Treatment of Fractures of the Tibial Shaft with Inter-Fragmentary Screws and External Fixation

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SUMMARY: In a prospective trial, 10 patients underwent inter-fragmentary screws and external fixation for unilateral tibial shaft fractures. Anatomical reduction was achieved in all cases and uncomplicated bone union occurred in nine patients with a mean time to union of 122 (SD 20) days. One patient had delayed union and the fracture malunited. A 20% pin tract sepsis rate was encountered. The high risk of infection, the demanding follow-up and availability of better methods, does not allow this technique to be recommended in the routine treatment of closed tibial diaphyseal fractures.

Introduction

Controversy surrounds the management of complicated fractures of the tibial diaphysis. A wide range of methods have been applied to this difficult group. Moed (1) claimed that in highly selected cases of closed tibial shaft fractures, simple screw fixation followed by plaster immobilisation provided an effective treatment alternative. In a retrospective review, only 44% of fractures healed with an excellent or good result (2). Muller *et al* (3) recommends this technique only for fractures with a L:D ratio* greater than 3-4.

This paper reports the results of a prospective pilot study utilising inter-fragmentary screws and external fixation in the treatment of closed fractures of the tibial shaft.

Materials and Methods

Between April 1986 and March 1988, 10 patients admitted to the British Military Hospital Rinteln with unilateral fractures of the tibial shaft, were included in this study. These were fractures that could not be accurately reduced by closed means or in whom the reduction was lost whilst treated in plaster splintage. All were closed fractures and were not associated with any other lower limb injury. Intra-articular fractures were excluded from the study. The mean age was 26 (range 19-42) years; there was only one female patient. Sports related injuries accounted for half the cases (Table 1). The characteristics of the fractures are listed in Table 2.

Using the AO fracture classification system, the distribution of fracture patterns was as follows: (number of patients in parentheses): A2(2), B1(2), B2(1), B3(1), C1(3), C3(1) (4).

Three cases underwent operation within twenty-four hours of injury, four within one week and the remainder within three weeks.

Technique: (Fig 1 a, b & c)

The fractures were reduced through a small incision and the reduction held with AO/ASIF inter-fragmentary screws. One screw alone was used in two cases, two in four cases and three in the remainder.

* Ratio of fracture length to the tibial diameter at the level of the fracture site.

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Table 1
Cause of Injury

	Number of cases
Road traffic accident	1
Sporting injury	5
Entrapment in tank traverse	2
Assault	1
Fall from height	1

Table 2
Fracture Characteristics

	Number of cases
Site — middle 1/3	6
—lower 1/3	4
Displacement (>25% width)	5
Comminution (>3 fragments)	8
L:D ratio — <2	5
L:D ratio — >2	5
Butterfly fragments	6
Associated fibular fracture	5

After wound closure, an AO/ASIF tubular external fixator was applied. This employed four Schanz screws with two connecting rods arranged in a uniplanar, unilateral configuration. The Schanz screws were pre-stressed and inserted in the tibial subcutaneous border.

The pin sites were hand drilled and prophylactic antibiotics were administered with induction of anaesthesia.

Post-operative care:

Active knee and ankle movements were encouraged in the immediate post-operative period. Mobilisation with partial weight bearing was commenced once the leg oedema had settled and progression to full weight bearing achieved in most patients by the second post-operative week. The mean time from operation to hospital discharge was 7 (SD 2) days.

Fig 1a

Fig 1b

Fig 1c

Figs 1a, b, c.

Serial radiographs showing the process of bone union.

The rigidity of the external fixator was progressively decreased from the fourth post-operative week. This entailed loosening of the retaining clamps and increasing the distance of the connecting rods from the skin surface till only one rod remained.

When radiological evidence of external callus formation was present, the fixator was removed and a Sarmiento cast applied.

Splintage was discarded when radiological (as defined by trabeculae crossing three quarters of the fracture site in two perpendicular views) and clinical union was achieved.

The military patients were medically downgraded and only sedentary activities permitted. This was continued for six months after splintage was discontinued whereupon they were returned to full duties.

No re-fractures occurred in this study.

Results

Post-operative radiographs showed anatomical reduction of the fracture in all cases.

Time to union:

The time to clinical union was defined as when full weight bearing of the unsplinted limb occurred. Uncomplicated bone union occurred in nine cases with a mean time of 122 (SD 20) days.

Delayed union:

This was defined as union occurring after 20 weeks. It occurred in one patient where the fracture united after 234 days. The external fixator was initially mal-applied; two Schanz screws fractured and a pin tract infection progressed to osteitis and ring sequestrum formation.

Further operations were required as was prolonged plaster splintage. The fracture mal-united.

Mal-union:

Mal-union was present if the bone united with 5° or more of angulation, or 0.5 cms shortening. One patient (*vide supra*) healed with a 5° valgus deformity.

Pin tract infection:

This was present when a persistent discharge issued from a pin site with a positive bacteriological culture. Eight episodes of pin tract sepsis occurred; all but one settled with antibiotic therapy.

Discussion

Burny (5) has championed the role of the external fixator in closed tibial fractures; he advocates a 'minimal approach' technique. This involves a 3-4 cms incision to allow precise fracture reduction without significant periosteal disturbance. The treatment of tibial fractures with inter-fragmentary screws without a neutralization plate has not been widely practised. This method exposes the patient to the risk of infection without secure fixation being obtained. The combination of the above two techniques viz. inter-fragmentary screws and a dynamic external fixator has theoretical attractions. The screws allow maintenance of the reduction and the fixator initially functions as a neutralization plate (without the periosteal disturbance inherent in the latter). However, early dynamisation of the external fixator allows stabilisation of the fracture by external callus formation. This method is not without complications: in a series of 20 patients so treated, loss of screw fixation occurred in 50% soon after removal of the external fixator (6).

One observation from this study was that the appearance of callus was both delayed, and the total amount decreased as compared to fractures treated solely by external fixation. A corollary of this was that the external fixator was applied for a long period ($102 \pm \text{SD } 38$ days). No loss of screw fixation occurred after removal of the fixator in those cases that went on to uncomplicated bone union. This may have been as a result of the length of time the fixator was in place; this was at the expense of 20% pin tract sepsis rate that in one case led to significant problems.

Furthermore, this treatment required frequent outpatient attendance as well as a well motivated patient. The ultimate goal of fracture treatment is the rapid restoration of functional activity. When considering comminuted and segmental fractures of the tibial shaft, the closed locked intra-medullary nail technique well meets that objective. The reported infection and delayed union rate is low (7). When this study was commenced the expertise and instrumentation for the above method was not available within the hospital. The experience from this small group does not lend support for the routine use of inter-fragmentary screws and external fixation in the treatment of tibial shaft fractures. However, it may be of help in difficult situations when dealing with complicated types of fracture.

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