Unreamed intramedullary locking nailing for open tibial fractures

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Accepted: 10 October 1997

Summary. *We reviewed the results of the treatment of 24 cases of open tibial fractures using unreamed intramedullary locking nailing. The fractures were classified, following the Gustilo system as grade I-7, grade II-7 and grade III-10. The average time to achieve bony union was 22 weeks with a 26% incidence of pseudoarthrosis. There were no cases of deep infection. Five cases healed with shortening of over 1 cm, but we did not observe angular deformity in any of the patients. In 2 fractures with associated articular lesions, joint motion was limited at final follow up. The nail broke in 2 cases and the screws in 5. The surgical procedure is well tolerated by patients, allows good management of soft tissue lesions and rehabilitation with low rate of infection and malunion. The main disadvantages have been the relative high incidence of nonunion and breakage of metal.*

Résumé. *Les auteurs rapportent les résultats du traitement de vingt-quatre fractures ouvertes de la jambe stabilisées avec un enclouage verrouillé sans alésage. On a classifié les fractures en suivant le système de Gustilo: 7 grade I, 7 grade II et 10 grade III. La moyenne de consolidation fut de 22 semaines avec un pourcentage de pseudoarthroses de 26%. Il n'y a pas eu d'infection profonde. Cinq cas ont consolidé avec un raccourcissement de plus d'un cm mais on n'a pas observé d'angulation. On a noté une limitation de la mo-*

bilité articulaire chez deux patients qui avaient des lésions articulaires. On a eu deux ruptures du clou et cinq de vis. Nous concluons que cette technique chirurgicale est bien tolérée par la patient, elle permet un bon maniement des tissus nous, une réhabilitation précoce et elle a un pourcentage bas d'infection ou mauvaise consolidation. Le principal désavantage a été la relative incidence de pseudoarthroses et de ruptures du matériel par stabilité insuffisante.

Introduction

Orr [20] and Trueta [28] laid down principles for the treatment of open fractures in world war one and the Spanish civil war. It is accepted that the initial management should include profuse lavage, extensive soft tissue and bone debridement, stabilisation and early skin cover.

There is, however, no agreement about the ideal method of bony fixation. External fixation has been accepted by many surgeons as it does not damage the endosteal and periosteal circulation.

Recently, the development of solid intramedullary locking nails, used without reaming, offers an alternative treatment which we evaluate in this paper.

Materials and methods

From January 1992 to December 1993, 30 patients with open tibial fractures were treated by unreamed locking nailing. Twenty-four cases were followed up and form the basis of this study; the remainder were discharged to other medical centres after their initial management. The mean age was 47 years

Fig. 1. Anteroposterior radiographs showing, from left to right, the sliding mechanism at the proximal locking screw taking place after weightbearing, and before final breakage

Fig. 2. Radiographic series, from left to right, of a grade IIIA open tibial fracture in a man who was 59 years of age. On the day after operation he got out of bed and walked without support; the nail failed at one of the distal locking holes and had to be replaced by an external fixator

Fig. 3. Radiographic series, from left to right, of a grade III open tibial fracture in a woman, 60 years of age, which shows progress to fracture healing; she developed osteomyelitis of the calcaneum as a result of a wound which exposed the underlying bone

The patients were managed during the first hours after arrival by intramedullary nailing in 21 and external fixation in 3. The latter were converted to intramedullary nailing soon afterwards. The reasons for this early change were poor fracture reduction, loss of reduction and one case of pin tract infection which underwent an intermediate three week period of skeletal traction before nailing.

Initial treatment always included extensive soft tissue debridement and irrigation, combined with intravenous antibiotics with third generation cephalosporins and aminoglycosides for an average period of 10 days. Wounds in grade I and II open fractures were closed primarily over drains. In grade III fractures, 4 patients had delayed primary closure (all of them IIIA), 3 healed secondarily with free skin grafting (2 cases IIIA and one IIIC), and 3 by muscle pedicle flaps with the medial gastrocnemius in 2 and soleus in one (2 cases IIIA and one IIIC).

Nailing was carried out in every case with a solid locking nail specifically designed for unreamed use (UTN, Synthes Switzerland). A transtendinous approach was always performed and the biggest diameter of nail possible was used (19 number 8 and 5 number 9). Nine nails were locked proximally and distally, 14 were locked proximally and distally only with a proximal screw placed in a slot designed to control rotation but allow sliding (Fig. 1), and one with only distal screws. The 2 patients with ankle involvement required additional osteosynthesis.

Electrical stimulation was used in 5 patients, and 4 out of the 9 nails with proximal and distal locking were dynamised. Two patients required a plaster cast, one due to a proximal tibial fracture scarcely controlled by the nail, and the other because the nail broke one month after operation. One unreamed nail was exchanged for a bigger reamed one at one month to provide better stability. Finally, one nail was converted to external fixation because of nail breakage during the first postoperative day (Fig. 2).

Weightbearing was immediate, except in 7 cases where it was delayed for an average of 70 days due to associated lesions, joint involvement or poor stability.

One patient had an early amputation after a grade IIIC open fracture when arterial reconstruction failed. The other 23 cases were followed for an average of 18 months (range 12 to 24 months). At the final evaluation, leg length discrepancy, torsional and angular deformities were recorded in every case.

Table 1. Open fracture grading following Gustilo

Grade I	7
Grade II	7
Grade IIIA	6
Grade IIIB	2
Grade IIIC	2

(range 16 years to 84 years) with a ratio of 2 men to 1 woman. The site of the fractures, dividing the tibia into 5 segments, was mainly in the middle (6) and middle-inferior (10) segments. Pedestrian, automobile and motorcycle accidents were the main causes, with significant associated lesions present in half of the patients.

Open fractures were classified by the Gustilo system [9] as: grade I in 7 cases, grade II in 7 and grade III in 10 (Table 1). The fracture pattern included: transverse fractures – 1, short oblique – 4, long oblique – 3, spiral – 3, butterfly – 4, comminuted – 6 and segmental – 5. The ankle joint was involved in 2 cases, and in every case the fibula was fractured.

Fig. 4. Radiographic series, *from left to right*, of a grade I open tibial fracture in a man, 19 years of age, showing slight sliding of the nail at the proximal locking screw. The final result was excellent at one year of follow-up

Table 2. Complications

Pseudoarthroses	6
Deep infection	0
Screw breakage	5
Nail breakage	2
Shortening > 1 cm	5
Valgus > 10°, varus > 5°	0
Ante, recurvatum > 10°	0

Results

Fracture healing was achieved in 17 patients at an average of 5 months (range 2 to 14 months). Complications are shown in Table 2. Six patients (26%) developed a pseudoarthrosis; their fractures were classified as grade I – 1, grade II – 2, grade IIIA – 2, and grade IIIB – 1. They were treated by a conventional reamed locking nail without bone grafting. Infection occurred in one patient with previous osteomyelitis of the tibia who sustained a grade IIIB fracture. There were no other cases of deep infection at the fracture site. The patient who had the external fixation removed, with delayed repeat nailing because of pin tract infection, healed uneventfully. One patient developed osteomyelitis of the calcaneum due to direct bone exposure caused by a heel wound (Fig. 3).

In 7 cases (30%) metal failure occurred at 4 proximal screws, one distal screw and 2 nails. The nail broke in one case on the day of the operation when the patient got out of bed and walked with full weightbearing. It was changed for an external fixator (Fig. 2). The second nail failed during

weightbearing, but the fracture healed with the added support of a cast.

Leg length discrepancy greater than 1 cm was present in 5 patients (21%) with an average for the series of 0.3 cm without any functional impairment for this reason. No cases of malalignment in valgus, or anterior bowing, or recurvatum of over 10° or varus over 5°, were recorded. A nail with proximal protrusion was removed after the fracture had healed. Two patients had slight stiffness of the ankle.

Discussion

External fixators provide rigid fixation and have a low infection rate, but the disadvantages are frequent pin tract infection and loss of reduction with malunion and pseudoarthrosis [6, 12, 25]. Conventional intramedullary reamed locking nailing offers better control of alignment, rotation, and shortening, and better stability. However, reaming destroys the endosteal circulation adding impairment to the blood flow to the already damaged bone [6, 22], and also increases pressure in the adjacent compartments [18, 19, 26]. This is the reason why many authors dislike using this technique for open fractures and attribute a high infection rate to it [3, 24]. Nevertheless, good results have been reported in grade I and II open fractures [5, 9, 15], and there are reports of a good outcome with its use in grade III cases [7, 15]. Some authors have used delayed intramedullary nailing after initial external fixation in order to avoid the disadvantages, and report good results [1, 2]. Flexible nails [11, 12] or small diameter rigid nails [13, 29] have been tried with the aim of avoiding disturbance of cortical vascularity and increase of compartmental pressure, but with a significant number of cases of malunion.

Solid, rigid, small diameter nails with locking have the beneficial effect on bone circulation of not reaming, with better control of rotation, shortening and angular deformities. An infection rate of 3%, nonunion in 4% and no angular deformity has been reported by Whittle et al. [30]. They also had breakage of locking screws in 10% and nail breakage in 6%, but their results were better than other methods of fixation. Singer et al. had a high index of broken locking screws, but their results are comparable with other types of external fixation [23]. This kind of nail has also been used in closed tibial fractures, which are unstable or have severe soft tissue injury, with breakage of cross-locking screws in 15% [8, 17].

The management of soft tissue injury has improved with the use of pedicle flaps and free vascularised grafts, which allow more aggressive initial debridement and diminish the importance of the type of osteosynthesis used [10, 21, 27]. We think that control of infection depends more on thorough debridement and the provision of well vascularised soft tissue cover than the kind of fixation used.

In our series the implant used offers good control of alignment and rotation, and has a low infection rate. Shortening associated with screw breakage (Fig. 3), or by the proximal sliding locking slot (Fig. 4) could be considered a disadvantage, leading to a leg length discrepancy. The amount of shortening was significant in only 5 of our patients and did not influence the final functional outcome. The number of pseudoarthroses may indicate low stability at the fracture site. The rate of metal failure has been higher than in previous series [8, 14, 15, 17, 30, 31]. This could be explained since, as we were encouraged by the initial results and by our experience with reamed nails, we encouraged early weightbearing which is not recommended with this type of osteosynthesis. Failure has been more common at locking holes in the nail and at the point of nail contact in the case of screws. Although it did not influence fracture healing in the cases in which it has been observed, this weakness of the implant prevents early weightbearing. On the other hand, the use of intramedullary nailing makes soft tissue management easier, permits good rehabilitation and is well tolerated by the patient.

Our experience has produced a treatment protocol for severe open tibial fractures at our centre, with the initial use of unreamed nailing which will allow weightbearing and can be exchanged for a bigger diameter reamed intramedullary nail, if needed, after soft tissue healing.

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