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Operative management of tibial plateau fractures

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Abstract

Background and Objectives: Advance in mechanization and acceleration of travel have been accompanied by increase in number and severity of fractures and those of tibial plateau are no exception. Treatment modality in these fractures has been a controversial question. The objectives of the study were assessment of the functional outcome of fixation of proximal tibial fractures using cannulated cancellous screws or ORIF with BP/LCP or External fixator, comparing the results of different treatment modalities and at the same time, identifying the complications associated with them.

Materials and Methods: 22 cases of tibial plateau fractures in K.V.G. Medical College, Sullia were treated in from October 2013 to October 2015 with the objectives of precise reconstruction of articular surface, stable fragment fixation and early range of motions. Totally 23 patients were treated, among which 6 patients were treated by cancellous screws fixation, 13 patients by ORIF with BP, 3 patients by ORIF with LCP and 1 patient with Hybrid external fixator. The functional evaluation of knee joint was done using modified Hohl and Luck Criteria.

Results: The result revealed most patients were aged between 31–50 years (56.5%) with male preponderance, commonest mode of injury being RTA (86.2%). Schatzker type I fracture was commonest (26.7%). The functional result for ORIF with Buttress plate was excellent in 25.2% of cases and good in 50.1% of cases. 66.7% of cases treated with LCP had good functional result. Cancellous screws fixation was associated with equal number of good and fair results (33.3%). Commonest complication with operative treatment were wound related (37.5%) followed by knee stiffness (36.36%).

Interpretation and Conclusion: Operative management of tibial plateau fractures will give excellent anatomical reduction to restore articular congruity and rigid fixation to facilitate early motion thereby reducing post-traumatic OA and achieving optimal knee function.

Keywords: Tibial plateau; cannulated cancellous screws; buttress plate; locked compression plate, hybrid external fixator; anatomical reduction; schatzker type; modified hohl and luck; knee stiffness

Introduction

Fractures of the proximal tibia, particularly those that extend into the knee joint are termed as tibial plateau or tibial condylar fractures. Fractures of the proximal tibia involve a major weight bearing joint. These are serious injuries that frequently result in functional impairment, as they affect knee alignment, stability and movement. This makes 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% of the reported series [1]. Advance in mechanization and the acceleration of travel have been associated with increase in the number and severity of fractures. Fractures of the upper part of the tibia are no exception to this. High velocity injury sustained in automobile disasters and increase in road traffic accidents as a whole is creating an ever-growing problem. Such injuries are associated with neurovascular injury, compartment syndrome, deep vein thrombosis or soft tissue damage. The spectrum of injuries to tibial plateau is so great that no single method of treatment has proven uniformly successful. Because of wide range of fracture types and associated soft tissue and neurovascular structures involved, it is not surprising that literature is confusing regarding the outcome of various non-operative or operative treatment protocols. Nevertheless, tibial plateau fractures remain challenging because of their number, variety and complexity. Despite a plethora of articles, written in the past 50 years, that have addressed the problems of classification and results of various treatments, the optimal method of management remains controversial [2].

The objectives of treatment of tibial plateau fracture, is precise reconstruction of the articular surfaces, stable fragment fixation allowing early mobilization and repair of all concomitant ligamentous and other soft tissue lesions^[3].

Newer techniques have been developed in the 2010s that have aided the surgeon in the treatment of the high energy fractures, specifically those complex fracture patterns that occur with severe soft tissue compromise. For the high energy fractures, there is little controversy regarding the need for operative management.

In the past two decades, with improvement in surgical techniques and implants, there has been an unmistakable trend towards surgical management of these injuries.

Material and Methods

This is a study of surgical management of Tibial plateau fractures conducted in the department of orthopedics, K.V.G. Medical College, Sullia at between October 2013 to October 2015. Clearance was obtained from hospital ethical committee.

Inclusion criteria

- AGE-Patients above 18 years of age of either gender
- All Tibial Plateau fractures–Closed and all types of Gustilo and Anderson Open fractures except Type 3C which are clinically and radiologically diagnosed with classification based on Schatzkers classification

Exclusion criteria

- AGE-Patients less than 18 years
- Gustilo and Anderson Type 3C Open fractures.

Management

The patients were first seen in the casualty. The history was taken followed by general and local examination of the patient. Intensive care was given to those patients who presented with shock and immediate resuscitative measures were taken. Once the patient's general condition was fit, relevant X-rays were taken. Higher investigations such as CT scan were not done in all cases for tibial plateau fractures due to financial constraints. All these patients were immediately splinted with a long Knee brace or a Above knee POP slab and the limb was elevated. Some patients' knees with tense haemarthrosis were aspirated and a tight compression bandage was applied.

Surgery was done within 24hrs of admission or was delayed for more than 5-10 days, if there was gross swelling or if there was skin and soft tissue complications. 6 patients were treated with cancellous screw fixation, 13 patients were treated by open reduction and internal fixation with buttress plate and screws, of which 2 fractures were fixed with Dual Buttress plates. 3 patients were treated by Locked compression plate fixation and 1 case treated with Hybrid external fixator. Midline incision extending from the midline of patella till tibial tuberosity was the most common approach used.

A 'L' shaped incision was used in few patients. Tibial articular surface was inspected through sub meniscal exposure. Out of the 23 patients 1 was lost for follow up at the end of the study. Selection of the appropriate surgery method and implant choice was based on literatures and previous experience. Percutaneous fixation of the screws were done in minimally displaced lateral condyle fractures with no complications. Open reduction and internal fixation of fractures with buttress plates and locked compression plates were done in comminuted lateral or medial condyle fractures.

Bicondylar fractures were treated on the basis of amount of displacement, degree of depression of the tibial plateau and the

condition of the soft tissue. Some bicondylar fractures were treated with a single Buttress plate on lateral condyle and stabilising the medial condyle with the tension of the screws. Two cases of bicondylar fractures were fixed with Dual buttress plates, provided there was no gross swelling, blisters, subcutaneous haemorrhage, bruising or other skin and soft tissue complications.

An open Type VI tibial plateau fracture was initially treated with wound debridement and a knee spanning external fixator was applied. Gastrocnemius based rotation flap was done 2 days later. Hybrid external fixator was then applied after 4 weeks with acute docking at the fracture site. The tensioned wires were placed in percutaneous fashion with minimal devitalisation of the bone, periosteal blood supply and endosteal blood supply. For fractures with articular depression more than 5 mm, open reduction with plating and bone grafting was done after elevating the depressed fragment. The source of bone graft was ipsilateral/ contra lateral iliac crest.

Post operatively patients were immobilized with an above knee posterior slab/ cast or a knee brace depending on the rigidity of fixation. Antibiotics were continued postoperatively with limb elevation to prevent wound complications. The sutures were removed on the 10th post-operative day. Antibiotics were given till suture removal. The patients were advised quadriceps exercises, non-weight bearing crutch walking from first post op day. An immediate postoperative X-ray was also done. Immediate weight bearing and knee mobilization exercises were started in patients treated with hybrid external fixator.

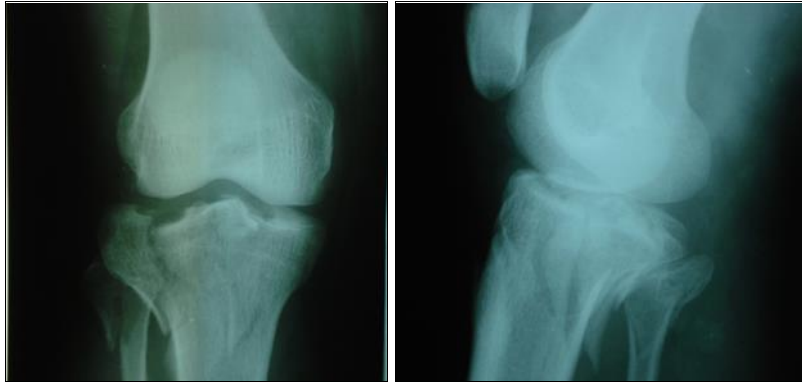
Result

A Prospective surgical study consisting of 23 patients with various fractures is undertaken to study the types of fractures, associated injuries, Neurovascular complications, Schatzker's classification, implant used, bone graft, post-op complications, functional outcome. The youngest age in our study was 23 years & oldest was 64 years. 30.4 % were between 41-50 years. Majority of them (56.5%) were between 31-50 years. 18 (78.3%) patients were males & 5 (21.7%) were females. Most common mode of injury in our patients were Road Traffic accidents (82.6%) of which majority of them were fall from 2 wheelers. 2 patients, who were labourers sustained high velocity injuries in their working places. Both the sides were equally affected & 1 patient had bilateral Tibial plateau fractures. For this patient, Left Tibial displaced lateral condyle fracture was treated with cancellous screw fixation & Right undisplaced Tibial plateau fracture was treated conservatively with A/K POP Cast. So this was not included in our study. In this study, 26.7% of fractures were Type 1, 21.7% were Type 6 and only 8.7% were Type 3 fractures. The types 4,5 and 6 which constituted High energy fractures formed 52.2% of the fractures. Most common early complication was wound related, which included wound gaping, delayed healing, superficial wound infections. 1 patient had undergone external fixator application who developed pin tract infection. 1 patient treated with buttress plate had extensive muscle and soft tissue necrosis of anterior and lateral compartments of leg, the cause for which was thought to be due to pre-existing uncontrolled Diabetes mellitus with feeble distal pulses seen at the time of presentation to casualty. The implant was removed in this patient and a A/K POP Cast was applied for 6 weeks. Knee stiffness with restricted knee motion was the common late complication seen in all types of treatment. 1 patient with type 6 fracture lost reduction and underwent second surgery, but still had articular step > 5mm.

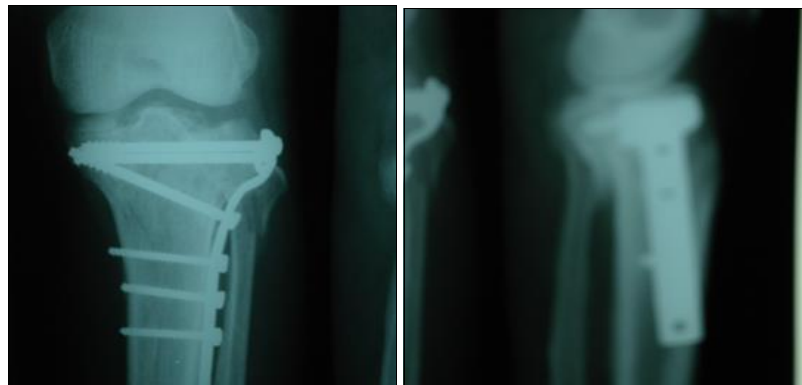
The functional result for ORIF with Buttress plate was excellent in 25.2% of cases and good in 50.1% of cases. 66.7 % of cases treated with LCP had good functional result. Cancellous screws fixation was associated with equal no. of good and fair results (33.3%). After stratification of excellent and good results as satisfactory and fair and poor results as

unsatisfactory, fixation with cancellous screws revealed 50 % satisfactory and 50% unsatisfactory. ORIF with buttress plate revealed 75.3% satisfactory results. ORIF with LCP had 66.7% satisfactory results. Totally satisfactory results were seen in 63.6% of cases treated with operative method.

Case 1: Schatzker's Type V Fracture



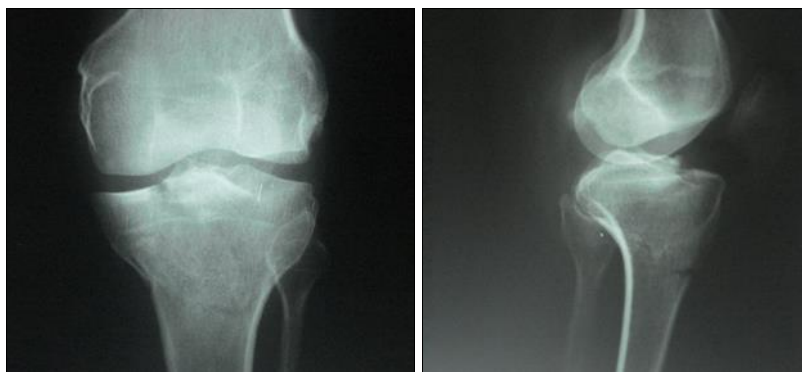
Post-operative X-rays



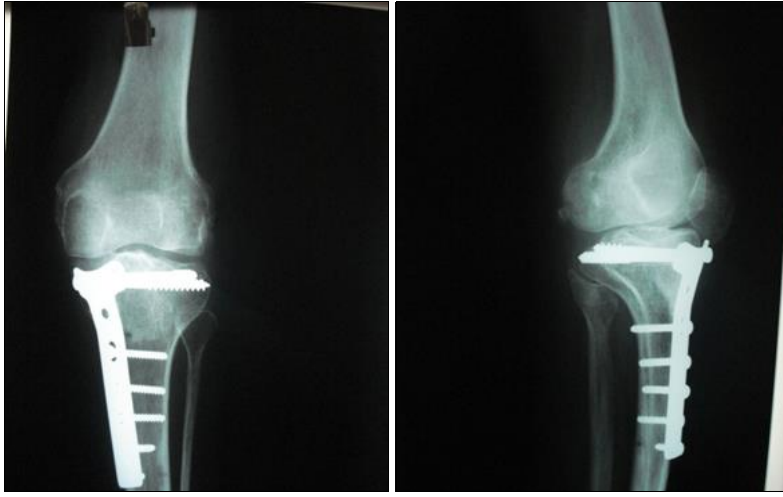
3 MONTHS Post –Operative Status



Case 2: Schatzker's Type IV Fracture



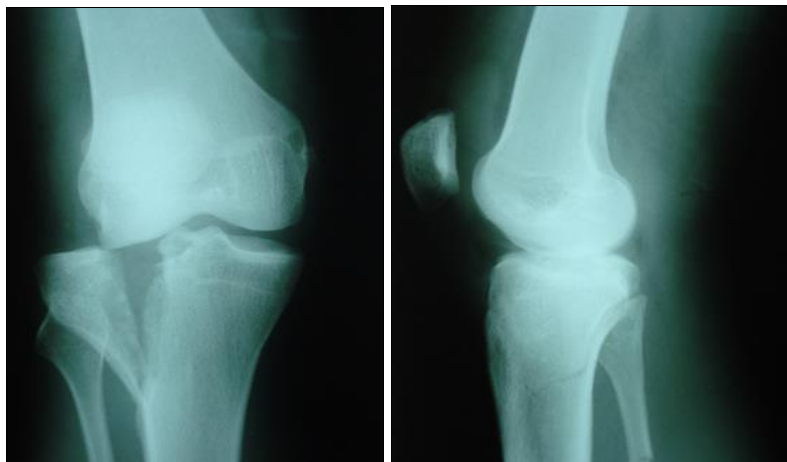
Post-Operative X-rays



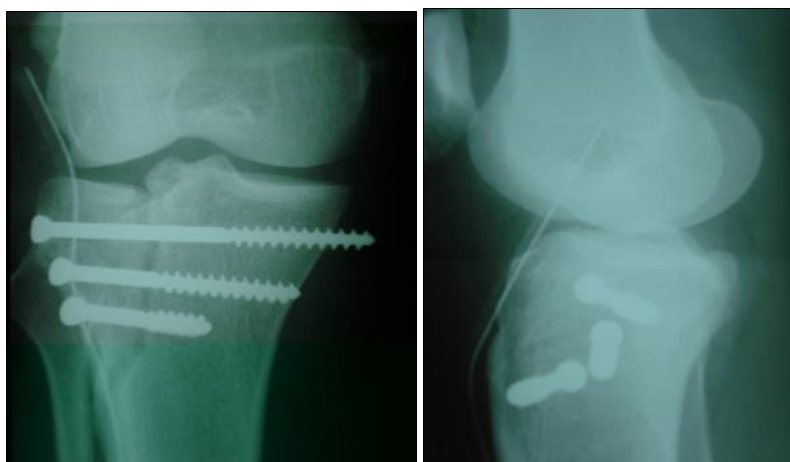
3 Months Post –Operative status



Case 3: Schatzker's Type I fracture

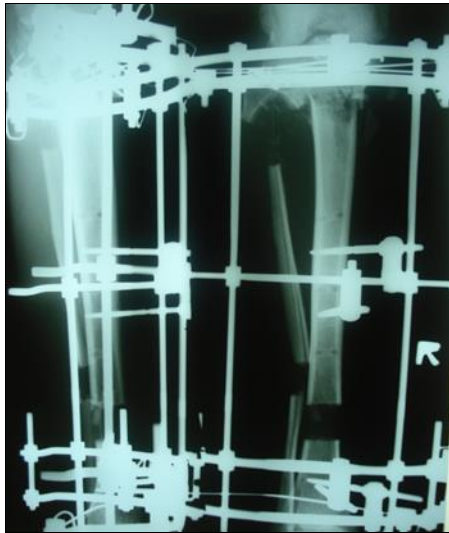


Cancellous screws fixation



Case 4: Type III B Open fracture: Schatzker's Type VI

Initial Treatment: Knee spanning external fixator



Definitive treatment: Hybrid External Fixator

Discussion

Tibial plateau fractures are common injuries for which a unified approach to treatment and outcome assessment remains elusive [2, 4, 5]. These fractures often affect patients during the most productive years of their lives with potentially devastating consequences. As with any intraarticular fracture, inadequate treatment may result in joint instability and deformity coupled with a restricted range of motion⁴. For many years, the treatment of tibial plateau fractures has been the subject of much controversy involving both the indications for surgical intervention and the specific type of intervention to be employed. The orthopaedic literature is confusing regarding the outcome of operatively treated tibial plateau fractures because of studies involving different patient populations, fracture types, techniques employed, variable duration of (usually short-term) follow-up and widely differing outcome assessment tools applied [6].

Prompt diagnosis, thorough pre-operative assessment of the bony and soft-tissue trauma [7, 8] adequate soft-tissue monitoring and resuscitation, anatomic reduction and sound fixation allowing early joint movement, and intensive rehabilitation often for over 1 year postinjury are mandatory for good clinical results.

This study group comprises of 23 patients with Tibial plateau fractures, all treated with operative method of whom 1 patient was lost to follow up. 6 patients were treated with Cancellous screw fixation, 13 patients treated by ORIF with buttress plate, 3 patients treated by ORIF with LCP and 1 patient was treated with hybrid external fixator. These patients were followed up for an average period of 8 months. The analysis of the results were made in terms of age of the patient, sex distribution,

occupation, mode of injury, laterality of the fracture, analysis of the types, modalities of treatment, complications associated with injuries and surgery and the functional outcome.

In our study, the average age was 44.57 years ranging from 23 to 64 years. The youngest age in our study was 23 years and oldest was 64 years. 30.4 % were between 41-50 years. Majority of them (56.5%) were between 31-50 years. In study conducted by, Biggi F *et al.* [9] the mean age is 43 years (range 19-79), Yao Ye *et al.* [10] mean age 43.0 +/- 8.8 years; range, 18-64 years). Mean age in a study conducted by Tscherne and Lobenhoffer *et al.* [11] in 1993 was 45 yrs (range 17-88 yrs).

In our study there were 18 males (78.3%) and 5 females (21.7%). The study conducted by, Biggi F *et al.* [9] 19 were women and 39 men and Yao Ye *et al.* [10] 48 men, 26 women. This can be attributed to our Indian setup where the female population largely work indoor or in agricultural fields and do not travel much.

In this study, there were 3 groups based on causes or Mechanism of Injury: 19 cases (82.6%) were due to RTA, 2(8.7%) were due to Occupational injury and 2 cases (8.7%) were due to Domestic fall. The study conducted by, Biggi F *et al.* [9] most common mechanism of injury was related to road traffic accidents (RTA) accounting for the 75% of the cases. In a study by David G Stevens *et al.* [6], the mechanisms of injury were RTA 26 patients, fall (9 patients), sports activity (6 patients), an industrial accident (2 patients), and other causes (3patients).

In our study, both the sides were equally affected and 1 patient had bilateral tibial plateau fractures. For this patient, Left tibial displaced lateral condyle fracture was treated with cancellous screw fixation and right undisplaced tibial plateau fracture was treated conservatively with A/K POP Cast which is not included in the study. In the study by Hohl and Luck *et al.* [12] in 1956, Right side involved in 348 cases and Left side involved in 378 cases. Rasmussen *et al.* [13] also reported that tibial plateau fractures were equally distributed in right and left lower limbs, involving 131 on right tibia and 129 on left tibia in his study.

Schatzker's classification was used in this study, including all six types. 26.7% of fractures were Type I, 21.7% were Type VI and only 8.7% were Type III fractures. There were equal number of patients (13.1% each) with Types II and IV. Type V fractures involving both the condyles were seen in 17.4 % of the cases. The types IV, V and VI which constituted high energy fractures formed 52.2% of the fractures.

In this study, lateral condyle fractures are more than medial condyle fractures as in all other studies. The normal anatomy (valgus position), shape of lateral femoral condyle and weaker trabeculation of lateral tibial condyle is reflected in higher statistical incidence of lateral tibial condyle fractures.

In the study by David G Stevens *et al.* [6], There were four type I, sixteen type II, five type III, eight type IV, three type V, and eleven type VI fractures. Buchko *et al.* [14] in their study had 6% Type I, 25% Type II, 36% Type III, 10% Type IV, 3% Type V and 20% Type VI fractures. Schatzker *et al.* [15] in his study in 1979 had 6% Type I, 25% Type II, 36% Type III, 10% Type IV, 3% Type V and 20% Type VI. Yao Ye *et al.* [10] in there study there were 30 type V fractures and 44 type VI fractures.

All patients in this study were treated by operative method. There were no stringent criteria as to a particular method of fixation for particular type of fracture. So each case was individualized and treated accordingly as it needs. Most of the type I, 1 case each of type III and type VI were treated with cancellous screw fixation. ORIF with buttress plate or LCP

were done for all the six types of fractures in this study. Only one case of Type VI was treated by hybrid external fixator. For fractures with articular depression more than 5 mm, open reduction with plating and bone grafting was done after elevating the depressed fragment. The extent of articular displacement, depression, instability of knee, condition of the surrounding skin and soft tissues, age and physical activity of the patient were all taken into consideration before adopting a particular operative method for treatment.

Adequate condition of the soft tissue is an important prerequisite for reconstruction of Tibial plateau. If the skin is contused, surgery is postponed until the soft tissue has recovered. In our study 4 patients were treated by closed reduction and percutaneous cancellous screw fixation. 2 cases (Type VI and type III fractures) were treated with ORIF with cancellous screw fixation combined with Intramedullary interlocking nail as they were associated with fracture shaft of Tibia^[16]. 13 patients were treated by ORIF with buttress plate, of which 1 patient was lost to follow up after 4 weeks. Dual plates were used in 2 patients (1 Type V and 1 Type VI), using a single midline incision. Dual plate fixation had been performed by many surgeons with less complications^[6]. ORIF with Locked Compression plates were used in 3 patients.

In Schatzker's *et al.*^[15] study 41 pts were treated surgically, of which 11 cases of Type II, 5 of Type III and 3 of Type VI fractures were treated by ORIF with buttress plate, 6 Type II and 4 Type III fractures were treated by ORIF with lag screws. Michael. S. Sirkin *et al.*^[16] reported results with various percutaneous methods of tibial plateau fracture fixation. Unicondylar split and split depression fractures were reduced and fixed with percutaneously placed 2 or more screws, supplemented with cortical windows made for percutaneous elevation of depressed fragment. A lag screw and washer is placed at the apex of condylar fragment in medial condyle fractures, which provide a buttressing effect. Bicondylar fractures were reduced by traction and ligamentotaxis and fixed with percutaneously placed screws or with Hybrid external fixators. They also used an intramedullary nail in treating unicondylar or bicondylar fractures complicated by a fracture in the diaphysis or metaphysis or in a bicondylar fracture that forms a proximal segment of at least 6 cm in length. In our study we have used intramedullary nails in 2 cases. One case with type 6 tibial plateau fracture with segmental fracture of the tibial diaphysis was treated with a Synthes Expert intramedullary nail along with 2 cancellous screws which are placed in such a way that they did not obstruct the nail insertion. Another patient with type 3 tibial plateau fracture associated with avulsion fracture of tibial tuberosity and fracture shaft of tibia was fixed with 3 cancellous screws and intramedullary nail.

In a study by David. G. Stevens *et al.*^[6], Forty-six patients with forty-seven displaced tibial plateau fractures, which were treated with open reduction, inter fragmental screw fixation of the articular fragments, and buttress plate fixation, were followed up for five years. In simple fracture patterns (Types I to III), a single lateral large fragment plate was used for buttress plate fixation. In complex fracture patterns, if necessary, a medial plate was used in addition to the lateral plate. Dual plating was also used if there was an associated displaced metaphyseal-diaphyseal fracture.

In the study by Biggi F *et al.*^[9] the majority (90%) of cases (44) were treated with open reduction and internal fixation with anatomical angular stable polyaxial locking plates (Perilocking and NCB, Zimmer). Nine of these cases underwent also grafting (either autologous or synthetic) to

support the depression of the subchondral bone and the articular surface. For open reduction and internal fixation a lateral "hockey-stick" approach was used in all patients. In 29 cases, a MIPO technique via a proximal incision of 5 cm was feasible. In three cases a medial approach was utilised for reduction and additional fixation of the medial condyle. Five fractures (10%) underwent mini-osteosynthesis with cannulated screws. Three of which were arthroscopically assisted procedures. A conventional antero-lateral portal was utilised for the arthroscope, and an antero-medial for the instruments. Indirect reduction of the depressed articular surface was attained via an inferior transosseous tunnel, verified with arthroscopy, and stabilised with 6.5 mm cannulated cancellous screws.

We had used Hybrid external fixator in one of our patient. The advantages of this fixator according to a study by Gaudinez *et al.*^[17] were that it minimized further soft tissue stripping, it is stable enough to allow for early range of motion and finally it allows access to any open wounds.

Functional evaluation in our study revealed 16.67% excellent results, 33.34% good results and 33.34% fair results in the patients treated with cancellous screws fixation. Among the fractures treated by ORIF with Buttress plate, 23.07% patients had excellent results, 46.14% had good results, 7.69% had fair results and 15.38% had poor results. ORIF with LCP revealed 66.68% of good results and 33.34% of fair results. 1 patient treated with Hybrid external fixator had fair result.

Complications in our study were divided into early and late. Most common early complication was wound related, which included wound gaping, delayed healing, superficial wound infections. 1 patient who had undergone external fixator application developed pin tract infection. 1 patient had extensive muscle and soft tissue necrosis of anterior and lateral compartments of leg, the cause for which was thought to be pre-existing uncontrolled Diabetes mellitus and distal vascular compromise, detected at the time of presentation. The implant was removed in this patient and A/K POP Cast was applied. The fracture united with articular incongruity and though there was osteoarthritis features at 8 months follow up, functionally he had good knee flexion and walking distance.

In Schatzker's *et al.*^[15] study where 41 pts of all types were treated by operative methods, Excellent or good results were seen in 75% cases of Type II, 67.5% cases of Type III and 80% cases of Type VI. Poor result was seen in 2 Type IV cases.

In a study by David. G. Stevens *et al.*^[6], Treatment complications were few involving one case of septic arthritis in an open fracture (grade II) and five superficial wound infections. Multiple-classifications analysis of all data revealed that presentation age was the most significant source of variation with respect to functional outcome. Fracture type had much less influence and adequacy of reduction had no significant influence on outcome. They concluded that ORIF is a satisfactory technique for the treatment of displaced fractures of the tibial plateau, particularly for patients younger than forty years.

In the study by Gaudinez *et al.*^[17] where complex tibial plateau fractures were treated with Hybrid external fixator, 4 patients had developed superficial pin tract infections and 3 patients developed mild varus deformity.

In the study by Biggi F *et al.*^[9] the 47 patients that were examined at the final follow-up, the results were good to excellent in 41 patients (87%) at 6 months, and in 44 patients (94%) at 1 year. Three cases developed superficial infections, which delayed the wound healing, and were managed with a

short antibiotic course. One case of deep infection with persistent wound drainage occurred 4 months after surgery. It was treated with debridement, plate removal, and nailing, obtaining bone healing in 3 months. No infections occurred in patients treated with the MIPO technique. One patient had a pulmonary embolism 2 months after the surgical operation and one patient sustained deep-venous thrombosis.

In the study by Yao Ye *et al.* [10] functional outcome was excellent in 31, good in 25, and fair in 13 patients. 3 cases appeared postoperative superficial infection, which gradually healed with dressing changes. In two patients, clinical symptoms and ultrasound Doppler examination during postoperative hospitalization revealed deep vein thrombosis. One was distal to the knee and one was proximal to the knee, and both gradually improved with anticoagulant and thrombolytic agents.

Conclusion

In our study, it was difficult to come to a conclusion as the number of patients were less for individual type of treatment. But some of the conclusions that can be drawn are

- Tibial plateau fractures are increasing (especially the high velocity injuries) with the increase in automobile accidents.
- These fractures need optimum treatment as most of them involve the men in productive age group.
- The age of the patient, the extent of articular displacement or depression, presence of instability of the knee, skin and soft tissue status are all important in deciding the need for surgical intervention, the type of surgery and also for the outcome.
- In the treatment of displaced or depressed fractures, fractures with impaction, combination fractures and comminuted fractures, a carefully planned and adequately performed surgical procedure can produce a good result through reconstruction of Tibial joint surface and rigid internal fixation for early motion
- The recent methods of external fixation, combined external and minimal internal fixation may be helpful for management of severe soft tissue injuries, but these techniques may not be necessary for simple fractures without significant soft tissue injury and they may be less reliably performed if the goal is to reduce the articular surface to as close to the anatomical position as possible
- ORIF with buttress plate or LCP with or without bone grafting is a better choice in the management of fractures with articular displacement or depression, especially in young individuals.

Hence, to conclude, the surgical management of tibial plateau fractures gives excellent anatomical reduction and rigid fixation to restore articular congruity, facilitate early knee motion by reducing post-traumatic osteoarthritis and thus achieving optimal knee function. But the treating surgeon should have a sound knowledge of the personality of injury and must be familiar with the variety of techniques available at present for treating Tibial condyle fractures.

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