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Effect of VMO strengthening with and without hip strengthening on pain and function in patients with Patellofemoral Pain Syndrome

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Abstract
Patellofemoral pain syndrome (PFPS), as a common source of diffused anterior knee pain in young and active individuals, accounts for 25% of all the knee problems in sports medicine clinic. It is an idiopathic condition characterized by aching pain in the peripatellar area, which is exacerbated by physical activities, such as climbing stairs, squatting, jumping, running and prolonged sitting. Despite its prevalence, the etiology and treatment of this syndrome remain vague and controversial. More recently, studies have focused on hip muscle dysfunction as a possible contributor to patellofemoral pain. Recent studies show that Hip weakness is associated with PFPS especially hip abductors and external rotators. Patients with PFPS could benefit from hip muscle strengthening, since this intervention may reduce excessive hip motion and, as a consequence, excessive patellofemoral joint stress. The main of the study to compare the efficacy between VMO strengthening with Hip strengthening Vs. VMO strengthening alone on pain and function in patients with PFPS.A total of Subjects who matched the inclusion and exclusion criteria were recruited for this study and randomly divided into two groups. Permission was obtained from the hospital authorities. Subjects were explained in detail about the study and written consent form was taken. Demographic data of the subjects was collected and recorded. Pre-participation evaluation form consisted of VAS and AKPS. Pain was assessed by Visual analogue Scale, and Functional Disability by Anterior Knee Pain Scale. The patients were divided into two groups: Experimental group and Control group. Experimental group was given VMO Strengthening exercises along with Hip Strengthening exercises and Control group was given VMO Strengthening exercises alone. After 4 weeks of intervention the subjects were again assessed by VAS and AKPS and values were recorded. All the exercises were performed under guidance and home program was given. Treatment protocol: 3 times a week for 4 weeks. The data obtained were recorded and analyzed. Student t test (two tailed, dependent) has been used to find the significance of study parameters on continuous scale within each group. Student t test (two tailed, independent) has been used to find the significance of study parameters on continuous scale between two groups (Inter group analysis) on metric parameters. The statistical analysis indicated that there was strong statistical significance in VAS and AKPS in both the groups with P value of<0.001**, but in between groups, group A showed suggestive statistical significance with P value of 0.074+ in AKPS score and no statistical significance in VAS score compared to group B

Keywords: Patellofemoral pain syndrome VMO strengthening hip strengthening

Introduction
The knee consists of two major joints, the tibiofemoral joint and the patellofemoral joint. In PFPS the problem the problem will be localized in the patellofemoral joint. The patella sits within the femoral groove; the fascies articularis patellae (posterior side) is covered with cartilage that glides over the cartilage of the anterior part of the femoral condyles (femoral groove).

Patellofemoral pain syndrome (PFPS), as a common source of diffused anterior knee pain in young and active individuals, accounts for 25% of all the knee problems in sports medicine clinic [1, 2,]. It is an idiopathic condition characterized by aching pain in the peripatellar area, which is exacerbated by physical activities, such as climbing stairs, squatting, jumping, running and prolonged sitting [3]. Despite its prevalence, the etiology and treatment of this syndrome remain vague and controversial [4].

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It has been suggested that factors like abnormal lower limb biomechanics, soft tissue tightness, muscle weakness, overuse and overload may result in increased cartilage and subchondral bone stress and subsequent patellofemoral pain [2,-5,]. Abnormal muscular factors (weakness and tightness) that alter tracking of the patella in the femoral trochlear notch can contribute to increased patellofemoral contact pressure and result in pain and dysfunction [6- 8].

Traditionally, research and clinical practice have focused on muscle function of the quadriceps, based on the theory that an imbalance between the vastus medialis oblique and the vastus lateralis can lead to increased lateral stress in the patellofemoral joint [9-10]. Most exercise therapy programmes for PFPS have focused on strengthening the quadriceps muscles, which was seen as the most promising conservative treatment method for patellofemoral pain syndrome. Conservative management remains the treatment of choice for frontline management of PFPS, with exercise therapy forming the mainstay [11]. In recent years, hip muscle strengthening has been proposed as a proper treatment for patients with PFPS. The rationale for this intervention is supported by the theoretical background hypothesizing that excessive hip motion, especially in frontal and transverse planes, places stress on the patellofemoral joint [12]. This excessive hip motion may be related to the weakness of muscles surrounding the hip joint [13-17]. Researchers have recently investigated the influence of the proximal musculature, including the hip girdle and lumbo-pelvic region [18, 19]. Hip muscle weakness and reduced dynamic postural stability have been reported in the literature as potential contributors to abnormal patellofemoral joint kinematics [18]. As a result there has been a recent shift towards including proximal exercises in the management of PFPS in order to decrease the load on the patellofemoral joint and normalize the kinematics. Traditionally VMO strengthening was focused, due to its weakness which results in lateral tracking of patella. Recent studies show that Hip weakness is associated with PFPS especially hip abductors and external rotators. Patients with PFPS could benefit from hip muscle strengthening, since this intervention may reduce excessive hip motion and, as a consequence, excessive patellofemoral joint stress. Therefore, there is need to find the effect of VMO strengthening along with hip strengthening vs. isolated VMO strengthening on pain and function in PFPS.

Methodology and Procedure

A total of 30 Subjects who matched the inclusion and exclusion criteria were recruited for this study and randomly divided into two groups. Permission was obtained from the hospital authorities. Subjects were explained in detail about the study and written consent form was taken. Demographic data of the subjects was collected and recorded. Pre-participation evaluation form consisted of VAS and AKPS. Pain was assessed by Visual analogue Scale, and Functional Disability by Anterior Knee Pain Scale. The patients were divided into two groups: Experimental group and Control group. Experimental group was given VMO Strengthening exercises along with Hip Strengthening exercises and Control group was given VMO Strengthening exercises alone. After 4 weeks of intervention the subjects were again assessed by VAS and AKPS and values were recorded. All the exercises were performed under guidance and home program was given. Treatment protocol: 3 times a week for 4 weeks. The data obtained were recorded and analyzed.

Inclusion Criteria

Insidious onset of symptoms unrelated to trauma, Both male and female and Pain in the anterior knee associated with any of the following: During or after activity, Prolonged sitting, Stair ascent or descent, Squatting. Kneeling, and Pain with palpation of the patellar facets

Exclusion Criteria

Meniscal or other intra-articular injury, Patellar tendon, iliotibial band or pes anserine tenderness, Positive patellar-apprehension sign, Osgood-Schlatter or Sinding-Larsen-johansen syndrome, Evidence of effusion, Hip or lumbar referred pain, History of recurrent patellar subluxation or dislocation, History of surgery to the knee joint, Congenital acquired lower limb deformities, Pregnancy

Intervention

For Mini wall squat exercise, it was performed from 0-40 degrees of knee flexion. The subject stood with his back supported on the wall and put ball between both knees, with the feet approximately 1ft away from the wall. The subject was instructed to lower his/her trunk on the wall with knee flexion of 40 degrees while squeezing the ball between the knees by hip adduction and medial rotation and hold this position for 6 sec count, then return back to starting position [19]. For Terminal knee extension, it was performed in standing position with feet shoulder-width apart, facing toward the plinth, and one band of theraband attached around the knee and another to the plinth leg. The subject was instructed to bend the knee to 30 degrees (keeping the foot on floor) and then straighten the leg to full extension against resistance of band, hold this position for 6 sec, then the subject was to return to starting position and relax [19]. Both mini wall squat and terminal knee extension were performed for 10 repetitions with 1 minute rest before proceeding to next exercise. These two exercises specifically strengthen the VMO muscle. For Hip abduction exercise, the subject was asked to lie in side-lying position on the non-affected side with knee bent. Ankle cuff was wrapped proximal to lateral malleolus and the subject was instructed to raise his/her limb in abduction while the pelvis was stabilized, hold for 6 sec, then return to starting position [19].

For Hip external rotation exercise, the subject was asked to sit at the edge of plinth with the hip and knee bent to 90 degrees and hand behind for support. Ankle cuff was wrapped proximal to lateral malleolus and the patient was instructed to rotate the leg inward toward the non-affected side while the thigh was stabilized, hold for 6 sec, then return to starting position [19]. Each strengthening exercise of hip was performed for 2 sets of 10 repetitions with 1 minute rest after each set. Each subject was trained at 60% of 10 repetition maximum (the amount of weight that could be lifted and lowered through available range of motion exactly 10 times) [20]. A new 10 repetition maximum was established every week for adjustment.

Statistical Analysis

Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean ± SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5 % level of significance. The following assumptions on data is made, Assumptions: 1.Dependent variables should be normally distributed, 2.Samples drawn from the population should be random,

Cases of the samples should be independent
Student t test (two tailed, independent) has been used to find the significance of study parameters on continuous scale between two groups (Inter group analysis) on metric parameters. Student t test (two tailed, dependent) has been used to find the significance of study parameters on continuous scale within each group.
Chi-square/ Fisher Exact test has been used to find the significance of study parameters on categorical scale between two or more groups, Non-parametric setting for Qualitative data analysis.

Results

Table 1: Age distribution of patients studied

Age in years	Group A	Group B	Total
<30	0(0%)	2(13.3%)	2(6.7%)
30-40	2(13.3%)	3(20%)	5(16.7%)
41-50	7(46.7%)	8(53.3%)	15(50%)
51-60	6(40%)	2(13.3%)	8(26.7%)
Total	15(100%)	15(100%)	30(100%)
Mean ± SD	46.80±6.73	41.13±8.63	43.97±8.13

Table 1 shows the percentile distribution of the age in group A is 46.80±6.73 and in group B is 41.13±8.63 which matches the P value of 0.100

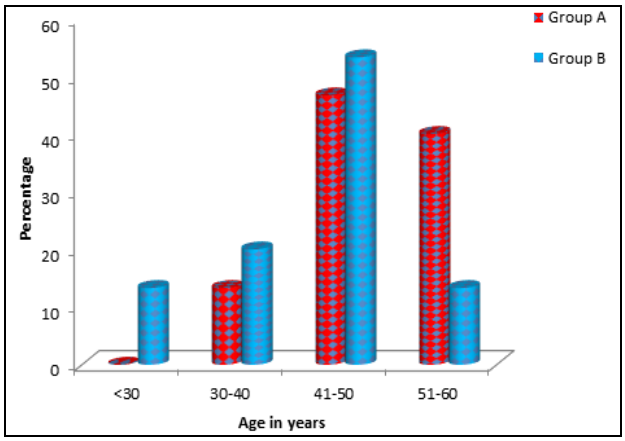

Fig 1: Graphical representation of age distribution of patients studied

Table 2: Gender distribution of patients studied

Gender	Group A	Group B	Total
Female	14(93.3%)	14(93.3%)	28(93.3%)
Male	1(6.7%)	1(6.7%)	2(6.7%)
Total	15(100%)	15(100%)	30(100%)

Table 2 shows the percentile distribution on gender for group A was 1(6.7%) male and 14(93.3%) female and for group B, the percentile gender distribution was 1(6.7%) male and female 14(93.3%). It shows homogeneity

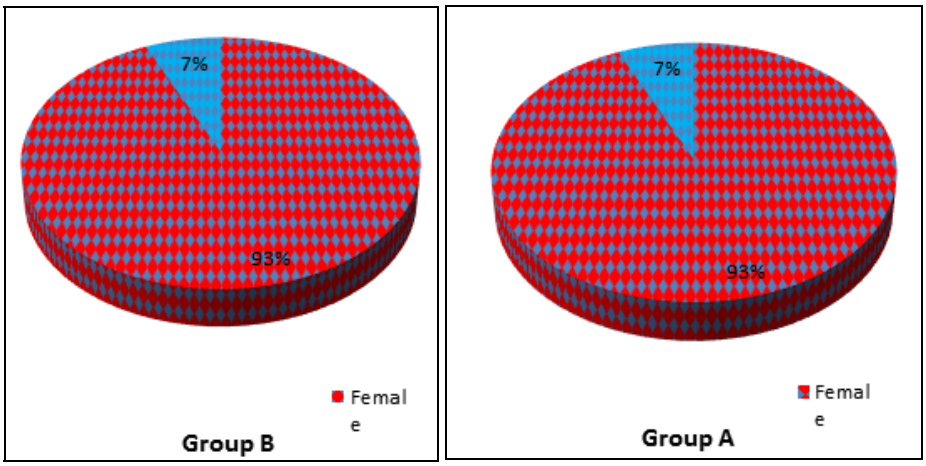

Fig 2: Graphical representation of gender distribution of patients studied

Table 3: Comparative assessment of VAS score at p

VAS	Pre score	Post score	Difference	t value	P value
Group A	6.87±1.55	1.80±0.94	5.067	22.205	<0.001**
Group B	6.67±1.54	2.13±0.99	4.53	16.562	<0.001**
P value	0.726	0.353	-	-	-

Table 3 shows comparative assessment of VAS score at pre and post in both groups.
Group A with pre score of 6.87±1.55 and post score of 1.80±0.94 shows strong statistical significance in pain reduction with P value of<0.001 and with 5.067 difference between pre and post VAS scores.
Group B with pre score of 6.67±1.54 and post score of 2.13±0.99 shows strong statistical significance in pain reduction with P value of<0.001 and with 4.53 difference between pre and post VAS scores.
VAS score comparison between Group A and Group B shows no statistical difference with p value of 0.353. Hence, null hypothesis (H_0) accepted for VAS score.

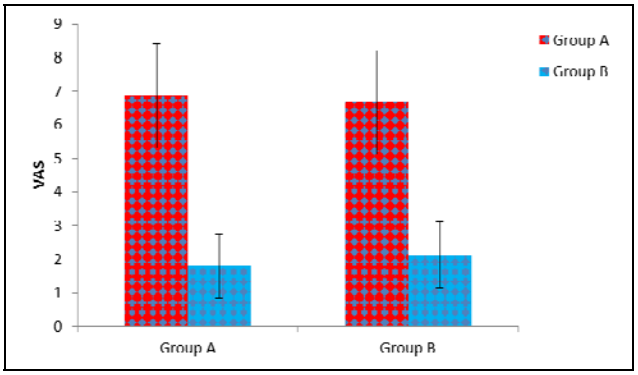

Fig 3: Graphical representation of comparative assessment of VAS score at pre and post

Table 4: Comparative assessment of AKPS score at pre and post

AKPS	Pre score	Post score	difference	t value	P value
Group A	60.27±8.88	86.53±5.94	26.267	19.658	<0.001**
Group B	59.33±15.05	80.87±10.25	21.533	12.205	<0.001**
P value	0.838	0.074+	-	-	-

Table 4 shows comparative assessment of AKPS score at pre and post in both groups.

Group A with pre score of 60.27±8.88 and post score of 86.53±5.94 shows strong statistical significance in functional improvement with P value of<0.001 and with 26.267 difference between pre and post AKPS scores.

Group B with pre score of 59.33±15.05 and post score of 80.87±10.25 shows strong statistical significance in functional improvement with P value of<0.001 and with 21.533 difference between pre and post AKPS scores.

AKPS score comparison between Group A and Group B shows suggestive statistical difference with P value of 0.074+. Hence, alternate hypothesis (H_1) accepted for AKPS score

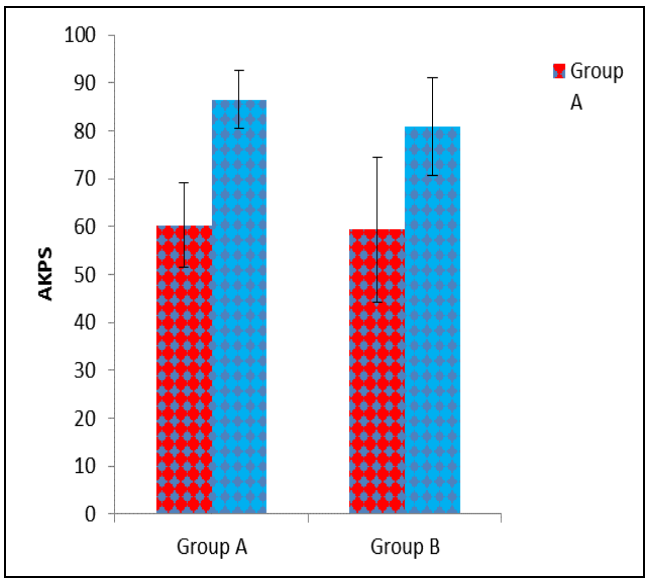

Fig 4: Graphical representation of comparative assessment of AKPS at pre and post

Discussion

This study analysed the results of VMO strengthening along with hip strengthening and VMO strengthening alone with Ultrasound as common in patients with PFPS. In the present study 30 subjects were taken and divided into two groups; 15 in each group. Group-A was given VMO strengthening along with hip strengthening and Group-B was given VMO strengthening alone.

The objective of the study was to find out the effectiveness of VMO strengthening along with hip strengthening and VMO strengthening alone and to compare between them in reducing pain and improving function in patients with PFPS. VMO strengthening exercises in this study included mini wall squat exercise and terminal knee extension and both exercises were performed for 10 repetitions; Hip strengthening exercises included hip external rotation and hip adduction exercises and were performed for 10 repetitions of two sets. All the exercises were performed 3 times per weeks for 4 weeks

The two groups were analyzed with VAS and AKPS questionnaires' for pain relief and functional status and the mean and standard deviation was calculated for the statistical analysis.

Group A with pre score of 6.87±1.55 and post score of 1.80±0.94 shows strong statistical significance in pain reduction with P value of<0.001 and with 5.067 difference between pre and post VAS scores. Group B with pre score of 6.67±1.54 and post score of 2.13±0.99 shows strong statistical significance in pain reduction with P value of<0.001 and with 4.53 difference between pre and post VAS scores. VAS score comparison between Group A and Group B shows no statistical difference with p value of 0.353. Hence, null hypothesis (H_0) accepted for VAS score.

Group B with pre score of 60.27±8.88 and post score of 86.53±5.94 shows strong statistical significance in functional improvement with P value of<0.001 and with 26.267 difference between pre and post AKPS scores. Group B with pre score of 59.33±15.05 and post score of 80.87±10.25 shows strong statistical significance in functional improvement with P value of<0.001 and with 21.533 difference between pre and post AKPS scores. AKPS score comparison between Group A and Group B shows suggestive statistical difference with P value of 0.074+. Hence, alternate hypothesis (H_1) accepted for AKPS score.

The results of the present study indicate a significant decrease in pain and improvement of function in both groups. However, between groups, there was no significant difference in pain reduction but there was significant difference in improvement of function in group A as compared to group B. Thus, both the groups showed significant decrease in pain and improvement in function but group a showed better results in improvement of function compared to group B but pain reduction in both groups showed no significant difference.

In PFPS there is lateral tracking of patella due to VMO weakness. VMO strengthening exercises used in this study helps to specifically activate and strengthen VMO muscle, thereby improving the knee function. A majority of research suggests close kinetic chain (CKC) exercises to be more beneficial in strengthening VMO.

The theoretical background suggests that excessive hip motion, especially in frontal and transverse planes, places stress on the patellofemoral joint. This excessive hip motion may is related to the weakness of muscles surrounding the hip joint. Recent studies show that Hip weakness is associated with PFPS especially hip abductors and external rotators. Thus, addition of hip strengthening exercises to VMO strengthening exercises was carried out in this study. Hip strengthening exercises in this study included hip external rotation and hip abduction exercises thus mainly targeting the weak gluteus medius muscle associated in PFPS syndrome.

There was no significant difference in pain reduction between groups but clinically group a showed pain reduction earlier than 4th week compared to group a, but after completion of 4 weeks of intervention both the groups had similar effects on pain reduction statistically. There was significant improvement in function in group A statistically, however clinically group A showed more significant improvement in function compared to group B, because of addition of hip strengthening exercises which improve the strength of weak abductors and external rotators of hip seen in PFPS patients, this reduces stress on joint and helps in functional improvement.

Conclusion

This was concluded that VMO strengthening along with hip strengthening exercises for 3 days a week for total duration of 4weeks had a suggestive statistical improvement in function [AKPS] and similar statistical results in pain reduction [VAS] compared to group treated with VMO strengthening alone given for the same period

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