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Association of common intrinsic risk factors in development of patellofemoral pain syndrome

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Keywords

Patellofemoral pain syndrome,
Intrinsic risk factors,
Q-angle,
Hip muscle strength,
Flexibility

Abstract

Background: Patellofemoral pain (PFP) is recognized as one of the most common lower-extremity disorders encountered by Orthopedic physical therapists. PFPS is defined as pain around (peripatellar) or behind the kneecap (retro patellar) that is aggravated by activities loading the knee joint, such as running, squatting, climbing stairs or even prolonged sitting with knee flexion above 90 degree. It is one of the most common knee conditions clinicians encounter in young and active individuals. It is estimated that 22.7% of the general population is affected by PFP at some point, while the prevalence in adolescents is slightly higher at 28.9%. It has also been reported that females, as compared with their male counterparts, are significantly more likely to experience PFPS. There is a high incidence of this condition among physically active populations; it affects 8.75% of the individuals involved in intense physical training and has a significant impact on their occupational activities, Faulty hip kinematics may contribute to PFPS. Conflicting data have existed regarding an absolute association between hip weakness and altered lower extremity kinematics. This study aims to delve into the complexities of patellofemoral pain syndrome, exploring its multifaceted etiology,clinical manifestations, and contemporary approaches to diagnosis and management. By synthesizing current research findings,clinical insights, and patientperspectives, this study seeks to contribute to the growing body of knowledge surrounding PFPS.

Objective: To find the association of intrinsic risk factors such as Q-angle, hip abductors and external rotators strength, tightness of hams, quads and IT band with PFPS.

Method: In the present correlational study,prevalence was found using Patellar tilt test and KUJALA questionnaire and on the basis of prevalence total 63 patients with PFPS, aged between 18 to 35 years were included. Subjects were evaluated for Q-angle, hip abductors, external rotators, tightness of hamstrings,quads, and IT band using goniometer, handheld dynamometer for isometric strength , 90-90 hams test, E ley's test and Ober's test respectively. Statistical analysis was done by using SPSS 26.0 version.

Result: The prevalence of PFPS in Surat, Gujarat was 20.7%. on the basis of that, sample size was 63. The data were checked for their normal distribution using the Shapiro-Wilk Test. As it was not normally distributed, spearman's correlation test was used to find the association between variables and PFPS. In which, the hip abductors, external rotators, tightness of quads, tightness of it-band showed positive correlation while, Q- angle and tightness of hamstrings showed negative correlation with PFPS.

Conclusion: So, it can be concluded that significant association was found between intrinsic risk factors and PFPS.

Introduction

Patellofemoral pain (PFP) is recognized as one of the most common lower-extremity disorders encountered by orthopedic physical therapists[1]. PFPS is defined as pain around (peripatellar) or behind the kneecap (retro patellar) that is aggravated by activities loading the knee joint, such as running, squatting, climbing stairs or even prolonged sitting with knee flexion above 90◦ [1] Patellofemoral pain syndrome (PFPS), also historically described as chondromalacia of the patella. the latter specifically refers to the finding of softened patellofemoral cartilage on plain radiography, magnetic resonance imaging, or knee arthroscopy. It is one of the most common knee conditions clinicians encounter in young and active individuals[2] . It is estimated that 22.7% of the general population is affected by PFP at some point, while the prevalence in adolescents is slightly higher at 28.9%[1] . It has also been reported that females, as compared with their male counterparts, are significantly more likely to experience PFP[3] . There is a high incidence of this condition among physically active populations; it affects 8.75% of the individuals involved in intense physical training and has a significant impact on their occupational activities[4]

Conflicting data have existed regarding an absolute association between hip weakness and altered lower extremity kinematics. Numerous authors have explored the relationship between excessive or prolonged foot pronation during functional activities and lateral patellar compression syndrome.

By synthesizing evidence from studies such as those conducted by Crossley et al. (2016)20 and Witvrouw et al. (2019)21, we seek to consolidate the latest knowledge on PFPS etiology and explore innovative approaches to its diagnosis and management. In this study, we identified PFPS in people with various physical characteristics through PFPS diagnosis, and then studied the correlation of PFPS with risk factors that may affect PFPS in terms of the dynamics of the lower extremity, as identified by previous studies, to provide the basic data for the prevention and appropriate treatment of PFPS. This study aims to delve into the complexities of patellofemoral pain syndrome, exploring its multifaceted etiology, clinical manifestations, and contemporary approaches to diagnosis and management. By synthesizing current research findings, clinical insights, and patient perspectives, this study seeks to contribute to the growing body of knowledge surrounding PFPS. Through a comprehensive review and analysis, we aspire to shed light on potential breakthroughs in understanding this syndrome, ultimately paving the way for improved diagnostic accuracy and more effective therapeutic interventions. In addressing the gaps in our knowledge, this research endeavors to provide valuable insights for healthcare professionals, researchers, and individuals affected by PFPS. The ultimate goal is to enhance our ability to prevent, diagnose, and treat this challenging condition, thereby optimizing the overall health and well-being of those grappling with Patellofemoral Pain Syndrome.

As per my search, there is no study available showing the prevalence of patellofemoral pain syndrome in Surat, Gujarat population, so this study will provide information about the prevalence of PFPS in Surat. In patients with patellofemoral pain syndrome impairment is seen in certain variables such as weakness of hip musculature, hamstring, quadriceps and IT band tightness, increased Q-angle of affected individuals. Very few studies have shown significant association between these variables and PFPS. Also literature have warranted that more studies on these variables are required for better understanding of a relationship between these variables, This study will provide significant findings and provide base for the treatment protocols for the betterment of patients quality of life

Aim and objectives of the study:-

Aim- • To see the association of common intrinsic risk factors in development of Patellofemoral pain syndrome.

Objectives-

• To find the association between PFPS & Hip abductors and external rotators weakness.
• To find the association between PFPS & Q-angle.
• To find association between PFPS & Hamstring tightness.
• To find the association between PFPS & IT-band tightness. • To find the association between PFPS & Quadriceps tightness.

Methodology

Study design

Observational Study.

Study population- Patients of Patellofemoral pain with 18-35 years of age group.

Sampling technique- Convenient sampling.

Study duration- 1 year.

Sample size- the prevalence was calculated through, $n = z\ 2p(1{-}p)\ d2$ where, confidence interval set at 95% and precision at 0.10 so 92 subjects were taken for prevalence[34] . The sample size was calculated on basis of prevalence, In which, p=20.7% (prevalence of PFPS)[28], CI=90% and error=10% was taken. And formula used for the calculation was35 ,$N = [\ (z\alpha/2)\ 2 \times p(1 - P)\ d$ 2] So the final sample size was 63.[37]STUDY

Setting- Different physiotherapy OPD and other clinical OPDs of Surat.

Selection Criteria: Inclusion criteria Patient willing to participate in the study will be included if they meet the following criteria:

• Both male and female
• 18-35 years age group
• Anterior or retro patellar knee pain of the following activities- prolong sitting, stair climbing, squatting, running, jumping/hopping.
• Positive Patellar tilt test1[3]
• Patients with KUJALA score below 80[6] .
Exclusion criteria
• Signs and symptoms of meniscal or other intra-articular injury conditions.
• Cruciate or collateral ligament involvement.
• Tenderness over the Patellar tendon, Iliotibial band, or Pes Anserinus tendon.
• Evidence of the knee joint effusion.
• A history of dislocation.
• Previous surgery on Patellofemoral joint Previous surgery on Patellofemoral joint.
• Sinding-Larsen-Johansson syndrome.

Material and tools:

• KUJALA scoring questionnaire [13]
• Consent Form
• Plinth
• Handheld dynamometer[14]
• Goniometer
• Gravity Goniometer[15]

- Measuring tape
- Weighing machine
- Stadiometer
- Marker

Outcome measures:

1. Patellofemoral pain syndrome was confirmed by positive Patellar tilt test[6] .
2. Prevalence was found through KUJALA questionnaire[10].
3. Muscle strength (hip abductors, external rotators) was assessed through Handheld dynamometer.[27]
4. Flexibility (Quadriceps, Hamstrings, IT band) was assessed through Gravity Goniometer.[13]
5. Q- angle was measured by Goniometer

Procedure:

- Ethical clearance was taken from institutional ethical committee.
- Subjects were preliminary screened based on the inclusion and exclusion criteria. Demographic details were obtained from all the subjects (annexure 4). The purpose of the study was explained and all the participants were asked to give written informed consent (annexure 1,2,3).
- Participants were choosen through convenient sampling method.

- Demographic details of patients was taken (Annexure 4).
- The demographic data collection includes; age, body mass index, the side of the affected knee, chronicity, vitals and the Kujala score. In case of bilateral PFPS, the patients were informed to evaluate the more affected side. Patients will be asked to fill a KUJALA scoring questionnaire, which is valid and reliable for patellofemoral pain syndrome[5] . Patients with score lower than 80 were included in this study to evaluate hip muscle strength, flexibility and quadriceps angle.

Evaluation of hip muscle strength-Subjects undergone isometric muscle strength testing for hip abduction and external rotation using hand-held dynamometer and stabilization straps.

Testing for each subject 25 took approximately 10 minutes and was randomly performed according to muscle action. The test positions were selected based on their similarity to traditional manual muscle testing procedures 16 and have been reported to be highly reliable for testing isometric strength with hand-held dynamometers.[4]

To evaluate hip abductors strength ,Hip abduction isometric strength testing was performed with subjects positioned in side lying on a treatment table (Figure 1). A pillow was placed between the subjects legs, using additional towelling as needed, such that the hip of the leg to be tested is abducted approximately 10° as measured with respect to a line connecting the anterior superior iliac spines. A strap placed just proximal to the iliac crest and secured firmly around the underside of the table was used to stabilize the subject’s trunk. The center of the force pad of a hand-held dynamometer was then placed directly over a mark located 5 cm proximal to the lateral knee joint line. After zeroing the dynamometer, the subject was instructed to push the leg upward with maximal effort for 5 seconds. The force value displayed on the dynamometer was recorded. One practice trial and 3 experimental trials was performed, with 15 seconds of rest between trials. The peak value from the 3 experimental trials was recorded.[2]

To evaluate hip external rotators strengthHip external rotation (ER) isometric strength testing was performed with subjects positioned on a padded chair with the hips and knees flexed to 90° (Figure 2). To prevent substitution by the hip adductors, a strap was used to stabilize the thigh of the tested leg and a towel roll was placed between the subjects’ knees. The dynamometer was then placed such that the center of the force pad was directly over a mark that is 5 cm proximal to the medial malleolus. A strap around the leg and around the base of a stationary object held the dynamometer in place during contractions. After zeroing the dynamometer, the subject was instructed to push the leg inward with maximal effort for 5 seconds. The force value displayed on the dynamometer was recorded and the device was re-zeroed. One practice trial and 3 experimental trials were performed with 15seconds of rest between trials. The peak value from the 3 experimental trials was recorded.[2]

Evaluation of flexibility[3,7]- To evaluate quadriceps tightness,Length of the quadriceps muscle was determined by measuring the knee angle during passive knee flexion, with the subject in the prone position, using a bubble inclinometer zeroed on a horizontal surface prior to the measurements. The bubble inclinometer was placed over the distal tibia and the subject's knee passively flexed to knee end range of motion. The examiner monitored the subject's pelvis position with the free hand to avoid anterior tilting of the pelvis and/or extension of the lumbar spine . Theexaminer recorded the measurement when the lumbar spine or pelvis first began to move or with the perception of end feel.

To evaluate IT band tightness ,Length of the ITB was examined using the Ober's test, according to the procedure, The subject was positioned in side-lying, with the tested leg superior and the pelvis perpendicular to the table. The lower leg is slightly flexed at the hip and knee to maintain stability and to restrain body rotation. The subject's pelvis was blocked by the examiner's body and the pelvis stabilized with the examiner's free hand. The bubble inclinometer was zeroed on a horizontal surface prior to the measurement and was placed over the distal portion of the IT Band (Figure 4). The result was recorded as a continuous variable. Negative values represent lesser flexibility, whereas positive values (below horizontal) represent greater flexibility.

To evaluate hamstring tightness,Length of the hamstrings was determined by measuring the straight leg raise. The subject is in the supine position and the inclinometer was zeroed on the lower half of the anterior border of the tibia. The leg not being measured remained flat on the table to avoid excessive posterior pelvic tilt. Then, the lower extremity was passively lifted to the end range of motion (firm end feel) or until the examiner noted any change in the normal lumbar curve. While holding the bubble inclinometer, the examiner will keep the forearm parallel with the subject's tibia and use the elbow to maintain knee extension during the straight leg raise.

Evaluation of Q-angle[8,9] - Subject was first given detailed information about the procedure. Subjects had been decently exposed to show the landmarks. The anatomical landmarks including the border of the patella, tibia tubercle and anterior superior iliac spine (ASIS) were located through palpation and then marked with a water - soluble marker. Subject was in standing position & quadriceps are relaxed and feet were in neutral position. Q angle was taken by universal goniometer. The anatomical landmarks which is already marked joined by the use of a meter ruler and a marker. With the pivot of the goniometer placed on the mid-point of the patella, the stationary arm on the line adjoining the ASIS to the midpoint of the patella, and the moveable arm placed over the line adjoining the tibial tubercle to the mid-point of the patella. The angle thus formed between the two arms of the goniometer was measured and recorded as the Q-angle.

Statistical analysis - The data was entered using Microsoft excel 2019 and it was analysed using SPSS 26 version software. Descriptive analysis of participant's PFPS Score, Q-angle, Hip abductors and adductors strength, and tightness of Hamstrings, Quadriceps, IT band was done. Normality of distribution of participant's PFPS Score, Q-angle, Hip abductors and adductors strength, and tightness of Hamstrings, Quadriceps, IT band were tested using Shapiro wilk test. Correlation of Q-angle, Hip abductors and adductors strength, tightness of Hamstrings, Quadriceps, IT band were analysed with PFPS Score. All the parameters of this study were not normally distributed. Based on that data were analysed using non-parametric test (spearman's rank correlation test). Results were considered to be significant as p< $|\rho| \leq 0.19$) veryweak correlation, ($0.20 \leq |\rho| \leq 0.39$) weak correlation, ($0.40 \leq |\rho| \leq 0.59$) moderate correlation, ($0.60 \leq |\rho| \leq 0.79$) strong correlation, ($0.80 \leq |\rho| \leq 1.00$) very strong correlation, ($p = 1$) perfect correlation.

	MEAN	S.D.
AGE	28.90	3.30
PPFS	67.93	6.52
HIP MUSCLE STRENGTH		
ABDUCTORSE	17.41	3.95
EXTERNAL ROTATORS	15.70	4.43
Q-ANGLE	18.47	1.37
HIP MUSCLE TIGHTNESS		
QUADS	53.78	10.25
HAMSTRINGS	50.03	5.66
ITBAND	36.38	3.00

TABLE 1:Illustrates mean and standard deviation of age and outcome measures of participants.

	statistics	dF	Sig.p value
AGE	.926	63	.001
PFPS	.951	63	.013
HMSAB	.956	63	.070
HMSER	.963	63	.056
QANGLE	.783	63	.000
HAMSTIGHTNESS	.939	63	.004
ITBANDTIGHTNESS	.813	63	.000
QUADSTIGHTNESS	.783	63	.000

Table 2.Illustrates shows the result of shapiro -wilk test which is used to check normality of data.

On the basis of normality which was analysed by Shapiro wilk test on the outcome measures, the data was not normally distributed ($p < 0.05$). Thus, a non-parametric test (Spearman's Rank Correlation Of Coefficient) was used to establish the correlation between PFPS and intrinsic risk factors.

			AGE
Spearman's rho	PPFS	Correlation Coefficient(r)	0.47
		P value	.715
		No.	63

** Correlation is significant at the < 0.01 level (2-tailed).

Table 3 Analysis Including Correlation Between PFPS And Age.

			HMSAB
Spearman's rho	PPFS	Correlation Coefficient(r)	0.016
		P value	0.898
		No.	63

** Correlation is significant at the 0.01 level (2-tailed).

Table 4. Analysis Including Correlation Between PFPS And HIP MUSCLE STRENGTH OF ABDUCTORS.

			HMSER
Spearman’s rho	PPFS	Correlation Coefficient(r)	0.216
		P value	0.090
		No.	63

** Correlation is significant at the 0.01 level (2-tailed).
Table 5.Analysis Including Correlation Between PFPS And HIP MUSCLE STRENGTH OF EXTERNAL ROTATORS.

			Q angle
Spearman’s rho	PPFS	Correlation Coefficient(r)	-0.014
		P value	0.419
		No.	63

** Correlation is significant at the 0.01 level (2-tailed).
Table 6. Analysis Including Correlation Between PFPS And Q-ANGLE

			HAMSTIGHTNESS
Spearman’s rho	PPFS	Correlation Coefficient(r)	-0.046
		P value	0.719
		No.	63

** Correlation is significant at the 0.01 level (2-tailed).
Table 7.Analysis Including Correlation Between PFPS And TIGHTNESS OF HAMSTRINGS.

			QUADSTIGHTNESS
Spearman’s rho	PPFS	Correlation Coefficient(r)	0.072
		P value	0.575
		No.	63

** Correlation is significant at the 0.01 level (2-tailed).
Table 8. Analysis Including Correlation Between PFPS And TIGHTNESS OF QUADRICEPS.

			ITBANDTIGHTNESS
Spearman’s rho	PPFS	Correlation Coefficient(r)	0.244
		P value	0.54
		No.	63

** Correlation is significant at the 0.01 level (2-tailed).
Table 9. Analysis Including Correlation Between PFPS And TIGHTNESS OF IT-BAND.

Discussion

This study was conducted on 63 subjects with age group of 18-35 years. The mean age of subjects were 28.90 ± 3.30 and mean score of PFPS was 67.93±6.52. The variables which were taken for the analysis were Q- angle, hip abductor strength, hip external rotator strength, tightness of hamstrings, quadriceps and IT band. Association of age with PFPS was also analyzed.

In this study, coefficient correlation (r=0.016) between PFPS and hip abductor muscle strength shows weak positive correlation ,coefficient correlation (r=0.216) between PFPS and external rotators of hip shows weak positive correlation. The hip abductors help to control rotational alignment of the limb and maintain pelvic stability in single leg stance. Weak hip abductors may cause a compensatory dynamic valgus knee alignment resulting in increased stress on the iliotibial band. Because the iliotibial band attaches to the lateral surface of the patella, such an alteration may pull the patella laterally and increase the compressive forces on the lateral aspect of the patellofemoral joint potentially contributing to PFPS. Regarding the hip external rotators, some authors have proposed that they help to eccentrically control femoral internal rotation during gait and sport activities. Hip external rotators weakness may increase medial femoral rotation and valgus knee moments during the stance phase of walking. The excessive knee valgus and medial femoral rotation may increase the Q-angle, which may pull the patella laterally and result in increased stresses over the lateral surface of the patellofemoral joint[17] .

coefficient correlation (r=-0.046) between PFPS and tightness of hamstrings shows a negative correlation which means hamstring tightness is not a cause of the occurrence of PFPS. This result is supported by the study of Witvrouw et al18, who investigated the risk factors in the development of PFPS using a longitudinal design and concluded that hamstrings flexibility was not a significant factor. They reported a mean of 91° ± 20° during the straight leg raise test for the athletes who developed PFPS, and a mean of 94° ± 16° for those who did not develop PFPS, Sara R. Piva et al also concluded in the study that, both the subjects with and without PFPS had less hamstrings flexibility. which may be explained by the age of the subjects.In this study, the coefficient correlation (r=0.47) between PFPS and age shows a moderate positive correlation.

The coefficient correlation (r=0.072) between PFPS and quadriceps tightness shows a positive correlation, It is theorized that limited flexibility of the quadriceps muscles may pull the patella superiorly, thus increasing compression of the patellofemoral joint during physical activities. Edward A. et al. concluded in the study that The patients with PFPS had significantly less quadriceps flexibility compared to the control subjects5. These data are consistent with 2 previous studies demonstrating an association between PFPS and limited quadriceps flexibility, helping to support the theory that lack of flexibility of the quadriceps may be a factor to consider during the assessment and treatment of patients with PFPS[19,20].

The coefficient correlation (r=0.244) between PFPS and IT band shows a positive correlation. This means subjects presenting with PFPS in the present study had a tighter ITB. This data would support clinical observations of IT Band tightness in subjects presenting with PFPS[21] (Hudson and Darthuy, 2006). If altered biomechanics are the underlying cause for PFPS, then proximally, poor control of medial hip rotation via Gluteus Medius could place an existing tight ITB onto a stretch, whereby it is more likely to cause lateral tracking of the patella during dynamic weight-bearing. Distally, excessive or uncontrolled pronation would also increase lower extremity internal rotation, which would have a similar effect on the ITB length. Increasing the flexibility of the hip flexors and ITB would allow the pelvis to rotate posteriorly, creating relative femoral external rotation and helping to align the patella in the trochlear groove of the femur[22]

In this study, the Q-angle was measured by a goniometer, coefficient correlation (r=- 0.104) between PFPS and Q angle shows a negative correlation, Many studies have reported that an excessive quadriceps angle is correlated with PFPS symptoms[23,24]. If the quadriceps angle exceeds 15 degrees, the valgus of the knee appears, and peak knee valgus is also expected to contribute to PFPS through excessive pressures on the knees[25]. But according to our results, the static quadriceps angle of the subjects with symptoms of intrinsic PFPS shows a negative correlation. However, the quadriceps angle exceeds 15 degrees, so secondary risk factors due to an excessive quadriceps angle need to be considered. This result is supported by a study of OhjeOung KwOn et al[26]where neither the static quadriceps angle nor the dynamic quadriceps angle of the group with PFPS show a statistically significant difference from the normal group. There are many intrinsic factors affecting PFPS. But only limited factors were studied. In addition to the six biomechanical parameters selected and analyzed in this study, there are still many controversial biomechanical factors affecting PFPS. such as hip flexors strength, femoral anteversion and pronation of foot which can also be affecting patients with PFPS. Also the study was limited to one geographical location. the patients can also be taken from different zones and cities of Gujarat .

Conclusion

Also, it is concluded that there is mostly significant association of PFPS and intrinsic risk factors. Age of the patient is also associated with the occurrence of PFPS, signifying that the greater the patient's age will be the chance of PFPS. Strength of hip abductors and hip external rotators are positively correlated, signifying the more the strength of muscles, lesser will be the chance of occurrence of PFPS. IT band tightness and quadriceps tightness are also positively correlated while hamstrings are negatively correlated with PFPS. Also, Q-angle is negatively correlated with PFPS, which means if the PFPS score is greater, lesser will be Q- angle.

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