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Review Article

Efficacy of core stability exercises and short foot exercises in patellofemoral pain syndrome: a brief review

Poonam Rajput[1], Suman Mehra[1]*, Umesh Yadav[2], Kiran Nehra[1], Deepak Yadav[1]

[1]College of Physiotherapy, Pt. B. D. Sharma UHS, Rohtak, Haryana, India
[2]Department of Orthopedices, Pt. B. D. Sharma UHS, Rohtak, Haryana, India

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***Correspondence:**
Dr. Suman Mehra,
E-mail: sumanmehra2017@gmail.com

ABSTRACT

Patellofemoral pain syndrome (PFPS) is one of the most common knee problems that disturb function and daily activities. Symptoms of PFPS can develop either slowly or abruptly and pain tends to worsen with activities such as squatting, prolonged sitting, stair climbing, jumping or running. Deficits in neuromuscular control of the core muscles and weakness of foot muscles have been associated with occurrence of PFPS. Physical therapy has got a profound role in treatment of patellofemoral pain syndrome patient. Strengthening of the core muscles must have rectified the improper recruitment of the muscles, in order to provide proximal stability, reported that improvement in core muscles could be an effective strategy in the rehabilitation of patients with PFPS. Aim of this review is to find out effect of core stabilization exercises and short foot exercises in patellofemoral pain syndrome. Following electronic databases MEDLINE, PubMed, Cochrane Library and one search engine (google scholar) were searched for literature between 2005 to 2023.

Keywords: Anterior knee pain, Core stability exercises, Patellofemoral pain syndrome, Short foot exercises

INTRODUCTION

Patellofemoral pain syndrome (PFPS) is one of the most common knee problems that disturb function and daily activities. Symptoms of PFPS can develop either slowly or abruptly and pain tends to worsen with activities such as squatting, prolonged sitting, stair climbing, jumping or running.[1] In the general population, the annual prevalence of patellofemoral pain syndrome was reported to be 22.7%, whereas in teenagers, it was 28.9%. Women have a 2.23 times higher risk of developing PFPS than males and it is most typically found in young, physically active people between the ages of 18 and 50.[2]

PFPS is caused by abnormal patellar tracking as a result of an imbalance in the functioning of the quadriceps muscle. There have also been reports of the development of patellofemoral pain syndrome in patellar tracking during knee flexion and extension due to excessive hip adduction and internal rotation during weight bearing, which causes medial knee rotation, tibia abduction and foot pronation, ultimately resulting in dynamic knee valgus. Excessive knee valgus is associated with decreased hip muscle strength and has been linked to a number of knee alignments, such as patellofemoral joint dysfunction and anterior cruciate ligament rupture. The mechanics and dynamic control of the lower limbs are impaired in patients with PFPS.[3,4]

PFPS is linked to deficiencies in the neuromuscular regulation of the core muscles. PFPS patients have a notable delay in core muscle contraction during heel raise as compared to healthy individuals. As a result, those with PFPS have compromised feed-forward and feedback mechanisms of core stabilisation.[5]

An inherent risk factor for PFPS is a pronated foot. A pronated foot can lead to abnormalities in the alignment of

the lower extremities, including calcaneal eversion, tibia internal rotation, valgus knee and femur internal rotation. It can also change the angle at which the quadriceps femoris contracts, which causes the patella to track laterally and result in PFPS.[6]

Despite the pharamacological treatment, Physical therapy plays remarkable role in management of patellofemoral pain syndrome. Physical therapy includes exercises, such as quadriceps, hamstring, hip abductor and external rotators strengthening. Stretching exercises for the hamstrings, quadriceps, tensor fascia latae and iliotibial band (IT), core stabilization and short foot exercises demonstrate a greater improvement in pain and functional activity in patellofemoral pain syndrome patients.[3,7]

The main aim of this review article was to evaluate the efficacy of core stability and short foot exercises in patellofemoral pain syndrome.

Core stability exercises

Core stabilization exercises is a type of exercises that target the muscle of the core, including the abdominals, back and pelvis to improve their ability to stabilize the spine, pelvis and entire body during movement. CSE helps to maintain spinal stability by activating muscle and increase intraabdominal pressure and play a crucial role in transmitting from the lower limb to the trunk and pelvis, enabling efficient movement patterns. These exercises engage the core muscles promoting stability, strength and improved biomechanics.

Short foot exercises

Short foot exercise is a technique used to strengthen and stabilize the foot by shortening its length through contraction of intrinsic foot muscles, specifically Abductor hallucis and Flexor digitorum brevis, resulting in a more stable and supportive arch. Short foot exercises helps to improve foot alignment, reduce stress in the foot and ankle, prevent injuries and enhance over all function.

Effect of core stability exercises on patellofemoral pain syndrome

Core stabilization exercises (CSE), based on the motor learning approach, emphasize the coactivation of the transversus abdominis and lumbar multifidus muscles. These deep stabilization muscles attach to the thoracolumbar fascia, create a stiffening effect in the lumbar spine by increasing intra-abdominal pressure and provide segmental stability to the spine. In addition, CSE can reverse pain-related restructuring in the motor cortex, enhance muscle behavior and retrain the important function of local trunk muscles for neuromuscular control of spinal stability. Thus CSE enhance proprioception, helping patients move more efficiently and reduce stress on the patellofemoral joint.[9]

Effect of short foot exercises on patellofemoral pain syndrome

Short foot exercises strengthen the intrinsic foot muscles, reduce foot pronation and enhance the medial longitudinal arch (MLA), resulting in a more stable and supportive arch. Short foot exercises helps to improve foot alignment, reduce stress in the knee, ankle and foot.[6]

Studies are searched from the following search engine PubMed, Google scholar, Scopus, web of knowledge, Virtual Health Library, Research Gate and Cochrane library to review the literature. Studies include that investigate, efficacy of core stability exercises and short foot exercise in patellofemoral pain syndrome. We researched 30 records are found from various search database 21 records are evaluated at title and abstract level 13 studies are rejected not meetup the inclusion criteria 8 studies are assessed with full text reading and included in this review.

Table 1: Summary of studies conducted on efficacy of core stability exercises and short foot exercise in patellofemoral pain syndrome.

Author journal Year	Study location	Study Design	No. of Participant	Interventions	Outcome Measures	Result
Yilmer Yelvar 2015[1]	Turkey	Quasi experiment al study	N=42 CG=20 TG=22	Control group=Therapeutic knee exercises for home program Treatment group=core stabilization exercises. Duration=3 times a week for 6 weeks.	Visual analog scale, Kujala scale, 90/90 passive test for hamstring 90/90 Passive test for hamstring muscle flexibility One leg- Hop Test Beiring Sorenson Test Sit- up test	The results were statistically significant between the groups in terms of pain, flexibility, function, strength, endurance, postural control and the parameters of the Kujala patellofemoral pain scale ($p<0.05$).

Continued.

Author journal Year	Study location	Study Design	No. of Participant	Interventions	Outcome Measures	Result
Mohamed Faisal Chevidikunnan 2016[10]	Saudi Arabia	Randomized controlled clinical trial	N=20 CG=10 TG=10	Control group=conventional treatment Treatment group=core muscle strengthening exercise. Duration: 3 times a week for 4 weeks.	Visual analog scale Star Excursion balance test (SEBT)	Intergroup comparison for VAS shows that there is a significant difference between the groups in terms of the intensity of pain (p>0.05). The results for the SEBT score show significant improvement between the groups (p>0.05)
Foroughi Forouzan 2019 [4]	Iran	Randomized controlled experimental trail	N=33 CG=16 TG=17	Control group=stretching and strengthening exercises of hip and knee. Treatment group=stretching and strengthening exercises + isolated core postural training with an unstable seat apparatus.	Numeric pain rating scale Kujala scale Centre of pressure Trajectories Step- down test	Both group have siginificant improvement in pain, function (P<0.001) and centre of pressure in sitting postural (Control group P<0.05, experimental group P<0.001). Experimental group had Significantly greater improvements in pain and kujala score at 3 month follow up compared to control group (P<0.001).
Fernanda Perito Garcia 2020[11]	Colombia	Randomised control group trail	N=40 CG=20 TG=20	Control group=hip and knee strengthening exercises. Treatment group=core muscle, hip and knee muscles strengthening exercises. Duration=8 weeks.	International physical activity Questionnaire Visual Analoge scale Kujala score Q-Angle Prone plank Side plank Trunk Extension Squats.	The addition of core muscle strengthening exercises to the traditional treatment improved the quality of life of participants in the intervention group A, where a significant reduction of pain with a statistically significant difference in the total score of the kujala scale (P=0.025) was observed
Behnaz Tazesh 2021 [13]	Iran	Parallel randomised control	N=60 CG=30 TG=30	Control group=Routine treatment Treatment group=core	Visual analog scale, Kujala scale, Front plank for anterior core Modified beiring	Significant improvements were reported in both groups (P<0.001). There were significant

Continued.

Author journal Year	Study location	Study Design	No. of Participant	Interventions	Outcome Measures	Result
		group trail		stability and routine exercises. Duration: 5 times a week for 12 weeks.	Sorenson posterior core muscle Side plank for lateral core.	between- group differences in both outcomes in favour of the Treatment group.
Pinar Kisacik 2020 [12]	Turkey	Randomized controlled parallel group trial	N=30 CG=15 TG=15	Control group=hip and knee strengthening and stretching exercises. Treatment group=Short foot exercises + hip and knee strengthening and stretching exercises. Duration: 2 times per week for 6 weeks.	Visual analog scale Anterior Knee pain scale Navicular Drop test Rearfoot Angle Foot Posture Index Strength test of the lower extremity muscle by hand held Dynamometer.	Both groups displayed decreases in pVAS scores, but it was only significant in favor of SFEG. NDT, RA, FPI scores decreased in SFEG whereas they increased in ConG. There was significant improvement in extensor muscle strength also.
Abdallah Mohamed Kamel (2024) [9]	Egypt	Randomized single blended trail	N=28 CG=14 TG=14	Control group=Hip and knee strengthening exercises. Treatment group=Short foot exercises in addition to hip and knee exercises Duration: 2 days in a week for 6 weeks.	Visual analog scale Kujala scale Hand-held dynamometer Biodex Balance System	Within-group comparsion showed significant improvement in pain severity, function, balance and muscle strength of hip abductors and quadriceps in both groups. Between groups analysis, showed significant improvement between both groups in pain, function and mediolateral stability.
Hyun- Joong Kim 2022[6]	Korea	Single Blinded parallel randomized controlled trail.	N=48 CG=16 TG^1=16 TG^2=16	Control group=Talonavicular joint Mobilization of grade III maitland technique Treatment group 1st=foot Core strengthening Exercise Treatment group 2^{nd}=Blended intervention of FCS and TJM Duration: 4 weeks	Numeric pain rating scale Anterior knee pain scale (AKPS) Dynamic Valgus Index Foot Posture Index VM/VL ratio.	TJM reduced pain more than the FCS at post-test ($p<0.05$) and Blended intervention improved lower extremity function ($p<0.05$) and valgus knee more than the TJM at 4weeks follow-up ($p<0.05$) and blended intervention were more effective in foot posture than the FCS in 4weeks follow-

Continued.

Author journal Year	Study location	Study Design	No. of Participant	Interventions	Outcome Measures	Result
						up. Blended intervention showed greater improvement in muscle activity than the TJM.

DISCUSSION

Patellofemoral pain syndrome (PFPS) is a common condition characterized by pain around the patella (kneecap) and is often associated with activities that put stress on the knee, such as running, jumping and squatting. Exercise interventions are a popular treatment option for PFPS, but the effectiveness of different exercises is not well understood.

Recent studies have investigated the effectiveness of various exercise interventions for PFPS. A study by Yelvar et al, (2015) found that core stabilization exercises were more effective than therapeutic knee exercises in reducing pain and improving function in individuals with PFPS.[1] Similarly, a study by Chevidikunnan et al, (2016) found that core muscle strengthening exercises were more effective than conventional treatment in reducing pain and improving function in individuals with PFPS.[10] Other studies have investigated the effectiveness of exercises targeting the hip and knee. A study by Foroughi et al, (2019) found that stretching and strengthening exercises of the hip and knee, combined with isolated core postural training, were more effective than stretching and strengthening exercises alone in reducing pain and improving function in individuals with PFPS.[4]

A study by Garcia et al, (2020) found that the addition of core muscle strengthening exercises to traditional hip and knee strengthening exercises improved the quality of life and reduced pain in individuals with PFPS.[11] Another study by Tazesh et al, (2021) found that core stability exercises, combined with routine treatment, were more effective than routine treatment alone in reducing pain and improving function in individuals with PFPS.[13] These studies suggest that exercise interventions targeting the core, hip and knee can be effective in reducing pain and improving function in individuals with PFPS. However, the effectiveness of different exercises may vary depending on the specific characteristics of the individual and the severity of their symptoms.

Exercise interventions are a popular treatment option for PFPS and recent studies have investigated the effectiveness of different exercises. Recent studies have consistently shown that exercise interventions, particularly core stabilization exercises, hip and knee strengthening exercises and foot exercises, are effective in reducing pain and improving function in individuals with patellofemoral pain syndrome (PFPS). Specifically, core stability exercises and short foot exercises have been found to be effective in improving pain, lower extremity function and functional mobility in PFPS patients. Moreover, combining these exercises with other interventions, such as hip and knee muscle stretching and strengthening exercises, has been shown to be even more effective in improving neuromuscular control, pain and lower extremity function in individuals with PFPS.

CONCLUSION

The current studies provide strong evidence that exercise interventions are a valuable treatment option for individuals with patellofemoral pain syndrome (PFPS), highlighting the importance of incorporating exercises that target the core, hip, knee and foot into treatment programs. The findings suggest that core stabilization exercises, hip and knee strengthening exercises and foot exercises, including short foot exercises, can be effective in reducing pain and improving function in individuals with PFPS. Furthermore, blended interventions, which combine multiple exercises or interventions, can be more effective than single interventions in improving pain, function and muscle activity in individuals with PFPS.

By incorporating these exercises into treatment programs, Therapists can help individuals with PFPS to reduce pain, improve function and improve quality of life, ultimately leading to better treatment outcomes and improved overall health and function of lower extremity. Therefore, exercise interventions should be considered a key component of treatment programs for individuals with PFPS and healthcare professionals should aim to incorporate a combination of core, hip, knee and foot exercises into their treatment approaches to achieve optimal results. Core stability exercises and short foot exercises have been found effective in reducing pain intensity and improving function of lower extremity in patients with patellofemoral pain syndrome. Both techniques also found very effective in improving core muscle endurance and improving balance in patellofemoral pain syndrome. So, it is expected that this technique can be usefully utilized in clinical practice for treatment of anterior knee pain in patients having patellofemoral pain syndrome.

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