

# The Effect of Various Pilates Activities on Abdominal Muscles Thickness

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## Abstract

**Objectives:** The purpose of this study is to investigate eight pilates exercise effective in thickness of abdominal muscles and to suggest effective pilates exercise. **Methods/Statistical Analysis:** This study was conducted in a total 21 participants applied the eight pilates exercise and using sonography during pilates exercise. Firstly, at resting position using scanning Transverse Abdominis (TrA), Internal Oblique (IO) and External Oblique (EO) thickness in sonography. After measurement, using sonography scanned thickness of the TrA, IO and EO while maintaining the eight pilates exercise. While maintaining exercise, scanning again done if the body was shaken violently. The starting position of all the exercise in supine position were proceeding at supine abdominal strength. Three times scanning was done to calculate and average per data was analyzed. Two minute resting time was taken between the exercises to prevent muscle fatigue. **Findings:** We compared the thickness variation of TrA, IO and EO in resting position and the eight pilates exercise shown ( $p < .05$ ). Results of post-test, TrA showed significant differences in resting position, shoulder bridge, hundred, one leg stretch, double leg stretch, roll up, crisscross, scissors and one leg circle exercise ( $p < .05$ ). IO was significantly different between resting position and roll up exercise ( $p < .05$ ), EO; similarly significantly different for shoulder bridge between one leg stretch, crisscross and scissors ( $p < .05$ ). Comparison of all the results, TrA, IO and EO were all statistically significant different ( $p < .05$ ). This study using sonography during eight pilates exercise compared to real-time measurement of the change in abdominal muscle thickness. As a result, each exercises different in the thickness of the TrA, IO and EO. Most of the previous paper about pilates exercise and abdominal muscles using pilates exercise program, researchers made measurement through the EMG activity of the abdominal muscles after a long period of time applied to the subjects. Electromyography (EMG) is difficult to estimate and indirectly shown muscle contraction, relaxation because it is non invasive method and the data is forecasts. So we conducted a study using sonography. In addition, the various research program of around one hour and mix pilates exercise it is difficult to know how exercise activated each muscles. **Application/Improvements:** Purpose of this study is to compare the eight pilates exercise affecting TrA, IO and EO thickness compare analyze. Our findings eight pilates exercise are effective in TrA, roll up is effective in IO and one leg stretch, crisscross, scissors are effective in EO. Therefore, strengthening of the trunk local muscle is effective in roll up. In addition, strengthening of the global muscle high kinetic effect can be obtained in one leg stretch, crisscross and scissors with trunk rotation.

**Keywords:** Global Muscles, Local Muscles, Pilates, Sonography

## 1. Introduction

Pilates was developed by Joseph H. Pilates from Germany in the early 1900s, this form of exercise controlled movement using the special mechanism to exercise techniques developed until now. And the exercises also involve some

form of exercise and controlled using tool that continually Union<sup>1</sup>. The main purpose of pilates make a wrong posture change corrected to flexible and balanced body, strengthening the muscles at the same time. Also, make soft the body and mind mutual organically<sup>2</sup>. Pilates is especially focus on lumbar strengthening the body that

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including the thigh, strengthening the back of abdomen, to supporting the spine very reasonably effective to adult, even though tailored to excessive exercise<sup>3</sup>. Also, correction of body posture and balance while strengthening at the same time, relieve the body stress, relieve back pain and stabilize the center of body<sup>4</sup>.

Recent participation of Pilates has increased and is used for various purposes. According to previous research the pilates improves body composition and abdominal, thoracic posture of strength and endurance, effective improves flexibility of biceps femoris<sup>5</sup>. Evidence supports the effectiveness of the Pilates exercise, mainly not only by assisting the trunk muscles reactivate and consequently increasing the support of the lower back, but also reducing pain and disability<sup>6</sup>. The Pilates can improve physiological and psychological functions, as well as teach functional posture and appropriate motor patterns<sup>7</sup>. Pilates exercise has been reported effective for improving static and postural balance among a group of dancers<sup>8</sup>.

Core muscle gives all the power and mobility of the body, and maintaining the muscle gives the bone structure<sup>9</sup>. Anatomical classification of trunk muscles that contributed to the body stabilization can be divided into local muscle and global muscle<sup>10</sup>. Anterior of trunk muscle is the local muscle which includes the Transverse Abdominis muscle (TrA) and Internal Oblique muscle (IO); the global muscle muscles are the rectus Abdominis Muscle (RA) and external Oblique Muscle (EO<sup>11</sup>). Local muscle of TrA and IO is connected directly to the spine and it can provide a fine adjustment and segmental spinal stability of the spine. RA and EO mainly produce for muscle force (torque) and create a large movement of the pelvis and trunks which are involved in the whole body stability<sup>12</sup>. In Pilate’s movements the local muscles which are attached to the body of the spine are critical factor that responsible for the stabilization of the body<sup>13</sup>. However, the spine has been reported to be stabilized by co-contraction of the muscles around the spine, rather than a single action of a specific muscle<sup>14</sup>. Having healthy trunk mainly needs RA and erector spine, such as global muscle of strong strength but if there is no co-contraction of the body by means of deep muscle in TrA, IO, multifidus and pelvic floor, it can lead to low back pain<sup>15</sup>. Also, the centering principle consists of an isometric contraction of the TrA, IO and EO which contributes to increased antagonist activation of the deep trunk muscles<sup>16</sup>.

Pilate’s action helps improving identification of core muscle strength exercises included roll up, single leg

stretch and shoulder bridge. No studies were made in comparing of each exercises. In addition, most researchers compared the Electromyography (EMG) activities of muscle and electrically of muscle the total motion for each muscles. However, no studies were made using sonography on changes in the thickness of the muscles during a particular exercise.

Thus, this study compares and analyses eight palates exercise apply on TrA, Io of local muscle and EO of global muscle to influence the muscle thickness. Also, finds most effective palates exercise to improve the quality of life of modern people.

## 2. Methods

### 2.1 Subjects

The participants as the body healthy men and women were elected to those who are agree to participate in this study. Based on the sample size calculation using the G\*power software required by the 23 subjects, preparation for the eliminated participants were recruited male 13 and female 12 people to a total of 25 subjects. Participant’s physical subjects are shown in Table 1. The participants in this study, following to the Helsinki Declaration, provide written informed consent prior to participation in this study. Selection criteria is the subject has no lower back pain and not the usual regular exercise in order not to affect the result, that is an exclude criteria in the last six months of surgery or affecting the holding operation, balance disorder or back muscle. Apply the exclusion criteria there’s have been no drop out participants excluded due to this factors.

However, the research process failed to progress end the study because difficult to maintain exercise of four participants drop out so total of 21 participants were finally acquired data. This study was approved by the Institutional Review Board (IRB) of Sunmoon University.

### 2.2 Procedure

This study was designed as a single group, single blind and randomly arranged procedure. Prior to this procedure,

**Table 1.** General characteristics (n=25)

	male (n=13)	Female (n=12)
Age(year)	20.07 ± 0.27 <sup>a</sup>	20.08 ± 0.28
Height(cm)	177.69 ± 4.97	163.41 ± 6.24
Weight(kg)	70.07 ± 6.10	54.00 ± 4.47

participants were recruited for training prior to the procedure and the expert teach eight pilates exercise used in this study to all participants. All participants were practiced twice the exercise. Also, using body composition (Inbody 570, Biospace, Korea, 2013) to measured the height and weight. Dress of the before procedure participants were unified physical therapy uniform and remove belt, pocket stuff and accessories.

Participants are selected randomly eight pilates exercise to perform the movement before the start of procedure. Also, give plenty of rest helped participants to maintain exercise without fatigue.

First, at resting position scanning of TrA, IO and EO thickness was done using sonography. After measurement, scanning of the thickness of the TrA, IO and EO was done while maintaining the eight pilates exercise. While maintaining exercise, scanning again done if the body was shaken violently. The starting position of all the exercise were supine position were proceeding at supine abdominal strength. Eight pilates exercise are shown in Table 2. Three times scanning to calculated average per data was collected and analyzed. Between the exercise and exercise in procedure to prevent muscle fatigue two minute resting time was given.

- External oblique muscle.
- Internal oblique muscle.
- Transverse abdominis muscle.

### 2.3 Procedure and Instrument

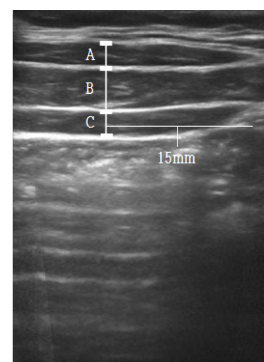
While maintaining the eight pilates exercise scanning for TrA, IO and EO thickness using sonography to find change of muscle thickness the image B-mode with 7~10MHZ (eZono 3000, Germany, 2011) was made as real-time measurement. Experienced observers ensured consistency with 1 person, scanning on the between centered on the anterior axillary line midway between iliac crest and lowest rib. From collected data on the basis of the thickness measurement was made 15 mm away from TrA linea alba. As a standard point from the top of first muscle is TrA, second muscle is IO and last muscle is EO (Figure 1).

### 2.4 Statistical Analysis

All collected data were analyzed using SPSS version 18.0 (SPSS Inc., Chicago, IL, USA). Collected statistics were calculated average of variables and standard deviation by

**Table 2.** Eight pilates exercise

Eight pilates exercise	
[A] Shoulder bridge: In lying position, arms by side, draw-in abdominal muscles lift pelvis.	[B] Hundred: In lying position, arms by side, draw-in abdominal muscles then flexion head. And shoulders raise arms up and down. Progress to lifting legs to 90° hip and knee flexion.
[C] One leg stretch: In lying position, arms holding head, draw-in abdominal muscles then lift straighten legs to full with knee extension. Starting with both legs in 90° hip and knee flexion.	[D] Double leg stretch: In lying position, holding both of knee, extension both of knee and arm.
[E] Roll up: In lying position, shoulder flexion, starting trunk flexion.	[F] Cirsscross: In lying position arms holding head, draw-in abdominal muscles then lift straighten both of legs to full knee extension. Starting with both legs in 90° flexion and knee extension.
[G] Scissors: In lying position, arms by side. Draw-in abdominal muscles and 90° flexion one leg, back and forth both of legs.	[H] One leg circle: In lying position, arms by side. And draw-in abdominal muscles and 90° flexion one leg make circle.



**Figure 1.** Sonography imaging.

General characteristics of the subjects and eight pilates exercise. Using one-way repeated ANOVA is to compared muscles thickness while maintaining eight pilates exercise. Each variable was used between a post hoc Bonferroni method (post-hoc) for the difference. The level of statistical significance was set at  $p < .05$ .

### 3. Result

The thickness variation was compared for TrA, IO and EO in resting position and the eight pilates exercise shown ( $p < .05$ ). Results of post-test, TrA showed significant differences in resting position, shoulder bridge, hundred, one leg stretch, double leg stretch, roll up, crisscross, scissors and one leg circle exercise ( $p < .05$ ). IO was significant different between resting position and roll up exercise ( $p < .05$ ), EO was significantly differed for shoulder bridge between one leg stretch, crisscross and scissors ( $p < .05$ ) Figure 2. In comparison, all of the results of TrA, IO, EO were all statistically significant different ( $p < .05$ ).

### 4. Discussion

This study using sonography during eight pilates exercise compared to real-time measurement of the change in abdominal muscle thickness. As a result, each of exercise differs in the thickness of the TrA, IO and EO. Most of the previous paper about pilates exercise and abdominal muscles using pilates exercise program, researchers measured through the EMG activity of the abdominal muscles after elapse of a long period<sup>17</sup>. EMG is difficult to estimate and indirectly shown muscle contraction, relaxation because it is non invasive method and a data forecast<sup>18</sup>. So we conducted a study using sonography. In addition, the various research program of around one hour and mix pilates exercise it is difficult to know how exercise activated each muscles.

In the previous research, pilates exercise affected TrA activity and thickness also influence positively on the clinical and functional movement in the abdominal muscle<sup>19</sup>. Similarly<sup>20</sup> compared typical shoulder bridge and bridging with right leg lift; side bridge has three types of bridge movement before and after TrA thickness of change. All three of thickness of TrA increased after the exercise than before; among them TrA was reported for thicker in side bridge<sup>20</sup>. In<sup>19</sup> used sonography method same as this study. When applied Pilates exercise program included hundred in eight weeks, it reported TrA thickness increased but IO thickness decreased<sup>19</sup>. However, their study use mixed all of 10 exercise program so it is difficult to know each muscles using pattern with exercise.

TrA in this study showed no significant difference in both resting position and during the eight pilates exercise. TrA is the first activated muscle in abdominal movement and it is control abdominal pressure with IO, diaphragm and pelvic floor<sup>20</sup>. Abdominal pressure is important for muscle activity to increase, it affects the stabilization and posture control for the balance<sup>21</sup>. TrA is first activated in fast movement of the upper and lower trunk, and the TrA was activated independently from other trunk muscles to increase the stability of the spine prepared posture disturbances<sup>20</sup>. Also, TrA is active in all Pilates exercise because it is 'local' muscle. The results of this study appeared to mix of various Pilates' movement similar to the results of reported in the previous studies TrA thickness. It can be known that basis of TrA contraction can be seen in a variety Pilates exercise.

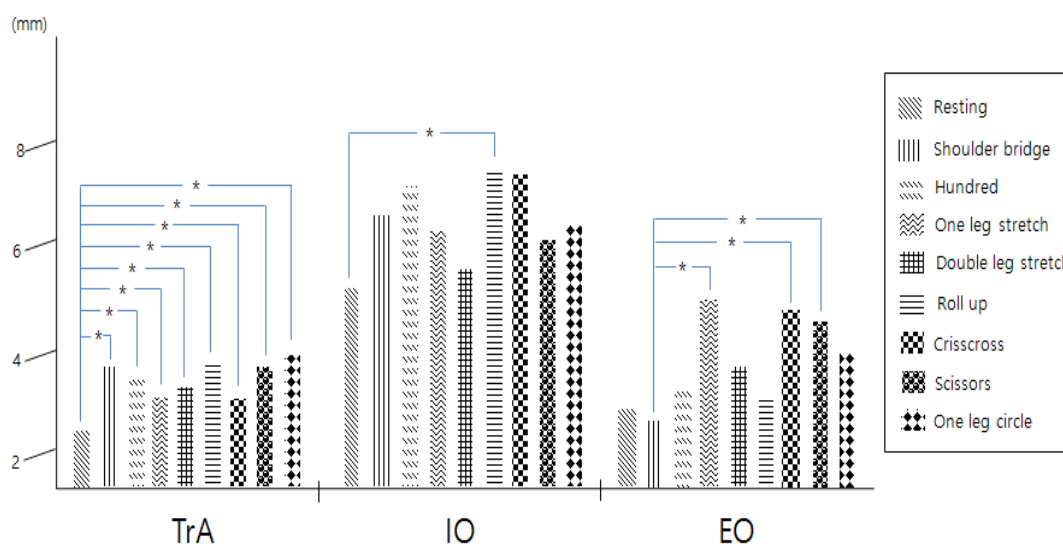


Figure 2. Comparison in the thickness TrA, IO and EO.



In<sup>22</sup> compared 4 Pilates exercise including one leg circle, shoulder bridge, roll up, and scissors and studied how this exercise affected the IO muscle. There is little different exercise in our study i.e., Shoulder Bridge adds one leg extension. All the four exercises shown the IO activity increased and the most effective exercise is one leg circle and shoulder bridge<sup>22</sup>. In<sup>23</sup> measured the muscle activity of the IO muscle with double leg raise. In our study using double leg stretch like both knee and hip flexion movement, however, Peter measured using little different exercise that double leg raise like both knee extension movement. Double leg raise makes muscle activity increased of the IO during exercise<sup>23</sup>.

IO in this study showed statistically significant difference in resting position and Roll up. The TrA and IO are part of a deep muscle has important position stability of spine<sup>20</sup>. Pilate's exercises involve activation of the TrA and IO stability of trunk<sup>1</sup>.

Our study showed that similar results of previous study reported the activity of the IO during pilates exercise. Roll up is approximately 45° trunk flexion exercise, that IO involved in the movement of trunk flexion, so roll up is the most influential contraction in IO. Therefore, roll up can be very effective exercise in the trunk local muscle strengthening.

In<sup>24</sup> studied changing how muscle activity patterns in the various exercise using the EMG and curl-up exercise. Curl-up is adding movement in the roll up in our study that is 90° flexion one leg with roll up. EO is the highest activity reported that appeared in various exercise of trunk rotation exercise after exercise and curl-up<sup>24</sup>.

In our study, Shoulder Bridge is showed statistically significant difference between one leg stretch, crisscross and scissors. EO muscle concluded part of a 'global' muscle system that controls spinal orientation, balances of the trunk that influence the spine and pelvic stability<sup>25</sup>. The activity of EO is appeared higher in lower trunk exercise than upper trunk exercise<sup>26</sup>. Also, EO involved in trunk rotation so it can be showed the large contraction of activity in trunk rotation exercise. Both IO and EO involved in trunk rotation but that requires a larger movement exercise included one leg stretch, crisscross and scissors showed significant difference in the EO in global muscle showed more than local muscle in IO. So in this study, trunk rotation exercise can be seen that make higher the muscle contraction in EO called 'global' muscle.

This study, however, has some limitations. First, it is difficult to maintain the exercise in the normal subjects so

there was a limit in view of an affective muscles contraction in a short time. Second, applied in real-time method to measure instantaneous muscle contraction were scanned in each procedure a transient change of the abdominal muscles. Third, all the subjects are healthy young adults, so it couldn't be seen that pilates exercise effective on back pain relief. Therefore, in future research studies it will be needed to see the affects of pilates exercise applied in low back pain patients.

## 5. Conclusions

Purpose of this study is to compare the eight pilates exercise affecting TrA, IO and EO thickness. Eight pilates exercise are effective in TrA, roll up is effective in IO and one leg stretch, crisscross and scissors are effective in EO. Therefore, strengthening of the trunk local muscle is effective in roll up. In addition, strengthening of the global muscle of high kinetic effect can be obtained in one leg stretch, crisscross and scissors with trunk rotation.

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