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The effect of stretching type on hamstring flexibility

The purpose of this study was to investigate whether static stretching or Thera-band stretching of hamstrings is more effective in improving the flexibility of hamstrings. A total of 40 participants performed stretching 3 times a week for 4 weeks, and a sitting trunk flexion meter was used to measure the flexibility of the hamstrings. Differences in hamstring flexibility before and after the application of static and Thera-band stretching were analyzed, and differences between the stretching methods were also analyzed.

As a result, hamstring flexibility increased significantly after the static stretching program (p=.000), and also increased significantly after the Thera-band stretching program (p=.000). Although both programs were effective in improving hamstring flexibility, but there was no significant difference between the two groups (p=.058). Therefore, static stretching and Thera-band stretching are effective interventions to improve and maintain hamstring flexibility.

Key words: *Hamstring, Static stretching, Thera-band stretching, Flexibility*

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INTRODUCTION

Changes in living environments due to industrialization, decreased physical activity, decreased flexibility, and aging lead to decreases in elastic components of muscles and muscle fibers, thereby leading to impaired muscle elongation [1].

In particular, increases in the time spent sitting on chairs in inappropriate postures act to decrease the flexibility of hamstrings. Among many muscles, hamstrings are shortened most often, and many people experience difficulties due to shortened hamstrings [2]. Shortening and stiffness of hamstrings exert significant influences on spinal health and decrease lordosis of lumbar vertebrae [3]. These result in posterior tilting of the pelvis, causing functional disorders such as lower back pain, abnormal posture, and gait difficulties [4,5]. Moreover, decreased flexibility caused by shortening of hamstrings biomechanically increases the risk of injury during physical activities [6]. The problem of hamstring is becoming an important factor for athletes and also is being studied actively [7,8].

Hamstring strain is a commonly seen injury in sports, and decreased flexibility has been recognized as a cause [9]. Hamstring flexibility is required to prevent functional disorders arising from injuries, and many studies have continued to investigate ways to increase hamstring flexibility [10,11,12,13,14,15,16]. Most studies observed that stretching is effective in improving hamstring flexibility [17,18], and studies also reported that Thera-band stretching can increase hamstring flexibility [19,20,21].

Stretching relaxes muscle tension and allows lengthening, and is a good warm-up exercise [22]. Stretching decreases muscle stress or pain after physical activities [23] and increases the ranges of motion of muscles and joints [22,24,25]. Increases in joint range of motion prepare the body for physical movement, thereby improving the efficiency of movement. Stretching also improves mobility, enables difficult movements and exercise, relaxes the mind and body, and decreases the risk of tendon distortion or muscle sprain [26].

Therefore, to investigate more effective stretching methods, the present study aimed to comparatively analyze static stretching, which is the most commonly used method in clinical practice, and Thera-band

stretching, a resistance exercise that utilizes elasticity. We compare the flexibility of the two groups and propose a more effective stretching method when applying stretching for the purpose of preventing the damage and increasing exercise performance in the rehabilitation program.

SUBJECTS AND METHODS

The subjects were female and male adults attending C University located in J city. The subjects received sufficient explanation on the study and voluntarily consented to participate through a written consent form; the total number of subjects was 40 (20 males and 20 females). Those that were taking drugs or supplements that can influence the results of this study and those that had musculoskeletal or neurological diseases in the prior 6 months were excluded. The subjects were asked not to engage in any vigorous physical activity for 1 week before the start of the experiment and to refrain from other exercises during the experiment. The experiment was conducted from October 13 to November 20, 2017. Table 1 presents the general characteristics of the subjects.

Table 1. General characteristics of the subjects (N=40)

Variables	Static stretching Mean±SD	Thera-band stretching Mean±SD
Age (yr)	19.05±0.51	21.10±1.68
Height (cm)	166.12±8.84	166.45±7.01
Weight (kg)	61.46±9.34	59.17±6.83
Sex (males/females)	9/11	11/9
Body mass index (kg/m2)	22.15±1.56	21.32±1.94

Experimental methods

Subjects who agreed to participate received explanation of the study purpose, and preliminary evaluation was conducted 2 days prior to the beginning of the stretching exercise program. The program was applied after sufficient education was provided. The experiment was conducted for a total of 4 weeks, and the subjects were divided into static stretching and Thera-band stretching groups that performed stretching 3 times a week. Post-test evaluation was conducted after 12 stretching exercise sessions were applied for 4 weeks.

Experimental tool

To measure hamstring flexibility, a sitting trunk flexion meter (Expert, Seoul, South Korea, SAT-116) was used. A 45-cm measurement bar is fixed on top of a 30-cm-high instrument. The measurement range is −10-35 cm, and measurements are made in units of 1 mm.

Measurement methods

Measurements were made in a sit-and-reach test, in which the subjects were asked to place their feet at the width of their pelvis in a long sitting position, while maintaining the ankle joints fixed at 90°. When subjects maintained this posture for 2 seconds or more, with the waist maximally flexed, and the bar pushed maximally, the toe-to-finger distance was measured. To improve reliability, the measurements were made in the same location at a temperature of 20-24℃. One experimenter made all measurements to decrease potential errors, and an assistant fixed the body of the subjects to prevent bending of the knees or countermovement. Three consecutive measurements were made under another experimenter's supervision, and the mean was calculated.

Stretching method

Static stretching program

For the static stretching program, each action is performed within ranges that caused no pain and moderate discomfort.

The static stretching program consisted of 3 actions. Each action was held for 30 seconds followed by 10 seconds rest period. The action was repeated 5 times and the completion of all 3 actions in this manner was consider as a set. After the completion of a set, subjects were given a 1 minute rest and this pattern was repeated for a total of 5 sets.

Table 2. Static stretching program

Position	Exercise	Time	Set
	Warm-up stretching	10 min	
Long sitting	① Right leg stretched with ankle dorsiflexed and left leg flexed until the left sole is pressed against the inner right thigh. Chest down to the right leg, grasp the foot and bring forehead to knee. ② Left leg stretched with ankle dorsiflexed and right leg flexed until the right sole is pressed against the inner left thigh. Chest down to the left leg, grasp the foot and bring forehead to knee. ③ Both legs stretched with ankles dorsiflexed, Chest down to both legs, grasp both feet and bring forehead to knee.	hold 30 sec rest 10 sec ×5 times	1
	Cool-down stretching	10 min	

Thera-band stretching program

The hamstring muscle flexibility exercise using Thera-band was conducted as below, and all subjects used blue Thera-bands made of identical materials.

① Supine position single leg raising
In supine position, the subject wraps the Thera-band around the sole of one foot. The top of the foot faces the body, and the leg is lifted while keeping the knee straight. The hip joint is lifted to flexion 120°, held for 30seconds, and returned to its original position. While performing the movement, the other leg is held straight on the floor. Although the band should not be loose, it should also not be too tight to interfere with blood flow.

② The same stretching is repeated in the other leg.

③ The same steps are followed for both legs.

Table 3. Thera-band stretching program

Position	Exercise	Time	Set
	Warm-up stretching	10 min	
Supine	① Straight leg raising (Right) ② Straight leg raising (Left) ③ Straight leg raising (Both)	hold 30 sec rest 10 sec ×5 times	1
	Cool-down stretching	10 min	

Data analysis

SPSS WIN 18.0 was used for statistical analysis. Since some data did not follow a normal distribution on the Kolmogorov-Smirnov test, nonparametric analysis was conducted ($p<.05$).

Wilcoxon signed-rank tests were conducted to compare pre-test and post-test measurements after each intervention method. Mann-Whitney tests were conducted to compare the homogeneity between the groups and to investigate differences in changes observed after the interventions.

RESULTS

No significant difference was noted when Mann-Whitney tests were conducted to investigate the pre-test homogeneity of the static stretching and Thera-band stretching groups ($p>.05$) (Table 4).

Table 4. Homogeneity tests between 2 groups (N=40)

Variables	Static stretching(cm) Mean±SD	Thera-band stretching(cm) Mean±SD	z	p
Stretching pretest	15.52±6.32	13.63±10.68	-.325	.745

When pre-test and post-test measurements were compared according to each stretching method, the measurements were 15.52±6.32 cm and 22.20±4.93 cm before and after static stretching, respectively (p=.000). The measurements changed from 13.63±10.68 cm before Thera-band stretching to 22.60±9.01 cm after stretching (p=.000). Since the measurements increased significantly, both methods were effective (Table 5).

When differences in the magnitude of change between stretching methods were compared, static stretching resulted in an increase of 6.68±3.45 cm whereas Thera-band stretching resulted in an increase of 8.97±2.54 cm. However, no significant difference between the methods was noted (p=.058) (Table 6).

Table 5. Pre- and post-test comparison according to the stretching method (N=40)

Variables	Pre (cm) M±SD	Post (cm) M±SD	z	p
Static stretching	15.52±6.32	22.20±4.93	-3.927	.000
Thera-band stretching	13.63±10.68	22.60±9.01	-3.930	.000

Table 6. An analysis of differences between the stretching methods (N=40)

Variables	Changes (cm) M±SD	z	p
Static stretching	6.68±3.45	-1.898	.058
Thera-band stretching	8.97±2.54		

DISCUSSION

A stretching exercise is one of the flexibility exercises that help to soften muscles, prepares them for adaptation to intense movements, and increase the range of muscle elongation [27]. In addition to improving posture and blood circulation and exercise performance, it also helps to lower psychological anxiety, relieve stress, and boost vitality so as to have confidence [28]. Improved flexibility serves as an important factor in maintaining appropriate posture, correcting inappropriate posture, increasing appropriate and elegant movement, promoting and developing motor function, and preventing injuries in daily life or during exercise [29,30].

The present study compared static and Thera-band stretching to identify the more effective stretching method for improvement of hamstring flexibility in university students who did not perform any other exercise and only engaged in activities of daily living. Hamstring flexibility in the static stretching group increased significantly (p<.000). Lim [31] applied static stretching to hamstrings for 20 days in subjects in their 20s and observed statistically significant increases (p<.01). Kim [32] also conducted 3 static hamstring stretching methods 3 times a week for 6 weeks and reported that all 3 methods were effective in increasing flexibility. In light of these findings, our results further proved that static stretching has significant effects in improving hamstring flexibility.

In a study investigating "The Effect of Time, Duration, and Timing of Static Stretching on Flexibility of Juvenile's Hamstring Muscle", Kim [33] conducted static stretching for 15 seconds, 30 seconds, and 60 seconds and reported that hamstring muscle flexibility increased further when the training duration were longer. Moreover, Chan [34] conducted static stretching for 4 and 8 weeks in a study investigating improvement in hamstring muscle flexibility. In that study, significant increases (p<.05) in flexibility were observed in both groups, although no between-group difference was noted. As these results,

suggest that the application of static stretching is effective to increase the flexibility of hamstring, but has the difference of flexibility according to the application time and the application duration of static stretching.

We also found that Thera-band stretching led to significant increases in hamstring flexibility ($p<.000$), similar to the findings of Shin [20] who observed significant ($p<.001$) increases in flexibility in elderly females after Thera-band stretching.

Jun [21] also applied Thera-band stretching to middle-aged females with chronic lower back pain, and found that the stretching program led to significant ($p<.000$) increases in hamstring flexibility and decreased lower back pain. Therefore, Thera-band stretching is an effective exercise for improving flexibility and joint range of motion, with no risk of injury, no limit in age, space, or time, or burden on joints or muscles.

However, Lee's study of applying the Thera-bend stretching to the elderly observed increases in flexibility all with and without Thera-band stretching. In contrary, there was no significant difference in flexibility between the two groups statistically (p=2.203).

Thus, studies have confirmed that static or Thera-band stretching applied to hamstrings can improve flexibility, but it is still unclear whether one is more effective. In contrast to the results of the study that applied Thera-band stretching in the elderly, we observed significant increases in the flexibility of hamstrings, most likely because our subjects were in their 20s, and were more active and had superior physical abilities. In terms of an analysis of differences between the stretching methods, no significant difference statistically (p=.058), but the increased flexibility of Thera-bend stretching is noteworthy and needs further study. However, the present study had a small sample size and applied the programs for a relatively short period of time. In order to improve flexibility and apply more effective stretching intervention, it is necessary to continue the further study with various application of stretching time, duration, and different body regions. Sit-and-reach test is influenced by not only hamstring flexibility, but also by trunk and hip flexion movements. However, this study did not consider trunk and hip flexion movements. Moreover, although many studies have investigated the effects of either static or Thera-band stretching, few previous studies compared the 2 methods; therefore, studies that can confirm the effects of stretching should be conducted more widely.

CONCLUSION

According to our findings, hamstring flexibility increased significantly both after a static stretching program (p=.000) and after a Thera-band stretching program (p=.000). No significant difference was observed after the analysis of differences between the stretching methods (p=.058). Therefore, static stretching and Thera-band stretching are effective interventions to improve and maintain hamstring flexibility. Future studies should comparatively analyze various stretching methods to improve hamstring flexibility and should identify more effective stretching interventions.

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