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Role of hybrid external fixator in proximal tibial fractures: A prospective analysis

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Abstract
Introduction: The proximal tibial fractures are associated with high energy trauma and present with difficulty in treatment due to poor skin condition. In our study, we have operated 32 patients with hybrid external fixator for definitive treatment of these fractures. This technique gives good reduction, adequate stability, early mobilization and less complications.
Aim: To assess the functional and radiological outcome after application of hybrid external fixator in proximal tibial fractures.
Material and Methods: Prospective analysis of 32 patients was done with proximal tibial fractures classified according to Schatzker classification in our institute who were treated by application of hybrid external fixator.
Results: In our study, Road traffic accident was the most common mechanism of injury (n=23). There was a male preponderance (n=23) in our study. The mean age was 39.2±11.0 years. Functional and radiological outcome was assessed using Rasmussen functional and radiological criteria at final followup. 16 patients had an excellent functional outcome and 13 patients had excellent radiological outcome. Superficial pin tract infection was seen in 4 patients which healed uneventfully. Varus malalignment was seen in 2 patients.
Conclusion: Hybrid external fixator is a simple way to treat proximal tibial fractures with a low complication rate and good clinical outcomes.

Keywords: Proximal tibia, hybrid fixator

1. Introduction
Tibial plateau fractures are the commonest intra-articular fractures. They occur as a result of indirect coronal or direct axial compressive forces. They comprise about 1% of all fractures and 8% of the fractures in elderly. Most injuries affect lateral tibial condyle (55 to 70%) and isolated medial condyle fractures occur in 10 to 23% whereas the involvement of bicondylar lesions is found in 10 to 30% as reported in many series [1] With the increasing incidence of road traffic accident and high velocity trauma the incidence of this fracture is on a rise. With modern diagnostic procedures like computerized tomography with 3 Dimentional reconstruction the various fracture patterns have been widely studied and described [2] These fractures represent a wide range of severity ranging from simple fractures which can be treated conservatively with predictable outcomes and complex fracture patterns which challenges even an experienced surgeon. The various fracture patterns comprise lateral condyle or medial condyle fractures or both. Also there can be a split or depression in the articular surface. Various classifications have been developed to study the various fracture pattern and to treat them accordingly. The associated soft tissue injury is quite common with this fracture in form of compound fractures, deep abrasions, blistering and neurovascular injury which change the course of treatment and pose a major problem for the treating surgeon [6]. Associated meniscal and ligamentous injury also pose a problem for the treating surgeon [3]. Due to a better understanding of biomechanics, quality of implants, principles of internal fixation, soft tissue care, antibiotics and asepsis have all contributed to the radical change in the way we perceive these fractures. Because of the type of trauma involved and the relatively high frequency of major soft-tissue injuries the complication rate is high, regardless of treatment. Operative management of the tibial plateau fractures include internal fixation with plate and screws, external fixator or hybrid external fixator [5].

In our study we discuss the use of hybrid external fixator in proximal tibial fractures and the functional and radiological outcome using this procedure.

2. Material and methods

The study was conducted in department of orthopedics, Dr. S.N. medical college, Jodhpur over a period of 10 months ranging from March 2016 to December 2016.

A total of 32 patient who were operated with hybrid fixator for proximal tibial fractures were included in the study. All the relevant data was collected with regular followup of the patients. Both closed and compound injury patients were included in the study. Patients with ipsilateral femoral fractures were excluded from the study.

All patients with proximal tibial fractures were admitted and a thorough workup was done. X-rays of the knee with upper tibia in both AP and lateral views were taken in all patients and were assessed for associated injuries.

Toileting of all compound fractures was done with 2 litres normal saline and were started intravenous antibiotics. Soft tissue status of all closed fractures were assessed. Per operative workup included complete hemogram, blood sugar, electrolytes, chest x ray and viral markers (HIV, HBsAg, HCV) were done in all patients.

Pre anaesthetic checkup was done in all patients one day prior to surgery. Pre-operative intravenous antibiotic (Inj. Ceftriaxone 1 gram) was given to all patients on day of surgery. All surgeries were performed under spinal anaesthesia. Intra-articular reduction was first done by closed method or by minimal incision.

2 olive wires were inserted parallel to the joint line, one from posterolateral aspect and other from posteromedial aspect, both exiting anteriorly forming an angle of >60 degrees between them. Half ring was attached to rings and the olive wires were tensioned with tensioner. 2 schanz pins were inserted in the tibial shaft and was attached to the ring in cantilever fashion to provide maximum stability. Whole procedure was done under fluoroscopy guidance. Knee bending and quadriceps exercises were started from 2-5 post-operative day. Sutures if any were removed on 10th post-operative day. Patients were kept non weight bearing till signs of union were visible on x-rays.

The fixator was removed after 2 months and weight bearing was started. Patients were followed up for 6 months and were assessed by Rasmussen functional and radiological scoring.

3. Observation and results

Statistical analysis was done using epiinfo version 7. A p value of <0.05 was considered significant.

There were a total of 32 patients in our study. The mean age of the patients was 39.2±11.0 years. There were 23 male patients (71.8%) in our study. 25 patients (78.1%) had an open injury. Road traffic accident was the most common mechanism of injury in our series with 23 patients (71.8%), 8 patients had history of fall and one patient had bullet injury. Schatzker classification was used to classify the fractures with 8 patients of type 3, 10 of type 5 and 14 of type 6. Early knee bending was started in all patients with a mean of 3.1+1.1 days. The knee bending was slightly delayed in patients with type 6 fracture pattern with a mean of 3.4±1.1 days. (Table 1) Weight bearing was started after removal of fixator and had a mean period of 8.9±1.3 weeks. Weight bearing was delayed in Schatzker type 6 fractures with a mean of 9.5±1.6 weeks and was significant (p<0.05). Mean range of motion achieved at final followup was 107.6±11.4 degrees. Type 3 fractures had the best range of motion with a mean of 114.3±7.2 degrees. Two patients with schatzker type 6 fractures had an extensor lag of 10 degrees. (Table 1)

The functional assessment was done with help of Rasmussen functional criteria, with 16 patients having excellent functional outcome, 13 patients had good functional outcome and 3 patients had fair functional outcome.

The radiological union was assessed using the Rasmussen radiological criteria, 13 patients had excellent radiological outcome, 16 patients had good radiological outcome and 3 patients had fair radiological outcome. Superficial pin tract infection were seen in 4 patients which were healed with oral antibiotic therapy. One patient developed deep infection which required redebridement and was subsequently healed. No incidence of peroneal nerve injury was seen. Knee joint laxity was observed in 2 patients but the patients had no functional knee instability. Varus malalignment was seen in 2 patients.

Table 1: Stratification of various factors according to Schatzker classification

	Schatzker type 3	**Schatzker type 5**	**Schatzker type 6**	**P value**
Mean Age				
	37.0±8.8	35.7±7.3	43.1±13.5	0.2
Gender				
Male	3	7	13	0.02
Female	5	3	1	
Mean Knee bending started (post operative day)				
	2.5±1.0	3.3±1.0	3.4±1.1	0.05
Post operative weight bearing (in weeks)				
	8.2±0.7	8.6±0.9	9.5±1.6	0.05
Mean range of motion at final followup				
	114.3±7.2	109.0±11.0	102.8±12.2	0.36
Mean Rasmussen functional status				
	28.5±1.3	26.8±2.6	26.5±1.9	0.19
Rasmussen functional status				
Excellent	7	5	4	0.12
Good	1	4	8	
Fair	0	1	2	
Rasmussen Radiological Union				
Excellent	4	4	5	0.84
Good	4	5	7	
Fair	0	1	2	
Poor	0	0	0	

Fig 1: Pre operative x rays showing Schatzker type 6 proximal tibia fracture

Fig 2: Post operative X-rays

Fig 3: Follow op range of motion prior to remval of fixator

4. Discussion

Tibial plateau fractures are commonly seen in the active productive age group (31-50 years) due to high-energy trauma as reported in many studies. Majority of the patients involved were males due to road traffic accident being the most common cause of injury. Internal fixation of fractures despite the advantages of direct visualization, proper reduction of the articular surface as well as repair of soft tissue injuries, also has serious disadvantages, including skin or soft-tissue necrosis caused by surgical manipulations on an already damaged soft-tissue envelope and a high rate of infection, which compromises the final result [4]

Tscherne *et al*, comparing the results of surgical versus conservative treatment for tibial plateau fractures, reported improved range of motion, decreased percentage of malunion and 5% reoperation rate for the surgical group [29].

Stevens *et al*, presented several transoperative - postoperative complications [30], while Young and Barrack, in their series of dual plating for complex bicondylar tibial plateau fractures reported an 88% deep infection rate [31,32].

External fixator and hybrid fixator as a definitive method of treatment in literature. Though certain authors recommend this mode of treatment as a temporary mean of fixation. With the development of circular and hybrid frames, the capability of axial, lateral compression, the development of olive wires have offered new possibilities to the treatment of complex proximal tibial fractures.

The application of the fixator has a simple technique reducing the surgical time. Most unicondylar tibial fractures are caused by varus or valgus load. In bicondylar fractures, there is also axial loading resulting in a combination of depression of the articular surface, metaphyseal crush and shearing of one or both condyles. Vertical displacement is possible because there is no shaft below the fragments thus creating a shear vector. With the “olive wires” in the hybrid fixator these forces are counteracted, holding the two condyles together, which creates a relatively stable joint surface configuration that can be fixed to the tibia distally of the fracture. Mahadeva *et al*, comparing external to internal fixation, concluded that hybrid external fixation possesses theoretical advantages in terms of the soft tissues protection; however the benefit over internal fixation is modest as far as accuracy of reduction is concerned [7].

Chin *et al* presented 38.9% good/excellent, and 61.1% fair/poor results in his type V and VI fracture series [8]. Catagni *et al*, in their series of high-energy Schatzker V and VI tibial plateau fractures treated with circular external fixator, reported excellent and good results in 30 (50.85%) and 27 (45.76%) patients respectively [9] Our study has reported excellent results in 50% of the patients.

Parameswaran *et al* [10] reported that ring fixators had the lowest incidence of infection. Using the Ilizarov technique, Catagni *et al* [9] did not report any deep infections in their case series of 59 patients with Schatzker V-VI fractures. Our study reported superficial infection in 4 patients and deep infection in one patient which healed uneventfully.

Knee stiffness is a common problem after proximal tibial fractures. With the application of hybrid fixator and early knee mobilization excellent range of motion is achieved with a mean of 107.6±11.4 degrees. Mikulak *et al* also reported excellent range of motion using ring fixator.

The mobilisation and degree of weight-bearing that is allowed is determined by the fracture displacement, method of treatment, and quality of aftercare.

The fixator is applied by closed or mini open techniques resulting in no or minimal blood loss. With the fracture haematoma not disturbed the union rates are higher and low incidence of infection [11]

Excellent functional criteria in follow up also denotes that the fixator is well tolerated by majority of patients. 2 patients in our study had varus malalignment in followup which is comparable with other studies.

5. Conclusion

With our study, we have found that hybrid external fixator is an acceptable method for definitive fixation of proximal tibial fractures. With lower rate of infection, good range of motion, early mobilisation and good functional outcomes it can be used as a preferred mode of treatment in proximal tibial fractures especially in high energy trauma where the skin condition is compromised and also in open fractures.

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