

Effect of Foam Roller and Static Stretch on Hamstring Flexibility

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Abstract

Objective: The primary purpose of this study is to investigate the immediate effect of hamstring flexibility. **Method:** A pre/post- test design was used for this study. 75 participants were recruited from 6 different organizations. There were 3 groups (foam rolling, static stretch and relaxation). Each participant received the intervention between the pretest and posttest. **Results:** There was no significant difference in time (pretest and posttest) * interventions ($F_{2,73} = 1.895, P = .158$). The within-subject ANOVA, all 3 interventions can significantly improve hamstring flexibility ($F_{1,73} = 83.714, p = .000$). From the between-subject ANOVA, there was no significant different improvement between 3 interventions ($F_{1,73} = 83.714, p = .075$). **Conclusion:** Applying foam rolling with RumblerRoller, static stretching and relaxation on hamstring for 30 seconds had a significant improvement on flexibility.

Introduction

Foam rollers have become a popular recovery and warm-up tool used by athletes, physical therapists and trainers in the past few years. Its use is known as the Self-Myofascial Release (SMR) technique, which applies pressure to trigger points in order to improve joint Range of motion (ROM), muscular function, provide relief to muscle pain and soreness. There are different types of foam rollers available on the market, such as MuscleTrac and

RumbleRoller. These products claim to relieve muscle pain and tightness, improve blood flow and flexibility. However, the true benefits of the foam roller are doubtful, particularly its effects on flexibility.

In general, flexibility is properly defined as the range of motion (ROM) of a joint. Flexibility is an intrinsic property of the body tissues that determines the range of motion achievable without injury to a joint or group of joints (Thacker, Gilchrist, Stroup & Kimsey Jr, 2004). Flexibility

is “the ability of a joint, or series of joints, to move through a full range of motion without injury (ROM)” (Heyward, 2006, pp.245). Static flexibility is the “measure of the total ROM at the joint and limited by the extensibility of the musculotendinous unit” (Heyward, 2006, pp.245). Flexibility is the ability to move a joint through complete ROM. ROM of a joint is controlled by the normal extensibility of all soft tissues surrounding it (Clark, Sutton, & Lucett, 2014). Therefore, foam rollers claim that it can improve the ROM of a joint.

Athletes are concerned about increasing or sustaining an appropriate flexibility because it can help to prevent injury, while there is general public awareness on maintaining flexibility in order to keep fit. ACSM (2011) recommends that adults perform flexibility exercises two or three days per week to improve ROM. Flexibility training not only prevents injuries but can also improve muscular imbalances, improve neuromuscular efficiency and function, increase muscle extensibility and relieve excessive tension of muscles and joint stress (Clark, Sutton, & Lucett, 2014).

There are different types of foam rollers. The typical foam roller is a cylinder of variable length. However, there are some novel shapes, such as the RumbleRoller and The Grid.



Figure 1: Traditional foam roller (Kerry, 2015)



Figure 2: Four different styles Rumble Roller (RumbleRoller, 2009)



Figure 3: The Grid (Wicked Fitness, 2015)

In lieu of the dubious effects of foam rolling on flexibility, this paper investigates the role of the RumbleRoller as a tool to do so. The primary purpose of this study is to investigate the immediate effect of hamstring flexibility after applying a foam roller (RumbleRoller) for 30 seconds. We also compare the effects between static stretching and self-myofascial release, thereby providing recommendations for and against the usage of foam rollers.

Hypotheses

1. Hamstring flexibility will increase after applying a RumbleRoller for 30 seconds.
2. Applying a RumbleRoller on the hamstrings for 30 seconds result a better flexibility performance than applying a hamstring static stretching exercise for 30 seconds.

Literature review

Vivian (2004) has shown that flexibility decreases with age; females have better flexibility than

males; people who are physically active have better flexibility than those who are inactive.

The U.S. Department of Health & Human Services recommends (2008) that most adults engage in at least 150 minutes of moderate-intensity exercise each week.

Since gender and physical activity levels affect flexibility, this study also collected the gender and physical activity levels of the participants.

Stevens (2013) mentions that foam rolling might improve joint ROM, flexibility, muscular function and performance, which is a combination of self-massage (SM) and self-myofascial release (SMR) technique.

Mohr, Long & Goad (2014) indicates that many athletes have said that foam rolling helps them release their muscle tension and improve their ROM.

Sullivan, Silvey, Button, & Behm (2013) performed research with the roller-massager by Theraband® (The Hygenic Corporation, Akron, OH). It had 7 males and 10 females as participants. The participants were

divided into two groups, 3 males and 6 females as a control group, 4 males and 4 females form the experimental group. The experimental group received 4 trials of hamstrings roller-massager rolling (1 set – 5 seconds, 1 set – 10 seconds, 2 sets – 5 seconds, and 2 sets – 10 seconds) at a constant pressure (13 kgs) at a constant rate (120 bpm) with the same machine. Hamstring flexibility was measured by a Sit-and-Reach test and a maximal voluntary contraction (MVC) force measurement. Muscle activation of the hamstrings was measured before and after each session of rolling. The experimental group experienced an increase in hamstring flexibility after foam rolling within 5 to 10 seconds. There was a significant increase of 4.3% ($p = .0001$) in ROM from pretest to posttest. This study shows that foam rolling can significantly improve flexibility, especially when a longer duration was applied. However, there was no significant effect on muscle strength.



Figure 4: Roller Massager+ Standard version (Theraband®, 2014)

Sheffield & Cooper (2013) did a study of the immediate effects of SMR on female footballers. 15 female football players were recruited. They train four times a week and during the season played 90 minute competitive football matches twice a week. They were rolled thrice distally and thrice proximally from hamstring to knee. An area of discomfort was held for 30 seconds. An active knee extension (AKE) test had been performed both before and after the interventions. It was found that there was an immediate increase in hamstring flexibility after performing hamstring SMR with a foam roller. Extension of the left leg improved by 4.6° and right leg improved by 3°.

Mohr, Long & Goad (2014) did published on the change in Passive Hip-Flexion Range of Motion after receiving static stretch, foam roller

and both treatments. Number of participants with less than 90° of passive hip-flexion ROM is 40. Half years before the test, these participants were free of lower-extremity. Participants were divided into 3 10-person groups with an extra control group. Each experiment group were given one of static stretching, foam rolling, both; the control group did not receive any intervention. The study found that static stretch and foam roller can both individually increase the Passive Hip-Flexion Range of Motion, while receiving both treatments has an even greater effect. However, there were no significant differences between any of the other interventions ($p > .09$).

Roylance, George, Hammer, Rencher, Gellingham, Hager & Myrer (2013) performed research on the acute change in joint ROM using SMR, Postural Alignment Exercises, and Static Stretches. There were 27 participants (14 males and 13 females) who were university students aged between 18-27 in this study. They were randomly assigned into two groups, both group did the Sit-and-Reach test thrice. Participants received a treatment between each two test, each

treatment included foam-rolling, postural alignment exercises, or static stretching. It found that there were no single acute treatment significantly posterior mean sit-and-reach scores but the combination in foam rolling and static stretches or postural alignment exercise can significant increase ROM in participants with below average joint.

The studies above show that flexibility training is strongly recommended to maintain health. Some have found that static stretching and roller-massage can increase flexibility (but the difference is not significant), while the combination of static stretching and roll-massage causes a significant increase in flexibility.

The above literature utilized the traditional foam roller; the different shape of foam rollers mentioned in the introduction were not tested. The shape of RumbleRoller seems to be able to provide a stronger stimulation on the trigger points than the traditional foam roller. The above studies shows that using the foam roller alone cannot get the best result. Thus, it is interesting to see whether using the RumbleRoller alone can

provide significant flexibility improvement. This study is to find out the immediate flexibility change after foam rolling and also the difference in effect between foam rolling and static stretch. Only the RumbleRoller was used in this study.

Method

Participants

75 participants were recruited from 6 different organizations, including 2 swimming clubs and 4 institutions. 36 females and 39 males took part in the Sit and reach test. There were 3 age categories, 71 of them were 18-25 years old, 3 were 26-35 years old and 1 was 36-45 years old. 36 of the participants were physically active (exercise more than 150mins per week), and 39 participants were not. Participants were divided into 3 groups with 25 participants each.

Experiment approach

A pre/post- test design was used for this study. There were 3 groups; each group received one intervention: foam rolling on each hamstring for 15 seconds; static stretch on each hamstring for 15 seconds; relaxing for 30 seconds. Each participant received the intervention between the pretest and posttest.

Procedure

After the participants' recruitment, each participant was assigned into a group by stratified random sampling. Each group consisted 12 females and 13 males. The data collection occurred between February and March 2015.

The data collection procedure was as follows:

Before starting the test, each participant completed a PAR-Q to guarantee that he/she is able to participate in the study. A helper then demonstrated and described the procedure of the sit and reach test, and the 3 interventions. Each participant then performed the sit and reach test thrice, with the best performance marked as the pretest result. After the pretest, the participant received an intervention for 30 seconds, depending on which group he/she is. Finally, the participants performed the sit and reach rest thrice again, with the best performance marked as the posttest result.

Variable

The dependent variable in this experiment is the flexibility performance. The independent variable in this experiment is the

RumbleRoller Compact X-Firm, static stretching, relaxation and gender.

YMCA Sit-and-Reach Test

“Place a yardstick on the floor and put a 12-to15-in. piece of adhesive tape across the yardstick at the 15-in. mark at right angles to the tape. Have the participant sit with the yardstick between the legs with the 0-in. mark toward the crotch and the knees extended and the abducted about 12in. Shoes should be removed, and the heels of the feet should nearly touch the edge of the taped line. When the individual leans forward down the yardstick, the heels tend to slide forward, so if the participant starts about an inch behind the line, the heels will be in the correct position. When the fingertips in contact with the yardstick, have the participant slowly reach forward with both hands as far as possible on the yardstick, holding this farthest position momentarily” (YMCA of the USA, 2000, pp.159). do the test 3 times and the highest scores will be recorded (Shape Up America!, 2015).

Instruments and Measurements

This study uses the YMCA Sit-and-Reach Test (YMCA of the

USA, 2000) because it is recommended by YMCA and used for the past 40 years as a general test of flexibility.

Interventions

Intervention #1 Roller massage on hamstring (each leg for 15 seconds)

Using RumbleRoller Compact X-firm as the SMR tool.



Figure 5: RumbleRoller Compact X-firm (Walmart, 2015)

Sit with back of the thighs on the top of the RumbleRoller and both hands on the floor behind, crossing the legs at the ankle and keeping the muscles relaxed. Roll the hamstring from just above the knees to just below pelvis. (RumblerRoller, 2009).

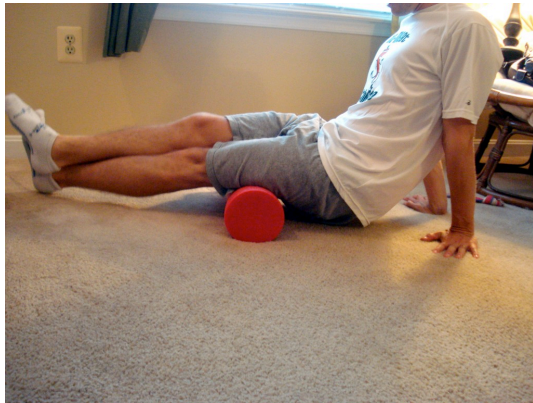


Figure 6: Roller massage for hamstring (Frazier, 2009)

Intervention #2 Hamstring static stretching (each leg for 15 seconds)

Sit on the floor with one leg out straight. Then, bend the other leg at the knee and position the sole of that foot against your opposite inner thigh.

Extend your arms and reach forward over the one straight leg by bending at the waist as far as possible for 15 seconds.



Figure 7: Hamstring stretching (Success, 2014)

Intervention #3 Relaxation

This group is regarded as the control group.

Analysis

Initially, an independent sample t-test was performed to investigate the difference between the two genders. Then, a one-way ANOVA was performed to determine whether there was any baseline difference between the 3 groups during the pretest. All data was analyzed with a one-way with repeated measures ANOVA. Variables in between participants were the Sit-and-reach results (pretest and posttest results), while within subject factors included gender (male and female) and intervention (foam rolling, static stretching, relaxation). Differences were considered significant for $p < .05$. Data is reported as the mean \pm standard deviation (SD).

Results

A significant gender difference ($p = .028$) was found in the participants, females' flexibility is better than males (mean = 2.20, sd = 0.98 inch). There was no significant difference between the 3 groups on the pretest ($F_{2,73} = 2.64, p = .078$).

Table 1 2*3 between subject ANOVA

Group	N	Pretest mean ± SD	Posttest mean ± SD	F	p-value
Foam Rolling	25	15.62±4.00	16.77±3.80	1.895	0.158
Stretching	25	17.09±4.22	18.69±3.74		
Relaxation	25	18.38±4.51	19.33±4.52		

There was no significant difference in time (pretest and posttest) * interventions ($F_{2,,73} = 1.895, P = .158$).

From the within-subject ANOVA, all 3 interventions can significantly improve hamstring flexibility ($F_{1,73} = 83.714, p = .000$),

After applying foam rolling, the flexibility increased from pretest (mean = 15.62, sd = 4.00 inches) to posttest (mean = 16.77, sd = 3.80 inches) by 1.15 inches (sd = 1.04, p = .000).

After static stretching, the flexibility increased from pretest (mean =

17.09, sd = 4.22 inches) to posttest (mean = 18.69, sd = 3.74 inches) by 1.60 inches (sd = 1.50, p = .000).

After relaxation, the flexibility increased from pretest (mean = 18.38, sd = 4.51 inch) to posttest (mean = 19.33, sd = 4.52 inch) of 0.95 inch (sd = .85, p = .000).

However, **from the between-subject ANOVA, there was no significant different improvement between 3 interventions ($F_{1, 73} = 83.714, p = .075$).**

Discussion

The results show that gender difference exists and it has the same result as the YMCA's Sit and reach test; the pretest baseline had no significant difference, indicating that the baseline of the study is appropriate; 3 interventions were each able to improve hamstring flexibility significantly but there was no significant difference between the effectiveness of the 3 interventions.

Although the analysis can use the one way ANOVA with pretest, posttest and posttest minus pretest to get the result, this method has more errors/inaccuracy than the one-way with repeated measures ANOVA because it neglects the errors in the data of posttest minus pretest, and the one-way with repeated measures ANOVA takes time into consideration.

Flexibility can be affected by many factors, including genetics, connective tissue elasticity, composition of tendons, joint structure, strength of opposing muscle groups, body composition, sex, age, activity level, previous injuries and repetitive movements (Clark, Sutton, & Lucett, 2014).

This study collected age, sex and activity level of the participants but each group did not have a large enough sample size to get an accurate result from age and activity level. Thus, it did not analyze the effect of gender and activity level on flexibility. However, the effect of age had been minimized in the study because these two factors had been standardized and divided into 3 groups; almost 95% of the participants are in 18-25 years old category and the number of physically active participants was almost the same as those who were not. Therefore, there was no significant difference between 3 groups, demonstrated by the baseline hamstring flexibility performance.

Due to the many factors affecting flexibility, it is hard to have the same flexibility performance on every test. This is demonstrated by the change in flexibility in the control group. The posttest flexibility performance is better than pretest could be due to a warm-up effect. The other possible reason could be the activity level. For example, if someone is physically active, he/she easily increases his/her activity rate, which means

that it is easier to get warmed-up.

The above situation shows that the experimental design does not perfectly fit the study. This study uses a traditional pretest-posttest design, involving two experimental groups (static stretch and foam rolling) and a control group (relaxation) to test the effectiveness of the interventions. Thus, the interference that appears on the pretest-posttest design, such as warm-up effect and practice effect, cannot be avoided. The warm-up effect may improve hamstring flexibility because the pretest can be regarded as a warm-up activity for the posttest. The practice effect may also improve hamstring flexibility because participants may not be familiar with the sit-and-reach test during the pretest but become familiar during the posttest. A better experimental design is needed to solve these problems: Participants are divided into 2 groups and each group will do sit-and-reach test thrice. One group does the pretest, then relaxes (no intervention received) for 30 seconds. After that, they perform the first posttest and receive the foam rolling for 30 seconds. They then perform the second posttest. Another group does the pretest first.

They receive the foam rolling intervention for 30 seconds and perform the first posttest. After that, they relax (no intervention received) for 30 seconds and do the second posttest. This design compares the performance after receiving foam rolling between two groups. This design can avoid the warm-up effect. Moreover, before starting the test, all participants do a sit-and-reach test once to become familiar with the test to avoid practice effect.

On the other hand, there are 3 types of flexibility training: corrective, active and functional. In this study, foam rolling (SMR) and static stretching belongs to corrective flexibility training. It aims to increase joint ROM, improve muscle imbalances and correct altered joint motion (Clark, Sutton, & Lucett, 2014). This statement is also supported by the experiment. Considering that both foam rolling and stretching can improve hamstring flexibility, and that there was no significant difference between them, this shows that the two interventions are an equally effective flexibility exercise. As a result, people who want to improve their ROM, can choose either one intervention to do or do both.

SMR is used to help correct existing muscle imbalance, relief pain (reduce trigger points) and inhibit overactive musculature. Static stretching is used to correct existing muscle imbalances and improve tight musculature. Both of them are suggested before and after exercise (Clark, Sutton, & Lucett, 2014). In a study of static hamstring stretching on passive knee-extension ROM, Ford et al (2005) found that all participants who did a 5-week daily stretching program had a significant improvement on passive knee-extension ROM. Myofascial release provided by ischemic compression therapy is one of the most effective ways of immediate pain relief (Hou et al, 2002).

Foam rolling and static stretching can increase flexibility significantly. Roylance, George, Hammer, Rencher, Gellingham, Hager & Myrer (2013) found that the combination in foam rolling and static stretches or postural alignment exercise can significant increase ROM in participants with below average joint. Mohr, Long & Goad (2014) found that receiving foam roller and static stretch can have the greater increase in Passive Hip-Flexion Range of Motion. Thus, the combination of

foam rolling and static stretch could be the best flexibility training technique. It could provide the best immediate effect of flexibility improvement. Despite the fact that foam rolling and static stretch both belong to corrective flexibility training, their functions are not exactly the same. Therefore, doing both as flexibility training is good for long-term health.

However, although the result shows that there was no significant difference between foam rolling and static stretch, Peacock, Krein, Silver, Sanders, & Von Carlowitz (2014) found that using dynamic warm up and adding 5 minutes foam rolling in the warm-up activity leads to a significant improvement in vertical jump, standing long jump, 18.3m pro-agility, indirect 1-RM bench press and 37m sprint but no significant difference in the sit and reach test. Therefore, using foam rolling alone cannot maximize the best effect but a combination of foam rolling with dynamic stretch could be a best warm up technique and a combination with static stretch could be the best flexibility training technique.

Besides, Stevens (2013) states that

SMR is treated as a recovery aid for athletes; it includes less intense rolling movements and intense hold for trigger points, 60 seconds minimum for each muscle to cause a recovery effect. SCRAGG (2012) states that stretching is the most common and accepted recovery technique after exercise; each stretch takes 30-60 seconds. Pearcey, Bradbury-Squires, Kawamoto, Drinkwater, Behm & Button (2015) did a study of foam rolling for Delayed-Onset Muscle Soreness and Recovery (DOMS), which found that a 20 minutes foam rolling after exercise can reduce muscle tenderness and decrements in multi-jointed dynamic movements every 24hours thereafter. 3 x 20 minutes of foam rolling can enhance recovery after DOMS substantially and alleviate muscle tenderness. It states that foam rolling is an effective aid for muscle recovery. Thus, the recovery effect is one of major concern for athlete; it is important that they should know more about foam rolling and static stretch.

Limitations

There are some limitations of the study. The YMCA Sit-and-Reach test may not be the best indicator of

hamstring flexibility. Sullivan, Hoeger, Hopkins, Button & Palmer (1990) stated that the Sit-and-Reach test is a common technique used for testing trunk and hip flexibility or lower back and hamstring flexibility. As this study used the YMCA Sit-and-Reach test to be the instrument, the scores were affected by hamstring and lower back flexibility. However, the intervention only applied on the hamstring while neglecting the lower back. Thus, it might not reflect the maximum effect on the scores because the improvement only happened on the hamstring. If the interventions applied on both hamstring and lower back, which includes foam rolling and static stretch, the posttest result may have a bigger improvement than the result of this study. This adjustment could cause a significant different result between the interventions.

The force and speed of the foam rolling are not standardized. Silvey, Button, & Behm (2013) used a custom-made device to provide a steady force and speed foam rolling for the subjects. Since the RumbleRoller is applied by the subjects themselves, the rolling force and speed are different but this study does not have enough budget to

control this interference. Besides, since the participants were volunteers, and there was a lack of helpers, the test was done in rush. Some participants were not able to immediately perform the posttest after the intervention. This could affect the accuracy of the result.

Furthermore, in general, most stretching guidelines recommend 15-30 seconds of stretching. Thus, this study follows the general guidelines in order to standardize the time of applying each intervention. It neglects the effect of the intervention's duration, for example applying foam rolling for 2mins may have a better result. Besides, apart from RumbleRoller, there are a lot of different foam rolling in the market. Although they all belong to SMR, different SMR tools may have different results.

In addition, Sullivan, J. Silvey, Button & Behm (2013) mentioned that foam rolling has no negative effect on muscular performance but static stretching has a significant negative effect on neuromuscular performance. This was not considered in this study. The relationship between muscle

performance and foam rolling can be investigated in future studies.

Follow up studies

There are a number of potential follow-up studies that could be completed as a result of this study. First, increase the sample size of other factors, such as physical activity level. Second, more diverse SMR tools for comparing the effectiveness of different SMR tool. Third, longer intervention times that comparing the effectiveness of different durations of SMR. Fourth, the long term effect of different interventions, which immediate improvement not the goal of flexibility training. Fifth, pain relief and improve muscular imbalance performance that are advertised SMR functions. Sixth, athletic performance, since too much static stretch may reduce muscular performance; it can test the athletic performance after having foam rolling, such as jumping ability, agility and power. Seventh, the recovery effect of foam rolling and static stretch. This should be a major concern that either doing foam rolling or static stretch after exercise. Lastly, to eliminate the error/inaccuracy of YMCA Sit-and-Reach test, such as adding intervention on lower back or using other instrument that can only

testing hamstring flexibility.

Conclusion

To conclude, applying foam rolling with RumblerRoller, static stretching and relaxation on hamstring for 30 seconds had a significant improvement on flexibility. However, there is no significant difference between the 3 interventions. Further studies on foam rolling should be conducted the different foam rolling and duration of using foam rolling

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