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Self-Myofascial Release Does Not Improve Back Squat Range of Motion, Alter Muscle Activation, or Aid in Perceived Recovery 24-Hours Following Lower Body Resistance Training

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ABSTRACT

International Journal of Exercise Science 12(3): 839-846, 2019. Self-myofascial release (SMR) is an alternative therapy believed to increase myofascial mobility by exciting muscles and increasing blood flow to the treated area. Previous literature suggest SMR produces conflicting results on performance, muscle activation, range of motion (ROM), and recovery. This study was designed to utilize SMR on a fatigued individual prior to exercise and measure its' effects on muscle activation, ROM, and perceived recovery compared to a dynamic warm-up session. The findings could help develop an efficient warm-up protocol for resistance-trained individuals. Electromyography (EMG) measured muscle activation of the rectus femoris (RF) and the gluteus maximus (GM), while a bluetooth goniometer assessed knee ROM during a submaximal back-squat. Eleven resistance trained participants (estimated squat 1RM 163% body weight) completed four total sessions of testing with sessions 1 and 3 solely used to induce muscle fatigue. In a counterbalanced design, participants during sessions 2 and 4 received either a dynamic standardized warm-up, or a SMR warm-up. Participants performed 10 repetitions of the back-squat at 70% estimated 1RM load. Peak and mean muscle activation of both muscles, knee ROM, and participants' perceived recovery was measured during the submaximal repetitions during sessions 2 and 4. Results indicated no significant differences between the dynamic warm-up and SMR warm-up among muscle activation, knee ROM, and participants perceived recovery ($p > 0.05$). In resistance trained squatters, coaches/trainers can prescribe SMR or a dynamic warm-up/stretching routine for results indicated no differences in perceived recovery, muscle activation, or squat depth.

KEY WORDS: Foam Rolling, electromyography, flexibility, muscle soreness

INTRODUCTION

The squat is a fundamental daily movement that is required for individuals to perform everyday activities such as getting out of a chair, picking up objects, and most all sporting activities (17). According to Duehring et al., it is a key form of exercise shown to increase performance in strength and conditioning (6). Self-myofascial release (SMR) is a type of massage therapy often used to treat muscle pain and stiffness by applying pressure on the thin fascia tissue surrounding the muscle. Previous literature suggests SMR relaxes the contracted muscles by inducing a Golgi tendon organ (GTO) reflex. In theory, SMR causes tension to a fatigued muscles. This in turn causes the GTO reflex to initiate a relaxation or inhibition to the tensed muscle via the peripheral nervous system (7,9,12). Literature also has stated SMR improves fatigued muscles by increasing blood flow which transports essential hormones throughout the body to aide in recovery to the damage site (7,9,12). In combination of both mechanisms, the relaxation of the muscles and increase in blood flow are two benefits most commonly associated with SMR, though results are conflicting.

Previous research has shown benefits to SMR using a foam or stick roller, and the topic has gained popularity over recent years with more research emerging (2). Montiero et al. (16) reported that self-massage on the anterior thigh resulted in a statistically greater range of motion (ROM) in both hip extension and flexion. Further research by Jay et al. (11) suggests that a form of SMR directly following exercise reduces the self-perceived intensity of muscle soreness following exercise known as delayed onset muscle soreness (DOMS). Previously, treatments the following days were an effective way to relieve DOMS (14) measured with a Perceived Recovery Scale (PRS) to quantitatively analyze and assess the rate of DOMS following exercise (13). However, these results are not always conclusive as Fleckenstein et al. (7) concluded, effects of SMR are based on individual variability. Electromyography (EMG) is a device used to measure motor unit activation and can aid in tracking changes in fatigue and recovery during activities such as a squat, deadlift, and other dynamic movements (5,10,12). Bradbury-Squires et al. (2) suggests evidence that foam rolling treatment can be used to increase neuromuscular efficiency, allowing an individual to perform the same tasks without using as much muscle activation measured via EMG.

To further understand the effects of SMR treatment, researchers must compare each measured movement from a baseline measurement. Couture et al. (3) failed to compare their results to any sort of baseline, which could have caused a lack of statistical significance. Although there is differing opinions on what the optimal volume is for SMR treatment, no significant data indicates a gold standard for best results. There is a trend however in studies, while not significant, that SMR produces greater results as the volume or time of treatment increases (2). It is impossible to truly utilize the treatment of self-myofascial release without knowing the outcomes and how to optimize results. Previous literature utilizing SMR treatments have also instructed the participants being examined to SMR roll themselves. This is a potential error as studies have found it is difficult to know the validity of the results without controlling for the time and pressure of the treatment, creating a potential flaw in previous protocols (15,19).

Therefore, the purpose of this study was to observe the effects of SMR treatment compared to a dynamic stretching warm-up on mean and peak muscle activation of the rectus femoris (RF) and gluteus maximus (GM), knee ROM, and perceived recovery during a back squat in a fatigued state. A secondary purpose was to examine how to efficiently and effectively complete a warm up prior to a resistance training protocol, and how to examine SMR affects an individual's pre/post treatment. It was hypothesized that the SMR treatment would result in improvements of knee ROM and perceived recovery via a PRS, with little to no change in peak or mean muscle activation of the RF and GM muscles.

METHODS

Participants

A power analysis performed by G*POWER 3.1.9.2 (Universitat Kiel, Germany) indicated 11 participants were needed with a power of 0.80, an effect size of 0.8, and an α= 0.05. Eleven highly trained healthy males (176.4±7.5 cm, 84.1±10.2 kgs, 29.4±4.3 yrs) participated in this study, and had lifting experience for 6 months minimum, 2x/week. Participants signed an informed consent and were verbally informed of all procedures prior to testing. A University Institutional Review Board approved this study.

Protocol

A counterbalanced within subjects design was used to measure all dependent variables. Participants completed 4 sessions approximately one hour in length. Session 1 included a familiarization trial with the exercises tested, and a lower body strength training session designed with hopes to induce DOMS. Session 2 consisted of testing and recording muscle activation via EMG, knee ROM, and perceived recovery during a parallel back squat. Session 3 was identical to session 1, a lower body strength training day. Lastly, session 4 was identical to session 2, but in a counterbalanced order receiving either the SMR treatment or traditional dynamic warm-up. Sessions 1 and 2 took place 24 hours apart, along with sessions 3 and 4; while sessions 2 and 3 were spaced by a week. A detailed description of each session are shown in Table 1.

During sessions 2 and 4, participants peak and mean muscle activation was measured via surface EMG (Trigno; Delsys, Natick, MA, USA) of the GM and RF during a submaximal back squat. Placement of the EMG electrode on the GM was exactly halfway on the line between the sacral vertebrae and the greater trochanter, while the sensor on the RF was halfway on the line between the anterior spina iliaca superior and the superior part of the patella. All of the locations and placements of the EMG electrodes followed the guidelines of the SENIAM project (9). Electrodes sat directly on the skin with no interference. Skin was shaved and cleaned to rid the skin of any hair or dead skin on their dominant leg, assessed by which leg they would kick a ball. An Electric goniometer (Delsys Trigno) was used to test ROM at the knee joint during sessions 2 and 4. SMR treatments used the Body Stick (The Stick, model number HD-2400, Atlanta, GA, USA). Lastly, a PRS scale ranging from 1 to 10 measured participants perceived recovery prior to exercise (13).

During sessions 2 and 4, following EMG electrode placement, Maximum Voluntary Isometric Contractions (MVICs) were performed on the RF and GM. The MVIC for the GM was performed by having the participant lay flat on the table with their dominant leg bent at a 90-degree angle. The participant pressed the foot vertically maximally against an immovable object for three seconds (4). The MVIC for the RF placed participants on the edge of a table, both legs hanging off the edge, then instructed to use their dominant leg in knee extension against an immovable object for three seconds (4). The SMR treatment consisted of 2 minutes of heavy pressure performed by the researchers on the RF and GM. SMR treatments were performed by the same primary investigator on all days to prevent error of not being consistent between participants.

The participants that were not receiving SMR that day went straight from the warm up to the testing. Lastly, following the warm-up, participants performed 10 repetitions of the back squat at 70% estimated 1RM load using a National Strength and Conditioning Association training load chart (8).

Table 1. Experimental Design. Flow chart illustrates participants tasks. EMG measured on the RF and GM.

Day 1	Day 2	Day 3	Day 4
Standard Warm Up	Standard Warm Up	Standard Warm Up	Standard Warm Up
5 Minute Bike	5 Minute Bike	5 Minutes Bike	5 Minute Bike
15 Back Squat Reps	15 Back Squat Reps	15 Back Squat Reps	15 Back Squat Reps
15 Hip Extension Reps	15 Hip Extension Reps	15 Hip Extension Reps	15 Hip Extension Reps
	½ receive 2 mins of SMR		½ receive 2 mins of SMR
	No SMR=straight to testing		No SMR=straight to testing
Block 1		**Block 1**	
3x3 Heavy Back Squat		3x3 Heavy Back Squat	
3x10 Back Squat @70%1RM		3x10 Back Squat @70%1RM	
Block 2	**Testing**	**Block 2**	**Testing**
4X10 Box Jump	MVIC of RF and GM	4x10 Box Jump	MVIC of RF and GM
4x10 SL Weighted Box	1x10 @70%1RM Back Squat	4x10 SL Weighted Box	1x10 @70%1RM Back Squat
	PRS, EMG and Knee ROM recorded		PRS, EMG and Knee ROM recorded
Block 3		**Block 3**	
4x10/ea Lunges (Weighted)		4x10/ea Lunges (Weighted)	
4x10/ea Hip Extensions		4x10/ea Hip Extension	

EMG Signal Processing: EMG signals were full-wave rectified and smoothed using a root-mean-square (RMS) method. A Band pass filter was applied at (low/high pass cut offs) 20-450Hz (20). The mean and peak RMS muscle activity signals during repetitions 4-7 were normalized to the peak muscle activity during the MVIC's of the (RF) and (GM) (20). The total lift included the eccentric and concentric contraction.

Statistical Analysis

A counterbalanced within participants study design was used. Pre/post measurements of mean and peak GM and RF muscle activation, PRS, and knee ROM were measured with six separate paired samples *t*-test. An alpha of 0.05, Beta of 0.2, and power of 0.8 were used for all statistical analysis performed using SPSS (version 25, SPSS Inc, Chicago, IL, USA). Two participants muscle activity were removed for the statistical analysis for the peak and mean RF due to the data being ≥2 standard deviations from the mean.

RESULTS

No significant differences were found in peak RF muscle activation, t (9) = -.951, p = 0.366, d = -0.301, or mean RF muscle activation, t (9) = -0.913, p = 0.385, d = -0.289. Further, no significant differences were found in peak GM muscle activation, t (10) = 0.200, p = 0.846, d = 0.060, or mean GM muscle activation, t (10) = 0.301, p = 0.770, d = 0.090.

Recovery did not statistically differ between groups via PRS, t (10) = -1.158, p = 0.274, d = -0.349 (No Treatment Mean = 5.22 ± 1.75, SMR Group Mean = 5.91± 1.81). Lastly, ROM of the knee did not statistically differ among participants, t (10) = 1.191, p = 0.852, d = 0.057 (No Treatment Group Mean = 110.73 ± 11.03, SMR Group Mean = 110.20 ± 12.36).

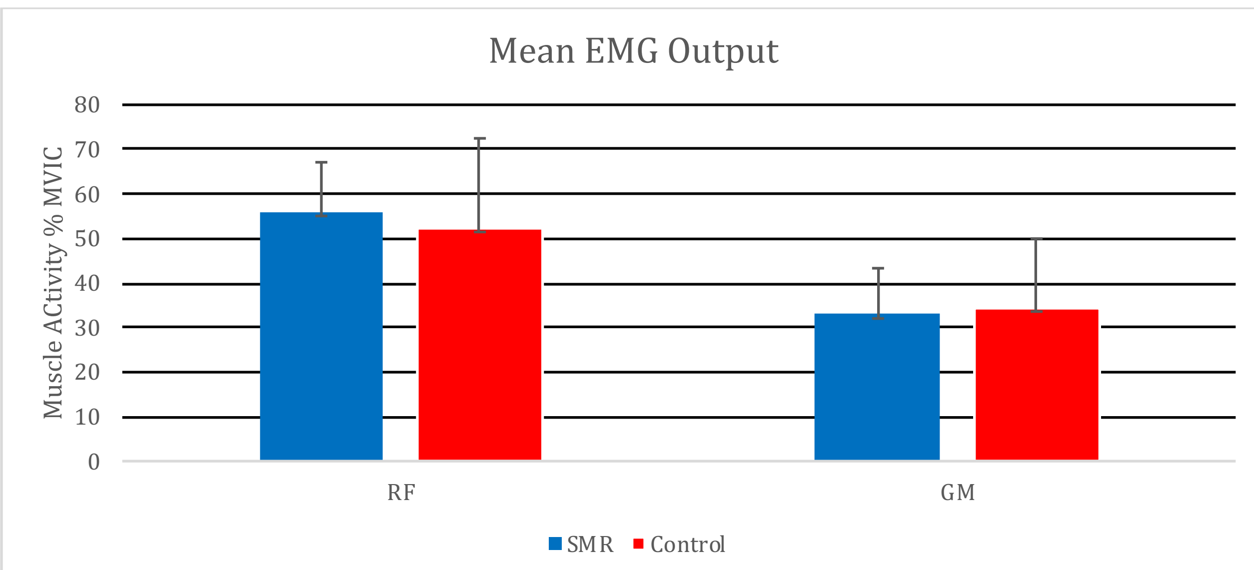

Figure 1. Mean muscle activation during a 10-rep back squat at 70% of the participants estimated 1RM. RF = Rectus Femoris GM = Gluteus Maximus

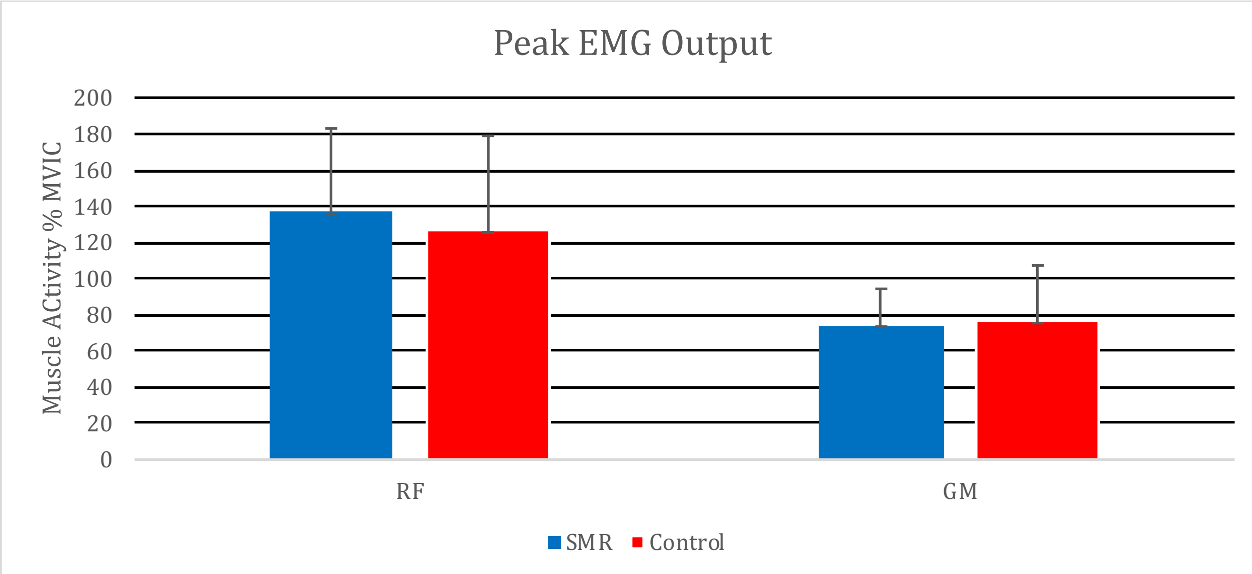

Figure 2. Peak muscle activation during a 10-rep back squat at 70% of the participants estimated 1RM. RF = Rectus Femoris GM = Gluteus Maximus

DISCUSSION

This study examined how SMR treatment prior to back squatting would affect knee ROM, peak and mean muscle activation of the RF and GM, and perceived recovery via a PRS during the back squat exercise. The outcomes indicated a failed hypothesis due to lack of significance of SMR improving knee ROM or perceived recovery. However, our hypothesis was correct regarding no expected difference in mean or peak muscle activation between SMR treatment and dynamic warm- up of the GM and RF muscles.

Previous studies have indicated mixed outcomes regarding SMR treatment on recovery. For example, Fleckenstein et al. indicated no significant effect of foam rolling on reducing muscle fatigue following exercise (7). It was concluded the effects of foam rolling depend on the individual, and there is no constant outcome when it comes to its effect on DOMS. The lack of consistency with the results from using SMR corresponds with the outcomes in the current study. While there were some participants that showed a trend in increased recovery via PRS, overall there was no significant data that allowed for the conclusion that SMR can be confidently relied on to reduce DOMS and increase recovery post exercise.

On the contrary, MacDonald et al. (14) found a significant difference in knee range of motion from implementing the use of a foam roller. A main difference between the current study, and MacDonald et al. that lead to contrasting results could be MacDonald et al. tested recreationally trained resistance trainers classified as moderately active. The current study however examined highly experienced lifters who were extremely well trained. Participants stated subjectively to be highly familiar with squatting and exercising under extreme fatigue. This could have led to the lack of difference in perceived recovery between the SMR and dynamic warm-up group in the current study. Having trained individuals may have caused the SMR treatment to not play as big of role in affecting ROM, muscle activation, and perceived recovery measurements. Other related studies that found significance between SMR and ROM, for the most part, used a weighted lunge to assess ROM rather than a back squat (14,18). The difference in the lunge vs. the back squat movement could impact knee ROM results, due to the participants familiarity with squatting to the same depth during each repetition. While both the lunge and squat are lower body compound movements, they differ in movement mechanics, making it difficult to compare results (8).

If muscle activity is measured across multiple days of testing, EMG data must be normalized to a set reference point. It is possible the MVIC's performed across two days of testing were not ideal due to the lack of consistency throughout the testing, and the unfamiliarity of the movement. Comparing data to a different normalization method, such as a dynamic task like a 1RM or submaximal repetition, might reduce EMG error and standard deviation across multiple days of testing (1). Future studies should examine more long-term chronic effects of SMR treatment. Furthermore, future research, a similar design and protocol using less trained individuals could lead to more positive outcomes of SMR. Having highly trained individuals who are used to performing a back squat in a fatigued state might make it harder to indicate a difference in variables due to the muscle memory developed over their time training fatigued. Lastly, future studies should compare different volumes of SMR. If an ideal time or pressure of SMR can be identified, it would become easier to use and prescribe to increase performance variables.

In conclusion, the findings of this study indicate SMR did not improve knee ROM during a back squat, and perceived recovery following a heavy resistance training session. Furthermore, mean and peak muscle activity of the GM and RF did not differ between the SMR and dynamic warm-up protocol.

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