

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

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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 10°). 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.

Patients and methods

From October 1999 to January 2003, we treated 211 fractures of the proximal tibia (AO/OTA 41, 124 cases; AO/OTA 42, 87 cases) (OTA Committee 1996). Children, patients who had sustained severe open fractures (grade II and III) (Gustilo and Anderson 1976), patients with compartment syndrome, and fractures necessitating open reduction of both the articular and metaphyseal fractures were excluded from the study. 23 patients (mean age 54 (36–78) years, 18 men) were included and were operated by 2 experienced trauma surgeons (OCW, OJK). The fractures were stabilized with 2 kinds of plate (a narrow limited contact-dynamic compression plate (LC-DCP; Synthes) and/or a locking compression plate (LCP; Synthes) using the MIPO technique.

Using the classification developed by the AO and the Orthopaedic Trauma Association (OTA Committee 1996), 5 fractures were 41A, 13 were 41C

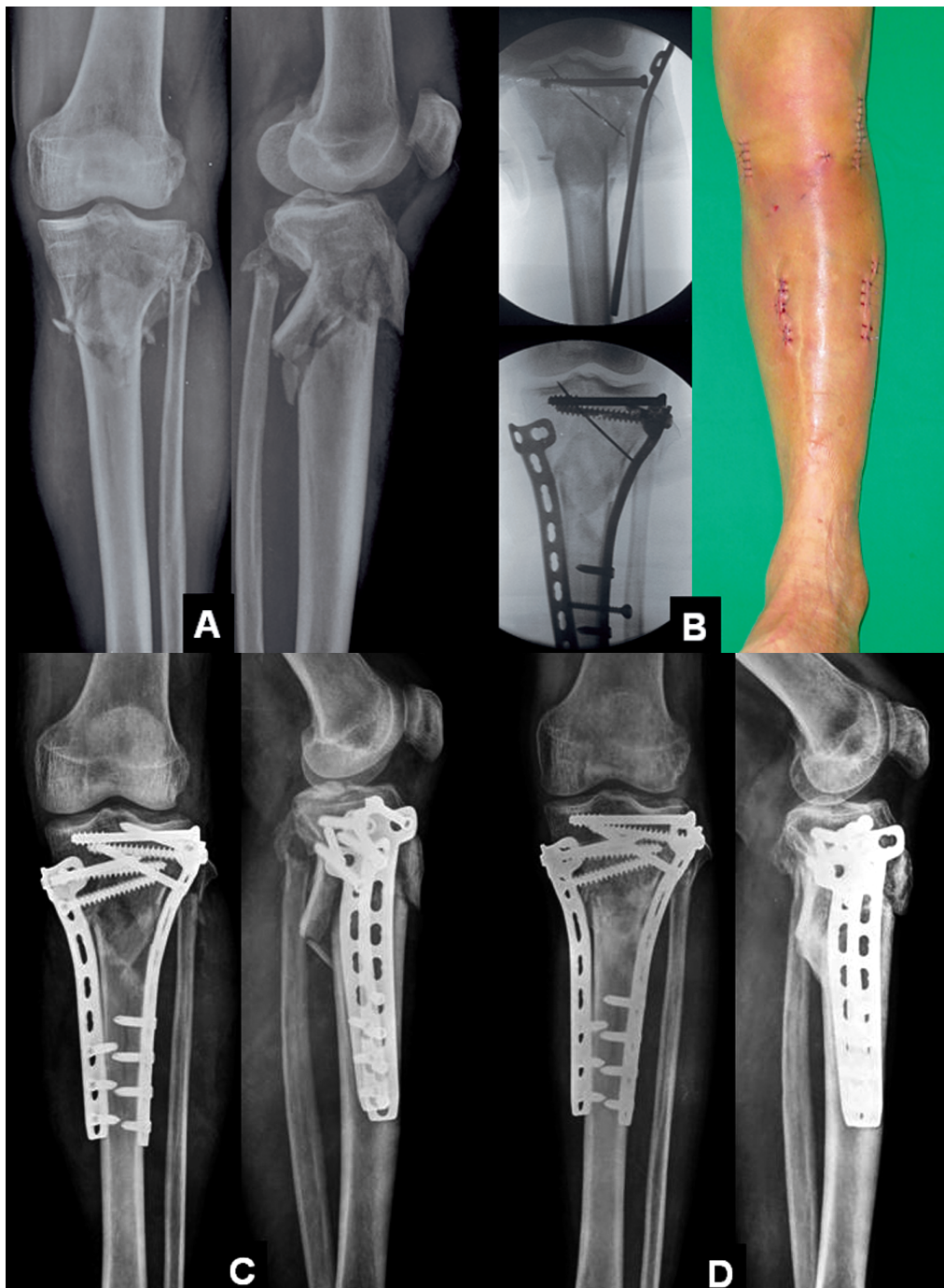


Figure 1–2. A 75-year-old man (case 18) had an intraarticular fracture of the proximal tibia (A). After screw fixation of articular involvement under fluoroscopy, bilateral percutaneous plating with 2 LCPs was done (B). Satisfactory alignment was achieved (C). The fracture had healed by 18 weeks after surgery (D).

(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-



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).

tures. 8 patients had sustained multiple fractures or associated injuries, which included clavicle frac-

tures, ipsilateral femoral fractures, contralateral tibial fractures, and posterior cruciate ligament

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)).

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	1 cm shortening
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	LCP	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	Good	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	
20	43	C	42C	LC-DCP	16	Excel	Excel	130	Screw loosening
21	50	F	42C	LC-DCP	18	Excel	Excel	130	
22	56	P	42C	LCP	22	Excel	Excel	130	
23	46	P	42C	LCP	32	Good	Excel	130	Varus 8°
Mean	53.5		41A; 5 41C; 13 42C; 5		19.3			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).

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).

No skin necrosis, compartment syndrome, or deep infection occurred. We excluded patients with severe open fractures or established compartment syndromes, since these patients are at high risk of developing deep infection. The low incidence of soft tissue problems and infection seems to be lower than after conventional open plating. The fracture alignment we obtained was probably better after external fixation (Dendrinis et al. 1996, Duwelius et al. 1997).

In very high proximal tibial fractures or proximal metaphyseal fractures, it is often difficult to secure 3 or more screws at the proximal segment with a unilateral (commonly lateral) plate. This weak construction may limit immediate knee motion and early weight bearing, and may result in late angular deformity. In this respect, the double plating technique gives better stability of tibial plateau fractures (Horwitz et al. 1999, Mueller et al. 2003, Peindl et al. 2004). A lateral plate with a medial

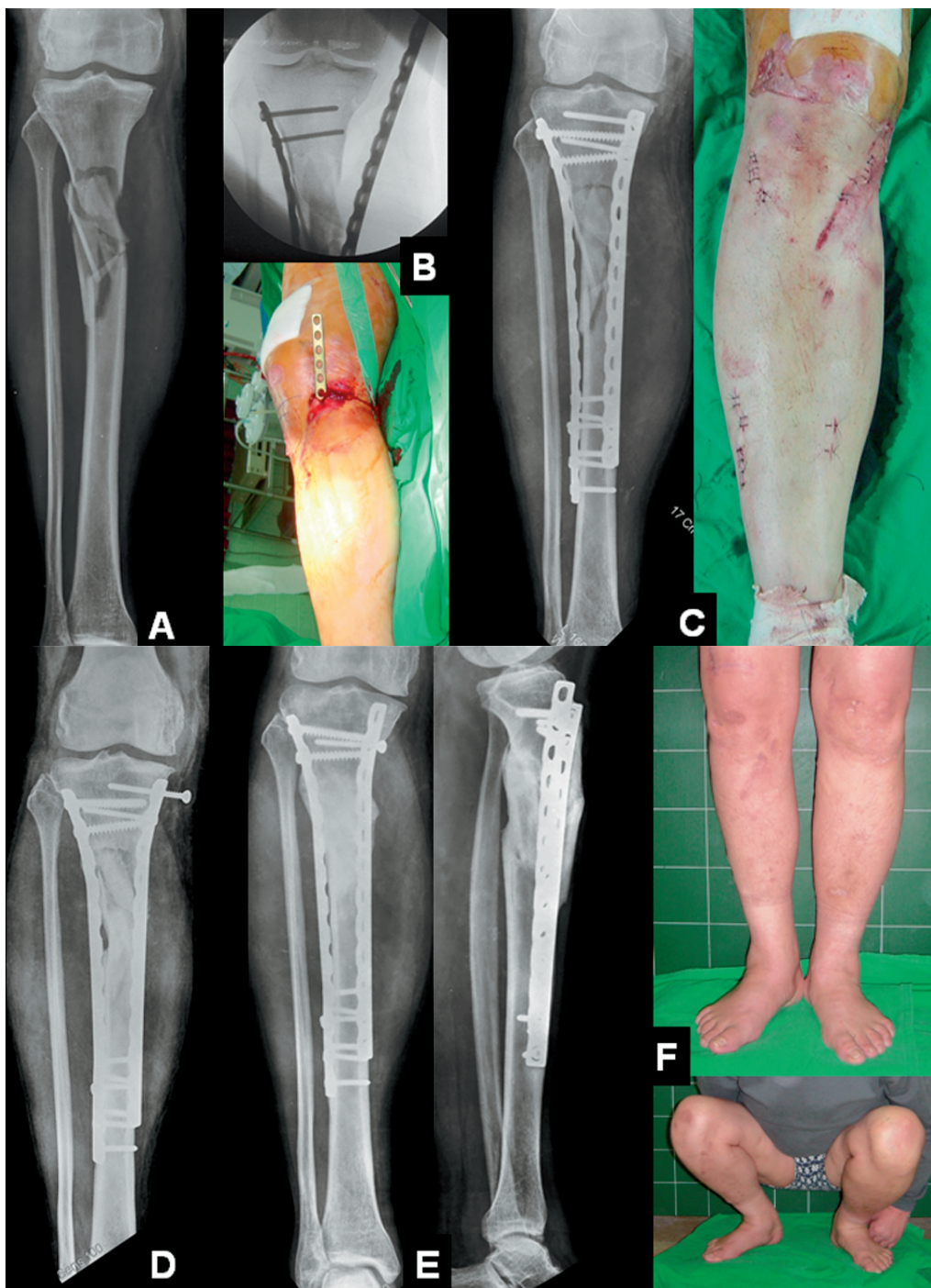


Figure 5–6. A proximal tibial fracture with comminution in a 43-year-old man (case 20) (A). Using the MIPO technique, double plating was done with LC-DCPs (B). Good alignment was achieved (C). A proximal medial screw loosened at 8 weeks after operation (D). The fracture had healed by 20 weeks after surgery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

substitution external fixator can be considered as an alternative solution for these fractures (Bolhof-

ner 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 hand-made, 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.

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