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Research Article

CLINICAL FOLLOW-UP STUDY ON THE MANAGEMENT OF COMPLEX METAPHYSEAL FRACTURES OF THE TIBIA WITH HYBRID EXTERNAL FIXATION

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ABSTRACT

Background and objectives:

The difficulty in treating the fracture of tibial metaphysis is exemplified by orthopaedists. Since there was no definitive protocol for the treatment of such fractures, the Hybrid External Fixator seemed suitable for such fractures as they combine the advantages of monolateral and circular fixation. It allows early weight bearing and movement of the knee and ankle at all times.

Methods:

Fifty patients with tibialmetaphyseal fractures were studied from June 2014 to October 2016 in our institution and followed up for a period of 6-24 months. Results assessed based on IOWA scoring.

Results:

6 patients were lost to follow up before removal of the fixator and 4 patients were lost to follow up after removal of external fixator thus not included in the statistics. All the fractures consolidated at an average of 14 to 16 weeks and the fixators were removed. All but one of the studied fractures resulted in good union. Two cases had delayed union (one proximal and one distal tibia) which resulted in union after bone marrow injection and one case of non-union distal tibia resulted in union after bone grafting. Results according to the IOWA score (knee and ankle for proximal and distal fractures) proximal fractures showed 3(15%) excellent, 12(60%) good and 5(25%) fair results and distal fractures showed 3(15%) excellent, 14(70%) good and 3(15%) fair results.

Interpretation and conclusion:

Hybrid external fixator is simple, rapid and straightforward application, reduced surgical time, minimally invasive and adjustable. It has negligible complications and resulted in excellent results for this type of fractures.

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INTRODUCTION

Intra-articular and extra-articular fractures of the proximal tibia present a wide spectrum of soft tissue and bony injury patterns that can produce permanent impairments. For patients treated operatively the residual disabilities are not only attributable to the severity of the injury, but also to the complications and side effects of the operative intervention. Open fractures, fractures accompanying a compartment syndrome and fractures associated with vascular compromise usually require immediate intervention.¹

Distal tibial fractures represent a significant challenge to most of the surgeons even today. They are only 1-10% of all fewer extremity fractures². The low energy type of fractures often get dramatic results with open reduction and internal fixation. But high energy fractures are documented to show a high amount of

complications due to soft tissue coverage, skin necrosis, infections and also the usually comminuted nature of the fractures.³

Conservative treatment by cast application lead to prolonged immobilization, leading to joint stiffness affecting quality of life of the patient⁴. Introduction of the external fixator was a revolution in the evolution of management of fractures. It has undergone a sea of change from a simple frame to a more complex frame and various pin arrangements.

The Hybrid External Fixator combines the advantages of the monolateral pin fixators and the circular Ilizarov wire fixators. The tensioned wires provide improved fixation in the small cancellous fragment, whereas the pin fixators give adequate stability to the diaphyseal fragment. It is simple, has a rapid and straight forward application, reduced surgical time and is

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minimally invasive. It is adjustable, hence fracture reduction can be easily attained after frame assembly⁵. Along with rigid fixation, it allows immediate mobilization of the joints and early weight bearing "Early motion has been touted as the functional savior of major intra articular injuries"⁶.

Aims and objectives

To study the functional outcome and duration of union following the use of hybrid external fixation for complex tibial metaphyseal fractures (proximal and distal).

MATERIAL AND METHODS

A prospective study of 50 patients with complex tibial metaphyseal injuries which were treated with Hybrid external fixator at two Hospitals attached to J.J.M Medical College Davangere, Karnataka, India between June 2014 to October 2016. Patients with Segmental fracture, pathological fracture and fracture before physeal closure were excluded. Soft tissue injury in closed fractures was graded according to the Tscherne classification. Patients with open fractures were graded using the Gustilo Anderson classification for open fractures.

Operative Procedure

Type of Anesthesia- Lumbar Sub Arachnoid Block Position-supine with affected leg elevated on a pillow/sand bag for distal end fractures and with a pillow under the distal thigh for proximal end fractures.

Securing the peri-articular fragment

- After reduction of the peri-articular fragment, it was secured using three Ilizarov wires. The wires were pushed manually till it hit the cortex, then drilled across both the cortices and hammered out through the opposite soft tissue.
- Olive wires were used if it was deemed necessary the compression of the longitudinal split was desired. Else bayonet tipped or trocar tipped wires were used.
- The first wire was passed parallel to the joint in a lateral to medial direction under fluoroscopic control. It is fixed to an appropriate size ilizarov $\frac{3}{4}$ ring so as to leave at least 2cms between the leg and the ring on all sides.
- One wire each from posterolateral to anteromedial and posteromedial to anterolateral under fluoroscopic control keeping an angle of 30 to 60 degrees between the wires.
- The axial plane of the wires was about 5mm from the joint and as parallel to it as possible. If any internal fixation using cancellous screws was deemed necessary it was done before passage of the wires.
- The wires were fixed to the rings using cannulated/slotted wire connecting bolts and tensioned using a dynamometric tensioner.
- Skin traction by the wires, if any were released using minimal incisions on the side of the skin stretching

Securing the diaphysial fragment

- The regular tibial external pin fixator was used for the diaphysial fracture fragment three 4.5mm Shanz pins

were placed 3-4cms apart on the antero-medial surface of tibia perpendicular to the operating table.

- Generous (1-1.5cms) incisions were put and skin and fascia was cut.
- Drill holes were made using 3.2/3.5mm drill bit in the same saggital plane. The Shanz pins were driven into the drill hole using a T-Handle to the extent
- that the proximal end of the threads of the pin were well buried in the proximal cortex.
- All the pins were placed in the same saggital plane. The pins were connected to the connecting rods with the pin clamps.

Fracture reduction and frame assembly

- Fracture reduction was obtained using longitudinal traction (Ligamentotaxis), confirmed using the image intensifier.
- The pin fixator assembly was connected to the ring assembly using a twisted connecting plate.
- All nuts and bolts were tightened.
- One or two diagonal struts was connected from the proximal Shanz pin or the connecting rod to the lateral and/or the medial half of the ring for extra stability.
- The compound fractures were treated with primary or secondary flap reconstructions or split thickness skin grafting as deemed suitable by the plastic surgeon
- Patients with extra articular fractures were encouraged to bear weight as early as possible where as those with intra articular fractures were allowed to bear weight after a minimum of 6 weeks after the fixator was applied.

Post operative regimen

- Active mobilization of the ankle, knee and non-weight bearing of the patient using standard walking frame was done from the first post operative day under the supervision of a physiotherapist.
- Intravenous antibiotic regimen was continued for 5-7 days (12-14 days in compound fractures) after the surgery. Another 5 days of oral antibiotics were advised. Regular cleansing of the pin exit points was done. Compound fractures were dressed as per instructions from the plastic surgeon.
- Patients with extra articular fractures were encouraged to bear weight as early as possible where as those with intra articular fractures were allowed to bear weight after a minimum of 6 weeks after the fixator was applied.
- Patients were followed up at 6 weekly intervals until fracture union and at once at the end of 12-16 months. The scoring system used in this study was the Iowa knee /ankle score according to the location of the fracture.

RESULTS

The present study consists of 50 cases of metaphyseal fractures of the tibia. 10 patients were lost to follow up and not included in the analysis.

The age of the patients ranged from 26-62 with a mean age of 41.6 years among which 32 (80%) patients were males and 8 (20%) patients were females. 31 (77.5%) of patients sustained injury following road traffic accident and 9(22.5%) patients sustained injury following fall. Out of the 40 cases, 24 (60%) cases were closed fractures and 16(40%) cases were open fractures. Classification of the 16 cases of open fractures based on Gustillo Anderson classification of open fractures, 3 (19%) were type I compound, 7 (44%) were of type II compound, 4(25%) were type IIIA and 2(13%) were type IIIB. All patients with closed fracture had some form of soft tissue injury classified according to Tscherne classification among which 4(17%) patients had C1 injury, 17(71%) had C2 injury and 3(13%) had C3 injury.

The fracture pattern was classified based on AO/OTA classification for fractures of distal tibia of the 20 cases studied, 7 (35%) cases were A1, 7(35%) were A3, 4(20%) were C1 and 2 (10%) case was C3 type of fracture.

The fracture pattern was classified based on AO/OTA classification for fractures of proximal tibia of the 20 cases studied, 2(10%) cases were A1, 8(40%) were A3, 6(30%) were C2 and 4 (20%) cases were C3 type of fracture.



Figure 1 A case of Proximal Tibia Fracture treated with HYBRID EX-FIX, A)PreOperativeXray, B)Immediate Post Operative, C)At 3months Post Operative, D) At 6monthsPost Operative E) At 1yr follow up



Figure 2 A case of Distal tibia Fracture treated with HYBRID EX-FIX, A)PreOperativeXray, B)Immediate Post Operative, C)At 3months Post Operative, D) At 6monthsPost Operative E) At one year follow up

Table 1 Comparison of results of the present study with various other studies

	Mean Age (yrs)	Sex %		Mode of Injury %		Clinical Type		Union in weeks
		Male	Female	High Energy	Low Energy	Closed fracture	Open fracture	
Gardinez et al ⁷	35	67	33	93	7	21	79	18
Barbieri et al ⁸	39	59	41	75	25	30	70	13
Kumar et al ⁹	44	72	28	87	13	39	61	24
Wrysh et al ¹⁰	39	69	31	-	-	26	74	15
S.K.Venkatesh Gupta ¹¹	40	67	33	-	-	35	65	Proximal-14.4 Distal -14.9
Present Study	41	80	20	78	22	40	60	Proximal- 14.9 Distal- 14

The fractures of the proximal tibia united with an average of 14.9 weeks (13-26 weeks). There were two cases of delayed union which united with bone marrow injections and the fractures of the distal tibia united with an average of 14 weeks (12-16weeks). There were no cases of delayed union or non-union.

Among the 20 cases of proximal tibia fractures treated with Hybrid external fixator, according to Iowa knee and Ankle Scoring 3 (15%) had excellent results, 12 (60%) had good results and 5 (25%) had fair results.

Among the 20 cases of distal tibia fractures treated with Hybrid external fixator, according to Iowa knee and Ankle Scoring 3 (15%) had excellent results, 14 (70%) had good results and 3 (15%) had fair results.

Complications

Among 20 patients treated for proximal tibia fractures, 3(15%) patients had knee stiffness, 2(10%) patients had delayed union and 4(20%) patients developed pin tract infection.

Among 20 patients treated for distal tibia fractures, 5(25%) patients developed pin tract infection, 1 (5%) had delayed union and 3(15%) had ankle stiffness.

DISCUSSION

Metaphyseal fractures of the tibia are among the most difficult fractures to treat effectively. The status of the soft tissues, the degree of comminution and articular damage sustained at the time of injury affect the long term clinical results. The goal of operative treatment is to obtain anatomic realignment of the joint surface while providing enough stability to allow early motion. This should be accomplished using techniques that minimize osseous and soft tissue de-vascularization in the hopes of decreasing the complications resulting from treatment. The present study was under taken to determine the efficacy of the Hybrid External Fixator in treatment of the fractures of the tibial metaphysis. We evaluated our results and compared them with those obtained by various other studies.

There are more than one modalities of treatment for these kind of fractures which are also in study phase but compare to other studies done for this kind of fractures this study shows similar results and better outcome functionally as well as radiologically after 1 year follow up, less post-operative complications and early mobilization¹².

This is a simple & user friendly technique. This frame fixation does not require meticulous pre-operative work like that required in Ilizarov technique^{13,14,15}.

Since the hematoma is not touched / opened, this technique promotes biological healing of the fracture. Less incidence of soft tissue or bone necrosis, results in less morbidity. Post-surgery changes in alignment were possible in the frame. Incidence of knee stiffness can be significantly reduced by early mobilization of the knee. It is good technique for fixing comminuted prox. third - distal third fractures, tibial plateau, and tibial plafond fractures with reasonably good functional outcome.

CONCLUSION

Hybrid external fixator is simple, rapid and straightforward application, reduced surgical time, minimally invasive and adjustable. It has negligible complications and resulted in excellent results for this type of fractures. Although, a larger sample of patients and longer follow up are required to fully evaluate this method of treatment, we strongly encourage its consideration in the treatment of such complex fractures.

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