

Evaluation of Functional Outcome in Patients with Tibial Plateau Fractures Treated with Open Reduction and Internal Fixation with Lateral Condylar Plate and Cancellous Screws with Hydroxy-Apatite Blocks in Adults: A Prospective Study

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ABSTRACT

Background: The goal of treatment of tibial plateau fractures is to restore a stable, congruent, pain free, mobile knee joint, to maintain the normal mechanical axis, to ensure joint stability and restore full range of motion and to prevent early degenerative changes. Recent advances in technology for treatment of tibial plateau fractures with lateral condylar plate (combi-holes) become popular and has clear biomechanical advantages over other method of fixation. The present prospective study to evaluate the functional outcome of tibial plateau fractures treated with open reduction and internal fixation with lateral condylar plate and cancellous screws with Hydroxyapatite block in adults.

Methods: The present study was undertaken in the department of Orthopedics, Government Medical College, Barmer, Rajasthan, India with aim of assessing functional outcome of tibial plateau fractures treated with open reduction and internal fixation with lateral condylar plate and cancellous screws with Hydroxyapatite Block in adults. A total of 32 patients were enrolled in the present study. Ethical approval was obtained from institutional ethical committee and written consent was obtained from all the patients after explaining in detail of the entire research process. Complete demographic details of all the patients were obtained. All the results were recorded in Microsoft excel sheet and were analyzed by SPSS software.

Results: Most common type of fracture in our study was schatzker's II & VI and associated injuries were present in

46.66 % cases (Ligamentous injury in 16.66% and bony injury in 30%). Range of motion in the knee joint was > 90° in majority of cases. The Rasmussen's criteria were excellent in 12 cases (40%), Good in 14 cases (46.66%), fair in 3 cases and poor in 1 case.

Conclusion: It can be concluded that radiological and clinical outcome was satisfactory in majority of cases. and obtained in all cases without complications. This injectable novel biphasic hydroxyapatite and calcium sulfate ceramic material is a valuable armamentarium in the treatment of trauma where bone graft is required.

Keywords: Lateral Condylar Plate (LCP), Hydroxyapatite (HA) Block, Complications.

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INTRODUCTION

The knee joint is a complex joint and is the commonly injured joint now a days because of increased vehicular trauma and sports related injuries. Being superficial joint it is more exposed to external forces and easily gets injured. According to Hohl [1967] tibial plateau fractures accounts approximately 1% of all fractures. Management of tibial plateau fractures dates back to 1822, when Sir Astley Cooper¹, reported different treatment methods. In the literature the conservative management of tibial plateau fracture

reported with variable degree of success. Complication included mal-union, non-union, degenerative arthritis, stiffness of knee joint, instability and it usually required longer hospital stay.²⁻⁴ Optimal treatment requires a complete understanding of pattern of the fractures and familiarity with a variety of surgical techniques. The goal of treatment of tibial plateau fractures is to restore a stable, congruent, pain free, mobile knee joint, maintain the normal mechanical axis, to ensure joint stability and restore full

range of motion and to prevent early degenerative changes. Recent advances in technology for treatment of tibial plateau fractures with lateral condylar plate (combi-holes) become popular and has clear biomechanical advantages over other method of fixation. When combined with minimally invasive surgically techniques, LCP may cause substantially less iatrogenic tissue damage when compared with conventional plate. LCP offers multiple point of fixed angle contact between the plate and screws and to support the lateral tibial condyle to prevent collapse. Clinical study of LCP has demonstrated a high rate of fracture union with lower incidence of mal-alignment, these characteristics may make LCP an attractive option for treating of tibial plateau fractures.

The main biomechanical difference from conventional plate is with increasing axial loading cycles, the screws can begin to toggle, which decreases the friction force and leads to plate loosening. If this occurs prematurely fracture instability will occur, leading to implant failure. In contrast, LCP follow the biomechanical principles of external fixators and not require friction between the plate and bone. LCP is a single beam construct where strength of its fixation is equal to the sum of all screws-bone interface rather than a single screw axial stiffness or pullout resistance as seen in unlocked plate. Its unique biomechanical function is based on splinting rather than compression result in flexible stabilization, avoidance of stress shielding and induction of callus formation. Locking the screws into the plate to ensure angular as well as axial stability, eliminate the possibility for the screw to toggle, slide or be dislodged and thus strongly reduces the risk of post-operative loss of reduction and implant failure.

To minimize the redisplacement of the reduced articular fragments, fill the voids with bone graft substitutes like hydroxyapatite blocks which has excellent bone in growth properties and act as a osteoconductive material. Its (HA BLOCK) characteristic are good biocompatibility and bioaffinity, mechanical resistance, similar to inorganic part of bone, good osteoconductivity, high brittle and, quick colonization. Its fragility limits the use at high mechanically loading area, prepared by reaction between calcium hydroxide and phosphates at high pressure and temperature. Various author in their study shown good to excellent results (walter et al. and Hsu et al).⁵

With more complex fractures, it is essential to consider not only the bony injury but also the associated soft tissue damage. The use of limited open approaches in conjunction with ligament axis, indirect reduction aids, wire-guided cannulated cancellous screws and minimally invasive plating techniques allows the surgeon to treat higher energy injuries effectively with internal fixation. If extensive comminution and soft tissue condition are not favourable for open reduction and internal fixation (ORIF), hybrid external fixators and circular small wire external fixators offer a safe means for early fracture reduction and stabilization. Treatment based on the general principles and techniques usually results in a functionally satisfactory outcome.

SUBJECTS AND METHODS

The present study was conducted on 32 patients suffering from tibial plateau fractures. Two patients lost to the follow up. The final results are based on evaluation of 30 adult patients with closed tibial plateau fractures treated with open reduction and internal fixation with lateral condylar plate, cancellous screws and

hydroxyapatite block in the department of orthopaedics, Govt. medical college Barmer with a maximum period of follow up of 2 years and minimum of 9 months follow up.

Inclusion Criteria

1. Patients age > 18 years.
2. Patient with closed tibial plateau fractures [schatzker's type II, III, V & VI].
3. Patient willing and fit for surgery.
4. Traumatic fractures.

Exclusion Criteria

1. Any open / compound fractures.
2. Medically unfit for surgery.
3. Pathological fractures.
4. Schatzker's type I & IV tibial plateau fractures
5. Other associated fractures in the same limb.

All patients were subjected to a detailed history and clinical examination with particular emphasis on mode of injury, time of injury, interval between injury and admission and nature of treatment taken prior to admission. Patient age and sex taken into consideration. Clinical examination includes general, systemic and local examination of injured part, particularly skin condition, blisters and symptoms and sign of compartment syndrome and neurovascular injuries. Associated injuries like head, chest, visceral injuries and other associated skeletal injuries were noted. Depending on the nature of injuries, relevant radiological examination like antero-posterior and lateral views of the injured knee joint were taken, whenever required CT scan of part also be done, to evaluate and classify tibial plateau fractures and planned for suitable surgical procedure. Patients were given pre-operative antibiotics, which included a third-generation cephalosporin 30 minute prior to the operation. Patients were taken for surgery as he/she fit for surgery. Patient position supine on traction table. Pneumatic tourniquet applied. The entire injured extremity painted with 10% povidone iodine solution, after cleaning with chlorhexidine solution and 7.5% povidone iodine scrub. Draping done with sterile sheets Operative treatment was performed when any intra-articular displacement or depression was present. In the present study only stainless-steel implants [LCP]. The plate and screws are manufactured from Stainless alloy. Anatomically precontoured plate Lateral condylar plate (LCP) available from 4 to 16 holes. On completion of procedure tourniquet released, sterile dressing and GT pop slab applied. Post-operatively, the operated limb was kept in elevation on a splint with knee in 10 to 15 degree of flexion. Postoperatively third generation cephalosporin I/V antibiotics were given for 5 days and oral antibiotics till suture removal. Oral NSAIDS analgesics given for 48 hours, those patients with renal and cardiac dysfunction were given oral tramadol- paracetamol combination. Patients were encouraged to sit next post-operative day and static quadriceps exercises initiated at 2nd post-Operative day. Postoperative radiograph was obtained and fracture reduction and implant position were checked. Pop slab removed on 5th day and gentle knee bending exercise started. The extremity supported in long leg knee brace. Sutures were removal at 12th to 14th post operative days. Clinical follow up was performed at 3week, 6 week, 3month and 6 months and any 1 year; including radiographic analysis and knee functional grading. X-ray review allowed the assessment of osteosynthesis stability, preserved alignment of the joint surface following reduction, bone substitute resorption and fracture

healing. Functional outcome was assessed as per Rasmussen's criteria and radiological evaluation were done as per status of union at fracture site.

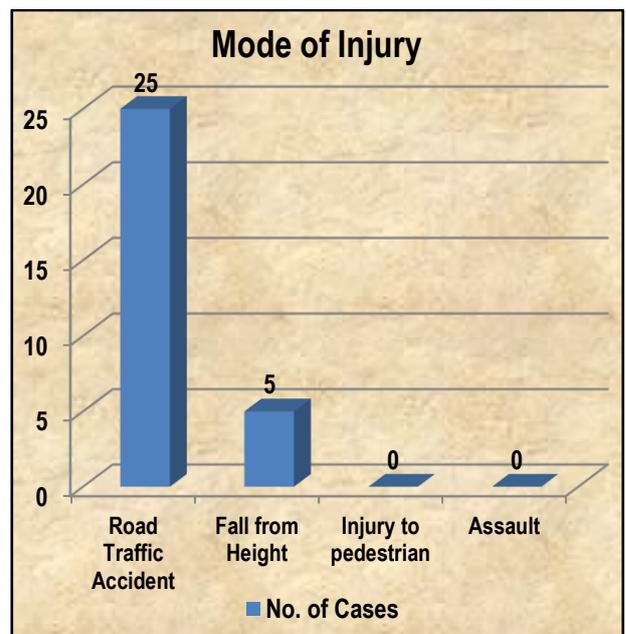
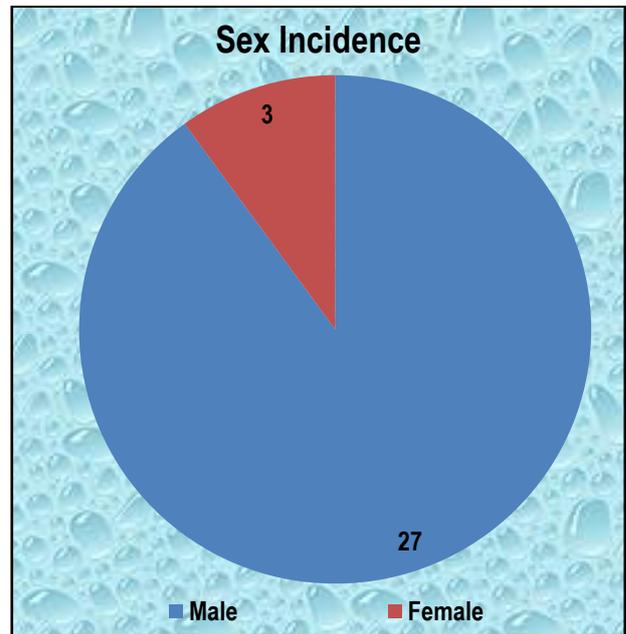
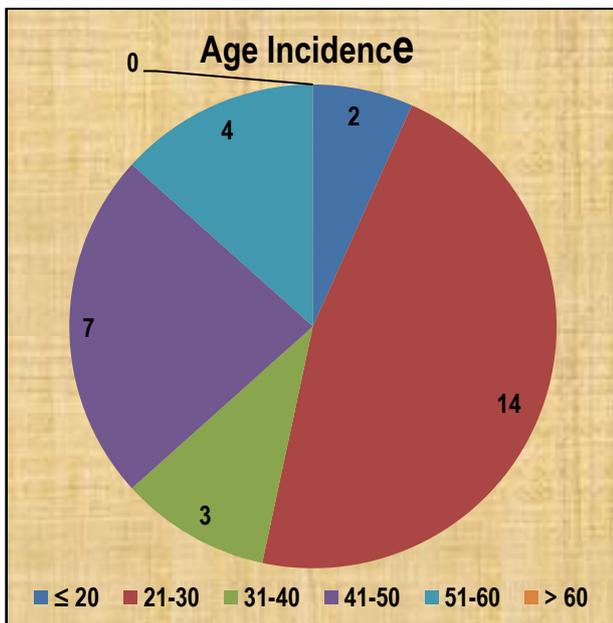
RESULTS

In present study, 90% of patients were males and 10% were females. (M/F ratio: 9:1). Most of cases were in 3rd to 5th decade (age ranged from 18 to 58 years with a mean 35.4 yrs in present study. Left side involved more than right i.e. Left to right ratio 1.3: 1. Road traffic accident (high energy trauma) was major mode of injury in 25 (83.35%) cases. Most common type of fracture in our study was schatzker's II & VI and associated injuries were present in 46.66 % cases (Ligamentous injury in 16.66% and bony injury in 30%). Out of 30 cases, 28 were operated within 7 days of admission as soon as he / she fit for surgery. Range of motion in the knee joint was > 90° in majority of cases. Extensor lag of more than 10° was observed in one case (3.33%). Walking capacity of less than one hour was observed in 2 cases (6.66%). Knee instability in 20° flexion was observed in 4 cases (13.33 %). Complication were encountered in patients included superficial infection (3), wound dehiscence (3), late deep infection (1) and varus / valgus deformity (5). Delayed union & non-union was noted in none of the cases. Postoperative outcome was evaluated as per criteria of Rasmussen's knee scoring. The final result according to Rasmussen's criteria were excellent in 12 cases (40%), Good in 14 cases (46.66%), fair in 3 cases and poor in 1 case.

Table 1: Schatzker's classification

S.No.	Type of Fracture	No. of Cases	%
1	I	0	0
2	II	12	39.96
3	III	1	3.33
4	IV	0	0
5	V	5	16.65
6	VI	12	39.96

DEMOGRAPHIC PROFILE



DISCUSSION

The road traffic accidents are on rise due to increased high speed vehicular traffic on roads. The LCP acts on the internal fixator principle. As screws once locked to the plate do not pull the fracture towards the implant, hence there is no re-displacement of the fracture once reduced. LCP facilitate angular stability. As it preserves periosteal blood supply and bone perfusion and requires less soft tissue dissection (Biological fixation), contribute to enhance fracture healing. To minimize the re-displacement of the reduced articular fragments, fill the voids with bone graft substitute like Hydroxyapatite block which had good biocompatibility, bioaffinity, mechanical resistance and good osteoconductivity, quick colonization. It avoids morbidity of harvesting bone graft from iliac crest. Beyond a critical threshold, depression or displacement of tibial plateau leads to significant rise in joint "stress". If the degree of stress in a joint exceeds the ability of the articular cartilage for self-repair then accelerated osteoarthritis is likely to occur.⁶ The outcome seems to correlate with type of fracture, anatomic reduction, bone quality and exact

positioning and fixation of the implant. Modified calcium hydroxyapatite blocks were used as a bone graft substitute to fill the metaphyseal defect in depressed fractures. Robert D et al⁷ compared the effect of a calcium hydroxyapatite with that of impacted cancellous autograft for maintaining an anatomical reduction in an experimental model of tibial plateau fracture. We have used indirect method of reduction for achieving biological fixation to conserve the vascularity of bone. Stable anatomic reduction can be achieved allowing early mobilization, which is the pre-requisite for optimal results. Calcium hydroxyapatite block is a useful alternative to bone grafting in depressed tibial plateau fractures. Its ability to maintain articular reduction in response to an axial load is comparable to cancellous bone graft. It exhibits the proper porosity to allow for osteoblastic in growth and to achieve effective bone healing (osteoconductive). It is gradually incorporated in the surrounding bone. In present study maximum numbers of cases (80%) were of type II and type VI (Schatzker's classification) in the present series while shreshta et al noted 16.25 % cases of type VI and 8.75 % cases of type V in their series. Our finding was comparable to Koval KJ et al⁸ who reported good to excellent result in all of 20 patients with unicondylar tibial plateau fracture fixed with percutaneously placed 6.5mm CCS. Keogh et al⁹ reported similar results in their series of 13 patients. There were no intraoperative complications. In present study out of 30 cases, 8 cases had either full or more than 120° range of motion, 18 cases had at least 120°, 3 cases at least 90° and only one case had range of motion at least 60°. Out of 30 cases 26 cases (86.66%) had > 90° range of motion. J.F Keating et al¹⁰ reported comparative results (129° knee flexion) at 1-year follow-up. Paul F. Lachiewicz et al¹¹ reported 120 mean range of motion at knee in a study of 43 patients of tibial plateau fracture. After fixation, under anaesthesia patients were tested clinically for associated ligamentous injury. In present study 6 cases (19.98 %) had associated ligamentous injury (MCL -5, ACL-

1). All injuries were treated conservatively. At 9 months follow-up none had symptomatic residual instability. Similar incidence was reported by Dela Marter et al 23% and Hohl M et al¹² 20%. Caldwell E H et al, Cave EF et al¹³ and several others from their study concluded that ligamentous injury associated with tibial plateau fracture is not significant and need not to be repaired as long as bone injury is reduced.

Paul F. Lachiewicz et al¹¹ in their study reported fracture fibula in 20.9 % (9 out of 43 cases) in their series. In present study there were 6 cases (20 %) had associated fractures of fibula ipsilateral. Other associated injury was noted two cases of head injury (6.66 %), one case (3.33 %) of fracture both bone forearm ipsilateral. In the present study most of the patients 25 cases (83.35 %) were operated within 7 days after admission. Which is similar to the observations of Hitin Mathur et al.¹⁴ In present study we observed the incidence of pain in knee joint in 17 cases (56.61 %). Paul F. Lachiewicz et al¹¹, the incidence was 32.55 % which is less in comparison to our study. Harsh Jain et al in their study found, normal walking capacity in 13 cases (43.33 %). Present study found in 14 cases (46.66 %) which is similar to that observations. None of cases were non ambulatory or wheel chair dependent in our study.

In the present study, most of the cases (43.33 %) had extensor lag of less than 10 degree. which is similar to the observations of the Harsh Jain et al who noted 17 cases (56.66 %) of extensor lag in their series. In our study, 26 cases (86.66 %) had more than 90-degree range of motion. Which is Similar to the observations of Burri et al¹⁵ who noted 100-degree flexion of knee in 83.1 % cases in their series. In the present study, 6 cases (19.98 %) had abnormal instability which is similar to the observations of Paul F. Lachiewicz et al¹¹, (20.93 %). In our study, 5 cases (16.65 %) had varus / valgus deformity. Which is similar to the observations of Paul F. Lachiewicz et al (13 % cases) and Harsh Jain et al (19.98 %) in their series.

Table 2: Rasmussen's criteria

S.No.	Type of Fracture	Total No. of Cases	Acceptable Results		Unacceptable Results	
			Excellent	Good	Fair	Poor
1	I	0	0	0	0	0
2	II	12	6	6	0	0
3	III	1	0	1	0	0
4	IV	0	0	0	0	0
5	V	5	1	2	1	1
6	VI	12	5	5	2	0
	Total	30	12	14	3	1

We used the criteria of Rasmussen's¹⁶ for assessing the conclusive results. According to this subjective complaint Pain, walking capacity and clinical sign eg. Extension, range of movement (ROM), stability of injured knee was considered. Broadly two categories of case were observed:

(I) Acceptable

(II) Unacceptable results

Acceptable category included excellent and good results while unacceptable category included fair and poor results.

Considering all the above-mentioned criteria, we achieved excellent results in 39.96 % (12 cases), good results in 46.66 %

(14 cases), while 3 cases (9.99 %) were observed as fair and 1 case (3.33 %) as poor. All the 4 unacceptable cases were of schatzker's type V and VI categories. Union was achieved in all cases. It was assessed clinically by stability without pain, under stress without support and radiographically by evidence of bridging callus. The average time of union was 14.7 weeks. Raikin and fromson¹⁷ also reported similar duration of union (around 15 weeks) in tibial plateau fractures. Using Rasmussen's functional criteria 38% patients had excellent, 54% had good and 8 % had fair outcome. The median Rasmussen score was 24 at 6 months. J F Keating et al¹⁸ reported similar result with good and excellent

in 92% of cases at 6 months and 95% at 1 year. Schatzker et al¹⁹ reported 78% and 58% result in those treated operatively and non-operatively respectively. Our results are similar to the observation of other study eg. Rasmussen's observed 87% acceptable results (60% excellent, 27% good), and 13% unacceptable results (9% fair, 4% poor). While Burri et al¹⁶ observed 71% good and excellent results and 6.5% poor results in their series. In our study 2 cases had superficial infection and 1 had wound dehiscence in our series which resolved in 3 weeks. There was deep infection in one case (type -VI) although union was achieved and infection healed with treatment like exploration and irrigation thoroughly and dressing along with antibiotics as per culture and sensitivity reports. In 6 cases we immobilized the knee joint for 3 weeks (suspecting collateral ligamentous & ACL injury) otherwise all patients were mobilized (gentle knee bending) on 5th day post operatively. Partial weight bearing started at 6th weeks and full weight bearing at 3rd months depending on clinical and radiological sign of union. We did not observe any neurovascular complication, compartment syndrome in our cases. None of our cases had implant failure and non- union.

CONCLUSION

Tibial plateau fractures need optimum treatment in order to return to early productive life without morbidity. Present study shows that limited open reduction and internal fixation with lateral condylar plate (LCP) and use of hydroxyapatite block to fill the void created after elevation of depressed fragment is a better treatment option to achieve a congruous, stable joints, allowing early mobilization yields good functional results in majority of these complex fractures.

There was no complication seen in any case with hydroxyapatite crystals. Bone ingrowth and bone formation around hydroxyapatite crystals are excellent. Hydroxyapatite crystals have great biological safety, good biocompatibility and good bone conduction.

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