The acute effect of self-myofascial release on the counter movement jump.

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5th June 2016

This Research Project is submitted as partial fulfilment of the requirements for the degree of Master of Science, St Mary's University.

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ACKNOWLEDGMENTS

I would like to thank my family and friends who have supported me throughout all of life’s struggles. Furthermore, I would like to thank all St Marys University staff that have inspired and developed my academic and personal qualities. I would like to thank my project supervisors Dr. Daniel Cleather and Richard Blagrove. Jack Lineham and PASCO scientific for technical support, and all the project participants.

ABSTRACT

Stewart, C. The acute effect of self-myofascial release on the counter movement jump. The purpose of this study was to evaluate the effectiveness of myofascial release in the form of foam rolling (FR) compared to deep tissue massage and its impact on countermovement jump (CMJ) performance. There is evidence to suggest that myofascial release may impact short-term measures of performance such as dynamic power, however, there is still no clear agreement between a small number of studies. This study is a within-person design (repeated measures). All participants took part in a repeated measures study, completing 4 treatments; 1) control, 2) lower limb foam rolling 3) upper thigh foam rolling and 4) intervention of deep tissue massage to the upper thigh, specifically the hip flexors and then completed a standardised warm up.FR duration varied depending on the treatment, with the shortest duration being 8 minutes and longest 12 minutes. Following each of the protocols, the subjects rested for 5 minutes and then performed 3 CMJ's on a force plate with hands on hips. CMJ heights were calculated using take-off velocity (TOV) $TOV = TOV^2/2g$ and the highest of the three jumps were taken. The protocol that provided the highest jump heights was protocol A, of upper and lower leg SMR with a p value of p = 0.011. Statistical analysis was performed using one-way ANOVA. The conclusion from this current study indicates that FR increases performance in the CMJ, all treatments outperforming the control group, with a combined upper and lower leg FR treatment increasing displacement the most.

KEYWORDS*: facia, foam rolling, hip, jump height, force, mobility.*

INTRODUCTION

The modern strength and conditioning coach endeavours to try and find the most effective and efficient ways to enhance performance. To fulfil this role, pre-performance routines such as warm-ups, nutritional interventions, and psychological strategies are now part of the modern coach's toolbox to meet the individual needs of the athlete. The extent to which pre-performance interventions and specific warm up procedures affect performance have been well researched (5,8,9,16,53,73). In recent years, the incorporation of myofascial release (MFR) as part of warm up routines to enhance subsequent performance, has become a popular modality in strength and conditioning (S&C). Particularly the integration of self-myofascial release (SMR) using foam rollers (FR), as part of warm-up strategies, post-exercise recuperation, and rehabilitation (25,26,55,58).

MFR is a collective term for many kinds of manual therapy techniques, such as active release, petrissage, friction, tapotement, and effleurage. MFR is proposed to acutely increase the joint range of motion by reducing the stiffness of fascial tissue in adjacent muscles when subjected to mechanical pressure (36,65,81). However, massage still receives scepticism and its mechanisms are not always well received. Nonetheless, massage is well-known to have effects that create relaxation and decrease in anxiety which appears to result in improvements in mood (39,81). For athletes, massage could have a positive psychological effect when performed pre or post exercise (81). Furthermore, the use of MFR has been shown to aid recovery and enhance tissue quality (28,81). Therefore, prominence should be placed on the type of massage carried out as there is a multitude of techniques. This study aims to elucidate the effects of manual therapy in the form of MFR and massage to enhance tissue quality and dynamic power performance.

The incorporation of MFR and SMR as a legitimate tool for enhancement is substantiated, as it has been used to improve wellbeing through affecting muscle fascia and its positive impacts on lower back disorders and headaches (3,75). This further validates the use of SMR as a means of improving the condition of an individual's performance. There is still debate regarding the specific meaning of the term fascia, but it can be regarded as a global system of interconnecting tissues from head to toe; superficial and visceral fasciae as well as muscles, tendons, ligaments and also intramuscular connective tissues; endomysium, perimysium, and epimysium (66,77). Fascia can be described as sheaths, connecting the entire muscular system from deep to peripheral tissue, the more flexible and elastic fascia is, is thought to improve performance (66). The role of fascia may be extremely pertinent in athletic development as it has been shown to contribute up to 30-40% of muscular force transmission (30–32,63,89). Fascia's role in the connection of forces between muscles is an important factor and should be a consideration when designing S&C programs. Program design should aim to enhance all connective tissues rather than isolated muscles or muscle groups.

Moreover, in individual muscle groups, the angle of fibre pennation has been shown to play a huge role in muscular strength and force (1,38). The fascia aids this force production and transmission by serving as a stabiliser to allow muscles to generate movement (66). The fascia providing greater stability and force transmission would aid strength training. Strength training has been shown to increase the angle of fibre pennation, resulting in an increase in muscle cross-sectional area, which has shown to have a direct correlation to muscular strength and therefore performance (1,67). This is of importance because resistance training has been shown to increase fascicle length, which has been publicised to positively impact performance (44,67). Therefore, if an individual can maintain or improve movement quality by performing SMR as a warmup and recovery strategy, to resist muscle fascia becoming restrictive. This may then enable greater force production when training, increasing the absolute loads lifted and thereby increasing the training effect.

The motive for this current study assesses whether SMR can influence jump performance in trained individuals. Tightness in the anterior portion of the hips (hip flexors), can excessively pull the pelvis into anterior pelvic tilt, and excessive anterior pelvic tilt could cause restricted movement and has been renowned for causing lower back pain which in turn would result in decreased performance (75). The efforts to release fascia around the hip in individuals with lower back pain has reported positive results, reducing lower back pain, and an increase in fascial mobility and perceived pain threshold (75). Individuals with tight hip flexors experiencing lumbar pain are often related to increased anterior pelvic tilt and related spinal lordosis, which places excess stress on the lumbar discs and tissues (19,29,60). The main muscle groups that act as hip flexors and may contribute to anterior pelvic tilt are; rectus femoris, psoas, iliacus, adductors (longus, brevis, gracilise, pectineus), sartorius and tensor fasciae latae (47,79). Hip ROM can be increased through static stretching of these muscle groups, although an increase in hip flexor compliance has revealed to not increase CMJ performance (79). Nonetheless, Wakefield and Cottrell (79) demonstrated an increase in muscular compliance of the hip flexors through static stretching which resulted in a reduction in vertical jump performance. This would have most likely reduced performance capabilities due to a reduction in elastic components of the muscular tendinous unit and coordination of the neuromuscular system (35,37,83). It should be noted that if it is the tightness of hip flexors that is the cause of movement restrictions, this may be due to muscular imbalance (86).The extensors, flexors, adductors and abductors should be trained sufficiently whilst maintaining mobility. Strong and large hip flexors can improve athletic performance in sprinting and jumping (64).

Awareness of the fascial system and its influence on performance could help underpin performance-enhancing strategies. It is important to understand that an optimal ROM is required by the individual to ensure sporting movements and postures are carried out safely (82,87). If an individual's movement is restricted due to their passive stiffness, the optimal range of motion and postures could be impaired which may well mean lowered performance levels. On the other hand, it is understood that decrease in muscle stiffness results in lowered performance, particularly actions that use a stretch-shortening cycle (SSC) (37,53,73,85). It is important to distinguish between individuals that possess useful muscle stiffness that will aid performance versus individuals that have tightness that is detrimental. Flexibility and mobility can be increased acutely and chronically through static stretching (37,55), proprioceptive neuromuscular facilitation stretching (PNF) (11,35,68), ballistic stretching (35,88) and MFR (10,49,74). It is the requirements of the individual, training context and the sport that should influence the type of mobilisation strategies as part of a warm-up routine (85).

SMR is performed manually by the individual as opposed to a therapist by using tools such as foam rollers (FR), handheld rollers and trigger point balls (7). SMR has grown in popularity due to its efficient and effective means, it has been publicised to result in an increase in muscular compliance, increase in blood flow, decrease arterial stiffness and generate excitability to the neuromuscular system (8,13,57,78,81), FR has been shown to reduce headaches (3), physical stress (39) and increase ankle ROM (24,69) and increase perceived pain threshold and fatigue (2,36,59). Furthermore, SMR has also been shown to aid recovery after intense exercise and reduce exercise induced muscle damage (25,50,51). SMR has also conveyed acute increases in ROM without a decrease in muscle force or activation due to loss of force production capabilities (37,53,73,83). On the other hand, SMR using an FR alone has been shown to not influence performance or joint

ROM (69,78), but when FR is combined with postural adjustment exercises or stretching, joint ROM was significantly increased. It is important to understand that the majority of studies regarding MFR using FR have performed the treatment very localised rather than globally, this is important because the fascial system is regarded as a global interconnecting structure (23,66,71,77). On the other hand, PNF has shown both acute and chronic increases in ROM without a reduction in performance or increase the risk of injury (11,68). Still, this is not to suggest that PNF overrules the use of FR, FR has additional benefits such as decreasing arterial stiffness, increasing muscle temperature amongst others aforementioned (7,25), both could be used in conjunction with each other or the best strategy suited to the individual and context. Previous studies that have investigated SMR on explosive activities include FR on VJ performance (58,81), back squats (59), maximum voluntary contraction (49) and agility, isometric force and VJ (25).

This study is analysing the acute effects of SMR on CMJ height, there are many different performance tests that are used for performance monitoring, talent identification and biomechanical analysis. However, the countermovement jump (CMJ) is a recognised testing and monitoring tool and also a predictor of performance in many sports (6,21,27,40,48,61). The reason for its selection is often due to its specificity to sporting actions and the many different types of data that can be assessed, such as; power, force, velocity, the rate of force development and more (15). Furthermore, the test has a relatively low injury risk and is convenient to perform for both experimenter and participants, hence why in this study it was chosen as the performance indicator (80). The CMJ is used as a performance test and training tool due to its validity to many sports contexts, there has been acute improvements in CMJ height in studies looking into post activation potentiation protocols, incorporating plyometric and weighted procedures (14,70).

A crucial factor against FR as an MFR strategy is the ability to exert enough pressure and stimulation to the fascia to cause enough compliance, the reason being that SMR relies upon the individual applying the pressure using their own body weight to target the desired area. Moreover, the pressure applied can be varied by the participant if the pain is too great, so based upon their individual pain threshold, could result in inadequate pressure being applied to cause effective fascia release. However even if an individual has unrestrictive fascia and or high pain threshold, their body weight and the SMR tool being used may not be able to influence the deep fascial tissues. This study used an intervention of deep tissue massage by a manual therapist, to target the deep fascia that may not be possible when using FR's. If SMR does acutely affect performance, it would help guide coaches and athletes with their program design, reassessment of performance needs and how best to prepare for athletic activity to increase force production.

The hypothesis of this study is that an increase in the ability to extend at the hip during jumping would help produce a larger jump height. The ability to create greater ROM at the hip in an extension pattern is possible during lunging activities as a result of an FR intervention (13), the ability to effectively extend the hip and the importance of the hip extension musculature plays the most important role in propulsion (33). An important aspect of being able to extend properly through a joint ROM is that the agonist's muscles are able to contract to a greater degree (30,84), in jumping this would enable the hip extensors to work effectively (hamstrings glutes etc.). The Larger net impulse in the vertical propulsive phase determines jump height in accordance with Newton's second law (41). Therefore, if FR increases greater hip ROM by allowing the hips to extend and enable the athlete to generate a larger impulse in the propulsive phase, the height of the participant's jump would increase. As long as there are no negative effects such as reduction in the SSC, however, this is deemed unlikely, as FR has demonstrated improvement in performance in a battery of tests (58). In addition, improving movement quality in athletes with tight hips would help improve movement kinematics and therefore improve jump biomechanics which would help increase jump height, as technique is an important factor in producing increases in performance (15).

METHODS

Experimental approach to the problem

This study was designed to examine the effect of myofascial release on CMJ performance. Subjects completed one familiarisation session and four different procedures (control, MFR1, MFR2 and deep tissue massage intervention), attending a total of 5 separate occasions. Each protocol involved performing the treatment followed by a standardised warm up. After resting 5 minutes the subject then performed 3 CMJs with hands on hips, the highest jump value of three attempts was taken

The study will test the hypothesis by completing a within-subject design involving four protocols, the control group performing a standardised warm up with no direct effort made to improve hip ROM (no placebo). The other trials involve subjects performing SMR using an FR followed by a standardised warm up. Finally, the intervention involved a deep tissue massage administered by a professional manual therapist to increase the mobility of the hip musculature, and subsequently, a standardised warm-up was performed, followed by a rest period of 5 minutes before completing 3 jumps on the force platform, and finishing with a cool down.

Subjects

10 healthy male subjects from a similar population were invited to take part in the study via a letter of invitation and completion of a consent form and health screen questionnaire. The subjects had experience of strength and conditioning activities, massage pain and training more than 4 hours a week (subject characteristics in table 1). The importance of the subject sample being from a similar population (with S&C experience), meant that the results would specify more accurately to the target group (athletes and strength and conditioning practitioners). Exclusion criteria stipulated that participants had no lower body injuries or pathologies in the last 6 months before data collection. Subjects were also made known of the risks and benefits involved in the study and were informed that they could withdraw from the study at any time. The 10 participants were allocated a protocol in a randomised order to support the internal validity of the study, the subjects were randomised using Microsoft excel. The actual sample size (*n*) was calculated using G*power software, *n* = 24 subjects, however, the researcher was unable to recruit the required sample size. The experiment was granted ethical approval by the institutional ethics board at St Marys University Twickenham

Subject characteristics

Subjects	**Height (cm)**	**Weight (kg)**	**Age (years)**	**Years training**
n = 10	*180.8 ± 3.7*	*87 ± 16.5*	*28 ± 7.0*	*10 ± 3*

Table 1

Procedures

Subjects completed an initial familiarisation session where anthropometry was taken including weight (mass) and height (cm), all subjects were then shown and practiced the experiment FR techniques and standardised warm up. Lastly, participants performed a minimum of 3 CMJ on the force platform, hands on hips and technical feedback was given to participant if necessary, participants were encouraged to dip to no greater than approximately 90-degree knee flexion. This was to maximise the SSC of the leg musculature (46) if participants did dip excessively they were asked to perform another CMJ.

SMR conditions consisted of 60 seconds rolling per position, at a steady rate going from proximal to distal end continuously, if a tighter region was located along the muscle this was isolated for a few seconds but not for the full 60 seconds. The researcher monitored all participants when they were performing FR to ensure accurate technique. The FR techniques can be seen in figure 1. The intervention of deep tissue massage was carried out by a qualified manual therapist, subjects lay supine on a massage bed with knees bent and feet flat on the bed to allow access to the quadriceps, vastus medialis oblique (VMO), adductor magnus, vastus intermedius/ rectus femoris, vastus latteralis, psoas and hip flexors. The massage involved a combination of effleurage (pressured strokes) and petrissage techniques (squeezing and kneading) for 4 minutes per leg. Protocols B and C were equated to 8 minutes' total massage time, it was only protocol A that exceeded this (12 total minutes od SMR) due to SMR being performed to the upper and lower leg. The intervention did not include lower leg massage because the rationale of the study was focussed on the musculature in the hip region.

All protocols involved a standardised dynamic warm-up (Table 2) performed after the designated protocol, This type of warm up was chosen over any other type of static stretching based warm up, as dynamic warm ups have been shown to provide optimal preparation for performance that involves stretch-shortening cycles (SSC) (37,53). Then 5 minutes rest post warm-up made sure fatigue was not a contributing factor to the experiment and allowed for phosphocreatine and adenosine triphosphate stores to be fully restored (9).

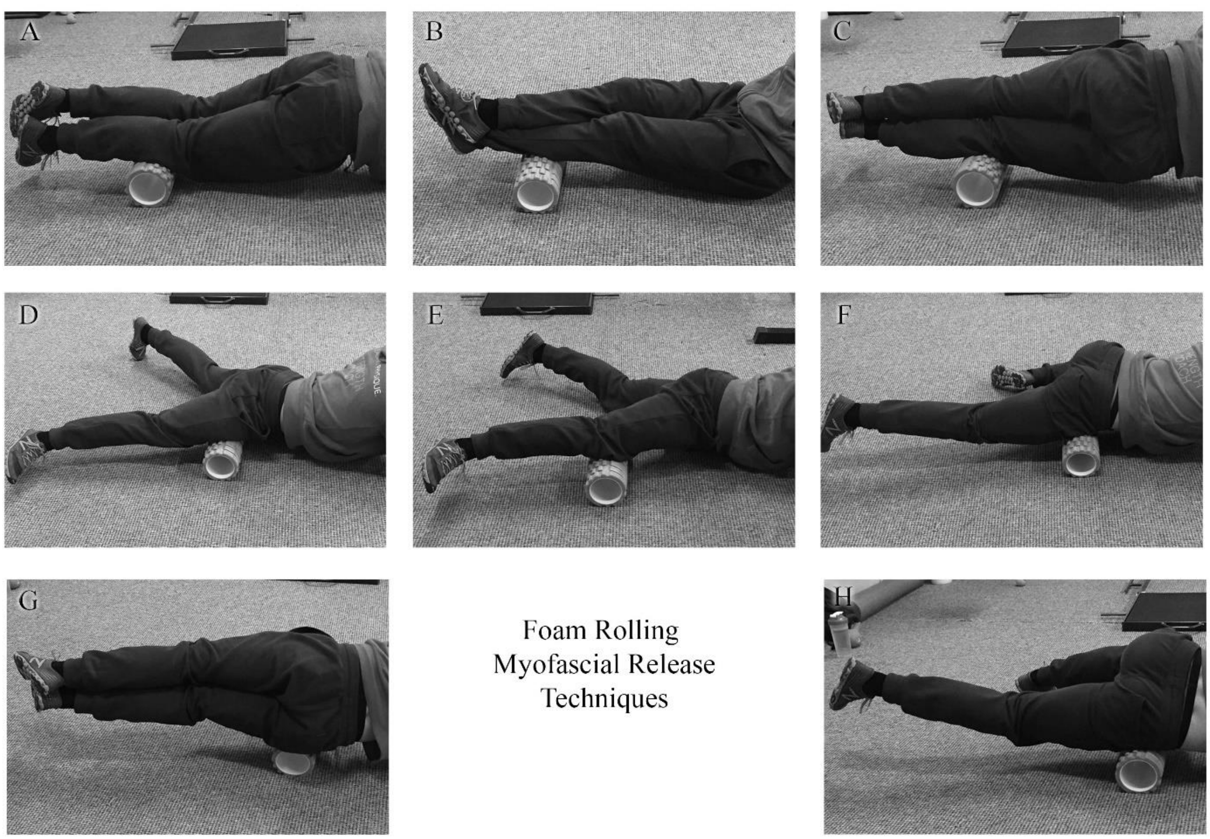
Dynamic warm up procedure			
Exercise	***Repetitions***	***Sets***	***Rest (seconds)***
Slow steady state jogging	5 minutes	1	20 seconds
Body weight squats	12	1	20 seconds
Walking Lunges	20	1	20 seconds
Calf raises	12	1	20 seconds
High knees	10 metres	1	20 seconds
CMJ	3	1	20 seconds
5-minute post warm up recovery			

Table 2

The protocols for each treatment A, B, C, and D are as follows and can be seen in figure 2:

- Protocol A - performed SMR the lower leg, gastrocnemius (lateral and medial) and soleus, peroneus longus, anterior tibialis. The upper leg; quadriceps, vastus medialis oblique (VMO), Adductor muscles, vastus intermedius/ rectus femoris and vastus latteralis (12 total minutes of FR), plus a dynamic warm up.

- Protocol B - SMR to the upper leg quadriceps, vastus medialis oblique (VMO), adductor muscles, vastus intermedius/ rectus femoris and vastus latteralis. hip flexors (8 minutes total FR, 4 minutes each leg) plus a dynamic warm up.
- Protocol C - the intervention of deep tissue massage performed by a qualified physical therapist of the quadriceps, vastus medialis oblique (VMO), adductor muscles, vastus intermedius/ rectus femoris and vastus latteralis. hip flexors (8 minutes total FR, 4 minutes each leg) plus a dynamic warm up
- Control – a dynamic warm up (no SMR or intervention).



A- Anterior Tibialis, B- Gastrocnemius and Soleus, C- Peroneus Longus, D- Adductor Magnus,
E - Vastus Medialis Oblique, F- Hip Flexors, G-Vastus Lateralis, H- Psoas

Figure 1

Each of the FR techniques was performed to ensure that fascia in each protocol was sufficiently stimulated, rather than attempt to isolate individual muscle groups. Separately participants were monitored individually during the FR treatment and warm up procedures to make sure they were performing the FR techniques correctly, coaching points were given where necessary. The type of FR used for self-myofascial release is made from hard plastic centre tube surrounded by firm rigid foam, MIRAFIT High-Density Foam Massage Roller, 33cm length and 14cm diameter (Mirafit, Boundary Road, Harfreys Industrial Estate, Norfolk, NR31 0LY). High-density foam rollers were chosen as they pose a realistic purchase option at a reasonable price for athletes and coaches but more importantly have been shown to produce a superior pressure during SMR than those which are made from just foam (17). Numeric rating scales (0-10) were used to aid standardisation of pressure, participants were encouraged to exert moderate pressure that caused a scale reading in the region of 6-8, participants were asked approximately once every minute what the pressure pain was on the numeric rating scale, moderate pressure is deemed appropriate for MFR benefits (4).

The impact of each procedure was examined through testing jump height using a PASCO force plate, PASO010660, 35cm by 35cm, sample rate capacity of 1000Hz using Capstone software, range -1100 N to +4400 N, 0.1N resolution and 6600N force overload protection and one PS-2100A USB air Link 2.

Once subjects had completed the allocated protocol, as part of the standardised warm up participants performed 3 jumps (not on the force plate) ensuring correct technique for the propulsive and landing phase. This also provided the appropriate final element of the dynamic warm-up procedure, preparing the body for explosive activity (8). The 3 jumps in the warm up was appropriate due to the fact that this study is to try and increase athletic performance, and low-level plyometric movements are an important part of a warm up for maximal performance (8,9,20). Post 5 minutes' rest the three CMJ's with hands placed on hips were performed with maximal intent by the participant on the force platform. Each participant was allowed 30 seconds to refocus and adjust between each of the 3 jumps, and let the researcher know when they were ready to perform the next jump, although perceived preparedness to perform was not measured, once the athlete signalled they were ready, the researcher gave a cue for when the participant could begin their jump once the platform had begun to collect data. Hands were placed on hips during all CMJs so that the subject's centre of mass was not radically altered during the jumps, additionally the use arms is not of significance to the research in question as it is to primarily focus on the lower body (62). Jump height was calculated using take-off velocity (TOV) $TOV = TOV^2/2g$, because the calculation for hang time / time in air, has been shown to be less accurate than TOV (56). In addition, this method was most suitable for the force plate equipment and software available. After each participant had completed their allocated trial, they performed a cool down. Participants had a minimum of 72 hours and a maximum of one week before returning to complete their next treatment which was allocated randomly. All protocols took place at a similar time of day (evening).

Statistical Analysis

All data was collated in Microsoft Excel 2010, a one-way repeated measures statistical analysis of variance (ANOVA) was performed using IBM SPSS Statistics (Version 22; IBM Corp., Armonk, NY, USA). The one-way repeated measures ANOVA was used to check for significant differences within groups. The significance level was set at an alpha reading of $p \leq 0.05$ for all data. A

Bonferroni post hoc analysis was used to test for difference in the dependent variables with an alpha reading of $p \leq 0.05$.

RESULTS

Results in Figure 2 indicate that there was a significant improvement in CMJ displacement when performing protocol A involving upper and lower leg SMR when compared to the intervention condition of deep tissue massage (protocol C). No other significant differences were observed between conditions (effect size = 0.702, $p > 0.05$). A repeated measures ANOVA and a Bonferroni post hoc analysis determined that there was a significant improvement in CMJ displacement in protocol A ($p = 0.011$). Table 3 presents the mean ± SD and confidence intervals for the 4 treatment conditions.

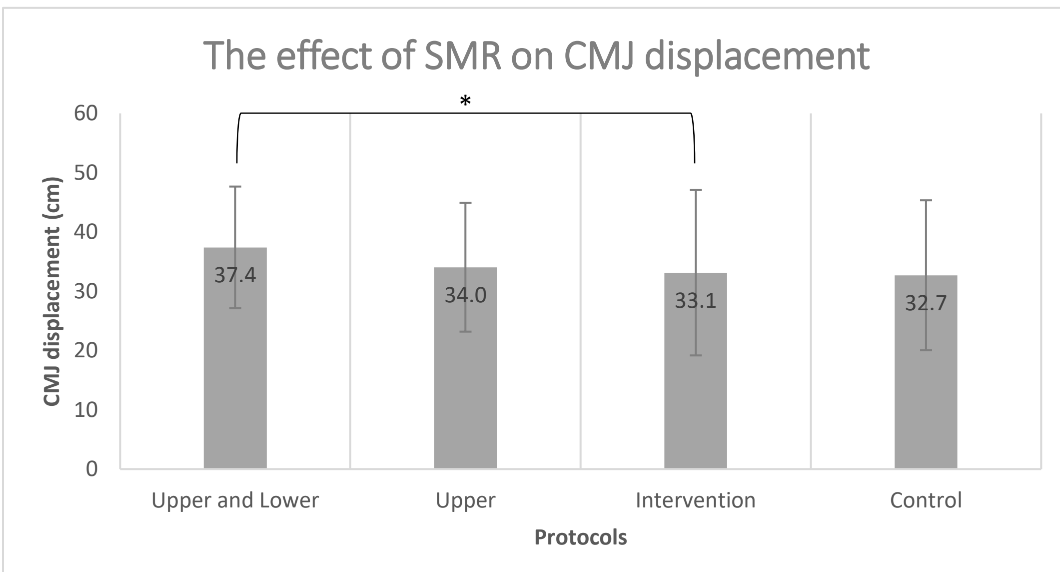


Figure 2

Table 3 demonstrates the mean (± SD), upper and lower range and confidence intervals of CMJ displacement following the 4 conditions.

Descriptive statistics					
Countermovement jump height (cm)					
Protocol	**Upper value**	**Lower Value**	**Mean**	***Std. Deviation***	***Confidence intervals***
A - Upper and Lower	58.0	18.0	37.4	14.0	8.6 (28.7 – 46.0)
B - Upper leg	50.2	15.2	34.0	10.9	6.7 (27.3 – 40.8)
C - Deep tissue massage	48.7	16.3	33.1	12.7	7.8 (25.3 -41.0)
D - Control	49.6	12.6	32.7	10.3	6.4 (26.3-39.1)

Table 3

DISCUSSION

This study was novel as it aimed to identify the impact of SMR on subsequent jump performance, comparing FR conditions to manual therapy. Interestingly the results lead to a slightly different conclusion to that which was hypothesised which leads us to reject the experimental hypothesis. FR or deep tissue massage to the upper leg only did not produce the greatest performance. Instead it was the combined upper and lower leg condition that produced the significant result. These results are similar to other studies when considering the more isolated treatments of upper leg FR and upper leg deep tissue massage (protocol B and C), there was a limited improvement in performance when compared to the control condition. Similarly, Goodwin et al. (22) found no improvement in 30m sprint times when massage was performed to the lower leg only, by manual therapy. Healey and colleagues (25) found FR to be no different to planking when performing a battery of tests and Fletcher (18) showed no improvement in sprint performance with a pre-competition massage by a manual therapist. However, most of the previous research with negative or no different results between FR and control condition only performed FR to isolated areas (69,78). Although this is conflicting, this may have been as a result of a number of factors, however, one that seems most likely is massage duration. In this current study, there was a considerable amount of time spent performing SMR, between 8 to 12 minutes. Previous studies that have shown negative effects of FR only performed FR for 30 seconds per muscle group (5 total minutes) (25), this would barely allow for the known effects of MFR to take place such as decrease arterial stiffness, neurological effects and increase muscle temperature. Additionally, studies that have demonstrated positive results from SMR have used longer duration MFR – minutes rather than seconds per muscle group (7,59,72). On a similar note, the pressure exerted or the type of MFR techniques used in these other studies was questionable to cause adequate stimulation. For example, the type of FR used in one study (25) was not the model of FR shown to exhibit greatest pressure when performing SMR (17). Moreover, other studies that involved manual therapy and resulted in negative performances carried out MFR by manual therapists for a lengthy period of time (18,22). Likewise, in this study, the significant difference (p = 0.011) between deep tissue massage and the combined upper and lower leg FR treatment support this. Perhaps MFR by a manual therapist is too disruptive for the connective tissues to then produce maximal performance whereas FR provides more of a stimulatory response to the fascial system.

Furthermore, FR has been shown to improve performance when performed on a global scale (full body foam rolling) (58). Albeit that this study was relatively isolated to the lower body, when SMR was carried out over more musculature involving the upper and lower leg (protocol A), FR produced the highest displacement in comparison to the more isolated treatments; protocol B (upper leg) and C (deep tissue intervention) producing lower performances but still greater than the control condition which only performed the dynamic warm up. The justification for this improvement in performance in protocol A is reasonable when considering the fascia as a universal structure (71), the connecting fascia from lower to upper leg interconnecting to produce the greatest force and propulsion, reason being that fascia has revealed to be responsible for up to 30 - 40% of muscular force transmission (66). Protocol A may have enhanced the force connectivity and enhanced efficiency between the upper and lower leg resulting in superior performance because movement efficiency has been exemplified when FR was performed to the upper thigh (10). However, as seen in table 3, SMR to the upper and lower leg has a SD of 14.0, this wider concentration of data compared to the other conditions may suggest that the individual subjects respond very differently to this treatment, furthermore the confidence width for protocol A was the widest of the 4 conditions meaning the precision of the estimates could be questionable, that being said, the confidence level was the highest out of the 4 conditions for protocol A. Having a larger sample size would have probably lead to more decisive conclusions.

The ankle extensors are very important during jumping, particularly during the late push off phase the ankle extensors increase the impulse during upward propulsion (45), the larger the net impulse in the vertical propulsive phase determines jump height in accordance with Newton's second law (41). Therefore, the combined contribution of hip and ankle extension plays a significant role in CMJ performance. Likewise, the importance of the lower leg musculature (fascicles) has also been shown to be related to sprinting performance (44), and the large role that the lower leg plays in plyometric training utilising the muscular tendinous unit of the gastrocnemius, soleus, and tendinous tissues. Plyometric training has been shown to improve performance in jumping, sprinting, and running economy (42,52,54,76). Hence, the importance of including combined lower and upper leg MFR is imperative as FR to the lower leg would help stimulate the fascial system, blood flow, and neuromuscular excitability of the working structures (8,13,57,66,78,81).

On a similar note, for the duration of FR in this current study, the pressure applied was in line with the numerical rating scale, which could possibly impact on results based upon an individual's pain threshold, bodyweight, and intent. To try and standardise this issue, this study used a numerical rating scale and subjects were asked approximately one every minute where they rated on the scale, to try and ensure subjects applied enough pressure to the targeted areas. Further studies could look at using electromyography (EMG) or performing FR on force plates to try and standardise pressure exerted more accurately.

Furthermore, the reason for enhanced performance when more global FR was performed could be linked to fascia and its proprioceptive qualities (65,66), SMR is known to yield neuromuscular excitability (8,13,57,78,81), SMR, therefore, may provide the stimulatory response to enhance the proprioceptive qualities of the fascia, assisting with neuromuscular coordination, recruiting the hip knee and ankle extensors and thereby aid correct jumping technique such as dipping to the appropriate depth to obtain the greatest SSC (34).

This study hypothesised that Performing SMR to the hip flexors and surrounding musculature could lead to increases in CMJ performance. The rationale for this is the increased impulse in the propulsive phase generated from an increase in ROM. This study indicates that the use of SMR affects the main triple extension joints (ankle, knee, and hip) and contributes to jump performance. Isolated lower body SMR did not greatly influence CMJ performance but still outperformed the dynamic warm up only. When SMR was completed across both upper and lower leg this produced the greatest performance, possibly due to the overall decrease in passive and active stiffness of the fascia. Similarly, when the SMR was performed over a greater surface area, its effects were similar to when full body FR acutely improved performance in a battery of tests (58).

This study indicates that FR acutely affects performance but when performed very localised, there are marginal improvements in performance but when FR is performed over more musculature for a total duration of 12 minutes to the upper and lower leg there is a more substantial acute improvement. Moreover, this study highlights the importance of the ankle extensors in combination with adequate hip extension capabilities, both ankle and hip have demonstrated to be pertinent to propulsion (33,45).

Further studies involving the upper body and the agonist hip extensor muscle groups would help further these findings and assess the mechanisms by which FR and MFR influence performance. The main limitation of the current study is the sample effect size which would affect the ability to generalise the results outside of the study population. Further research with the required sample size (*n* = 24) would provide a more accurate result that would be more beneficial to athletes and coaches. However, this study does still provide outcomes that would be of interest to S&C practitioners. Further improvements to this study could be a different population as this study contained men only in the trained population, so it would be interesting to see what effects SMR had in elite standard athletes and women, many previous studies have only contained similar subject status as this one. Additionally, one variable not accounted for was participant nutrition and hydration and how this may have influenced performance. For further research of a similar design, it would be of more value if other dependent variables were measured, such as impulse, RFD, ROM and EMG against a battery of tests, and perform MFR on all agonist musculature such as the hip extensors like the glutes and hamstrings which may result in further fascia and muscular enhancement.

PRACTICAL APPLICATIONS

MFR is now being shown to have effects when previously scepticism surrounded the mechanisms and worth of MFR.As a performance enhancing tool the following needs to be considered: 1) the scale of FR and areas covered, 2) the type of FR or other MFR tools based upon the desired effect of the strategy, the type of tool used should be chosen based upon the needs of the individual, and duration of the activity. 3) The techniques performed should be selected carefully to maximise time and effect. The current study isolated FR movements for a long duration compared to previous studies that showed no improvement in performance, and the time incurred may consume valuable coaching time for other training modalities (strength training etc.), particularly if full body FR has performed this approach.

FR is a valid tool for S&C coaches to provide for athletes to perform SMR to aid performance, they are a cheap and convenient method for MFR and relatively simple to coach individuals the different techniques to target certain sections of fascia and muscle groups. The intensity and firmness of SMR implements should depend on factors such as the amount of muscle mass the individual has, their stiffness or mobility restrictions, pain threshold etc. when possible the type of FR used should be one similar to this study (hard plastic centre with firm foam outer) as this produced the desired pressure and effects (17). S&C coaches must understand the importance of the fascial system and its role in movement and performance, and not just focus on the enhancement of isolated muscle groups when trying to cultivate muscle strength and hypertrophy. SMR can be part of the strategies for coaches to try and improve the functional movement patterns for individuals and their sport. The functional movement has become more popular, particularly with athlete screening tests such as functional movement screens (12,43), movement and postural adjustment strategies should be included as part of most S&C programmes to adhere to the needs of the individual and sport to minimise injury and enhance kinematics. FR is a justifiable method of developing healthier movement patterns in an effective and efficient way.

It would appear that performance can be enhanced acutely when performing SMR using FR as the MFR tool, carrying out SMR to major muscle groups in the lower body involved in jumping increases jump height in the CMJ. MFR would appear to be a useful tool to enhance performance FR movements selected and duration should be selected carefully to maximise training time, especially if FR is also part of post-exercise routines.

- Use foam rolling for performance but ensure all major muscle groups are stimulated.
- Spend 30 to 60 seconds on each area so to maximise coaching time if time is of the essence.
- Apply moderate pressure from proximal to distal ends of the fascia – use a numerical rating system or similar to standardise the pressure among athletes.
- Use FR as a post exercise routine to reduce the effects of exercise-induced muscle damage.
- Use hard plastic centred foam rollers for optimal pressure.

Coaches who endeavour to enhance athletic capabilities through strength and conditioning modalities, should remain diligent and make sure that the biomotor abilities that have been adapted can be fully accessed and not inhibited through postural interference or fascial tightness. Coaches need to ensure that the motions needed for sports performance can be fully applied so that force is applied with the greatest precision, magnitude and direction for the optimal performance outcome.

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APPENDICES

Signed ethical approval

Research Ethics Application Comments Form

Level:	2
Type:	Postgraduate
Proposer:	Christopher Stewart
Supervisor:	Daniel Cleather
School:	SHAS
Programme:	S&C MSc
Title:	The acute effect of myofacial release on the counter movement jump. Is there a positive contribution to performance?
Date:	March 2016
Review No.:	**2**

Comments (number corresponds to relevant section on Ethics Application Form)

Impression/Decision
All amendments made

Recommendation
Approved

Dr Jessica Hill
Ethics Representative.
School of Sport, Health and Applied Science.
St Mary's University.

Signed ethical approval

St Mary's University Twickenham London

St Mary's University

Ethics Sub-Committee

Application for Ethical Approval (Research)

St Mary's Ethics Application Checklist

The checklist below will help you to ensure that all the supporting documents are submitted with your ethics application form. The supporting documents are necessary for the Ethics Sub-Committee to be able to review and approve your application.

Please note, if the appropriate documents are not submitted with the application form then the application will be returned directly to the applicant and may need to be resubmitted at a later date.

	Enclosed? (delete as appropriate)		Version No
Document	Yes	Not applicable	
1. Application Form	Mandatory		
2. Risk Assessment Form	Yes		
3. Participant Invitation Letter	Yes		
4. Participant Information Sheet	Mandatory		
5. Participant Consent Form	Mandatory		
6. Parental Consent Form		N/A	
7. Participant Recruitment Material - e.g. copies of Posters, newspaper adverts, website, emails		N/A	

8. Letter from host organisation (granting permission to conduct the study on the premises)		Leading Physique ltd – S&C facility.	
9. Research instrument, e.g. validated questionnaire, survey, interview schedule	Yes		
10. DBS **(to be sent separately)**		N/A	
11. Other Research Ethics Committee application (e.g. NHS REC form)		N/A	

I can confirm that all relevant documents are included in order of the list and in one PDF document (any DBS check to be sent separately) named in the following format: ***Full Name, School, Supervisor.***

Signature of Applicant: 

Signature of Supervisor: 

Letter of invitation

St Mary's
University
Twickenham
London

Letter of Invitation

The acute effects of self-mayofacial release on the counter movement jump, through the use of foam rolling. Is there a positive contribution to performance?

I would like to invite you to be a participant in the above study. The purpose of the study is to find out if the use of mobility techniques such as foam rolling and massage when part of a standardised warm-up routine improves performance in subsequent activities. This study could better inform you how to warm up to maximise performance and give you an indication of your current performance in the counter movement jump (vertical jump), which is often used to assess power. Therefore, I would like to invite you to participate in this informative study of which I'm sure you will find useful.

The organiser of the study is Chris Stewart who is being supervised by Dr Daniel Cleather from St Marys University, Twickenham. The project is entirely self-funded and the results from the study will be publish as part of a major independent study and hopefully go on to be published in a journal, however results will be kept anomenous, and all participant information kept highly confidential.

You have been invited to take part in the above study as you are considered to be associated with strength and conditioning activities. You do not have to take part in the study, if you wish to decline the invitation please let the project organiser know at the soonest possible time. At any point during the study you have the right to withdraw with no obligation, please inform the project organiser in writing by email.

If you agree to take part, there will be an initial induction and familiarisation session, where documentation such as health screens will take place. Your anthropometric measurements will be taken (height, weight) and you will become introduced to the foam rolling movements needed. From here you will be asked to return for a further 4 protocols that should not last longer than 30 minutes each. Each protocol will involve different foam rolling techniques at different locations on the lower limbs (e.g. gluts and quads) leading up to the 3 counter movement jumps. One protocol will involve aggressive massage of the hip flexors which will carried out by a professional physical therapist.

You may be asked to complete a food diary to recall the dietary intake the night before and day of the tests to try and make the tests as similar as possible. If you require further information please contact the project organiser.

YOU WILL BE GIVEN A COPY OF THIS FORM TO KEEP TOGETHER WITH A COPY OF YOUR CONSENT FORM

Project organiser:

Chris Stewart

Unit 6, Whalley Industrial Park

Barrow

Clitheroe

BB7 9WP

125288@live.smuc.ac.uk

University:

St Marys University

Strawberry Hill

Twickenham

London

TW1 4SX

Consent form

St Mary's University Twickenham London

Practical activity consent form

Name of participant:
……………………………………………………………………………………………..

Title of the practical activity: The acute effect of self myofacial release on the counter-movement jump.

Main coordinator and contact details: Chris Stewart, 125288@smuc.live.ac.uk, 07999236980

Participants of the practical activity:

1. I agree to take part in the above practical activity.
2. I have had the practical activity explained to me, and understand what my role will be. All of my questions have been answered to my satisfaction.
3. I understand that I am free to withdraw from the practical activity at any time, for any reason and without prejudice.
4. I have been informed that the confidentiality of the information I provide will be safeguarded.
5. I am free to ask any questions at any time before and during the practical activity.
6. I am aware that I can obtain a copy of this form, and the relevant Confidential Medical History and/or Physical Activity Readiness Questionnaire (PAR-Q) Form.

Data Protection: I agree to the University College processing personal data which I have supplied. I agree to the processing of such data for any purposes connected with the teaching activity as outlined to me.

Name of participant (print)………………………….Signed………………..….Date………………

Name of witness (print)……………………………..Signed………………..….Date………………

If you wish to withdraw from the practical activity, please advise the practical activity coordinator, and complete the form below.

Title of Project:

I WISH TO WITHDRAW FROM THIS PRACTICAL ACTIVITY

Name: ………………………………………

Signed: ……………………………………………Date: …………………………………

SCHOOL OF Sport, health and applied science

CONFIDENTIAL Medical History / Physical Activity Readiness Questionnaire (PAR-Q) FORM

This screening form must be used in conjunction with an agreed Consent Form.

Full Name: ______ Date of Birth: ______

Height (cm): ______ Weight (kg): ______

Have you ever suffered from any of the following medical conditions? If yes please give details:

	Yes	No	Details
Heart Disease or attack	☐	☐	______
High or low blood pressure	☐	☐	______
Stroke	☐	☐	______
Cancer	☐	☐	______
Diabetes	☐	☐	______
Asthma	☐	☐	______
High cholesterol	☐	☐	______
Epilepsy	☐	☐	______
Allergies	☐	☐	______
Other, please give details	☐	☐	______

Do you suffer from any blood borne diseases? If yes please give details;

______

Please give details of any **medication** you are currently taking or have taken regularly within the last year:

______

Please give details of any **musculoskeletal injuries** you have had in the **past 6 months** which have affected your capacity to exercise or caused you to take time off work or seek medical advice:

Other Important Information

During a typical week approximately how many hours would you spend exercising?

If you **smoke** please indicate how many per day:

If you drink **alcohol** please indicate how many units per week:

Are you currently taking any **supplements or medication?** Please give details:

Is there any reason not prompted above that would prevent you from participating within the relevant activity?

By signing this document I agree to inform the relevant individual(s) of any change(s) to my circumstances that would prevent me from participating in specific activities.

Signature (Participant): **Date:**

Signature (Test Coordinator*): **Date:**

**Test coordinator: The individual responsible for administering the test(s)/session and subsequent data collection*