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A prospective study on surgical management of complex proximal metaphyseal fracture of tibia with hybrid external fixation

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Abstract

Background and Objectives: Fracture of Tibia shaft are the most common long bone fractures. The difficulty in treating the fracture of tibial metaphysis is exemplified by orthopaedists, who in the first half of 20th century, believed the injuries were so severe and operative repair was fraught with so many complications that the fracture was deemed not amenable for surgical reconstruction. 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, Tensioned wires provide improved fixation in the peri-articular fragments. It allows early weight bearing and movement of the knee and ankle at all times.

Methods: A Prospective study of 51 cases of surgically managed fractures of proximal Tibia using Hybrid External fixation undertaken at Department of Orthopaedics, J.J.M Medical College, Davangere from 1st June 2017 to 30th August 2020 who follow Inclusion and Exclusion criteria and followed up for a period of 6-24 months.

Results: 9 patients were lost to follow up before removal of the fixator and were thus not included in the statistics. All the fractures consolidated at an average of 14 weeks and the fixators were removed. All but one of the studied fractures resulted in good union. Two proximal tibial fracture resulted in non-union. 14 patients developed pin tract infections which resolved with regular dressings. 10 patients had stiffness of the knee joint. This was probably due to the patient in compliance to the physiotherapy regimen. 4 cases had delayed union which resulted in union after bone marrow injection and 2 case of non-union. Results according to the Iowa score of knee showed 5(12%) excellent, 32 (76%) good and 5(12%) 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.

Keywords: Metaphyseal proximal tibial fractures, hybrid external fixators

Introduction

Proximal tibia fractures are usually caused by high energy mechanisms ^[1]. 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. Because many fractures of the proximal tibia are caused by high-energy mechanisms, a careful evaluation of the entire patient must be done before the tibial injury is addressed. In proximal tibia high energy fractures with bad soft tissue, open fractures or severe comminuted fractures often force a surgeon to look for alternative methods of fixation of fracture like ring fixator or tubular external fixator as soft tissue stripping is not feasible under such circumstances due to high chances of wound break down and infection ^[2]. The recent advances in an external fixation systems including hybrid fixator and their use in proximal tibial fractures has shown promising results ^[3]. Open fractures, fractures accompanying a compartment syndrome and fractures associated with vascular compromise usually require immediate intervention ^[4]. 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 [5]. Conservative treatment by cast application lead to prolonged immobilization, leading to joint stiffness affecting quality of life of the patient [6]. Introduction of the 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 minimally invasive. It is adjustable, hence fracture reduction can be easily attained after frame assembly [7]. It is safe, versatile and effective in providing stability and has minimal impact on underlying soft tissues. It also facilitates early knee motion thus achieving optimal knee function [8]. Literature widely supports the use of hybrid external fixator as a definitive management in these complex fractures, where soft tissue compromise may limit open reduction as a modality [9].

Material and Methods

A Prospective study of 51 cases of surgically managed fracture of proximal tibial metaphyseal using Hybrid ex-fix undertaken at Department of Orthopaedics, J.J.M. Medical College, Davangere from 1st June 2017 to 30th August 2020. Inclusion criteria: Adults aged >18 years of age, patients present with simple metaphyseal fractures of the proximal tibia unsuitable for interlocking nailing and Complex metaphyseal fractures of the proximal tibia. Exclusion criteria are Patients aged below 18 years. Patients unwilling to undergo surgery, Patients medically unfit for surgery.

Surgical Technique

Instruments and Implants

Ilizarov half rings, 5/8 rings, Bayonet edged Ilizarov wires-plain/olive, Slotted/cannulated wire connecting bolts, Twisted connecting plates, 4.5mm Schanz pins, Pin clamps, Connecting rods, Nuts and Bolts, 3.5 mm drill bits, T-handle, 10/11 wrenches, 3.5mm drill sleeves, Wire bender/cutter, General instruments.

Operative Procedure

Type of Anesthesia-Lumbar Sub Arachnoid Block

Position-supine with affected leg elevated 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.
- Nerves and vessels were avoided by the awareness of the anatomy, based on the safe corridor for pin insertion in the lower leg.
- 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 ¾ 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 Schanz 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 Schanz 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 Schanz 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.

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. 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 1 year. The fracture was said to united when there was bridging callus at the fracture site at least in three cortices in the anteroposterior and lateral views. Trabeculations extending across the fracture site was also taken into consideration. The scoring system used in this study was the Iowa knee according to the location of the fracture.

40 years/M Left proximal 1/3rd tibia fracture**Result**

The present study consists of 51 cases of metaphyseal fractures of the proximal tibia. 9 patients were lost to follow up before removal of the fixator and were thus not included in the statistics. The age of the patients ranged from 23-62 years with the fracture being most common in the 4th decade and an average age of 40.6 years. Out of 42 patients, 32 (76%) patients were males and 10 (24%) patients were females showing male preponderance. In our study, 35 (83%) of patients sustained injury following road traffic accident and 6(14%) patients sustained injury following fall. There was 1 patient (3%) with a firecracker injury. Out of the 42 cases, 24 (57%) cases were closed fractures and 18(43%) cases were open fractures. Open fractures: Classification of the 18 cases of open fractures based on Gustillo Anderson classification of open fractures, 4 (22%) were type I compound 8 (44%) were of type II compound, 3(17%) were type IIIA and 3(17%) were type IIIBAll. All patients with closed had some form of soft tissue injury 8(33%) patients had c1 injury, 13(54%) had c2 injury and 3(13%) had c3 injury according to Tschern classification. The fracture pattern was classified based on AO/OTA classification for fractures of proximal tibia of the 42 cases studied, 6 (14%) cases were A1, 14(33%) were A3, 14(33%) were C2 and 8 (20%) cases were C3 type of fracture. The duration of surgery ranged from 40 to 70 minutes for the proximal tibia averaging 51 minutes. The fractures of the Proximal tibia united with an average of 14.42 weeks (13-22weeks). All the fractures consolidated at an average of 14 weeks and the fixators were removed. Four cases had delayed

union which resulted in union after bone marrow injection and two case of non-union. The results were based on the objective and subjective parameters as described by TC Merchant and FR Dietz ^[10] in the Iowa scores for the knee for proximal tibial fractures showed 5(12%) excellent, 32 (76%) good and 5(12%) fair results.

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 devascularization 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 proximal tibial metaphysis. We evaluated our results and compared them with those obtained by various other studies.

Our study revealed the average age of patients with such injuries to be 40.6 years Range 23 to 62 years whereas a study by Guadinez *et al.* ^[11] found the average age was 47years. In our study, the male preponderance for such kind of injuries were high 76% compared to the study by Kumar *et al.* ^[12] which was 72%. Agarwal *et al.* ^[13] observed 87% high energy fractures in his study whereas our present study has 83% of

high energy fractures. Our study had 43% open injuries. This was comparable to studies conducted by Kumar *et al.* [14] had 39% and Guadinez *et al.* [15] has 21% of open injuries. 57% patients in the present study had soft tissue injuries associated with the fracture. They were classified according to Tschern. The number of patients with c2 and c3 injuries are similar to those in Zeman *et al.* [14] study but the number of c1 injuries in the present study are higher in number. Our study had an average fracture union of 14 weeks which were comparable with studies conducted by Kumar *et al.* [12] had an average of 24.7 weeks and Guadinez *et al.* [11] had an average of 18 weeks. There were 6 excellent, 30 good and 6 fair results. There were 14 cases of pin tract infection (33%), 10 cases of knee stiffness (24%), 4 cases of delayed union (9.5%) which required bone marrow injection, 2 case of non-union (4.7%) and 2 case of wire breakage (4.7%). Pin tract infection resolved in all patients with regular dressings.

Conclusion

According to the study, 42 patients with fractures of the Proximal tibial metaphysis had undergone closed reduction and application of the hybrid external fixator. This technique has resulted in the effective stabilization of these fractures. It does provide adequate stability and allows early motion. The closed reduction not only helps in achieving reduction in difficult situations, but also in rapid union, because it facilitates preservation of blood supply to the fragment. This method limits further damage to the already compromised soft tissue. Its greatest advantage is in open fractures where wounds can be left open. It is also effective in extraarticular fractures occurring within 5cm of the joint because, intramedullary nails often do not provide enough stability and plates would require extensive soft tissue dissection. It is a simple, has a rapid and straight forward application and has a reduced surgical time. Tensioned wires provided unproved fixation in small and osteoporotic fragments. When encountered with the unreconstructable tibial metaphyseal fracture, those with comminution or poor bone stock, closed reduction and Hybrid External Fixator satisfies the goals of fracture and soft tissue healing, without obviating any other means of further treatment. 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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