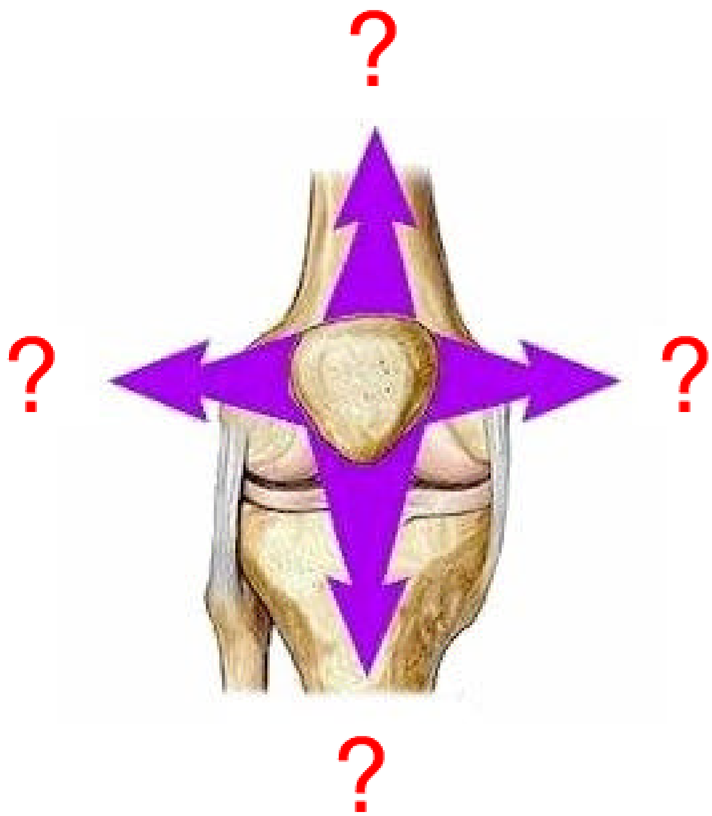
# Patellofemoral Syndrome:
# Evaluation & Management




**Scott Sevinsky MSPT**

## What is Patellofemoral Syndrome?

Patellofemoral syndrome (PFS) is a term commonly used to describe a condition where the patella 'tracks' or glides improperly between the femoral condyles. This improper tracking causes pain in the anterior knee and may lead to degenerative changes or dislocation of the knee cap.

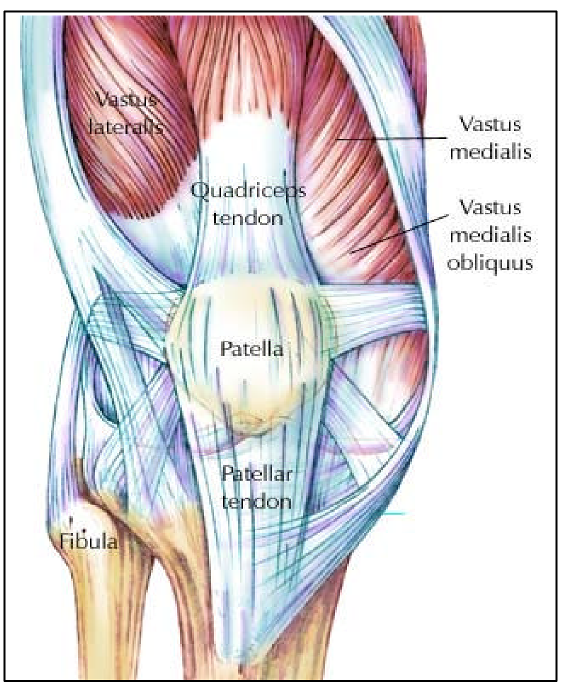
To be more precise the term 'anterior knee pain' is suggested to encompass all pain-related problems of the anterior part of the knee. By excluding anterior knee pain due to intra-articular pathology, peripatellar tendinitis or bursitis, plica syndromes, Sinding Larsen's disease, Osgood Schlatter's disease, neuromas and other rarely occurring pathologies it is suggested that remaining patients with a clinical presentation of anterior knee pain could be diagnosed with PFPS. The term 'patellofemoral' is used as no distinction can be made as to which specific structure of the patella or femur is affected.

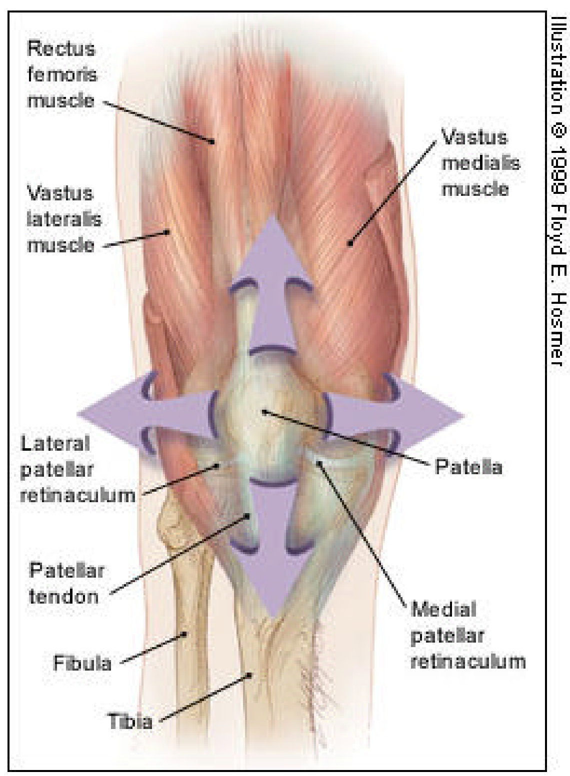
The term 'chondromalacia patellae', defined at the beginning of the 20$^{th}$ century to describe pathological changes of the retropatellar cartilage,[7,8] was for half a century, used as a synonym for the syndrome of patellofemoral pain. However, several studies during the last 2 decades have shown a poor correlation between articular cartilage damage and the still not well-defined pain mechanism of retropatellar pain.

## Review of Knee Anatomy

1. Femur – thigh bone; longest bone in the body.
   - Lateral femoral condyle larger than medial condyle & projects farther anteriorly.
   - Medial femoral condyle longer anterior to posterior
   - Distal surfaces are convex
   - Intercondylar (trochlear) notch: groove in which the patella glides or 'tracks'

2. Tibia – shin bone; tibial plateau site for attachment of menisci; allows glide of condyles.
   - Tibial tuberosity/tubercle: distal attachment site for patellar tendon.
     1. Tibiofemoral joint = articulation site of tibia + femur
     2. Patellofemoral joint = articulation site of patella + femur



3. Patella – sesamoid bone within the quadriceps tendon. The patella:
    - Improves mechanical efficiency of the quadriceps pull in the last 30° of knee extension.
    - Acts as a guide for the quadriceps tendon & reduces friction.
    - Acts as a bony shield for the tibio-femoral joint.
    - Contains the thickest layer of cartilage in the body. (on the posterior medial side)
    - Has 5 facets (articular surfaces)
        1. Superior
        2. Inferior
        3. Lateral
        4. Medial
        5. Odd

**The Patellofemoral Joint: Anatomy & Biomechanics**

During extension from approximately 30° of knee flexion, the tibia rotates outwards and the patella is guided through the trochlea of the femur by the interacting heads of the quadriceps muscle (screw-home mechanism). During knee flexion from full knee extension, the distal part of the patella comes in contact with the lateral femoral condyle at 10 to 20° of knee flexion, and the patella then follows an S-shaped curve through the trochlea. The part of the patellar surface articulating with the femur moves proximally during flexion of the knee.

At full knee extension, the patella rests on the supra-patellar fat pad/bursa. Initial contact between the inferior aspect of the patella and the trochlea occurs at approximately 20° of flexion. The contact area moves proximal as the knee flexes so that by 90° of flexion the superior portion of the patella contacts the trochlea. Beyond 90° of flexion the patella rides down into the intercondylar notch and the quadriceps tendon articulates with the trochlear groove of the femur. It is not until 135° of flexion that the odd facet of the patella makes contact with the medial femoral condyle.

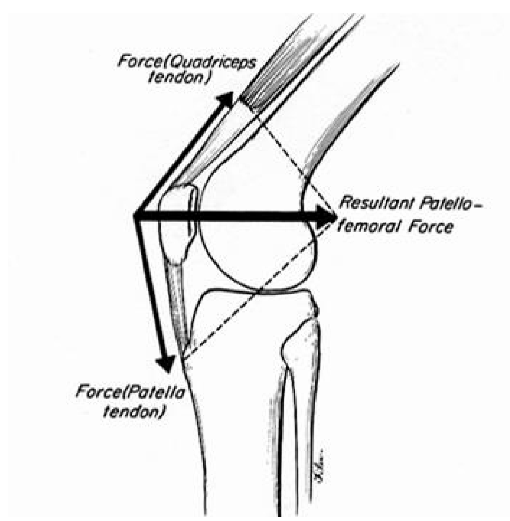
Patellofemoral compression forces increase with increasing knee angles up to 90° of knee flexion and can reach up to 8 X bodyweight.

There is a natural anatomical bias of the muscular pull of the quadriceps which produces a bowstring effect on the patella. The VMO is one of the sole muscles responsible for counteracting this pull.

**Patellofemoral Joint Reaction Force**

The PFJ reaction force is the measure of the compression of the patella against the femur. PFJRF is determined by quads force and amount of knee flexion. During weight-bearing activities, it is the vector summation of the quadriceps muscle and patellar ligament forces.

Women tend to have higher peak PF contact pressures even at lower knee flexion angles.



**What Causes PFS?**

No single biomechanical factor has been identified as a primary cause of patellofemoral pain, although many have been hypothesized. Some of the more popular and accepted theories are:

1. **Osseous Abnormality or Malalignment**
   Bony abnormalities such as a shallow trochlear notch, over or undersized patella, femoral anteversion, tibial torsion, genu valgum, can all be a contributing or causal factor in PFS.

2. **Muscular or Ligamentous Imbalance** – PFS can result from weakness or tightness in one or multiple muscle groups as well as tightness of soft tissue structures surrounding the knee cap. Soft tissue structures such as the medial patellofemoral ligament or lateral patellar retinaculum can either be overstretched or tight as a result of a bony malalignment or muscular imbalance. Muscular weakness and/or, specifically of the vastus medialis oblique (VMO) is commonly seen in PFS.

   - Static patellar stabilizers – the patella is passively stabilized by its own shape, the trochlea of the femur, peripatellar retinaculum and medial patellofemoral ligament.

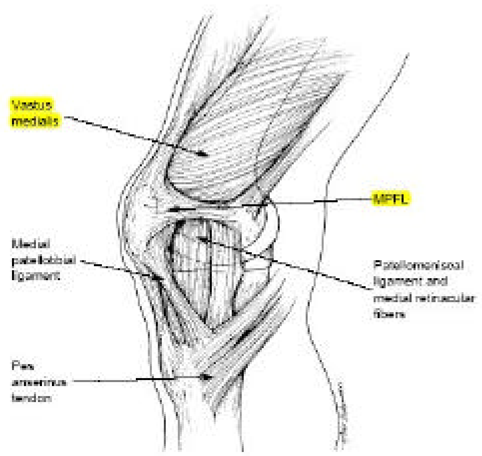


Fig. 1 Anatomy of the medial aspect of the knee. The MPFL provides 53% of the restraining force in preventing lateral displacement of the patella; the patellomeniscal ligament and medial retinacular fibers, on average 22%.[3]

**MPFL** (Medial patellofemoral ligament) – extends from the anterior aspect of the femoral condyle to the superomedial margin of the patella. As the ligament courses anteriorly its fibers fan out and fuse with the undersurface of the vastus medialis tendon. [1]

Conlan et al. [3] performed a biomechanical study of the relative contributions of the medial soft-tissue restraints in the prevention of lateral displacement of the patella. They found the MPFL to be the major medial soft-tissue stabilizer, providing **53%** of the total restraining force.

   - Dynamic Patellar Stabilizers:
     - Biceps femoris
     - Semimembranosus
     - Sartorius
     - Gracilis
     - Semitendinosus
     - Vastus medialis oblique (VMO)
     - Vastus medialis
     - Vastus intermedius
     - Vastus lateralis
     - Rectus femoris

The muscle most commonly weakened muscle in PFS, is the VMO. VMO weakness results from a muscular ‘inhibition’ defined as both a decreased ability to exert muscular torque and provide a stabilizing force, as well as disorganization of normal muscle firing & timing patterns.

Muscle inhibition relates to Sherry’s law of reciprocal inhibition and the muscle spindle. Activation of a muscle uses stretch reflex connections to stimulate or facilitate an agonist and to inhibit the antagonist to movement using an inhibitory interneuron. If a muscle, or muscle group(s) are continually recruited or facilitated in an abnormal or unbalanced pattern (as in a cramp, spasm, or chronic tension), eventually the antagonist muscles become inhibited due to their continued receiving of inhibitory impulses.

Arthrogenic muscle inhibition (AMI) is a presynaptic, ongoing reflex inhibition of musculature surrounding a joint after distension or damage to that joint. AMI is a natural response designed to protect the joint from further damage. The presence of AMI retards rehabilitation despite complete muscle integrity.

Proprioception is the ability to detect static or dynamic position of a limb in space. Injury to a joint may cause direct or indirect alterations in sensory information provided by mechanoreceptors; specialized receptors that sense mechanical deformation in soft tissue. Mechanoreceptors function by transducing some form of mechanical deformation into a frequency-modulated neural signal which is transmitted via afferent (sensory) and efferent (motor) pathways.

Direct physical trauma can cause capsular and /or ligamentous tearing ending in rupture of innervating nerve fibers. Consequently, the destruction of the messages to and from the joint receptors then causes a “deafferentation” and proprioceptive loss.

Indirect proprioceptive disruption may result from the effects of joint effusion or hemarthrosis. Sensory receptors remain intact, but provide incorrect positional information due to increased pressure. In the presence of significant swelling this form of inhibition deactivates neuromuscular pathways resulting in insufficient or uncoordinated muscle group activation (dyskinesis). In addition, swelling increases intra-capsular knee pressure restricting range of motion leaving a ‘boggy’ end-feel.

3. **Overactivity –** Because bending the knee increases the pressure between the patella and its various points of contact with the femur, patellofemoral pain syndrome is often classified as an overuse injury. However, a more appropriate term may be "overload," because the syndrome can also affect inactive patients. When the patient’s problem is due to overuse often there is a bilateral representation of symptoms.

**Common Impairments**

- pronated foot
- retropatellar pain with a painful flexion arc*
- patellar creptius, swelling, or locking.
- weakness, inhibition, poor recruitment, timing of firing of the VMO.
- tight gastrocnemius, soleus, hamstrings, rectus femoris muscles
- overstretched medial retinaculum
- decreased medial gliding or medial tipping of the patella
- restricted lateral retinaculum, IT band or fascial structures around the patella.
- irritated patellar tendon or infrapatellar fat pads

*Although cartilage damage is frequently implicated in PFS, hyaline cartilage has no nerve endings, and therefore pain is generated by other structures, including the retinaculum, subchondral bone, synovium, or local small nerve endings.[6]

**Common Functional Limitations**

- pain and stiffness with prolonged flexed knee positions such as sitting or squatting.
- pain or poor knee control when descending or ascending stairs
- pain with walking, jumping, squatting, or running interfering during ADL, work, recreational or sport activities.

**Differential Diagnosis**

Other causes of chronic anterior knee pain besides PFS include Sinding-Larsen-Johansson (SLJ) disease, Osgood-Schlatter disease (OSD) Chondromalacia and Osteochondritis Dissecans. SLJ disease and patellofemoral syndrome occasionally coexist with OSD in adolescents

Figure 3: Mary Albury-Noyes

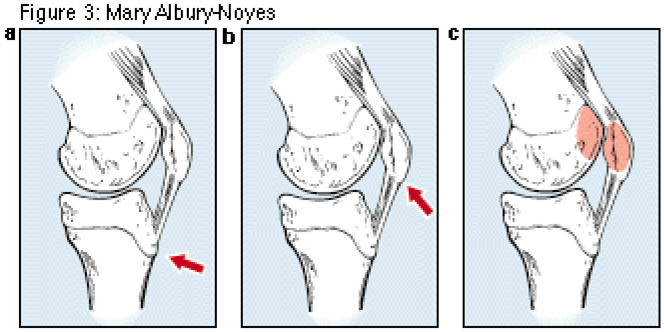



Figure 3. Chronic anterior knee pain in adolescents may be a result of OSD or other conditions. OSD is a disturbance at the junction of the patellar tendon and the tibial tubercle apophysis (a, arrow). Snding-Larsen-Johansson disease involves pain, swelling, and tendemess of the inferior patellar pole at the origin of the patellar tendon (b, arrow). Patients who have patellofemoral syndrome (c, shaded areas) have poorly localized peripatellar pain.

**Osgood-Schlatter Disease (OSD)**: characterized by a prominent painful tibial tuberosity. The exact cause is unknown, but is proposed to result from repetitive microavulsion (overuse) of the tibial tubercle

**Sinding-Larsen-Johansson Disease (SLJ)**: an osteochondrosis involving the apex of the patella causing pain and tenderness over inferior pole of patella. Also believed to also be precipitated by overstraining or trauma. The lesion is felt to be due to a traction phenomenon in which contusion or tendinitis in the proximal attachment of the patellar tendon can be followed by calcification and ossification, or in which patellar fracture or avulsion produces one or more distinct ossification sites.

**Patient Examination**

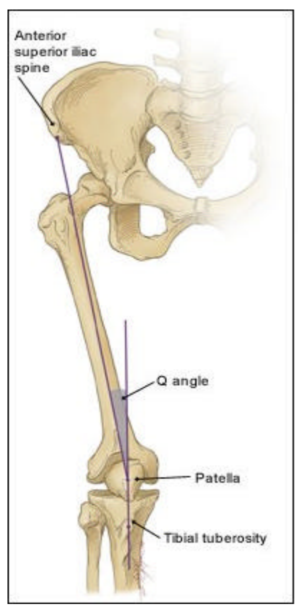
✓ **Interview**
 ? onset and duration of symptoms
 ? where is your pain? *
 ? was there a MOI?
  - Patients who are injured by high-impact blunt trauma are much more likely to have suffered articular cartilage damage
 ? any previous patellar symptoms?

* Many patients are able to localize their site of pain especially if the pain has a retinacular or tendinous origin.

✓ **Observation of gait pattern**
  - increased toe out?
  - > 15° – associated with femoral anteversion; hip IR.
  - < 15° – associated with femoral retroversion; hip ER.

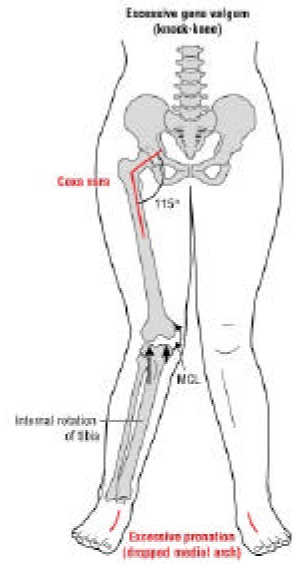
✓ **Quadriceps / VMO bulk & symmetry**

✓ **Quadriceps "Q" Angle** – the angle formed by a line from the ASIS to mid patella and from mid patella to the tibial tuberosity.
  - Normal angle = 13 – 18°
  - < 13° are associated with pain and patella alta.
  - angles $\geq$ 18° are associated with pain, subluxing patella, genu valgum, and lateral tibial torsion / tibial external rotation.
  - Females typically have larger Q-angle's because they tend to have a wider pelvis.
  - **Bayonet sign** – Q-angle in sitting




? Is the Q-angle a reliable assessment of dysfunction ?

✓ **LE Alignment**




**Femoral alignment**

- Genu Varus = bow legged; 'grasshopper patellas' (~ 7° normal)
- Genu Varum = knock kneed; shortens lateral soft tissues. Commonly referred to as 'kissing kneecaps' or 'squinting patellas'
- Genu Recurvatum = hyperextension of the knees & increased patellofemoral contact pressures.
- External femoral rotation increases medial side patellar contact and internal femoral rotation increases lateral patellar contact.

**Tibial Torsion/Rotation**

- Medial – feet point toward each other; 'Pigeon-toed'. Medial tibial torsion affects patellar tracking causing increased medial patellar contact pressures as well as creates a fulcrum to laterally displace the patella.
- Lateral – feet point outward; 'Duck footed' → lateral soft tissue shortening.

**Foot & Ankle**

- Excessive pronation results in ↑'d internal tibial torsion during gait. As the knee begins to extend during midstance the femur undergoes compensatory internal rotation. As gait progress to terminal extension the tibia ends in relative external rotation resulting in increased Q-angle and lateral retropatellar contact pressures. (JOSPT)

✓ **Palpation**

Palpation over the patella during knee flexion and extension often reveals crepitus, which is of debatable significance.[6] One study[9] that examined knee findings in normal subjects found that 40% of females had asymptomatic, and most often bilateral, patellofemoral crepitus. When crepitus is new, painful, or markedly asymmetric, however, it may signal other pathology. Distal quadriceps or patellar tendon tenderness may be suggestive of an overuse injury.

✓ **Muscular Flexibility & Soft Tissue Mobility**

Quadriceps, hamstrings, gastrocnemius-soleus complex, and iliotibial band flexibility.[17]

- SLR testing
- Ely's test → quadriceps tightness
- Ober's test → ITB tightness
- Thomas test → hip flexor tightness.
  - Hamstring tightness = ↑'d quadriceps force needed for extension
  - Quadriceps tightness = ↑'d posterior force across the patellofemoral joint
  - ↓'d D/F or calf tightness = ↑'d internal tibial rotation → ↑'d knee valgus
  - Iliotibial band tightness = ↑'d lateral pull on patella

✓ **ROM**

- Examine in supine repeated flexion & extension observing whether the patella enters the trochlea promptly or whether the patella abruptly jumps from a lateral position into the trochlea. Is a painful flexion arc present? If so, it is extremely important to note at what point in the knee flexion arc pain occurs as this can give insight into the location of a possible articular lesion on the underside of the patella. If a chondral lesion is suspected, MRI testing should performed as the location of a chondral lesion greatly influences exercise prescription. Articular cartilage lesions on the distal patella will produce pain early in knee flexion while more proximal lesions will be notable farther into the flexion arc. For example, if a painful proximal patellar lesion is detected, exercises between 60° and 90° of flexion should be avoided.

✓ **Muscle strength testing**

- Examine quad set quality and presence of extensor lag in long sitting or with supine SLR.
- + Trendelenburg sign; single limb stance causes ipsilateral pelvic drop.
  - Hip abductor and external rotator weakness = ↑'d knee valgus
  - Traditionally lateral patellar tracking or subluxation is the result of the patella moving on the femur. This may hold true in open kinetic chain motions. However, recent evidence suggests that subluxation during weight-bearing activities may be the result of the femur rotating underneath the patella in the transverse plane. [10]

✓ **Patellar size, mobility & position**:

- patella alta (high sitting), baja (low sitting), parva (undersized), magna (oversized)
- patella should normally glide ~ 1/2 its width medially and laterally in full extension.

Figures 4-6: Courtesy of Michele LaBotz, MD

FIGURE 4. The patellar glide (apprehension) test assesses tightness of the retinaculum and associated structures and is done with the patient's knee flexed about 20° and the quadriceps relaxed. The examiner grasps the medial and lateral aspects of the patella and translates the patella medially and laterally. Glide testing should be pain free. Medial glide of one quadrant or less (<5 mm) is consistent with tightness of lateral structures. Medial or lateral glide of three or more quadrants indicates hypermobility. Discomfort or apprehension, particularly with lateral glide testing, indicates patellar instability.

The patellar glide [12] and patellar tilt tests assess patellar mobility. They primarily assess for retinacular tightness or laxity. The medial and lateral retinaculi are frequently tender and can be gently palpated using the same maneuver as the patellar tilt test. If the retinaculi are not tender, the posterior patellar facets can then be palpated as the patella is again tilted. Clinicians should be aware that retropatellar palpation is often uncomfortable, even in normal individuals, so examination of the uninvolved knee can provide a baseline for patient tolerance to this test.

- A tight lateral retinaculum results in abnormally high forces between the lateral facet of the patella and the lateral trochlea.



FIGURE 5. The patellar tilt test is done by compressing the medial aspect of the patella posteriorly and lifting the lateral aspect. Normally, the lateral patellar edge can be elevated slightly above horizontal. If not, the lateral retinaculum is tight (ie, "lateral tilt"). This maneuver may then be repeated on the medial side. The peripatellar retinaculum and retropatellar surface may be gently palpated while performing these maneuvers.

Lateral tilt [12] can be assessed by observing distal patellar movement as the patient isometrically contracts the quadriceps. If the distal pole of the patella appears to move posteriorly, the action may be irritating the infrapatellar fat pad.

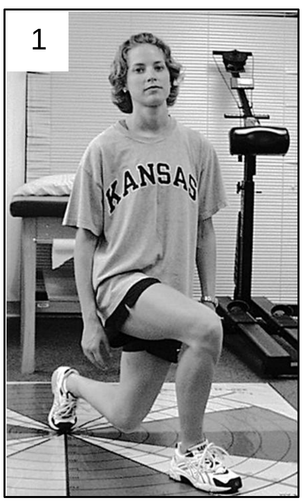
It is also important to assess if at rest the patella is internally/externally rotated or tilts inferiorly. This also may lead to infrapatellar fat pad irritation or impingement especially in patients who exhibit combined genu recurvatum and increased knee valgus.

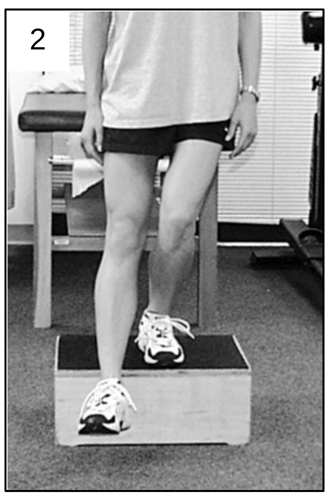
Compression testing done at differing degrees of flexion assesses pain as the patella moves through the femoral groove.[6] Since compression testing can be quite painful, it needs to be performed carefully and is often the final step in the physical examination.

**Functional Outcome Tests:**

1. **Anteromedial Lunge Test:** challenges lateral PF articulation by placing valgus stress on knee combined with CKC motion
2. **Step Down Test:** examines eccentric quad control in closed chain (CKC).
3. **Unilateral Leg Press Test** CKC isolation of the PF joint
4. **Balance & Reach Test** Combines CKC proprioceptive function with slight knee flexion.

FIGURE 6. Patellar compression can be used to assess retropatellar tenderness. The examiner directly compresses the posterior aspect of the patella into the femoral groove. Although this test is often described as being done with the patient's knee in full extension, it is best done initially with a knee flexed to about 15° to avoid trapping synovial tissue, which can be quite painful even in a normal knee. This maneuver is then repeated at increasing flexion angles as the patella moves through the femoral groove. Pain with greater flexion indicates pathology more superior on the retropatellar surface.






**McConnel Test:** (not pictured) Examiner takes their first web space and places it along lateral border of the knee. Patient attempts to squat down while the examiner gently pushes the patella medially. A decrease in symptoms indicates a positive test for patello-femoral syndrome.

| Summary of Common Biomechanical Factors That Can Contribute to Patellofemoral Syndrome* [12] | |
|---|---|
| **Structure** | **Pathophysiologic Cascade** |
| Foot or Ankle | Increased pronation → increased internal tibial rotation → Increased knee valgus<br><br>Decreased dorsiflexion or calf tightness → Increased internal tibial rotation → Increased knee valgus |
| Knee | Lateral patellar tilt or retinacular tightness → Increased pressure on lateral aspect of posterior patella, decreased pressure on medial posterior patella, and increased traction on the medial retinaculum |
| Thigh | Decreased VMO function → Increased lateral movement of patella with quadriceps activation<br><br>Quadriceps tightness → Increased posterior force across the patellofemoral joint<br><br>Hamstring tightness → Increased quadriceps force needed for extension |
| Hip | Iliotibial band tightness → Increased lateral traction on patella<br><br>Hip abductor and external rotator weakness → Increased knee valgus |

* Most of these contributors involve dynamic effects occurring with weight-bearing activity.

### What We Know

- PFS has a higher incidence among females. This is believed to be the combination of both a wider pelvis and weaker hip musculature. A wider pelvis increases the quadriceps angle thereby altering PF contact pressures.
- PF contact pressures differ among genders. Females tend to have higher contact pressures even at lower knee flexion angles.
- Females tend to exhibit decreased hip musculature strength, increased knee valgus moments and movements into valgus positions compared to males. Proximal hip strength is antagonistic to combined valgus and internal rotation movements. In the absence of proximal hip strength the knee tends to fall into or assume and adducted and internally rotated position which further increases lateral patellar contact pressures.
- Females with symptomatic PFP tend to exhibit decreased hip abductor and external rotator strength.
- Tibial and femoral rotation may play a role in patellofemoral pain.
- Femoral retroversion (ER) increases medial patellar facet pressures; femoral anteversion (IR) femur increases lateral patellar facet pressures.
- Internal tibial rotation

### What We Don't Know (or is debated)

- Can we influence patellar proprioception…or why does McConnel taping works for some individuals and for some it does nothing?
- Can the vastus medialis be isolated or preferentially recruited?
- Are closed chain exercises superior to open chain exercises for patellofemoral pain?

## PFS Treatment & Interventions

The first step in treatment is to reduce pain and inflammation. This includes regular and frequent ice application for 15 to 20 minutes at a time, especially after activity as well as use of any medications prescribed by the referring physician combined with rest and/or activity modification Modalities such as pulsed US or interferential current can also help alleviate pain and control edema. Home exercise programs should begin with addressing flexibility deficits and initiation of pain-free quadriceps re-education and strengthening. Restoration of quadriceps strength is the key component to symptom reduction and improving long-term outcome in PFS.[12]

- Patients should be encouraged to continue pain-free activity and maintain aerobic conditioning. Athletes or highly active patients should decrease their training intensity and volume by about 50%. Patients who cannot tolerate continued activity and those with acute injury may require rest for up to 3 – 4 weeks or longer until activities of daily living are pain free.
- Trial use of a brace may be beneficial.
- Alternate activities patients may tolerate include freestyle swimming, bicycling (seat elevated to avoid excessive knee flexion), or elliptical trainers. Stair-stepping machines and step aerobics should usually be avoided and patients should also be advised to avoid unnecessary force across the knee (cross-leg sitting, prolonged sitting or squatting).

Clinical Treatment should address the following:

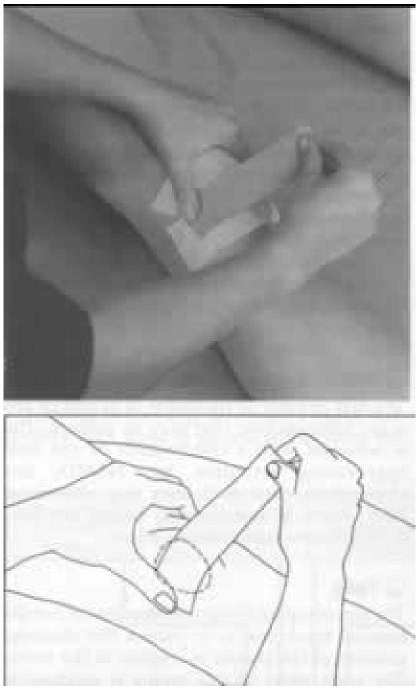
- Quadriceps and adductor setting
- Retrain VMO firing/timing with Russian current (30 – 50 pps.)
- Stretching of tight soft tissues (gastrocs, hamstrings, ITBs, quadriceps & hip flexors)
- Restoration of patellar mobility (instruction in self patellar mobs & lateral retinacular stretches)
- "short arc" knee extension in pain free ranges
- Closed chain ¼ squats (cueing to avoid allowing knees to go over toes)
- Eccentric quad control ('step downs' noting patellar tracking or short arc leg press)
- Strengthening of hip abductors & external rotators [2,4,9,10,12,]
- Strengthening of foot intrinsics (tibialis posterior).
- Trial PF taping (medial, rotation, lateral tilt, fat pad)
  Whittingham et. al 2004 demonstrated that PF taping techniques combined with specific exercise is superior to exercise alone for the management. [12]

Figure 4: Courtesy of Michele LaBotz, MD

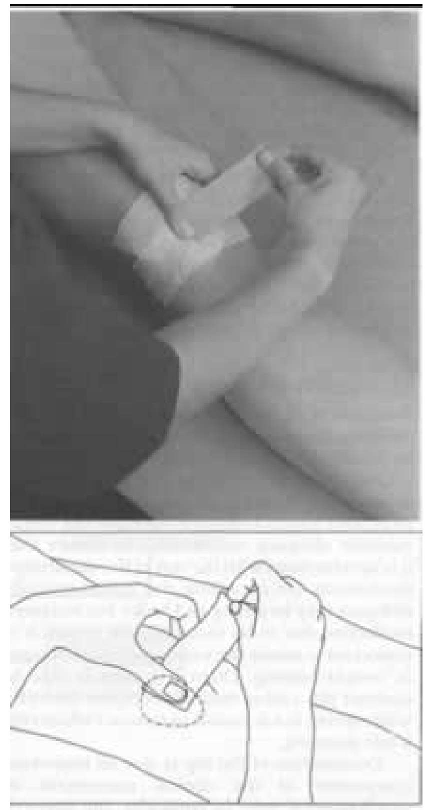
FIGURE 4. Patellar stretch. Sit with your injured leg straight and your leg muscles relaxed. Grasp your kneecap by placing your thumbs just outside the kneecap and index fingers just inside the kneecap. Push the kneecap slowly and firmly with the thumbs until you feel resistance. Hold for 15 to 20 seconds.

## McConnell Taping Techniques

http://www.clinicalsportsmedicine.com/chapters/24c.htm

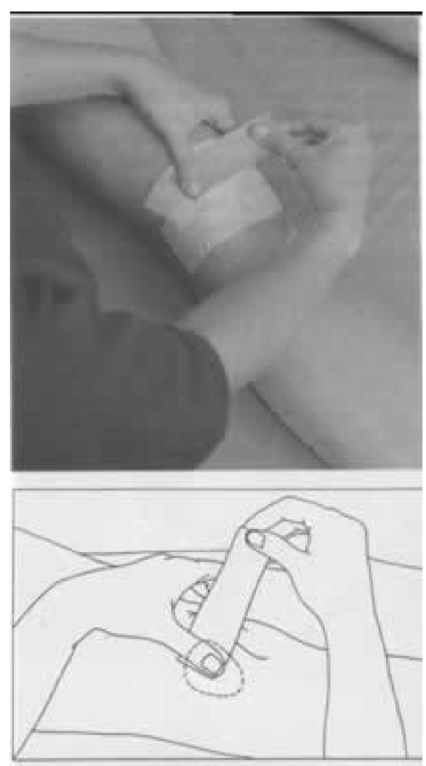


(a) Knee taped showing medial glide. Tape is applied to the lateral aspect of the patella. The patella is glided medially and the tape anchored to the skin over the medial aspect of the knee. When taping is completed, skin creases should be evident on the inside of the knee indicating adequate tension on the patella.



(b) Knee taped showing correction of lateral tilt. Tape is applied to the medial aspect of the patella and secured to the soft tissue on the inner aspect of the knee

(c) Knee taped showing correction of rotation. Tape is applied to the inferior pole of the patella and taken medially and superiorly to rotate the patella



(d) Knee taped showing correction of inferior tilt. Tape is applied across the superior pole of the patella with sufficient firmness to elevate the inferior pole

**Patellofemoral Bracing & Orthotic Use**

There is limited evidence to support any particular type of PF brace or the potential for PF braces to change patellar position. In most cases braces are used more of a means of either enhancing proprioceptive input or preventing the patella from tracking incorrectly by providing a "bumper" rather than position change. Cost and design of knee braces vary considerably so trial bracing should be based on patient preference. Some commonly encountered PFS braces include Don Joy's Opto-track, Lateral "J" or the Protonics knee bracing system.

Although recommendations for foot orthoses are common in PFS treatment, this appears based largely on theoretic grounds of their effects on kinetic-chain alignment.[17] Research-based evidence is scarce.[17] Some patients with increased pronation may experience benefit from over-the-counter antipronation orthoses. Heel lifts may help some patients with leg-length discrepancies or genu recurvatum.[17]

Although taping and braces are not substitutes for rehabilitation, they may significantly enhance comfort for some patients and allow for more effective rehabilitation. Taping may enhance earlier VMO firing, and greatest benefit appears to occur when taping is used in conjuction with an individualized rehabilitation program.[18] Recent literature review of McConnel taping suggests that the taping techniques may play a role in providing proprioceptive feedback rather than actual patellar repositioning. It's thought that by improving proprioceptive feedback, taping encourages and reinforces proper tracking facilitated by muscular control. It is important to note McConnel taping techniques are not meant for long term use. The duration in which tape should be left in place is debatable. Some clinicians believe taping techniques are most effective when used for a short time (less than 40 minutes) because after this time it is argued tape adhesive breaks down. On the other hand some clinicians argue acute cases of patellofemoral pain may initially need tape applied at least 6-8 hours per day until the condition settles. Tape time is then gradually reduced.

**Treatment Program Suggestions**

The following program is a suggested clinical pathway for treating patellofemoral syndrome. It should be noted and emphasized that this program will need modification based upon biomechanical factors, strength and flexibility deficits identified during the initial examination.

HEP

- ❒ QS with ADD ball squeezes
- ❒ Self gastroc/hamstring stretching with long bath towel, theraband or stretch out strap.
- ❒ SLRs:
  - o Progress EXT → ADD → ABD → Flexion
- ❒ Bilateral ankle INV thera-band PREs
- ❒ Ice application PRN X 10 – 15 minutes
- ❒ Trial OTC orthotic use
- ❒ Complete rest or activity modification
- ❒ Unwilling/unable to modify activity → PF bracing (Lateral J)

Visits 2 – 6

- ❒ Passive / self B LE stretching as flexibility deficits indicate:
  - o Gastrocs
  - o Hamstrings
  - o Quadriceps
  - o IT bands
  - o Piriformis
  - o Hip Flexors
- ❒ Myofascial release along IT band
- ❒ Russian Current to quadriceps and VMO
- ❒ * McConnel taping trial ?
  - o use tape prior at start of session as adhesive will loosen with time or with excessive ROM activities. EX : quad sets, SAQs, multi-angle isometrics, closed chain exercises.
- ❒ * Multi-angle isometrics
  - o Clinician MREs
  - o Progress to stability ball "ball on wall" isometrics
- ❒ * SAQs: 0 – 30°
  - o can attempt to progress with hip in external rotation if tolerated.
- ❒ * SLRs: EXT → ADDUCTION → ABDUCTION
  - o if able perform ABD with leg against wall to isolate gluteus medius.
- ❒ "Clam Shells"
  - o start without weight → cuff weights → thera-band
- ❒ * thera-band TKEs
  - o progress to selectorized (Life Fitness) weight stack
- ❒ * OLS
  - o Verbal cues to avoid ipsilateral hip drop.
  - o Progress to "wall OLS"
- ❒ ¼ wall squats with adductor squeeze
  - o progress to over weighted with dumb bells
  - o pain free with over weighing X 2 – 3 visits advance to leg press w / BS
- ❒ FWD step ups 4" → 6" (no greater than 6")
  - o Emphasis on avoiding valgus drifting during ascent and descent

Visits 7 – 15

- ❒ Prone TKEs weight cuff overweighting (3 – 5# cuffs)
  - o Progress patient to BOSU with combined plank for core strengthening
- ❒ Single leg ( S/L ) bridges
  - o Progress with dynadisc under affected LE
- ❒ gluteus medius lunge (t-band resisted side stepping)
  - o band wrapped just above ankles
- ❒ T-band TKE with step ups (diagonal resistance applied to thighs)
- ❒ standing t-band / weight stack hip EXT, ABD, ADD → diagonals
  - o progress to multi-hip
- ❒ single leg dead lifts
  - o Progress to ipsilateral weighting with dumbbell 3 – 5 – 7#
- ❒ Dyna Disc ¼ squats
  - o step stool hold for visual cues and/or balance for controlled descent
- ❒ Reverse treadmill ambulation progressed to inclined walking.
- ❒ Leg press with ball squeeze no greater than 60° flexion
- ❒ Standing reverse lunge combined with bilateral t-band forward raise.
- ❒ Sport cord FWD ¼ to ½ lunge
  - o progress to lateral lunges (instruct to make " V "s alternating)

**Surgical Options**

Surgery for PFS is indicated in those few patients who have persistent symptoms in spite of appropriate rehabilitation and who have a genuinely surgically correctible problem such as patellofemoral malalignment or articular cartilage injury. Surgery for PFS encompasses various specific procedures.

- Lateral retinacular release
- Derotational tibial osteotomy a.k.a. realignment of patellar ligament insertion
- Debridement of articular surface of the patella

One of the more common techniques is a "lateral release", which involves a division of the lateral patellar retinaculum. The procedure is usually performed in patients who have an excessive lateral tilt of the patella. Outcomes are highly variable. Studies reveal that between 17% and 92% of patients report satisfactory results after lateral release.[19] Articular cartilage debridement is also common, and the procedure may be performed in conjunction with a lateral release or other techniques aimed at correcting malalignment.

While the literature contains widely varying rates of success for many PFS surgeries, patient selection and postoperative rehabilitation appear critical for improving chances of a favorable outcome.[20] Patients whose conservative therapy has failed because of noncompliance with rehabilitation are often not good surgical candidates.

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