Immediate effect of self-myofascial release on hamstring flexibility

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Objective: This study aimed to identify the area with greatest effect using self-myofascial release technique (self-MFR) in the hamstring, suboccipital, and plantar regions.

Design: Cross-sectional study.

Methods: Twenty-two adult subjects were evaluated for flexibility and hamstring pain threshold after self-MFR. Based on the superficial back line, the self-MFR application areas were the suboccipital region, hamstring, and plantar regions. Self-MFR was applied to each area using a wooden pole for a total of 4 minutes. Self-MFR was applied for 3 days at the same time of day, which was randomly assigned for each subject. Treatment was applied to one area each day. The sit and reach test (SRT), active range of motion (AROM), and passive ROM (PROM) were used to determine changes in flexibility, and an algometer was used to determine pain threshold. Pre/post-self-MFR effectiveness was tested using a paired t-test. Repeated measurement was used to compare self-MFR effects in the suboccipital, hamstring, and plantar regions.

Results: When the self-MFR technique was applied to the 3 areas, the SRT showed significant improvement over baseline ($p < 0.05$). Bilateral AROM and PROM showed significant improvements ($p < 0.05$). When the self-MFR technique was applied to the hamstring, the semimembranosus showed a significant change in pain threshold ($p < 0.05$).

Conclusions: Our findings suggest that indirect application based on the Anatomy Trains could be effective for those who need to improve muscle flexibility. Moreover, self-MFR easily alleviates myofascial pain while maintaining flexibility, and can be performed at any time and place.

Key Words: Fascia, Hamstring muscle, Pliability

Introduction

Myofascial release (MFR) is one of the commonly utilized manual techniques to facilitate the stretching of corresponding tissue continuously or enhance the extensibility of soft tissue through compression while restoring restricted fascia or normal muscular length [1]. MFR is generally to apply slow and continued pressure to restricted fascial layers for 120 to 300 seconds [2]. Self-MFR is a type of MFR im-

plemented by each individual using a tool instead of therapist [3]. Self-MFR is an affordable and easily available method to help patients ease their muscular and fascia pain and maintain flexibility [4]. One of the most common instruments for self-MFR is foam roller [5-8] and roller massage [9-13]. Self-MFR increases flexibility, reduces delayed onset muscle soreness [14], adjusts arterial function and hemangioendothelial function [15], and adjusts autonomic nervous system [16] on the continuous basis.

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Hamstring muscle is a two joint muscle spanning both hip joint and knee joints, functioning as a major muscle for hip extension, knee flexion, and pelvic posterior tilt movement [17]. In ambulation, hamstring reduces velocity of knee extension to prevent hip and knee joint damage while providing dynamic stability. Interaction with hamstring provides correct knee movement and stability. Also in the dynamic movement of sagittal plane abduction and adduction, hamstring muscle provides stability [18] to affect postural balance [19]. The muscular strength ratio to quadriceps and hamstring plays an important role in hip and knee joint stability as well. In addition, hamstring flexibility is important to maintain full range of motion (ROM) of joint and musculoskeletal function while preventing damages [20]. Once flexibility decreases, risks of muscular and postural imbalance grows higher along with the risk of muscular sprain [21,22]. Of the hamstring, bicepsfemoris muscle is firmly connected to sacrotuberous ligament and stretched into femoris longus fascia. So, if there is any muscle tightness, movement performance ability would decrease and even low back pain could be caused [23].

In Myers "anatomy train" [24], fascia connected from plantar fascia to epicranial fascia is called as superficial back line (SBL). Based on the SBL, to enhance hamstring flexibility; studies have examined its effect by applying to suboccipital region [25], hamstrings [9,26], and plantar region of the feet [12]. As a result, it was found that muscle tone could decrease indirectly even without directly adjusting hamstrings.

When suboccipital muscle inhibition and self-MFR are applied to suboccipital region, hamstring flexibility instantly increased in self-MFR group [25]. Kim *et al.* [26], in their study, directly applied to hamstring and found significant change in flexibility as well as muscle strength related to the interaction between quadriceps and hamstring and knee joint ROM. Grieve *et al.* [12], in their study, applied to plantar region of the feet for hamstring and lumbar spine flexibility and proved its effectiveness.

Based on SBL, preceding study applied self-MFR to each body area and found effectiveness in all of them. But no study has applied the method to three areas to compare the effectiveness of each of them. Also, to choose the area with largest effectiveness under self-MFR on hamstring; these three areas will need to be directly compared for their effect of application. The main purpose of this study is to investigate instant effect on hamstring flexibility increase by applying self-MFR to three areas (suboccipital region, ham-

string, and plantar region).

Methods

Subjects

For this study, 60 participants were recruited through a 2-week verbal promotion among adult women and men enrolled at Sahmyook University in Nowon-gu, Seoul, Korea. Of these, 30 consented to the study after learning the purpose, significance, and methodology. Among the 30 participants, those scoring less than 4 points of 9 points on the Beighton score were selected [27] for this study. The Beighton score evaluates hypermobility of selected joints. It is a widely used tool with high validity [12]. Of the 30 subjects, 5 scored greater than 4 points, and were excluded from this study. Those with low joint mobility, metabolic disease, incomplete post-fracture bone fusion, acute joint pain with exercise or muscle extension, and inflammation around tissues were excluded. All protocols and procedures were approved by the Institutional Review Board of Sahmyook University, and all subjects signed a statement of informed consent before the study began.

Procedure

This study had a cross-sectional design. To determine the effectiveness of self-MFR, data on 25 subjects meeting the selection criteria were collected. All subjects wore stretchable and loose-fitting pants that did not affect ROM. Preliminary testing included the sit and reach test (SRT), hip joint passive and active ROM in supine position, and assessment of hamstring pain-pressure thresholds (PPTs). To decrease the carry-over effect of each area (suboccipital, hamstring, and plantar regions), self-MFR was applied for 3 days at the same time of day at 24-hour intervals. The application area was randomly chosen for each subject, and self-MFR was applied to one of the areas each day. During the intervention, 3 subjects complained of musculoskeletal pain and were excluded from the experiment. The remaining 22 subjects completed this study, and were assessed for SRT performance, hip joint active ROM (AROM) and passive ROM (PROM), and hamstring flexibility in the same manner as in the posttest.

Self-MFR was applied as follows (Figure 1). (1) For the suboccipital region, subjects were comfortably supine. A wooden pole (diameter 8 cm, length 40 cm) was placed under the area, and the head was slowly and gently turned to the left and right for 4 minutes. (2) For the hamstrings, the

Figure 1. Three types of self-myofascial release. (A) Suboccipital region. (B) Hamstring region. (C) Plantar region.

subjects assumed a long sitting position on a firm and even surface by placing the arms backward and loading body weight on the palms. A wooden pole was placed under the hamstrings and slowly moved back and forth from the ischial tuberosity to the popliteus, by applying pressure for 4 minutes. (3) For the plantar region, the subjects stood in front of a 1-m-high support. A wooden pole was placed under the sole, and centered on the metatarsals and inner side of the heel, with support from the other limb. The pole was rolled back and forth slowly for 2 minutes on each side by applying pressure, with a total application time of 4 minutes [12].

Outcome measure

Hamstring flexibility was assessed using the SRT. In the SRT, subjects take a long sitting position with bare feet on a firm and even surface; the ankles are placed together at 90° of dorsiflexion in a standard sit and reach box (30.5 cm); the hands are placed alongside the legs; the subject slowly bends forward along a ruler to the maximum extent possible without low back pain. The maximum bent-forward position is maintained for 2 seconds [27]. At the same time, based on a medial-lateral axis passing through the femoral head, the pelvis should rotate forward on the femur, and the neck and lower back should also bend forward [28]. When the subjects maintained this position, the distance of ruler movement at the edge of the box surface was measured. The test was implemented 3 times and the results were averaged and recorded. The ruler is 35-cm long and is placed parallel to the toe tips. The equipment can measure from 0 cm (very low flexibility) to 50 cm (very high flexibility) [29,30]. The

SRT method had an intraclass correlation coefficient of 0.96 [9].

Change in AROM was measured using the straight-leg raising (SLR) test. Subjects were supine and flat on a firm and even surface, straightened their knees, and bent one hip joint through the end of its range. A goniometer was used to record the hip joint angle. The same process was followed on the other leg [31]. Unlike SRT, this method measures hamstring flexibility with the neck and lower back fixed. In the same position, the hip joint passive ROM was also measured. The test-retest reliability was as high as $r=0.71$ [32].

Hamstring PPTs were assessed with an electronic algometer (Jtech Medical, Midvale, UT, USA) applied to the trigger points of the semitendinosus (ST), semimembranosus (SM), and biceps femoris (BF). The ST, SM, and BF trigger points were treated with palpation by referring to a prior study [33]. Measurement was performed by a skilled evaluator with experience using an algometer. The evaluator identified a trigger point, applied pressure perpendicularly, and increased pressure at a rate of 1 kg/s. Subjects were instructed to say “now” when they felt pain or discomfort. The process was repeated 3 times and average values were recorded [34]. The inter-rater reliability for the pain threshold, digital pressure gauge was 0.75 or greater [35].

Statistical analysis

IBM SPSS statistics ver. 19.0 (IBM Co., Armonk, NY, USA) was employed for data analysis. Descriptive statistics were used to analyze subject general characteristics. Pre/post self-MFR effectiveness was tested using a paired

t-test. Repeated measurement was used to compare self-MFR effects in the suboccipital, hamstring, and plantar regions. Statistical significance was set at 0.05.

Results

This study had 22 subjects (male, 14; female, 8) who met the selection criteria. The male subjects had an average age of 22.93 years, height of 174.64 cm, and body weight of 70.57 kg. The female subjects had an average age of 21.13 years, height of 162.63 cm, and body weight of 53.00 kg (Table 1).

When self-MFR technique was applied to the suboccipital, hamstring, and plantar regions, the SRT showed significant improvement ($p<0.05$). Hip joint AROM and PROM also showed significant increases ($p<0.05$). The pain pressure threshold only changed significantly in the semi-membranosus, when self-MFR was applied to the hamstring ($F=3.511$, $p<0.05$).

Discussion

In this study, self-MFR was applied to 3 areas (suboccipital, hamstring, and plantar regions), and all induced significant improvement in hamstring flexibility ($p<0.05$) (Tables 2, 3). This finding is consistent with that of a preceding study, in which self-MFR application to each area affected hamstring flexibility [9,11,12,25,26]. Cho *et al.* [25] reported that self-MFR applied to the suboccipital region significantly increased hamstring flexibility by about 9%, as measured by the SLR test ($p<0.05$). In this study, AROM and PROM measured by the SLR test were significantly improved after self-MFR was applied at the occipital region. Hip joint AROM increased by 3.75% on the right and 8.71% on the left, and PROM increased by 5.86% on the right and 9.69% on the left. A study in which MFR was applied by roller massage directly to the hamstring re-

Table 1. General characteristics of participants (N=22)

Demographic	Self-MFR	
	Male (n=14)	Female (n=8)
Age (yr)	22.93 (1.94)	21.13 (0.64)
Body weight (kg)	70.57 (8.97)	53.00 (6.05)
Height (cm)	174.64 (5.27)	162.63 (5.13)

Values are presented as mean (SD).
MFR: myofascial release.

Table 2. Change of SRT by self-myofascial release technique (N=22)

Variable	Suboccipital region			Hamstring region			Plantar region			F (p)
	Pre-test	Post-test	Difference	Pre-test	Post-test	Difference	Pre-test	Post-test	Difference	
SRT (cm)	22.89 (9.44)	26.95 (10.55)*	4.06 (3.66)	22.61 (10.05)	26.47 (9.27)*	3.86 (2.76)	22.08 (10.11)	25.94 (9.85)*	3.86 (2.55)	0.033 (0.968)

Values are presented as mean (SD).

SRT: sit and reach test.

* $p<0.05$ was presented to significant difference between pre-test and post-test.

Table 3. Change of ROM of hip joint by self-myofascial release technique (N=22)

Variable	Suboccipital region			Hamstring region			Plantar region			F (p)
	Pre-test	Post-test	Difference	Pre-test	Post-test	Difference	Pre-test	Post-test	Difference	
AROM (degree)										
Right side	72.55 (11.35)	75.27 (12.04)*	2.73 (5.86)	70.23 (11.53)	77.45 (10.99)*	7.23 (6.75)	71.50 (9.71)	76.91 (9.80)*	5.41 (7.25)	2.788 (0.87)
Left side	71.50 (11.11)	77.73 (11.09)*	6.23 (8.41)	71.68 (10.73)	78.55 (11.46)*	6.86 (7.27)	73.59 (11.27)	80.55 (11.38)*	6.95 (10.08)	0.048 (0.954)
PROM (degree)										
Right side	82.32 (12.10)	87.14 (11.88)*	4.82 (6.02)	79.68 (11.06)	88.45 (12.88)*	8.77 (6.66)	82.23 (9.85)	88.32 (10.53)*	6.09 (6.79)	1.851 (0.170)
Left side	80.64 (10.98)	88.45 (12.75)*	7.82 (7.97)	81.55 (11.19)	89.14 (12.86)*	7.59 (7.31)	83.41 (9.20)	89.86 (12.20)*	6.45 (8.14)	0.213 (0.809)

Values are presented as mean (SD).

AROM: active range of motion, PROM: passive range of motion.

* $p < 0.05$ was presented to significant difference between pre-test and post-test.

Table 4. Change of pain threshold of hamstring by self-myofascial release technique (N=22)

Variable	Suboccipital region			Hamstring region			Plantar region			F (p)
	Pre-test	Post-test	Difference	Pre-test	Post-test	Difference	Pre-test	Post-test	Difference	
Right side (kg/cm ²)										
ST	83.26 (23.42)	85.27 (21.71)	2.01 (13.47)	81.36 (19.36)	85.43 (19.20)	4.07 (12.49)	77.62 (25.36)	79.96 (21.37)	2.34 (13.99)	0.153 (0.858)
SM	70.52 (22.87)	68.80 (22.29)	1.73 (15.67)	63.33 (18.40)	73.36 (22.15)*	10.03 (15.68)	66.41 (21.33)	67.52 (24.89)	1.11 (17.07)	3.511 (0.039)
BF	74.07 (25.24)	74.88 (24.12)	0.81 (9.99)	74.20 (23.46)	78.48 (19.19)	4.28 (16.64)	69.79 (19.87)	70.90 (22.48)	1.11 (9.95)	0.493 (0.614)
Left side (kg/cm ²)										
ST	80.16 (24.36)	80.36 (20.29)	0.24 (15.63)	83.46 (23.50)	85.58 (20.23)	2.12 (19.69)	82.18 (24.71)	81.40 (22.36)	0.78 (15.08)	0.189 (0.828)
SM	65.03 (23.11)	67.47 (24.11)	2.44 (14.41)	62.36 (21.39)	65.87 (22.13)	3.51 (13.90)	69.10 (22.25)	69.88 (21.47)	0.78 (15.92)	0.267 (0.712)
BF	72.31 (21.93)	71.22 (23.36)	7.82 (7.97)	1.09 (19.02)	72.56 (23.50)	7.59 (7.31)	0.51 (13.94)	66.15 (23.46)*	4.58 (12.51)	0.454 (0.638)

Values are presented as mean (SD).

ST: semitendinosus, SM: semimembranosus, BF: biceps femoris.

* $p < 0.05$ was presented to significant difference between pre-test and post-test.

gion improved hip joint ROM ($p<0.05$) by 4.3% [9]; as in a previous study, right hip joint AROM (10.28%) and PROM (11.01%), and left hip joint AROM (9.58%) and PROM (9.31%) were also increased in our study ($p<0.05$). Grieve *et al.* [12] reported that the sit and reach test (SRT) measurement was significantly increased when self-MFR was applied to the plantar region ($p=0.03$). We also observed an increase in SRT by 9.52% when self-MFR was applied to the plantar region, for the same duration as in a previous study ($p<0.05$).

We used the SRT to measure hamstring flexibility. In previous studies, SRT was reportedly correlated with lumbar spine flexibility; based on studies [27,29] suggesting that pelvic angle measurement was able to assess hamstring flexibility, we measured AROM and PROM of the hip joint using the SLR test position. When self-MFR was applied to the suboccipital, hamstring, and plantar regions, SRT and hip joint AROM and PROM showed significant improvements. This suggests that self-MFR can increase hamstring flexibility when applied to 3 sites.

Application of self-MFR to each area showed significant changes in hamstring flexibility, based on SRT and ROM measurement. This may be associated with the SBL effect of the Anatomy Trains suggested by Myers [24]. Several studies applied interventions to the SBL. Webb and Rajendran [36] reported in systemic review by each indicate that MFR reduces hamstring pain and increases joint ROM. Hyong and Kang also found that passive hamstring stretching was effective in improving cervical ROM and balance ability [37].

The PPT only decreased in the hamstring area (Table 4). A significant change in the hamstring pain threshold was only found in the right SM when self-MFR was applied directly to the hamstring. This may be because most subjects were right-side dominant, and could not apply as much force on the left side during self-MFR; moreover, since they performed self-MFR, they could not properly release the entire hamstring when rolling the wooden pole.

This study found that the same degree of effectiveness could be achieved by applying self-MFR to the back of the head and soles as an alternative, when self-MFR could not be used directly due to hamstring inflammation, skin damage, scarring, etc. This implies that indirect application based on the Anatomy Trains by Myers could be effective for those who need to improve muscle flexibility. Moreover, self-MFR easily alleviates myofascial pain while maintaining flexibility, and can be performed at any time and place.

Thus, it is easily available and applicable [4].

Hamstring tightness causes pelvic posterior tilting and postural imbalance. Consistent use of self-MFR can help maintain hamstring flexibility. Self-MFR can be used by busy individuals and only requires a simple tool. Hamstring tightness or shortening occurs in those with a sedentary lifestyle or inadequate exercise. Self-MFR could prevent and treat hamstring disorders.

A limitation of this study was that the total time for self-MFR was equal for each region. Although the application time was different within each region, the result was meaningful, because a previous study showed sufficient efficacy. Moreover, during self-MFR on the hamstring, the subjects may not have properly adjusted the amount of pressure. In some cases, subjects excessively tensed the supporting upper limb. Thus, they might have had greater difficulty maintaining position than when the occipital or plantar regions were treated with the subjects supine or standing, respectively.

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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