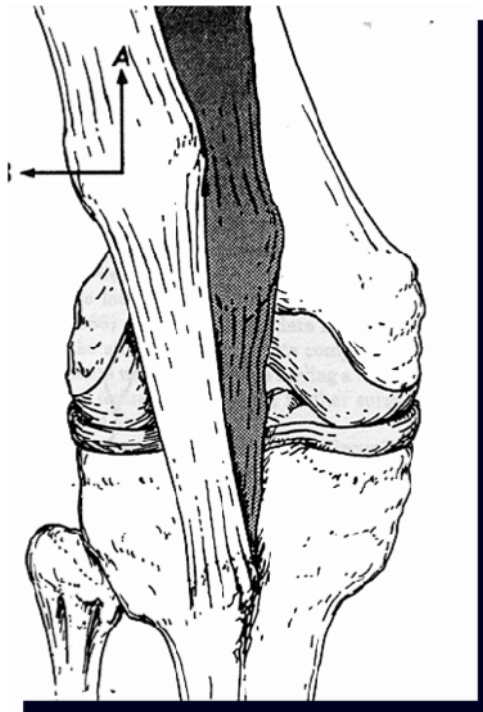


Patello-Femoral Malalignment



The patello-femoral joint consists of the patella itself (knee-cap) and the groove of the femur (thigh bone) in which it lies. During bending of the knee the patella glides up and down that groove acting like a pulley for the large tendon that passes from the quadriceps muscles of the thigh to their insertion on the tibia (shin bone). It is the most delicately balanced part of the knee and, as a consequence, it is the part of the knee that is subject to the most number of problems. It is easily injured because of its prominent position at the front of the knee. In addition however it suffers from a large number of congenital and developmental abnormalities. These can generally be divided into problems of recurrent dislocation of the patella and problems of painful

malalignment, both of which can lead to early wearing out of the patello-femoral mechanism or osteo-arthritis.

Patella function

The patella is a bone which sits in the middle of the tendon between the quadriceps (thigh) muscle and the tibia (shin). It forms in this tendon so that it can guide the tendon over the groove in the end of the femur (thigh bone). Having the patella in the middle of this tendon lifts the tendon off the groove somewhat, and hence it increases the leverage that the quadriceps has on the tibia. This is like using a bigger pulley, so that the rope is lifted further away from the axis. In addition to this function, the patella has a smooth, low friction lining (like most joints) and this decreases the friction that would ordinarily be present if the tendon ran over the groove unprotected.

In addition to the above function, to deliver increased power from the quadriceps muscle, the patella also acts to keep the force of the muscle in the right line. In fact the tendon goes around a slight corner as it enters the groove and this means that there is a force pushing the tendon laterally (away from the opposite knee) out of its groove. In the normal situation, this is balanced by the inside part of the quadriceps, the VMO (vastus medialis obliquus). This muscle pulls the tendon and patella almost directly across towards the opposite leg (medially). In doing this the force across the tendon is balanced. Despite the tendon going around a corner in the femoral groove, the balanced forces are such that there is no force actually pulling the tendon out of its groove.

Abnormal forces

During calm everyday type activities the forces across the patella are well balanced by the muscles. During times of high activity, and especially when there is a lot of twisting and turning occurring, the forces can vary quite markedly. Within certain limits the groove that the patella runs in will tolerate some imbalance. If the forces exceed those limits however, then the patella may come out of its groove. This may represent a full dislocation, where the patella comes out and stays out, or a subluxation where the patella only partly comes out of joint and then returns to its normal position.

In order to get right out of joint, the structures on the medial (inside) of the patella must become stretched or torn. If the groove and the rest of the patella anatomy is normal however, the damaged tissues will often return to normal and recurrence may not happen.

Abnormal anatomy

If the anatomy is abnormal then there maybe far less resistance to dislocation. If the groove is shallow and the patella correspondingly flat, then this provides very little resistance to forces across the knee. Similarly, if the patella tendon goes round too

large a corner, then the forces across it will be higher. Here again these can more easily exceed the limits of the tissues and the patella can dislocate.

A further factor that may contribute to this problem, is that of a very high patella (patella alta). In this circumstance the patella may be so high that it does not enter its groove until well into knee flexion, and hence is more at the mercy of any abnormal forces.

Patella Malalignment

In the above description we have assumed that the patella, in everyday type situations, is sitting comfortably in the centre of its groove. It will not try to come out of that groove unless abnormal forces act and if those forces do act, then the patella will come out of its groove more easily if the patella is high or, if the patella and its groove are flat.

Unfortunately, this is not always the case. Situations do exist where even at rest the patella does not sit balanced in the centre of its groove. In fact the patella may be:

1. tilted over so that only one side of it rests on the groove

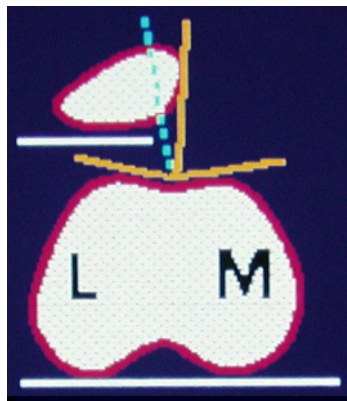


Figure 1:Patellar Tilt

2. subluxed so that it sits off to the lateral side of its groove (away from the other knee) or

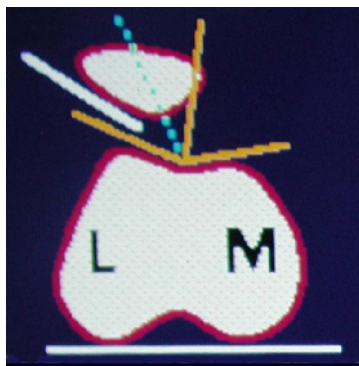


Figure 2:Patellar Subluxation

3. tilted and subluxed

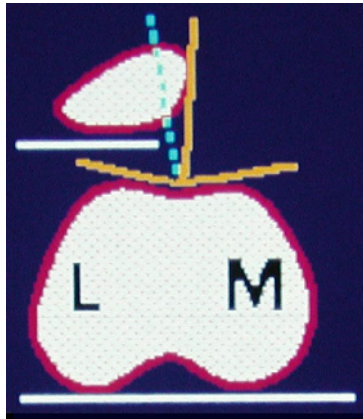


Figure 3: Patellar Tilt and Subluxation

These forms of mal-alignment are not always susceptible to increased rates of dislocation. Indeed, the problem here is generally one of pain. If the patella does not fit nicely into its groove, then the area of contact between the two bones will be much smaller. As a consequence, the pressure that occurs between them will be much greater. This means that the lining of the surfaces of that part of the joint is under stress. As a consequence these areas are subject to much higher forces and ultimately this causes them to hurt.

If the situation is bad enough and the forces are high enough then these areas will actually start to wear out prematurely. This is arthritis due to mal-alignment and is often termed excessive lateral pressure syndrome. This term refers to the fact that there are excessively high pressures under the lateral facet (outside half) of the knee cap, to the extent where permanent damage may be caused. In the worse situation this can lead to rapidly progressive wear, in that part of the joint, down to bare bone.

Once these areas have started to wear, the situation is not reversible. Correction of the mal-alignment however, may slow down the rate of wear and also, by decreasing the pressure under the outside of the knee cap it may substantially help the pain. Obviously if the mal-alignment is attended to early while the lining cartilage is still basically healthy, the situation may be totally reversible. The lining may still take some months to fully recover, but if no permanent damage has occurred, this does happen.

Minor degrees of mal-alignment

These are common, particularly in females and in general these can be managed non-operatively. A VMO strengthening program to help balance the patella forces can be 90% successful in relieving pain. This is the mainstay of treatment and is backed up with a taping program. It was initially believed that the tape pulled the patella to the

medial side (inside of the knee). This is not so. In fact, the tape pulls on the skin and causes the VMO muscle on the inside to contract a split-second sooner, resulting in a greater pull towards the inside of the knee. This helps stretch up the tight lateral retinacular ligaments and helps bring the patella back into its groove.

Biofeedback supervised by your physiotherapist can also be useful. By using an electrical device or simply by palpating (feeling) the VMO muscle the patient can be taught to contract the VMO muscle more efficiently.

Hamstring muscle stretching is useful. The hamstrings are at the back of the thigh. If they are tight, the knee tends to be in a more flexed position at heel-strike. This puts extra pressure on the patello-femoral joint.

Orthotics are also useful and these can correct any foot pronation (flat footedness). As the arches are lifted up the patella faces outwards instead of inwards (squinting towards the opposite patella). This means that the patella has less of a corner to go around in the groove, and hence there is less contact force under the outside of the patella.

Who gets these problems?

The problems of patella subluxation where the abnormal forces are high but the anatomy is normal, is predominantly a male problem. This is because males tend to have a lower incidence of abnormal anatomy and also because they are stronger and play more twisting, turning and contact sports. This leads to a high incidence of abnormal forces across the knee and hence a high incidence of transient patella subluxation (coming partly out of joint). Because the underlying anatomy is good, healing is often good and re-alignment type surgery is usually not required.

Problems of abnormal anatomy, patella dislocation and the painful mal-alignment syndromes are more common in females. It is thought that this is because of the earlier maturity of females. At the critical age, where the knee joint is undergoing its final changes in shape and realignment the female goes into puberty and due to rising oestrogen levels stops growing. Unfortunately the knee may not have finished its final adjustments by then so that the extra year or so that males have to sort this out is not available. Because of this, mal-alignment and other problems of anatomical development are more common in the female.

The fact to note in all of this is that the alignment of the knee is predetermined and most of these problems come on without injury. Some may show up as a consequence of injury, but injury per se is not a requirement for patella-femoral pain.

An injury in a person with mal-alignment may cause a problem that persists beyond expectations. Whereas in a normal knee that injury may recover, in a knee which is not normal and in which the pressures are high, there may be less chance of recovery. Lining cartilage under the patella that was under pressure but not hurting may not need much of an injury to start hurting. Then, having commenced causing pain, may

continue to do so because of the excessive pressure which never lets up to allow the lining sufficient rest to recover.

Patella Re-alignment

This operation is designed to re-align the patella (knee cap) so that it sits in the centre of its groove. It consists of two major components:-

1. A lateral retinacular ligament release, to free up the outside of the patella, thus correcting any tilt and
2. a shift of the tibial tubercle, which is the piece of bone to which the patella tendon attaches. This effectively brings the whole patella mechanism over medially (towards the opposite knee), thus bringing the out of position (subluxed) patella back into its groove.

Lateral retinacular release

This operation is designed to free up the lateral side (outside) of the patella (knee cap) by releasing the tight lateral retinacular ligaments that tie that side of the patella down to the rest of the knee. It is performed with the aid of the arthroscope and the ligaments are divided usually using an electric knife (radiofrequency device). This allows the patella tilt to correct and by taking the pressure off the outside of the patella it allows the articular (lining) cartilage to recover. What it does not do is correct the subluxation of the patella, which is the displacement of the patella away from the centre of its groove. To correct this requires the second part of the procedure, a tibial tubercle shift.

If the patella has been very tight for a long period of time and if the pressure underneath has been great then the lining cartilage, the smooth bearing surface of the joint, may already have started to degenerate and thus softening or fragmentation may have started to occur. Even in this situation freeing up the patella and decreasing the pressure on the damaged portion may help decrease pain. What it does not do however, is to reverse any damage that is already present. That damage does not heal but nevertheless reducing the pressure may slow down the progression of the wear (which may at this stage be called osteoarthritis).



Figure 4:After a period, the cartilage of the joint can wear thin.

The other situation where damage to the patella lining surface may occur is if the patella dislocates (comes right out of joint). The difference here is that the damage occurs as the patella moves out of its groove when it is pulled out to the side of the knee. In this situation the damage does not occur on the lateral facet (outside edge) of the kneecap but rather occurs in the centre of the patella. This is because this is the part that is scraped over the lateral condyle (outside part of the groove) as it dislocates.

In this situation therefore, releasing the pressure on the outside of the knee cap may not necessarily reduce the pressure on the damaged area and hence this procedure may be less beneficial as a pain relieving operation than in the non-dislocation situation. With a dislocating patella however, there is still some benefit to be gained by releasing the tight retinacular ligaments as these are part of the abnormal anatomy that causes the dislocation in the first place. In general more than just a lateral release is required to correct a dislocating patella but this release is almost always needed to allow the patella to come across medially into its groove.

Antero-medialisation of the tibial tubercle (Fulkerson Osteotomy)

This is the second part of this re-alignment procedure and it is designed to bring the end of the patella tendon across to the medial side (inside). Because the patella tendon is attached to the patella at the top end, any shift of the attachment at the bottom end will necessarily cause a shift of the whole patella mechanism, including the patella itself. In addition to shifting this medially however, it is now recognised that there is some benefit in lifting this attachment site (the tibial tubercle) somewhat off the bone (anteriorly). What this does is to lift the patella off its groove somewhat and thus decrease the pressure underneath it. Depending on the individual anatomy and the reason for the procedure, this may be necessary to a variable degree. In the most usual situation the

tubercle is lifted off the bone about 2-3 mm, but it can, in some circumstances, be lifted off the bone up to 15 mm or so.

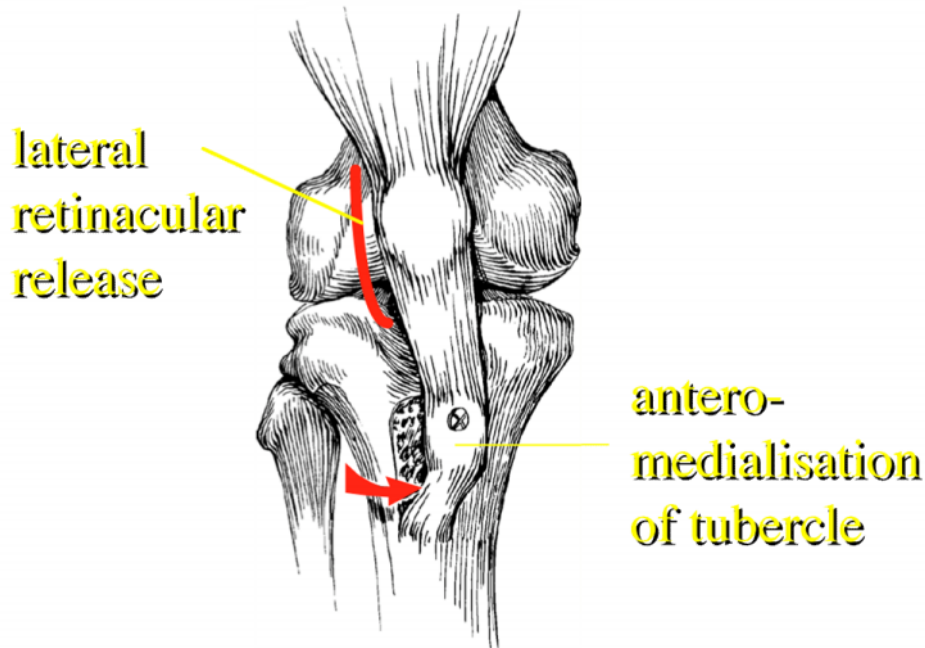


Figure 5:Antero-medialisation with lateral release

The tibial tubercle is moved, with its attached tendon, by cutting underneath it. This is done without dividing its lower bony attachment. When the bone is moved across therefore, it is done by partly breaking this lower attachment site. This is like breaking a green stick; the bone is still attached but can be bent a certain amount to allow some shift. The advantage of using this method is that it preserves some strength so that the screws that are used to hold the shifted tubercle in place are not totally responsible for resisting the force along the tendon. This means that no splint is required and it means that early motion and weight bearing can be allowed.



Figure 6: The incision at 6 weeks post-op

Additional procedures

VMO (vastus medialis obliquus) tightening may be added to the above procedures if necessary. This is a tightening of the inside part of the quadriceps muscle. It is done by pulling this further over onto the patella and suturing it into place there. Because it tends to stretch out somewhat this is not done as commonly as it once was. Nevertheless, in the recurrently dislocating patella, this muscle may be stretched out quite badly and hence may require tightening to allow it to function normally.

Inferiorization of the tibial tubercle is a procedure whereby the tibial tubercle is shifted downwards (inferiorly) on the tibia (towards the foot). This is done to bring an abnormally high patella downwards into a more normal position so that it engages its groove earlier in knee flexion (bend). This can be done in association with both medial and anterior shifts of the tubercle. Unlike the isolated antero-medialization however, the tubercle must be completely separated from the bone to bring it down. This means that the fixation to the bone relies totally on the screws that are used, and hence, it is not as strong as where the bone is still partly attached and just swung across. For this reason, a splint is often used to protect the knee whilst standing, and weight bearing is often delayed until healing has commenced (3-4 weeks).

Medial Patello-femoral Ligament Reconstruction:

If the bony anatomy is good, (as determined by CT scan) then it does not make sense to try and alter it. In this instance we reconstruct the strong soft tissue restraint on the medial (inside) of the knee. The graft tissue used is the gracilis tendon, a small hamstring tendon that recovers well. This usually involves three small 2cm incisions on

the medial side of the knee: one for the hamstring harvest, one to insert the graft into the patella and the third to insert the graft into the femur bone. Graft position and tension is critical as getting it wrong can make the knee very stiff. This operation has a very good track record with a very low re-dislocation rate. (<10%)

Complications of this surgery

Bleeding is the major complication of this surgery and this can occur from either or both of the areas of surgery. Firstly, the lateral retinacular structures themselves may contain quite large blood vessels. In order to minimise bleeding from these, the tourniquet is always released at the end of this part of the procedure. Wherever possible all bleeding vessels are coagulated to seal them up. This is not always possible to do completely, but nevertheless, bleeding from most of the large vessels can usually be stopped and the minor vessels will then stop by themselves.

The second area of bleeding is that of the bone where the tubercle is shifted. All bone has a good blood supply and therefore it bleeds when cut. If it did not do this, then of course, it would not heal. With this in mind therefore, one cannot plug up the bleeding areas of bone with products such as bone wax, because although this would decrease the bleeding, it would also decrease the chance of the shifted piece of bone healing back into the tibia. For this reason the bone is allowed to bleed and a drain is inserted to help remove that excess blood from the wound area. This is never a complete process and some bruising will always remain.

In spite of one's best attempts to control bleeding it does still occur. It is uncommon for this to be serious but it does make the knee quite swollen and uncomfortable for a while. Unlike a recently injured knee, where the internal bleeding does not clot; in a lateral retinacular ligament release, the blood in the knee does tend to clot. Because of this, any accumulation of blood, tends to become jelly like and cannot be removed with a needle. If absolutely necessary it can be removed arthroscopically, but fortunately this is rarely required. If bleeding does occur, then ice and elevation is all that is generally required. Resolution then occurs over a couple of weeks.

Delayed union (slow joining up) of the transferred tibial tubercle is possible but fortunately rare. One could normally expect reasonable bony union to have occurred by 6 weeks. Failure seems only to occur where some injury, such as a fall, has occurred to interfere with the normal recovery. Even then union usually proceeds albeit knocked off course for a while.

Failure to control pain in patella malalignment can occur, despite an adequate re-alignment procedure. This is relative and it is uncommon for an adequate re-alignment not to at least improve the pain level by several grades. The usual cause for on-going pain is established damage to the surface of the patella and/or the patella groove (osteo-arthritis). Even in this situation however, some marked improvement can usually be expected given time.

Failure to control dislocation is also uncommon but this does occur. The usual reason for this, is a failure to correct enough of the abnormal anatomy. Re-alignment is only part of the problem and other problems such as a deficient patella groove and a flat patella may be strongly contributory to the problem. There are procedures that can be done for these other problems but they are more difficult to perform, have a higher complication rate and fortunately are generally not necessary. On that basis therefore, a re-alignment procedure is procedure of choice initially, despite the presence of other problems.

Thrombo-embolism or clots in the veins occur occasionally, as they do with all lower limb surgery. The commonest occurrence is that of a D.V.T. or deep venous thrombosis. This, essentially, is a clot or series of clots in the deep leg veins. The exact frequency of occurrence of this problem is unknown, but it is likely to occur less than 5% of the time. The vast majority of these clots either, are never symptomatic and just disappear, or are minor and just require the blood to be thinned for a while to allow them to dissolve.

Potentially, any leg vein clot, can spread to the lungs where it can be serious. This would seem to be a very rare event indeed in this sort of surgery, based on what little data is available.

Prevention of all these clots is not possible. The incidence however, can be reduced by thinning the blood out somewhat, so that it does not clot as well as normal. This is possible to do, and in selected cases, it is done. For most people however, the increased risk of bleeding, in an operation whose major complication is bleeding, outweighs the potential benefits of the prophylaxis. This form of treatment therefore, is not routine, and probably will not be, until a safer method of prevention exists.

Infection is very uncommon in this setting. The incidence of infection in straight forward knee arthroscopy is less than 1 in a 1000. The incidence of infection in open knee surgery is probably about 1 and 100, with the majority of these being minor infections caused by the stitches.

Deep and significant infection is certainly rare with this sort of surgery. Despite this however, prophylactic anti-biotics are given to all patients undergoing tibial tubercle shift to even further lessen the chance of infection. This is important because the screws that are used to hold the bone in place represent foreign bodies and infection can develop around them.

Recovery – lateral retinacular ligament release alone

Generally, this is performed as a day case procedure. Sometimes, however, particularly when the patella has required a lot of cleaning up for wear and tear (arthritis), it is more painful than anticipated and an overnight stay is required. If only

one knee is operated on, then crutches are rarely required. If both knees are operated on however, then crutches may be helpful for a few days.

The knee is generally more painful than it would be for simple meniscectomy (cartilage removal). Despite this recovery usually progresses quite quickly in the first week. By six weeks there is usually no limp, and by three months the knee should be feeling quite strong. The exact length of time for recovery however, is somewhat unpredictable. This is because the lining of the knee-cap needs to recover having had the pressure taken off it. Sometimes this occurs quickly and sometimes it takes up to a year. To some extent, the length of the time the problem has been present and the degree of damage, reflect the length of recovery, but this is not always the case.

From a work point of view, most people require 1 week off to allow the knee to settle down. If the job is heavy however this may be a longer period up to 6 weeks.

Recovery – lateral release and tibial tubercle shift.

This a more major procedure than is lateral release alone. Because part of this is open surgery, it is more painful, and, at least in the shorter term it is harder to get the knee going again. Most people require one night in hospital after the procedure, and everyone needs crutches for 2 weeks. Once things settle down however, further recovery can be quite rapid. Most people can walk with only a minimal limp by 6 weeks and by 3 months are starting to return to everyday exercise and even sport.

In general, a splint is not required, and weight can be taken on the leg immediately. Over the first few weeks, the amount of weight taken through that leg generally increases until full weight bearing is possible.

It is possible to do two legs at once, if both are symptomatic. This usually requires an extra night in hospital and an extra week or two on crutches. The recovery is much less than twice as long so for busy people, this affords an opportunity for less time off work or recreational activities.

Depending on the nature of your work, a variable period of time off is required. Student or office work level requires 2-3 weeks off work. For a walking and standing job return to work is 4-6 weeks, and for a heavy labouring type job, 12 weeks. Even after this length of time the leg will not feel normal, and indeed, it may take 9-12 months to feel as good as it is ever going to feel.