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ORIGINAL PAPER

# Distal tibia fractures: management and complications of 101 cases

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**Abstract** Distal tibia fractures are complex injuries with a high complication rate. In this retrospective and multicentre study we attempted to detail complications and outcomes of this type of injury in order to determine predictive factors of poor results. Between 2002 and 2004, 104 patients were admitted for 105 distal tibia fractures. One hundred patients (101 fractures) were reviewed with an average follow-up of 19 months (range, 12–46). Internal fixation, external fixation, limited internal fixation (K-wires or screws), intramedullary nailing and conservative treatment were used. Outcome parameters included occurrence of complications, radiographic analysis, evaluation of the American Orthopaedic Foot and Ankle Society (AOFAS) ankle score and measures of the ankle range of motion. The average functional score was 76 points (range, 30–100 points), and complications occurred in 30 patients. Predictive factors of poor results were fracture severity, complications, malunion and the use of external fixation. We believe that external fixation must be reserved for trauma with severe skin injury, as a temporary solution in a two-staged protocol. For other cases, we recommend ORIF with early mobilisation.

Level of evidence: Therapeutic study, level IV

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## Introduction

Management of distal tibia fractures, with or without articular involvement, is a therapeutic challenge [1–4]. The goal of orthopaedic surgeons is to restore the tibial anatomy, to fix the epi-metaphyseal block with the diaphysis and to avoid complications.

Many osteosynthesis techniques can be used for these fractures such as; traditional open reduction and internal fixation (ORIF), external fixation with or without limited internal fixation, intramedullary nailing or, more recently, minimally invasive plate osteosynthesis (MIPO) [5–9]. All of these techniques have advantages and disadvantages and there is no consensus concerning the management of these fractures [2, 10].

Despite progress of surgical procedures, outcomes are not always excellent and complications affect 20–50% of patients [2, 11, 12]. The purpose of this paper was to study the functional and radiographic outcomes after distal tibia

fractures, to evaluate complications and to determine predictive factors of poor results.

## Materials and methods

### Description of patients

This retrospective and multicentre study concerned 104 patients with 105 distal tibia fractures from 2002 to 2004 in six general hospitals in northeast France. The study group included 35 women and 69 men with an average age of 44 years (range, 15–86 years). There was one bilateral case. Four subjects were lost at final follow-up and 95% of patients were reviewed for clinical and radiological evaluation. Thus we obtained a group of 101 consecutive fractures (100 patients). High-energy injury occurred in 74 cases (42 road traffic accidents and 32 falls from height) and low-energy traumatism in 27 cases (twisting injuries).

We classified the distal tibia fractures according to the AO/OTA classification [2] as type 43 (metaphyseal) with distinction of type A fractures (extra-articular), type B (partial articular) and type C (total articular) (Table 1). Open fractures were classified according to the Gustilo classification for open fractures [13] and involved 17 patients (seven type I, eight type II and two type IIIA). There were two preoperative nerve injuries and one vascular injury requiring specialised management. Eighteen patients had multiple injuries with visceral injuries and/or associated fractures.

### Surgical procedures

Type of osteosynthesis and surgical approach were determined by the surgeon according to the fracture type, fragments localisation and skin injury (Table 2). Open fractures were treated within 24 hours of injury as were the fractures without skin damage. For other cases, the procedure was performed after soft tissue recovery.

- Thirty-five patients underwent open reduction and internal fixation. No locking plates were used in this study, only conventional and anatomical AO plates. The surgical approach was determined by the local state of the skin (wound, blister, etc.). Approaches were anteromedial (80%), anterolateral (11%) or strictly anterior (9%). No minimally invasive approach was used. Postoperatively, six patients were mobilised with partial weight-bearing without a cast and 29 patients were immobilised in a non weight-bearing cast for an average period of 79.7 days. Full weight-bearing was allowed after an average period of 87.0 days.
- Thirty-two patients were treated with external fixation. When indirect reduction techniques permitted a satisfactory reduction under fluoroscopy, external fixation was used alone (14 cases). For other cases, limited internal fixation using 3.5-mm or 4.5-mm cannulated screws and/or K-wires through short incisions was performed in order to reduce and stabilise articular and periarticular fragments (18 cases). Ankle spanning systems were used which comprised a unilateral frame anchored with pins at the medial border of the tibial diaphysis and at the neck of the talus and calcaneum. On average, the ankle joint was held for three weeks. Ankle sparing systems were used when technically feasible with a complete ring applied distally in the metaphyseal region with two or three wires. This ring was connected to the frame and the system was anchored at the tibial shaft with two or three pins. These systems allowed early ankle and subtalar motion. The two different devices were used for external fixation but the design of this study (multicentre and retrospective) did not provide further information about the distribution. External fixation was always used as a definitive device; partial weight-bearing was allowed and the fixator was removed when the fracture healed after an average period of 124.6 days.
- Twenty-five patients underwent a limited internal fixation which was reserved for undisplaced or anatomically reducible fracture without meta-diaphyseal extension. The fracture was reduced under fluoroscopy using manipulation and traction. Sometimes, limited incisions were necessary to optimise the fracture reduction. Reduction was maintained by 3.5-mm or 4.5-mm cannulated screws and/or K-wires fixed on each of the major fracture fragments. Postoperatively, the ankle was protected in a non weight-bearing cast for an average period of 55.1 days. Full weight-bearing was allowed after an average period of 76.7 days.
- Eight patients were treated by intramedullary nailing. This method was reserved for the type A fractures according to the AO/OTA classification and for the type B or C without articular comminution. Postoperatively, one patient was mobilised partial weight-bearing without a cast and seven patients were immobilised in a non weight-bearing cast for an average period of 58.0 days.

**Table 1** Type of fracture according to the AO/OTA classification

| Subgroup | AO/OTA classification | | |
|---|---|---|---|
| | 43-A ($n$=22) | 43-B ($n$=51) | 43-C ($n$=28) |
| Subgroup 1 | 10 | 28 | 7 |
| Subgroup 2 | 6 | 14 | 13 |
| Subgroup 3 | 6 | 9 | 8 |

**Table 2** Demographic data and fracture type according to the osteosynthesis method

| Demographic | Limited internal fixation ($n$=25) | Plate ($n$=35) | External fixation ($n$=32) | Intramedullary nailing ($n$=8) | Conservative treatment ($n$=1) | $p$ value |
|---|---|---|---|---|---|---|
| Gender | | | | | | |
| Male | 15 | 23 | 23 | 5 | 1 | 0.84 |
| Female | 10 | 12 | 9 | 3 | | |
| Age (years) | 43.0 ±15.4 | 43.8 ±16.6 | 45.0 ±18.0 | 47.1 ±20.0 | 23.0 | 0.74 |
| Polytrauma | 3 | 3 | 11 | 1 | 0 | <0.02 |
| Open fracture | 3 | 3 | 11 | 0 | 0 | <0.02 |
| AO/OTA Classification | | | | | | |
| Type A | 4 (16%) | 8 (23%) | 4 (13%) | 6 (75%) | 0 | 0.70 |
| Type B | 15 (60%) | 16 (46%) | 17 (53%) | 2 (25%) | 1 (100%) | |
| Type C | 6 (24%) | 11 (31%) | 11 (34%) | 0 | 0 | |
| AO/OTA Classification | | | | | | |
| Subgroup 1 | 14 (56%) | 16 (46%) | 8 (25%) | 5 (63%) | 1 (100%) | 0.08 |
| Subgroup 2 | 8 (32%) | 11 (31%) | 11 (34%) | 3 (37%) | 0 | |
| Subgroup 3 | 3 (12%) | 8 (23%) | 13 (41%) | 0 | 0 | |

Full weight-bearing was allowed after an average period of 83.6 days.

- One patient with an undisplaced type B-1 fracture was treated with conservative treatment. A non weight-bearing cast was maintained for 90 days.

Ipsilateral fibular fracture occurred in 46 cases (46%) and was treated by open reduction and plate fixation in 36 cases (78% of the fractured fibulas). Fibular osteosynthesis was done mostly to restore the length of the tibia and to control the rotation effect in the ORIF group or the limited internal fixation group.

Sixteen bone grafts were used during the initial procedure (autograft or bone graft substitute). Five patients needed a fasciocutaneous flap coverage during secondary surgery.

### Methodology

At final follow-up, clinical examination was made in the hospital where the procedure was performed and all subjects gave their informed consent prior to their inclusion in the study. Range of motion (ROM) was assessed with a goniometer and the American Orthopaedic Foot and Ankle Society (AOFAS) ankle score [14] was also determined. This scoring system classified the evaluated items into three major categories: pain, function and alignment. In this scale, 50 points have been assigned to function, 40 points to pain, and 10 points to alignment. Usually, a score between 90 and 100 is excellent, 75–89 good, 50–74 fair and <50 poor [15].

Radiological records included initial, postoperative and final follow-up ankle X-rays. Initial CT scan was made for all the comminuted cases without delaying the surgical treatment. On X-rays, anatomical reduction was assessed by restitution of a normal articular surface with ankle and hindfoot correct alignment. Step-off of 2 mm was considered significant.

Statistical analysis was performed with the SPSS software package (SPSS Inc., Chicago, IL). The chi-square test and Fisher′s exact test were used to analyse qualitative data. When quantitative values were evaluated, ANOVA was performed to determine significance. A $p$ value of 0.05 or less was considered significant.

## Results

The minimal follow-up was 12 months with an average follow-up of 19 months (range, 12–46 months). Demographic data were similar in the different osteosynthesis groups (Table 2). However, regarding the injury data, we noted that external fixation was used mostly for open fractures ($p < 0.02$) or in case of polytrauma ($p < 0.02$). In the same way, external fixation was used for 54% of comminuted fractures (subcategory 3 according to AO/OTA classification) ($p < 0.02$).

### Complications

Surgical complications occurred in 30 patients (30%). Twenty-one patients developed one complication, two complications occurred in seven patients and three in two patients. There were 14 nonunions including two septic nonunions, nine infections, nine skin necrosis, six second-

ary displacements, one compartment syndrome, one refracture and one nerve injury. The complication rate was significantly higher for subgroup 3 (50%) according to the AO/OTA classification than subgroups 2 (12%) or 1 (32%) ($p<0.01$). This rate was also significantly different according to the osteosynthesis type (Table 3).

Among these complications, nonunion was found in 35% of comminuted fractures ($p<0.001$), in 38% of open fractures (against 8% closed fractures and $p<0.007$) and in 29% of cases of external fixation (against 6% for other treatments and $p<0.003$). Secondary displacement rate was higher in the external fixation group ($p<0.04$) and skin necrosis increases the risk of infection ($p<0.05$). We did not find any correlation between infection or skin necrosis and fracture severity, osteosynthesis type, surgical approach or initial skin injury.

Eighteen medical complications occurred in the postoperative period: fourteen reflex sympathetic dystrophies and four deep vein thrombosis. The diagnosis of reflex sympathetic dystrophy was made after a clinical evaluation of patients who presented pain and persistent skin changes. No complementary investigations were required for this diagnosis (scintigraphy, RMI, etc.) and all patients healed with medical treatment.

At final follow-up, ten patients (10%) presented with intra-articular step-off and malunion occurred in eight patients (8%). The intra-articular step-off rate was higher in the external fixation group (16% vs 4.3% for other treatments and $p=0.056$); in the same way, malunion rate was higher in the external fixation group (19% vs 5.7% for other treatments and $p<0.05$).

### Clinical outcomes

Using the AOFAS ankle-hindfoot scale, the average functional score was 76 points (range, 30−100 points). Results were excellent in 31 cases, good in 25, fair in 37 and poor in eight cases. The average pain score was 30±8.6 points, function score was 37±10.7 points and the alignment score was 9±2.3 points.

At final follow-up, functional score and sub-units were statistically different according to the osteosynthesis method (Table 3). AOFAS score was 70.7 points if complications occurred and 78.8 points without complications ($p<0.04$). The score was 55.0 points in cases of malunion and 78.7 points in cases of correct alignment ($p<0.001$). Intra-articular step-off did not influence the functional score.

The final ranges of motion averaged 10° (range, −15° to 30°) of ankle dorsiflexion and 28° (range, 0–60°) of ankle plantar flexion.

According to the AO/OTA classification, total range of motion was 48° for type A fractures, 36° for type B and 34° for type C ($p<0.04$). For the malunion group, average ankle dorsiflexion was 2° (versus 11° without malunion and $p<0.02$) and average ankle plantar flexion was 17° (versus 29° and $p<0.007$). If a complication occurred, average ankle dorsiflexion was 7° (versus 13° and $p<0.02$) and average ankle plantar flexion was 23° (versus 32° and $p<0.001$). At final follow-up, ankle ROM was influenced by the osteosynthesis method (Table 3).

## Discussion

This retrospective and multicentre study of 100 patients confirms the difficulty of distal tibia fracture management and the high complication rate.

Postoperative complications concerned 30% of patients and were mostly infectious or cutaneous problems and nonunions. This rate is comparable to other series with rates ranging from 20% to 50% [2, 9, 11, 12]. As others have pointed out, we found a correlation between complication rate and initial fracture severity [6, 12]. In the same way, high fracture severity, complications or malunion were associated with poor clinical results.

The best clinical results were observed for the limited internal fixation group with a complication rate of 8%. Open reduction and internal fixation with a plate permitted a correct and stable fracture reduction with good clinical

**Table 3** Comparison between principle osteosynthesis method and functional outcomes

| Scoring category | Limited internal fixation ($n=25$) | Plate ($n=35$) | External fixation ($n=32$) | $p$ value |
|---|---|---|---|---|
| AOFAS scoring system | 85.2 points | 76.7 points | 67.7 points | <0.001 |
| Pain (max 40) | 33.2 points | 30.4 points | 26.8 points | <0.02 |
| Function (max 50) | 42.5 points | 37.5 points | 32.7 points | <0.002 |
| Alignment (max 10) | 9.5 points | 8.8 points | 8.2 points | 0.15 |
| Total range of motion | 48.3° | 38.5° | 26.8° | <0.001 |
| Complication rate | 8% (2/25) | 29% (10/35) | 50% (16/32) | <0.004 |

results without any increase of cutaneous or infection complication rate, contrary to other authors [11, 12, 16]. For the external fixation group, no two-staged protocol was undertaken in this study and external fixation was always a definitive device. Similar to many other authors, we found that definitive external fixation provided more malunion, stiffness or pain than ORIF [6, 8, 10]. Thus, we believe that external fixation should be preferentially used in two-staged protocols as a temporary device before ORIF or limited internal fixation [1, 5].

Our ipsilateral fibular fracture rate was small in comparison to rates near 80% found in the literature [17, 18]. This difference may be explained by the injury mechanisms in our study. Indeed, we had fewer high energy injuries than Lee et al. (73% in our study versus 91% for Lee et al.) [17]. We recommend a fibular osteosynthesis with a plate as often as possible in order to restore the length of the tibia, to control rotation forces and to avoid valgus malunion.

No locking plates and no minimally invasive approaches were used in this study. At the time of this work, such techniques were not used in our departments. Minimally invasive plate osteosynthesis (MIPO) reduces soft tissue damage, and preserves bone vascularity and fracture haematoma [3, 7, 19]. However, there are some complications with this method. Lau et al. found 15% with late infection and 52% of patients underwent hardware removal for skin impingement [3]. In addition, there is an important risk of saphenous nerve and great saphenous vein injury during percutaneous screw placement [20].

With regard to medical complications, the reflex sympathetic dystrophy rate was high in this study but probably overestimated. This diagnosis was made mostly after a single clinical assessment showing persistent skin changes that are typical symptoms after long periods of non weight-bearing, and no investigations were made to establish this diagnosis.

Distal tibia fractures are complex cases and need appropriate treatment to limit the incidence of complications.

For acute fractures without skin injury, we prefer a stable and rigid internal fixation in a one-staged procedure. Limited internal fixation can be used for fractures without important comminution and easily reducible by traction or external manipulation. However, with this technique a non weight-bearing cast is recommended. ORIF with conventional or locking plates should be used for comminuted cases in order to reduce the articular surface perfectly. Surgical approaches must preserve the soft tissue and can be anteromedial or anterolateral according to surgeon preference and fracture localisation. One advantage of the locking plate is to permit faster full weight-bearing and stronger fracture stabilisation as an internal fixator.

For fractures with skin injury, important soft tissue oedema or delayed surgery, we recommend a two-staged protocol similar to that of many other authors [1, 5, 21]. The first stage consists of an approximate reduction and application of an external fixator spanning the ankle joint. The second stage is delayed from seven to ten days until soft tissue recovery and consists of an open reduction and internal fixation. External fixation should not be used as a definitive device.

We limit the use of intramedullary nailing to extra-articular closed fractures (type 43-A) or articular fractures without comminution (type 43-C1).

The limitations of this work include the retrospective study design, multiple surgeons involved and multiple treatment methods. We did not observe differences in the management of those fractures according to the hospital centre. However, there is a selection bias in our study because the injury mechanisms were more severe in the external fixation group compared with other groups. Thus, functional outcomes in the external fixation group were probably underestimated. Another limitation is that the follow-up of this work did not permit the study of long-term complications as osteoarthritis.

## Conclusion

Distal tibia fractures remain a therapeutic challenge for orthopaedic surgeons. According to the literature, these fractures are often associated with a high complication rate [2, 9, 11, 12]. Based on our study, when using external fixation, the complication rate is higher and functional outcomes are worse. We believe that external fixation must be reserved for trauma with severe skin injury as a temporary solution in a two-staged protocol as described by Sirkin et al. [1]. For other cases, we recommend ORIF with early mobilisation. Future prospective randomised trials are required to determine the optimal treatment strategy for these injuries with more accuracy.

*Conflict of interest* The authors declare that they have no conflict of interest.

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