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Immediate Effects of Release Ball Massage and Self-stretching Exercise on Hamstring's Temperature, Range of Motion and Strength in 20's Women

Background: There have been many studies on self-myofascial release (SMR) stretching, but there are few comparative studies on the effects of massages using a release ball, which is a type of the SMR method.
Objective: To investigate the immediate effects of release ball massage and self- stretching on proprioceptive sensory, hamstring's temperature, range of motion (ROM) muscle strength,.
Design: Crossover study.
Methods: Thirty women in 20's at S University in Busan voluntarily participated in the study. Participants were random to release ball group (n=15) or self-stretching group (n=15). Both groups performed 3 sets of exercises, stretching for 30 seconds and resting for 15 seconds in each position. The proprioceptive sensory, temperature of the hamstring muscle, ROM, and strength were measured before exercise, 5 minutes after exercise, and 30 minutes after exercise.
Results: Release ball group showed significant differences in muscle length and temperature over time ($p<.05$). The comparison between two group over time showed significant differences in muscle length, temperature, and muscle strength ($p<.05$).
Conclusions: These results demonstrate that release ball massage and self-stretching are beneficial for improving hamstring's temperature, ROM and muscle strength.

Key words: *Hamstring, Muscle length, Muscle strength, Release ball, Self-stretching, Sensory*

Younghun Jeong, PT [a], Jihwan Park, PT [a], Jin Yu, PT [a], Sunyeong Lee, PT [a], Jihee Ha, PT [a], Yeonki Choo, Ph.D, PT [b], Taeyoung Oh, Ph.D, Prof.[a]

[a]Silla University, Busan, [b]Gupo Sung Shim Hospital, Busan, Republic of Korea

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Address for correspondence
Tae Young Oh, PT, Ph.D, Prof.
Department of Physical Therapy, Silla University, 140, 700 Baegyang daero, Sassang gu, Busan, Korea
Tel: 82-051-999-5282 E-mail: ohtaeyoung@silla.ac.kr

INTRODUCTION

Spinal pain is a common problem that occurs in people living in modern society and it is an element that can lead to social, psychological, and economic burdens. In a year, 15-20% of adults experience lower back pains and over 50% of the total population say that they have experienced lower back pains at least once throughout their lifetime [1].

Reasons for lower back pains include trauma, fracture, tumors, instability of sacroiliac joint, weakened muscular strength due to damages of the torso's soft tissue, shortening of hamstrings and excessive elongation of the hamstring [2].

Shortening of the hamstring is reported to be caused by the limitation of the front bend of the pelvis and spine [3] and it can cause inappropriate movement patterns in the lower waist and pelvic area. For normal movement of the hip joint, the bending must not exceed the range of bend movement of the lumbar vertebrae more than 50% before the hip joint movement occurs [4, 5]. However, it was reported that patients with lower back pains exhibit more movements in the lumbar vertebrae than movement of the hip joint when bending forward [4, 6]. Shortened hamstring and strong stiffness of muscles reduce the forward bend of the lower back and it is accompanied by dysfunctions of lower back flexibility, hip joint bend, and sacroiliac joint, thus causing lower back pains [7].

Due to the seated lifestyle of modern people, it causes long periods of shortening of hamstrings resulting in reduced flexibility, lower back pains, and malfunctions such as poor posture and walking disorders [8].

Takata and Takahashi [9] claimed that in order to restore the mobility of chronic lumbar pain patients with limited lumbar bends, stretching of the muscles in the back of the leg and especially the hamstring is crucial.

Preceding studies emphasized the need for treatment and prevention of lower back pain patients pertaining to the flexibility of the hamstrings. It was also reported that as an intervention method to increase flexibility of the hamstrings, stretching softens muscles to prepare to adapt to intensive exercise in order to increase the scope of muscle stretching [10].

Stretching of the hamstring increases the maximum torque of the hamstring to increase the lower back bend angle [11] and reduce pains, while creating proper posture [12], and increases the active range of the knee joints [13].

Stretching expands the body muscles and soft tissues such as tendons and ligaments to increase the active range of the joint, maintain and improve flexibility and prevent injuries. It was also reported that it can ease excessive tension and pain of the muscles, increase blood circulation, and improve respiratory circulation abilities and environmental adaptiveness, while having various psychological effects for the muscles as well [14].

Common stretching methods include static stretching, ballistic stretching, passive stretching, and active stretching [15].

Inhibiting hyper activated tissue is the first step of exercise. Methods for this include massage or manipulation (positional release technique, myopractic release techniques, soft tissue release technique, active release technique, joint mobilization), but the recommended method is self-myofascial release [16].

Self-myofascial release (SMR) is a flexibility technique used to suppress hyperactive muscle fibers. This is a treatment method where subjects can use therapeutic balls, tennis balls, form rollers or other tools to relax their muscles. It lowers pain and induces stretch reflexes to increase movement. In addition, the participant can engage in the exercise alone since it has the advantage that it can easily be applied clinically [17].

SMR is a stretching method aiming at improving the myofascial system that surrounds the nervous system and muscle tissues in the body. It uses pressure from a used tool to stimulate the 'proprioceptor' in the muscles or tendons, or reduces agitation to release muscle tension [18].

Furthermore, SMR calibrates muscular imbalances and increases the active range of the joint, while easing small spams that occur in damaged tissues, blocks myofascial adhesion that occurs in the course of accumulated damages, while helping to improve the expansibility of tissues through stretching [19].

There have been many studies on SMR stretching, but there are few comparative studies on the effects of massages using a release ball, which is a type of the SMR method. Accordingly, this study aims at providing evidence on efficient stretching methods by comparing flexibility, muscular strength, senses, and temperature immediately after self-stretching and applying release ball massage on the hamstring.

METHODS

Subjects

This study was conducted from December 2017 to February 2018 and the subjects were 30 healthy women without any physical or mental disorders in their early 20s enrolled at S University in Busan. The 30 subjects were randomly categorized to place 15 in the stretching group and 15 in the release ball group. The mean age was 21.8 years, height was 159.93 cm and weight was 56.4 kg. As a result of homogeneity analysis of general characteristics, there was no significant difference between groups in all measurements.

Since the length of the hamstring could affect the research for test results, this study selected women with heights between 155 cm and 165 cm, considering that the average height of Korean women is 160.54 cm. Those with prior operations or who are engaged in regular flexibility exercise or leg muscle exercise were excluded from this study. Explanations on the purpose and method of this study were given to the subjects and they agreed to participate in this experiment voluntarily.

Materials and outcome measures

Proprioceptive sensory

90-90 straight leg raising test was performed. For the start posture, the subjects were instructed to lie on their back and maintain a 90-degree bend in the hip joint and knee joint, and then they were told to perform dorsiflexion in the ankle joints.

In order to measure the precise angle, the femur lateral epicondyle and lateral malleolus were marked with dots and while blindfolding the subjects, they were instructed to straighten their knees to an angle where they felt comfortable and maintain the posture for five seconds to remember that angle. After resting

for one minute, they were instructed to once again close their eyes and straighten their knees to the angle that they remembered. This was repeated three times and the angle was measured a total of three times - before exercise, 5 minutes after exercise, 30 minutes after exercise - using a goniometer.

Hamstring's temperature

The subjects changed into short shorts and they stayed in the lab from 10 to 20 minutes. Room temperature was measured with a digital thermometer (TFA Dostmann, Wertheim, Germany) and was also held constant as far as possible (temperature pre-test: 22.3 ± 1.7℃, temperature post-test: 22.1 ± 1.8℃).

The temperature at the center of the hamstring in the non-dominant leg was measured with a digital thermometer and measurements were taken before exercise, 5 minutes after exercise, and 30 minutes after exercise for a total of three times. The thermometer measured the temperature at a distance of 5 cm away from the skin surface.

Range of motion

A 90-90 straight leg raising test was performed to measure the flexibility of the hamstring. The subjects were instructed to lie on their back and maintain a 90-degree bend in the hip joint and knee joint, and then they were told to perform dorsiflexion in the ankle joints. In order to measure the angle accurately, it was measured by marking a dot on the femur lateral epicondyle and lateral malleolus. The subjects were then told to actively raise the knees while maintaining 90-degree bend and straighten out as much as possible. At this time, the leg which was not being measured remained still on the ground. When the subjects could no longer straighten out their needs, a goniometer was used to measure the joint activity range from the starting posture. Measures were taken before exercise, 5 minutes after exercise, and 30 minutes after exercise for a total of three times.

Muscular Strength

Using Biodex System 3 (Biodex Medical Systems, Shirley, NY, USA) as an isokinetic muscular strength measurement device, the knee joint bend and hip joint straightening muscle strength were measured once over three times before exercise, 5 minutes after exercise, and 30 minutes after exercise for a total of three repeated measurements.

Knee flexor muscle strength

The subjects were seated on an isokinetic device chair and instructed to rest on the seat rest with the trunk and hip joint making a right angle, and the trunk and hamstring were fixed with a fastening belt. After aligning the isokinetic device's dynamometer axis and femur lateral epicondyle of the non-dominant leg, the ankles were fastened to the device. The subjects were instructed in advance to look forward and gently grab the handles on both sides for measurements.

The isokinetic device was set to be fixed at a position where the knee joints are bent to 90 degrees and the subjects were told to maintain the bend giving maximum force in the knee joints so that they could fee a pull in the hamstrings for measurement.

Hip extensor muscle strength

The subjects were instructed to stand on the isokinetic device and after aligning the isokinetic device dynamometer axis with the greater trochanter of the femur, the femur was fixed to the device. The subjects were instructed before the experiment to look straight ahead and maintain proper posture so that they do not fall over while straightening the hip joint. The isokinetic device was set to be fixed while straightening the hip joint at 10 degrees and the subjects were told to maintain straightness by applying maximum force on the hip joint to feel a pull in the hamstrings for measurement.

Exercise Procedures

Release Ball Massage

Before release ball exercise, a form roller was used to apply self-massage on the back of the hamstring for 30 seconds and they were told to rest for 15 seconds. Afterwards, subjects performed 30 second massage and 15 second rests on the hamstring using the methods below. Applying all three methods was defined as one set and a total of three sets were performed for about 10 minutes.

① The non-dominant leg is straightened and placed on top of the release ball and dorsiflexion is performed. The dominant leg is placed on top of the non-dominant leg to add to the weight load while massaging.

② On top of the release ball, the non-dominant hip joint is laterally turned to sit cross-legged and the release ball is used to massage the rear lateral part of the thigh.

③ On top of the release ball, the non-dominant hip joint is internal rotation to lie on the side and

the release ball is used to massage the rear inner part of the thigh.

Self-stretching of Hamstring

Performing all three stretching methods was defined as one set and each stretching set was performed for 30 seconds and resting for 15 seconds, for a total of four sets. The total exercise time was about 10 minutes.

Hamstring stretch while supine

The starting position is to have the subjects lie down with the knees bent and the non-dominant knee was bent and the hand on the same side was used to grab the toe. The dominant hand was placed behind the non-dominant thigh and the knee was pulled up to the chest with the sole of the foot facing the ceiling. At this time, the subjects were instructed to make sure that their dominant foot stays on the floor.

Hamstring self-stretch while sitting

The start posture is to sit on the floor with both legs straightened out. The subjects were told to bend their torso to reach as far towards the toes of the dorsiflexed non-dominant foot with both hands. However, they were not allowed to have their knees leave the floor.

One-leg stretching

While standing, the non-dominant leg is placed on top of a chair and with both legs being straightened out, the subjects were instructed to loosen up and bend the center of their body forward. They placed their head on their knee and maintained that posture. This was performed by stretching their hands toward the foot as if pressing their chest down on the knees. The subjects were instructed to maintain straightness in their dominant leg.

Data and statistical analysis

Data analysis used IBM SPSS Statistics 20.0 (IBM Co., Armonk, NY, USA) and the level of statistical significance test was set at .05. Repeated measures analysis of variance was used to analyze the difference of each measurement value between and within each groups over time.

RESULTS

Upon analyzing the measurements on the senses, temperature, range of motion, and muscular strength for the release ball massage group and self-stretch group, the following results were obtained 〈Table 1〉.

Proprioceptive senses

Changes in the proprioceptive senses measured before exercise, 5 minutes after exercise, and 30 minutes after exercise for the release ball massage group and self-stretch group did not show significant values within the groups or between the groups over time 〈Table 1〉.

Hamstring's temperature

Changes in temperature measured before exercise, 5 minutes after exercise, and 30 minutes after exercise for the release ball massage group and self-stretch group showed statistically significant differences 〈Table 1〉.

There was significant difference over time for the release ball massage group, but the self-stretch group did not show statistically significant differences over time.

Range of motion

Results of the range of motion measured before exercise, 5 minutes after exercise, and 30 minutes after exercise for the release ball massage group and self-stretch group showed significant differences within groups and between groups over time 〈Table 1〉.

Knee flexor muscle strength

Knee joint bend muscle strength result values measured before exercise, 5 minutes after exercise, and 30 minutes after exercise for the release ball massage group and self-stretch group did not show significant differences within each group over time, but it showed significant differences between the two groups.

Hip extensor muscle strength

Hip joint extensor muscle strength result values measured before exercise, 5 minutes after exercise, and 30 minutes after exercise for the release ball massage group and self-stretch group showed significant differences within each group and between the groups over time 〈Table 1〉.

Table 1. Effects of release ball massage and self-stretching exercise in each group

	Group	Before	After 5min	After 30min	F	p	p
Proprioceptive sensory(°)	RB	1.42±0.86	1.69±1.101	1.44±1.35	.26	.77	.29
	SS	2.98±1.676	2.38±1.521	2.07±1.79	1.16	.32	
Temperature (°)	RB	27.51±3.58	32.47±4.005	31.77±4.18	6.01	.01*	.00*
	SS	26.25±1.54	27.75±2.434	28.51±3.20	3.21	.05	
Range of motion (°)	RB	42.02±9.40	51.31±9.638	59.16±8.77	12.82	.00*	.00*
	SS	48.13±5.79	56.51±5.199	61.58±3.84	27.57	.00*	
Knee flexor muscle strength (°/sec)	RB	35.10±4.93	38.73±5.829	36.43±6.04	1.60	.21	.01*
	SS	33.94±5.49	33.04±4.319	34.90±5.53	.49	.62	
Hip extensor muscle strength (°/sec)	RB	37.78±12.40	43.64±14.582	49.53±13.89	2.79	.07	.00*
	SS	40.21±12.81	41.82±14.423	43.18±13.83	.18	.84	

RB : Release ball group, SS : Self stretching group
Values are means ± standard deviation, *p<.05

DISCUSSION

This study made a comparative analysis using a thermometer, goniometer, 90-90 straight leg raising test, and isokinetic muscular strength measurement device before exercise, 5 minutes after exercise, and 30 minutes after exercise on young women with no lower back pains to compare self-stretching of the hamstring and SMR using a release ball and examine its impact on the proprioceptive senses, temperature, joint activity range, and muscular strength of the hamstring.

The release ball massage group showed significant difference in joint activity range and temperature, while the self-stretch group showed significant difference in the joint activity range with the passage of time (p<.05).

Comparisons between the two groups showed that the release ball massage group was more effective than the self-stretch group for joint activity range, temperature, and muscular strength (p<.05).

This comparison is on the significant change of hamstring biodynamics and mechanical properties to show the difference in effects by applying SMR techniques and self-stretching effects.

In exercises aiming to stretch muscles through release ball massage or self-stretching, temperature has been deemed as an important element for determining the muscle's viscoelasticity status, physical activities, and exercise [20].

Furthermore, maintaining sensory feedback according to changes in the temperature is important for manifesting maximum motor abilities and changes in the proprioception abilities displayed in static changes are highly important for maintaining sensory levels [21].

Muscles make it possible to adapt to discomforts resulting from stretching stimulation. When the length increases, tolerance for such discomfort grows, and therefore, stretching and the joint activity range are greatly closely related [22].

Magnusson et al. [23] claimed that the increase of joint activity range after stretching increases tolerance for stretching, while Morse et al. [24] reported that changes of the mechanical properties of muscles, or in other words, the joint activity range increases due to reduced muscle stiffness.

The difference in muscular strength of both hamstrings affects lumbar pains and lowers flexibility of the lower back and hamstring, and it is also evident that such difference affects the length of both legs. Furthermore, it was reported that it is necessary to maintain balance in the lower limbs through strengthened muscles in the hamstrings and flexibility of the hamstrings [25].

Kim and Kim [26] conducted tests on 45 healthy male and female in their 20's. They categorized the subjects into three groups of passive stretching group, passive stretching group with dorsiflexion, and active stretching group. The subjects were to maintain their posture for 30 seconds and then rest for 10 seconds as one set. The sets were repeated three times and it was reported that there was an increase in joint activity range, and therefore, the same results as this

study was obtained.

Kim et al. [27] conducted a study on 16 male and female who had no lower back pains with shortened hamstrings. Passive hamstring stretching was performed every day for two weeks at 45 seconds each in a total of three sets, and hamstring massage was performed every day for 10 minutes for two weeks, and thereby reported that flexibility increased in a short period of time.

Static stretching is mostly a part of the preparation procedures prior to physical activities. Some studies showed that by including a short stretching protocol (30 to 90 seconds) before physical activities, it was possible to extend the joint activity range without reducing functions, while improving motor conditions [20].

Lee et al. [28] conducted studies on 24 male and female in their 20's to measure foot pressure and the activity range of ankle joints using static stretching and tools for the ankle joint muscles. Results showed that there was an increase in joint activity ranges, but there was no evidence of increase in muscular strength in the ankle joints.

SMR is an exercise where the performer moves front and back using a form roller, massage ball or other special tools that start from the proximal parts of muscles to the distal parts [18].

Application of SMR gives manual pressure on stiff muscles to relax sarcomeres, and decreased fascial tension and lower general pains also increase joint angle range. A study that supports this claim conducted ischemic pressure therapy on office workers with chronic pains for four weeks and it was found that there were significant improvements to general neck and shoulder pains, strain, mobility, and muscle intensity [29].

Park [30]. divided 10 people with significantly low lumbar bending flexibility into the stretching group and form roller massage group, performed exercise for 30 minutes a day, three times a week, for four weeks, and claimed that applying form roller massage had the same effect in increasing long-term flexibility as stretching.

Release ball (tennis ball, golf ball, etc.) can concentrate on one focal point in three dimensions and, therefore, can be more effectively used than form rollers. It was also reported that the release ball is suitable for treating small surface muscles or fascia [17].

Limitations of this study were that the number of subjects were few and that it was conducted only on female. In addition, learning effects obtained from repeating the tests several times were not controlled. Moreover, this study could not limit various effects to the research results such as regular dietary habits, food consumption, and level of activity during the research period.

CONCLUSION

The following conclusions were obtained through this study.

First, there was no significant difference in the changes of the proprioceptive senses of the legs for both release ball massage and self-stretching.

Second, it was found that the temperature of the hamstring in the release ball massage group was statistically higher than in the self-stretch group.

Third, it was found that release ball massage and self-stretching both statistically significantly increased the joint activity range of the knee joint and muscular strength of the hamstring.

Therefore, these results demonstrate that release ball massage and self-stretching are beneficial for improving hamstring's temperature, ROM and muscle strength. It is suggested that the release ball massage will be positively applied in clinical fields in the future.

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