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Prevalence of VMO muscle insufficiency in PFPS patients

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Abstract: Background: *PFPS describes anterior and retro patellar knee pain in the absence of other pathology. PFPS is one of the most common disorders of the knee accounts for 25% of knee injuries in sports medicine clinics. Prevalence rate is 20% in USA students and morbidity is directly related to activity of patients. EMG studies of normal subject have revealed that VMO /VL ratio is about 1:1 (power CM et al)*
Objective: *To study the VMO/VL ratio during ECCENTRIC, CONCENTRIC, ISOMETRIC exercise and Q-angle in PFPS patients and control groups.*
Materials & Method: *SUBJECTS; 25 diagnosed with PFPS and 25 asymptomatic control were recruited for study. EMG activity of VMO VL was recorded by surface electrodes.EMG data were analyzed in three activities for both groups, ISOMETRIC, CONCENTRIC and ECCENTRIC exercise. Outcome measure was EMG MUAP amplitude and Q-angle.*
Results: *Results showed that VMO/VL ratio is lower in PFPS subjects. And static and dynamic Q-angle is higher for PFPS groups.*
Conclusion: *There was significant difference in VMO/VL ratio and Q-angle in both groups.*
Key words: *VMO, Surface EMG, Q-angle.*

I. Introduction:

PFPS describes anterior or retro patellar knee pain in the absence of other pathology. PFPS which is one of the most common disorders of the knee accounts for 25% of all knee injuries treated in sports clinics. [1] Female patient are particularly more affected than male [2]. Incidence rate is 7% and 10% in young male and female. [2]

Prevalence rate is 20% in students in USA and morbidity is directly proportional to activity of Patients [3]

In one study done by **Winslow et al 1995** out of 16,748 patients presenting with sports related musculoskeletal problems, 11.3% had an anterior knee pain. Incidence of PFPS in general population is reported in some studies to be high as one in four with proportion increase in athletes**. (Levine 1979, Outbridge 1984)**

In orthopedics sports medicine, the most common reasons for anterior knee pain are**,** [4]

- -Overuse
- -Mal-alignment
- -Trauma

Studies on the natural history of PFPS report that in general it is a benign condition that may improve or persist over time serious disability is uncommon. PFPS is a condition of both malalignment and muscular dysfunction.

Rehabilitation exercises can restore PF joint homeostasis although the anatomical malalignment of PFPS may not be corrected**.** [5]

Symptoms of anterior knee pain are brought on by overuse stress; PFPS is an ideal condition for prerehabilitation**.** [6]

Total or near total recovery was noted in 22% at 16 years **(Noman et al 1998)**
70 % at 3 years **(Kanmus et al 1994**), 81% at 12 years **(jensssen et al 1990),** 85% at 11 years **(Karlsson et al 1996).**

The basic origin and exact pathogenesis of PFPS are unknown but many predisposing factors have been proposed including [7]

- -Acute trauma
- -Knee ligament injury
- -Instability
- -Overuse
- -Immobilization
- -Overweight
- -Genetic
- -Malalignment of extensor mechanism

In many cases, however there are no obvious reasons for the symptoms, there is no clear association between severity of the symptoms and the radiologic and arthroscopic findings.
Some theories for the origin of non- traumatic gradual onset of PFPS are [8]

- Neuromuscular imbalance of VMO VL
- Tightness of lateral retinaculum, Hamstrings , Iliotibial band
- Overpronation of subtalar joint.

Several authors have exposed the theory that abnormal patellar alignment is the root of pain [8]
Patients usually complain of insidious onset of vague, activity related pain coupled with evidence of wasting of Vastus medialis. [9]
EMG studies of normal subjects have revealed that VMO/VL activity ratio is about 1:1,
Whereas EMG recording in patients having PFPS has shown that the ratio of VMO/VL is le than 1:1. [10] [11].
Controversy exist in the literature as to the normal relationship between the timing of EMG activity of the VMO and VL and whether this difference in population with PFPS. [12, 13]
Many rehabilitation strategies have implemented for patients with PFPS. In general the goals of patella femoral rehabilitation are to maximize quadriceps strength while minimizing the patella femoral joint reaction force and stress. [18, 15]

Recently EMG biofeedback is also useful method to activate VMO muscle. Selina Lm Yip et al concluded that EMG biofeedback + exercise programme is beneficial than alone exercise in PFPS patients. [16]
Other investigators [17, 18] have examined VMO and VL EMG levels in the patients with PFPS, but have not used control groups. Approximately 70% of patella femoral disorder will improve with conservative management.
Also in outpatient department the cases of PFPS is increasing day by day, and so the clinical assessment and treatment of the condition are extremely challenging because of the multiple forces affecting the patella femoral joints.

II. Materials And Methodology:

Study Design:
Cross Sectional Study

Study Setting:
This Study Was Conducted At Physiotherapy Institute Of Ahmedabad. All The Patients Were Referred From Orthopedic Out Patient Department Of V.S Hospital, Ahmedabad.

Sample Size: 25 Subjects In Each Group

Subjects: Male And Female With Clinical Diagnosis Of Pfps Who Were Referred To Physiotherapy Opd

Inclusion Criteria:
1) Age Between 25-40 Year
2) Anterior knee pain more than 1 month
3) Knee pain atleast 2 of the following activities
   Ascending stairs
   Descending stairs
   Squatting
   Kneeling
4) Diagnostic tests were positive for PFPS
5) Subjects willing to participate in study

Exclusion Criteria:
1) Any trauma around knee joint
2) Any previous surgery around knee joint
3) Neurological disorder
4) Skin abrasion around knee
5) Previous physiotherapy taken in past 6 months for knee

Materials Used In Study:
Electrode
Electrode gel
Goniometer

Measure tape
Micropore tape
Spirit
Plinth
Consent form
Pencil, Papers assessment charts and recording sheets

Apparatus Used In Study:

Emg Machine With Neuro Perfect Plus Software
Computer System With Printer

Outcome Measures:

Emg Amplitude
Q- Angle: Static And Dynamic

Materials

EMG machine with Computer system

III. Procedure:

Twenty five subjects diagnosed with PFPS on the basis of clinical examination and referred from orthopedic OPD, and 25 asymptomatic controls were recruited for the study. Subjects were selected on the basis of inclusion and exclusion criteria. Detailed assessment of patients with diagnostic tests for PFPS and radiological examination was done. All subjects were provided written informed consent. Then patient's data was entered to EMG programme (Neuro Perfect plus Software) in computer. Then EMG surface electrodes with gel were placed over the selected muscle. Micropore tape was used to adhere the electrodes on skin.
EMG parameters were:

- SWEEP- 10 ms
- SENSITIVITY- 100 micro volts
- LOW CUT - 100Hz
- HIGH CUT- 5KHz
- PULSE/SEC- 1
- PULSE WIDTH- 0.02 ms

VMO placed over the muscle belly approximately 4 cm superior to and 3 cm medial to the superomedial patellar border and oriented 55 degrees to vertical. [19] (Fig 2)
EMG amplitude was recorded during ISOMETRIC, CONCENTRIC and ECCENTRIC exercises.
EMG MUAP Amplitudes were identified from individual trials and averaged over the 5 repetition.
After that electrodes were removed and placed for VL muscle and MUAP amplitude was recorded during above described three exercises.
The electrode for VL was placed 10 cm superior and 6-8 cm lateral to the superior border of the patella, and oriented 15 degrees to vertical. [19] (Fig 1)

Averaged EMG Amplitude was taken for both VMO and VL and then VMO/VL ratio was calculated manually.

Static and Dynamic Q-angle was measured for both groups. For static Q-angle measured with knee in full extension with subject in supine position. ASIS (anterior superior iliac spine), centre of patella and tibial tuberosity was marked with pencil. The angle formed by the intersection of line from ASIS to centre of patella with centre of patella to tibial tuberosity was measured in degrees with universal goniometer. [Fig-3]
Dynamic Q-angle was measured with static quadriceps contraction in supine position with knee extended. Procedure of measurement was same as for static Q-angle.

VL electrode placement

Fig-1

VMO electrode placement

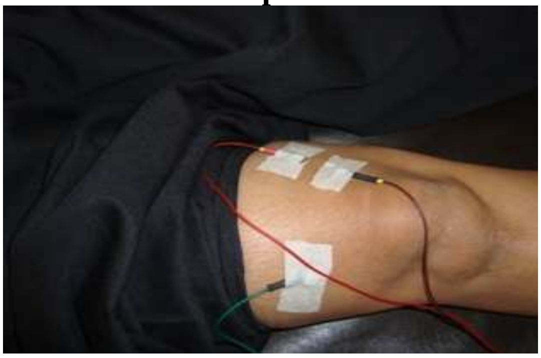


Fig – 2

Q-angle measurement

Fig -3

IV. Results:

In this study all the tests were performed manually as well as with the use of Graph pad software.
To analyze the value of static and dynamic Q-angle within the groups for control and PFPS groups **paired t-test** was used, as the data is normally distributed.
To analyze the static Q-angle between groups mann-whitney U-test was used as the data is non parametric.
To analyze the dynamic Q-angle between groups mann-whitney U- test was used as the data is non parametric.
To analyze the value of VMO/VL ratio between control and PFPS groups during isometric exercise unpaired t-test was used, as the data is normally distributed.
To analyze the value of VMO/VL ratio between control and PFPS groups during concentric exercise unpaired t-test was used, as the data is normally distributed.
To analyze the value of VMO/VL ratio between control and PFPS groups during eccentric exercise unpaired t-test was used, as the data is normally distributed.

Table 5.1 Age distribution of both group patients

Groups	**Mean**	**SD**
Control	32.56	5.324
Experimental	33.12	4.825

The mean age of the control group was 32.56 ± 5.324 and in the PFPS patients, the mean age was 33.12 ± 4.825 No significant difference was seen across the two groups.

Table 5.2 Comparison of static and dynamic Q-angle in PFPS patients

Q-angle	**mean**	**SD**	**Test used**	**t-value**	**p-value**	**significance**
Static	16.12	2.789	paired t-test	t=3.663	P=0.0006	Extremely significant
Dynamic	19.52	3.709				

Here the paired t-test was used as the data is normally distributed. Mean value for static and dynamic Q-angle were respectively 16.12 ± 2.789 and 19.52 ± 3.709. t=3.663 and p=0.0006 so the difference was extremely significant at 95% confidence interval.

Table 5.3 Comparison of static and dynamic Q-angle in control group

Q-angle	**mean**	**SD**	**Test used**	**t-value**	**p-value**	**significance**
Static	14.36	3.390	paired t-test	t=0.8088	P=0.4272	Not significant
Dynamic	15.12	3.321				

Here the paired t-test was used as the data is normally distributed. Mean value for static and dynamic Q-angle were respectively 14.36 ± 3.390 and 15.12 ± 3.321. t=0.8088 and p=0.4272 so the difference was not significant at 95% confidence interval.

Table 5.4 Comparison of static Q-angle in PFPS and control groups

Q-angle	**mean**	**SD**	**Test used**	**U-value**	**p-value**	**significance**
PFPS	16.12	2.789	Mann whitney U test	U= 210	P=0.0475	Considered significant
Control	14.36	3.390				

Here the Mann Whitney U test was used as the data is non-parametric. Mean value of static Q-angle for control and PFPS groups respectively were 16.12 ± 2.789 and 14.36 ± 3.390. Difference was significant at 95% confidence interval.

Table 5.5 Comparison of dynamic Q-angle in PFPS and control groups

Q-angle	**mean**	**SD**	**Test used**	**U-value**	**p-value**	**significance**
PFPS	19.52	3.709	Mann whitney U test	U= 120.50	P=0.0002	Extremely significant
Control	15.12	3.321				

Here the Mann Whitney U test was used as the data is non-parametric. Mean value of static Q-angle for control and PFPS groups respectively were 19.52 ± 3.709 and 15.12 ± 3.321. Difference was significant at 95% confidence interval.

Table 5.6
Comparison of VMO/VL ratio during ISOMETRIC exercise in PFPS and control

Groups	mean	SD	Test used	t-value	p-value	significance
Control	0.9260	0.0482	Unpaired t-test	t=5.136	P=0.0001	Extremely significant
Experimental	0.8124	0.0995				

Here the un paired t-test was used. Mean value of VMO/VL in control group was 0.9260 ± 0.0482 and PFPS group was 0.8124 ± 0.0995. t=5.136 and p < 0.0001. so the difference was extremely significant at 95% confidence interval.

Table 5.7
Comparison of VMO/VL ratio during CONCENTRIC exercise in PFPS and control groups

Groups	mean	SD	Test used	t-value	p-value	significance
Control	0.9484	0.0300	Unpaired t-test	t=4.976	P=0.0001	Extremely significant
Experimental	0.8336	0.1113				

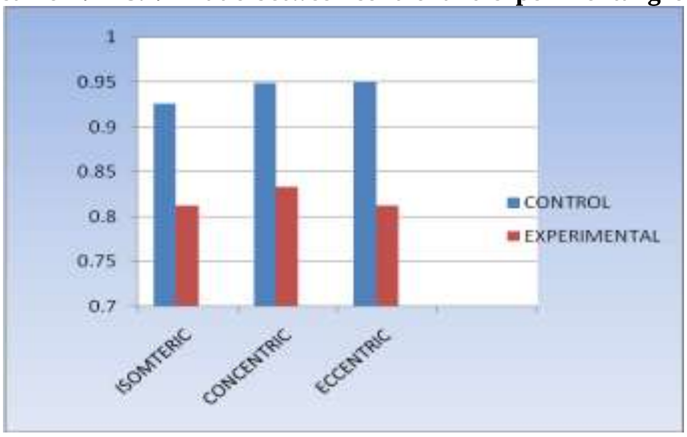
Here the un paired t-test was used. Mean value of VMO/VL in control group was 0.9484 ± 0.0300 and PFPS group was 0.8336 ± 0.1113. t=4.976 and p < 0.0001. so the difference was extremely significant at 95% confidence interval.

Table 5.8 Comparison of VMO/VL ratio during ECCENTRIC exercise in PFPS and control groups

Groups	mean	SD	Test used	t-value	p-value	significance
Control	0.9505	0.0374	Unpaired t-test	t=7.457	P=0.0001	Extremely significant
Experimental	0.8126	0.0844				

Here the un paired t-test was used. Mean value of VMO/VL in control group was 0.9505 ± 0.0374 and PFPS group was 0.8126 ± 0.0844. t=7.457 and p < 0.0001. so the difference was extremely significant at 95% confidence interval.

Graph -1
Comparison of mean of VMO/VL ratio between control and experimental groups



V. Conclusion:

This is a cross sectional study comparing the VMO/VL ratio and Q-angle in PFPS and control groups on 50 total subjects.

There was a statistically significant difference in VMO/VL ratio between control and PFPS subjects during ISOMETRIC, CONCENTRIC and ECCENTRIC exercise, so null hypothesis was rejected and experimental hypothesis was accepted.

There was a statistically significant difference in static and dynamic Q-angle in both groups. Static and dynamic Q-angle value was higher in PFPS patients.

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Interest Of Conflict:

The authors perceive no conflict of interest in this study.

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