Patello-femoral pain describes a spectrum of conditions, beginning with the common mild pain coming from under the knee-cap (patella) and extending up to frank arthritis of the patello-femoral joint. Previously the term chondromalacia was used to describe all of these conditions, however, it is now felt that this term is no longer descriptive enough, and hence, is now much less used.

Pain in the patello-femoral joint can only be caused by a few things. It can be that the joint surfaces in that area are damaged (be that by direct injury or by degenerative deterioration), that parts of the joint are under excessive pressure, or both. Treatment is aimed at improving contact pressures in the sore part of the joint, either by therapy, with or without orthotics, or by surgical means.

What is the anatomy?
The patella is a small round bone that lies embedded within the tendon of the quadriceps muscle (see opposite). Although it is one continuous tendon from the quadriceps muscle to the tibia, it is called the quadriceps tendon above the patella, and the patella tendon below it. The main function of the quadriceps is to extend (straighten) the knee, and this occurs when this muscle contracts. The patella helps the quadriceps muscle extend the knee joint by improving the mechanical advantage of the muscle at the knee joint. It does this by lifting the tendon out of the groove in the femur (the trochlear groove), thereby improving the direction of pull of the patella tendon on the tibia. This leverage is then maintained during motion of the knee (flexion and extension), as the patella glides (downwards and upwards respectively) in the trochlear groove.

The patella and the femoral groove (trochlear) are each covered by the smooth, low friction, hyaline cartilage that forms the bearing surface of every joint. It turns out that the lining of the patella is the thickest such surface of any joint in the body and, in places, is about 4 to 6 millimetres in depth. This cartilage lining is thought to be this thick because of the enormous forces that go through the patello-femoral joint. Indeed, it is thought that these are the highest joint forces in the body, and that the cartilage develops to be this thick because of that.

The forces produced across the patello-femoral joint are enormous. Simply walking on level ground exerts a force equivalent to one half of the body weight on it. Climbing on stairs may increase that force up to more than three times body weight and, arising from a full squat, may generate forces as large as eight times body weight!

What causes the pain?
Patello-femoral pain may develop following an acute injury...
to the knee such as, a direct blow to the patella, a fracture, or a dislocation of the patella. In this situation, the patella contact forces may be normal, but the hyaline cartilage lining is damaged.

More often, this pain has an insidious onset, not specifically related to any one injury. In these cases it is thought that the contact pressure under some part of the patella (usually the lateral or outside half) is higher than normal, and that the excessive pressure on that part of the hyaline cartilage layer causes pain. If bad enough, this pressure may also lead to premature wear of that lining which, in essence, is osteo-arthritis. Once this happens, the situation changes to one where there is excessive pressure on a surface that is wearing out: hence, this can be expected to progress with time. Similarly, changing those contact pressures, thereby unloading the damaged areas, will lead to pain reduction, but it does not undo the wear. This means that, whilst this process may give some relief from the pain, and whilst it may prolong the life of the patello-femoral joint, it is not a permanent cure for the problem.

**Tight lateral retinacular structures**

In some cases, the overall alignment and tracking of the patella in its groove (the trochlear) is normal, yet there is on-going pain. When there has been no significant injury, it may still be the case that there is excessive pressure under the lateral facet (the outside half) of the patella (sometimes called excessive lateral pressure syndrome). One possibility for this is a tight lateral retinacular ligament (see top diagram opposite). This structure is on the outside of the patella and it holds that side of the patella down. This can be tested clinically and, if the rest of the alignment is satisfactory, then this is most likely the cause of the problem.

One example of this is the bi-partite (2 piece) patella (see middle diagram opposite). In this problem, the outside portion of the patella never fuses to the main body of the patella with bone. It is attached by cartilage but, due to the pull of tight retinacular ligaments during childhood and the growth phase, the cartilage junction remains. Whereas, in the normal course of events, the cartilage patella of childhood just turns to bone, in this instance, the tension on the side of the patella seems to flex the bone at this point, and the patella on each side of this junction then turns to bone separately.

Rarely is the junction loose or sore in its own right. More usually, it is the high pressures under the lateral part of the patella, due to the persisting tightness of the retinacular structures, that causes pain. Treatment therefore, usually consists of a release of those tight lateral retinacular structures.

**Patello-femoral mal-alignment**

Various other anatomic variations exist which can also lead to patello-femoral pain. In general, any variation which results in mal-tracking of the patella in the femoral groove, may expose the cartilage lining to larger loads and higher pressures than it can stand: and this can result in pain and/or abnormal wear of that cartilage lining. The common denominator in most of these problems is a force that pushes the ‘V’ shaped patella laterally (towards the outside - lateral subluxation) into the lateral wall of the similarly ‘V’ shaped trochlear (see bottom diagram on next page). This then unloads the medial side, but loads up the lateral side of the patello-femoral joint, leading to symptoms.
Often what determines the lateral force is the so called ‘Q’ angle (see bottom diagram on previous page). The quadriceps pulls the patella not only upwards but also a bit to the lateral side (see opposite diagram). This happens, not only because of the angle of the thigh bone, but also because the tibial tubercle sits off centre on the tibia. This means that when the quadriceps contract, there is always a resultant sideways force that wants to push the patella laterally (outwards). In most people, where the ‘Q’ angle is normal, this force is balanced by the near horizontal fibres of the VMO (vastus medialis obliquus) muscle. This is not a separate muscle from the quadriceps, but rather, it is its lowest fibres on the inside of the knee, designed specially for the purpose of holding the patella centrally when the main bulk of the quadriceps contracts (see bottom diagram on previous page).

When the ‘Q’ angle is increased, the lateral force on the patella cannot be matched by the pull of the VMO. Hence, the patella is pushed sideways, compressing the lateral trochlear groove, and perhaps even subluxing the patella out of the groove somewhat. Where the lateral aspect of the trochlear is steep, this increases pressure under the lateral part of the patella causing pain. Where the trochlear is flat, and doesn’t resist this force, patella dislocation can occur.

Causes of malalignment

Many things contribute to an overall mal-alignment of the patello-femoral joint. These include:

- a laterally displaced tibial tubercle. (See opposite - middle picture) The patella tendon inserts more laterally on the tibia, thereby increasing the ‘Q’ angle. Correction of this can be achieved by moving the tubercle (and thereby the patella tendon insertion) medially to reduce the ‘Q’ angle. This is sometimes known as a TTT (tibial tubercle osteotomy).

- a valgus knee (knock knee deformity). (See top diagram on next page) where the tibial tubercle may be in the normal position on the tibia, but the angle of pull of the quadriceps is increased because of the valgus angle of the leg. This deformity is generally just above the knee, in the lower femur. Correction of this can be achieved by correcting the alignment at that site, which means a femoral osteotomy. This is where the femur is cut just above the knee, and re-aligned to straighten the leg. This in turn corrects the mal-alignment by reducing the ‘Q’ angle.

- foot pronation. With a collapsed arch or flat foot, the sub-talar joint (the joint below the ankle) collapses, causing an inward rotation of the tibia such that the patellae come to face each other a bit. This is often referred to as patella squint, and it increases the ‘Q’ angle because of the change in the direction of pull from the part of the quadriceps that comes from the pelvis. Treatment of this usually begins with an appropriate orthotic to correct the flat foot, plus a patello-femoral rehabilitation program.

- miserable mal-alignment, where the patellae face inwards (squint) when the feet are facing forwards. This is caused by an abnormal twist or rotation in the femoral bones, usually high up near the hip. It is usually the femoral neck that is at fault, being rotated forwards. This so called ‘femoral neck ante-version’ is often manifest as someone who can easily sit between his or her ankles, but can’t cross his or her legs properly. Whilst the patello-femoral pain caused by this can sometimes be corrected by moving the tibial tubercle, if it is severe, then the rotational deformity of the femur may need...
to be corrected. This is done by cutting the femur at the top of the leg, just below the neck, and rotating it out. When this happens however, the feet also rotate out, thus creating a ‘Charlie Chaplin’ or ‘Donald Duck’ look. Hence, if this becomes an issue, the lower tibia, just above the ankle, can also be cut and the foot and ankle rotated back in. This is clearly major surgery, and hence, is not undertaken except in dire circumstances.

**The lunge lesion**

This is a lesion where the central part of the trochlear groove is damaged, often by exploding a piece of lining cartilage out of it during a lunging, twisting type of motion. This is most noticed in decelerating injuries associated with a side step, a time when the patello-femoral joint is under maximal load. Unlike the patella, it responds less well to treatment aimed at changing the tracking. Usually it requires an arthroscopy to clean up the area and to remove the loose edges of the pot-hole that has been created. If small this lesion may do quite well with debridement, but the larger defects often leave permanent symptoms that may be very difficult to treat.

**Who gets patello-femoral pain?**

Patello-femoral pain is more common in women than in men. It is seen most frequently during the adolescent and early adult years, but may occur at any age. It is seen more often in those individuals involved in activities that require a significant amount of kneeling, squatting, or climbing. Despite this however, it can come on in individuals who are not involved in much sport at all.

All activities that involve the bent knee aggravate it: so it is frequently seen in jumping sports, gym activities that involve squats, lunges, or knee extensions, and even in swimming, where it affects breast-strokers. Whilst it may come on early in the teenage years without specific cause, it is frequently seen in later years when unaccustomed activity is undertaken. New fitness classes, boot camps, and other similarly intensive exercise activities are particularly aggravational if not commenced slowly, and built up over time.

In the older population group, it is frequently a degenerative problem. It may be part of overall knee arthritis, or it may be just in the patello-femoral joint alone.

**What are the symptoms?**

The signs and symptoms of patello-femoral pain are often non-specific and may vary somewhat from individual to individual. Most commonly, there is a dull aching pain across the front of the knee. Sometimes however, it is not as well localised as this, and may instead be felt on the sides of the knee or even at the back of the knee. Indeed it is quite common for the condition to present as a tightness at the back of the knee which is worse when the patella is stressed (squatting, stair-climbing, etc.).

Patello-femoral pain may occur during or, more commonly, after an aggravating activity. With symptomatic episodes there may be a mild puffiness or feeling of fullness about the knee and, if the joint surface is starting to wear (becoming rough), there may be a clicking or grating with knee motion. This will be particularly noticeable when the patella is maximally loaded up; that is in activities such as stair climbing and the like.

Prolonged periods of sitting, such as a long trip in the car or sitting through a movie in the theatre, often result in an
achingly stiffness, most noticeable when trying to stand again. Frequently, the knee has to be straightened or moved to lessen the pain, and this is often referred to as ‘movie goer’s knee’.

The pain experienced in this condition is thought to result from increased pressure on the bone under the area of stressed lining cartilage, but the exact mechanism is not well understood. The pain thus generated however, may inhibit quadriceps muscle function, and this may cause giving way or collapsing of the knee. Sometimes this presents as a fairly classical buckling of the knee but, on other occasions, it feels like the knee is hyper-extending (over straightening).

Swelling can occur if the knee is aggravated sufficiently, or if the lining starts to wear (arthritis). This swelling, caused by increased formation of joint fluid in the knee, also causes some weakness and dysfunction of the quadriceps muscle. For this reason, it can cause increased symptoms that may be more difficult to deal with, and recovery may take longer.

How is it diagnosed?

There is no one test that is effective and, as such, it is generally diagnosed on the symptoms described by the patient. It may be confirmed by examining the knee but the findings are often not all that great. X-rays may sometimes be helpful but, usually, only in more advanced cases or in those with definite and major mal-tracking of the patella.

MRI scanning is useful to look at the status of the joint, and also to exclude or confirm other pathologies. It is not in itself diagnostic because the scan can be entirely normal even when the symptoms are quite marked.

CT scanning to look more critically at patello-femoral alignment is useful when further investigation is needed. This is the investigation of choice when conservative care has failed and surgical options are being explored.

Arthroscopy may be helpful though, in the majority of cases (where the pathology is mild), no abnormality will be found. It is therefore not regarded as a diagnostic tool but, rather, is considered one of the surgical options.

What is the treatment?

Activity modification. Patello-femoral pain generally does not result in any serious or permanent damage to the knee. This is particularly so in the growing adolescent where, with growth, the anatomy of the patella and its relationship with the femoral groove keep changing. In these cases the problem may finally stabilise when growing has finished.

Typically, the patient, with patello-femoral pain will experience ups and downs in their symptoms, usually related to their activities. Part of the treatment therefore, is aimed at reducing the frequency and severity of the painful episodes by avoiding or decreasing aggravating activities. This may then allow the lining cartilage to stabilise, and to become asymptomatic. This may involve changing, or decreasing the intensity of, some sporting activities, usually those that involve jumping, squatting and climbing.

Therapy. A specific exercise program designed to strengthen the VMO muscle and to stretch the hamstring muscles is often beneficial. This may need to be done in association with a taping program which is designed to help pull the patella across medially. This reduces the pain by improving tracking of the patella (unloading the lateral facet) and, as a consequence, allows more intensive VMO strengthening exercises to be performed.

With the correct exercise program to build up this muscle, enough strength can usually be gained to take over from the tape, thus making the tape unnecessary. Once this happens, normal activities, including sport, are usually possible. A formal patello-femoral rehabilitation program, under the supervision of a sports physiotherapist, will help to achieve this.

Orthotics. Where there is an underlying biomechanical abnormality such as squinting patellae (kneecaps that turn in to face each other), in association with pronated or flat feet, a muscle strengthening program may not in itself be adequate. If it is not, then some alteration in the biomechanics may be necessary. The simplest form of this is an orthotic, which is a custom made insert, which is placed into the shoe to lift the arch and alter the position of the foot. This in turn alters the mechanics of the knee by rotating the patellae outwards, and hence, more normalises tracking. This may be extremely effective, particularly in some of the more resistant cases.

Braces. Where mal-tracking continues to be a problem, a stabilising patella brace may help by holding the patella centrally in its groove. It is useful when tape helps, but the skin starts to break down because of it. The long term results of using a brace are mixed, but some people do get benefit.

Anti-inflammatory treatments. The simplest form of this is ice. Used after painful activities, or after therapy, can be helpful. It can be done with gel packs, frozen peas, or a bag of ice, placed on towels on the knee, for 15 minutes.

Anti-inflammatory tablets may help, particularly when there is real swelling within the knee (synovitis). These are more effective than ice for controlling such inflammation.

Cortisone injection is a very powerful form of anti-inflammatory treatment. It can be put into the knee directly, and it is the most effective treatment for swelling. By itself, it is unlikely to be a cure, but it can settle the knee down quite quickly, thus allowing implementation of a therapy program.

Surgery. It is not often that surgery is necessary, given how common this condition is. In cases where the problem is resistant, or in cases where the patello-femoral joint is becoming damaged however (significant grating etc.), surgical intervention to try and change the tracking can be helpful. Generally, if taping helps, then surgery will also.

The aim of all surgery for this condition is to unload the areas of the patella under most stress, and to load up less used parts. It does not actually reverse any arthritis but, by changing the stresses on damaged parts of the joint, it can lead to substantial and prolonged pain relief and, hopefully, to a joint which will wear out more slowly.

Further information can also be obtained on this and other related topics including:

Patello-femoral surgery
Knee arthritis
Osteotomy
Knee replacement

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