

Treatment of Open Tibial Fractures: Converting or Continuing External Fixation?

S. Tabatabai, E. Hosseini

Abstract

Background: The treatment of open tibial fractures is still an orthopaedic challenge and full of complications. In many cases the use of external fixator that has been known as a non-union machine is obligatory with a high incidence of pin track infection and other complications. The aim of this study was to compare the use of external fixation as a definite method for treatment of open tibial fractures with its subsequent conversion to internal fixation or casting.

Methods: Sixty-seven young patients with type III open tibial fractures (Gustilo-Anderson classification) were treated with half pin external fixation. Twenty of them were converted into internal fixation after a period of 6-8 weeks. For another twenty-five, external fixator was removed and treatment continued with casting for a period lasting from 16 to 20 weeks. And for twenty two patients the fixator continued until complete union. The patients followed up for 10-16 months and were evaluated in terms of union time, union rate, infection, range of motion, malunion, non-union, nerve injury, and reduction.

Results: There was a meaningful difference only in the union time and superficial infection between the first group and the other two groups.

Conclusion: The conversion of external to internal fixation can be considered as a safe, effective, less complicated, and more acceptable method for the treatment of open tibial fractures.

Iran J Med Sci 2008; 33(1): 7-11.

Keywords • External fixation • conversion • union

Introduction

The incidence of open tibial fractures has increased because of motor vehicle accidents and war injuries.¹ The standard treatment for open tibial fractures has been external fixation particularly in fractures associated with severe soft tissue injuries.²⁻⁴ Although there are controversies over the use of external fixation, it has to be used in severe open fractures. The U.S. Army termed the external fixator a "non-union machine" because the incidence of non-union is about 6% to 41%. This incidence varies according to the severity of the trauma, soft tissue injury, early bone grafting, and the quality of reduction.⁵

In addition to non-union, external fixation has frequent complications such as pin track infection, osteomyelitis, pin loosening, neurovascular injury, long treatment time, poor

Department of Orthopedics
Razi Hospital,
Jondishapour University of Medical
Sciences,
Ahwaz, Iran.

Correspondence:
Saaïd Tabatabai MD,
Department of Orthopedics
Razi Hospital,
Jondishapour University of Medical
Sciences,
Ahwaz, Iran.
Tel: +98 916 113 5654
Fax: +98 611 3910857
Email: Saaïdt1379@yahoo.com

tolerance, and loss of motion of adjacent joints.⁶⁻¹¹

Accordingly, surgeons have tried to find a method of treatment that is safer, less expensive, less complicated, more effective, and has less union time for the treatment of open tibial fracture. They use external fixation as a primary treatment until soft tissues have been healed and then employ another technique to secure union.¹²⁻¹⁷

In this study we compared three more common methods of treatment after external fixation.

Materials and Methods

During June 2004 to July 2006 in a randomized controlled trial, 67 patients with types A and B Arbeitsgemeinschaft fur Osteosynthesefragen (AO) open tibial and fibular diaphyseal fractures were studied (table 1). Mean age of the patients was 25 years (18-40 years) and mean follow up time was 8 months.

After the external fixation of the fractures, the patients were divided into three groups by drawing from the random table of numbers. Group one consisted of 20 patients with the mean age of 26 years (range 19-40) who were selected for delayed conversion to internal fixation after 6-8 weeks (after 3 weeks of removal of external fixator). Of them seven patients had unreamed intramedullary nailing and 13 had plating.

Group two consisted of 25 patients with the mean age of 24 years (range 17-37) in whom external fixation was continued in order to convert to patellar-tendon bearing cast after developing union (between 16th-20th weeks). The remaining 22 patients with the mean age of 25 years (range 20-42) were considered as group three in whom external fixation was continued until complete union or until the end of the study.

The cause of all the fractures was motor cycle accidents. Patients with concomitant neurovascular, abdominal or other organ injuries or fractures were excluded from the study. The anatomical sites of the fractures are depicted in table 2.

Table 2: The anatomical sites of tibial fractures in the three groups of patients.

	Proximal part	Middle part	Distal part
First group	4	10	6
Second group	6	12	7
Third group	4	12	6

Table 1: Comparison of sex, Gustilo classification, and AO classification in 3 groups.

	SEX		Gustilo classification		AO classification					
	male	female	IIIA	IIIB	A1	A2	A3	B1	B2	B3
First group	18	2	12	8	6	4	2	4	2	2
Second group	24	1	17	8	6	8	3	5	3	0
Third group	22	0	16	6	7	5	2	3	3	2

The average time between the accident and surgery was 12-48 hours (36 patients before the first 24 hours and 31 patients after 24 hours). After reduction of the fracture, it was fixed according to standard operative technique by 4 half-pins (2 pins proximal and 2 pins distal to the fracture site) and 2 longitudinal rods in one plane. Good irrigation and meticulous debridement were carried out for all the patients and repeated after 24 hours or accordingly.

Intravenous antibiotics (cephalosporin and gentamycin) were administered before and after the operation for all the patients and continued according to the clinical status of the wound.

Early range of motion of the knee and the ankle started and in the follow-up visits it was carefully checked. In addition, the wound status, pin loosening, pin track infection, reduction, rigidity of fixation, callus formation, shortening, and malunion, were regularly checked and recorded.

In patients of the first group the external fixation was converted to plating or non-reamed intramedullary nailing after 6-8 weeks and they followed up for signs of union and were observed for any probable complications.

In patients of the second group, the external fixator was converted to patellar tendon bearing cast after observing the signs of union in plain radiography. And in the third group the external fixator remained in place until complete union.

The data analysis was carried out by one-way ANOVA for the mean union time and Fisher exact test for the rest of the data. P values < 0.05 were considered significant.

Follow up was weekly in the first month, every other week for the next 2 months, and monthly thereafter.

Results

The external fixator was removed at a mean time of (50±4) days in group A and (90±5) days in group B and remained until union in group C (31 wks).

The time interval for bony union was significantly shorter in group A (21 wks) than the other two groups (29 and 31 weeks respectively) (table 3).

Six (30%) patients in group A, six (25%) patients in group B and nine (40%) patients in group C developed delayed union (we considered delayed union as the absence of callus

formation after at least 6 weeks of the onset of treatment with external fixator). Autogenous bone grafting was used in them to secure the union.

Table 3: comparison of union time in the three groups.

Study group	Union time
First	21 weeks
Second	29 weeks
Third	31 weeks

In 100% of the patients in group A, 88% of the patients in group B and 80% of those in group C the union was established at a mean time of 31 weeks (figures 1,2,3).

Malunion (more than 5 degrees of angulation and more than 10 degrees of internal or external rotation) was not seen in group A but 10% of the patients in group B and 17% of the patients in group C had degrees of malunion as lateral and medial bowing at the fracture site.



Figure 1: Complete union after conversion to plating (group 1).

Patients were taught to clean the external fixator pins at home. Pin track infection with a discharge and cellulites were seen in 10% of the patients in group A, 30% of the patients in group B, and 53% of the patients in group C. The infection was controlled by prescribing a short course antibiotic.

Deep infection was observed in 13% of the patients in group C. Healing occurred only after antibiotic therapy and removal of the pin and inserting it in a new site.

Knee flexion limitation in the first group was zero, in the second group was 10%, and in the third group was 16%. Limitation in ankle dorsiflexion was 10% in the first group, 15% in the second group, and 33% in the third group. It

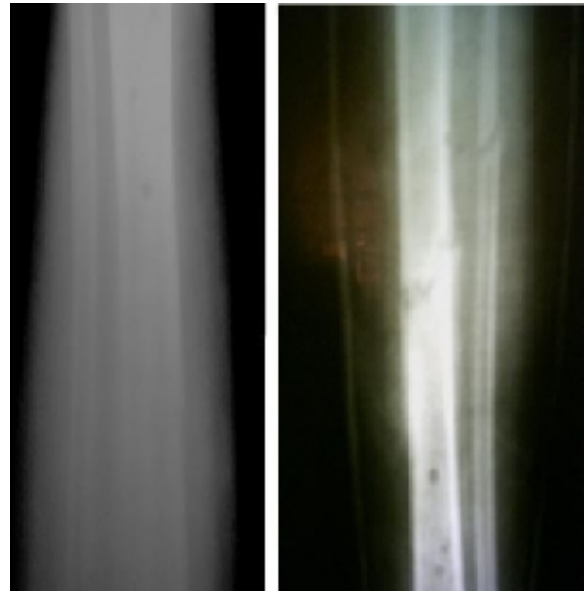


Figure 2: Partial union in a patient after 18 weeks ready for casting (group 2).



Figure 3: Complete union after treatment with external fixation (group 3).

was continued until the last visit and there was no considerable response to physiotherapy.

The patients in group A had underwent two operations and spent longer time in hospital but the patients in the other two groups had more outpatients visits and radiographies. No significant shortening (more than 2 cm) was observed in the three groups.

There was only a significant difference in the union time and superficial infection between the first and the other two groups.

Discussion

Many authors have tried to put forward a suitable

treatment for open tibial fractures and to evaluate the best and safest regimen for dealing with this difficult challenge, however the best management after external fixation of open tibial fractures is less clear.

The aim of treatment in open tibial fractures is securing a viable, healthy, painless, and functioning limb.¹⁸ There are many reports of the use of secondary nailing or plating after the initial external fixation.^{6,12,15,17,19-22} In the present study, the external fixator was used for temporary stabilization while the soft tissues were healed in the first group.

There was a significant difference between the first group with the other two groups with regard to the duration of the external fixation (6-8 weeks v 29-31 weeks). Leaving the external fixator in place or immobilization in a plaster cast for a long time has the complication of superficial infection and delayed union time. Pin site infection due to prolonged external fixation has been noted by many authors.^{12,14,23} In our study, 30% of the patients in group B and 53% of patients in group C had superficial infection, while 13% of patients in group C had deep infection.

In the study done by Lawyer et al, the total union time was 35 weeks for patients treated with external fixator only.⁴ Malik et al. reported that with conversion to internal fixation, union rate was 94%, union time was 6 months, superficial infection was 13%, and deep infection was 6%.²⁴ Rommens and co workers showed that 30% of the patients with external fixation after 6 weeks, needed casting and 21% of them underwent bone grafting.²⁵

In our study there was not any significant differences between the three groups regarding the rate of union, deep infection, knee and ankle range of motion, malunion, and non-union. Meanwhile mean union time in the first group was 21 weeks (19-30 weeks), which was significantly lower than the mean union time in the second (29 weeks) and the third groups (31 weeks)(P=0.001).

Superficial infection (10%) was significantly lower in the first group compared with the second (30%) and third (53%) (P =0.018).

Accordingly, it was found that in the treatment of open tibial fractures, there is priority for method of conversion of external fixation to internal fixation compared with the other protocols of treatment. In addition, considering the patients' acceptability and relatively better clinical results of internal fixation (with respect to union rate, range of motion, alignment, and incidence of infection) one may observe that conversion to internal fixation is a more reliable method of treatment and can be considered as a proper

method and approach to treatment of type III open tibial fractures.

References

- 1 Bucholz Robert W, et al. Rochwood and Green's Fractures in adults 6th edition Vol 2; 2006. p. 2080.
- 2 Debastiani G, Aldegheri R, Brivio LR, et al. The treatment of fractures with dynamic axial fixator. *J Bone Joint Surg* 1984; 66b: 538-45.
- 3 Edwards CC. Staged reconstruction of complex open tibial fractures using Hoffmann external fixation. *Clin Orthop* 1983; 178: 130-61.
- 4 Lawyer RB Jr, Lubbers LM. Use of the Hoffmann apparatus in the treatment of unstable tibial fractures. *J Bone Joint Surg* 1980; 62: 1264-73.
- 5 Akeson AH, Woo SL-Y, Schandelmaier P, Tscherne H. Intramedullary nailing of open fractures. *Orthopedic* 1996; 25 223-33.
- 6 Antich-Adrover P, Martí-Garin D, Murias-Alvarez J, Puente-Alonso C. External fixation and secondary intramedullary nailing of open tibial fractures, a randomized prospective trial. *J Bone Joint Surg Br* 1997; 79: 433-7.
- 7 McGraw JG, Edward VA. Treatment of open tibial shaft fractures. *J Bone Joint Surg* 1988; 70-A: 900-11.
- 8 Keating JF, Gardner E, Leach WJ, et al. Management of tibial fractures with the orthofix dynamic external fixator. *J R Coll Surg Edinb* 1991; 36: 272-7.
- 9 Tornetta P 3rd, Bergman M, Watnik N, et al. Treatment of grade IIIB open tibial fractures, a prospective randomized comparison of external fixation and non-reamed locking nailing. *J Bone Joint Surg Br* 1994; 76: 13-9.
- 10 Velazco A, Fleming LL. Open fractures of the tibia treated by the Hoffmann external fixator. *Clin Orthop Relat Res* 1983; (180): 125-32.
- 11 Byrd HS, Spicer TE, Cierney G3rd. Management of open tibial fractures. *Plast Reconstr Surg* 1985; 76: 719-30.
- 12 Johnson EE, Simpson LA, Helfet DL. Delayed intramedullary nailing after failed external fixation of the tibia. *Clin Orthop Relat Res* 1990; (253): 251-7.
- 13 Blachut PA, Meek RN, O'Brien PT. External fixation and delayed intramedullary nailing of open fractures of the tibial shaft; a sequential protocol. *J Bone Joint Surg Am* 1990; 72: 729-35.
- 14 Wheelwright EF, Court-Brown CM. Primary external fixation and secondary intramedullary

- nailing in the treatment of tibial fractures. *Injury* 1992; 23: 373-6.
- 15 Matsoukis J, Thomine JM, Khallouk R, Biga N. Secondary locked nailing of the leg after external fixation in 25 cases. *Rev Chir Orthop Rev Chir Orthop Reparatrice Appar Mot* 1991; 77: 555-61.
 - 16 Siebenrock AK, Schill B, Jakob RP. Treatment of complex tibial shaft fractures: experiments for secondary intramedullary nailing. *ClinOrthop* 1993; 290: 269-74.
 - 17 Bernat M, Lecoq C, Lempidakis M, et al. Secondary internal fixation after external fixation for open fracture of the lower limbs. *Rev Chir Orthop* 1996; 82: 137-44.
 - 18 Krettek C, Glüer S, Schandelmaier P, Tscherne H. Intramedullary nailing of open fractures. *Orthopade* 1996; 25: 223-33.
 - 19 Rommens PM, Van Raemdonck DE, Broos PL. Reosteosynthesis of the tibial shaft. Part I. Changing of procedure after external fixation. *Acta Chir Belg* 1989; 89: 281-6.
 - 20 Olerud S, Karlstrom G. Secondary intramedullary nailing of tibial fractures. *J Bone and Joint Surg AM* 1972; 54: 1419-28.
 - 21 Wu CC, Shih CH. Treatment of open femoral and tibial shaft fractures preliminary report on external fixation and secondary intramedullary nailing. *J Formos Med Assoc* 1991; 90: 1179-85.
 - 22 Clancey GJ, Hansen ST Jr. Open fractures of the tibia, A review of one hundred and two cases. *J Bone and Joint Surg* 1978; 60: 118-22.
 - 23 Maurer DJ, Merkow RL, Gustillo RB. Infection after intramedullary nailing of severe open tibial fractures initially treated with external fixation. *J Bone and Joint Surg AM* 1989; 71: 835-8.
 - 24 Malik ZU, Hanif MS, Safdar A, Masood T. Planned external Fixation to locked intramedullary nailing conversion for open fractures of shaft of femur and tibia. *J Coll Physicians Surg Pak* 2005; 15: 133-6.
 - 25 Rommens P, Gielen J, Broos P, Gruwez J. Intrinsic problems with the external fixation device of Hoffmann-Vidal-Adrey: a critical evaluation of 117 patients with complex tibial shaft fractures. *J Trauma* 1989; 29: 630-8.