IS CONSERVATIVE TREATMENT OF DISPLACED TIBIAL SHAFT FRACTURES JUSTIFIED?

J. F. HAINES, E. A. WILLIAMS, E. J. HARGADON, D. R. A. DAVIES

From Park Hospital, Davyhulme, Manchester

All tibial shaft fractures treated at one hospital during a five-year period were studied in a prospective trial. Ninety-one displaced fractures in adults were treated using a conservative policy that included early bone grafting when indicated. Sound bony union was obtained in all cases. Those that healed primarily took on average 16.3 weeks whereas the 24 per cent that required bone grafts took 35.1 weeks. The number of complications, most of which were minor, was considered acceptable.

It is concluded that provided early bone grafting is performed when necessary, a basically conservative policy of treatment is satisfactory; bony union of all displaced tibial fractures is achieved in a reasonable period of time.

The treatment of tibial fractures has always been controversial. The protagonists of conservative treatment have been supported by the classic paper of Nicoll (1964) who demonstrated the acceptability of allowing bone healing to take place without operative interference. However, with the great advances in orthopaedics, especially with regard to methods of rigid fixation, many papers have extolled the virtues of early internal fixation of tibial fractures. In fact the pendulum has swung so far in this direction that, in a recent paper, Christensen, Greiff and Rosendahl (1981) stated that "rigid internal fixation is advocated for all displaced fractures of the shaft of the tibia and is advocated as an urgent procedure especially in open fractures". In other words they felt that in every case of displaced tibial shaft fracture operative treatment was mandatory.

With this prevailing situation in mind we examined our own results using conservative treatment. We designed this prospective study to answer the question "Is our present policy of conservative treatment for displaced tibial shaft fractures justified?"

PATIENTS AND METHODS

The trial described in this paper was a prospective one and all the patients were treated in one single centre; the

policy was uniformly conservative. All the tibial fractures over a five-year period from July 1976 to June 1981 were studied. Standard information from each was recorded on a specially prepared punch card (Paramount Card, Copeland Chatterson Co. Ltd, Manchester). Each patient was followed up until no further change was anticipated. On discharge, the patients were examined for any sequelae such as joint stiffness or contracture, and the post-union radiographs were examined for malunion.

We included all fractures of the shaft of the tibia except those involving the knee or ankle joints. There was no upper age limit, but we excluded patients under 16 years of age, since in them the outcome was always excellent. We also excluded all undisplaced fractures in adults, again because their inclusion would have flattered the results. Thus, out of a total of 204 tibial fractures, we were left with 99 adult displaced fractures (Fig. 1) and

Fig. 1

Fractures in children and undisplaced fractures were discounted.

J. F. Haines, FRCS, Senior Orthopaedic Registrar
Wrightington Hospital, Appley Bridge, near Wigan, Lancashire WN6 9EP, England.

E. A. Williams, FRCS, Lecturer in Orthopaedic Surgery
Victoria University of Manchester, Oxford Road, Manchester M13 9PL, England.

E. J. Hargadon, FRCS, FRCS Ed, Consultant Orthopaedic Surgeon
D. R. A. Davies, MD, FRCS, Consultant Orthopaedic Surgeon
Park Hospital, Moorside Road, Davyhulme, Urmston, Manchester M31 3SL, England.

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Fig. 2

Age and sex distribution.

these have been analysed in detail; Figure 2 shows their age and sex distribution.

Treatment. The precise nature of the conservative treatment used depended on the nature of the fracture.

Stable fractures. In low velocity injuries with little soft tissue damage closed reduction under general anaesthesia was performed and a long leg plaster cast applied. Regular radiographs were taken to check the length and alignment, and the plaster was wedged or changed as necessary.

Unstable fractures. Fractures which felt unstable under anaesthesia were treated by os calcis traction for two to three weeks; a long leg plaster cast was then applied and retained until the twelfth week.

Compound fractures. These were explored immediately under general anaesthesia; the wound was cleaned and the skin edges excised. If the skin could not be closed without tension, a skin graft was applied as soon as possible. The fracture was stabilised by os calcis traction or by a long leg plaster as necessary.

All patients were assessed for union, both clinically and radiologically, at 12 weeks. If the fracture was united, unprotected weight-bearing was allowed. If union had not occurred at 12 weeks the limb was immobilised for a

further four weeks and then reassessed. If union was still not present at 16 weeks then bone grafting was performed using strips of bone from the iliac crest. Occasionally, if delayed union was predictable at 12 weeks, grafting was performed earlier.

A few patients were treated by internal fixation using a compression plate. Plating was considered if there were: multiple fractures in the same limb; if early walking seemed imperative because the patient was debilitated; if gross soft tissue interposition prevented reduction; or if conservative treatment had failed.

RESULTS

The cause and severity of the injuries are shown in Table I. The figures reflect the high incidence of road traffic accidents seen in any hospital in a large industrial city. It is important to note that more than half the fractures had complicating factors.

One patient, with a severe head injury, died 10 days after the accident; five fractures were treated by early internal fixation and two by late fixation. These eight have been excluded, leaving a total of 91 displaced tibial fractures (in 89 patients). The 52 stable fractures (of which 15 were compound) were treated in long leg

Table I. The aetiology of the fractures and their severity

Cause	Number	Severely comminuted		Compound (all grades)		Significant associated injuries	
		Number	Per cent	Number	Per cent	Number	Per cent
RTA	57	15	26.3	33	57.9	25	43.8
Sport	16	3	18.75	0		0	
Other (fall etc.)	26	4	15.4	3	11.5	2	7.7
TOTAL	99	22	22.2	36	36.3	27	27.3

RTA, road traffic accident

plasters. The remaining 39 fractures (of which 17 were compound) were treated initially by os calcis traction.

Bony union. The results of the conservative methods used can be summed up as follows: all the fractures united; 69 in an average of 16.3 weeks; the remaining 22 (who had bone grafts) took an average of 35.1 weeks. The average for the entire series was just under 21 weeks.

Grafting was used if delayed union had occurred or could be predicted; it was performed at an average of 19.4 weeks from the time of fracture. Although it was decided at 16 weeks whether or not grafting was necessary, it was not always possible to operate immediately and some patients at first refused operation. Union was present at an average of 15.7 weeks after grafting.

The tibia is the most common site of non-union in long bone fractures. We have considered several factors in relation to the time they take to unite and to the need for bone grafting. Table II records the effect of the site of

Table II. The effect of the level of the fracture on the time to union in the 91 fractures

Level	Number	Time to union (weeks)	Grafted (per cent)
Upper third	10	20.6	30.0
Middle third	35	22.4	31.4
Lower third	46	19.7	17.4

Table III. The effect of comminution and displacement on the time to union

Severity of fracture	Number	Time to union (weeks)	Grafted (per cent)
Severe comminution	21	25.6	33.3
Slight comminution	27	19.6	22.2
No comminution	43	19.4	20.9
Severe displacement	30	25.6	36.7
Slight displacement	61	18.5	18.0

Table IV. The effect of skin damage on the time to union

Severity of skin damage	Number	Time to union (weeks)	Grafted (per cent)
Severely compound	9	30.6	55.6
Slightly compound	12	25.0	41.7
Compound from within	11	18.5	9.1
Closed fractures	59	18.9	18.6

the fracture on the time to union. In this series, fractures of the middle third took the longest and required bone grafting in 31.4 per cent of cases.

Table III records the effect on fracture healing of comminution and of the displacement seen on the first radiograph. The distinction between severe and slight

was, of necessity, arbitrary. In grading comminution, small fragments or undisplaced cracks were regarded as slight, whereas butterfly fragments or several displaced fragments were regarded as severe. All the fractures were, by selection, displaced. Those with up to half a diameter displacement were graded as slight, those with more as severe. Comminution and displacement clearly affect healing time; the average time to union in the groups graded as severe was six weeks longer than in the groups graded as slight.

Table IV records the effect of skin damage on fracture healing. Again the distinction between slight and severe was arbitrary; small wounds less than one inch in length were classified as slight. It appears that the degree of compounding has a profound effect on the healing time of the fracture. The three cases with major skin loss all required bone grafting. Even slightly compound wounds had a noticeably delayed union time. Only small puncture wounds, compound from within, had no effect on union time.

Complications. The critics of conservative treatment assert that the incidence of complications is unacceptably high. We have therefore scrutinised our patients carefully to see if they had significant problems. Complications were recorded even if the patient had noticed no abnormality and complained of no symptoms.

Shortening. Table V shows the details of the 10 patients who had half an inch or more of shortening; only the two with more than one inch of shortening had any symptoms and required shoe raises.

Malunion. The malunion rate is shown in Table VI. Only two patients were aware of deformity; both had medial rotation of 15 degrees. None of the patients was functionally disabled in any way and none required corrective osteotomy.

Joint stiffness. Table VII shows that a third of the patients had some degree of stiffness affecting one or more joints. No patient had stiffness of all three joints studied and only two had major stiffness of two joints. One of these two developed Sudeck's atrophy with marked swelling and stiffness of the foot and ankle; the other had an associated fracture-dislocation of the tarsometatarsal joint, again with marked residual stiffness of the foot and ankle.

Lack of knee flexion affected function most. Of the six patients with greatly limited knee movements three had associated femoral fractures and one had a patellectomy. Two patients regained a useful range of movement following quadricepsplasty. We have not found it easy to predict which patients are likely to become stiff. It is interesting to note that the average time in plaster for the 30 patients with stiffness was 24.0 weeks as compared with 19.4 weeks for the patients without stiffness, a difference of only just over four weeks.

Infection. Infection at the fracture site is a serious complication whichever method of treatment is used. There were three cases in which it occurred; in two the

infection was superficial and in one it was deep. In all three the organism was *Staphylococcus aureus* and in all three the infection was cured by excision of dead tissue, regular dressings and antibiotics. There was no case of residual infection.

Refraction. There was one refracture. A 30-year-old man had good clinical and radiological union at 16 weeks, but at 26 weeks he fell whilst drunk, and refractured. Bone grafting was performed and the fracture united after a further 12 weeks in plaster.

Table V. Complications: shortening

Amount of shortening (inches)	Number	Type of fracture
> 1.0	2	Both severely comminuted
0.75 to 1.0	3	All oblique
0.5 to 0.75	5	Oblique or comminuted

Table VI. Complications: malunion

Type of malunion	5 to 14°	Over 14°
Valgus	7	0
Varus	12	1
Medial rotation	1	2
TOTAL	20	3

Table VII. Complications: joint stiffness. Some degree of stiffness occurred in a total of 30 limbs

Joint	Amount of stiffness	Number
Knee	Minor—flexion to 110° or more	6
	Major—less than 110° flexion	6
Ankle	Minor—more than 75% movement	14
	Major—less than 75% movement	4
Subtalar	Minor—more than 50% movement	5
	Major—less than 50% movement	7
TOTALS	Minor	25
	Major	17

Other features. Anaesthesia was administered on average 2.3 times per patient. Every patient had a general anaesthetic for the first manipulation. Wedging of the plaster was usually done under sedation. Early manipulations, removal of os calcis pins and bone grafts all required general anaesthesia.

Inpatient stay. There were 78 patients whose length of stay in hospital was governed solely by the tibial fracture; in them the average stay, including all periods of inpatient care, was 14 days (range 1 to 45 days).

Time back to work. For the 60 patients who were employed, the average time away from work was 31 weeks; little can, however, be concluded from this figure since much depends upon the nature of the work and the

motivation of the patient. Some of the remaining patients were housewives, some were retired, some were unemployed and one was in prison.

Primary internal fixation. Five tibial shaft fractures required open reduction and internal fixation. Three of these patients had multiple fractures of one limb and plating the tibia seemed the best way of controlling the limb. One elderly lady had supracondylar fractures of both femora together with an unstable fracture of the tibia; to simplify her management elective plating of the tibia was performed. The fifth patient had widely separated fragments after closed reduction; open reduction to remove the soft tissue was performed, followed by compression plating.

Late internal fixation. Two fractures failed to unite with conservative treatment and we elected to perform rigid internal fixation with a compression plate. The first patient had ipsilateral fractures of the femur and tibia. The femur was plated and the tibia treated conservatively. He was mobilised at 16 weeks, but three months later he stumbled and refractured his tibia. Because he had significant stiffness of his knee at this stage the tibia was plated so that he could continue exercising the knee.

The second patient had a grossly compound tibial fracture with a segment of the tibial shaft missing. The fracture was initially treated by os calcis traction. A bone graft was performed at nine weeks to bridge the osseous defect. However, non-union developed and a second bone graft was performed. A hypertrophic non-union developed and the fracture was then, 18 months after the injury, rigidly fixed with a plate; union occurred three months later.

DISCUSSION

The orthopaedic literature abounds with reports on the treatment of tibial fractures by various methods. These include rigid plates (Blockley 1956; Burwell 1971; Smith 1974), dynamic compression plates (Ruedi, Webb and Allgower 1976; Jensen, Hansen and Johansen 1977; Christensen *et al.* 1981), intramedullary nailing (Christensen 1973; Harvey, Hodgkinson and Harvey 1975), external fixation (Karlstrom and Olerud 1975), and various forms of cast bracing (McCollough, Vinsant and Sarmiento 1978; Austin 1981; Suman 1981). It is not the purpose of this present study to arbitrate between the various factions proposing or justifying any particular form of treatment. They all have advantages and disadvantages. Lengthy reviews already exist for reference (Nicoll 1974; Karlstrom and Olerud 1974; Austin 1978).

We set ourselves to examine a consecutive series of tibial fractures treated conservatively over five years. All the fractures have united including those regarded as failures of conservative treatment and all the patients are now independently mobile, no matter how severe their injuries were.

This series does not confirm the generally held view

that fractures of the lower third take longest to unite. It also shows that severe degrees of displacement, comminution and compounding cause significant delay in union. This is to be expected since such fractures are caused by high energy injuries, with associated major soft tissue damage.

Tibial fractures are prone to delayed union or non-union. To overcome this our policy has been to offer bone grafting for those fractures not united at 16 weeks after injury. Some might have progressed to union with further immobilisation, but to predict which would do so is difficult. Our past experience has been that procrastination at this stage merely delays the ultimate time of healing and brings with it increased complications. Our somewhat aggressive policy of bone grafting resulted in these difficult cases uniting at an average of 35 weeks. In fact 93 per cent of the fractures were united by eight months. There has been no complication from bone grafting and we feel this is a safe and useful procedure which ensures bone union without greatly prolonging the period of immobilisation.

Sound bony union is the primary objective in the treatment of tibial fractures. However, the method chosen to obtain union must take into account the soft tissues and must not itself be responsible for a significant number of complications. In this series there was no

death that could be even remotely connected with treatment, no delayed amputation, no case of chronic osteomyelitis and, most significantly, no complication attributable to operative interference. Post-traumatic stiffness was a problem, although it was not the inevitable consequence of treating any particular type of injury conservatively.

To have a universal policy of internal fixation is to impose upon the majority of patients an operation that, in our opinion, is unnecessary and that has its own potential for complications. The possibility of improved results in the problem cases can hardly be used as a justification to operate on all fractures. It is tempting to suggest that the worst fractures with severe soft tissue damage might be fixed internally. However, they do not invariably develop complications when treated conservatively and to superimpose operative trauma onto a severely damaged limb is inviting complications which may result in disaster. Chronic osteomyelitis, skin necrosis and infected non-union of fractures can all occur as a result of internal fixation.

We accept that other methods of immobilising tibial fractures have a place. However, we believe that a conservative approach, with early bone grafting if necessary, is justified as the basic method of treatment from which variations can be applied as indicated.

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