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# Comparison of Contraction Rates of Abdominal Muscles of Chronic Low Back Pain Patients in Different Postures

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**Abstract.** [Purpose] This study examined the contraction rates of abdominal muscles in relation to the posture of chronic lumbar pain patients and normal subjects. [Subjects] The subjects were 17 chronic low back pain (CLBP) patients and 17 normal people between the ages of 20 and 59. [Methods] Experimental postures included a supine position, a sitting position, and a standing position. Measurements were taken at rest and during abdominal contraction. The measurement at rest was taken during expiration with comfortable breathing, and the measurement during contraction was taken at maximum expiration of forced expiration. Muscle contraction rates (on contraction and at relaxation) were calculated. [Results] There were significant differences between CLBP patients and normal subjects in the transversus abdominis (TrA) in the standing position. [Conclusion] Changes in contraction rates of the abdominal muscles of normal subjects and CLBP patients were examined in different postures at maximum expiration. It was found that the contraction rate of TrA in CLBP patients in a standing position, is significantly lower than that of normal subjects.

**Key words:** Posture, Contraction rates, Transversus abdominis

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## INTRODUCTION

Trunk muscles play an important role in postural adjustment. The multifidus muscle (MF) plays a crucial part in the lumbar segments and dynamically supports the intervertebral segments, while the transversus abdominis (TrA) plays an important role in providing stability during dynamic tasks[1)]. These muscles co-contract, stabilizing the spine, and hold the spine in a neutral position[2)]. Activation of abdominal muscles, such as the TrA, and the internal oblique (IO), differs according to changes in position[3, 4)]. Rosie Mew[5)] and Bunce et al.[6)] have reported changes in the thicknesses of the abdominal muscles of normal subjects in relation to posture.

The trunk adjustment ability of low back pain patients is weakened relative to those of normal subjects[7)]. This results from dysfunction of local segmental muscles, such as TrA, IO, and MF[1)]. The abdominal drawing-in maneuver (ADIM) is a method frequently used to volitionally activate the TrA, a representative local segmental muscle, in order to resolve the dysfunction of these local muscles. ADIM makes contraction of the IO and external oblique muscle (EO) relatively small, and the contraction of the TrA, a deep muscle, relatively large[1, 8)]. However, ADIM is not easy, and it takes a long time to become familiar with it. There is a study showing that ADIM increases the thickness of the TrA, however there is also research reporting the opposite result[9, 10)]. Maximum expiration is a recently developed method used to train the TrA which uses the expiration action. This method serves to increase the TrA activities rather than the IO and EO, uses global muscles, and has the advantage of being easier to perform than abdominal hollowing[11, 12)].

Methods used to evaluate the activity of deep trunk muscles, such as the TrA, include an EMG method using implantation of electrodes, and an ultrasound (US) method. However, the EMG method using implantation electrodes is not easy to measure, and there has been difficulty in recruiting subjects. Recently, the US method has been recognized as a method that is both reliable and effective, permitting the identification of changes in contraction rate, which are very important when studying the activities of deep muscles, such as the deep abdominal muscles[13, 14)].

In evaluating the capabilities of the abdominal muscles, their contraction rates are more important than their thicknesses because their thicknesses differ according to the measurement location, gender, age and body mass index[13)].

Research into changes in trunk muscle thickness in chronic low back pain (CLBP) patients has largely focused on changes in the MF muscle, a back muscle. Research on the TrA is has examined changes in its thickness in a particular posture; research comparing the muscle contraction in each posture has been rare. While many stabilization ex-

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ercise methods have been developed for particular postures, research into which posture provides the most appropriate method for increasing contraction rate of TrA in low back pain patients has been rare. Therefore, this study intended to examine the contraction rate of abdominal muscles in relation to the posture of chronic lumbar patients and normal subjects.

## SUBJECTS AND METHODS

The subjects were 17 CLBP patients and 17 normal people between the ages of 20 and 59. The experimental group consisted of CLBP patients who had experienced low back pain continuously for more than 12 weeks, while the control group was composed of those who had not complained of low back pain during the previous year. Those who met the following criteria were excluded: those who had undergone surgery of the abdomen or lumbar region, those who were pregnant, those who had problems with their cardiovascular system, or those who had neurological problems, such as stroke. Sufficient prior explanation about the experiment was given, and the experiment was conducted only with those who had consented to participation. The low back pain patients were selected from among those who had visited the J oriental medical clinic.

Experimental postures included a supine position, in which the subject bent the knees at 90° a comfortable, sitting position, in which the hip and the knees of the subject were flexed at 90° and a comfortable standing position, in which subjects placed their feet on the ground shoulder width apart. Measurements were taken at rest and during contraction. The measurement at rest was taken during expiration with comfortable breathing, and the measurement during contraction was taken at maximum expiration of forced expiration[15].

Abdominal muscle measurements were taken with a LOGIQ Book XP (GE Healthcare Products, Milwaukee, WI, USA) using an 8MHZ linear transducer. With the transducer placed 2.5 cm distal from the center line at the midpoint, between the iliac crest and the rib, the thickness of the right TrA was measured. The TrA was measured vertically at 1 cm from the edge of the muscle. All the muscles were measured three times by a blinded reviewer, and average values were used in the analysis. The statistical program SPSS 20.0 was used to calculate muscle contraction rates (at contraction and at relaxation). The independent t-test was used to compare the contraction rates of the TrA in each position. A significance level of α=0.05 was chosen.

**Table 1.** Characteristics of the subjects (N=34)

| Description | the CLBP patients | the healthy subjects |
|---|---|---|
| men | 9 | 9 |
| women | 8 | 8 |
| age (y) | 34.29 (9.51) | 29.00 (6.91) |
| height (cm) | 168.94 (9.83) | 166.18 (7.30) |
| weight (kg) | 62.71 (11.77) | 63.41 (10.94) |
| BMI | 21.85 (2.72) | 22.75 (2.86) |

Values are Means ± SD

## RESULTS

There were no the significant differences between the two groups in the comparison of CLBP patients and the normal subjects' gender, height, weight and BMI. The general characteristics of the two groups are shown in Table 1. In the comparison of the contraction of abdominal muscles, none of the abdominal muscles in the supine or sitting positions showed had not the significant differences between the two groups. However, the rate of contraction of TrA of the CLBP group (1.27 ± 0.26) in the standing position was significantly than that of the the normal subjects (1.75 ± 0.57) (Table 2).

## DISCUSSION

According to the results of the abdominal muscle contraction rates in relation to posture, the TrA contraction rate of low back pain patients in the standing position was significantly less than that of normal subjects. Although the TrA became thicker at rest in the standing position than in the other positions in both normal subjects and low back pain patients, there was a significant reduction in the contraction rate of the CLBP patients.

The thicknesses of the abdominal muscles at rest as measured by US is an index that indicates the capability of the muscle, but low back pain patients' TrA is already decreased in comparison to that of normal subjects[7], therefore, it is not convincing to deduce that the capability of the abdominal muscles is deficient merely because of differences in the thicknesses, when considering the role of abdominal muscles in relation to posture. The reason is that the absolute thicknesses of the abdominal muscles differ according to individual characteristics, as well as to the existence of low back pain[13]. What is important, when evaluating the abdominal muscles in addition to their absolute thicknesses, is their contraction ability, which is evaluated by contraction rates. Contraction rates indicate the ability of the muscles when activated as compared to when they are at rest.

**Table 2.** Contraction rates of the abdominal muscles in each position

| | | CLBP | Healthy |
|---|---|---|---|
| Supine | TrA | 1.89 ± 0.59 | 2.04 ± 0.78 |
| | IO | 1.23 ± 0.34 | 1.44 ± 0.34 |
| | EO | 1.01 ± 0.19 | 0.90 ± 0.18 |
| Sitting | TrA | 1.46 ± 0.29 | 1.69 ± 0.78 |
| | IO | 1.46 ± 0.38 | 1.50 ± 0.51 |
| | EO | 1.04 ± 0.26 | 0.97 ± 0.21 |
| Standing | TrA* | 1.27 ± 0.26 | 1.75 ± 0.57 |
| | IO | 1.39 ± 0.45 | 1.39 ± 0.32 |
| | EO | 0.96 ± 0.17 | 0.98 ± 0.29 |

change of thickness ratio=(contraction/resting)
TrA= transversus abdominalis, IO= internal oblique, EO= external oblique (*p<0.05)

Previous research has reported that the thickness of the TrA becomes greater in a standing position in normal subjects[5]. This was also observed in the present experiment. In the case of the CLBP patients, the absolute thickness of the TrA became greatest when they were in the standing position (CLBP: 0.25, 0.29, 0.32, healthy: 0.32, 0.36, 0.37, in the supine, sitting, and standing positions, respectively). However, contraction rates were significantly lower in the low back pain patients than in the normal subjects.

In other, earlier research, no significant differences were shown in the TrA between normal subjects and CLBP patients in a supine position[9]. This is probably because little activity is required of the TrA when subjects are in a supine position. More TrA activity is required in a standing position than in a supine position. This is probably because greater TrA activity is required in order to provide stability to counteract gravity and weight in a standing position than in a supine position. In addition, the mobility of the trunk increases in a standing position compared to in a supine position, demanding more stability of the trunk.

In normal subjects, a standing position, in which the thickness of the TrA becomes greater, may be the recommended position for strengthening trunk stability compared to other postures[5]. However, in CLBP patients, a standing position is exactly where the TrA contraction rate is significantly lower than that of normal subjects, and this position should therefore be used with care when prescribing stabilizing exercises for CLBP patients.

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