ORIGINAL RESEARCH PAPER

Volume-8 | Issue-7 | July - 2019 | PRINT ISSN No. 2277 - 8179

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ANALYSIS OF RESULTS AND OUTCOME OF ARTHROSCOPY ASSISTED MANAGEMENT OF TIBIAL PLATEAU FRACTURES

Orthopaedics

Dr. I. Mubarak basha Chief Medical Officer, Dept of Orthopaedic surgery, ESIC Medical college and hospital, K.K.Nagar, Chennai-78, India.

Dr. E. Rajarajan* Junior consultant, Apollo Hospital, Chennai, India. *Corresponding Author

Dr. K. S. Maheswaran Professor of orthopaedics, Government Medical College & ESIC hospital , Coimbatore, India.

ABSTRACT

Tibial plateau fractures are one of the commonest periarticular fractures in the knee joint. Each fracture type has its own morphology, treatment considerations and prognosis. Apart from bony injury, meniscal tear and ligament injuries and soft tissue envelop compromise are associated with this type of fractures. The treatment of tibial plateau fractures has completely changed from conservative treatment with casting to anatomical reduction and surgical fixation. Successful results depend on anatomical reduction, restoration of ligamentous stability, treatment of concomitant injuries and preservation of soft tissue envelope. We analyzed Arthroscopy-assisted fixation to improve the quality of the articular surface reduction and fixation. In our prospective study 18 patients with tibial plateau fractures classified according to Schatzker classification who got admitted in our Institute of Orthopaedics and Rajiv Gandhi Govt General Hospital were included for Arthroscopy assisted reduction and fixation of tibial plateau fractures. A total of 17 patients were available for evaluation of final outcome by Modified Rasmussen criteria Clinical and Radiological assessment. This study found excellent to good results as per Modified Rasmussen's clinical and radiological score at short term follow up in all Schatzker types of tibial plateau fractures.

KEYWORDS

Tibial plateau fracture, Arthroscopy assisted, anatomical reduction, internal fixation.

INTRODUCTION

Tibial plateau fractures are one of the commonest periarticular fractures in the knee joint. These fractures include 1% of all fractures [(1)].. Apart from bony injury, meniscal tear and ligament injuries are associated with this type of fractures. Each fracture type has its own morphology, treatment considerations and prognosis. Successful results depend on anatomical reduction, restoration of ligamentous stability, treatment of concomitant injuries and preservation of soft tissue envelope. Additionally, good visualization of the articular joint surface with minimal dissection of soft tissue can help in achieving this goal [(2-5)].

Surgical management of Tibial plateau fractures are challenging. They require extensive exposure for reduction of the fractures which leads to risk of infection and soft tissue complications. The surgical treatment should inflict minimal surgical trauma, to achieve desired satisfactory outcomes. Therefore, the indirect reduction has now become the standard option in the management of these fractures. Although indirect reduction has the advantage of avoiding extensive exposures, adequacy of joint articular surface reduction can be difficult to evaluate under routine intra -operative fluoroscopy.[(6)]

The potential benefits of arthroscopic assisted reduction of tibial plateau fractures and internal fixation are well documented[(6)]. Arthroscopy-assisted percutaneous tibial plateau fracture fixation is the option of treatment in Schatzker classification types I, II, III, and IV fractures, as it ensures optimal reduction and stable fixation consistent with early mobilization. The option of percutaneous cannulated screw fixation is less invasive than open plate fixation. In all this tibial plateau fractures, arthroscopy may allow an evaluation of articular fracture reduction, thereby obviating the need for extensive arthrotomy. The use of arthroscopy for Schatzker Classification types V and VI has been suggested, to improve the quality of the reduction of the articular surface and must be combined with rigid fixation with a plate or external device.[(7).]

In addition to assisting with fracture reduction, arthroscopy has further advantage of allowing associated intraarticular soft tissue to be directly assessed and treated [(8).] Faster rehabilitation and more accurate reductions when compared to open techniques with arthrotomy have been reported. Good results have been reported for arthroscopic treatment for elderly patients, mostly for lower energy fractures[(8)].

MATERIALS AND METHODS

This study was conducted at Institute of Orthopaedics & Traumatology, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai for a duration of 24 months from May 2015 to April 2017 as prospective study. Eighteen patients with different types in schatzkar classification were enrolled in this study out of which one patient lost for follow up after surgery. Inclusion Criteria for the study was all type closed tibial plateau fractures . The tibial plateau fractures with minimal displacement and minimal acceptable deformity in elderly age were excluded. Patients are subjected to history taking, clinical examination, Radiographs, CT and MRI for evaluation if needed. Treatment as per ATLS guidelines was initiated as required.Demographic and injury data was recorded for the patients included in the study. Above knee slab or Calcaneal pin traction is applied until the patient is fit for surgery. Prior to reduction maneuvers Arthroscopy was done. Findings were recorded. Acceptable Reduction achieved with help of C Arm and Articular reduction verified under arthroscopic guidelines. Lateral / medial / both column Plating was done depending on the morphology of fracture. Post-operative X ray Follow-up and recording of outcome data was done. Results were evaluated using modified Rasmussen criteria for clinical and radiological assessment.

Table-1: Modified Rasmussen criteria for Clinical assessment

Pain	Points
None	6
Occasional	5
Stabbing pain in certain positions	3
Constant pain after activity	1
Significant rest pain	–3
Walking capacity	
Normal walking capacity for age	6
Walking outdoors (>1 h)	5
Walking outdoors (15 min–1 h)	3
Walking outdoors (<15 min)	1
Walking indoors only	0
Wheelchair/bedridden	–3
Knee extension	
Normal	4
Lack of extension (<10°)	2
Lack of extension (>10°)	0
Lack of extension (>20°)	–2
Total range of motion	

Full	6
At least 120°	5
At least 90°	3
At least 60°	1
<60°	–3
Stability	
Normal stability in extension and 20° flexion	6
Abnormal stability in 20° flexion	4
Instability in extension (<10°)	2
Instability in extension (>10°)	0
Power of quadriceps	
Grade 5	2
Grade 3–4	1
Grade <3	2
Maximum score	30
Excellent	28–30
Good	24–27
Fair	20–23
Poor	<20

Table 2 Modified Rasmussen criteria for radiological assessment

Articular depression	Points
None	3
<5 mm	2
6–10 mm	1
>10 mm	0
Condylar widening	
None	3
<5 mm	2
6–10 mm	1
>10 mm	0
Varus/valgus angulation	
None	3
<10°	2
10–20°	1
>20°	0
Osteoarthritis	
None/no progress	1
Progression by 1 grade	0
Progression by >1 grade	–1
Maximum score	
Excellent	9–10
Good	7–8
Fair	5–6
Poor	<5

RESULTS

We had 18 patients in our study with tibial plateau fractures admitted at Rajiv Gandhi Government general hospital Chennai. All the patients were treated with arthroscopy assisted tibial plateau fixation. The longest follow-up was 18 months and shortest follow-up period was 6 months. Mean follow-up period was 14 months. Follow-up scoring was made using Modified Rasmussen's clinical and Radiological Criteria.

In our study, most of the patients (6numbers (33.3%)) were in age group of 50-59 years.15 patients (86.6%)were males and 3 patients (13.4%) were females

10 patients got affected in the Right side (55.5%) which is more when compared to left side (44.5%)

All patients sustained injury due to Road Traffic Accident (100%). 7 patients had type V tibial plateau fractures as per Schatzker classification (38.8%)is the most common type in our study.

In our study 2 patients (11.1%) had type I,3 (16.7%) patients had type II,3 (16.7%) patients had had type IV ,7 patients (38.8%) had type V ,3 patients (16.7%) had type VI as per Schatzker classification of tibial plateau fractures. There were no Type III fracture.

Associated injuries were 1 patient had shaft of femur fracture same side, 1 patient had distal radius extraarticular fracture,1 patient had ipsilateral side T Type Acetabulum fracture.

2 patients were diabetic, 1 patient had previous history of coronary heart disease and one patient had congenital diaphragmatic hernia Average delay for surgery was 20.5 days (Range 7 to 60 days).

3 patients had articular depression and 4 patients had meniscus entrapment which was released arthroscopically. There were No other ligamentous and meniscal injuries.

Autologous bone grafting from iliac crest was used in 3 cases of type II and 1 case of type 4 through a lateral cortical window tibial plateau fractures cases for elevating the depression (mean 8mm range from 6mm-10mm) of the articular surface. We didn't use bone grafts in other type tibial plateau cases.

In 3 patients (16.7%) we did medial column tibial plating, 5 (27.8%)patients we did lateral column tibial plating,2 patients (11.1%) lateral plating with mediolateral cancellous screws,3 patients (16.6%) cancellous screws alone and in 5 (27.8%) patients we did Bi column plating.

Postoperatively none of our patients in our series developed thromboembolism.

Weight bearing started on 6 to 8 weeks in all the patients.

A total of 17 patients were available for final evaluation of final outcome.

According to Modified Rasmussen criteria Clinical assessment in our study,11 (61.1%) patients had excellent outcome,1(5.5%) patients had fair outcome,3 (16.6%) had poor outcome. No patients had good outcome.

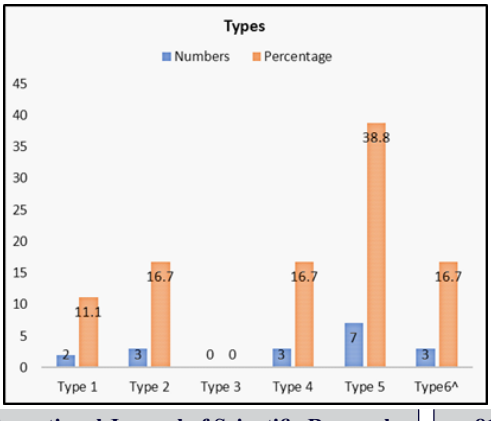
According to Radiological assessment of the same criteria 11(64.7%) patients had excellent outcome,3(17.6%) had good outcome,3(17.6%) percent had fair outcome. No patients had poor outcome.

In our study 4(22.2%) patients developed wound infection postoperatively. One patient(5.5%) went against medical advice and it was considered as lost follow-up. Remaining three patients had superficial infection who were treated with antibiotics for 6 weeks, wound wash and debridementDue to persistent deep infection implant exit was done for 1 patient (5.5%). None of thepatients required any further plastic surgery procedure. Two patients (11.7%) developed varus deformity which was not affecting the daily living life.

Most common age group in our study is 50 to 59 years (33.3%).Sex incidence, in our study males (86.6%) are more affected than males (13.4%).Mode of injury in our study was Road traffic accident in allthecases (100%). Right side (55.5%) is more affected then the left side (44.5%).

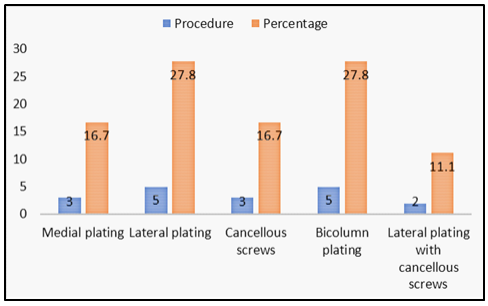
TYPES AS PER SCHATZKER CLASSIFICATION:

Most common type of fracture is Type V (38.8%).

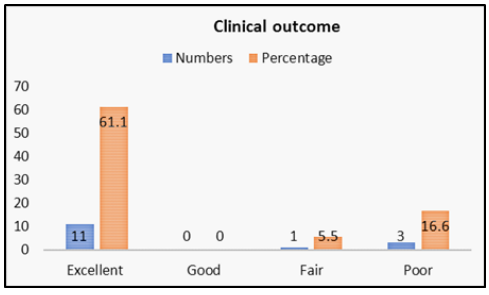


PROCEDURE DONE

Lateral plating was done in 27.8% of cases



OVERALL CLINICAL OUTCOME:



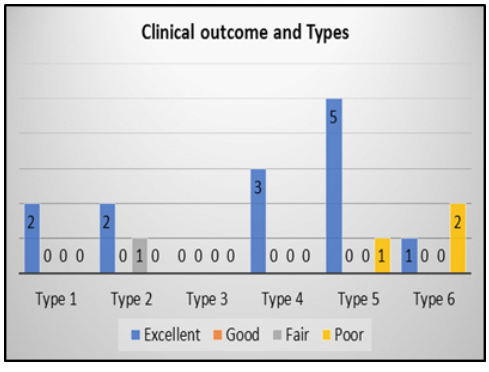
INTRA OPERATIVE ARTHROSCOPY FINDINGS

Among 15 patients 3 patients had meniscus entrapment which was released Arthroscopically

INDIVIDUAL TYPE RADIOLOGICAL OUTCOME

In our study we had fair radiological outcome in 2 cases of type VI tibial plateau fracture which is statically significant ($p<0.02$) and in one case of type II tibial plateau fracture

INDIVIDUAL TYPE CLINICAL OUTCOME



Complications in our study

In our study two complications were met postoperatively. Four patients developed infections which were managed conservatively in 2 and implant exit in 1 and lost follow up in 1.Two had residual varus deformity managed conservatively.

DISCUSSION

The management of tibial plateau fractures has been changing from conservative cast bracing to surgical management which includes external fixators, percutaneous fixation and traditional open reduction internal fixation with plates. Non-operative methods were indicated for fractures that will heal without significant deformity in elderly patients and patients with high risk medical co-morbidities and also for deformities which are acceptable.

DeCoster et. al[9]., Delamarter and Hohl[10] used cast bracing. Apley[11] and Moore et. al[12]. used both initial traction and early joint mobilization, Duparc and Ficat et. al.[13], showed better results for surgical management (54%) than conservative treatment(46%) Palmer et. al[14,15] showed satisfactory results in short and long term outcome with surgical management Robert JM[16] showed good results with 72% conservative, 80% traction mobilization, 81% surgical management and also advocated early mobilization, preservation of meniscus and repair of torn ligament for best results. He Porter BB[17] found surgical treatment with articular depression of more than 10 mm surgical treatment offered the best results. Schatzker et. al.[18] achieved 88% acceptable results in 70 cases treated with Open reduction and Internal fixation with bone grafting. Lachiewicz et. al.[19] obtained excellent to good results by open reduction and Internal fixation and found that poor results were due to faulty techniques or absence of bone grafts. Delamarter et. al[20] insisted soft tissue injuries associated with tibial plateau fractures are in 10 to 30 % of cases which need to be addressed to avoid instability. Tscherne et. al.[21] proposed a classification system for open and soft tissue injuries. Primary treatment for tibial plateau fractures includes closed reduction. If necessary open reduction internal fixation, bone and Soft tissue reconstruction were performed . Sushil H Mankar et. al [22] studied the outcome of complex tibial plateau fracture treated with external fixator which will help in reducing soft tissue complications if near anatomical reduction is achieved.Thomas et. al[23] evaluated 18 cases in which they used meniscal detachment method for excellent exposure and accurate reduction of the joint. They showed 72% excellent and 38% good results.Ballmer et. al [24] used 3.5mm small fragment implants with atraumatic soft tissue dissection for good results in management of proximal tibia fractures. Mills WJ [25] studied high energy tibial plateau fractures internal fixation and showed that open reduction is advantageous over External fixation. Jong-keun O [26] showed excellent results with Minimally invasive methods like MIPPO with lesser incidence of infections, soft tissue damage with high rates of early fracture union using smaller incision and Locking Compression Plate. Sirkin et. al.[27]described various methods of percutaneous fixations with advantages of shorter surgery time and hospital stay, reduced blood loss due to minimal incision and early rehabilitation. Percutaneous fixation of tibial plateau fractures preserves periosteal supply which helps in preventing complications such as infection, necrosis and non-union[28]. Koval et. al. [29] used fluoroscopy for indirect reduction of tibial plateau fractures in 18 cases which showed excellent reduction in 13 cases. Duwelius et. al [30], Harper et. al[31], Keogh et. al[32] reported excellent results with simple cases amenable to fluoroscopy and other complex cases required arthroscopy/ Arthrotomies.Lobenhoffer et. al.[33]conducted a comparative study between fluoroscopy and arthroscopy and found that fluoroscopic assessment of tibial plateau with image intensifier was equivalent to and technically easier than assessing with arthroscope. Patients assessed with fluoroscopy did not have any clinical problems due to unrecognized soft tissue problems.

Arthroscopy Assisted Reduction and internal fixation (ARIF)in the tibial plateau fractures was first introduced by Caspri et al[34] and Jennings[35] in the 1980s. Acute fractures and associated soft tissue injuries can be precisely defined, reduced and stabilized.TarekA.Aziz Mahmoud et al"s[36] concluded that for closed type fracture I-IV according to the Schatzker classification with step off of the articular surface more than 3mm and condylar widening more than 5 mm, percutaneous fixation with assisted arthroscopy is safe and effective procedure with excellent results and early mobilization.They G.Burdin CHU de Caenet al's[37] view in complex proximal tibial fractures is that arthroscopy obviating the need for extensive arthrotomy. Complementary stable fixation and early mobilization is crucial.Jerome E Jennings Suite et al[38] states that Arthroscopy bridges that controversy, allowing the advantages of accurate reduction and rigid fixation without extensive operative exposurein addition to thorough lavage, removal of loose fragments and accurate diagnosis of associated intraarticular pathology. Xing-Zuo Chen et al[39] ,Arthroscopic Assisted Internal Fixation (ARIF) is a reliable, effective and safe method for the treatment of tibial plateau fractures, especially when they present with concomitant injuries. ARIF has also been suggested as a potential risk factor for compartment syndrome during arthroscopic examination or treatment.Lemon and Bartlett[40] were the first to report an arthroscopic technique for reduction of displaced intraarticular fracture of tibial plateau.Hung et. al[41-42] recommended the use of arthroscopy for tibial plateau fixation. Suganuma and Akutsa et. al[43] reported that arthroscopy reduces the period of rehabilitation. Yi sheng Chan et al[44] described Arthroscopy is straightforward in the diagnosis and treatment of meniscal and ligamentous injuries and removal of loose fragments with good early to medium-term results.
Buchko and Johnson [45]described an arthroscopic technique using tourniquet and low pressure arthroscopic pump to improve exposure and facilitates joint lavage. , the reduction can be performed with the pump off or a dry arthroscopic technique. If the lateral meniscus is entrapped in the fracture site, it can be lifted out with a hook. Meniscal tears usually can be repaired and should be treated accordingly.

In our study clinical and radiological outcome of Schatzker Type I to Type VI Tibial plateau fractures treated by Arthroscopy assisted fixation in 18 cases were analyzed using Modified Rasmussen criteria for clinical and Radiological outcome.

In this Study, Tibial plateau fractures were more commonly seen in 50to 59 years due to RTA. It is very important to visualize the articular reduction to obtain stable fracture fixation. Anatomic reduction is more important in Younger patients because of the higher functional demands placed on to the knee and longer time they take to develop arthritis.

In our series majority of patients were male (86.6%) as they were involved mostly in RTA (100%) due to their outdoor occupation. In our series right side (55.5%) is more commonly affected than the left side (45.5%).In our study 4(22.2%) patients developed wound infection postoperatively.1(5.5%) patient went against medical advice and it was considered lost follow-up.3 patients had superficial infection who were treated with antibiotics for 6 weeks, wound wash and debridement. They didn't require any further plastic surgery procedure. Due to persistent deep infection implant exit was done for 1 patient (5.5%). 2 patients fixed with lateral column plating and mediolateral cancellous screws who developed varus deformity in the follow-up had Schatzker Type VI tibial plateau fracture. Reason for varus deformity is probably inadequate medial column fixation in the retrospect bicolumn plating would have been the better option.

In a Study by Roerdink et. al[52]. 80% of the patients were with Clinical Rasmussen score Excellent or good. Meniscal tears were noted in 42.7 % of all tibial plateau fractures. Most common types were peripheral and radial tears. 21.3 % of ACL injuries were with Schatzker Type IV & VI fractures. In our study we encountered only meniscal entrapment and there was no meniscal injury.

Outcome assessment for soft tissue injuries was beyond the scope of our study since it was a short period study.

Benea H et. al.[53] which included Shatzker Type I to Type VI fractures showed excellent results(assessed by Rasmussen score) in 5 cases and good in one case. In our study we had 5 cases of Schatzker Type I and Type II In which four had excellent outcome and 1 had good outcome.

Various studies have shown the use of bone grafts ranging 11.1% to 100%.[53]in our study Autologous bone grafting from iliac crest was used in 3 cases of Schatzker type II and 1 case of type 4 through a lateral cortical window tibial plateau fractures cases for elevating the depression (mean 8mm range from 6mm-10mm)of the articular surface.

Various studies used Rasmussen scoring system and Ahlback scale for evaluating the radiological outcome. We used modified radiological Rasmussen Scoring. They showed that depression of no less than 2 mm was considered a displacement postoperatively and occurred in 30 patients. At least 9 patients had an articular depression of more than 4 mm and 25.9% of the patients presented with osteoarthritis postoperatively[53]. We had articular depression in two patients Mean of 3.5mm(3mm-4mm) postoperatively in 1 case of Schatzker type V and 1 case of Schatzker type VI. Progression of osteoarthritis couldn't be studied since it is short term outcome study. Shen G et. al[54] showed that the fracture healing time of arthroscope group was shorter than that of control group but the difference was not significant. We did not have control group to compare the fracture healing time.Richard B Caspari et. al. showed that in around 29 patients 2 patients had peroneal nerve palsy. We didn't encounter any peroneal nerve palsy due to extravasation of fluids and compression of nerve. Belanger et al[56]. Showed a case of compartment syndrome in the leg postoperatively, they advised the precautions when irrigation pump is used, the pressure should not exceed 50mmHg and the calf should be monitored during the procedure. However, in our study we did not face any Compartment syndrome.

Average delay for surgery was a mean of 20.5 days (7 days to 60 days). Due to delay and prolonged immobilization Schatzker type V and Type VI (10 patients) tibial plateau fracture developed arthrofibrosis for whom it was difficult to do arthroscopy and arthrofibrosis is removed with shaver and further evaluation was done.

In a study by Hung SS et. al[57]., Chan et. al. Buchko GM et. al[58]., Brenfeld GM et. al[59] showed deep infection s in cases operated with Arthroscopy assisted techniques. We faced 4 infections for whom we did Wound debridement, Wound Wash and antibiotics and for 1 patient who had persistent infection, implant exit was done after 9 months.

In our study 2 patients developed varus deformity (15 degrees) which doesn't affect their daily living activity.

In various studies it was pointed out that significant joint space narrowing was found in 10% to 30 % of patients followed up for 3 years[60]. Our study is a short term study with a maximum follow up of 20 months we didn't encounter any joint space narrowing on x ray.

In more complex tibial plateau fractures medial side patterns, it is preferred to use two approaches to avoid varus collapse or in accurate medial reduction[62]. We used lateral column plating and mediolateral cancellous screws for 2 cases of Schatzker type VI tibial plateau fractures which led on to varus collapse and varus deformity in the follow-up. It is preferable to use bicolumn plating in these cases.

Dall'oca C et al[63] who compared the outcomes between Arthroscopic assisted fixation and Open reduction internal fixation suggests that there is no difference between these two treatments in Schatzker type I fractures. Arthroscopy assisted fixation may increase the outcome in Schatzker type II-III-IV fractures. In Schatzker Type V and VI fractures, both techniques have both poor medium and long-term results, but they indicated Arthroscopic assisted treatment is best choice for the lower rate of infections.

Wang Z et al[64] who also compared the outcome of Arthroscopy assisted and Open reduction internal fixation methods they found that Both this method gave satisfactory clinical results for the treatment of the Schatzker I-IV tibial plateau fractures. Arthroscopy assisted technique led to better radiological results than open reduction and internal fixation techniques and concomitant soft tissue lesions can be addressed during Arthroscopy.

Our study is not the comparative study between arthroscopy assisted fixation and open reduction internal fixation to compare the outcomes between two groups. But we had excellent outcome in eleven cases of Schatzker type I-V tibial plateau fractures Hung et. al[56] reported excellent and good results for arthroscopic assisted fixation of tibial plateau fractures ranging from 85% - 90%.Chan . al on the basis of Rasmussen scoring system showed Satisfactory, good to excellent results in 96% cases at 2 – 10-years follow-up.Chiu et. al.[55] reported 92 % patients showed excellent clinical and radiological results according to Rasmussen score.

In our study ,clinically 11 (61.1%) patients had excellent outcome,1(5.5%) patients had fair outcome,3 (16.6%) had poor outcome.

Clinical poor outcome was because we failed to support the medial column with plate in Schatzker type VI fractures.

CONCLUSION

Arthroscopic Assisted tibial plateau fracture fixation is a technically demanding procedure and requires a long learning curve.

Arthroscopic assisted fixation of tibial plateau fractures is a reliable and safe method for the treatment of tibial plateau fractures, especially when they present with concomitant injuries. Arthroscopic evaluation of fracture reduction without an extensive arthrotomy incision enables optimal treatment of concomitant lesions. This study found excellent to good results as per Modified Rasmussen's clinical and radiological score at short term follow up in all Schatzker types of tibial plateau fractures.

REFERENCES

1) J.L.Marsh,Rockwood C A Jr,Green O P,Bucholz R W,Heckman J D.Tibial Plateau Fractures:Rockwood and Green's. Fracture in Adults.7th Edition,vol 2.Philadelphia:Lippincott Williams & Wilkins:2010.p!780-1830
2) Jensen DB,Rude C,Duus B,Bjerg-Nielsen A.Tibial plateau fractures:A comparison of conservative and surgical treatment.J Bone Joint Surg Am 1990;72:49-52.
3) Hohl M.Tibial condylar fractures.J Bone Joint Surg Am 1967:49:1455.
4) Laciewicz PF,Funcik T.Factors influencing the results of open reduction and internal fixation of tibial plateau fractures.Clin orthop 1990;210-5
5) Scheerlinck T,Ng CS,Handelberg F,Casteleyn PP.Medium-term results of percutaneous,arthroscopically-assisted osteosynthesis of fractures of the tibial plateau.J Bone joint Surg Br 1998;80:959-64.
6) Caspari RB,Hutton PM,Whipple TL,Meyers JF.The Role of arthroscopy in the

management of tibial plateau fractures.Arthrosc J Arthrosc Realt Surg off Publ Arthrosc Assoc N Am Int Arthrosc Assoc 1985;76-82.
7) Burdin G.Arthroscopic management of tibial plateau fractures: Surgical Technique.Orthop Traumatol Surg Res 2013;99(1):S208-18.
8) Schulak DJ,Gunn DR. Fractures of the tibial plateaus- A review of the literature.Clin Orthop 1975;109:166-77. .
9) DeCoster TA,Nepola JV,el-Khoury GY.Cast brace treatment of proximal tibia fractures A ten year followup study.Clin Orthop Relat Res 1988(231):196-204
10) Dalamarter R, Hohl M and Hopp E Jr. Ligament injuries associated with tibial plateau fractures. Clin Orthop 1990; 250:226.
11) Apley AG.Fractures of the lateral tibial condyle treated by skeletal traction and early mobilization;a review of sixty cases with special references to the long term results J Bone Joint Surg Br.1956;38-B(3):699-708
12) Moore TM, Patzakis Mj, Harvey JP Jr. Tibial plateau fractures: definition, Demographics, Treatment rationale, and long term results of closed traction management or operative reduction. J Orthop Trauma.1987;1(2):97-119.
13) Duparc and Ficat. Fracture of Tibial plateau in Insall et. al. Surgery of Knee 2nd ed. New York, Churchill Livingstone,1995, Vol:2,1074
14) Palmer I, Compression fractures of lateral tibial condyle and Their treatment. J Bone and Joint Surg 1939; 2(Am):674.
15) Palmer I, Fracture of the upper end of Tibia. J Bone and Joint Surg : 1951; 33(Br):160
16) Roberts J.M. Fractures of the Condyles of Tibia, An Anatomical and Clinical End Result study of 100 Cases. J Bone and Joint Surg 1968; 50(Am): 1505.
17) Porter B B. Crush fractures of Lateral Tibial Table, Factors influencing the prognosis. J Bone and Joint Surg 1970; 52(Br): 676.
18) Schatzkar J, Mc Broom R, and Bruce D. The Tibial Plateau fractures- Toronto Experience.Clin Orthop,1979; 138:94.
19) Lachiewicz PF and Funik T. Factors Influencing the results of Open reduction and Internal Fixation of Tibial Plateau Fractures.Clin Orthop 1990; 259:210.
20) Dalamarter R, Hohl M and Hopp E Jr. Ligament injuries associated with tibial plateau fractures. Clin Orthop 1990; 250:226.
21) Tscherne H and Lobenhoffer P. Tibial Plateau fractures- Management and Expected Results. Clin Orthop 1993; 292: 87.
22) Sushil H Mankar,Anil v Golhar.Outcome of complex Tibial Plateau Fractures treated with External Fixator, Indian J Orthop.2012. 570-574.
23) Thomas G, Padanilam and Nabil A. Meniscal detachment to approach lateral Tibial Plateau Fractures Clin Orthop 1995; 314: 192-198.
24) Ballmer FT, Hertel R, Notzil HP. Treatment of Tibial Plateau Fractures with Small fragment Internal fixation; a preliminary report.J Orthop Trauma 2000; 14(7): 467-74
25) Mills WJ and Nork SE.Open reduction and Internal Fixation of High energy tibial Plateau Fractures.Orthop Clin North Am 2002;33: 177-194.
26) Jong-Keun O, Chang-Wug O, In-Ho J, Sung-jung K, Hee-soo K, IL-Hyung P et al. Percutaneous plate stabilization of proximal tibial fractures.J Trauma Aug 2005; 5: 431-437.
27) Sirkin MS, Bono CM, Reilly MC, Behrens FF. Percutaneous methods of tibial Plateau Fixation. Clin Orthop 2000; 375: 60-8.
28) Hammadouche DD, Duparc F, Beaufils P. The arterial Vasculaturization of the lateral Tibial Condyle: Anatomy and Surgical applications. Surg Radiol Anat 2006; 28; 38-45.
29) Koval KJ, Sanders R, Borelli J et. al. Indirect reduction and Percutaneous Screw Fixation of Displaced Tibial Plateau fractures. J Orthop Trauma. 1992; 6(3): 340-346
30) Duwelius PJ and Rangitsch MR. Treatment of Tibial Plateau Fractures by limited Internal Fixation. Clin Orthop 1997; 339: 47-57.
31) Harper MC, Henstorf JF, Vessely MB. Closed Reduction And Percutaneous Stabilization of Tibial Plateau Fractures. Orthopaedics.1995; 18(7); 623-626.
32) Keogh P, Kelly C, Cashman WF, et al. Percutaneous Screw Fixation Of Tibial Plateau Fractures. Injury.1992;23(6):387-389.
33) Lobenhoffer P, Schulze M, Gerich T, et. al. Closed Reduction/Percutaneous fixation of Tibial Plateau Fractures: Arthroscopic vs Fluoroscopic control of Reduction. J Orthop Trauma 1999; 13(6): 426-431.
34) Caspari RB,Hutton PMJ,Whiplle,Meyers JF.The Role of arthroscopy in the management of tibial plateau fracture.Arthroscopy 1985;1:76-82.
35) Jennings JE. Arthroscopic Management of Tibial Plateau Fractures. Arthroscopy.1985.1(3)160-168.
36) Tarek A. Aziz Mahmoud, Mohamed A Radwan. Functional Results of Percutaneous fixation of displaced tibial plateau fractures assisted by arthroscopy. Egyptian Orthopaedic Journal 2014.
37) Burdin G. Arthroscopic management of tibial plateau fractures: surgical technique. Orthop Traumatol Surg Res 2013; 99:S208-S218
38) Jennings JE. Arthroscopic management of tibial plateau fractures. Arthroscopy 1985; 1:160-168.
39) Chan YS, Yuan LJ, Hung SS, Wang CJ, Yu SW, Chen CY, et al. Arthroscopic-assisted reduction with bilateral buttress plate fixation of complex tibial plateau fractures. Arthroscopy 2003; 19:974-984.
40) Chan YS, Chiu CH, Lo YP, Chen AC, Hsu KY, Wang CJ, Chen WJ. Arthroscopy-assisted surgery for tibial plateau fractures: 2- to 10-year follow-up results. Arthroscopy 2008; 24:760-768.
40) Lemon RA, Bartlett DH. Arthroscopic assisted internal fixation of certain fractures about the knee. J Trauma 1985; 25:355-358
41) Hung SS, Chao EK, Chan YS, Yuan LJ, Chung PC, Chen CY, et al.. Arthroscopically assisted osteosynthesis for tibial plateau fractures. J Trauma 2003; 54:356-363.
42) Suganuma J, Akutsu S. Arthroscopically assisted treatment of tibial plateau fractures. Arthroscopy 2004; 20:1084-1089.
43) Chan Y-S.Arthroscopy – assisted surgery for tibial plateau fractures.Chang gung Med J 2011;34(3) :669-75.
44) Bucko GM,Johnson DH.Arthroscopy-assisted operative management of tibial plateau fracture.Clin Orthrop 1996;332:29-36
45) Susan standring.Knee in Gray's Anatomy.Newell R LM ana Davies.MS Ed.29thEd.Spain Elsevier Churchill Livingstone.2005:1471-86.
46) Netter FH.Atlas of human Anatomy.3rd Ed.Teterboro New Jersey Icon Learning System.2003;488-94
47) Whittle AP and Wood II GW.Fractures of Lower Extremity chapter 51 in Cambells operative Orthopaedics Canale ST Ed:10th Edn,Vol 3:New York,Mosby 2003:2782-2796
48) Schatzker J,Ma CBroom R,Bruce D.The tibial plateau fracture.The Toronto experience 1968-1975.Clin Orthop 1779;138:94-104
49) Hohl M.Part I :Fractures of the proximal tibia and fibula.In:Rockwood ,C ,Green D,Bucyholz R,eds.Fractures in Adults,3rd.Philadelphia,JB:Lippincoot,1992:1725-57
50) Muller ME,Nazarian S Koch P.Classfication AO des Fractures.Berlin:Springer-Verlag;!897,p.71-6.
51) Duwelius Pj and Rangitsch MR.Treatment of tibial plateau fractures by limited internal fixation.Clic ORthop1997:339:47-57.
52) Roerdick WH,Oskam J,Vierhout Pam.Arthroscopically assisted osteosynthesis of tibial plateau fracture in patients older than 77 years.Arthroscopy2001;17:826-831
53) Xibg-zuo chen M.D.,Cheng-Gang Liu.,Ying Chen,M.D.,Li-qiang wang, M.D.,Qian-zheng zhu,M.D., an Peng Lin,M.D.Systematic review Arthroscopy -Assisted Sugery for tibial plateau fracturesArthroscopy:The J arthroscopic and related surgery,Vol 31,No 1(January),2015:143-153.
54) Benea H, Tomoaia G, Martin A, Bardas C. Arthroscopic management of proximal tibial fractures: technical note and case series presentation. Clujul Medical. 2015;88(2);233-6
55) Shen G1, Zhou J. Comparison study on effectiveness between arthroscopy assisted percutaneous internal fixation and open reduction and internal fixation for Schatzker types II and III tibial plateau fractures. 2011 Oct;25(10):1201-4
56) Chiu CH,Cheng CY,Tsai MC,Et all Arthroscopy -assisted reduction of posteromedial tibial plateau fractures with buttress plate and cannulated screw construct.Arthroscopy 2013;29:1346-1354
57) Belanger M,Fadale P.Compartment syndrome of the leg after arthroscopic examination of tibial plateau fracture.Case report and review of literature.Arthroscopy1997;13:646-51
58) Hung SS,Chao Ek,Chan YS, et al.Combined arthroscopically assisted osteosynthesi fir tibial plateau
59) Buchko GM,Johnson DH.Arthroscopy -Assisted operative management of tibial plateau fractures.Clin Orthop 1996;12:598-602
60) Bernfeld B,Kligman M,Roffman M.Arthroscopic assistance for unselected tibial plateau fractures.Arthroscopy 1996;14:263-70.
61) Holzach P, Matter P, Minter J. Arthroscopically assisted treatment of lateral plateau fractures in skiers: use of a cannulated reduction system. J Orthop Trauma 1994;8:273—81.
62) Rockwood and Green's fractures in adults 8th edition,Vol 2.Wolters Kluwer:p2364
63) Dall'oca C,Maluta T,Lavini F,Bondi M,Micheloni GM,Bartolozi P.Tibial plateau fractures:Compared outcomes between ARIF and ORIF.Strateg Trauma Limb Reconstr 2012;7(3):163-73
64) Wang Z,Tang Z,Liu C,Liu J,Xu Y.Comparison of outcome of ARIF and ORIF in the treatment of tibial plateau fractures.Knee surg sports Traumatol Arthrosc.2016 Aug 23
65) Research analysis wing, Institute of Orthopaedics and Traumatology (IOT RAW)