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Anterior Cruciate Ligament Injuries

A.C.L Function

The cruciate ligaments and the collateral ligaments provide stability to the joint by holding the bones together. Of those ligaments, the anterior cruciate is important in that it holds the knee together during twisting type activities. During everyday walking and in straight line running, the ACL is hardly used. As soon as any twisting is performed however, this ligament is essential. Without it the knee twists further than it is designed to, giving a feeling that the knee comes out of joint. It is this feeling of coming apart that gives rise to the instability or loss of confidence in the knee that is seen when the ACL is torn. As it is a rotatory instability, it occurs when twisting or sidestepping is attempted, or when uneven ground is encountered. If major, it may occur in everyday activities. In some however, it occurs only on the sporting field, where it is hard to concentrate on protecting the knee and where sudden twisting and turning occurs.

Meniscal Cartilage and Articular (Lining) Cartilage:

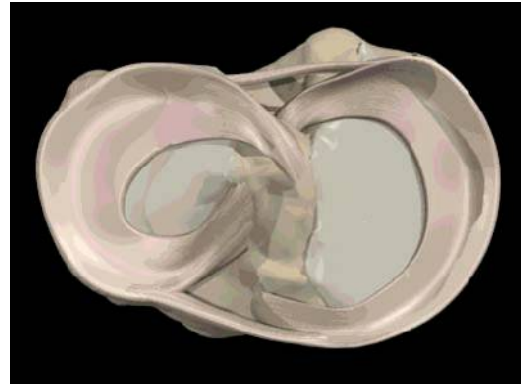


Figure 1: The lateral and medial menisci attach near the centre of the tibia.

The menisci function as space fillers to spread the load between the surfaces of the femur and tibia. The ends of these bones are not the same shape and thus the menisci are needed to make up for that incongruity. The end of the femur is round and the top of the tibia is flat. They primarily function somewhat like shock absorbers but they also have a secondary role to enhance lubrication and nutrition of the articular or lining cartilage. They are made of springy cartilage, a little like your ears.

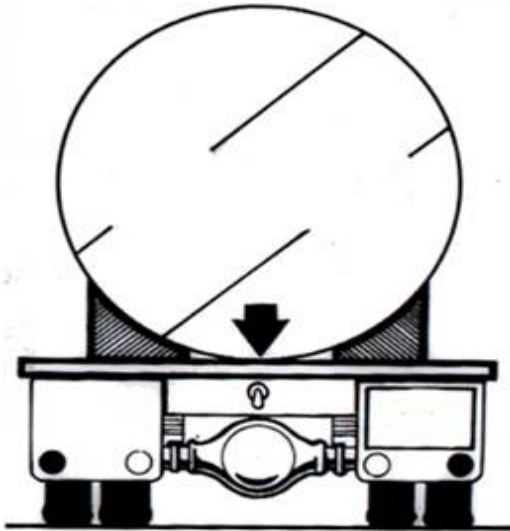


Figure 2: The menisci act like these chocks to stabilize and support the round load (Femur) on a flat surface (Tibia)

Loss of meniscus (particularly the lateral one) leads to a poor spread of weight across the joint surface. This means that loads are taken over smaller areas of the joint, and hence, pressures are higher, causing increased rates of wear of the lining surface. It also follows that the more meniscus that is lost, the faster that wear occurs.

The articular cartilage covers the ends of the bones of the knee joint and allows for its smooth movement. It is a shiny, white, ultra low friction material, that acts as a bearing surface for the joint. (it is easily seen on the end of uncooked lamb bones etc). This articular cartilage is very different from the meniscal cartilages (or menisci mentioned above) and is the most delicate and irreplaceable structure within the knee. Once this gets damaged and wear starts to occur, the knee can no longer be returned to its normal state. Injury to

this lining can be treated by **debridement**, a process of cleaning up: removing loose fragments and smoothing the remaining damaged surface. This removes all the fragments which may potentially fall into the knee and in a number of cases, it also helps to decrease pain. Despite this however, a permanent defect remains which shows almost no attempt to repair itself. Once a defect exists in the smooth lining surface, further wear occurs with time. In essence, it is this damage to the bearing surface of the knee that starts off the progressive process known as 'osteo arthritis'.

Microfracture is the most commonly used cartilage-repair technique. The bare bone at the base of the ulcerated area is cleaned until smooth. A very small awl or pick is then introduced and 2mm diameter holes are punched in the underlying bone. This allows bone marrow cells to escape and form a healing cell population. The intended result is a fibrocartilage patch. (fibrous cartilage or scar tissue cartilage) Although this is not as durable as the cartilage we are born with, it is better than bare bone.

The other factors that affect wear rates are age and usage. The young high demand athlete puts his knees through much more than the weekend recreational sportsman. For this reason, a lateral meniscectomy in a sixteen year old, is virtually guaranteed to produce wear, that is sufficient to be noticeable on x-ray within ten years. On the other hand, a medial meniscectomy in a 35 year old, may show very little

change on x-ray for 20 years. In the young therefore, menisci should be repaired whenever possible and this is particularly so in the case of the lateral meniscus which seems to be more important than its medial counterpart. Family history is also important as osteoarthritis has an inherited component. An athlete who has a strong family history of osteoarthritis is especially at risk if he or she loses a meniscus.

Injury Mechanism

Injuries to the anterior cruciate ligament occur most often in athletic activities (especially twisting and turning sports, such as football and netball) but may be ruptured in work injuries and non-athletic activities. The injury usually occurs without contact and often is associated with a sudden change in direction (eg side stepping) or a sudden change in speed (a deceleration injury). It may also occur with the body falling over a fixed leg or with a hyper-extension (over straightening) injury to the knee.

The athlete often describes the incident "My knee went one way and my body went the other."

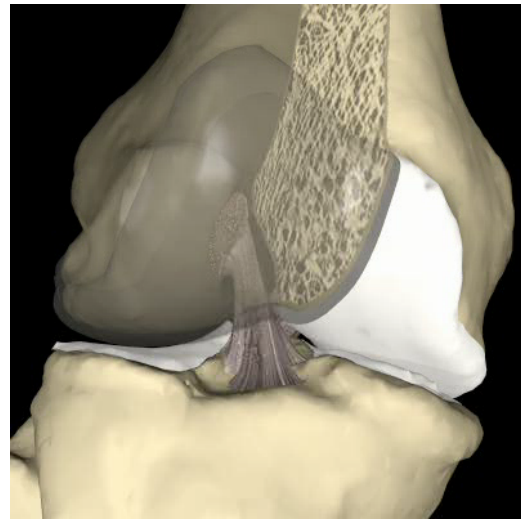


Figure 3: The ACL is the grey ligament visible in the centre of this 3D knee model.

When the injury occurs, the individual will often hear a 'pop' or 'snap' or experience the sensation of tearing inside the knee. The knee then swells almost immediately, because of bleeding from vessels in the torn ligament. Generally the injured person has to be carried off the field and finds that any attempt to weight bear is difficult because the knee feels extremely unstable. The immediate feeling of instability is due, not only to the loss of the ligament, but also to a loss of the nerve fibres within that ligament. These nerves provide a sense of where the joint is in space which is called proprioception. Loss of that sense causes a loss of the sensation of how bent the joint is, how fast it is bending and so on. Without that knowledge there can be no accurate feedback to the muscles that move the knee or to the muscles that protect the knee; and hence, control of the joint may be lost, leading to a

feeling of instability or loss of confidence.

With time the feeling of proprioception improves. This is because the nerve fibres in the other ligaments attempt to make up for the loss of sensation from the nerve fibres in the anterior cruciate ligament. This situation is never quite as good as the original but, if the demands on the knee are low, it may be sufficient to get by.

After the Injury

What happens after injury to the anterior cruciate ligament is a sudden loss of control of the knee, which gradually returns. In most people, it takes about two months to reach a level where they can think about playing sport again. Those who seem to get back to sport without surgery (about 30%) often only have partial tears of the ligament. Whilst the injured knee in this group may be looser than normal, it is thought that function may be satisfactory because some of the proprioceptive nerve fibres remain intact. These are thought to provide enough feedback to the muscles around the knee, to enable those muscles to compensate somewhat for the partial loss of the ligament.

Even for those with a complete rupture, the feeling of stability does gradually improve over a 2-3 month period. If by that time however, full confidence in the knee has not been restored, then that knee will probably never be able to perform a twisting, turning sport again without ACL

reconstruction. If a return to those sports is made, then a repeat injury is likely, due to the ongoing instability. From then on, every time that the knee gives way, more damage is done. Sooner or later, that damage will include injury to the articular lining cartilage, which is irreparable. This may herald an end to impact loading type activities and in essence, represents osteoarthritis, which will progressively worsen with time. Because of this risk it is now considered preferable to reconstruct the unstable knee early on, thus hopefully, preventing recurrent injury. Our studies show that the athlete who undergoes reconstruction in the first 6 months before many instability episodes does better long term than someone who has the operation 2-3 years later after multiple episodes of giving way.

In general patients with ACL injuries may be put into one of three roughly equal size groups:

The first group contains people who do well and return to their sport without too much trouble. In this group the re-injury rate is not all that high and, as suggested above, the majority in this group, have partial tears only. Essentially, the re-injury rate, over a two year period, is thought to roughly equal the percentage tear of the ligament. It could be said that a 30% tear probably has a 30% chance of going on to complete rupture within two years if normal sporting activity is continued.

The second group contains people with a complete ACL tear who seem

to do well until they play a demanding sport. They may even do well at training but, on taking to the field, a re-injury soon occurs. This group otherwise copes well in day to day life and thus, only requires surgery if a return to twisting type sports is desired. Sports such as netball and football demand good ACL function and for people wanting to play these sports, even at low levels, reconstruction of a completely torn ligament is recommended.

The third group contains people whose knees feel frankly unstable in everyday life. This group all require surgery to give their knee a feeling of stability. That stability then protects against further injury and further damage to the knee.

Who Warrants Surgery?

Overall, it may be seen that a large number of people who injure their anterior cruciate ligament might eventually benefit from surgery. The exact number is uncertain but currently it is thought that some 50% or more would be helped. As with meniscal injury, this is somewhat age dependent and the requirement for surgery does decrease with age. This is not only because the demands placed on the knee decrease with advancing age but also because the number of partial tears increase with age and the ability to cope with proprioceptive loss improves with age. The opposite situation occurs in the young age group (under 18) where almost all tears are complete and the majority tend to be very symptomatic. In this group

therefore, almost all patients will develop enough instability to warrant surgery.

Those who sustain injuries to other ligaments of the knee, in addition to a tear of the anterior cruciate ligament are more likely to fall into the third group. Virtually all of these people are better off considering surgery.

Those with suspected meniscal tears, which may be repairable, may also be better off considering surgery. It is not possible to know whether a meniscal tear will be repairable or not until the knee is looked into but nevertheless if the injury seems major and suggests this possibility, then surgery may be a better long term alternative.

It is possible to repair a meniscus and leave a torn ACL alone, but the breakdown rate of meniscal repairs in an unstable knee is more than double the failure rate in stable knees. For this reason, isolated meniscal repair without ACL reconstruction is rarely performed. If a meniscal tear is symptomatic and requires treatment and, for reasons of time or employment, a reconstruction cannot be performed, then partial menisectomy is undertaken. This situation is regarded as a compromise to hasten return to work and is not a substitute for reconstructive surgery. Twisting, turning sports then need to be avoided, until such time as the knee is made stable.

Conservative Treatment

Treatment for injuries of the anterior cruciate ligament cannot be standardized because of individual differences in injury patterns and because of different expectations of patients in regard to return to sporting activities. In the patient who sees sport purely as recreation and who would consider giving it up if it meant that an operation could be avoided, a hamstring re-education and rehabilitation programme may provide a satisfactory knee for everyday use. This type of exercise programme however, is not a substitute for ACL reconstruction because the ligament itself never heals. What it achieves is better control over the knee, by improving strength and by improving the feedback from the other ligaments (proprioceptive training). This type of programme is supervised by your physiotherapist and involves hard work that can only be done by you. Given adequate provocation, however, the knee will still give way and further injury may occur.

Patients with an old anterior cruciate ligament rupture need to avoid recurrent giving way and buckling. If these episodes are associated with pain and swelling and are frequent, the knee will develop progressive wear and tear arthritis (osteoarthritis). Patients in this situation need to either consider the option of surgical reconstruction or change the demands that they are placing on their knee.

For those patients who are athletic and who do not wish to consider giving up sporting activities, it may be that a surgical procedure to reconstruct the ligament will provide the best chance of returning to a reasonable level of performance.

Anterior Cruciate Ligament Reconstruction

Reconstruction of the anterior cruciate ligament is a complex surgical procedure and there are many different ways to go about it. The preferred method is to use a portion of tendon from elsewhere as a graft. In most cases this means using two of the hamstring tendons (semi-tendinosus and gracilis) but other tendons can be used. Another graft is the middle one third of the patellar tendon.

Choice of Graft

The two most common graft choices are the **hamstring graft** and the **patellar tendon graft**. Each has advantages and disadvantages and each has excellent long term results.

Twenty years ago the patellar tendon was the most commonly used graft. Today around 85% of sports knee specialists will use the hamstring tendons as their first choice. This is because using the hamstrings causes fewer problems. The majority of the tendons grow back and strength deficits in the harvested leg vary between 3 and 15% one year after surgery. The major loss is "terminal flexion torque". This is the hamstring power in the last few degrees of flexion. This range is

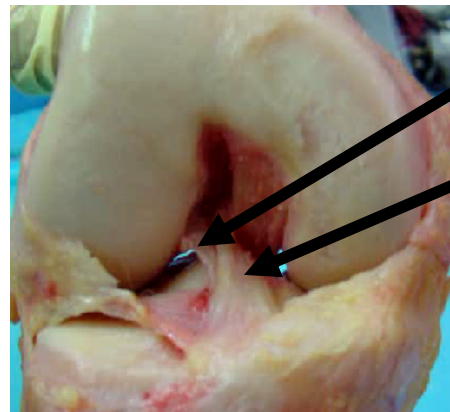
infrequently used by most athletes. I would hesitate to use a hamstring graft in a track sprinter as even a tiny loss of top end speed could make the athlete uncompetitive. (I would suggest delaying surgery until the track career is over.) Nonetheless hamstring ACL grafts have returned All Blacks and Silver Ferns to their former level.

Patellar tendon grafts also have been successfully used for athletes at the highest level for many years. The main problems that concern us is many patients complain of knee cap pain, the inability to kneel and the loss of the last 3-5 degrees of extension. (I can't quite straighten my knee doc!) Follow up also shows a worrying incidence of early arthritis of the knee cap within 7 years or so.

The technique for reconstructing the anterior cruciate ligament has improved significantly in recent years and can now be done in an arthroscopically aided manner. This does not mean that there are no incisions, however, because the graft still has to be taken in a standard open type manner. The incisions can be kept to around 3cm though by using the scope. The knee joint itself is usually not opened as all the work in the joint can be done via the arthroscope. This causes less pain and a shorter hospital stay and allows for an earlier and better range of knee motion. It also means less wasting of the muscles post operatively and an earlier return to normal knee function.

Surgical Technique

My primary graft choice is almost always the hamstring tendons. I use a **double bundle reconstruction**. The normal ACL has two distinct and separate bundles each with a different function. Traditionally ACL reconstruction has been a single bundle approximation somewhere between the two original bundles. Surgical techniques usually try and recreate the pre-injury anatomy but there have been many technical problems with making both bundles. The operation is more difficult, takes more time and has more potential complications.



Postero-lateral
Antero-medial

The two normal ACL bundles

Testing in the lab has shown the two bundle reconstruction to be more like the natural state and is more stable. We do not yet have the long term proof in the clinical setting to show superior function and return to sport.

My own reasons for developing this technique are:

1. The loss of the ACL alters the biomechanics of the knee, placing more load on the medial (inside) aspect of the knee. Single bundle reconstruction does NOT restore this. This may explain why single

bundle reconstruction makes no difference to the long-term arthritis rate suffered by patients who rupture their ACL. Fully 50% eventually develop arthritis **whether or not they have their ACL reconstructed**. It is my hope that by making biomechanics (forces across the knee) more normal (and double bundle reconstruction does) this late arthritis rate might be reduced.

2. Few patients with a single bundle reconstruction will describe their knee as “normal”. Yes, it is good enough to return to sport but not fully normal. More patients with a well performed double bundle ACL will describe their knee as normal. My own patients with a previous single bundle in one side and a double bundle in the other side prefer their double bundle knee every time so far with no prompting. It is my hope to get a better functional result as nature almost always does know best!

3. I have dealt with the common technical problems of double bundle reconstruction. The operation takes a very acceptable 68 minutes or so and complications have been minimized. I perform the operation at least 70 times per year so get plenty of practice!

To date double bundle reconstruction is commonly performed in various centres in the US and Europe but not elsewhere in New Zealand.

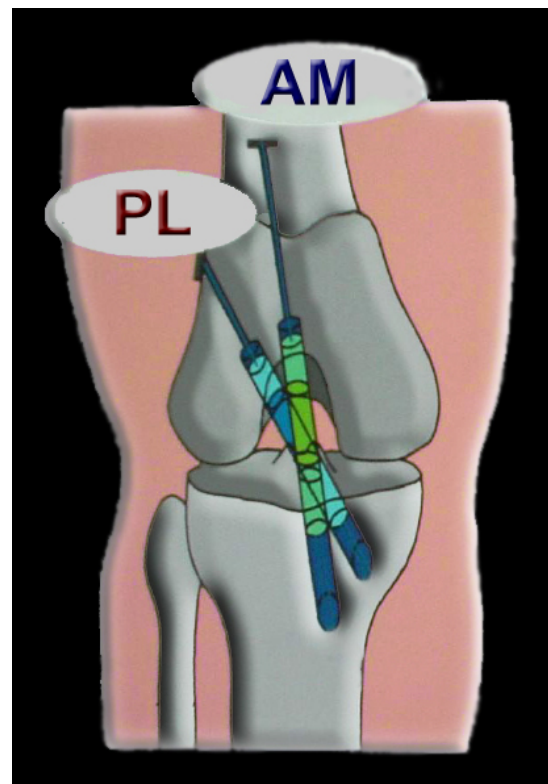


Diagram representing two Bundles of the ACL

The Post-op Period

Reconstruction of the anterior cruciate ligament is now an everyday procedure, thanks to the very major advances in instruments and techniques that have occurred in the last few years. Patients are in hospital as a daystay or overnight stay and generally no brace is required. Crutches are necessary for 1-2 weeks and by 6 weeks most people can walk with only a minimal limp. Between week 2 and week 6 the patient can swim with a pull-buoy to avoid kicking. Biking can be commenced at week 4 and running on even surfaces at week 12 provided there is sufficient thigh muscle bulk.

When first put into the knee, the graft itself is dead. Over a period of time, however, it gains a new blood supply, comes back to life and strengthens. Whilst this process probably takes some **two years to fully complete**, it is thought that by three months some running can be commenced, and by six months training for sport can be started. Actually getting back to full sport depends on individual progress at that stage, including the regaining of proprioception in the knee. This means a return of the ability to run around corners and to twist and turn on the knee. Exercises to promote this ability are essential to decrease the risk of re-injury and are encouraged when running is well progressed. You will work closely with your physiotherapist who will assess your progress. A return to sport can be undertaken anywhere from six to nine months post-op.

Return to sport is not determined by how much time has passed but by when you have completed a series of tests. The "Return to Sport" protocol is a four stage programme where progress to the next level is allowed when specific goals have been met. Passing the level four tests is the signal that sport can be commenced. Your physiotherapist or trainer will determine when you have passed these tests. A professional athlete will almost always achieve this in six months from operation. With work and family commitments most patients take 7-9 months.

Because recovery is now much quicker and easier than previously a

home exercise program is the mainstay of post operative treatment. At your one week check you will be provided with a post operative program. After discharge that exercise program is continued without change for six weeks. At the six week mark, most people are helped by a visit to a sports physiotherapist. At that stage an upgraded program can be organized and, if necessary, supervised. If extra therapy is specifically needed, it is easily arranged, and therapists with particular expertise in this area of surgery can be recommended.

Another time that most people find therapy helpful is at the four to six month mark, when they are just starting to jog or run on the knee. A rehabilitation program here can be most helpful, particularly to regain proprioception, which is essential for a safe return to sport.

Patients who may benefit from early therapy are those who have tight knees and who are having more trouble than usual getting motion back. This includes the patient with repairs of other ligaments and the patient with a meniscal repair whose knee is tight due to the stitches in the capsule around the joint.

Time off work

Students can generally return at 7-10 days provided that the amount of time spent on their feet is limited. They may also wish to use their crutches for a longer period of time.

People in a sit down job can usually return in two weeks. If the job

involves prolonged standing, then four weeks may be more realistic. A job requiring plenty of walking and driving such as a sales person usually requires six weeks off.

If there is any heavy work to be done then two months is probably the earliest that a return can be made with light duties. Jobs requiring prolonged squatting and bending may also take at least this long. Heavy manual labour may take four to five months. Jobs requiring the ability to run are the most demanding and these may require six or more months for adequate recovery to ensue.

Problems of surgery

Overall the number of people who have problems following ACL reconstruction is small. Nevertheless problems do occur and these need some consideration.

Bruising in the immediate post operative period is the commonest problem. Obviously everybody has some bruising, but occasionally, it is such that the knee becomes swollen and sore and the normal mild discoloration that extends to the foot becomes very obvious. This gives discomfort particularly when standing up and may last two weeks. To a degree this can be avoided by not walking around too much when first allowed home from hospital. Some people however, do bruise more easily than others.

D.V.T's (deep vein thromboses) also occur but are uncommon (less than 5%). These represent clots in

the deep veins of the leg, usually the calf. They probably occur at the time of surgery and then get slowly bigger over several days. Because of this they may not be felt in the first few days. If noticeable, it is usually as an ache in the calf at the back of the leg. If this is thought to be occurring, then a Doppler (ultrasound) scan can be used to detect it and appropriate treatment organized.

If a patient is at risk for this complication (eg those on a high dose of oestrogen supplement or high dose 'pill') then some prophylactic thinning of the blood can be performed. This does increase bruising and bleeding however, and thus, is not regarded as routine treatment.

The concern of having clots in the vein is always that they may spread to the lungs (**pulmonary embolism or PE**). This is a rare event but does represent the one major and serious complication of this and other lower limb surgery. In the majority of cases, like DVT's themselves, it is treatable by thinning of the blood. This prevents new clot from forming and allows the body to slowly dissolve the clot that is present.

Deep **infection** is uncommon and occurs in about 1 in every 200 cases. Almost all such infections can be treated without loss or failure of the graft. Nevertheless, the graft is threatened by this problem which requires prompt treatment, including arthroscopic washout of the knee and antibiotics. Early diagnosis is very important to avoid damage to the rest of the knee joint.

Loss of full extension of the knee

is the most common medium to long term problem encountered. Some 10% of people who undergo ACL reconstruction have a scarring and tightening reaction to that surgery. The reason for this is unknown, but it does lead to a general tightening of the knee as a whole. This means slower initial progress, the knee being stiffer and more painful. At the end of the day, however, the ligament in this group remains tight and strong, and, as the motion is regained, excellent stability can be expected.

In almost all cases some loss of extension is common at three months following surgery. Most then go on to regain that motion and at one year less than 5% have any residual loss. For that group, there are procedures that can be undertaken to help this problem and if necessary, these can be performed. With the newer techniques of reconstruction, however, this type of secondary surgery is becoming less and less necessary. Loss of extension is more common with the patellar tendon graft than with the hamstring graft.

Graft loosening and failure may also occur. Just as there is a 10% group at the tight extreme, so there is a 10% group who seem to progressively loosen with time. This group regains motion early and easily and as a consequence, their knees are not particularly sore. Accordingly, they tend to return to activity early and tend not to protect the knee as much as perhaps is

ideal. In some instances this can cause early failure of the graft.

A cause of late failure (6-12 months) is where the graft fails to get a new blood supply and thus fails to come back to life. It is not understood how this process works, why it works, and why, in some instances it does not work. If the graft remains dead, however, it does not have the capacity to heal and hence everyday stresses will eventually lead to progressive rupture of the fibres. Revision reconstruction may then be necessary and is usually successful.

Graft re-rupture can and does occur. No graft is as strong as a normal ligament and hence a big enough injury can cause damage to it. As it turns out however, rupture of the ACL in the other leg is more common than rupture of the graft. This is not because a graft is stronger than a normal ACL but rather that a large percentage of people who rupture this ligament, have a weaker than normal ligament in the first place. This may also be seen in some families where several generations all rupture their ACLs.

Patello-femoral pain or ache under the kneecap (patella) is common once activity has begun. This is mostly due to the muscles being wasted and weak and therefore responds well to exercise, particularly of the VMO muscle. Physiotherapy at this stage can be very helpful to reeducate this muscle and to improve patello-femoral joint function. This is more common in female patients who usually have less thigh muscle to begin with.

Patello-femoral pain can also occur from damage to the articular lining of the patella itself. This happens in about 10% of ACL injuries and unfortunately, it can prove relatively difficult to treat. Nevertheless this problem is generally minor and usually does not interfere with sporting activities to any great extent.

Patella tendonitis or ache from the remaining patella tendon, is not uncommon at some stage during recovery when using a patellar tendon graft. Fortunately, this tends to be transient and tends to settle over a 1-2 month period. In most people this occurs when running is commenced and it represents stress on the remaining smaller patella tendon. This stress then stimulates the tendon to get bigger and stronger (hypertrophy) until it is able to cope. As such therefore, with time the tendon usually settles down and stops aching when used. On the few occasions when this does not happen, steroid ionto-phoresis can help. This is where cortisone (a strong anti-inflammatory agent) is driven across the skin and into the tendon electrically (without having to inject it).

Ultimately most knees settle down over a **12 to 15 month period** of time and by that stage most people are no longer conscious of their knee. Ache from the fixation screw is not all that uncommon, but fortunately is rarely bad enough to require treatment. If the screw is prominent enough to interfere with

kneeling, however, then removal may well be warranted.

Graft Malposition is a surgical error when the new graft is not placed exactly where the original ACL was sited. The graft only needs to be a few millimeters away from the correct site to cause problems like persistent instability and loss of motion. I urge patients to make sure their surgeon performs this operation frequently as "practice makes perfect". I believe ACL reconstruction is not an easy operation that can be performed accurately by the occasional surgeon

Summary

The anterior cruciate ligament is a major and important ligament in the knee which is commonly injured. Treatment depends on the age of the patient, the exact nature of the injury, the nature of any associated injuries, the lifestyle of the patient and their future sporting aspirations. In those patients who are willing to alter their lifestyle a rehabilitation programme may be adequate but for the keen athlete who is wanting to return to twisting and turnings sports, a reconstruction may be the better alternative. With the advent of better operative procedures to reconstruct this ligament, such as have been developed in the last few years, the problems that use to be associated with this form of surgery are less common and the functional results are better. In general 90% of those undergoing reconstruction will be able to return to their previous sport

and more than 70% will be able to compete at their previous level.

Nowadays, an ability to return to sport at the pre-injury level is rarely due to loss of the anterior cruciate ligament: reconstruction of that ligament being generally successful. Rather, it is more usually due to irreparable damage that has been caused to other parts of the knee at the time of the initial injury or in subsequent injuries. **(Collateral Damage)** It is known that early reconstruction with intact menisci and articular cartilage has a better long-term outcome than late reconstruction, when repeated episodes of instability have damaged these structures.

What do I do now?

The decision to proceed with surgery is one that can only be made by you. You should not feel pushed in any one direction. I see my role as answering all of the questions you can think of and helping you make the decision you believe is best for your future.

There is no rush to make a decision. If the notes above have raised questions for you, you are welcome to email me at matbrick@xtra.co.nz

If you wish to proceed with surgery you need to let my office know so that I can make an application to ACC for funding for your surgery. This process is supposed to take no more than 21 days but unfortunately delays are common. As soon as ACC writes to you with an approval

for surgery you can get in touch with Rose or Bridget at my office to plan a time for surgery that suits you. My lists are usually booked up for about 6 weeks and your ACC approval remains valid for 6 months. (It can usually be renewed if necessary.)

Rose and Bridget
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