One Stage Treatment of Open Proximal Tibia Fractures by Minimally Invasive Technique Using Locked Plate

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Abstract: Objective: This prospective study was performed to evaluate the results of treating open proximal tibia fractures by locked plate as one stage technique. **Methods:** Twelve patients (9 males and 3 females), the mean age was 38 years, with acute open proximal tibia fractures were treated by aggressive debridement, irrigation and primary definitive fixation by preshaped anatomical locked plate. There were six patients type A, four patients type B3 and two patients type C2 according to AO/OTA classification. There were eight patients type III and four patients type II open fractures according to Gustilo and Anderson classification. **Results:** All patients were followed clinically and radiologically with a mean of 16.5 months. All fractures united at a mean of 24 weeks. Knee motion ranged from a mean of 1° (range, 0°-5°) to 110° of flexion (range, 100°-140°).There were only two patients with superficial infection, no deep infection developed. At final follow –up ten patients had excellent results and two patients had good results. **Conclusion:** The use of this method for the treatment of open proximal tibia fractures had promising results. However this technique is not generally used and it needs more clinical work to evaluate its results.

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1. Introduction

Open proximal tibia fractures pose treatment dilemmas for orthopedic surgeons. These injuries are associated with significant morbidity due to increased risk of infection, nonunion, malunion, knee stiffness and possible amputation.[1-5] They require reconstruction of fractures and soft - tissues coverage of open fractures, whether by free tissue flaps, local pedicle flaps or wound repair. Moreover, the optimal management of these injuries remains controversial. External fixation is gaining interest and has application to decrease complication rates related to plating.[2,6-9,11] However the main disadvantages of external fixators are lengthy treatment and long-term disabilities. Techniques of open reduction with internal fixation employing a traditional plate and screw construct for these injuries offer little resistance to varus deformity. Augmentation of these constructs by either a plate[12] or medial external fixator[13-15] has been advocated to increase stability. These methods increase associated morbidity and have the potential to devitalize bone.[5,13,16] Intramedullary nailing also was used to treat these fractures, however this technique is frequently complicated by valgus or apex anterior angulation and residual displacement at the fracture site.[17,18] Recently, staged management of high-energy injury and use of temporary joint-spanning external fixation were used successfully for the treatment of open proximal tibial fractures. Several authors demonstrated the benefits of bridging external fixation followed by definitive internal fixation once the soft-tissue envelope had sufficiently healed.[1,6,11] Standard external fixators are relatively inexpensive and easy and quick to apply. However, frames are often bulky and cumbersome for the patient. When used on lower extremities, especially in the knee area, patients typically encounter problems with clothing, sleeping and impeding the contralateral extremity when walking. Most often, in open knee and ankle injuries, these external fixators are used for bridging the fixation across the joint for long periods of time until soft-tissue reconstruction is achieved, and is then followed by definitive fixation. Nonetheless, this treatment can result in muscle atrophy and joint stiffness.[19] In an effort to deal with some of the clinical concerns regarding treatment of these fractures, a periosteal-sparing, minimally invasive internal fixator has been developed for the distal femur and proximal tibia (LISS; Synthes USA, Paoli, PA) is introduced at joint level above the periosteum via one small lateral incision. It has minimal bony contact and uses self-drilling screws, which lock into the plate to form a fixed angle device.[20-26] The Less Invasive Stabilization method of fracture fixation proposes the advantages of indirect fracture reduction and percutaneous, submuscular implant placement. The fixator implants and instrumentation system

offers a method of percutaneous placement of self-drilling/self-tapping screws. These screws have threaded heads to provide a fixed angle with matching threaded heads in the fixator. Proximal placement of these fixed-angled screws in multiple strategic locations provides capture of the articular segment. Distally, along the stem of the implant, self-drilling/self-tapping screws can be used to achieve fixation in the distal diaphysis.[27]

2. Patients and methods

From May 2011 – April 2013, 12 patients (9 males and 3 females), ranging in age from 20 to 50 years (mean age, 38 years), with open proximal tibia fractures were treated at Zagazig University Hospitals and Sohag University Hospitals by minimal invasive technique using the proximal tibia locked plate as a definitive one stage treatment method. The fractures were classified according to the Orthopedic Trauma Association (AO/OTA) classification.[12] There were six type A fractures (four type A3 fractures, two type A2 fractures), four type B3 fractures and two type C2 fractures. Soft tissue injuries were classified according to Gustilo and Anderson classification,[28] there were eight patients with type III (5 type IIIA, 3 type IIIB), and four patients with type II (Table 1).

Operative technique

All patients were treated by irrigation and debridement (ten patients were debrided within 6 hours of the injury and the other two were debrided between 6-12 hours of their injury), we used at least ten bottles of saline to clean the wound in every patient. The fracture was reduced by longitudinal traction and under C-arm control, the proximal lateral tibia locked plate was inserted through a small incision on the lateral aspect of the proximal tibia, after preparing a submuscular tunnel over the periosteum. Ten patients were fixed by using the 11 hole plate and two patients were treated by using the 13 hole plate. Three to six screws were placed in the proximal fragment and three to four screws were placed in the distal fragment under C-arm control. Soft tissue reconstruction started 5-7 days after the definitive fixation. A soft dressing was used postoperatively, early functional mobilization was allowed to all patients, partial protected weight bearing started 3 weeks after fixation and increasing to full weight bearing was decided individually according to the stage of healing as diagnosed clinically and radiologically.

Table 1: Patients data

Case	Gender/age	Mechanism of injury	AO/OTA classification	Gustilo grade	Other fractures
1	M/30	Gunshot	41-A3	IIIA	---
2	M/27	Gunshot	41-B3	IIIA	---
3	M/26	Gunshot	41-C2	IIIB	Humerous
4	F/38	Gunshot	41-A3	II	Radius
5	M/50	Gunshot	41-A2	II	---
6	M/40	Gunshot	41-A3	IIIB	---
7	M/39	Gunshot	41-B3	IIIA	---
8	M/42	Gunshot	41-B3	IIIA	---
9	F/55	Gunshot	41-C2	IIIB	Femur
1	M/20	Gunshot	41-A2	IIIA	---
11	F/50	Gunshot	41-A3	II	---
12	M/39	Gunshot	41-B3	II	---

Radiographic assessment

All patients were evaluated using antero-posterior and lateral postoperative radiographs. The degree of mechanical axis deviation, the amount of articular depression and the degree of condylar widening were assessed. If the articular reduction was reduced anatomically or had less than 2 mm of widening at step off, it was considered good reduction; 2-5 mm of step off was considered fair reduction, and greater than 5 mm of step off or widening was considered a poor reduction.[29] Follow up radiographs were assessed to determine displacement of the fracture fragments, residual deviation of mechanical axis, healing of the fracture.

Clinical assessment

A functional knee score was obtained at the final follow-up using the Knee Society clinical Rating Score. A score of 85-100 represents an excellent result; 70-84, represents a good result; 60-69, represents a fair result; and less than 60, represents a poor result.[30]

3. Results

For all patients, the mean follow-up duration was 16.5 months (range, 10-22 months). Five patients treated by split thickness skin graft after mobilization of the medial gastrocnemius muscle to cover the periosteum, three patients treated by using pedicled, medial gastrocnemius local flaps and four patients

were treated with primary wound repair. Three patients required autogenous bone graft to bridge bone defects 3 months after fixation. There were two patients with superficial wound infection that treated well with dressing and antibiotics, and three patients with prominent implants after healing which necessitate removal. All fractures united at a mean of 24 weeks (range, 16-40 weeks). Knee motion ranged from a mean of 1° (range, 0°-5°) to110° of flexion (range, 100°-140°). At final follow-up 10 patients had excellent results and 2 patients had good results (Table 2).

A

B

C

D

E

F

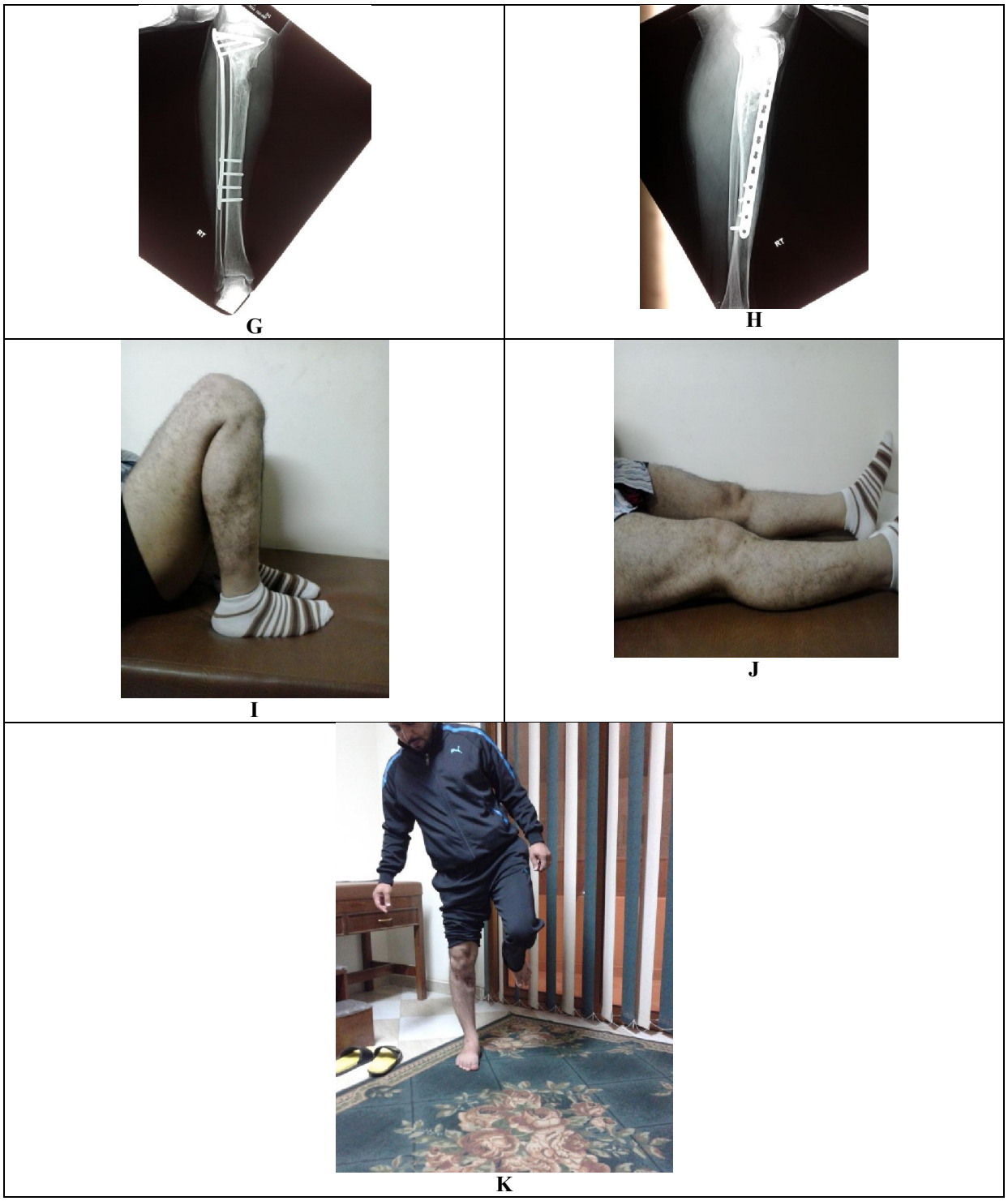

Fig. 1 (A) A 40 years old male patient (case number 6), had a Gustilo type IIIB, open right proximal tibia fracture due to gunshot injury. (B and C) X-ray shows AO/OTA 41-A3 fracture. (D, E and F) Postoperative x- ray after fixation with proximal tibia locked plate and mobilization of the medial gastrocnemius to cover the bone. (F and G) Postoperative x- ray 24 weeks shows union after fixation and autogenous bone graft. (H, I and J) Shows clinical photos of the patient after complete union, range of knee motion and the ability to bear weight on the operated side.

Table 2: Patients results.

Case	Follow-up (months)	Soft tissue reconstruction	Union (weeks)	Complications	Functional score	Rangeof motion (degrees)	Articular reduction
1	12	Skin graft	24	---	Excellent	0-140	Good
2	18	Skin graft	30	---	Excellent	0-135	Good
3	18	Local flap	32	Superficial infection	Good	5-100	Fair
4	20	Repair	16	---	Excellent	0-125	Good
5	17	Repair	20	---	Excellent	0-135	Good
6	21	Skin graft	24	Prominent implant	Excellent	0-135	Good
7	10	Local flap	24	---	Excellent	0-130	Good
8	15	Skin graft	18	Prominent implant	Excellent	0-135	Good
9	22	Local flap	40	Superficial infection	Good	5-110	Fair
1	14	Skin graft	26	---	Excellent	0-130	Good
11	15	Repair	20	Prominent implant	Excellent	0-135	Good
12	16	Repair	14	----	Excellent	0-135	Good

4. Discussion

The management of open proximal tibia fractures presents numerous challenges for addressing both soft tissue and skeletal issues. Despite aggressive protocols of debridement and irrigation, skeletal fixation and subsequent soft tissue reconstruction, problems of nonunion, infection, and the need for amputation persist.[31]The use of external fixation for the initial treatment of severe open tibial fractures has proved successful in providing adequate skeletal stability and access to the wound.[1,6,10] Ilizarov-type device is highly versatile and reproducible.[10, 11, 32] It maintains the reduction of fractures, eliminates the need for implanted hardware and provides a stable platform for soft-tissue reconstruction. In addition to its many advantages, the main disadvantages of the Ilizarov method are the lengthy treatment times and the long-term disabilities associated with it. It also has the theoretical risks that can occur, even in experienced hands, including pin infections or loosening, neurovascular injury, muscular damage, articular injury, persistent pain and scarring.[11, 33, 34] The use of external fixation for the treatment of these injuries has been associated with minor pin tract complication in up to 100% of cases, and more serious complications such as septic arthritis of the knee and osteomyelitis in up to 20 %. Also, external fixation for proximal tibia fractures can inhibit knee motion and is associated with poor patient satisfaction. [35, 36]

Several reports described the use of staged protocols for the treatment of open, severe, high-energy proximal tibial fractures. In these studies, patients had initial treatment with a joint-spanning external fixator, followed by delayed open reduction and internal fixation, once the soft-tissue envelope had healed.[5,7,8,37]Also, some authors used the standard AO plate as external fixators.[38] In their recent study Ching-Hou*et al.,* used locked plate as external fixation for staged treatment of open proximal tibial fractures followed by definitive fixation of these fractures by the minimally invasive technique using locked plate. The fractures healed at a mean of 38.6 weeks (range, 18-66 weeks) and the knee range of motion ranged from a mean of 1° (range, 0°-5°) to 125° of flexion (range, 100°-145°).[39] In this study the fracture healed at a mean of 24 weeks (rang, 16-40 weeks), and the knee range of motion ranged from a mean of 1° (range, 0°-5°) to110° of flexion (range, 100°-140°).

Intramedullary nailing is the most commonly used method of minimally invasive stabilization for long bone fractures. However, malalignments in the coronal and sagittal planes are common because of the insufficient stability of the nail with regard to the geographic characteristics of proximal tibial shaft fractures.[40, 41]

The surgical treatment of proximal tibia fractures, with or without intraarticular involvement, is associated with well-described patterns of failure with significant complication rate. The less invasive stabilization system can be thought of as (internal external fixator). Its use prevents varus collape by virtue of its fixed-angled screws, which offer multiple points of fixation in the proximal articular segment. The less invasive stabilization system technique and technology appears to provide stable fixation (96%), a high rate of union (96%), and an acceptable rate of infection (4%) for proximal tibia fractures.[27]

Conclusion

In this study, treatment of open proximal tibial fractures was done as one stage technique including debridement, irrigation and fixation with locked plate using the minimally invasive technique. The good anatomic reduction obtained was due to early reduction (within 6-12 hours of the injury), and using the wound to aid in reducing the fracture. There was no deep infection which possibly due to aggressive irrigation, removal of any damaged tissues and early postoperative fixation. Using this method to treat this kind of fractures is not a generally accepted technique

and little experience with it is reported. The drawbacks of this study were the limited number of patients and more clinical studies are required to evaluate the use of this technique.

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