Patello-femoral pain is a very common problem, for which the treatment is usually an appropriate therapy program. When unrelenting, or when it is associated with degeneration of the patello-femoral joint however, it may require surgery. This surgery is very similar to that required for patello-femoral instability, either being a release and/or a formal re-alignment procedure. These are designed to change the forces on the patella, unloading the lateral side in the case of pain, and decreasing the dislocation force vector in the case of instability.

Patello-femoral mechanics
These are well described in the patello-femoral pain information sheet, available on the website listed at the bottom of this document.

Essentially, the patella is a ‘V’ shaped bone that runs in a matching ‘V’ shaped groove on the femur (the trochlear). The patella is forced laterally (to the outside of the knee) because of the ‘Q’ angle formed by the patella tendon and the quadriceps tendon (see diagram opposite). This is countered during activity by the VMO (vastus medialis obliquus) muscle, which is the lowest part of the quadriceps muscle, and which pulls the patella medially.

If the lateral force is excessive, and the ‘V’ is deep, then this laterally directed force will cause excessive pressure under the lateral facet of the patella, causing pain. If the ‘V’ is shallow or absent, then there is no resistance to patella subluxation laterally, and hence, dislocation may occur.

Another factor to be considered is the patella height. If it is too high, then it does not enter the trochlear until late in knee flexion, and hence is more likely to dislocate. Alternatively, the lower part of the patella that is doing most of the work may just wear out. If it is low, then it may have excessive pressure under it causing pain, but it will not dislocate.

In some individuals, the overall alignment is satisfactory, but the knee cap is just tight. This is due to the lateral retinacular structures being overly tight and, in this instance, a release of those structures alone may be enough to relieve pain.

Classification of mal-alignment
By using the CT scanner, the patello-femoral alignment can be deduced. This is done along the lines of John Fulkerson who first described the classification system. The scans are done with the knee at about 20º of flexion (knee bend), both with the quadriceps relaxed and with the quadriceps contracted. It is critical that this is done correctly, and that the knee is not fully straight when the scans are done, in order to best determine the alignment. This can then be documented by measuring various angles and distances. In addition, a plain x-ray, taken with the knee flexed to 90º, is the best way of...
determining patella height.

Once done, the patella can be classified on the basis of its relationship to the underlying patella groove as follows:

1) **tilted** over so that only one side of it rests on the groove (see top diagram opposite)

2) **subluxed**, so that the patella sits off to the lateral side of its groove (see second top diagram opposite), or

3) **tilted and subluxed** (see bottom two diagrams opposite)

4) **changing with muscle contraction** - a patella may be in the correct place when relaxed but may sublux out of its groove when the quadriceps are contracted. This will then change the assessment.

5) **high or low** - if high, the patella sits at the top of the trochlear groove or above it. If low, it sits near, or actually on, the tibia. (See pictures below)

![CT scan showing patella tilt](image1)
Note that the gap on the lateral side is much narrower than that on the medial side.

![CT scan showing patella subluxation](image2)
Note the large gap on the medial side and that the patella hangs over the edge of the trochlear groove.

![CT scan showing both tilt and subluxation](image3)
Note the small area of contact that leads to very high contact pressures.

![Arthroscopic view of tilt and subluxation](image4)
Note how, during flexion of the knee, the patella does not sit centrally in the trochlear groove.

**Treatment**

By establishing the above criteria, a view of the overall alignment can be obtained, and a treatment plan formulated.

It is generally accepted that tilt is caused by tight retinacular ligaments, and that subluxation is caused by an increased 'Q' angle. If that is so, then the treatment for a tilted patella is a lateral retinacular release, and the treatment for patella subluxation is a tibial tubercle transfer (which will correct the increased 'Q' angle). Unfortunately however, interpretation of the results is often not quite that straightforward and, especially when the results are close to normal, the decision...
Lateral retinacular release

This operation (see diagram opposite) is designed to free up the lateral side of the patella (knee-cap) by releasing tight lateral retinacular ligaments that attach to the lateral side of the patella, and which cause tilt. It is performed with the aid of the arthroscope, and the ligaments are divided, usually using an electric knife (diathermy). This allows the patella tilt to correct, and thereby reduces the pressure under the lateral facet (outside half) of the patella. What it does not do is to correct any subluxation of the patella, that being a displacement of the patella away from the centre of its groove. Indeed, if there is subluxation present, then a lateral retinacular release will actually make this subluxation worse. This is because the lateral retinacular ligaments tie the patella into the trochlear groove (see middle diagram opposite), hence making it such that it cannot escape. As such, the lateral wall of the trochlear will then act to limit any subluxation. If freed up, and if the ‘Q’ angle is sufficiently large, the patella can then escape the protecting lateral wall of the trochlear groove, and subluxation will increase (or dislocation may occur). This means that the force on the lateral facet of the patella will then be unchanged or even increased. For this reason, a lateral release should only be performed where there is negligible subluxation and a normal ‘Q’ angle. It should not be considered a first stage operation for all patello-femoral pain, and it should not be done in isolation for patella instability.

If the lateral retinaculum has been very tight for a long period of time, and if the pressure underneath the patella 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. Often this is apparent because the increasingly rough surface of the knee cap gives rise to grating and grinding during knee flexion, especially when under load (e.g. - going up and down stairs). Even in this situation however, releasing the patella, thereby decreasing the pressure on the damaged portion, should still help decrease pain. What it does not do however, is to reverse any damage that is already present. Unfortunately, that damage (wear) does not ever heal but, by reducing the pressure on that area, this sort of surgery may slow down the progression of that wear (patello-femoral osteo-arthritis).

Antero-medialisation of the tibial tubercle

Sometimes simply referred to as a Tibial Tubercle Transfer or ‘triple T’ (T.T.T.), this is a formal re-alignment procedure which is designed to bring the end of the patella tendon across to the medial side (inside). By doing this, it corrects the ‘Q’ angle, and leads to a decrease in the lateral subluxation forces that some patellae are subjected to (see diagrams on next page). 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. The shift is made by moving a piece of bone, rather than by moving the tendon insertion itself, because this gives rise to stronger fixation and a much quicker recovery. This then means that, if the transfer is only in the medial direction (brought across towards the opposite leg), then splints are usually not required.

In addition to shifting the tibial tubercle medially however, it...
can also be moved up or down to correct a very low (patella baja) or high (patella alta) patella position respectively. In doing any of these transfers, the tubercle can also be elevated somewhat off the bone (moving it anteriorly). What this does is to lift the patella out of its groove somewhat, thus decreasing the pressure underneath it still more. Depending on the individual anatomy and the reason for the procedure, this may be necessary to a variable degree. Mostly, the tubercle is lifted off the bone about 2 - 3 mm, but it can, in some circumstances, be lifted off the bone up to 10 mm or so (the so called ‘Maquet’ procedure).

**Technique:** The tibial tubercle is moved, with its attached tendon, by cutting away a small block of bone from the tibia that has the tendon attached to it. This is done as open surgery through a small (3 - 4 cm) incision just to the lateral side of the tibial tubercle itself. When the transfer is just medially (not up or down), it 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 of the attachment 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 that early motion and weight bearing can be allowed. Whilst crutches are initially used therefore, they can often be discarded by about 10 days post surgery.

**Patella Dislocation**

Patella dislocation is something that occurs in predisposed individuals who have both abnormal patella mechanics, and a trochlear that is largely flat and not ‘V’ shaped (see CT below). This means that there is little or no resistance to lateral subluxation of the patella, allowing it to come totally out of joint if enough force is applied. This becomes even more problematic if the patella sits very high, and therefore, does not engage the trochlear properly in early knee flexion.

In addition to the lateral retinacular ligament which holds the patella into the trochlear, the patella is also partly held by the Medial Patello-Femoral Ligament (MPFL). This is not a very big structure, but it acts as a check rein, preventing significant lateral subluxation of the patella. Given that it is small however, it will not overcome dislocating forces by itself so, if the trochlear is very flat, the patella can still be dislocated. In the process, the MPFL can be torn or, more usually, it can pull a small piece of bone off the medial patella (top diagram overleaf).
As the patella dislocates, it can also take with it a portion of the lateral femoral condyle (second diagram from the top opposite). Usually this piece is fairly small and, fortunately, it does not involve the weight bearing area of the joint. Hence, the area of damage is not usually much of a problem. When it goes a stage further however, and the central patella is damaged (third diagram from the top opposite), either being stripped of its lining surface, or having a central piece of bone removed, then this becomes more significant. The defect in the central patella will remain, and will be loaded up with all knee flexion (bending) activities. Despite any repair to stabilise the patella therefore, there may be residual problems of pain with use.

**Additional procedures**

**Inferiorisation 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-medialisation 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 when 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).

**MPFL (Medial Patello-Femoral Ligament) Repair** is sometimes performed. Unfortunately however, this is not usually the primary cause of dislocation, and hence, even if it can be repaired back to how it was, the underlying susceptibility still remains. For this reason therefore, it is more usual to correct the underlying mal-alignment first and then to reassess the stability afterwards. In the acute setting, a repair can then be performed if thought needed.

**MPFL Reconstruction** is a very powerful stabilising procedure (see bottom diagram opposite). Rather than trying to repair the small, damaged MPFL, a hamstring tendon can be harvested to reconstruct the MPFL. This then re-attaches the medial patella to the medial femur, acting like a check rein to lateral subluxation and dislocation. This reconstruction tends to be much stronger than the original ligament, and is perhaps the most powerful stabilising procedure that we have.

Unfortunately, MPFL reconstruction, whilst powerful, has some problems that tibial tubercle transfer does not have. Firstly, it has a tendency to early stiffness and tightness that can take some time to resolve. Secondly, the new ligament can rub over the medial femur during knee flexion, and this may need further surgery to be corrected. Finally, if done in the setting of an increased ‘Q’ angle, the combination of forces pulling in different directions can squeeze the patella into its groove even harder, and thus, where the problem was instability, it now may be pain.

For the above reasons, MPFL reconstruction is rarely seen as a primary procedure for instability, and almost never for pain. Instead, it is thought that the best option for both problems, is to correct the ‘Q’ angle with a tibial tubercle transfer first, thus removing some of the deforming force; then to reassess the stability of the patella thereafter. If still dislocateable, then MPFL reconstruction should be carried out. For most, this step will not be necessary but, for those with loose ligaments and loose joints, this may be essential to achieve maximal...
stability that won’t stretch out.

**Femoral osteotomy** is a procedure to correct the very valgus knee (knock knee deformity). This deformity increases the ‘Q’ angle considerably and, if significant, then it may be better to correct the deformity in the femur, rather than by tubercle transfer. Certainly, if there is any osteoarthritis developing in the lateral compartment of the knee (the outside part), then this procedure will address both this and the patella malalignment problem. This is a bigger procedure to do than a tubercle transfer, involving cutting of the lower femur, and correcting the alignment with a plate and screws. Nevertheless, despite it being more major, it has excellent long term results and, for some, it is the procedure of choice. More detailed information on osteotomy, and on the treatment of arthritis, can be obtained from the website listed below.

**Recovery - lateral retinacular release alone**

This is done as an arthroscopy and, generally, 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 sorcr 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 sorcr than it would be for simple meniscectomy (cartilage removal). Despite this, some people do feel improvement within the first week or so. Generally however, recovery is a bit slower. There is usually a moderate amount of swelling in the joint and, because the capsule and retinaculum have been cut, there is an opening in the side of the joint through which blood can leak out into the soft tissues. This then tracks towards the back of the distal thigh and knee because of gravity, frequently leaving bruises in those areas. This is normal.

By six weeks, there is usually no limp, but there may still be some swelling present. If this is the case, sometimes a cortisone injection will help resolve that more quickly. When the swelling has settled, and usually by six weeks, some physiotherapy is recommended to help get the patella tracking and functioning better.

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 patella needs to recover, having had the pressure partly taken off it. Also, areas of wear (osteo-arthritis) will still be present, and will still take some load, even if that load is less than previously. Ultimate recovery therefore can be difficult to predict, either in terms of time, or in terms of the ultimate end result. In the right circumstances however, the chances of significant improvement is over 90%, with improvement occurring for up to 6 months or so, and sometimes even up to a year, post surgery.

From a work point of view, most people require 7 - 10 days off to allow the knee to settle down. For those in physical jobs however, the time course can be much longer. Depending on the activities required, this can be 6 or more weeks.

**Recovery - tibial tubercle transfer**

This a more major procedure than is lateral release. Whether or not a release is performed at the same time, moving the tibial tubercle is more painful and, at least in the shorter term, needs more hospitalisation and subsequent rest.

Most people require 3 nights in hospital after the procedure, and everyone needs crutches for at least 10 days. If the tubercle has been brought down, or if the bone is soft and fixation is poor, then longer may be necessary. Similarly, in those latter instances, a splint may also be required to protect the knee. For the first 48 hours, the pain usually requires an intravenous pain pump but, thereafter, oral medication (albeit strong medication) is usually enough.

Because it is the shin that tends to bruise and get sore, the leg will need to be elevated, preferably to waist height, for 7 - 10 days. Up until that time, it will be sore to hang down but, after that, it settles down quite quickly. Full weight bearing is usually possible between 10 and 14 days, allowing the crutches to be dispensed with. Most can walk with only a minimal limp by 6 weeks and, by 3 months, are starting to return to everyday exercise. To run moderately hard however, usually requires about 3 months.

By 3 months, the transferred bit of bone is usually well healed. If this is the case, then the screws should be removed. This will not only make the knee feel better, it will allow kneeling again. It is also important to get the screws out early (within 9 - 12 months), before the bone grows into them so solidly that they cannot be removed without breaking them. Residual screws can be difficult to deal with later on, and can present problems at the time of knee replacement, which may be 20 or 30 years further down the line.

**Recovery - MPFL reconstruction**

Recovery for this procedure, whether in isolation or when done in conjunction with a tubercle transfer, is similar to a tubercle transfer in terms of pain and hospital stay. Initially, a splint will be required, and for 2 - 6 weeks depending on the exact surgery performed. Following this period, motion will need to be regained. This may take some months, but it is variable and they do loosen with time. Recovery can be helped by physiotherapy, beginning at the 4 - 6 week mark.

**One knee or two?**

Where a straightforward tubercle transfer is being considered, with or without a lateral release, both knees can be operated on at the same time. In general, this needs a bit more rest than when just one knee is being done, and perhaps crutches for a few days longer, but overall recovery is similar after the first couple of weeks. For a high percentage of people with patello-femoral pain, it will be the case that both knees are giving enough trouble to consider surgery: hence, it is usual to operate on both knees together when this is the case.

If the tubercle is being brought down as well as across, the fixation is not as good, and the bone union is less assured. For this reason, a splint and crutches may be needed for 4 - 6 weeks to protect this and, even with these precautions, delayed union of the tubercle is possible. Our experience therefore, is that, only one knee should be operated on at a time in this situation.

Where MPFL reconstruction is being carried out, depending on what else is being done at the same time, it is also usual to only operate on one knee at a time.
Complications of this surgery

**Bleeding** is the major complication of this surgery. Firstly, the lateral retinacular structures themselves may contain quite large blood vessels, so even when a release is being performed in isolation, there is some risk. In order to minimise that risk, the tourniquet is always released at the end of this 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.

Secondly, when the tubercle is being transferred, the underlying bone sometimes bleeds more than expected. All bone has a good blood supply, and it therefore bleeds when cut. For this reason, a drain is usually inserted to help remove that excess blood from the wound area. This will then be removed the day following surgery. Despite this however, some bruising will always occur; hence, elevation is important in the days following surgery.

MPFL reconstruction generally does not cause too much extra bleeding. If excess bleeding occurs however, with this or any of these procedures, then investigation of clotting profile will be undertaken.

**Delayed union** (slow joining up) of the transferred tibial tubercle is possible but, fortunately, uncommon now that precautions are taken when the tubercle is moved down, or if fixation is poor. Every tubercle transfer will be x-rayed at the 6 week mark, but at other times if indicated.

**Failure to improve pain** after a release alone can occur and, sometimes, this is due to the patella now subluxing whereas previously it was thought just to be tight. This outcome is not always predictable but, if it occurs, then subsequent tubercle transfer may resolve the problem. Further scans may be indicated to re-investigate the alignment, which may have changed following surgery.

Following formal re-alignment (**T.T.T**.), some 90% will have improvement in their knee pain, even if this is incomplete. 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, even if it takes 9 - 12 months to occur.

It is to be understood that this sort of re-alignment improves alignment from what it was, but it can never make it normal: hence, there is always a degree of unpredictability to it. Also, where the patella has been moved to unload a damaged area, the rest of the patella is consequently being overloaded to spare that bit. This means that, given enough time, the rest of the patella will wear out. This may take years to occur, and pain and function may be excellent between times, but it may be inevitable.

**Lateral release pain** occurs in a few people. It is local, usually at the bottom end of the release next to the patella, and tends to persist despite all treatment. In particular, it does not seem to improve with taping. The treatment is to repair the release and, whilst this theoretically can make the patella tight again, the reality is that this does not seem to matter; the pain generally resolving quite quickly.

**Tibial tubercle pain** occurs in a small percentage of people. Often however, it does not occur for a year or more after surgery. The cause of this is unknown but, often, an injection into the area will settle it down. If all else fails, then the periosteum (the covering on the bone with all the nerves in it) can be cauterised around the tubercle, and this usually fixes the problem.

**Failure to control dislocation** is uncommon but does occur. The usual reason for this is a failure to correct enough of the abnormal anatomy. Most can be solved by further surgery and, in particular, by MPFL reconstruction.

**D.V.T.’s** (deep venous thromboses) also occur but are uncommon (less than 5%). These represent clots in the deep veins of the leg, usually the calf. They may occur at the time of surgery, or sometime over the next few weeks. Most commonly however, it is in the first 10 days. If noticeable, it is usually as an ache in the calf at the back of the leg. If this is occurring, then a doppler (ultrasound) scan can be used to detect it, and appropriate treatment organised.

Usually, some mild thinning of the blood will be organised for every Tibial Tubercle Transfer (**AMTT and AIMTT**), with or without an MPFL reconstruction, most commonly being low dose cloxane injections. When an isolated MPFL reconstruction is performed (without a bony procedure), the risk of bleeding, particularly where the hamstring has been harvested from, can make the risk of bleeding exceed the possible benefit. Like when this is done for ACL reconstruction therefore, it is usual that the prophylaxis will be changed to aspirin 100mg per day for 2 weeks, starting on the evening of surgery.

When a patient is at higher than normal risk for this complication (e.g. a significantly positive thrombophilia factor like Factor V Leiden) then this prophylactic thinning of the blood can be upgraded to a more prolonged administration of cloxane injections, or to cloxane followed by aspirin or other agents. These additional measures increase bleeding and bruising however, and thus will only be instituted where the risk is thought to be higher.

The at risk period for getting a DVT is generally regarded as being the first two months, albeit that the majority occur within the first 10 days. For those who travel in that period of time however, consideration of further anticoagulation should be given and, depending on distances travelled, prophylaxis may be indicated even out to the three month mark. This can be done using cloxane (or similar) injections, and usually by self injection. A newer alternative however is to use oral anticoagulants, which may not be on the PBS listing yet, but are not overly expensive. Different tablets are taken as per their recommended dose regime. For rivaroxaban, 10mg taken 1 - 2 hours before travelling, and repeated at 18 hours if still travelling, will provide good prophylaxis, especially if combined with flight socks or flight stockings. Such travel would include plane flights, long-distance car journeys and long train journeys.

**P.E.(Pulmonary Embolism)** is perhaps the most serious complication of all surgery and anaesthesia, and indeed, can be fatal. The problem of having clots in a vein (**DVT**) is always that they may spread to the lungs. This, fortunately, is a rare event, occurring perhaps just once in every 100 cases. It generally presents as chest pain which is worse with deep breathing. It may also lead to intermittent shortness of breath and a general feeling of unwellness. Unfortunately, whilst we can reduce the incidence of DVT’s by the use of low-dose peri-operative anticoagulation, the same cannot
be said for pulmonary embolism. Standard peri-operative anticoagulation does not seem to change the incidence of pulmonary embolism, almost as if it is a separate disease entity. For those at high risk of PE therefore, more substantial anticoagulation is required which may involve full, and prolonged, anticoagulation with warfarin, rivaroxaban, or similar agents.

**Infection** is uncommon in this surgery. The incidence of infection in straightforward knee arthroscopy is less than 1 in a 1000. In open knee surgery it is higher but, usually, it is superficial and controllable by oral antibiotics.

Deep and significant infection is certainly rare with this sort of surgery. To some extent, this is because prophylactic antibiotics are given to all patients undergoing re-alignment procedures. If established however, then a washout of the wound and intravenous antibiotics may be indicated.