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Nicola Maffulli · Andrew D. Toms · Andrew McMurtie · Francesco Oliva

Percutaneous plating of distal tibial fractures

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Abstract We studied 20 patients (mean age 47.9±3.9, range 25–85 years) undergoing percutaneous plating of the distal tibia for 43A or 43C fractures in the period 1999–2002. Bony and functional results were classified into four categories ranging from excellent to poor. Union was achieved in all but one patient. Seven patients had angular deformities between 7 and 10°, but none of these patients required further operations. No patient had a leg-length discrepancy greater than 1 cm. Thirteen patients had excellent and good bone results, and none used walking aids. Seven patients reported stiffness of the operated ankle. This reported use of percutaneous techniques in the management of fractures of the distal tibial metaphysis is preliminary. However, the functional results and the lack of soft tissue complications are encouraging.

Résumé Nous avons étudié 20 malades (âge moyen de 47.9±3.9 ans, gamme 25 à 85) qui dans la période 1999–2002 ont eu une ostéosynthèse du tibia distal par plaque percutanée pour des fractures de type 43A ou 43C. Les résultats osseux et les résultats fonctionnels ont été classés dans quatre catégories, d'excellent à mauvais. La consolidation a été obtenue dans tous les cas sauf un. Sept malades avaient une désaxation angulaire entre 7° et 10° mais aucun n'a du être réopéré. Aucun malade n'avait une inégalité de longueur de plus d'un centimètre. 13 malades avaient des résultants osseux excellents et bons, et aucun n'utilise d'aide à la marche. Sept malades ont une raideur de la cheville opérée. L'usage de techniques percutanées dans la gestion de fractures de la métaphyse tibiale distale est préliminaire. Cependant, les résultats fonctionnels et l'absence de complication au niveau des parties molles sont favorables à cette technique.

N. Maffulli (✉) · A. D. Toms · A. McMurtie · F. Oliva
Department of Trauma and Orthopaedic Surgery,
Keele University School of Medicine,
North Staffordshire Hospital,
Thornburrow Drive, Hartshill, Stoke on Trent, Staffordshire,
ST4 7QB, UK
e-mail: n.maffulli@keele.ac.uk
Tel.: +44-1782-554608
Fax: +44-1782-412236

Introduction

Open anatomical reduction and stable internal fixation allows axial alignment of the limb, permits early mobilisation, and results in bony union from endosteal bone healing [14]. However, in the distal tibia, the surgical dissection required to achieve anatomical reduction evacuates the osteogenic fracture haematoma and causes soft tissue stripping that can result in infection, wound necrosis and delayed or non-union. A balance between anatomical reduction and soft tissue devitalisation is therefore required. Minimally invasive surgery requires that direct anatomical reduction with rigid fixation through compression be substituted for indirect reduction and the maintenance of alignment by bridging the fracture without compression [6].

Percutaneous plating preserves the soft tissue envelope and the periosteum, maintains arterial vascularity and therefore minimises the surgical trauma to the zone of injury [2, 7, 19]. A high success rate of minimally invasive plating techniques in the distal tibia, the femur, proximal tibia and tibial shaft has been reported [8, 10, 11, 12].

We report the mid-term results of percutaneous plating in metaphyseal fractures of the distal tibia treated by a single surgeon using conventional implants.

Patients and methods

The study was conducted in two tertiary referral centres—the Department of Orthopaedic Surgery of the University of Aberdeen Medical School, and the Department of Trauma and Orthopaedic Surgery, Keele University School of Medicine.

All patients sustained a fracture of the distal tibial metaphysis, at times extending into the ankle joint and at times associated with a fracture of the distal fibula. A total of 20 patients (mean age 47.9±3.9, range 25–85 years; nine men, mean age 48.5±6.6, range 26–76 years; 11 women, mean age 47.3±4.8 years, range 25–85

Fig. 1A–F Male patient aged 54. **A** At presentation. **B** Immediate post-operative view: Both the tibia and the fibula underwent percutaneous fixation with the tibia being fixed first. **C** Six weeks after internal fixation: The patient had started full weight bearing 4 weeks after the index operation. Note early callus formation over the lateral aspect of the lower tibia. **D** Six months after the index operation: Evident callus formation over the lateral aspect of the lower tibia. **E** One year after the index operation. Note the breakage of the most distal of the proximal screws. **F** Two years after the index operation: The patient was asymptomatic despite the breakage of all proximal screws

years) entered the study. There were 15 AO 43A fractures and five AO 43C fractures. Two patients, both men, presented with a type IIIB open tibial fracture, and one necessitated a rotational flap. An 85-year-old woman presented with a grade I wound over the fibular fracture.

Rapid skeletal stabilisation was achieved by splintage with an above-knee back slab. We planned that the plate was to be applied on the antero-medial aspect of the distal tibia. Contoured plates are commercially available, but we used standard one-third tubular, cloverleaf and dynamic compression plates (DCP), pre-contouring them on dry bones for each specific fracture before undertaking the procedure.

The patient was placed supine on a radiolucent table. Antibiotic prophylaxis was administered, and standard intra-operative fluo-

Table 1 Categories of Bone and Functional results

Categories	Bone results	Functional results
Excellent	Union No infection Angular deformity of <7° Shortening of <2.5 cm A bone result cannot be graded excellent if bone grafts are used to achieve union	Active with none of the four bone results criteria
Good	Union with any two of the other three criteria	Active with any one or two of the four bone results criteria
Fair	Union with any one of the other three criteria	Active with any three or four of the four bone results criteria
Poor	Non-union or refracture or union with none of the other three criteria	Inactive

roscopy was used throughout the procedure. Both the injured and the non-injured limb were prepped and draped above the knee, thus allowing intra-operative alignment to be checked against the uninjured limb. The joint line of both the knee and the ankle were defined and marked on the skin. We did not use a tourniquet. We performed the procedure applying manual traction with the limb free in nine patients, or with a Steinman pin inserted into the calcaneum in the remaining 11 patients. If appropriate length and rotation could be achieved, we preferred to address the tibia first (Fig. 1). In eight patients, the fibula was stabilised using a percutaneous approach. The main fragments of the tibial fracture were aligned and reduced percutaneously. Separate stab incisions may have been required to achieve reduction. Reduction of large fragments was maintained using individual lag screws. A pre-contoured plate was used to adequately bridge the fracture site. The plate extended proximally and distally so that at least two bicortical screws could be inserted both proximally and distally to the fracture. With the fracture adequately reduced, a small transverse incision was made distal to the medial malleolus, and a sub-muscular tunnel was created. The plate was then passed along this tunnel. The alignment and position of the plate was adjusted using unicortical Kirschner wires to control the track that the plate would follow. The final position of the plate was secured by passing one Kirschner wire through a hole proximal to the fracture site and another through a hole distal to the fracture site. At this stage, the surgeon made a thorough assessment of the limb alignment and established that the correct rotation had been achieved by comparison with the other limb. Further screws were then inserted percutaneously as necessary, with at least two bicortical screws at either end. The reduction could only be appreciated when the plate was secured, as the plate itself, having been pre-contoured, effected the final reduction. The stab incisions were sutured in the standard fashion, the wounds dressed, and the limb placed in a split plaster-of-Paris cast. A drain was never used.

Prophylactic antibiotic coverage was continued for 24 h. Low-molecular-weight heparin was used as routine anti-thrombotic prophylaxis. The limb was kept elevated for 48 h when the split plaster-of-Paris cast was changed for a short-leg, lightweight synthetic cast for 6 weeks. Most patients were able to bear weight at least partially at 6 weeks. The cast was removed at 6 weeks, and out-patient physiotherapy was instituted to maximise the range of motion at the foot and ankle. Results were evaluated at an average of 26.3±14.5 months from the injury (range 14–47 months), and classified in accordance to described criteria [16] validated in our setting [15]. Based on these criteria, both bony and functional results were classified into four categories ranging from excellent to poor (Table 1).

Results

During the study period, a female patient aged 85 at the time of the operation died of a cerebral cardiovascular accident. No patients developed an infection. Union was achieved in all but one patient. None of the other 19 patients required bone grafting. Seven patients had angular deformities greater than 7°; three had a valgus deformity; two had a varus deformity and another two had anterior bowing of the tibia at the fracture site. No patient required further operations, and none had a leg-length discrepancy greater that 1 cm. Thirteen patients had excellent and good bone results,; none had a fair result. We considered two patients to have a poor result given the necessity for a further operation (see below).

In five patients, the subcutaneous plate was clinically detectable in the subcutaneous tissues at the time of the last clinic visit, but it did not bother any patient. Four patients had a clinically detectable limp but none used walking aids. Seven patients reported stiffness of the operated ankle. No patient had soft-tissue dystrophy, though two reported pain that interfered with daily activities. All except those two patients were able to resume their daily activities and remained active in the community. All patients were able to wear normal shoes at the time of their latest out-patient clinic follow-up.

Two patients required re-operation. In one woman, the plate broke 14 months after the original operation. This resulted from the fact that the reduction had been sub-optimal, and a non-union ensued. Removal of the plate, bone grafting and further internal fixation was performed and union achieved. One man presented with a broken screw 13 weeks after the original operation with loss of fixation despite abundant callus. The broken screw was removed through the old stab-wound scar and another inserted in a slightly different direction. The original post-operative regime was implemented, and union took place.

Discussion

Peri-articular fractures of the distal tibia are difficult to manage [18]. In combination with the poor soft-tissue cover, these fractures are often comminuted with a small metaphyseal fragment. Traditional techniques either fail to adequately reduce and hold the fracture or may further disrupt the already tenuous soft-tissue envelope [3].

Percutaneous plating offers a reasonable management option for these complex injuries but demands attention to detail and careful pre-operative planning [4]. Minimally

invasive techniques do not allow direct visualisation of the fracture. Therefore, the surgeon is reliant on intra-operative fluoroscopy to confirm adequate reduction. It is important to ensure that the set up and quality of the images are adequate before starting the procedure [5].

Intra-operative determination of limb alignment, both axial and rotational, can be difficult. There are a number of techniques that can be helpful in avoiding malalignment:

- Marking the joint lines above and below the fracture
- Sterile prepping and draping of the un-injured limb allows direct comparison, particularly useful with respect to the foot progression angle
- Elevating the injured limb on radiolucent trays enables a clear lateral view and avoids interference from the other leg
- The use of a bridging external fixator to maintain limb alignment while the fracture is fixed

Our patients were followed up prospectively as part of their clinical evaluation. Despite its limitations, this study marries the realities of clinical practice with the rigours of scientific investigation and may invite hypotheses for future prospective randomised trials. Also, although patients were discharged when their healing was satisfactory clinically, functionally and radiographically, we could not be absolutely certain that no problems arose subsequently and were taken care of by other hospitals. However, given the "open door" policy implemented in our clinic to these patients, it is unlikely that they had problems after bony union.

The technique we describe is less invasive than conventional open procedures that require extensive soft-tissue stripping but it is technically demanding. Other authors have used minimally invasive percutaneous screw fixation and external fixation with excellent results [17]. However, not all patients are able to tolerate prolonged external fixation and, despite accurate cleaning, pin-site infections are common and can dictate the abandonment of external fixation [1]. Also, external fixation, even by an experienced surgeon, is not always successful; indeed, some authors reported worse clinical results, slower return to function, a higher rate of complications, more non-unions and malunions and more infections when compared with internal fixation [1].

A further option for metaphyseal fractures located 4–5 cm proximal to the ankle joint is intra-medullary nailing, possibly cutting one centimetre off the tip of a tibial nail thus allowing placement of two distal interlocking screws [9, 13]. However, fixation strength with these distal fractures is not high enough to resist even moderate compression and bending loads. Thus, patients with distal tibia fractures treated with intra-medullary nailing must follow weight-bearing restrictions until significant fracture healing occurs to prevent malalignment [9]. Also, this technique is ill-suited to the management of the intra-articular component of distal tibial fractures.

Our experience in the use of percutaneous techniques in the management of fractures of the distal tibial metaphysis is preliminary. However, the functional results and, above all, the lack of soft-tissue complications, are encouraging.

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