A Study on the Role of External Locking Plate in Stabilization of Compound Tibial Fractures

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ABSTRACT

BACKGROUND

Open fractures are more prone for non-union as there is extensive damage to endosteal and periosteal blood supply. Probability of non-union increases with severity of open wound. As the plate is at a distance from the bone, there is less soft tissue dissection. It is less rigid than the internal fixation with locking plate. Load sharing during weight bearing may stimulate the developing callus until bony union. Multiple locking holes in the metaphyseal region of the pre contoured plates provide more stability compared to the standard two large external fixator pins. Though it is recommended that external locking plate has to be used as an external fixator to convert a compound fracture into a simple fracture, as an alternative to external fixator, as they are less cumbersome and more rigid compared to the conventional external fixator, surprisingly, it is also contributing for the union of fracture, in addition to converting a compound to simple fracture, in majority of the cases.

METHODS

This is a prospective interventional and observational study of 23 cases of compound tibial fractures managed with external locking plate in the Department of Orthopaedics, Government General Hospital, Rangaraya Medical College, Kakinada.

RESULTS

Proximal tibial fractures took 20 weeks to unite; middle 3rd fractures took 24 weeks and distal 3rd fractures took 22 weeks for union. Most common complication was superficial infection.

CONCLUSIONS

External plating has good patient compliance as it is comfortable, convenient, and can be easily covered by the trousers due its less bulky construct. They have low profile and hence needs less space for clearance and hence, less likely to hit the opposite limb in swing phase of gait cycle. It can easily be removed under local anaesthesia.

KEYWORDS

External Fixators E07.858.442.660.43, Bony callus A10.165.265.200, Fractures Bone C26.404

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BACKGROUND

Open fractures are a major problem in the mechanized world because they affect the livelihood of the individual in particular and productivity of the society in general. Surgeon faces lot of challenges in managing compound fractures in terms of soft tissue coverage, neurovascular injury and infection. Even if utmost care is taken, it is very difficult to predict the outcome regarding the above problems. The protocol for the management of compound fractures is by stabilization of the fracture with external fixator and soft tissue coverage, converting compound fractures into a simple fracture in the initial stage and going for definitive fixation of the fracture in later stage. Locking compression plate, by the very principal of preserving the blood supply of bone, have gained popularity in the concept of biological fracture fixation. Zespol system was the earliest to use external plate. Their use has been described in the management of open fractures and septic arthritis. It is also called the "Supercutaneous plating technique".

Objectives

1. To study the advantages and disadvantages in the application of locking compression plate as external locking plate.
2. To evaluate the results when external locking plate is encouraged for definitive fixation.

METHODS

Twenty three patients with compound fracture (Type I, II, and IIIA) of tibial fractures underwent supercutaneous plating using LCP. 14 cases had associated fractures. 7 cases underwent 2-staged procedures due to the involvement of knee joint and distal femur fracture and 16 cases underwent 1-stage procedure. Patients were followed up for 16 months.

Surgical Technique

In fractures where knee joint is opened, thorough debridement of the joint is done and suction and irrigation drains are placed. Knee joint is irrigated with antibiotics daily once for 5-7 days. In cases where 2 staged procedure is planned, (if the proximal tibia fracture is associated with distal femur fracture) external fixator is applied initially to span the joint or to consider for flap coverage over exposed bone. Later after 3 to 4 weeks it is converted into external locking plate. With patient under spinal anaesthesia and with strict antibiotic coverage given 30 minutes before tourniquet is applied, to allow adequate antibiotic perfusion. Tourniquet is applied. Thorough wound wash is given. Wound is debrided meticulously and extended if necessary to allow proper debridement. Fracture is reduced anatomically through indirect reduction techniques with Schanz pins, patella holding clamps etc., Fracture is accessed with small stab incisions (<1 cm) if necessary, without disturbing the fracture biology. It should be anatomically reduced before applying a locking plate as no further fracture manipulation can be done once locking plate is applied. Reduction is confirmed under fluoroscopic guidance. A locking compression plate was chosen depending upon the site of fracture a proximal tibial locking plate for proximal tibial fractures, distal tibial locking plate for distal tibial fractures or LISS plate used for femur fractures can be used for both proximal and distal tibial fractures. A long plate, enough for fixation of at least 3 to 4 screws each, proximal and distal to fracture (fixing consecutive holes makes the construct too rigid, hence fixing alternate screw holes is preferred) is chosen. The appropriate plate is taken and applied onto the antero-medial surface of tibia. It is provisionally fixed proximally and distally with k wires. Plate is fixed approximately 2 cms away from the skin. <2 cms of space between plate and skin makes wound management difficult and more space decreases the strength of the construct. All screws have a bi-cortical purchase. Knee and ankle movements were started in the immediate postoperative period. Screw tracks were cleaned daily. Non-weight bearing exercises are started after 2nd or 3rd POD. All patients were followed up for a mean period of 16 months Partial weight bearing is started after 4 weeks. Once bridging callus is found on radiograph progressive weight bearing is allowed. Plate is removed when fracture union is confirmed on follow-up radiographs.

Inclusion Criteria

1. Both males and females between age group of 18-70 years.
2. Gustilo-Anderson type I, II, III A. fractures.
3. Fracture with intra-articular extension with or without fibula fracture.
4. Diaphyseal fractures of tibia with or without fibula fracture.

Exclusion Criteria

1. Immature skeleton
2. Pathological fractures.
3. Lower limb fracture with pre-existing neurological deficit or vascular disease.
4. Gustilo-Anderson type III B, III C. fractures.

RESULTS

The present study consisted of 23 patients (n=23) with compound tibial fractures managed with external locking plate done in the Department of Orthopaedics, Government General Hospital, Rangaraya Medical College, Kakinada.

The age of the patients ranged from 18 to 70 years with most predominant in the age group of 31-40 years with 35 percent (Table 1).

Age	No. of Patients	%
18-30	4	17
31-40	8	35
41-50	5	22
51-60	5	22
61-70	1	4
total	23	100

Table 1. Age Distribution

Out of 23 patients, 20 were male, i.e. 87% showing male preponderance. Predominant mode of injury mechanism is road traffic accidents, i.e. high velocity trauma. This explains the male preponderance as the chief working group gender earning livelihood. Majority of the fractures were of compound type IIIA with 74% (indicating high velocity trauma).we used Gustilo–Anderson classification for the purpose of classifying the compound fractures (Table-2).

Type	No. of Patients	%
Type I	02	09
Type II	04	17
Type IIIA	17	74
Total	23	100

Table 2. Fracture Classification Gustilo-Anderson

Most of the injuries were high velocity injuries. Hence, most of the tibial fractures were associated with other injuries (14 patients). Out of those associated injuries, majority were distal femur fractures (7 patients), associated with proximal tibia fractures. Almost all were associated with fibula fractures. One case of proximal tibia fracture associated with distal femur fracture was also associated with undisplaced patella fracture that did not need fixation. One case with ipsilateral fracture shaft of femur was segmental i.e. shaft femur and sub trochanteric femur fracture. This was managed with long PFN. Most of the proximal tibial fractures were associated with distal femur fractures and knee joint exposed (Table-3).

Associated Fractures (n=14)	No. of Patients	%
Ipsilateral distal femur	7	50
Ipsilateral shaft of femur	6	43
Contralateral tibia	1	7
Total	14	100

Table 3. Associated Fractures

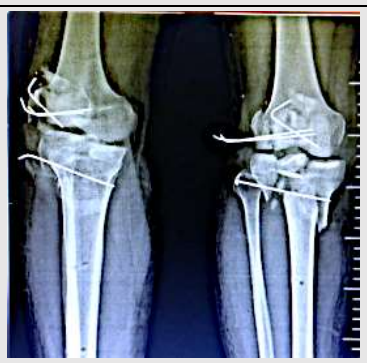
Sixteen cases were treated with external locking plate, as a 1-staged procedure and rest were treated in 2-staged procedure, as they were associated with distal femur fracture that needed spanning external fixator (7 patients). Some of these cases also were associated with compound injury of knee that needed debridement of knee joint and suction and irrigation. Five of our cases needed skin grafting (Table-4).

Staged Procedure	No. of Cases	%
1-staged procedure	16	69
2-staged procedure	7	31
Total	23	100

Table 4. Staged Procedure

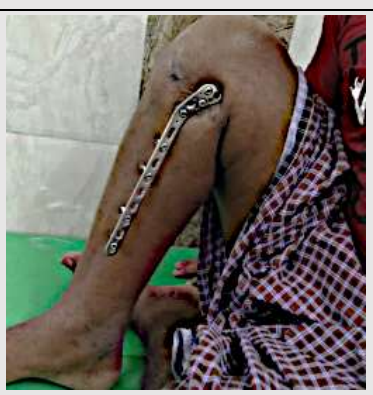
All the patients were started adjacent joint movements on the third postoperative period. Partial weight bearing was started after a mean period of 2 months.

Open Fracture

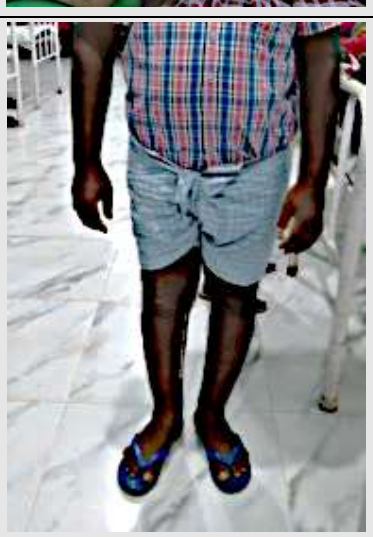


Post Exfix Removal

Super Cutaneous Plating



Range of Knee Flexion



Weight Bearing

Figure Series 1 (Patient Number 2)

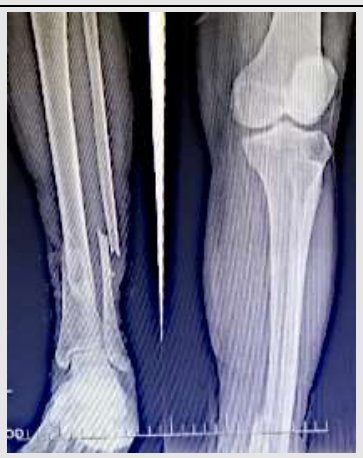
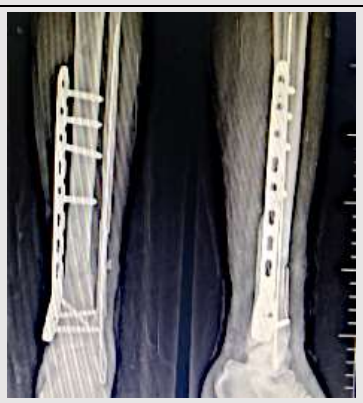
	***Open Fracture***
	***Pre-Op X-Ray***
	***Post Op-X-Ray***
	***Plantar Flexion***
	***Dorsi Flexion***

Figure Series 2 (Patient Number 17)

Complete weight bearing was allowed at 3 months post operatively. Monthly follow-up was done for first 6 months and thereafter for 2 months. Radiographs were taken at every visit and compared for signs of union. Once union was confirmed the implant was removed. Mean time for implant removal was 7 months for fractures with minimal comminution and up to 1 year for gross comminuted fractures. Range of movement of knee and ankle were not affected in middle 3rd fractures of tibia. Out of the 9 proximal fractures of tibia, 3 had excellent range of motion compared to opposite limb. Five cases had good range of motion (full range of extension but with 30 degrees of flexion lag). This may be accounted to the application of spanning external fixator initially and 1 case had poor result. Out of 5 distal tibial fractures one had excellent result comparable to normal limb, 4 had good result with 10 to 20 degrees of loss of ankle dorsiflexion and with complete plantar flexion. All the fractures are followed up for a mean period of 16 months. The mean fracture healing time was 23 weeks. Union time lagged with the site of fracture with mid shaft fractures taking longer time (2 weeks) when compared to the lower third fractures which further lagged over proximal third fractures by 2 weeks (Table-5).

Mean Duration of Fracture Union	Duration in Weeks
Proximal tibia	20
Shaft tibia	24
Distal tibia	22

Table 5. Time for Fracture Union

Complications developed in 6 patients. Most common complication was superficial infection at pin site in four patients. One patient developed non-union and one developed adjacent joint stiffness. (Table-6). All the superficial infections healed with regular pin site dressing, and oral antibiotics. None needed implant removal.

Complications	No. of Patients
Non-union	1
Infection (superficial)	4
Infection (deep)	0
Screw or plate breakage	0
Stiffness of joints	1

Table 6. Complications

Two patients one with proximal tibial fracture treated with external locking plating and one with distal tibial fracture treated with external locking plate were depicted in serial photographs showing clinical radiological and range of movements achieved were shown in figures series 1 and 2.

DISCUSSION

Jingwei Zhang, et al in their study of 116 patients treated with external plating found considerably less operating time (mean 42 minutes). There were no complications in their study. They opined that external plate fixation was effective for tibial fractures and more so if they were metaphyseal.[1] Shrinivas Prabhuand Binayak Ray in their study reported a mean healing time of 18.42 weeks and two delayed unions. They used this technique for open tibial fractures.[2] with the present study we report a mean healing period of 22 weeks for tibial fractures we also found that mid shaft fractures took a mean 2 weeks longer for union. We report a non-union in the present study. Win Min Thein et al in their study concluded that the outcome of LCP as external fixator was comparable to traditional external fixators.[3] Cronier P, Pietu

G, Dujardin C et al. described the difference between the locking and non-locking plate bio mechanics with a simple analogy fixing each to an apple and then loading them with 47 Kg man.[4] Bhandari M et al re confirmed the role of locking plates in their survey regarding Surgeons' preferences for the operative treatment of fractures of the tibial shaft.[5] Ma CH, Tu YK, Yeh JH, Yang SC, Wu CH et al used a two stage procedure for fixing compound tibial fractures and demonstrated a mean union time of 23 weeks which was similar to the present study.[6] Tejwani et al studied high energy trauma to upper tibial fractures and treatment options and decision making and supported a staged procedure with an initial external fixator and later by definitive fixation by MIPPO technique.[7] We have performed both single stage procedures and double staged procedures depending on the severity of injury. We observed load sharing during weight bearing which stimulate the developing callus until bony union with super cutaneous plating. Multiple locking holes in the metaphyseal region of the pre con-toured plates provided more stability compared to the standard two large conventional external fixator pins. Ahmad et al in their bio mechanical study concluded that at a distance greater than 5 mm from bone to LCP the plates performance was decremental. This shows that when LCP was used as an external fixator it works on par with an external fixator hence the equivalent results.[8] In the present study the distance between bone and plate constituted the thickness of the soft tissue covering the bone plus two cm to allow for proper wound care of the stab incisions /portals for locking screws. This allowed no chance of deep seated infection and it may flare up with definitive fixation after removal of external locking plate by keeping the external locking plate for >3-4 months in a single stage procedure. In traditional external fixator application fracture can be aligned even after passing Schanz pins. Adjusting the fracture fragments into reduction is easy in it. But in an external locking plate, the constraint is that the fracture should be anatomically reduced before fixing the plate, as the locking plate construct will not allow further reduction of fracture fragments once the screws are locked into the plate.

Panda Shakti S., Panda Damodar and Suri Nikhil in their study at rural medical college Loni India found high rates of union in their ten cases which were applied locking plates as external fixators for distal femoral and proximal tibial compound juxta articular fractures. They concluded that their study was with low complication rate as there was no extra dissection associated with the surgical procedure.[9] Sandeep Kalia and Shalini Sharma in their study of 23 patients with compound tibial fractures fixed with supra cutaneous plating opined that the technique of supra cutaneous plating to be simple when compared to bulky external fixation.[10]

CONCLUSIONS

External plating has good patient compliance as it is comfortable, convenient, and can be easily covered by the trousers due it being a less bulky construct. They have a low profile, and hence, need less space for clearance and hence, are less likely to hit the opposite limb in swing phase of gait cycle. It can be easily removed under local anaesthesia. The learning curve of this technique is less steep than conventional locking plating.

Financial or Other Competing Interests: None.

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