Internal Medicine and Medical Investigation Journal
E-ISSN: 2474-7750
Homepage: www.imminv.com

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

Seyed Esmaeil Shafiei[1], Hamed Jafarpour[2], Zahra Madani[1], Hanieh Adib[1], Siavash Moradi[1], Parisa Islami Parkoohi[1], Zahra Safari[2]*

1. Assistant Professor, Mazandaran University of Medical Sciences, Sari, Iran.
2. Student Research Committee, Mazandaran University of Medical Sciences, Sari, Iran.

*Correspondence: Zahra Safari, Student Research Committee, Mazandaran University of Medical Sciences, Sari, Iran.
Email: Dr.zahra.safari83@gmail.com, Phone number: +989143017161

## ARTICLE INFO

*Received 2018-05-12*
*Accepted: 2018-10-18*
*Published: 2019-02-30*
*Volume: 4*
*Issue: 1*

*Conflicts of interest: None*
*Funding: None*

**Keywords:**
Patella femoral pain syndrome,
AKPS questionnaire,
NRPS questionnaire

## 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, increasein the hip abduction capacity is beneficial forthepatients 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/per- formance. **Results:** The mean age of the patients was 33.4±6.1 and 33.7±7.3years in the abductor and adductor groups, respectively, indicatingno significant difference (P=0.1). The improvement in the NRPS and step-down test scoresafter 6 weeks of training exercises wasstatistically significant in both the abductor and adductor groups(P<0.05). However, only the mean scores of the step-downtest after the exer- cises were significantly different between the two groups (P=0.03). **Conclusion:** The resultsindicate 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 bypain 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 coversa 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 andpatellar deviation; atrophy of the vastus medialis muscle and a consequent imbalance; excessive subtalar pronation; and lateral rotation of the tibia (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 forshort-term relief,but many of these exercise 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 ofdeveloping patellofemoral pain syndrome (7, 8).

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

Published by Mehrabani Publishing LLC.

http://dx.doi.org/10.24200/imminv.v3i4.8

cles,especially the abductor and external rotator muscles. Hip abductors control the knee valgus on the frontal plane, and strengthening these abductorscan be beneficial for knee function and pain in patients with this syndrome (3, 9, 10). Becauseonly 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 6weeks of abductor muscle-strengthening exercises vs. adductor muscle-strengthening exercises on the pain management and knee joint function ofpatients with patellofemoral pain syndrome.The results of this study will help develop a new exercise protocol toensurea better treatment response insuchpatients and contribute to a better management of theircondition.

**Materials and Methods**

This clinical trial includedpatients 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 severityof patients,with a score of 10 indicatingthe 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 demonstrateda significant effect on the Anterior Knee Pain Scale (AKPS) score of patients by10 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 calculatedconsidering 27 patients per treatment group with an expected drop-outrate of10%.Accordingly, a total sample size of 60 patients was determined. Thus, patients who met the following inclusion criteriawere 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 toclimbing 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.

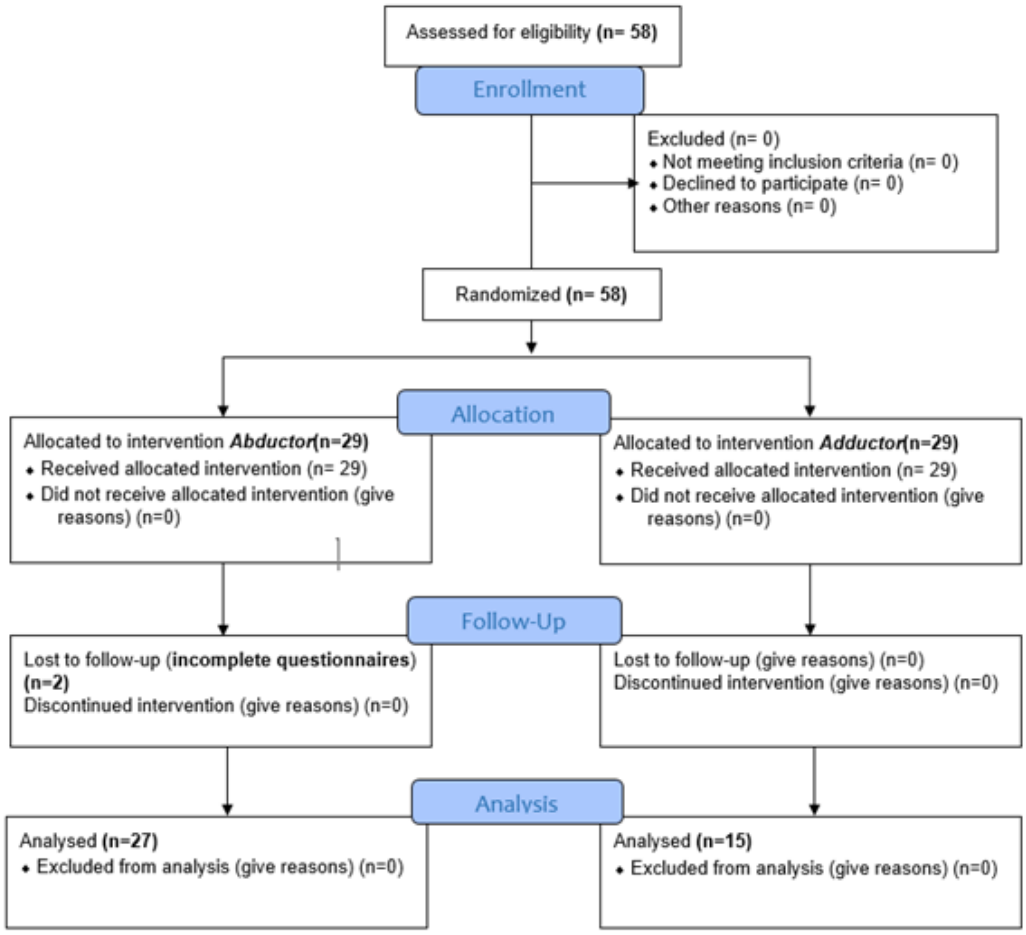
The enrolled patients with patellofemoral pain syndrome (based on patient history and physical examination) were assignedtoeither the control group (group 1: abductor exercise of the knees and hips for 6weeks) or the case group (group 2: adductor exercise of the knees and hips for 6weeks).Different treatment 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 bandsto 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 usingresistance bandswhile 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 theiractivities. 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 aspercentage and frequency distribution. Quantitative variables,namely age, the NRPS score for pain severity, and the number of repetitionsin thestep-down test, were described using a histogram and a normal distribution graph using the Kolmogorov–Smirnov test. Variablesthat werenormally distributed were described asthe mean and standard deviation,whereasthose that were not normally distributed were reported asthe median and interquartile range. In the two-variable analysis of before and after treatment, first, the mean value of each of the quantitative variables before the treatment in each group and between the treatment groups wasreported,and then, based on whether the data had a normal distribution, parametric tests, such as the t-test andone-way analysis of variance,and non-parametric tests, such asthe Wilcoxon and Mann–Whitney Utests, were performed. The stratification method was also used for dataanalysis to control the intervening effect of the gender. A p-value of $<0.05$ was considered statistically significant.

## Results

Intotal, 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 | .0001 |
| NRPS | 5.54 | 1.07 | 2.11 | 0.95 | |
| 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 | .0001 |
| NRPS | 5.04 | 1.36 | 1.83 | 0.88 | |
| 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 inthe knees because they are the most important joint that carry body's weight and playa key role in a patient's physical performance. Pain in the kneejoint reduces the patient's abilitytoperform daily tasks below thenormal level, e.g.,in patients with patellofemoral pain syndrome. In the presented study,we demonstrated an exercise regimen that significantlyreducedthe knee pain in patientswith patellofemoral pain syndrome and improved their abilityto 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) orhip 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-weektreatment compared with pre-treatment in both groups($p<0.05$;Tables 1 and 2). The mean scoresbefore and after treatment of bothgroups are provided in Tables 3 and 4. These results indicate thatthe addition of hip abductor- and adductor-strengthening exercises to the routine knee exercises can reduce the knee pain and improve the overall performanceof patients.Thus, our findings established the importance of including hip exercises with the knee exercisesin the pain management ofpatients 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 weakenswhen the abductor and external rotator muscles are weak, resulting inmisalignment ofthe patellofemoral joint (11). In oneclinical study,Cichanowski et al. (14)measured and compared the hip muscle strength of the affected and unaffected sidesof 13 athletes with patellofemoral pain syndromeand concluded that the muscles of the affected side were significantly weaker than those of the unaffected side.Thisresult highlightsthe importance of strengthening the hip muscles in suchpatients forreducing 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 studyby 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 6weeks. After the treatment, the strength of the flexor muscles and the flexibility of allmuscles significantly increased,improving patients' performance indaily activities; however, the pain severity did not reducecorresponding tothe increase in the muscle strength.This finding is inconsistentwith our result probablydue to the difference inthe treatment protocols betweenthe two studies.

Furthermore, in the presented study, the stepdown test scoresafter 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 asthey 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.Thisin 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 foundthat the abductor and external rotator muscles of the hip weregenerally weak in patients with patellofemoral pain syndrome;therefore, we propose that strengthening exercises for the thigh muscles should be included inthe physical treatmentcourse 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 iscommonin patients with patellofemoral pain syndrome, but weakness in the adductor muscles in relevance to this syndrome was not emphasized. In a study onpatients with patellofemoral pain syndrome,Razeghi et al.(18) compared the improvement between patients who performed hip muscle exercises and thosewho performedonly 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)concludedthat the exercises focusing on strengthening the hip muscles are only slightly more effective than those focusing only strengthening the knee muscles; however, the general outcome of most of these studies that Thomson reviewed demonstratedthat both these exercises are equally effective. In contrast, in the presentstudy, we proved that adding hip exercises to the routine knee exercises significantlyreduced the pain and improved the performance of patients; however,-to better determinethe 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 ofpatients 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 exercisesover two 6-week courses.The exercises were performed in the sports medicine clinic during the first 6 weeks and at patients' homesin 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 significantlyimprovedthe general patient condition, consistent with theresults of the present study. However, in ourstudy, we also compared the effects ofstrengthening different compartments of the thigh on thegeneralcondition. Otherdifferencesbetween that study and our studyis 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 patientsin the step-down test compared with that of the adductor group patients,indicating that strengthening of the abductor musclesis more important for and effective in improving performance.

## References

1. Bizzini M, Childs JD, Piva SR, Delitto A. Systematic review of the quality of randomized controlled trials for patellofemoral pain syndrome. The Journal of orthopaedic and sports physical therapy. 2003;33(1):4-20.
2. Crossley K, Bennell K, Green S, McConnell J. A systematic review of physical interventions for patellofemoral pain syndrome. Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine. 2001;11(2):103-10.
3. Frye JL, Ramey LN, Hart JM. The effects of exercise on decreasing pain and increasing function in patients with patellofemoral pain syndrome: a systematic review. Sports health. 2012;4(3):205-10.
4. Carlsson AM, Werner S, Mattlar CE, Edman G, Puukka P, Eriksson E. Personality in patients with long-term patellofemoral pain syndrome. Knee surgery, sports traumatology, arthroscopy : official journal of the ESSKA. 1993;1(3-4):178-83.
5. Fulkerson JP. The etiology of patellofemoral pain in young, active patients: a prospective study. Clinical orthopaedics and related research. 1983(179):129-33.
6. Dierks TA, Manal KT, Hamill J, Davis IS. Proximal and distal influences on hip and knee kinematics in runners with patellofemoral pain during a prolonged run. The Journal of orthopaedic and sports physical therapy. 2008;38(8):448-56.
7. Khayambashi K, Mohammadkhani Z, Ghaznavi K, Lyle MA, Powers CM. The effects of isolated hip abductor and external rotator muscle strengthening on pain, health status, and hip strength in females with patellofemoral pain: a randomized controlled trial. The Journal of orthopaedic and sports physical therapy. 2012;42(1):22-9.
8. Marx RG, Jones EC, Allen AA, Altchek DW, O'Brien SJ, Rodeo SA, et al. Reliability, validity, and responsiveness of four knee outcome scales for athletic patients. The Journal of bone and joint surgery American volume. 2001;83-a(10):1459-69.
9. Meira EP, Brumitt J. Influence of the hip on patients with patellofemoral pain syndrome: a systematic review. Sports health. 2011;3(5):455-65.
10. Hollman JH, Ginos BE, Kozuchowski J, Vaughn AS, Krause DA, Youdas JW. Relationships between knee valgus, hip-muscle strength, and hip-muscle recruitment during a single-limb step-down. Journal of sport rehabilitation. 2009;18(1):104-17.
11. Robinson RL, Nee RJ. Analysis of hip strength in females seeking physical therapy treatment for unilateral patellofemoral pain syndrome. The Journal of orthopaedic and sports physical therapy. 2007;37(5):232-8.
12. Bolgla LA, Malone TR, Umberger BR, Uhl TL. Hip strength and hip and knee kinematics during stair descent in females with and without patellofemoral pain syndrome. The Journal of orthopaedic and sports physical therapy. 2008;38(1):12-8.
13. Piva S, A Goodnite E, Childs J. Strength Around the Hip and Flexibility of Soft Tissues in Individuals With and Without Patellofemoral Pain Syndrome2006. 793-801 p.
14. Cichanowski HR, Schmitt JS, Johnson RJ, Niemuth PE. Hip strength in collegiate female athletes with patellofemoral pain. Medicine and science in sports and exercise. 2007;39(8):1227-32.
15. Tyler TF, Nicholas SJ, Mullaney MJ, McHugh MP. The Role of Hip Muscle Function in the Treatment of Patellofemoral Pain Syndrome. The American Journal of Sports Medicine. 2006;34(4):630-6.
16. Powers CM. The influence of abnormal hip mechanics on knee injury: a biomechanical perspective. The Journal of orthopaedic and sports physical therapy.

2010;40(2):42-51.
17. Prins MR, van der Wurff P. Females with patellofemoral pain syndrome have weak hip muscles: a systematic review. The Australian journal of physiotherapy. 2009;55(1):9-15.
18. Razeghi M, Etemadi Y, Taghizadeh S, Ghaem H. Could Hip and Knee Muscle Strengthening Alter the Pain Intensity in Patellofemoral Pain Syndrome? Iran Red Crescent Med J. 2010;12(2):104-10.
19. Thomson C, Krouwel O, Kuisma R, Hebron C. The outcome of hip exercise in patellofemoral pain: A systematic review. Manual Therapy.26:1-30.
20. Sahin M, Ayhan FF, Borman P, Atasoy H. The effect of hip and knee exercises on pain, function, and strength in patientswith patellofemoral pain syndrome: a randomized controlled trial. Turkish journal of medical sciences. 2016;46(2):265-77.