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The Effects of Static Stretching on Pennation Angle and Muscle Power Production in the Triceps Surae Complex

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The Effects of Static Stretching on Pennation Angle and Muscle Power Production in the Triceps Surae Complex

An Honors Thesis submitted in partial fulfillment of the requirements for Honors in Health and Kinesiology.

By Lacey Dennis

Under the mentorship of Dr. Li Li and Dr. Daniel Czech

ABSTRACT

Many studies have examined how power is affected by static stretching. However, little research has been completed to examine why the muscle power production is affected by static stretching. The purpose of this study is to see the correlation of how pennation angle (PA) and muscle power production (MPP) is affected by a static stretching protocol. For the methodology, PA of the medial and lateral gastrocnemius muscle will be measured using Terason ultrasound machine. After the PA is measured participants will perform a vertical jump on a force plate while utilizing a Vertec, to determine the height of their jump in order to calculate power. Then participants will complete the static stretching protocol. The protocol will have the participant place their foot on a pre-set incline board while keeping the bottom of their foot flush with the board's surface and the knee fully extended. This position will be held for 3x30s. Static stretching will be deemed reliable with an increase in 1 cm increase in the weight bearing lunge. Then PA and MMP of the medial and lateral gastrocnemius muscle will be measured after the stretching protocol. The results showed an increase in both pre-stretch lateral PA (13.61± 2.84°) to post-stretch lateral PA (15.61± 2.08°) and pre-stretch medial PA (13.81± 3.20°) to post-stretch lateral PA(16.34± 2.29°). Between pre-stretch MPP (3020.97 N ±2216.23 N) and post-stretch MPP (2369.68 N ±1524.47 N), a decrease in MPP was observed.

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First, I would like to thank Dr. Li Li for giving me the opportunity to work on this project. Also, taking the time to explain aspects of the project for my learning and understanding. I have been able to learn and challenge myself immensely with this project. Secondly, I would also like to thank Dr. Daniel Czech for working with me to prepare this project for the many conferences that I was able to present at. He is always a positive encouragement and has pushed me to think outside the box. Lastly, I would like to thank Klarie Ake, research assistant, with helping me set up parts of the protocol in the biomechanics lab and making sure everything would go smoothly.

Introduction

Static stretching is shown to have benefits with slower velocity eccentric contraction, and contractions of a more prolonged duration or stretch-shortening cycle. This is applicable for sports such as: shot put, discus, and eccentric contractions with long contact times when jumping or hopping (Behm, 2011). Given the potential positive effect of pre-exercise static stretching on the reduction of incidence of muscle strains, static stretching can be incorporated into a comprehensive pre-exercise warm-up routine, when maximal muscular performance is not the focus (Simic, Sarabon, & Markovic, 2013). A duration of 0-45s could be performed after activity to facilitate an increase in range of motion, flexibility, and decrease muscle soreness (Behm, & Chaouachi, 2011; Kay, & Blazevich, 2012; Simic, Sarabon, & Markovic, 2013).

However, static stretching is not suggested to be used before activities that are high-speed, explosive or in activities were reactive forces are necessary due to the negative impact on acute power production and muscle performance (Cramer, et al.2005; Kay, & Blazevich, 2012;Simic, Sarabon, & Markovic, G. 2013). Activities such as: vertical jump, sprint, agility, and one repetition maximum lifts (Behm, 2011) can be affected by static stretching by reduction in force production, balance, sprint times, power output, peak torque, and electromyography amplitude (Cramer,et al.2005; Curry, et al. 2009; Behm, et al. 2004). It also needs to be noted that the effects of static stretching decreasing the musculotendinous unit stiffness can be maintained for 10 minutes after static stretching (Nakamura et al., 2011). The mechanism for the decrease in the musculotendinous unit stiffness and muscle stiffness has been related to changes at the musculotendinous unit proximal to the musculotendinous junction and an increase in the flexibility and movement of the aponeurosis and the connective tissue (Nakamura et al., 2011). Many studies have examined the effect of static stretching on muscle power production based on the duration, type, and timing of stretch (Cramer,et al.2005; Curry, et al. 2009; Behm, et al. 2004; Kay, et al. 2013;Simic, Sarabon, & Markovic, 2013; Behm, Bambury, Farrell, and Power, 2004). However, none of the present studies justify why the muscle power production is affected (Cramer, et al.2005, Curry, et al. 2009; Behm, et al. 2004, Kay, et al. 2013; Sarabon, & Markovic, 2013; Behm, Bambury, Farrell, and Power, K. 2004). There are a number of reasons the muscle power production can be effected such as a result of a change in pennation angle.

Pennation angle is defined as the angle between the insertion of the muscle fascicle and the aponeurosis of the muscle (Kawakami, Ichinose, & Fukunaga, 1998; Padhiar, et al. 2008). When a muscle contracts, muscle fibers shorten and pennation angle increases (Padhiar, et al. 2008; Kawakami, et al., 1998). The correlation between pennation angle and muscle power production can be found but no current study examines how they are affected by static stretching (Edama, et al. 2015; Kawakami, et al., 1998). When a muscle contracts the pennation angle will increase and reduce the force-producing capabilities of the muscle as the force of the muscle fibers being exerted on the tendon is equivalent to the value of the cosine of the pennation angle (Finni, 2006; Kawakami, et al., 1998).

Pennation angle can be measured with the use of ultrasound (US). When using ultrasound understand the echogenicity, ability to reflect or transmit US waves in the context of surrounding tissues, is important in order to know what structures are being seen (Ihnatsenka, 2010). In this study ultrasound will be used to look at pennation angle. The muscle fascicles and aponeurosis in an ultrasound image will appear as hyperechoic lines (Ihnatsenka, 2010). In order to manipulate the US probe the mnemonic PART (pressure, alignment, rotation, and tilt) is useful (Ihnatsenka, 2010). The correct pressure, alignment, rotation, and tilt application can considerably improve the image quality when measuring structures with US. Knowledge of fundamentals of US will allow practitioners and researchers to use musculoskeletal US effectively and safely (Ihnatsenka, 2010).

Currently, there is a lack of research examining the effect of static stretching on muscle power production and pennation angle. The significance of this study is to explain why muscle power production and pennation angle are affected by static stretch in the triceps surae muscle. For this study we expect the pennation angle to increases, which will cause less muscle power production to be produced after static stretching.

Methods

Participants:

The participants for this study were college aged students, 18-28 years old, from Georgia Southern University College of Health and Human Science. To determine if the participants were eligible to complete the study, a Par Q form was be completed. If the participants answered "yes" to any of the questions on the Par Q and they would not be eligible to participant in the study. The Par Q form was within the informed consent that was explained and signed before the participant were able participate in the study.

Ultrasound:

The participant stood on a small beam with one foot off the ground while holding on to a stabilization bar to maintain balance during the measurement. While standing with their forefoot on the beam, the ankle was in a neutral position. To ensure that the participant was standing in a neutral position airex pads, three for this study in order to be at the same height of our small beam, were placed against the small beam for the participant to rest their calcaneus on before testing. During testing to ensure that the participants were standing in a neutral position it was observed if they are in contact with the airex pad. If their calcaneus was in contact with the airex pad then the participant was not in a neutral position. The participant was instructed to raise up or down in order to obtain a neutral position of the ankle. The longitudinal images of the medial and lateral gastrocnemius were obtained at the 30% proximal site on the connecting line between the popliteal crease and the center of the lateral and medial malleolus (Edama, et al., 2015; Abellaneda, et al. 1998). The mediolateral widths of the medial and lateral gastrocnemius were measured over the one-half of the width of the belly of the muscle which were determined on the skin surface (Kawakami, et al.1998).

Vertical Jump:

The vertical jump was completed by jumping straight up with the only the use of the gastrocnemius soleus complex. The ankle was dorsiflexed to jump up while the knees stayed extended or locked, so that no countermovement is produced by anterior muscles of the upper leg. The participants performed a vertical jump on a force plate while utilizing a Vertec to determine the height of their jump. During the jump the flight time, height of jump, and force of the jump were collected. The force was determined by finding the difference in the force exerted on the force plates from the participant standing and participant jumping. The participant had two practice jumps where data was not recorded. After the practice jumps the participant performed three maximal jumps with flight time, height of jump, and force of jump recorded. Participants performed single jumps and rapid jumps for a total of three trials both before, and after the stretch. A single jump was performed by completing one jump with maximum power output. Jumping was performed before and after static stretching to determine if there was a difference in the jump force after static stretching.

Stretch Effectiveness:

This range of motion was measured before and after static stretching to ensure that stretch was effective. The range of motion was determined with the use of a weight bearing lunge (Konor, 2012). The weight bearing lunge was performed in a standing position with the heel in contact with the ground, the right knee in line with the second toe, and the great toe 10cm away from the wall (Konor, 2012). The distance was measured with the use of a centimeter measuring strip secured to the floor. Balanced was maintained by allowing contact with the wall using two fingers from each hand (Konor, 2012). Participants were asked to lunge forward, directing their knees towards the wall until there right knee touched the wall (Konor, 2012). The foot was progressed away from the wall 1 cm at a time if the subject was able to touch the wall at 10 cm (Konor, 2012). If the subject could not reach the wall at 10 cm then the subject was progressed towards the wall 1 cm at a time (Konor, 2012). The subject has to be able to touch the wall with their right knee without lifting the heel from the ground (Konor, 2012). The stretch will be reliable with a 1 cm increase in the weight bearing lunge before and after static stretching. The increase of 1 cm of distance between pre- and post- measurements equals 4.1* of dorsiflexion ROM (Konor, 2012). If the static stretching after the initial 30 seconds for a total of three times was not reliable the participant will be stretched again for another three sets of 30 seconds.

Static Stretching:

Static stretching was performed by having the participant place their foot on an incline board and maximally dorsiflex the ankle joint while keeping the bottom of their foot flush with the board's surface and the knee fully extended (Cornwell, A., Sidaway, B., Nelson,A. 2002). This position was held for 30 seconds for a total of three times.

Experimental Protocol:

The participants first performed a vertical jump on a force plate to determine the amount of muscle power production the triceps surae produced before stretching. Next, the pennation angle was measured and recorded using an ultrasound. After the pennation angle was measured, the participant's ankle dorsiflexion range of motion was determined before completing the static stretching protocol. Once dorsiflexion range of motion was measured the participant completed the static stretching protocol. Then participant's pennation angle was measured again and recorded. The participant then perform another vertical jump on a force place to determine the effect of static stretching on flight time. The results from before stretching and after stretching was recorded and analyzed. For the control participants they completed the protocol above, however, they did not complete the static stretching protocol. Instead these participants went through the measurement of pennation angle and vertical jump on the force plate twice in order to determine reliability of pennation angle measurements between trials.

Results

The descriptive statistics (X± SD) for the pre-stretch and post-stretch pennation angle (PA) measurements for medial and lateral triceps surae complex in test subjects can be seen in table 1. The pennation angle mean and standard error values for test subjects can be seen in figure 1. The t-test values for pre-stretch and post-stretch pennation angle for the lateral triceps surae is .00272. The effect size (using Cohen's d) for pre-stretch and post-stretch pennation angle for the lateral triceps surae is 0.6897. This value is medium which shows there was a consistent value for pennation angle of the lateral triceps surae complex. The t-test values for pre-stretch and post-stretch pennation angle for the medial triceps surae was .00544. The effect size (using Cohen's d) for pre-stretch and post-stretch pennation angle for the lateral triceps surae is 0.7249. This value is medium which shows there was a consistent value for pennation angle of the lateral triceps surae complex. The descriptive statistics weight bearing lunge measurement averages for static stretching reliability can be found in table 2. The descriptive data of test subjects WBL pre-stretch, WBL post-stretch, PA Lateral pre-stretch, PA Lateral post-stretch, PA medial pre-stretch, and PA medial post-stretch can be found in table 3. The values of pre-stretch muscle power production and post-stretch muscle power production for each test subject can be seen in table 4. The descriptive statistics (X± SD) for muscle power production in test subjects can be seen in table 5. The t-test value for the pre-stretch muscle power production and post-stretch muscle power production was 0.0664.

Test Subjects

Table 1

Pre-stretch and Post-stretch Pennation Angle (PA)Measurement Averages for Medial and Lateral Triceps Surae

Pennation Angle	Mean± SD	Standard Error
Pre-stretch Lateral	13.61± 2.84°	0.790
Post-stretch Lateral	15.61± 2.08°	0.576
Pre-stretch Medial	13.81± 3.20°	0.887
Post-stretch Medial	16.34± 2.29°	0.635

Table 2

Weight Bearing Lunge Measurement Averages for Static Stretching Reliability

Weight Bearing Lunge (WBL)	Mean± SD
WBL pre-stretch	9.423±2.44
WBL post-stretch	10.86± 2.54

Table 3

Values of test subjects WBL pre-stretch, WBL post-stretch, PA Lateral pre-stretch, PA Lateral post-stretch, PA medial pre-stretch, and PA medial post-stretch.

Subject	WBL pre-stretch	WBL post-stretch	PA Lateral Pre-stretch	PA Lateral Post-stretch	PA Medial Pre-stretch	PA Medial Post-stretch
1	9	11	15.04	17.1	19.02	19.74
2	9	11	10.1	15.39	11.033	14.12
3	7	8	10.86	13.34	9.27	13.2
4	11	12	17.4	17.7	14.83	15.38
6	13	14	11.17	13.51	14.36	17.8
9	6	7	14.96	18.27	15.57	16.372
13	11	13	15.745	14.009	12.585	17.771

Table 4

Values of test subjects pre-stretch muscle power production and post-stretch muscle power production

Subject	Pre-stretch single jump muscle power production	Post-stretch single jump muscle power production
1	2944.29	2993.15
2	1317.44	1324.9
3	5041.88	4520.49
4	3225.97	2255.92
6	877.24	650.06
9	1006.52	862.39
13	6733.44	3980.86

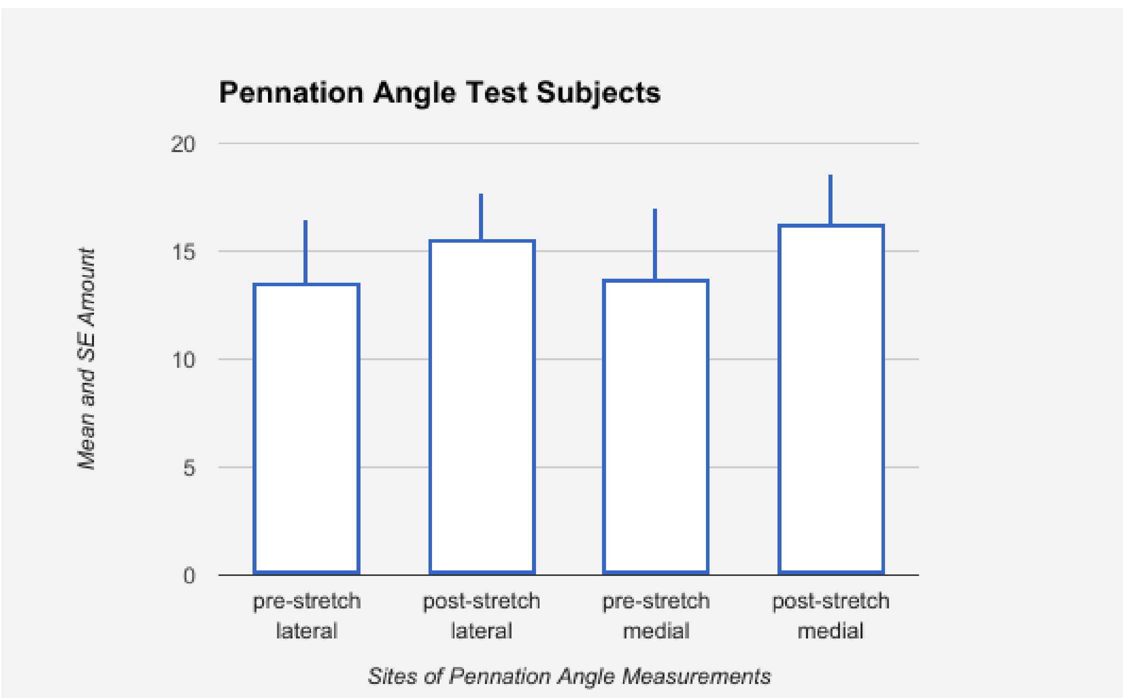

Figure 1. Pennation Angle mean and standard error values for test subjects who performed static stretching protocol.

Table 5		
Muscle Power Production pre-stretch single jump and post-stretch single jump		
Muscle Power Production	Mean$\pm$ SD	Standard Error
Pre-stretch power	3020.97$\pm$2216.23	614.6714
Post-stretch power	2369.68$\pm$1524.47	422.813

The descriptive statistics (X$\pm$ SD) for control subject's trial 1 and trial 2 pennation angle (PA) measurement averages for medial and lateral triceps surae can be found in table 6. The values of control subjects PA Lateral trial 1, PA Lateral trial 2, PA medial trial 1, and PA trial 2 can be found in table 7. The t-test values for pre-stretch and post-stretch pennation angle for the lateral triceps surae in control subjects was 0.3961. The t-test values for pre-stretch and post-stretch pennation angle for the medial triceps surae was 0.4457. The values of control subjects PA lateral trial 1, PA lateral trial 2, PA medial trial 1, PA medial trial 2 can be found in table 7. The values of pre-stretch muscle power production and post-stretch muscle power production for each test subject can be seen in table 8. The pennation angle mean and standard error for control subjects, ones who did not performed static stretching protocol can be found in figure 2. The descriptive statistics (X$\pm$ SD) for muscle power production in control subjects can be seen in table 9. The t-test value for the pre-stretch muscle power production and post-stretch muscle power production was 0.2257.

Control Subjects

Table 6

Trial 1 and Trial 2 Pennation Angle (PA)Measurement Averages for Medial and Lateral Triceps Surae

Pennation Angle	Mean± SD	Standard Error
Trial 1 PA Lateral	11.58± 3.709°	1.659
Trial 2 PA Lateral	11.61± 3.86°	1.726
Trial 1 PA Medial	14.037±2.08°	0.931
Trail 2 PA Medial	14.067± 2.26°	1.008

Table 7

Values of control subjects PA Lateral trial 1, PA Lateral trial 2, PA medial trial 1, and PA trial 2

Subject	PA Lateral Trial 1	PA Lateral Trial 2	PA Medial Trial 1	PA Medial Trial 2
10	15.48	15.47	12.679	12.98
14	8.48	8.56	17.257	17.19
15	12.71	12.877	14.729	15.12
16	6.944	6.6	11.93	11.195
17	14.308	14.56	13.59	13.85

Table 8

Values of pre-stretch muscle power production and post-stretch muscle power production in control subjects.

Subject	Pre-stretch single jump muscle power production	Post-stretch single jump muscle power production
10	1120.57	1146.95
14	2576.43	2310.17
15	1127.09	1285.01
16	1845.79	2647.6
17	500.42	520.55

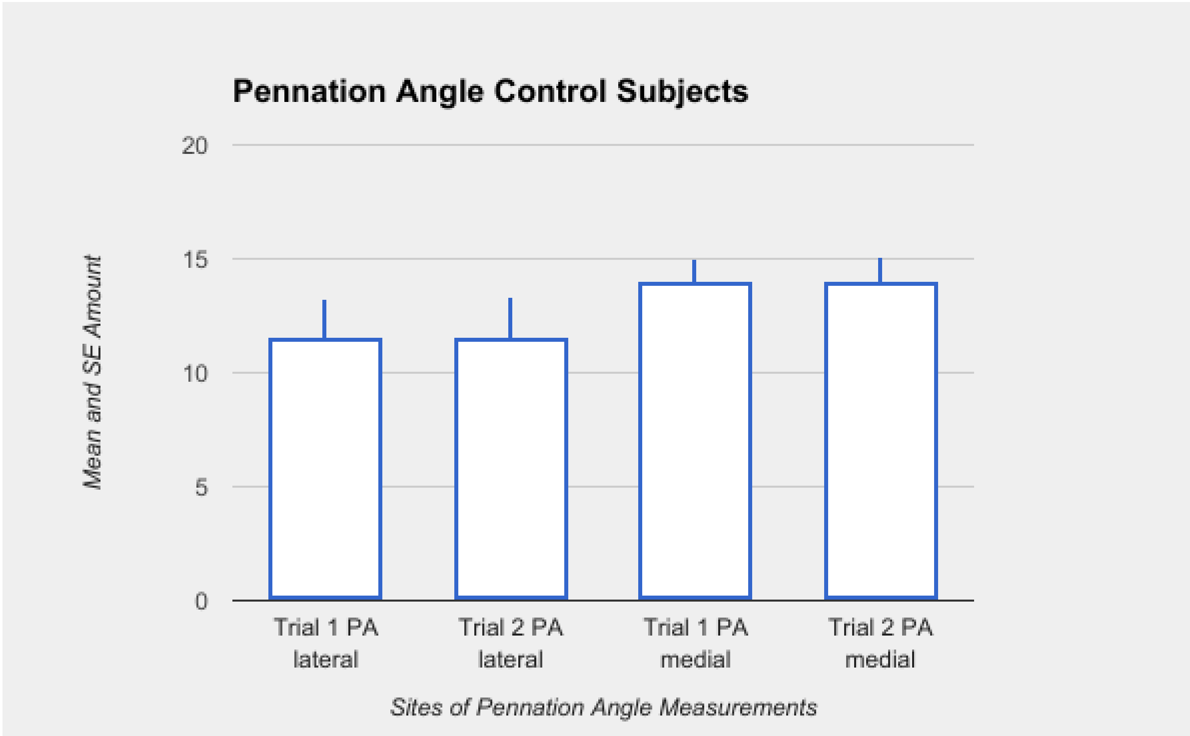

Figure 2. Pennation Angle mean and standard error for control subjects, ones who did not performed static stretching protocol

Table 9

Muscle Power Production pre-stretch and post-stretch single jump

Muscle Power Production	Mean± SD	Standard Error
Pre-stretch power	1434.06±796.67	356.28
Post-stretch power	1582.06±879.05	391.78

Discussion

When performing ultrasound measurement the ultrasound user has to be competent in the measuring technique with the ultrasound probe. If the user is not competent then the data could be unreliable (Ihnatsenka, 2010). In this study the user competency was verified with the use of control subjects. From the data is can been seen that the pennation angle was measured in two trials with the results being within less than 1° of each other. In this study the muscle power production was also measured to see how it was affected when the static stretching protocol was not complete. After measuring muscle power production with the control subjects we saw in increase in muscle power production between the two trials. This can also support the findings from this study.

Based on the results from the study, it can be concluded that our hypothesis was valid. One part of the hypothesis was the effect of static stretching pennation Angle. From this study it showed that pennation angle measurements when compared before and after static stretching did increased on both the medial and lateral gastrocnemius. The second part of the hypothesis was the effect of static stretching on muscle power production. This study showed that the muscle power production when compared before and after static stretching did decreased. Both of these finding support our hypothesis.

This study can also be deemed valid from the results found from the control subjects. The trial 1 and trial 2 pennation angle measurements averages for medial and lateral triceps surae control subjects were within less than 0.1° of each other. For muscle power production pre-stretch single jump and post-stretch single jump in control subjects showed an increase in muscle power production. This increase could be due to the subjects becoming more familiar with how to jump without using their knees between the two trials. However, even though this learning curve could have been present the fact that the muscle production decreased with static stretching and increased without static stretch shows that the muscle power production was affected by the static stretching.

Limitations for this study include pennation angle usually is a 3D measurement. However, if there is a change in measuring pennation angle with a 2D ultrasound then measuring pennation angle with a 3D will demonstrate a change in pennation angle. This limitation does not affect our results.

When a muscle is contracted it is known that the pennation angle will increase which will reduce the force-producing capabilities of the muscle (Kawakami, Y., et al., 1998). In many other studies it was found that static stretching would lead to a decrease in muscle power production, which is what was also found in this study. However, other studies did not look at specific aspects within the musculoskeletal unit like pennation angle to determine why the decrease in muscle power production was occurring. Overall, this study showed that the decrease in muscle power production after static stretch could be due to the increase in pennation angle. This factor could be one of many that cause a decrease in muscle power production, however from the results it can be seen that it is one factor that decreases muscle power production in high intensity activities. In future studies other aspects of the musculoskeletal system could be observed to see if those also have an effect on muscle power production after static stretching. Also, this study could be performed on specific sports and/or athletes to see if there would be a difference due to the different types of musculature on different types of athletes.

APPENDIX A

RESEARCH QUESTION/ EXCLUSION CRITERIA/ RISK

Purpose

The purpose of this study is to determine the effects of static stretching on muscle power production in regards to pennation angle.

Exclusion Criteria

Participants for this study will be no more than 30 total. Participants include both male and female participants from age 20-28. Exclusion criteria include if a doctor has diagnosed a heart condition and that the participant should only do physical activity when recommended by a doctor, pain in chest during physical activity, pain in chest in the last month while not doing physical activity, if the participant ever loses balance because of dizziness or ever loses consciousness, bone or joint problems that could be worsened by change in physical activity, prescribed medications for blood pressure or heart condition, any reason the participant should not participate in physical activity or if the participant has taken pain medication in the last 24 hours.

Risk

There is minimal risk with this research study. If anything were to happen to a participant during this study, is could be caused by tripping, losing balance, possible having a skin reaction to the ultrasound gel, over stretching, pulling a muscle when jumping on the force plate, or falling when jumping. We will minimize the risk by clearing the testing area, stop testing if there is skin reaction to the ultrasound gel, instruct participants on appropriate stretching techniques, have an emergency stop button for the Biodex machine, asking participants if there is any reason they should not participate in jumping, and instructing them on how to safely jump in a manner that prevents injury.

APPENDIX B

IRB APPROVAL

APPENDIX C

INFORMED CONSENT FORM

COLLEGE OF Health and Human Sciences

SCHOOL OF Health and Kinesiology

INFORMED CONSENT FORM

Principal Investigators: Lacey Dennis Student, Eva Blais Student, Kolyse Wagstaff Student, Li Li, Ph.D Research Professor

Title of Project: Potential mechanisms for reduction of muscle power production after static stretching.

Purpose of the Study: To determine the effects of static stretching on muscle power production in regards to proprioception, pennation angle, and electrical mechanical delay.

Testing Procedures: This study will be performed in the Biomechanics Laboratory. The testing will occur only once lasting approximately one hour. You will be informed about the testing procedures and possible risks and be asked to sign the informed consent forms. You will then be asked to fill out medical history and activity level questionnaires, and provide basic demographic data.

For the study you will begin by performing a vertical jump on this force plate to measure maximum force output of the gastrocnemius complex. Then you will then proceed to one station; either pennation angle, proprioception, or electrical mechanical delay. From there you will rotate to the next station. After you have completed each station, you go through a static stretching protocol. Before stretching, we will measure you dorsiflexion range of motion using a goniometer. You will be statically stretched by standing on a slant board with you heel still touching the ground and standing upright. After stretching we will measure you dorsiflexion range of motion again, to achieve reliable stretching an increase in 3° of dorsiflexion must be seen. After static stretching you go through the stations again. After pennation angle, electrical mechanical delay, and proprioception are measured after static stretching your maximum force production will be measure using the force plate.

Discomforts and Risks: There is minimal risk with this research study. If anything were to happen to a participant during this study, is could be caused by tripping, losing balance, possible having a skin reaction to the ultrasound gel, over stretching, pulling a muscle when jumping on the force plate, or falling when jumping. We will minimize the risk by clearing the testing area, stop testing if there is skin reaction to the ultrasound gel, instruct participants on appropriate stretching techniques, have an emergency stop button for the Biodex machine, asking participants if there is any reason they should not participate in jumping, and instructing them on how to safely jump in a manner that prevents injury. If a participant does sustain a life threatening injury 911 will be called. If a participant does sustain an injury that is not life-threatening then they will be directed to a local physician.

Benefits: There are no direct benefits offered to you for participation in this study. Despite this, the benefit to society will be to contribute to the body of knowledge regarding possible explanation for decreased muscle power production after static stretching.

Statement of Confidentiality: Every effort will be made to ensure confidentiality is maintained. All data will be deidentified and stored in a password protected computer. Signed consents and all other paper documents will be kept in a locked cabinet in a locked room.

Right to Ask Questions: You have the right to ask questions and have those questions answered. If you have questions about this study, please contact Lacey Dennis, Eva Blais, or Kolyse Wagstaff or Dr. Li Li, whose contact information is located at the end of the informed consent. For questions concerning your rights as a research participant, contact Georgia Southern University Office of Research Services and Sponsored Programs at 912-478-0843.

You will not receive compensation for your participation in this project.

Medical Liability: You understand that medical care is your responsibility in the event of injury resulting from research, no financial compensation or free medical treatment is provided. In the event of an emergency 911 will be called. For all minor injuries, you will be advised to consult with your healthcare provider.

Voluntary Participation: You understand that you do not have to participate in this project and that your participation is purely voluntary. If it is applicable, you may decline to answer specific questions. You may choose to withdraw from this study without penalty. If you choose not to participate or would like to stop at any time, please notify either principal investigators: Lacey Dennis, Eva Blais, Kolyse Wagstaff or Dr. Li Li.

Exclusion Criteria: You understand that if you answer yes to any of the following questions, you will not be able to participate in this study for health safety reasons.

1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?
2. Do you feel pain in your chest when you do physical activity?
3. In the past month, have you had chest pain when you were not doing physical activity?
4. Do you lose your balance because of dizziness or do you ever lose consciousness?
5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?
6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?
7. Do you know of any other reason why you should not do physical activity?
8. Have you taken any pain medication within the last 24 hours?

You understand that you may terminate participation in this study at any time without prejudice to future care or any possible reimbursement of expenses, compensation, employment status, or course grade except provided herein, and that owing to the scientific nature of this study, the investigator may in his/her absolute discretion terminate the procedures and/or investigation at any time.

You understand that there is no deception involved in this project.

You certify you are 18 years of age or older and you have read the preceding information, or it has been read to you, and understand its contents. If you consent to participate in this study and to the terms above, please sign your name and indicate the date below.

You will be given a copy of this consent form to keep for your records. To contact the Office of Research Compliance for answers to questions about the rights of research participants or for privacy concerns please email IRB@georgiasouthern.edu or call (912) 478-0843. This project has been reviewed and approved by the GSU Institutional Review Board under tracking number __H17100__.

Title of Project: Potential mechanisms for reduction of muscle power production after static stretching.

Principal Investigator: Lacey Dennis ld02728@georgiasouthern.edu, Eva Blais eb03135@georgiasouthern.edu, or Kolyse Wagstaff kw06640@georgiasouthern.edu

Faculty Advisor: Li Li, PhD, office address: Room 0107B – Hollis Building, 62 Georgia Ave, telephone: (912)478-0200, email: lili@georgiasouthern.edu

____________________________________ ____________________

Participant Signature Date

I, the undersigned, verify that the above informed consent procedure has been followed.

____________________________________ ____________________

Investigator Signature Date

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