# Segmental tibial fractures treated with interlocking nails

## A retrospective study of 33 cases

Ching-Kuei Huang[2], Wei-Ming Chen[1], Tain-Hsiung Chen[1] and Wai-Hee Lo[1]

We treated 33 segmental tibial fractures with interlocking nails between 1986 and 1991. All fractures were managed with calcaneal traction, closed reduction, reaming and fixation with a Grosse-Kempf interlocking nail. The patients were followed for at least 15 months. The mean duration to union was 17 (12–20) weeks for the distal fractures and 20 (12–34) weeks for the proximal ones. There were only 3 cases of delayed union of the proximal fracture, 2 of which united after dynamization by removal of distal screws and 1 after autogenous bone grafting. There were 2 cases of deep infection, which were diagnosed after the fractures were united. The infection was treated with removal of the nail, reaming, and antibiotic treatment intravenously for 2 weeks and orally for 4 weeks. All patients returned to their previous activity level. We conclude that segmental tibial fractures can be treated with an interlocking nail and have a high rate of union and a low complication rate.

Departments of [1]Orthopaedics and Traumatology, Veterans General Hospital-Taipei, No. 201, Sec. 2, Shih-Pai Road, Taipei, Taiwan 112, R.O.C. Tel +886 2-8757557, ext 101. Fax -8728017; [2]Surgical Department, Medical School of National Yang-Ming University, Taipei, Taiwan, R.O.C. Correspondence: Dr. Wei-Ming Chen
Submitted 96-05-15. Accepted 97-06-24

Nonoperative treatment of a segmental tibial fracture may need a long period of cast immobilization (Sarmiento et al. 1989). Fixation with plate and screws requires a large incision with stripping of the contused soft tissues, with a substantial risk of skin necrosis and deep infection. Conventional Küntscher intramedullary nailing can neither give enough rotational stability nor correct the length of tibia. An interlocking nail can offset the shortcomings of plating and conventional Küntscher nailing; the fractures can be stabilized immediately, and early ambulation becomes possible (Ekeland et al. 1988).

We performed a retrospective survey of the Grosse-Kempf interlocking nails used for segmental tibial fractures in our hospital during the past 7 years.

## Patients and methods

From January 1986 to December 1992, 512 tibial shaft fractures were treated at our institution, of which 33 were segmental fractures treated with Grosse-Kempf interlocking nails (Table). A motorcycle accident was the cause in half of the cases. The average age was 56 (18–79) years. 29 were men. 27 patients had associated injuries (Injury Severity Score 9–27). 9 fractures were opened: there were 4 Type I, 4 Type II, and 1 Type III (Gustilo and Anderson 1976). The mean time from injury to nailing was 12 (3–103) hours. The operation was usually performed with calcaneal traction. The fracture was reduced with the aid of an image intensifier. A guide pin was inserted, and the tibia was reamed, during which the intermediate fragment was held with a towel clip. After insertion of the nail, the distal screws were driven in without a guide instrument. 1 case was locked proximally only; all the other cases were locked at both ends. In 5 cases, the distal screws were removed for dynamization after 14 (8–24) weeks.

The patients were evaluated clinically and radiographically at 4-week intervals. Weight bearing was not allowed until there was callus briding across the fracture site on both the AP and the lateral projections. Delayed union was defined as a healing time of more than 24 weeks. The average period to follow-up was 4 (1–7 years).

The paired t-test was used to compare the union time of proximal and distal fractures.

## Results

The mean union time for the distal fracture was 17 (12–20) weeks and 20 (12–34) weeks for the proximal one ($p = 0.01$). There were 3 cases of delayed union of the proximal fracture. 2 cases healed 8 weeks

**Clinical data of the 33 patients**

| Case | A | B | C | D | E | F | G | H | I | J | K | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 18 | m | r | O-I | Multiple abrasion wounds | 9 | 7 | 12 | 16 | 16 | – | |
| 2 | 25 | m | r | C | L. Galeazzi fr., l. Zygoma fr. | 17 | 11 | 13 | 23 | 17 | – | |
| 3 | 27 | m | l | C | Multiple laceration wounds | 9 | 4 | 12 | 12 | 12 | – | |
| 4 | 35 | m | l | C | Head injury, l. humeral shaft fr. | 17 | 13 | 12 | 20 | 12 | +(8) | Removal of the distal screws |
| 5 | 37 | m | l | C | L. 3rd, 4th ribs fr. | 10 | 16 | 12 | 16 | 20 | – | |
| 6 | 38 | m | r | C | | 9 | 9 | 13 | 21 | 13 | +(8) | Removal of the distal screws |
| 7 | 39 | m | r | C | L. hand avulsion wound | 10 | 8 | 12 | 13 | 17 | – | |
| 8 | 41 | f | l | C | Laceration wound over popliteal fossa | 9 | 6 | 11 | 20 | 12 | +(i) | Proximal fr. was stable, distal fr. at the isthmic level |
| 9 | 46 | m | r | C | Multiple laceration wounds | 10 | 6 | 13 | 17 | 17 | – | |
| 10 | 49 | m | l | O-I | Multiple laceration wounds | 9 | 4 | 11 | 20 | 12 | +(8) | Removal of the distal screws; 1.5 cm shortening of the tibia |
| 11 | 53 | f | l | C | R. 5th metacarpal fr. | 10 | 17 | 9 | 16 | 16 | – | |
| 12 | 53 | m | r | C | | 9 | 7 | 13 | 16 | 20 | – | |
| 13 | 55 | m | r | O-I | Chest wall contusion | 10 | 5 | 11 | 20 | 20 | – | |
| 14 | 56 | m | l | O-II | Laceration wound over r. forearm | 9 | 3 | 12 | 17 | 20 | – | |
| 15 | 57 | m | r | O-I | Head injury, multiple laceration wounds | 13 | 3 | 12 | 32 | 20 | +(24) | Delayed union (proximal), union 8 weeks later after removal of the distal screws, 12° anterior angulation |
| 16 | 61 | f | r | O-IIIa | R. medial malleolar fr. | 13 | 3 | 10 | 20 | 20 | – | Delayed infection (8 months postop.), culture: S. aureus |
| 17 | 62 | m | r | O-II | Knee hemarthrosis | 10 | 6 | 10 | 34 | 18 | – | Delayed union (proximal). Union 10 weeks later after autogenous bone graft |
| 18 | 62 | m | l | C | | 9 | 15 | 12 | 16 | 20 | – | |
| 19 | 62 | m | l | C | Spleen laceration | 18 | 4 | 12 | 16 | 16 | – | |
| 20 | 64 | m | r | C | L. medial malleolar fr. | 13 | 11 | 12 | 16 | 16 | – | |
| 21 | 64 | m | r | C | | 9 | 19 | 12 | 32 | 20 | +(24) | Delayed union (proximal), union 8 weeks later after removal of the distal screws |
| 22 | 66 | m | r | C | Head injury, chest wall contusion | 14 | 103 | 11 | 16 | 12 | – | Operation was delayed due to unstable vital signs. |
| 23 | 67 | m | l | C | L. distal radius fr. | 13 | 21 | 12 | 16 | 20 | – | |
| 24 | 69 | m | r | C | L. shoulder dislocation, multiple abrasion wound | 13 | 3 | 12 | 19 | 15 | – | |
| 25 | 69 | m | r | C | Cervical spine strain | 10 | 11 | 12 | 20 | 16 | – | |
| 26 | 70 | f | r | O-II | R. superior pubic ramus fr. | 13 | 7 | 9 | 21 | 15 | – | |
| 27 | 70 | m | r | C | Liver laceration, pneumothorax, r. 3rd, 4th, 5th ribs fr | 27 | 5 | 12 | 20 | 20 | – | |
| 28 | 71 | m | l | C | | 9 | 11 | 12 | 16 | 20 | – | |
| 29 | 71 | m | r | C | R. distal radius fr. | 13 | 25 | 11 | 19 | 19 | – | |
| 30 | 73 | m | l | O-II | R. 4th, 5th ribs fr. | 13 | 5 | 12 | 20 | 20 | – | Delayed infection (11 months postop.), culture: S. aureus |
| 31 | 76 | m | l | C | L. displaced femoral neck fr. | 18 | 6 | 12 | 22 | 16 | – | |
| 32 | 76 | m | l | C | Head injury | 13 | 29 | 10 | 20 | 20 | – | |
| 33 | 79 | m | r | C | | 9 | 7 | 12 | 22 | 16 | – | |

A Age
B Sex
C Fracture side
  r right
  l left
D Closed or open fracture
  C closed
  O open (Gustilo classification)
E Associated injuries
F Injury severity score
G Time from injury to nailing, hours
H Nail size (mm)
I Union time (weeks) of proximal fracture site
J Union time (weeks) of distal fracture site
K Dynamization of interlocking nail procedure (hours)
  + (no.) yes (weeks after operation)
  + (i) yes (immediately during operation)
  – no

after dynamization. Bone grafting was performed in the other case and the fracture united 10 weeks later. Callus and consolidation appeared earlier posterolaterally, both in the proximal and the distal fractures (Figures 1 and 2). There were 1 case of anterior angulation of more than 10 degrees at the proximal fracture, and 1 case of shortening about 1.5 cm due to dynamization after 8 weeks. There were 2 cases of deep infection diagnosed after 8 and 11 months. *Staphylococcus aureus* was cultured in both cases. The infec-

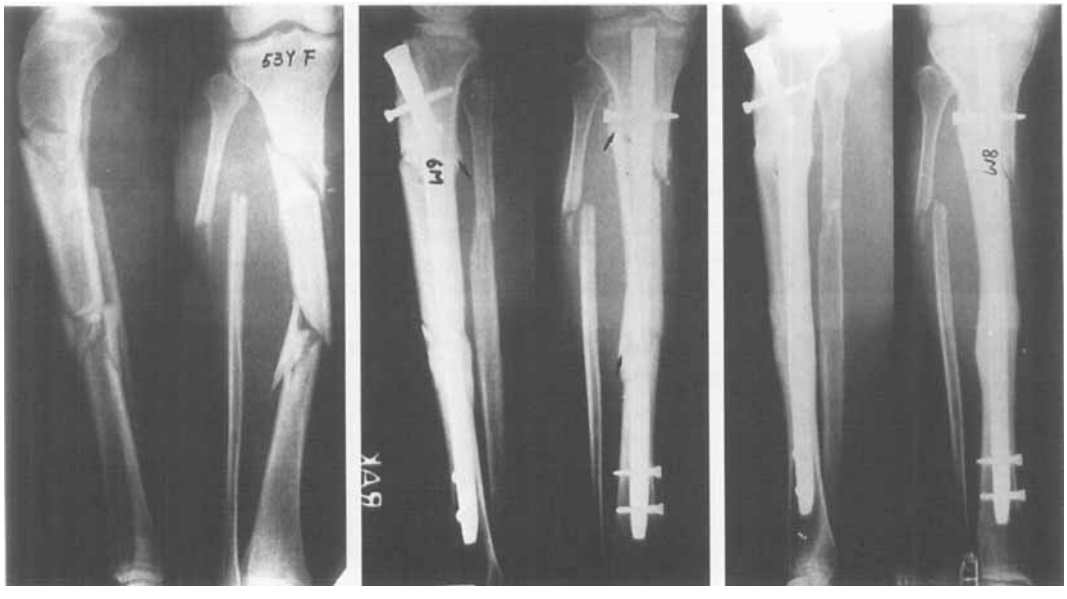
**Figure 1. Case 3.**


A 27-year-old man with left segmental tibial fracture.

The fracture is fixed with a Groose-Kempf interlocking nail.

6 months after the initial treatment (3 months after dynamization), callus formation was noted more in the posterior and medial aspects of the fracture site.

**Figure 2. Case 11.**




A 53-year-old woman with a right comminuted segmental tibial fracture.

6 months after the initial treatment, callus formation was noted mainly in the posterior and medial parts of the fracture.

8 months later, the distal fracture has consolidated and the proximal fracture has not consolidated yet.

tion was managed by removal of the nail, reaming, followed by antibiotic treatment intravenously for 2 weeks and orally for another 4 weeks. All 33 patients returned to their previous level of activity.

## Discussion

In previous studies of segmental tibial fractures, the distal fracture united more slowly than or at the same

time as the proximal sites (Langard and Bo 1976, Melis et al. 1981, Merianos et al. 1988). Melis and coworkers (1981) reported a slower fracture healing of the distal fracture in 38 segmental tibial fractures treated with a reamed unlocked intramedullary nail, while Merianos et al. (1988) reported no difference in union rate in 22 cases treated with Ender nails. We found that the distal fracture united, on average, approximately 3 weeks earlier than the proximal one. There are 3 explanations for our results. First, the fixation of distal fractures was more stable. Secondly, the distal fracture was better reduced and had a better contact surface than the proximal one. Thirdly, the reaming bone dust tended to accumulate more at the distal part of the tibia and this may accelerate the fracture healing.

We found that callus formation was observed earlier in the posterior and lateral parts of the tibia. This had not been reported earlier. As regards consolidation, the sequence was the same. Our view is that more muscular coverage, better vascular supply and less contusion of soft tissue may be the main causes of earlier callus formation and consolidation at the posterior and lateral aspects.

Nonunion of distal fractures has been reported by many authors. Woll and Duwelius (1991) reported 11 cases of nonunion in a series of 31 segmental tibial fractures, treated with a nonlocked and unreamed nail. Rommens et al. (1989) reported 12 cases of nonunion in their series of 41 segmental fractures, 23 of which were treated with plate fixation,18 with an external fixator. There was no nonunion in our series, as in the results reported by Wu and Shih (1993); there was only one nonunion in their series of 38 cases treated with a reamed interlocking nail. The more stable fixation provided by the locking nail may contribute to this low complication rate.

There were 2 cases of delayed deep infection. These two cases (1 Gustilo open type II and 1 type IIIa) developed infection at 11 and 8 months after operative treatment. Therefore, reamed locked nailing for open segmental tibial fractures may mean a higher risk of infection.

In a series of 31 segmental tibial fractures, of which 25 were open fractures, there were 15 cases of compartment syndrome necessitating fasciotomy (Woll and Duwelius 1992). Although we did not measure the compartment pressure routinely, before and after internal fixation, we found no case of compartment syndrome in this series.

## References

Ekeland A, Thoresen B O, Alho A, Stromsoe K, Folleras G, Haukebo A. Interlocking intramedullary nailing in the treatment of tibial fractures—A report of 45 cases. Clin Orthop 1988; 231: 205-5.

Gustilo R B, Anderson J T. Prevention of infection in the treatment of one thousand and twenty-five fractures of long bone. J Bone Joint Surg (Am) 1976; 58: 543-8.

Langard O, Bo O. Segmental tibial shaft fractures. Acta Orthop Scand 1976; 47: 351-7.

Melis G C, Sotgiu F, Lepori M, Guido P. Intramedullary nailing in segmental tibial fractures. J Bone Joint Surg (Am) 1981; 63: 1310-8.

Merianos P, Papagiannakos K, Scretas E, Smyrnis P. Ender nails for segmental tibial fracture, early weight bearing in 22 cases. Acta Orthop Scand 1988; 59 (3): 297-301.

Rommens P M, Coosemans W, Broos P L O. The difficult healing of segmental fractures of the tibial shaft. Arch Orthop Trauma Surg 1989; 108: 238-42.

Sarmiento A, Gersten L M, Sobol P A, Shankwiler J A, Vangsness C T. Tibial shaft fracture treated with functional braces. J Bone Joint Surg (Br) 1989; 71: 602-9.

Woll T S, Duwelius P J. The segmental tibial fracture. Clin Orthop 1992; 281: 204-7.

Wu C C, Shih S H. Segmental tibial shaft fractures treated with interlocking nailing. J Orthop Trauma 1993; 7 (5): 468-72.