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Acute Effects of Foam Rolling on Flexibility, Isokinetic and Isometric Strength

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ACUTE EFFECTS OF FOAM ROLLING ON FLEXIBILITY, ISOKINETIC AND
ISOMETRIC STRENGTH

by

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B.S. Beijing Sport University, 2012

Research Paper

Submitted in Partial Fulfillment of the Requirements for the
Master of Science

Department of Kinesiology
in the Graduate School
Southern Illinois University Carbondale
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RESEARCH PAPER APPROVAL

ACUTE EFFECTS OF FOAM ROLLING ON FLEXIBILITY, ISOKINETIC AND
ISOMETRIC STRENGTH

By

Zidong Li

A Research Paper Submitted in Partial
Fulfillment of the Requirements
for the Degree of
Master of Science
in the field of Kinesiology

Approved by:

Dr. M. Daniel Becque, Chair

Dr. Michael Olson

Graduate School

Southern Illinois University Carbondale

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Zidong Li, for the Master of Science degree in Kinesiology, presented on December 12, 2014 of defense, at Southern Illinois University Carbondale.

TITLE: ACUTE EFFECTS OF FOAM ROLLING ON FLEXIBILITY, ISOKINETIC AND ISOMETRIC STRENGTH

MAJOR PROFESSOR: Dr. M. Daniel Becque

The purpose of this study was to investigate the acute effects of foam rolling on quadriceps isokinetic and isometric force production as well as knee joint range of motion. Twelve healthy, light to moderately physically active college students volunteered for this study. They had different treatments on three separate days. Participants' non-dominant knee joint range of motion (ROM), quadriceps isokinetic and isometric peak torque were measured under both the foam rolled (FR) and non-foam rolled (no-FR) conditions. The intervention was two minutes of foam rolling on their non-dominant thighs. Results showed that foam rolling significantly increased knee joint ROM ($p = .0051$, $F(1, 11) = 12.173$) by approximately eight degrees. No significant difference was found for isokinetic ($p = .4655$, $F(1, 11) = 0.572$) or isometric peak torques ($p = .9447$, $F(1, 11) = 0.005$) between the FR and no-FR conditions. In conclusion, a brief duration of foam rolling can effectively increase joint flexibility and maintain the level of muscle peak force production.

Key words: foam rolling, quadriceps, range of motion, force

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Introduction

Fascia is the soft tissue component of the connective tissue system that penetrates and surrounds muscles, bones, organs, nerves, blood vessels and other structures (LeMoon, 2008). It is a continuous tissue that extends from head to toe, front to back without interruption. Fascia is a very important structure that has so many biological functions, such as maintaining structural integrity, providing support and protection, creating an environment for tissue repair after injuries, playing a role as the body's first line of defense against infections, providing a matrix to allow for intercellular communication, and so on (LeMoon, 2008). Fascial restrictions often result from injuries, physical inactivity, scars or inflammation. Since fascia is a continuous tissue, it has been hypothesized that fascial restrictions in one part of the body can cause tension in other parts of the body, so it may produce stress in structures that are wrapped, divided or supported by fascia (Ajimsha, 2011). Once fascial restrictions occur, fascial tissue may become dehydrated and lose elasticity, and then bind around the traumatized area causing the formation of a fibrous adhesion. Fibrous adhesions can have negative influences on exercise performance, such as pain and decrease in muscle strength and flexibility.

Myofascial release is a hands-on treatment that can reduce fascial restrictions and fibrous adhesions between layers of fascial tissues (Barnes, 1997). It includes a variety of techniques such as osteopathic soft-tissue techniques, massage, instrument-assisted fascial release and many others (Simmonds, Miller & Gemmell, 2012). A new myofascial release technique called

self-myofascial release has generated a lot of interest. It simply requires individuals themselves rather than massagers to perform the myofascial release techniques. Usually individuals need some tools to help themselves. Foam rolling, as a type of self-myofascial release, has been more and more commonly used by athletes and physical trainers. Foam rolling can be applied on many muscles, such as quadriceps, hamstrings, gastrocnemius, latissimus dorsi, hip flexors, etc. When doing foam rolling, people apply their own body mass onto a foam roller to produce pressure in the muscle and fascia to cause release. Compared with traditional myofascial release techniques and static stretching, foam rolling has its own advantages. First, it is easy and convenient to foam roll as long as you have a foam roller and a little space. There is no need to have a therapist or a massager to provide manual therapy. Second, individuals can control the foam rolling areas and pressure on their own, so that it is easier to find trigger points because they can feel them. Here, trigger points are defined as exquisitely tender spots in discrete taut bands of hardened muscle that produce local and referred pain (Bron & Dommerholt, 2012).

People do it because they believe foam rolling is beneficial. For example, they think that foam rolling before exercise can reduce muscle viscosity and increase flexibility, and foam rolling after exercise can reduce muscle soreness and accelerate recovery. However, studies on the effects of foam rolling are very limited and controversial, and there is little scientific evidence to support opinions about foam rolling. MacDonald and his colleagues (2013) focused on the acute effects of foam rolling. They recruited eleven male students to foam roll their right

quadriceps for two sets of one minute, with one minute rest between sets. Participants' quadriceps maximal voluntary contraction force, evoked force and activation, knee joint range of motion (ROM) were measured before and after foam rolling. They found that foam rolling had no significant effect on the neuromuscular dependent variables. However, knee joint ROM increased significantly from pre to post treatment. MacDonald, Button, Drinkwater and Behm (2014) tested the effects of foam rolling as a recovery tool after exercise-induced muscle damage (EIMD). Twenty experienced male exercisers were randomly divided into two groups. After completing the EIMD protocol, perceived pain, vertical jump height, hamstrings and quadriceps ROM, evoked and voluntary contractile properties were measured at post-0, post-24, post-48 and post-72 hours. Subjects in the foam rolling group foam rolled their related muscles for 20 minutes right after the measurements at post-0, post-24 and post-48. Results showed that foam rolling reduced muscle soreness and increased muscle activation and ROM significantly. Peak twitch force decreased substantially between groups, while MVC force showed no significant difference. Therefore, the authors suggested that foam rolling benefits were primarily accrued through neural responses and connective tissue. Healey, Hatfield, Blanpied, Dorfman and Riebe (2014) studied foam rolling before athletic tests of muscular performance. Results showed that foam rolling made no significant differences for all of the four tests, including vertical jump height and power, isometric force and agility. However, fatigue after foam rolling was significantly less. The authors suggested that the reduced feeling of fatigue might help to extend workout time and volume,

which could lead to long term enhancement of performance. Halperin, Aboodarda, Button, Andersen and Behm (2014) compared the effects of static stretching and roller massaging of calf muscle on ankle ROM, MVC force, EMG and a single limb balance test. For the interventions, static stretching and roller massaging both consisted of three sets of 30 seconds with 10 seconds of rest between each set. Results revealed that both conditions increased ankle ROM significantly, but roller massaging improved MVC force slightly while static stretching decreased maximal force output. On the other hand, Miller and Rockey (2006) examined chronic effects of foam rolling. Subjects in the treatment group foam rolled on their hamstrings three days a week for eight weeks. No significant difference in ROM between treatment and control groups was found. The authors suggested that foam rolling hamstrings might not be an effective way for increasing range of motion.

Scientific evidence supporting foam rolling is limited, and some studies even present controversial findings. In addition, most of the existing studies only tested isometric force as the indicator of voluntary contractile properties. Therefore, the purpose of this study consisted of two aspects. The first objective was to examine the acute effects of foam rolling on knee joint ROM. The second was to examine the effect of foam rolling on isometric and isokinetic force production. We hypothesized that knee joint ROM would increase while isometric and isokinetic force production would decrease after foam rolling.

Methods

Participants

Twelve healthy, light to moderately physically active male students (height 175.79 ± 6.64 cm, mass 71.29 ± 7.77 kg, ages 22.33 ± 1.92 years) from Southern Illinois University Carbondale were recruited for this study. They reported no previous or present injury or inflammation in their quadriceps. All the participants were orally informed of the research process. After oral acknowledgement of a willingness to participate, they read and signed a written informed consent for this study. Southern Illinois University Human Subjects Committee had previously approved this study.

Study design

All the participants reported to the laboratory on 3 separate days. Each day had a different foam rolling (FR) treatment, which were no-FR, FR-isokinetic, and FR-isometric. The interval between days was at least 24 hours. Treatment order was assigned with a 3 * 3 Latin square. The orders were randomized across the participants. On each treatment day, participants performed a five-minute warm-up by walking on a treadmill at 5 km/h. After warm-up, for the no-FR condition, participants' knee joint ROM was measured. Participants then were tested for non-dominant quadriceps isokinetic strength at speed of 60°/second on a Biodex System 3 dynamometer (Biodex Medical Systems, Inc., Shirley, NY, USA). Participants completed two sets of four repetitions of knee extension and flexion with one minute of rest between sets. The peak torque was recorded. After 30 minutes rest, participants tested their non-dominant quadriceps isometric

strength at 90 degrees. Two reps of five seconds duration of knee extension with one minute of rest between reps were completed by each participant. The peak torque was recorded. The FR-isokinetic and FR-isometric treatments both contained two minutes of quadriceps foam rolling after warm-up. After foam rolling, knee joint ROM was measured. The FR-isokinetic condition required knee extension and flexion for two sets of four reps with one minute of rest between sets. FR-isometric condition completed knee extension for two reps of five seconds duration with one minute of rest between reps. The peak torque was recorded.

Independent variables

Foam roller and foam rolling technique. A black foam roller was used for the treatment. A black foam roller was denser, so all the foam rolling in this study could be considered high pressure. Participants foam rolled in the prone position. The roller was placed initially under the hip. The foam roller was perpendicular to their body throughout the treatment. Participants used their forearms to balance themselves as they rolled. They foam rolled their non-dominant quadriceps only. Participants placed all their body weight onto their non-dominant leg to increase pressure. They foam rolled for two minutes and if they found a trigger point, they would stay on that point for 20 to 30 seconds and then continued rolling.

Dependent variables

Knee joint ROM. The knee joint ROM was measured by a goniometer. The participants were asked to lie in the prone position lying on a massage couch. The non-dominant thigh was supported with a 6cm high sand bag just proximal to

the knee. They bent their non-dominant lower legs towards their hips. The experimenter helped to push their lower legs towards their hips until they reached a point of discomfort. The axis of the goniometer was placed next to the knee joint. One arm of the goniometer was fixed parallel with the thigh, and the other arm was parallel with the lower leg. The obtuse angle read from the goniometer was the ROM measurement.

Quadriceps peak torques. Non-dominant leg quadriceps isokinetic and isometric force production was measured with a Biodex System 3 dynamometer (Biodex Medical Systems, Inc., Shirley, NY, USA). For isokinetic, the participants were seated on the dynamometer strapped in and performed knee extension and flexion for two sets of four reps at speed of 60°/second, with one minute rest between sets. Participants were also tested for their isometric force at 90° for two reps of five seconds, with one minute rest between reps. They were instructed to try as hard as they could. Verbal encouragement was given to all the participants by the experimenter. The dynamometer was calibrated before and after data collection, and was within the manufacture's specifications. Data were collected at a rate of 100 Hz and saved for future processing.

Statistical Analyses

All statistical data were analyzed with IBM SPSS statistics v20.0. Differences between the two conditions were analyzed with a one-way repeated measures ANOVA. Descriptive statistics are presented with mean \pm SD. The significance level was set at $\alpha = .05$.

Results

Knee joint range of motion

A significant difference was found ($p = .0051$, $F(1, 11) = 12.173$) in knee joint ROM between the no-FR and FR conditions. On average, there was an eight degree increase from the no-FR to FR conditions (151.2 ± 8.29 vs. 159.2 ± 6.85 degrees). Nine out of twelve participants increased their knee joint flexibility after 2 minutes of foam rolling.

Isokinetic peak torque

No significant difference ($p = .4655$, $F(1, 11) = 0.572$) was found for quadriceps isokinetic peak torque between the no-FR (178.9 ± 55.4 Nm) and FR conditions (187.4 ± 61.0 Nm). Specifically, half of the participants increased while the other half decreased in isokinetic peak torque after foam rolling. Generally the participants were able to maintain peak torque within 4.8% during both conditions.

Isometric peak torque

No significant difference was found ($p = .9447$, $F(1, 11) = 0.005$) for isometric peak torque between the no-FR (264.7 ± 68.9 Nm) and FR conditions (263.5 ± 69.6 Nm). It is interesting that nine participants slightly decreased in isometric peak torque after foam rolling, while three participants increased isometric peak torque.

Discussion

The purpose of this study was to examine the acute effects of quadriceps foam rolling on knee joint ROM as well as isokinetic and isometric force production. The major findings of this study were as follows: two minutes of foam

rolling of the quadriceps (a) significantly increased knee joint ROM by 8 degrees, and (b) simultaneously there was no change in isometric or isokinetic peak force. These results, along with the findings of a similar study (MacDonald et al., 2013), indicate that a brief duration of foam rolling can increase joint ROM without concomitant detrimental effects on voluntary muscle force production.

One potential principle to explain the increase in ROM after foam rolling is called autogenic inhibition. Golgi tendon organs (GTO) are mechanoreceptors located at muscle-tendon junction. When muscles contract at high tensions, the GTO is stimulated and relaxes the muscle. This reflex is called autogenic inhibition, and can also lead to an increase in range of motion (Robertson, 2008). It is also possible that the increase in ROM from foam rolling is due to a breakdown of scar tissue and fibrous adhesions. Fascia is made of collagen, elastin and ground substance. When fascial restriction occurs, the ground substance viscosity has changed from a gel to a more solid state. With foam rolling, individuals disturb the fascia via mechanical stress, stretch the fascial elastic components, shear fascial cross-links, and cause the ground substance to return to its gel state (Stone, 2000). Once the fascial tissue becomes more gel-like, it allows for a greater ROM (Barnes, 1997).

The autogenic inhibition theory would suggest that a decrease in muscle force production would accompany an increase in ROM after foam rolling. However, the results of this study contradict the application of this theory to these results, as neither isokinetic nor isometric peak torque is decreased. It is possible that the brief duration of foam rolling causes no detrimental effects on force production.

Arroyo-Morales et al. (2008) showed that 40 minutes of massage-myofascial release resulted in a significant decrease in EMG, which might cause a decrease in muscle force production. However, some studies focusing on the acute effects of myofascial release and foam rolling showed no significant change on force production. McKechnie, Young and Behm (2007) found that three minutes of massage had no effect on the power of plantar flexors. MacDonald and his colleagues (2013) found that two sets of one minute trials of foam rolling with 30 seconds between sets didn't affect any neuromuscular dependent variables. Therefore, based on these and current studies, it is plausible to say that a short duration of foam rolling does not significantly affect muscle force production.

In addition, although participants' isokinetic and isometric peak torque didn't change significantly as a whole, we did see that some individuals increased peak torque while others decreased peak torque. This is likely due to the fitness of the participants. In this study, all of the participants were light to moderately physically active, but not experienced weight lifters. They were taught how to perform the movements but they were not familiar with how to perform them prior to the study. Thus, during the study participants may still have been learning and the reliability of the data may have been decreased. Further studies should examine the effects of foam rolling with experienced weightlifters as participants.

Conclusion

The results of this study suggest that two minutes of foam rolling will increase ROM without an impact on isokinetic or isometric peak force production. This

study provides supporting evidence for foam rolling especially as a warm-up program before exercise.

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