Dislocation of the knee is a serious injury which can have long-term adverse effects which may impair the patient’s return to physical employment and recreational activity. Vascular disruption and injury to the common peroneal nerve are not unusual and will complicate the initial assessment and management. Presentation with the knee still dislocated gives an obvious diagnosis. However, spontaneous relocation may occur, in which case, the severity of the ligamentous disruption may be underestimated.\(^1,2\) There is still debate about the timing of surgery, the technique of reconstruction and the selection of the most appropriate graft material for the disrupted tissues.

This review emphasises the importance of awareness of the possibility of multiple ligamentous injuries in the traumatised knee and examines the epidemiology, management and outcome of dislocation of the knee.

\section*{Epidemiology}

Dislocation of the knee is uncommon, representing less than 0.2\% of all orthopaedic injuries.\(^3,5\) It occurs mainly as a result of high-energy trauma, usually in young men. Motor-vehicle accidents account for over half of the cases and sports injuries for slightly less than one-third. Dislocation is associated with multiple trauma in between 14\% and 44\% of cases and is bilateral in 5\% of patients.\(^6-10\) (Table I). The mechanism of posterior dislocation (33\%) is usually an anteroposterior force, such as in the ‘dashboard’-type injury. Varus or valgus loading may produce medial (4\%) or lateral (18\%) dislocations associated with fractures of the tibial plateau and combined force vectors will result in rotatory dislocations (5\%).\(^11\)

Dislocation of the knee is always associated with considerable ligamentous disruption, but the pattern of injury varies considerably. Complete disruption of all four major ligament stabilisers (the anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), medial collateral ligament (MCL) and the posterolateral corner) is uncommon and accounts for only 11\% of cases.\(^6,8-10\) (Table III). The most common pattern of injury is a bicruciate disruption with associated disruption of the MCL or posterolateral corner depending upon the direction of the deforming force. The PCL can sustain significant structural damage during dislocation of the knee, but remain in continuity. In these circumstances the ACL and collateral ligaments may be torn with an apparently intact, although functionally incompetent, PCL.\(^14-18\)

\section*{Patterns of injury}

\subsection*{Classification}

Dislocation of the knee may be regarded as acute when seen at less than three weeks, or chronic after this. Anatomical classifications depend on either the direction of the joint dislocation in relation to the femur, as proposed by Kennedy,\(^3\) or on the pattern of ligamentous disruption and associated injuries as described by Schenck\(^11\) and others.\(^2,12\) In Kennedy’s system, five types of dislocation are described: anterior, posterior, lateral, medial and rotatory. These may be subdivided into anteromedial, posteromedial, anterolateral and posterolateral types. A directional-based system of classification is an unreliable guide to the specific pattern of ligamentous disruption and has the drawback that knees which spontaneously reduce, or have been reduced before transfer, are difficult to classify.

A more recent classification based on the nature of the ligamentous disruption was devised by Schenck\(^11\) and modified by others\(^2,12\) (Table II). This system assesses the pattern of ligamentous disruption and the presence or absence of an associated intra-articular fracture, providing a clearer guide to the nature and severity of the injury and options for treatment.

\subsection*{Mechanisms and patterns of ligamentous injury}

Anterior dislocation as a result of hyperextension of the knee is considered to be the most common type of injury, accounting for 40\% of cases.\(^13\) The mechanism of posterior dislocation (33\%) is usually an anteroposterior force, such as in the ‘dashboard’-type injury. Varus or valgus loading may produce medial (4\%) or lateral (18\%) dislocations associated with fractures of the tibial plateau and combined force vectors will result in rotatory dislocations (5\%).\(^11\)

\section*{Associated injuries}

The most common soft-tissue injuries in the dislocated knee are to the popliteal artery (19\%) and the common peroneal nerve (20\%) (Table IV).
Estimates of the incidence of vascular injury in dislocation vary between 4.8% in low-velocity injuries and 65% in high energy trauma. An analysis of more recent studies with larger numbers of patients gives an overall estimate for vascular injury of 19% and emphasises the importance of vigilance for an occult injury (Table IV).

Damage to the common peroneal nerve, although less well recognised than vascular injury, has an overall incidence of 20% (Table IV). It is important to note that in dislocations with disruption of the PCL and posterolateral corner the incidence is greater and may be as high as 45%.24

Fractures of either the distal femur or proximal tibia are present in 16% of cases (Table IV). Bony avulsion injuries of the PCL are not unusual. Marginal avulsion fractures of the lateral tibial plateau (Segond fractures; Fig. 1) may be observed, indicating significant capsular, collateral and cruciate disruption. Fractures of the anteromedial tibial plateau in particular are associated with the presence of disruption of the PCL and posterolateral corner.

### Table I. Epidemiology of dislocation of the knee

<table>
<thead>
<tr>
<th>Author/s</th>
<th>Number of patients</th>
<th>Mean age (yrs)</th>
<th>Male:female</th>
<th>MVA*</th>
<th>Sports injury</th>
<th>Falls</th>
<th>Multiple trauma</th>
<th>Bilateral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harner et al9</td>
<td>31</td>
<td>28</td>
<td>Not stated</td>
<td>8</td>
<td>17</td>
<td>2</td>
<td>Excluded</td>
<td>Not stated</td>
</tr>
<tr>
<td>Liow et al7</td>
<td>21</td>
<td>28</td>
<td>16:5</td>
<td>9</td>
<td>9</td>
<td>3</td>
<td>3 (14%)</td>
<td>1</td>
</tr>
<tr>
<td>Twaddle et al7</td>
<td>60</td>
<td>28</td>
<td>48:12</td>
<td>34</td>
<td>23</td>
<td>3</td>
<td>Not stated</td>
<td>3</td>
</tr>
<tr>
<td>Werier et al8</td>
<td>36</td>
<td>32</td>
<td>28:8</td>
<td>25</td>
<td>4</td>
<td>6</td>
<td>6 (16%)</td>
<td>2</td>
</tr>
<tr>
<td>Wascher2</td>
<td>47</td>
<td>28</td>
<td>36:11</td>
<td>37</td>
<td>10</td>
<td>3</td>
<td>21 (44%)</td>
<td>3</td>
</tr>
<tr>
<td>Almekinders and Logan21</td>
<td>31</td>
<td>32</td>
<td>26:5</td>
<td>16</td>
<td>Not stated</td>
<td>6</td>
<td>Not stated</td>
<td>0</td>
</tr>
<tr>
<td>Summary</td>
<td>228</td>
<td>29</td>
<td>4:1</td>
<td>57%</td>
<td>32%</td>
<td>10%</td>
<td>29%</td>
<td>5%</td>
</tr>
</tbody>
</table>

* MVA, motor-vehicle accident

### Table II. Current classification of dislocation of the knee based on the extent of ligamentous injury

<table>
<thead>
<tr>
<th>Classification</th>
<th>Associated ligamentous injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>KD-I</td>
<td>Dislocation without both cruciates involved</td>
</tr>
<tr>
<td>KD-II</td>
<td>Dislocation with bicruciate disruption only</td>
</tr>
<tr>
<td>KD-III</td>
<td>Dislocation with bicruciate + posteromedial or posterolateral disruption</td>
</tr>
<tr>
<td>KD-IV</td>
<td>Dislocation with bicruciate + posteromedial and posterolateral disruption</td>
</tr>
<tr>
<td>KD-V</td>
<td>Dislocation with fracture</td>
</tr>
</tbody>
</table>

### Table III. Pattern of ligamentous disruption in association with dislocation

<table>
<thead>
<tr>
<th>Author/s</th>
<th>Number of knees</th>
<th>ACL/PCL/MCL/PLC*</th>
<th>ACL/PCL/MCL</th>
<th>ACL/PCL/PLC</th>
<th>ACL/PCL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harner et al9</td>
<td>19</td>
<td>0</td>
<td>10</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Liow et al7</td>
<td>22</td>
<td>0</td>
<td>5</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Werier et al8</td>
<td>38</td>
<td>8</td>
<td>14</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Wascher et al10</td>
<td>50</td>
<td>6</td>
<td>24</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Summary</td>
<td>129</td>
<td>11%</td>
<td>41%</td>
<td>28%</td>
<td>8.5%</td>
</tr>
</tbody>
</table>

* ACL, anterior cruciate ligament; PCL, posterior cruciate ligament; MCL, medial collateral ligament; PLC, posterolateral corner

### Table IV. Incidence of associated injuries with dislocation

<table>
<thead>
<tr>
<th>Author/s</th>
<th>Number of knees</th>
<th>Vascular injury</th>
<th>CPN* palsy</th>
<th>Associated knee fracture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twaddle et al7</td>
<td>63</td>
<td>9</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Liow et al7</td>
<td>22</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Werier et al8</td>
<td>38</td>
<td>4</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Wascher et al10</td>
<td>50</td>
<td>11</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>Almekinders and Logan21</td>
<td>31</td>
<td>10</td>
<td>5</td>
<td>Excluded</td>
</tr>
<tr>
<td>Frassica et al22</td>
<td>20</td>
<td>10</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Sisto and Warren23</td>
<td>20</td>
<td>2</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Summary</td>
<td>244</td>
<td>19%</td>
<td>20%</td>
<td>16%</td>
</tr>
</tbody>
</table>

* CPN, common peroneal nerve
supplement physical examination and assist in deciding whether angiography is required. Although very sensitive, the ankle-brachial index has a low specificity. However, application of a threshold of < 0.90 for this index will give a positive predictive value of 100% for the presence of a vascular injury requiring surgical intervention.

The unreduced dislocation of the knee offers an obvious diagnosis, but if the dislocation has reduced spontaneously the extent of the soft-tissue injury to the knee may not be apparent. An uncontained haemarthrosis causing extensive bruising and swelling on either the medial or lateral side of the knee suggests a major disruption of the joint capsule. This should alert the examiner to the possibility that a dislocation has occurred. Clinical assessment of specific knee ligaments may be difficult because of pain. Recurvatum on passive elevation of the limb is a characteristic finding with disruption of the PCL and posterior capsule. In the presence of bicruciate injury, testing of anteroposterior stability using the Lachman test will be grossly abnormal in both directions. The anterior drawer test is often difficult to perform reliably in the acute situation because of pain, limited knee flexion and muscle spasm. Similarly, the pivot-shift or reverse pivot-shift tests are impossible to undertake in the acutely swollen knee if the MCL is disrupted. In addition, in most other cases there is usually too much discomfort to allow these tests to be performed easily.

In the chronic situation the pivot- and reverse pivot-shift tests can be carried out without difficulty and are much more helpful. The dial test, performed at 30° and 90° of knee flexion, may help in clarifying involvement of the PCL and the posterolateral corner. An increased degree of external rotation of the tibia in comparison with the normal knee is considered to indicate insufficiency of the posterolateral corner at 30° and laxity of the posterolateral corner at 90°.

**Imaging studies.** Plain anteroposterior and lateral radiographs should be obtained in all cases of suspected dislocation, given the high incidence of associated fractures and avulsions (Fig. 2).

The need for routine angiography has been a source of debate. Some authors consider it to be mandatory while others think that it is necessary only in selected cases. The evidence in the literature suggests that routine angiography in all cases is not required. However, it is indicated in any patient who has a history of ischaemia or when there are any signs of impaired circulation such as ischaemic colour change, diminished or absent pulses on presentation with colour or temperature changes below the level of the knee, or a reduced ankle-brachial index (< 0.90). Clearly, if there are doubts it is safer to carry out angiography.

MR angiography can be used as an alternative to standard arteriography in the acute setting. However, this investigation does not yield adequate diagnostic information regarding the ligamentous injury and most patients ultimately require conventional MRI for accurate preoperative planning.

**Management**

**Immediate.** After reduction and temporary stabilisation of the knee the vascular status of the limb should be assessed.
and a vascular opinion sought if there is concern regarding perfusion of the limb.

If a vascular injury is confirmed urgent revascularisation, using bypass grafting of the popliteal artery or repair using a reversed saphenous vein graft, is required since delay in restoring the circulation is associated with an increased risk of amputation. Immediately after vascular repair the medial or lateral capsular injury should be explored and repaired by reattachment of the ligament, augmentation or by a combination of both techniques. In most cases this will stabilise the knee sufficiently to protect the vascular repair. If instability persists, a bridging external fixator may be used. Delayed reconstruction of the cruciate ligaments can then be carried out as a staged procedure if required once swelling of the knee has resolved and movement has been regained. This is usually at least six to 12 months later, to allow time for maturation of the vascular graft to permit the safe application of a tourniquet to the limb.  

Immediate reconstruction of all injured ligaments is a major surgical challenge requiring expertise in reconstructive surgery and access to essential resources including allograft tendons. When appropriate skill and resources are not immediately available, a limited reconstruction of the capsule and collateral ligament should be performed. After an interval to allow healing of the capsule (6 to 12 weeks), reconstruction of the cruciate ligaments can be performed using arthroscopically-assisted techniques, assuming that swelling has reduced and a normal range of movement has been regained. This is usually at least six to 12 months later, to allow time for maturation of the vascular graft to permit the safe application of a tourniquet to the limb.  

Intermediate. In patients with no vascular damage the pattern of ligamentous injury determines early management. Although older studies have suggested that dislocation could be treated non-operatively with good results, there is now an established body of evidence demonstrating that early reconstruction results in a better outcome. A meta-analysis of studies on the management of dislocation concluded that, overall, reconstruction of the ligaments was associated with better results, with a significantly lower risk of residual stiffness and better Lysholm scores.

Immediate reconstruction of all injured ligaments is a major surgical challenge requiring expertise in reconstructive surgery and access to essential resources including allograft tendons. When appropriate skill and resources are not immediately available, a limited reconstruction of the capsule and collateral ligament should be performed. After an interval to allow healing of the capsule (6 to 12 weeks), reconstruction of the cruciate ligaments can be performed using arthroscopically-assisted techniques, assuming that swelling has reduced and a normal range of movement has returned. Attempts to perform arthroscopic surgery before the capsule has healed run the risk of fluid extravasation producing a possible compartment syndrome.

**Operative technique**

**Acute.** The choice of surgical approach will be determined by the pattern of ligamentous injury and the presence of skin loss. Reconstruction of the PCL is the key to reducing the subluxed joint. In the acute phase an anteromedial arthrotomy allows access for reconstruction of both cruciates. In this situation our preference is to use allograft tendons, most commonly tendo Achillis, to reconstruct the PCL and patellar tendon allograft for the ACL, in order to avoid further trauma caused by using autogenous tissue from the injured knee. The use of autogenous grafts from the uninjured knee is an alternative if allograft tendons are not available. In most cases the cruciate injury is a mid-substance disruption or a soft-tissue ‘peel-off’ lesion at either the femoral or tibial insertion. In the latter case reattachment of the ligament is an option, although there is some evidence of a poorer outcome with this technique. Reconstruction of the capsule and collateral ligaments involves reattachment of avulsed structures using suture anchors or other techniques of fixation. Mid-substance ligamentous tears may be repaired directly and augmented with locally available hamstring or patellar tendon grafts.  

**Late.** Arthroscopically-assisted reconstruction of the cruciates can be performed using a combination of autografts and allografts. There is no general consensus about the optimum choice of graft for the various components of the reconstruction. Those used have included autogenous hamstring and patellar tendon grafts, allografts, synthetic grafts and composite grafts. Hamstring or middle-third patellar tendon grafts are commonly used to reconstruct the ACL. For reconstruction of the PCL either a tendo Achillis allograft, the middle-third of the patellar tendon or a composite graft may be used. There is little evidence in the literature to recommend one type of graft over another, although tendo Achillis allograft is now a popular choice. Reconstruction of the collateral ligaments is complicated by scarring and adhesions which obscure the normal anatomy. Direct repair of individual components of the posterolateral corner is rarely possible and reconstruction can be divided into advancement and augmentation techniques. If the ligament midsubstance is not attenuated, its insertion may be advanced, and this may be applied to the attachment of the MCL to the medial femoral condyle. More commonly, since the ligament has been lengthened, augmentation with a tendon graft is required. This applies particularly to the posterolateral corner, when the principles include reconstruction of the lateral collateral ligament and the use of grafts to recreate the role of popliteus and the arcuate ligament complex.

**Common peroneal nerve injury.** This is present in 20% of cases (Table IV). Complete disruption of the nerve is present in 28% of these injuries and in other patients there is often extensive damage to the nerve even although it is in continuity. The extent of the injury can usually be defined at the time of surgery. Patients with lesions in continuity can be observed for signs of spontaneous recovery, which occurs in 20%, with a better prognosis if the nerve is damaged over short distances. Nerve grafting or transfer of tibialis posterior can be considered as a late reconstructive procedure. The former is best reserved for patients with involvement of short segments since those with disruption greater than 7 cm have a poor outlook for functional recovery after grafting. Transfer of the tendon of tibialis posterior may be a useful alternative procedure to restore some dorsiflexion.  

**Rehabilitation.** There is good evidence that accelerated post-operative rehabilitation with bracing and early movement reduces the risk of disabling stiffness associated with
prolonged immobilisation.\textsuperscript{49} Mobilisation of the knee must be carefully supervised, with most authors recommending a more cautious regime than that used after isolated ligament reconstruction.\textsuperscript{8,9,44-46,48-51} Patients may be mobilised in a hinged knee brace with touch weight-bearing for six weeks post-operatively, after which they can progress to full weight-bearing by three months. Passive or active assisted knee flexion is recommended for the first six to 12 weeks after reconstruction to protect the PCL component of the repair. Rehabilitation must be matched to the pattern of ligamentous injury and the presence of associated bony, vascular and neurological damage for each patient. The development of stiffness may necessitate a more rapid programme of rehabilitation. If stiffness persists, manipulation under anaesthesia or arthrolysis can be considered between three and six months after surgery.

**Outcome**

Dislocation of the knee results in severe soft-tissue disruption and although modern surgical techniques and better understanding of these injuries have improved the outcome, a return to normal function is uncommon. In three recent studies\textsuperscript{8-10} in which patients were evaluated using the International Knee Documentation\textsuperscript{31} score, none was rated as normal at the time of review. Overall, 39\% were nearly normal, 40\% were abnormal and 21\% were severely abnormal. Although the range of movement and functional outcome scores are better in patients treated by ligamentous reconstruction rather than non-surgical treatment, some residual impairment of function is expected.\textsuperscript{47} The most common complications after surgical repair are joint stiffness and failure of some component of the reconstruction. In one long-term evaluation of outcome, dislocation was associated with a risk of post-traumatic osteoarthritis of 50\%.\textsuperscript{6}

**Summary**

Dislocation of the knee is not a common injury, but it is important to consider the diagnosis after high-energy trauma even when radiographs demonstrate congruent joint surfaces, since spontaneous reduction may have occurred. If, in addition, the physical signs include an uncontained haemarthrosis with extensive bruising, an abnormal degree of recurvatum and varus-valgus instability with the knee in full extension, further importance should be attached to this possible diagnosis. Early neurovascular assessment is essential and angiography should be carried out if indicated. Multiple ligamentous reconstruction in the acute situation should only be attempted when appropriate expertise and equipment are available but primary repair of injuries of the capsule with secondary reconstruction of the cruciates is an acceptable alternative. The results of ligamentous reconstruction after dislocation of the knee are improving, but patients should be given a guarded prognosis for recovery of function and warned of the long-term risk of osteoarthritis.

**References**