



Original Article

The effects of three types of piriform muscle stretching on muscle thickness and the medial rotation angle of the coxal articulation

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Abstract. [Purpose] The purpose of this study was three kinds of stretching methods and measured the change in the thickness of the piriform muscle in real time using ultrasound images and compared the medial rotation angle of the coxal articulation. [Subjects and Methods] Forty-five subjects who attend B University in Cheonan, divided into three groups. The subjects in these three groups then underwent stretching with flexion of coxal articulation over 90°, stretching with flexion of coxal articulation under 90°, and muscle energy technique (MET) application. The main outcome measures were piriform muscle thickness and medial rotation angle of the coxal articulation. [Results] All groups showed decreased piriform muscle thickness and increased medial rotation angle of the coxal articulation. [Conclusion] Based on the above results, three kinds of piriform muscle stretching methods are effective of reduce muscle thickness and increase medial rotation angle of the coxal articulation.

Key words: Piriform muscle stretching, Muscle thickness, Medial rotation angle

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INTRODUCTION

The piriform muscle can develop sciatic nerve pain through muscle hypertrophy or a nearby anomaly due to its anatomical closeness to the sciatic nerve. Moreover, it is difficult to differentiate from other diseases related to the spine, making diagnosis difficult. Piriform muscle syndrome is a disease that causes pain and allesthesia in the hip, thigh, calf, and foot as a result of pressure on the sciatic nerve from the piriform muscle^{1, 2)}. The cause of piriform muscle syndrome includes pelvis or hip injury, an anatomical anomaly of the piriform muscle or the sciatic nerve, a difference in leg length, and myositis in the piriform muscle³⁻⁵⁾. Among these, the most general cause is myofascial pain that is related to the pain trigger point of the piriform muscle in reaction to a change or increase in muscle action⁶⁾. Medicinal treatment including nonsteroidal anti-inflammatory drugs (NSAIDs) and local injection of an anesthetic or corticosteroid and diverse physiotherapies are being implemented as therapy methods aimed at reducing such myofascial pain⁷⁾.

Piriform muscle stretching is a physiotherapy method that is generally used for patients who are diagnosed with piriform muscle syndrome⁸⁾. The purpose of stretching is to increase the length of the shortened piriform muscle and reduce pressure on the sciatic nerve. Piriform muscle stretching, which is performed in a standing or prone position, is performed with complicated motions, including flexion of the knee and coxal articulation, coxal articulation adduction, and the internal and external rotation of the thigh^{8, 9)}.

In recent years, the muscle energy technique (MET), which has the same effects as stretching, has been widely used for reducing pain and enhancing range of motion. MET is a therapy that corrects asymmetry by inducing muscle relaxation through low intensity isotonic contractions of the antagonistic and agonistic muscles aiming at the maintenance or recovery of the free mobility of joints^{10, 11)}.

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Ultrasonography that can measure asymmetry has the advantages that it is low-cost and non-invasive, and that real time observation and repeated tests are possible without concerns about radiographic exposure^{12, 13}. Despite these advantages, very few studies have quantitatively measured changes in the thickness of the piriform muscle using ultrasound. This study applied three kinds of stretching methods and measured the change in the thickness of the piriform muscle in real time using ultrasound images and compared the medial rotation angle of the coxal articulation. We aimed to discover the most effective stretching method for the piriform muscle.

SUBJECTS AND METHODS

Normal male students in their twenties who were enrolled in University B located in Cheonan City, Chungnam, Korea were selected as research subjects for this study. The exclusion criteria included those with surgical experience in the spine or pelvis, orthopedic or neurologic diseases in the lower back or leg, and pain due to injury in the lower back or lower extremity in the past three months. We gave sufficient explanations on the purpose and method of this study to the subjects before the experiment and only those who agreed to participate in the experiment were included in the study. [Table 1](#) shows the general characteristics of the subjects.

A total of 45 subjects who participated in the study were randomly allocated into three groups: stretching with flexion of coxal articulation over (SFCO) 90°, stretching with flexion of coxal articulation under (SFCU) 90°, and MET application.

For the SFCO, the subjects bent two legs in a supine position and put the leg of one side on the opposite side knee that would be measured. The subjects bent their knee over 90° until they felt tension in the direction toward the shoulder on the same side as the leg that was being stretched and then maintained the position for 30 seconds. This was repeated twice with a 30-second resting time in between¹⁴.

For the SFCU, the leg that would be stretched was crossed over the opposite side knee in a supine position. The subjects touched the outside of the knee of the leg that was being stretched with the opposite side hand and pressed the knee toward the ground for 30 seconds. This was repeated twice with a 30-second resting time in between¹⁴.

For MET, the subjects bent the coxal articulation and knee joint of the leg that was being tested in a supine position and placed their testing side foot outside the opposite side knee so that the foot touched the ground. Here, the flexion angle of the coxal articulation did not exceed 60°. The researcher restricted the movement of the pelvis by putting one hand on the anterior superior iliac spine on the opposite side. The researcher put the opposite side hand outside the bent knee to implement abduction for 10 seconds and applied pushing resistance during the contraction of the piriform muscle. After contraction, the researcher implemented adduction until the range that the resistance on the leg that was being tested could be felt and maintained the adduction for 20 seconds. This was repeated twice with a 30-second resting time in between¹⁰.

We used LOGIQ e (GE Inc., USA), which is an ultrasound image device for diagnosis, to measure the thickness of the piriform muscle. First, we drew a virtual line that connected the posterior superior iliac spine and the sacral hiatus and then drew another virtual line that connected the center of the previously drawn line and the greater trochanter. After placing the transducer probe parallel to the virtual line, passive medial rotation and external rotation of the coxal articulation was performed to clearly distinguish the piriform muscle before measurement^{15, 16}. The change in the thickness of the piriform muscle was measured at a point 1 cm from the ilium.

As for the medial rotation angle of the coxal articulation, the test was conducted while the subjects were in a prone position on the side with the smaller measured angle. The test was conducted on the chosen leg in a sitting position. Using the Image J (National Institutes of Health, USA) program, we measured an angle formed by a vertical axis from the center of the patella and a line that connects the malleolus on both sides¹⁷.

This study used SPSS ver. 18.0 (SPSS Inc., Chicago, USA) for Windows for statistical analysis. We conducted a paired t-test to compare piriform muscle thickness and the medial rotation angle of the coxal articulation before and after each stretching method. For the comparison of piriform muscle thickness and the medial rotation angle of the coxal articulation between each stretching method, we conducted a one-way analysis of variance (ANOVA). The statistical significance level for all data was set at $p < 0.05$.

RESULTS

The AHF group had a mean age of 23.13 ± 2.20 years, weight of 64.47 ± 12.77 kg, and height of 173.68 ± 6.90 cm, while the HF group values were 22.07 ± 2.37 years, 65.53 ± 7.93 kg, and 174.27 ± 4.86 cm, and MET group 24.00 ± 3.00 years, 70.67 ± 9.81 kg, and 174.87 ± 5.24 cm, respectively. There were no baseline differences in demographic and clinical findings between the experimental and control groups ([Table 1](#)).

In the tests of changes in piriform muscle thickness after stretching, all three groups (SFCO, SFCU, and MET) showed a statistically significant difference ($p < 0.05$). In a comparison of piriform muscle thickness by stretching method, no statistically significant difference was observed ([Table 2](#)).

In the tests of changes in the medial rotation angle of the coxal articulation after stretching, all three groups (SFCO, SFCU, and MET) showed a statistically significant difference ($p < 0.05$). In a comparison of the medial rotation angle of the coxal articulation by stretching method, no statistically significant difference was observed ([Table 3](#)).

Table 1. Characteristics of subjects

	SFCO	SFCU	MET
Age (years)	23.1 ± 2.2	22.1 ± 2.4	24.0 ± 3.0
Weight (kg)	64.5 ± 12.8	65.5 ± 7.9	70.7 ± 9.8
Height (cm)	173.7 ± 6.9	174.3 ± 4.9	174.9 ± 5.2

Values are presented as mean ± SD.

Table 2. Comparison of piriform muscle thickness within and between groups

		SFCO	SFCU	MET
Thickness (cm)	Pre	1.38 ± 0.42	1.51 ± 0.37	1.64 ± 0.30
	Post	1.18 ± 0.44	1.33 ± 0.39	1.44 ± 0.29
	Change	0.20 ± 0.13*	0.17 ± 0.11*	0.19 ± 0.15*

Values are presented as mean ± SD. *p<0.05

Table 3. Comparison of internal rotation angle within and between groups

		SFCO	SFCU	MET
degree (°)	Pre	24.60 ± 5.03	28.13 ± 8.18	25.53 ± 5.62
	Post	27.13 ± 6.49	30.67 ± 7.90	27.80 ± 5.60
	Change	2.53 ± 2.45*	2.53 ± 3.14*	2.27 ± 2.15*

Values are presented as mean ± SD. *p<0.05

DISCUSSION

This study applied diverse stretching methods of the piriform muscle to normal male adults to improve the prevention and rehabilitation of lower back pain and piriform muscle syndrome. We aimed to discover the most effective stretching method by examining their effects on piriform muscle thickness and the medial rotation angle of the coxal articulation.

In this study's results, the application of diverse stretching methods resulted in a decrease of piriform muscle thickness and a significant increase in the medial rotation angle of the coxal articulation. There was no difference among the stretching methods.

Stretching improves physical performance ability, prevents injury, reduces muscle pain, and increases flexibility¹⁸⁾. In general, static stretching exercise is implemented more than other types of stretching methods in many sports. Murphy et al.¹⁹⁾ argued that static stretching exercise harms isometric and isokinetic power, balance, reaction time, and agility. Avela et al.²⁰⁾ argued that these side effects are related to mechanic and neuromuscular factors such as tendon relaxation, decreased activation of the exercise unit, and change in reflexion sensitivity. Donti et al.²¹⁾ attributed these side effects to the duration and intensity of stretching. Bandy et al.²²⁾ who investigated effects according to duration, reported that 30-second or 60-second stretching is more effective than 15-second stretching. Ogura et al.²³⁾ emphasized the importance of the duration of stretching, reporting that 60-second stretching decreased muscle strength while 30-second stretching did not affect muscle function. This study chose the 30-second duration considering the results of these previous studies.

Hashemirad et al.⁷⁾ applied taping to the trigger point of the piriform muscle in a stretched position and reported that pain decreased from 6.5 points to 3.9 points and the medial rotation angle increased from 39.5° to 46.2°. Their study attributed the increase of the medial rotation angle to the increased flexibility of the soft tissue of the piriform muscle following pain reduction. Similar to the previous study, decreased piriform muscle thickness and an increased medial rotation angle after applying diverse stretching methods in this study can be attributed to the improved flexibility of the soft tissue. The differences in the medial rotation angle between the two studies come from the fact that Hashemirad et al.⁷⁾ measured the rotation angle in a prone position, while this study measured it in a sitting position.

Gulledge et al.²⁴⁾ investigated an effective stretching method by applying piriform muscle stretching in the order of 90° flexion, adduction, and the external rotation of the coxal articulation and in the order of 90° flexion, external rotation, and adduction, and they reported that there was no significant difference between the two orders. In this study, the comparison of thickness change and the medial rotation angle by applying three different kinds of stretching methods did not produce a difference. We conclude that stretching in diverse postures can be applied for stretching the piriform muscle.

MET is a therapy method that can effectively provide positive neuro-physiological and mechanical influences for the strengthening of a shortened or contracted muscle, edema reduction, and the treatment of joints that have a restricted range

of motion or a functionally fixated joint^{11, 25}). Choi and Yoon²⁶) applied MET to women in their twenties who complained about buttock and lower extremity pain due to piriform muscle syndrome. Their study reported that pain decreased from 4 points to 2 points and the passive flexion angle of the coxal articulation increased from 90° to 120°. Based on these results, we conclude that it is more appropriate to implement MET when pain has been reduced to a certain level, rather than during an acute phase where patients cannot properly perform exercise due to severe pain because the method uses force by patients. This supports the usability of stretching using MET.

This study has limitations in that only normal male adults in their twenties participated in the experiment, instead of more diverse subjects, including patients. In addition, the number of subjects was not large. Hence, it is difficult to generalize the results of this study to subjects in other age groups. Moreover, the stretching time applied to all subjects was short, producing temporary effects, and we could not control the minor motion of subjects during the ultrasound measurement. We also could not measure the change in medial rotators in addition to the piriform muscle. Further studies will be required to address these limitations. We expect that this study will be used for recommending diverse stretching postures to those who have a restriction of the medial rotation of the coxal articulation due to the shortening of the piriform muscle.

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