Renewed interest in injuries to the posterior cruciate ligament (PCL) and its associated structures has resulted in an increasing number of reports on the anatomy, biomechanics, diagnosis and treatment. However, set against our knowledge of the management of injuries to the anterior cruciate ligament, that of injuries to the PCL is less clear. There are many reasons for this. Injuries to the PCL are much less common; an individual surgeon will see very few each year and his experience will be limited. Acute cases are often missed, either from lack of experience of the original examiner or because the patient does not realise the severity of the injury and does not seek medical help at the acute stage. Attempts at treatment in the past have produced relatively poor results and the indications for surgery are unclear.

With increasing knowledge the situation is improving. Methods of diagnosis from clinical examination and special investigations are becoming more widely known and these, together with a high index of suspicion, should lead to the identification of a greater number of these injuries.

Until recently, the natural history of isolated PCL injuries was unclear. The literature contained many retrospective studies with small numbers of cases and a varied aetiology. Their conclusions led to confusion. More recent prospective papers have aided clarification.

The importance of the posterolateral corner in relation to PCL injuries has been increasingly understood both from original biomechanical studies and clinical observation. Without attention to injuries to this site the treatment of rupture of the PCL may be compromised and failure almost inevitable.

Injuries to the PCL may be associated with multiple damage to other ligaments of the knee including dislocation. The management of complex injuries is beyond the scope of this review, but the basic principles will be described including the importance of injury to the PCL. Early surgical treatment has been advocated by most experienced surgeons, but few comparative studies of conservative versus operative treatment are available.

While there have been many reports of methods of reconstruction of the PCL and associated structures, few long term results are available. Future knowledge and understanding will depend on prospective studies on specific forms of treatment allowing the surgeon to make an objective assessment and be armed with accurate information to provide the best treatment.

Incidence of injury
A review of the literature produces a wide variation in the incidence of injury to the PCL, from 2% for isolated PCL laxity found in pre-draft physical examinations for the National Football League by Bergfeld,1 to 40% in 222 trauma patients presenting with an acute haemarthrosis as described by Fanelli and Edson.2

One of the more common complex injuries is rupture of the PCL and of the posterolateral structures. This produces a more profound effect on the biomechanics of the joint than an isolated injury to the PCL. In the series of Farelli and Edson,2 only 1.4% of patients with a haemarthrosis had an isolated injury of the PCL, while injury to the posterolateral complex with rupture of the PCL occurred in 16%.

The incidence of rupture of the PCL therefore depends on the type of patient seen in the clinic. It is self-evident that low-velocity injuries are likely to have less severe effects than high-velocity injuries such as road-traffic accidents.

Mechanism of the injury
The classical cause of isolated injury to the PCL is the dashboard injury. In a series of 20 patients reported by Dandy and Pusey3 this had occurred in 50% of the patients, when a flexed knee hit the dashboard. In sport, a similar injury can be sustained when the knee hits the ground, pushing the tibia backwards. Other causes of injury are hyperflexion or hyperextension of the knee.4,5
A common mechanism of injury in patients with rupture of the PCL and posterolateral structures is a blow to the inner aspect of the thigh producing a varus deformity to the straight or almost straight knee, resulting in rupture of the lateral structures and the PCL. Other causes include external rotation injuries seen in skiers when the ski fails to disengage.

It should be emphasised that while a specific mechanism of injury may be described, many patients cannot explain how it happened and in chronic cases when it took place.

**Anatomy and biomechanics**

The PCL has a broad attachment to the lateral surface of the medial femoral condyle and passes downwards and inserts into a narrow area approximately 1 to 1.5 cm below the posterior edge of the tibia in a depression between the medial and lateral tibial plateaux (Fig. 1). Its mean length is 38 mm and mean width 13 mm according to Girgis, Marshall and Al-Monajem.\(^6\) It has two major bundles, functionally described as the anterolateral and posteromedial bands. The first is the larger and accounts for 85% of the cross-sectional area of the ligament. It is the band which is reconstructed in single-bundle reconstructions. It is tight in flexion and lax in extension while the posteromedial bundle is tight in extension and lax in flexion. The meniscofemoral ligaments lie in front (Humphrey) and behind (Wrisberg) the PCL and are present to a variable degree.

The PCL is the primary restraint to posterior tibial translation resisting between 85% and 100% of posteriorly directed loads on the knee in flexion.\(^7\) The lateral collateral ligament, the posterolateral corner and the medial collateral ligaments are important secondary restraints.\(^8\) In isolated rupture of the PCL the amount of posterior translation of the tibia is approximately 10 mm or more at 90° of flexion.\(^7,9\) A combined loss of the PCL, lateral collateral ligament, medial collateral ligament and posterolateral corner produces a greater degree of posterior translation.

The PCL is also a secondary restraint to external rotation of the tibia on the femur and with loss of the lateral collateral ligament and the posterolateral corner together with rupture of the PCL the amount of external rotation of the tibia on the femur at 90° increases significantly.\(^10\) It should be emphasised that the posterolateral corner is a primary restraint to external rotation of the tibia and that rupture of these structures results in an increase in forces on the intact PCL.\(^8,11\) Kumagai et al\(^9\) also noted increased patellar flexion on transection of the PCL associated with an increase in the posterior forces acting on the patella, especially the inferior pole, which theoretically might increase the risk of patellofemoral pain and arthritis. Several authors\(^12,13\) have shown that sectioning of the PCL led to a significant increase in pressure in the medial compartment. Ahmed and Burke\(^14\) demonstrated in vitro, by measurement of the distribution of static pressure in the joint, that posterior translation of the tibia produced a decrease in the load transmitted through the menisci. Because this causes failure of the medial meniscus, there is an increased risk of damage to the articular cartilage resulting in arthritis.\(^15\)

The anatomy of the posterolateral corner is variable and its terminology inconsistent.\(^16\) Seebacher et al\(^17\) divided the anatomy into three layers from superficial to deep. In the superficial layer were the iliobibial tract and biceps femoris and its posterior expansion. The common peroneal nerve lies behind the biceps tendon. In the middle layer were the quadriceps retinaculum, the patellofemoral ligaments and the lateral collateral ligament. In the deep layer were the coronary ligament which is the capsular attachment of the lateral meniscus and the popliteus tendon, which passes from its muscle belly on the posterior tibia upwards and laterally under a gap in the coronary ligament into the lateral femoral condyle immediately anterior to the insertion of the lateral collateral ligament. It also included the Y-shaped arcuate ligament which has a medial limb passing from the posterior capsule over the popliteus muscle to the oblique popliteal ligament. The lateral limb passes from the posterior capsule over the popliteus muscle into the head of the fibula. The popliteofibular ligament comes from the popliteus tendon and inserts into the posterior aspect of the fibular head (Fig. 2). While this description is common, it should be emphasised that there are wide anatomical variations.

The importance of the popliteus muscle-tendon unit cannot be overemphasised. It is not just a static stabiliser, but is dynamic and the detail of this aspect of its function is still not completely understood.\(^18\) Operations to substitute...
this structure can only be static in nature and therefore cannot completely replace the function of the popliteus complex.

Clinical findings

Acute isolated PCL injury. It is uncommon to see a patient presenting with an acute, isolated injury to the PCL and the diagnosis is easily missed. The symptoms may be mild with the patient regarding the condition as a sprain which will resolve. The diagnosis may be missed initially because the signs may be minimal or the index of suspicion low. In the acute stage, there may be an abrasion over the front of the tibia associated with a swollen knee. Over the next few days, bruising may develop in the popliteal fossa from rupture of the posterior capsule. In the early stages, a posterior sag may be difficult to identify on clinical examination (vide infra). After a week or two most patients will have no pain and a firm end-point to the posterior-drawer test.\(^{15}\)

Acute combined injury to the posterolateral corner and PCL. In this injury a typical history may or may not be forthcoming. The amount of pain may vary but is more severe than in isolated cases and the patient is usually reluctant to flex the knee in the acute stage.

Early physical examination may show bruising and swelling over the lateral aspect of the knee and proximal fibula. A significant effusion from the joint may be absent if the capsule has ruptured allowing extravasation of fluid. A careful examination of the neurological and vascular status is mandatory. The common peroneal nerve is at risk from injury to the lateral complex and symptoms may vary from paraesthesia to foot drop. The initial examination may preclude careful stress testing of the knee because of pain so that a further examination should be carried out after a period of time. An examination under general anaesthesia may be necessary and of value.

Chronic isolated PCL injury. The clinical features and natural history of this injury have been reported many times.

Reviewers such as Spindler and Benson,\(^{19}\) Shelbourne et al\(^{15}\) and Dejour et al\(^{20}\) have all stated that the literature is confusing. Many papers are retrospective and only report symptomatic patients. Rarely are all the patients seen at follow-up. The aetiology of the injury may be mixed including sports injury and high-speed road-traffic accidents. The degree of injury to the ligament may vary. In reports which are prospective, the number of patients may be small or the follow-up too short. All these factors lead to confusing and misleading conclusions.

Most authors comment on the incidence of pain which is aching in nature and frequently localised to the medial and patellofemoral compartments of the knee. In their study Fowler and Messieh\(^4\) reported a very low incidence of pain. The study was prospective, but with a mean follow-up of only 2.5 years. Most reports describe an increase in pain with time from the initial injury. Keller et al\(^{21}\) in their retrospective assessment of 40 patients with rupture of the PCL reported a total incidence of some pain in 90% of patients and in 43% during day-to-day living. When the radiological incidence of degenerative change is assessed, several authors\(^{4,22,23}\) have suggested that there was no relationship between the period of follow-up and degenerative change while most observed an increase in changes over time.\(^{5,20,21,24}\)

The incidence of symptoms of instability varies. In their prospective study Shelbourne et al\(^{15}\) reported that while 54% of patients had no feeling of instability, 20% had a feeling of giving-way on activities of daily living. The mean follow-up was 5.4 years. Dandy and Pusey\(^5\) stated that 20% of their patients had a history of giving-way on straight-line running. Only three of the patients of Parolie and Bergfeld\(^{23}\) (12%) had a feeling of giving-way on exercise. It would appear therefore that a feeling of instability is a symptom of isolated rupture of the PCL, but significant symptoms of giving-way should lead to a suspicion of a more complex injury.

Most papers report a relatively high level of return to sport after conservative treatment. In the short-term prospective study of Fowler and Messieh\(^4\) all patients returned to such activities. In the series of Parolie and Bergfeld,\(^{21}\) 68% and in that of Shelbourne et al\(^{15}\) 50% returned to
their original level of activity, with the remainder participating to a lesser degree. In other series, 80% to 90% of patients were satisfied with the results of conservative treatment.\textsuperscript{3, 22}

Dejour et al\textsuperscript{20} stated that the natural history of isolated rupture of the PCL has three phases: initial functional adaptation, subsequent functional tolerance and eventual arthritic deterioration.

**Chronic combined injury to the posterolateral corner and PCL.** The symptoms are similar to those of isolated cases, but more severe with a more significant history of instability and pain. The patient is much less likely to return to sport and may have symptoms of instability in daily living.

**Physical examination of the knee**

The presence or absence of posterior sag is the essence of clinical examination for rupture of the PCL since it is the most accurate test\textsuperscript{11} (Fig. 3).

The posterior-drawer test is performed in 90° of flexion. In this position, the tibia will fall back on the femur. In severe cases, the posterior sag will be obvious when the knee is viewed from the side. The examiner stabilises the leg by gently sitting on the patient’s foot. Normally, the medial tibial plateau lies 1 cm in front of the anterior aspect of the medial femoral condyle. If it lies behind that point but still anterior to the femur, it is a grade-1 laxity. If the femur is in the same plane as the tibial plateau it is grade 2 and if the tibial plateau lies behind the femur it is grade 3. A check should be made to identify whether there is a firm end-point to the posterior drawer. Most surgeons would agree that if the posterior sag is grade 2 or grade 3, there is almost invariably a degree of damage to the posterolateral structures together as well as the PCL. Other tests include the quadriceps active test described by Daniel et al\textsuperscript{25} and the reverse Lachman test. Assessment of the posterior drawer before carrying out the Lachman test may avoid the mistake of believing that the ‘positive’ Lachman test results from rupture of the anterior cruciate ligament.

In chronic rupture of the posterolateral corner and the PCL the positive physical signs will include posterior sag, usually greater than grade 2. The dial test for tibial external rotation will be positive (Fig. 4). This may be performed either prone or supine. It is said that increased external rotation at 30° but not at 90° of knee flexion is indicative of isolated rupture of the posterolateral corner. A positive test at both 30° and 90° suggests rupture of both.\textsuperscript{26}

Another simple test of laxity of the posterolateral corner is to flex the knee to 90° with the patient supine and with the examiner stabilising the foot. Gentle pulling of the head of the fibula forwards and backwards on the affected and unaffected sides will demonstrate an increase in the external rotation of the lateral compartment of the knee on the injured side compared with the normal. Occasionally, the patient may be able actively to demonstrate excess postero-lateral rotation by contracting his biceps muscle.

The reversed pivot-shift test described by Jakob, Hassler and Staubli\textsuperscript{27} is another useful test for laxity of the posterolateral complex. The patient lies supine. The examiner lifts the affected leg and flexes the knee to about 70° to 80°. The foot is externally rotated resulting in posterior subluxation of the lateral tibial plateau on the femur. The examiner then exerts an axial and valgus load to the knee and gently extends the joint. At about 20° to 30°, the lateral tibial plateau reduces from the subluxed position with a jerk produ-
censing the symptoms and pain. It is essential to check the opposite normal knee since in some patients the reversed pivot shift can be a normal variant.28

Excessive varus opening should be assessed at 30° of flexion and is a sign of injury to the lateral ligament (Fig. 5). It can be palpated by applying tension to the structure by abducting the flexed hip and flexing the knee to 90°. Other tests include the external rotation recurvatum test which may be positive in injury to the posterolateral corner and PCL.29

Examination of gait is essential especially in patients with a tendency to varus knees. It may demonstrate an obvious varus thrust of the knee during the stance phase of walking. Any suggestion of physiological varus of the knee should result in careful assessment including full radiographs of the leg and a decision made on whether a valgus tibial osteotomy is necessary to decrease the tension in the soft-tissue structures of the lateral side of the knee. Some patients may walk with a slightly flexed, internally rotated foot to prevent painful posterior subluxation of the lateral tibial plateau.

Investigations
Radiological examination. Routine radiographs may show an avulsion fracture of the insertion of the PCL into the posterior aspect of the tibia. Injury to the posterolateral corner may be associated with bony avulsion of the head of the fibula. Long-standing cases of rupture of the PCL may show degenerative disease in the medial compartment of the knee and possibly the patellofemoral compartment, although in the author’s experience the latter is uncommon.

Stress radiographs may be useful when comparing the normal stable with the abnormal knee (Fig. 6). Neutral posterior pressure on the tibia will show posterior displacement of the tibia on the femur. Adding external rotation of the tibia to posterior pressure will produce greater displacement in cases of rupture of the posterolateral corner and the PCL. There are many methods of stress testing the knee including the use of the Telos machine, but no standardised, commonly used method has yet been developed. Obtaining a complete set of stress films is also time-consuming but it is
an objective method of assessing stability before and after surgery.

**MRI.** This can be very useful in acute tears of the PCL but is only of limited value in chronic injuries. Gross et al.\(^3^0\) showed a sensitivity and specificity of 100% in a study of 13 clinically confirmed tears and no false-positive results in 190 knees with the PCL intact. Harner and Hoher\(^8\) stated that MRI is useful for diagnosing a tear and may give information on the position along the ligament of the rupture which may affect treatment. On MRI it should be emphasised that the anterior cruciate ligament may give a false impression of laxity because of posterior sag.

The PCL can be identified in all three conventional MRI planes. It is uniformly of low signal on all fast spin-echo sequences (T1-weighted and T2-weighted and fat-suppression techniques). On sagittal sequences it is seen as a curved low signal band usually visible throughout its length on a single cut or more. In the coronal plane, it is cut through obliquely as it runs from the tibial to the femoral insertion. On axial sequences it appears as a rounded low signal structure. A synovial sheath surrounds the PCL which is therefore intra-articular but extrasynovial.

In acute tears of the PCL any increase in signal on all fast spin-echo sequences is indicative of a tear. A complete rupture is shown as discontinuity of the PCL which is interrupted by high signal material although this is a rare finding. More commonly, a complete tear is shown as a diffuse high signal throughout a long length or even the whole length of the ligament (Fig. 7), which is also thickened. A partial intrasubstance tear is seen as some thickening of the PCL with oedema separating some of the fibres. This is seen as a striated pattern through a portion, usually the mid-segment, of the PCL.

Chronic tears which have healed by fibrosis may show some abnormally low signals along the length of the PCL on all spin-echo sequences but this may be a subtle finding and hard to detect. There is no doubt that the PCL can heal with time whereas the anterior cruciate ligament does not.\(^3^1\) During the healing phase the PCL may heal in a lengthened manner and will be mechanically unsound. In chronic cases therefore, clinical examination is superior to MRI.

While acute rupture of the posterolateral structures may be visualised on MRI using oblique coronal T1-weighted images,\(^3^2,3^3\) this is not always the case and will depend on the experience of the observer and the positioning of the knee in the MRI scanner.

**Radioisotope scanning.** In patients with aching pain after rupture of the PCL it is important to differentiate the pain of ‘instability’ from degenerative knee pain. Radioactive bone scanning has been suggested for this purpose.\(^8,3^4\) If the scan is ‘hot’ and provided that there is no significant degenerative change on MRI or arthroscopy, a stabilisation procedure may resolve the symptoms. In the author’s experience even moderate degrees of degenerative change resulting in pain do not improve with attempts at stabilisation.

**Arthroscopy.** The role of arthroscopy in acute tears of the PCL is debated. Many surgeons argue that history taking, clinical examination and MRI are sufficient for diagnosis.\(^4\) Others state that arthroscopy can provide further information which is useful in the management of the patient. An advantage of general anaesthesia is the ability to carry out a full examination of all the ligamentous structures. In the acute setting it is essential to avoid compartment syn-
dromes from extravasation of fluid from capsular tears. Most tears have sealed by two to three weeks and this may be the best time for the procedure. A serious pitfall of arthroscopy is to observe apparent laxity of the anterior cruciate ligament leading to a diagnosis of rupture and mistaken reconstruction of that structure. Pulling the tibia forward will tension the anterior cruciate ligament. Evaluation of the lateral compartment of the knee may demonstrate a lax haemorrhagic popliteus tendon, suggesting posterolateral instability. Significant injury to the lateral compartment may result in increased opening of the compartment allowing unusually easy access for the arthroscope. The PCL initially may appear to be normal unless the synovium is removed from the structure. “Peel-off” injuries from the femur may be apparent. Ruptures of the lower midsubstance and lower third of the PCL may not be apparent from an anterior approach and the posteromedial portal is most useful for visualising the lower two-thirds of the ligament.

In chronic cases, apart from an apparently lax anterior cruciate, the PCL may appear to be intact since healing may occur with elongation. Degenerative change may be observed and meniscal injuries are uncommon. Again with injury to the posterolateral corner and the PCL, the lateral compartment of the knee may appear to open excessively and the popliteus tendon may be abnormal.

**Treatment of isolated injuries to the PCL**

An acute isolated midsubstance rupture of the PCL may heal. The knee may be treated in a brace in full extension for a period of six weeks followed by mobilisation. There is no published report of the results of this treatment but occasional patients treated by the author appear to have had a satisfactory outcome. Further work is necessary.

Bony avulsion of the insertion of the PCL into the back of the tibia is an indication for early operative treatment. Using the posteromedial approach described by Trickey it is possible to enter the back of the knee by mobilising the medial head of gastrocnemius and retracting it laterally to protect the neurovascular bundle. The posterior capsule can be divided and the fragment of bone identified and fixed with a screw (Fig. 8).

There is almost no indication for reconstruction of an isolated intrasubstance rupture of the PCL in view of the natural history of the injury. Shelbourne et al compared their results of conservative treatment of isolated rupture with the operative results of L’Insalata and Harner and found them to be similar with a mean modified Noyes score of 84.

In the author’s view almost the only indication for reconstruction of the PCL in the chronic isolated case may be for aching pain resolved by bracing and without degenerative change provided that the laxity is significant. Otherwise, the results of conservative management are relatively good and up to the present there has not been a report of operative treatment which has produced better results. There is no proof that operative surgery decreases the risk of osteoarthritis in the long term.

**Treatment of injuries to the posterolateral corner and to the PCL**

**Acute injuries.** Most authors advise early repair of both the PCL and the posterolateral corner to achieve the best results. The ideal time is within two to three weeks of injury before identification of the individual structures becomes difficult.

Without doubt, avulsion fractures of the fibular head containing many components of the posterolateral corner and avulsion of the bony insertion of the PCL into the tibia should be fixed acutely since this is likely to produce good results. The ruptured cruciate ligament associated with the former can be treated at a later date once capsular healing has occurred.

The aim of acute management of the posterolateral corner is to repair as many of the torn components as possible starting from the deep structures and working to the superficial. The tissues, however, may be thin and atrophic and the popliteus tendon may be pulled out of the muscle belly making repair impossible. More recent attempts at acute repair of the posterolateral corner have included reinforcement of the structures using either a biceps or some other type of tenodesis.
Chronic injuries. As stated by Jakob and Edwards\(^4^1\) in 1994, the results of reconstruction of the PCL have until recently been almost universally less satisfying than those for the anterior cruciate ligament. The reasons are complex, including the positioning of the graft, early diagnosis before the onset of degenerative change and also the lack of awareness of other instabilities, especially those at the posterolateral corner, which require treatment. More recent methods of reconstruction of the PCL appear to be promising. The chronic laxity of the posterolateral corner must be assessed and some form of tenodesis incorporated in the surgical treatment to return stability to the knee. Assessment of the varus knee is also essential since soft-tissue reconstruction without addressing this problem by valgus osteotomy will lead to failure.

Reconstruction of the PCL

Methods of reconstruction have advanced since that of Hey Groves in 1917.\(^4^2\) He used a semitendinosus and gracilis graft with an open technique. Details of recent developments are well described in the literature and it serves no useful purpose to describe them in detail here. In general terms, these methods have described an open technique using an onlay graft on the back of the tibia\(^4^3,4^4\) (Fig. 9) or a method which avoids opening the back of the tibia and is usually, but not always, arthroscopically assisted\(^4^5-4^7\) (Fig. 10).

The three main problems with an arthroscopic technique are the possibility of damage to the popliteal artery by the guide wire or drill as it passes through the back of the tibia, problems of rupture of the graft as it curves at a sharp angle from the back of the tibia and then forward towards the medial femoral condyle and, finally, in acute cases, the risk of fluid extravasation and compartment syndromes, obviated by an open procedure. The problem with open techniques is that the patient has to be moved from a prone or semiprone position for fixation of the graft into the back of the tibia into the supine position to bring the graft through into the medial femoral condyle. This can be time-consuming and potentially risks dersterilisation of the operation site.

Until recently, most reconstructions of the PCL have been designed to replace the stronger anterolateral bundle, but methods have been described to replace both the anterolateral and posteromedial bundles\(^4^8\) with the aim of providing a more functional and anatomical reconstruction.\(^4^9\) Results of these procedures are awaited together with a comparison with those of the single-bundle technique.

Many different types of graft material have been described including autografts, allografts and synthetics. Patellar tendon autografts and allografts of tendo Achillis are useful in onlay techniques. Quadruple hamstrings and soft-tissue allografts facilitate the arthroscopic method and can be split into two sets for the double-bundle technique. Studies have not found any significant difference between allograft of tendo Achillis and autogenous patellar tendon, but the numbers were small.
Fixation devices are numerous and include interference screws, both metal and bioabsorbable, soft tissue and bone. Transfixation methods such as the Rigidfix and Transfix have increased the surgical options and may be better than the Endobutton type of device which fixes the graft at a distance from the mouth of the tunnel increasing the potential for the ‘windscreen-wiper effect’.

**Reconstruction of the posterolateral corner**

Earlier reconstructions included biceps tenodesis described by Clancy and Sutherland50 (Fig. 11) in which the biceps tendon is mobilised and attached proximally to the lateral epicondyle using a screw with the knee in 30˚ of flexion. Since this procedure removes one of the dynamic stabilisers of the knee, others have used half of the biceps to perform a tenodesis.39 A simple method to augment the lateral collateral ligament is the circle graft of Noyes and Barber-Westin51 in which a strip of allograft or semitendinosus autograft is passed through the fibular head and a tunnel through the lateral epicondyle to form a circle round the damaged lateral collateral ligament. Bousquet et al52 described a method of reconstructing the popliteus complex using a strip of the middle third of the biceps tendon 10 to 12 cm in length, which is left attached to the head of the fibula. It is passed under the iliotibial tract. An 8 cm drill hole is made at the site of the insertions of popliteus and a second at the femoral attachment of the lateral ligament. The two are then connected. The graft passes through the popliteal tunnel and out through the tunnel of the lateral ligament to be sutured onto itself. Laxity of the lateral ligament can be augmented by a Lemaire-type of procedure in which a strip of iliotibial tract attached to Gerdy’s tubercle is passed through the posterior hole, out through the anterior and sutured back on itself and down onto the fibular head (Fig. 12).

The author at present uses the Larson procedure53 (Fig. 13a). A strip of semitendinosus or allograft of tendo Achillis is passed from anterior to posterior through a tunnel in the fibular head usually measuring about 7 to 8 mm in diameter. It is then passed into a tunnel in the area of the lateral epicondyle and fixed into position with the tibia pulled forward on the femur in about 30˚ of flexion. If the lateral ligament is deficient the graft is brought down towards the fibular head and fixed (Fig. 13b). This procedure acts as a sling which prevents excessive posterolateral laxity.

**Results of reconstruction of the PCL**

In the series of Clancy et al55 of 23 patients with at least grade-2 posterior sag undergoing reconstruction of the PCL using the middle-third of the patellar tendon, all ten with an acute isolated injury had an excellent or good result at follow-up and all had had at least a 2+ posterior-drawer sign before operation. In the patients with a chronic injury six of the seven with an isolated injury had an absent or trace of posterior sag and of the combined group five of the
six had symptomatic improvement with static stability which was good in five and excellent in one.

In the more recent series of Fanelli et al\textsuperscript{40} in which the PCL was reconstructed arthroscopically and the posterolateral instability treated by a biceps tenodesis, the follow-up was a minimum of two years. Fresh frozen irradiated allograft of tendo Achillis was used in 15 patients and autogenous bone-patellar tendon-bone grafts in six. There was an improvement in both functional status and tibial step-off in all 21 patients, with 48\% being restored to normal and 48\% to a grade-1 laxity.

In the series of Freeman, Duri and Dowd,\textsuperscript{54} of 17 patients with a grade-3 posterior drawer preoperatively, all had grade-1 laxity at follow-up apart from one who was a failure with grade-2 posterior sag.

There have been no reported results which are as good as those expected from reconstruction of the ACL. Those of the latest techniques, including the two-tunnel technique, have yet to be described. The ideal positioning of the graft may still be unclear and the postoperative management is uncertain, but, overall, there are grounds for cautious optimism.

**Results of reconstruction of the PCL and the posterolateral complex**

The results of the various methods of reconstruction and comparisons between them are essential before an optimal plan of treatment can be recommended. A reproducible successful reconstruction has not yet been devised.

Fanelli et al\textsuperscript{40} as described above, presented 21 patients with both injury to the PCL and the posterolateral corner. In all the reversed pivot-shift and posterolateral drawer tests were negative after the operation. The mean Tegner score was 2.2 before and 5.1 after, and the mean Lysholm score was 51.8 before and 90.9 after.

Freeman et al\textsuperscript{54} presented a small series of 17 patients with chronic injury to the PCL and the posterolateral corner. He compared a series of 11 reconstructions of the PCL with a group of six repairs of both the PCL and the posterolateral corner using allograft of tendo Achillis or bone-patellar-tendon-bone in the former and a Larson procedure in the latter. The overall results were similar to those of Fanelli et al\textsuperscript{40} with the statistically better group being the combined reconstruction. This confirms the importance of the combined approach as suggested by Harner et al.\textsuperscript{55} The mean Tegner score improved from just over 2 before to just over 6 in the patients in whom both the PCL reconstruction and the Larson were performed. The mean pre-operative Lysholm score was 42 with a post-operative score of 68. These results, while an improvement, are not as good as would be expected in patients with a chronic injury to the anterior cruciate ligament.

The author’s post-operative regime has changed from early mobilisation to rest in a splint allowing 0˚ to 30˚ of flexion for approximately four to six weeks with partial mobilisation to full weight-bearing and quadriceps exercises. Knee flexion then begins and only at about four to six months are strenuous exercises allowed. Residual stiffness in patients with reconstruction of the PCL and the posterolateral corner has not been a major problem provided that the patient is well motivated.

**Reconstruction of the PCL in dislocation of the knee**

A detailed description of management is outside the scope of this article. However, for completeness, the principles are presented since they do include treatment of the PCL.

Dislocation of the knee is a very uncommon injury (Fig. 14). After a careful neurological and vascular examination, the essence of management is urgent reduction of the dislo-
cation under general anaesthesia and a careful examination of the knee to identify those structures which have been injured.

The recent trend has been to reconstruct the knee at an early stage rather than treating it conservatively, but there are few reports available which compare the two methods.56

If there is gross instability after reduction or a vascular, soft-tissue or open injury, an external fixator can be used to stabilise the joint in about 20˚ of knee flexion.

Pre-operative planning is necessary to decide on which structures to reconstruct and when to perform the procedure. MRI is essential for gathering further information.

Ligament injuries associated with bony avulsions can be treated by internal fixation, often with excellent results. These include avulsion fractures of the posterior and anterior cruciate ligaments and the head of the fibula.

Rupture of the PCL can be treated either by an open or arthroscopic procedure. Operations which include reconstruction of the PCL are usually planned two to three weeks after the injury and are part of a more complicated reconstruction depending on which other structures require repair.

Graft tissue can be from the opposite knee or allograft. It is better to add tissue to the injured knee rather than to produce further damage by ipsilateral graft retrieval.

Reconstruction of the PCL in these situations is only part of a more complex procedure on the knee. These procedures are technically very difficult and require experience and expertise.57-59

The published results are variable, but encouraging.57,58 Improved techniques of rehabilitation, braking and early manipulation of the knee under general anaesthesia have decreased the risk of severe stiffness in the joint, which was a significant complication in early attempts at surgical intervention.

Dislocation of the knee requires a multidisciplinary approach with careful planning and surgical expertise. Reconstruction of the PCL is only one factor in a complex situation and one which is not suitable for the surgeon with limited experience.

References


