Posterolateral instability of the knee is difficult to diagnose and treat. It has been attributed to failure of ligament reconstruction and has been the cause of numerous knee operations.

We present a small group of patients who complained of giving way of the knee and who had an increased range of external rotation of the tibia at 90° knee flexion. The patients all had similar symptoms. We describe the standing apprehension test, which was positive in every case. Anterior subluxation of the lateral femoral condyle was detected manually in four patients and confirmed by radiography and MRI in one.

The medial knee pain which is often associated with episodes of instability is probably due to stretching of the posteromedial soft tissues and perhaps the saphenous nerve.

Received 11 May 1993; Accepted after revision 11 October 1993

Complaints of knee instability are difficult to assess when the anterior and posterior cruciate ligaments are intact, or after a technically successful reconstruction of the anterior cruciate ligament (ACL). In a series of ACL reconstructions, O’Brien et al (1991) noted that posterolateral rotatory laxity was one reason for poor results. Hughston and Jacobson (1985) also recognised posterolateral rotatory instability and suggested that the associated medial knee pain was caused when distraction of the posterolateral corner produced compression of the medial compartment.

We present a series of patients in whom the sensation of giving way was associated with an increased range of external rotation at 90° flexion in knees with intact or successfully repaired anterior cruciate ligaments.

**PATIENTS**

Fifteen patients who presented with similar symptoms and had a demonstrable increase in external rotation at 90° knee flexion were followed for two to five years. They fell into two groups. Group I included five patients in whom a previous ACL injury had been treated by reconstruction and group II contained ten patients with no evidence of cruciate ligament injury. The duration of their symptoms ranged from one to ten years. Details of the patients are given in Tables I and II.

**METHODS AND RESULTS**

**Mechanism of injury.** All patients had suffered either a twisting or hyperextension injury of the knee. There were no contact or high-energy injuries such as occur in motor car or motor cycle accidents.

**Diagnosis.** All the patients presented with the complaint of unpredictable giving way which occurred often without provocation even when standing. This instability prevented participation in athletic pursuits but did not interfere with less demanding physical activities or sedentary jobs.

The episodes of instability were not followed by swelling of the knee or limitation of function. All patients, however, experienced medial knee pain during them. In eight cases, this continued for some time after each episode or there was persistent tenderness on the medial aspect of the knee.

Thirteen patients had been subjected to a variety of operations, such as repeated arthroscopy and meniscectomy, before presenting to the senior author (DAF) (Tables I and II).

All those in group I underwent repeat arthroscopy (DAF) for evaluation of the ACL reconstruction. All those in group II had arthroscopy performed for various other reasons (Table II). Physical examination showed posterolateral rotatory laxity at 90° flexion in all cases (Fig. 1). This increased external tibial rotation was either not demonstrable or was much less marked when the knee was in 30° flexion. No patient had varus or valgus laxity, or recurvatum. The reverse pivot-shift test was negative in all cases.
Method of demonstrating the increased range of external tibial rotation at 90° flexion.

Ligament laxity testing with the OSI Ligament Laxity Tester (OSI, Hayward, California) was performed on all patients in group I; no patient had more than a 2 mm difference between the two sides. Two patients, one in each group, had 1+ laxity on posterior drawer testing. The degree of laxity was never more than 1+ as demonstrated by the quadriceps active test, and arthroscopic evaluation showed no loss of continuity of any posterior cruciate ligament.

Instability could be demonstrated by the following test. With the patient standing and bearing weight on the affected leg, the examiner's thumb was placed on the anterior part of the lateral femoral condyle spanning the joint line (Fig. 2A). The patient was asked to flex the knee slightly and at the same time the examiner pushed the femoral condyle with the thumb. The increased rotation could be felt as the tip of the thumb moved with the femur and the proximal portion of the thumb remained in contact with the lateral tibia (Fig. 2B). The patient experienced the feeling of giving way (Fig. 3). We termed this manoeuvre the standing apprehension test. In all 15

Table I. Details of patients in group I (reconstructed ACL)

<table>
<thead>
<tr>
<th>Case</th>
<th>Time from injury (yr)</th>
<th>Mechanism of injury</th>
<th>Method of ACL reconstruction*</th>
<th>Persisting medial pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>Hyperextension</td>
<td>STD</td>
<td>+</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>Twist</td>
<td>STD</td>
<td>+</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>Twist</td>
<td>BTB</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>Twist</td>
<td>ITB</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>Hyperextension</td>
<td>STD</td>
<td></td>
</tr>
</tbody>
</table>

* STD = semitendinosus tendon graft; BTB = bone-tendon-bone patellar tendon graft; ITB = iliotibial band graft

Fig. 1

Fig. 2

Figure 2A – The standing apprehension test. The thumb palpates both the anterior lateral joint line and anterior lateral femur. Figure 2B – The femur is felt to rotate as the tip of the thumb pushes.

Case 1, group I. Standing apprehension test (a) reduced, (b) subluxated.
Table II. Details of patients in group II (intact ACL)

<table>
<thead>
<tr>
<th>Case</th>
<th>Time from injury (yr)</th>
<th>Mechanism</th>
<th>Surgical treatments before diagnosis</th>
<th>Medial pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.5</td>
<td>Twist</td>
<td>Lateral meniscectomy</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Popliteal cyst</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Medial meniscectomy</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>Twist</td>
<td>Medial meniscectomy (x 3)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>Twist</td>
<td>Lateral retinacular release</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lateral meniscectomy</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>Twist</td>
<td>Arthroscopy</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>Twist</td>
<td>–</td>
<td>+</td>
</tr>
<tr>
<td>6</td>
<td>2.5</td>
<td>Twist</td>
<td>Medial meniscectomy (x 2)</td>
<td>+</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>Twist</td>
<td>Arthroscopy</td>
<td>+</td>
</tr>
<tr>
<td>8</td>
<td>10</td>
<td>Twist</td>
<td>Lateral meniscectomy (x 3)</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>6</td>
<td>Twist</td>
<td>Arthroscopy</td>
<td>+</td>
</tr>
<tr>
<td>10</td>
<td>4</td>
<td>Twist</td>
<td>Arthroscopy</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Drilling of medial femoral condyle</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 4
The same patient could voluntarily maintain the subluxated position of his left knee. He had undergone reconstruction of his ruptured ACL 2 years before.

patients it produced the feeling of giving way and, in all, movement of the femoral condyle on the tibial plateau could be felt by the examiner. In three patients, the test produced gross subluxation of the femoral condyle and one patient was able to maintain the subluxated position for long enough to be photographed (Fig. 4) and to have radiography and MRI (Figs 5 and 6). It was clear from these studies that the giving way resulted from anterior displacement of the lateral femoral condyle on the tibial plateau.

DISCUSSION
The only consistently positive physical finding was an increase in external rotation with the knee flexed to 90°.

In group I, the symptoms of instability were present before the ACL reconstruction in two cases (i.e., the instability was part of the ACL injury complex but was not appreciated). In the other three cases in group I, the knees functioned well after ACL reconstruction until they sustained minor injuries which caused recurrent instability.

As Hughston and Jacobson (1985) have noted, confusion regarding posterolateral instability can lead to numerous operations, usually repeated arthroscopy and meniscectomy. Pivoting of the femur on the medial tibial condyle, possibly rotating on the medial meniscus, causes painful stretching of the medial soft tissues which may suggest the diagnosis of a torn medial meniscus. In eight of our patients, however, the medial pain persisted and occurred independently of the episodes of instability, for example during walking or rehabilitation exercises. Medial tenderness to palpation was localised to an area approximately 4 to 5 finger breadths above the medial epicondyle, along the line of the subsartorial canal and was also found at the anterior medial joint line and occasionally at the medial tibial plateau. There was never any accompanying numbness. In seven of the eight patients, the pain was relieved by local anaesthetic nerve block of the saphenous nerve. Nerve blocks have been used to diagnose and treat saphenous nerve entrapment (Romanoff et al 1989) and it may be that the medial condylar rotation causes traction on the nerve, possibly as it leaves the adductor canal. This would explain the medial pain which is not related to degenerative change on the meniscus or relieved by meniscectomy. The eighth patient responded to the injection of local anaesthetic at the medial joint line beneath the tibial collateral ligament.

The patient who underwent lateral retinacular release was thought to have patellar subluxation because of the position the patella adopted when the lateral femoral condyle was subluxated. One other patient was extensively investigated for suspected patellar subluxation. He had patella alta associated with dysplasia of the vastus medialis and complained that the patella dislocated inwards. In reality, it was the femur which rotated, carrying the patella with it in the trochlear groove.

Gollehon, Torzilli and Warren (1987) and Grood, Stowers and Noyes (1988) advised testing for competence of the posterior lateral complex with the knee flexed 30° to 40°. In our series, increased external rotation at 30° was not consistently found. The average increase of 6° reported by Grood et al (1988) from laboratory studies is difficult.
to appreciate when the position of the knee and laxity of the ankle have to be judged at the same time. Cooper (1991) also had difficulty in performing this test. In the laboratory, all the posterior lateral structures, including the lateral collateral ligament, had to be sectioned before a significant increase in external rotation at 30° flexion could be detected (Grood et al 1988). All the lateral collateral ligaments in our cases were tight when tested by manual stress at 0° and 30° flexion.

Performing the test as shown in Figure 2 at 90° flexion eliminates errors from ankle rotation and the use of both hands to push and rotate the tibia allows easier appreciation of external rotation and of posterior translation, which has also been shown to result from laxity of the posterior lateral structures (Noyes et al 1993). This finding should, nevertheless, be confirmed by a positive standing apprehension test. The reproduction of the symptoms of giving way is the significant finding.

Grood et al (1988) suggested that a deficiency of the posterior cruciate ligament was necessary to allow an increase in external rotation at 90° flexion. All except two of our patients appeared to have competent posterior cruciate ligaments by evaluation which included MRI.

Shino, Horibe and Ono (1987) have suggested that the instability is due to posterior subluxation of the lateral tibial plateau caused by biceps femoris activity and reduced by popliteus muscle action. Their patients had severely damaged posterior cruciate ligaments and posterior lateral complexes. In one of our patients (group I, case 1) the MRI and radiographs showed that the tibia did not translate posteriorly, but that the lateral femoral condyle pivoted forwards about the medial condyle. Our
MRI utilising a volume-acquired gradient-echo axial series at 0.7 mm slice thickness and continuous incrementation through the distal femur and proximal tibia. The sections are taken at the levels of the proximal tibia (a), the distal femoral condyles (b) and the mid-femoral condyles (c) with the patient maintaining voluntary subluxation. Cursors (O) were positioned at the centre of the medial and lateral tibial plateaux and maintained in this location throughout the 128 acquired axial sections. The lateral femoral condyle is displaced anteriorly with respect to the centre of the lateral tibial plateau.

Standing test was performed with the tibia fixed, further confirming the findings of Jakob, Hassler and Staubli (1981) that it is the rotation of the femur on the tibia which produces the sense of giving way in posterolateral instability.

We recognise that our description of movement of the femur on the fixed tibia is at variance with the standard convention that instabilities should be described in terms of movement of the tibia (Noyes, Grood and Torzilli 1989). We have found medial rotation of the femur, and our description makes it easier to understand the giving way and the occurrence of pain on the medial side.

During repeated arthroscopic examinations, we found no evidence of intra-articular pathology that could explain the instability. Two of the five patients in group I, however, were found to have injuries to the popliteus muscle and tendon at open lateral reconstruction which were not visible arthroscopically. In the semiflexed knee, and therefore during the stance phase of gait, the popliteus is the main medial rotator of the tibia (Mann and Hagy 1977). Failure to rotate the tibia internally (or the femur externally) allows the lateral femoral condyle to translate forwards in relation to the lateral tibial spine, prevents winding up of the anterior and posterior cruciate ligaments (Kapandji 1970), and causes loss of contact between the tibial spine and the femoral condyle. Gollehon et al (1987) believed that the popliteus was in the best position to prevent external rotation when the knee was flexed to 90°.

Patients may have increased external rotation of the tibia at 90° flexion and yet not develop symptoms of instability (Cooper 1991). Increased external rotation and a positive reverse pivot-shift test have been shown to be detectable under anaesthesia in asymptomatic patients (Cooper 1991). Zarins and Rowe (1986) noted that the reverse pivot-shift test was positive in seven knees after ACL reconstruction, but he did not comment on the clinical consequences. O’Brien et al (1991) thought that increased external rotation of the tibia after anterior cruciate ligament reconstruction was associated with an unsatisfactory result but they did not state whether any subjective symptoms accompanied the increased rotation.

In our group of patients the feeling of giving way is
annoying but it does not always require surgical treatment, perhaps because the episodes of instability are not followed by swelling or prolonged pain. The instability did, however, prevent participation in athletic activities (except golf) in all our patients. Two believed that they could live with the instability if the pain was relieved, and anaesthetic block of the saphenous nerve did relieve pain temporarily, and allowed surgery to be deferred.

Conclusion. Complaints of momentary giving way and medial knee pain without effusion, associated with the finding of increased external tibial rotation at 90° flexion, suggest anterior translation of the lateral femoral condyle as the cause of the giving way. The diagnosis was confirmed by a positive standing apprehension test. The syndrome may be associated with ACL or PCL injuries, may persist after successful cruciate ligament reconstruction, or may present as an isolated phenomenon.

The authors chose not to respond to the request for a conflict of interest statement.

REFERENCES


