



Effects of Hip Exercises on the pain Severity in Patients with Patellofemoral Pain Syndrome

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ABSTRACT

Introduction: Patellofemoral pain syndrome is associated with a decrease in the strength of hip muscles, especially the abductor and external rotator muscles. Hip abductors control the knee valgus on the frontal plane, and therefore, increase in the hip abduction capacity is beneficial for the patients with this syndrome. This study aimed to determine the effect of abductor and adductor exercises, in addition to knee exercises, on knee joint pain in patients with patellofemoral pain syndrome. **Method:** This clinical trial included patients with patellofemoral pain syndrome who visited the Sports Medicine Department of Imam Khomeini Hospital Clinic. The Numeric Pain Rating Scale (NRPS) was used to evaluate the pain severity among the patients, and the step-down test was used to evaluate the knee joint function/performance. **Results:** The mean age of the patients was 33.4 ± 6.1 and 33.7 ± 7.3 years in the abductor and adductor groups, respectively, indicating no significant difference ($P=0.1$). The improvement in the NRPS and step-down test scores after 6 weeks of training exercises was statistically significant in both the abductor and adductor groups ($P<0.05$). However, only the mean scores of the step-down test after the exercises were significantly different between the two groups ($P=0.03$). **Conclusion:** The results indicate that 6 weeks of exercises of the abductor and adductor muscles, specially the abductor muscles, help reduce knee pain and improve joint function in patients with patellofemoral pain syndrome.

Introduction

Patellofemoral pain syndrome is characterized by pain in the anterior patellar region and is a common cause of knee pain among young adults of 15–35 years old. The pain is mostly felt behind and around the patella and is aggravated by activities such as climbing the stairs and sitting down with crossed knees (1, 2). Patellofemoral pain syndrome covers a variety of symptoms, including mild swelling, crepitation, tenderness of the medial surface of the patella, and knee buckling (3). Several orthopedic factors can contribute to this syndrome, such as a decrease in the flexibility of the quadriceps, the gastrocnemius muscles, and the iliotibial band; joint instability and patellar deviation; atrophy of the vastus medialis muscle and a consequent imbalance; excessive subtalar pronation; and lateral rotation of the tib-

ia (4, 5).

Different therapeutic approaches, including exercises of the vastus medialis muscle, open-chain exercises, isokinetic exercises and kinesiology tapes, sacroiliac joint manipulation, acupuncture, and laser procedures, have been proven beneficial for short-term relief, but many of these exercises cannot be performed at home (6). Strengthening and stretching exercises of the quadriceps femoris muscle and the abductors and rotators of the thigh are also a part of the conservative treatment. Subluxation of the patella, an increase in the pressure on the patellofemoral joint, and a combination of different biomechanical factors can increase the risk of developing patellofemoral pain syndrome (7, 8).

Patellofemoral pain syndrome is characterized by a decrease in the strength of the hip mus-

cles, especially the abductor and external rotator muscles. Hip abductors control the knee valgus on the frontal plane, and strengthening these abductors can be beneficial for knee function and pain in patients with this syndrome (3, 9, 10). Because only few studies have evaluated the effect of strengthening the hip adductor muscles in patients with patellofemoral pain syndrome, this study aimed to compare the effects of 6 weeks of abductor muscle-strengthening exercises vs. adductor muscle-strengthening exercises on the pain management and knee joint function of patients with patellofemoral pain syndrome. The results of this study will help develop a new exercise protocol to ensure a better treatment response in such patients and contribute to a better management of their condition.

Materials and Methods

This clinical trial included patients with patellofemoral pain syndrome who visited the Sports Medicine Department of Imam Khomeini Hospital Clinic. The Numerical Rating Pain Scale (NRPS) of 0–10 was used to evaluate the pain severity of patients, with a score of 10 indicating the highest level of pain. The step-down test from a 20-cm-high platform was performed to evaluate the knee joint function/performance. In this test, the patients repeatedly stepped forward and down toward the floor for 30 s.

In the study by Kay Crossley et al. (2), physical therapy demonstrated a significant effect on the Anterior Knee Pain Scale (AKPS) score of patients by 10 points, with an effect size of 0.9. The average AKPS score in the case group was 86 ± 9 , which compared with the score (score, 78) of the control group, showed an 8-point difference. Based on this study, in the present study, with a confidence interval of 95% and a statistical power of 90%, requirement of 30 patients per group was calculated considering 27 patients per treatment group with an expected drop-out rate of 10%. Accordingly, a total sample size of 60 patients was determined. Thus, patients who met the following inclusion criteria were enrolled in to the study: patients who were 18–40 years old, did not have any physical mobility problems, and had increased anterior knee pain due to climbing or descending the stairs, running or sitting down for long periods of time, or performing squat exercises or jumping. The exclusion criteria were as

follows: patients with a history of recent trauma to the lower extremities; dislocation or subluxation of the patella, pulling of the muscles or tendons, or otherwise any indication of injury to the knee compartment; recent use of corticosteroids; pain due to direct trauma; or any abnormality on X-ray imaging. The treatment and study course were fully explained to each patient, and an informed consent was obtained from each patient prior to enrollment in the study.

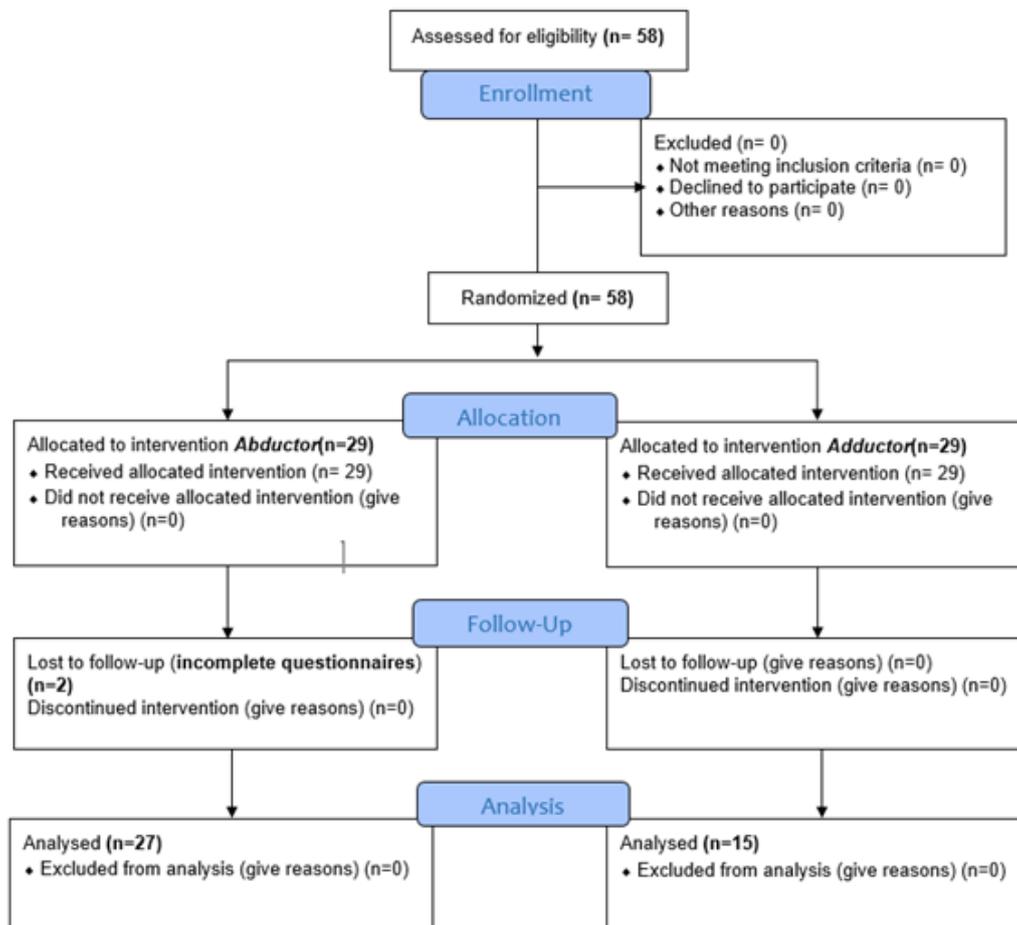
The enrolled patients with patellofemoral pain syndrome (based on patient history and physical examination) were assigned to either the control group (group 1: abductor exercise of the knees and hips for 6 weeks) or the case group (group 2: adductor exercise of the knees and hips for 6 weeks). Different treatment protocols that were divided into four blocks (AABB, ABAB, ABBA, ...) were randomly assigned to the patients. Each patient entered their assigned block in order of the block number.

In both groups, knee exercises were performed three times a day, with 10 repetitions each time, for 5 days a week over a period of 6 weeks. The exercises started with a 5-min warm-up, followed by stretching exercises of the hamstring, quadriceps, gastrocnemius, and iliotibial band (each stretch held for 10 s). Subsequently, isometric exercises were performed with resistance bands to strengthen the quadriceps and other knee muscles, and the straight leg raise exercise was repeated 10 times.

In the abductor (control) group, knee exercises were performed three times a day, with 10 repetitions each time, for 5 days a week over a period of 6 weeks. These exercises were followed by hip-strengthening exercises using resistance bands while standing for the abductor muscles and while sitting down on a chair for the external rotator muscles.

In the adductor (case) group, knee exercises were performed three times a day, with 10 repetitions each time, for 5 days a week over a period of 6 weeks. These exercises were followed by hip-strengthening exercises using resistance bands while standing for the adductor muscles and while sitting down on a chair for the internal rotator muscles.

The exercises were performed under the observation of a sports medicine resident doctor during the first week of treatment and were then per-



formed by patients at home without observation. All patients were asked to maintain a designated logbook to record their activities. Each week, patients were contacted by telephone to record their progress. After completing the 6-week course, the patients visited the clinic, and the attending sports medicine doctor who was blinded to the treatment course and group assignment performed the physical examination of each patient. SPSS version 16 was used for statistical analysis of the data. Categorical variables, namely the gender and treatment, were reported as percentage and frequency distribution. Quantitative variables, namely age, the NRPS score for pain severity, and the number of repetitions in the step-down test, were described using a histogram and a normal distribution graph using the Kolmogorov–Smirnov test. Variables that were normally distributed were described as the mean and standard deviation, whereas those that were not normally distributed were reported as the median and interquartile range. In the two-variable analysis of before and after treatment, first, the mean value of each of the quantitative variables be-

fore the treatment in each group and between the treatment groups was reported, and then, based on whether the data had a normal distribution, parametric tests, such as the t-test and one-way analysis of variance, and non-parametric tests, such as the Wilcoxon and Mann–Whitney U tests, were performed. The stratification method was also used for data analysis to control the intervening effect of the gender. A p-value of <0.05 was considered statistically significant.

Results

In total, 58 patients (29 in each group) were evaluated. The distribution of patients in each treatment group is shown in the consort diagram. Of the 58 patients, 34.5% were male and 65.5% were female. The mean age of the patients in the adductor and abductor groups were 33.4 ± 6.1 and 30.4 ± 7.3 years, respectively, indicating that the age difference between the two groups was not statistically significant ($p=0.1$). The statistical analysis of the post-treatment evaluation of patients showed significant improvement in the adductor group.

Tables

Table 1. NPRS in the adductor group before and after 6 weeks' exercise

	Before		After		*P-Value
	Mean	SD	Mean	SD	
NRPS	5.54	1.07	2.11	0.95	.0001
Step Down	28.75	7.08	33.75	7.95	.0001

*Paired t test

Table 2. NPRS in the abductor group before and after 6 weeks' exercise

	Before		After		Before
	Standard Deviation	Mean	Standard Deviation	Standard Deviation	
NRPS	5.04	1.36	1.83	0.88	.0001
Step Down	33.43	10.51	39.83	11.59	.0001

Paired t test*

Discussion

A decrease in patients' ability to perform daily tasks is one of the basic problems that patients with orthopedic ailments experience. Usually the inability to perform daily tasks is caused by pain in different anatomical locations, which is most commonly in the knees because they are the most important joint that carry body's weight and play a key role in a patient's physical performance. Pain in the knee joint reduces the patient's ability to perform daily tasks below the normal level, e.g., in patients with patellofemoral pain syndrome. In the presented study, we demonstrated an exercise regimen that significantly reduced the knee pain in patients with patellofemoral pain syndrome and improved their ability to perform daily activities.

This study involved two groups of patients who were assigned a treatment course of hip abductor exercises (Group 1: control group, 29 patients) or hip adductor exercises (Group 2: case group, 29 patients) for 6 weeks. The results showed a significant improvement in the NRPS scores and step-down test results of patients after the 6-week treatment compared with pre-treatment in both groups ($p < 0.05$; Tables 1 and 2). The mean scores before and after treatment of both groups are provided in Tables 3 and 4. These results indicate that the addition of hip abductor- and adductor-strengthening exercises to the routine knee exercises can reduce the knee pain and improve the overall performance of patients. Thus, our

findings established the importance of including hip exercises with the knee exercises in the pain management of patients with patellofemoral pain syndrome.

Several studies have shown that a weak muscle group in the thigh can disrupt the knee alignment, leading to patellofemoral pain syndrome (11-13). The extrinsic control of adduction and internal rotation weakens when the abductor and external rotator muscles are weak, resulting in misalignment of the patellofemoral joint (11). In one clinical study, Cichanowski et al. (14) measured and compared the hip muscle strength of the affected and unaffected sides of 13 athletes with patellofemoral pain syndrome and concluded that the muscles of the affected side were significantly weaker than those of the unaffected side. This result highlights the importance of strengthening the hip muscles in such patients for reducing pain and improving patient performance, consistent with the results of the present study. In Cichanowski's study, the difference in the strength of the adductor muscles between the two groups was not significant. However, in the present study, the muscle strength of patients was not measured before and after the 6-week treatment; only the level of pain and performance of patients were measured.

In the study by Timothy Tyler (15), 35 patients with patellofemoral pain syndrome underwent strengthening exercises for the flexor, abductor, and adductor hip muscles and stretching exer-

Table 3. Comparison of mean NRPS and Step Down score between Adductor and Abductor groups before exercise

	Adductor		Abductor		P-Value*
	Mean	SD	Mean	SD	
NRPS	5.54	1.07	4.89	1.31	0.05
Step Down	28.75	7.08	33.89	9.82	0.03

Independent t test*

Table 4. Comparison of mean NRPS and Step Down score between Adductor and Abductor groups after exercise

	Adductor		Abductor		P-Value*
	Mean	SD	Mean	SD	
NRPS	2.11	0.95	1.83	0.88	0.28
Step Down	33.75	7.95	39.83	11.59	0.03

Independent t test*

cises for the iliotibial and iliopsoas bands for 6 weeks. After the treatment, the strength of the flexor muscles and the flexibility of all muscles significantly increased, improving patients' performance in daily activities; however, the pain severity did not reduce corresponding to the increase in the muscle strength. This finding is inconsistent with our result probably due to the difference in the treatment protocols between the two studies.

Furthermore, in the presented study, the step-down test scores after the treatment course were significantly different between the abductor and adductor groups ($p=0.03$), with a more prominent improvement observed in the abductor group. This result emphasizes the significance of strengthening the abductor muscle group and external rotators as they reduce the activity of the tensor fasciae latae muscle and thus decrease the tension applied to the lateral retinaculum of the patella by the iliotibial band. This in turn helps stabilize the patella in its appropriate location and reduces the contact between the patella and the lateral epicondyle of the femur (16). Furthermore, we found that the abductor and external rotator muscles of the hip were generally weak in patients with patellofemoral pain syndrome; therefore, we propose that strengthening exercises for the thigh muscles should be included in the physical treatment course of such patients.

In a systematic review article, Prins (17) reported that a decrease in the strength of the abductor, extensor, and external rotator muscles and a moderate weakness in the internal rotator and flexor muscles is common in patients with pa-

tellofemoral pain syndrome, but weakness in the adductor muscles in relevance to this syndrome was not emphasized. In a study on patients with patellofemoral pain syndrome, Razeghi et al. (18) compared the improvement between patients who performed hip muscle exercises and those who performed only knee muscle exercises. They reported that after 4 weeks of treatment, pain reduction was observed in patients who focused on strengthening the external rotator, abductor, and knee muscles but not in those who focused on strengthening the adductor, extensor, and internal rotator muscles. This finding emphasizes the importance of strengthening the abductor muscle group and is inconsistent with the results of the present study, which demonstrated significant improvement in pain management and performance in the adductor group compared with that in the abductor group.

In another systematic review, Thomson (19) concluded that the exercises focusing on strengthening the hip muscles are only slightly more effective than those focusing only on strengthening the knee muscles; however, the general outcome of most of these studies that Thomson reviewed demonstrated that both these exercises are equally effective. In contrast, in the present study, we proved that adding hip exercises to the routine knee exercises significantly reduced the pain and improved the performance of patients; however, to better determine the benefits of hip exercises alone, a third group of patients that performed knee exercises alone should be included.

In 2014, Mahtab Shahin (20) compared two groups of patients with patellofemoral pain syn-

drome: one that only performed knee exercises and another that performed knee and hip exercises including quadriceps, abductor, and external rotator muscle exercises over two 6-week courses. The exercises were performed in the sports medicine clinic during the first 6 weeks and at patients' homes in the next 6 weeks. After the treatment course, single leg hop, single leg squat, and stair descend tests were performed, in addition to knee pain questionnaire assessment, Thomas test, and Ober's test. The muscle strength was also measured using an isokinetic device. Data analysis showed that the addition of hip exercises to the routine knee exercises significantly improved the general patient condition, consistent with the results of the present study. However, in our study, we also compared the effects of strengthening different compartments of the thigh on the general condition. Other differences between that study and our study is that we did not measure the muscle strength and that all exercise sessions were performed under medical supervision in the previous study. However, our study has one advantage that it evaluated both sexes, whereas most studies on this subject have evaluated only female patients.

Conclusion

The results of the present study indicate that 6 weeks of abductor and adductor muscle exercises, especially abductor muscle exercises, help reduce pain and improve joint function in patients with patellofemoral pain syndrome. In addition to better pain management and performance in both groups, the results showed significantly improved performance of the abductor group patients in the step-down test compared with that of the adductor group patients, indicating that strengthening of the abductor muscles is more important for and effective in improving performance.

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