Does research support the use of foam rolling?

by Chris Beardsley on October 1, 2013

Foam rolling is a form of self-myofascial release that is commonly used by fitness professionals. However, it is a relatively new technique and research has only recently emerged to describe its effects.

What's more, the fields of research into the areas of fascia, myofascial release, self-myofascial release and myofascial trigger points are also young and quickly developing.

In the first part of this article, I cover the background relating to fascia, myofascial release and myofascial trigger points. In the second part, I've reviewed the current state of the foam rolling research. To skip the background and jump to the foam rolling research, click here.

What is fascia?

Any discussion of self-myofascial release first has to present some background to fascia and the research into fascia. However, the field of fascia research is quite young and researchers are still very much feeling their way through an extremely complex and difficult area. Therefore, much of the following is presented as the general and high-level consensus of researchers in the field with the (rather large) caveat that nobody really knows what is actually going on.

According to the standard definition provided by the Journal of Bodywork and Movement Therapies (LeMoon, 2008), fascia is the soft tissue component of the connective tissue system that both penetrates and surrounds muscles, bones, organs, nerves, blood vessels and other structures and extends from head to toe, from front to back, and from surface to deep in an uninterrupted, three-dimensional web. Schleip (2012) also define fascia as "the soft tissue component of the connective tissue system that permeates the human body (and) that is part of a body wide tensional force transmission system."

However, quite unsurprisingly given the difficulties, there has been significant disagreement in respect of exactly what fascia comprises (Schleip, 2012). This lack of agreement has caused a great deal of confusion regarding and a breakdown in communication between researchers working in different fields and geographies as well as between researchers and clinicians. Consequently, different anatomy textbooks and articles referring to fascia continue to do so on the basis of slightly different definitions.

Disagreements aside, anatomically, researchers have differentiated between several layers of fascia: a superficial fascia, a deep fascia and visceral fascia. The superficial fascia is a fibrous layer with a membranous appearance and abundant elastic fibers and occasional thin sub-layers of fat cells interspersed between layers of collagen fibers. The deep fascia seems to differ in its make-up depending on anatomical location. In the trunk region, it is formed by a single layer of undulating collagen fibers mixed with elastic fibers (Findley, 2012).

In broad terms, therefore, fascia is connective tissue that wraps around all of our muscles and is heavily interconnected with muscular function. It is also a continuous sheet all around the body, which means that if it is altered or shortened in one area, that could potentially have a knock-on effect in other areas of the body. However, as always, the devil is in the details and the extent to which such knock-on effects can and do occur is difficult to determine.

What does fascia actually do?

On the basis of the above definition, we can see that fascia might be somewhat important for transmitting tension from one part of the body to the other. Additionally, researchers have implicated fascia in a number of other areas. Again, according to the standard definition provided by the Journal of Bodywork and Movement Therapies (LeMoon, 2008), fascia is responsible for:

- Maintaining structural integrity
- Providing support and protection
- Acting as a shock absorber
- Plays a role in hemodynamic and biochemical processes
- Provides the matrix permitting intercellular communication
- Functions as the body's first line of defense against pathogenic agents and infections
- Creates an environment for tissue repair post-injury

The extent to which fascia is involved in these areas and its relative important remains difficult to quantify, as the field is rapidly evolving (as the problem with nomenclature will testify). However, based on these findings, we should not be too surprised if we see an effect via fascia on areas as diverse as muscular force transmission (e.g. Huijing, 2005) and arterial function (e.g. Okamoto, 2013).

What is myofascial release?

It is thought that the term myofascial release was first coined in 1981 by Chila, Peckham and Manheim, in a course titled ‘‘Myofascial Release’’ at Michigan State University (McKenney, 2013). Since the 1980s, myofascial release has become a broad term covering a wide variety of techniques, including osteopathic soft-tissue techniques, structural integration (Rolfing), massage, instrument-assisted fascial release, Graston technique, trigger point release and many others (Simmonds, 2012).

In general, a myofascial release technique is intended to address localized tightness in the fascia, although the literature often seems to me to be slightly confusing regarding whether muscle tissue, fascia itself or a combination of both is being treated by the various techniques. In any event, researchers have suggested that following acute inflammation, fascia may tighten and lose its pliability and that when this inflamed fascia tightens, what was previously a pain free range-of-motion may now cause (1) pain to be felt at sensitive areas and (2) blood flow restrictions (Findley, 2012).

Consequently, researchers have suggested that performing myofascial release techniques may therefore improve such sensations of pain and poor blood flow circulation that may be caused by inflamed fascia. Indeed, studies suggest that this may indeed be possible in respect of pain (e.g. Miernik, 2012) and blood flow restrictions (e.g. Walton, 2008).

Additionally, some researchers have proposed that specific fascial training techniques, including myofascial release, may help cause other beneficial adaptations to fascia (e.g. Schleip, 2013). For example, researchers have noted that since 67% of the volume of fascial tissues is made up of water and that the application of load squeezes water out of the structures, fascia may therefore lack water in certain areas. The application of external force may therefore be required in order to redistribute water and rehydrate the tissues. This external force can be supplied via myofascial release therapy.

What are myofascial trigger points?

The sensations of pain that are caused by localized tightness in the fascia are generally referred to as "myofascial pain syndrome" and the localized tightness itself is thought to be caused by myofascial trigger points. Myofascial trigger points are more usually defined as "tender spots in discrete, taut bands of hardened muscle that produce local and referred pain" (Bron, 2012). As noted above, there appears to be some slight confusion about the terminology, as it is not immediately clear here on the face of it whether fascia, muscle tissue or the combined unit (just as we often refer to muscle-tendon units, for example) are being described.

A commonly-held hypothesis about myofascial trigger points is that they are caused when motor endplates release excessive acetylcholine, leading to localized sarcomere shortening and consequently very short muscle fibers in one particular area (e.g. Hong, 1998). Indeed, in such myofascial trigger points, researchers have observed a disruption of the cell membrane, damage to the sarcoplasmic reticulum and a subsequent release of high amounts of calcium-ions, and the presence of cytokines, indicating localized inflammation (Bron, 2012 and Gerwin, 2010).

Some researchers believe that myofascial trigger points develop after muscle overuse, possibly following excessive eccentric muscular contractions, or sustained concentric muscular contractions to muscular failure, particularly where such contractions involve localized ischemia, which leads to a lowered pH and the release of inflammatory mediators (Bron, 2012). However, the literature is still very sparse in this area.

Additionally, very recent research is now beginning to make connections between the existence of myofascial trigger points and musculoskeletal disorders. For example, Roach (2012) found individuals with patellofemoral pain syndrome had a higher prevalence of myofascial trigger points in the gluteus medius and quadratus lumborum muscles on both sides.

However, other researchers have been very sceptical about the existence of myofascial trigger points. A recent systematic review by Myburgh (2008) concluded that only local tenderness of the trapezius and pain referral of the gluteus medius and quadratus lumborum were reproducible intra- and inter-examiner. Such research suggests that at very best we do not fully understand myofascial trigger points and at worst they may not even exist. What is actually going on is very difficult to say.

How do myofascial release therapies affect myofascial trigger points?

Exactly how myofascial release therapies might affect either muscle and/or fascia is unclear and highly contentious. There are two main categories of proposed mechanisms: mechanical and neurophysiological.

Mechanical models

In mechanical models, which were among the first explanations to be proposed, it is suggested that the direct effects of either stretch or pressure physically "break up" the adhesions in the myofascial tissue. Developed explanations in this vein propose that it is possible through myofascial release to cause a reduction in the strength of cross-links between collagen fibers as well as causing micro-failure of collagen fibrils, which increase gliding functions between fascial layers (Martınez Rodrıguez, 2013).

However, there are two main problems with such models. Firstly, it is difficult to see how the extremely fast changes in myofascial tone that are observed in practice can be achieved through this mechanism. Indeed, Chaudhry (2008) found that forces outside the physiological range are required to produce even 1% compression and 1% shear of the fascia lata and plantar fascia. Secondly, the relatively low level of forces used by manual therapists is not enough to cause significant deformation of collagen (Simmonds, 2012 and Martınez Rodrıguez, 2013).

Neurophysiological models

In neurophysiological models, which are now becoming more widely accepted than the older, mechanical models, myofascial release is thought to stimulate intra-fascial mechanoreceptors, which cause alterations in the afferent input to the central nervous system, leading to a reduction in the activation of specific groups of motor units (see my review of Schleip, 2003 at Greg Lehman's website).

In this way, myofascial release does not affect the physical properties of the muscle or fascia but rather sends signals to the brain through afferent nerves, which then signals to the muscle to relax its excessively contracted state. As noted above, this model assumes that muscle tissue is responsible for the tightness and that it is muscle tissue that is being changed by treatment.

Where can I find out more about these issues?

The purpose of this article up to this point was certainly not to analyze the current state of the research on fascia, myofascial release, self-myofascial release or myofascial trigger points. Rather, it was intended to provide some background for the following research reviews about foam rolling. If you're interested in reading further about these topics, you might want to jump ship now, as we're about to dive into the practical side of things.

If you're looking to jump ship and find more detailed discussion and extensive analysis about the current state of research in these areas, try looking at Todd Hargrove's thoughts or Greg Lehman's analysis on these subjects,as they are much more widely read in these areas than I am.

What is self-myofascial release?

Self-myofascial release is simply that category of myofascial release techniques that are performed by the individual themselves rather than by a clinician. Consequently, self- myofascial techniques most often involve a tool with which the individual puts pressure upon the affected area. The most commonly-used self-myofascial release tool is the foam roller.

What is foam rolling?

Foam rolling is a common form of self- myofascial release that is often used by fitness enthusiasts and athletes prior to a workout with a view to improving flexibility or after a workout with a view to reducing muscle soreness and promoting quicker recovery. However, the available research has until recently been very limited in respect of both of these effects.

What acute effects does foam rolling have?

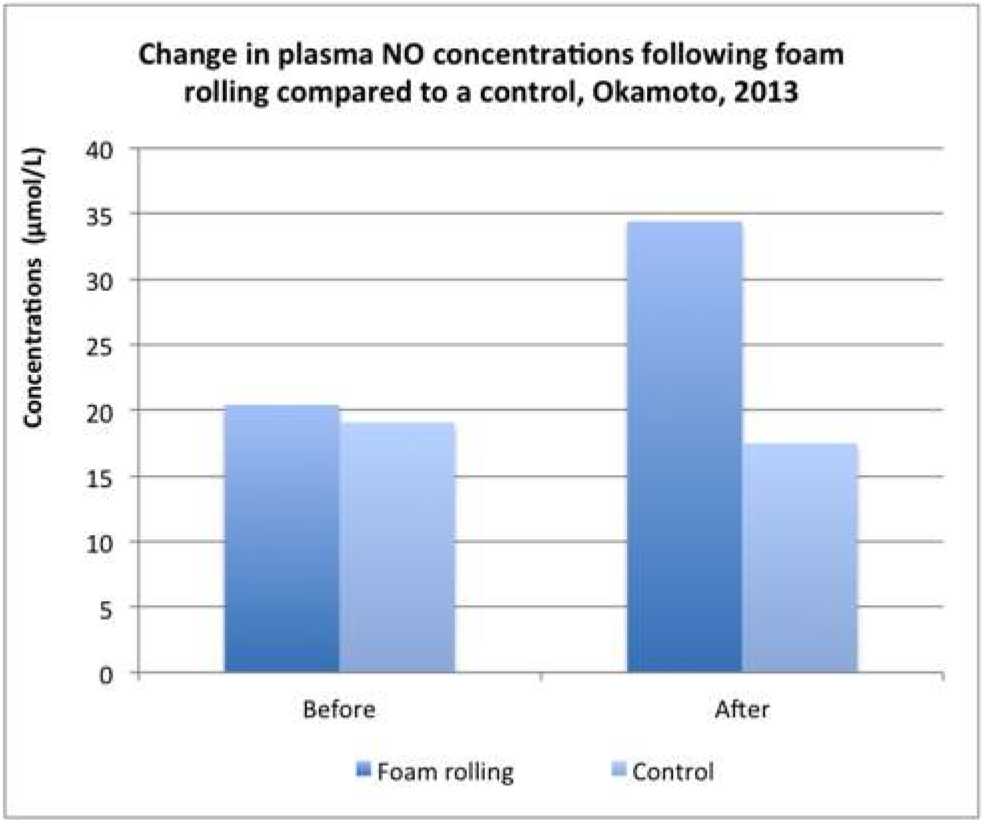
Although foam rolling is a very new area of research for sports scientists, it is increasingly being studied. The following studies have investigated the acute (i.e. very short-term) effects of foam rolling:

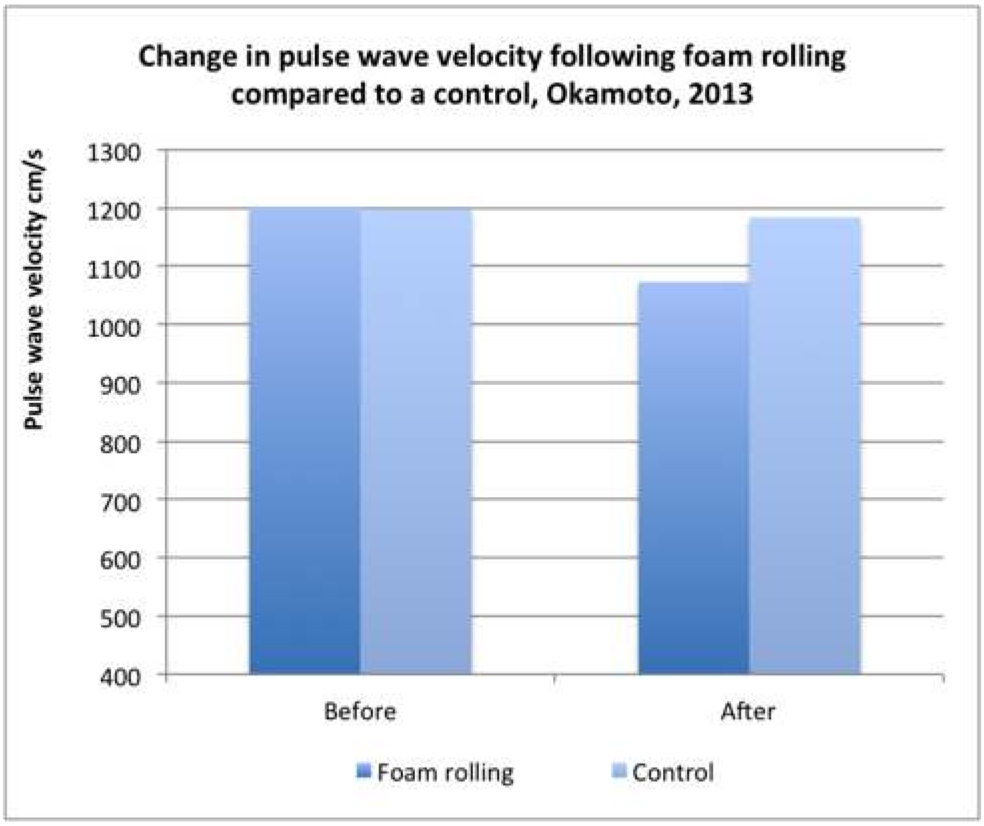
Foam rolling may reduce arterial stiffness, improve arterial function and improve vascular endothelial function

Okamoto (2013) explored the acute effect of self-myofascial release with a foam roller on arterial stiffness and vascular endothelial function, as measured using pulse wave velocity in 10 healthy but sedentary subjects (7 males and 3 females). They compared self-myofascial release with a foam roller and a control condition in a randomized, cross-over design, at least 3 days apart.

They measured brachial-ankle pulse wave velocity and plasma nitric oxide (NO) concentrations both before and 30-minutes after both conditions. The researchers found that brachial-ankle pulse wave velocity significantly decreased after the self-myofascial release with a foam roller condition but did not change following the control condition. The researchers also found that plasma NO concentrations significantly increased after the self-myofascial release with a foam roller condition but did not change significantly after the control condition.

The researchers therefore concluded that self-myofascial release with a foam roller is able to reduce arterial stiffness, improve arterial function and improve vascular endothelial function in sedentary subjects. They suggest that foam rolling may consequently be a useful tool for improving cardiovascular health in the general population.



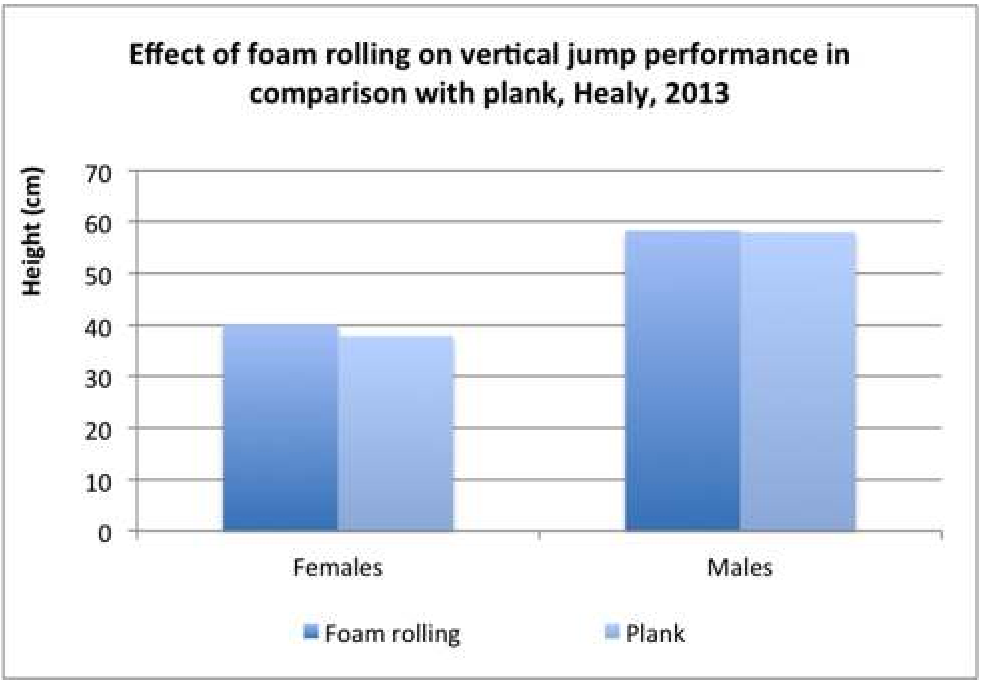


Foam rolling may have no detrimental effects on athletic performance pre-workout

Healy (2013) investigated whether self-myofascial release with a foam roller would alter athletic performance acutely in comparison with a control condition. The researchers therefore recruited 26 recreationally active, college-aged subjects (13 males and 13 females) for the trial, which was performed in a randomized, crossover design, with the trials separated by 5 days to avoid any interactions.

The control condition involved a similar position to the foam rolling condition but without the foam roller: holding a plank position for 30 seconds. Before and after each condition, the researchers took measurements of muscle soreness, fatigue and perceived exertion as well as 3 performance tests: isometric quarter squat force in a Smith machine squat bar using a force plate, counter-movement jump height and power using a force plate, and agility using the 5-10-5 yard shuttle run.

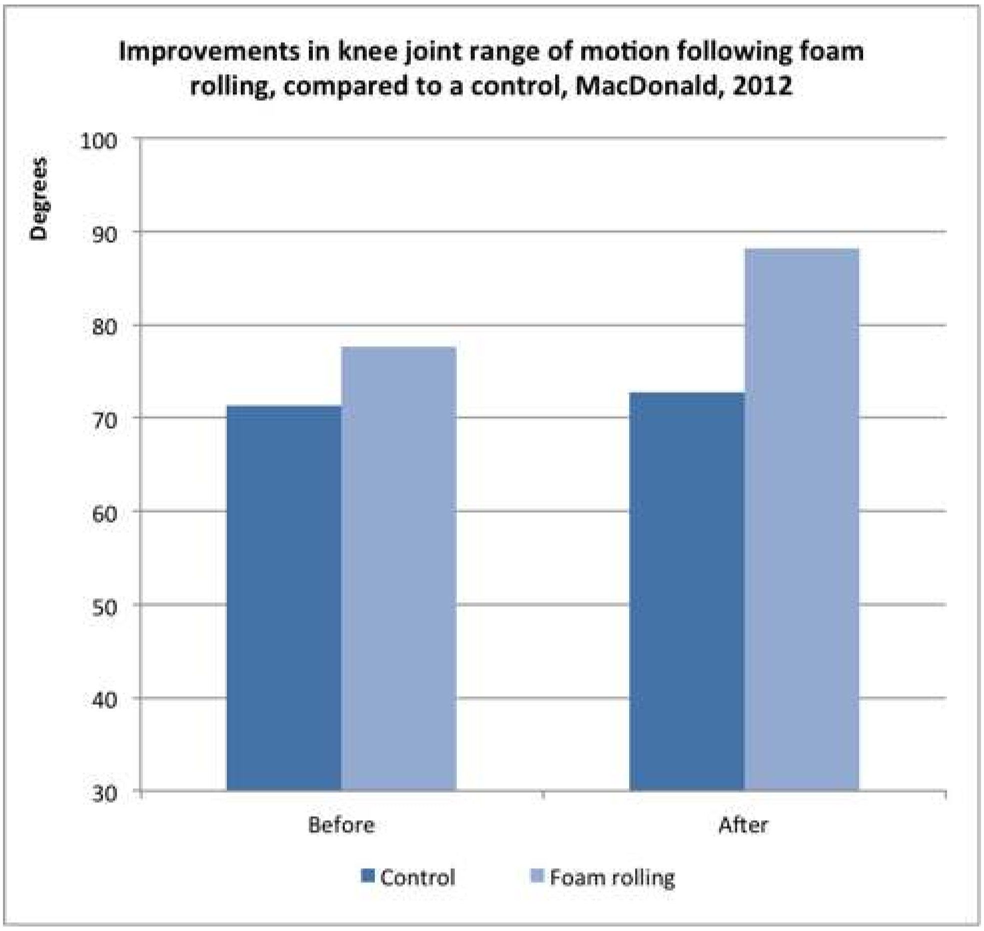
The researchers found no significant differences between the foam rolling and control conditions for all of the athletic tests but they did observe that fatigue was significantly greater after the plank (control) condition than after the foam rolling condition. The researchers therefore concluded that use of a foam roller prior to exercise does not improve or reduce athletic performance acutely.



Foam rolling may increase joint range-of-motion (ROM) while not impeding the production of muscular force or rate of force development

MacDonald (2012) investigated whether two 1-minute bouts of foam rolling would affect knee joint range-of-motion (ROM), voluntary and involuntary quadriceps muscular force during isometric knee extension at a 90-degree knee angle, rate of force development and quadriceps EMG activity acutely in 11 male subjects from a university.

They found no significant differences in muscle force, rate of force development or muscular activation between the control and foam roller conditions but they did observe that the foam rolling condition produced a significantly greater improvement in knee joint ROM in comparison with the control condition. The researchers therefore concluded that two 1-minute bouts of foam rolling significantly increased joint ROM but did not impede the production of muscular force or rate of force development.



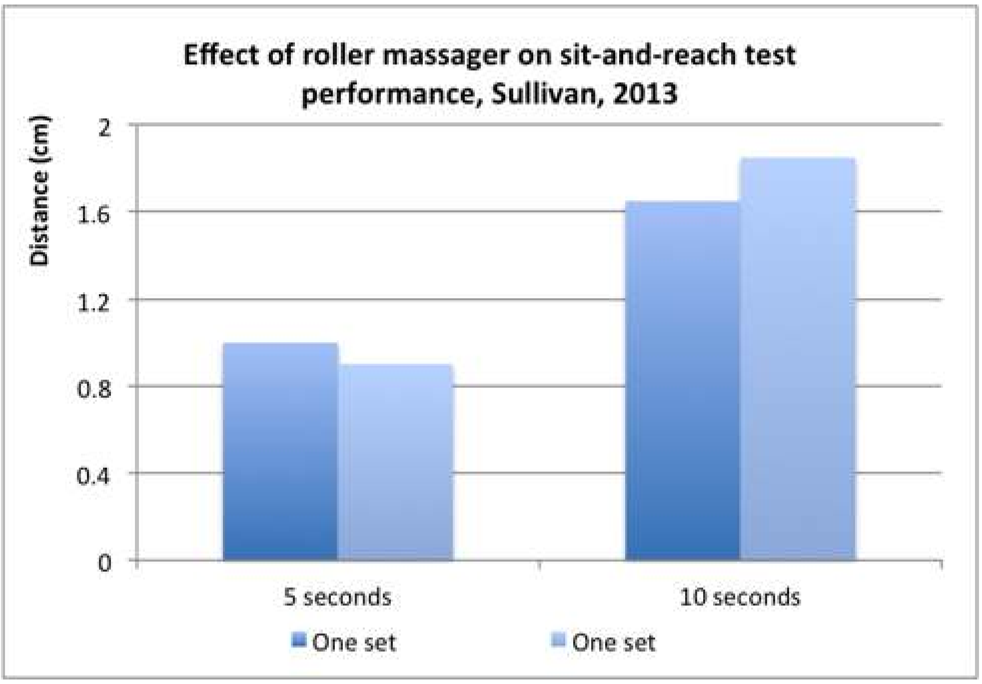
Foam rolling may increase flexibility while not impeding muscular force production

Sullivan (2013) investigated the effects of a roller massager provided by Theraband on joint range-of-motion (ROM) and performance in 17 subjects (7 males and 10 females). The roller-massager is a portable solid plastic cylinder wrapped in dense, ridged foam. The researchers randomly allocated the subjects to either a roller-massager group or to a control group.

They measured flexibility using the sit-and-reach test, muscle activation, maximum voluntary isometric contraction (MVIC), knee flexion torque, evoked twitch force, and electromechanical delay before and after 4 different interventions of hamstring roller-massage (either 5-second or 10-second durations, and either 1 or 2 sets).

The researchers found that the roller-massager produced a significant increase in sit-and-reach performance and they noted a trend towards a dose-response effect with 10-seconds of roller-massager rolling being slightly more effective at increasing sit-and-reach performance than 5-seconds, irrespective of the number of sets. They also noted that potentiated twitch force was significantly reduced after roller massage in comparison with no roller massage. However, the researchers found no significant differences between conditions for MVIC knee flexion torque, muscle activity or electromechanical delay.

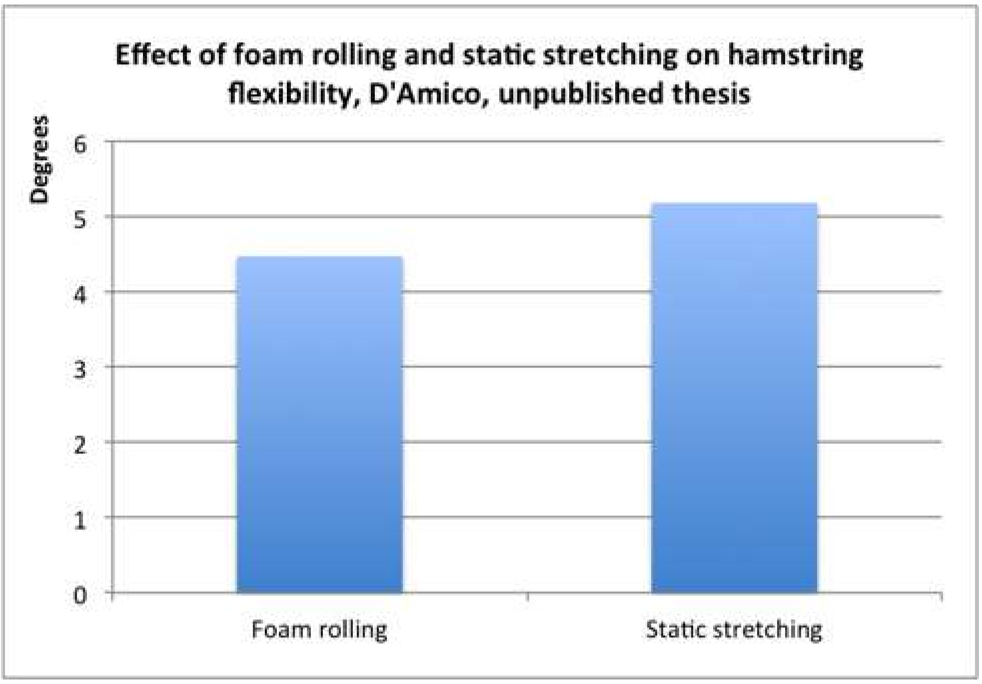
The researchers therefore concluded that use of a roller-massager on the hamstrings led to significant increase in sit-and-reach performance but did not cause any significant decreases in MVIC knee flexion torque.



Foam rolling is equally effective as static stretching for improving joint range-of-motion (ROM) but does not acutely reduce muscular strength and power

Amico (undated, non-peer reviewed) compared the effects of foam rolling with static stretching on knee flexion range-of-motion with the hip in 90 degrees of flexion, isometric knee flexion torque in 90 degrees of knee angle, and one-leg horizontal jump performance in 13 resistance-trained subjects. The static stretching protocol comprised 3 sets of 30-second stretches. The foam rolling protocol comprised 1 set of 90-seconds. The researchers took measurements for all subjects pre- and post-each intervention in a randomized, cross-over design in which all subjects performed both protocols 2 weeks apart.

The researchers found that both static stretching and foam rolling significantly improved ROM but there was no significant difference between the effects of the two interventions. Additionally, the researchers found that while the static stretching group acutely reduced knee flexion torque and one-leg jump distance significantly, the foam rolling group did not.

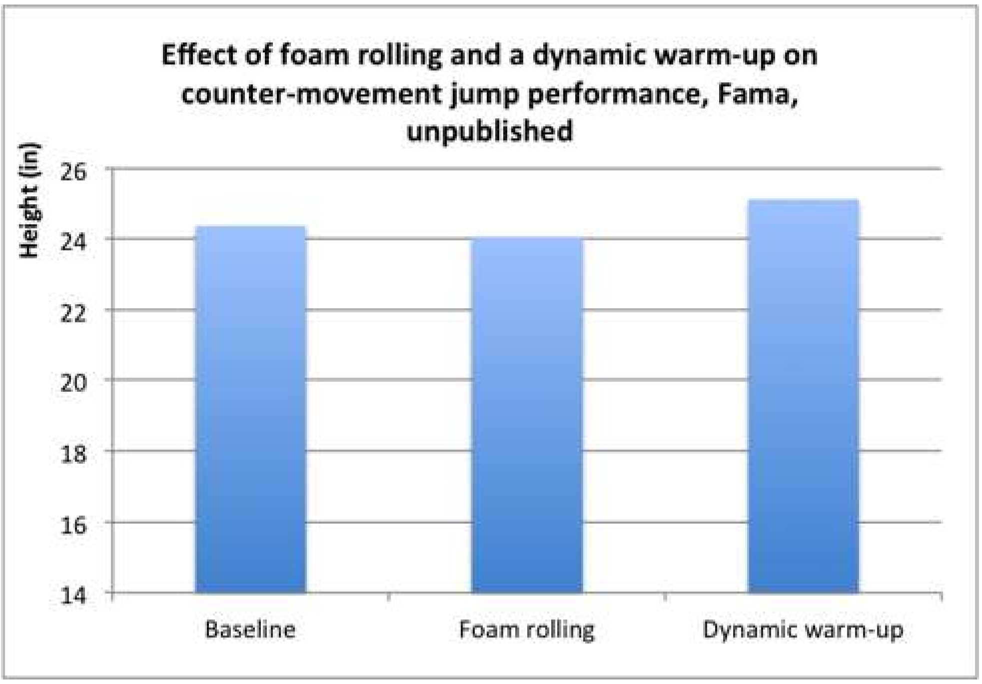


Foam rolling does not acutely affect counter-movement, squat or depth jump performance

Fama (2011, non-peer reviewed) investigated the acute effects of foam rolling and of a dynamic warm-up on strength, power, and reactive power in 9 college-aged, recreationally active males with 1-year of plyometric training experience. The researchers therefore tested squat jump, counter-movement jump and depth jump performance both before after two different warm-up protocols. One warm-up protocol comprised a general warm-up (5 minutes of treadmill walking) plus a dynamic warm-up (walking lunges, reverse lunges, single-leg Romanian deadlifts, walking leg kicks, and straight-leg skipping).

The other warm-up protocol comprised a general warm-up plus foam rolling. The foam rolling was performed for 1-minute for each of the major muscle groups that were similarly affected by the dynamic warm-up (i.e. gluteals, hamstrings, quadriceps and calves). The researchers reported that there was a significant increase in jump height following the dynamic warm up in the counter-movement jump but there were no other significant changes between pre- and post-warm-up. There was a trend towards a small reduction in counter-movement jump performance in the foam rolling protocol but this did not reach statistical significance.

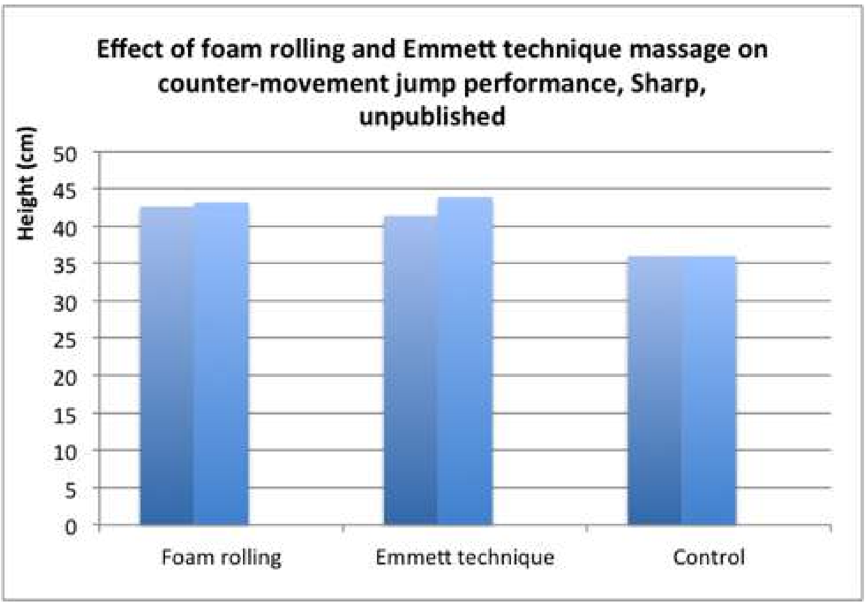
The researchers therefore concluded that a dynamic warm-up improves countermovement jump performance acutely while foam rolling does not.



Foam rolling does not acutely affect counter-movement jump performance

Sharp (2012, non-peer-reviewed) compared the effects of a manual therapy technique (Emmett) and foam rolling on the iliotibial band for improving lower body flexibility and lower body power in 15 asymptomatic non-professional, rugby forwards, aged 19 – 30 years. The subjects were randomly allocated to one of 3 groups: a foam rolling group, an Emmett technique group and a control group. The foam rolling was carried out for 60 – 90 seconds. Both interventions targeted the iliotibial band. Before and after the intervention, the researcher measured dynamic flexibility associated with the iliotibial band and counter-movement jump performance.

The researcher found that while the Emmett technique improved the dynamic flexibility associated with the iliotibial band, the foam rolling technique did not. Moreover, the researchers found that neither the Emmett technique nor the foam rolling technique had any effect on counter-movement jump performance.



What is the summary of the acute effects?

In summary, these individual studies suggest that foam rolling could reduce arterial stiffness, improve arterial function and improve vascular endothelial function and increase joint range-of-motion (ROM) while not impeding the production of muscular force or rate of force development and having no detrimental effects on athletic performance pre-workout.

Can foam rolling improve flexibility long-term?

Although foam rolling is a very new area of research for sports scientists, it is increasingly being studied. The following studies have investigated the chronic (i.e. longer-term) effects of foam rolling:

Foam rolling may not increase flexibility long-term

Miller (2006) investigated whether foam rolling would cause increases in range-of-motion (ROM) in the hamstring muscle group in 23 healthy college students with tight hamstrings. The subjects were selected if they had active knee extension of <80 degrees while supine and with the hip maintained at 90 degrees of flexion.

The subjects were divided into 2 groups: a foam rolling group and a control group for an 8-week intervention, during which the foam-rolling group performed 3 sessions of foam rolling per week for 3 sets of 1-minute of foam rolling on the hamstrings. The control group was instructed to continue with normal activity but to avoid additional stretching that was in addition to their normal regimen.

The researchers found that both foam rolling and control groups had significant increases in ROM for both the dominant and the non-dominant leg. However, there was a trend for the foam rolling group to display a larger increase in ROM than the control group.

The researchers therefore concluded that foam rollers are an ineffective technique for increasing hamstring flexibility over an 8-week time period. However, the significant increase in ROM observed in the control group in this study is a cause for concern that implies that there may have been problems either in the accuracy of the measurements or in respect of the behavior of the control group.

Foam rolling may increase flexibility long-term

Scherer (2013, non-peer reviewed) investigated the effects of 4 weeks of foam rolling on hamstring flexibility, as assessed by the sit-and-reach test in 18 college-aged students with resistance-training experience. The researcher allocated the subjects randomly to either a foam rolling group or to a control group.

The foam rolling group carried out foam rolling for 3 – 5 minutes, 2 – 4 times per week for the 4-week intervention period, using 30-second periods of hamstring foam rolling interspersed with 30-second periods of rest. The researcher found that the foam rolling group significantly improved sit-and-reach test performance while the control group did not improve. The researcher therefore concluded that in resistance-trained, college-aged populations, foam rolling was able to improve hamstrings flexibility over a 4-week time period.

What is the summary of the chronic effects on flexibility?

In summary, the literature is conflicting in respect of whether foam rolling can improve joint range-of-motion (ROM) over a longer period of time. Additionally, we must take caution in drawing too many inferences from either study. The study by Scherer (2013) was not peer-reviewed and in the study by Miller (2006), a significant improvement in joint ROM was found in the control group, which raises concerns over the quality of the study.

What is the effect of foam rolling on short-term recovery?

The following studies have assessed the effects of foam rolling on aspects of recovery:

Foam rolling reduces muscle soreness while increasing range-of-motion, reducing deterioration in vertical jump height and leaving torque production unaffected

MacDonald (2013) investigated whether foam rolling would affect delayed-onset-muscle-soreness (DOMS) in 20 physically active, male subjects with resistance-training experience. The researchers randomly allocated the subjects to either a foam rolling group or to a control group. All subjects performed 5 different testing sessions, which included 1RM squat testing and a series of further tests performed both pre- and post- (at 0, 24, 48 and 72 hours) a workout protocol intended to create DOMS (10 sets of 10 reps of squats at 60% of 1RM with a 4-second eccentric phase and a 1-second concentric phase with 2 minutes of rest between sets).

The researchers measured thigh girth, maximal voluntary isometric contraction (MVIC) knee extension torque at a knee angle of 90 degrees, quadriceps and hamstrings range-of-motion (ROM) measurements and counter-movement vertical jump performance. The subjects in the foam rolling group performed several foam rolling exercises for 2 bouts of 60-seconds per exercise.

The researchers found that neither thigh girth nor MVIC knee extension torque were significantly different between groups at any time point. However, they found that muscle soreness was significantly reduced in the foam rolling group in comparison with the control group at 24, 48 and 72 hours post-workout, that quadriceps passive ROM was significantly larger in the foam-rolling group at 48 and 72 hours post-workout, that hamstrings passive ROM was significantly larger in the foam-rolling group at 72 hours post-workout, that hamstring dynamic ROM was significantly larger in the foam rolling group at 24 hours post-workout, that muscular activation during the MVICs was reduced by significantly less in the foam rolling group at all time points, and finally that the foam rolling group displayed a significantly smaller reduction in countermovement vertical jump height after 48 hours than the control group.

The researchers concluded that foam rolling produced significant reductions in muscle soreness at all time points and significant increases in ROM and vertical jump height at certain time points along with no changes in torque production.

What is the summary of the effects on short-term recovery?

In summary, this individual study indicates that foam rolling reduces muscle soreness while increasing range-of-motion (ROM), reducing deterioration in vertical jump height and leaving torque production unaffected. Obviously, the existence of only one study makes it harder to be sure that the effects were not coincidental.

What are the limitations with foam rolling research?

The main limitations with the current state of foam rolling research are as follows:

1. All of the major peer-reviewed studies have been performed in non-athletic populations of varying levels of physical activity. Therefore, we may find that once further studies are performed in athletic populations, the effects of foam rolling are different.
2. All of the major peer-reviewed studies have been performed over very short time periods (<72 hours) and we do not really therefore understand the effects of foam rolling over longer periods of time. Of course, for certain applications (e.g. short-term recovery of performance measures during a tournament or during a single day of multiple performances), this is irrelevant but equally it would be useful to know the effects of foam rolling on long-term recovery measures or overtraining monitoring measures (e.g. HRV) and neuromuscular adaptations.
3. While the effects of foam rolling have been assessed on various outcome measures, there are many other measures that have not been assessed. We therefore do not know what the acute or long-term effects of foam rolling might be on overall sympathetic nervous system activity or subjective measures such as mood and affect, for example.
4. While mechanisms are not the answer to everything (and may often be a hindrance in many cases), we still do not have a working model of exactly what happens when we perform myofascial release and self-myofascial release in general, and foam rolling in particular.

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What are the practical applications?

For pre-workout

Athletes could try foam rolling pre-workout to improve joint range-of-motion (ROM) without the risk of reducing neuromuscular performance in either high-force-low-velocity or high-velocity-low-force muscular actions, as can occur with static stretching.

For short-term recovery

Athletes could try foam rolling post-workout or post-competition to reduce the deterioration in countermovement jump performance in order to improve their ability to perform again more quickly.

For long-term recovery

Athletes could try foam rolling post-workout or post-competition to reduce muscle soreness in order to improve their ability to train again more frequently.

For health

Foam rolling may acutely reduce arterial stiffness, improve arterial function and improve vascular endothelial function. These findings may indicate that foam rolling is beneficial for cardiovascular health.