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Physiotherapy for Anterior Knee Pain - A Narrative Review

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ABSTRACT

Background: Anterior knee pain (AKP) is a common musculoskeletal complaint including pathologies like patellofemoral pain syndrome (PFPS), patellar or quadriceps tendinopathy and patellar instability. PFPS is the commonest of all, described as retro-patellar or anterior knee aching with diffuse pain most prominent when ascending or descending stairs, squatting, or sitting for prolonged periods with the knees flexed. It is a multifactorial condition with various treatment approaches being suggested. However, there is no clear physiotherapy protocol to be followed for the same.
Objectives: This review aimed at finding recent advances in rehabilitation approaches (non-surgical and non-pharmaceutical) for patients with PFPS in last 5 years.
Methods: 35 published articles were found from Google scholar, PubMed (NLM) and PEDrO databases and 19 studies were included in this reviewed.
Conclusion: Five treatment protocols emerged from the reviewed articles: hip and knee muscle strengthening, core muscle strengthening, patellar taping, stretching and spinal mobilization. The current review suggested that a multimodal conservative management is more beneficial in these kinds of patients.

Key Words: Anterior knee pain, Physiotherapy, Patellofemoral pain.

INTRODUCTION

Anterior knee pain (AKP) is a common musculoskeletal complaint contributing to functional limitation in persons of all ages and activity levels (in sedentary as well as in athlete)[(1)] AKP is related to various types of pathologies of the patella and anterior aspect of the femur. These pathologies often include patellofemoral pain syndrome (PFPS), patellar or quadriceps tendinopathy and patellar instability.[(2)] PFPS is the commonest among all, thus, often used as interchangeable term with AKP. PFPS is described as retro-patellar or anterior knee aching with diffuse pain most prominent when ascending or descending stairs, squatting, or sitting for prolonged periods with the knees flexed.[(1,3)] The incidence of PFPS in general population is 11–17% and in a sports person 25–40% of all knee problems seen in clinical practice, with women affected more than men at a ratio of 2:1.[(1,23)] PFPS is caused by repetitive stress on the musculo-tendinous structures which surround the knee and is aggravated in athletes by cycling and running.[(4)]

Various causes have been found for this syndrome including the weakness of quadriceps femoris muscles especially vastus medialis, abnormal patellar tracking, patella lateralization, hormonal factors, stiffness of lateral structure, shortness of soft tissues around joints, overuse of muscles, and muscle imbalance between vastus medialis oblique (VMO) and vastus lateralis (VL) muscles[(1,2,4,5,26)] The diagnosis of a patient with PFP requires a thorough physical examination based on a complete

history. The nature of the injury and specific physical findings of the retinacular structure around the patella can give the specific source of AKP or instability. Radiographs and other imaging can give an idea about structural changes in details.[6]

The treatment approaches for PFPS are conservative and surgical interventions. Fulkerson JP suggested that non-operative treatment is effective in most patients.[6] Conservative treatment leads to relief of symptoms in most patients and generally includes strengthening exercises (with emphasis on VMO), muscle stretching, motor control, therapeutic modalities, and anti-inflammatory drug use;[3,6,7] however, there is no objective data to determine the best conservative approach to this syndrome. Dixit S et al suggested that surgical treatment for PFPS may be considered for those patients whose symptoms persist despite their completing at least 6 to 12 months of a thorough program of rehabilitation, and in whom other causes of AKP have been excluded. Surgical options include release of the lateral retinaculum, articular cartilage procedures, proximal and distal patellar realignment often with antero-medialization of the tibial tubercle.[8] Post-operative physiotherapy is recommended to prevent complications like post-operative pain, stiffness and quadriceps atrophy, although recurrence of instability of patella is rare if indications are followed properly.[9]

Due to the complex nature of PFPS, a multitude of treatment approaches have been suggested with physiotherapy being the most preferred plan of care in all age group individuals. Many recent randomized controlled trials (RCTs) have compared different types of interventions, such as patella taping, orthoses, knee strengthening, hip strengthening and patient education to evaluate which interventions has good effect on PFP patients[3.6.7] as well as recent systemic reviews by Heijden et.al in 2019 and McClinton SM in 2020 have found that exercise therapy is effective in reducing pain, improving function of knee and enhancing the long term recovery in daily routine but they were unable to find best form of exercise for patients with AKP.[2,10]

Appropriate physiotherapy intervention for AKP should address all identified strength and flexibility deficits in order to improve functional biomechanics and normalize altered body movement patterns during daily activities (e.g. walking, squatting, stair climbing). However, there is not yet a clear consensus among clinicians regarding the optimal physiotherapy treatment of PFPS, the purpose of this review is to describe the current evidence of physiotherapy management for AKP.

METHODS

The search was performed online for English language articles. The databases used were Google scholar, PubMed (NLM) and PEDrO. The key words used were 'physiotherapy', 'physical therapy', 'anterior knee pain' and 'patellofemoral pain syndrome'. The scientific literature related to physiotherapy management for AKP published from 2016 to 2021 was searched. Screening of the reference lists of all the retrieved articles was also done.

Through online database search 35 articles were reviewed, 19 articles were included in this study based on predetermined inclusion criteria.

Inclusion criteria:

Design: Studies with RCTs only were included.

Participants: Studies had to include individuals with AKP/PFP with pain lasting for more than 2-3 months and severity of pain on visual analog scale (VAS) $\geq$ 3. Participants of study had to have diffuse retro-patellar/peri-patellar pain with insidious onset, often provoked by at least two of the following activities: jumping, squatting, ascending/ descending stairs, kneeling, prolonged sitting and or a positive patellar compression test. The number of participants (N), their age, gender and level of physical activity were extracted to assess the similarity of the subject populations among studies.

Intervention: studies with the experimental intervention had to give physiotherapy treatment in form of strengthening program using body weight, free weights, machines, or elastic resistance, stretching, mobilization/manipulation and/or patellar taping. Only those studies were included with focus on the non-electrotherapeutic, non-surgical and non-pharmacological interventions for the rehabilitation of patients with AKP. Session duration, frequency and division of group for comparison of treatment were recorded to assess the similarity of the interventions among the studies.

Outcome measures: Two outcome measures were of interest: Pain and function. The pain measurement had to be reported as pain intensity and based on validated self-reported scale (eg, VAS or numeric pain rating scale (NPRS)). The function measurement had to be reported by self-reported questionnaire used for AKP individuals (eg. Anterior Knee Pain Scale (AKPS)). Apart from pain and function other outcome measures (e.g. strength, balance, range of motion, flexibility etc.) and the timing of the measurements of outcomes were recorded.

The articles were excluded in the study for review, if they were not relevant to AKP, were not given physiotherapy treatment or given post-operative physiotherapy treatment, were published in other languages, were systemic reviews/meta-analysis and their full texts were not available.

RESULT

Details of the 19 articles included for final analysis, discussion are shown in Table-1. To make recommendations based on a high level of evidence (1a), this review included only randomized controlled trials.[48]

Table-1: Summary of studies included in this study (n=19)

No.	Author/s	Study design	Study group(N)	Intervention (including frequency & duration)		Outcome measures	Conclusion
1.	Sahin et al.[29] (2016)	RCT	N= 55 Age: 20 to 45 years Gender: Sedentary females with PFPs	5 days/week for 6 weeks+ 6 weeks home exercise Group A: only knee exercises	Group B: hip and knee exercises	Timing:0,6,12 weeks Pain: VAS in 9 different activities (resting, standing, walking, running, prolonged sitting, kneeling, squatting, stairs, and ramp) Function: KPS Isokinetic muscle strength test: using an isokinetic dynamometer (knee extension, hip flexion, abduction & external rotation) Objective patellofemoral function: The three-limb hop test, one-leg squat test, and step-down test Secondary outcome: Trendelenburg and muscle tightness tests	Addition of hip-strengthening to patients with PFPS in order to decrease pain and increase function is more beneficial than only knee strengthening exercises.
2.	Shetty K et al.[20] (2016)	RCT	N= 30 Age: 18 to 40 years Gender: both with PFPS	4 weeks Experimental group: Same exercises as the control group plus eccentric strengthening for the hip abductors and lateral rotators.	The Control group: conventional knee-stretching and strengthening program	Timing:0,4 weeks Pain: NPRS Function: AKPS and Lower extremity functional scale	Knee strengthening plus eccentric hip abductors and lateral rotators strengthening exercises were more effective than knee exercises alone in improving function and reducing pain in sedentary people with PFPS.

Table 1 Continued...							
3.	Chevidikunnan MF[23] (2016)	RCT	N=20 Age: 16 to 40 years Gender: females with AKP	3 days/week for 4 weeks The experimental group was given core muscle strengthening and the conventional physical therapy program.	The control group was given only the conventional intervention program during the same time period.	Timing:0,4 weeks Pain: VAS Function/balance: Star Excursion Balance Test	Adding a core muscle-strengthening program to the conventional physical therapy management improves pain and dynamic balance in female patients with PFPS.
4.	M.S.Sundaram[22] (2017)	RCT	N= 30 Age: 18 to 22 years Gender: female athletes with PFPS	3 times a day, alternative days in a week for 4 weeks. Group A: conventional knee exercise (Stretching, Squatting, seated knee extension, Prone knee flexion, single leg calf raise) and weight bearing hip strengthening exercise	Group B: conventional knee exercise and hip strengthening exercise with resistance.	Timing:0,4 weeks Pain: NPRS Function: AKPS Muscle strength: Manual Muscle Testing	Both exercise program were effective in reduction of pain, improvement of muscle strength and functional status, but combined exercise program was more effective among female sprinters with PFPS.
5.	Anusha M[21] (2017)	RCT	N= 30 Age: up to 60 years Gender: both with PFPS	3 days/week for 4 weeks All the exercises were performed under guidance and home program was given. Experimental group: VMO Strengthening plus Hip Strengthening exercises	Control group: VMO Strengthening exercises alone.	Timing:0,4 weeks Pain: NPRS Function: AKPS	VMO strengthening along with hip strengthening exercises had more improvement in pain and function compared to group treated with VMO strengthening alone.
6.	M.C. Saad et al.[11] (2018)	RCT	N=40 Age: 18 to 28 years Gender: female athletes with PFP	2 sessions/week for 8 weeks Quadriceps strengthening group (QG) Hip strengthening group (HG)	Stretching group (SG) Control group (CG)	Timing:0,8 weeks. Pain: VAS Function: AKPS Kinematic data analysis: the Qualisys® Pro-Reflex video camera system was used during movement on stairs Strength evaluation: all muscle around the hip and knee joint using handheld dynamometer	Both hip and quadriceps strengthening exercises improved lower extremity kinematics after 8 weeks of intervention.
7.	Motealleh et al[18] (2019)	RCT	N=28 Age: 18 to 40 years Gender: Women with PFPS	3 sessions per day daily for 4 weeks. Intervention Group: core neuromuscular training plus same exercise as in the control group	Control Group: strengthening the knee muscles and flexibility exercises for the gastrocnemius, iliotibial band, and hamstring muscles.	Timing:0,4 weeks Pain: VAS Function: KPS Balance: Y-balance test in all 3 directions.	Core neuromuscular training plus routine physiotherapy exercise was more effective than routine physiotherapy alone for improving pain, balance, and functional performance in individuals with PFPS.
8.	Yalfani A et al.[26] (2019)	RCT	N=45 Gender: Female patients with Knee pain	3 days/week for 8 weeks Exercise therapy group (strengthening and stretching of muscles around knee joint	Exercise therapy with kinesio taping group	Control group	Timing:0,8 weeks Pain: VAS Surface EMG: for onset of activity of VMO and VL during stairs climbing up and coming down.	Multifactorial rehabilitation programs with exercise along with the supportive equipment such as tapes to improve the conditions of patients with PFPS.

Table 1 Continued...							
9.	Azizi et al.[17] (2019)	RCT	N= 54 Age: 20 to 40 years Gender: Both with PFPs	twice a day, 3 times/week for 8 weeks		Timing:0,8 weeks Pain: VAS at rest, on running, stairs climbing & during Scott's exercise Function: Questionnaire for knee function	Strengthening of hip extensors and lateral rotators have shown improvement in pain and function in patients with PFPS.
				The study group: strengthening of hip extensor and external rotator muscles	The control group was not allowed to perform any specific lower extremities training during the 8 weeks.		
10.	Sharif F et.al[16] (2020)	RCT	N=30 Age: 25 to 50 years Gender: Male and female patients with PFPS	5 days/ week for 6 weeks		Timing:0,3,6 weeks Pain: VAS Function: KPS	Hip strengthening exercise along with conventional physiotherapy was more effective than conventional physiotherapy for patient with PFPS.
				Group A: hip strengthening exercises (open chain resistive exercises) along with conventional physiotherapy.	Group-B: only conventional physiotherapy. (ultrasound, quadriceps strengthening and proprioceptive training)		
11.	R. Begum et al[12] (2020)	RCT	N=51 Age: 25-45 years Gender: Female with PFPS	4 -5 days per week for 2 weeks.		Timing:0,2 weeks Pain: NPRS Function: Lower Extremity Functional Index (LEFI) Range of motion: Goniometry	McConnell taping combined with VMO strengthening is more effective in reducing pain and improved lower extremity function when compared to VMO strengthening alone in females with PFPS.
				Group A: McConnell Taping combined with VMO strengthening exercises	Group B: VMO strengthening exercises		
12.	Prieto-García LF et al.[27] (2021)	RCT	N=40 Age: 15 to 40 years Gender: Both with PFPS	8 weeks Both groups performed warm up prior to strengthening for 8-10 mins and neuromuscular training and stretching following strengthening.		Timing:0,8 weeks Pain: VAS Function: KPS Secondary outcomes: International Physical Activity Questionnaire, Q angle, core, hip and knee muscle strength, muscle length, static balance, and postural assessment.	Including core muscle strengthening exercises in the conservative management of PFPS increases its effectiveness to reduce pain and improve the quality of life of these patients.
				The intervention group: core, hip and knee muscle strengthening exercises.	The control group: hip and knee muscle strengthening exercises.		
13.	Raisi A[28] (2020)	RCT	N= 27 Gender: Women with PFPS	3 day/week for 8 weeks		Timing:0,8,12 weeks Pain: VAS Function: Lower Extremity Functional Scale (LEFS)	There was beneficial effects of both core and hip training on pain intensity and function in the female patients with PFPS. The comparison between the groups of the core and hip training highlighted that core training had a greater impact on the function than the hip.
				Core stability training group	Hip training group	Control group	
14.	Mistry P. and Shukla Y.[15] (2020)	RCT	N= 30 Age: 17 to 35 years, Gender: Both with PFPs	5 sessions/week for 6 weeks		Timing:0,6 weeks Pain: VAS Function: KPS	At the end of 6 weeks both the treatment group showed similar results in improving pain and functional level in patients with PFPS.
				Group A (VMO strengthening and conventional physiotherapy)	Group B (Patellar taping and conventional physiotherapy).		
15.	Tazesh et al.[19] (2020)	RCT	N= 60 Age: 18 to 50 years Gender: both with PFPS	5 days/week for 12 weeks (minimum 4 sessions under supervision- 1,3,7 and 9th week)		Timing:0,12 weeks Pain: VAS Function: AKPS Secondary outcomes: Core endurance: assessed using three tests of front plank (for anterior), modified Bering-Sorensen (for posterior) and side bridge (for lateral).	The addition of core exercises may lead to lesser pain and better function after 12-week program compared with routine exercise therapy in persons with PFPS.
				Intervention group: core stability, hip muscles and routine exercise program like control group.	Control group: Routine exercise program focusing on quadriceps strengthening plus hamstring, quadriceps, iliotibial band stretch		

Table 1 Continued...							
16.	Luqman Ali et.al[14] (2021)	RCT	N=30 Age: 15 to 35 years Gender: Both with AKP	5 session/week for 6 weeks		Timing:0,6 weeks Pain: VAS Function: AKPS, Knee injury and osteoarthritis outcome score (KOOS)	Hip and core muscle strengthening were more effective than knee strengthening exercises to manage AKP and function.
				Group A: hip and core muscles strengthening including hip Abductors, Extensors, External & Internal rotators strengthening.	Group B: knee extensors strengthening.		
17.	Lee et al[24] (2020)	RCT	N= 46 Male and female patients with PFP who had <141° of knee extension angle during the hamstring flexibility test were included.	twice a day, daily for 12 weeks.		Timing:0,12 weeks Pain: VAS Function: AKPS Secondary outcome: Knee muscle strength and muscle activation time: using the isokinetic Biodex Multi-Joint System 4 Hamstring flexibility: 90-90 hamstring flexibility test	The dynamic stretching was more beneficial than static stretching for improving muscle activation time and clinical outcomes in patients with PFP with inflexible hamstrings.
				One group was given static hamstring stretching with conventional physiotherapy	another group was given dynamic hamstring stretching with conventional physiotherapy		
18.	Jellad et al[25] (2021)	RCT	N= 109 Age: 14 to 50 years Gender: both with PFPS	3 days/week for 4 weeks, both the times. Protocol A- standard protocol for treating PFPS. It consisted of transcutaneous electrical nerve stimulation (2 minutes); patellar mobilization (2 minutes); hamstring, quadriceps, and tensor fasciae latae muscle stretching; open kinetic chain strengthening of the quadriceps; and proprioceptive exercises. Protocol B supplemented protocol A with concentric strengthening of the hip external rotators and abductors using weight bearing pulley systems as well as stretching of the hip internal rotators.		Timing: at baseline(0), end of first protocol(4 weeks), end of second protocol(4 weeks), 12 weeks from end of second protocol. Pain: VAS Function: AKPS and Functional Index Questionnaire (FIQ)	Combined strengthening of the hip abductors and external rotators with stretching of the hip internal rotators provided better outcomes, which were maintained for at least 12 weeks, in terms of pain and function in patients with PFPS.
				AB group: 1st given Protocol A. After washout period (symptom free period) subjects were given another protocol i.e. Protocol B.	BA group: 1st given Protocol B. After washout period (symptom free period) subjects were given another protocol i.e. Protocol A.		
19.	Scafoglieri et al.[13] (2021)	RCT	N=43 Age: adults Gender: both with PFPS	1 session/week for 6 weeks		Timing:0,6,12 weeks Pain: VAS Function: AKPS Secondary outcomes: Maximum voluntary peak force of the quadriceps: Biodex system 3 isokinetic dynamometer	The spinal manual therapy was more effective than local exercise therapy in improving pain and function in patients with PFPS in the medium term
				The local exercise group: knee and hip muscles exercise with mobilization of the patellofemoral joint.	The spinal manual therapy group: high velocity low thrust manipulations at the thoracolumbar region, sacroiliac joint, and/or hip.		

Note: RCT= Randomized Controlled Trial, VAS= Visual Analogue Scale, NPRS= Numeratic Pain Rating Scale, KPS= Kujala patellofemoral scale/ AKPS= Anterior Knee Pain Scale, VMO= Vastus Medialis Oblique, VL= Vastus Lateralis.

DISCUSSION

PFPS is one of the most common knee complaints in young active individuals. This syndrome can have a negative effect on daily or athletic activities and lead to absence from workplace or stoppage of participation in sports if not treated properly.[17] In sports medicine also, development of practical and effective clinical protocols for PFP and preventive strategies are a central part of clinical research due to high prevalence and chronic nature of PFPS.[19]

This review aimed at finding recent advances in rehabilitation approaches for patients with PFPS in last 5 years. 19 published articles were reviewed. Five treatment protocols emerged from it: hip and knee muscle strengthening, core muscle strengthening, patellar taping, stretching and spinal mobilization.[11-29] Most of the studies that were included were conducted in developed countries and they all were RCTs.

1. Hip vs knee muscle strengthening exercises

8 studies have compared effect of Strengthening of quadriceps muscles vs muscles around hip joint and all of them have found improvement in pain and function of knee in both the groups but those who have received combined hip and knee muscle strengthening have shown greater improvement[11,16,17,20-22,29] and a study by Jellad et al have also shown it's long term effect.[25]

As the contact area between the patella and the femur changes throughout knee flexion-extension, Kaya et al. suggested that the prescription of the quadriceps strengthening for PFPS patients must be well-designed.[22,30] In PFPS there is lateral tracking of patella due to weakness of VMO. Exercises focused on VMO strengthening helps to activate and strengthen VMO, thereby improving the knee function.[21] According to McMullen et al. isometric quadriceps exercises such as straight leg raises can facilitate quadriceps activation without stressing the patello-femoral joint and minimizes patello-femoral joint reaction forces, because the patella has no contact with the femoral condyles in the full extension position.[31] But a majority of research suggests close kinetic chain (CKC) exercises to be more beneficial (as it may increase joint compressive force, thus enhance joint stability) in strengthening VMO. In CKC exercises, movement at one joint produces predictable movements at all other joints.[32,33]

Planning for weight-bearing CKC exercises of knee joint also includes hip and ankle joint muscle actions. Studies have found association between hip muscle weakness and the PFPS.[16,17,20] Poor hip control may lead to abnormal lateral patellar tracking, increasing patello-femoral joint stress and causing wear on the articular cartilage. Mechanically, poor eccentric control of hip abductors and lateral rotators can result in femoral adduction and medial rotation during dynamic weight bearing activities, which leads to a predisposition to lateral patellar tracking as the femur medially rotates underneath the patella. Here all 8 studies have focused on optimizing hip abductors and lateral rotators muscle function in patients with PFPs to control these femoral motions and prevent or reduce greater lateral forces acting on the patella. They all have shown greater improvement in pain and function in knee joint after treatment.[22]

2. Core strengthening vs conventional therapy

The core muscles play a significant role in providing dynamic stability for lower-extremity movement in all 3 planes. Control and coordination of the trunk and hip muscles is important for functional activity in patients with PFPS.

In patients with PFPS, weakness of hip abductors and lateral rotators leads to knee valgus and loss of control of hip on frontal plane.[27] Besides, decreased core stability could lead to the excessive movement of the trunk in different planes resulting in pelvic prolapse, adduction and

the internal rotation of the hip and the larger vector of the valgus force in the knee. Knee valgus posture may produce changes in the patello-femoral joint leading to pain.[18,23,28] On the other hand, strengthening the core muscles of the trunk places the pelvis in the correct position and a proper femoral direction is maintained. Such improvement may increase the use of hip abductor and external rotator muscles, reduce the over activity of tensor facia latae (TFL) followed by stretching the lateral retinaculum of the patella through the iliotibial band; eventually, it helps to place the patella in the right direction and patellar bone contact with the lateral condyle of the femur is reduced.[18,23,28]

Five studies have found significant improvement in pain and function after adding core muscle strengthening in conventional physiotherapy protocol.[14,18,19,23,27] And one study have not found significant difference between only hip strengthening vs only core strengthening exercise.[28] They also have found improvement in balance, level of physical activity and core muscle strength.

In conventional physiotherapy these studies have focused on quadriceps muscle strengthening, hip abductor and lateral rotator strengthening and stretching of quadriceps, hamstring, gastrocnemius and illiotibial band. Core muscle strengthening included progressive exercises like planks (in supine and side lying), curl ups/ cross curl ups, single leg bridging, trunk rotation and quadruped stance with opposite side shoulder and hip extension etc. ranging from 4 weeks to 12 weeks duration.[14,18,19,23,27,28]

3. Patellar taping

Recently 3 different studies have shown different effect of patellar taping on patients with PFPS. There are two ways patellar taping is done in patients with PFPS. One is McConnell taping and another is kinesio-taping.[34]

McConnell taping is widely used to treat PFPS through an improvement of the quadriceps function and an alignment of the patella. It was invented by Jenny McConnell, a Physiotherapist from Australia, in 1996. Misalignments of the patella can be treated through four different ways i.e. medial tilt, rotation, medial glide and an anterior tilt.[12] The patella is manually moved medially and maintained in medial tilt with the athletic tape.[35] In McConnell taping, under tape that exerts no tension on the skin of the patient is applied, followed by a rigid tape to correct the patellar position.[12,35,36]

In this review two studies have compared effect of McConnell taping vs VMO strengthening.[12,15] They were also given conventional physiotherapy treatment. R. Begum et al. found significant improvement in pain and function following 2 weeks of taping technique[12] while Mistry P and Shukla Y have found improvement in both groups after 6 weeks of treatment but no significant difference was found between those who received VMO strengthening and taping.[15] Result of studies also indicate that McConnell taping corrects patellar alignment and tracking[12,15] but does not improve the motor function and proprioception of PFPS patients, as by medially tracking patella will be doing work of VMO and will not improve or facilitate it's work. One more limitation of McConnell taping is that PFPS patients must apply the tape before exercise and remove it after exercise.

In contrast, Kinesio taping is a multiform approach. Kinesio tape is applied to correct the patellar position, to improve proprioceptive stimulation for VMO muscle weakness and to relieve muscle tension from tightness of the VL muscles, hamstring muscles, and the iliotibial band.[26, 37-39] Yalfani A et al. have found those who have received Kinesio taping as well as VMO strengthening have shown greater improvement than those who had received only strengthening for 8 weeks. They also found improvement in VMO/VL muscle electrical activity ratio in EMG studies during stair climbing up and down in PFPS

patients following Kinesio taping and strengthening for 8 weeks.[26] Results from Akbaş et al.[38] and Kuru et al.[40] demonstrated that Kinesio taping combined with strengthening exercises can improve training effects of the VMO muscle. They concluded that the use of Kinesio taping on VMO muscle could activate cutaneous mechanoreceptors to facilitate muscle contraction. Kinesio taping combined with strengthening exercise can enhance the awareness of the correct muscle contraction during exercise training in PFPS patients.[38,40]

Reduction of pain due to taping seems to involve the gate control theory as a cause of pain modulation. Most studies indicate that Kinesio taping or McConnell taping can stimulate cutaneous mechanoreceptors and improve knee proprioception.[26,39,41] The sensory input can increase feedback to the central nervous system and cause pain to decrease. Thus, compared with McConnell taping, the use of Kinesio taping is more accepted in PFPS patients.

4. Hamstring muscle Stretching [dynamic vs static stretching]

Muscular tightness is another symptom in patients with PFPS.[18] Previous studies[3,32,42] have reported that PFP syndrome could be closely associated with hamstrings tightness. Limited hamstrings flexibility has been theorized either to require higher quadriceps force production to overcome the passive resistance offered by the hamstrings or to cause a slight knee flexion during physical activities, both of which may result in increased patellofemoral joint reaction forces.[43] Therefore, some therapists focus on restoration of hamstring flexibility which can be achieved by stretching exercises recommended by previous studies in patients with PFPS.[2,32]

A study by Lee et al.[24] aimed to compare hamstring flexibility, knee muscle strength, muscle activation time, and clinical outcomes after static and dynamic hamstring stretching (with 3 sets of stretching with 15 second hold) plus strengthening exercises in patients with PFPS who have inflexible hamstrings. The most important result of this study was that compared with the static stretching group, the dynamic stretching group had significantly improved muscle activation time and clinical outcomes but not significantly improved hamstring flexibility or knee muscle strength.

Bandy and Irion[44] have demonstrated that longer holding times for stretching, such as 30 to 60 seconds, were more effective than 15 seconds of holding time for improving muscle flexibility, particularly in static stretching versus dynamic stretching.[24] Other than hamstrings, tightness of soft tissues such as the gastrocnemius, quadriceps and ITB/TFL, have also been suggested to influence PFPS. It is theorized that limited flexibility of the quadriceps may pull the patella superiorly, thus increasing compression of the patellofemoral joint during physical activities.[43] Tightness of the gastrocnemius and soleus complex is associated with limited ankle dorsiflexion. Reduced ankle dorsiflexion during gait may result in excessive subtalar joint pronation and tibial internal rotation to gain additional range of motion for the terminal stance phase of gait. Excessive tibial internal rotation leads to increased femoral internal rotation and Q-angle and consequently increased patellofemoral stresses.[32,43] It has been theorized that tightness of ITB/TFL may pull the patella laterally and increase the stress over the patellofemoral joint. Because the distal fibers of the ITB/TFL complex attach to the lateral aspect of the patella via the ITB, it has been theorized that tightness of ITB/TFL may pull the patella laterally and increase the stress over the patellofemoral joint.[32,43] Therefore most of the conventional therapy for PFPS includes stretching of all these muscles.

5. Spinal mobilization

Recently Scafoglieri et al. has shown benefits of spinal manipulations in patients with PFPS in medium term. They suggested local physiotherapy techniques help to reduce pain in short term but spinal manipulations of the thoracolumbar region and/or sacroiliac joint (SIJ) have also shown improvement in medium term.[13] Since the thoracolumbar zygapophyseal joints (T12 to L3) and knee joint (L2 to S2) share a partial common innervation, it has been suggested that thoracolumbar manipulations appear to modulate afferent input by stimulating inhibitory systems at various spinal levels.[45] Likewise, since the SIJ (L1 to S2) and quadriceps muscle (L2 to L4) share overlap in segmental innervation,[46] it has been suggested that SIJ manipulation may increase activation and strength of the quadriceps in patients with PFPS. Hereby, altered mechanoreceptor afferent activity in the ventral part of the SIJ may contribute to a decrease in quadriceps muscle inhibition.[45-47]

That was the first study supporting evidence that spinal manual therapy is more effective than local exercise therapy in patients with PFPS in the medium term.[13] Thus, further studies need to be performed to confirm its evidences.

These results suggest that exercise therapy is the foundation of AKP care and leads to long-term improvements in pain and function. An exercise plan that focuses on strengthening of VMO and improving neuromuscular control of the hip and core muscles produces positive results in patients with PFPS. Patellar taping as a supportive adjunct to exercise therapy helps to align patella during functional movements and help reduce pain. Beneficial effect of high velocity low thrust manipulations at the thoracolumbar region, SIJ, and/or hip joint is need to be studied further.

CONCLUSION

AKP is a common musculoskeletal complaint with PFPS affecting all age group of patients. PFPS is often multifactorial in nature and may vary from patient to patient. Patients with PFPS demonstrate a decrease in strength of VMO, hip abductor and external rotators on the affected side. There is usually tight lateral patellar structures and patellar instability. This all factors leads to diffuse retro-patellar or peri-patellar pain most prominent when ascending or descending stairs, squatting, or sitting for prolonged periods with the knees flexed. The current review suggested a multimodal conservative management is more beneficial in these patients. A complex exercise program including the core, lower extremity, hip and trunk muscles strengthening has been shown to be the best course of treatment for improvement of pain and function in patients with AKP. The supportive equipment such as a taping have also shown improvement of pain and function of the knee. Improved strength of hip and core muscles provides proximal stability and prevents knee valgus forces, patellar taping helps to improve alignment of patella thus correcting factors responsible and improves condition. As PFPS affecting sedentary and athletes both the population, the physical needs being different in both the population further interventional studies should be undertaken to address difference of plan of treatment as well as frequency and duration of exercise for them.

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