Double plating of unstable proximal tibial fractures using minimally invasive percutaneous osteosynthesis technique

Chang-Wug Oh, Jong-Keon Oh, Hee-Soo Kyung, In-Ho Jeon, Byung-Chul Park, Woo-Kie Min & Poong-Taek Kim

To cite this article: Chang-Wug Oh, Jong-Keon Oh, Hee-Soo Kyung, In-Ho Jeon, Byung-Chul Park, Woo-Kie Min & Poong-Taek Kim (2006) Double plating of unstable proximal tibial fractures using minimally invasive percutaneous osteosynthesis technique, Acta Orthopaedica, 77:3, 524-530, DOI: 10.1080/17453670610012548

To link to this article: https://doi.org/10.1080/17453670610012548

© 2006 Informa UK Ltd All rights reserved: reproduction in whole or part not permitted

Published online: 08 Jul 2009.

Submit your article to this journal

Article views: 1546

Citing articles: 21 View citing articles
Double plating of unstable proximal tibial fractures using minimally invasive percutaneous osteosynthesis technique

Chang-Wug Oh¹, Jong-Keon Oh², Hee-Soo Kyung¹, In-Ho Jeon¹, Byung-Chul Park¹, Woo-Kie Min¹ and Poong-Taek Kim¹

Background  Double plating of proximal tibial fractures with traditional open osteosynthesis gives a stable fixation, but may be complicated by wound healing problems. Minimally invasive methods have been recommended to decrease the wound complication rates. We report the efficacy of double plating of proximal tibial fractures using a minimally invasive percutaneous technique.

Patients and methods  23 proximal tibial fractures in 23 patients (mean age 54 (36–78) years) were treated with double plating using a minimally invasive percutaneous technique. Functional and radiographic results were evaluated by a modified Rasmussen scoring system.

Results  All fractures healed. The average time for fracture healing was 19 (10–32) weeks. 21 patients had excellent or good clinical and radiographic results. 2 patients had a fair clinical result because of associated knee injuries. Complications included 1 case of shortening (1 cm) and 2 cases of mild malalignments (varus less than 10º). There was 1 case of superficial infection that healed after removal of the plate. No deep infections occurred.

Interpretation  Double plating using minimally invasive percutaneous technique can provide favorable results in the treatment of proximal tibial fractures.

The best mechanical construct for a proximal tibial fracture is double plating (Peindl et al. 2004). Conventional plate fixation often requires exposure of the fracture zone, however, which may endanger the soft tissue and increase the risk of infection (Blokker et al. 1984). This may be reduced by minimally invasive percutaneous osteosynthesis (MIPO) (Krettek et al. 1997, Collinge et al. 2000, Perren 2002). We reviewed the clinical and radiographic results of double plating performed with the MIPO technique in 23 proximal tibial fractures.

Copyright © Taylor & Francis 2006. ISSN 1745–3674. Printed in Sweden – all rights reserved.
DOI 10.1080/17453670610012548
(Figures 1 and 2), and 5 were 42C (Figures 3 and 4). 8 fractures were segmental. The causes of injury were motor vehicle accidents (16 patients) and falls (7 patients). There were 3 open Grade I frac-
8 patients had sustained multiple fractures or associated injuries, which included clavicle fractures, ipsilateral femoral fractures, contralateral tibial fractures, and posterior cruciate ligament injuries. Figure 3–4. A 56-year-old man (case 22) with severe comminuted proximal tibial fracture (A) was treated with bilateral plating using the MIPO technique (B and C). Good alignment was achieved (D). The fracture had healed by 16 weeks after surgery (E). Knee function was excellent (F).
injury. There was no major neurovascular injury. The timing of surgery depended on the condition of soft tissue, and surgery was delayed if there was severe swelling and skin blistering. 11 patients had delayed surgery until improvement by calcaneal traction (7 patients) or bridging external fixation (4 patients). The average delay was 10 (8–14) days.

**Operative technique**

Before surgery, the appropriate length of the plate was chosen and was contoured (except the LCP-proximal tibia) to the proximal anteromedial and anterolateral surface of a saw-bone model of the tibia. The ipsilateral iliac crest and the entire lower limb were prepared. A tourniquet was not used. If necessary, the intraarticular fracture was reduced and fixed with screws. The fractures were temporarily reduced with or without a distractor and a bone reduction forceps. A 2–3-cm linear incision over the proximal (medial and lateral) aspect of the tibia was made. A 2–3-cm incision over the distal end of the plate was also made. To prevent malalignment of the plate on the shaft of the tibia, the plate was controlled by working through these two incisions and assistance was temporarily provided by percutaneous K-wires through screw holes at each end. After reduction and plate position had been evaluated with fluoroscopy, the screws were placed. A submuscular plane of the lateral side was developed under the anterior compartment muscles and the selected plate was slid under the muscles. A subcutaneous plate was also inserted on the medial side by a similar method. The fracture site was not exposed and anatomic reduction of individual fragments was not performed. The location of the plate was evaluated by fluoroscopy in the coronal and sagittal planes.

Among the 13 cases of intraarticular fracture (AO 41C), 11 patients had a minimal displacement or depression that required closed reduction and screwing under a fluoroscopic guide. 2 patients required open reduction for articular reconstruction of the depressed lateral condyle fracture with an extended proximal incision. The major metaphyseal or proximal shaft fractures of these patients were, however, treated with the MIPO technique. The average operating time was 101 (70–145) min, and the intraoperative radiographic exposure time was 270 (90–430) sec.

**Postoperative care**

Quadriceps setting and continuous passive motion of the knee were initiated on the second postoperative day. After discharge, the patients were encouraged to perform straight leg raising exercises and active flexion of their knees with a hinged knee brace. Approximately 4–6 weeks after surgery, partial weight bearing was started with the patient wearing a brace. Full weight bearing was not permitted until consolidation of the fracture site. Follow-up routine antero-posterior, lateral, and oblique radiographs were obtained every 4 weeks until the radiographs showed solid continuous callus formation. The mean follow-up time was 25 (14–41) months.

**Results (Table)**

All fractures united without bone graft after an average of 19 (10–32) weeks. The mean time to full, unprotected weight bearing was 15 (6–22) weeks. 2 patients needed a secondary operation for removal of a protruding screw (Figures 5 and 6) or removal of a plate because of superficial infection.

There was 1 case of shortening of 1 cm in a comminuted fracture, and 2 varus deformities of 5° and 8°. These malalignments occurred early in the series because of inadequate contouring of the plate before insertion, and not because of secondary loss of fixation. There was 1 case of a superficial infection which healed after plate removal, but there was no deep infection.

4 patients had some discomfort over the medial plate, including 2 cases of screw breakage and 1 of screw back-out. The final results were evaluated according to Rasmussen (1973) by independent observers (one orthopedic surgeon and one clinical fellow who did not participate in the surgery). 21 patients had excellent or good clinical results (mean score 26 (14–30)). 2 patients had fair results after associated injuries of the ipsilateral femoral condylar fracture and posterior cruciate injury, respectively. The mean range of knee motion was 123° (80–140). All patients showed excellent or good radiographic results (mean score 17 (14–18)).
Discussion

With the damage to soft tissue following the high energy of proximal tibial fractures, conventional open reduction and internal fixation often result in substantial soft tissue complications such as wound breakdown and deep infection (Schatzker and McBroom 1979, Lachiewicz and Funcik 1990, Littenberg et al. 1998). To avoid these complications, the hybrid or circular wire external fixator is a good option, but problems of nonunion, mal-union, and pin track infections are common (Marsh et al. 1995). Recently, the MIPO technique has been developed—not only to improve the rate of fracture healing (Krettek et al. 1997, Collinge et al. 2000), but also to limit soft tissue elevation at the fracture site (Farouk et al. 1999). In our series, all fractures united without primary or secondary bone graft, as has been reported for distal tibial metaphyseal fractures (Oh et al. 2003).

Proximal tibial fractures treated with double plating using the minimally invasive percutaneous osteosynthesis (MIPO) technique

| No. | Age (years) | Injury a | AO/OTA | Kinds of plates | Union time (weeks) | Radiologic score b | Clinical score b | ROM | Complications |
|-----|-------------|----------|--------|-----------------|-------------------|--------------------|------------------|-----|---------------|
| 1   | 60          | F        | 41A    | LC-DCP          | 20                | Excel              | Excel            | 130 |               |
| 2   | 41          | C        | 41A    | LC-DCP          | 18                | Excel              | Excel            | 120 |               |
| 3   | 36          | F        | 41A    | LC-DCP          | 16                | Excel              | Excel            | 130 |               |
| 4   | 38          | P        | 41A    | LC-DCP          | 20                | Good               | Fair             | 130 |               |
| 5   | 52          | C        | 41A    | LC-DCP          | 14                | Excel              | Excel            | 130 |               |
| 6   | 43          | C        | 41C    | LC-DCP          | 16                | Excel              | Excel            | 130 |               |
| 7   | 74          | P        | 41C    | LC-DCP          | 16                | Good               | Good             | 120 |               |
| 8   | 43          | M        | 41C    | LC-DCP          | 20                | Excel              | Excel            | 120 |               |
| 9   | 54          | C        | 41C    | LC-DCP          | 10                | Excel              | Excel            | 110 |               |
| 10  | 45          | C        | 41C    | LC-DCP          | 12                | Good               | Good             | 130 |               |
| 11  | 49          | M        | 41C    | LC-DCP          | 16                | Excel              | Excel            | 120 |               |
| 12  | 66          | C        | 41C    | LCP             | 30                | Excel              | Good             | 80  |               |
| 13  | 65          | F        | 41C    | LCP             | 20                | Good               | Fair             | 110 |               |
| 14  | 40          | F        | 41C    | LCP             | 20                | Good               | Excel            | 110 |               |
| 15  | 78          | F        | 41C    | LC-DCP          | 18                | Excel              | Excel            | 130 |               |
| 16  | 64          | M        | 41C    | LCP             | 28                | Excel              | Excel            | 120 | Varus 5°. Superficial infection |
| 17  | 56          | C        | 41C    | LC-DCP          | 18                | Excel              | Excel            | 130 |               |
| 18  | 75          | P        | 41C    | LCP             | 24                | Good               | Excel            | 130 |               |
| 19  | 56          | F        | 42C    | LC-DCP          | 20                | Excel              | Excel            | 130 | Screw loosening |
| 20  | 43          | C        | 42C    | LC-DCP          | 16                | Excel              | Excel            | 130 |               |
| 21  | 50          | F        | 42C    | LC-DCP          | 18                | Excel              | Excel            | 130 |               |
| 22  | 56          | P        | 42C    | LCP             | 22                | Excel              | Excel            | 130 | Varus 8°       |
| 23  | 46          | P        | 42C    | LCP             | 32                | Good               | Excel            | 130 | Varus 5°       |
| Mean | 53.5        |         | 41A; 5 | 41C; 13         | 42C; 5            |                   |                  |     | 123.3°        |

a Injury mechanisms: F, fall from a height; M, motorcycle accident; C, car accident; and P, pedestrian traffic accident.

b Radiographic and clinical knee score according to Rasmussen (1973).
Figure 5–6. A proximal tibial fracture with comminution in a 43-year-old man (case 20) (A). Using the MIPO technique, double plating was done with LC-DCPs (B). Good alignment was achieved (C). A proximal medial screw loosened at 8 weeks after operation (D). The fracture had healed by 20 weeks after surgery (E). Excellent knee motion was obtained (F).

substitution external fixator can be considered as an alternative solution for these fractures (Bolhöfer 1995), but this is certainly not as elegant and stable as the double plating technique.
The Less Invasive Stabilization System (LISS, Synthes) has been developed to treat proximal tibia fractures, although its usage in some countries has been strongly limited by the high cost. The LISS is characterized by anatomical design, minimal bony contact and unicortical locking screws, and may be the ideal MIPO implant (Ricci et al. 2004, Stannard et al. 2004). LISS is superior to our handmade, roughly contoured plate. When the LISS is not available, double-plate fixation with the MIPO technique may be another good option.

Contributions of authors
CWO and JKO collected data and wrote the manuscript. All other co-authors interpreted the data.

No competing interests declared.

Bolhofner B R. Indirect reduction and composite fixation of extraarticular proximal tibial fractures. Clin Orthop 1995; (315): 75-83.

Blokker C P, Rorabeck C H, Bourne R B. Tibial plateau fractures. An analysis of the results of treatment in 60 patients. Clin Orthop 1984; (182): 193-9.

Collinge C, Sanders R, DiPasquale T. Treatment of complex tibial periarticular fractures using percutaneous techniques. Clin Orthop 2000; (375): 69-77.

Dendrinos G K, Kontos S, Katsenis D, Dalas A. Treatment of high-energy tibial plateau fractures by the Ilizarov circular fixator. J Bone Joint Surg (Br) 1996; 78: 710-7.

Duwelius P J, Rangitsch M R, Colville M R, Woll T S. Treatment of tibial plateau fractures by limited internal fixation. Clin Orthop 1997; (339): 47-57.

Farouk O, Krettek C, Miclau T, Schandelmaier P, Guy P, Tscherne H. Minimally invasive plate osteosynthesis: does percutaneous plating disrupt femoral blood supply less than the traditional technique? J Orthop Trauma 1999; 13: 401-6.

Gustilo R B, Anderson J T. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. J Bone Joint Surg (Am) 1976; 58: 453–8.

Horwitz D S, Bachus K N, Craig M A, Peters C L. A biomechanical analysis of internal fixation of complex tibial plateau fractures. J Orthop Trauma 1999; 13: 545-9.

Krettek C, Schandelmaier P, Miclau T, Tscherne H. Minimally invasive percutaneous plate osteosynthesis (MIPO) using the DCS in proximal and distal femoral fractures. Injury (Suppl 1) 1997; 28: A20-30.

Lachiewicz P F, Funkic T. Factors influencing the results of open reduction and internal fixation of tibial plateau fractures. Clin Orthop 1990; (259): 210-5.

Littenberg B, Weinstein L P, McCaren M, Mead T, Swiontkowski M F, Rudicel S A, Heck D. Closed fractures of the tibial shaft: Ameta-analysis of three methods of treatment. J Bone Joint Surg (Am) 1998; 80: 174-83.

Marsh J L, Smith S T, Do T T. External fixation and limited internal fixation for complex fractures of the tibial plateau. J Bone Joint Surg (Am) 1995; 77: 661-73.

Mueller K L, Karunakar M A, Frankenburg E P, Scott D S. Bicondylar tibial plateau fractures: a biomechanical study. Clin Orthop 2003; (412): 189-95.

Oh C W, Kyung H S, Park I H, Kim P T, Ihn J C. Distal tibia metaphyseal fractures treated by percutaneous plate osteosynthesis. Clin Orthop 2003; (408): 286-91.

Orthopaedic Trauma Association Committee for Coding and Classification. Fracture and Dislocation Compendium: Orthopaedic Trauma Association Committee for Coding and Classification. J Orthop Trauma (Suppl 1) 1996; 10: v-ix: 1-154.

Peindl R D, Zura R D, Vincent A, Coley ER, Bosse M J, Sims S H. Unstable proximal extraarticular tibia fractures: a biomechanical evaluation of four methods of fixation. J Orthop Trauma 2004; 18: 540-5.

Perren S M. Evolution of the internal fixation of long bone fractures: The scientific basis of biological internal fixation: choosing a new balance between stability and biology. J Bone Joint Surg (Br) 2002; 84: 1093-110.

Rasmussen P S. Tibial condylar fractures. Impairment of knee joint stability as an indication for surgical treatment. J Bone Joint Surg (Am) 1973; 55: 1331-50.

Ricci W M, Rudzki J R, Borrelli J Jr. Treatment of complex proximal tibia fractures with the less invasive skeletal stabilization system. J Orthop Trauma 2004; 18: 521-7.

Schatzker J, McBroom R. The tibial plateau fracture. Clin Orthop 1979; (138): 94-104.

Stannard J P, Wilson T C, Volgas D A, Alonso J E. The less invasive stabilization system in the treatment of complex fractures of the tibial plateau: short-term results. J Orthop Trauma 2004; 18: 552-8.