

The Knee Foundation



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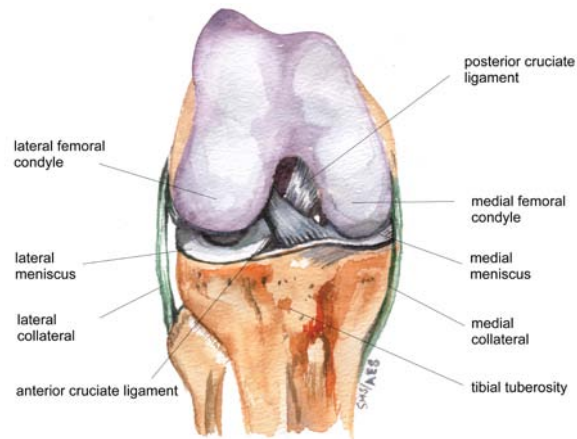
ACL INJURY

Your Knee

The knee joint is a complex structure designed to allow normal function whilst withstanding the huge stresses we put through it during everyday activities and sport.

The main weight bearing part of the joint is formed between the two rounded 'condyles' on the end of the femur (the thigh bone) and the flatter top surface of the tibia (the shin bone).

The menisci are made of fibro-cartilage and sit on top of the tibial condyles, they act rather like spacers and shock absorbers within the joint and their shape adds to the congruency of the joint. The 'medial' meniscus is situated on the inner side of the joint while the 'lateral' meniscus is on the outer side. The medial meniscus is more firmly attached to the tibia, is less mobile and consequently is more prone to injury than the lateral meniscus.



The space between the condyles of the femur is called the 'intercondylar notch'; this provides the surface attachments for two of the main ligaments in the knee. The notch extends forwards forming a groove at the front of the bone (the trochlea); the kneecap (patella) is situated at the front of the knee and is shaped to sit and glide in the trochlea during movement of the joint.

When you can successfully complete these activities without any symptoms and you feel confident that your leg is as strong as your other leg you can go back to your sports training. If you play a contact sport you will require a period of non-contact training before the contact element is added.

If at any time you have a period of relative inactivity such as a long vacation, then it is important for you to fully regain any loss of strength before you play competitive sport again.

Good luck, keep your leg strong and hopefully you will not have further problems.

If you have experienced episodes of instability or feelings of 'giving way' at any stage then you should go back a stage.

If you find it impossible to progress because any increase in activity results in instability or giving way, you should seek further help. You may need to reconsider your expectations or consider surgery.

Stage 5:

This is the final stage before you return to full sports training.

Activities must be increased to include acceleration, deceleration and cutting movements. Jumping and hopping activities, including plyometric training, can be started.

It is also important that you try to simulate some of the movements involved in your own particular sport – if you play soccer you can start dribbling and passing a ball, if you are a basketball player you can start dribbling the ball, initially in a straight line and then between cones – eventually add a jump shot at the end.

If you are attending a gym you may choose to join a training class at this stage circuit training, step aerobics etc. will all help to improve strength, agility, endurance and general fitness. Be sure that the instructor knows that you are recovering from injury and you may not complete all activities.



carioca running



figure 8 running



multi-directional hopping



multi-directional jumping



jumping, rebounding & landing

The knee is a ‘synovial hinge joint’ – this means that movement is restricted to one plane – ie. bending and straightening in a forward / backward direction. This however, is rather too simplistic – the knee is a complex structure where some rotation also occurs, thus allowing a locking and unlocking mechanism to take place.

There are four major ligaments in the knee – the collateral ligaments which are outside the joint on either side, and the cruciate ligaments which are in the centre of the joint and form a cross, hence the name.

Ligaments attach bone to bone and basically hold the joint together. There is a small amount of give in a ligament but it is not essentially an elastic structure, its function is to limit unwanted movement in the joint. The bony configuration of the knee lacks stability - this is provided primarily by the ligaments and they in turn are protected by strong muscle control.

The ACL (anterior cruciate ligament) is in the middle of the joint and passes from the centre front of the tibia, upwards and backwards to attach to the outer side of the intercondylar notch.

It is responsible for controlling forward glide of the tibia in relation to the femur, this movement is known as ‘anterior tibial translation’. The ACL also works in conjunction with the other ligaments (the posterior cruciate ligament and the collateral ligaments) to restrict rotation (or twisting) of the knee.

How does injury occur?

Firstly, let’s point out that the ACL is a very strong structure. It takes approx 1700N of force to break the ACL and usually, during everyday activity, the maximum force we put through the ligament is approximately 450N. Obviously when we start to take part in certain sports or if we have an

accident then those force levels can increase significantly.

A large percentage of ACL injuries occur whilst playing contact sports such as football and rugby however, surprisingly, most happen in a non-contact situation. Commonly there is sudden deceleration followed by a change of direction (a footballer sprints to the ball, slows quickly and twists as he kicks the ball). Twisting injuries are also common in skiing and often occur while stationary or moving relatively slowly - rupture of the ACL can occur particularly if bindings fail to release.

Finally, sports which involve high impact landing can increase risk of injury. Any fault or disruption to landing technique or timing can lead to high twisting forces passing through the joint.

Diagnosis

It has been suggested that approximately 35% of ACL injuries are missed on initial diagnosis. Assessment of an acutely painful and swollen knee is not always easy; a good history is extremely helpful. Your doctor will ask you to describe exactly how the injury occurred, whether you could stand and continue with your activity and he will also want to know about swelling, particularly how quickly it occurred.

Clinical assessment:

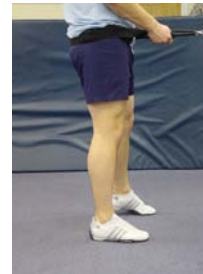
If you have given a good history your clinician will probably already have an idea what has happened before he examines you. He will always look at your opposite leg as well to make comparisons.

Palpation (feeling) the knee allows an assessment of swelling and inflammation – an inflamed knee may be very hot and tender as well as swollen. The examiner will ask you to bend and straighten the knee as far as you can,

Stage 4:

Your physiotherapist will advise when you are ready to move onto this more advanced stage.

- Introduce change of direction activities
- Brisk walk / jogging programme



side stepping



angled lunging



sideways movement

Now is the time to try some running, you must start gently and build up gradually. Begin by increasing the speed of the treadmill up to a gentle jog, just for a couple of minutes, in the middle of a brisk walk (perhaps walk for 5 minutes, jog for 2 and then back down to a walk again). Providing you do not have any adverse reaction you can steadily increase the jogging time and decrease the walk.

Do not increase the speed beyond a gentle jog until you are completely comfortable.

The treadmill is the ideal place to begin a running programme because the surface is obviously flat, not too hard and the environment is controlled.

You can progress to running outside when you are confident but no cross country or accompanying football yet!!

At this stage you could start to attend your local gym. The advantage of the gym is that it is a controlled environment and all exercises are 'straight line' in nature – there is no twisting or turning involved.

Begin using the aerobic equipment – the static bicycle, the rower, the cross-trainer, the stepper – these are all closed chain activities and should not be a problem. Start by doing just a few minutes on a variety of different exercises rather than spending a long time on just a single piece of equipment, this way you will work more muscles in a greater variety of ways. You can also do some walking on the treadmill – gradually increase speed and distance but do not run yet.

If you want to lift fixed weights then you can do hamstring curls and leg press but avoid the quads bench (leg extensions in a sitting position) – these are open chain exercises. Begin lifting low weights and doing more repetitions, rather than trying to lift maximum weight, of course you can do any upper body training you wish.

he may then add some overpressure at the limits of your movement to check the full range. Any block to movement or pain will be significant.

Typically your doctor or physiotherapist will test for cruciate ligament damage by assessing how far the tibia will glide forwards and backwards on the femur. Usually he will test both legs and compare them – this is because there is a natural difference in normal movement between different people, the examiner will use your uninjured leg to represent what is normal for you.

Testing for the ACL is done with your knee bent approximately 20-30° from the horizontal. This is called the 'Lachman test' and is very sensitive and specific for the ACL.



exercises on rocker board for balance & proprioception



walking on treadmill



stepper



Lachman Test

Testing for the PCL (posterior cruciate ligament) is done with the knee bent at 90° and is called the ‘Drawer test’.



Drawer Test

There is another test which is very reliable for ACL injury called the ‘lateral pivot shift’ test. This involves applying a sideways pressure on the joint while rotating and bending it however, it can be difficult to perform in an acute situation or if you are very tense. It is more likely to be tried when examining a more chronic injury, or if assessing a joint under anaesthetic. The examiner will also check your collateral ligaments, your menisci (cartilages) and the joint between your kneecap and femur.



Lateral Pivot Shift Test

You do not want to aggravate the knee or cause it to swell. Begin with just a few repetitions of each exercise and gradually increase, providing the knee does not react. When you have full range of movement, can walk without a limp and are confident on stairs you can move to stage 3.

Stage 3:

- Introduce balance and co-ordination work
- Progress strengthening exercises – single leg work, cycling, trampette, gym work

Examples:



single leg balance & dips



balance on rubber cushion



increase height of step



knee extension with cliniband resistance



half squats on gymball



balance & gentle jogging on trampette

The aim is to achieve full movement – both flexion (bend) and extension (straightness) equal to your other leg. Strength and co-ordination (balance) are also important.

Quadriceps and general leg exercises:

These should be done slowly and carefully so that the movement is controlled. You can also practise standing and balancing on one leg but be sure to have something to hold near by in case you wobble.



Small dips on both legs



Lunging on step



Step-ups on bottom stair



gentle leg press



hamstring curls



knees straight – lift hips

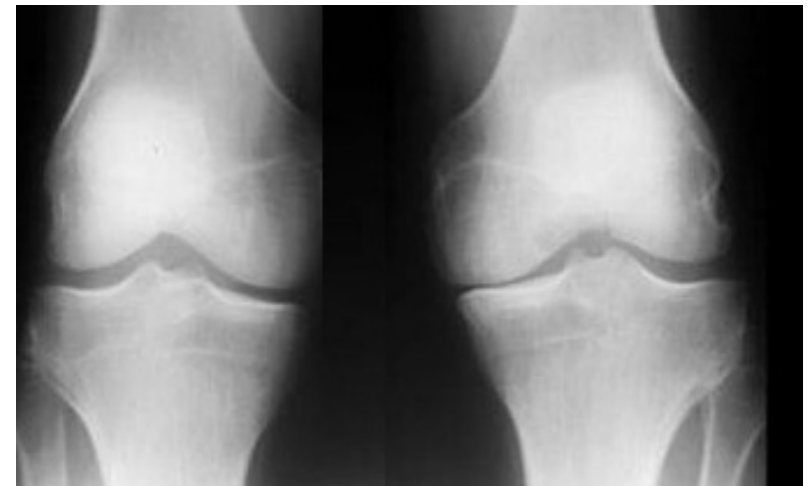
Most of these are easy to practice at home. It is better to do a few exercises regularly throughout the day, rather than try to do too many in one go – 10 minutes four or five times a day is better than 45 minutes at once, at this stage.

Remember, if the joint is very swollen at the time of examination it is not always easy to obtain reliable results, hence your accurate description of the mechanism of injury and the period immediately after is invaluable.

Other investigations:

Further diagnostic tests may be indicated to confirm a questionable diagnosis or to check if any other structures have also been injured – this could affect the treatment required.

- A Standard X'ray: this will only show bone but it may be important to rule out any fractures (breaks) and also to see how the bones are positioned in relation to each other. Sometimes a 'stress X'ray' is done to assess the integrity of the collateral ligaments – the X'ray is taken while sideways pressure is applied to the knee.



Normal views

Stress views

- An MRI Scan: this will show all the structures in the knee and enables a reliable diagnosis to be made.



- The KT2000 is the most commonly used arthrometer to assess the ACL. The machine gives an objective measure of how much Anterior tibial translation the ACL allows, again comparing with the uninjured side. The difference in movement between the two sides, with the same degree of force application, is the significant measure.



KT2000

Early Treatment

Damage to the 'soft tissues' (ligaments, muscles, tendons, joint capsule etc) will cause inflammation, this is your body's natural response to injury and is the first phase of the healing process.

The inflammatory phase should start to settle approximately 5 days from injury however, this can be prolonged by inappropriate management. This phase prepares the area for healing but sometimes the body's response is excessive, leading to increased pain, heat, swelling and loss of movement. Correct management will ensure that this phase is not extended.

Stage 2:

- Regain full range of movement equal to your other uninjured leg.
- Basic strengthening exercises – The emphasis is on simple closed chain exercises and specific hamstring exercises. Everything should be in a straight line – no twisting, turning or change of direction activities at this stage.
- Walking re-education – weaning off crutches, eradication of limp.

We have already mentioned that the hamstring muscles tend to reinforce the action of the ACL, it therefore follows that if you have a damaged or ruptured ACL, strong hamstring muscles are vital.

Suggested simple exercise progression which can be done at home:

These will help to bend the knee and work the hamstrings:



Knee bending – assist with other leg
Use other leg to gradually increase bend



Knee bend – no assistance
Progress by adding a small ankle weight



Gently take buttocks towards heels
– hold this position, relax and repeat

Continuous increased movement can also lead to secondary damage to other structures which have undue stress placed upon them. The menisci in the knee become more vulnerable to injury and the articular (hyaline or joint surface cartilage) may become damaged by increased wear.

ACL deficient knees are likely to have increased anterior tibial translation and increased rotation (twisting) in the knee and it is commonly during activities which involve twisting that instability is felt.

Progressing your exercises

If you and your consultant have decided that surgery is the right option then you will be required to reach stage 2 prior to your operation.

If you are going to follow a conservative path, then you must work through all the stages. Your physiotherapist is there to help you and guide you through the programme and will advise on progression at the appropriate times.

As your swelling settles down it is important to gradually increase your exercises and work through the following stages, but progression from one stage to the next will be dependant on you rather than a definite time scale. You should be able to complete exercises at each level without experiencing pain or instability before you move on – this is particularly important when moving from stages 3 to 4 and from 4 to 5. If you experience instability or giving way you may have tried to progress too soon.

Stage 1:

The early acute days – follow the PRICE regime – move on to stage 2 when swelling has settled down.

Regardless of how quickly an accurate diagnosis is made, early treatment to reduce swelling and inflammation and regain movement is imperative.

The principles of (P)PRICE should be followed from the time of injury.

PRICE

Protection

Protection prevents further injury which would increase the inflammatory response and delay healing. Protection may mean using a walking aid or splint to limit weight bearing and prevent giving way.



Rest

Relative rest is a more appropriate term to use – it is certainly important to completely rest the injured knee for the first 24 hours but limited activity is then possible by using crutches to relieve weight.

Gentle pain-free movement will prevent the knee becoming stiff and improve the alignment and ultimate strength of any healing tissue. A fine line exists between enough activity and too much activity, both of which can be detrimental to the healing process. Total inactivity can lead to a delay in healing, adhesion formation, muscle weakness and reduced sensory awareness (this is called ‘proprioception’ and is important for balance and co-ordination).

Too much activity can cause stress to healing structures and an increased and prolonged inflammatory phase.

As a general guide movements should be kept within a pain-free range and repeated ‘little and often’. Do not be tempted to add resistance in the form of weights at this stage.

Ice

Ice or cold therapy is effective in reducing excessive inflammation following injury. It should be applied as soon as possible - within 1 hour preferably. It is more effective at preventing swelling than reducing it once it has developed. Applied immediately, ice will also help to decrease soft tissue damage, pain and muscle spasm.

Application:

BEWARE - Frost-bite can occur if the skin temperature drops to -3.9C or below. If you use a bag of frozen peas (a two pound bag is the right size and moulds nicely to the shape of the knee) wrap it in a **damp** towel before you apply it to the skin. Gel packs can reach very low temperatures in the freezer, so again be sure to protect the skin with a layer of **damp** towel.

Apply ice for a maximum of 15-20 minutes, every two hours. Continue until the tendency to swell stops - this is usually 12 - 72 hours after injury.

Compression

Compression should be applied to the injured area as soon as possible to reduce internal bleeding and control swelling formation. If ice has been applied then the compression should be administered immediately after the ice. Compression should be applied from below the injury site (just above the ankle), across it and continue for some way above (mid thigh). It will remain effective until swelling has dispersed

Elevation

Immediately following injury, ie. while ice is in situ, elevate your leg so that the knee is higher than your heart; this will limit the development of swelling.

Depending where you are when you become injured, it may be impractical to elevate the leg to this height – if this is the case then at least try to put your leg up on a chair so that it is horizontal. Keep the leg elevated as much as possible,

In both of these examples you can see that movement is occurring at the hip, the knee and the ankle. During the step-up the hamstring muscles work to extend the hip and the quads work to extend the knee.

Why is this significant?

We have already discussed the fact that the hamstring muscles pass down the back of the thigh and attach to the top of the lower leg bones, thus tending to hold the tibia back in relation to the femur. Conversely, the quadriceps pass down the front of the thigh and have a tendency to pull the tibia forwards in relation to the femur, particularly in the range of movement from 30° of flexion to fully straight.

In normal circumstances this ‘tibial translation’ is controlled by the cruciate ligaments. If the ACL is damaged, there is nothing to prevent excessive anterior (forward) translation of the tibia when the quadriceps work in isolation (open chain exercise). Working the quadriceps in conjunction with the hamstrings, as in closed chain exercise, allows good strengthening without causing undue translation.

Why is excessive translation undesirable?

All joints have a certain amount of play in them, this is termed ‘accessory movement’ and is usually controlled by ligaments and other soft tissues around the joint. Damage to these structures can result in gross accessory movement accompanying voluntary movement and this often causes the feeling of instability or giving way.

Over a prolonged period of time these secondary restraints in the joint can become stretched.

Kinetic Chain Exercise: The terminology used here has been hijacked from engineering but in our context the 'kinetic chain' is referring to a series of joints, specifically the hip, knee and ankle. The kinetic chain is referred to as being either 'open' or 'closed' during various exercises and this does have significant relevance for ACL injured or deficient knees.

In an '**open**' chain exercise the terminal part of the chain (the ankle or foot) does not meet any resistance and is free to move in space, thus movement is only occurring at one joint and, essentially, only one muscle group is working.

Examples:



open chain hamstring exercise



open chain quads exercise

In both of these examples the foot is free, actual joint movement is only occurring at the knee and consequently only one primary muscle group is active. Conversely, during a '**closed**' chain exercise the foot is in contact with some form of resistance, be it the floor, the pedal of a bike or the plate of a leg-press machine. This means that movement is occurring at all three joints and there is 'co-contraction' of various muscle groups including both the quads and hamstrings.

Examples:



certainly in the first 24 hours.



Summary

- Apply ice - 2lb bag of peas or gel pack wrapped in a **damp** towel.
- Elevate the leg 15-25 cm above heart level.
- Leave for 15 -20 minutes - remove ice - maintain elevation.
- Apply compression.
- Reapply ice up to 2 hourly.
- Use a stick or crutches for any unavoidable moving about.

During this phase simple exercises to maintain pain-free range of movement and some muscle function are useful. It is important to be able to straighten the knee fully as well as bend it.

Here are some simple exercises you can practise while resting.



Gently bend your knee up & down



Brace the muscle on the front of the thigh (Quads) to straighten the knee and hold for 10 secs. Relax and repeat approx 10X hourly.

An extension stretch – rest heel & allow knee to stretch back fully straight – do this for 5 minutes every hour, if possible.



As inflammation settles down exercises can be progressed. It is important at this stage to gradually increase movement in the joint and to begin graduated strengthening exercises – be careful not to push too hard or you may make the knee swell again. You should gradually wean off the crutches (if you have been using them), but only when you can walk safely and without a limp.

maintain some level of activity in the muscles are needed from day 1 after injury. This may amount to nothing more than damage limitation as far as muscle wasting is concerned but nevertheless is valuable. The type of exercise performed for the quadriceps is relevant therefore please read the section explaining the ‘open and closed kinetic chain’ concept.

The hamstrings, on the back of your thigh, are another large group of muscles responsible primarily for bending the knee (they also pass across the back of the hip and help to extend it). The hamstring muscles cross the back of the knee and attach to the bones just below the joint, they have a tendency to hold the tibia back in relation to the femur and this reinforces the action of the ACL. It therefore follows that strong hamstring muscles will help to stabilise the knee in the absence of the ACL.

The calf, hip and trunk muscles can also become weak very quickly if you have a period of inactivity. It is important to re-establish strength in all muscle groups for the return of normal function.

Proprioception: This refers to the body’s ability to produce balanced, coordinated movement, to have spatial awareness and to react to altering conditions. Ligaments and other soft tissues around the joint have special nerve endings within them, which are responsible for telling the brain where you are in space – if you hold your arm out to the side, you know exactly where it is even though you are not looking at it – it is these proprioceptive nerve endings which are responsible for providing this information.

If you damage a major ligament then information from that source will be lost – specific exercises which encourage balance, co-ordination and reaction will help to sharpen up the responses in the surrounding structures, thus minimising the effect of the lost ligament.

Ideally you should discuss the options with your consultant, fully understand the alternatives and their implications and only then make an informed choice.

Rehabilitation

General Principles

Reduction of swelling: Following injury this is the first step – a swollen knee restricts movement and has an inhibitory effect on the muscles. You can do lots of exercises but will not progress while the knee is swollen and prolonged swelling can lead to adhesion formation with resultant stiffness.

Range of movement: Any restriction of movement will affect return to normal function. The longer a knee remains restricted, the harder it is to regain the movement. The old adage ‘if you don’t use it, you lose it’ certainly does apply to joint movement therefore gradually increasing range, once inflammation has settled down, is important. Swelling in a static knee is the environment in which adhesions form within the joint – if these are allowed to develop and mature they can become very tough and difficult to stretch out at a later date.

Strength: Muscles are your joints’ first line of protection, so good muscle control is important if joint stability is to be achieved. Strengthening exercises have to be progressed steadily and must be staged so that they do not aggravate the knee or put you at risk of further injury by being too aggressive too soon.

The quadriceps, on the front of your thigh, is a large group of muscles responsible for straightening the knee, and for holding you upright against gravity. They also act as decelerators when doing running and jumping type activities. They are a powerful group of muscles and are important for normal function of the joint. This is putting things rather simply but basic exercises to

What happens next?

This is a big question for which there may not be a straight-forward answer– you will see that no single course of action can be right for everyone.

Firstly, let’s consider the ‘rule of thirds’:

- 1 Approximately one third of people can lead an absolutely normal life, including competitive sport, without an ACL. The only way to find out if you fit into this category is to follow a conservative rehabilitation programme and see what happens – if the knee is stable at each stage, move onto the next, being sure to regain full strength and mobility before attempting any sports specific training.
- 2 Approximately one third of people can manage every day life without an ACL but cannot increase their activities to include a reasonable level of sport. This group may be able to manage controlled exercise such as using a gym and cycling but would not be able to play tennis or football, which involve twisting and unexpected movements. Typically people in this group follow a conservative protocol but have problems as soon as they return to sport, however, if they are at a stage in their life where they are prepared to curtail certain activities, they will probably manage very well without surgery.
- 3 The final third of people experience instability during everyday activities such as stair climbing, walking on uneven ground or even turning from the sink to the cooker in the kitchen! This group need surgery.

If we all knew in advance which group we fitted into, life would be so much simpler. The only way to find out is to follow a conservative rehabilitation

programme and see what happens. It is important to progress in stages and gradually increase activity levels as strength, mobility and co-ordination allow. Return to sport (depending on the sport), is likely to be at least 3–6 months. Return to sport before adequate strength is acquired is just increasing the risk of further injury.

Secondly, let's consider the possible effects of an ACL deficient knee:

- Instability – the knee may give way unexpectedly or it may just feel ‘wobbly’. Episodes of instability can lead to additional trauma in the joint, other structures such as the menisci (cartilages) may become damaged.
- Increased movement may be present in the joint even though you are unaware of it. Over time this can lead to stretching of ‘secondary restraints’ – other structures which have become limiting factors in the absence of the ACL.
- Increased movement in the joint may also lead to the early onset of degenerative changes (wear and tear) in the joint surface cartilage.

Will surgery prevent these?

Some years ago it was generally felt that reconstruction was advisable, even if the knee wasn't giving way, to avoid the development of degenerative changes. It has however, not been shown that reconstruction necessarily prevents this onset.

It is now accepted that the primary indication for surgery is giving way or instability however, other considerations such as activity level; occupation; age; other damage in the joint and compliance with rehabilitation, all play a part in the decision.

The Options:

Conservative management – Once the knee has settled down from the injury, this requires an intensive rehabilitation programme to regain full movement, strength, flexibility and co-ordination. Progression should be staged to avoid further injury and sport should only be resumed when strength is equivalent to the uninjured leg and there has been no evidence of instability. You may find that you progress to a certain level and cannot move on thereby having to limit some activities in the future.

Immediate reconstructive surgery - It is now generally accepted that even if the preferred course of action is surgery, it is advisable to wait until the acute post-injury phase has settled - usually 4 - 6 week. Post-operative recovery will be easier if the swelling in the knee has gone, if there is full movement and reasonable muscle control.

Wait and see approach – In this case you may consider surgery in the future only if it proves necessary. A conservative protocol will be initiated but if there are episodes of instability then reconstruction occurs. The advantage of this approach is that you will not undergo surgery unnecessarily however, there is always the risk that the episode of instability that promotes surgery, may cause further damage in the joint. The disadvantage of this approach is that you may spend months in rehab only to find that you need surgery anyway, thus increasing the time from injury to full recovery. The fact is, that the higher the level of activity you want to participate in, the higher the likelihood you will eventually require surgery.

Which option is right for me?

As you can see, there is not always a simple answer – each person is an individual and the decision has to be based on a variety of factors.