BMJ Best Practice

Patellofemoral pain syndrome

Straight to the point of care

Last updated: Jan 10, 2025

Table of Contents

Overview 3

- Summary 3
- Definition 3

Theory 4

- Epidemiology 4
- Etiology 4
- Pathophysiology 4
- Case history 5

Diagnosis 6

- Approach 6
- History and exam 9
- Risk factors 11
- Tests 13
- Differentials 14

Management 15

- Approach 15
- Treatment algorithm overview 17
- Treatment algorithm 19
- Primary prevention 25
- Secondary prevention 25
- Patient discussions 25

Follow up 27

- Monitoring 27
- Prognosis 27

References 29

Images 38

Disclaimer 39

Summary

Patellofemoral pain syndrome is one of the most common disorders of the knee, accounting for 25% of knee injuries seen in a sports medicine clinic.

The causes of patellofemoral problems are multifactorial, including abnormal patellofemoral joint mechanics, lower kinetic chain alterations, and overuse.

Patients typically note the insidious onset of an ill-defined ache localized to the anterior knee behind the patella.

There is no one physical exam or imaging test that is a standard for diagnosis.

Treatment is focused on activity modification and correction of specific risk factors.

Nonoperative treatment is successful in the majority of cases.

Definition

Patellofemoral pain syndrome is defined as knee pain resulting from mechanical and biochemical changes to the patellofemoral joint.

Epidemiology

Patellofemoral pain syndrome is one of the most common disorders of the knee, accounting for 25% of knee injuries seen in the sports medicine clinic.[1] It is most common in the second and third decade of life. In one study of athletic patients over a 7-year period in the US, 7.4% of all male injuries (and 18.1% of knee injuries) and 19.6% of all female injuries (and 33.2% of knee injuries) were diagnosed as patellofemoral pain syndrome.[2] In a Canadian study of patients with running-related injuries, the most common complaint was patellofemoral pain (16.5%), and, of these, 38% were men and 62% were women.[3]

Etiology

Many theories have been proposed to explain the cause of patellofemoral pain.[4] The exact etiology is unknown, but it is likely to be multifactorial with contributing factors including:[5] [6]

- Abnormal patellofemoral joint mechanics
    - Bony and structural abnormalities
    - Tightness of soft tissue structures
    - Decreased patellar mobility
    - Quadriceps muscle weakness
- Altered lower-extremity alignment and/or motion
    - Subtalar joint pronation
    - Excessive hip internal rotation
    - Hip abductors weakness
    - Gait deviations
- Overuse
    - Training errors.

Pathophysiology

The pathophysiology of patellofemoral pain is not well understood.

Normal patellar tracking requires a balance of forces acting on the patella. If any force is too large or too small, the movement of the patella may be altered, thereby placing additional stresses on joint soft tissue. As the stress exceeds the tissue's mechanical strength, microdamage, inflammation, and pain result.[7] Delayed onset of vastus medialis activity compared with that of vastus lateralis may lead to an imbalance in muscle forces and subsequent patellar maltracking. A statistically significant correlation has been found between measures of patellar maltracking (patellar tilt and bisect offset) and delay in vastus medialis activation in patients with patellofemoral pain.[8]

Excessive stress or normal stress applied in an abnormal direction to the cartilage, with resultant deformation, can transmit abnormal shear stress to the subchondral bone. Patients with patellofemoral pain exhibit elevated bone metabolic activity at the patellofemoral joint.[9] Nerves are associated with a blood supply to the subchondral bone, and the increase in pressure between the patella and femur is likely to be transmitted to these nerve receptors and perceived as patellar pain.

The lateral retinaculum also plays an important role in patellofemoral pain. The chronic lateral subluxation of the patella can lead to shortening of the retinaculum with secondary nerve damage, resembling the histopathologic picture of a Morton neuroma.[10] [11]

Case history

Case history #1

A 25-year-old female recreational runner presents with anterior knee pain. She feels pain or stiffness on prolonged sitting with the knees flexed. Pain is aggravated when she ascends and descends hills or stairs, or performs squats. She has no history of knee trauma.

Approach

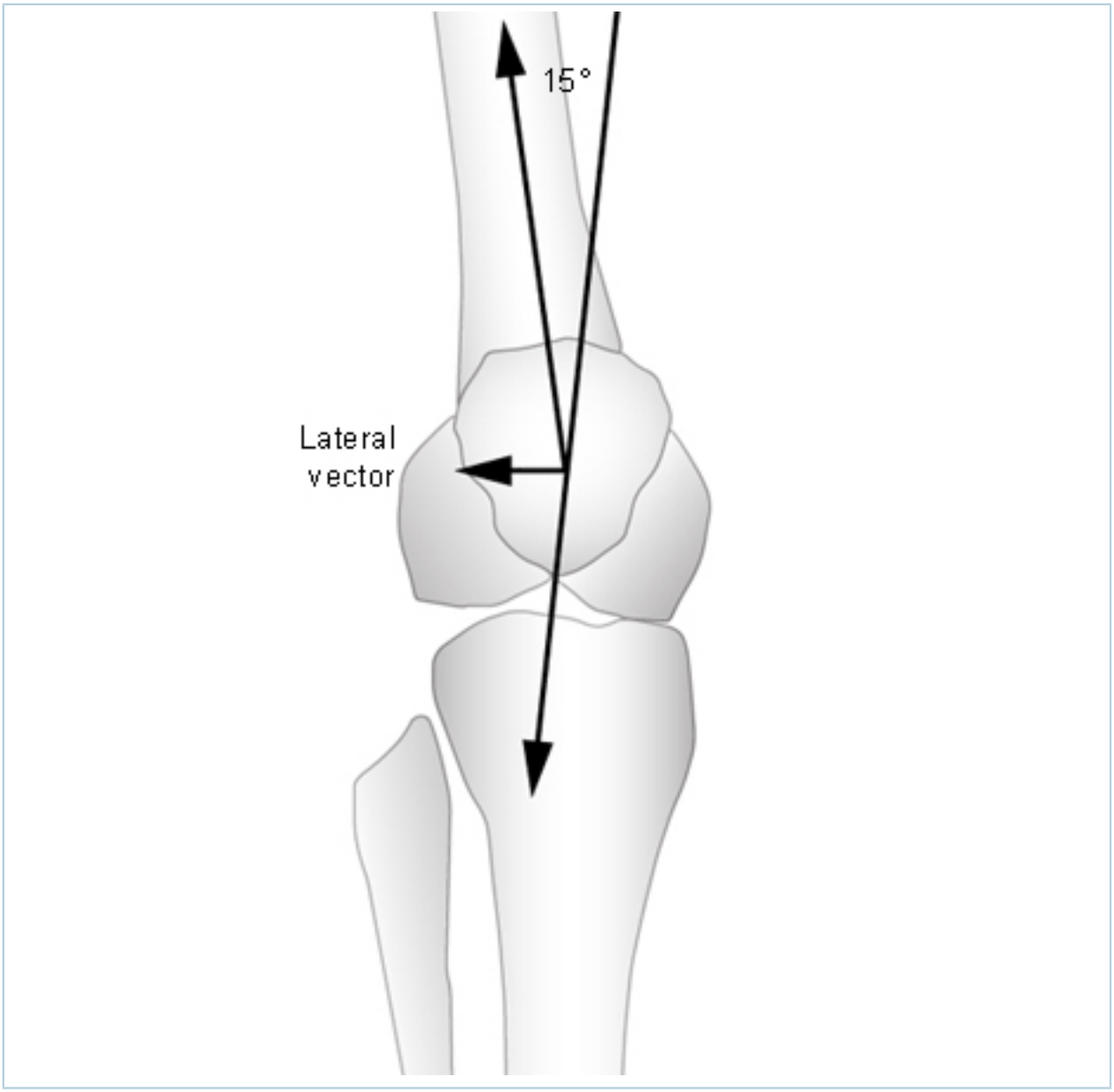
In most patients a history and physical exam is sufficient to make a diagnosis, although imaging techniques are useful in certain cases.

History

Patients typically note the insidious onset of an ill-defined ache localized to the anterior knee behind the patella. Occasionally, the pain may be centered along the medial or lateral patellofemoral joint and retinaculum. Pain is typically aggravated with activities that increase patellofemoral compressive forces, such as ascending and descending hills or stairs, running, squatting, and prolonged sitting with the knee in a flexed position.[5] [23]

Physical exam

There is no single confirming test and, as the condition has a multifactorial etiology, a diagnosis should only be made following multiple physical tests yielding a cluster of positive exam tests.[24] A complete exam of the knee should be performed, including a careful assessment of the patellofemoral joint.[23]
The Q angle, which is a measure of the patellar tendency to move laterally when the quadriceps muscles are contracted, should be measured to determine whether this is within the normal range. 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. Clinical Q-angle measurement is highly sensitive to error, and there is disagreement on its reliability and validity.[25]
In a study in 150 normal asymptomatic knees, the average Q angle in a supine position with the knee extended was 15°, with significant differences according to the patient's sex, showing an average value of 14 ± 3° in men and 17 ± 3° in women (P ≤0.001).[26]



Q angle

Created at BMJ Evidence Centre

Gentle palpation of the lateral and medial patellar retinacula may detect the location of obvious pain sources. With the knee in full extension, portions of the lateral and medial knee retinacula are palpated gently to see whether there is an obvious source of pain. The patella should be displaced medially and laterally to see whether this is painful. Evaluation should also include 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.[27] [28] Several studies have presented evidence of nerve damage and hyperinnervation into the lateral retinaculum in patients with patellofemoral malalignment.[29] [30] [31] [32]

Patellar tilt tests should be performed to assess medial and lateral tilt.[33] [34] [35] There are 2 methods for evaluating patellar tilt:

1. In the supine position, the test is performed with the knee extended and the quadriceps relaxed. The examiner places his or her thumb and index finger on the medial and lateral border of the

patella.[33] If the digit palpating the medial border is more anterior than that on the lateral border, then the patella is tilted laterally. If the digit palpating the lateral border is more anterior than that on the medial border, then the patella is tilted medially.

2. The knee is extended, the patella is grasped between the thumb and forefinger, and the medial aspect of the patella is compressed posteriorly while the lateral aspect is elevated.[34] If the lateral aspect of the patella is fixed and cannot be raised to at least the horizontal position, then the test is positive and indicates tight lateral structures.

Mediolateral glide, patellar mobility, patellar apprehension, and patellar tracking tests should also be performed:

Mediolateral test

- The midpatella point is first determined by visual assessment, then a tape measure should be used to measure the distance from the midpatella to the lateral femoral epicondyle and the distance from the midpatella to the medial femoral epicondyle.[33]
- The patella should be sitting equidistant (±5 mm) from each epicondyle when the knee is flexed to 20°.
- A 5 mm lateral displacement of the patella causes a 50% decrease in vastus medialis oblique tension.[36]

Patellar mobility test

- The patellar mobility test measures passive patellar mediolateral range of motion from the patellar resting position, and indicates the integrity and tightness of the medial and lateral restraints.
- The test should be performed with the knee flexed 20° to 30° and the quadriceps relaxed (e.g., resting the knee over the examiner's thigh or with a small pillow underneath the knee).
- The patella is divided into 4 longitudinal quadrants, and then the patella is displaced in a medial direction and then a lateral direction using index finger and thumb.[37]
- There is an association between patellar hypomobility and a tight iliotibial band.[15]
- Lateral patellar mobility of 3 quadrants suggests an incompetent medial restraint. Medial mobility of only 1 quadrant is consistent with a tight lateral restraint, and medial mobility of 3 or more quadrants suggests a hypermobile patella.
- Hypermobility with lateral patellar glide is correlated with laxity of the medial patellofemoral ligament or the patellomeniscal ligament and is often noted in association with patellar subluxation.[13] [14]

Patellar apprehension test

- The thumbs of both hands are used to press on the medial side of the patella, to exert lateral pressure on the medial side of the patella, with the patient's knees flexed about 30° and quadriceps relaxed.
- The leg is allowed to project over the side of the examining table and is supported with the knees at 30° of flexion by resting the leg on the thigh of the examiner, who sits on a stool. In this position the examiner can almost dislocate the patella over the lateral femoral condyle.[38]
- The patient becomes uncomfortable and apprehensive as the patella reaches the point of maximum passive displacement, with the result that they begin to resist and attempt to straighten their knee, pulling the patella back into a relatively normal position.
- This test can be unreliable if the patient is truly apprehensive.

Patellar tracking test

- Dynamic patellar tracking measures patellar instability.

- The examiner should ask the seated patient to extend the knee from 90° to full extension, and observes the movement pattern of the patella from the front.
- In most people, 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 maltracking. 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.[39] [40]

Further physical exams include tests for muscle flexibility (quadriceps, hamstring muscle, and iliotibial band) and muscle weakness (e.g., using functional performance tests).

The lack of significant findings on physical exam (i.e., normal patellar mechanics, normal lower-extremity function) suggests that the source of patellofemoral pain may be related to overuse and peripatellar synovitis.[41] If there is evidence of significant joint effusion and no history of overuse or trauma, then one must consider potential rheumatologic causes of joint inflammation.

Imaging

An x-ray of the knee is used as an adjunct to history and physical exam to provide further information on patellar positioning, or where the clinical exam suggests osteoarthritis; it is the initial imaging study that should be performed.[42] Magnetic resonance imaging (MRI) of the knee should be avoided in patients with an absence of joint effusion or mechanical symptoms, unless the patient has completed a rehabilitation program without any symptomatic improvement and radiography findings are negative.[43] MRI of the knee without intravenous contrast may also be indicated if further information is needed to evaluate for meniscal tear, synovial plica (symptoms include medial pain, tenderness, and a palpable band along the medial edge of the patella), fat pad inflammation/impingement (inferior pain, tenderness, and swelling deep to the patellar tendon, pain aggravated by knee extension), and patellar tendonitis (inferior pain and tenderness of the inferior pole and patellar tendon).[42] MRI may also be used to grade degrees of chondromalacia or osteochondral defect.[5] Kinematic MRI or computed tomography may also be appropriate, for example, to more accurately define patellar tracking abnormalities, and in these instances the patient is supine or standing upright in a weight-bearing, closed-chain position while performing continuous knee flexion and extension movements.[5] [42][44]

History and exam

Key diagnostic factors

ill-defined ache (common)

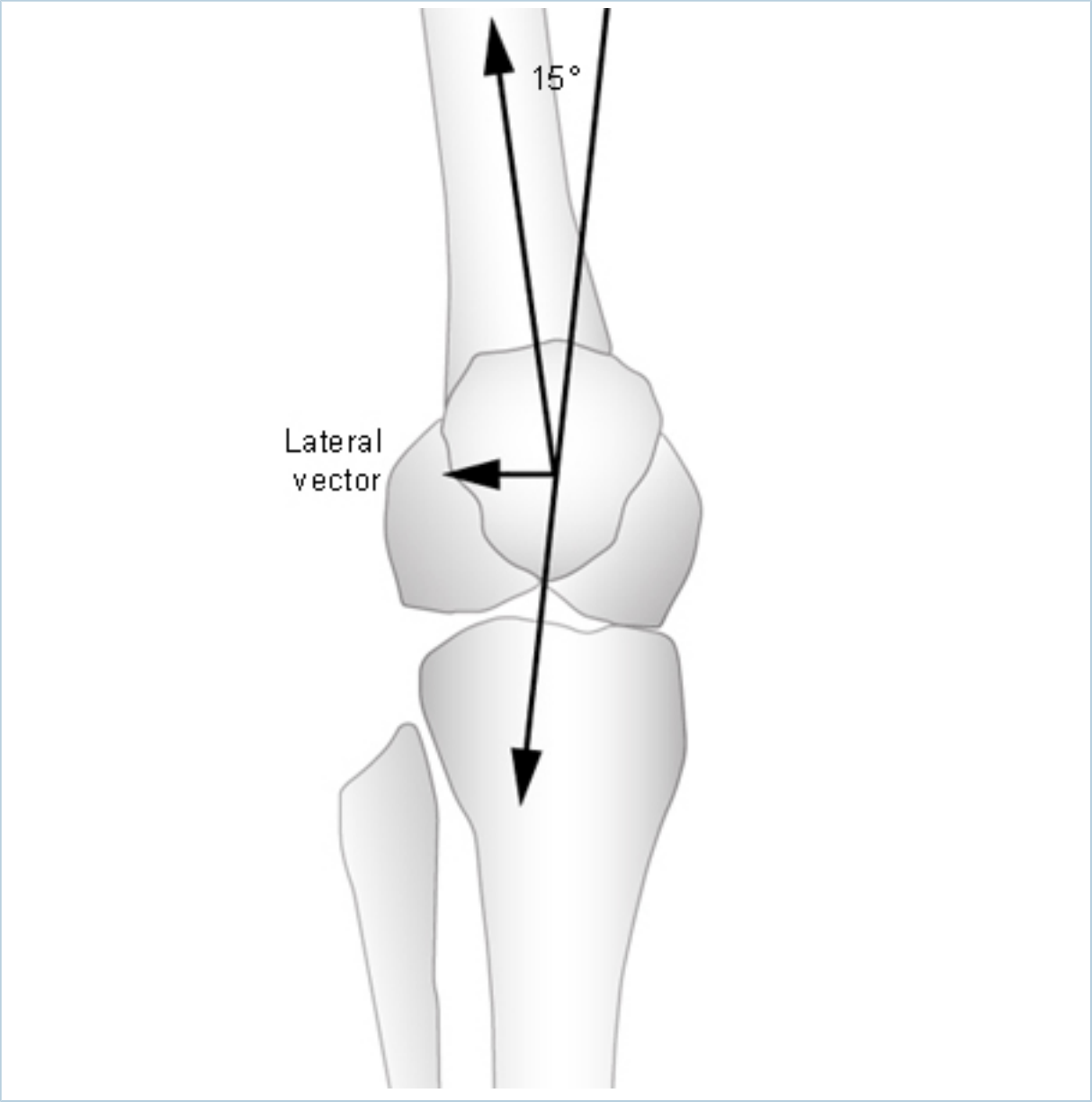
- A patient may note the insidious onset of an ill-defined ache localized to the anterior knee behind the patella. Occasionally, the pain may be centered along the medial or lateral patellofemoral joint and retinaculum.

pain aggravated by compressive force (common)

- Pain can be aggravated by activities that increase patellofemoral compressive force, which include ascending and descending hills or stairs, squatting, and prolonged sitting with the knee in a flexed position.[5]

Q angle (common)

- 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.[26]



Q angle

Created at BMJ Evidence Centre

- It is a measure of patellar tendency to move laterally when the quadriceps muscles are contracted. The Q angle should be measured to determine whether this value falls within the normal range.
- The patient should be in a supine position with the knees extended and the legs relaxed.
- Most practitioners accept 10° to 15° as a normal range for the Q angle when the knee is extended or slightly flexed.[33] The greater the Q angle, the greater the patellar tendency to move laterally.
- The difference in Q angles between men and women may be due to differences in average height, so height may be used as a correction factor.[45] [46] [47] Lower Q angles are associated with taller patients.

pain on palpation of patellar retinaculum (common)

- If pain results from gentle palpation, this test is considered positive.

patellar tilt test (common)

- Lateral patellar tilt suggests tight lateral structures contributing to patellofemoral pain syndrome. One way to evaluate the patellar tilt is by comparing the height of the medial and lateral border of the patella. With the patient lying supine with knee extended and the quadriceps relaxed, the examiner places the thumb and index fingers on the medial and lateral border of the patella. If the finger close to the medial border is more anterior than the lateral border, then the patella is tilted laterally.[33]

mediolateral glide test (common)

- A 5 mm lateral displacement of the patella causes a 50% decrease in vastus medialis oblique tension.[36]

patellar mobility test (common)

- Lateral patellar mobility of 3 quadrants suggests an incompetent medial restraint.
- Medial mobility of only 1 quadrant is consistent with a tight lateral restraint.
- Medial mobility of 3 or more quadrants suggests a hypermobile patella.
- Hypermobility with lateral patellar glide is correlated with laxity of the medial patellofemoral ligament or the patellomeniscal ligament and is often noted in association with patellar subluxation.[13] [14]

patellar apprehension test (common)

- Lateral movement of the patella results in the patient becoming apprehensive at the point of maximum passive displacement.

patellar maltracking test (common)

- The term "J sign" describes the path of the patella with maltracking. 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.[39] [40]

decreased muscle flexibility (common)

- Decreased muscle flexibility, typically in the quadriceps, hamstring muscle, or iliotibial band, is associated with patellofemoral pain, particularly in athletes.[15] [48] [49]

muscle weakness (common)

- Quadriceps muscle or hip abduction and external rotation muscle weakness is often seen in patients with patellofemoral pain syndrome.[16] [21] [50]
- In athletes, manual muscle testing does not consistently detect muscle strength deficits or clearly demonstrate the effect of such deficits on the knee, so functional performance testing may be preferred.
- Functional performance tests simulate the demands of weight-bearing sport participation on the knee and the entire lower limb kinetic chain.

Risk factors

Strong

bony and structural abnormalities

- Significant deviations in patella alignment secondary to patella alta, trochlear dysplasia, femoral anteversion, knee valgus, and a laterally displaced tibial tuberosity can cause patellofemoral pain.[5] [12]

iliotibial band tightness

- Tightness of the iliotibial band (ITB) can affect normal patella excursion. The distal ITB fibers blend with the superficial and deep fibers of the lateral retinaculum, and tightness in the ITB can contribute to lateral patellar tilt and excessive pressure on the lateral patella.[5]

abnormal patellar mobility

- There is an association between patellar hypomobility and a tight iliotibial band. Hypermobility with increased lateral patellar glide is correlated with laxity of the medial patellofemoral ligament or the patellomeniscal ligament and is often noted in association with patellar subluxation or dislocation.[13] [14] [15]

quadriceps muscle weakness

- Quadriceps muscle weakness is often seen in patients with patellofemoral pain syndrome.[16] [17] However, the mechanism by which strengthening improves patellofemoral pain symptoms is not entirely clear. Improved quadriceps strength may improve patellar tracking or lead to more subtle changes in patellar contact and pressure distribution. Quadriceps muscle activation imbalance due to delayed activation of the vastus medialis has also been reported as a contributing factor of patellofemoral pain, particularly in those with documented maltracking.[8] [18]

subtalar joint pronation

- Hyperpronation of the foot is a causative factor for this condition.[19] In theory, increased pronation causes the tibia to internally rotate during the weight acceptance phase of gait, preventing the tibia from fully externally rotating during midstance and so preventing the knee from fully locking via the screw-home mechanism. To compensate, the femur internally rotates to allow the knee to fully lock. Femoral internal rotation during quadriceps contraction may cause a greater lateral force on the patella as it is compressed against the lateral trochlear groove.

hip internal rotation

- Increased femoral internal rotation leads to increased contact pressure between the patella and the lateral trochlear groove, which can increase subchondral bone stress and patellofemoral pain syndrome symptoms.[20] Hip muscle weakness in abduction and external rotation can cause increased femoral internal rotation in patients with patellofemoral pain.[21]

gait deviations

- Deviations in gait can give rise to patellofemoral pain, especially in runners. Hyperextension of the knee and decreased knee flexion on weight acceptance, which reduce shock absorption, can often lead to patellofemoral pain.

Tests

1st test to order

Test	Result
no initial test	**clinical diagnosis**

Other tests to consider

Test	Result
knee x-ray • Diagnosis of patellofemoral pain syndrome depends mainly on history and physical exam, with radiography as an adjunctive test where examination indicates patellar alignment abnormalities. Radiography should be the initial imaging study performed.[42] • The following views should be included: 1) weight-bearing anterior-posterior view: allows evaluation of joint arthritis; 2) weight-bearing true lateral view: allows the measurement of patella alta (the Blackburne-Peel measurement is the most accurate, reliable, and reproducible); and 3) Merchant axial view: with 45° of knee flexion.[23]	**trochlear dysplasia with the sulcus angle, patellar displacement with the bisect offset angle, and patellar tilt with the lateral tilt angle**
MRI • MRI of the knee should be avoided in patients with an absence of joint effusion or mechanical symptoms, unless the patient has completed a rehabilitation program without any symptomatic improvement and radiography findings are negative.[43] • MRI without intravenous contrast is indicated when radiography findings are negative and/or further information is needed to evaluate for meniscal tear, synovial plica, fat pad inflammation/impingement, and patellar tendonitis. It can also grade degrees of chondromalacia or osteochondral defect.[5] [42] [44]	**abnormal knee morphology**
kinematic MRI or CT • Kinematic MRI or computed tomography may also be appropriate, for example, to more accurately define patellar tracking abnormalities.[42] • The patient should be supine or standing upright in a weight-bearing, closed-chain position while performing continuous knee flexion and extension movements.[5] [44]	**patellar tracking abnormalities**

Differentials

Condition	Differentiating signs / symptoms	Differentiating tests
Iliotibial band syndrome	• Lateral pain. • Tenderness on palpation of the iliotibial band 2 to 3 cm superior to the lateral joint line.	• Clinical differentiation usually suffices.
Plica syndrome	• Medial pain. • Tenderness and a palpable band along the medial edge of the patella.	• MRI with contrast or arthroscopy for definitive diagnosis. • Synovial plicae appear as bands of low signal intensity within the high-signal-intensity joint fluid.[51]
Patellar tendonitis/ tendinopathy	• Inferior pain. • Tenderness of the inferior pole and patellar tendon.	• Clinical differentiation usually suffices.
Patellar fat pad inflammation	• Inferior pain. • Tenderness and swelling deep to the patellar tendon. • Pain is aggravated by knee extension.	• Clinical differentiation usually suffices.
Patellofemoral osteoarthritis	• Deep retropatellar pain. • Tenderness and swelling on undersurface of patella.	• Radiographic findings can show joint-space narrowing, subchondral sclerosis, and osteophyte formation, which are all consistent with osteoarthritis.
Quadriceps tendonitis/ tendinopathy	• Superior pain. • Tenderness of the superior pole and quadriceps tendon.	• Clinical differentiation usually suffices.
Chondromalacia patellae/ osteochondral defect	• Anterior pain. • In this condition there is softening of the patellar articular cartilage. It occurs in a subset of patients who present with anterior knee pain.	• MRI or arthroscopy is performed for definitive diagnosis. • Arthroscopic findings may show softening, blistering, fibrillation, or full-thickness ulceration of cartilage. • MRI may show decreased signal areas of patellar cartilage on T1-weighted sequences or osteochondral defect.

Approach

The first stage in the management of patellofemoral pain syndrome is symptom control: e.g., activity modification, NSAIDs, ice or cold application, and patellar taping or patellar bracing. Once the pain is under control, patients should be classified according to the type of mechanism contributing to their patellofemoral pain, and treatment decisions should be focused appropriately.[5]

Symptom control

The treatment program should focus on relative rest and activity modification (i.e., lower levels of activity, particularly of those exerting compressive force). During the acute phase, ice or other methods of cold application may be used for 10 to 15 minutes, 2 to 3 times daily, to further reduce symptoms. Heat is generally not recommended.[23] There is limited evidence for the effectiveness of NSAIDs for short-term pain reduction.[52] [53] [54]

Correcting abnormal patellar posture using the McConnell taping technique may help align the patella within the trochlea (or in some way decrease patellofemoral contact stresses) for those patients unable to perform strengthening exercises due to pain.[55] Taping the patella may reduce symptoms, increase quadriceps activity, and permit increased loading of the knee joint; although, evidence regarding the efficacy of patellar taping from trials reporting clinically relevant outcomes is insufficient and of low quality, and further trials measuring the long-term effects of such taping are required.[56] [57] [58] There is limited evidence of sufficient quality to determine whether taping is an effective treatment in addition to physical therapy alone.[59]

Patients may report decreased pain from wearing a properly fitted dynamic patellar stabilization brace. Kinematic imaging studies have shown a mechanical effect of knee braces on reducing patellar tracking abnormalities.[60] Improvement may be related to increasing contact area (through compression), dispersing joint reaction forces over a greater surface, and decreasing joint stress.[61] Studies have shown inconsistent results in evaluating the efficacy of the patellofemoral brace; however, use of a brace is recommended if a long-term solution is needed. It is likely that a subgroup of patients, such as those with increased patellar displacement, will respond favorably to brace therapy.[62] [63] [64] [65]

Treatment of specific mechanical problem

Once the specific mechanical problem has been identified, treatment should focus on exercises aimed at restabilizing the patella.

Abnormal patellofemoral joint mechanics

- For patients with abnormal patellofemoral joint mechanics and quadriceps muscle weakness or imbalance, an open or closed kinetic chain exercise program is initiated, with addition of taping or a brace if pain limits the patient's ability to perform these exercises.[59] Open-chain exercises include knee extension exercises, and closed-chain exercises include lunges, wall slides, and leg press machine exercises. Closed-chain exercises are preferred by many practitioners because they better replicate the demands of athletic activity by requiring co-contraction of muscle groups and loading of the joint in functional positions.[66][67][68][69][70][71][72]
- For patients with abnormal patellofemoral tracking/alignment and tightness of soft tissue structures, adhesions between the iliotibial band and the overlying fascia may be reduced with deep longitudinal massage. Passive stretches may also be applied to the lateral patellar retinacular structures through a sustained medial glide of the patella.

- For patients with abnormal patellofemoral tracking/alignment and decreased patellar mobility, mobilization techniques can be beneficial.[73] These techniques aim to passively mobilize the patella and increase range of motion, especially in the medial direction. This therapy should be performed with care to prevent excessive patellofemoral joint compression. Mobilization techniques should be employed when the knee is either in extension or slightly flexed (no more than 20°).

Altered lower-extremity alignment and/or motion

- Lower kinetic chain problems should be managed by orthotics; strengthening of hip extensors, abductors, and external rotators; and normalization of gait mechanics.
- Orthotics may be indicated in patients with subtalar joint pronation in order to reduce the dynamic Q angle.[74][75][76][77] Orthotics should extend to the sulcus or web space of the toes for control of forefoot instability in athletes. The addition of orthoses and foot targeted exercises was more effective than knee targeted exercises alone in one study.[78]
- Hip internal rotation should be treated with weight-bearing exercises to the hip extensors, abductors, and external rotators. Young women with patellofemoral pain are more likely to demonstrate external rotation and weakness in hip abduction than age-matched nonsymptomatic women.[21] [50] [79]
- Gait deviations should also be addressed using real-time video feedback while running on a treadmill. Evaluating kinematics of the knee, hip, and foot/ankle simultaneously is recommended. Further research is needed to better address kinematic gait characteristics associated with patellofemoral pain syndrome, although some studies suggest that a midfoot to forefoot strike pattern may convey less stress to the patellofemoral joint than a heelstrike running gait.[80]

Overuse

- Patients likely to have overuse as the etiology of their patellofemoral pain syndrome (e.g., athletes) should have their training program evaluated for obvious errors, including increasing exercise intensity too quickly, inadequate time for recovery, and excessive hill work.[5] Runners should reduce mileage to a level that does not provoke pain (while running or the day after running). Alternative activities such as cycling, swimming, or the use of an elliptical trainer or antigravity treadmill can be used to maintain fitness while treatment is ongoing.[23]

Rehabilitation

A comprehensive rehabilitation program should form part of the treatment approach. Symptoms in some patients will return when rehabilitation is terminated or when they return to their previous activity level. In this case, a comprehensive home exercise program is necessary. Exercise therapy reduces pain, and improves function and symptoms in the short to long term.[81]

Surgery

Surgery for patellofemoral pain syndrome is used when patients have persistent symptoms despite rehabilitation, provided they have structural alignment abnormalities that are potentially correctable by surgery.

Treatment algorithm overview

Please note that formulations/routes and doses may differ between drug names and brands, drug formularies, or locations. Treatment recommendations are specific to patient groups: see disclaimer

Initial (summary)

acute pain		
	1st	activity modification + cold application
	adjunct	NSAIDs
	adjunct	patellar taping or patellar bracing

Acute (summary)

abnormal patellofemoral joint mechanics		
■ abnormal patellofemoral tracking/alignment and quadriceps muscle weakness	1st	open or closed kinetic chain exercises
	adjunct	patellar taping or patellar bracing
■ abnormal patellofemoral tracking/alignment and tightness of soft tissue structures	1st	deep longitudinal massage + passive stretch
■ abnormal patellofemoral tracking/alignment and decreased patellar mobility	1st	patellar mobilization techniques
lower kinetic chain problems		
■ subtalar joint pronation	1st	orthotics
■ hip internal rotation	1st	strengthening of hip extensors, abductors, and external rotators
■ gait deviations	1st	normalization of gait mechanics
overuse in athletes		
	1st	training regime modification

Ongoing (summary)		
post initial and reactivation-phase treatment		
	1st	**comprehensive home exercise program**
bony and structural abnormalities with deviation in patella alignment and inadequate response to treatment and rehabilitation	**plus**	**surgery**

Treatment algorithm

Please note that formulations/routes and doses may differ between drug names and brands, drug formularies, or locations. Treatment recommendations are specific to patient groups: see disclaimer

Initial

acute pain

1st **activity modification + cold application**

» The treatment program should focus on relative rest and activity modification (i.e., lower levels of activity, particularly of those exerting compressive force).

» During the acute phase, ice or other methods of cold application may be used for 10 to 15 minutes, 2 to 3 times daily, to further reduce symptoms. Heat is generally not recommended.[23]

adjunct **NSAIDs**

Treatment recommended for SOME patients in selected patient group

Primary options

» diclofenac potassium: 25-50 mg orally (immediate-release) three times daily when required, maximum 150 mg/day

OR

» ibuprofen: 200-400 mg orally every 4-6 hours when required, maximum 2400 mg/day

OR

» indomethacin: 25-50 mg orally (immediate-release) two to three times daily when required, maximum 200 mg/day

OR

» naproxen: 250-500 mg orally (immediate-release) twice daily when required, maximum 1250 mg/day

OR

» celecoxib: 200 mg orally once daily when required; or 100 mg twice daily when required

» There is limited evidence for the effectiveness of NSAIDs for short-term pain reduction.[52][53][54]

Initial

adjunct **patellar taping or patellar bracing**

Treatment recommended for SOME patients in selected patient group

» Taping the patella may reduce symptoms, increase quadriceps activity, and permit increased loading of the knee joint, although evidence regarding the efficacy of patellar taping from trials reporting clinically relevant outcomes is insufficient and of low quality, and further trials measuring the long-term effects of such taping are required.[56] [57] [58]

» Patients may report decreased pain from wearing a properly fitted dynamic patellar stabilization brace.

Acute

abnormal patellofemoral joint mechanics

abnormal patellofemoral tracking/alignment and quadriceps muscle weakness

1st **open or closed kinetic chain exercises**

» Quadriceps strength, function, and activation patterns may be restored through an open- and closed-chain exercise program.[62][82][83] The mechanism is not clear; it is possible that improved quadriceps strength alters patellar tracking, but subtle changes in contact location and pressure distribution may also explain observed benefits.[84]

» Examples of open-chain exercises include knee extension exercises, and closed-chain exercises include lunges, wall slides, and leg press machine exercises. Many practitioners prefer closed-chain exercises because they better replicate the demands of athletic activity by requiring co-contraction of muscle groups and loading of the joint in functional positions.[66][67]

» There is good evidence that open and closed kinetic chain exercises are equally effective.[66][67][68][69][70][71][72]

» Regardless of the type of exercise, improving muscular endurance, as well as strength, is important especially for endurance athletes. High-dose, high-repetition exercise therapy is more efficacious than low-dose, low-repetition exercise therapy.[85] Furthermore, there appear to be long-term effects of high-dose, high-repetition exercise therapy in patients with patellofemoral pain syndrome with respect to pain and functional outcomes.[86]

» The addition of foot targeted exercises and orthoses was more effective than knee targeted exercises alone in one study.[78]

adjunct **patellar taping or patellar bracing**

Treatment recommended for SOME patients in selected patient group

» Correcting abnormal patellar posture using the McConnell taping technique may help align the patella within the trochlea (or in some way decrease patellofemoral contact stresses) for those patients unable to perform strengthening exercises due to pain.[55] Taping the patella may reduce symptoms, increase quadriceps activity, and permit increased loading of the knee joint, although evidence regarding the efficacy of patellar taping from trials reporting

Acute

clinically relevant outcomes is insufficient and of low quality, and further trials measuring the long-term effects of such taping are required.[56] [57] [58] There is limited evidence of sufficient quality to determine whether taping is an effective treatment in addition to physical therapy alone.[59]

» Patients may report decreased pain from wearing a properly fitted dynamic patellar stabilization brace. Kinematic imaging studies have shown a mechanical effect of knee braces on reducing patellar tracking abnormalities.[60] Improvement may be related to increasing contact area (through compression), dispersing joint reaction forces over a greater surface, and decreasing joint stress.[61] Studies have shown inconsistent results in evaluating the efficacy of the patellofemoral brace. Use of a brace is recommended if a long-term solution is needed. It is likely that a subgroup of patients such as those with increased patellar displacement will respond favorably to brace therapy.[62] [63] [64] [65]

- **abnormal patellofemoral tracking/alignment and tightness of soft tissue structures** — **1st** — **deep longitudinal massage + passive stretch**

» Tightness of soft tissue structures typically includes the iliotibial band or lateral retinaculum.

» Reducing adhesions between the iliotibial band and the overlying fascia may be facilitated through deep longitudinal massage.

» Passive stretches may also be applied to the lateral patellar retinacular structures through a sustained medial glide of the patella.

» Subjects with patellofemoral pain also have a higher prevalence of myofascial trigger points in the gluteus medius and quadratus lumborum muscles. These areas should be targeted with deep tissue myofascial release as part of the therapy program. These trigger points may become less prevalent once the proximal hip abductor muscles are better activated.[87]

- **abnormal patellofemoral tracking/alignment and decreased patellar mobility** — **1st** — **patellar mobilization techniques**

» Patients with global patellar hypomobility can benefit from mobilization techniques.

» These techniques should be performed with care to prevent excessive patellofemoral joint compression.

MANAGEMENT

Acute

		» To facilitate mobilization of the patella, the knee should be in extension or slightly flexed (no more than 20°). » If the knee is flexed beyond 20°, the patella becomes seated within the trochlear groove, and passive tension of the quadriceps will restrict patellar mobility.[5]
lower kinetic chain problems		
subtalar joint pronation	**1st**	**orthotics** » Orthotics may be used to reduce the dynamic Q angle by controlling lower-extremity rotation.[74][75][76][77] » If the Q angle does not change more than 5° between relaxed standing and placing the patient in subtalar joint neutral, then the use of an orthotic may not significantly influence lower-extremity alignment. » Forefoot stability may also play a key role in rear-foot stability, as instability in the forefoot at push-off can create rear-foot instability.[88] For this reason, orthotics need to extend to the sulcus or web space of the toes for control of forefoot instability in athletes.[89] » The addition of orthoses and foot targeted exercises was more effective than knee targeted exercises alone in one study.[78]
hip internal rotation	**1st**	**strengthening of hip extensors, abductors, and external rotators** » In this group, observations show that the femur collapses into internal rotation during gait, and this motion appears to originate from the pelvis (as opposed to being influenced by tibial rotation). The functional significance of an internally rotated femur is that the trochlear groove can rotate beneath the patella, placing the patella in a relatively lateral position.[90] [91] » Patients may benefit from weight-bearing exercises that emphasize strengthening of the hip abductors and external rotators to control femoral rotation. » Young women with patellofemoral pain are more likely to demonstrate external rotation and weakness in hip abduction than age-matched nonsymptomatic women.[50] [79] The addition of knee-stretching and -strengthening exercises supplemented by hip posterolateral musculature-strengthening exercises was more effective than

Acute

		knee exercises alone in improving long-term function and reducing pain in sedentary women with patellofemoral pain syndrome.[92]
gait deviations	**1st**	**normalization of gait mechanics** » The restoration of normal gait function is essential to an overall treatment plan. » Real-time video feedback while running on a treadmill can be used as an effective tool.[93] » By reducing the common error of excessive hip internal rotation and adduction during stance, patients may be able to improve lower-extremity alignment and decrease pain.
overuse in athletes		
	1st	**training regime modification** » Patients likely to have overuse as the etiology of their patellofemoral pain syndrome (e.g., athletes) should have their training program evaluated for obvious errors, including increasing exercise intensity too quickly, inadequate time for recovery, and excessive hill work.[5] » Runners should reduce mileage to a level that does not provoke pain (while running or the day after running). » Alternative activities such as cycling, swimming, or the use of an elliptical trainer can be used to maintain fitness while treatment is ongoing.[23]

MANAGEMENT

Ongoing

post initial and reactivation-phase treatment

post initial and reactivation-phase treatment	**1st**	**comprehensive home exercise program** » All patients should be given a comprehensive independent exercise program after completing initial and reactivation-phase treatments. Exercise therapy reduces pain, and improves function and symptoms in the short to long term.[81] The majority of patients have success with conservative treatment programs and a generalized rehabilitation program. » Symptoms in some patients will return when rehabilitation is terminated or when they return to their previous activity level, especially athletes with a hypermobile patella.[1] [94]
bony and structural abnormalities with deviation in patella alignment and inadequate response to treatment and rehabilitation	**plus**	**surgery** Treatment recommended for ALL patients in selected patient group » Surgery for patellofemoral pain syndrome is indicated in patients who have persistent symptoms in spite of rehabilitation and who have structural alignment abnormalities that are potentially correctable with surgery, especially those with radiographic evidence of chronic subluxation or dislocation.[7]

Primary prevention

Neuromuscular warm-up strategies, which include stretching, strengthening, balance exercises, sports-specific agility drills, and landing techniques, can reduce lower-extremity injury. In a population of army recruits, a warm-up and warm-down exercise intervention consisting of closed-chain strengthening and stretching exercises performed consistently over a 14-week training period proved effective in substantially reducing the incidence of anterior knee pain.[22]

Secondary prevention

Risk factor modification is important to prevent recurrence. Multiple risk factors contribute to the development of patellofemoral pain. Poor long-term results from rehabilitation programs may be related to the underlying etiologic factors not being fully addressed. A risk factor modification program may include patellar taping/bracing, foot orthoses, hip/core and quadriceps strengthening, a flexibility program, or soft tissue mobilization techniques. An effective preventive strategy needs to be specific for each patient and sustained in time.[6] A regular independent home therapy program should be recommended to achieve long-term successful results and avoid recurrence.[97] [98]

Patient discussions

Patients should be educated so that they understand which activities aggravate the condition.

The patient's physical therapist should educate the patient about a home exercise program, making sure the patient has a good understanding of the exercises.

All patients should be given a comprehensive independent exercise program after completing initial and reactivation-phase treatments. The majority of patients have success with conservative treatment programs and a generalized rehabilitation program.

Symptoms of some patients will return when rehabilitation is terminated or when they return to their previous activity level, especially athletes with a hypermobile patella.[1] [94]

Monitoring

Monitoring

Adequate time should be allowed for conservative measures to have an effect. A period of 4 to 6 weeks is usually sufficient for resolution of symptoms.

Longer delays before follow-up often result in reduced compliance with treatment recommendations.

Prognosis

Most patients are successfully treated by conservative means, with few requiring surgical intervention. The current standard of care is conservative treatment including physical therapy to address biomechanical issues, with quadriceps-based strengthening; iliotibial band, hamstring, and quadriceps stretching; and proximally focused hip stabilization programs, as well as orthotic intervention, taping, and bracing.[7] However, there is no one exercise modality that is clearly superior to others, and each patient with patellofemoral pain should be given an individualized program based on their specific deficits.[95] [96] A period of 4 to 6 weeks is usually adequate for resolution of symptoms. Successful long-term outcomes (67%-85%) have been reported with a comprehensive home exercise program.[97] [98]

Key articles

- Fredericson M, Powers CM. Practical management of patellofemoral pain. Clin J Sport Med. 2002;12:36-38. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/11854587?tool=bestpractice.bmj.com)
- Earl JE, Vetter CS. Patellofemoral pain. Phys Med Rehabil Clin N Am. 2007;18:439-458,viii. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/17678761?tool=bestpractice.bmj.com)
- Fredericson M, Yoon K. Physical examination and patellofemoral pain syndrome: a review. Am J Phys Med Rehabil. 2006;85:234-243. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/16505640?tool=bestpractice.bmj.com)
- American College of Radiology. ACR Appropriateness Criteria. Chronic knee pain. 2018 [internet publication]. Full text (https://www.acr.org/clinical-resources/acr-appropriateness-criteria)
- Collins NJ, Bisset LM, Crossley KM, et al. Efficacy of nonsurgical interventions for anterior knee pain: systematic review and meta-analysis of randomized trials. Sports Med. 2012;42:31-49. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/22149696?tool=bestpractice.bmj.com)

References

1. Devereaux MD, Lachmann SM. Patello-femoral arthralgia in athletes attending a sports injury clinic. Br J Sports Med. 1984;18:18-21. Full text (http://bjsm.bmj.com/content/18/1/18.long) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/6722419?tool=bestpractice.bmj.com)
2. DeHaven KE, Lintner DM. Athletic injuries: comparison by age, sport, and gender. Am J Sports Med. 1986;14:218-224. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/3752362?tool=bestpractice.bmj.com)
3. Taunton JE, Ryan MB, Clement DB, et al. A retrospective case-control analysis of 2002 running injuries. Br J Sports Med. 2002;36:95-101. Full text (http://bjsm.bmj.com/content/36/2/95.long) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/11916889?tool=bestpractice.bmj.com)
4. Juhn MS. Patellofemoral pain syndrome: a review and guidelines for treatment. Am Fam Physician. 1999;60:2012-2018. Full text (http://www.aafp.org/afp/1999/1101/p2012.html) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/10569504?tool=bestpractice.bmj.com)
5. Fredericson M, Powers CM. Practical management of patellofemoral pain. Clin J Sport Med. 2002;12:36-38. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/11854587?tool=bestpractice.bmj.com)
6. Davis IS, Powers CM. Patellofemoral pain syndrome: proximal, distal, and local factors, an international retreat, April 30-May 2, 2009, Fells Point, Baltimore, MD. J Orthop Sports Phys Ther. 2010;40:A1-A16. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/20195028?tool=bestpractice.bmj.com)
7. Earl JE, Vetter CS. Patellofemoral pain. Phys Med Rehabil Clin N Am. 2007;18:439-458,viii. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/17678761?tool=bestpractice.bmj.com)

REFERENCES

8. Pal S, Draper CE, Fredericson M, et al. Patellar maltracking correlates with vastus medialis activation delay in patellofemoral pain patients. Am J Sports Med. 2011;39:590-598. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/21076015?tool=bestpractice.bmj.com)

9. Draper CE, Fredericson M, Gold GE, et al. Patients with patellofemoral pain exhibit elevated bone metabolic activity at the patellofemoral joint. J Orthop Res. 2012;30:209-213. Full text (http://onlinelibrary.wiley.com/doi/10.1002/jor.21523/full) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/21812024?tool=bestpractice.bmj.com)

10. Fredericson M. Patellofemoral pain syndrome. In: O'Connor FG, Wilder RP, Nirschl R, eds. Textbook of running medicine. New York, NY: McGraw Hill; 2001:169-180.

11. Sanchis-Alfonso V, Rosello-Sastre E, Martinez-Sanjuan V. Pathogenesis of anterior knee pain syndrome and functional patellofemoral instability in the active young. Am J Knee Surg. 1999;12:29-40. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/10050691?tool=bestpractice.bmj.com)

12. Pal S, Besier TF, Beaupre GS, et al. Patellar maltracking is prevalent among patellofemoral pain subjects with patella alta: an upright, weightbearing MRI study. J Orthop Res. 2013;31:448-457. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/23165335?tool=bestpractice.bmj.com)

13. Reider B, Marshall JL, Warren RF. Clinical characteristics of patellar disorders in young athletes. Am J Sports Med. 1981;9:270-274. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/7258473?tool=bestpractice.bmj.com)

14. Conlan T, Garth WP Jr, Lemons JE. Evaluation of the medial soft-tissue restraints of the extensor mechanism of the knee. J Bone Joint Surg Am. 1993;75:682-693. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/8501083?tool=bestpractice.bmj.com)

15. Puniello MS. Iliotibial band tightness and medial patellar glide in patients with patellofemoral dysfunction. J Orthop Sports Phys Ther. 1993;17:144-148. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/8472078?tool=bestpractice.bmj.com)

16. Thomee R, Renstrom P, Karlsson J, et al. Patellofemoral pain syndrome in young women. II. Muscle function in patients and healthy controls. Scand J Med Sci Sports. 1995;5:245-251. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/7552770?tool=bestpractice.bmj.com)

17. Callaghan MJ, Oldham JA. Quadriceps atrophy: to what extent does it exist in patellofemoral pain syndrome? Br J Sports Med. 2004;38:295-299. Full text (http://bjsm.bmj.com/content/38/3/295.long) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/15155431?tool=bestpractice.bmj.com)

18. Van Tiggelen D, Cowan S, Coorevits P, et al. Delayed vastus medialis obliquus to vastus lateralis onset timing contributes to the development of patellofemoral pain in previously healthy men: a prospective study. Am J Sports Med. 2009;37:1099-1105. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/19282508?tool=bestpractice.bmj.com)

19. Powers CM, Maffucci R, Hampton S. Rearfoot posture in subjects with patellofemoral pain. J Orthop Sports Phys Ther. 1995;22:155-160. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/8535473?tool=bestpractice.bmj.com)

20. Lee TQ, Anzel SH, Bennett KA, et al. The influence of fixed rotational deformities of the femur on the patellofemoral contact pressures in human cadaver knees. Clin Orthop Relat Res. 1994;302:69-74. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/8168325?tool=bestpractice.bmj.com)

21. Souza RB, Powers CM. Predictors of hip internal rotation during running: an evaluation of hip strength and femoral structure in women with and without patellofemoral pain. Am J Sports Med. 2009;37:579-587. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/19098153?tool=bestpractice.bmj.com)

22. Herman K, Barton C, Malliaras P, et al. The effectiveness of neuromuscular warm-up strategies, that require no additional equipment, for preventing lower limb injuries during sports participation: a systematic review. BMC Med. 2012;10:75. Full text (http://bmcmedicine.biomedcentral.com/articles/10.1186/1741-7015-10-75) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/22812375?tool=bestpractice.bmj.com)

23. Dixit S, DiFiori JP, Burton M, et al. Management of patellofemoral pain syndrome. Am Fam Physician. 2007;75:194-202. Full text (http://www.aafp.org/afp/2007/0115/p194.html) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/17263214?tool=bestpractice.bmj.com)

24. Fredericson M, Yoon K. Physical examination and patellofemoral pain syndrome: a review. Am J Phys Med Rehabil. 2006;85:234-243. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/16505640?tool=bestpractice.bmj.com)

25. Smith TO, Hunt NJ, Donell ST. The reliability and validity of the Q-angle: a systematic review. Knee Surg Sports Traumatol Arthrosc. 2008;16:1068-1079. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/18841346?tool=bestpractice.bmj.com)

26. Aglietti P, Insall JN, Cerulli G. Patellar pain and incongruence. I: Measurements of incongruence. Clin Orthop Relat Res. 1983;176:217-224. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/6851329?tool=bestpractice.bmj.com)

27. Fulkerson JP. Awareness of the retinaculum in evaluating patellofemoral pain. Am J Sports Med. 1982;10:147-149. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/7114350?tool=bestpractice.bmj.com)

28. Fulkerson JP. Evaluation of the peripatellar soft tissues and retinaculum in patients with patellofemoral pain. Clin Sports Med. 1989;8:197-202. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/2752435?tool=bestpractice.bmj.com)

29. Fulkerson JP, Tennant R, Jaivin JS, et al. Histologic evidence of retinacular nerve injury associated with patellofemoral malalignment. Clin Orthop Relat Res. 1985;197:196-205. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/4017335?tool=bestpractice.bmj.com)

30. Mori Y, Fujimoto A, Okumo H, et al. Lateral retinaculum release in adolescent patellofemoral disorders: its relationship to peripheral nerve injury in the lateral retinaculum. Bull Hosp Jt Dis Orthop Inst. 1991;51:218-229. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/1666010?tool=bestpractice.bmj.com)

31. Sanchis-Alfonso V, Rosello-Sastre E. Immunohistochemical analysis for neural markers of the lateral retinaculum in patients with isolated symptomatic patellofemoral malalignment. A neuroanatomic basis

for anterior knee pain in the active young patient. Am J Sports Med. 2000;28:725-731. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/11032232?tool=bestpractice.bmj.com)

32. Sanchis-Alfonso V, Rosello-Sastre E, Revert F. Neural growth factor expression in the lateral retinaculum in painful patellofemoral malalignment. Acta Orthop Scand. 2001;72:146-149. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/11372945?tool=bestpractice.bmj.com)

33. Grelsamer RP, McConnell J. The patella: a team approach. Gaithersburg, MD: Aspen Publishers; 1998.

34. Walsh WM. Recurrent dislocation of the knee in the adult. In: DeLee JC, Drez D Jr, Miller MD, eds. DeLee & Drez's orthopaedic sports medicine: principles and practice. 2nd ed. Philadelphia, PA: Saunders; 2003:1718-1721.

35. Boden BP, Pearsall AW, Garrett WE Jr, et al. Patellofemoral instability: evaluation and management. J Am Acad Orthop Surg. 1997;5:47-57. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/10797207?tool=bestpractice.bmj.com)

36. Ahmed A, Shi S, Hyder A, et al. The effect of quadriceps tension characteristics on the patellar tracking pattern. Trans Annu Meet Orthop Res Soc. 1988;13:280.

37. Kolowich PA, Paulos LE, Rosenberg TD, et al. Lateral release of the patella: indications and contraindications. Am J Sports Med. 1990;18:359-365. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/2403183?tool=bestpractice.bmj.com)

38. Hughston JC. Subluxation of the patella. J Bone Joint Surg Am. 1968;50:1003-1026. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/5676827?tool=bestpractice.bmj.com)

39. Nissen CW, Cullen MC, Hewett TE, et al. Physical and arthroscopic examination techniques of the patellofemoral joint. J Orthop Sports Phys Ther. 1998;28:277-285. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/9809276?tool=bestpractice.bmj.com)

40. Post WR. Clinical evaluation of patients with patellofemoral disorders. Arthroscopy. 1999;15:841-851. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/10564862?tool=bestpractice.bmj.com)

41. Dye SF. The pathophysiology of patellofemoral pain: a tissue homeostasis perspective. Clin Orthop Relat Res. 2005;436:100-110. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/15995427?tool=bestpractice.bmj.com)

42. American College of Radiology. ACR Appropriateness Criteria. Chronic knee pain. 2018 [internet publication]. Full text (https://www.acr.org/clinical-resources/acr-appropriateness-criteria)

43. American Medical Society for Sports Medicine. Ten things physicians and patients should question. Choosing Wisely, an initiative of the ABIM Foundation. 2022 [internet publication]. Full text (https://web.archive.org/web/20230323081534/https://www.choosingwisely.org/societies/american-medical-society-for-sports-medicine)

44. Elias DA, White LM. Imaging of patellofemoral disorders. Clin Radiol. 2004;59:543-57. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/15208060?tool=bestpractice.bmj.com)

45. Hvid I, Andersen LI. The quadriceps angle and its relation to femoral torsion. Acta Orthop Scand. 1982;53:577-579. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/7102275?tool=bestpractice.bmj.com)

46. Livingston LA. The quadriceps angle: a review of the literature. J Orthop Sports Phys Ther. 1998;28:105-109. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/9699160?tool=bestpractice.bmj.com)

47. Grelsamer RP, Dubey A, Weinstein CH. Men and women have similar Q angles: a clinical and trigonometric evaluation. J Bone Joint Surg Br. 2005;87:1498-1501. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/16260666?tool=bestpractice.bmj.com)

48. Smith AD, Stroud L, McQueen C. Flexibility and anterior knee pain in adolescent elite figure skaters. J Pediatr Orthop. 1991;11:77-82. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/1988483?tool=bestpractice.bmj.com)

49. Winslow J, Yoder E. Patellofemoral pain in female ballet dancers: correlation with iliotibial band tightness and tibial external rotation. J Orthop Sports Phys Ther. 1995;22:18-21. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/7550298?tool=bestpractice.bmj.com)

50. Ireland ML, Willson JD, Ballantyne BT, et al. Hip strength in females with and without patellofemoral pain. J Orthop Sports Phys Ther. 2003;33:671-676. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/14669962?tool=bestpractice.bmj.com)

51. García-Valtuille R, Abascal F, Cerezal L, et al. Anatomy and MR imaging appearances of synovial plicae of the knee. Radiographics. 2002;22:775-784. Full text (http://pubs.rsna.org/doi/full/10.1148/radiographics.22.4.g02jl03775) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/12110709?tool=bestpractice.bmj.com)

52. Suter E, Herzog W, De Souza K, et al. Inhibition of the quadriceps muscles in patients with anterior knee pain. J Appl Biomech. 1998;14:360-73.

53. Bentley G, Leslie IJ, Fischer D. Effect of aspirin treatment on chondromalacia patellae. Ann Rheum Dis. 1981 Feb;40(1):37-41. Full text (https://pmc.ncbi.nlm.nih.gov/articles/PMC1000652) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/7008711?tool=bestpractice.bmj.com)

54. Marchese A, Cherubini M, Forte R. Laser therapy versus pharmacological in anterior knee pain. La Riabilitazione. 1998;31:189-98.

55. Derasari A, Brindle TJ, Alter KE, Sheehan FT. McConnell taping shifts the patella inferiorly in patients with patellofemoral pain: a dynamic magnetic resonance imaging study. Phys Ther. 2010;90:411-419. Full text (https://academic.oup.com/ptj/article-lookup/doi/10.2522/ptj.20080365) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/20110340?tool=bestpractice.bmj.com)

56. Callaghan MJ, Selfe J. Patellar taping for patellofemoral pain syndrome in adults. Cochrane Database Syst Rev. 2012;(4):CD006717. Full text (http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD006717.pub2/full) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/22513943?tool=bestpractice.bmj.com)

57. Powers CM. Rehabilitation of patellofemoral joint disorders: a critical review. J Ortho Sports Phys Ther. 1998;28:345-354. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/9809282?tool=bestpractice.bmj.com)

58. Aminaka N, Gribble PA. A systematic review of the effects of therapeutic taping on patellofemoral pain syndrome. J Athl Train. 2005;40:341-351. Full text (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1323297) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/16404457?tool=bestpractice.bmj.com)

59. Collins NJ, Bisset LM, Crossley KM, et al. Efficacy of nonsurgical interventions for anterior knee pain: systematic review and meta-analysis of randomized trials. Sports Med. 2012;42:31-49. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/22149696?tool=bestpractice.bmj.com)

60. Draper CE, Besier TF, Santos JM, et al. Using real-time MRI to quantify altered joint kinematics in subjects with patellofemoral pain and to evaluate the effects of a patellar brace or sleeve on joint motion. J Orthop Res. 2009;27:571-577. Full text (http://onlinelibrary.wiley.com/doi/10.1002/jor.20790/pdf) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/18985690?tool=bestpractice.bmj.com)

61. Powers CM, Shellock FG, Beering TV, et al. Effect of bracing on patellar kinematics in patients with patellofemoral joint pain. Med Sci Sports Exerc. 1999;31:1714-1720. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/10613420?tool=bestpractice.bmj.com)

62. Timm KE. Randomized controlled trial of Protonics on patellar pain, position, and function. Med Sci Sports Exerc. 1998;30:665-70. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/9588606?tool=bestpractice.bmj.com)

63. Miller MD, Hinkin DT, Wisnowski JW. The efficacy of orthotics for anterior knee pain in military trainees: a preliminary report. Am J Knee Surg. 1997;10:10-13. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/9051172?tool=bestpractice.bmj.com)

64. Lun VM, Wiley JP, Meeuwisse WH, et al. Effectiveness of patellar bracing for treatment of patellofemoral pain syndrome. Clin J Sport Med. 2005;15:235-40. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/16003037?tool=bestpractice.bmj.com)

65. Swart NM, van Linschoten R, Bierma-Zeinstra SM, et al. The additional effect of orthotic devices on exercise therapy for patients with patellofemoral pain syndrome: a systematic review. Br J Sports Med. 2012;46:570-577. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/21402565?tool=bestpractice.bmj.com)

66. Irish SE, Millward AJ, Wride J, et al. The effect of closed-kinetic chain exercises and open-kinetic chain exercise on the muscle activity of vastus medialis oblique and vastus lateralis. J Strength Cond Res. 2010;24:1256-62. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/20386128?tool=bestpractice.bmj.com)

67. Bennell K, Duncan M, Cowan S, et al. Effects of vastus medialis oblique retraining versus general quadriceps strengthening on vasti onset. Med Sci Sports Exerc. 2010;42:856-64. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/19997004?tool=bestpractice.bmj.com)

68. Stiene HA, Brosky T, Reinking MF, et al. A comparison of closed kinetic chain and isokinetic joint isolation exercise in patients with patellofemoral dysfunction. J Orthop Sports Phys Ther. 1996;24:136-141. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/8866272?tool=bestpractice.bmj.com)

69. Witvrouw E, Lysens R, Bellemans J, et al. Open versus closed kinetic chain exercises for patellofemoral pain: a prospective, randomized study. Am J Sports Med. 2000;28:687-694. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/11032226?tool=bestpractice.bmj.com)

70. Wijnen LC, Lenssen AF, Kuys-Wouters YM, et al. McConnell therapy versus Coumans bandage for patellofemoral pain: a randomised pilot study. Ned Tijdschr Fysiother. 1996;(special issue):12-17.

71. Gaffney K, Fricker P, Dwyer T, et al. Patellofemoral joint pain: a comparison of two treatment programmes. Excel. 1992;8:179-189.

72. Smith TO, Bowyer D, Dixon J, et al. Can vastus medialis oblique be preferentially activated? A systematic review of electromyographic studies. Physiother Theory Pract. 2009;25:69-98. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/19212898?tool=bestpractice.bmj.com)

73. Brantingham JW, Globe G, Pollard H, et al. Manipulative therapy for lower extremity conditions: expansion of literature review. J Manipulative Physiol Ther. 2009;32:53-71. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/19121464?tool=bestpractice.bmj.com)

74. Johnston LB, Gross MT. Effects of foot orthoses on quality of life for individuals with patellofemoral pain syndrome. J Orthop Sports Phys Ther. 2004;34:440-448. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/15373007?tool=bestpractice.bmj.com)

75. Eng JJ, Pierrynowski MR. Evaluation of soft foot orthotics in the treatment of patellofemoral pain syndrome. Phys Ther. 1993;73:62-68. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/8421719?tool=bestpractice.bmj.com)

76. Hossain M, Alexander P, Burls A,et al. Foot orthoses for patellofemoral pain in adults. Cochrane Database Syst Rev. 2011;(1):CD008402. Full text (http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD008402.pub2/full) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/21249707?tool=bestpractice.bmj.com)

77. Barton CJ, Munteanu SE, Menz HB, et al. The efficacy of foot orthoses in the treatment of individuals with patellofemoral pain syndrome: a systematic review. Sports Med. 2010;40:377-395. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/20433211?tool=bestpractice.bmj.com)

78. Mølgaard CM, Rathleff MS, Andreasen J, et al. Foot exercises and foot orthoses are more effective than knee focused exercises in individuals with patellofemoral pain. J Sci Med Sport. 2017 Jun 28;21(1):10-15. Full text (https://www.doi.org/10.1016/j.jsams.2017.05.019) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/28844333?tool=bestpractice.bmj.com)

79. Cichanowski HR, Schmitt JS, Johnson RJ, et al. Hip strength in collegiate female athletes with patellofemoral pain. Med Sci Sports Exerc. 2007;39:1227-1232. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/17762354?tool=bestpractice.bmj.com)

80. Barton CJ, Levinger P, Menz HB, et al. Kinematic gait characteristics associated with patellofemoral pain syndrome: a systematic review. Gait Posture. 2009;30:405-416. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/19651515?tool=bestpractice.bmj.com)

81. Collins NJ, Barton CJ, van Middelkoop M, et al. 2018 Consensus statement on exercise therapy and physical interventions (orthoses, taping and manual therapy) to treat patellofemoral pain: recommendations from the 5th International Patellofemoral Pain Research Retreat, Gold Coast, Australia, 2017. Br J Sports Med. 2018 Jun 20;52(18):1170-1178. Full text (https://www.doi.org/10.1136/bjsports-2018-099397) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/29925502?tool=bestpractice.bmj.com)

82. Clark DI, Downing N, Mitchell J, et al. Physiotherapy for anterior knee pain: a randomised controlled trial. Ann Rheum Dis. 2000;59:700-704. Full text (http://ard.bmj.com/content/59/9/700.long) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/10976083?tool=bestpractice.bmj.com)

83. McMullen W, Roncarati A, Koval P. Static and isokinetic treatments of chondromalacia patella: a comparative investigation. J Orthop Sports Phys Ther. 1990;12:256-266. Full text (http://www.jospt.org/doi/pdf/10.2519/jospt.1990.12.6.256) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/18796869?tool=bestpractice.bmj.com)

84. Besier TF, Fredericson M, Gold GE, et al. Knee muscle forces during walking and running in patellofemoral pain patients and pain-free controls. J Biomech. 2009;42:898-905. Full text (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2671570) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/19268945?tool=bestpractice.bmj.com)

85. Østerås B, Østerås H, Torstensen TA, et al. Dose-response effects of medical exercise therapy in patients with patellofemoral pain syndrome: a randomised controlled clinical trial. Physiotherapy. 2013;99:126-131. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/23219636?tool=bestpractice.bmj.com)

86. Østerås B, Østerås H, Torstensen TA. Long-term effects of medical exercise therapy in patients with patellofemoral pain syndrome: results from a single-blinded randomized controlled trial with 12 months follow-up. Physiotherapy. 2013;99:311-316. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/23764516?tool=bestpractice.bmj.com)

87. Roach S, Sorenson E, Headley B, et al. Prevalence of myofascial trigger points in the hip in patellofemoral pain. Arch Phys Med Rehabil. 2013;94:522-526. Full text (http://www.archives-pmr.org/article/S0003-9993(12)01079-9/fulltext) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/23127304?tool=bestpractice.bmj.com)

88. Eng JJ, Pierrynowski MR. The effect of soft foot orthotics on three-dimensional lower-limb kinematics during walking and running. Phys Ther. 1994;74:836-844. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/8066110?tool=bestpractice.bmj.com)

89. Watson CJ, Propps M, Galt W, et al. Reliability of McConnell's classification of patellar orientation in symptomatic and asymptomatic subjects. J Orthop Sports Phys Ther. 1999;29:378-385. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/10416177?tool=bestpractice.bmj.com)

90. Powers CM, Ward SR, Fredericson M, et al. Patellar kinematics during weight-bearing and non-weight bearing knee extension in persons with lateral subluxation of the patella: a preliminary study. J Orthop Sports Phys Ther. 2003;33:677-685. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/14669963?tool=bestpractice.bmj.com)

91. Peters JS, Tyson NL. Proximal exercises are effective in treating patellofemoral pain syndrome: a systematic review. Int J Sports Phys Ther. 2013;8:689-700. Full text (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3811739) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/24175148?tool=bestpractice.bmj.com)

92. Fukuda TY, Melo WP, Zaffalon BM, et al. Hip posterolateral musculature strengthening in sedentary women with patellofemoral pain syndrome: a randomized controlled clinical trial with 1-year follow-up. J Orthop Sports Phys Ther. 2012;42:823-830. Full text (http://www.jospt.org/doi/full/10.2519/jospt.2012.4184#.U-BD9uOSxgk) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/22951491?tool=bestpractice.bmj.com)

93. Davis I. Gait retraining in runners. Orthop Pract. 2005;17:8-13.

94. Blond L, Hansen L. Patellofemoral pain syndrome in athletes: a 5.7 year retrospective follow-up study of 250 athletes. Acta Orthop Belg. 1998;64:393-400. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/9922542?tool=bestpractice.bmj.com)

95. Clijsen R, Fuchs J, Taeymans J. Effectiveness of exercise therapy in treatment of patients with patellofemoral pain syndrome: systematic review and meta-analysis. Phys Ther. 2014;94:1697-1708. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/25082920?tool=bestpractice.bmj.com)

96. van der Heijden RA, Lankhorst NE, van Linschoten R, et al. Exercise for treating patellofemoral pain syndrome. Cochrane Database Syst Rev. 2015;(1):CD010387. Full text (http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD010387.pub2/full) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/25603546?tool=bestpractice.bmj.com)

97. Karlsson J, Thomee R, Sward L. Eleven year follow-up of patello-femoral pain syndrome. Clin J Sport Med. 1996;6:22-26. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/8925361?tool=bestpractice.bmj.com)

98. Kannus P, Natri A, Paakkala T, et al. An outcome study of chronic patellofemoral pain syndrome: seven-year follow-up of patients in a randomized, controlled trial. J Bone Joint Surg Am. 1999;81:355-363. Abstract (http://www.ncbi.nlm.nih.gov/pubmed/10199273?tool=bestpractice.bmj.com)

Images

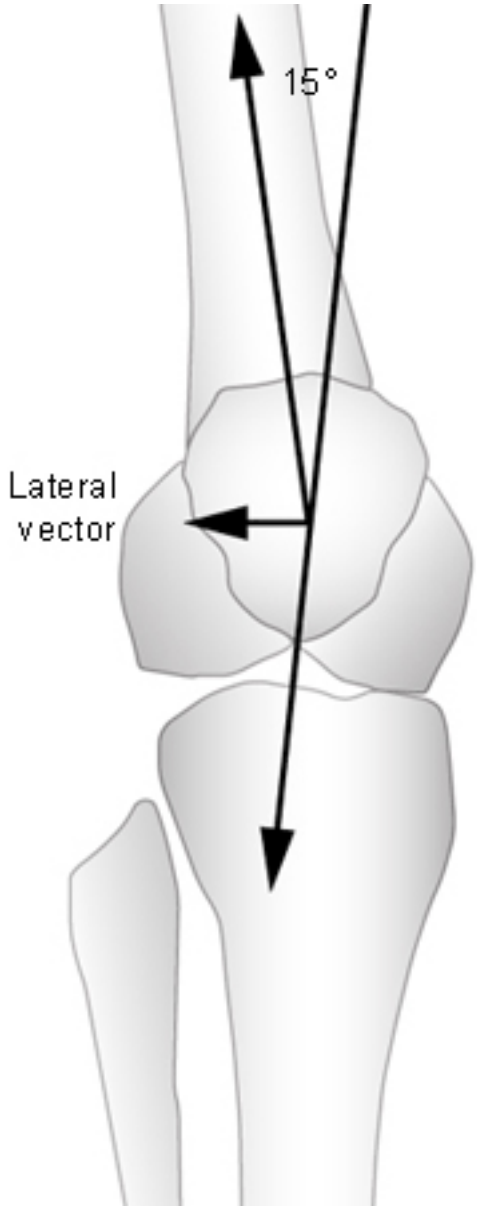


Figure 1: Q angle

Created at BMJ Evidence Centre

Disclaimer

BMJ Best Practice is intended for licensed medical professionals. BMJ Publishing Group Ltd (BMJ) does not advocate or endorse the use of any drug or therapy contained within this publication nor does it diagnose patients. As a medical professional you retain full responsibility for the care and treatment of your patients and you should use your own clinical judgement and expertise when using this product.

This content is not intended to cover all possible diagnosis methods, treatments, follow up, drugs and any contraindications or side effects. In addition, since such standards and practices in medicine change as new data become available, you should consult a variety of sources. We strongly recommend that you independently verify specified diagnosis, treatments and follow-up and ensure it is appropriate for your patient within your region. In addition, with respect to prescription medication, you are advised to check the product information sheet accompanying each drug to verify conditions of use and identify any changes in dosage schedule or contraindications, particularly if the drug to be administered is new, infrequently used, or has a narrow therapeutic range. You must always check that drugs referenced are licensed for the specified use and at the specified doses in your region.

Information included in BMJ Best Practice is provided on an “as is” basis without any representations, conditions or warranties that it is accurate and up to date. BMJ and its licensors and licensees assume no responsibility for any aspect of treatment administered to any patients with the aid of this information. To the fullest extent permitted by law, BMJ and its licensors and licensees shall not incur any liability, including without limitation, liability for damages, arising from the content. All conditions, warranties and other terms which might otherwise be implied by the law including, without limitation, the warranties of satisfactory quality, fitness for a particular purpose, use of reasonable care and skill and non-infringement of proprietary rights are excluded.

Where BMJ Best Practice has been translated into a language other than English, BMJ does not warrant the accuracy and reliability of the translations or the content provided by third parties (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages). BMJ is not responsible for any errors and omissions arising from translation and adaptation or otherwise.Where BMJ Best Practice lists drug names, it does so by recommended International Nonproprietary Names (rINNs) only. It is possible that certain drug formularies might refer to the same drugs using different names.

Please note that recommended formulations and doses may differ between drug databases drug names and brands, drug formularies, or locations. A local drug formulary should always be consulted for full prescribing information.

Treatment recommendations in BMJ Best Practice are specific to patient groups. Care is advised when selecting the integrated drug formulary as some treatment recommendations are for adults only, and external links to a paediatric formulary do not necessarily advocate use in children (and vice-versa). Always check that you have selected the correct drug formulary for your patient.

Where your version of BMJ Best Practice does not integrate with a local drug formulary, you should consult a local pharmaceutical database for comprehensive drug information including contraindications, drug interactions, and alternative dosing before prescribing.

Interpretation of numbers

Regardless of the language in which the content is displayed, numerals are displayed according to the original English-language numerical separator standard. For example 4 digit numbers shall not include a comma nor a decimal point; numbers of 5 or more digits shall include commas; and numbers stated to be less than 1 shall be depicted using decimal points. See Figure 1 below for an explanatory table.

BMJ accepts no responsibility for misinterpretation of numbers which comply with this stated numerical separator standard.

This approach is in line with the guidance of the International Bureau of Weights and Measures Service.

Figure 1 – BMJ Best Practice Numeral Style

5-digit numerals: 10,000

4-digit numerals: 1000

numerals < 1: 0.25

Our full website and application terms and conditions can be found here: Website Terms and Conditions.

Contact us

+ 44 (0) 207 111 1105
support@bmj.com

BMJ
BMA House
Tavistock Square
London
WC1H 9JR
UK

DISCLAIMER

Contributors:

// Authors:

Michael Fredericson, MD, FACSM

Associate Professor and Director
Physical Medicine & Rehabilitation Clinics, Stanford University, Stanford, CA
DISCLOSURES: MF declares that he has no competing interests.

// Acknowledgements:

Dr Michael Fredericson would like to gratefully acknowledge Dr Jong In Lee and Dr Julia Arroyo, previous contributors to this topic. JIL and JA declare that they have no competing interests.

// Peer Reviewers:

John Cianca, MD

Clinical Associate Professor
Department of Physical Medicine & Rehabilitation, Baylor College of Medicine, Houston, TX
DISCLOSURES: JC declares that he has no competing interests.

John Halperin, MD

Physician
Sharp Rees-Stealy Medical Group, La Mesa, San Diego, CA
DISCLOSURES: JH declares that he has no competing interests.