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Minimally invasive plate osteosynthesis for tibial plateau fractures

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ABSTRACT

Purpose. To evaluate radiological and clinical outcome of minimally invasive plate osteosynthesis (MIPO) for tibial plateau fractures.
Methods. 35 men and 6 women aged 19 to 75 (mean, 40; standard deviation [SD], 14) years underwent MIPO for displaced tibial plateau fractures. According to the Schatzker system, the tibial plateau fractures were classified as types I (n=3), II (n=9), III (n=11), IV (n=6), V (n=7), and VI (n=5). Six patients had open fractures; 2 of them underwent debridement before MIPO. 10 patients needed additional bone grafting. Radiological (at immediate postoperation) and clinical (at the 12-month follow-up) assessments based on the Rasmussen anatomic and functional scoring system were recorded using a proforma. Patients with acceptable and unacceptable outcomes were compared in terms of age.
Results. The mean Rasmussen anatomic score was 15.1 (SD, 2.2; range, 10–18); the mean Rasmussen functional score was 25.3 (SD, 3.2; range, 14–29); and the mean range of knee motion was 118º (SD, 10º; range, 90º–140º). Anatomic outcome was excellent in 10, good in 28, and unacceptable in 3 patients (one each had Schatzker type-I, -II, and -III fractures). 27 (71%) of the 38 patients with acceptable anatomic outcome were aged ≤45 years, whereas 2 (67%) of the 3 patients with unacceptable anatomic outcome were aged ≥60 years (p=0.001). Functional outcome was excellent in 18, good in 19, and unacceptable in 4 patients (2 had Schatzker type-III and another 2 had Schatzker type-I or -II fractures). 37 of the patients had a range of knee motion of ≥120º; 27 (73%) of them were age d ≤45 years, whereas 3 (75%) of the 4 patients with unacceptable functional outcome were aged ≥60 years (p=0.001).
Conclusion. MIPO for tibial plateau fractures achieved good outcome with minimal soft-tissue complications. Older age was the predictor of unacceptable outcome.

Key words: *bone plates; surgical procedures, minimally invasive; tibial fractures*

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INTRODUCTION

Tibial plateau fractures affect knee function and stability.[1] They were first described as car bumper fractures.[2] Mostly they were caused by high-speed motor vehicle accidents, followed by falls from heights.[3] Tibial plateau fractures can be classified according to severity of comminution, soft-tissue disruption, articular depression, condylar displacement, metadiaphyseal fracture extension, open wounds, and extensive closed degloving injuries.[4,5] The Schatzker classification is most widely used for preoperative planning.[6,7]

Both conservative and operative treatments have achieved good results for tibial plateau fractures.[8,9] Surgical treatment is recommended for fractures with >5 mm displacement or >5º varus or valgus in order to restore joint congruity and limb alignment and enable early knee mobilisation.[1,10,11] Open reduction and internal fixation (ORIF) with plates and screws enables fracture visualisation, reduction, and fixation, but results in substantial soft-tissue dissection and risks wound breakdown, stiffness, and deep infection.[12] The small wire external fixator avoids such problems, but risks non-union and pin tract infections.[13,14] Minimally invasive plate osteosynthesis (MIPO) improves the healing rate by minimising disruption of soft tissues (including periosteum) and preserving vascular supply at the fracture site.[15,16]

The goals of treatment are to restore joint congruity and limb alignment.[17] Functional outcome depends mainly on range of knee motion and strength of the quadriceps. Knee stiffness is more clinically relevant than instability in tibial plateau fractures.[18] We evaluated radiological and clinical outcomes of MIPO for tibial plateau fractures.

MATERIALS AND METHODS

Between March 2008 and March 2010, 35 men and 6 women aged 19 to 75 (mean, 40; standard deviation [SD], 14) years underwent MIPO for displaced tibial

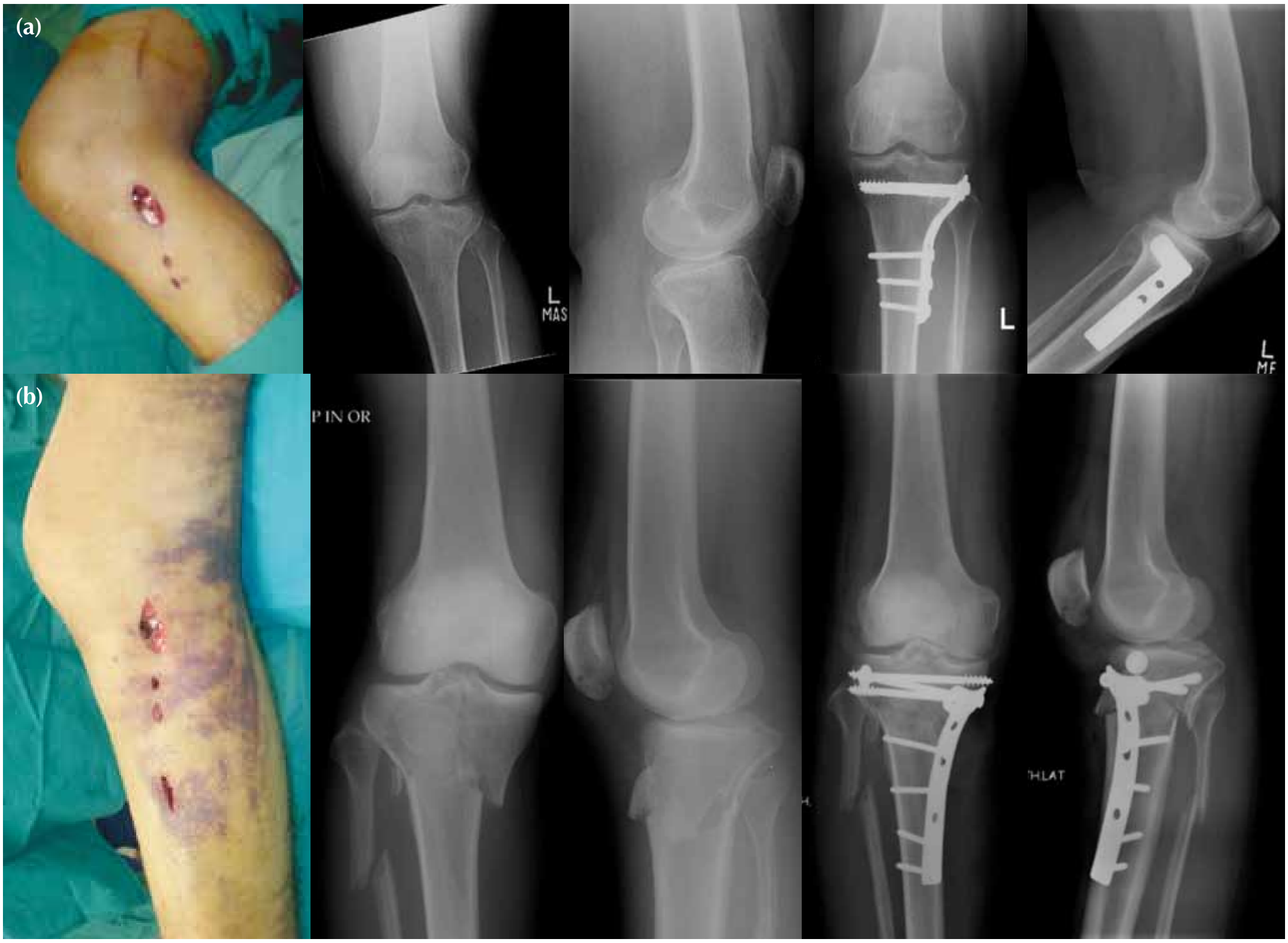

Figure Schatzker **(a)** type-II and **(b)** type-V tibial plateau fractures fixed with minimally invasive plate osteosynthesis.

plateau fractures. Patients with neurological injury, other fractures in the ipsilateral or contralateral lower limb, open fractures other than Gustilo type I, or mental/physical handicap were excluded. Informed consent of each patient was obtained.

According to the Schatzker system, the tibial plateau fractures were classified as types I (n=3), II (n=9), III (n=11), IV (n=6), V (n=7), and VI (n=5). Six patients had open fractures; 2 of them underwent debridement and then MIPO after confirmation of no growth in tissue cultures 72 hours later. 10 patients needed additional bone grafting.

Radiography and computed tomography with 3-dimensional reconstruction (for complex injuries) were obtained to identify the size, location, and extent of articular depression of fracture fragments (Fig.).

Patients were positioned supine on a radiolucent table. The ipsilateral iliac crest was prepared and draped for possible autogenous bone grafting. Perioperative intravenous antibiotics were administered. Articular fractures were reduced indirectly by a reduction forceps under fluoroscopic guidance and by ligamentotaxis using a femoral distractor with a proximal pin in the distal femur and a distal pin in the tibia (distal to the fracture). For centrally depressed articular fragments (when reduction was not feasible by ligamentotaxis), a window through the cortical bone was made in the subchondral metaphyseal region. The cavity was filled with cancellous autologous bone grafts.

A stainless steel 4.5-mm L plate or T buttress plate of an appropriate length was precontoured, according to the fracture site. An incision of 2 to 3 cm over the proximal aspect of the tibia on the medial, lateral, or both sides was made, according to the fracture site and the use of single or double plates. A submuscular plane was created and the plate was slid in the anterior submuscular plane. The plate was then fixed with screws, which were inserted percutaneously through the primary surgical incisions. In few patients, separate cancellous or cannulated screws were inserted.

Table 1
Patient distribution according to fracture types and outcomes

Schatzker type	No. of patients (n=41)	No. (%) of patients	
		Acceptable anatomic outcome	Acceptable functional outcome
I	3	2 (5)	2 (5)
II	9	8 (20)	8 (20)
III	11	10 (24)	9 (22)
IV	6	6 (15)	6 (15)
V	7	7 (17)	7 (17)
VI	5	5 (12)	5 (12)

Postoperatively, the limbs were protected in a knee brace for 2 weeks until subsidence of swelling and removal of stitches. Active and passive range-of-motion exercises were allowed to prevent knee stiffness and to strengthen the quadriceps. Non-weight bearing walking with crutches or walker was allowed for 6 weeks. Partial weight bearing was allowed according to fracture healing and patient compliance. At week 12, full weight bearing was allowed as tolerated.

Radiological (at immediate postoperation) and clinical (at the 12-month follow-up) assessments based on the Rasmussen anatomic and functional scoring system were recorded using a proforma. For the anatomic score, 18 was considered as excellent, 12 to 17 as good, and <12 as unacceptable. For the functional score, 27 to 30 was considered as excellent, 20 to 26 as good, and <20 as unacceptable. Patients with acceptable and unacceptable outcomes were compared in terms of age using the Chi squared test or Fisher's exact test.

RESULTS

The mean operating time was 113 (SD, 28; range, 65–180) minutes; the mean length of hospital stay was 3.8 (SD, 1.5; range, 2–7) days; the mean Rasmussen anatomic score was 15.1 (SD, 2.2; range, 10–18); the mean Rasmussen functional score was 25.3 (SD, 3.2; range, 14–29); and the mean range of knee motion was 118º (SD, 10º; range, 90º–140º) [Tables 1 and 2]. Anatomic outcome was excellent in 10, good in 28, and unacceptable in 3 patients (one each had Schatzker type-I, -II, and -III fractures). 27 (71%) of the 38 patients with acceptable anatomic outcome were aged ≤45 years, whereas 2 (67%) of the 3 patients with unacceptable anatomic outcome were aged ≥60 years ($p=0.001$). Functional outcome was excellent in 18, good in 19, and unacceptable in 4 patients (2 had Schatzker type-III and another 2 had Schatzker type-I or -II fractures). 37 of the patients had a range of knee motion of ≥120º; 27 (73%) of them were aged ≤45 years, whereas 3 (75%) of the 4 patients with unacceptable functional outcome were aged ≥60 years ($p=0.001$).

DISCUSSION

MIPO enables indirect fracture reduction and percutaneous submuscular implant placement.[19]

Table 2
Rasmussen anatomic and functional scores

Sex/age (years)	Rasmussen scoring system				Range of knee motion (degree)
	Anatomic score	Anatomic outcome	Functional score	Functional outcome	
Schatzker type-I fracture					
M/60	18	Excellent	24	Fair	120
M/28	14	Good	26	Good	120
M/63	16	Good	21	Good	90
Schatzker type-II fracture					
F/45	18	Excellent	28	Excellent	120
F/45	18	Excellent	28	Excellent	120
M/40	18	Excellent	27	Excellent	120
M/28	18	Excellent	27	Excellent	130
M/46	18	Excellent	28	Excellent	120
M/49	14	Good	22	Good	120
M/38	14	Good	26	Good	120
M/29	14	Good	27	Excellent	120
M/75	10	Fair	14	Fair	90
Schatzker type-III fracture					
M/31	18	Excellent	29	Excellent	120
M/27	12	Good	26	Good	120
F/42	14	Good	25	Good	120
F/42	14	Good	25	Good	120
M/27	12	Good	26	Good	120
M/39	16	Good	24	Good	120
M/54	16	Good	25	Good	140
M/69	14	Good	19	Fair	90
M/32	14	Good	26	Good	120
M/24	15	Good	27	Excellent	130
M/27	10	Fair	18	Fair	120
Schatzker type-IV fracture					
M/41	18	Excellent	25	Good	120
M/32	16	Good	22	Good	120
M/27	14	Good	25	Good	120
M/40	14	Good	28	Excellent	120
M/61	16	Good	23	Good	120
F/26	15	Good	25	Good	120
Schatzker type-V fracture					
M/31	18	Excellent	28	Excellent	130
M/35	14	Good	28	Excellent	120
M/35	14	Good	28	Excellent	120
M/19	16	Good	29	Excellent	120
M/29	12	Good	28	Excellent	120
M/19	14	Good	28	Excellent	120
F/54	14	Good	26	Good	120
Schatzker type-VI fracture					
M/35	18	Excellent	28	Excellent	120
M/50	16	Good	27	Excellent	120
M/50	16	Good	27	Excellent	120
M/48	12	Good	20	Good	90
M/50	15	Fair	26	Good	120

Favourable outcome is not due to MIPO but less extensive dissection of soft-tissue envelope and devitalisation of fracture fragments. In a study of ORIF, 20% of patients developed superficial or deep infections despite acceptable functional outcome.[20] In our study, all patients had fracture healing with no wound dehiscence or infection, except for one who had a closed type-III fracture that developed late-onset (at month 5) deep infection, which was treated with debridement and plate removal. MIPO results in lower incidence of soft-tissue problems and complications and achieves better outcome than ORIF does.[21–24]

93% of our patients achieved acceptable anatomic (reduction) outcome, which was comparable to other studies reporting 91%[25] to 100%.[15] 90% of our patients achieved acceptable functional outcome, which was comparable to other studies reporting

64%[26] to 91%.[25] In our study, 3 of the 4 patients with unacceptable functional outcome were aged ≥60 years. Elderly patients usually have underlying degenerative changes in the joints that is aggravated after intra-articular fractures; age is a main predictor of functional outcome.[27] Nonetheless, treatment principles are the same for both older and younger patients.[28]

In our study, anatomic outcome was associated with functional outcome, except in one younger patient who achieved good functional outcome despite fair anatomic outcome. Two of the 4 patients with unacceptable functional outcome had Schatzker type-III fractures, whereas all 18 patients with Schatzker type-V and -VI fractures achieved acceptable outcome. Schatzker type-V and -VI fractures are usually associated with worse outcome.

MIPO reduces postoperative pain and enables early rehabilitation, which improves articular cartilage nutrition and healing.[29] It is cosmetically more acceptable owing to less scar formation.[30]

In our study, computed tomography with 3-dimensional reconstruction was only used to evaluate complex injuries. It should have been performed for all cases to delineate the fracture pattern and guide the operation plan.[31] The use of more modern implants with locking screws and pre-contoured locking plates provide better stability and may further improve outcome, particularly for the elderly. Patience is important for soft-tissue management, particularly when the soft-tissue envelope is severely contused. A simple anterior spanning external fixator across the knee should be considered as an interim measure. Intra-articular fractures are commonly associated with late-onset post-traumatic secondary arthritis if they are inadequately treated. Long-term follow-up is therefore necessary.[32] One limitation of our study was a mean follow-up period of 12 months.

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