# The Effect of Hip Position and Lower Extremity Stabilization on Peak Trunk Flexion Force and Activation of the Abdominal and Hip Flexor Muscles

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## Introduction

▪ Strong abdominal muscles are thought to be important in maintaining a healthy spine. However, exercises geared toward abdominal strengthening also facilitate contraction of the hip flexor muscles secondary to their origin on the spine.

▪ Given the variety of ways to train the abdominals and the potential hip flexor activation and incidence of low back pain (LBP), it's imperative to understand the effect of hip position and lower extremity (LE) stabilization on abdominal force production and activation.

▪ Purpose #1: determine the effect of hip position (i.e. hips in neutral with knees extended versus hips and knees flexed) and LE stabilization (no strap versus strap) on activation of the abdominal and hip flexor muscles.

▪ Purpose #2: determine the effect of hip position and LE stabilization on peak trunk flexion force.

## Methods

- Preliminary Data
  - 20 healthy subjects (10 male, 10 female)
  - All participants signed an informed consent and the protocol was approved by the Institutional Review Board of Ohio University.
  - Hip flexor flexibility: An inclinometer was used to measure:
    - Thomas Test (hip flexed and knee extended)
    - Modified Thomas Test (hip and knee flexed)
    - The inclinometer was zeroed on mid thigh before performing measurement.
- Procedures
  - Subjects were positioned supine on a customized table, with the thorax strapped to a free-floating board counterweighted to the subject's trunk mass. The pelvis and lower extremities rested on the table.
  - Two maximal voluntary contractions were performed in two different test positions with and without LE stabilization.
    - Test position 1: knees extended, no strap, followed by knees extended, strap.
    - Test position 2: hips and knees flexed, no strap, followed by hips and knees flexed, strap.
      - The hip was flexed to 60˚ with the tibial shafts resting on a suspended platform.
    - When indicated, the strap was placed over the tibial shafts.
    - Verbal encouragement was given.
  - Subject's peak trunk flexion force was recorded. A 5-minute rest period was given, and then a second MVC trial was performed using the same procedure. If the subject's max force output on their second trial was within 10 pounds of their first trial, the higher of the two was used as the subject's MVC. If the subject's second trial was not within 10 pounds of their first trial, the subject was allowed another 5-minute rest and a third trial was performed.
  - Real-time visual feedback of max force was displayed on a flat-panel monitor using software developed in LabVIEW (National Instruments, Austin, Texas, USA).
- EMG Recordings
  - In order to measure abdominal and hip muscle activation, surface electromyography (EMG) was recorded bilaterally for the following muscles: rectus abdominus, external oblique, internal oblique, and rectus femoris.

## Data Analysis

▪ Peak trunk flexion force and peak muscle activation were analyzed using separate 3-way mixed model ANOVAs.

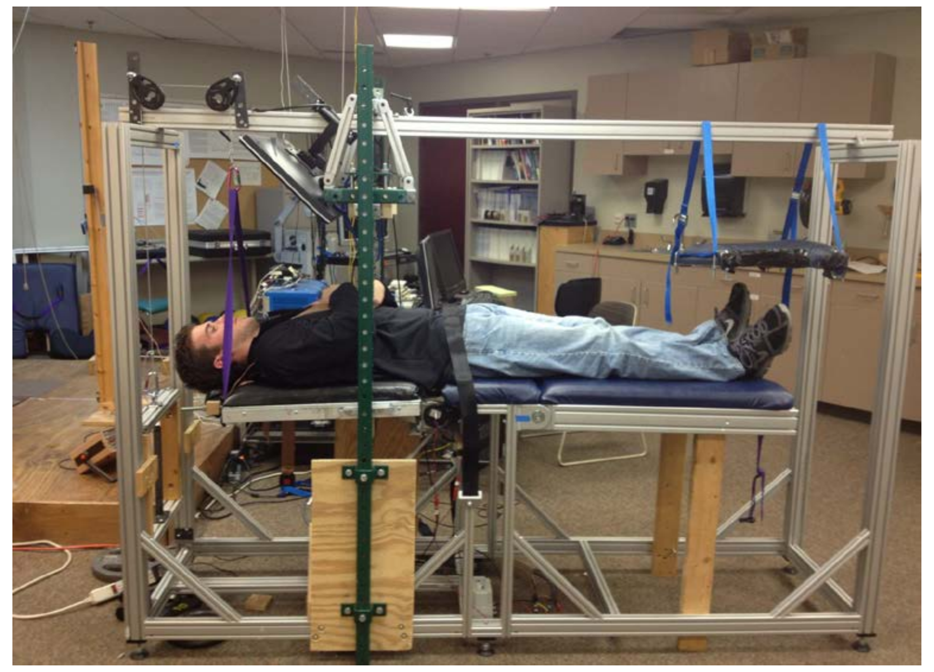

**Figure 1: Subject is depicted in test position 1 (knees extended, no strap).**

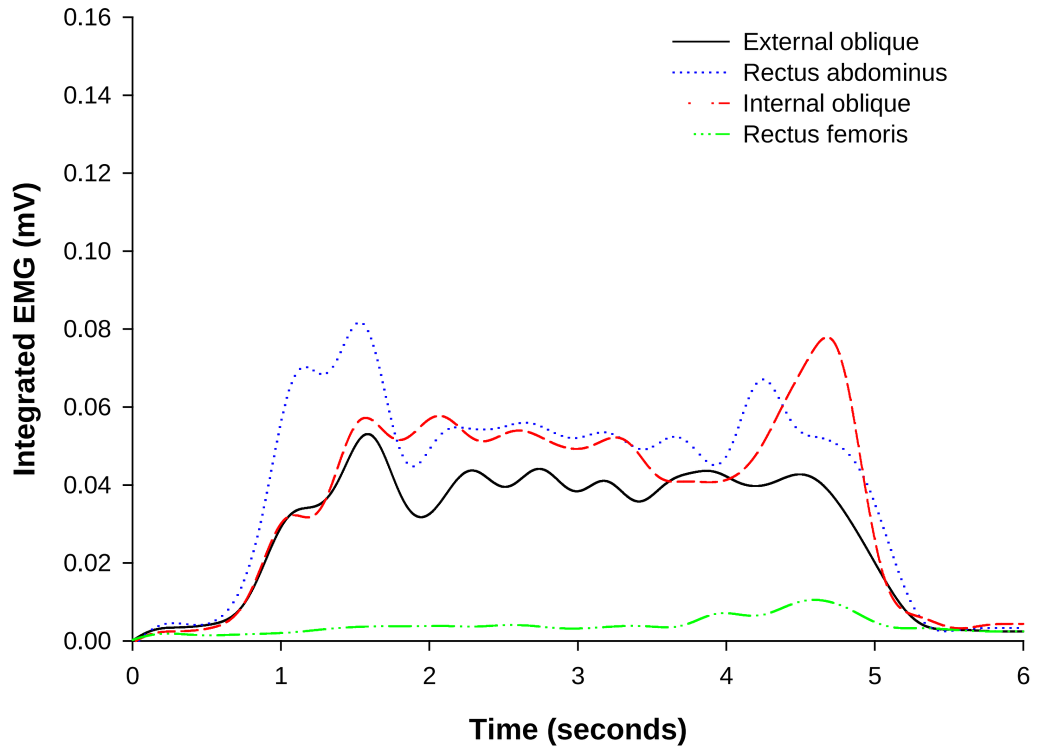


**Figure 2: Time series data displayed as a linear envelope demonstrates muscle EMG activation during test position 1 (knees extended, no strap).**

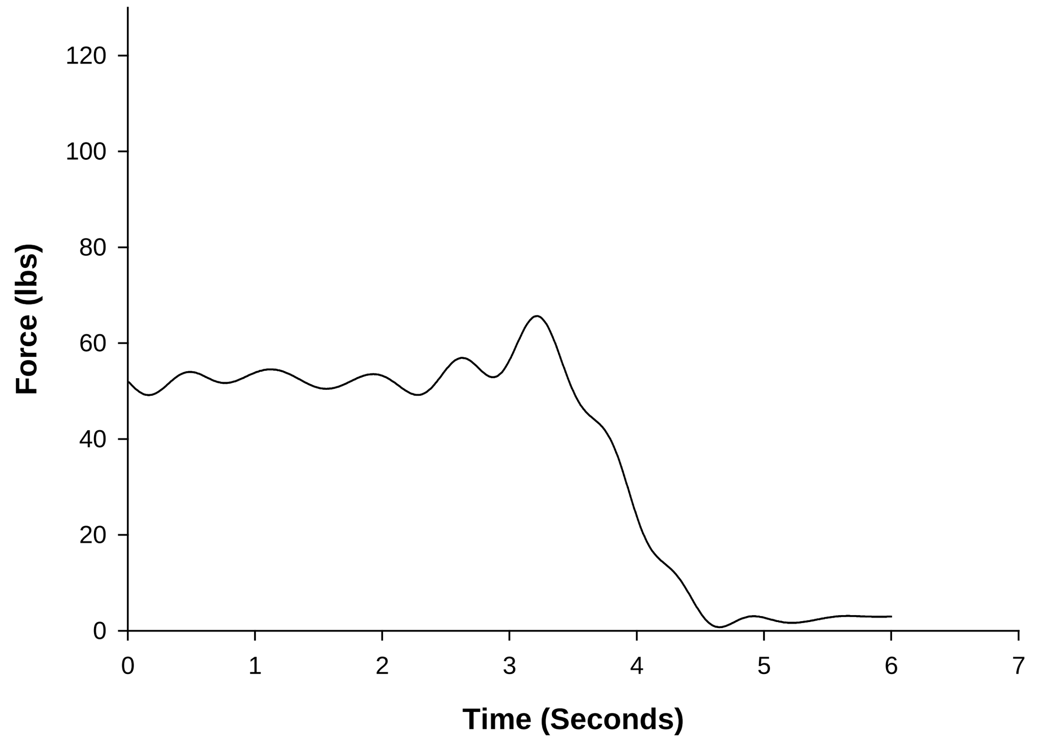


**Figure 3: Force during MVC trial during test position 1 (knees extended, no strap).**

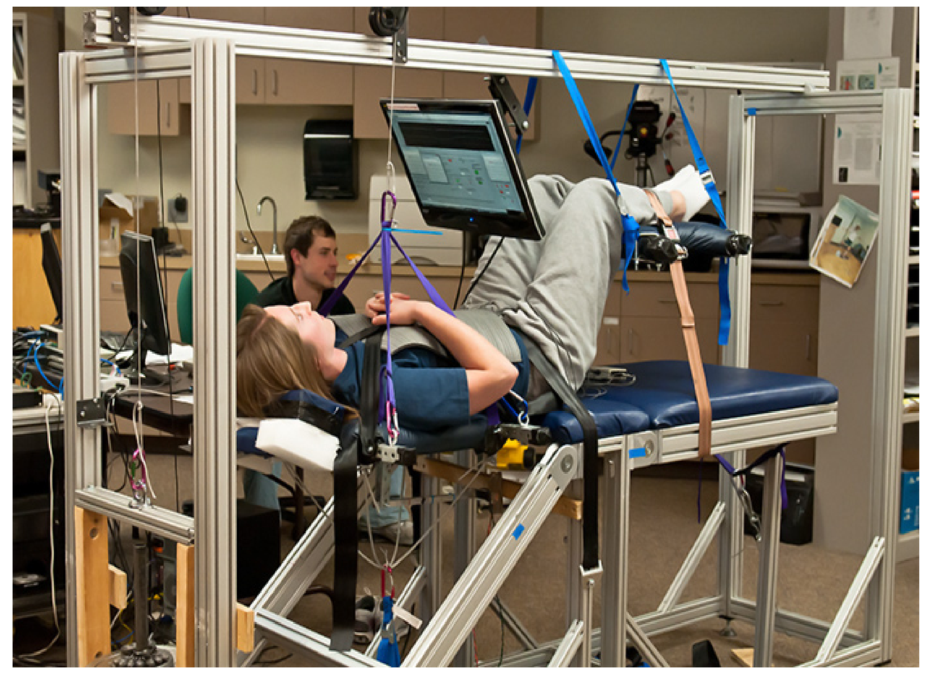

**Figure 4: Subject is depicted in test position 2 (knees flexed, strap).**

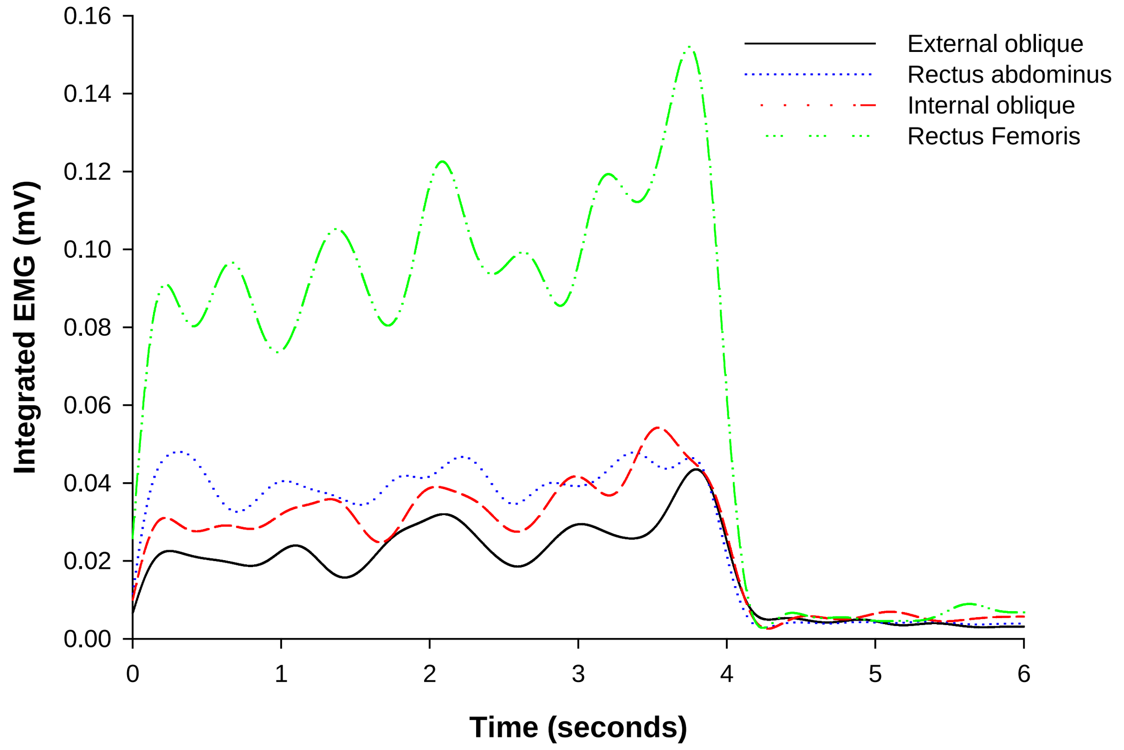


**Figure 5: Time series data displayed as a linear envelope demonstrates muscle EMG activation during test position 1 (knees extended, strap).**

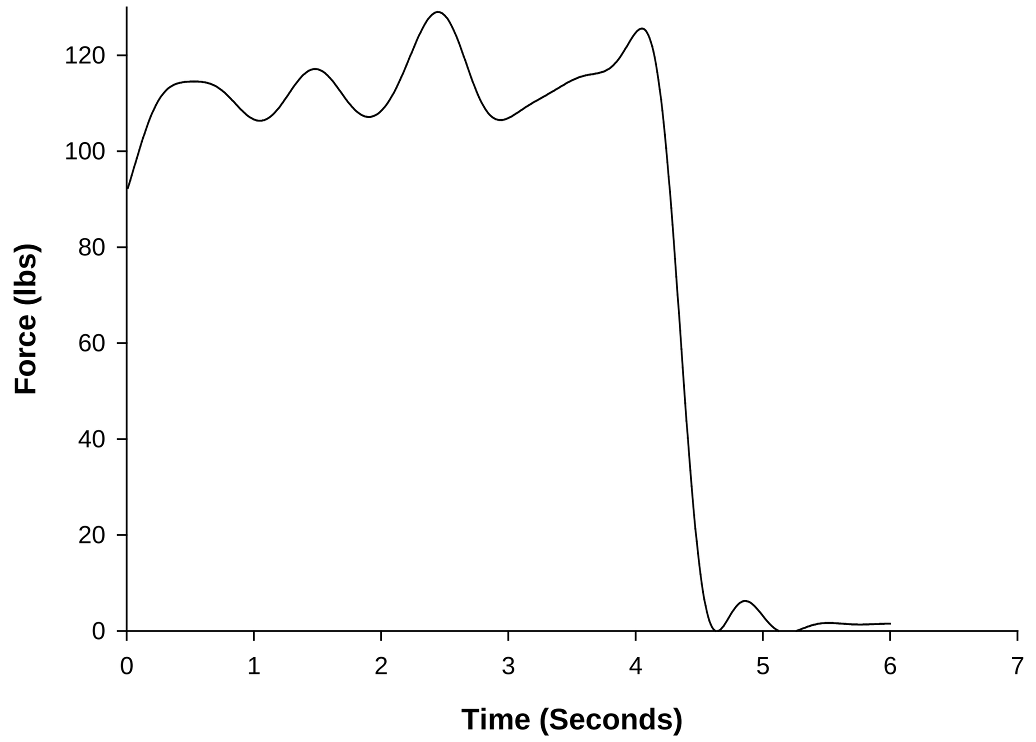


**Figure 6: Force during MVC trial during test position 1 (knees extended, strap).**

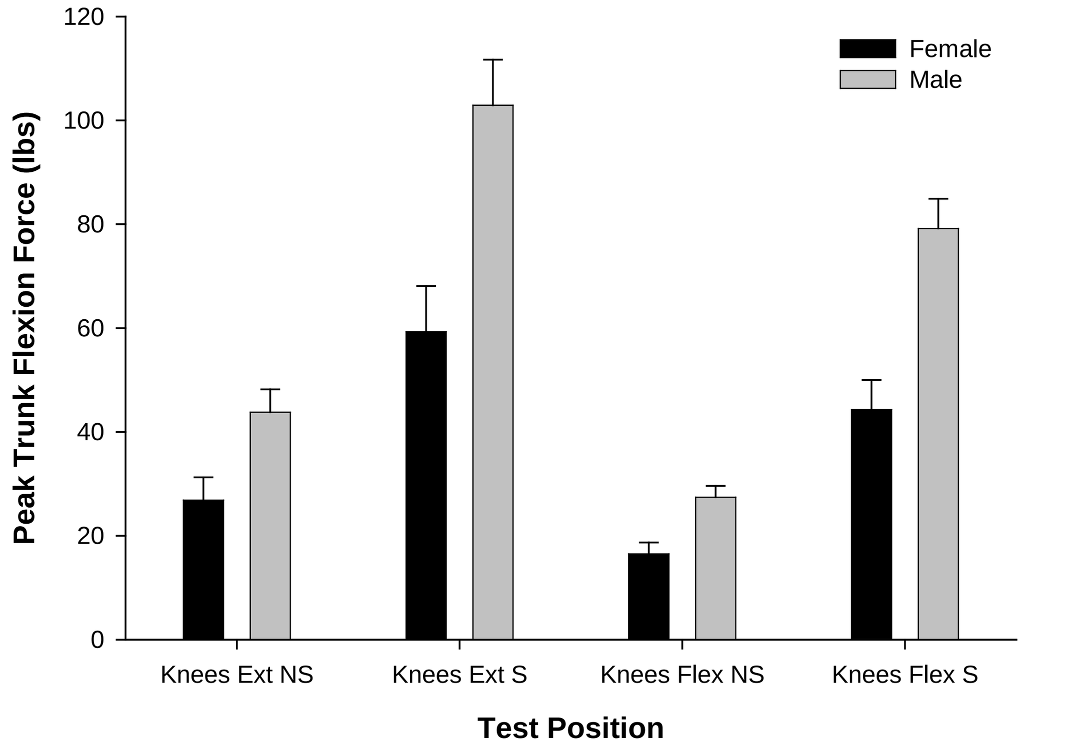


**Figure 7: Depicted are peak force values for females versus males in the two test positions, demonstrating increased force production from males.**

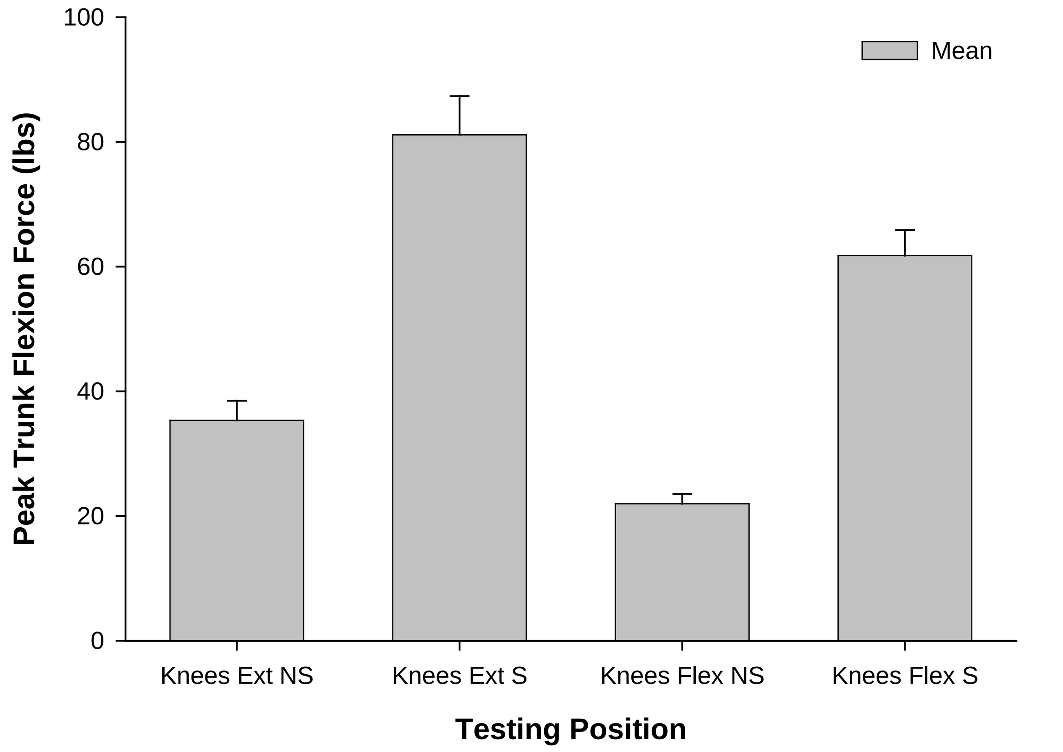


**Figure 8: Depicted are mean peak force values collapsed across gender in the two test positions, demonstrating increased forced production with the strap conditions.**

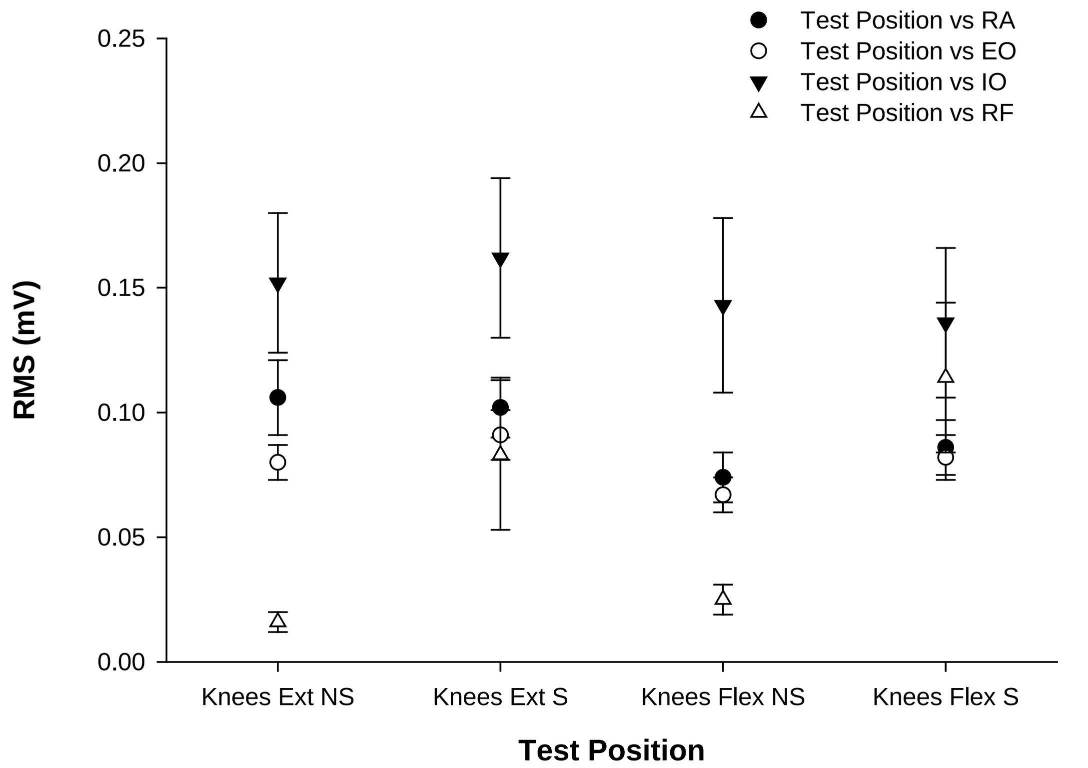


**Figure 9: RMS of each muscle assessed for 2 seconds during peak force production.**

## Results

__Main effects__: *Analysis of simple effects revealed:*

__Position__

▪ Peak trunk flexion force was not significantly higher contingent on test position (p=.064).

▪ Knees extended, no strap, mean =35.338, versus knees flexed, no strap mean = 21.969.

__Strap__

▪ ***Peak trunk flexion force was significantly higher with distal fixation*** versus no distal fixation (F(1,18)=130.618, p<.05).

▪ Knees extended, strap, mean = 81.118, versus knees extended, no strap, mean = 35.338.

__Gender__

▪ ***Peak trunk flexion force was significantly higher in males*** versus females (F(1,18)=16.092, p<.05).

▪ Males, knees extended, strap, mean = 102.922, versus females, knees extended, strap, mean = 59.314.

__Interactions__: *Analysis of interactions revealed:*

__Position by gender__

▪ There was no significant interaction of position by gender (p=.146).

__Strap by gender__

▪ There was a ***significant interaction of strap by gender on peak trunk flexion force*** (F(1,18)=11.415, p<.05).

__Position by strap__

▪ There was no significant interaction of position by strap (p=.138).

__Position by gender by strap__

▪ There was no significant interaction of position by gender by strap (p=.734).

__Correlation Analysis__

▪ There was no significant correlation between hip flexor muscle length (assessed via Thomas Test and Modified Thomas Test) and peak trunk flexion force for any of the test positions (p= .425 - .979)

## Conclusion

▪ Previous studies have failed to look at the effect of distal fixation and hip position on the production of peak trunk flexion force, and activation of the abdominal and hip flexor muscles.

▪ This study reveals that hip position has no significant effect on peak force. Additionally, there was no effect of test position on peak EMG activation of any of the abdominal muscles.

▪ For all subjects, regardless of hip position, the ability to generate peak trunk flexion force and the greatest activation of the hip flexors occurred with lower extremity stabilization.

▪ Gender had a significant effect on the ability to produce peak force (males greater than females), and there was as significant interaction of strap by gender on peak force.

▪ Additionally, preliminary Thomas Test measurements and peak trunk flexion force were assessed using a two-tailed Pearson correlation, which indicated that in all testing positions there was no significant correlation between hip flexor muscle length and the ability to generate force (p>.05).

▪ Core strengthening is a key component in the treatment of low back pain. Our findings suggest that in a healthy population, the abdominal muscles can be maximally activated without lower extremity stabilization. Our data also reveals that hip flexor muscle length does not effect force production. Therefore emphasis should not be placed on lower extremity stabilization or hip flexor flexibility when strengthening the abdominal muscles.