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# The Acute Effect Of Self-Myofascial Release On Lower Extremity Plyometric Performance

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COLLEGE OF HEALTH PROFESSIONS

# THE ACUTE EFFECT OF SELF-MYOFASCIAL RELEASE ON LOWER EXTREMITY PLYOMETRIC PERFORMANCE

By

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**ABSTRACT**

Fama B, Bueti D. *The Acute Effect of Self-Myofascial Release on Lower Extremity Plyometric Performance.* The purpose of this study was to evaluate the acute effect of a Foam Roller (FR) warm up routine and a dynamic warm-up routine on strength, power, and reactive power using a squat jump (SJ) countermovement jump (CMJ) and depth jump (DJ). Nine college aged recreational males with a minimum of 1-year experience in plyometric training completed the study. Following baseline testing, subjectswere randomly assigned to a warm up protocol on the second session of the study and then completed the otherprotocol on the third day of the study.  The best of three jumps were recorded. RMANOVA revealed a significant increase in jump height following the dynamic warm up in the CMJ (p=.018). A post hoc paired t-test revealed significance of (p=.015) between the FR to dynamic warm-up routines following the CMJ. All other jumps yielded decreases in performance, with no significant changes SJ (p=0.135) and DJ (p=0.145). A lack of significant change may be attributed to the removal of the trigger point (TrP) release from the FR due to the subjectivity of each individual's pain level and amount of trigger points. In conclusion FR warm ups are not recommended prior to physical activity requiring increased neurologic activation as the FR warm up was shown to decrease jump performance as the neurologic demand of the jumps increased. Foam roller routines may be beneficial for the injured athlete prior to activity but should be followed by a dynamic warm up before partaking in activity.

**INTRODUCTION**

The importance of flexibility or the range of motion around a joint is a topic of debate between researchers and clinicians. Flexibility is associated with numerous benefits within fitness and rehabilitative programs[1,2]. An improvement in flexibility is correlated with improved athletic performance and the reduction of injuries amongst professional athletes, when a flexibility program is followed regularly[1,2]. Prior to power training, a warm-up including dynamic stretching has been to shown to increase countermovement jump (CMJ) height, following power training it is shown to increase CMJ height[3,4].

A common modality used for improving flexibility that has become increasingly prevalent in the allied health and fitness field is the foam roller (FR)[5]. Foam rollers are used for multiple purposes, and self-myofascial release (SMFR) as well as core and proprioceptive exercises are among its applications[6]. Fitness authorities claim foam rolling is a self-treating form of myofascial release technique (MRT)[6]. Myofascial release technique is a collection of modalities used to release soft tissue from muscle spasms[7]. Acupressure or ischemic compression (IC) is the type of MRT that FR stretching is based upon[7].

Ischemic compression releases adhesions in soft tissue that lack a supply of blood[7]. Anecdotal evidence suggests that the pressure exerted by the individual's bodyweight on the muscle during foam rolling causes the golgi tendon organ (GTO) to react to the change in tension in the muscle and responds by inducing the relaxation of muscle spindles[9]. As a result, there is an acute increase in range of motion (ROM) around the joint[9].

Literature supports that MRT is effective at improving ROM and perceived pain levels[9]. Ischemic compression is shown to improve cervical ROM and decreases pain levels in patients with myofascial pain syndrome (MPS) as well as those patients with low back pain (LBP)[10,11,12]. Acutely, IC improves the active range of motion (AROM) of the shoulder complex in patients presenting dysfunction from myofascial origins[13]. For illiotibial-band friction syndrome, MRT improved both palpable pain threshold and AROM in hip adduction and flexion[14]. When combined with stretching, MRT therapy improves AROM of the shoulder complex in patients with thoracic outlet syndrome[9].

However, while IC is effective, the efficacy of foam rolling as a facilitator of IC is not as clear. There has been a limited amount of research conducted on the effectiveness of foam rollers as an ischemic compression technique[8,15]. The only study performed was by Curran et al. that compared the effectiveness of two types of FR on trigger point (TrP) release. A bio-foam roll (BFR) was compared against a multi-rigid layered roll (MRR). Ischemic compression techniques differed by the amount of pressure exerted to the TrP. Mean sensel pressure exerted on the soft tissue of the lateral thigh by the MRR (51.8 ± 10.7 kPa) was significantly ($P < .001$) greater than that of the conventional BFR (33.4 ± 6.4 kPa). Mean contact area of the MRR (47.0 ± 16.1 cm2) was significantly ($P < .005$) less than that of the BFR (68.4 ±

25.3 cm2). The authors concluded that the smaller contact area leads to a more focal and direct pressure applied by the FR.

Due to the lack of research on foam rolling, authors do not cite published studies on foam roller recommendations[5,16-18]. Rather, the claims reference literature on MFR, and assert that foam rolling causes neuro-myofascial inhibition, which decreases the stiffness of the muscle and increases its compliance[19]. That is of concern because multiple advocates suggest foam rolling prior to exercise, which may negatively affect performance by causing latency in neuromuscular responses to exercise or physical activity[5,16-18].

While there is an abundance of literature indicating MFR as a modality to increase ROM and decrease pain in patients suffering from a variety of musculoskeletal ailments, there are no studies that have attempted to support the claims from coaches and fitness professionals that foam rolling elicits the same effects as other MFR techniques[9,20,21]. Despite the lack of evidence in favor of MFR, authorities within the collegiate and professional strength and conditioning settings as well as the fitness industry claim that foam rolling improves flexibility and athletic performance[16-18]. Additionally, the prescription and timing of when to administer FR within a structured workout bout also varies between industry authorities[5,16-18]. Numerous authors recommend FR as a warm-up claiming that MFR, and an increase in circulation caused by the FR, leads to improved performance[5,16-18].

The purpose of this study was to evaluate the acute effect of a Foam Roller (FR) warm up routine and a dynamic warm-up routine on strength, power, and reactive power using a squat jump (SJ) countermovement jump (CMJ) and depth jump (DJ). It was hypothesized that a FR warm-up would result in an acute decrease in strength, power, and reactive power. Another supposition is that the FR causes autogenic inhibition, leading to GTO excitation and a decrease in muscle spindle activity. This study compared a FR warm-up and dynamic warm-up due to the acute increases in lower body power demonstrated following a dynamic warm-up[3,4].

## REVIEW OF LITERATURE

The review of literature begins with the mechanisms involved in stretching and during power movements. An examination of the mechanical and neuromuscular components involved during different stretching techniques will be explored. After which, the types of stretching in the study are clearly defined. The review is concluded with comparisons of studies previously examining similar concepts and their impact on this study.

### Proprioceptors

A proprioceptor is a sensory receptor found in muscles, tendons and joints that respond to changes in muscle tension, length and pain. Once stimulated, afferent neurons send messages to the central nervous system (CNS). In response the CNS sends excitatory or inhibitory signals to the targeted tissue via efferent neuron pathways[17].

Nociceptor stimulation results in pain messages sent to the soft tissue structures affected by an abnormal tight hold on perturbated tissue. The tight hold eventually causes fibrous adhesions to the affected tissue, which decreases elasticity and motion of the tissue[18].

The muscle spindle is located in the belly of the muscle. It senses changes in muscle length. When the muscle spindle detects an aggressive stretch to the muscle, the neural pathways send efferent signals to that muscle ensuing a contraction to resist the excessive stretch. Forceful static stretching that does not alleviate muscle spindle activation after 8 seconds can damage muscle spindle receptors and increase the risk of muscle strains or tears[17]. In plyometric exercises, the muscle spindle is excited through neurophysical pathways. The stretch reflex causes the muscle spindle to become stimulated. This results in a powerful concentric contraction of the muscle[19]. The mechanical and neurophysical pathways of plyometric exercise will be further explored in the review of plyometrics.

The GTO is located in the tendon and reacts to changes in tension placed upon a muscle. If the GTO senses excessive muscle contraction that can harm the related soft tissue structures it will become excited and result in a relaxation, or failure of contraction. The stimulation of the GTO is inhibitory to the muscle spindle and causes muscle relaxation[20]. Different muscle energy techniques (MET) have been developed to activate the GTO. This allows for a superior stretch to improve flexibility and ROM[7,21-23].

## Fascia

Fascia is a fibrous, soft connective tissue that permeates the human body. It acts as a web of tissue that surrounds all components and compartments of the body to maintain integrity, support and protect structure. When irritated the fibrous tissue forms adhesions, decreases compliance of the fascia, limiting circulation through the underlying tissue and inhibit function due to ischemia[7,24].

Somatic dysfunction involves any altered or impaired function of the musculoskeletal system. The maintenance of muscles, joints and connective tissues in an abnormal guarding position causes changes in the connective tissue. By restoring normal structure to the tissue, ideal proprioception is reconditioned[18].

## Trigger Points

Trigger points are palpable hyperirritable, hypertonic fibers within a muscle or fascia. Trigger Point pain can be dormant or active and exist at some level in virtually all muscle and fascia. The extent of which will determine functional capacity of the muscle. Existence of TrP results in somatic dysfunction[7,18].

To release TrP, a number of techniques have been developed and validated as effective modalities of treatment[17,20,21]. These techniques are known as TrP release or MRT. Techniques vary from active to passive. Muscle Energy Techniques use combined methods of contraction and relaxation to release TrP. Others are passive and use compression to release the TrP[7,17,21,25].

**Myofascial Release**

Myofascial Release Technique involves applying sustained pressure onto myofascial tissue restrictions. The sustained pressure diminishes associated pain, increases circulation and increases motion by rousing the stretch reflex of the muscles and overlying fascia[7].

Sucher showed that MRT combined with aggressive static stretching is useful in the treatment of thoracic outlet syndrome[11]. Along with patient education including a home myofascial release and stretching protocol; Sucher found that MRT combined with static stretching releases local myofascial structures, "re-energizing the tissues and re-programming the tissue length".

Fernandez et al. found that myofascial pain syndrome has been effectively treated by the use of numerous modalities[7]. Fernandez et al. concluded that MRT is effective in treatment by restoring tissue length and structure. Godges compared the effects of static stretching and MRT with PNF technique on gait economy and hip extension[26]. Godges contends that MRT combined with proprioceptive neuromuscular facilitation (PNF) stretching showed significant improvement in goniometric measurement of ROM in hip extension and hip flexion in seven asymptomatic college-aged runners ($p < 0.01$). However, only static stretching had a significant impact on gait economy during 40%, 60%, 80% $VO_2$ max ($p<0.01$).

**Acupressure**

Acupressure is a hybrid technique that stems from acupuncture. In traditional Chinese medicine, acupressure is physical pressure applied directly to acupoints or meridians that are located throughout the body. In modern practice, acupressure requires physical pressure be applied directly to TrP[12]. This technique is synonymously referred to as ischemic compression.

Hanten et al. found that a home based program including self-IC combined with static stretching elicited less perceived pain and increases in AROM of the neck and upper back as graded by a visual analog scale and inclinometer, respectively[22]. Patients were either assigned to a treatment group including static stretching and self –ischemic compression, or a control group practicing AROM. At the conclusion of the study, groups did not differ in percentage of time in pain, only severity of pain via visual analog scale. Ischemic compression was found to be an effective modality in the treatment of shoulder dysfunction[12]. Hains mentions the effectiveness of IC in the treatment of adhesive capsulitis of the shoulder by restoring tissue structure and length, increasing A/PROM via goniometric measurement[12].

**Foam Rollers**

Curran et al. contend that FR treatments restores soft tissue extensibility and treats myofascial restrictions[6]. Curran et al. compared the effectiveness of two types of FR on TrP release. A bio-foam roll (BFR) was compared against a multi-rigid layered roll (MRR). Ischemic Compression techniques differ by the amount of pressure exerted to the TrP. Mean sensel pressure exerted on the soft tissue of the lateral thigh by the MRR (51.8 +/- 10.7 kPa) was significantly (P < .001) greater than that of the conventional BFR (33.4 +/- 6.4 kPa). Mean contact area of the MRR (47.0 +/- 16.1 cm2) was significantly (P < .005) less than that of the BFR (68.4 +/- 25.3 cm2). The smaller contact area leads to a more focal and direct pressure applied by the FR.

According to Russell et al. FR use results in autogenic inhibition[5]:

> Two basic neural receptors are located in skeletal muscle tissue. These receptors are the muscle spindle and the golgi tendon organ. Muscle Spindles are located parallel to the muscle fibers. They record changes in fiber length and rate of change to the CNS. This triggers the myotatic stretch reflex, which reflexively shortens muscle tissue, alters the normal length-tension relationship and often induces pain. The Golgi Tendon Organ (GTO) is located at the musculotendinous junction. The GTO is sensitive to change in tension and rate of tension change. Stimulation of the GTO past a certain threshold inhibits the muscle spindle activity and decreases muscular tension. This phenomenon is referred to as autogenic inhibition. It is said to be "autogenic" because the contracting agonist is inhibited by its own receptors. Reduction in soft-tissue tension decreases pain, restores normal muscle length-tension relationships and improves function.[35]

Alternatively, Miller and Rockey found that the use of FR on the hamstrings for one minute long treatments did not elicit significant differences from a control group in AROM of knee extension ($p<0.05$)[27]. Miller and Rockey used an inclinometer and flexometer to measure joint angles of the knee and hip to determine AROM differences. This study was limited to healthy UW undergraduate students, the treatment using BFR, and measurement of hamstring flexibility. Foam Roller manufacturers recommend treatment of the entire extremity consisting of at least one to two minutes of rolling on each muscle group[5,13,14].

**Plyometrics**

Plyometric exercise refers to activities that enable a muscle to reach maximal force in the shortest possible time. Plyometric exercise requires a powerful movement that involves a pre-stretch and excitation of the stretch shortening cycle. There are mechanical and neurophysical models for plyometric exercise[19].

The mechanical model involves the series elastic component (SEC). The SEC is an element of the non-contractile component of muscle that stores energy when eccentrically contracted. This stored energy is released when a concentric contraction follows. The stretch reflex and muscle spindle are involved in the neurophysical model. The stretch reflex is the body's involuntary response to an external stimulus that stretches the muscles. Muscle spindles respond to the rate and magnitude of a stretch[28].

Reflexes involve multiple components. First, the muscle spindle receptor, which lies in parallel with normal extrafusal fibers, detects the rate and magnitude of a stretch. Second, the Ia-afferent neurons, which synapse in the gray matter of the spinal cord depolarizes information to the nucleus pulpous of the dorsal horn of the spinal cord. Stimulation of the gamma-motoneuron provides proprioceptive feedback to the intrafusal and extrafusal muscle fibers and controls the resulting concentric muscle contraction response[28].

The combinations of the mechanical and neurophysical models result in the stretch-shortening cycle (SSC). The SSC employs the energy storage capabilities of the SEC and stimulation of the stretch reflex to facilitate maximal increase in muscle recruitment over a minimal amount of time. There are three phases to the SSC; the eccentric, amortization, and concentric phases[19]. The eccentric phase involves the stretch of an agonist muscle. This results in elastic energy to be stored in the SEC and the stimulation of muscle spindles. The amortization phase is the pause between the preceding and latter stage. The effects of amortization are the synapse between type Ia afferent nerves with alpha motor neurons. The alpha motor neuron then transmits signals to the agonist muscles. The concentric phase, or shortening of the agonist muscles results in the release of elastic energy from the SEC and the alpha motor neurons stimulating the agonist muscles.

**Plyometrics and Power**

Plyometric training is commonly used in athletes to help improve overall power and speed. Plyometric training commonly consists of countermovement jumps (CMJ), depth jumps (DJ), and drop jumps[29-32].

Thomas et al. completed a pre-posttest study comparing DJ and CMJ techniques on leg power, speed, and agility. It was found that after the 6-week intervention increases in jump height and decreases in agility times were noted for both groups. DJ training resulted in a 1.1 effect size (high) and CMJ training resulted in a .7 effect size (moderate to high)[29].

Meylan et al. used three different tests to examine vertical jump height. Jump test included squat jump (SJ), CMJ and a contact test (CT), which required subjects to jump over a 20cm hurdle and upon landing jump vertically as high as possible. During the 8-week study subjects completed 25 minutes of plyometric drills. Meylan et al found that the training group yielded significant increases of 7.9% ($p=.004$) in CMJ compared to the control group which did not yield significant findings as well as significant increases of 10.9% ($p=.01$) in the CT[31].

Holcomb et al. compared the effects of four power-based programs on vertical jump height. A DJ, CMJ, weight training program and a control group were all compared. Tested jumps included CMJ and static jumps. Holcomb et al found that all groups increased peak power and vertical jump performance. The plyometric training groups were the only groups with significant increases in peak power and vertical jump height during the countermovement jump[30].

Sedano et al. compared a 12-week plyometric program to a traditional soccer-conditioning program amongst adult female soccer players. Significant increases ($P < .05$) were noted in jumping ability in the plyometric group for both the drop jump and CMJ tests[32].

## METHODS

### Experimental ApproachTo The Problem

This study was conducted to evaluate the acute effect of FR against the supported practice of a dynamic warm up on strength; power, and reactive power[22]. The SJ, CMJ, and DJ, respectively, were used as testing parameters representing those lower body physical characteristics.

The study was a 3x3 crossover design wherein the three conditions (baseline, FR and dynamic warm-up) were compared across each of the three jumps (SJ, CMJ, DJ). There were three testing sessions for this study.

For the first session, subjects performed baseline testing, and a familiarization of the FR and dynamic warm-ups. During session 2 and 3, subjects randomly performed a FR or dynamic warm-up routine .Time was controlled during the FR protocol (1 min. per body part), while repetitions were controlled during the dynamic protocol (10 repetitions of each exercise with a walk-back recovery).

### Subjects

A total of 9 college-aged recreationally active males were recruited for the study (table 2-1). All subjects reported a minimum of 1-year experience with plyometric training prior to the study and were free of lower extremity injuries. All subjects agreed to maintain their current resistance training protocols for the duration of the study. Subjects were informed of the experimental procedures and signed informed consent statements. The Sacred Heart University institutional review board approved the research.

| Variable | Mean ± SD |
|---|---|
| Height (cm) | 178.646 ±4.3 |
| Weight (kg) | 78.585 ±8.6 |
| Yrs | 19.222 ±1.6 |

**Table 2-1.**Demographics data for all subjects (Mean ± SD).

**Procedures**

Subjects completed a 5-minute general warm-up led by one of the researchers at the start of each of the three study's session. The general warm up routine remained the same for all testing days throughout the study. Subjects completed baseline testing and a review of both the dynamic and FR protocols during the familiarization portion of session 1. Following baseline testing, subjects returned for sessions 2 and 3. Each subject was randomly assigned either the dynamic or FR protocol for the second session and was assigned to the warm-up protocol in session 3 that was not performed in session 2(table 2-2). Subjects were required to complete all sessions within 1-week of baseline testing with at least 1 day between sessions 2 and 3.

**Example Layout for One Subject**

| | **Session 1 (Familiarization Day)** | **Study Session 2** | **Study Session 3** |
|---|---|---|---|
| General Warm Up | 5 Min treadmill run increased 1mph per min for 5 min | 5 Min treadmill run increased 1mph per min for 5 min | 5 Min treadmill run increased 1mph per min for 5 min |
| | 2 Min Rest | 2 Min Rest | 2 Min Rest |
| Dynamic Warm Up | Walking Lunges | Walking Lunges | X |
| | Reverse Lunges | Reverse Lunges | |
| | Single Leg RDL | Single Leg RDL | X |
| | Walking Leg Kicks | Walking Leg Kicks | X |
| | Straight Leg Skipping | Straight Leg Skipping | X |
| | 2 Min Rest | 2 Min Rest | |
| Foam Roller Warm Up | 1 Min per Muscle Group | X | 1 Min per Muscle Group |
| | Triceps Surae | X | Triceps Surae |
| | Hamstrings | X | Hamstrings |
| | Gluteals | X | Gluteals |
| | Quads | X | Quads |
| | 2 Min Rest | | 2 Min Rest |
| Jumps | | | |
| | SJ | SJ | SJ |
| | CMJ | CMJ | CMJ |
| | DJ | DJ | DJ |

**Table 2-2.**Testing protocol for all three days of the study. All sessions were completed within 1 week of baseline testing (x- indicates subjects did not perform the task).

## Session 1 (Familiarization day): Baseline Testing

Baseline testing of jump protocols was completed following the familiarization period during session 1. The jump protocol consisted of three jumps. All jumps were completed with the subject's hands on their hips (iliac crests) throughout the jump. The first jump was a SJ with a 2 second hold at 90 degrees of hip and knee flexion. The second jump was a CMJ with no pause before the jump. For the CMJ, subjects started by standing on the just jump mat with hands on their hips(iliac crests) and were asked to squat down before exploding upward. The third jump was a DJ using a .5m plyometric box manufactured by UCS Spirit (Lincolnton, NC). During the DJ subjects started by standing on the .5m plyometric box with hands on their hips (iliac crests) and stepped down onto the just jump mat and then jumping upward with maximal force, spending as little time on the ground as they could. Jump height was recorded in inches.

A one-minute rest interval was provided between each of the 3 jump tests. The maximum height of three jumps was recorded for all tests. The jump testing order remained the same throughout the testing period. All jumps were measured using the just jump training system (Huntsville, AL).

**Session 2**

For session 2 and 3 subjects completed a general warm-up, followed by either a foam roller MFR routine or a dynamic warm up routine. Subjects were randomly assigned into the dynamic warm up group or foam roller group during study session 2. The warm-up routine not utilized in session 2 was employed in session 3.

All FR warm-ups were performed using power systems, high-density foam rollers (Knoxville, TN). The foam roller treatment was performed bilaterally to the lower extremities for 1 minute on each muscle group. The dynamic treatment consisted of 10 repetitions performed on each leg, with a walk-back recovery. The muscle groups included in each treatment protocol were the triceps surae, anterior and posterior thigh, and gluteus maximus. The dynamic protocol involved; walking lunges (gluteals/ hamstrings/ quadriceps), reverse lunges (quadriceps), single-leg Romanian dead lift (gluteals/ hamstrings), straight leg kicks (illiopsoas/hamstrings), straight leg skipping (triceps surae)[23].

When completing the foam roller routine participants were instructed to begin rolling the muscle from its origin to its insertion, maintaining a consistent pressure throughout the roll. The researchers helped determine if pressure was constant through visual observation.

During the foam roller routine, researchers helped demonstrate and correct rolling for the lower extremities. Each muscle group was rolled continuously in a rhythmic manner to mimic MFR for 1 minute each[6]. Due to the subjectivity of TrP, an IC release was not performed with the foam roller routine.

Following either the FR or dynamic warm-up routines, subjects waited 2 minutes to begin the jump testing[24]. Jumps remained in the same order as those of baseline testing. The best of three attempts were recorded for each jump.

**Session 3**

Subjects returned within 1 week of baseline testing to conduct the opposite warm-up protocol from session 2. The instructions, general warm-up and jump testing remained the same as session 2.

## Statistical Analysis

Three within-subjects RMANOVAs (one for each jump, SJ, CMJ, DJ) were applied to the data. RMANOVAs were run with an alpha level set to $p<0.03$ after Bonferroni adjustment. Paired t-test were performed for post hoc comparisons using an alpha level of $p<0.05$. Sample size was based off of a $p<0.03$ alpha levels and an estimated large effect size of .8. Power was set to .80. Data was analyzed using SPSS (version16.0).

## RESULTS

The RMANOVA analysis revealed a significant difference between the baseline and dynamic warm-up routine for the CMJ ($p<0.018$). There was not a significant difference between jump height following the dynamic and FR routine for the SJ (22.66 vs. 22.07, $p<0.135$) and DJ (25.15 vs. 24.18, $p<0.145$), respectively (Figure 2).

The post hoc analysis of the significant RMANOVA result found for the CMJ showed a significant difference occurring between the dynamic warm up (25.12 ± 3.9 inches) and the FR (24.06 ± 3.6), $p<0.015$ (figure 2). Countermovement jump height at baseline was recorded at 24.37 inches following the FR routine was at 24.06 inches and following the dynamic warm up routine was recorded at 25.12 inches.

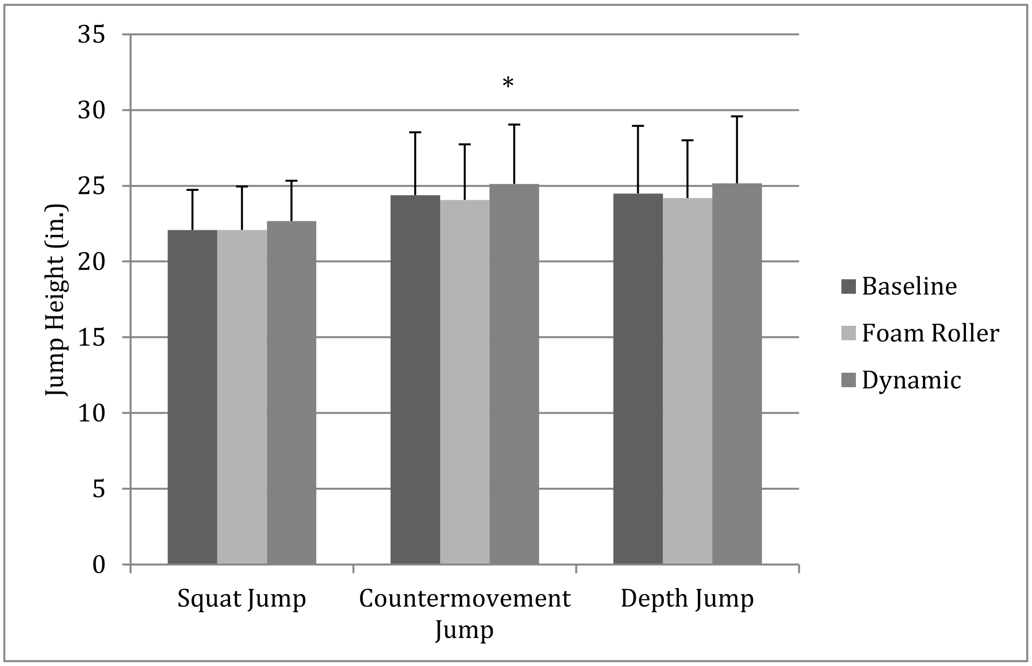


**Figure 1.**Jump heights across all three jumps and all three conditions. Only the CMJ was significantly different (FR<Dynamic). *p<0.05.

**DISCUSSION**

The purpose of this study was to examine the acute effects of a FR warm-up strength, power, and reactive power. The results of the study showed that a dynamic warm-up produced a significant increase in CMJ height compared to the FR warm-up. When comparing the two warm-up techniques, the FR routine did not elicit any significant changes in performance in the SJ or DJ. Additionally, the FR warm-up did not improve performance but it was actually detrimental to the CMJ. The findings of this study are not consistent with anecdotal claims of performance benefits associated with FR warm-ups made by fitness authorities[5,16-18].

Fitness professionals assume that a FR warm-up improves performance, despite no experimental evidence to support this[5,16-18]. In this study, we have shown that a lower body FR warm-up does not improve acute performance in lower body strength or reactive power test. Foam roller warm-ups are advocated in multiple articles[5,16-18]. However, their advice is contradictory to the supported benefits of a warm-up. Static stretching is not recommended during a warm-up due to its effects on decreasing muscle stiffness, and increased compliance, which may cause physiological damage during activity[22,25]. These physiological changes to muscle are the same effects that occur with MFR techniques, and likely foam rolling.

Russell and Wallace recommend a FR warm-up, citing autogenic inhibitionas the result of the warm-up[6]. Autogenic inhibition via foam roll stretching is caused by pressure exuded onto the roller by the individual. The pressure causes stimulation of the GTO. Golgi tendon organ stimulation past a certain threshold inhibits muscle spindle activity and decreases muscular tension[6]. If autogenic inhibition occurs during foam rolling, it would result in a decrease in muscle stiffness and increased compliance of the muscle, negatively affecting performance and increasing the risk of injury during physical activity[3]. This potential decrease in performance was found in the results for CMJ height in our study.

There is no experimental evidence verifying that foam rollers cause autogenic inhibition. However, it is likely that the pressure exerted by the roller causes GTO stimulation via ischemic compression. To ensure focal, direct pressure was exerted onto the roller, high-density foam rollers were used during this study. According to Curran et al. the smaller contact area leads to a more focal and direct pressure applied by the foam roller, providing IC to the tissue[7].

The mechanisms and components of plyometrics performance are contradictory to the benefits suggested with FR warm-ups. The results of this study show a negative trend in jump performance as the neurological demand of each jump increased. From what is known about the neurological mechanisms involved with plyometric activities, it is likely that the FR causes autogenic inhibition, leading to GTO excitation and a decrease in muscle spindle activity.

There were several limitations to this study. This study was limited to college-aged recreationally active participants. A power analyses revealed that 9 participants were required for testing. However, the only jump analyzed that was not underpowered was the CMJ and therefore the SJ and DJ analyses were underpowered. The FR protocol performed did not follow acupressure TrP release technique recommendations[5,6]. This was due to individual subjectivity of pain levels, number of TrP on each participant, and time spent on the treatment protocols.

In conclusion, FR warm-up protocols do not elicit any significant changes in strength or reactive power. The FR protocol produced significant decreases in power compared to the dynamic warm-up protocol. Therefore, we do not advocate a FR warm-up immediately before activity for a power athlete. Squat jump performance was not affected by the FR warm-up. It is possible that FR did not negatively affect the SJ because there was no SSC or GTO inhibition required for the jump. Administering a FR warm-up prior to activity for a strength athlete may not hinder performance. Although the DJ analysis was underpowered, it too may have been negatively influenced by the FR warm-up due to the neurological demand of the activity.

Future research should investigate the FR warm-up in a more applied study, allowing for TrP release to be performed by participants. Although this would be subjective to each participant, and time on the FR would vary considerably depending on the sensitivity of each participant, it will allow for applicable relevance to current practices. By performing TrP release with the participants, it may be possible to find significant performance changes in the neurologically demanding jumps.

More interestingly, would be to compare jump results as neurological demand increases (i.e. varying DJ height). Examining DJ performance from various heights may show significant changes in the reactive power required during competition. Future research may validate the physiological effects of FR warm-ups and its implications on performance parameters, allowing clinicians better insight of when to implement MFR techniques within a structured workout bout.

Furthermore, examining the duration of autogenic inhibition caused by foam rolling may allow the clinician insight of optimal timing of FR prescription prior to activity. Likewise, investigating methods to diminish autogenic inhibition while sequenced with a dynamic warm-up may validate or further contradict FR prescription prior to power activities.

**PRACTICAL APPLICATIONS**

A lower body FR warm-up did not produce any significant changes in strength or reactive power, but did significantly decrease lower body power when compared to a dynamic warm up. A trend toward the FR being detrimental to neuromuscular power development as found with the CMJ was significant and the DJ might have been if our study was powered. A minimal difference in performance could separate winning from losing in any particular sport. When optimizing athletic performance, it is not ideal to perform a warm-up that may not only hinder performance, causing neurologic latency in muscle contraction.

The timing and administration of a FR warm-up should be implemented on an individual basis. From a performance standpoint, it is recommended to complete a dynamic warm up prior to exercise. The administration of a FR warm-up may be warranted for the injured athlete[19]. However, the Strength and Conditioning coach can perform a dynamic warm-up and jump testing following the FR protocol to confirm any latency in muscle contraction and reduced rate of force production caused by GTO activation from the foam roller is diminished before activity begins.

**APPENDIX A**

**SACRED HEART UNIVERSITY**
**INSTITUTIONAL REVIEW BOARD**

**APPENDIX C: EXPEDITED/FULL REVIEW FORM**

Submit (by mail or email) completed form to:
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Office of Foundations & Grants
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Fairfield, CT 06825-1000
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PROPOSAL TITLE: The Acute Effect of Self-Myofascial Release on Lower Extremity Plyometric Performance.

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FACULTY ADVISOR (if student): Jason Miller, Ph.D.

TYPE OF REVIEW REQUESTED: FULL_____ EXPEDITED__X___

IF EXPEDITED REVIEW, indicate the section(s) in 6.2 of the IRB Guide under which this proposal qualifies for expedited review: ____ 6.2.1 & 6.2.2 _____

FULL OR EXPEDITED REVIEW, check the appropriate response:
____YES __X__NO The protocol involves human subjects who will receive drugs.
____YES __X__NO The protocol involves human subjects who will receive or be exposed to radioactive materials.
____YES __X__NO The protocol involves human subjects and will take place in an outside facility.

The protocol involves human subjects who are: ___minors (under age 18), ___fetuses, ___pregnant women, ___prisoners, ___mentally retarded, ___mentally disabled.

The protocol is being submitted for ___ Federal funding, ___Other external funding.

The investigator must provide summary statements addressing the following points of information. Where indicated, include the protocol page number(s) that contains detailed information. Use supplemental pages if necessary.

PURPOSE OF THE STUDY:

The purpose of this study is to examine the acute effects of self-myofascial release on lower extremity plyometric performance in male college athletes (n=12).

CHARACTERSITIC OF SUBJECT POPULATION: Include selection criteria and any age, sex, physical, mental and health restrictions.

- To participate as a subject, you must be a male, between the ages of 18-22 years of age, and there must be no reason you cannot participate according to the PAR-Q form. You must meet all the following criterion to be considered for participation: 1) Free of any history of major medical problems including musculoskeletal problems to the back and lower extremities and 2) have been recreationally active for at least one year. There are no mental restrictions. Subjects will be recruited from campus fliers. Based on pilot data and previous research, 12 subjects will be needed for this experiment.

METHODS AND PROCEDURES APPLIED TO HUMAN SUBJECTS:

- Prior to participation in this study, all subjects will complete a PAR-Q health history form and will only be allowed to participate in the study if they do not have any contraindications to exercise or the procedures used in this study.

- Subjects will undergo an initial familiarization of the squat jump, depth jump and countermovement jumps. Each participant will perform 3 repetitions of each jump. After completion of the familiarization jumps, participants will undergo a general warm-up followed by a 2-minute rest interval. Following the rest interval participants will all be tested on the squat jump, depth jump and countermovement jump, respectively. Following the jump testing participants will undergo a familiarization process of the foam roller and dynamic warm-up protocols.

- Two days later, participants will undergo the jump testing in a randomized order. Participants will perform a general warm-up followed by a foam roller protocol or dynamic warm up. Following the warm-up protocol, participants will then undergo a 2-minute rest interval and proceed to perform the squat jump, depth jump and countermovement jumps. The following week, participants will report back and follow the same protocol, performing the other warm-up protocol.

DESCRIPTION OF JUMP TESTING PROTOCOLS:

-Squat Jump:

- •Hands on hips
- •90° knee bend
- •2-second hold, followed by a vertical jump on testing mat.

–Countermovement Jump (CMJ)

- •Hands on hips
- Perform a quick Countermovement toward ground, followed by a vertical Jump on testing mat.

–Depth Jump from 30cm box (DJ)

- Hands on hips
- With both feet, drop from a 30cm box, followed by a vertical jump upon ground contact on testing mat.

DESCRIPTION OF WARM-UP PROTOCOLS:

-General Warm-Up:

- 5 minute Warm up
    - First minute at 4mph.
    - Increase 1mph each minute for the remaining 4 minutes.

-Foam Roller Protocol:

- Participants will perform each drill in the following order with long sweeping strokes to each major muscle group listed below.
- Each muscle group will be rolled for 1 minute.
    - Gluteals
    - Hamstrings
    - Illiopsoas/ Quadriceps
    - Hip Adductors
    - Tricep Surae

-Dynamic Warm-Up Protocol:

- Participants will perform 10 repetitions in the following order on each leg independently, with a walk-back recovery.
    - Walking Lungs (gluteals/ hamstrings/ quadriceps)
    - Reverse Lunges (quadriceps)
    - Single-Leg Romanian Dead life (gluteals/ hamstrings)
    - Straight leg kicks (illiopsoas/ hamstrings)
    - Straight leg skipping (tricep surae)

RISKS TO THE SUBJECT: __X__YES ____NO If subjects will be at risk, assess the probability, severity, potential duration and reversibility of each risk. Indicate protective measures to be utilized.

- None of the procedures in this study are experimental to the participants. All risks for the study have been minimized. Risks and discomforts to the participants are exertional discomfort in the lower extremities during stretching or foam rolling and bruising secondary to pressure elicited by foam roller (1-2 days) post-stretching.

- All participants will be given explicit instructions on jump technique by the co-investigator who has extensive experience in exercise prescription. Participants will be working in a clean environment in the motion analysis lab. All foam rollers will be given to participants in their respective packaging to ensure quality and unmarked use of the products.

- All jump analysis measurement equipment will be cleaned and prepared prior to each test.

- CPR and First Aid Certified personnel will conduct all tests in a laboratory and all safety procedures will be adhered to at all times. There will be cell phones on hand in the event that emergency personnel need to be summoned.

BENEFITS: __X__YES ____NO Describe any potential benefits to be gained by the subject as well as benefits that may accrue to society in general.

Subjects will receive a plyometric jump analysis measuring the lower extremity plyometric performance. Society may benefit be determining the efficacy of the foam roll protocol.

INFORMATION PURPOSELY WITHHELD: ____YES _X_NO State any information purposely withheld from the subject and justify this non-disclosure.

CONFIDENTIALITY: Describe how confidentiality of data will be maintained.

- Assigning each participant a code number and recording all data by that code will maintain confidentiality. Brian Fama will keep the only record with the subject's name and code number in a locked cabinet at Sacred Heart University. No name, initials, or other indentifying characteristics will be reported in the publication of the data obtained. Data will be stored for a period of 5 years and then be destroyed no later than August 2016.

___Brian Fama___________________2/5/11_________
SIGNATURE OF PRINCIPAL INVESTIGATOR*

David Bueti______________________2/5/11__________________
CO-INVESTIGATOR

*Signature certifies that the investigator to the best of his/her knowledge is in full compliance with the federal and Sacred Heart University regulations governing human subjects research.

ATTACHMENTS, for example

1. Informed Consent Form(s) (required, unless waiver is requested)
2. Detailed Research Protocol (see Appendix D)
3. Questionnaires or Test Instruments

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FOR IRB USE ONLY

ACTION TAKEN: ________________________________________________________
DATE: ________________ SIGNATURE:____________________________

IRB CHAIRPERSON

**(Revised August, 2005)**

## APPENDIX B

**Sacred Heart University**
**Consent to Act as a Research Subject**

*The Acute Effect of Self Myofascial Release on Lower Extremity Plyometric Performance*

Participants are being asked to participate in a research study. Before each participant gives consent to volunteer, it is important to read the following information and ask as many questions as necessary, and understand what will be asked to do.

Investigators: Brian Fama, CSCS,HFS, and David Bueti, ATC, CSCS, are Masters of Science candidates in the Department of Physical Therapy and Human Movement Science at Sacred Heart University (SHU) and are Co-Investigators in this study.

Purpose of the Study:

The purpose of this study is to examine the acute effects of self-myofascial release on lower extremity plyometric performance in male college athletes (n=12).

To participate as a subject, you must be a male, between the ages of 18-22 years of age, and there must be no reason you cannot participate according to the Health History Questionnaire. Participants must meet all the following criterion to be considered for participation: 1) Free of any history of major medical problems including musculoskeletal problems of the lower extremity 2) have been recreationally active for at least one year.

Procedures for this Study

Participants will come to the SHU Motion Analysis Lab (Trumbull, CT) for an orientation/information session that will include an explanation of all procedures; height, weight, age will all be assessed. All jump tests will be performed to assess jump performance. There will be familiarized with the warm-up protocols after the explanation of procedures. Participants will return to the Motion Analysis Lab no longer than 2 days later. During this time each person will be required to once again perform all jumps on the just jump mat. Two days later, participants will report back to the SHU Motion Analysis Lab and perform the other warm-up protocol.

A description of exercise testing and measurements is provided below.

<u>Description of Measurements:</u> If you decide to participate in this study, you will be asked to perform the following tests and allow the following measurements:

-Squat Jump:

- •Hands on hips
- •90° knee bend
- •2-second hold, followed by a vertical jump on testing mat.

–Countermovement Jump (CMJ)

- •Hands on hips
- Perform a Countermovement Jump on testing mat.

–Depth Jump from 30cm (DJ)

- •Hands on hips
- With both feet, drop from a 30cm box, followed by a vertical jump upon ground contact on testing mat.

<u>What is Experimental in this Study:</u> None of the procedures in this study are experimental in nature. The only experimental aspect of this study is the information gathered for analysis.

Initial: ________

<u>Risks or Discomforts:</u>

<u>Exercise Testing</u>: Potential risks and discomforts to you are exertional discomfort in the quadriceps during exercise testing. All equipment will be cleaned and sterilized according to manufactures recommendations. All testing will be conducted by CPR and First Aid certified laboratory personnel on hand and safety procedures of this laboratory will be adhered to at all times. There is a telephone in the lab in the event that emergency personnel need to be summoned. Should you desire, you may stop any test at any time.

Dynamic Stretching: Potential risks and discomforts are muscle strain and muscle cramping. Every effort will be made to minimize these risks and discomforts by ensuring you are properly educated on self-stretching techniques. An individual with extensive experience teaching and prescribing stretching will educate you on stretching. If the Dynamic Stretching in uncomfortable and causes any degree of musculoskeletal pain to you, you are free to leave the experiment at any time.

Myofascial Foam Roller: Potential risks and discomforts are bruising, muscle strain and muscle cramping. If the Foam Roller is uncomfortable and causes any degree of musculoskeletal pain to you, you are free to leave the experiment at any time.

Responsibilities of the Participant: Information you possess about your health status or previous experiences of heart-related symptoms (such as shortness of breath with activity, pain, pressure, tightness, heaviness in the chest, neck, jaw, back and/or arms) or other abnormal responses with physical effort might affect the safety of your exercise test. Your prompt reporting of these and any other unusual feelings before and during the test is of great importance. You are responsible to fully disclose your medical history, as well as symptoms that may occur during the test. You are also expected to report all medications (including non-prescription) taken recently and in particular, those taken on each day of the study, to the testing staff. It is also expected that you will report your dietary habits honestly and that you will adhere to any dietary restrictions required by the study.

Benefits of the study: Potential benefits to each participant are measurement of lower extremity power and an orientation to warm-up and flexibility training. However, we cannot guarantee that anyone will receive benefits from participating in this study.

Confidentiality: Records identifying the participant will be maintained confidential to the extent allowed by law. All results mentioned relative to testing will be provided to the participant. The data will be stored in locked cabinet maintained by Brian Fama until December 2016 at which time it will be destroyed.

Incentives to Participate: While there will not be payment to participate in this study, participants will receive vertical jump analysis that may be beneficial to their understanding of physical ability to perform exercise. They will also receive a myofascial foam roller following successful completion of experiment.

Voluntary Nature of Participation: Participation in this study is voluntary. Each persons choice of whether or not to participate will not influence their future relations with Sacred Heart University. If one decides to participate, they are free to withdraw consent and stop participation at any time without penalty or loss of benefits that they are allowed.

Questions about the Study: If there are any questions about the research now, please ask. If you have any questions later about research, you may contact Brian Fama at (914) 489-0479.

Initial: ______

Consent to Participate: The Sacred Heart University IRB committee has approved this consent form.

Your signature below indicates that you have read the information in this document and have had a chance to ask any questions you may have about the study. Your signature also indicates that you agree to be in the study and have been told that you can change you mind and stop your participation at any time. You have been told that by signing this consent form you are not giving up any of your legal rights.

You are making a decision whether or not to participate. Your signature indicates that you have decided to participate, having read the information provided above. You will be given a copy of this consent form to keep.

______________________________

Name of Participant (please print)

______________________________ ______________

Signature of Participant Date

______________________________ ______________

Signature of Co-Investigator Date

______________________________ ______________

Signature of Co-Investigator Date

## APPENDIX C

## P A R - Q .

**Yes** **No** Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?

**Yes** **No** Do you feel a pain in your chest when you do physical activity?

**Yes** **No** In the past month, have you had chest pain when you were not doing physical activity?

**Yes** **No** Do you lose your balance because of dizziness or do you ever lose consciousness?

**Yes** **No** Do you have a bone or joint problem that could be made worse by a change in your physical activity?

**Yes** **No** Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?

**Yes** **No** Do you know of any reason why you should not do physical activity?

*Excerpted from the Physical Activity Readiness Questionnaire (PAR-Q) © 2002. Used with permission from the Canadian Society for Exercise Physiology.*

I have read and have answered all the questions above accurately and honestly.

All participants must sign. Participants must be 18 years or older to participate.

Participant Signature: ________________________________ DATE: ___________

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