OSTEOCHONDRAL FRACTURES OF THE FEMORAL CONDYLES

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The origin of a loose body suddenly appearing in an otherwise healthy knee joint has always been a matter for speculation. Over several years we have been particularly interested in the problems of internal derangements of the knee in young people. The rarity of meniscal tears in such patients is recognised. The unexpected discovery of a fresh osteochondral fracture at the time of arthrotomy has led to an increasing awareness of this condition and has prompted this investigation.

This paper will be confined to osteochondral fractures of the femoral condyles and will exclude tangential osteochondral fractures of the patella described by Milgram (1943).

FIGS. 1 TO 5
The various ways in which the fractures occur. Figure 1—A direct shearing force on the medial condyle. Figure 2—A rotary compression force on the medial epicondyle. Figure 3—A direct shearing force on the lateral condyle. Figure 4—A rotary compression force on the lateral condyle. Figure 5—The action of the patella on the lateral condyle in dislocation or reduction.

MECHANISM

On the basis of mechanism two main clinical groups are apparent: exogenous fractures resulting from direct injury, and endogenous fractures resulting from combined rotary and compression forces (Table 1).
Tangential fractures of the medial condyle may result from a direct exogenous injury to an unprotected condylar surface shearing off a large peripheral sector of cartilage and subchondral bone (Fig. 1). Endogenous osteochondral fractures of the medial condyle are the result of combined rotary and compression forces acting on a fixed weight-bearing surface. The lesion is small and centrally placed (Fig. 2). The role of the tibial spine in the production of this lesion is not clear.

A direct exogenous shearing injury of the lateral condyle may cause a large peripheral osteochondral fracture (Fig. 3). Endogenous osteochondral fractures of the lateral condyle may result from combined rotary and compression forces. As with the medial endogenous type, the lesion is small and centrally placed (Fig. 4). In addition the shearing force of the patella, either at the time of dislocation or of reduction, may cause a small osteochondral fracture of the lateral femoral condyle (Fig. 5).

**TABLE I**

**Classification of Osteochondral Fractures of the Femoral Condyles**

<table>
<thead>
<tr>
<th>Site</th>
<th>Type</th>
<th>Mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medial condyle</td>
<td>Exogenous</td>
<td>Direct impact</td>
</tr>
<tr>
<td></td>
<td>Endogenous</td>
<td>Rotation and compression forces</td>
</tr>
<tr>
<td>Lateral condyle</td>
<td>Exogenous</td>
<td>Direct impact</td>
</tr>
<tr>
<td></td>
<td>Endogenous</td>
<td>1) Rotation and compression</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2) Patellar dislocation or reduction</td>
</tr>
</tbody>
</table>

**TABLE II**

**Summary of Experimental Endogenous Femoral Osteochondral Fractures**

<table>
<thead>
<tr>
<th>Number of experiments</th>
<th>Knee flexion in degrees</th>
<th>Degrees of rotation</th>
<th>Axial compression in pounds</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>0</td>
<td>45 lateral</td>
<td>300–400</td>
<td>Five cartilage defects of the medial condyle</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>45 medial</td>
<td>300–400</td>
<td>Three medial tibial plateau fractures only</td>
</tr>
<tr>
<td>4</td>
<td>35</td>
<td>45 lateral</td>
<td>300–400</td>
<td>Four lateral tibial plateau fractures only</td>
</tr>
<tr>
<td>6</td>
<td>35</td>
<td>45 medial</td>
<td>300–400</td>
<td>Four cartilage defects of the medial condyle; two osteochondral fractures</td>
</tr>
</tbody>
</table>

**EXPERIMENTAL STUDIES**

To study further the endogenous osteochondral fracture mechanism a "stress machine" was employed. In this apparatus large bone-holding clamps grasp the femur and tibia at fixed distances above and below the knee joint. Stress forces are generated by means of a dial torque hand wrench, and the readings are converted to inch-pounds by means of conversion tables. With this machine it is possible to exert almost any conceivable force against the knee. These forces are static and not kinetic; nevertheless, certain osteochondral fractures have been produced in the fresh cadaver (Fig. 6).
The effects of predetermined stresses to the knee joint were studied in an attempt to produce endogenous osteochondral fractures. The clamps were applied with the least dissection possible. The right leg of the cadaver was always used. The knee was subjected to 300 to 400 pounds of axial compression. With the knee joint in full extension or 35 degrees of flexion the tibia was rotated either medially or laterally on a fixed femur. The axial compression force of 300 to 400 pounds was applied to duplicate the forces of weight bearing and muscular contraction, while 35 degrees of knee flexion was chosen to approximate the knee position during erect activity. The limit of tibial rotation in all cases, medial or lateral, was 45 degrees. The results are summarised in Table II.

The experimental lesions were few in number and not always of the same depth. This, it is thought, is directly related to the age of the cadavers, with an average of sixty-nine years.

Clinically the osteochondral fracture is almost always confined to the adolescent. Landells (1957) and Rosenberg (1964) have pointed out that adult articular cartilage tends to tear at the junction between calcified and uncalcified cartilage, leaving the osteochondral junction undisturbed. This cleavage plane has been referred to as the tide mark (Fig. 7). The adolescent in contrast does not have a tide mark because he has very little, if any, calcified cartilage so that the shearing forces are transmitted deep to the osteochondral junction (Fig. 8).

**DIAGNOSIS**

The fracture almost always occurs in the adolescent, with no pre-existing recognisable knee deformity. There is a history of either a direct blow to a flexed knee or a violent twist
on a flexed knee. In the latter type a loud snap may be both heard and felt. Pain is considerable — particularly on attempted weight bearing. With both types of injury a frank effusion occurs, which, on aspiration during the first two weeks, reveals bloody synovial fluid and occasionally fat droplets. The knee joint lacks full extension and may be locked. It is difficult to determine how often lateral dislocation of the patella is associated with the endogenous lateral condylar fracture. If it has occurred, there may be medial compartment tenderness from the tear of the medial patellar retinacular fibres. The combination of medial compartment tenderness, a locked knee, and effusion may lead to the erroneous diagnosis of medial meniscus tear. Associated cruciate and collateral ligament instability is not found. If first seen some time later the patient complains of pain, effusion and intermittent locking.

Radiologically the loose or undisplaced fragment may not be seen in the routine radiographs. High quality radiographs including antero-posterior, lateral, right and left obliques, tunnel and patellar views all may be required to locate the elusive fragment (Fig. 9). Often radiographs are reported to be normal in the unsuspected but surgically proven case. In the late case the ununited osteochondral fracture acquires the radiological appearance of osteochondritis dissecans.

**TREATMENT**

Treatment is by operation, because of the difficulty in determining the size of the fragment before operation: involvement of unexpectedly large weight-bearing surfaces and the subsequent internal derangement that results from fragments being left in the joint makes conservative treatment undesirable.

At the time of arthrotomy a decision has to be made whether to remove the fragment or replace it. We believe that replacement is indicated if the fracture is fresh, if it is large and if it is on the weight-bearing surface and surgically accessible.
It is important that diagnosis and operation should not be delayed. Even after only ten days delay the host area begins to fill in and the free fragment will not fit back without difficulty. Trimming the fragment never achieves the precise fit possible with a fresh fragment. Pins projecting into the knee joint are contra-indicated because they irritate the sensitive synovial lining and may result in harmful pannus formation and joint stiffness.

Whereas replacement of a fresh osteochondral fragment is a new and exciting surgical exercise, there is no evidence to suggest that the removal of these fragments produces serious complications. A recent review of eight patients seen on an average of six years after removal of large osteochondral fragments showed most satisfactory results in seven, but it is felt that a fifteen-year follow-up would be more helpful in deciding whether or not to discard the fragment.

CONCLUSIONS
1. The importance of recognising osteochondral fractures of the femoral condyle in the adolescent knee joint is emphasised.
2. The mechanism of the formation of the fractures is discussed. Essentially, a powerful rotary and compressive force shears off cartilage and subchondral bone. The absence of lateral condylar lesions in the experimental group lends support to the theory that the patella may cause the fracture by impingement.
3. On the basis of the mechanism a clinical classification of osteochondral fractures of the femoral condyles is presented.
4. Early surgery is recommended. The arguments for removal or replacement of the fragment are discussed.

REFERENCES