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# Comparison of Abdominal Muscle Thickness According to Duration after Side Body Crunch Exercise with Audiovisual Feedback

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**Abstract**

**Background/Objectives**: This study aims to show the transformation in the effect of side body crunches on abdominal muscle thickness through various types of feedback.

**Methods/Statistical analysis**: 20 young, healthy adults (10 men and ten women) contributedto this study. The subjects were measured in a supine place. The dimension area of the internal oblique,transverse abdominis,and external oblique muscles was the right lower quadrant of the subjects, which is 2cm inward, alongside the anterior superior iliac spine. The width of abdominal muscles was measured by ultrasound measurement of the external oblique, internal oblique, and transverse abdominal muscles.

**Findings**: The outcomes of this study were as follows.The prior homogeneity among the two groups was confirmed for the width of the abdominal muscle of the study subjects. The average values of each powerwere taken for the 0th, 3rd, and 6$^{th}$-week workouts. There was anessentialchangeamong the transverse abdominis, external oblique, and internal oblique muscles according to the period ($p<.05$), and there was no significant difference among the period and the group interaction effect and between the groups($p>.05$).

**Improvements/Applications**: Based on the present study's findings, visual feedback applied during side body crunch exerciseswas influentialinchanging the width of the abdominal muscles.

**Keywords**: external oblique, transverse abdominis, internal oblique, side body crunch, visual feedback, ultrasonic imaging.

## 1. Introduction

The trunk muscle is a collection of muscles that encircle the back and work together to stabilize the body by applying pressure to the waist with deep muscles near the spine[1]. As an abdomen muscle, the external oblique muscle helps in terms of stability toward external stimuli, and the deep internal oblique and transverse abdominal muscles, which are deep muscles, influence the strength of the trunk [2]. This means "the high activity of small muscles is essentialto steady the box properly"[3].

It has been said that the crunch exercise is the most effective abdominal muscle strengthening exercise since it engages all four abdominal muscles (rectus abdominis, exterior obliques,transverse abdominis, andinteriorobliques) [4].

Feedback is a method for learning how to voluntarily control the autonomic nervous system's response by receiving one's inner physiological response as an immediate feedback signal using a physiological measurement device [5]."Visual feedback contributes to postural control by integrating with concentric information from the sense of equilibrium and somatic purpose. Training using this can improve postural control ability by helping to reduce postural fluctuations" [6].

Feedback in postural rehabilitation therapy is a technique that uses visual, auditory, and bodily sensory feedback to measurethe central sway of the body[2]. It has been hypothesized that people with balance control issues benefit greatly from visual feedback in maintaining their postural control.Pictorial feedback exercise has been

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suggested as an alternative to weight-bearing practice [7].Numerous studies have demonstrated that “visual feedback can benefit athletes' performance and task accuracy”[8,9].

Many studies on visual feedback have been conducted to improve the motor skills of ordinary people and sports players. In most cases, action observation, which is applied by watching and learning activities performed by others, was used as a cognitive intervention method [10]. Therefore, an educational video of the side body crunch exercise was visual feedback.

The purpose of this study is to apply side body crunch exercises to compare and compare the presence or lack of separation between the exterior oblique,transverse, andinterior oblique abdominal muscles or the companyand duration of feedback and to identify if it is a more effective exercise method for subjects who need to strengthen their abdominal muscles. We intend to lay the foundation for presenting.

## 2. Materials and Methods

### 2.1. Participants

It was performed by the principles stated in the Declaration of Helsinki.Random assignment classified ten peopleinto the visual feedback exercise groups (Group A) and the auditory feedback exercise group (Group B).

All subjects voluntarily signed anagreement form after being knowledgeableof the persistence and method of the study before the experiment. The exercise was led for six weeks.

### 2.2. Measurement device

A diagnostic ultrasonic measuring instrument was used to assess the width of the abdominal wall, the exterior oblique, and the interior oblique muscles in pre- and post-exercise states. (MyLab One World, Esaote, Italy). The forces and surface layers were measured with a straight-line probe designed for the purpose.

### 2.3. Measurement method

To measure muscle thickness, the subject took a comfortable supine position. The ultrasonic probe was located at the midway where the 12th beam and the upper forward iliac spine meet, and it was centered on the axillary line on the right side of the body. It was used to portion the width of the exterior oblique, transverse, interior oblique, and abdominal muscles.From the ultrasound image, as in Figure 1, the width of the internal abdominal oblique and transversus abdominis muscles was calculated by drawing a vertical line 2.5 cm away from the fascia connection where the thoracolumbar fascia and the transversus abdominismuscle met[11]. For “image clarity, the transducer was positioned vertically, and the width of the transversus abdominis muscle was changed according to respiration, so measurements were taken at the end of inhalation”[12].

The calculation of muscle thickness was measured by one examiner using the software. Measurements were recorded three times in each experimental condition to increase reliability, and the expected value was used for investigation.

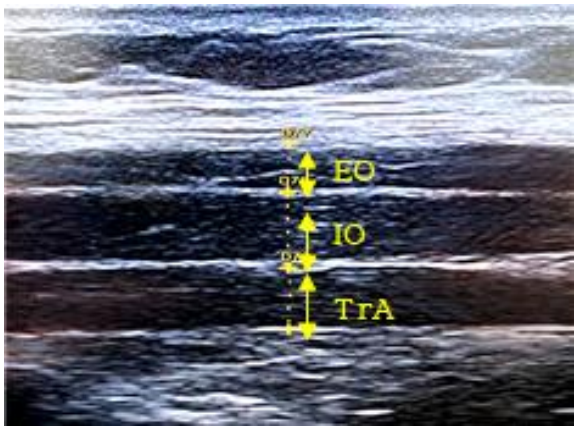


**Figure 1. Ultrasound image of abdominal muscle thickness measurement**

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**2.4.Exercise methods**

**2.4.1. Side body crunch exercise**

Side body crunch exercise and side body crunch exercise with visual feedback through video were achievedthreewhiles a week for six weeks at a rate of 3 sets of 10 repetitions each.

The trunk rotation grade 3 (fair) posture was referenced from Daniels and Worthingham's muscle testing for the side body crunch exercises. To prevent a reaction of the hip flexor muscles, the arms were extended forward parallel to the trunk in a hook-lying position with knee flexion of 90° and hip flexion of 45°. The subject's heads and shoulders were elevated without bending their necks. Then, the focus's right fingertip was taken to the left knee, and the left fingertip was brought to the right knee. The subject's chin was then turned to face the ceiling. "The scapula needs to be raised entirely off the ground"[13].

**2.4.2. Visual feedback side body crunch exercise**

The visual feedback exercise group wasprovided with an exercise guide through a pre-made side body crunch training video. Figure 2 shows theexercise performed while the subject watches the video. Besides the video, the experimenter provided no feedback on the issues.

**Figure 2. Side body crunch exercise with visual feedback**

**2.5.Data analysis**

SPSS/PC, a statistical package for Windows, was used to do the statistical processing and analysis. The Shapiro-Wilk test proved that the sample's general characteristics were usually distributed. Expressly, the difference in abdominal muscle thickness over time was confirmed using a one-factor repeated measures examination of variance.A t-test with an independent sample was conducted to evaluate the disparities in mean values between the groups. The statistical implication level was set as a=.05.

**3. Results and Discussion**

As seen in Table 1, prior homogeneity between the two groups was confirmed for the study subjects' abdominal muscle thickness.

**Table 1: Comparison of pre-homogeneity between two groups for abdominal muscle thickness (unit: mm)**

| | A group (n=10) | B group (n=10) | t-value | p-value |
|---|---|---|---|---|
| TrA | 3.71±1.30 | 3.79±0.90 | -.150 | 0.883 |
| EO | 4.91±1.25 | 4.72±1.59 | 0.301 | 0.767 |
| IO | 6.45±1.83 | 6.35±1.74 | 0.125 | 0.902 |

TrA: transverse abdominis, IO: interior oblique muscle, EO: exterior oblique muscle

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Table 2 compares the average values of each muscle for the 0th, 3rd, and 6th-week workouts. There was a criticalchange between the transverseinterior oblique, abdominis, andexterior oblique muscles according to the period ($p<.05$), and there was no substantialchangeamong the period and the group interaction effect and between the groups($p>.05$).

**Table 2: Comparison of average values between two groups according to period**

| Muscle | Group | 0week | Threeweeks | Sixweeks | Period (F) | Group (F) | Period * Group (F) |
|---|---|---|---|---|---|---|---|
| TrA | Agroup | 3.71±1.30 | 3.82±1.00 | 4.52±0.98 | 6.159** | .131 | .526 |
| | B Group | 3.79±0.90 | 4.26±1.57 | 4.54±1.48 | | | |
| EO | A group | 4.91±1.25 | 5.57±1.46 | 5.28±1.56 | 3.945* | .000 | .324 |
| | B Group | 4.72±1.59 | 5.55±1.80 | 5.53±2.08 | | | |
| IO | A group | 6.45±1.83 | 7.95±3.50 | 8.40±2.42 | 7.351** | .513 | .652 |
| | B Group | 6.35±1.74 | 7.20±1.52 | 7.39±1.51 | | | |

*p<.05, A group: side body crunch exercise, B group: visual feedback exercise group

The abdominal muscles help the smooth movement of the legs and arms and are highly important for maintaining the stable alignment of the axial skeleton [14]. When you move your arms or legs, the transverse abdominis muscle contracts first. When properly activated, it strengthens the lumbar vertebrae and improves trunk stability by controlling pressure in the belly and the internal oblique, diaphragm, and pelvic floor muscles [15]. Co-activation of these muscles creates “abdominal pressure, contributing to trunk stability and enhancing the upper and lower extremities' dynamic and static movement capability”[16].Crunch exercise plansare widely cast off for trunk muscle stabilization exercises and can quicklyrecover abdominal strength in any position without special equipment [17].

This study aimed to provide an efficient exercise method through ultrasound imaging of abdominal muscle thickness by applying visual feedback to subjects during side body crunch exercises. Ultrasound is a non-invasive method for evaluating “abdominal muscles, quantifying muscle response, and identifying morphology” [18].

The length of the transverse abdominis, interior oblique, and exterior oblique muscles in each group varied significantly due to the experiment. As a result, each of these muscles contributes to bracing the trunk against spinal rotation.

The study of [19] provided visual and auditory feedback to stroke patients and delivered results on weight shift. As a result, it was reported that although the symmetry of weight bearing in stroke patients was not statistically significant in the group comparison, it affected the quantitative improvement of sitting and standing motions through repetitive task performance.The study of [20] confirmed:“the improvement of walking and balance ability due to applying visual feedback to stroke patients for six weeks.” In the study of [21], “With and without visualization, we compared muscular activation in the trunk and hip extensors.” It was reported that the difference in muscle activity between both sides was significantly reduced when visual feedback was applied.

In this way, visual feedback increases task accuracy, increasing selective muscle activity [21].The study of [22] also “reported that when visual feedback was provided, the movement of the trunk muscles was further increased by continuously maintaining the correct trunk posture.” This is because giving visual feedback directly affects the deep muscles of the box and the muscles involved in stability. Therefore, appropriate sensory

feedback should be shown for correct motor control [23]. The study of [21] reported that “visual feedback helps enhance selective muscle activity by changing motor control.”

In terms of the restrictions of this study, the number of subjects needed to be bigger, and the experiment's duration required to be longer to compare the core muscles' thickness more precisely. The study was also unable to control the subjects’ daily activities. Therefore, future research ona proper visual feedback exercise that expands the number of issues and is appliedover a long period will be needed[25-28].

**4. Conclusion**

This research aimed to determine whether visual feedback during side-body crunches affected the width alterations of the transverseexterior oblique, abdominis, interior oblique, and muscles, as shown in ultrasound scans.

As a result of measuring the width of these musclesthroughout side body crunch exercises for six weeks according to the occurrence or nonappearance of visual feedback, the difference in thickness was confirmed by period. Still, according to feedback, the significance of the difference in muscle thickness between groups could not be guaranteed.

Future research will be necessary to observe the relationship between muscle activity and abdominal muscle thickness by adding electromyography and ultrasound for subjects of various age groups.

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