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Effect of VMO Strengthening on Pain, Strength and Function in Subjects with Patellofemoral Pain Syndrome: An Experimental Study

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ABSTRACT

The objective of this randomized controlled trial was to evaluate the effect of "SQUAT ADD" exercises in patellofemoral pain syndrome in terms of pain, strength and functional ability with and without biofeedback. Twenty five subjects were recruited for the study on the basis of inclusion and exclusion criteria after signing the informed consent form. They were randomly assigned to two groups with 13 subjects in Group A and 12 subjects in Group B. Subjects of both the group were first administered by Squat add exercise for 2 sets along with 3 repetition with 6 sec of cuff hold time in between 10 sec of rest in each repetition with and without biofeedback. Numeric pain scale was used to measure pain, kujala questionnaire was used to measure functional ability, and VMO strength was measured by SQUAT-ADD. The within group comparisons at the end of the trial showed significant improvement. The between-group comparisons at the end of the trial showed significant improvement in function only. The result of present study indicates that SQUAT ADD exercise improved the quality of life as well as strengthening of VMO leads to decrease pain in subjects with PFPS. The present study concluded that SQUAT ADD exercise showed reduction in pain, increase in functional ability and increase in muscle strength of subjects with PFPS. The benefit of biofeedback although remains unclear.

Key Words: Numeric pain scale, Kujala questionnaire, VMO Strength, Squat-add exercise, Patellofemoral pain syndrome

INTRODUCTION

Patellofemoral pain syndrome (PFPS) is common clinical entity used to describe a variety of pathologic conditions associated with the articulation between the under surface of the patella and the femoral condyles.[1]

PFPS is characterized by diffuse pain over the anterior aspects of the knee and is aggravated by activities that increase patellofemoral joint compressive force, such as squatting and prolonged sitting and repetitive activities such as walking, running, measurement of patellar alignment is imperative in the examination of the patient with PFPS.[2]

PFPS can be caused by a variety of factors such as: quadriceps weakness, increased Q- angle, VMO weakness, faulty lower limb mechanics, overuse and lateral retinaculum tightness. The major complaints of patients with PFPS are diffuse knee pain, patellar crepitus, and locking, knee joint stiffness, and decreased activity level.[1]

It often affects people between 10 and 35 years of age and it occurs 2-3 times more frequently in women than in men.Vastus medialis obliquus (VMO) played an important role in controlling the contact area and pressure distribution in patellofemoral joint.[3]

Vastus medialis is a primary medial dynamic stabilizer which stabilizes the patella medially and the distal obliquely angled fibers of the vastus medialis, keeps the patella in alignment in the femoral sulcus. Therefore, if there is any patellar maltracking occur it may be attributed due to weakness of VMO.[4] Therefore, strengthening of VMO might be lead to correction of patellar tracking.

A number of scales have been developed attempting to measure the functional ability in impact of knee related problems in a range of PFPS population. Kujala questionnaire scale are specifically designed for the patients with anterior knee pain syndrome or PFPS and assesses the knee status by evaluating the knee pain. Validity of this questionnaire was provided by Kujala et.al and its reliability was reported to be 0.96[6] Crossley et.al.showed that the Kujala questionnaire scale had considerable validity,reliability, and sensitivity, in the assessment of patients with PFPS.[5]

A large number of scales have been used to measure the pain.Among all Ferraz MB et.al. reported the higher reliability of Numeric pain Scale in the assessment of literate and illiterate patients with rheumatoid arthritis.[6]

Sphygmomanometer shows the reliability to measure the strength of muscle.[7]

A form of close kinetic chain exercise called, “Squat add” exercise revealed the maximum activation of VMO in normal healthy individuals but no literature exists regarding effect of ‘Squat add’exercise in subjects with patellofemoral pain syndrome. The purpose of the study is to show the effect of “SQUAT ADD” exercises in patellofemoral pain syndrome in terms of pain,strength ,and functional ability,with and without biofeedback.”

No study to our knowledge has determined whether VMO strengthening actually leads to changes in function and reduction pain in PFPS subjects. Thus, the present study was to design to fulfil these objectives.

MATERIALS AND METHOD

An experimental study was conducted on total of 25 subjects who were enrolled from various hospitals and health centers in Odisha on the basis of inclusion and exclusion criteria for 5 week 3 days/week [8] and they were divided into 2 groups after informed consent was informed. To be considered for the study, patient had to be diagnosed PFPS. The diagnosis of PFP was based on the location of symptoms (Peripatellar and / or Retropatellar) and the reproduction of pain with activities commonly association with this condition, such as stair descent, squatting, kneeling, and prolonged sitting. Subjects were screened by physical examination to rule out, plica syndrome, chondromalaciae patellae as possible causes of current symptoms. Subjects were excluded from participation if they reported a history of any knee disorder other than PFPS, recurrent patella dislocation, any surgery involving the knee, clinical evidence of meniscal or ligaments lesion and patella tendon pathology, a history of knee trauma or intra articular injection therapy, any neurological disease, hip flexion of less than 45 degree, history of diabetes. Subjects were included if they were diagnosed chronic PFPS, they were in between age group 18yr to 35yr, both genders male and female were allowed for the study followed by normal Body mass index (BMI). All the 25 subjects were screened met the study inclusion criteria and randomly assigned to two groups with 13 subjects in Group A followed by Squat- add exercise with biofeedback and 12 subjects in Group B followed by Squat-add exercise without biofeedback. In general, the subjects enrolled in the study were relatively sedentary and participated in activities of daily living. Subjects were selected and assigned by convenient sampling and randomized distribution method. Method, purposes and risks associated with the study were explained to the subjects and signed consent forms were taken and pre intervention data were collected from the subjects. No other treatment or drugs were used during the study period. Outcome measures were checked. All relevant ethical safeguards were met in relation to subjects protection in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, revised 2002. The study was approved by the institutional research ethics committee. After the baseline parameters were taken, subjects received the intervention according to group allotted. Instruments used for the intervention was Sphygmomanometer, Universal Goniometer, Straps, Stop watch, Digital Video Camera.

Outcome measures

For subjects assigned to the exercise group, outcome measures were obtained on 2 occasions: pre intervention measurement and post intervention measurement. Pre interventionly recorded all the data for measuring strength of VMO by 45 degree[9] angled Squat-add exercises, pain severity by numeric pain rating scale and functional ability by kujala questionnaire. After the baseline parameters were taken, subjects received the intervention according to group allotted. After 5 week again the datas were recorded.

DATA ANALYSIS

The data was analyzed by using SPSS version-16. Paired t-test, one way independent sample was used for analysis of data. Paired t-test was applied to compare the data within the groups. Independent sample test was used to compare the data between the groups. The statistical significance was set at 0.05 at 95% confidence and p value <0.05 was considered significant.

Table-1. Demographic Data

VARIABLES	MEAN		STANDARD DEVIATION	
	GROUP A	GROUP B	GROUP A	GROUP B
AGE(YRS)	26.923	26	5.678	4.748
HEIGHT(CM)	163.46	162.422	6.838	6.037
WEIGHT(KG)	61.2311	61.583	6.521	6.302
BMI	22.955	23.296	1.483	1.395

Figure 1 (A) Squat-Add Exercise with Biofeedback **(B)** Squat-Add Exercise Without Biofeedback

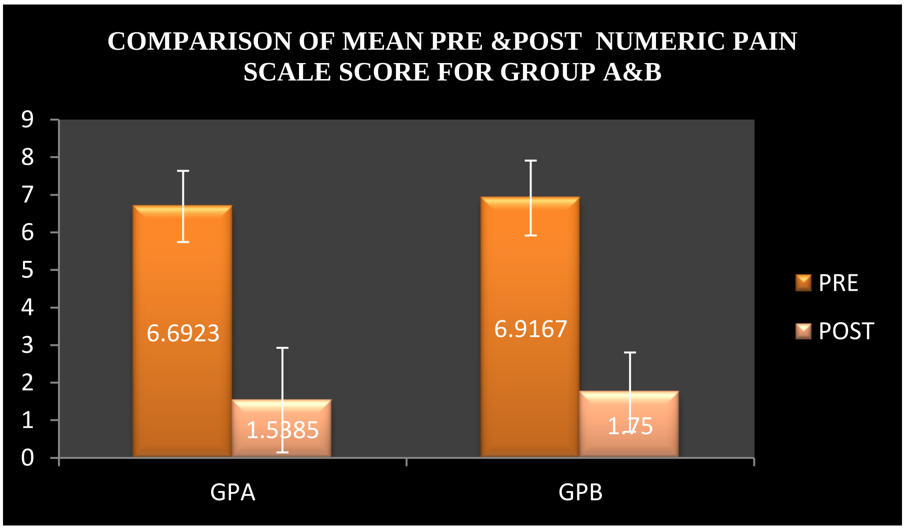

Figure 2 Comparison Of Mean Pre and Post Numeric Pain Scale Score For Group A & B

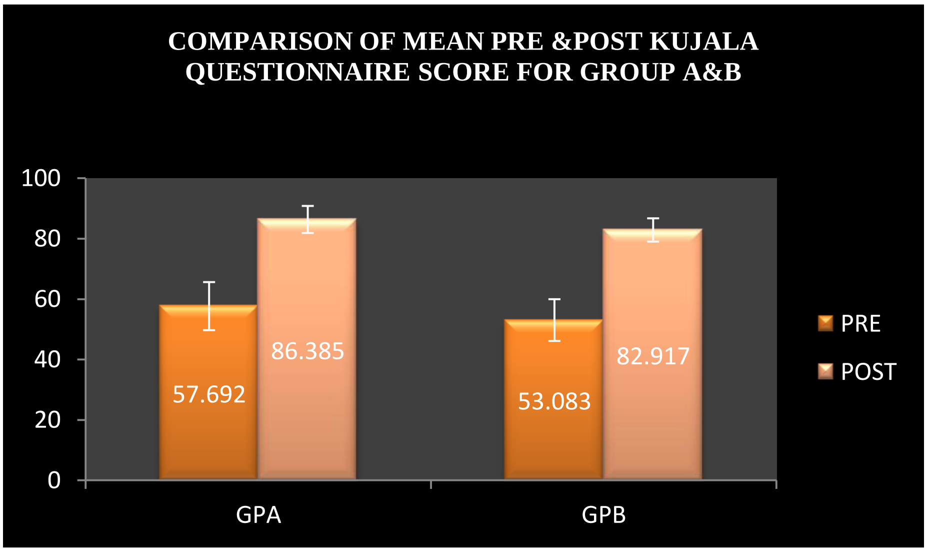

Figure 3 Comparison Of Mean Pre and Post Kujala Questionnaire Score For Group A and B

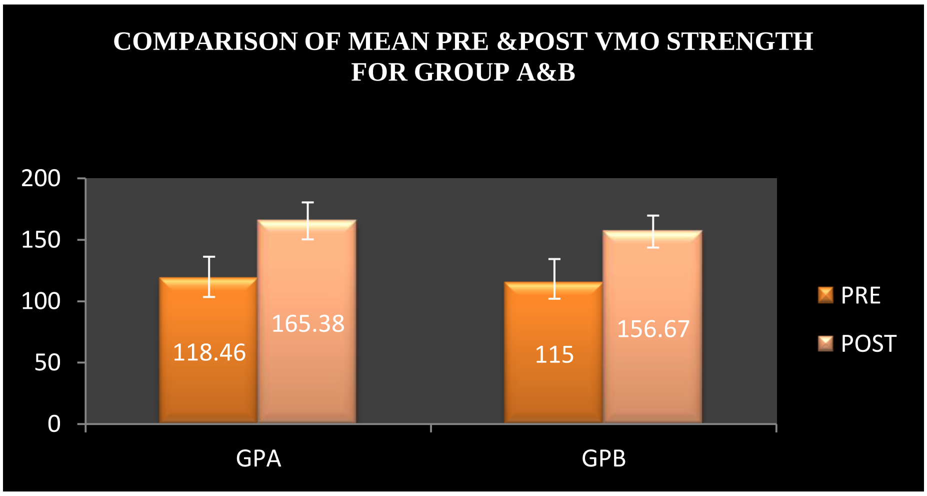

Figure 4 Comparison Of Mean Pre and Post VMO Strength For Group A and B

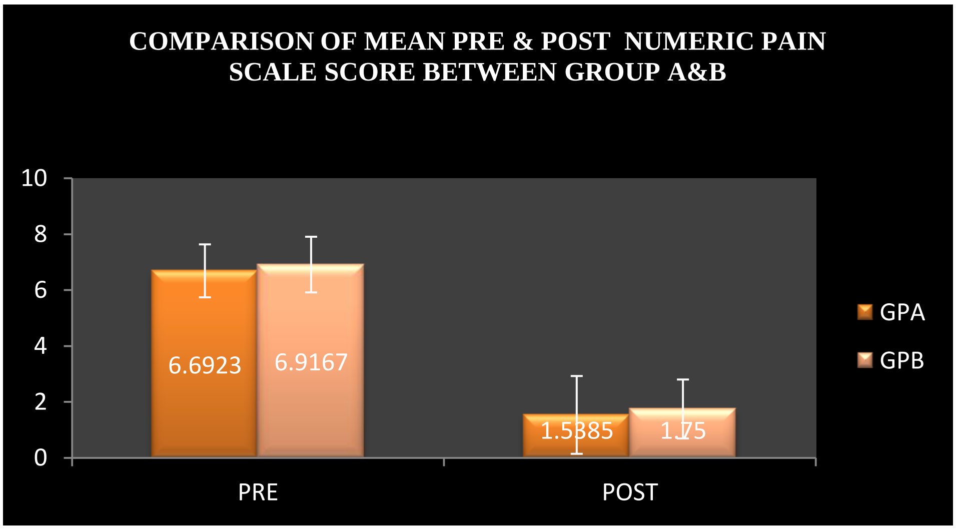

Figure 5 Comparison Of Mean Pre and Post Numeric Pain Scale Score Between Group A and B

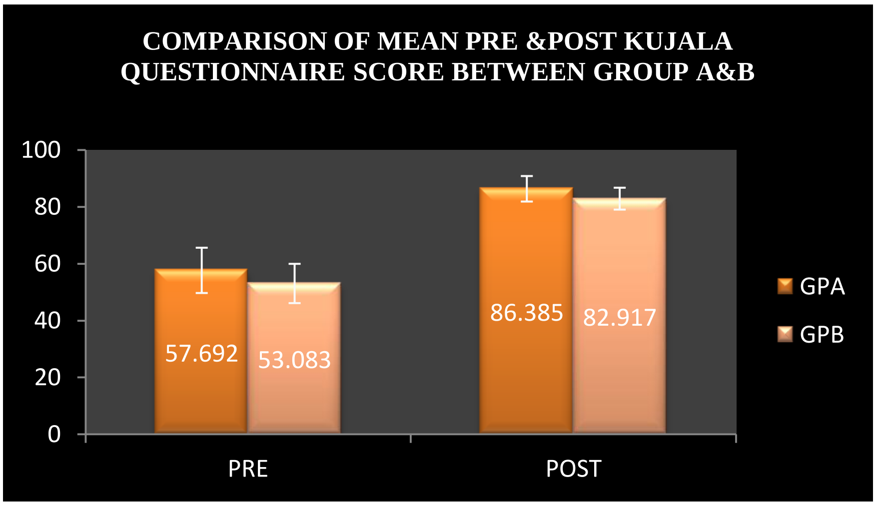

Figure 6 Comparison Of Mean Pre and Post Kujala Questionnaire Score Between Group A and B

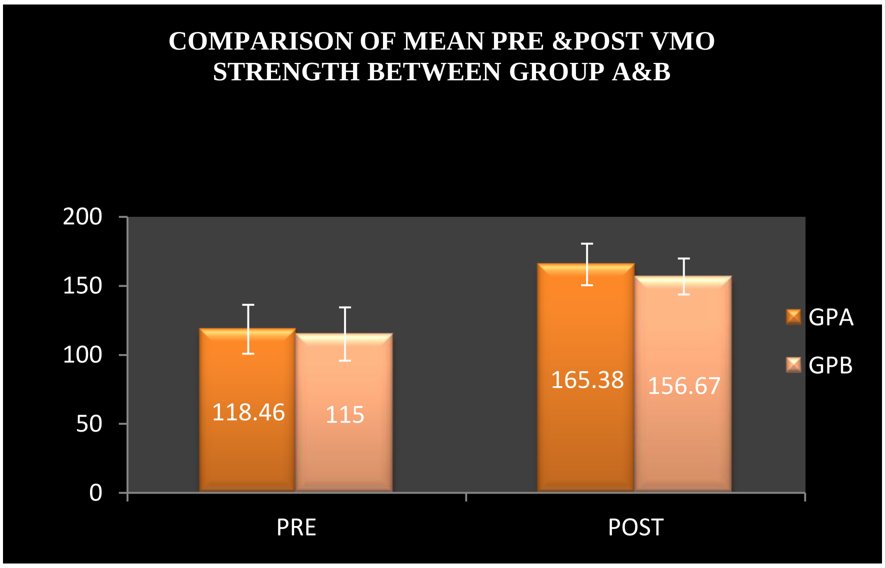

Figure 7 Comparison Of Mean Pre and Post VMO Strength Between Group A and B

RESULT

The mean and standard deviation of age, height, weight and BMI was calculated for subjects were shown in Table:1 in both groups respectively.

Paired t-test was done to compare the data of NPS, kujala questionnaire score, VMO strength, within the groups.

For pain severity, both groups showed statistically significant difference. [Group A (p =.000), Group B (p = .000)]

For functional ability, both groups showed statistically significant difference [Group A (p=.000), Group B (p =.000)]

For VMO strength both groups showed statistically significant difference [Group A (p =.000), Group B (p = .000)]

Independent Sample Test was done to compare the data of pre-post values of numeric pain scale, kujala questionnaire score and VMO strength between the groups.

For Pain severity between the groups was not statistically significant [Pre (p=.570) and Post (p=.674)].

For Functional ability between the groups show statistically significance after post- intervention (p=.049). But show no statistically significant difference pre-intervention (p=.135).

For VMO Strength between the groups was not statistically significance.

[Pre (p=.646) and Post (p=.137)]

DISCUSSION

The result of the present study reveals that there was a potential significant difference on decreasing pain, increasing functional ability and increasing VMO strength in subjects with chronic patellofemoral pain syndrome through "Squat-add" exercise in both groups. In inter group subjects we found that function is the only variable which shows statistically significant difference.

According to K. Mrityunjaya et.al (2014) VMO strengthening may have greater effect as it has a direct relation to the patellar alignment and VMO muscle has been suggested to act as a dynamic medial stabilizer, which helps to realign the patella during the last 20^0 to 30^0 of knee extension. Also, the insufficiency of the VMO, including diminished VMO activity, may increase the lateral pull of the patella and reduce function at the knee joint. Hence, it can be said VMO is the most important muscle to control the patellar alignment and its strengthening can very much contribute to the normalization of patellar position. They also found isometric quadriceps exercises to be less effective as it works on whole of the quadriceps muscle and not specifically on patellar stabilizers.[10]

H. Minoonejad et.al. (2012) mentioned in his study that, imbalance between the vastus lateralis (VL) and vastus medialis oblique (VMO) muscles is closely related to patella maltracking and PFPS. Dysfunction in motor control are largely managed by retraining of vasti muscles, especially VMO. Therefore combined exercises focused on selective strengthening of VMO leads to correction of patellar maltracking. Strengthening of the quadriceps by focusing on retraining of the

VMO which stabilizes the patella in trochlea groove, is the most commonly used and highly accepted procedure in management of patellofemoral pain syndrome, known as "Gold Standard".[11] There are various studies which mention, VMO plays an important role in patellar stabilizing factor.

Jessica Carlson et.al (2010) mentioned in her study that hip adduction increases VMO amplitude. The origin of VMO from the adductor longus and magnus tendons has led clinicians to believe that an isometric contraction of the hip adductors may facilitate VMO activity when strengthening quadriceps.Close kinetic chain exercise are significantly better than both the OKC exercise in terms of VMO: VL ratio. Close kinetic chain exercises are more functional than Open kinetic chain exercises as the quadriceps do not work in isolation during daily activities hence close kinetic chain exercises have been indicated for knee rehabilitation. Squat-add exercise is superior in preferentially activating VMO. Due to pain associated with PFPS, it may not be indicated to maximally activate the VMO without prior reconditioning of this muscle.[12]

Erik.Witvrouw et al (2000) mentioned in his study that close kinetic chain exercises contain more eccentric muscle work than open kinetic chain exercise.[13]

Sian.E.Irish et.al.(2010) reported that, double leg squat with isometric hip adduction (Squatt-add) exercise produce significantly greater VMO activation than open kinetic chain exercises. Open kinetic chain exercises were shown to preferentially activate Vastus lateralis instead of VMO and therefore may not be suitable for patients with PFPS.[14]

H. Minoonejad et.al (2012) reported that open kinetic chain exercises are the traditional method of strengthening the quadriceps muscle, which has been used since past years, but close kinetic chain exercises are remarkably used during recent years. One of the reasons to use close kinetic chain exercises is that they are similar to activities of daily living i;e. they are functional. Low stress is imposed on patellofemoral joint in closed as compared to open kinetic chain exercise.[11]

According to Kelly Rafael et.al (2005) close kinetic chain knee extension exercises in the functional range of motion should be emphasized to strengthen the knee joint muscles because of its lower stress on the patellofemoral joint. 45^0 degree knee flexion is a optimal angle for squatting because the peak compressive forces generally occur near maximum knee flexion, this angle would not cause any harm to PFPS patient, individuals with patellofemoral disorders should avoid performing the squat at high knee flexion angle due to pain aggravating factor.[9]

H. Farahini et.al (2006) reported that VMO activity was significantly higher in closed chain exercise as compared to the open kinetic chain exercise regardless of angle.[15]

G.Y.F. Ng et.al (2006) in a study reported that, VMO/VL EMG ratio was significantly improved over time in the EMG biofeedback + exercise group but not in the other group. This result suggested that the addition of biofeedback to exercise could have a beneficial effect on VMO activation. EMG biofeedback and conventional physiotherapy helped in the functional recovery of quadriceps femoris muscle in 42 patients with uncomplicated menisectomy. It was found that the average difference between pre and post training EMG output for the biofeedback group was 10 times higher than that of the standard therapy group. [16]

EMG biofeedback although appears to be the more popular form of biofeedback is not available everywhere. Hence, in our study, we used a simpler form of pressure feedback which can be easily used in a clinical setting. The result of present study is in agreement with previously mentioned literature whereby biofeedback led to better improvement in function on experimental group as compared to the control group, although we did not find any concurrent difference in pain and VMO strength. This, leads us to believe that, biofeedback in this study had psychological benefits as well as physiological. The actual mechanism for the change however remains unclear. A limitation of the present study was small sample size and short duration of treatment protocol. For future studies propose that large sample size, studies with longer duration are recommended with follow-up and comparison of the effect of VMO strengthening in subjects with and without PFPS.

CONCLUSION

We can conclude that, Squat-add exercise showed reduction in pain, increase in functional ability, and increase in muscle strength of subjects with PFPS. The benefit of biofeedback although remains unclear.

CLINICAL SIGNIFICANCE

SQUAT ADD exercises may be recommended to subjects with PFPS since they have been proved effective in increasing strength, decreasing pain, and increasing function.

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