM. The independent t-test was also performed in order to compare the muscle's thicknesses of TrA, IO and EO measured during ASLR and ADIM. A significance level of 0.05 was chosen.

RESULTS

The gender ratio of the subjects in this study was: men vs women, 9 vs. 28. Subjects mean age was 20.8 ± 1.0 years; their mean height was 165.0 ± 6.3 cm; and their mean body weight was 57.8 ± 7.4 kg.

In the results of the correlation analysis of each muscle thickness during, ADIM and ASLR, all muscle thicknesses except that of the right EO showed high level of correlation (p<0.01)(Table 1). When the thicknesses of the muscles were compared between the two maneuvers, only the right EO showed a significant difference (p<0.05) (Table 2).

DISCUSSION

In this study, we compared the thickness variations in TrA, IO and EO between ADIM and ASLR, and only the right EO had showed a significant difference ($p<0.05$). In the correlation analysis of the same side muscle thicknesses in each maneuver, all except the right EO showed high levels of correlation ($p<0.01$). Meaning, EO thickness of the raised-leg side measured during ASLR was difference from EO of the same side measured during ADIM. All muscles except the right EO showed similar thicknesses and high levels of correlation, leading us to conclude that both ADIM and ASLR are suitable for measurements of TrA and IO.

There was a difference in the thicknesses of EO measured during ADIM and ASLR, and we consider it originates in the measurement of ADIM. In ADIM, EO should suppress, not contract, and the measurer needs to provide continuous feedback to the subjects while viewing the sonograms to ensure EO is suppressed. If the contraction of EO increases significantly, it is considered that ADIM is being performed incorrectly[5, 10]. ADIM is a complicate procedure which requires training and continuous monitoring. Thus, we conclude that ADIM is not suitable for measuring TrA, IO and EO. On the other hand, the ASLR method should provide results for TrA and IO which are similar to those of ADIM, and we consider it is an easy approach, because it only requires instructing the subjects to lift the leg, making the performance and clinical diagnosis much easier. Therefore, we consider the ASLR sonographic diagnosis method for TrA and IO raises the efficiency of clinical diagnosis. We should, however, point out that, this study was limited by a small sample size and the age and gender of the subjects which makes generalization of the results difficult (young adults and a higher ratio of women). Therefore, clinical research should be continued to remedy these deficiencies, with the aim of raising the efficiency of clinical diagnosis.

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