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# Staged external and internal less-invasive stabilisation system plating for open proximal tibial fractures

Ching-Hou Ma, Chin-Hsien Wu, Shang-Won Yu, Cheng-Yo Yen, Yuan-Kun Tu *

*Department of Orthopedics, E-Da Hospital/I-Shou University, No. 1 E-Da Road, Jiau-Shu Tsuen, Yan-Chau Shiang, Kaohsiung 824, Taiwan*

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ABSTRACT

High-energy proximal tibial fractures are complex injuries that may lead to significant complications. Staged treatment of these injuries using a spanning external fixator across the knee joint in the acute setting decreases the incidence of complications. This article is a prospective evaluation of outcomes using a two-stage procedure for treatment of 15 patients who sustained open proximal tibial fractures between April 2006 and January 2008. In the first stage, we used low profile, less-invasive stabilisation system (LISS) plates for temporary external fixation to immobilise the fractures after anatomic reduction, followed by soft-tissue reconstruction. In the second stage, we applied LISS plates for definitive internal fixation, using minimally invasive percutaneous osteosynthesis. All fractures were monitored for a mean of 20.4 months (range, 12–32 months). All fractures united at a mean of 38.6 weeks (range, 18–66 weeks). Knee motion ranged from a mean of 1° (range, 0° to 5°) to 125° of flexion (range, 100° to 145°). The reduction was scored as good in 13 patients and fair in two patients. At follow-up, 10 patients had excellent, and five had good knee scores. The complications included minor screw-track infections in three patients. In conclusion, the two-stage technique was well suited for treating these difficult injuries, and for patients who needed longer periods of external fixation. Surgeons were able to achieve gross anatomy restoration, soft-tissue reconstruction, stable fixation and high union rates. Patients obtained good-to-excellent motion, function and comfort after treatment.



Open proximal tibial fractures pose treatment dilemmas for orthopaedic surgeons. These injuries are associated with significant morbidity due to increased risks of infection, nonunion, malunion, knee stiffness and possible amputation.[21,22,25,29,30] They require reconstruction of fractures and soft-tissue 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.[1,4,6,11–13,20] The external circular fixator, originally introduced by Ilizarov, has used to manage open fractures in the past two decades.[12,13,20] However, the main disadvantages of Ilizarov fixators are lengthy treatment time and long-term disabilities.

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.

Low-profile external fixation is a helpful adjunct in complex traumatic fractures as part of a staged reconstructive effort. A locking plate, such as the less-invasive stabilisation system (LISS) plate, is advocated as an internal–external fixator, given its angular stable screw fixation. These properties make them good candidates for external plate fixation. Based on the success with staged management of open proximal tibial fractures, we instituted a similar protocol for open proximal tibia fractures (types II and III open fractures). This protocol consisted of a two-stage treatment:

* Corresponding author. Tel.: +886 7 615 0011x2971.
*E-mail address:* ed100130@edah.org.tw (Y.-K. Tu).

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in the first stage, the locking plate (LISS-distal femur (DF) or LISS-proximal lateral tibia (PLT), Synthes, Paoli, PA, USA) is applied temporarily as external fixator to immobilise the fracture after anatomic reduction, followed by soft-tissue reconstruction. In the second stage, definitive internal fixation with an LISS plate is applied using the minimally invasive percutaneous osteosynthesis (MIPO) technique. The benefits of using the locking plate for temporary external fixation include immediate osseous stabilisation without crossing the knee, low-profile rigid fixation, access to wounds, better patient comfort, ease of subsequent definitive fixation, early range of motion of the knee joint and shorter hospitalisation time.

The purpose of this study was to evaluate the use of the LISS locking plate as a temporary external fixator for the management of types II and III open, proximal tibial fractures, with regard to soft-tissue reconstruction, followed by definitive fixation using MIPO procedures.

## Patients and methods

From April 2006 to January 2008, 15 consecutive patients (six males, nine females), ranging in age from 19 to 55 years (mean age, 36 years), with open proximal tibial fractures were treated using the described technique (Table 1). Of these fractures, 11 were Gustilo and Anderson type III (one type IIIA, eight type IIIB and two type IIIC) and four were type II.[9] The fractures were classified according to the Orthopaedic Trauma Association (AO/OTA) classification,[23] there were seven type C fractures (two type C3 fractures, four type C2 and one type C1), four type B3 fractures and four type A fractures (three type A3 fractures, one type A2). There were 10 cases of orthopaedic injuries only and five cases of multiple traumas. Five patients were initially managed at different institutions.

### *Protocol*

The protocol for the treatment of open proximal tibial fractures consisted of several specific steps (Fig. 1).

### *Stage 1*

All of the patients who had open, proximal tibial fractures were treated with immediate irrigation and debridement. If the condition of the patient was unstable, the fracture was stabilised with standard external fixators. Otherwise, the proximal end of the tibia was reduced and aligned by manual longitudinal traction with percutaneous insertion of elevators. If necessary, we performed direct reduction through the open trauma wound,

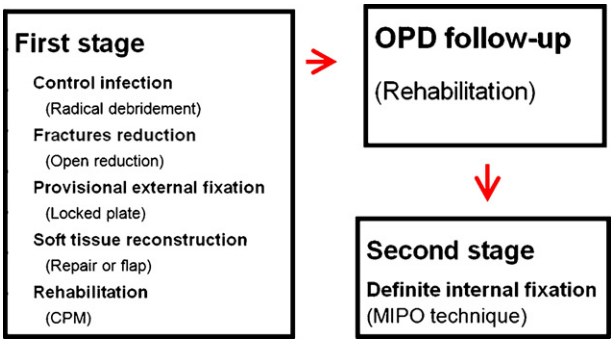


**Fig. 1.** Flow diagram of treatment protocol.

with short extending incisions as needed for access. Limited intra-articular fragment fixation was performed using 4.5- or 6.5-mm screws. Fluoroscopic views, obtained in two planes, assisted in the assessment of the reduction and in the placement of the screws.

After reduction and limited fixation of the proximal tibia, a non-spanning external fixator was applied; we used locking internal fixators, LISS-DF or LISS-PLT plates, as external fixators. In the study, most patients ($n = 12$) used the 13-hole LISS-DF plate, which was used upside down to stabilise the metaphysis and diaphysis of the tibia. The LISS plate was placed on the opposite side of the open trauma wound, and it did not interfere with the following soft-tissue reconstruction procedures. We used 4.5-mm self-drilling and self-tapping locking screws to stabilise the fractures through the drill sleeves and through the stab incisions. To ensure secure fixation, four or five screws were placed into the metaphysis component of the fracture and three screws were used to stabilise the diaphysis component of the fracture. The plate was positioned 3–5 cm above the skin. Sterile prepping and draping of the plate is easier during subsequent procedures, given its low profile. Although unicortical screw fixation is recommended for standard use of these plates, it seems prudent for bicortical fixation when using the plates as external fixators until biomechanical data for this application provide more insight.

We began soft-tissue reconstruction immediately after achieving temporary stabilisation of the bone. Although no specific protocol for soft-tissue coverage was used, 15 patients were treated using the pedicled, medial gastrocnemius local flap, latissimus dorsi free flap or primary wound repair, within 5 days of admission. After soft-tissue reconstruction, the leg was

**Table 1**
Patient demographics.

| Case | Gender/age | Mechanism | Gustilo grade | AO/OTA classification | Other fractures | Associated injury |
|---|---|---|---|---|---|---|
| 1 | M/33 | MCA | IIIB | 41-C2 | – | Haemopneumothorax |
| 2 | M/39 | MCA | IIIB | 41-C3 | – | – |
| 3 | F/29 | MVA | IIIB | 41-A3 | Femur | Liver laceration spleen rupture |
| 4 | F/21 | MCA | IIIB | 41-A2 | – | – |
| 5 | F/55 | MCA | IIIA | 41-C2 | – | – |
| 6 | F/25 | Fall | IIIB | 41-A3 | Lumbar spine | ICH |
| 7 | M/44 | MVA | II | 41-B3 | – | – |
| 8 | M/27 | MCA | IIIB | 41-B3 | Ankle | – |
| 9 | F/46 | MCA | IIIC | 41-B3 | – | – |
| 10 | F/31 | Fall | IIIC | 41-C1 | Pelvis | Bladder rupture |
| 11 | F/51 | MCA | IIIB | 41-C2 | – | – |
| 12 | M/40 | MCA | II | 41-B3 | – | – |
| 13 | F/19 | MVA | II | 41-C2 | Femur, pelvis | Haemopneumothorax EDH |
| 14 | M/27 | MCA | IIIB | 41-C3 | Radius | – |
| 15 | F/54 | MCA | II | 41-A3 | – | – |

M, male; F, female; MCA, motorcycle accident; MVA, motor vehicle accident; ICH, intracranial haemorrhage; EDH, epidural haemorrhage.