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Adhith KJ
II yr MPT, Saveetha College of Physiotherapy, Saveetha University, Chennai, Tamil Nadu, India

Lalthutiamngheti
II yr MPT, Saveetha College of Physiotherapy, Saveetha University, Chennai, Tamil Nadu, India

Dr. Senthil Kumar S
MPT, PhD, Associate Professor, Orthopaedic Physiotherapy, Saveetha College of Physiotherapy, Saveetha University, Chennai, Tamil Nadu, India

Correspondence
Adhith KJ
II yr MPT, Saveetha College of Physiotherapy, Saveetha University, Chennai, Tamil Nadu, India

Effects of hip strengthening exercises on pain and function in females with patellofemoral pain: A case series

Adhith KJ, Lalthutiamngheti and Dr. Senthil Kumar S

Abstract
Study Design: Case Study Series
Background: Patellofemoral pain is a common overuse injury in active female. It has been suggested that hip muscle weakness may be an important factor in the etiology of females with PFP. This case series describes the effect of hip muscle strengthening on pain and function to manage patellofemoral pain in females.
Case Description: Three patients who are diagnosed having PFP is treated with a three weeks exercise program of hip strengthening. Outcome measures used to capture change in patient status includes the Numeric Pain Rating Scale and Kujala Anterior Knee Pain Scale.
Discussion: Three patients of age in between 18 to 30 with anterior knee pain were included in this prospective case series. All the three patient got statistical significant improvement in NPRS and AKPS after three weeks exercise program.
Conclusion: This case study series provided data to support further investigation to understand the relationship between hip muscle strength and PFP, and to identify patients who will best respond to hip strengthening exercise program.

Keywords: Patellofemoral pain, hip strengthening, Numerical pain rating scale, Kujala knee pain scale

Introduction
Patellofemoral pain (PFP) is one of the most common overuse injuries of the lower extremity seen in the physical therapy outpatient clinic. It affects 10% to 20% of the general population and is associated with higher risk of injury in active females [1]. The aetiology of this condition remains unknown, although many intrinsic and extrinsic factors have been suggested [2, 3]. Thus a variety of conservative treatments have been suggested, including quadriceps strengthening, patellar taping, stretching and biofeedback [4, 5]. Nevertheless, no single intervention has been shown to be the most effective and the results of these treatment approaches have been mixed [6]. Recently, various authors have suggested an association between hip muscle weakness and the patellofemoral pain [7, 8]. Poor hip control may lead to abnormal patellar tracking, increasing patellofemoral joint stress and causing wear on the articular cartilage [9]. A systematic review concluded that there is strong evidence that females with PFP demonstrate impaired strength of the hip musculature, as compared to control subjects [10]. As such, hip strengthening has been advocated as an intervention for persons with PFP. The purpose of the case series reports was to illustrate that an exercise program focusing on progressive hip strengthening for 3 weeks duration could have a positive effect on pain and functional status in three females patients with PFP.

Case Description
Three consecutive patients, referred to a single physical therapy outpatient department with a diagnosis of PFP were screened for the eligibility criteria in this study. All participants satisfied the inclusion criteria; 18 to 30 years of age, anterior knee pain on at least two of the following activities like prolonged sitting, squatting, climbing up or down stairs, running and kneeling, pain on at least two of the following evaluations like palpation, patellar compression and resisted knee extension and having symptoms for at least 1 month and pain level >3 and <8 on NPRS.

Exclusion criteria for this study includes prior knee surgery, radicular pain, positive clinical tests of meniscal or ligamentous involvement, and a clinical exam consistent with nonmusculoskeletal etiology of symptoms. Each subject agreed to participate and provided informed consent.

Examination

Patients completed a standardized history and physical examination. The subjective examination included screening for serious pathology and standardized interview questions. Patient demographic variables at baseline are shown in (TABLE 1).

Physical Examination

A postural examination was performed, which included an assessment of postural deviations of the subtalar joint, calcaneal varus/valgus, external tibial torsion, pelvic rotation, and symmetrical weight bearing [11]. A neurological examination to screen for pain of spinal origin was also performed on each patient [12]. In muscle length examination all patients were assessed for flexibility of the hamstrings with the 90-90 hamstring length test, quadriceps length was assessed in prone, Iliopsoas length was assessed by a supine modified Thomas test [13, 14]. As iliotibial band has been purported to influence patellar mechanics, the Ober's test was used to assess the iliotibial band length [15]. Mobility and strength testing measurements of knee and hip active range of motion (AROM) and passive range of motion (PROM) were assessed with a standard goniometer for all the movements. Manual muscle testing of the hip and knee joint musculatures was performed. Patellofemoral joint assessment of static patellar position and orientation was performed for medial/lateral glide, medial/lateral rotation, and anteroposterior and lateral tilt, as described by McConnell [16]. Assessment of dynamic patellar tracking was performed during non–weight-bearing knee extension (45°-0°).Clinical tests that have been described to assess patellofemoral dysfunction also were performed [17]. These includes the patellar compression test, passive patellar mobility test and the apprehension (Fairbanks) test [18]. Symptom reproduction was evaluated during resisted knee extension at various knee flexion angles and palpation was performed for retinaculum tenderness.

Table 1: Demographic details

Patient	Age	BMI	Involved Knee	Symptom Duration
A	28	27.34	Both Knee	5 Months
B	23	23.82	Left Knee	3 Months
C	21	21.25	Left Knee	2 Months

Patient A

This patient was a 28-year-old female with bilateral knee pain of 5 months duration, who reported pain with walking, squatting, descending stairs and sitting more than 20 minutes. She rated the pain as a constant dull ache (8/10) with all activities. On examination, she demonstrated calcaneal valgus in standing but no excessive pronation and less than 3-mm navicular drop in single-limb standing. Muscle length assessment demonstrated decreased hamstring, quadriceps, and hip flexor length and normal iliotibial band/tensor fascia lata length. Active and passive ROM of the knee was full and painless, but hip rotation was limited in internal rotation bilaterally, with a difference from side to side of 8°. Passive joint accessory motion assessment revealed decreased inferior glide of both the hip and patella. Provocative testing elicited pain with the patellar compression test. Muscle testing revealed weakness in the gluteus medius and gluteus maximus (4/5)

Patient B

This patient was a 23-year-old female with left knee pain of 3 month's duration, who reported pain with running, ascending and descending steps, squatting, and sitting greater than 30 minutes. She rated the most painful activities as 7/10 at worst. Postural assessment revealed bilateral subtalar pronation with navicular drop greater than 3 mm and bilateral calcaneal valgus in standing. ROM assessment revealed normal knee ROM, limited hip internal rotation ROM, with a side-to side difference. Muscle length assessment revealed decreased flexibility of the hamstrings, quadriceps, iliotibial band complex, and hip flexors. Muscle testing demonstrated weakness of the gluteus medius and maximus (4/5). Provocative patellar compression testing was positive; however, passive accessory motion assessment demonstrated limited inferior and medial glide of the patella.

Patient C

This patient was a 21-year-old female who reported left anterior knee pain of 2 month's duration with running, squatting, and descending stairs. She rated the most painful activity, running, as 5/10 at worst. Assessment of posture revealed tibial varum and genu varum bilaterally, subtalar joint supination in relaxed stance, and no navicular drop in singlelimb stance. Active ROM of the knee was normal but painful with overpressure into flexion, and hip internal rotation was limited with capsular end feel. Muscle strength testing showed decreased gluteus medius and maximus strength (4^+/5). Muscle length testing revealed shortness of the hamstrings, and iliotibial band complex bilaterally. Provocative testing reproduced pain with the patellar compression test, and passive accessory motion revealed limited superior glide of the patellofemoral joint.

Intervention

For the exercise program, each patient with PFP visited the outpatient clinic 5 times a week during three week period. The physiotherapist was responsible for administering the rehabilitation protocol for each patient, and he or she demonstrated all the exercises and made clinic-based decisions about the weekly progression of exercises. Progression of exercises, increases or decreases in sets and repetitions or duration of exercises, and changes in TheraBand resistance were at the decision of the physiotherapist, based on patient feedback, PFP, and symptoms during rehabilitation progression. (Table 2). The physiotherapist chose the TheraBand resistance based on the patient's ability to complete 10 repetitions of the exercise, maintaining 10 seconds hold for each repletion. All exercises were performed bilaterally.

Table 2: Exercise Protocol

Week	Exercise	Sets, No	Repetitions
1	Hip abduction-side lying	3	10
	Hip external rotation-sitting	3	10
	Hip extension-prone lying	3	10
2	Hip abduction-side lying	3	10 (Red Theraband)
	Hip external rotation-sitting	3	10 (Red Theraband)
	Hip extension-prone lying	3	10 (Red Theraband)
3	Hip abduction-side lying	3	10 (Green Theraband)
	Hip external rotation-sitting	3	10 (Green Theraband)
	Hip extension-prone lying	3	10 (Green Theraband)

Outcomes

The outcome measures utilized in this study included the Numeric Pain Rating Scale (NPRS), and Kujala Anterior Knee Pain Scale (AKPS), were collected at baseline and three weeks after intervention (Table 3). An 11-point Numerical Pain Rating Scale (NPRS) [19], where 0 corresponded to "no pain" and 10 corresponded to "worst imaginable pain," was used to measure pain. Anterior Knee Pain Scale (AKPS) [20] were used to measure function. AKPS have been used previously for clinical outcome studies and are recommended for use with the PFPS population. The AKPS is a 13-item assessment tool, with items differentially weighted for a maximum score of 100 and higher scores indicating better function. The NPRS and AKPS are reliable and valid, with a minimal clinically important difference (MCID) of 2 and 13 points [25, 26].

Results

All the three patients were evaluated pre-intervention and post-intervention after three weeks. Every patient receives 15 visits to treatment. All the patients showed clinical significant improvement in pain and function post intervention (MCID, NPRS>2 & AKPS>13).

Pain

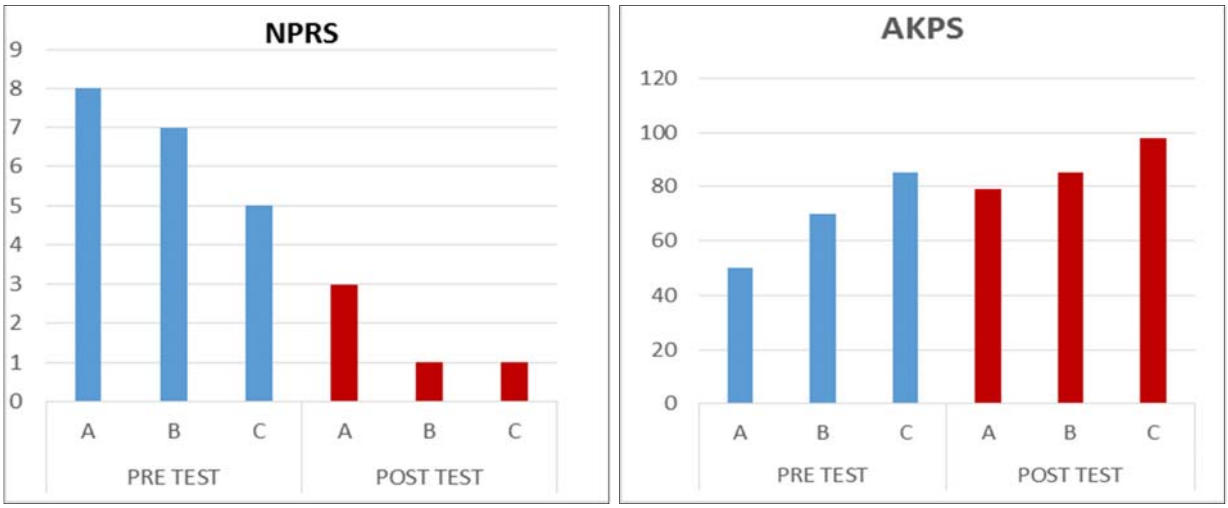
All the three patients had considerable reduction in their pain levels. All the patients are now able to do ascend and descend stairs and involve in squatting activities. Only the patient A had occasional discomfort (3/10) only if she had been on her flexed knees for a considerable long time.

Functional Outcomes

The post-intervention functional assessment scores increased from 50 to 79 in PATIENT A, 70 to 85 in PATIENT B and from 85 to 98 in PATIENT C, respectively.

Table 3: Pre & Post-test evaluation

	Pre Test			Post Test		
	A	B	C	A	B	C
NPRS	8	7	5	3	1	1
AKPS	50	70	85	79	85	98



Graph: Comparison of pre and post-test NPRS & AKPS

Discussion

This small case study series presents preliminary findings to support a novel intervention of strengthening of hip musculatures in females with PFP. A three weeks exercise program of hip strengthening decrease the pain and improves the function of all the three patients.

The findings of the present study support the growing body of literature which suggests that hip strengthening may be a viable intervention for PFP [21, 22]. Mascal *et al.* [23] were the first to demonstrate that an exercise program focusing on hip and trunk strength was effective in decreasing pain, improving hip kinematics, and restoring function in 2 patients with PFP. Subsequent studies by Earl and Hoch [24], demonstrated that exercise programs which incorporate hip strengthening result in improved pain and functional outcomes in females with PFP. Limitations of this report is that no blinding occurred with patients or the investigator, as a single treating therapist completed all examinations and

interventions and since all sessions were supervised, the effectiveness of unsupervised home exercise program need to be known.

Conclusion

This case study series present three patients who responded favorably to a three weeks exercise program specifically targeting the hip musculature strengthening. Further research is needed to better define the relationship between hip muscle strength and PFP, and to identify patients who will best respond to this treatment approach.

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