KNEE

Postero-lateral rotatory instability

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Summary
The three key components of the postero-lateral corner are the lateral collateral, the popliteal muscle-tendon unit and the popliteo-fibular ligament. Injuries to these structures are becoming increasingly recognized either in isolation or more commonly as part of a combined ligament injury. Careful assessment will avoid missing such injuries and MRI scanning is an aid to diagnosis. Treatment options range from conservative for mild isolated injuries, to surgical repair and/or reconstruction for combined and chronic injuries.

Introduction
Injuries to the postero-lateral corner of the knee are relatively rare, accounting for less than 2% of acute knee injuries. Despite this, knowledge of injuries to the postero-lateral corner of the knee has expanded considerably over the last 10 years, so much so that even FRCS (Tr and Orth) examiners expect candidates to have some grasp of Postero-Lateral Rotatory Instability (PLRI). Anatomical structures and function are now more clearly defined, and treatment options have expanded accordingly. Despite recent advances, PLRI is still frequently missed and left untreated. Presentation can be isolated or more commonly as a part of a multi-ligamentous injury.

Surgical anatomy
Numerous cadaveric studies\textsuperscript{1–3} have clarified our understanding of the postero-lateral structures. However, some structures may be absent. The lateral side of the knee was divided into three layers by Seebacher et al.\textsuperscript{4} from superficial to deep (see Fig. 1):

- ilio-tibial band and biceps tendon;
- patellar retinaculum and patello-femoral ligament;
- capsule, lateral collateral ligament (LCL), arcuate ligament, fabella-femoral ligament, popliteo-fibular ligament, popliteus muscle tendon unit.

It is the third, deepest layer which causes confusion regarding both nomenclature and variability of anatomical structures. The three key components of the postero-lateral corner are the LCL, popliteo-fibular ligament and popliteus muscle tendon unit.

These form an inverted ‘Y’ inserting onto the lateral aspect of the femur (Fig. 2).

The lateral collateral ligament runs from just proximal and posterior to the lateral epicondyle and inserts just anterior to the midpoint of the head of the fibula. The popliteo-fibular ligament runs posterior to the lateral collateral ligament from the styloid process of the fibula.

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proximally to the musculo-tendinous junction of the popliteal tendon.

The popliteus muscle tendon unit is a complex structure with three popliteo-meniscal fascicles, viz.; the popliteo-fibular ligament (described above), the arcuate ligament and the muscle and tendon of popliteus itself.

The tendon attaches to the lateral aspect of the femur approximately 2 cm distal and anterior to the LCL, passing intra-articularly into the popliteal hiatus which is formed by the three popliteo-meniscal ligaments. These anchor the popliteal tendon to the lateral meniscus. The arcuate ligament is a broad sheet of tissue that runs from the popliteus muscle belly to the posterior capsule and lateral meniscus.

The fabello-fibular ligament is a variable structure running parallel to the LCL from fibula to fabella.

**Biomechanics of the postero-lateral corner**

The biomechanics of the postero-lateral corner has been largely defined by sequential cadaveric sectioning studies. After the application of a load, motion is measured following division of structures first individually and then combined to determine the contribution that each structure makes to the stability of the knee.

From these studies, it is clear that the LCL is the primary restraint to varus translation and the popliteo-fibular ligament and popliteal muscle tendon unit are important...
secondary stabilizers. If the LCL and deep structures are absent, the ACL and PCL have a secondary restraining role.

The LCL, popliteo-fibular ligament and popliteal muscle tendon unit are all primary restrainers of tibial external rotation, maximal at 30° of flexion, whereas at 90° of flexion, the ACL and PCL are important secondary stabilizers. These biomechanical data form the basis for the dial test.

Finally, the postero-lateral corner structures are secondary restraints to posterior translation.

**Mechanism of injury**

A combined varus and hyperextension force\(^\text{10}\) are thought to produce PLRI and it may also occur with forced external rotation. Isolated injuries are rare, usually the injury is combined most commonly with a PCL, ACL or both as in an acute knee dislocation. In such severe injury, the biceps may be avulsed and the common peroneal nerve is at risk.\(^\text{11}\)

There is disagreement in the literature as to the most common site of postero-lateral corner injury with Ross et al.\(^\text{15}\) stating that the majority occur distally, whilst Stannard et al.\(^\text{16}\) stated they occurred from the femoral side. The difference of opinion regarding the site of rupture may be due to the magnitude of trauma and pattern of associated injuries. The former series were all sports injuries with ACL ruptures, whilst the latter were high-energy injuries resulting in a multi-ligamentous knee injury.

**Clinical features**

In the acute setting, the presentation depends on the degree of trauma. In a severely traumatized patient with an acute dislocation, having first stabilized the patient’s general condition, a careful vascular and peripheral nerve examination must be carried out as injuries to one or both are common. However, patients with lesser degrees of trauma may present as outpatients, and a high index of suspicion is essential to avoid missing such pathology.

Patients presenting late usually complain of pain and instability. The pain is typically postero-lateral and there is instability in extension.

On examination, there may be a varus deformity with hyperextension and lateral thrust in the stance phase of gait.

Lateral collateral instability is detected by applying a varus stress with the knee flexed to 30°. If the joint also opens in full extension, this suggests a concomitant cruciate ligament injury.

Three tests have been described to look specifically for PLRI and its most common associated ligament injury, the PCL:

**The reverse Lachman test**

This is performed as one would for a Lachman to identify ACL laxity. On performing the test, there is the impression of AP laxity but with a definite end point. One should always suspect PL corner laxity in this situation. The PL corner controls posterior translation towards extension. If one looks carefully, there is an impression of posterior movement rather than anterior with coupled external rotation, i.e. the tibial tubercle appears to externally rotate.

**Figure 3** X-ray showing fibula avulsion fracture.

**Dial test**\(^\text{13}\)

With the patient prone, the degree of external rotation is compared with the normal side at 30° and 90° of flexion. If the knee has an increase of 10° external rotation at 30° flexion then PLRI is suspected. If there is an increase at 90° then associated posterior cruciate ligament injury is suspected. This should be part of a routine knee examination.

**Hughston test**\(^\text{12}\)

With the patient supine, both lower limbs are elevated by lifting the great toes. On the affected side, the leg drops into hyperextension and varus, if positive injuries to both the PCL and PLRI are suspected.

**Imaging**

Plain X-rays may show a Segond fracture, avulsion from the fibula or Gerdy’s tubercle any of which should alert the physician for the possibility of PLRI (Fig. 3).

MRI is used to demonstrate the extent of injury and particularly whether the cruciates have been injured. The larger structures of the postero-lateral corner such as the biceps tendon, lateral collateral ligament and popliteal muscle tendon unit are readily identified on MRI. Smaller structures such as the poplteeo-fibular ligament, arcuate ligament and the fabello-fibular ligament are less easily seen and dependent on image quality and interpretation.\(^\text{14}\)

Secondary MRI features of PLRI include bone bruising typically on the medial femoral condyle.\(^\text{15}\) It is important to try and determine the level of injury, i.e. whether structures are avulsed from the femur or tibia/fibula or injured in mid substance, as this influences treatment.

**Treatment: Acute injuries**

**Conservative**

Mild to moderate isolated PLRI does well if treated conservatively particularly in older age group low demand patients.
Acute repair with or without augmentation

Acute injuries (within 2-3 weeks) may be amenable to surgical repair. The aim of surgery is to restore the three key structures of the postero-lateral corner: the LCL, PFL and popliteal muscle tendon unit. Concomitant cruciate ligament injury should be addressed at the same time. The lateral structures are exposed through a hockey shaped incision based over Gerdy's tubercle. From superficial to deep, the postero-lateral corner structures are explored, taking care to protect and assess the common peroneal nerve. Any tendon avulsion from bone can be repaired directly with suture anchors but usually the popliteal muscle ruptures at the musculo-tendinous interval and is difficult to repair. We prefer augmentation with a Larson-type procedure if midsubstance rupture occurs. There is evidence now\textsuperscript{16} that acute augmentation is better than repair alone.

Treatment: Chronic injuries

The majority of patients present with chronic injuries are commonly associated with a PCL injury. Treatment must therefore address both injuries.

The type of graft material used (allograft or autograft) must be chosen. If autograft is used should both hamstrings be harvested or ipsilateral hamstring and patella tendon?

Osteotomy

Valgus osteotomy should be considered in all patients, either as a staged procedure or combined with ligament reconstruction. Patients with varus alignment of the lower limbs and obvious lateral thrust clinically are more suitable for osteotomy and osteotomy alone may be sufficient to reduce symptoms to an acceptable level in low demand patients.

PLRI reconstruction

Whichever of the many techniques have been described over the years for reconstruction of the postero-lateral corner, there are some basic principles\textsuperscript{17}:

- restoration of the three key structures of the postero-lateral corner;
- a graft of sufficient strength to support the postero-lateral corner;
- an isometric graft through all ranges of flexion and extension.

A variety of techniques have been described.

Hughston and Jacobsen\textsuperscript{18} used a lateral gastrocnemius, capsular, LCL and popliteus advancement procedure. This technique has fallen out of favour as it relies on the integrity of postero-lateral structures and did not offer a strong enough repair for more severe injuries.

Clancy\textsuperscript{19} diverted the biceps tendon into a trough formed in the lateral epicondyle and fixed there with a screw and washer. The theoretical advantage of this procedure is that it reduces the external rotation effect of the biceps tendon. Exponents of this technique claim excellent results (Fig. 4).

Muller\textsuperscript{20} used a strip of the iliotibial band along the line of the popliteus tendon as a popliteal bypass procedure.

The Larson\textsuperscript{21} technique, currently commonly used, utilizes a free semitendinosis graft as a figure of eight through a fibula tunnel and around a screw and washer in the lateral femoral condyle. The tunnel technique\textsuperscript{22} is similar but simplified in that the semitendinosis loop forms a triangle and is secured in the lateral epicondyle using an interference screw.

Recently, the two-tailed technique\textsuperscript{16} has been described which although being more complex gives a more anatomical reconstruction by adding a tibial tunnel to the construct.

Authors’ preferred surgical technique

After induction of anaesthesia with the patient supine, a full examination of the knee ligaments is repeated and compared with the opposite side. The tourniquet is then inflated and the patient is prepared and draped. The semitendinosis and gracilis tendons are harvested, trimmed to the required length and whipstitched with No. 5 Ethibond.

With the knee flexed to 60–70°, a lateral curved skin incision is centred distally between Gerdy’s tubercle on the tibia and the anterior aspect of the fibular head. The skin and subcutaneous tissue are reflected from the fascia as a posteriorly based flap. The iliotibial band is then split in the line of its fibres at the level of the lateral femoral condyle and along the length of the skin incision. The common peroneal nerve is exposed at the inferior portion of the
biceps tendon and is dissected free of its fascial attachments and protected. The fibular head is exposed and a transverse tunnel is made using a cannulated reamer (usually 7 or 8 mm). The lateral epicondyle is dissected and a guide wire is inserted from lateral to medial at the site of insertion of the popliteus tendon and lateral collateral ligament. A blind ending 40 mm tunnel is made (8 or 9 mm diameter depending on graft size) and the edges rasped to prevent damage to the tendon. The graft is pulled through the fibular tunnel and then the posterior limb is passed under the iliotibial band. The anterior limb is used to reconstruct the lateral collateral ligament and the posterior limb to reconstruct the popliteo-fibular ligament. The No. 5 Ethibond suture ends are threaded through the guide wire which is then pulled through the medial side of the knee. Whilst maintaining tension on the suture, the graft is positioned so that the posterior limb lies anteriorly and the posterior limb posteriorly within the tunnel. The graft is tensioned and cycled to ensure isometry. A Bio fix interference screw of size 1 mm larger than the reamer size is inserted and a subcuticular 3/0 moncryl used for skin.

Post-operatively if combined with PCL reconstruction, a PCL brace is used for 2 weeks in full extension followed by 4 weeks weight bearing. If combined with an ACL reconstruction, they are braced for 6 weeks with weight bearing as tolerated (Fig. 5a and b).

Conclusion

Injury to the postero-lateral corner, although rare in isolation, is increasingly recognized in association with cruciate ligament injuries. Careful examination will avoid missed injuries.

Surgery is aimed to restore the three key structures of the postero-lateral corner: the lateral collateral ligament, popliteo-fibular ligament and the popliteus muscle tendon unit. A variety of techniques have been described to reconstruct the postero-lateral corner.

References