Spring 5-2014

Self Myofascial Release: Effects on Hamstring Range of Motion and Torque

Dillion F. Evans
University of Southern Mississippi

The University of Southern Mississippi

Self Myofascial Release: Effects on Hamstring Range of Motion and Torque

by

Dillion F. Evans

A Thesis
Submitted to the Honors College of
The University of Southern Mississippi
in Partial Fulfillment
of the Requirement for the Degree of
Bachelor of Science
in the School of Human Performance and Recreation

May 2014

Approved by

Michael Webster, Ph.D., Thesis Advisor
Associate Professor of Exercise Science

William Holcomb, Ph.D., Thesis Co-advisor
Associate Professor of Athletic Training

Michael D. Forester, Ph.D., Dean
College of Health

David R. Davies, Ph.D., Dean
Honors College

Abstract

Research has indicated that static stretching may reduce force production capabilities. This has led many practitioners to exchange static stretching for alternative methods of increasing range of motion (ROM) in warm-ups. Despite having little research to support its use, self myofascial release—foam rolling—has been suggested as a viable alternative (Macdonald et al, 2013). The objective of this study was to determine how self myofascial release (SMR) of the hamstring muscle group affects ROM and torque production capabilities of the hamstring muscle group. Ten subjects (age 26.5 $\pm$ 6.5 years, mass 74.4$\pm$12.1 kg, height 173$\pm$8 cm) were recruited. A within subjects randomized, cross-over design was used. In the control session subjects warmed up and rested passively before having their hamstring ROM and isokinetic eccentric/concentric hamstring torque production capabilities measured. In the experimental session, subjects warmed up and performed SMR before testing. Paired t-tests were used to assess mean differences between passive and experimental measures ($p > 0.05$). No significant differences in ROM or torque production were found between the control and experimental measures. In contrast to previous reports, these findings suggest that SMR is no more effective than passive rest in increasing ROM or isokinetic force production of the hamstring muscle group.

Key Words: Self myofascial release, foam rolling, hamstring, range of motion, torque

Dedication

To my fiancé, Meagan Farris, and my parents, Shane and Rhonda Evans:

Thank you for your support and your endurance of my frequent use of “homework” as an excuse for the past four years.

Acknowledgements

Much credit is due to my Advisor, Dr. Michael Webster, for his patient guidance and encouragement. Without his efforts, this work could not have been completed. I greatly appreciate all that you have done.

I would also like to acknowledge Michael Robbins. His ideas and assistance in the lab contributed much to the success of this study. Thank you for all the time you dedicated to this project.

Table of Contents

List of Tables

List of Abbreviations

SMR	Self Myofascial Release
ROM	Range of Motion

Introduction

In recent decades, there have been numerous studies on static stretching (Behm & Chaouachi, 2011; Kay & Blazevich, 2012), and many of these works indicated that static stretching may temporarily decrease force production and related factors (Fletcher & Anness, 2007; Fletcher & Jones, 2004; Knudson, Bennet, Corn, Leick, & Smith, 2000; Kokkonen, Nelson, & Cornwell, 1998; Winchester, Nelson, Landin, Young, & Schexnavder, 2008; Winchester, Nelson, & Kokkonen, 2009; Yamaguchi & Ishii, 2005).These reports have lead professionals in the field of human performance to reconsider where static stretching fits into their strength and conditioning programs. Consequently, many have decided to remove static stretching from their warm-ups and replace it with other methods that may increase range of motion without decreasing force production. One suggested alternative is self myofascial release (SMR) (Macdonald et al., 2013).

Self myofascial release is a type of self massage in which the practitioner utilizes their body weight and implements such as foam rollers to apply pressure and stretch to problematic areas of the body in an attempt to improve tissue quality. The theory behind this practice centers on the fascia, which is a normally gelatinous tissue that envelopes the musculature in the human body. When exposed to injury, inflammation, inactivity, or other forms of trauma, the fascia achieves a more solid state and forms adhesions with the underlying musculature (Barnes, 1997; Sefton, 2004). These adhesions create tension and pain that resonates throughout the body thereby limiting range of motion (ROM) and facilitating dysfunctional movement patterns. It is proposed that the proper application of pressure and stretch can release these adhesions, eliminate pain, and restore a healthy ROM (Barnes, 1997; Sefton, 2004).

Self myofascial release is the do-it-yourself version of an osteopathic treatment known as myofascial release. While the term myofascial release is relatively new—coined in 1960s by Robert Ward—the practice has been around since the late 19th century (Grant & Riggs, 2008). It originated from the mind of Andrew Taylor Still who taught that fascia is ubiquitous in the human body and that abnormalities in one area of the fascia can lead to pain or illness in the rest of the body (Findley & Shalwala, 2013). To treat fascial abnormalities and alleviate pain, Still used pressure applied via touch and feedback from the patient's body (Educational Council on Osteopathic Principles, 2011). Over the years, findings concerning the fascia have confirmed Still's ideas. An example of this is Dr. Janet Travell's identification of myofascial trigger points—small, dysfunctional areas of the muscle and fascia that refer pain to different areas of the body when palpated (Travell, 1942).

Though the ideas behind myofascial release are supported by research, there is very little empirical data to support the efficacy of the treatment (Remvig, Ellis, & Patijn, 2008). The same can be said for its descendent, SMR. To date, only six peer review studies of SMR have been published (Curran, Fiore, & Crisco, 2008; Healey, Hatfield, Blanpied, Dorfman, & Riebe, 2014; Lanigan & Harrison, 2012; Macdonald et al., 2013; Miller & Rockey, 2006; Okatoma, Masuhara, & Ikuta, 2014). Of these six, only three have examined factors that are pertinent to the use of SMR during the warm up (Healey et al., 2014; Lanigan & Harrison, 2012; Macdonald et al., 2013). The earliest of these found that SMR on the plantar surface of the foot positively affected reactive strength index and vertical jump height during single leg rebound jump tests (Lanigan & Harrison, 2012). MacDonald et al. (2013) reported that two minutes of SMR significantly increased quadriceps ROM without having detrimental effects on force production or rate of force development. Most recently, Healey et al. (2014) examined how an SMR based warm up affected power, force, agility, fatigue, soreness, and rate of perceived exertion in comparison to a planking based warm-up. They found the only difference between the two to be a lower level of fatigue following the SMR warm up.

Though these studies offer interesting beginnings for a body of knowledge on the acute effects of SMR, many questions remain to be answered before the practice can be accepted as an effective replacement for static stretching during warm ups. One particularly noticeable omission in the research is investigation into the acute effects of SMR on the ever important and injury prone posterior chain. The purpose of this study was to examine the acute effects of SMR on the ROM and force production capabilities of the hamstring muscle group. Based on the findings of previous research it was hypothesized that SMR of the hamstrings would increase ROM without detriment to force production capabilities.

Methods

Subjects

Eight males and two females (age 26.5 $\pm$ 6.5 years, mass 74.4$\pm$12.1 kg, height 173$\pm$8 cm) were recruited from the general population for participation in this study. All subjects completed a medical history questionnaire and were determined to be healthy and without injury prior to participation. All procedures and risks were explained both verbally and in written form, and informed consent was given prior to participation.

Experimental Design

A within subjects randomized, cross-over design was utilized to investigate the effects of SMR on the ROM and force production capabilities of the hamstring muscle group. All subjects participated in four laboratory sessions, each separated by at least 24 hours. The first two sessions were familiarization sessions in which subjects learned and practiced all protocols. The order of the final two sessions—the control and experimental sessions—was randomly assigned to each subject. In the control session subjects had their hamstring torque production and ROM measured following passive rest. In the experimental session, torque production and ROM were measured following completion of a SMR protocol on a foam roller.

Procedures

Familiarization Sessions. At the beginning of the first familiarization session subjects were asked to put on a heart rate monitor (Polar FS1; Lake Success, NY) and were fitted on a cycle ergometer (Monarch Exercise AB 828E; Vansbro, Sweden). Subjects then began a five minute cycling warm-up in which they gradually increased the pedaling rate until they achieved 60% of their age predicted maximal heart rate. After the warm-up, subjects were seated on the computerized robotic dynamometer (Biodex Medical Systems 840-0000 System 4 Quick-Set; Shirley, NY) while the proper anthropometric adjustments were determined and recorded. Subjects then began a brief dynamometer familiarization protocol that consisted of five sets of three repetitions of a maximal isokinetic knee extension resistance (eccentric hamstring action) from 90 to 0 degrees of flexion followed by a maximal isokinetic leg curl (concentric hamstring action) from 0 to 90 degrees of knee flexion. All repetitions were performed at a speed of 60 degrees per second, and all sets were separated by a 30 second passive recovery period.

Upon completion of the dynamometer familiarization protocol, the back saver sit & reach test and the SMR protocol were explained and demonstrated (see following descriptions). Subjects then performed three practice repetitions of the back saver sit & reach test and five minutes of SMR practice on their dominant leg. Subjects then performed a self-governed cool down. Subjects returned to the laboratory within 24-48 hours to perform a second familiarization session that was identical to the first.

Control & Experimental Sessions. Both the control and experimental sessions began with the same warm-up utilized in the familiarization sessions. In the control session, the warm-up was followed by an eight minute period consisting of six minutes of seated passive rest and a two minute transition to the dynamometer. In the experimental session, the warm-up was followed by an 8-minute period consisting of a one minute transition to the foam roller, a five minute SMR protocol, and a two minute transition to the dynamometer. In both sessions, maximal torque production measurements (see following description) began 8 minutes after the warm-up—2 minutes after SMR in the experimental session and 2 minutes after passive rest in the control. Immediately after torque measurements, subjects transitioned to the floor and performed the back-saver sit & reach test. The torque production measurements and sit & reach test were again performed ten minutes after SMR or passive rest in the experimental and control sessions, respectively.

Self Myofascial Release. The SMR protocol consisted of three, one minute periods of rolling on a multilevel rigid foam roller, each separated by one minute rest periods. Subjects began each rolling period with the roller placed under their dominant leg just above the knee. They then crossed their non-dominant leg over the top of their dominant leg, placed both hands on the ground behind them, and rolled to the proximal end of their hamstrings in a kneading motion. Once the length of the hamstrings had been rolled, the roller was returned to the start position in one smooth roll. This process was repeated for the allotted time.

Torque Measurement. All hamstring torque production measurements were performed on a computerized robotic dynamometer (Biodex Medical Systems 840-0000 System 4 Quick-Set; Shirley, NY) configured to the standard position for unilateral knee extension/flexion. For each testing session, the dynamometer chair was adjusted to properly fit each subject. The dynamometer protocol required subjects to complete three repetitions of maximally resisting an isokinetic knee extension (eccentric hamstring action) from 90 to 0 degrees of flexion followed by a maximal isokinetic leg curl (concentric hamstring action) from 0 to 90 degrees of knee flexion with their dominant leg. All repetitions were performed at a speed of 60 degrees per second. Subjects were secured into the dynamometer chair across the shoulders, at the hip, and above the knee in order to assure that only the hamstrings contributed to the torque readings. The highest eccentric and concentric torque measurements from the three reps were recorded as the maximal torque production of the hamstrings.

Back Saver Sit and Reach. The back saver sit and reach test was used to assess hamstring ROM. Subjects began in a seated position with the foot of their extended dominant leg placed flat against the sit and reach box. The non-dominant knee was flexed at a 90 degree angle and the foot was placed flat on the floor beside the dominant leg's knee. The subject then reached forward as far as they could with both hands without letting their dominant knee bend. This reach was repeated three times, and the greatest distance of the three was recorded as the hamstring ROM at that point in time.

Data Analysis

Student paired t-tests were used to assess mean differences between control and experimental measures of eccentric, concentric torque, and measured distance in the back saver sit and reach test. Statistical significance was set at $p < 0.05$.

Results

Eccentric torque was not significantly different between sessions at either two minutes (2-min post: Control 161.8 ± 40.3 Nm; Experimental 165.2 ± 46.8 Nm) or ten minutes post (10-min post: Control 166.3 ± 45.7 Nm; Experimental 161.3 ± 43.1 Nm). Likewise, mean concentric torque was also not significantly different between sessions at either two minutes (2-min post: Control 150.8 ± 48.1 Nm; Experimental 143.6 ±38.1 Nm) or ten minutes post (10-min post: Control 150.3 ± 38.9 Nm; Experimental 154.6 ± 35.5 Nm) (Table 1).

The difference in ROM between the control and experimental session was also statistically insignificant. In the control session, the mean sit and reach score was 37.6±8.7 cm two minutes post rest and 38.7±9.5 cm ten minutes post rest. The mean sit and reach score in the experimental session was 38.7±9.2 cm two minutes after SMR and 39.5±9.9 ten minutes after SMR (Table 1).

Table 1. Mean Concentric and Eccentric torque output and Back saver sit and reach distance 2-minutes and 10-minutes after performing the Control and Experimental sessions.

	Control		Experimental	
	2 minutes	10 minutes	2 minutes	10 minutes
Concentric Torque (Nm)	150.8±48.1	150.3±38.9	143.6±38.1	154.6±35.5
Eccentric Torque (Nm)	161.8±40.3	166.3±45.7	165.2±46.8	161.3±43.1
Back saver sit and reach (cm)	37.6±8.7	38.7±9.5	38.7±9.2	39.5±9.9

Discussion

The purpose of this study was to examine the acute effects of SMR on the dynamic force production and ROM of the hamstring muscle group. It was hypothesized that SMR of the hamstrings would promote an increased ROM without detriment to force production. In comparison to passive rest, the SMR protocol used in this study yielded no statistically significant differences in active ROM, concentric torque production at an isokinetic speed of 60 degrees per second, or eccentric torque production at an isokinetic speed of 60 degrees per second. Results were the same both two and ten minutes after treatment with SMR. These findings suggest that SMR does not improve hamstring ROM, and neither does it affect dynamic hamstring force production capabilities.

The present study's findings on ROM are somewhat unique. Previous studies examining the effects of SMR and similar types of massage therapy reported a significant increase in ROM after treatment (Macdonald et al., 2013; Huang et al., 2010; Crossman, Chateauvert, & Weisberg, 1984). A possible explanation for the lack of change in ROM reported in the present study is insufficient pressure application to the target tissue during the SMR protocol. This is supported by the anecdotal reports of several subjects who claimed to feel little or no pressure during the SMR protocol. This may be attributable to a disadvantageous position assumed while rolling the hamstrings, which may place a significant amount of the subject's body weight on their hands rather than the roller and the target tissue. Future studies of hamstring SMR might want to consider the use of yoga blocks placed under the hands while rolling in order to improve leverage and increase the pressure placed on the hamstrings.

While only speculative, another explanation for the variant ROM findings among studies could be the ROM measure utilized. All of the previous studies utilized a passive measure of ROM (Macdonald et al., 2013; Huang et al., 2010; Crossman et al., 1984). Due to a lack of experience with passive testing methods, the current study utilized the back saver sit and reach test, which is an active measure of ROM. Studies on the back saver sit and reach test, as well as the traditional sit and reach test, indicate that these tests may not be as accurate as passive hamstring ROM tests because they are largely dependent on several factors other than hamstring ROM (Hartman & Looney, 2003; Hoeger, Hopkins, Button, & Palmer, 1990; Hopkins & Hoeger, 1992; Sinclair & Tester, 1993). Future research should consider a more precise measure of hamstring ROM such as the passive straight leg raise.

The present study examined concentric and eccentric isokinetic torque production following SMR and found SMR to have no impact on torque production. Macdonald et al. (2013) found that SMR had no effect on maximal isometric force production, rate of force development, or muscle activation. Healey et al. (2013) concluded that SMR had no effect on vertical jump height and power, isometric force, and agility in comparison to planking. The congruity of these findings along with the positive effects of SMR reported by Lanigan and Harrison (2012) indicates that SMR presents no threat to the force production capabilities of muscle; however, this may only apply to the general population as this is the only population examined in the research. Research on special populations such as collegiate and professional athletes is warranted before a conclusion can be reached on the effects of SMR on force production.

Conclusion

The present study found that SMR had no effect on ROM or eccentric/concentric isokinetic torque production of the hamstring muscle group. Based on these findings, it is suggested that the use of SMR to increase ROM in warm ups is not warranted. In some ways these findings conflict with those of previous research making the body of research on SMR equivocal. Because of this, more research is needed to determine the efficacy of SMR to improve ROM during the warm up. Until this research is conducted those performing and administering warm ups will be best served using better understood alternatives to static stretching.

Appendix A: IRB Approval Letter

THE UNIVERSITY OF
SOUTHERN MISSISSIPPI

INSTITUTIONAL REVIEW BOARD
118 College Drive #5147 | Hattiesburg, MS 39406-0001
Phone: 601.266.6820 | Fax: 601.266.4377 | www.usm.edu/irb

NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months.
  Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: **13080701**
PROJECT TITLE: **Self Myofascial Release: Effect on Muscle Range of Motion and Power**
PROJECT TYPE: **New Project**
RESEARCHER(S): **Dillion Evans**
COLLEGE/DIVISION: **College of Health**
DEPARTMENT: **Human Performance and Recreation**
FUNDING AGENCY/SPONSOR: **N/A**
IRB COMMITTEE ACTION: **Expedited Review Approval**
PERIOD OF APPROVAL: **10/1/2013 to 09/30/2014**

Lawrence A. Hosman, Ph.D.
Institutional Review Board

Appendix B: Medical History Questionnaire

Appendix A: Medical History Questionnaire

University of Southern Mississippi
Laboratory of Applied Physiology
Medical History Questionnaire

Directions. The purpose of this questionnaire is to enable the staff of the Laboratory of Applied Physiology to evaluate your health and fitness status. Please answer the following questions to the best of your knowledge. All information given is **CONFIDENTIAL** as described in the **Informed Consent Statement.**

Name: ______________________ Age ________ Date of Birth__________

Name of your Physician:______________________

MEDICAL HISTORY
Do you have or have you ever had any of the following conditions? (Please write the date when you had the condition in blank).

___ Heart murmur, clicks, or other cardiac findings
___ Frequent extra, skipped, or rapid heartbeats
___ Chest Pain of Angina (with or without exertion)
___ High cholesterol
___ Diagnosed high blood pressure
___ Heart attack or any cardiac surgery
___ Leg cramps (during exercise)
___ Varicose veins
___ Frequent dizziness/fainting
___ Muscle or joint problems
___ High blood sugar/diabetes
___ Thyroid Disease
___ Low testosterone/hypogonadism
___ Glaucoma
___ Chronic swollen ankles
___ Asthma/breathing difficulty
___ Bronchitis/Chest Cold
___ Melanoma/Suspected skin Lesions
___ Stroke or Blood Clots
___ Emphysema/lung disease
___ Epilepsy/seizures
___ Rheumatic fever
___ Ulcers or digestive disorders
___ Pneumonia
___ Anemia
___ Liver (hepatic) or kidney (renal) disease
___ Autoimmune disease
___ Nerve disease
___ Psychological Disorders

Do you have or have you been diagnosed with any other medical condition not listed

____

Please provide any additional comments/explanations of your current or past medical history that you feel might impact/influence your ability to participate in this study.

____

Please list any recent surgery that you feel might impact/influence your ability to participate in this study. (i.e., type, dates etc.).

____

List all prescription/non-prescription medications and nutritional supplements you have taken in the last 3 months.

____

Do you know of any medical problem that might make it dangerous or unwise for you to participate in this study?

____

Do you have, or have you recently had, any type of injury to your hips, knees, or surrounding musculature?

____

Appendix C: Informed Consent

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

AUTHORIZATION TO PARTICPATE IN RESEARCH PROJECT

Participant's Name: ____ Date:_______

Self Myofascial Release: Effect on Muscle Range of Motion and Torque

This project contains an exercise component and as such it is recommended that before beginning this or any exercise or health program, participants should consult a physician.

Purpose

The purpose of this study is to identify how self myofascial release, also known as foam rolling, affects range of motion and power of the hamstring muscle group. The traditional warm-up performed by exercise and sport participants consists of submaximal aerobic activity, static stretching, and sport specific movements. In recent years, the static stretching component of the warm-up has been removed by many because research suggests that it may negatively affect performance. This has left many searching for a new method of increasing range of motion during the warm-up. Some have selected foam rolling as a replacement for static stretching, but little is known about the effects of this method. Consequently, more investigation is necessary before this technique can be considered a viable alternative for use during a warm-up prior to physical activity.

Description of Procedures

All procedures will be conducted in room 105 of the Human Performance and Recreation Building on the Hattiesburg, MS campus of the University of Southern Mississippi. Approximately 20 participants, ages 18-45 years will be recruited for the study. Requirements for participation are as follows:

1) I must be between 18 and 45 years of age.
2) I must not be suffering from any knee or hip injury that would prevent me from performing the required physical activity.

All experimental procedures will be explained in written form. Any questions and/or concerns raised will be address by the primary investigator or his advisor. I must voluntarily provide informed consent to continue participation in the study.

Preliminary testing session:

Following the completion of informed consent and a medical history questionnaire, I will complete two preliminary testing sessions. In these sessions I will perform a five minute warm up on a stationary bike at 60% of my age predicted maximal heart rate followed by a six minute familiarization program on a specialized leg extension/curl device. I will then practice a single leg sit and reach test. The specialized leg extension/curl device is routinely used in orthopedic assessments and rehabilitation settings to assess muscle function. The single leg sit and reach test is frequently used for general fitness assessments.

Upon completion of the measurements, I will be introduced to the foam rolling protocol that will be utilized in the experimental testing session. I will be verbally and visually instructed on how to properly use the foam roller (a self myofascial release implement), and then I will be asked to spend time practicing the protocol on my dominant leg.

Experimental Testing Sessions:

Approximately 24 hours after completion of the preliminary sessions, I will return to the laboratory to complete one of two randomly assigned experimental testing sessions (A and B). **Session A** will consist of a five minute warm up on a stationary bike at 60% of age predicted maximal heart rate, followed by eight minutes of passive rest. Upon completion of the rest period, I will have my hamstring muscle group torque production capabilities and range of motion assessed. These variables will be again measured at 8 minutes post rest. **Session B** will consist of a five minute warm up on a stationary bike at 60% of age predicted maximal heart rate, immediately followed by a one minute transition period and three, one-minute bouts of hamstring muscle group foam rolling of the dominant leg, performed according to instructions given in the preliminary testing session. The first two bouts will be followed by one minute of rest. The third bout will be followed by a two minute rest. Upon completion of the final rest period, I will have the torque production capabilities and the range of motion of my hamstring muscle group measured. These variables will be measured again at ten minutes post foam rolling. Assessments will be completed in approximately five minutes. All torque measurements will be made using the specialized leg extension/curl device, and all range of motion measurements will be made using the single leg sit and reach test.

Preliminary Sessions	Experimental Testing Session A	Experimental Testing Session B
Read and sign informed consent (Prior to first preliminary session)		
Review of medical history questionnaire (prior to first preliminary session)		
Five minute stationary bike warm-up	Five minute stationary bike warm-up	Five minute stationary bike warm-up
Familiarization program on the specialized leg extension/curl device	Eight minutes of passive rest	Eight minute foam rolling protocol
Practice single leg sit and reach test	Measurement of hamstring torque production and flexibility	Measurement of hamstring torque production and flexibility
Familiarization with eight minute foam rolling protocol		

Risks

As with any exercise regimen, there is an inherent risk of injury; however, no physical stress greater than that which I encounter during a light, self-paced 20 minute jog will be placed on me. I will keep in mind that the University of Southern Mississippi has no mechanism to provide compensation for participants who may incur injuries as a result of participating in research projects. However, efforts will be made to make available the facilities and professional skills at the University.

Steps to minimize risks:

1) The exercise being performed does not require any added stress other than that which I would encounter during a light, self-paced 20 minute jog.
2) Should an emergency arise, trained personnel will be available to intervene appropriately with CPR skills and in initiating emergency procedures. Dr(s) Webster and Boyd are both CPR and first aid certified and one of them will be available during all experimental procedures. Two automated external defibrillators (AEDs) are conveniently located in the building. In addition, Dr. Webster is certified with the American College of Sports Medicine as a Clinical Exercise Specialist. A portion of this certification requires successful demonstration of skill in handling emergency situations that may arise in cardiovascular and pulmonary rehabilitation settings.
3) I should report to Dr. Webster any unexpected problems or adverse events that are encountered during the course of the study

.

Benefits

I will learn a simple foam rolling protocol which may be useful in my physical fitness or athletic pursuits. I will also be informed of the overall findings of this study.

Confidentiality of Data

1) All data will be dealt with using a numerical identification code. The coding will only be known by the investigators. My information will only be released upon written request to the principal investigator by me, or in the event of a medical emergency, by my physician.
2) All data will be on file in the office of the principal investigator's advisor and only the principal investigator and his advisor will be allowed to examine the data collected about me.
3) Only group data will be disclosed upon completion and publication of this investigation.
4) Data will be kept on file in the office of the principal investigator's advisor for three years, after which time all data will be destroyed.

Participant's Assurance

Whereas no assurance can be made concerning results that may be obtained (since results from investigational studies cannot be predicted) the researcher will take every precaution consistent with the best scientific practice. Participation in this project is completely voluntary and I may withdraw from this study at any time without penalty, prejudice, or loss of benefits. Questions concerning the research should be directed to Dillion Evans at (601)-770-0889 or dillion.evans@eagles.usm.edu or Dr. Michael Webster at (601) 266-5866 or Michael.Webster@usm.edu.

This project and this consent form have been reviewed by the Institutional Review Board, which ensures that research projects involving human subjects follow federal regulations. Any questions or concerns about rights as a research participant should be directed to the Chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive #5147, Hattiesburg, MS 39406-0001, (601) 266-6820.

Consent to participate in this project is hereby given by the undersigned. A copy of this form has been given to me.

Signature of the Research Participant Date

Signature of the Person Explaining the Study Date

Signature of Witness Date

References

Barnes, M. F. (1997). The basic science of myofascial release: Morphological change in connective tissue. *Journal of Bodywork and Movement Therapies, 1*(4), 231-238.

Behm, D. G., & Chaouachi, A. (2011). A review of the acute effects of static and dynamic stretching on performance. *European Journal of Applied Physiology, 111*, 2633-2651. doi:DOI 10.1007/s00421-011-1879-2

Crosman, L. J., Chateauvert, S. R., & Weisberg, J. (1984). The effects of massage to the hamstring muscle group on range of motion. *Journal of Orthopedic & Sports Physical Therapy, 6*(3), 168-172. Retrieved from http://articles.sirc.ca/search.cfm?id=161226; http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=SPH161226&site=ehost-live; http://articles.sirc.ca/search.cfm?id=161226

Curran, P. F., Fiore, R. D., & Crisco, J. J. (2008). A comparison of the pressure exerted on soft tissue by 2 myofascial rollers. *Journal of Sport Rehabilitation, 17*, 432-442.

Educational Council on Osteopathic Principles of the American Association of Colleges of Osteopathic Medicine. (2011). Glossary of osteopathic terminology. Retrieved May 3, 2014. Retrieved from http://www.aacom.org/resources/bookstore/Documents/GOT2011ed.pdf

Findley, T. W., & Shalwala, M. (2013). Fascia research congress evidence from the 100 year perspective of Andrew Taylor still. *Journal of Bodywork and Movement Therapies, 17*(3), 356-364. doi:http://dx.doi.org.lynx.lib.usm.edu/10.1016/j.jbmt.2013.05.015

Fletcher, I. M., & Anness, R. (2007). The acute effects of combined static and dynamic stretch protocols on fifty-meter sprint performance in track and field athletes. *Journal of Strength and Conditioning Research, 21*, 784-787.

Fletcher, I. M., & Jones, B. (2004). The effects of different warm-up stretch protocols on 20 meter sprint performance in trained rugby union players. *Journal of Strength and Conditioning Research, 18*, 885-888.

Grant, K. E., & Riggs, A. (2008). Myofascial release. In E. Stillerman (Ed.), *Modalities for massage and bodywork* (1st ed., pp. 149). Maryland Heights, Missouri: Mosby.

Hartman, J. G., & Looney, M. (2003). Norm-referenced and criterion-referenced reliability and validity of the back-saver sit-and-reach. *Measurement in Physical Education and Exercise Science, 7*(2), 71-87.

Healey, K. C., Hatfield, D. L., Blanpied, P., Dorfman, L. R., & Riebe, D. (2014). The effects of myofascial release with foam rolling on performance. *Journal of Strength and Conditioning Research, 28*(1), 61-68.

Hoeger, W. W. K., Hopkins, D. R., Button, S., & Palmer, T. A. (1990). Comparing the sit and reach with modified sit and reach in measuring flexibility in adolescents. *Pediatric Exercise Science, 2*, 156-162.

Hopkins, D. R., & Hoeger, W. W. K. (1992). A comparison of the sit-and-reach test and the modified sit-and-reach test in the measurement of flexibility for males. *Journal of Applied Sport Science Research, 6*, 7-10.

Huang, S. Y., Di Santo, M., Wadden, K. P., Cappa, D. F., Alkanani, T., & Behm, D. G. (2010). Short duration massage at the hamstrings musculotendinous junction induces greater range of motion. *Journal of Strength and Conditioning Research, 24*(7), 1917-1924.

Kay, A. D., & Blazevich, A. J. (2012). Effect of acute static stretch on maximal muscle performance: A systematic review. *Medicine & Science in Sports & Exercise, 44*(1), 154-164. doi:10.1249/MSS.0b013e318225cb27

Knudson, D., Bennet, K., Corn, R., Leick, D., & Smith, C. (2000). Acute effects of stretching are not evident in the kinematics of the vertical jump. *Research Quarterly for Exercise and Sport, 71,* A-30.

Kokkonen, J., Nelson, A. G., & Cornwell, A. (1998). Acute muscle stretching inhibits maximal strength performance. *Research Quarterly for Exercise and Sport, 69*, 411-415.

Lanigan, C. S., & Harrison, A. J. (2012). The effects of self myofascial release on the plantar surface of the foot during sledge rebound jumps. *Journal of Bodywork and Movement Therapies, 16*(4), 521-522. doi:10.1016/j.jbmt.2012.01.008

MacDonald, G., Penney, M., Mullaley, M., Cuconato, A., Drake, C., Behm, D. G., & Button, D. C. (2013). An acute bout of self myofascial release increases range of motion without a subsequent decrease in muscle activation or force. *Journal of Strength and Conditioning Research, 27*(3), 812-821.

Miller, J. K., & Rockey, A. M. (2006). Foam rollers show no increase in the flexibility of the hamstring muscle group. *UW-L Journal of Undergraduate Research, 9*

Okamoto, T., Masuhara, M., & Ikuta, K. Acute effects of self-myofascial release using a foam roller on arterial function. *Journal of Strength and Conditioning Research, 28(1), 69-73.* doi:10.1519/JSC.0b013e31829480f5

Remvig, L., Ellis, R. M., & Patijn, J. (2008). Myofascial release: An evidence based treatment approach? *International Musculoskeletal Medicine, 30*(1), 29-35.

Sefton, J. (2004). Myofascial release for athletic trainers, part I: Theory and session guidelines. *Athletic Therapy Today, 9*(1), 48-49.

Sinclair, A., & Tester, G. (1993). The sit and reach test: What does it actually measure? *Australian Council for Health, Physical Education and Recreation National Journal, Winter*, 8-13.

Travell, J., Rinzler, S., & Herman, M. (1942). Pain and disability of the shoulder and arm: Treatment with intramuscular infiltration with procaine hydrochloride. *Journal of the American Medical Association, 120*(6), 417-422.

Winchester, J. B., Nelson, A. G., & Kokkonen, J. (2009). A single 30-s stretch is sufficient to inhibit maximal voluntary strength. *Research Quarterly for Exercise and Sport, 80*, 257-261.

Winchester, J. B., Nelson, A. G., Landin, D., Young, M. A., & Schexnavder, I. C. (2008). Static stretching impairs sprint performance in collegiate track and field athletes. *The Journal of Strength of Conditioning Research, 22*, 13-19.

Yamaguchi, T., & Ishii, K. (2005). Effects of static stretching for 30 seconds and dynamic stretching on leg extension power. *Journal of Strength and Conditioning Research, 19*, 677-683.