# Muscle Activity during Yoga Breathing Exercise Compared to Abdominal Crunches

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## ABSTRACT

Yoga and yoga-related training have often been touted as providing good muscle stretching and relaxation, as well as being beneficial for overall stress management. During forceful muscle contractions of yoga, substantial muscle activity can be demonstrated. In the present investigation, the muscle activity of the right and left rectus abdominis and of the right and left external oblique muscles was examined to assess the level of muscle activity during one type of yoga maneuver: a breathing exercise performed in the seated position. The results showed that while muscle activity during this yoga breathing exercise was comparable to that seen during the performance of abdominal crunches, the longer duration of the breathing exercises increased the total work on the abdominal muscles up to 5 times greater than the work during crunches. Because of the high muscle activity, this form of exercise would be good for people who cannot easily exercise on the floor such as people with disabilities or obese people.

## INTRODUCTION

Yoga, which is commonly used for muscle relaxation,[1] can be performed by most people, including young people and cardiac patients.[2-5] It has been used to build core stability during and after pregnancy[6] and has been shown to increase creativity and reduce stress,[7] as well as to improve muscle power, dexterity, visual perception,[8] and reaction time.[9] However, while strength, endurance, and muscle reaction times have been previously quantified, little has been done to quantify muscle use during yoga through the use of the electromyogram (EMG).[10,11]

The EMG, when measured by surface electrodes above an active muscle, represents an interference pattern giving the summation of activity of the underlying muscle fibers.[12] The amplitude of the surface EMG is generally related to the tension developed in muscle.[12,13] Therefore, the EMG has proved to be a useful measure in assessing both the extent of muscle activity and muscle fatigue.[12-17]

While some investigators find some variation in the EMG tension relationship due to the type of electrode (needle or surface) or the size or position of the electrodes,[18,19] if the EMG is nor-

**Figure 1.** Subject performing abdominal crunch

malized as a percent of the muscle's maximum EMG during a maximum strength measurement, the EMG is a reliable tool to measure muscle use.[16,17]

This paper uses the EMG to quantify abdominal muscle activity during abdominal yoga exercises versus traditional curls to understand the magnitude of muscle use associated with yoga. This is particularly important since yoga has been reported to increase muscle strength and the strength of respiratory muscles (including the obliques and rectus abdominis muscles).[8]

## MATERIALS AND METHODS

### Subjects

Twenty-nine subjects (14 male and 15 female) aged 17 to 49 years participated in this study. The general characteristics of the subjects are shown in Table 1. All experimental protocols and procedures were approved by the Human Review Committee at Azusa Pacific University and all subjects signed a statement of informed consent acknowledging that they are fully aware of the purposes and procedures of the project.

### Electromyogram

The EMG was recorded through 2 bipolar vinyl adhesive electrodes (silver silver-chloride) with an active surface area of 0.5 $cm^2$. One electrode was placed over the belly of the active muscle. The second electrode was placed 2 cm distal

**Table 1.** General Characteristics of Subjects

| | Age (years) | Weight (kg) | Height (cm) |
|---|---|---|---|
| Mean ± SD | 38.3 ± 13.4 | 73.3 ± 15.3 | 167.3 ± 11.8 |

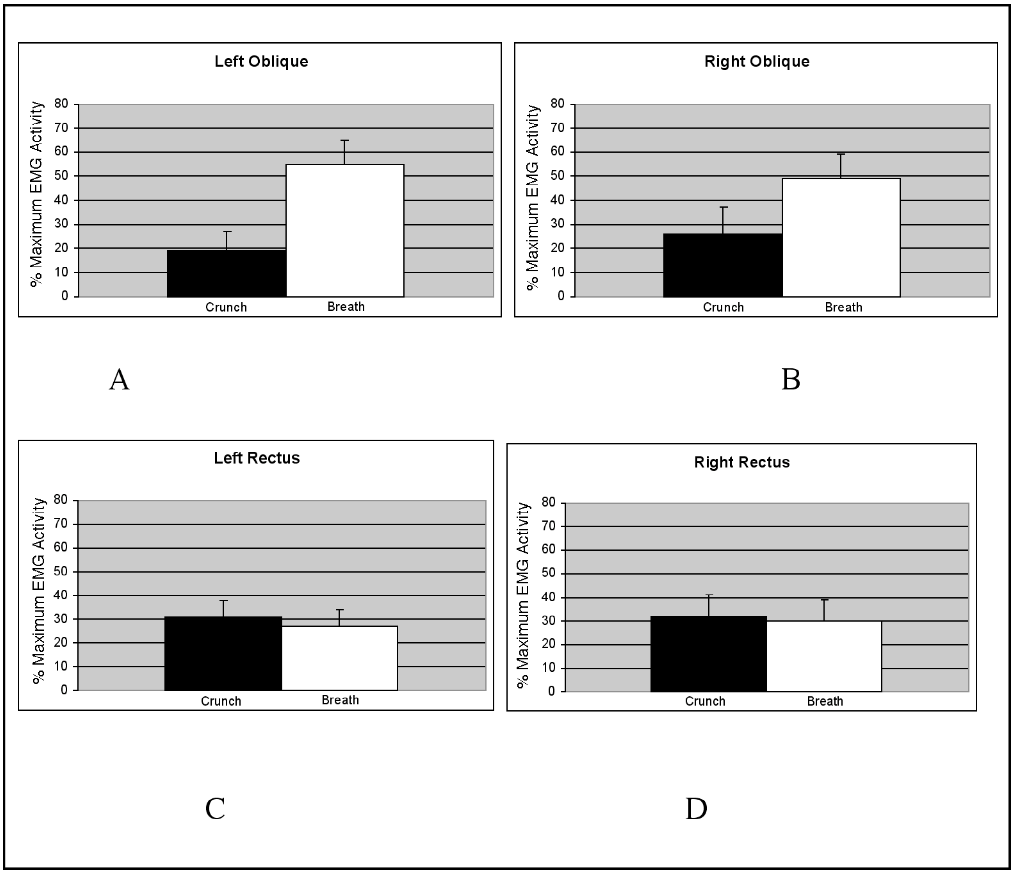


**Figure 2.** Average muscle activity of the (A) left and (B) right obliques and (C) left and (D) right rectus abdominis muscles during each of the two conditions. Each panel shows EMG activity expressed as a percent of the EMG during the maximum strength determinations. Yoga breathing exercise is compared to abdominal crunches lying supine on the floor. All data are the mean result for the entire group ± the respective SD.

to the active electrode. EMG was amplified using a 4-channel EMG amplifier whose frequency response was flat from DC to 1000 Hz. The common mode rejection ratio of the amplifier was greater than 120 Db. The EMG was digitized at 1,000 samples/sec by a Biopac (Biopac Corp., Santa Barbara, CA) 16-bit analog-to-digital converter and displayed and stored on a computer for later analysis. The amplitude of EMG was assessed by digitizing and half wave rectified the raw EMG and calculating the root mean square average (RMS) of the EMG.

**Measurement of Strength of the Abdominal Muscles**

Isometric strength of the abdominal muscles was measured in the seated position. To accomplish this, subjects sat with the hips at an angle of 90º. A modified exercise device with strain gauges was used to assess maximum strength. The strain gauge was linear from 0-200 kg of force. The output of the transducer was amplified with a strain gauge conditioner amplifier with a gain of 1000 and digitized in a Biopac 16-bit analog-to-digital converter and displayed and stored on a computer. The

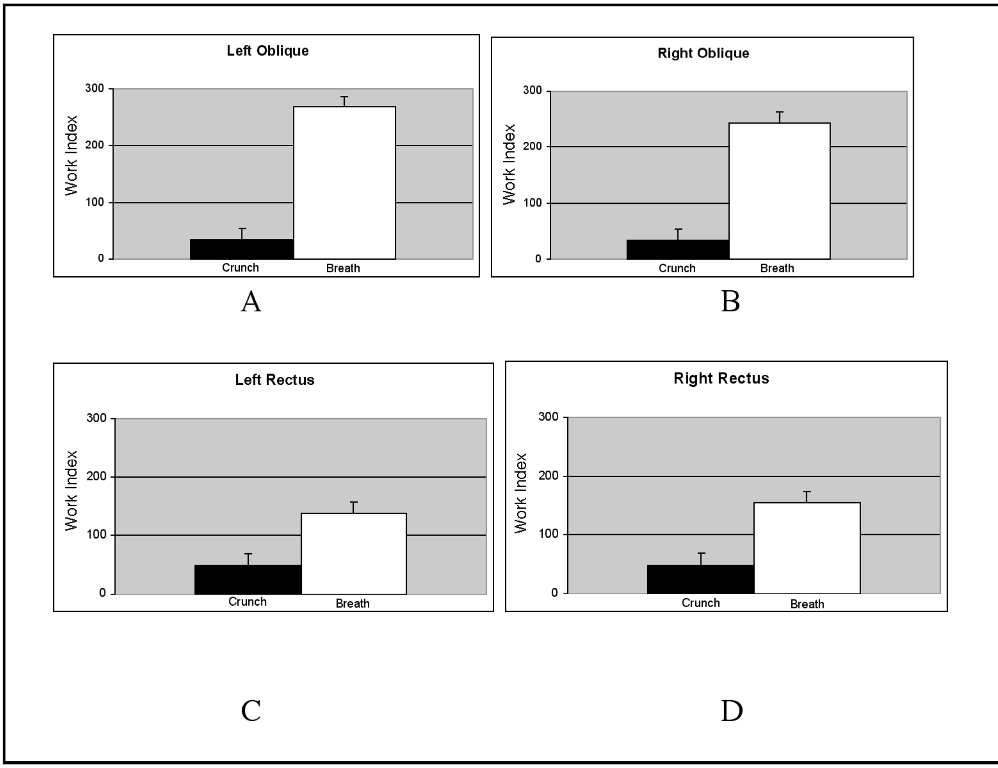


**Figure 3.** Work of the (A) left obliques, (B) right obliques, (C) left rectus abdominis, and (D) right rectus abdominis during breathing compared to work during supine abdominal crunches. Work is calculated as the product of muscle activity × the duration of the exercise. Since muscle activity is normalized to each person, it is in relative units.

output was stored and analyzed as the average strength over the middle of a 3-second contraction. Strength was measured by an isometric contraction for 3 seconds. At least 1 minute was allowed between each of 3 contractions to allow for recovery.

**Breathing Exercise**

Muscle activity was examined during Yoga deep breathing exercise performed in the seated position. The breathing exercise involved slowly exhaling through the mouth and then rapidly inhaling through the nose to fully expand the lungs. Next the air was exhaled through the mouth rapidly using the abdominal muscles and the diaphragm as much as possible. With the air exhaled, the mouth is kept closed and a maximum contraction was accomplished with the abdominal muscles against a closed glottis. This last position was held for an average of 6 seconds.

**Procedures**

Two series of experiments were performed. In the first, conventional abdominal crunches were accomplished by having the subjects lay supine on the floor and contract the abdominal muscles to bring the elbows and head to a position to where the shoulders just cleared the floor (Figure 1). The arms were folded on the chest. EMG was then measured during this activity. A yoga breathing exercise was then performed in the seated position as described under methods, during the contraction, EMG was also measured. To normalize the

EMG on both sets of experimental conditions, the maximum strength was determined for the abdominal muscles while sitting and with forward flexion for the rectus abdominis muscles and during rotation to the left and right to obtain maximum use of the obliques.

**Statistical Analysis**

Statistical analysis involved the calculations of mean standard deviations and *t*-tests. The level of significance was $P<0.05$.

## RESULTS

The results are shown in Figures 2 and 3. As shown, muscle activity for all 4 muscle groups during abdominal crunches averaged 24% of the total activity of these muscles. For breathing exercises, muscle activity was somewhat greater with 41% of the muscle activity. These differences were significant ($P<0.05$). For breathing exercises, the greatest muscle activity was for the obliques. Here activity was almost double that of the rectus abdominis muscles. In contrast, for crunches, the greatest activity was for the rectus abdominis muscles. Although the muscle activity was similar for the two exercises, there was a difference: the duration of the exercise was longer for the breathing exercises. The subjects had an average duration of 2.1 ± 0.8 sec for the crunches. In contrast, for yoga exercise, the average duration was 5.09 ± 2.1 sec; these differences were significant ($P<0.01$).

By multiplying the product of the duration of the exercise by the EMG levels, the workload, as shown in Figure 3, was significantly higher ($P<0.01$) for yoga exercises compared to standard abdominal crunches. The work for the obliques was over twice as high as that of the rectus abdominis muscles. The total work, adding all muscles together was 803 for the breathing exercises and 166 for the crunches. With yoga, the work for each muscle group and the total work were higher than that seen with crunches ($P<0.01$). Thus the work performed in a single breathing exercise was equivalent to 5 crunches. For the rectus abdominis, the work was about 2.5 times higher in the breathing exercises than for the crunches, whereas for the obliques, the work was 6 times higher than for the crunches.

## DISCUSSION

It is known that yoga is a good training technique for muscle relaxation.[20] From a psychological standpoint, it also reduces anxiety.[20] But yoga also has been shown to decrease neurological reaction time and improve muscle strength and endurance of the expiratory and abdominal muscles.[9] This, then, has important benefits in terms of expiratory disorders such as asthma.[21,22] For yoga, if there is increased muscle power and muscle dexterity, then the exercise itself must be using appreciable muscle strength.[8] This is especially true for women who wish to build core stability during and after pregnancy.[6] In the present investigation, considerable muscle activity was found for the rectus abdominis and exterior oblique muscles during yoga exercise involving the core muscles of the body.

Studies show that strengthening of the core muscles with sit-ups or other types of abdominal exercise contributes to increased functional abilities.[23,24] When the abdominals and lower back muscles are strengthened using exercise machines, bowel and bladder programs in rehabilitation or health centers have been shown to be more effective.[25] Further, if individuals are prone to falling, increasing core muscle stability increases the person's ability to maintain balance while reaching.[23,24] Thus, exercise of the core muscles[26-29] increases overall aerobic capacity and improves stability of the upper and lower body through training of the erector spinae, transversus abdominus and rectus abdominus muscles, resulting in improved therapeutic reach and balance, better breathing, and better activity of the bowel.

One particularly interesting finding of this investigation was the fact that even for the rectus abdominus muscle, which is somewhat active during abdominal crunches, the total muscle activity was substantially higher during the yoga breathing exercises than during the standard abdominal crunches. In the oblique muscles, which are used minimally during abdominal crunch exercises, yoga breathing exercises cause considerably more work in these muscles. Thus, yoga breathing is not only efficient when exercising the rectus abdominis but it also provides a good workout for the oblique muscles as well. If, for example, a yoga breathing workout were to continue for 20 breaths, this would be equivalent to 100 conventional crunches in abdominal work performed.

Abdominal crunches are usually considered the gold standard and used quite commonly during exercise in military programs and civilian fitness programs. However, yoga breathing exercises, in contrast, are used less frequently but workloads are much higher. Therefore, yoga breathing exercises, when combined with other exercise modalities, provide a much better workout for the core muscles in the body. Considering the abdominal work with yoga breathing exercises, total body workouts would be much more time efficient if yoga breathing exercises were combined and interlaced with other exercise modalities for a more efficient fitness program. Finally, since breathing exercises can be accomplished from the seated position, yoga is more approachable and compliance will be better for people who have difficulty working in a supine position such as the elderly and disabled or people with obesity.

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