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Effects of Foam Rolling on Range of Motion and Vertical Jump Height

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Abstract

Static stretching has been shown to elicit an acute improvement in range of motion (ROM) in both the contralateral and ipsilateral limb. However, static stretching has also been shown to impair performance. Foam rolling has been used in clinical settings as well as by the general population to increase ROM without impairing performance. To date, there is limited research evaluating the effect of foam rolling on the contralateral limb. Therefore, the purpose of this study was to explore the effect of foam rolling on ROM and single-leg drop jump performance in the foam rolled and non-foam rolled legs. The results of this study may help to understand the mechanism through which foam rolling can improve ROM.

Introduction

Foam rolling is a form of recovery and rehab that can be used as an alternative to stretching. Foam rolling involves using one's body weight to roll out a body part on a dense, foam cylinder. A person's body weight is used to apply pressure on the whole limb, including muscles, fascia, tendons, ligaments, and nerve receptors. Foam rolling a limb has been found to decrease delayed onset muscle soreness (DOMS), relax muscles and improve range of motion (Bradbury- Squires 2015). Studies have found benefits of static stretching on range of motion (ROM) and performance, but have yet to confirm if foam rolling has the same effects. Static stretching one side of the body can have a positive effect on ROM and performance on the body parts of the opposite side, according to a study by Chaouachi (2017). This could be due to central nervous system involvement and the cross- over effect. It is inconclusive whether foam rolling one side of the body will have a positive effect on muscular strength and ROM in the contralateral limbs as well. The aim of this investigation is to examine the possible effects of foam rolling on range of motion and muscular performance on the foam rolled side and the contralateral side of the body.

Background

There is extensive research on the positive impacts stretching has on range of motion, flexibility and performance. According to Behm, static stretching, dynamic stretching and PNF (proprioceptive neuromuscular facilitation) all have positive impacts on ROM because they lower muscle and tendon stiffness (2016). Foam rolling should have the same effect of reducing stiffness in muscles and tendons because foam rolling is a form self- myofascial release, which will facilitate tissue relaxation through afferent signals to the central nervous system (Kelly, 2016). Kelly suggests in his research that self myofascial release from foam rolling also might increase neural stretch tolerance and have the same effect that static stretching has on a specific part of the body and it's counterpart, which is increase ROM and enhance muscular performance (2016). When stretch tolerance is increased, more force can be applied to a joint, allowing the muscle- tendon unit to tolerate the greater amount of force and permit more ROM. Stretch tolerance is generally neurally mediated, which is why stretching or rolling just one body part may have an effect on another.

Stretching provides many benefits for the whole body, not just for the specific muscle group that is stretched. In another study by Behm, it was discovered that passive lower body static stretching significantly improved hip flexor ROM as well as shoulder ROM, even though upper body was not being stretched in the experiment (2015). The same study also discovered that there was a large increase in hip flexor ROM following static and dynamic stretching of the upper body. Behm concludes that because stretching any part of the body enhances stretch tolerance, improved ROM for the whole body is a result. Neural adaptations from stretching one side of the body leads to enhanced stretch tolerance (Behm, 2016). This concept of crossover flexibility and ROM improvements in can apply to any body section.

In a research study titled "Specific and Cross- over effects of Foam Rolling on Ankle Dorsiflexion Range of Motion" done by Shane Kelly, results show that within the foam rolling group, ROM for ankle dorsiflexion improved for up to 20 minutes. Results also depict a crossover effect of foam rolling from the ipsilateral limb to the contralateral limb in the 5 minute and 10 minute post foam rolling sessions. There were no significant differences for ROM in the between- group analysis (Kelly, 2016). Kelly concludes that foam rolling has positive effects on ROM in both the ipsilateral and contralateral legs, but has less of an effect on the contralateral side. The reasoning for the positive effect on ROM on the contralateral side has yet to be determined, however it is likely that it is related to increased neurally mediated stretch tolerance (Kelly, 2016).

Foam rolling does not just produce improvements on range of motion, but it may also enhance performance on vertical jump height in a single leg jump. The increased performance could apply to the foam- rolled leg and the opposite leg. Some research has shown that foam rolling improves range of motion, and in a general stress- strain curve, force production and torque increase as range of motion increases. Literature has observed that resistance training one side of the body improves force production on the contralateral side of the body (Kelly, 2016). Kelly describes in this same article that the strength gains from resistance training on one side of the body improve all parts of the body because of central changes in strength occur from neural adaptations of resistance training. Enhanced force production on both sides of the body from resistance training only one side stems from the whole body becoming accustomed to force producing exercises. If force production on one side of the body is improved from foam rolling, it should also produce neural adaptations in the central nervous system and increase force production in the opposite side of the body as resistance training has found to do.

Foam rolling activates the stretch shortening cycle (SSC), which is known to increase force production. In a journal written by Jake Phillips titled "Effect of Varying Self-myofascial Release Duration on Subsequent Athletic Performance", Phillips suggests that foam rolling will also enhance force production because it treats hypersensitive regions of myofascia. When myofascia gets micro- tears and inflammation, performance of them muscle is reduced (Phillips, 2018). Foam rolling helps relieve sensitive areas of muscle and restore movement function and force production. Phillips tested foam rolling on force production by having 24 subjects perform three sessions of foam rolling followed by ROM and strength tests. The results of the study found that overall, ROM increased slightly in the foam rolling groups but was not significant. Force production in the Pro- Agility test improved in the one minute foam rolling session but actually decreased in the five minute foam rolling session (2018). Short bouts of foam rolling may enhance force production, but long bouts of foam rolling could actually cause muscle fatigue and decrease performance on tests immediately after a foam rolling session. This may suggest that extensive foam rolling should not be incorporated into warm- ups for sports or work- out sessions because it could lead to muscle fatigue.

Although there is literature that has found positive effects on ROM and force production, there is also research that has found contrasting results. Josinaldo Jarbas da Silva conducted a study called "Unilateral Plantar Flexors Static- Stretching Effects on Ipsilateral and Contralateral Jump Measures" to examine the acute effects of static stretching on passive ROM of the stretched limb and single leg drop jump height of the stretched and contralateral limbs. For each subject in the study, Da Silva collected control values for passive ROM and single leg jumps on both legs, then had the subjects static stretch the dominant lower limb and test ROM and single leg jump on both limbs again. Da Silva found that static stretching increased passive ROM on the stretched limb, however, it decreased the jump height, muscle peak force and pre- activation of the non stretched limb (da Silva, 2015). Other results were insignificant. Since static stretching was not found to enhance performance in jump height or passive ROM of the contralateral side of the body, it can be inferred that it may not induce a central nervous system change. Foam rolling may actually inhibit a central nervous system mechanism for performance (da Silva, 2015).

Purpose

There is contrasting research on the effects of stretching and foam rolling on ROM and performance in the contralateral limb and there is very little research done on foam rolling and ROM/ force production of the contralateral limb, making it is difficult to determine the real effects it has. There is some evidence that stretching enhances ROM and performance on the contralateral side of the stretched limb, but more research still needs to be done to conclude if foam rolling one limb can have a positive cross- over effect on ROM and force production on the opposite side of the body. The purpose of this study is to explore the effect of foam rolling on ROM and single- leg drop jump height in the foam rolled and non- foam rolled legs. The results of this study may help to understand the mechanism through which foam rolling can improve ROM.

Procedures

Subjects for this study will be recruited within the Department of Kinesiology. Participants will complete four sessions in randomized order. On the first session, participants will identify their dominant leg, determined by asking each participant to identify their preferred leg to kick a soccer ball with. Each subject will complete a standardized warm-up consisting of walking on a treadmill for five minutes on a speed of the participants choice. This chosen speed will be the same speed used for all four sessions.

Control Session – Dominant Leg

The participants will complete their standardized warm up and then get measured for dorsiflexion ROM in their dominant leg by performing a wall stretch. For the wall stretch, the participant will stand facing a wall, about three feet from the wall, and lunge forward onto their non- dominant foot and have their dominant foot fully extended. They can place their hands on the wall for maximal extension and then will be measured with a digital torpedo on the anterior side of the tibia of the dominant leg. The participant will perform three trials of the wall stretch and the highest value will be used for data analysis. For the single leg drop jump, markers will be placed on the participant to track maximum range of motion in video analysis on a tracker software. White markers will be placed on the dominant side of the participant at the acromioclavicular joint, the greater trochanter and the 5th metatarsal. This will allow ROM to be measured at the hip, knee and ankle joints. The purpose of measuring the joint angles during the jump is to assure that the subject is using the same jump technique for each jump. The single- leg drop jumps will be performed three times in a row by the participant and the maximum height values will be used for statistical analysis. For the jump, the subject must step off of an elevated platform and fall onto the Kistler force plate. Upon landing, the subject will jump for maximal height. After, participants will rest for two minutes then be repeat the jumps and be re- assessed for dorsiflexion ROM.

Control Session – Non-Dominant Leg

This session is the same as the above Control Session for the dominant leg except dorsiflexion ROM and jumps are assessed on the opposite leg (non-dominant).

Experimental Session – Dominant Leg

Subjects will complete the same standardized warm-up, baseline dorsiflexion ROM assessment, and single-leg vertical jumps using their dominant leg in the previous procedure description. Subjects will use a foam roller on the posterior aspect of their lower dominant leg. Correct foam rolling technique will be demonstrated by a research member. With the dominant calf resting on a foam roller, the participants will place both hands and the non-dominant leg on the floor to support their body. A metronome play to control foam rolling speed. Subjects will foam roll by placing most of their weight on the roller and sliding forward and backwards to apply pressure on the calf. The metronome will guide the subjects rolling speed as they will roll forward and back at each beep. The subjects will foam roll for 30 seconds and rest for 15 seconds and repeat this pattern two more times. After foam rolling, the subject will be re-assessed for dorsiflexion ROM and perform three more single leg drop jumps on the same leg.

Experimental Session – Non-Dominant Leg

This session is the same as previously described in the dominant leg session but the jumps and dorsiflexion ROM will be assessed on the non- dominant leg. However, the dominant leg is still the leg that is being foam rolled.

Dorsiflexion ROM and jump height from each jump will be collected for each participant. The jumps will be recorded on video and the Kistler force plate data will be used for statistical analysis.

The study was conducted with four subjects. The average age of the subjects was 21.2 +/- 0.8 years. The average height in centimeters of the subjects was 162.2 +/- 4.5 cm. The average body mass of the subjects was 66.7 +/- 18.3 kg.

Data collection was done with five separate two way repeated measures ANOVA's, which were dorsiflexion ROM from both legs, vertical jump height, mean height, max height and time to peak force. The impulse momentum formula and the uniform acceleration formula were used in the data collection.

Results

There was no significant interaction or main effect for session or time for range of motion, vertical jump height, mean force, max force or time to peak force ($p > 0.05$). This result could likely be due to a low sample size and low statistical power. There was also no significant interaction for joint angle data. This however is a positive finding because it shows that the subjects used the same jump technique for each of their single leg vertical jumps. The similar joint angles for each jump represent that the lower leg, which is the foam rolled portion of the leg, was mainly used to power each jump.

Discussion

One limitation of this investigation is the sample size. Only four subjects were used in the study which made for a very low statistical power. The resulting statistical power was 0.053-0.498. The statistical power should be closer to one in order to be certain that the results are valid and reliable. Another limitation is that this study only looked at foam rolling one body part, which was the calf. The results may have been stronger if the whole leg was foam rolled including the upper leg and glute muscles which also aid in a single leg vertical jump.

The results of this research study can aid in future research on similar topics. There is still much research to be done on the topic of improving performance and range of motion on the contralateral limb that was treated. If more research is done on this topic, it can be of great use in rehabilitation settings. Many patients needing rehab have limitations to just one limb or one side of their body. It would be extremely beneficial for these patients to be able to get treatments on one side of their body or perform foam rolling or stretching on their functional limb and have improvements on their contralateral limb. Patients who suffer from stroke are a great example of a population who could benefit from this research.

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