Physical Examination and Patellofemoral Pain Syndrome

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Abstract

Patellofemoral pain syndrome, which accounts for 25% of all sports-related knee injuries, is multifactorial in origin. A combination of variables, including abnormal lower limb biomechanics, soft-tissue tightness, muscle weakness, and excessive exercise, may result in increased cartilage and subchondral bone stress, patellofemoral pain, and subtle or more overt patellar maltracking. Because of the multiple forces affecting the patellofemoral joint, the clinical evaluation and treatment of this disorder is challenging. An extensive search of the literature revealed no single gold-standard test maneuver for that disorder, and the reliability of the maneuvers described was generally low or untested. An abnormal Q-angle, generalized ligamentous laxity, hypomobile or hypermobile tenderness of the lateral patellar retinaculum, patellar tilt or mediolateral displacement, decreased flexibility of the iliotibial band and quadriceps, and quadriceps, hip abductor, and external rotator weakness were most often correlated with patellofemoral pain syndrome.

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INVITED REVIEW

Physical Examination and Patellofemoral Pain Syndrome

ABSTRACT

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Patellofemoral pain syndrome, which accounts for 25% of all sports-related k injuries, is multifactorial in origin. A combination of variables, including abnor lower limb biomechanics, soft-tissue tightness, muscle weakness, and excess exercise, may result in increased cartilage and subchondral bone stress, pa lofemoral pain, and subtle or more overt patellar maltracking. Because of multiple forces affecting the patellofemoral joint, the clinical evaluation treatment of this disorder is challenging. An extensive search of the literat revealed no single gold-standard test maneuver for that disorder, and the ability of the maneuvers described was generally low or untested. An abnor Q-angle, generalized ligamentous laxity, hypomobile or hypermobile tendern of the lateral patellar retinaculum, patellar tilt or mediolateral displacem decreased flexibility of the iliotibial band and quadriceps, and quadriceps, abductor, and external rotator weakness were most often correlated with pa lofemoral pain syndrome.

Key Words: Review, Patellofemoral Pain Syndrome, Anterior Knee Pain, Phys Examination

Patellofemoral pain syndrome (PFPS), which is one of the most comm disorders of the knee, accounts for 25% of all knee injuries treated in spo medicine clinics.[1,2] Clinical assessment and treatment of this condition extremely challenging because of the multiple forces affecting the patellofer ral joint. Wilk et al.[3] have stated that PFPS remains one of the "most vexati clinical challenges in rehabilitative medicine." A combination of factors, such abnormal lower limb biomechanics, soft-tissue tightness, muscle weakness, excessive exercise, may result in increased cartilage and subchondral b stress, subsequent PFPS, and subtle patellar malalignment or more o patellar maltracking. Fulkerson[4] states: "While opinions vary, there is li question that imbalance (malalignment) of the extensor mechanism can lea overload of the retinaculum and subchondral bone."

For most patients with PFPS, the results of physical examination are of subtle and do not consistently correlate with the symptoms described.[5] Clin studies have not consistently demonstrated biomechanical differences betw patients with PFPS and healthy individuals,[6–8] perhaps because of the difficu in defining where the range of normal alignment ends and malalignm light factors that potentiate patellofemoral malalignment and can thus be used to guide treatment. Because there is no single diagnostic test for PFPS, Merchant[9] recommends that the diagnosis be based on a cluster of objective findings from physical examination. This review will examine some of the tests most frequently used to diagnose PFPS. Our goal is to assist clinicians in the accurate diagnosis and treatment of this common orthopedic disorder.

METHODS

Literature searches were based on the following key words: patellofemoral pain syndrome, anterior knee pain syndrome, retropatellar pain syndrome, extensor mechanism disorder, lateral patellar compression syndrome, Q-angle, patellar tilt, patellar displacement, patellar glide, retinaculum, apprehension test, patellar compression, crepitus, patellar tracking, muscle flexibility, muscle strength, ligamentous laxity, accuracy, and validity. Searches of citations from 1956 to 2005 (journal articles via Medline and textbooks by means of the Lane Online Information System) were performed, and all studies investigating the use of physical examination in patients with PFPS syndrome were examined. Emphasis was placed on evaluating the description of tests used in those studies and the range of normal values.

Q-Angle

Brattström[10] first defined the Q-angle as the angle formed by the line of pull of the quadriceps mechanism and that of the patellar tendon as they intersect at the center of patella. The Q-angle is a measure of the patellar tendency to move laterally when the quadriceps muscles are contracted. The greater the angle, the greater this tendency. According to one cadaver study, however, the alignment of the quadriceps femoris musculature is more laterally directed than that indicated by the Q-angle.[11] This may explain the reason why the relationship between the Q-angle and PFPS remains unclear. Some studies show a clear relationship between a higher Q-angle and PFPS,[12] but others fail to demonstrate a difference between patients with that disorder and healthy individuals.[8,13]

Aglietti et al.[12] have described one method of measuring the Q-angle: “The patient is in a supine position with the knees extended and the legs relaxed. The Q-angle is formed by the line connecting the anterosuperior iliac spine to the center of the patella and the line connecting the center of the patella to the middle of the anterior tibial tuberosity.” Other investigators recommend measuring the Q-angle when the patient is standing or sitting.[14–16] Olerud and Berg [16] emphasi portance of standardizing the foot position of those undergoing Q-angle measurement and noted that positioning the patient in an erect stance (rather than the supine position) during the procedure provided more reliable results.

Q-angle measurement is highly sensitive to error because it is based on the determination of the line intersecting the center of the patella and the tibial tuberosity. France and Nester[14] reported that the patellar center must be defined with an accuracy of <2 mm if the error in the Q-angle is to remain at <5 degrees. The patella also must be centered in the trochlea when the measurement is taken. For example, a lateral displacement of just 3 mm results in a 4.3-degree decrease in the Q-angle.[17] The examiner also must make every effort to keep the patient’s leg in a neutral rotation. Rotating the patient’s foot outward while holding the thigh will increase the Q-angle by moving the tibial tuberosity laterally; rotating the thigh inward will likewise decrease the Q-angle.

There is considerable debate on whether the Q-angle varies according to the patient’s sex. In one study, investigators[12] observed an average value for supine patients of 14 $\pm$ 3 degrees in men and 17 $\pm$ 3 degrees in women ($P < 0.001$). Researchers in another study[18] reported even greater differences of values obtained from standing patients (11.2 $\pm$ 3.0 degrees in men and 15.8 $\pm$ 4.5 degrees in women). However, other reports have not shown a sex-related difference in the Q-angle.[19,20] Differences in measurement technique likely contributed to these varied findings.

Palpation of the Patellar Retinaculum

Fulkerson[21] studied the localization of pain in 78 knees in patients with PFPS. He reported that 90% of those patients had pain in some portion of the lateral retinaculum. The vastus lateralis insertion or epicondylopatellar band was most painful in 27% of the knees studied, and only 10% of the subjects’ knees were painful solely in the medial patellofemoral joint.[21] Several studies have presented evidence of nerve damage and hyperinnervation into the lateral retinaculum in patients with patellofemoral malalignment.[22–25] In those individuals, neural growth factor is overexpressed in the nerve fiber and vessel wall and stimulates the release of substance P in the free nerve endings.[22]

Fulkerson[26,27] described the palpation of the patellar retinaculum as follows: With the knee in full extension, portions of the lateral and medial knee retinacula are palpated gently to see if there is an obvious source of pain in any one location. The patella should be displaced medially and laterally, stressing all portions of the peripatellar retinaculum to see if this reproduces pain. For more accuthe side undergoing examination so that the retinacular fibers to be examined are placed under tension while being brought away from their underlying structures. Evaluation should also include careful palpation of the vastus lateralis tendon insertion into the proximal patella. The proximal deep lateral retinaculum interdigitates with the dense insertion of the vastus lateralis into the patella.

Patellar Tilt Test

Boden et al.[28] have demonstrated that excessive lateral tilt of the patella can lead to decreased medial patellar mobility and abnormally high forces between the lateral facet of the patella and the lateral trochlea. Grelsamer and McConnell[29] describe a method of performing the patellar tilt test as follows: In the supine position, the test is performed with the knee extended and the quadriceps relaxed. The degree of medial and lateral patellar tilting is determined by comparing the height of medial patella border with that of lateral patellar border. The examiner places his or her thumb and index finger on the medial and lateral border of the patella. Both digits should be of equal height. If the digit palpating the medial border is more anterior than the lateral border, then the patella is tilted laterally. If the digit palpating the lateral border is more anterior than the medial border, then the patella is tilted medially.

Kolowich et al.[30] provide the following description of an alternative method of testing for patellar tilt: "Standing at the foot of the examination table, the examiner lifts the lateral edge of the patella from the lateral femoral condyle. An excessively tight lateral restraint is demonstrated by a neutral or a negative angle to the horizontal with males tending to be tighter than females by five degrees." Tomsich et al.,[31] who used a goniometer in this evaluation, placed the calipers of the instrument over the medial and lateral aspects of the patella and reported improved intratester and intertester reliability.

Mediolateral Glide

Mediolateral glide is another measurement of static patellofemoral orientation.[32–34] McConnell[29,33] describes the technique as follows: The glide component is examined by use of a tape measure to record the distance from the midpatella to the lateral femoral epicondyle and the distance from the midpatella to the medial femoral epicondyle. The midpatella point is determined by visual assessment. The patella should be sitting equidistant (± 5 mm) from each epicondyle when the knee is flexed to 20 degrees.

Ahmed et al.[35] fou

placement of the patella caused a 50% decrease vastus medialis oblique tension.

Powers et al.[34] used magnetic resonance aging to measure the mediolateral patellar placement described by McConnell.[33] They ported that the agreement between the clinical magnetic resonance imaging determination of diolateral patellar displacement was poor (in class correlation coefficient [ICC] = 0.44). average degree of lateral patellar displacement termined by the clinical method was more th twice the position of the patella as determined magnetic resonance imaging. Clinicians theref should be careful not to overestimate the me lateral patellar glide when the technique descri by McConnell is used.

Patellar Mobility Test

The patellar mobility test measures pass patellar mediolateral range of motion from patellar resting position and indicates the integ and tightness of the medial and lateral restrai Puniello[36] observed an association between pate hypomobility and a tight iliotibial band (ITB). permobility with lateral patellar glide is correla with laxity of the medial patellofemoral ligamen the patellomeniscal ligament and is often noted association with patellar subluxation.[37,38]

Kolowich et al.[30] provide this description the patellar mobility test: The test is perform with the knee flexed 20 to 30 degrees and quadriceps relaxed. This can be done resting knee over the examiner's thigh or with a sm pillow underneath the knee. The patella is divi into four longitudinal quadrants and then an tempt is made to displace the patella in a me direction followed by displacement in a lateral rection under the guidance of the examiner's in finger and thumb.

According to those investigators, lateral pa lar mobility of three quadrants was suggestive o incompetent medial restraint. Medial mobility only one quadrant was consistent with a tight eral restraint, and medial mobility of three or m quadrants suggested a hypermobile patella.

As with other techniques of patellar positi the assessment of mediolateral mobility is diffic to quantify by manual assessment. Kujala et a reported a mediolateral range of motion of 31. 1.0 mm. Joshi and Heatley[40] observed lateral tellar mobility of 8.3–19.6 mm in women 9–18.6 mm in men and suggested that mobilit 8–20 mm is within normal limits. As with ot measurements of patellar position, however, reliability of these measurements is quite low.[3

Skalley et al.[42] used a handheld "pate pusher," which is a calibrated device that exer tellar mobility. Using this device, they found an average medial patellar mobility of 9.3 (range, 4–15 mm) and lateral patellar mobility of 5.3 (range, 4–11 mm).

Patellar Apprehension Test

The patellar apprehension test was initially described >60 yrs ago by Fairbank,[43] who wrote that while examining cases of suspected recurrent dislocation of the patellar, he had been struck by the marked apprehension often displayed by the patient when the patella was moved laterally. Hughston[44] depicted the apprehension test as follows: This test is carried out by pressing on the medial side of the patella with the knees flexed about 30 degrees and with the quadriceps relaxed. It requires the thumbs of both hands pressing on the medial side of the patella to exert a laterally directed pressure. Accordingly, the leg with muscles relaxed is allowed to project over the side of the examining table and is supported with the knees at 30 degrees of flexion by resting the leg on the thigh of the examiner who is sitting on a stool. In this position the examiner can almost dislocate the patella over the lateral femoral condyle. The patient becomes uncomfortable and apprehensive as the patella reaches the point of maximum passive displacement, with the result that he begins to resist and attempts to straighten his knee, thus pulling the affected patella back into a relatively normal position.

Tanner et al.[45] suggested a modified version of the patellar apprehension test. Those investigators believed that the displacement of the patella in a distal lateral direction would be a more sensitive method than classic lateral displacement in showing a deficiency of the medial restraints.

The apprehension test grossly detects patellar instability and is less sensitive in detecting PFPS. Korkala et al.[46] observed that the patellar apprehension test was positive in fewer than half of the patients with clearly symptomatic chondromalacia and was rarely positive in mild cases of that disorder.

Patellar Compression Test

The patellar compression test is performed when the patient is supine with knees extended. The examiner moves the patella superiorly and inferiorly while compressing the patella against the femoral groove. If pain results, the test is considered positive.[46,47]

Hand and Spalding[48] noted that patients with patellofemoral pain had a high probability of receiving a positive result from the patellar compression test, not only for the affected knee but also frequently for the unaffected knee; th

question the specificity and utility of that test as a diagnostic tool.

Crepitus

Crepitus is often present as a symptom or sign in patients with PFPS. However, there is no close association between crepitus and pain, and the symptom of crepitus is therefore of questionable diagnostic significance.[49] In their clinical evaluation of asymptomatic knees, Johnson et al.[50] noted that 94% of the healthy women and 45% of the healthy men studied exhibited patellofemoral crepitus.

Patellar Tracking Test

Dynamic patellar tracking is a measure of patellar instability. During that evaluation, the examiner asks the seated patient to actively extend the knee from 90 degrees to full extension and observes the movement pattern of the patella from the front. In most individuals, the patella seems to move straight proximally, with a slight lateral shift near terminal extension. The term *J sign* describes the path of the patella with poor tracking. Instead of moving superiorly with knee extension, the patella suddenly deviates laterally at terminal extension as it exits the trochlear groove to create an inverted J-shaped path.[51,52] The cause of this patellar maltracking J sign is not clear. Post[51] believed that vastus medialis oblique deficiency, underlying bony morphology (trochlear dysplasia, patella alta), or an imbalance of medial and lateral soft-tissue constraints might be related to a positive J sign during passive flexion-extension. Johnson et al.[50] evaluated 210 adults with healthy knee joints. A classic J sign with lateral superior subluxation during active knee extension was not noted in any of those subjects. To our knowledge, there have been no studies that objectively identify the J sign in patients with PFPS.

Muscle Flexibility

PFPS is frequently associated with deficits of lower limb flexibility. Several retrospective studies have shown an association between decreased quadriceps or hamstring muscle flexibility and patellofemoral pain in athletes.[53,54] In their prospective study of athletes with PFPS, Witvrouw et al.[55] also confirmed an association between tight quadriceps and the development of PFPS; this supports the concept that tight quadriceps muscles create high patellofemoral stresses during sports or the activities of daily living, thus potentiating PFPS. Those investigators did not, however, find a correlation between PFPS and hamstring tightness.

Post[56] described the prone measurement of prone, flex each knee with one hand while stabilizing the pelvis. Bring the heel as close as possible to the buttock. Record the distance from the heel to the buttock and any side-to-side asymmetry. A convenient method of measuring the heel-to-buttock distance is by fingerbreadths of the examiner's hand. Many young active patients can bring their heels to their buttock or at least within a few fingerbreadths. When the heel comes less than eight fingerbreadths from the buttock, it is more convenient to record quadriceps flexibility as degrees of prone knee flexion.

Several studies also suggest that ITB tightness may contribute to the development of PFPS.[36,57] In a study of 12 ballet dancers, Winslow and Yoder[57] found a correlation between ITB tightness and PFPS. Data analysis revealed that the degree of tibial external rotation used by dancers with ITB tightness was significantly greater than that in dancers without ITB tightness. Those researchers suggested that a tight ITB pulls the patella laterally during the knee flexion movement, thus increasing patellofemoral joint reaction forces. Puniello[36] studied 17 patients with PFPS and limited medial mobility of the patella. Twelve of those patients exhibited a tight ITB on Ober's test ($P < 0.05$). The results of that study support a relationship between iliotibial flexibility and limited medial patellar mobility. Because the fibers of the ITB help reinforce the superficial oblique lateral retinaculum, some investigators believe that any vertical shortening of the ITB can lead to a horizontal shortening of the lateral retinaculum.[36]

Ober's test was first described as a measurement of ITB tightness.[58] Ober provides this comment on the correct method of performing that test: The patient lies on his side, with the thigh next to the table and flexed enough to obliterate any lumbar lordosis. The upper leg is flexed at a right angle at the knee. The examiner grasps the ankle lightly with one hand and steadies the patient's hip with the other. The upper leg is abducted widely and extended so that the thigh is in line with the body. If there is any abduction contracture, the leg will remain more or less passively abducted, depending on the shortness of the iliotibial band.

Puniello[36] further suggests that during Ober's test "the patient's pelvis is supported by the seated examiner's body against the patient's pelvis, by the examiner's arm against the patient's thigh, and by the table."

Kendall et al.[59] proposed the modified Ober's test for the measurement of the ITB. They suggested that the tested knee be extended rather than flexed at 90 degrees. That maneuver places less strain medially on the

the patella, and less interference from a tight r
tus femoris muscle.

There are several methods of measuring
tightness of the ITB: clinical observation,[58,60]
niometer,[61] and inclinometer.[62,63] Gose a
Schweizer[60] depicted the following simple syst
for describing the position of the involved leg w
reference to the horizontal or sagittal body plane
the leg can be passively stretched to a posit
horizontal but not completely adducted to a tal
it constitutes a minimal tightness. If the leg can
passively adducted to horizontal at best, it con
tutes a moderate tightness. If the leg cannot
passively adducted to horizontal, this constitute
maximal tightness.

Reid et al.[61] described the use of a goniome
to qualify the tightness of the ITB as follows: "
stationary arm of the instrument remains para
to the horizontal axis, and the mobile arm mo
along the long axis of the adducting thigh from
anterosuperior iliac spine to the midpatella."

Melchione and Sullivan[62] used a fluid-fi
inclinometer to study the reliability of the modi
Ober's test. The reliability of the measurem
within testers (ICC = 0.94) was considered exc
lent, that among testers (ICC = 0.73) was cons
ered good.

Muscle Strength

Quadriceps muscle weakness is commo
seen in patients with PFPS.[54,64,65] Callaghan a
Oldham[64] have reported that the peak exten
torque of the affected knee in patients with PF
was 18.4% lower than that of the contralateral k
and the cross-sectional area of the affected k
was 3.4% lower than that of the contralateral kn
Thomeé et al.[65] also compared the muscle stren
of the knee extensor in patients with PFPS a
found a 17% strength deficit in those with PFPS
opposed to controls.

Some studies, however, show no decrease
quadriceps strength in patients with PFPS as
posed to control subjects.[6,55,66] Messier et al.[6] h
used isokinetic testing to evaluate muscle stren
in runners with PFPS and found no signific
differences in knee flexion or extension strength
patients with PFPS and controls. In their prosp
tive study of infantry recruits with PFPS, Milgr
et al.[66] found that recruits with PFPS exhibi
greater isometric quadriceps strength than
those without the disorder. In a prospective stu
Witvrouw et al.[55] found that subjects with PF
and controls exhibited no significant difference
quadriceps and hamstring muscle strength.

Ireland et al.[67] recorded isometric stren
measurements during hip abduction and exter
rotation on the injured side of 15 patients w

TABLE 1 Data for patellofemoral pain syndrome (PFPS) tests

Test	Reliability and Validity	Comments	Source
Q-angle	Significant ($P < 0.001$)	150 healthy knees and 90 knees with chondromalacia; subjects supine for evaluation Retrospective study	Aglietti et al.[12] (1983)
	Significant ($P < 0.01$)	16 runners with PFP and 20 noninjured runners Retrospective study	Messier et al.[6] (1991)
	Nonsignificant ($P = 0.07$)	50 patients with AKPS and 20 healthy subjects Retrospective study	Caylor et al.[13] (1993)
	Nonsignificant ($P = 0.394$)	24 patients with PFPS and 258 healthy subjects Prospective study	Witvrouw et al.[55] (200
	Nonsignificant	40 women with PFPS and 20 healthy women Subjects standing when measured Retrospective study	Thomeé et al.[8] (1995)
	Interrater ICC: 0.17–0.29 Intrarater ICC: 0.14–0.37 ICC between clinical and radiologic measurements: 0.13–0.32	50 healthy knees	Greene et al.[76] (2001)
Tilting	Intratester κ coefficients: 0.44–0.50 Intertester κ coefficients: 0.20–0.35	52 subjects Evaluated by the method of Kolowich et al.[30]	Watson et al.[41] (2001)
	Intertester κ coefficient: 0.21	66 subjects Evaluated by the method of McConnell[33]	Fitzgerald et al.[77] (199
	Intertester κ coefficients: -0.03 to 0.19 Intratester κ coefficients: -0.06 to 0.35	95 knees Evaluated by the method of McConnell[33]	Watson et al.[32] (1999)
Mediolateral glide	Intertester κ coefficient: 0.10	66 subjects Evaluated by the method of McConnell[33]	Fitzgerald et al.[77] (199
	Intertester κ coefficient: 0.02 Intratester κ coefficients: 0.11–0.35	95 knees Evaluated by the method of McConnell[33]	Watson et al.[32] (1999)
	ICC between clinical and MRI measurements: 0.44	14 subjects	Powers et al.[34] (1999)
Mediolateral mobility	14 of 17 PFPS patients exhibited hypomobility of the medial glide.	No controlled study	Puniello[36] (1993)
	Increased medial patellar displacement is significant ($P = 0.026$).	24 patients with PFPS and 258 healthy subjects Prospective study	Witvrouw et al.[55] (200
Patellar compression	Sensitivity: 56% Specificity: 55%	85 knees Chondromalacia in 40%, meniscal problem in 30%, miscellaneous knee disorders in 30% Chondromalacia investigated by arthroscopy Retrospective study	Niskanen et al.[47] (200
Tight quadriceps	Significant ($P = 0.028$)	24 patients with PFPS and 258 healthy subjects Prospective study	Witvrouw et al.[55] (200
	Significant ($P < 0.01$)	14 figure skaters with AKP and 32 noninjured skaters Retrospective study	Smith et al.[53] (1991)
	61% have tightness in quadriceps.	No controlled study 76 running athletes	Kibler[54] (1987)

TABLE 1 Continued

Test	Reliability and Validity	Comments	Source
Tight hamstring	Nonsignificant ($P = 0.442$)	24 patients with PFPS and 258 healthy subjects Prospective study	Witvrouw et al.[55] (200
	Significant ($P < 0.01$)	14 figure skaters with AKP and 32 noninjured figure skaters Retrospective study	Smith et al.[53] (1991)
	23% have tightness in quadriceps.	No controlled study 76 running athletes	Kibler[54] (1987)
Tight iliotibial band	Significant ($P < 0.01$)	14 knees with PFP (ballet dancers) and 34 pain-free knees (ballet dancers) Retrospective study	Winslow and Yoder[57] (1995)
Quadriceps weakness	Nonsignificant	77 knees with PFP (390 male infantry recruits) Prospective study	Milgrom et al.[66] (1991
	Nonsignificant	16 injured and 20 uninjured runners Retrospective study	Messier et al.[6] (1991)
	Significant ($P = 0.002$)	57 patients with PFPS and 10 healthy controls Retrospective study	Callaghan and Oldham (2004)
	Eccentric: significant ($P < 0.01$)	40 women with PFP and 20 healthy female controls	Thomeé et al.[65] (1995)
	Concentric and isometric: nonsignificant	Retrospective study	
	39% have weakness.	No controlled study 76 running athletes	Kibler[78] (1987)
	Decreased torque during eccentric exercise ($P < 0.05$)	130 various knee pain disorders Retrospective study	Bennett et al.[79] (1986)
Hip abductor weakness	26% less strength ($P < 0.001$)	15 women with PFP and 15 healthy women Retrospective study	Ireland et al.[67] (2003)
Functional performance	Intrarater ICC: 0.79–0.94	29 subjects with PFPS and 11 healthy controls	Loudon et al.[70] (2002)
	Anteromedial lunge, step-down, single-leg press, balance and reach: significant ($P < 0.05$)	Retrospective study	
General joint laxity	Nonsignificant	69 girls and 67 boys with knee pain and 310 healthy students Retrospective study	Fairbank et al.[73] (1984
	Nonsignificant except for thumb-forearm mobility	24 patients with PFPS and 258 healthy subjects Prospective study	Witvrouw et al.[55] (200
	Significant ($P < 0.001$)	115 chondromalacic patellas and 110 healthy patellas Retrospective study	al-Rawi and Nessan[74] (1997)

ICC, intraclass correlation coefficient; MRI, magnetic resonance imaging; AKP, anterior knee pain.

in hip abduction and 36% weaker in hip external rotation than were controls.[67] Those findings correlate with work by Powers et al.,[68] who used kinematic magnetic resonance imaging to evaluate six patients with patellofemoral pain and lateral subluxation of the patella. The study results suggest that the patellofemoral joint kinematics during weightbearing could be characterized as the femur rotating underneath the patella; the lack of control of femoral add

caused by weak hip abductors and external rotat could be a primary cause of patellar malalignme

In the clinical setting, hip abductor mus strength can be evaluated with the patient in side-lying position described by Janda.[69] Patie often compensate for weakness or inhibition of gluteus medius by relying on the tensor fascia la the quadratus lumborum muscles, or both. abduction may result from the internal rotat lata, or hip hiking from overactivation of the quadratus lumborum may be noted. A dysfunctional firing pattern also may be the source of tensor fascia lata and ITB tightness.

In athletes, manual muscle testing does not consistently detect muscle strength deficits or clearly demonstrate the effect of such deficits on the knee. For this reason, functional performance testing may be preferred. Functional performance tests simulate the demands of weightbearing sport participation on the knee and the entire lower limb kinetic chain. We are aware of only one study of the use of functional performance tests in patients with PFPS. Loudon et al.[70] evaluated five different functional performance tests (anteromedial lunge, step-down, single-leg press, bilateral squat, and balance and reach) in subjects with patellofemoral pain. All five of those tests revealed high intrarater reliability and correlated with changes on pain scales. Additional research is needed to further examine the validity and sensitivity of these clinical tests and interrater reliability.

General Ligamentous Laxity

Joint laxity is measured by a series of simple tests that assess the range of joint movements. Beighton et al.[71] present a modification of a technique initially described by Carter and Wilkinson.[72] They assign each patient a numerical score ranging from 0 to 9, with 1 point awarded for the ability to perform each of following movements (tests 1–4 are scored bilaterally and test 5 is a single score):

(1) Passive dorsiflexion of the little fingers beyond 90 degrees
(2) Passive apposition of the thumbs to the flexor aspects of the forearms
(3) Hyperextension of the elbows beyond 10 degrees
(4) Hyperextension of the knees beyond 10 degrees
(5) Forward flexion of the trunk, with knees straight, so that the palms of the hands rest easily on the floor

It is unclear whether systemic hypermobility is correlated with patellofemoral pain,[55,73,74] although patellar dislocation was six times more frequent in hypermobile patients than in age-matched controls.[75] Fairbank et al.[73] reported that no association could be found in adolescent subjects between the complaint of anterior knee pain and measurements of joint mobility or a global score for joint laxity. In a 2-yr prospective study, Witvrouw et al.[55] observed that when compared with their healthy counterparts, subjects with patellofemoral pain demonstrated a significantly greater range of motion in thumb-forearm mobility and that the values for shoulder mo finger extension, and knee extension were all greater in the group with patellofemoral pain. al-Rawi and Nessan[74] reported that the number of individuals with hypermobile joints and the total mobility scores described by Carter and Wilkinson[72] were significantly higher in patients with chondromalacia than they were in controls ($P < 0.001$) (Table 1).

CONCLUSIONS

In this article, the most common methods for the clinical diagnosis of PFPS are reviewed. The reliability of most such tests is low or untreated, and further research is necessary to establish a gold standard for diagnosing PFPS. Because that diagnosis cannot be determined by any single test, multiple evaluations are recommended. The evaluation of generalized ligamentous laxity, a hypomobile or hypermobile patella, tenderness of the lateral patellar retinaculum patellar tilt or mediolateral displacement, decreased flexibility of the ITB and quadriceps, and weakness of the quadriceps, hip abductor, and external rotator are recommended to reveal factors contributing to PFPS and patellofemoral malalignment.

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We demonstrated that lack of hip muscle flexibility is prevalent, especially in the rectus femoris and iliotibial band. These muscle groups may be less flexible due to biomechanical changes in the knee joint, knee pain, pain centralization and subsequent restriction of functional activities **[35]**. *Patients in this sample also walked at slower speeds.*

Physical examination findings and their relationship with performance-based function in adults with knee osteoarthritis

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Full-text · Article · Dec 2016

Maura D Iversen Lori Lyn Price Johan von Heideken +1 more author... William F Harvey

For instance, many retrospective studies have shown that adults with PFP present hip muscle weakness as compared to controls (Cant, Pineux, & Pitance, 2014; **Fredericson & Yoon, 2006;** *Razeghi, Etemadi, Taghizadeh, & Ghaem, 2010). However, these studies did not determine whether alterations such as muscle weakness are causes or effects of PFP.*

Patellofemoral pain and sports practice: Reduced symptoms and higher quality of life in adolescent athletes as compared to non-athletes

[Show abstract]

Full-text · Article · Mar 2016 · Gait & Posture

Danilo Oliveira Silva Maira Bergamaschi Coura W. Marina +1 more author... Juliana Pradela

*Patellofemoral pain syndrome (PFPS) is a common cause of painful knee problems. There are no standard clinical guidelines or standardisation for the diagnosis of the PFSP.***[1]** *Anterior knee pain or pain at the kneecap is the most common presenting symptom without pathognomonic signs in the diagnosis.[2] Patients report increasing pain with knee flexion, prolonged sitting, knee squats, jumping and activities involving stairs that cause disturbances to functional activities.[3] Many treatment modalities have bee*

The validity and reliability of the Thai version of the Kujala score for patients with patellofemoral pain syndrome

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Article · Jan 2016

Adinun Apivatgaroon Chayanin Angthong Pra Bancha Chernchujit

All the subjects signed consent forms. The diagnostic criteria for PFPS **[3, 21]** *were (1) anterior or retropatellar knee pain provoked by at least 2 of the following activities: prolonged sitting with flexed knees, squatting, ascending, stair climbing, kneeling, running, and jumping; and (2) exhibition of 2 or more of the following clinical criteria on assessment: pain with direct compression of the patella against the femoral condyles with the knee in full extension, tenderness on palpation of the posterior edge at the medial and/or lateral border of the patella, pain with resisted knee extension , and pain with direct compression of the patella against the femur during isometric quadriceps contraction with the knee in slight flexion. The inclusion criteria for SG included (1) age between 20 and 40 years (to reduce the likelihood of osteoarthritic changes in the patellofemoral joint); (2) the presence of patellofemoral pain for at least 3 months; and (3) scored less than six on the Visual Analogue Scale (VAS) during the peak of the pain.*

Vastus medialis oblique and vastus lateralis activity during a double-leg semisquat with or without hip adduction in patients with patellofemoral pain syndrome

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Overuse injuries are frequent in recreational runners, with a reported annual prevalence of up to 70% [1]. Patellofemoral pain syndrome (PFPS), described as anterior or retropatellar knee pain or pain along the lateral and medial borders of the patella **[2]***, is the most common running injury with 17% of diagnoses [3]. Several factors have been suggested to explain the presence of PFPS including decreased muscle strength and altered mechanical loading, lower limb kinematics, and muscle activation patterns during running.*

Lower limb control and strength in runners with and without patellofemoral pain syndrome

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*PFPS is one of the most common causes for knee pain seen in primary care (Bahr et al., 2012). PFPS may result from increased cartilage and subchondral bon stress (***Fredericson and Yoon, 2006***), and should be distinguished from patellar tendinopathy which involves the attachment of the patellar tendon to the patella. The risk factor that is most often associated with PFPS is weaker knee extension strength (Lankhorst et al., 2012b) Others factors for which there is some evidence that they are related to PFPS are a larger patellar tilt angle, lower peak extension, larger Q-angle, larger sulcus angle, lower hip a and lower hip external rotation strength (Lankhorst et al.,*

The Expert View on Running Injuries

[Show abstract]