2008

EMG Analysis of a Hamstring Co-Contraction and Its Effects on Abdominal Strength

Stephanie Rodman
University of North Dakota

Heather Robbins
University of North Dakota

Rebecca Thurn
University of North Dakota

EMG ANALYSIS OF A HAMSTRING CO-CONTRACTION AND ITS EFFECTS ON ABDOMINAL STRENGTH

Stephanie Rodman

Heather Robbins

Rebecca Thurn

Doctor of Physical Therapy

University of North Dakota, 2008

A Scholarly Project

Submitted to Graduate Faculty of the

Department of Physical Therapy

School of Medicine

University of North Dakota

In partial fulfillment of the requirements

for the degree of

Doctor of Physical Therapy

Grand Forks, North Dakota

May 2008

This Scholarly Project, submitted by Stephanie J. Rodman, Heather A. Robbins, and Rebecca M. Thurn in partial fulfillment of the requirements for the Degree of Doctor of Physical Therapy from the University of North Dakota, has been read by the Advisor and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

(Graduate School Advisor)

(Chairperson, Physical Therapy)

PERMISSION

Title	EMG analysis of a hamstring co-contraction and its effects on abdominal strength
Department	Physical Therapy
Degree	Doctor of Physical Therapy

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Signature Heather Ribbons

Signature Stephen J. [illegible]

Signature Rebecca Th[illegible]

Date 12/12/07

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ACKNOWLEDGEMENTS

We would like to thank our advisor, Dr. Schawnn Decker, as well as Dr. Dave Relling and Dr. Renee Mabey for their guidance and assistance in the completion of this project. We would also like to thank our families for their love and support.

ABSTRACT

Background and Purpose: Back pain and instability are common diagnoses treated by physical therapists. Treatment often includes abdominal or core strengthening exercises that act to improve stability about the lumbar spine. Hip flexors prevent the weaker abdominal muscles from working to their full potential and increase the lumbar lordosis placing the spine at risk of injury. Hip extensors work with abdominal muscles to reduce the lumbar lordosis, and restrict the hip flexor activity, allowing a stronger abdominal contraction. The purpose of this study was to determine if a co-contraction of the hamstring muscles during an abdominal crunch increased the electromyographic (EMG) activity of the abdominal musculature and decreased the EMG activity of the hip flexor musculature.

Subjects and Methods: Thirty volunteers between the ages of 22 and 56 participated in the study, including 15 men and 15 women. An EMG analysis was used measuring the activity of the upper rectus abdominus, lower rectus abdominus, external oblique, rectus femoris, semitendinosus, and biceps femoris while performing five abdominal crunches without and five abdominal crunches with a hamstring contraction by pressing their heels into a chair. Participants were positioned with their hips and knees at 90°. Subjects performed three practice trials prior to data collection and one minute rests in between trials. Each participant's EMG data was normalized to the respective maximal voluntary contraction (MVC) for each muscle group analyzed.

Results: A significant ($p<0.001$) decrease in abdominal activity during the crunch exercise with hamstring contraction was observed compared to the crunch exercise without hamstring contraction. Specifically, decreased activity of the upper (-54.8%) and lower (-7.65%) rectus abdominus muscles and external oblique (-1.42%) muscle was observed. There was an insignificant increase in hip flexor (rectus femoris, +11.77%) activity during the crunch with hamstring contraction.

Discussion and Conclusion: This study found a decrease in abdominal EMG activity and an increase in hip flexor activity during the abdominal crunch with hamstring contraction. Factors to consider are the position of the hips and knees at 90°, feet not being flat on a stable surface, and difficulty coordinating all aspects of the abdominal crunch with hamstring contraction.

Chapter I

Introduction

Back Pain & Weakness

A person has a 50-70% chance of experiencing low back pain in their lifetime[1] with lumbar instability accounting for as much as 25-30% of this pain.[2] It is hypothesized that this pain and/or instability has been related to muscular weakness and/or imbalance in the core musculature.[3] Treatment often includes core strengthening exercises, which are directed toward obtaining the muscular control required around the lumbar spine to maintain functional stability.[4]

The "core" has been described as a "box of muscles" with the abdominals in the front, paraspinals and gluteus muscles in the back, the diaphragm as the roof, and the pelvic floor and hip girdle muscles as the bottom.[5] This 'box' serves as a muscular corset, where all the muscles work together as a unit for optimal spinal stabilization and performance. Spinal instability or loss of function of the spinal tissues occurs when any of these components are disrupted. White and Panjabi[6] defined clinical instability as "the loss of the spine's ability to maintain its patterns of displacement under physiologic loads so there is no initial or additional neurologic deficit, no major deformity, and no incapacitation pain".

Problem Statement: Currently there is little evidence describing if a relationship exists between a co-contraction of the hamstring muscles during an abdominal crunch causing reciprocal inhibition of the hip flexor muscles, and increased activity of the abdominal musculature.

Purpose: The purpose of this study is to determine if a co-contraction of the hamstring muscles during an abdominal crunch increases the EMG activity of the abdominal musculature and decreases the EMG activity of the hip flexor musculature.

Significance: If there is evidence that performing an abdominal crunch a certain way can decrease the hip flexor activity and increase the abdominal activity, we can enhance strengthening of the abdominal musculature for better trunk stability. As Physical Therapists, we can use this evidence in our practice to develop exercise programs that focus on strengthening the abdominal musculature thus increasing trunk stability and decreasing low back pain.

Research Question: Does an abdominal crunch with a co-contraction of the hamstrings increase the EMG activity of the abdominal muscles and decrease the EMG activity of the hip flexor muscles when compared to an abdominal crunch without co-contraction of the hamstrings.

Null Hypothesis: There is no significant difference in EMG activity when comparing a co-contraction of the hamstrings during an abdominal crunch with an abdominal crunch without co-co-contraction of the hamstrings.

Chapter II

Literature Review

Strengthening the Core Musculature:

One exercise commonly used to strengthen the abdominal musculature is the abdominal crunch. An abdominal crunch is typically performed by lifting only the head and shoulder blades off the floor as the person is lying flat on their back with the knees bent and their feet flat on a surface. This minimizes lumbar motion and reduces psoas muscle activation, and therefore reduces the compressive and shear stress on the lumbar vertebra.[3,7] The crunch exercise has been recommended in place of a sit-up exercise because the crunch has been shown to activate abdominal musculature as effectively as the sit-up but without the relatively high hip flexor activity that occurs during the sit-up.[3,8]

Strong abdominal muscles help stabilize the trunk and unload the lumbar spine. However, many abdominal strengthening exercises also activate non-abdominal muscles, such as the hip flexors, lumbar paraspinals, or upper extremity muscles.[9]

Hip Flexor Involvement:

Hip flexors assist with movement at the hip joint and prevent the traditionally weaker abdominal muscles from working to the fullest. The low-back extensor muscles and the two primary hip flexor muscles, rectus femoris and iliopsoas, act as a force-couple that pull on the pelvis, causing an anterior tilt. This anterior tilt leads to increased lumbar lordosis, which can result in L4-5 compression.[8, 10] Greater lordosis also increases the compressive loads on the lumbar apophyseal joints.[11] When coupled with weak abdominal muslces there is an increased risk of low back pain and instability.[8]

Hip Extensor Involvement:

The hip extensors (gluteal & hamstring muscles) and abdominal muscles act as a force-couple to posteriorly tilt the pelvis and reduce the lumbar lordosis. [11] The hip flexor musculature works antagonistically to the abdominal muscles, and strong and/or tight hip flexors can result in weakening of the abdominal muscles. Activation of the hamstring and gluteal muscles while performing abdominal crunches is thought to lead to more efficient abdominal contractions via the process of reciprocal inhibition.[12]

Spring hypothesized that activating the hamstrings during bent-knee sit-ups would inhibit psoas. However, in a study by Juker et al. psoas activity was increased with a press-heels sit-up (pulling the heels up toward the buttocks) which activated the hamstrings. Also in the press heels style sit-up the activity of the external oblique and transverse abdominis were increased. They suggest that the psoas increased activation to balance the hip extensor moment resulting from the increased hamstring activity.[3]

Modifying the Abdominal Crunch:

Traditional & Non-traditional Abdominal Exercises:

Several research studies have analyzed the effects of using traditional and non-traditional abdominal exercises to strengthen the core musculature, including the abdominal crunch, bent-knee sit-up, and press-heels sit-up exercise (discussed previously). The three superficial muscles most often involved in lumbar spinal flexion and analyzed in these studies include: upper rectus abdominis (URA), lower rectus abdominis (LRA), and external oblique (EO).[3,8,9,12,13,14]

Upper and lower rectus abdominis muscle activity have been shown to be greater in the abdominal crunch exercise than in the bent-knee sit-up exercise.[8] External oblique muscle activity and to a lesser extent, internal oblique muscle activity has been shown to be significantly greater in the bent-knee sit-up than in the crunch exercise.[3,8]

Rectus femoris (RF) is an indicator of hip-flexor activity because it is the only superficial muscle of the hip-flexor group, and is therefore most often used in EMG analysis.[1] Rectus femoris and psoas muscle activity have been shown to be greater in the bent-knee sit-up exercise than in the crunch exercise.[3,8]

Commercial Abdominal Strengthening Equipment:

There are also commercial exercise machines on the market to help strengthen the abdominal musculature including the AbVice, AbRocker, and AbRoller. The AbVice activates the abdominal musculature in conjunction with the hamstring and gluteal muscles and it has been demonstrated that activity of the gluteus maximus may cause reciprocal inhibition of the hip flexors. The AbVice has been shown to elicit statistically greater EMG activation during contractions compared with the AbRocker, AbRoller, and standard crunch.[12]

The AbVice uses a position of greater hip flexion than the standard crunch in hooklying (where the knees are at 90° and the hips at 45°). The hip flexors (psoas and rectus femoris) are shorter during bent knee positions and force production is likely modulated or reduced by the force-length relationship. Howerver, Hildenbrand & Noble[13] stated in their study that greater hip flexion has been shown to diminish the activity of the abdominal muscles and is generally thought to be an undesirable element of safe, effective abdominal exercises.

In consideration of the previous research, the goal of this study was to determine an optimal position in which the hip flexor muscle activation would be inhibited by a co-contraction of the hamstring muscles during an abdominal crunch, thus increasing the muscle activation of the abdominal musculature.

Chapter III

Materials and Methods

This study comparing electromyographic (EMG) activity of the abdominal musculature during a modified crunch with hamstring contraction and a modified crunch without a hamstring contraction was approved by the University of North Dakota Institutional Review Board (*approval #IRB-200607-024, See Appendix A*).

Subjects for the study met inclusion criteria of being between the ages of 18 and 60 years old. Exclusion criteria used in this study included participants under the age of 18 years old, acute back pain, back and abdominal surgery, knee surgery, and pregnancy. Prior to performing the activity, participants were given a written and verbal explanation of the activity that they were going to complete. After all questions were answered, the subjects signed a consent form to participate in the study.

Self-adhesive, pre-gelled Ag/AgCl snap EMG surface electrodes (Model N-00-S, Ambu/Blue Sensor, Denmark) with an inter-electrode distance of 2.2 cm were placed unilaterally over the Upper and Lower Rectus Abdominus, External Oblique, Semitendenosus, Biceps Femoris, and Rectus Femoris musculature. Measurements for electrode placement were: Upper Rectus Abdominus (URA), 2 cm superior and 2 cm lateral to umbilicus; Lower Rectus Abdominus (LRA), 2 cm inferior and 2 cm lateral to the umbilicus; External Oblique (EO), 5 cm superior to the anterior superior iliac spine (ASIS); Biceps Femoris (BF), midpoint of a line from the ischial tuberosity to the lateral femoral condyle; Semitendinosis (ST), midpoint of a line from the ischial tuberosity to the medial femoral condyle; and rectus femoris, midpoint of a line from the ASIS to the superior pole of the patella (Figure 1 & 2).

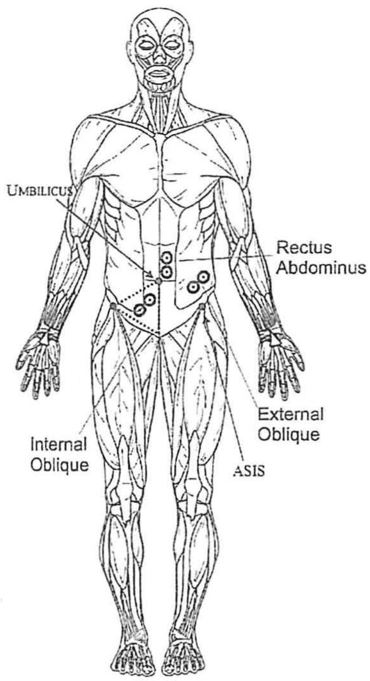


Figure 1: Abdominal electrode placement.

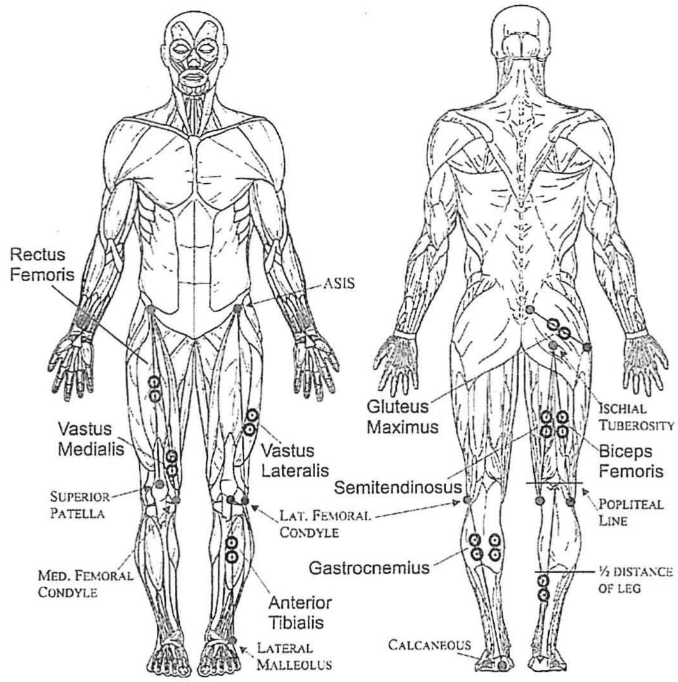


Figure 2: Hamstring and Rectus Femoris electrode placement.

Following marking, the electrode sites were prepared by clipping excess hair, rubbing with 400 grit sandpaper with five firm strokes over the skin, and vigorously wiping the skin with an isopropol alcohol soaked cotton towel five times. Surface electrode impedance levels were measured at 5 kOhms or less using an impedance checker (Noraxon USA, Scottsdale, AZ). The EMG activity was transmitted from the telemetry transmitter to a TeleMyo 900 (Noraxon USA, Scottsdale, AZ) receiver, which was interfaced with an analog to digital interface card (Noraxon USA), and viewed on a standard laptop computer monitor prior to saving to the hard-drive (HP Pavilion ZV5000, Pentium 4 2.80 GHz processor). Data analysis was performed using the MyoResearch XP (Noraxon, USA) software program.

The subjects were instructed on the proper performance for the maximum voluntary contractions (MVCs) of hip flexion, knee flexion, and trunk flexion. Rectus

Femoris EMG activity was recorded with the participant sitting on the edge of an examination table, knees bent with feet unsupported, and arms crossed at the chest. A three inch nylon strap was placed over the distal portion of the right thigh and the participant was instructed to lift their knee up against the strap 'as hard as they could'. This was repeated three times while the EMG activity was recorded. The maximal EMG activity was determined for the upper abdominals, lower abdominals and external oblique muscles by performing an abdominal MVC where the subject was supine, with the hips and knees flexed to 90 degrees while supported on a chair. The hip and knee angles were assessed by measuring with a goniometer (McCoy, Maryland Heights, MO). Pillows or blocks were added to the height of the chair to maintain the proper angle for the hips and knees. A three inch nylon strap was placed across the subjects' chest while the arms were at the side. The subject was instructed to crunch up into the strap 'as hard as they could'. This was repeated three times (figure 3). The hamstring MVC was recorded with the participant in the same position as the abdominal MVC, except the manual therapy strap was lowered to their pelvis for stability. The subjects were instructed to press their heels into the chair 'as hard as they could'. This was repeated three times, and recorded.[3]

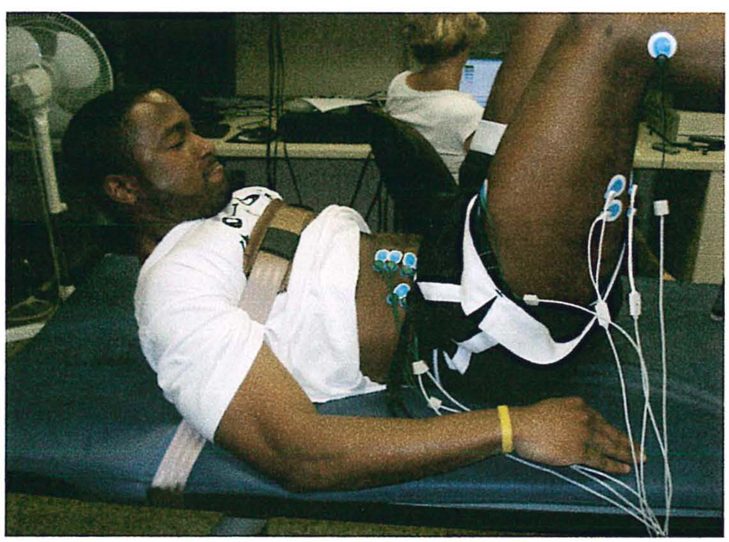


Figure 3: Abdominal maximum voluntary contraction.

After collecting the maximum voluntary contraction data, the participant was then instructed on how to perform the two types of the crunches. Three practice crunches in each position were performed before data acquisition and recording. The crunch without hamstring contraction was performed first followed by the crunch with hamstring contraction for each subject. The crunch without hamstring contraction was performed with the subject supine, feet and legs supported by a chair as previously described. The hips and knees were flexed at 90°as measured by a goniometer. A metronome (Franz MFG, CO, Inc, 2000, New Haven, CT 06511) and switch (UND, North Dakota) were used to control the speed of the movement and define the movement respectively. The switch was placed 3inches from the right hand while the metronome was set at 40 cycles per minute. Each subject was instructed to begin the crunch at the sound of the metronome, press the switch at the peak of the crunch, and return to the relaxed position on the mat after the next sound of the metronome. This allowed a pace of twenty crunches per minute. The EMG activity of five crunches was measured and recorded for later analysis. The positioning for the crunch with hamstring contraction was exactly the same with the exception that the subjects were instructed to perform an isometric hamstring contraction into the chair that their feet were resting on each time they performed a crunch.

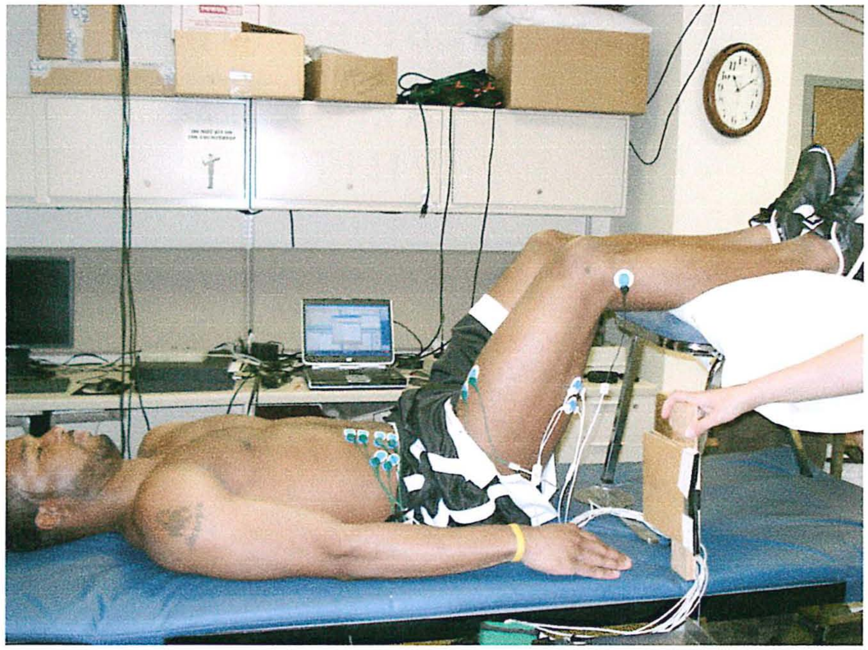


Figure 4: Crunch position showing EMG electrode set up.

DATA ANALYSYS:

To compare EMG data between subjects, signals were rectified and smoothed (RMS 50 ms) using the MyoResearch XP (Noraxon, USA) software program. The signals were then rendered as a percentage of maximal voluntary contraction for each subject. This was accomplished by normalizing the raw EMG signals to the maximal 1000 contiguous points of EMG activity that occurred within the maximal voluntary contraction of each muscle.

Statistical Comparisons

A repeated measures t-test was utilized to assess differences in EMG activity between the standard and alternate crunch positions (alpha = 0.05) using the Statistical Package for the Social Sciences (version 14, SPSS, Chicago, IL). Data presented with Mean ± standard deviation and utilized for statistical comparisons of the averages of three consecutive abdominal crunches recorded.

Chapter IV

Results

Thirty-four participants volunteered for the study. Four of the participants were excluded because they did not meet the study inclusion criteria. One participant was excluded due to hernia surgery, two were excluded due to knee surgery involving a hamstring graft on the right, and the fourth volunteer was excluded due to acute low back pain and an inability to lie supine. Of the remaining 30 participants in the study 6 (20%) reported performing abdominal exercises one or more times per week.

<u>Table 1.</u> Demographic Information

	Number	Mean Age	Min Age	Max Age
Female	15	24	23	30
Male	15	28	22	56

Upper Rectus Abdominus:

The addition of the hamstring isometric contraction to the crunch exercise significantly decreased upper rectus abdominus (URA) activity ($p<0.001$). Without the isometric hamstring contraction the mean EMG activity of the URA was 66.50% of the MVC. The simultaneous contraction of the hamstring and URA muscles resulted in a decrease of URA activity to 54.8% of the MVC. Therefore, adding the isometric hamstring contraction decreased the overall EMG activity of the URA by 11.7%. Data from two subjects was observed to be vastly different from the remaining 28 subjects for this activity. The data points were removed from the final statistical analysis after reviewing the raw data. To assure that removal of the data did not bias the final result, statistical analysis was performed with and without the questionable data. The statistical analysis was significantly different regardless of the inclusion or exclusion of these data points.

Lower Rectus Abdominus:

Results for lower rectus abdominus (LRA) activity were similar to URA activity during the crunch exercise with isometric hamstring contraction. LRA activity displayed a significant ($p<0.001$) decrease in activity with the isometric hamstring contraction. The mean LRA activity with simultaneous hamstring contraction and LRA contraction was 57.19% of the MVC. The mean LRA activity without hamstring contraction displayed increased LRA activity of 64.84% of the MVC. This is a difference of 7.65%. There was one subject whose data point for LRA activity with and without hamstring contraction was an outlier when compared to other data points. These outlier data points were removed from the final statistical analysis after it was determined there was a significant difference with and without the points factored into the data.

External Oblique:

The external oblique (EO) results also demonstrated a significant ($p<0.001$) decrease in activity during the crunch exercise with hamstring contraction when compared to the crunch exercise without hamstring contraction. During the crunch without hamstring contraction the mean EMG activity of the EO was 59.57% of the MVC. With the addition of the hamstring contraction to the partial crunch there was a decrease in EMG activity of the EO of 1.42%, to 58.15% of the MVC. After reviewing the raw data it was noted that one participant's results for EO activity with and without hamstring contraction were higher than other data points. To ensure they did not affect the final results statistical analysis was run with and without the data points. It was found that there was significant difference whether the points were included or excluded. These outlying data points were excluded from the final statistical analysis.

Rectus Femoris:

Unlike the abdominal muscle activation above, EMG activity for rectus femoris (RF) displayed no significance (p>0.05) difference with or without hamstring contraction. The mean EMG activity for the RF muscle during the crunch exercise without hamstring contraction was 4.74% of the MVC. There was an increase in EMG activity of the RF muscle during the crunch exercise with hamstring contraction, presenting a mean of 16.51% of the MVC. This is a difference of 11.77%.

Biceps Femoris and Semitendinosus

The simultaneous contraction of the biceps femoris (BF) and semitendinosus (ST) muscles during the crunch exercise resulted in a significant increase in EMG activity of the BF and ST muscles. The average EMG increase for the BF muscle was 809.8% while the ST increased approximately 1108.0% from the baseline values.

Table 2. EMG activity of abdominal and thigh musculature during a crunch with and without hamstring contraction.

	Number	Mean	Std Dev	Min	Max
URA w HS	28	54.80	22.06	17.03	101.27
URA wo HS	28	66.50	22.34	25.30	109.33
LRA w HS	29	57.19	26.06	13.97	113.00
LRA wo HS	29	64.84	24.04	15.67	114.33
EO w HS	29	58.15	29.84	11.37	122.33
EO wo HS	29	59.57	28.89	17.43	128.33
RF w HS	30	16.51	16.23	0.64	69.20
RF wo HS	30	4.74	5.40	0.41	27.93

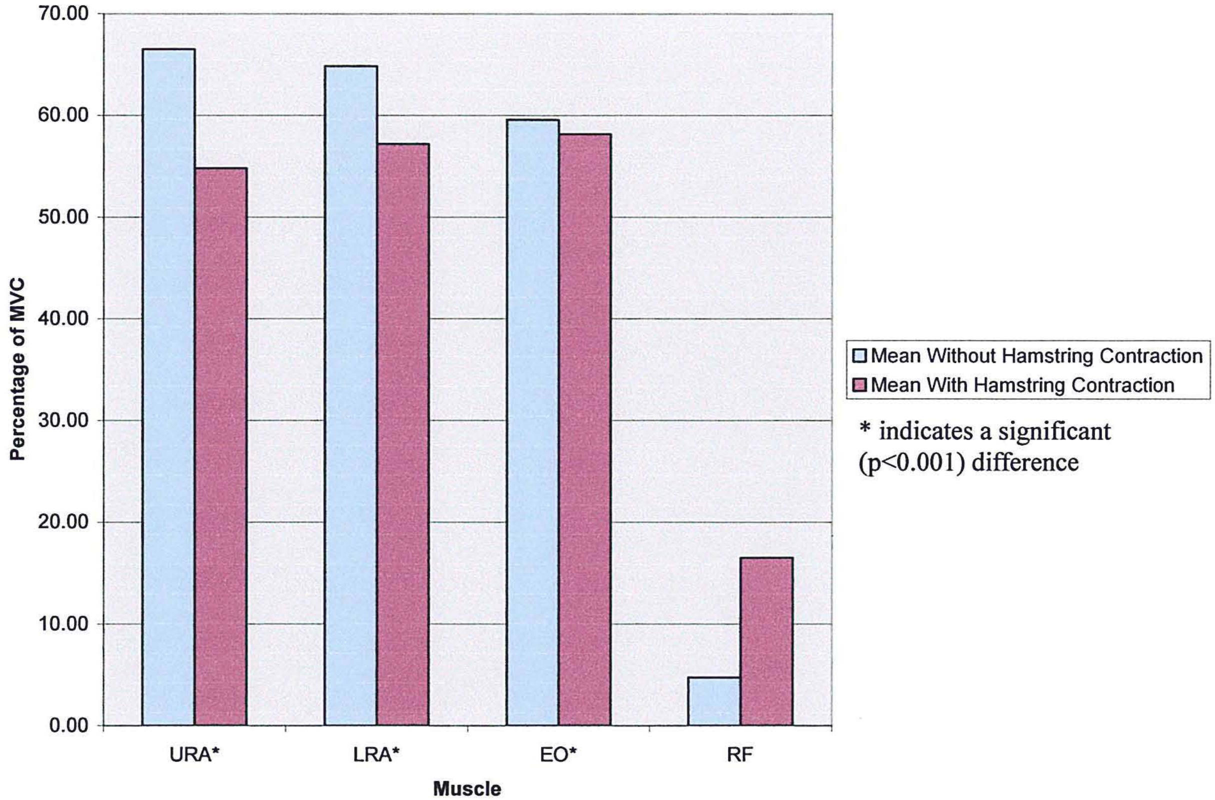


Figure 5. Mean EMG data as a percentage of the MVC for abdominal and thigh musculature during a crunch with and without hamstring contraction.

Chapter V

Discussion

This study demonstrates a significant decrease in abdominal activity during the abdominal crunch exercise with hamstring contraction as compared to the crunch exercise without hamstring contraction. Specifically, the study measured decreased abdominal activity in the upper and lower rectus abdominus and external oblique muscles. An increase in hip flexor (rectus femoris) activity was observed during the crunch with hamstring contraction but did not reach significance.

During an abdominal crunch the hip flexors and low back extensors work as a force-couple to anteriorly tilt the pelvis, increasing lumbar lordosis causing compression at L4-5 and the lumbar apophyseal joints, leading to an increased risk of low back pain. [8,7,11] While the hip extensor and abdominal muscles work to posteriorly tilt the pelvis, reducing lumbar lordosis. The hip extensor muscles also work antagonistically to the hip flexor muscles and are thought to cause reciprocal inhibition when activated, leading to a more efficient abdominal contraction. The current study positioned participants in 90° of hip and knee flexion, thus reducing the lumbar lordosis and decreasing the length of the hip flexor and abdominal muscles. According to the length tension relationship of muscle tissue, decreasing the length of a muscle will decrease the ability of the muscle to produce force. A study by Larson et al[14] measured EMG activity in the same musculature as the current study but positioned participants in 90° of knee flexion and 45° of hip flexion to perform the crunch with and without hamstring contraction. The results were much different. Their study reported a significant increase in lower rectus abdominus and external oblique activity during the crunch with hamstring contraction.

The difference in results indicates that the position of the lower extremities alters abdominal muscle activity and should be closely monitored during therapeutic exercises. The position of the pelvis was not measured or controlled in the current study and therefore this could be a confounding factor. The posteriorly tilted pelvis may have decreased the length of the lower abdominals and resulted in reduced recruitment of the lower abdominals to perform the abdominal crunch.

Participants were allowed three practice repetitions for the crunch and modified crunch exercises.[3,15] Although each subject was asked if they felt ready to perform the study, several participants reported difficulty with positioning and coordinating the hamstring contraction with the crunch while maintaining timing with the metronome. This may have led to a stronger co-contraction in the lower extremities and reduced abdominal activation during the modified crunch. Due to the fact that our participants had their hips at a greater angle of flexion (90°) than previous studies and their feet were not flat on the chair, more abdominal muscle activity may have been required to stabilize the trunk and lower extremities during this novel crunch exercise. Alternatively, the addition of a strong hamstring contraction may have acted as a support to the lower trunk, stabilizing the lower body and resulting in less recruitment of the abdominal muscles to maintain stability and perform the crunch exercise.

Although this study did not find a decrease in hip flexor activity during an abdominal crunch, the use of rectus femoris as a measure of hip flexor activity could have altered the results. Rectus femoris is a knee extensor as well as the most superficial hip flexor. Because of this, measuring psoas, the primary hip flexor, may have been a better indicator of hip flexor activity. However, to measure EMG activity of psoas invasive techniques using fine wire electrodes are required but not available to the researchers.

The clinical relevance of this study was to find a position in which the abdominal muscles are utilized in the most effective way to strengthen the core musculature. It is hypothesized that pain and/or instability has been related to muscular weakness and/or imbalance in the core musculature, which can lead to low back pain.[3] Low back pain is a common diagnosis in the field of Physical Therapy. Treatment for low back pain often includes strengthening the core musculature to obtain control and stability around the lumbar spine. Many abdominal exercises activate non-abdominal muscles, including the hip flexors, which prevent the traditionally weaker abdominal muscles from working to their fullest. This may limit the effectiveness of strengthening programs for the abdominals.

Chapter VI

Conclusion

The position used in this study hoped to reduce the compressive loads on the spine by reducing lumbar lordosis and decreasing the activation of the hip flexor muscles to allow better activation of the abdominal muscles. Unfortunately due to unknown variables, the results were not conducive to the initial aim of the study. Future studies should measure activity of the psoas muscle as the primary hip flexor, and also measure and control the position of the pelvis during the abdominal crunch.

APPENDIX A

RESEARCH PROJECT REVIEW AND PROGRESS REPORT
UNIVERSITY OF NORTH DAKOTA INSTITUTIONAL REVIEW BOARD

DATE 6-8-07 DEPARTMENT/COLLEGE PT

PRINCIPAL INVESTIGATOR Schawnn Decker

PROJECT TITLE The Effect of Hamstring Contractions in the Activation of the Abdominal Muscles During a Standard Abdominal Crunch

PROPOSAL NUMBER IRB-200607-024

IF MEDICAL COMPONENT, PLEASE GIVE PHYSICIANS NAME ______

IRB USE ONLY

☐ FULL BOARD REVIEW REQUIRED, EVEN THOUGH ORIGINAL APPROVAL WAS EXPEDITED

☒ CONTINUING APPROVAL, **EXPEDITED** CATEGORY 7

☒ NEXT REVIEW REQUIRED BEFORE: 7-10-08

☐ CONTINUING APPROVAL, BASED ON **FULL BOARD** REVIEW

☐ NEXT REVIEW REQUIRED BEFORE: ______

☐ SUSPEND APPROVAL, PENDING INVESTIGATION

☐ TERMINATE APPROVAL

COMMENTS OF REVIEWER: ______

Chair/Vice Chair/Member, IRB: [signature]

cc: Chair, Physical Therapy

Approval Date: 7-11-07

1. Is project complete? Yes ☐ No ☒

2. Is project ongoing? Yes ☒ No ☐
   If No, explain below and indicate if continued approval and continuing review is desired.

3. How many subjects have been enrolled in the research project:
   30 since the date of last approval, and
   30 since the initial approval

4. Is the research permanently closed to the enrollment of new subjects? Yes ☐ No ☒
   Have all subjects completed all research-related interventions? Yes ☒ No ☐
   Does the research remain active only for long-term follow-up of subjects? Yes ☐ No ☒

5. Is data analysis complete? Yes ☒ No ☐

*** If the research is permanently closed to the enrollment of new subjects, all subjects have completed all research-related interventions, the research does not need to remain active for long-term follow-up of subjects, and all data analysis is complete, please sign here that you would like the IRB to terminate approval for this project, and finish filling out the rest of this form.

Please terminate IRB approval for this research project. ______ Signature of Principal Investigator ______ Date

6. Has any additional grant money been awarded for this project in the past year? Yes ☐ No ☒
If yes, submit a copy of the grant along with this completed form.

7. Describe any adverse events and/or unanticipated problems involving risks to subjects or others that have occurred since the last approval. If you did not report the adverse event or unanticipated problem previously, a separate Unanticipated Problem/Adverse Event Form must be submitted to RD&C with this form.

None

8. Have any additional risks with this research been identified? Yes ☐ No ☒
Describe all benefits experienced by participants, and include a current risk/benefit assessment based on study results.

Participants have expressed appreciation in obtaining another technique that will ↑ abdominal strength

9. Have there been any changes or deviations from the approved protocol since the most recent approval? Yes ☐ No ☒ If Yes, elaborate below, and submit a separate Protocol Change Form to the RD&C indicating proposed protocol changes.

   a. Have any of these changes been implemented already? Yes ☐ No ☒
   If yes, please describe fully.

   b. Are any protocol changes being planned for later implementation? Yes ☒ No ☐
   If yes, please describe fully. A separate Protocol Change Form must be submitted to RD&C for approval before the proposed protocol changes can be implemented.

10. Have any subjects withdrawn from the research? Yes ☐ No ☒
If yes, state how many have withdrawn and describe the circumstances.

11. Have there been any complaints about the research since the last IRB review? Yes ☐ No ☒
If yes, please report and summarize the complaints and your response/action.

12. Summarize any multi-site trial reports relevant to your research.

None

13. Summarize any recent literature, findings, or other information relevant to your research, especially information about risks associated with the research.

None

14. Have all ~~PI's~~ involved with the research completed the IRB Educational Requirements?
Yes ☒ No ☐ (Educational requirements must be completed before the IRB can grant continued approval for the research project.)

15. On a separate piece of paper, provide a <u>thorough</u> protocol summary (approximately 300 words) giving a concise summary of the protocol's progress to date and the reasons for continuing the study or reasons for asking the IRB to terminate approval. The summary should include, for instance, an explanation of any complaints about the research, relevant multi-site trial reports, participant benefits, or a current risk-benefit assessment based on study results. Sufficient information is required in the summary so that the IRB can determine whether the proposed research continues to fulfill the criteria for approval.

16. A copy of the current informed consent document(s) (with the IRB Approval stamp), as well as a clean copy of the consent document(s) (with no IRB Approval stamp) must be submitted with this report.

17. Have there been any changes in the conflict of interest statement or situation for the Principal Investigators, research staff involved in the study, or each individual's respective family members in the last 12 months?
Yes ☐ No ☒ If yes, please describe fully on a separate sheet of paper.

Signature of Principal Investigator Schaunn Decker Date 6-18-07

Current email address: sdecker@medicine.nodak.edu

Current Address: 501 N Columbia Rd Stop 9037

This completed form should be returned to RD&C, University of North Dakota, 264 Centennial Drive Stop 7134, Grand Forks, ND 58202-7134.

REPORT OF ACTION: PROTOCOL CHANGE

University of North Dakota Institutional Review Board

Date: 6/26/2007 **Project Number:** IRB-200607-024

Principal Investigator: ✓ Decker, Schawnn; ~~Robbins, Heather; Rodman, Stephanie; Thurn, Becky~~

Department: Physical Therapy

Project Title: EMG Analysis of a Hamstring Co-Contraction and It's Effects on Abdominal Strength

The above referenced project was reviewed by a Designated Member for the University's Institutional Review Board on 7-11-07 and the following action was taken:

☒ Protocol Change approved. **Expedited Review** Category No. 7
Next scheduled review must be before: 7-10-08

☒ **Copies of the attached consent form with the IRB approval stamp dated** 7-11-07 **must be used in obtaining consent for this study.**

☐ Protocol Change approved. **Exempt Review** Category No. ______
This approval is valid until ______ as long as approved procedures are followed.
No periodic review scheduled unless so stated in the Remarks Section.

☐ **Copies of the attached consent form with the IRB approval stamp dated** ______ **must be used in obtaining consent for this study.**

☐ Minor modifications required. The required corrections/additions must be submitted to RDC for review and approval. **This study may NOT be started UNTIL final IRB approval has been received.**
(See Remarks Section for further information.)

☐ Protocol Change approval **deferred. This study may not be started until final IRB approval has been received.**
(See Remarks Section for further information.)

☐ Protocol Change **disapproved. This study may not be started until final IRB approval has been received.**

REMARKS: **Any unanticipated problem or adverse occurrence in the course of the research project must be reported within 5 days to the IRB Chairperson or RDC by submitting an Unanticipated Problem/Adverse Event Form.**

Any changes to the Protocol or Consent Forms must receive IRB approval prior to being implemented (except where necessary to eliminate apparent immediate hazards to the subjects or others).

PLEASE NOTE: **Requested revisions for student proposals MUST include adviser's signature. All revisions MUST be highlighted.**

☒ Education Requirements Completed. (Project cannot be started until IRB education requirements are met.)

[signature] 7-11-07

Signature of Designated IRB Member — Date
UND's Institutional Review Board

cc: Chair, Physical Therapy

If the proposed project (clinical medical) is to be part of a research activity funded by a Federal Agency, a special assurance statement or a completed 310 Form may be required. Contact RDC to obtain the required documents.

(Revised 10/2006)

APPENDIX B

INFORMED CONSENT

Title: ***EMG analysis of a hamstring co-contraction and its effects on abdominal strength.***

You are being invited to participate in a study conducted by Heather Robbins, Stephanie Rodman, Rebecca Thurn, and Dr. Schawnn Decker, DPT from the Physical Therapy Department at the University of North Dakota. The purpose of this study is to look at the effect of a hamstring co-contraction with the abdominal muscles during an abdominal crunch on a stable surface. Measurements from the abdominal and hamstring muscles will be taken using electromyography (EMG). EMG is a method of measuring the electrical output of muscles during activation. Initial abdominal crunches will be done on a stable surface with the lower legs supported on a chair, while activating abdominal contractions using a metronome. A second abdominal crunch will be measured with a co-contraction of the hamstrings while the legs are supported on the chair.

This procedure will involve placing six electrodes on various locations on the abdominals and on the posterior and anterior thigh. Only healthy individuals, over the age of 18, will be asked to participate in this study. Anyone with a history of abdominal or back surgery, hamstring strain, hamstring surgery, or any other medical condition that affects the participant from performing a crunch or hamstring contraction will not be eligible for this study. The benefit to you, as a participant, will be the experience of being involved in a scientific study and knowing that you will be contributing to the body of knowledge in exercise physiology and physical therapy.

You will be asked to perform three practice crunches on a stable surface with your lower legs up on a chair with and without a hamstring co-contraction prior to beginning EMG testing. Following the three practice crunches you will be required to perform a maximal voluntary contraction of your abdominals. You will crunch up against a resistive band placed around your chest, to measure your maximal contraction. EMG testing will take place during two sections of testing. Each will consist of five crunches to a metronome beat. The first section will be without a hamstring co-contraction and the second section will be with a hamstring co-contraction. This study will take approximately one hour of your time.

With any process of physical testing there are some degrees of risk. The investigators of this study have determined that the risk of injury or discomfort to the participants is minimal. During the process of recording the EMG information, we will need to place electrodes on the skin of the abdominals and the posterior and anterior thigh using an adhesive material. The hair at the electrode placement sites may need to the clipped in order to receive proper electrical readings. After electrode removal, there may be some redness on the surface of the skin, but this should resolve quickly.

There will be no personal identifiers such as names or numbers used during this study or in the results. All information will be kept confidential and will be identified to the researches by an assigned number. Data will only be released and available to the researches, the advisor, and the individuals involved in the IRB auditing procedures. All data and consent forms will be kept within the University of North Dakota Physical Therapy Department for three years, upon which all electronic media will be erased and paper documents shredded.

The experiment may be stopped by you or the researcher at any time if you are experiencing discomfort, pain, fatigue, or any other symptoms that may be detrimental to your health. You have the right to discontinue any involvement with the study at any time if you have reservations whatsoever. Your decision to participate will not have any effect on your relationship with the Physical Therapy Department or with the University of North Dakota in any way.

By participating in this study, you have the chance of winning a $30 gift card to your favorite local restaurant. Participants' names along with their favorite local restaurant will be obtained on a portion of the screening form which will be removed and destroyed following the gift card drawing. A participant from the study will be randomly drawn to win the gift certificate.

The researchers involved will be available to answer any questions that you currently have or have in the future about this research study. Questions may be asked by calling Dr. Schawnn Decker at 701-777-6389 or Stephanie Rodman at 701-770-0212. If you have any other questions or concerns, please call the Office of Research and Program Development at 701-777-4279. A copy of this consent form will be available to all subjects within this study.

I have read this consent form and I agree with all that is within. I understand the benefits as well as the risks of being a participant in this research study.

Signature_______________________________________ Date______________

SCREENING INFORMATION

Participant's Number:__________

Please fill out the following to the best of your knowledge.

Age:__________ Height:__________ Weight:__________

Sex: Male Female

Do you have a history of low back pain that has lasted longer than 3 days? Yes No

If yes, when was the last episode?____

Have you had any back or abdominal surgeries (C-sections or back fusions)? Yes No
If yes, please list here:____

Have you had an ACL repair using a hamstring graft? Yes No

Are you currently pregnant? Yes No

Do you have any conditions that would prevent you from lying on the floor and performing abdominal crunches? Yes No

Do you have any allergies or adverse skin reactions to rubbing alcohol, Band-Aids, adhesives, sandpaper, or hair clipping? Yes No

Do you participate in core stabilization, Pilates, or ball exercise routines? Yes No

If yes, how long have you been doing these exercises? ___Weeks ___Months ___Years

If yes, how may times a week do you do these exercises? 1-2 3-4 5-6

Please list any past or present medical conditions: Check if applicable.

___ High or low blood pressure ___ Cardiac Conditions
___ Skeletal or postural abnormalities of the spine

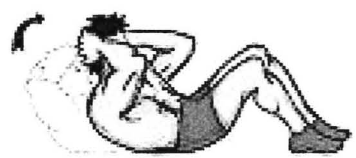
Please specify here:____

For participating in this study, you have a chance to win a gift certificate.
What is your favorite local restaurant?____
Name:___________________________________
Phone Number:____________________________

WANTED

People to participate in a research study, focusing on abdominal strengthening.

You will be required to perform abdominal crunches for the study.



Participants will be entered in a drawing to win a gift certificate to their favorite Grand Cities restaurant.

If interested please contact:
Stephanie (701) 770-0212
Becky (218) 791-8824
Heather (701) 215-1073

References

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