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Effect of Hip Muscle Strengthening as an Adjunct to Conservative Management in Patients with Patellofemoral Pain Syndrome

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Abstract: ***Introduction: Patellofemoral pain syndrome (PFPS) is the most common disorder affecting the lower extremity due to excessive patellofemoral joint pressure secondary to poor patellar tracking. Conservative management of PFPS includes taping, strengthening and stretching of knee musculature. In recent studies hip abductors and lateral rotators muscles weakness has been attributed as an important impairment in PFPS. Present study is done to investigate the effect of hip muscle strengthening as an adjunct to conservative management in patients with patellofemoral pain syndrome. Objectives: 1. To study the effect of conservative management and hip muscle (lateral rotators and abductors) strengthening as an adjunct to conservative management on pain and lower extremity functions in PFPS. Method: 40 consenting subjects fulfilling the selection criteria were included. Further, they were allocated into 2 equal groups- group A and group B, using chit method. Group A subjects were given conservative management in the form of quadriceps strengthening, Stretching of muscles and Mc connel tapping, whereas group B in addition, underwent strengthening of hip abductor and lateral rotator muscles. Both the groups completed 3 treatments sessions per week for four weeks i.e. total 12 sessions. Before the start of training and after four weeks of training, all the subjects were evaluated with respect to visual analogue scale, anterior knee pain scale and lower extremity functional scale. Results: Results shows improvement in pain and lower extremity functions in both the groups but group B was better as compared to group A. Conclusion: After four weeks of intervention, improvements of pain and function were greater for group B, but the difference was significant only for pain.***

Keywords: Patellofemoral pain syndrome, Visual Analoge Scale, Anterior knee pain scale ,Lower extremity functional scale

1. Introduction

Patellofemoral pain syndrome (PFPS) is a highly prevalent musculoskeletal overuse condition that has a significant impact on participation of individual in daily physical activities[1].The incidence in general population is reported to be as high as one in four with this proportion increasing in athletic population.[2] PFPS is characterized by dull aching, localized retro-patellar pain or peri- patellar pain which is aggravated by physical activities such as climbing stairs, squatting, jumping and with prolong period of sitting.[2,3]. Many parameters have been cited in literature as causing malalignment of patella and hence pain. These are increased Q angle, muscle tightness, excessive pronation, patella alta and VMO insufficiency.

An increased Q angle which may be associated with increased femoral anteversion external tibial torsion and lateral displacement of tibial tubercle increases the lateral pull of patella. Previous studies showed that the combination of factors such as abnormal lower limb biomechanics, soft tissue tension, muscle weakness and excessive exercise leads to patellar malalignment and result in increased stress on cartilage and subchondral bone and resulted in PFPS.[4] Altered stresses in the cartilage may also play a role in a pain response by transferring stresses into the underlying subchondral bone and exciting nociceptors. The most accepted hypothesis of PFPS is that abnormal patellar tracking increases patellofemoral joint stress and causes subsequent wear on articular cartilage[5].

Recently, it has been postulated that patellofemoral joint dysfunction may be the result of abnormal proximal joint control. Researchers have shown that the patellofemoral joint can be influenced by abnormal femoral transverse and frontal plane movements. It has been hypothesized that increased frontal plane hip motion may affect the lateral forces acting on the patella by increasing the "dynamic" quadriceps angle. In turn, internal rotation of the femur has been suggested to be a contributor to altered patellofemoral joint kinematics (lateral patella tilt and displacement) in weight bearing.[6] Clinically, weakness of the hip external rotators (i.e. gluteus maximus and deep rotators) can result in a „rolling in" of the femur during early stance, and therefore, may have an adverse effect on the patellofemoral joint. Given the theoretical link between faulty frontal and transverse plane hip kinematics during weight bearing and altered patellofemoral joint mechanics, investigators have begun to explore whether hip muscle strength is a contributing factor in PFPS. Many clinical interventions have focused directly on the patella, with the goal of trying to correct the patellar alignment and motion. The quadriceps strengthening especially the VMO, hamstring and Iliotibial band stretching, patellar mobilization, and patellar taping were interventions which focused directly on patella alignment.[7]. The use of patellar taping techniques for the treatment of patellofemoral pain syndrome became popular following the publication of McConnell original article in 1986. It has been proposed that when patella under medial glide tapping, it changes position, resulting in better alignment between patella and trochlea notch of femur; there is stretch on lateral structures as well as an increase in VMO activity and decrease in pain thereby facilitating in earlier initiation of strengthening exercise[8] Majority of studies included knee strengthening and stretching exercises with or without patella taping as intervention in PFPS.[9,10,4] But, very few studies have been done to verify the effectiveness of hip muscle strengthening in addition to knee muscle strengthening in treatment of patellofemoral pain syndrome

patients. Therefore, the purpose of this study was to investigate the effect of hip muscle strengthening as an adjunct to conservative management in patients with patellofemoral pain syndrome on pain and function in Indian population

2. Review of Literature

Defne Kaya et al (2011)[9] studied the effect of an exercise program in conjunction with short-period patellar taping on pain, electromyogram activity, and muscle strength in patellofemoral pain syndrome .Twelve patients and 16 healthy people participated. Patients underwent short-period patellar taping plus an exercise program for 3 months. They concluded that short-period patellar taping plus an exercise program improves VMO and VL activation. A shorter period of taping for the exercise program may be as beneficial as a prolonged taping application.

Khalil Khayambashi et al (2012)[6] examined the effectiveness of isolated hip abductor and external rotator strengthening on pain, health status, and hip strength in females with patellofemoral pain (PFP). They gave hip abductor and external rotator strengthening using theraband to one group and no exercise to other group. After the 8 week intervention, they found out that the group performed hip abductor and external rotator strengthening have significant reduction in pain & improvement in hip muscle strength compared to no exercise control group.

3. Materials and Methodology

40 participants with anterior knee pain, who were referred to physiotherapy department of CMF"s college of physiotherapy, chinchwad and willing to take treatment for 4 weeks, were recruited for the study. The subjects were screened and were randomly allocated into two groups- group A (conservative treatment which include quadriceps strengthening, stretching of hip ,knee muscles with Mc connel taping), group B (Hip muscle strengthening with conservative treatment) using chit method. A written informed consent was taken from each participant. Ethical clearance was obtained from university"s institutional review board. Inclusion criteria were 1) Subjects with peripatellar/retropatellar knee pain for past 3 months in at least two of the activities i.e. prolong sitting, stair ascent or descent, squatting, kneeling 2)Subjects with positive Mc connel test 3)Subjects with age group 18-35 4)Subjects with both genders, and with sedentary life styles. Exclusion criteria were 1)Subjects with recent soft tissue injuries of the knee, osteoarthritis and rheumatoid arthritis 2)Subjects with recent fractures of lower limb 3)Subjects with referred pain in lower extremity and with neurological deficits .

Intervention: Group A participants were given treatment in form of stretching to any of the tight muscles i.e. hamstring, rectusfemoris, gastrocnemius, Iliotebial band, followed by Mc connel taping and quadriceps strengthening exercises. Static passive stretching was done for the above mentioned muscles with 30 seconds hold, repeated for three times per session, total 3 sessions a week.[7].Hypoallergic non elastic adhesive tape was applied to correct one/any combinations of patellar orientation i.e. glide, tilt and rotation every alternate day before strengthening exercises for 4 weeks as prescribed by Mc connel.

Quadriceps strengthening exercises were performed using de lorme and Watkins regimen.[11]Subjects were asked to perform seated knee extension and mini squats (0-45^0) with weights in hands. In addition to above protocol, group B subjects were undergone strengthening of hip abductor and lateral rotator muscles in accordance to de lorme regimen.

3.1 Outcome Measures-: The pre and post intervention assessment was done by using visual analogue scale, Anterior knee pain scale score (AKPS), Lower extremity functional scale score(LEFS). Participants were also evaluated for 10 RM for hip and knee muscles to implement PRE regimen.

4. Statistical Analysis

Statistical analysis was performed by using Graph pad Instat and Microsoft excel. Descriptive statistics was used to find out mean, standard deviation for outcome variables. The baseline characteristics between the groups were compared to maintain uniformity between the groups. Wilcoxon Signed Rank test was used to find out the significant difference for VAS on activity, AKPS & LEFS (non-parametric data) within the groups.

Mann-Whitney U test was used to find out the significant difference for VAS on activity, AKPS &LEFS (non-parametric data) between the groups. For all the tests level of significance was set at p equal to or less than 0.05.

5. Results

There was no statistically significant difference between mean age and standard deviation of the participants in two groups. Mean age of Group A was 25.2 years and that Group B was 27.85 years. Out of total 40 participants, group A consisted 7 males, 13 females and group B had 4 males and 16 females. N is equal to 20 for both the groups.

Table 1: Comparison of Pre and Post value of Vas on activity in Group A and Group B

Group	T/T	MEAN	SD	P Value
A	PRE	6.82	0.93	0.00
	POST	3.26	0.85	
B	PRE	7.0	1.7	0.00
	POST	1.69	0.57	

Above table showed significant reduction in VAS on activity in group A after 4 weeks of conservative treatment ($p<0.05$). Group B showed significant decrease in VAS on activity after 4 weeks of hip strengthening protocol as an adjunct to conservative treatment ($p<0.05$)

Table 2: Comparison of pre and post value of AKPS in group A and B

Group	T/T	MEAN	SD	P Value
A	PRE	64.4	7.88	0.00
	POST	75.95	8.17	
B	PRE	60.30	6.86	0.00
	POST	75.13	6.97	

Above table showed significant difference in scores of AKPS in group A after 4 weeks of conservative treatment ($p<0.05$). Group B showed significant improvement in AKPS scores after 4 weeks of hip strengthening protocol as an adjunct to conservative treatment($p<0.05$).

Table 3: Comparison of Pre and Post value of LEFS in group A and B

GROUP	T/T	MEAN	SD	P Value
A	PRE	51.3	7.58	0.00
	POST	60.6	6.53	
B	PRE	53.4	6.22	0.00
	POST	64.55	4.62	

Above table showed significant difference in scores of LEFS in group A after four weeks of conservative treatment ($p<0.05$). Group B showed significant improvement in LEFS scores after 4 wks of hip strengthening protocol as an adjunct to conservative treatment($p<0.05$).

Table 4: Comparison of pre and post value of VAS on activity between two groups

Group	*T/T*	*Mean*	*SD*	*P Value*
A	PRE	6.82	0.93	0.473
B	PRE	7.0	1.08	
A	POST	3.26	0.85	0.00
B	POST	1.69	0.57	

Above table showed the comparative baseline and post intervention values of VAS on activity in both the groups. There was no statistically significant difference ($p>0.05$) between the groups for VAS at baseline. Post-intervention values showed significant reduction in VAS score ($p<0.05$) in both the groups. Group B showed more reduction as compared to group A.

Table 5: Comparison of pre and post value of AKPS between two group

Group	*T/T*	*MEAN*	*SD*	*P Value*
A	PRE	64.40	7.88	0.098
B	PRE	60.30	6.86	
A	POST	75.95	9.01	0.956
B	POST	75.13	6.97	

Above table showed the comparative baseline and post intervention values of AKPS in both the groups. There was no statistically significant difference ($p>0.05$) between the groups for AKPS at baseline. Post intervention values showed significant improvement in AKPS score in both the groups. However, there was no statistical difference ($p>0.05$) in post intervention AKPS score between the groups

Table 6: Comparison of pre and post value of LEFS between two groups

Group	*T/T*	*MEAN*	*SD*	*P Value*
A	PRE	51.3	7.58	0.317
B	PRE	53.4	6.22	
A	POST	60.6	6.53	0.48
B	POST	64.55	4.62	

Above table showed the comparative baseline and post intervention values of LEFS in both the groups. There was no statistically significant difference ($p>0.05$) between the groups for LEFS at baseline. Post intervention values showed significant improvement in LEFS score in both the groups. However, there was no statistical difference ($p>0.05$) in post intervention LEFS score between the groups.

6. Discussion

Patellofemoral pain syndrome is one of the most common and most challenging knee pathologies to manage unlike ACL injury, which has specific mechanism of injury and treatment approach, patients with PFPS receive various interventions.[12] The results of present study demonstrated that 4 week intervention either consisting of conservative management or conservative management supplemented by hip strengthening both led to improved function and decreased pain during activity significantly after the intervention.

Despite the lack of statistically significant difference in AKPS and LEFS between the two groups receiving an intervention, analysis of data based on the published MCID of 9 pts for LEFS, 13 pts for AKPS suggest greater clinical benefits for combined hip and conservative treatment The patients in group B showed improvement above the MICD for both scales- LEFS (11.15), AKPS (14.85) compared to those in group A LEFS (9.3), AKPS (11.55). However, comparing the pain reduction between the groups, post training demonstrated statistical significant improvement in group B. Mechanism by which pain reduction occurred by patellar taping could be because of changes brought about in the patellofemoral joint mechanism. The correction of lateral glide, lateral tilt and rotation of patella by taping leads to a restoration of proper patellar alignment and tracking in the trochlear groove. Thus shifting the location of contact surface of knee and reducing the contact stresses over the sensitive areas of knee and hence facilitating pain free function of knee joint.[2] Along with taping flexibility exercise was also included in the study, as tight structures place increased and uneven load on patellofemoral joint and cause pain and dysfunction. Tyler et. al[13] stated flexibility of the hip flexors and iliotibial band could reduce the tension in the lateral retinaculum and allow the appropriate patellar glide. Patients with PFPS historically have exhibited quadriceps weakness thought to contribute to abnormal patella tracking and patellofemoral joint irritation.[12]. Restoration of quadriceps strength and function has been demonstrated to be a significant contributing factor to recovery from patellofemoral symptoms.[14]In present study, statistically significant reduction in pain and improvement in daily functions according to MCID was noticed in group B which could be attributed to strengthening of hip muscle. Based on the findings of Mascal et. al., it is reasonable to suggest that improvements in hip abduction and external rotation strength which ranges from 32 to 56 % might have resulted in changes in hip kinematics during functional activities. Reduction in the adduction / internal rotation of the stance limb during functional activities that could decrease the dynamic Q angle and thereby reduce the amount of lateral forces action on the patella.[15]. It is possible that changes in hip muscle performance might have resulted in a decrease in patellofemoral joint loading and therefore pain and functions. Thus, reduction in pain and improvement

in functional status in both the groups can be attributed to better patellar alignment gained through taping, quadriceps strengthening and stretching of IT band, rectus femoris, hamstrings and gastrocnemius. However, better results with hip strengthening as an adjunct to conventional treatment was gained. Hip muscle strengthening especially hip abductors and external rotators add on to the pelvic stability and leg alignment during weight bearing activities

7. Conclusion

Four weeks of either conservative treatment or conservative treatment supplemented by hip strengthening exercises were effective in improving function and reducing pain in PFPS. Improvements of pain and function were greater for the group who performed the combined conservative treatment and hip muscle strengthening exercises, but the difference was significant only for pain.

8. Future Scope

Further research should include the effect of other hip muscles in development and treatment of PFPS. The effect of eccentric training of hip musculature on pain and function in PFPS can be investigated. The effect of functional training in PFPS can also be studied.

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