Fractures of the anterior intercondylar eminence in children are relatively uncommon. There is considerable debate as to the best treatment of displaced fractures, but most methods described in the literature involve an open procedure combined with some form of fixation. Using human anatomical dissections, we have shown that the transverse meniscal ligament can become incarcerated within the fracture and act as a block to reduction. We describe an arthroscopic technique which requires no fixation device and report the results of its use in eight displaced fractures. This method gives reliable results and offers the advantage of less potential morbidity.

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The anterior intercondylar eminence of the tibia lies between the anterior poles of the menisci, anterior to the anterior tibial spine (Fig. 1). The anterior cruciate ligament is attached to it. Fractures in this area are uncommon in adolescence with a reported annual incidence of 3 in 100,000. They have been classified into three types by Meyers and McKeever. Type I is the least severe with minimal displacement of the avulsed fragment and a high degree of bone apposition. Type II is displaced, but retains some apposition to the intercondylar eminence and type III is displaced with no apposition (Fig. 2). A modification of this classification describes a type-IV fracture in which the fragment is displaced and comminuted.

While most authors agree that undisplaced type-I fractures should be treated conservatively, there is much debate as to the best treatment of displaced type-II and type-III fractures. Most treatments described for displaced fractures involve some form of open reduction and internal fixation using absorbable sutures, multiple pins, Kirschner wires or screws.

We undertook a clinical and cadaver study which identified the transverse meniscal ligament as the main obstacle to reduction and now describe an arthroscopic technique to treat these fractures without internal fixation.

Patients and Methods

We performed the anatomical study on five fresh adult (two male, three female) cadaver knees which were dissected leaving the anterior structures intact. The anterior intercondylar eminence was osteotomised to simulate a displaced fracture and the structures incarcerated within the fracture identified. The best method of reduction of the fracture was then sought and the reduction compared with the knee held in flexion and extension.

For the clinical study, we treated and followed up eight adolescents (six girls, two boys) with a mean age of 12.6 years (11 to 14) with type-II or type-III fractures of the anterior intercondylar eminence, according to Meyers and McKeever, as judged by plain anteroposterior and lateral radiographs. There were five fractures of the left knee and three of the right. Although patients were unable to describe the exact mechanism of injury, three fractures occurred after a fall from a cycle and the remaining five during sporting activities. Six were type-II and two were type-III injuries. All patients underwent examination under anaesthesia and arthroscopy within 48 hours of injury. After washout of the haemarthrosis, the transverse meniscal ligament was seen to obstruct reduction. Using a probe, the ligament was pulled out of the site of the fracture which was then reduced by firm pressure. The reduction could be maintained by keeping the knee in hyperextension. An above-knee plaster cylinder was then applied with the knee in the hyperextended position. After observation overnight,
The patient was discharged the next day. Serial radiographs were taken at the first and second week after operation. Patients were non-weight-bearing for six weeks after which the plaster was removed. Full weight-bearing and physiotherapy were then started. Patients were followed up clinically using the International Knee Documentation Committee (IKDC) knee assessment. This includes documentation, qualification and evaluation sections. For qualification, there are four parameters (subjective assessment, symptoms, range of movement and ligament examination). The term qualification is used because no score is given. Instead, each parameter is qualified as ‘normal’ (A), ‘nearly normal’ (B), ‘abnormal’ (C) or ‘severely abnormal’ (D) to give a group grade. The lowest group grade of all of the parameters determines the final evaluation which is qualified A, B, C or D in the same manner.

Results

All five dissected specimens showed a transverse meniscal ligament (Fig. 3). The osteotomy showed that this could become incarcerated in the fracture (Fig. 4). Once the transverse meniscal ligament had been pulled away, the fracture could be reduced with firm pressure from a probe (Fig. 5) and remained reduced when the knee was hyperextended. When the knee was flexed beyond 30°, the site of the osteotomy was seen to open up with loss of anatomical reduction (Fig. 6).

All eight patients were followed up clinically for a mean of 17 months (6 to 30). Table I gives the results. There were no postoperative complications.

Discussion

Incarceration of anterior intra-articular structures after avulsion of the anterior intercondylar eminence has been identified more often since the advent of arthroscopy. It has been claimed that the meniscus (either medial or more commonly lateral) is the most commonly incarcerated tissue. The transverse ligament connects the anterior convex margin of the lateral meniscus to the anterior end of the medial meniscus, towards the articular rim. Our dissections showed that the transverse meniscal ligament becomes incarcerated within a displaced fracture of the anterior intercondylar eminence thus blocking reduction. We accept that it was not possible to mimic exactly the mechanism of fracture. We also accept the cadaver knees were obtained from adults with fused proximal physes but those of the relevant age are rare and were not available to us.

We found that reduction of the fracture could only be maintained by placing the knee in hyperextension. It has been claimed that complete extension stretches the anteromedial and intermediate bundles of the anterior cruciate ligament (ACL) and that hyperextension places the posterolateral bundle under tension which, in theory, would constitute an obstacle to reduction. Some authors have also stated that a knee placed in a hyperextension cast is uncomfortable. Our dissections did not show that any part of the ACL became taut when the knee was hyperextended. Clinically, a cast in hyperextension was well tolerated by the patients and had no long-term effect on function.

We feel that our technique is satisfactory. Judged by the
IKDC knee assessment, all patients reported that their knee had returned to a normal or a nearly normal. Those whose knee was nearly normal complained of feelings of instability. None, however, showed ligamentous abnormalities on examination and all had returned to normal sporting activities.

A recent review of fractures of the anterior intercondylar eminence in children showed similar clinical results and no significant difference in clinical outcome between patients treated conservatively or by open reduction and internal fixation. Another study showed that whether management was open or closed had no bearing on the eventual outcome.

**Table 1.** Details and clinical results in eight children with displaced fractures of the anterior intercondylar eminence treated by an arthroscopic technique which required no fixation device.

<table>
<thead>
<tr>
<th>Case</th>
<th>Age (yrs)</th>
<th>Gender</th>
<th>Side</th>
<th>Accident</th>
<th>Type of fracture</th>
<th>Follow-up (mths)</th>
<th>IKDC score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11.4</td>
<td>F</td>
<td>L</td>
<td>Sport</td>
<td>II</td>
<td>26</td>
<td>A</td>
</tr>
<tr>
<td>2</td>
<td>12.8</td>
<td>F</td>
<td>L</td>
<td>Sport</td>
<td>II</td>
<td>6</td>
<td>B</td>
</tr>
<tr>
<td>3</td>
<td>13.4</td>
<td>M</td>
<td>R</td>
<td>Cycle</td>
<td>II</td>
<td>28</td>
<td>A</td>
</tr>
<tr>
<td>4</td>
<td>12.2</td>
<td>F</td>
<td>L</td>
<td>Sport</td>
<td>II</td>
<td>16</td>
<td>A</td>
</tr>
<tr>
<td>5</td>
<td>13.9</td>
<td>F</td>
<td>L</td>
<td>Cycle</td>
<td>III</td>
<td>30</td>
<td>A</td>
</tr>
<tr>
<td>6</td>
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<td>10</td>
<td>A</td>
</tr>
<tr>
<td>7</td>
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<td>II</td>
<td>6</td>
<td>B</td>
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<td>8</td>
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<td>II</td>
<td>14</td>
<td>A</td>
</tr>
</tbody>
</table>

IKDC knee assessment, all patients reported that their knee had returned to a normal or a nearly normal. Those whose knee was nearly normal complained of feelings of instability. None, however, showed ligamentous abnormalities on examination and all had returned to normal sporting activities.
outcome. Fixation by an open procedure requires an arthrotomy and possibly a further procedure to remove the fixation device if the material is not absorbable. Introducing foreign material into a knee and multiple arthrotomies increases the risk of infection. Wires, screws and multiple pins also have the potential to damage the proximal tibial growth plate. With these disadvantages in mind, we feel that the closed procedure described is preferable to an open method.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References