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Functional Outcome of Complex Tibial Plateau Fractures Treated With Hybrid External Fixation

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ABSTRACT

***BACKGROUND**: High energy complex tibial plateau fractures present a surgical challenge to the orthopaedic surgeon. Over the years, treatment has ranged from cast immobilisation to open reduction and internal fixation .More recently, minimally invasive indirect reduction techniques with percutaneous internal fixation augmented by small wire external fixation frames have been used to reduce devastating complications of open reduction and internal fixation of complex tibial plateau fractures*

***OBJECTIVE**: The purpose of this study was to assess the functional outcome of complex tibial plateau fractures treated with hybrid external fixation.*

***METHODS**: The results of treatment of 26 knees were reviewed over a period of 30 months from August 2012 to December 2015. Patients were operated surgically, by the hybrid external fixation techniques. Patients were reviewed after 1, 3 and 6 months and functionally and radiologically assessed for outcome.*

***RESULTS**: Results were graded as excellent, good, fair and poor on basis of knee society scoring system. 18 patients (69.3%) had excellent outcome, 6 patients (23.1%) had good outcome, 1 patient (3.8%) had a fair result and 1 patient (3.8%) had poor result. The mean union time of fracture was 4 months and only 1 patient (3.8%) underwent secondary procedure for non-union.*

***CONCLUSION**: Hybrid external fixation is a very effective and useful treatment modality in complex high energy tibial plateau fractures with marked soft tissue damage. This combined minimally invasive internal fixation and external fixation technique provides excellent to good results in most of complex tibial condylar fractures. Minimal soft tissue dissection and early knee range of motion are the most attractive features of hybrid external fixation.*

KEYWORDS : Tibial Plateau, hybrid external fixation, knee society score, union

INTRODUCTION

Intra articular fractures of proximal tibia, the so called tibial plateau fractures are serious, complex injuries difficult to treat. Comminuted tibial plateau fractures are a surgical challenge to the orthopaedic surgeon[1]. Tibial plateau fractures caused by low energy mechanism of injury can be treated with traditional internal fixation using cancellous screws, ORIF with plates, MIPPO techniques or arthroscopic assisted techniques. However; the management of high energy complex tibial plateau fractures associated with marked soft tissue trauma is a challenging task for orthopaedic surgeon[2].These complex fractures may be associated with marked soft tissue trauma, compartment syndromes or open fractures with bone loss. Closed methods of treatment with traction or cast bracing are not useful in maintaining articular reduction and axial alignment. Traditional methods of ORIF requires extensive exposure which may compromise soft tissue further and devascularise the bone fragments and leading to infection. Attempts have been made to reduce incidence of complications in treatment of complex tibial plateau fractures by using less extensive exposures and indirect reduction techniques .The concept of HYBRID EXTERNAL FIXATION has gained wide approval in this scenario. The purpose of this study is to understand the functional outcome of complex tibial plateau fractures treated with hybrid external fixation.

MATERIALS AND METHODS:

The patients were chosen from those who presented in the emergency department of Govt. Medical College, Trivandrum and Kozhikode with clinical features suggestive of complex tibial plateau fractures. 26 patients were reviewed over a period of 30 months from August 2012 to December 2015. Patients were initially evaluated thoroughly clinically to assess neurovascular status of the limb and associated injuries like other bony fractures or visceral injuries. Diagnosis was confirmed with appropriate imaging techniques, mostly plain rontgenograms and in certain cases CT scan were also performed. And the fractures were classified according to Schatzker system[3-4]. Soft tissue status of the knee and instability were also clinically evaluated. In high energy tibial plateau fractures , there was high chance of development of compartment syndrome; it was assessed thoroughly and in doubtful cases vascular Doppler studies were performed, and emergency fasciotomy was done in certain cases. The fractures which were satisfying criteria for complex tibial plateau fractures, were included in the study. The initial management was to stabilize the fracture in a long leg slab after primary assessment (especially of the skin conditions, neurovascular status and compartment syndrome). In open fractures thorough wound washing and debridment was done and appropriate antibiotics were prescribed. In polytrauma patients ,initially resuscitated in the emergency department with IV fluids ,blood transfusions and other appropriate measures and patients were shifted to emergency theatre and performed appropriate initial management modalities like wound debridment, knee spanning external fixation for concomittent femur fractures and pelvic stabilization external fixation in patients with unstable pelvic injuries. Complex tibial plateau fractures like Schatzker type 5 & 6 with normal neurovascular status were admitted in orthopaedic ward after distal tibial or calcaneal skeletal traction with Steinmann pin. CT scan was advised in cases it was deemed necessary. The preoperative requisites like blood investigations, ECG, chest X-ray and necessary consultations including a pre anaesthetic check up by an anaesthesiologist were done before the patients posted for surgery.

In case of any comorbidities like diabetes or hypertension which requires to be controlled before surgery or in the event of severe soft tissue injury, as indicated by soft tissue oedema or blister formation, surgery was delayed.

Operative techniques

The anaesthesia used were either spinal or regional block. The objective was to reduce and fix the intra articular segment of the fracture and then attach it to the shaft. First closed reduction by ligmentotaxis either manually or using femoral distractor or the traction table was attempted in all fractures. The reduction forceps, elevators and provisional application of Steinman pin to assist in the traction were used as necessary. Once a satisfactory reduction of articular surface had been achieved by elevating the depressed fragments percutaneously under image intensification guidance, two 6.5mm cannulated cancellous screws were placed just distal to the subchondral bone to maintain the reduction and insert the transfixation olive wires safely in the extra capsular area to obtain inter-fragmental compression of the periarticular fragments [5]. Two or three 1.8 mm olive wires were used in the proximal part and connected to the proximal Ilizarov ring with the help of cannulated and slotted wire fixation nuts and bolts and properly tensioned and fixed with the ring. The proximal wires were placed 14mm inferior to the joint line to avoid intra capsular insertion and generally wires should be placed distal to the cannulated screws. All wires were inserted within the safe zone to avoid injury to neurovascular bundle, all major neurovascular structures lying in the posterior aspect of proximal tibia. The first wire was passed, transfixing fibular head with tibia from posterolateral to anteromedial tibia and second one from posteromedial aspect of tibia to anterolateral area and the third wire which is optional was passed from lateral to medial direction. Used a minimum of two wires with separating angle of atleast 60 degree and ideally all three wires should intersect at the center of tibia.[6] This configuration increases bending stiffness in the anteroposterior plane and thus better resist displacement forces.[7] Then applied two 1.8 mm olive wires or Ilizarov K wires distal to the proximal ring depending on the fracture pattern and metaphyseal communition or metaphysio-diaphysieal separation and connected to the distal Ilizarov ring and tensioned properly. Reduction of metaphysis to the diaphysis was achieved by indirect reduction technique using the fixator. The distal tibial diaphysis was fixed with three or two 4.5mm Schanz pin and these pins connected to the tubular rods with the help of AO clamps which were ultimately connected to the ring frame with the help of a male post. The whole frame was finally tightened. A thorough knowledge of the anatomy is mandatory to perform the correct placement of the wires. Wires should be positioned as proximal as possible but not through the joint surface because of the distal capsular insertion

Post-operative care

All closed fractures and type 1 open fractures were managed with intravenous cephalosporin for 2-3 days followed by oral antibiotics for 5 days. In type 2 and type 3 open fractures aminoglycosides were also added, along with other supportive medications such as antidiabetics and anti-hypertensives. Knee mobilization started as early as possible post operatively once pain had settled. A great importance was given for pin site management, especially in diabetic patients. Most of the patients were discharged 3rd or 4th post-operative day, after taking post-operative x-ray, as per wound condition and general condition of the patient. Patient were asked to review in 15 days ,1 month,3 month and 6 month post operatively in OPD for assessment clinically and radiologically. Most of the patients were started partial weight bearing in the first month itself after the clinical and radiological assessment. The frames were removed at an average of 2-3 months and few patients were managed with braces after frame removal. Full unassisted weight bearing were allowed at an average of 3 months post operatively. Each visit patients were subjected to clinical evaluation including range of movements, in addition functional and objective assessment was also undertaken using the knee society scoring system.

Fig 1: Pre-operative AP & lateral x-ray of Schatzker's VI tibial plateau fracture

Fig 2: Intra operative picture showing ring fixator with olive wires

Fig 3: Post-operative x-ray of same patient

Results:

Knee society score objective component revealed poor response in just 1 patient, 7.7% had a fair outcome, 42.3% had a good outcome and 46.2% of patients (12 patients) had excellent outcome.

Table 1.
Distribution based on objective outcome according to knee society scoring system

KSS- Objective component	Frequency	percent
Poor	11	3.8
Fair	2	7.7
Good	11	42.3
Excellent	12	46.2
Total	26	100.0

Majority of patients had excellent functional outcome (69.3%), 23.1% had good outcome and only 3.8% of the study population had fair and poor outcome

Table 2.
Distribution based on functional outcome according to knee society scoring system

KSS- Functional component	Frequency	percent
Poor	1	3.8

Fair	1	3.8
Good	6	23.1
Excellent	18	69.3
Total	26	100.0

The objective score and functional score of the population were comparable and was found to be statistically significant (p value<0.05)

Table 3.
Comparison of knee scoring system (objective) with knee scoring system (functional)

Functional - KSS	KSS- Objective				Total
	Poor	Fair	Good	Excellent	
Poor	1	0	0	0	1
Fair	0	1	0	0	1
Good	0	1	5	0	6
Excellent	0	0	6	12	18
Total	1	2	11	12	26

DISCUSSION:

The complex intra articular fractures of tibial plateau, especially caused by high energy trauma, pose a therapeutic dilemma. Such fractures usually associated with extensive soft tissue damage and the management of these complex fractures becomes a challenge to the trauma surgeon. The goals of management of these periarticular fractures are restoration of joint congruity by anatomical reduction of articular fragments, stable fixation of fragments thus allowing early joint movements. Early joint motion is an important factor in promoting cartilage nutrition and healing. [8] Few hybrid external fixation systems are commercially available, they are very expensive and not easily available. Thus in a developing country like India, such system is beyond the reach of poor patient. So in this study we have used a combination of Ilizarov ring fixator with AO type tubular fixators. Such frame is versatile, easy to use and economically within the reach of poor patients. Schatzker etal[9] in his study 1979 reported that 6th and 7th decade of life as the most common age group affected. Age of patients in our study showed a wide variation in the age groups with 3rd decade of life showing maximum representation (34.6%). In our study the lowering of the age groups affected to the 3rd decade has been greatly influenced by the increased frequency of high energy motor vehicle accidents. 4th and 5thdecades of life represented 23.1% of the study populations each. The mechanism of injury was RTA in most of the study population (84.6%) and fall was the other cause of injury in study (15.4%), in which two patients had a fall from height while working and two other had a simple fall at home. It was found that no statistical significant relation between mechanism of injury and type of fracture developed, p value 0.895. When mechanism of injury compared with final outcome (knee society score-objective component & functional component) it was found, there was no significant statistical relation (p value >0.05) between them. The left lower limb was slightly more involved than right, but it is not expected to be statistically significant due to very minimal variation from the midline. Majority of the fractures were closed fractures (96.2%) and only one was open fracture (according to Gustillo Anderson classification). The soft tissue damage in the fractures was graded in to 4 catagories according to Tscherine and Lobenhoffer classification system [10]. 88.5 % patient had a grade 1 soft tissue damage. 30.8 % of the study population had diabetes mellitus (8 patients) and this study showed that no statistical relation between diabetes mellitus and final outcome of patients (KSS scoring system –objective and functional component) p value >0.05. Type 5 Schatzker fracture represented 65.4%, while type 6 represented 34.6% of study population. The comparison between type of fracture (according to Schatzker classification) and knee society scoring system (objective component) was found to be significant statistically (p value 0.048). Type 5 Schatzker fracture had a mean KSS score of 83.1 and type 6 fractures had a mean KSS score of 73.7. But the relation between type of fractures and knee society scoring system (functional component) was not significant statistically (p value 0.101). The correlation between type of fracture and knee flexion in the 1st, 3rd and 6th post-operative months were found to be not significant statistically (p value >0.05). The mean knee flexion at 1st post-operative month of type 5 Schatzker fracture was 90.6 degree and that of type 6 Schatzker was 87.2 degree. The mean knee flexion at 3rd post-operative month of type 5 Schatzker fracture was 101.8 degree and that of type 6 Schatzker was 96.7 degree. The mean knee flexion at 6th post-operative month of type 5 Schatzker fracture was 115.6 degree and that of type 6 Schatzker was 107.2 degree. Most of the hybrid external fixation surgery were performed as elective procedure and most of the patients were initially managed with skeletal traction (88.5%).

One patient underwent emergency fasciotomy and one patient with open fracture patella along with Schatzker fracture was managed with total patellectomy and wound debridement in emergency theatre initially. The rate of pin tract infection in our study was 30.8% and the infection was milder and superficial, was managed with oral antibiotics effectively. None of the patient in our study had developed septic arthritis and deep infection. The pin tract infection when compared with outcome (KSS-objective component) was found to be significant statistically, P value 0.030. But the comparison between pin tract infection and functional outcome (KSS functional component) was not significant, p value 0.080. From the study it was also found that majority of patients who developed pin tract infection were diabetic patients (75%). The mean bone union time of fractures in this study was 4 months which was comparable with studies conducted by Guadinez et al[11] (mean union time was 3.4 months) The knee society score –objective component revealed poor response in just one patient (3.8%). 7.7% patients had fair outcome, 42.3% patients had good outcome and 46.2% had excellent outcome. The KSS score ranges from a minimum score of 53 to a maximum score of 95 with a mean score of 79.8. When the KSS score –objective component compared with age of patients showed a significant relation statistically. P value 0.010. The younger patients had a better outcome than the older group. The knee society scoring system, functional component revealed excellent outcome in 69.3% of the study population. 23.1% patients had good outcome, 3.8% patients had fair and poor outcomes each. The score ranges from a minimum score of 50 to a maximum score of 100 with a mean score of 83.3. When KSS functional score compared with age of the patients showed a significant relation, p value 0.003. The older patients had a worse functional score. The comparison between KSS objective component and KSS functional component showed a significant relation statistically. p value <0.05 George babis et al [2] conducted a study in 33 patients and outcome evaluated according to KSS criteria had 55% excellent, 31% good, 12% fair and 3% poor results. Weiner et al[13] in their study found that combined internal and external fixation combines the advantages of anatomic reduction, stable fixation and less soft tissue dissection and eliminates the need for large implants .There were 34% excellent, 48% good , 12% fair and 6% poor results in their study . By the 1st post- operative month, the mean knee flexion of the study population was 89.4 degree with a minimum flexion of 80 degree and maximum of 100 degree. By the 3rd post- operative month no patient had flexion less than 90 degree and the mean flexion was 100 degree. At 6th post-operative month none of the patient had flexion less than 90 degree, the mean value was 112.7 degree and the maximum value was 130 degree. The comparison of knee flexion at the 1st post-operative month with that of 3rd post-operative month was statistically significant(p value<0.001).Similarly the comparison between knee flexion in the 1st post-operative month and 6th post-operative month, comparison between 3rd post-operative month and 6th post-operative month also were found to be statistically significant(p value <0.001). The comparison between type of fracture (according to Schatzker classification) and knee flexion at 1st, 3rd and 6th postoperative months were not statistically significant. (p value <0.05). The mean knee flexion at 1st post-operative month of type 5 Schatzker fracture was 90.6 degree and that of type 6 Schatzker fracture was 87.2 degree. The mean knee flexion was 115.6 degree and 107.2 degree respectively for type 5 and 6 fractures at 6th post-operative month. Even though the comparison between post-operative knee flexion and type of fracture was not significant statistically, the study showed that type 5 Schatzker had a slightly higher degrees of knee flexion in the successive follow up than type 6 fractures.

The comparison of knee flexion at successive follow ups (1st, 3rd & 6th post-operative month) with knee society scoring system (both objective and functional component) were found to be statistically significant (p value <0.001). From this study it was found that high energy complex tibial plateau fractures with significant soft tissue damage can be effectively treated with hybrid external fixation techniques with minimal complications and excellent to good final outcome.

Conclusion:

Hybrid external fixation is a very effective and useful treatment modality in complex high energy tibial plateau fractures with marked soft tissue damage. This combined minimally invasive internal fixation and external fixation technique provides excellent to good results in most of complex tibial condylar fractures with minimum complications. Minimal soft tissue dissection and early knee range of motion are the most attractive features of hybrid external fixation.

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