Acute effect of self-myofascial release using a foam roller on the plantar fascia on hamstring and lumbar spine superficial back line flexibility

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Objective: The purpose of this study was to investigate the immediate effect of applying self-myofascial release (SMR) to the plantar fascia using a foam roller on hamstring and lumbar spine superficial back line (SBL).

Design: Randomized controlled trial.

Methods: Thirty-one healthy adults agreed to the method and purpose of the study. Selection and exclusion criteria were screened, and baseline measurements for the Toe Touch test and passive straight leg raise (PSLR) test were obtained. The participants were then randomly assigned to the SMR group or the sham group. After group assignment, the SMR group rolled the surface of the foot from the heel to the metatarsal head using a foam roller for 5 minutes. The sham group received passive mobilization of the ankle joint in the supine position. Afterwards, the Toe Touch test and the passive straight leg-raise test were re-assessed.

Results: In the SMR group, the Toe Touch test results showed significant improvement ($p < 0.05$). Left and right PSLR test results showed a significant increase ($p < 0.05$). In the sham group, there was no significant difference between pre and post-test results. The SMR group showed a significant difference in the PSLR test and Toe Touch test compared to the sham group ($p < 0.05$).

Conclusions: The results of this study showed that SMR on the plantar fascia was immediately effective for improving the flexibility of the SBL of the lumbar spine and hamstring.

Key Words: Plantar fascia, Range of motion, Self-myofascial release, Superficial back line

Introduction

Flexibility can be defined as the ability for muscle stretch to enable movement of a joint as far as the range of motion, which is an essential component of normal biomechanical function [1]. A change in flexibility is necessary for all movements because it can cause abnormal loads and result in damage to the musculoskeletal system [2,3]. One of the factors that cause damage to the lines of the musculoskeletal system is insufficient flexibility [4,5].

The thin sheets of fascia and connective tissue fibers that form a line can form a pathway, which is called the myofascial meridians. Among them, the superficial back line (SBL) is a plantar aponeurosis, achilles tendon and gastrocnemius, popliteus, hamstring, sacrotuberous ligament, sacrolumbar fascia, erector spinae, and galea aponeurotica/epicranial fascia. The SBL functions as a single continuous line with integrated muscle fascia. For example, plantar fasciitis is associated with tachypnea tension, lumbar lordosis, and resistance to superficial cervical spondylosis [6,7]. Because

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the hamstring and calf muscles are a connected continuity, the reduced flexibility and stiffness of the hamstring may be the cause of plantar fasciitis [8].

There are several methods for increasing the flexibility of the fascia including the Rolfing, instrument-assisted fascial release, connective tissue massage, myofascial trigger point therapy, muscle energy techniques, and strain-counter strain [9]. One of the most common manipulative techniques, the myofascial release (MFR), helps to reduce fibrous adhesion or limited membrane between fascial tissue layers [10]. The self-myofascial release (SMR) has the same theory as the MFR, which can be applied by self under the supervision of a therapist [11]. It has been developed from the myofascial release as a principle that stimulates the muscles, tendons, and mechanoreceptors of the fascia and biomechanically loads the soft tissues [12]. The Golgi tendon organ (GTO) reflex arc model and other mechanoreceptors are the two mechanisms for increasing fascia mobilization using SMR. When the muscles are stretched, GTOs provide afferent feedback to the spinal cord. As pressure increases in the fascia by MFR or SMR, it stimulates GTOs, which reduces the motor unit firing rate and consequently reduces muscle tone

[13]. The Ruffini and Pacinian corpuscles and the interstitial muscle receptors are the mechanoreceptors that are also involved in the neurophysiological mechanism for increasing fascia mobilization using SMR [14]. As pressure increases, the mechanical receptors stimulate the nervous system, thereby reducing muscle tone [15].

In previous studies, many studies have been conducted to improve flexibility using SMR [10,11,16-20]. Studies have focused mainly on the muscles that are to be increased. According to Anatomy Trains [7], there is a way to observe the association of the SBL. Myers [7] advocates that the effect of SBL can be seen through a simple test of rolling a tennis ball or golf ball on the plantar fascia. Relaxing the plantar fascia has additional effects on the hamstring and lumbar spine, which have the same myofascial train. This means that when one part of the body is relaxed, it affects the other connected fascia. However, this proposal has had some clinical effects, and no evidence has been provided through formal studies.

Therefore, the purpose of this study was to investigate the immediate effect of applying SMR to the plantar fascia using foam roller on hamstring and lumbar spine.

Methods

Subjects

Thirty-one healthy adults agreed to the method and purpose of the study. The selection criterion was defined as having no problems in the back and lower back, pain, sensory

Table 1. General characteristics (N=31)

Characteristic	SMR group (n=15)	Sham group (n=16)
Sex (male/female)	10/5	9/7
Height (cm)	170 (7.68)	168.4 (7.44)
Weight (kg)	65.73 (10.55)	60.18 (11.88)
Age (y)	30.53 (3.6)	23.93 (4.9)

Values are presented as number only or mean (SD).
SMR: self-myofascial release.

Figure 1. Micro foam roller (Ristroller, USA). The micro foam roller is device designed for release the forearm and plantar fascia with rolling motion. Small design of Foam rollers, commonly known as fascia relaxation.

Figure 2. Position of the foam roller on the plantar fascia during self-myofascial release.

abnormality, and other lower extremity and lumbar problems within the past 6 months. In addition, the Toe Touch test excluded those who could reach the floor. The characteristics of the study subjects are shown in Table 1.

This study was approved by the Institutional Review Board of the Sahmyook University (IRB No. 2-1040781-AB-N-01-2018009HR).

Procedure

The selection and exclusion criteria were screened, and Toe Touch test and passive straight leg raise (PSLR) test baseline were measured. The participants were then randomly assigned to the experimental group (SMR) or control group (Sham) and randomly used the online tool “Graph Pad” (GraphPad Software, San Diego, CA, USA; <http://www.graphpad.com/quickcalcs/randomize1.cfm/>). After group assignment, the SMR group rolled the surface of the foot from the heel to the metatarsal head for 5 minutes using a foam roller (Figures 1, 2) [21]. Participants were instructed to apply as much pressure as possible without pain [22]. Then, the Toe Touch test and the PSLR were re-measured. The sham group received passive mobilization of the ankle joint while being in a supine position. Passive movements applied in a randomized order were supination, pronation, abduction, adduction, flexion, and extension. Subjects were given 5 minutes of mobilization [23].

Outcome measures

Toe Touch test

Subjects were asked to stand up straight on a 20-cm high

platform with feet together and no shoes. Then, the subjects were instructed to bend down towards the platform as much as possible while keeping the knees, arms, and fingers in full extension. (Figure 3). The distance from the tip of the middle finger and the platform was measured in centimeters with a supple measuring tape. If the tip of the middle finger could not reach the platform, the test was considered positive. If the subject could reach past the platform, the test was considered negative. Both evaluators were experienced in measuring the finger-to-floor distance. The intra-class correlation coefficient (ICC) of the Toe Touch test was 0.99. The Spearman’s correlation coefficient for trunk flexion assessed by the test and the radiologic measure was -0.96 [24].

Passive straight leg raise

PSLR was conducted with the subject in supine position on a medical bed. The examiner performed the PSLR by keeping the knee in full extension and the ankle in neutral position. Full ankle dorsiflexion was avoided to prevent calf muscle stiffness or pain (gastrocnemius and soleus) from confounding the sensation of hamstring stiffness and pain, which would signal the limit of the PSLR test. The examiner stabilized the talus in order to prevent any hip rotation during hip flexion. The examiner lifted the subject's lower limb until the subject began to complain of pain or stiffness in the thigh region, perform knee flexion, or swing into a posterior pelvic tilt position (noted as movement of the anterior superior iliac spine). Range of motion measurements for the PSLR were taken using Clinometer (Plaincode, Stephan-

Figure 3. Toe Touch test.

Figure 4. Passive straight leg raise.

skirchen, Germany; <http://www.plaincode.com/products/clinometer/>), which is a smart phone application that has previously been shown to be reliable at measuring range of motion of the shoulder. The intra-observer reliability of the smartphone inclinometric and goniometric measurements was ICC value >0.9 [25]. The upper part of the patella was marked and the end of the smart phone was aligned (Figure 4).

Statistical analysis

Results were analyzed using the SPSS ver. 15.0 (SPSS Inc., Chicago, IL, USA). For the general subject characteristics, the descriptive statistics was conducted. To examine the changes in PSLR and Toe Touch results before and after intervention, the paired t-test was performed. To compare the PSLR and Toe Touch test results between the SMR and the Sham group, the independent t-test was performed. The statistical significance was assumed to be $\alpha = 0.05$.

Results

This study selected 31 healthy adults who passed the selection criteria. The general characteristics are shown (Table 1).

Before the experiment, there were no significant differences in PSLR and Toe Touch test results between the SMR group and the Sham group (Table 2). In the SMR group, the

Toe Touch test results showed a significant improved, from 17.88 to 13.22 ($p < 0.05$). Left PSLR significantly increased from 45.6 to 54.13 ($p < 0.05$). Right PSLR significantly increased from 45.27 to 53.73 ($p < 0.05$). In the Sham group, there were no significant differences between pre and post test. The SMR group showed a significant difference in PSLR and Toe Touch test results compared to the Sham group ($p < 0.05$; Table 2).

Discussion

There is a hypothesis that an increase in muscle tension in one part of the body causes excessive tension in other parts of the body due to the continuity of the body. This continuity of the fascia can cause stress on not only the muscles but all the structures that are surrounded and supported by the fascia [7]. Based on this hypothesis and anatomy, Myers [7] supported the increase in the Toe Touch test when the plantar fascia at the end of the SBL was released. However, some clinical effects were claimed and there were no formal studies. Therefore, the purpose of this study was to investigate the effect of performing SMR to the plantar fascia on hamstring and lumbar spine flexibility.

The PSLR and Toe Touch results of the SMR group were significantly increased after intervention ($p < 0.05$) and also showed a significant difference compared to the Sham group. There was no significant difference in the Sham group pre and post intervention. These results suggest that the SMR of the plantar fascia was immediately effective for the lumbar and hamstring flexibility. There have been many studies on the effect of SMR on the range of motion and flexibility [10,11,20,26]. However, previous research on increasing flexibility has been limited to selected parts of the body. There has been no research showing the effects of applying SMR to one part of the body may affect other parts of the body. According to the Anatomy Trains [7], SMR applied to the plantar fascia is effective in increasing flexibility anywhere along the SBL, but no evidence has been suggested through formal studies. However, this study found that the application of SMR using a foam roller to the plantar fascia could support the concept of increased flexibility of other body parts connected by myofascial meridians such as hamstring and lumbar spine.

Although we did not use SMR, there are some studies that have experimented with the concept of myofascial meridians. An RCT investigated the effects of hamstring passive stretching on the range of motion of the neck in healthy

Table 2. Comparison of PSLR and Toe Touch test between two groups (N=31)

Variable	SMR group (n=15)	Sham group (n=16)	t (p)
Left PSLR			
Pre-test	45.6 (7.10)	51.43 (10.25)	-1.83 (0.07)
Post-test	54.13 (8.12)	52.06 (10.20)	0.62 (0.53)
t (p)	-6.95 (<0.001)	-0.59 (0.56)	
Change value	8.53 (4.74)	0.62 (4.20)	4.91 (<0.001)
Right PSLR			
Pre-test	45.27 (5.99)	49.93 (7.46)	-1.91 (0.06)
Post-test	53.73 (8.87)	48.43 (8.64)	1.68 (0.10)
t (p)	-5.66 (<0.001)	1.66 (0.11)	
Change value	8.46 (5.79)	-1.50 (3.61)	5.78 (<0.001)
Toe Touch test			
Pre-test	17.88 (6.98)	17.76 (9.59)	0.39 (0.96)
Post-test	13.22 (6.91)	16.28 (8.37)	-1.10 (0.27)
t (p)	6.76 (<0.001)	2.11 (0.05)	
Change value	-4.66 (2.66)	-1.47 (2.78)	-3.24 (<0.001)

Values are presented as mean (SD).

PSLR: passive straight leg raise, SMR: self-myofascial release.

adults. The range of motion of the cervical, which is the ascending part of SBL, increased after hamstring stretching [27]. According to Spina [28], a patient with chronic hamstring pain was relieved of pain and dysfunction by applying an active release technique to the SBL, the lumbar spine, and calf. Akhbari *et al.* [29] reported that a patient with chronic plantar fasciitis was treated with dry needling on the Achilles tendon, medial gastrocnemius, biceps femoris, semimembranosus, and ischial tuberosity. After 4 treatments over 2 weeks, the patient showed a 60% to 70% reduction in pain.

Many anatomical books have described the function of muscles as separate from adjacent structures, excluding the upper and lower connective muscles, nerves and blood vessels. For example, it is simply defined that the distance between the origin and the insertion point of a particular muscle is close to the function of the muscle. Separate thinking of the muscles makes it difficult for current-generation therapists to have different views on the function of muscles and muscles [7]. This is similar to the view that clinicians limit the treatment to the area of pain or discomfort. In the future, it will be possible to get more effective treatments if you use a mixture of extended concepts such as myofascial meridian.

The limitation of this study is the lack of the number of experimental groups. Secondly, there is a lack of clinically relevant thinking about the application to healthy adults. In the future, it is hoped that further studies will be conducted to investigate the effects of the disease on pain and function.

The results of this study showed that SMR on the plantar fascia was immediately effective for improving the flexibility of the SBL of the lumbar spine and hamstring. These results suggest that in order to increase flexibility, interventions should be made not only to the body part but also to other parts of the body, taking into account the continuity of the myofascial meridian.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the authorship and/or publication of this article.

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