TWO-LEVEL FRACTURES OF THE TIBIA
Results in Thirty-six Cases Treated by Blind Nailing

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In the last fifteen years the indications for osteosynthesis in the treatment of tibial fractures have increased considerably. As early as 1958 Merle d’Aubigné and Franc insisted on the value of osteosynthesis in compound fractures. Since 1960 blind intramedullary nailing has been mainly adopted in the treatment of closed fractures (Zucman and Maurer 1965) and almost exclusively in the treatment of compound fractures at the Clinique Orthopédique of the Hôpital Cochin, under the direction of Professor R. Merle d’Aubigné.

Boutin (1956) pointed out the bad prognosis of two-level fractures of the tibia. In this article we present the results of blind intramedullary nailing in thirty-six recent two-level fractures.

MATERIAL AND METHODS

Technique—The technique that we use has been reported previously (Zucman and Maurer 1965). It is necessary to emphasise the following points: 1) Reaming of the medullary cavity was never employed. 2) We now employ a Kuntscher-type nail slightly bent forward in its upper part, allowing easier removal when indicated. 3) The insertion of the guide-wire presents some difficulty in two-level fractures. Nevertheless it was always achieved without the use of an image intensifier, and exposure of the fracture site was necessary in only one case. 4) In compound fractures the wound edges were systematically excised after nailing. When necessary a relieving incision was made to allow closure of the wound without tension.

Cases under treatment—In nineteen of the thirty-six cases the fracture was open, with skin wounds of the following types: stab wounds (ten cases); large openings exposing the fracture (six cases); wounds with impaired vitality or loss of skin (three cases).

Etiology—Thirty-four of the thirty-six fractures were due to road traffic accidents, including twenty-three in pedestrians run over by vehicles. The other two fractures were caused by industrial accidents.

Age of the patients—The average age of our patients was fifty-three years. The youngest was aged eighteen years. Seven were older than sixty-five.

Associated injuries—In only eighteen of the thirty-six patients was the tibial fracture the only injury. Among the others, the following injuries were observed: head injury (eight); injury to knee ligaments (three); fracture of the opposite tibia (four); fracture of the femur (two); fracture of the ankle (one); fracture of calcaneus (one); fracture of acetabulum...
(three); fracture of the humerus (three); fracture of wrist (three); fracture involving elbow (one); brachial plexus palsy (one); flail chest (one); rupture of spleen (one).

Assessment of the results—In the assessment of results the following definitions are relevant.

Two-level fractures—Two complete and distinct lines of fracture exist, isolating a circumferential, intermediate fragment. This last point distinguishes these fractures from "butterfly-wing fractures" in which the intermediate fragment is not circumferential.

Malunion—We take this to imply residual deformities of 10 degrees or more of varus or flexion, 15 degrees or more of valgus or recurvatum, 10 degrees or more of medial rotation, 20 degrees or more of lateral rotation.

Non-union—This term was applied to any three-month-old fracture which, in the opinion of the surgeon, had to be re-operated upon in order to achieve consolidation.

Sepsis—Two distinct complications are included in this word: 1) confirmed bacteriological infection spreading to the underlying bone; and 2) skin necrosis leading to an exposed bone.

RESULTS

SEVENTEEN CLOSED FRACTURES

Fifteen fractures united without incident. These patients started walking again without plaster and with full weight-bearing in an average time of sixteen weeks (Figs. 1-7). Some of these patients resumed walking before the appearance of complete radiological union,
because of good internal fixation. The average time for radiological union in these fifteen patients was seventeen and a half weeks.

**Complications**—There was no case of malunion and no sepsis. There were two cases of non-union, requiring further operation.

**Case 1**—A seventy-year-old man presented with a fracture at the junction of the upper and middle thirds of the diaphysis, with a second fracture at the junction of the middle and lower thirds, the intermediate fragment measuring fifteen centimetres. Both fractures were comminuted. There was no other injury. The fracture was fixed by means of a nail of eight millimetres diameter only, so that rotational mobility was not completely overcome and plaster immobilisation was used as well. After six months the lower fracture had united, but slight mobility was present at the upper. An onlay graft, fixed with screws, was then used and consolidation occurred within three months.

**Case 2**—This case in a thirty-four-year-old man was an example of failure of the method. Of his two fractures, the upper undisplaced fracture was at the junction of the upper and middle thirds. The lower fracture in the middle third of the tibia was comminuted. The intermediate fragment measured ten centimetres. There was no associated injury. The insertion of the nail proved to be impossible without exposure of the lower fracture. A nine-millimetre diameter nail was inserted, and the tibia was fixed with five millimetres of transverse displacement of the uppermost fragment. The upper fracture was united by the third month after operation, but the lower was not. An onlay autogenous graft led to final consolidation within four months of grafting.

The results of the seventeen closed two-level fractures are summarised in Table I.

**NINeteen Compound Fractures (FIGS. 4-7)**

Fifteen fractures united without any of the above-mentioned complications; that is 79 per cent of the cases. These patients started walking again without plaster and with full weight-bearing.
weight-bearing in an average time of 142 days. As in cases of closed fractures a certain number of patients began walking before radiological signs of consolidation were present. In these cases the average time for the appearance of radiological union was 169 days.

**Complications**—There was no case of malunion, nor was amputation required in any case in this series of nineteen two-level compound fractures. In four cases the patients developed sepsis, that is in 21 per cent. In three sepsis did not prevent bone union.

**Case 3**—A sixty-five-year-old man, run over by a car, sustained multiple injuries: cerebral trauma including a scalp wound; ruptured spleen; flail chest; a humeral diaphysis fracture; torn ligaments of the opposite knee; fracture of the opposite ankle and a two-level compound fracture of the tibia. The upper site was in the middle third of the tibia and was slightly comminuted. The lower fracture, at the junction of the middle and lower thirds, had minimal displacement. The intermediate fragment measured twelve centimetres. The skin was contused in front and there was a large posterolateral flap.

A nine-millimetre diameter nail was inserted and fairly good fixation of both fractures obtained. The contused soft tissues were excised and the skin sutured. Skin necrosis occurred, making a skin graft necessary on the thirty-fifth day. In spite of a persistent sinus bone union had occurred by the eleventh month without further surgery. The nail was removed in the sixteenth month but a small sinus was still present three months after this.

**Case 4**—A forty-two-year-old man suffered a severe head injury, a wrist fracture and compound fractures of both tibiae. On the right side there was a two-level fracture with the sites in the upper third and the middle third, both fractures being displaced. The intermediate fragment measured eight centimetres. The skin lesion was minimal. An eight-millimetre diameter nail was inserted.
small sinus appeared later, after which a small sequestrum was eliminated. Clinical and radiological bone union occurred within five months without any other surgical procedure. The sinus closed spontaneously during the sixth month.

Comment—Two particular points may be emphasised in this case. 1) In the opposite leg there was a comminuted fracture of the tibia with a large laceration exposing the fracture. This leg was treated conservatively. A much more severe infection occurred and two further operations (sequestrectomy; covering by skin flap) were required. Bone union was finally obtained after more than a year. 2) The patient had femoral arteritis in the leg which had sustained the double tibial fracture, and two years after the fracture sympathectomy and femoral endarterectomy were required.

**Fig. 8**
Case 6. Figure 8—Radiograph of a two-level compound tibial fracture in a 30-year-old man, a car driver. The skin laceration was six centimetres long. Figure 9—Six months after nailing the upper fracture had not united. A sinus had appeared and had not healed, despite sequestrectomy.

**Fig. 9**

Case 5—A forty-three-year-old woman sustained a fractured pelvis and an open fracture of the calcaneus on the same side as a two-level compound fracture of the tibia. The upper fracture was in the middle third, the lower at the junction between the upper three-quarters and the lowest quarter of the bone. Both fractures were comminuted. The intermediate fragment measured seven centimetres. The skin wound was severe and it had to be left partly open because of skin loss despite a posterior longitudinal relieving incision. The defect was grafted on the fifteenth day. Clinical and radiological consolidation occurred during the fifth month without the need for further surgery but after nine months a small abscess appeared, requiring incision and removal of the nail. After twelve months the patient, who had walked quite well with a dry wound, died of an unrelated cause.

**Case 6**—The fourth infected fracture was also the most severe, leading to non-union (Figs. 8 to 11). A thirty-year-old man sustained, beside a head injury, compound fractures of both tibias. On the left side there was a two-level fracture in the middle third of the shaft, both fractures being displaced and the intermediate fragment measuring six centimetres. This fracture was complicated by paralysis of the foot and toe extensor muscles. The skin wound was six centimetres long and exposed the fracture. It was carefully excised and sutured and a nine-millimetre diameter nail was inserted, good fixation of both fractures being obtained.
However, a sinus appeared within a few weeks. By the fifth month the lower fracture had united but not the upper, at which site there was a sequestrum. Sequestrectomy was performed and a month later a fibular bone graft was inserted into the tibia. In the thirteenth month the nail was removed and a month later a cancellous bone graft was inserted to reinforce the bone union. However, the sinus persisted and sixteen months later sequestrectomy was again performed with final closure of the sinus. The patient was last seen one year later, when the tibia was quite solid and the sinus closed. On the other side there had been a compound comminuted fracture of the tibia which had also been treated by nailing. There too an abscess had eventually appeared, but bony union had occurred without any other surgical procedure.

The results in these nineteen compound two-level fractures are summarised in Table I. Late complications—A comprehensive study of the late complications such as oedema, joint stiffness or trophic changes has not been attempted since these seem to us particularly difficult to assess after tibial fractures. The frequent association of other injuries makes evaluation of the permanent disability arising directly from the tibial fracture impossible. We can state only that the method of introducing the nail through the pre-spinal surface of the tibial plateau did not impair the function of the knee joint provided the proximal end of the nail was correctly sunk.

DISCUSSION

We would like to emphasise the fact that our thirty-six cases do not represent an ordinary cross-section of tibial fractures. In particular, the series includes no children, the youngest patient being eighteen years old. The average age of patients in this series is particularly
high (fifty-three years), that is to say much higher than the average age of the people treated at the Hôpital Cochin for tibial fractures (forty-two years). The violence resulting in two-level tibial fractures was probably much more severe than that causing tibial fractures as a whole. During the period of this study a total of 312 tibial fractures was seen, of which two-thirds were closed and one-third compound fractures. On the contrary, of the two-level fractures 53 per cent were compound. Half the patients with two-level fractures suffered associated injuries, and this figure is much higher than that in the total number of cases. This implies greater violence causing this type of fracture, with more extensive damage to soft tissues around the fracture sites.

The greater age of the patients and the associated important injury to soft tissues may explain why complications occur more frequently in such cases. This is clearly shown when we compare the results of this series with our total number of nailed tibial fractures. There were 192 closed tibial fractures nailed of which seventeen were two-level fractures. Six cases of non-union (3 per cent), one amputation (0·5 per cent) and one malunion (0·5 per cent) occurred. We have already noted the two cases of non-union in seventeen closed two-level fractures (12 per cent). It appears therefore that closed two-level fractures lead to a higher rate of non-union than do the other types of nailed closed tibial fractures. This impairment of osteogenesis is confirmed by the fact that in the total series of closed tibial fractures treated by nailing (192 cases) the patients walked after ninety-five days on the average, while walking was delayed to 111 days in the nailed two-level tibial fractures.

Septic complications are relatively frequent after compound fractures. Of 134 nailed compound tibial fractures (including nineteen at two levels) eleven cases were complicated by sepsis. In seven cases of infection primary bone union occurred but four went on to non-union. Our total rate of sepsis after compound tibial fractures treated by nailing was 8 per cent. As already noted there was a much higher rate of sepsis in the nineteen compound two-level fractures treated by nailing (three cases of sepsis with primary bone union and one of non-union, a percentage of 21). This higher rate of infection may be explained by several factors: decreased natural defence against infection in old people; the aggravating role of associated injuries and shock; extensive injury to soft-tissues and ischaemia of the intermediate fragment. We should like to emphasise the fact that in three out of four cases the infection was overcome while a small sinus persisted in the fourth case. Extension of infection to the entire length of the shaft was never observed, nor have we noted septic arthritis of the knee.

It is of interest that in our series both fractures appeared to have the same potential for bone union, and that consolidation took place in the same average time at the upper and lower sites. This point seems to us to be related to the fact that nailing provides equal immobilisation of both fractures.

<table>
<thead>
<tr>
<th>Result</th>
<th>Number of closed fractures</th>
<th>Number of compound fractures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary bone union in good position</td>
<td>15 (88 per cent)</td>
<td>15 (79 per cent)</td>
</tr>
<tr>
<td>Amputation</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Aseptic non-union</td>
<td>2 (12 per cent)</td>
<td>none</td>
</tr>
<tr>
<td>Malunion</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Primary bone union with sepsis</td>
<td>none</td>
<td>3 (16 per cent)</td>
</tr>
<tr>
<td>Septic non-union</td>
<td>none</td>
<td>1 (5 per cent)</td>
</tr>
</tbody>
</table>

TABLE I
RESULT OF THIRTY-SIX TWO-LEVEL TIBIAL FRACTURES TREATED BY NAILING
TWO-LEVEL FRACTURES OF THE TIBIA

Our results may be compared with previously published series. We recall here that Nicoll (1964) claimed a rate of 15 per cent of infection in a series of 144 compound tibial fractures treated conservatively.

As far as the rate of bone union is concerned, Cauchoix, Duparc, Deburge and Caracostas (1965) observed five cases of non-union in nine closed two-level fractures treated conservatively. Saegesser, Chapuis and Boumghar (1965) noted four non-unions in five compound two-level tibial fractures treated conservatively and Gérard and Vincent (1966) reported four cases of non-union in nine two-level fractures treated by external fixators. Finally, Decoulx, Ducloux and Dupont (1963) reported on thirteen two-level fractures of the tibia. Twelve of them were compound and all were treated conservatively. They noted six cases of non-union and two septic complications.

SUMMARY

1. Intramedullary nailing in two-level tibial fractures provides the following advantages: it allows walking with full weight-bearing in an average time of three to four months; it decreases the rate of non-union; it decreases the rate of malunion; it should decrease the rate of infection in closed fractures when compared with other types of internal fixation, due to the technique of blind nailing without exposure of the fracture site.

2. Compound tibial fractures treated by nailing are still often complicated by infection. Nevertheless, we have not been able to find studies in the literature based on series large enough to permit the conclusion that other methods could lower significantly the infection rate.

REFERENCES


