BIFOCAL FRACTURES OF THE TIBIA AND FIBULA

INCIDENCE, CLASSIFICATION AND TREATMENT

J. F. KEATING, R. S. KUO, C. M. COURT-BROWN

From the Royal Infirmary of Edinburgh, Scotland

We report the results of a three-year study of bifocal fractures of the tibia and fibula, excluding segmental shaft fractures. In our whole series, these formed 4.7% of all tibial diaphyseal fractures. We describe three groups: bifocal fractures of both the proximal and the distal joint surfaces, fractures of the shaft and tibial plateau, and fractures of the shaft and ankle. These groups of fractures had different characteristics and prognoses. We discuss treatment protocols for each of these three groups.

Received 8 July 1993; Accepted after revision 22 September 1993

Despite the high incidence of fractures of the tibia and fibula, little has been published about the incidence, epidemiology and treatment of double or bifocal fractures, other than segmental fractures of the shaft. The association of shaft fractures with those of the upper and lower joint surfaces of the tibia has been noted: Lonner, Jupiter and Healy (1993) have described the relationship of ankle injuries and tibial diaphyseal fractures, while Bostman and Hanninen (1982) found that posterior malleolar fractures were associated with about 3% of tibial diaphyseal fractures and suggested that internal fixation was appropriate.

We have reviewed our data on fractures of the tibia and fibula treated in the Edinburgh Orthopaedic Trauma Unit over a three-year period. We believe that such bifocal fractures are more common than is generally appreciated, and that they occur in three distinct groups with differing epidemiology, characteristics and treatment requirements.

PATIENTS AND METHODS

From January 1988 to December 1990, we treated a total of 523 diaphyseal fractures of the tibia in the Edinburgh Orthopaedic Trauma Unit. Of these, 28 in 26 patients were bifocal with associated fractures in different parts of the tibia and fibula. We excluded segmental fractures of the shaft. None of the 28 tibiae had more than two fractures.

The patients were 20 men and six women; their mean age was 45 years (21 to 81). Seventeen (65.4%) had been injured in road-traffic accidents, two in simple falls, and two by a fall from a height. Two were injured while playing sport and three had direct blows to the leg. Fourteen (53.8%) of the patients had multiple injuries.

Of the 28 fractures, 14 were open injuries: 13 were diaphyseal, and eight of these were of Gustilo grade-III severity (Gustilo and Anderson 1976). One was a grade-III open pilon fracture. The diaphyseal fractures and the proximal and distal fractures were all classified according to the AO system (Müller et al 1990), and the soft-tissue damage in closed fractures by the Tscherne system (Oestern and Tscherne 1984).

Two patients died of other injuries shortly after admission, and one at nine months. The other 23 were followed up for at least one year, and fracture union was assessed by standard radiological and clinical criteria. We defined diaphyseal malunion as more than 5° of angular or rotatory malalignment, or more than 1 cm leg-length discrepancy. We did not determine articular surface malunion or incongruity radiologically, but assessed the result at latest follow-up by measurement of range of joint movement compared with the normal side, and by function. We defined infection as the presence of a purulent discharge, from which organisms had been cultured.

The functional outcome was assessed from a short questionnaire. Patients who had returned to their preinjury level of work and leisure activity were recorded as having normal function. Those who were unable to play sport or resume routine activities were recorded as having impaired function; those requiring walking aids or had suffered a major disruption of life-style were termed disabled.
RESULTS

We studied the fractures in three groups, based on their location.

**Group I.** This group had both proximal and distal intra-articular fractures (Fig. 1), none of which was open. There were four patients with a mean age of 52.5 years. The tibial plateau fractures were one AO type A, two type B and one type C. Three of the distal fractures were malleolar (one type A and two type C), the other was a type-C pilon fracture.

**Group II.** This group had the combination of a tibial diaphyseal fracture and a tibial plateau fracture (Fig. 2). There were 11 such bifocal fractures in ten patients with a mean age of 50.5 years. The shaft fractures were one AO type A, five type B and five type C. Five of these
were closed (one Tscherne CO and four C2). Six were open, four being Gustilo grade III. The plateau fractures were one AO type A, six type B and four type C.

**Group III.** This group had the combination of a shaft fracture and a distal intra-articular fracture (Fig. 3). Of the 13 patients of mean age 34.4 years, 12 had malleolar fractures and one a pilon fracture.

The shaft fractures were three AO type A, six type B and four type C. Six fractures were closed (two Tscherne C1 and four C2); of the seven open fractures, four were Gustilo grade III. There were eight AO type-A and four type-B malleolar fractures, all closed. The pilon fracture was AO type C, open with Gustilo grade-III severity.

**Treatment**

**Group I (n = 4).** Two of the proximal plateau fractures were treated non-operatively and the other two by AO internal fixation techniques (Müller et al 1991). All the distal fractures were internally fixed by standard AO methods.

**Group II (n = 11).** The diaphyseal fractures were treated by a variety of methods: one was fixed with a Grosse-Kempf locking nail and one with two Rush pins. Three had primary external fixation and four dynamic compression plates. Two patients had primary amputations because of the severity of their injuries.

Two plateau fractures were treated conservatively, eight had AO plates and one was stabilised with intrafragmentary screws and an extension from the diaphyseal external fixator (Fig. 4).

**Group III (n = 13).** Shaft fractures had either primary intramedullary nailing or external fixation; five fractures were fixed with Grosse-Kempf nails and eight were externally fixed.

All the malleolar fractures were treated using AO techniques and the pilon fracture by extending the diaphyseal external fixation device distally.

**Outcome.** In group I, one patient died and one regained full movement in knee, ankle and subtalar joints. The other two had reduced ranges of knee and ankle movement.

In group II, all tibial plateau fractures united without

---

Radiographs of a patient in group III with a trimalleolar ankle fracture and a closed shaft fracture. The diaphyseal fracture was treated with a statically locked intramedullary nail and the ankle fracture by AO techniques.
Radiographs during treatment of a patient in group II with intrafragmentary screws used for the plateau fracture and closed external fixation for the comminuted diaphyseal fracture. The external fixation has been extended proximally to increase the stability of the plateau fracture.

Further treatment. One patient had some infection around a plate which resolved when this was removed. One patient with an AO type-C plateau fracture required knee arthroplasty for post-traumatic osteoarthritis within one year of the original injury.

In this group, the diaphyseal fractures united with no infection or malunion. Two patients required treatment for delayed union, one by removal of an external fixator and intramedullary nailing, the other by exchange nailing after a primary intramedullary nail. None needed bone grafting. The average time to union for these diaphyseal fractures was 28.6 weeks.

Final follow-up assessment of joint mobility and patient function was possible in eight legs of seven patients. Only one leg showed a full range of knee movement. The patient who had an arthroplasty at one year had 25° limitation of knee extension, the other six had full extension. Seven patients had loss of knee flexion with a mean of 110°.

In this group, six of the seven ankles assessed at final follow-up showed normal function; one had a peroneal nerve palsy which was associated with ankle stiffness. At final follow-up of the eight living patients, only three (37.5%) had regained a normal functional level; three had impaired function and two were significantly disabled.

In group III, five of the 13 diaphyseal fractures required secondary procedures to secure union. Two had bone grafting and in three others external fixators were changed for intramedullary nails. Two of these fractures became infected; both were externally fixed Gustilo type-III fractures and both were successfully treated. Two other externally fixed group-III diaphyseal fractures healed with malunion. The mean time to union for all group-III diaphyseal fractures was 34.0 weeks, and all the distal intra-articular fractures united.

At follow-up, knee movement was full in all 12 patients with diaphyseal and malleolar fractures. The patient with combined AO type-C diaphyseal and pilon fractures had reduced range of movement at knee, ankle and subtalar joints. Ankle movements were normal in six patients and reduced by an average of 20° dorsiflexion and 15° plantar flexion in the other six. Subtalar movement was normal in ten patients and reduced in the other two.

Of the 12 patients with malleolar fractures, seven had normal function at final follow-up, three had some functional impairment and two were significantly disabled.

DISCUSSION

Our study indicates that bifocal fractures involving the tibia and fibula are not uncommon, and many surgeons will have to deal with these injuries. The combination of intra-articular fractures proximally and distally is rare, but we found that 4.7% of tibial shaft fractures were associated with intra-articular fractures either proximally or distally.

Our group-I (proximal + distal) and group-II (shaft and proximal) fractures tended to occur in older patients after high-energy injury. Group-II fractures were seen almost exclusively in older pedestrians and were associated with a high mortality and amputation rate. Group-III fractures (shaft and distal) occurred in younger patients and there was a higher proportion of low-velocity injuries. Groups I and II included few diaphyseal or metaphyseal AO type-A fractures but in group-III bifocal fractures, 66% of the malleolar fractures were AO type A and none was AO type C.

The severity of the bifocal tibial fractures is compared with that of single fractures of the tibia and fibula in Tables I, II and III, for the same three-year period. The bifocal diaphyseal fractures show a more complex morphology: 79.2% were AO type B or C, as against 43.7% of the single tibial diaphyseal fractures (Table I). The greater severity of soft-tissue injury in bifocal fractures is shown by the higher incidence of open fractures and of Tscherne C2 and C3 groups. Tibial fracture associated with an intact fibula was more common in the single fracture group.

Our group-II plateau fractures also showed more severe fracture morphology than single plateau fractures,
Table I. Details of the patients' age and severity of shaft injuries in patients with bifocal and single tibial diaphyseal fractures, showing the more serious nature of the bifocal injuries

<table>
<thead>
<tr>
<th>Bifocal fractures (n = 24)</th>
<th>Single fractures (n = 499)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average age (yr)</td>
<td>43.6</td>
</tr>
<tr>
<td>AO type (%)</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>20.8</td>
</tr>
<tr>
<td>B</td>
<td>45.8</td>
</tr>
<tr>
<td>C</td>
<td>33.3</td>
</tr>
<tr>
<td>Open fractures (%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>41.7</td>
</tr>
<tr>
<td>Tscherne C2 and C3 (%)</td>
<td>70.8</td>
</tr>
<tr>
<td>Tibia only (%)</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Table II. The age of the patients and the AO types of bifocal fractures and single fractures of the tibial plateau

<table>
<thead>
<tr>
<th>Bifocal fractures (n = 15)</th>
<th>Single fractures (n = 210)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average age (yr)</td>
<td>53.9</td>
</tr>
<tr>
<td>AO type (%)</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>13.3</td>
</tr>
<tr>
<td>B</td>
<td>60.0</td>
</tr>
<tr>
<td>C</td>
<td>26.7</td>
</tr>
</tbody>
</table>

Table III. The age of the patients and the AO types of bifocal and single malleolar fractures

<table>
<thead>
<tr>
<th>Bifocal fractures (n = 15)</th>
<th>Single fractures (n = 1225)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average age (yr)</td>
<td>37.1</td>
</tr>
<tr>
<td>AO type (%)</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>60.0</td>
</tr>
<tr>
<td>B</td>
<td>26.7</td>
</tr>
<tr>
<td>C</td>
<td>13.3</td>
</tr>
</tbody>
</table>

with comparatively few AO type-C fractures among the single fractures (Table II). In our group III there was an opposite trend: malleolar fractures occurring alone showed more severe morphology than those associated with shaft fractures.

Bifocal tibial fractures which involve a joint surface present a number of problems. We believe that all such fractures should be treated by fixation, even when non-operative methods might be chosen for an equivalent single diaphyseal fracture. Bifocal fractures are due to high-energy injuries and are frequently unstable. Management in casts is inappropriate both because of the difficulty of maintaining fracture alignment and because of the likelihood of considerable joint stiffness after prolonged immobilisation. Even without associated intra-articular fractures, the use of casts to control shaft fractures tends to increase stiffness in adjacent joints (Digby, Holloway and Webb 1982; Oni, Hui and Gregg 1988). We suggest that rigid methods of internal or external fixation are used to treat such bifocal fractures; casts can then be avoided and early mobilisation of joints is possible.

We propose that group-I proximal and distal fractures be treated by standard AO techniques, but recognise that a surgeon might choose external fixation with minimal additional internal fixation to reduce and control some pilon and plateau fractures.

In our opinion, group-III bifocal fractures (shaft and distal) require AO techniques to stabilise the ankle fractures, with either closed intramedullary nailing or external fixation for the shaft fractures. In our series, eight of the 13 group-III fractures were treated with primary external fixation and five with intramedullary nails. The trend in Edinburgh, however, is towards the use of reamed intramedullary nails for all diaphyseal fractures regardless of their severity (Court-Brown, Christie and McQueen 1990; Court-Brown et al 1991), but external fixation is a satisfactory alternative and should certainly be considered for the shaft if it is to be used to stabilise an associated pilon fracture. The treatment of group-II bifocal fractures (shaft and plateau) may be difficult. The plateau fracture may present problems with the introduction of an intramedullary nail, although this can be used if the shaft fracture is in the middle or distal thirds and the plateau fracture requires only intrafragmentary screws. If the plateau fracture requires plating, then intramedullary nailing is impossible; another fixation method must be used to stabilise the diaphyseal fracture.

We have previously shown that only 6% of tibial diaphyseal fractures occur in the proximal third (Court-Brown et al 1990). Nearly all group-II bifocal fractures, however, were seen in elderly pedestrians, and proximal-third shaft fractures were present in 36.3% of the group. We now rarely use plating for shaft fractures, but in these cases only a relatively small extension of the wound is required to insert two plates. This is a reasonable choice of treatment for the group-II fractures with proximal diaphyseal fractures (Fig. 2), and the combination of internal fixation of the plateau and external fixation for the shaft is also satisfactory (Fig. 4).

The prolonged time to union of group-II and group-III combined fractures reflects the severity of these injuries, and this is confirmed by the fact that seven of the 24 group-II and group-III fractures required second operations to encourage bone union. These high-energy injuries have relatively poor prognoses: early exchange nailing or open bone grafting may be necessary.

Our results suggest that group III fractures have a good prognosis. The more severe group-I and group-II fractures do not always have a good outcome, and patients should be made aware of this early in their treatment.

Although none of the authors have received or will receive benefits for personal or professional use from a commercial party related directly or indirectly to the subject of this article, benefits have been or will be received by are directed solely to a research fund, foundation, educational institution, or other non-profit institution with which one or more of the authors is associated.
REFERENCES


