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Immediate Effect of Pressure Pain Threshold and Flexibility in Tensor Fascia Latae and Iliotibial Band According to Various Foam Roller Exercise Methods

Background: The treatment of pain in the iliotibial band friction syndrome has been difficult to determine, according to studies to date. However, recent studies have suggested that flexibility in the subacute stage of pain in the iliotibial band friction syndrome may help reduce pain.
Objective: To investigate the immediate effect on pressure pain threshold and flexibility of the tensor fascia latae and iliotibial band by applying static and dynamic myofascial release foam rolling and self-stretching to adults with shortening iliotibial band.
Design: Randomized controlled trial
Methods: In this study, 50 subjects who were selected in advance as a randomized controlled trial were randomly allocated using a R Studio program. The included subjects were randomly allocated to three intervention groups. The static self-myofascial release 18 people, dynamic self-myofascial release group 16 people separated the self-stretching group 16 people and conducted a homogeneity check in advance. Before the start of the experiment, after of the experiment, 5 minutes after the end of the experiment, the pressure pain threshold and flexibility change for each part were measured.
Results: The results of this study showed that the static self-myofascial release showed a significant difference in the pressure pain threshold in the tensor fascia latae and middle, lower part of the iliotibial band, compared with the other intervention groups ($p<.05$). In change of flexibility, the static self-myofascial release was significantly different than the other intervention groups ($p<.05$).
Conclusion: The result of this study suggest that static self-myofascial release using foam roller may help to improve the pain and flexibility of the iliotibial band and to apply it as a more discerning intervention.

Key words: *Myofascial release; Foam roller; Static stretching; Pressure pain threshold; Flexibility*

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INTRODUCTION

Myofascial limitation often occurs in response to injury, disease, inflammation and inactivity, where peritoneal tissue loses elasticity. If the myofascial loses momentum, fibrous adhesion may occur around the affected area. Fibrous adhesion is very painful and leads to a decrease in normal range of motion and increase in muscle length, hypertension, and decreased strength, endurance, motor coordination, and soft tissue extensibility.[1] One of the myofascial of the human body, iliotibial band is said to play an effective role in posture and balance along with the tensor fascia latae muscle and the gluteus maximus muscle.[2] Also serves to provide stability in the front part of the knee joint and assists in the rotational movement of the joint through cooperative action,[3] indirectly provides stability in the lateral direction,[4] and which is an important link between femur and patellar and tibia and plays an important role in

stabilizing the knee.[5] This shortening of iliotibial band results in an imbalance in pelvic mechanics.[4] resulting in iliotibial band friction syndrome.

Iliotibial band friction syndrome often indicates pain on the side of the lower leg and knees, and is frequently observed in people such as runners and cyclists.[6] Maximum to 15% of women and 7% of men are also present in the everyday lives of ordinary people.[7] According to studies that have been conducted so far, it is difficult to determine the most effective treatment strategy.[8] However, a previous study suggested that taking NSAIDs in the acute stage of iliotibial band friction syndrome and then treating flexibility in the subacute stage may help to reduce pain.[6, 9, 10] To increase the flexibility of iliotibial band, several treatments have been suggested including relaxation, underwater exercise, ice, stretching, strengthening of hip abductor, massage, and NSAID use, but recent studies have suggested foam rollers as a treatment method to improve the flexibility of iliotibial band.[11]

foam roller is a useful tool for friction and application of massage by applying pressure to under-function soft tissue,[12] which prevents athletes from improving performance and injuries and helps to improve muscle fatigue, muscle relaxation and pain reduction with treatment suitable for treating the limits of myofascial limitation.[13] In recent studies, many studies have been conducted to analyze interventions more effectively with the application methods of different foam rollers. In the preceding study, self-myofascial release was apply to calf muscles in a static and dynamic methods.[14] Another study demonstrated the importance of the application of foam roller by measuring the pressure pain threshold by dividing into the upper-middle-lower section after dynamically applying foam roller to the iliotibial band of normal people.[8] However, none of the studies have been recognized along with the tensor fascia latae, which is connected to the iliotibial band, and no study has been conducted on the change in flexibility by applying various self-myofascial release to the iliotibial band. In addition, there were no studies comparing self-stretching with various self-myofascial release.

Therefore, this study was designed to investigate the immediate effect on pressure pain threshold and flexibility of the tensor fascia latae and iliotibial band by applying static and dynamic myofascial release foam rolling and self-stretching to adults with shortening iliotibial band.

SUBJECTS AND METHODS

Subjects

The subjects of this study were students in their 20s located in D City. The criteria for selection of the target were those who showed positive effects during the Noble compression test to check if there was a shortening in the iliotibial band. The criteria for exclusion of the subjects were (1) A history of manual therapy to the lower extremity in the past week, (2) Current low back, hip or knee pain, (3) Popping, clicking or locking of the right knee, (4) Currently taking pain-relieving or anti-inflammatory medications, (5) lower extremity operated on within the last 12 months.[8] Of the 61 people recruited, 50 participated in the experiment, with the exception of 11 who did not meet the selection criteria. Prior to the experiment, the purpose and method of the study were explained to the study subjects and signed a consent form to participate in the study. This study was carrying out with the approval of the Institutional review board of Daejeon university (1030647-201906-HR-007-02).

Procedure

In this study, 50 subjects who were selected in advance as a randomized controlled trial were randomly allocated using a R Studio program. The included subjects were randomly allocated to three intervention groups. The static self-myofascial release 18 people, dynamic self-myofascial release group 16 people separated the self-stretching group 16 people and conducted a homogeneity check in advance. Before the start of the experiment, after of the experiment, 5 minutes after the end of the experiment, the pressure pain threshold and flexibility change for each part were measured. Training on subjects of intervention was conducted by the researcher one day before the start of the experiment.

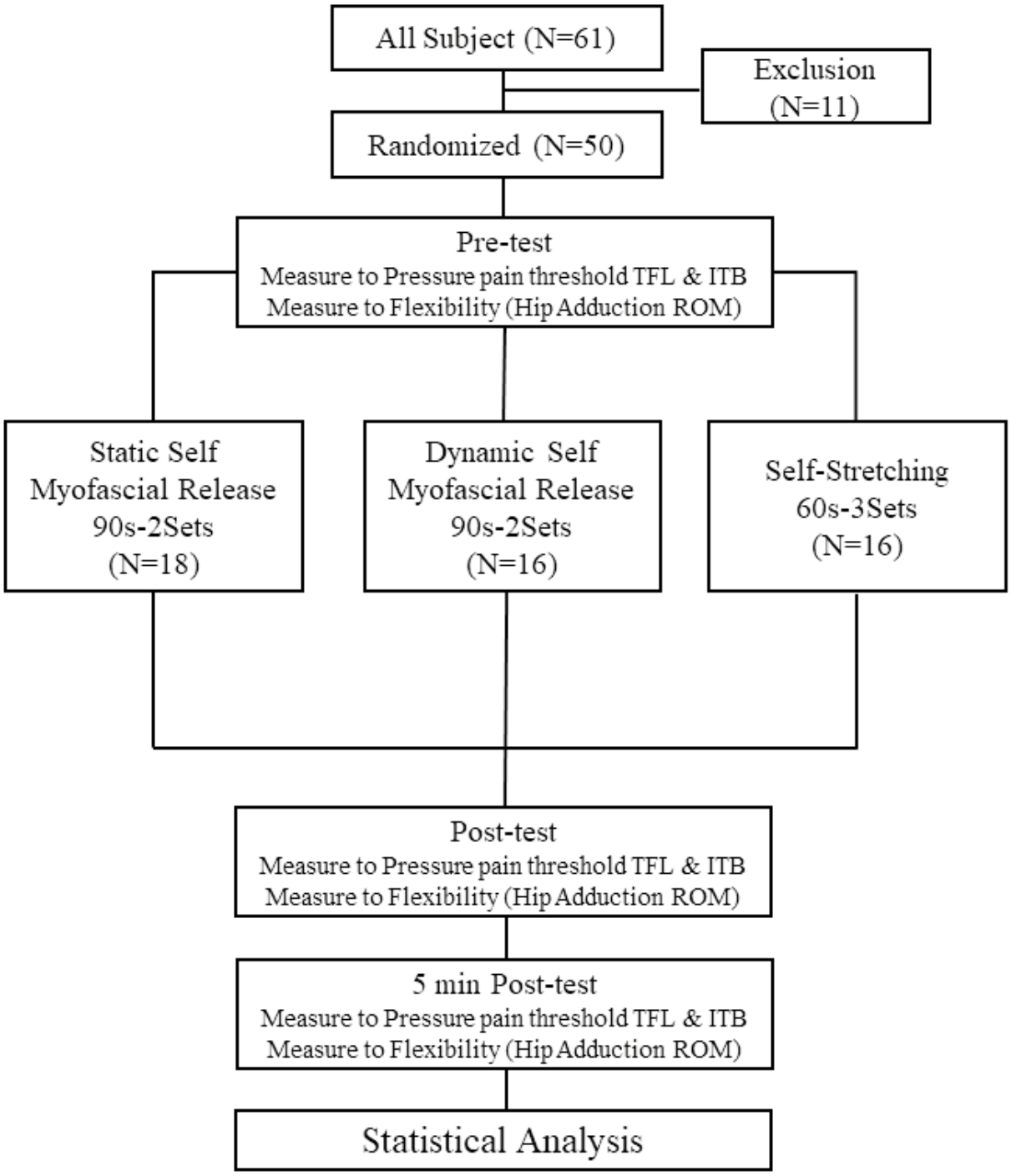

Fig. 1. Procedure

Intervention

1) Static self-myofascial release

The static self-myofascial release (S-SMR) assume a side-lying position to subject, and tensor fascia latae was applied to static pressure on the area between the iliac crest and femur greater trochanter by using a foam roller for 90 seconds. Also, iliotibial band was applied to the above of femur lateral epi-condyle. After 10 seconds of rest after the pressure on one side was over, intervention was performed on the other part.

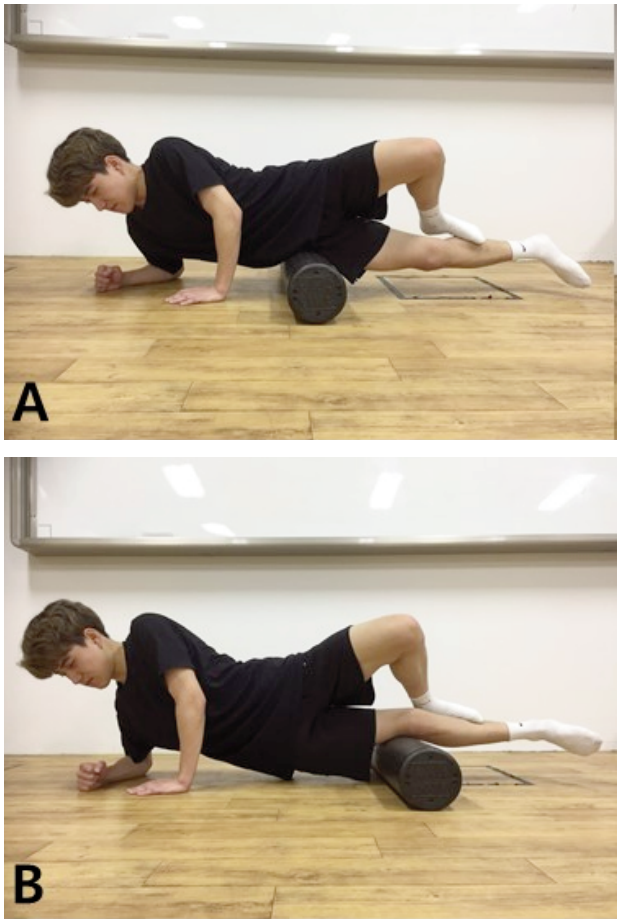

Fig. 2. Static self-myofascial release
(A. Tensor fascia latae, B. Iliotibial band)

2) Dynamic self-myofascial release

The dynamic self-myofascial release (D-SMR) assume a side-lying position to subject, and tensor fascia latae was applied to dynamic pressure on the area between the iliac crest and femur greater trochanter by using a foam roller for 90 seconds. Also, iliotibial band was applied to between the femur greater trochanter and femur lateral epicondyle.

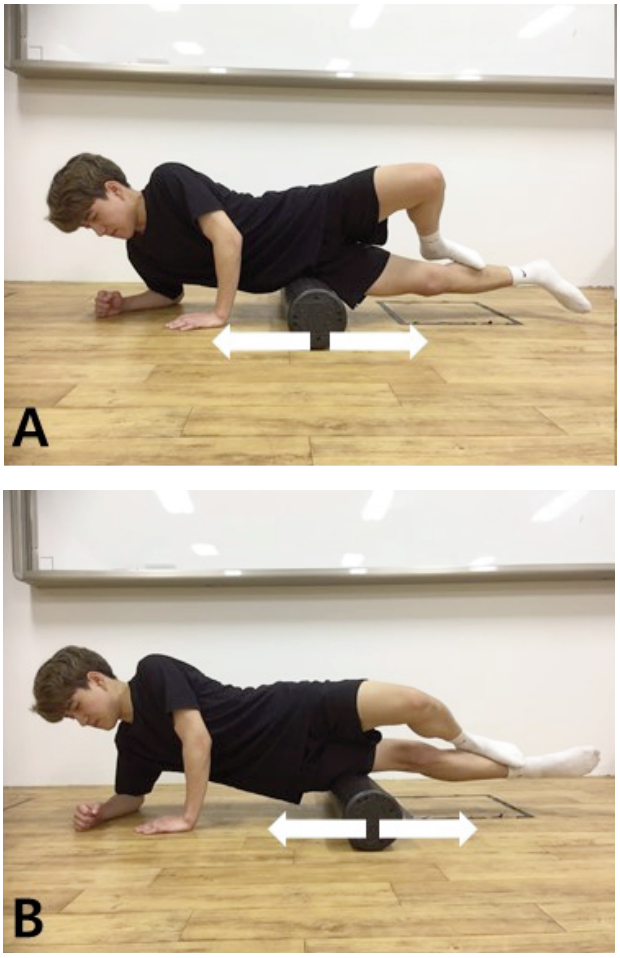

Fig. 3. Dynamic self-myofascial release
(A. Tensor fascia latae, B. Iliotibial band)

After 10 seconds of rest after the pressure on one side was over, intervention was performed on the other part.

3) Self-stretching

The self-stretching (SS) was applied with the most effective stretching during the postural iliotibial band stretching by previous study.[15] The target person raises his or her hands together and places the legs back where the stretching is to be applied. In this case, the target person should position the pelvis in the direction of the lower extremity to which the pelvis is intended, and bend the upper body laterally. The intervention period is a 60-second, 10-second break and a total of 3 sets were repeated.

Fig. 1. Self-stretching of Iliotibial band

Measurement

1) The noble compression test

The subject should supine or side-lying position, and lift the subject's leg to palpate and compress for femur lateral epicondyle, and manually extend the subject's knee. If the subject feels pain at a point of 30°, they show positive of iliotibial band. [9]

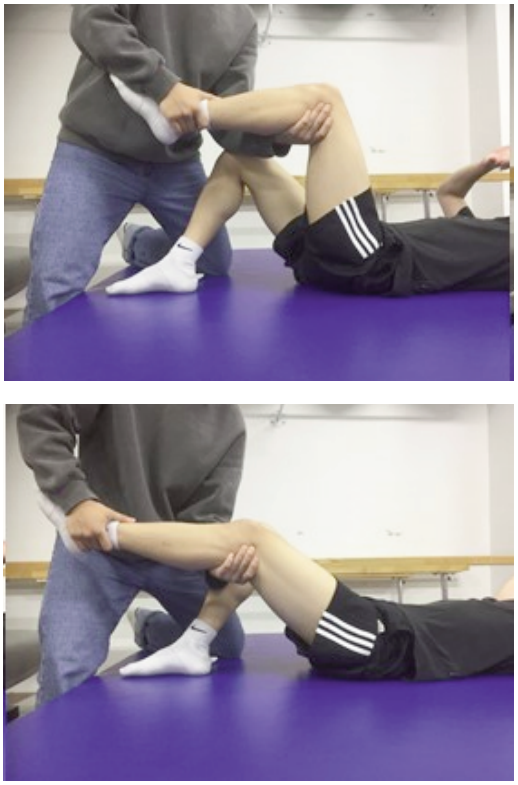

Fig. 5. The noble compression test

2) Pressure pain threshold

In order to find out the change in pressure pain thresholds of the tensor fascia latae and iliotibial band was measured using the Algometer (J-Tech Commander algometer, Preston Co, USA). The figure for the measured value is expressed in N (Newton). Tensor fascia latae muscle measured the anterior part of the iliac crest and the middle part of the femur greater trochanter. Iliotibial band measured the below of the femur greater trochanter, and above of the femur lateral epicondyle, and the middle part measured of the upper-lower part.[8] When the pressure starts to cause pain, say 'Ah', then apply the pressure, then recorded the pressure on the recording paper. The measurements was made by this researcher and was measured three times with 10-second time intervals to use the average values.[16] The reliability of the measurement tool was high (Intraclass Correlation Coefficients, ICC) in the range of 0.90 to 0.95.[17]

Fig. 6. Algometer (J-Tech Commander algometer, Preston Co, USA).

3) Flexibility

In order to find out the change in flexibility of the tensor fascia latae and iliotibial band, range of motion (ROM) was measured using a stainless steel goniometer (JAMAR stainless steel 360° 14 inch goniometer, Greendale, Wisconsin, USA). The subject should supine position, anterior superior iliac spine (ASIS) is axis, and connecting line of the ASIS is fixation, and center line of the anterior femur is movement arm and then measured for hip adduction using by goniometer.[18] At this time, researcher should continuously monitor the target, took care not to lift the pelvis of the target or to cause compensation action. The measurements was made by researcher and were taken three consecutive times to use the average values. The reliability of the measuring tool was 0.84.[19]

Fig. 7. Stainless steel goniometer (JAMAR stainless steel 360° 14 inch goniometer, Greendale, Wisconsin, USA)

Data Analysis

The collected data were analyzed using SPSS Win ver. 25.0. The general characteristics of the subjects were descriptive statistic to provide the mean and standard deviation values. The one-way ANOVA was performed to identify the homogeneity of the subjects, and the normality test was conducted through the Shapiro-Wilk test. One-way ANOVA with repeated measure was performed for compare of changes pre-post-5post of the within a group intervention, and one-way ANOVA was conducted and analyzed to compare the intergroup intervention effects, and the post-hoc analysis was used Bonferroni correction. An alpha level of 0.05 was used to determine significance level.

RESULTS

General characteristics

The total of 50 subjects were randomized to 18 S-SMR group, 16 D-SMR group, and 16 SS group. There were no significant differences in sex, age, height and weight between the three groups ($p>.05$) (Table 1).

Change of pressure pain threshold

In this study, there was a significant difference in the comparison between all three groups pre-post and pre-5post within the intervention group ($p<.05$). In the post-hoc analysis between the intervention groups, tensor fascia latae muscle showed a significant difference in the S-SMR compared to other intervention groups after pre-post and pre-5post ($p<.05$). There was no significant difference between the groups at the iliotibial band upper part ($p<.05$). In the pre-post of the iliotibial band middle part, S-SMR and D-SMR showed a significant difference compared to SS ($p<.05$). However, S-SMR was able to see a significant difference compared to other intervention groups in the pre-5post ($p<.05$). In the pre-post and pre-5post of the iliotibial band lower part, S-SMR and D-SMR showed a significant difference compared to SS ($p<.05$) (Table 2).

Change of flexibility

In this study, there was a significant difference in the comparison between all three groups pre-post and pre-5post within the intervention group ($p<.05$). In the post-hoc analysis between the intervention groups, flexibility showed a significant difference in the S-SMR compared to other intervention groups after pre-post and pre-5post ($p<.05$).

Table 1. General characteristics of subjects (N = 50)

	S-SMR	D-SMR	SS	x^2/F
Sex (M/F)	7/11	5/11	5/11	0.142
Age (years)	20.67 ± 0.67	21.00 ± 1.37	20.88 ± 1.31	0.369
Height (cm)	164.36 ± 9.87	163.38 ± 8.21	166.28 ± 7.70	0.461
Weight (kg)	65.47 ± 19.89	58.22 ± 9.30	61.16 ± 10.11	1.117

[a] Values are expressed as mean ± SD
S-SMR, Static-self myofascial release; D-SMR, Dynamic-self Myofascial Release; SS, Self-stretching.

Table 2. Comparison of Pressure pain threshold of TFL, ITB and Flexibility among the groups

Variable		S-SMR (n = 18)	Change (Pre-Post) (Pre-5Post)	D-SMR (n = 16)	Change (Pre-Post) (Pre-5Post)	SS (n = 16)	Change (Pre-Post) (Pre-5Post)	F (Pre-Post) (Pre-5Post)
TFL PPT (N)	Pre	33.32 ± 7.42		39.76 ± 8.32		37.28 ± 12.17		
	Post	60.37 ± 8.32	27.06 ± 4.56	57.68 ± 9.16	17.91 ± 4.83	52.82 ± 11.44	15.54 ± 7.26	20.135**
	5Post	53.59 ± 7.30	20.27 ± 4.50	48.93 ± 7.45	9.17 ± 3.93	48.48 ± 12.76	11.20 ± 8.29	17.639**
	F	375.179**††		142.694**		45.172**		
Upper PPT (N)	Pre	34.14 ± 6.35		37.58 ± 10.65		40.09 ± 12.68		
	Post	52.02 ± 5.74	17.87 ± 6.93	54.45 ± 6.66	16.87 ± 9.11	53.13 ± 13.79	13.03 ± 10.00	1.428
	5Post	46.69 ± 7.13	12.54 ± 9.24	48.46 ± 5.91	10.88 ± 6.33	47.31 ± 11.44	7.21 ± 7.96	1.945
	F	60.435**		45.006**		21.463**		
Middle PPT (N)	Pre	24.87 ± 5.46		28.64 ± 6.57		28.45 ± 6.12		
	Post	42.92 ± 8.59	18.05 ± 7.20	41.11 ± 6.82	12.48 ± 4.69	37.95 ± 9.88	9.51 ± 8.12	6.880**
	5Post	39.11 ± 6.44	14.23 ± 5.45	37.43 ± 5.58	8.79 ± 4.76	34.88 ± 8.00	6.42 ± 5.68	9.738**
	F	98.098**††		65.317**†		18.197**		
Lower PPT (N)	Pre	23.00 ± 2.80		21.15 ± 3.43		25.09 ± 7.28		
	Post	41.74 ± 8.05	18.74 ± 8.34	38.65 ± 7.49	17.50 ± 8.86	36.24 ± 8.92	11.16 ± 5.12	4.666*
	5Post	37.19 ± 5.96	14.19 ± 6.49	34.09 ± 6.41	12.94 ± 7.86	33.31 ± 7.49	8.22 ± 3.62	4.198*
	F	82.822**†		51.655**†		53.985**		
Flexibility (°)	Pre	19.00 ± 3.53		18.94 ± 3.87		20.94 ± 4.90		
	Post	29.39 ± 4.78	10.39 ± 2.66	27.06 ± 4.20	8.13 ± 2.33	25.31 ± 5.02	4.38 ± 1.89	28.467**
	5Post	28.11 ± 4.06	9.11 ± 2.06	24.44 ± 4.00	5.50 ± 3.55	23.56 ± 3.92	2.63 ± 1.89	32.828**
	F	245.873**††		91.188**†		47.020**		

[a] Values are expressed as mean ± SD

TFL, Tensor fascia latae; ITB, Iliotibial band; PPT, Pressure pain threshold;

S-SMR, Static-self myofascial release; D-SMR, Dynamic-self myofascial release; SS, Self-stretching.

*p<.05, **p<.01.

†Significant difference (p<.05) from Dynamic-self myofascial release group.

†Significant difference (p<.05) from Self-stretching group.

DISCUSSION

This study was conducted to investigate the immediate effect on pressure pain threshold and flexibility of the tensor fascia latae and iliotibial band by applying static and dynamic myofascial release and self-stretching using foam roller to adults with shortening iliotibial band. As a result of this study, in the tensor fascia latae and iliotibial band middle part, static self-myofascial release showed a significant difference compared to other interventions, and iliotibial band lower part showed a significant difference when the static and dynamic self-myofascial release were compared to self-stretching. This is consistent with a study by previous study, which showed a more significant difference in static self-myofascial release than in dynamic self-myofascial release. The pressure pain threshold are an objective method for assessing changes in pain levels.[20] and a tool that represents the minimum pressure that causes pain or sensitivity in various tissues.[16, 21] Also, one of the most careful examinations to investigate the mechanism of musculoskeletal pain.[22] The descending antinociceptive systems are more responsive to inputs from muscle nociceptors than skin nociceptors. therefore, it is possible that the foam roller is stimulating both the skin and muscle nociceptors, and activating the descending antinociceptive systems to produce an

increase in the pressure pain threshold.[23] Through this mechanism, evidence of an immediate increase in pressure pain threshold in this study can be suggestion. The sustained pressure increases the blood flow in the tissue, moreover it help to accelerate removal of bradykinin, CGRP, IL-6, IL-8 or TNF-α, which have been shown to be such as accumulated biochemicals.[24] Two important factors that increase on compliance of soft tissue through the use of foam roller are the application of mechanical compression, duration and force.[25,26] It is believed that the reason static self-myofascial release showed a significant difference between dynamic self-myofascial release and self-stretching in this study was due to sustained pressure on one part of the organization over a longer period of time than the other interventions.

In change of flexibility, static self-myofascial release showed a significant difference compared to dynamic self-myofascial release and self-stretching. The self-myofascial release using foam rollers has been reported to removal of abnormal crosslinks and scar tissue in the myofascial. Also, it has removal of limitation for biomechanics and improve on range of motion.[1] And then, It helps recover the extensibility of soft tissue, tendon, ligament, myofascial, by increasing blood flow and blood circulation of the soft tissue at the same time as it relaxes muscles.[27] Among them, the pressure applied to the soft tissues could increase the range of movement by increasing the stretch resistance by dulling the sense of end point of stretch by overloading the subcutaneous receptor.[1] The increase in flexibility through the foam rolling also affects hemodynamic response,[28] and stretched muscle fibers help improve cardiovascular function by activating the sympathetic nerve through activation of mechanical receptors.[29] Increasing the flexibility of applying the foam rolling may be related to the change of thixotropy surrounding the myofascial.[30] The myofascial is composed of colloidal materials and, when directly stimulated, is softened by heat and mechanical stress and taken into a gel-like state.[27] Also, keeping the myofascial in a gel-like state may allow for increased range of motion.[25] In order to maintain the gel-like state, it is suggested that a long time mechanical stress is required, not a short time stress.[31] Therefore, it is considered that the static self-myofascial release that applied static pressure to one part showed more significant difference than the other intervention groups.

In this study, the intervention time of the foam rolling was performed 90 seconds. However, many researcher suggested a self-myofascial release using foam roller for the intervention of shortened iliotibial band, but did not comment on the time of intervention. In the previous study, the 3 minute time was applied to the intervention, but the question of intervention time was still questioned.[8] In another study, 2 and 10 minute intervention period was compared using a self-myofascial release using foam roller. As a result, was more positive in the 2 minute intervention time than in the 10 minute intervention.[1] In addition, another study dealing with the intervention time of the foam rolling reported that the foam roller intervention time could be disbenefit for the ability to produce force when the time exceeds 90 seconds.[32] Therefore, intervention time of the myofascial release using foam roller in this study was sufficient.

The first limitation of this study is to apply the indirect method according to the change of the range of motion, rather than measuring the direct change in flexibility of the tensor fascia latae and iliotibial band. Second, since the study was to find immediate effects rather than long term intervention programs, it did not prove long-term effectiveness. In future studies, it is necessary to study the long term effects of long term exercise programs and the same case studies that complement the limitations of the direct length change of tensor fascia latae and iliotibial band.

CONCLUSION

This study was conducted to investigate the immediate effect on pressure pain threshold and flexibility of the tensor fascia latae and iliotibial band by applying static and dynamic foam rolling and self-stretching to adults with shortening iliotibial band. Also, this study was conducted to find a better efficient intervention method. The results of this study showed that the static self-myofascial release showed a significant difference in the pressure pain threshold in the tensor fascia latae and middle, lower part of the iliotibial band, compared with the other intervention groups. In change of flexibility, the static self-myofascial release was significantly different than the other intervention groups. In the previous study, only part of pressure pain threshold was presented for muscle trigger point. however this study, further verification of flexibility may affect existing pressure pain threshold and other functions. Therefore, the static self-myofascial release using foam roller may help to improve the pain and flexibility of the iliotibial band and to apply it as a more discerning intervention.

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