FRACTURES OF THE TIBIAL CONDyles

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Fractures of the tibial condyles, involving as they do weight-bearing articular surfaces and important soft tissues such as ligaments and semilunar cartilages, present a variety of problems in treatment and prognosis. Most opinions previously expressed in the literature have been in favour of operative reduction in most cases (Cubbins, Conley, Callahan and Scuderi 1934, Leadbetter and Hand 1940, Buckner 1941, Cave 1948, Palmer 1951) on the grounds that anatomical reduction is the primary aim of treatment and that this can more often be achieved by open reduction than by closed manipulation. On the other hand Cotton (1936) and Caldwell (1936) considered that operative reduction is rarely justified, and Rick (1941) used it only in cases with severe displacement.

This review of tibial condyle fractures treated during the years 1941 to 1953 was made in an attempt to assess the results of treatment, both conservative and operative. The records and radiographs of ninety-three patients with such injuries have been studied, and sixty patients attended for follow-up within the past few months.

ETIOLOGY

Fractures of the tibial condyles result either from valgus or varus strains occurring at the knee joint, from direct violence to the outer or inner aspect of the extended weight-bearing knee or from the indirect violence of a fall from a height upon the foot, transmitted up the tibial shaft to the extended knee. Varus strains lead to fractures of the lateral tibial condyle with

<table>
<thead>
<tr>
<th>Type of Injury</th>
<th>Number of cases</th>
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</thead>
<tbody>
<tr>
<td>&quot;Bumper&quot; or &quot;fender&quot; injuries to pedestrians</td>
<td>17</td>
</tr>
<tr>
<td>Motor cyclists or cyclists</td>
<td>23</td>
</tr>
<tr>
<td>Fall from a height</td>
<td>24</td>
</tr>
<tr>
<td>Struck by falling objects</td>
<td>10</td>
</tr>
<tr>
<td>Injuries by animals</td>
<td>5</td>
</tr>
<tr>
<td>Football injuries</td>
<td>6</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>93</td>
</tr>
</tbody>
</table>

associated damage to the medial ligament and sometimes to the anterior cruciate ligament. Varus strains, which are much less common, lead to fractures of the medial tibial condyle with associated damage to the lateral ligament and sometimes to the anterior cruciate ligament. The various causes of these injuries are shown in Table 1.

There were two pathological fractures, one of a tibia affected by Paget's disease, and the other in a patient with severe rheumatoid arthritis.

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Age incidence - The incidence of these injuries is twice as great in the fifth and sixth decades of life as in the third and fourth or seventh and eighth (Table II). The youngest patient in this series was twenty-three, the oldest eighty-four. There were no compound fractures.

### TABLE II

**Age Incidence of Tibial Condyle Injuries**

<table>
<thead>
<tr>
<th>Age</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-40</td>
<td>23</td>
</tr>
<tr>
<td>41-60</td>
<td>45</td>
</tr>
<tr>
<td>61-80</td>
<td>24</td>
</tr>
<tr>
<td>81+</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>93</td>
</tr>
</tbody>
</table>

**CLASSIFICATION**

A satisfactory classification is that suggested by Palmer (1951), with certain modifications.

**Type I. Split fractures** (Fig. 1) - This is the least common type of tibial condyle fracture. The lateral edge of the lateral femoral condyle is driven down into the articular surface of the lateral tibial condyle, causing a wedge-shaped fragment of varying size to become split off and displaced outwards. There is seldom any downward displacement of the lateral fragment in this type of injury. The fracture is associated with sprains of the medial ligament of varying severity. Similar fractures of the medial tibial condyle with sprains of the lateral ligament occurred in four of the seven patients with Type I fractures. These were the only medial condyle injuries in the series after fractures of both condyles (Type III) had been excluded.

**Type II. Compression fractures** - These injuries appear to be produced by the blunt inferior articular surface of the femoral condyle, which is driven into the articular surface of the opposing tibial condyle—acting like a hammer in contrast to the chisel-like action of the outer edge of the femoral condyle in the production of the Type I fractures. The displacement caused by this injury ranges from depression of the anterior, posterior, lateral or medial parts of the plateau with comminution of the area (Figs. 2 to 5), to depression of the whole condyle, the fracture line passing from the non-articular region of the tibial spine to the base of the condyle (Fig. 6). This latter type is associated with a fracture of the head or neck of the fibula when the lateral condyle is the seat of the injury.

In one variety the treatment and prognosis differ from that of the remainder of this group. Here a large lateral fragment is split off and displaced outwards, whereas the central and medial part of the articular surface is comminuted and depressed obliquely downwards and inwards (Fig. 7). Frequently fragments from the central part of the articular surface are driven downwards and wedged in the split between the major fragments. This fracture is usually associated with damage to the collateral and anterior cruciate ligaments. The semilunar cartilage is often torn and displaced, and may be driven down into the fracture line. This injury is a combination of Types I and II.
Type II (compression) fractures. Figure 2—Depression of lateral part of plateau. Figure 3—Depression of central and medial part of plateau.

Type II (compression) fracture with depression of antero-medial part of plateau. Figure 4—Before treatment. Figure 5—after manipulation.
The common feature of all these variations is the depression of part or all of the articular surface, with comminution and crushing of the subchondral layer of cancellous bone. Fracture of the head or neck of the fibula may occur in any of these varieties of compression fracture of the lateral condyle except those in which only an anterior segment of the articular surface is involved.

**Type III. T-shaped or Y-shaped fractures**

In this type both lateral and medial tibial condyles are fractured. In at least thirteen of the fifteen fractures of this type the predominant force was probably a vertical one along the shafts of the long bones. There are two main varieties of this injury: 1) Both condyles are fractured and displaced outwards and downwards, each as one large fragment, and the upper tibial shaft is driven upwards in between them. Their articular surfaces appear radiologically to be undamaged (Figs. 8 and 9). 2) Both condyles are fractured and displaced outwards and downwards, but one condyle (either lateral or medial) also shows the features of a Type II compression fracture (Fig. 11), commonly the mixture of Types I and II previously described. This type of fracture tends to be more comminuted than the last.
Type III fracture. Articular surfaces intact but marked displacement. Figure 9—Before treatment. Figure 10—After manipulation.

Type III fracture with Type II (compression) fracture of lateral condyle. Figure 11—Before treatment. Figure 12—After manipulation.
TREATMENT

Treatment of Type I (split) fractures (Fig. 1)—In those in which the outward displacement of the condylar fragment is only slight, the application of a plaster cylinder, with the knee extended and held in valgus or varus, is sufficient. When displacement is more than slight the fracture is manipulated under general anaesthesia, the fragments being compressed manually or by the application of an Esmarch’s bandage, and the limb immobilised in a plaster cylinder. Non-weight-bearing immobilisation is maintained for three to six weeks until union of the fracture and repair of the ligamentous damage has occurred and then, depending upon the severity of the injury, the patient either begins graduated weight-bearing exercises or performs non-weight-bearing exercises for four to six weeks before weight bearing is allowed. Quadriceps exercises are performed throughout the period of treatment.

In this series there was no fracture with more than a few millimetres displacement of the condylar fragment. One fracture with marked displacement, which radiologically appeared to be of this type, could not be reduced by manipulation, and open reduction was then performed. At operation a depressed fragment of articular surface was found between the main fragments, preventing reduction, and the main condylar fragment was too comminuted to allow the satisfactory insertion of a screw after reduction had been obtained. This type of fracture is a combination of Types I and II and is considered later.

![Fig. 13](image1.png)  ![Fig. 14](image2.png)

**Fig. 13** Type II (compression) fracture. **Fig. 14**—After manipulation.

Treatment of Type II (compression) fractures—When displacement is minimal, and when a small central or medial fragment of the articular surface is depressed but most of the articular surface remains in normal alignment, the knee is immobilised in a plaster cylinder, extended and moulded into varus or valgus, and a similar programme to that outlined for split fractures without displacement is followed. When displacement is moderate or marked manipulation under general anaesthesia is required (Figs. 4, 5, 13 and 14). The patient lies on the orthopaedic table and, while traction is maintained to the limb, the knee is forced
into a varus or valgus position. In the case of fractures of the anterior articular surface, manipulation into flexion is often effective in bringing about reduction. The limb is then fixed in traction on the table, an Esmarch bandage is applied firmly to the upper tibia from below upwards, and manual compression or percussion is applied to the fracture area in an attempt to reduce the outward displacement of the fragments (Kindersley 1937). Radiographs are taken, and when a satisfactory reduction has been obtained a long leg plaster from groin to toes is applied with the knee held in the varus or valgus position. In most cases with marked displacement the position of the fragments can be substantially improved, for it is usually possible to get the greater part of the articular surface into satisfactory alignment, and occasionally anatomical reduction may be achieved. Non-weight-bearing immobilisation is maintained for six weeks until bony union has occurred, a fresh close-fitting plaster being applied after three to four weeks when the swelling has subsided. The patient then mobilises his knee without bearing weight on it for a further three or four weeks, or until the quadriceps is strong enough to control it when graduated weight bearing is commenced. Quadriceps exercises are performed throughout the period of treatment.

**Treatment of Type III (T-shaped or Y-shaped) fractures**—Manipulation under general anaesthesia is performed, in the manner described for Type II (compression) fractures, when the displacement is more than slight. In the occasional case in which this form of traction is not sufficient to bring about reduction, skeletal traction is applied by means of a pin through the calcaneum. In almost every case it was possible to realign satisfactorily the greater part of the articular surfaces (Figs. 8 to 12). A plaster from groin to toes is then applied. The subsequent treatment follows the same lines as that for compression fractures, except that the period of non-weight-bearing immobilisation tends to be longer (from eight to twelve weeks).

**Treatment of Haemarthrosis**—Some degree of haemarthrosis of the knee joint is a constant accompaniment of tibial condyle fractures. In twenty-two patients in whom the haemarthrosis was causing distension of the joint aspiration was performed in the theatre with full aseptic technique before manipulation and immobilisation.

**Operative reduction**—The indications for operative reduction were as follows: 1) Failure to improve substantially the position of fractures with marked displacement by closed methods. This occurs most frequently in the mixed split and compression type of injury (Figs. 15 and 16), in which reduction is impeded by the interposition of the depressed central articular fragment or the displaced semilunar cartilage, or by both. 2) Instability of the fracture after manipulative reduction.

The ten fractures treated by operative reduction were not the worst fractures in the series. The indications for operation in two of them were not clear, and the author’s impression is that the results of these might have been better had they been treated by conservative methods.

**Operative technique**—In each case the knee was explored through an antero-lateral incision and the haemarthrosis evacuated. The semilunar cartilage was inspected and if it was intact or only slightly damaged it was retained. When it was seriously displaced or damaged it was excised. The depressed fragments of the tibial articular table were elevated and any completely detached fragments removed. Whenever possible the main fragments were fixed in position by one or two screws. In some cases the condyle was found to be too comminuted for internal fixation of this sort; pre-operative radiographs sometimes give little hint as to the presence of extensive comminution. After closure of the wound a groin to toe plaster was applied. The post-operative programme was the same as that of the cases treated conservatively.

**RESULTS**

Sixty patients attended for follow-up, of whom fifty had had conservative treatment and ten open reduction. Fifty-five patients were examined by me personally and the rest by orthopaedic colleagues at other clinics.
In the assessment of results the criteria used conformed to those of Palmer (1951), namely: Excellent—Pain-free, full function, normal or almost normal mobility, stable, no atrophy. Good—Pain-free or occasional aching after activity, good mobility, moderate atrophy, increased crepitation compared with the other side, stable. Fair—Inconvenience limiting the working capacity, reduced mobility, atrophy, deformity, marked crepitation, slight instability. Poor—Rest pain, poor mobility or ankylosis, deformity, or gross instability.

These patients were all treated between 1941 and 1953, and the average length of follow-up was four and a half years. The shortest follow-up was six months and the longest twelve and a half years. Fourteen patients were followed up for over five years. Three were followed up for over eight years and six for over ten years. Ten of the fourteen patients followed for more than five years had excellent results, and all those followed for more than eight and ten years had excellent results.

The results are assessed according to the type of fracture and the method of treatment (Tables III to V).

The least satisfactory results followed the combined Types I and II fractures (which are here included in the Type II group). Forty-three per cent of such fractures (including operative cases) had excellent results, 36 per cent good and 21 per cent fair, compared with 80 per cent excellent and 20 per cent good results from the remainder of the Type II fractures.

Of the Type III (T-shaped and Y-shaped) fractures 80 per cent had excellent results. Open reduction was performed in three cases because one of the fractured condyles had a combined Type I and II fracture which could not be satisfactorily reduced by manipulation and traction.

The results of the whole series were 73·6 per cent excellent, 18·3 per cent good, 6·6 per cent fair and 1·6 per cent poor.

Fracture of the fibular neck occurred in seventeen patients, but in none was there injury to the lateral popliteal nerve. These fractures do not appear to influence the results.

In seven out of the ten patients treated by operative reduction the semilunar cartilage was found to be damaged and was excised. This suggests that quite a number of the fairly severe fractures that were treated conservatively also had associated cartilage lesions, yet no patient had clinical evidence of such an injury at the time of the follow-up examination.
This observation accords with those of other authors (Clarke 1935, Barr 1940, Palmer 1951) and suggests that in patients treated by operation the cartilage should be conserved unless grossly damaged or displaced.

A period of immobilisation in plaster followed by non-weight-bearing exercises was considered of particular importance because ligamentous injury is a common feature, and its presence was taken into account when the programme of treatment of the individual fracture was decided. Although several fractures were originally associated with marked ligamentous instability, only one operative repair was performed. At follow-up there was one patient with definite ligamentous laxity and fourteen others with a trace of laxity, chiefly due to a minor residual valgus deformity, but in all these patients stability of the knee joint was well controlled by the quadriceps muscle.

In any assessment of the function of a joint the range of movement is an important consideration. In this series 70 per cent of the patients treated conservatively regained active knee flexion to 45 degrees or less, and only 8 per cent failed to gain flexion as far as 90 degrees.* Patients treated by operation did not show such good results in this respect, for only two patients out of the ten operated upon regained flexion to 45 degrees or less, and five failed to achieve active flexion to 90 degrees.

Residual atrophy of the thigh muscles of half an inch or more (measured five inches above the superior pole of the patella) was present in twelve patients, of whom four had been treated by open reduction.

Of the two pathological fractures in the series, the first was a Type III fracture of a tibia which was the site of Paget's disease. The fracture united satisfactorily and quite rapidly, and in spite of a further fracture of the upper end of the same tibia a year later, the result after eight years was excellent. The second was a Type III fracture in a patient with severe rheumatoid arthritis, who had had a pseudarthrosis performed upon the hip of the

* Full extension = 180 degrees; full flexion = 45 degrees or less.
same side two years before. The fracture was sustained while the patient was weight bearing without her caliper. Twenty months later the knee was stable, but pain persisted and movement was poor. This was the only poor result in the series.

Since three-quarters of these fractures occurred after the fourth decade of life, many patients showed radiologically some osteoarthritic change in the knee at the time of injury. So great is the variation in the normal degree of degenerative change that can be expected to be present during these later decades (Bennett et al. 1942) that it is difficult to assess the effect of trauma upon the progress of osteoarthritis. From a study of the radiographs of patients who sustained the injury during the third and fourth decades, the impression is gained that degenerative changes appear within eighteen months to three years; they are localised mainly to the damaged side of the joint and are not related to the severity of the injury as shown by the radiographs (Fig. 17). None of these patients had clinical evidence of such degenerative changes.

It is a striking fact that excellent function is frequently present in spite of the persistence of deformity of the tibial articular surfaces in the radiographs.

Analysis of the end-results in relation to the age of the patient at the time of injury shows that age has not had any appreciable influence upon the result; of the twelve patients aged between sixty-one and eighty years, eleven had excellent results and the twelfth a good result.

**COMMENT**

The aim of immediate treatment in fractures involving articular surfaces is to restore anatomical reduction. Because of the comminuted nature of most fractures of the tibial condyles it is often impossible to achieve the desired accuracy of reduction by any means. Some of the fragments of the tibial articular surface may be completely detached, and others nearly so, necessitating revascularisation of the fragments and leading to degeneration of the overlying cartilage. Complete regeneration of articular cartilage does not occur and the foundations for a degenerative arthritis are consequently already laid. In most of these fractures the position of the fragments can be considerably improved by the conservative measures already described, but perfect reduction is seldom achieved. Open reduction with internal fixation leads to greater improvement in the radiographic appearance, though in comminuted fractures anatomical reduction is not usually obtained and function is frequently disappointing. This is not altogether surprising, for dissection of soft tissues may endanger the blood supply of marginal fragments and cause periarticular fibrosis.

The analysis of the long-term results in this series suggests that conservative treatment along the lines set out gives good results, and that operative reduction should be reserved for fractures in which restoration of the general contour of the articular surface cannot be achieved by closed manipulation, or in which a satisfactory manipulative reduction cannot be maintained by external fixation alone. In the absence of either of these indications comminution should be regarded as a contra-indication to operative reduction.

**SUMMARY**

1. Sixty fractures of the tibial condyles have been reviewed. Fifty were treated by conservative measures and ten by operative reduction. The fractures are classified and the etiology, age incidence, mechanism of injury, methods of treatment, and results are discussed.
2. The indications for operative reduction are described.
3. The combined split and compression types of fracture give the least satisfactory results.
4. Age is no contra-indication to immobilisation in the treatment of these fractures.
5. Emphasis is laid upon the necessity for immobilisation in the treatment of the associated ligamentous injuries.
6. It is considered that the results justify the policy of treatment described.

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REFERENCES


