Knee Pain

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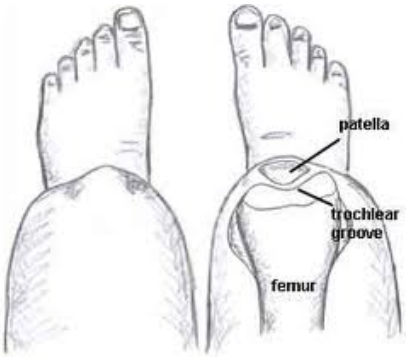
Patellofemoral Pain Syndrome

The *patella* (kneecap) has two important functions. It acts as a pulley, to transfer forces between the quadriceps (thigh) muscle and the patellar tendon. It also improves the leverage of the quadriceps. It does this by transferring the line of force further in front of the knee, for more efficient force production.

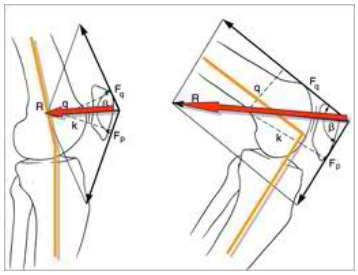
As a pulley, the patella slides in a groove in the lower end of the *femur* (the thigh bone). This is known as the *trochlear* groove. When the knee is fully straight, the patella rests at the top of, and slightly above the trochlear groove.

As the knee bends, it slides down and fully enters the groove. The further the knee bends, the lower and deeper the patella slides into the trochlear groove. The joint between the patella and the trochlear of the femur is known as the *patellofemoral joint*.



Patellofemoral Pain

Through its efficient leverage function, the patella increases the force of quadriceps action by as much as 50%. The downside is that very large forces are transmitted through the patellofemoral joint (PFJ). This is why the cartilage on the back of the patella is the thickest in the body, at 4-5mm thick. *Anterior knee pain* or *patellofemoral pain syndrome* (PFPS) is pain that arises in or around the PFJ. It is typically brought on by activities that create high PFJ loading. These include squatting, kneeling, stair climbing, running, and prolonged sitting. In most people, pain is felt when the knee bends past around 30º, and up to about 90º. This is when the greatest forces are applied to the joint surfaces.



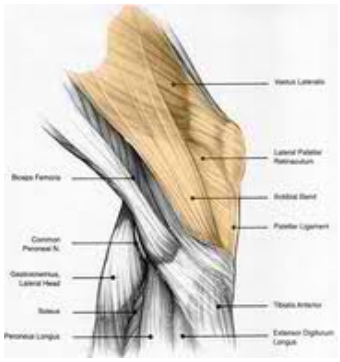
PFPS is the most common knee complaint seen in adolescents and young adults. It affects around 9% of all young adults, and accounts for up to 45% of all knee complaints, with a higher incidence reported for females. Up to 30% of children with PFPS will have the pain for a prolonged period of time. PFPS is extremely common and the subject of thousands of studies, yet many aspects of this problem are still poorly understood.

Source of Pain

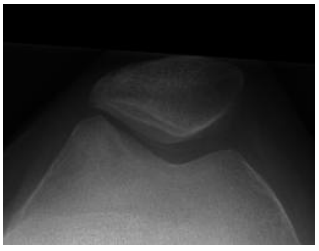
There is debate as to the main source of pain. While the joint cartilage sometimes bears extreme amounts of load, this is not the pain source as there are no

pain nerve fibres in cartilage. The two most popular theories as to the source of pain are:

(a) Soft tissue sensitivity. Pain may arise from tissues that connect to and support the patella. These are the patellar *ligaments* and *retinaculum.* For various reasons, these tissues may become overloaded or over-stretched. Regular or constant stress on any soft tissue in the body can quickly lead to pain. It has been proposed that stress to the retinaculum could lead to tissue *ischaemia* (reduced blood flow). Over time this could result in an increased growth of sensitized nerve endings within the retinaculum, which becomes a potent source of pain. There is also speculation that reduced tissue blood flow may affect the supply of blood to the patella, inducing 'ischaemic' pain from within the bone itself.



(b) Bone stress. Bone that is loaded excessively can become painful. This can occur for a few reasons. If the patellar contact with the femur is uneven, pressure can be applied to one part of the joint, causing overload. Another reason could be thinning or loss of cartilage, leading to reduced shock absorption. Or it could be due to general overload, with too much strenuous activity over a short period of time.



(c) Inflammation. Various tissues around the PFJ are pain sensitive and prone to inflammation. These include the joint capsule, the *synovium* (inner lining of the joint), and the fat pads above and below the patella (see the diagram on the left).

Pain in the front of the knee can also be due to causes not considered part of PFPS. These include:

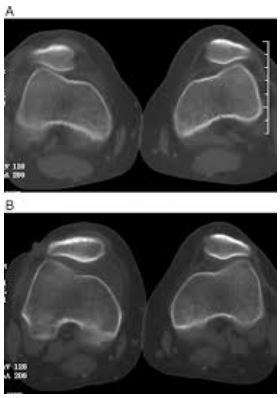
- *Patellar tendinopathy:* This is when pain arises at the attachment of the patellar tendon into the bottom edge of the patella. This is common in running and jumping sports. Tendinopathy can also occur at the top of the patella, where the quadriceps attach, and at the attachment of the patellar tendon into the tibia. However these areas are less common sources of tendinopathy.

- *Apophysitis:* In children and adolescents, it is common to get pain due to stress and inflammation at growth centres. This is often seen at locations where tendons attach into bone, particularly at the patellar tendon insertions into the patella (*Sinding-Larsen-Johansson syndrome*) and into the tibia (*Osgood-Schlatter disease*).

Causes of PFPS

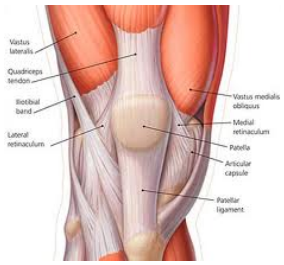
There are many theories as to the cause of this condition. It is possible that there are multiple causes, and that these vary from person to person. There is still a large gap in our knowledge as to why some knees become painful, and why this condition remains difficult to treat in many cases. Some of the possible causes are:

1. *Patellofemoral malalignment*. The most popular traditional theory is that PFPS arises due to *malalignment* of the patella within the trochlear groove. This in itself could occur due to other causes (described below). If the patella does not rest evenly against the femur, one part of the joint may be loaded more than another. This can lead to bone stress, impingement, or soft tissue overload. The idea that malalignment is the major cause of PFPS is not universally accepted. One of the problems with the theory is that many people with malalignment have no pain, and many people with PFPS have no malalignment. Nonetheless, it is likely to be a contributing factor in some people with PFPS.

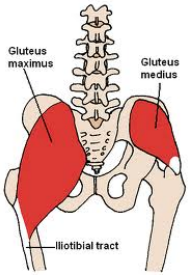


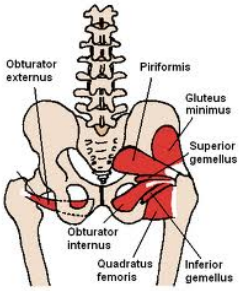
2. *Muscle imbalance*. This is one of the most likely causes, and possibly the most common. It only takes a slight alteration in the balance of muscles around a joint to result in uneven loading, and in time this will cause wear and tear. It's a bit like having the wheels out of alignment in your car. The tyres quickly wear on one side. Muscle imbalance is particularly problematic at the PFJ, because the patella floats within the quadriceps and tendon, and so is directly at the mercy of the forces applied by the muscles. Imbalance commonly arises from:
   (a) Tightness or tension. Tightness in the quadriceps, hamstring or calves can result in greater pressures being applied directly to the joints in the knee. Muscle tension is when the muscles are 'turned on' more than they should be. This can be more problematic than muscle tightness.

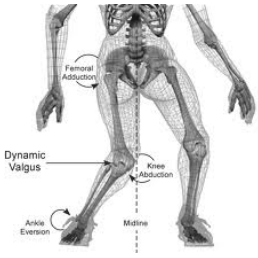
   (b) Quadriceps weakness. For years it has been proposed that weakness in the *medial* (closer to the middle) quadriceps, known as *vastus medialis*, is a major factor in PFPS. The theory is that an imbalance between the weak medialis and the stronger lateral quadriceps (*vastus lateralis*) leads to lateral pressure on the patella. General quadriceps weakness is also a risk factor, as there will be less loading through the muscle and more through the joint. Another theory is that the 'timing' of muscle contraction may be abnormal. If the vastus lateralis contracts before the medialis this can result in uneven pressure. An imbalance of strength between the quadriceps and hamstrings has also been proposed as being a risk factor for PFPS.



   (c) Hip muscle weakness. Recent research has suggested that weakness in muscles around the hip may be a more important factor than knee muscle weakness. The *gluteals* ('gluts') and deep hip rotators function to keep the whole leg in good alignment whenever we put weight through one side. Weakness or imbalance in these muscles can affect the whole leg. The result will be abnormal twisting and sideways bending. The knee may be an innocent bystander, because it is the link between an unstable hip, and the foot which is planted on the ground. The majority of the resulting

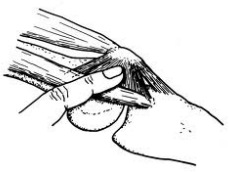


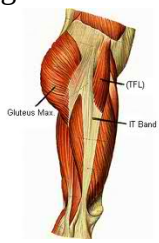




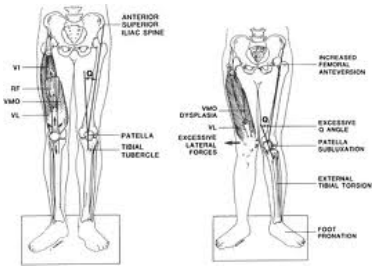
abnormal forces will be transmitted to the knee.

3. *Tightness of the lateral structures*. Tightness of the lateral ligaments and *retinaculum* (connective tissues that support the patella) has been proposed as a major factor leading to patellar malalignment or '*lateral pressure'*. Lateral tightness can occur for a number of reasons. For instance, the *iliotibial band*, which runs down the outside of the thigh, can tighten and put tension on the retinaculum. Muscles at the hip that attach to the ITB can contribute to this tightness. Habits, posture, genetics and body shape are all factors that may play a part.





4. *Biomechanics*. Faulty movement patterns can occur for a number of reasons. Tightness in joints of the foot and ankle, poor foot control (particularly *over-pronation*), and poor hip and lumbo-pelvic control are all factors that can cause abnormal movements at the knee. *Over-pronation* (rolling in) at the foot and ankle is thought to be a common cause of the knee twisting inwards, putting added pressure on the patellofemoral joint.



5. *Anatomical factors*. The shape, and the way that the bones and joints develop can affect PFJ loads. Some people are born with or develop bony shapes that naturally result in less efficient joint loading. Examples include:

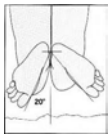
(a) Genu valgus. This is being excessively 'knock-kneed'

(b) Genu varum. This is being excessively bow-legged.

(c) Genu recurvatum. This is a knee that goes excessively past the straight position.

(d) Femoral anteversion. In some people the hip shape favors a leg that turns in excessively, because the femur twists medially relative to the knee. The picture on the left demonstrates this on the left side.

(e) Tibial torsion. A lower leg that twists excessively in or out can be another factor



6. Instability. An unstable PFJ sometimes becomes painful due to repeated trauma (see section on 'Instability / Dislocation').

Certain bone and joint abnormalities within the knee can also contribute to PFPS.

Treatment

Because there are many possible causes of PFPS, the best treatment is not always clear. Once the patient has been carefully assessed, a range of treatments may be applied. Of particular importance will be:

1. Muscle strengthening. Depending on where the main muscle imbalances or deficits seem to be, the muscles most likely to need strengthening are:

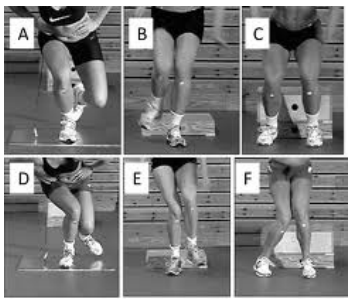
(a) Quadriceps, particularly the vastus medialis. This can be challenging, because quadriceps contractions often increase pressure and pain through the PFJ. Your physiotherapist will find ways to keep these exercises pain-free. Improving the balance between the medial and lateral quadriceps can also be challenging. EMG biofeedback, and specific exercises that favor medial quads recruitment, are ways to assist with effective strengthening.

(b) Hip muscles. Of particular importance are the gluteals - *gluteus maximus, medius* and *minimus*,

and the deep hip rotator muscles. Exercises to strengthen these muscles can also be very challenging. It is often difficult to isolate the correct muscles, and to turn off the overactive ones. It can also be difficult to select exercises that avoid knee pain. Careful guidance and biofeedback may overcome the problem.

(c) Core muscle groups. Hip and knee strengthening will be ineffective if the muscles are attempting to work through an unstable lumbo-pelvic region. Core strength and posture (see below) will often need to be improved early in rehab.

2. Neuromuscular retraining. As well as strength, the correct pattern of movement may be what is lacking. Sometimes muscles aren't particularly weak, they are just working inefficiently, and their 'timing' is out. Changing habits, practicing new ways of moving, and use of different types of biofeedback can all be helpful strategies.



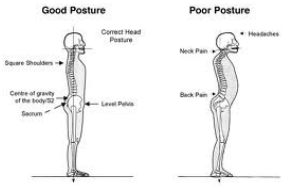
3. Orthotics. For some people, PFPS is very much related to faulty biomechanics of the foot and ankle. Use of orthotics, or selection of better footwear can help in these situations.

4. Stretching. Tight muscles, particularly around the knee, can increase joint loads and should be kept flexible. Tight muscles elsewhere in the body may also need releasing or stretching, as they sometimes cause compensations throughout the body. The main muscle groups in the legs that require regular stretching are the hip flexors, quadriceps, hamstrings and calves.

5. Taping or bracing. Techniques using adhesive strapping tape have been shown to reduce pain and help with exercises for PFPS. The tape may help by altering patellar alignment, or by creating more suitable loading through the PFJ. This method of taping is often referred to as *McConnell taping*, after the Australian physiotherapist Jenny McConnell who invented the technique. Certain patellofemoral braces may provide similar benefits.

6. Massage and mobilisation. Stiff joints of the foot, ankle, knee, hip or spine can all result in increased torsion through the knee. Joint mobilisation techniques may be helpful. Massage, including deep tissue and trigger point releases, can assist in relieving tension that is contributing to greater loading through the knee.

7. Postural correction. Certain postures, especially an excessive anterior pelvic tilt, can contribute to PFPS and other knee problems.



8. Balance and coordination training. There is evidence that balance and *proprioception* (joint position sense) are abnormal in people with PFPS. Training specifically aimed at these deficits can be very beneficial.

9. Functional exercises. Once rehabilitation is well under way and improvements have been made, the greatest challenge is returning to sport without suffering a return of pain. A graduated programme which targets the correct muscles, and which is specific to the type of sport or other activity, will be imperative. This will be included toward the end of the rehabilitation period.

Surgery

The role of surgery for PFPS is controversial. While recurrent patellar dislocation may require surgery (see 'Instability / Dislocation'), there is no evidence that surgical treatment of patellofemoral pain will be beneficial. In fact there have been many cases where surgery for PFPS has increased the pain, or resulted in patellar instability. Because the causes of this condition are complex and often unclear, it is very risky to use a treatment that results in permanent alteration of structures around the knee. Surgery for PFPS is not recommended in the majority of cases.

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