Journal Homepage: -www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI:10.21474/IJAR01/16718
DOI URL: http://dx.doi.org/10.21474/IJAR01/16718

RESEARCH ARTICLE

ASSESSMENT OF FUNCTIONAL OUTCOME AND COMPLICATIONS OF HIGH ENERGY SCHATZKER TYPE V AND VI PROXIMAL TIBIA FRACTURES MANAGED BY OPEN REDUCTION AND INTERNAL FIXATION

Choudhari P.[1], Jain N.[2] and Singh K.[3]

1. Professor and Head Department of Orthopaedics, Sri Aurobindo Medical College and Postgraduate Institute, Indore.
2. Assistant Professor Department of Orthopaedics, Sri Aurobindo Medical College and Postgraduate Institute, Indore.
3. Third Year Postgraduate Resident Department of Orthopaedics, Sri Aurobindo Medical College and Postgraduate Institute, Indore.

Manuscript Info

Manuscript History
Received: 20 February 2023
Final Accepted: 24 March 2023
Published: April 2023

Key words:-
Schatzker Type V and VI Tibial Plateau Fractures, Open Reduction And Internal Fixation, Oxford Knee Score

Abstract

Background: Schatzker Type V and VI tibial fractures are complex injuries and are usually treated with open reduction and internal fixation. Although there are many other treatment methods, there is no gold standard treatment for these fractures. Hence, the present study was undertaken to evaluate outcome and associated complications of open reduction and internal fixation for Schatzker type V and VI proximal tibial fractures.

Methodology: This observational study was conducted on 32 patients with Schatzker type V and VI tibial plateau fractures. Patients of age more than 18 years of any gender with these fractures were included. Clinical and radiological assessments were done at 1, 3 and 6 months postoperatively. Oxford Knee Scoring system was used for assessing the functional outcome. Analysis of repeated measurements was done using Generalized Estimating Equations method. A p value <0.05 was taken as statistically significant.

Results: The mean of the patients was 44.66 ± 12.31 years. Right side affection was more common. Complete radiological union was achieved in 84.4%, malunion in 12.5% and non-union in 3.1%. Most of the patients achieved union within 15-20 weeks. Knee stiffness (18.8%) was the commonest complication encountered. The mean Oxford score showed a significant improvement from 1 month till 6 months ($p<0.05$), but we could not find any significant differences in the mean Oxford score between the type V and VI tibial plateau fractures. Excellent and goods results were seen in 43.8% each; fair in 9.4% and poor in 3.1%.

Conclusion: Open reduction with internal fixation had shown good to excellent results in our study in patients with Schatzker type V and VI tibial plateau fractures with low rate of complications.

Corresponding Author:- Singh K.
Address:-Third Year Postgraduate Resident Department of Orthopaedics, Sri Aurobindo Medical College and Postgraduate Institute, Indore. 9685230352.

Introduction:-

Schatzker type V and VI tibial fractures are complex injuries, usually treated with open reduction and internal fixation (ORIF). The advantage is that pin tract care is not required.[1] It provides good fracture reduction and stability, but the disadvantage being higher rates of complications – deep wound infection, unplanned secondary procedures and even amputation.[2–5]

The proximal tibial fractures account for 1.2% of all the adult fractures.[6] Road traffic accidents, sports injuries or fall from height are the causes for such high energy trauma. Mechanism of injury is based on presence of an initial axial load which fractures the tibial articular surface resulting in impaction. Most of the time, the initial load is coupled with angular forces, which causes the metaphysis as well as the articular surfaces to deform. The medial compartment is split into medio-lateral direction with a posteromedial main fragment combined with various amounts of multi-fragmental lateral compartment depression. Surgery and fixation of bicondylar tibial plateau fracture is complicated because of metaphyseal and articular comminution and the frequent occurrence of related soft tissue injuries. Due to the complex anatomy and the high level of force transmission that the tibial joint surface is subjected during axial loading, its reconstruction is a major challenging avenue.[7]

Surgical treatment for these fractures is a challenging task for most surgeons. They are complex fractures, associated with soft tissue insult, increased post operative wound complications, are difficult to reduce, and satisfactory fixation for stabilization is tough.

Many treatment options are available, such as screws, external fixator, hybrid external fixation,[8] limited internal fixation combined with a tension wire,[9] classic dual buttress plates, a unilateral locking plate, and hybrid dual plates.

However, no optimum course of action has yet been determined.Hence, the present study was undertaken to evaluate the functional and radiological outcome and associated complications of treatment of Schatzker type V and VI proximal tibial fractures with open reduction and internal fixation with various implants.

Methodology:-

The present observational study was conducted in the Department of Orthopedics, Sri Aurobindo Medical College and Postgraduate Institute, Indore (M.P.) over a period of 18 months (from 01.04.2021 to 30.09.2022) on 32 patients with Schatzker type V and VI tibial plateau fractures.

The inclusion criteria waspatient of age more than 18 years, of any gender, with Schatzker type V or VI tibial plateau fracture. Patient with associated fracture such as fracture of ipsilateral lower limb, pelvis, or spine; compound fractures; associated vascular injuries; or patient not willing to participate in the study were excluded from the study.

The study was approved by the Institutional Ethics Committee and prior to the inclusion of any patient into the study, a voluntary written informed consent was obtained from the patient and/or his/her legally acceptable representative. The present study was not funded by any pharmaceutical company or any institution. All the expenses towards the conduct of the study was borne by the investigator.

All the eligible patients were explained about the study in great detail in their own language, including the aim and objectives, procedure being performed, risks/benefits, compliance, etc. All the study related procedures were initiated after obtaining the voluntary written informed consent.

Pre-Procedure Protocol

All the patients underwent thorough physical and clinical examination. Preoperative radiographs of knee with leg in antero-posterior (AP) and lateral views were obtained. CT scan of knee joint was done in all cases. Patients were given initial splintage in the form of above knee slab posteriorly, limb elevation for soft tissue swelling to subside and condition of skin noted. All the patients who underwent surgery were counselled in their own language and explained in detail about the nature of the disease, anesthesia and the operative procedure and possible complications. Preoperative investigations were done for each patient along with pre-anesthetic check-up. Parenteral

routine antibiotics were given 1 hour prior to surgery. All the patients were operated under spinal or combined spinal epidural anesthesia. After the surgery, check X-ray was taken.

Intra-Operative Protocol

All the patients were operated using standard techniques described for approaching the proximal tibia like anterolateral, medial, and posteromedial approach. Patients were taken in supine position under spinal or combined spinal and epidural anesthesia; and tourniquet was applied in all the cases. A figure of 4 position was made when medial or posteromedial approach was required.

Post-Operative Protocol

All the patients were advised to follow the postoperative protocol:

1. Antibiotics coverage was given till suture removal (initial 3 days intravenously and rest 10 days orally)
2. Sutures were removed on 14th-15th postoperative day
3. Check X-rays were taken immediately after the surgery
4. NWB gait and static quadriceps strengthening exercises were started from the next day of surgery
5. Knee range of motion exercises and Dynamic quadriceps strengthening exercises were permitted post suture removal
6. Patients were kept non-weight bearing till 6 weeks post operatively.

Follow-Up Protocol

Patients were called for review at 2 weeks for stitch removal and evaluated for functional and radiological outcome thereafter at 1 month, 3 months & 6 months postoperatively; thereafter till bony union and maximal functional recovery was achieved. Clinical and radiological assessment was done at each follow-up.

Clinical union was defined when the fracture site is stable and when there is absence of abnormal mobility and pain. Radiographic union was defined when plain radiographs show bone trabeculae or cortical bone crossing the fracture site. Union was determined by union in ¾ cortices.

The information collected was noted in proforma and functional outcome was be measured using oxford knee scoring system in terms of pain, and functional capacity and score of 40-48 represented excellent results.

Grading for the Oxford Knee Score

Score	Explanation	Interpretation
Score 0 to 19	May indicate severe knee arthritis. It is highly likely that you may well require some form of surgical intervention, contact your family physician for a consult with an Orthopaedic Surgeon.	Poor result
Score 20 to 29	May indicate moderate to severe knee arthritis. See your family physician for an assessment and x-ray. Consider a consult with an Orthopaedic Surgeon.	Fair result
Score 30 to 39	May indicate mild to moderate knee arthritis. Consider seeing your family physician for an assessment and possible x-ray. You may benefit from non-surgical treatment, such as exercise, weight loss, and /or anti-inflammatory medication	Good result
Score 40 to 48	May indicate satisfactory joint function. May not require any formal treatment.	Excellent result

Data was collected on a customized proforma.

Statistical Analysis

Descriptive statistics were presented as numbers and percentages. Analysis of repeated measurements was done using Generalized Estimating Equations method. A p value of <0.05 was taken as statistically significant.

Results:-

In the present study, we included 32 patients with Schatzker Type V and VI tibial plateau fractures.23 (71.9%) patients had Schatzker Type V and 9 (28.1%) had Schatzker Type VI tibial plateau fracture.

Most of the patients were in the age group 41-50 years, with a mean age of 44.66 ± 12.31 years. The youngest patient was 22 years old and the oldest one was 70 years old.(Table 1)

Table 1:- Distribution according to age.

Age	Frequency	Percentage
21-30Years	4	12.5%
31-40Years	7	21.9%
41-50Years	11	34.4%
51-60Years	7	21.9%
61-70Years	3	9.4%

There were 26 (81.2%) males and 6 (18.8%) females.Right side affection was seen in 18 (56.2%) and left side in 14 (43.8%) patients.

Thirty-one (96.9%) patients sustained injury due to road traffic accident and 1 (3.1%) sustained injury due to fall from height.

Hypertension was present in 7 (21.9%) patients and diabetes mellitus in 3 (9.4%) patients. In 25 (78.1%) patients, no comorbidities were present.

Complete radiological union was achieved in 27 (84.4%) patients. Malunion was present in 4 (12.5%) patients and in 1 (3.1%) patient, there was non-union. The mean union time in our study was 16.65 weeks. Three (9.7%) patients achieved union within 12-14 weeks; 6 (51.6%) within 15-17 weeks; and 12 (38.7%) within 18-20 weeks.

The complications encountered in our study were knee stiffness in 6 (18.8%), deep infection in 5 (15.6%); and compartment syndrome in 1 (3.1%) patient. In 20 (62.5%) patients, there were no complications.

The mean Oxford Knee Score at 1 month was 25.34 ± 4.12; at 3 months, it was 31.69 ± 5.43; and at 6 months, it was 37.31 ± 6.32. There was a significant improvement in mean Oxford Knee score from 1 month till 6 months ($p<0.05$).

Table 2:- Mean Oxford Knee Score at different time intervals.

TimePeriod	Mean±SD	Pvalue
1 Month	25.34± 4.12	<0.001
3 Months	31.69±5.43	<0.001
6 Months	37.31±6.32	<0.001

At 6 months, according to Oxford Knee Scoring system, excellent results were obtained in 14 (43.8%); good results in 14 (43.8%); fair results in 3 (9.4%); and poor result in 1 (3.1%) patient. (Table 3)

Table 3:- Functional outcome at 6 months (Oxford Knee Score).

Oxford Knee ScoreImpression(6Months)	Frequency	Percentage
Excellent	14	43.8%
Good	14	43.8%
Fair	3	9.4%
Poor	1	3.1%

Comparison of mean Oxford Knee score between the Schatzker Type V and VI tibial plateau fractures at different time intervals showed a significantly higher mean Oxford Knee score in Type V tibial plateau fracture in comparison to Type VI at 1 month ($p=0.046$); and at 6 months ($p=0.022$); while at 3 months, the mean Oxford Knee score was comparable between the two Schatzker types ($p=0.064$). But a statistically significant improvement was seen at 6 months when compared with 3 months and 1 months in both the Schatzker types ($p<0.001$).(Table 4 and Figure 1)

The overall change in Oxford Knee Score over time was compared in the two groups using the Generalized Estimating Equations method, was found to be statistically not significant ($p=0.090$). (Table 4)

Table 4:- Mean Oxford Knee Score within and between the Schatzker type V and VI tibial plateau fractures over three time points.

OxfordKneeScore	SchatzkerClassification		P value forcomparison of thetwo groups at eachof the timepoints(Wilcoxon-Mann-WhitneyTest)
	V	VI	
	Mean(SD)	Mean(SD)	
1Month	26.26(2.49)	23.00(6.32)	0.046,*
3 Months	32.87(3.95)	28.67(7.55)	0.064, NS
6 Months	38.87(4.97)	33.33(7.87)	0.022,*
P Value for change inOxford Knee Scoreover time within eachgroup(FriedmanTest)	<0.001*	<0.001*	
Overall P Value forcomparison of changein Oxford Knee Scoreover time between the two groups(GeneralizedEstimatingEquations)	0.090, NS		

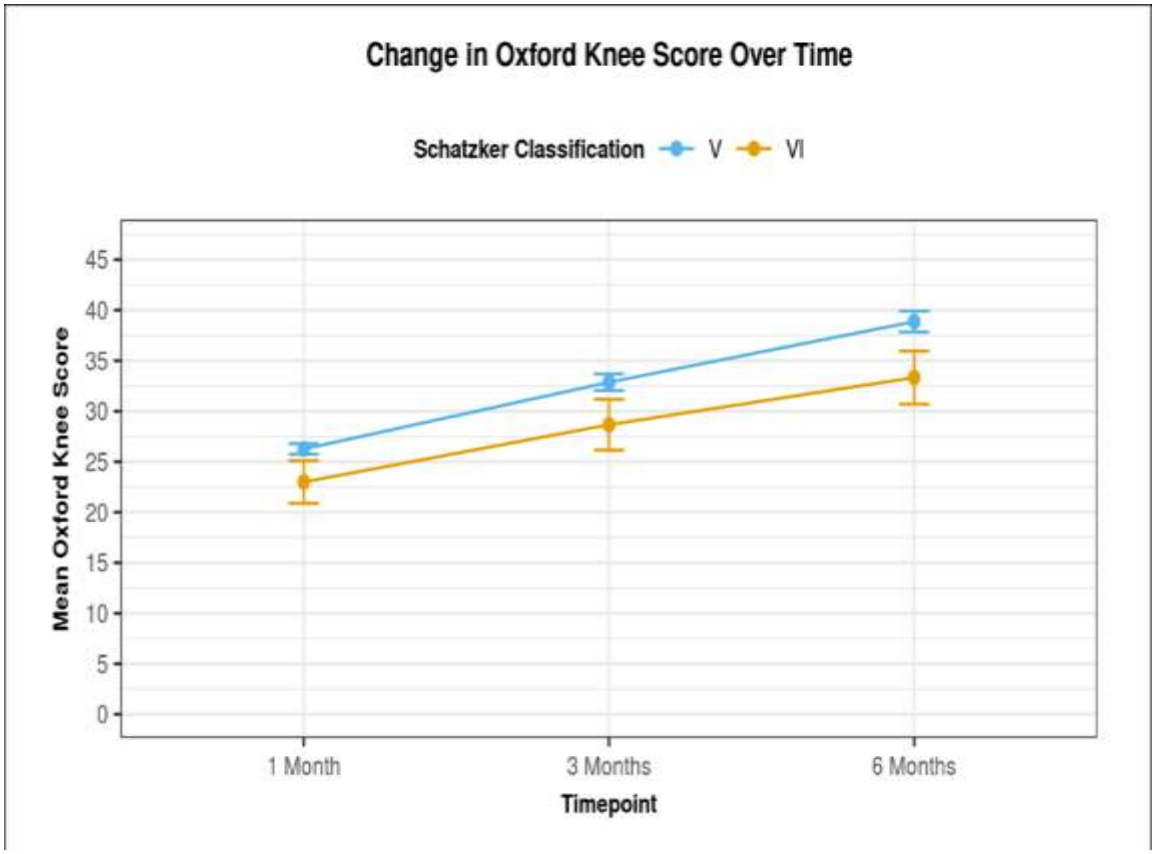

Figure 1:- Trend lines shows the change in mean Oxford Knee score over three time points.

Discussion:-

We included 32 patients with Schatzker Type V and VI tibial plateau fractures in our study, who underwent open reduction internal fixation.

Majority of the patients in our study were in the age group 41-50 years, with a mean age of 44.66 ± 12.31 years. The youngest patient being 22 years old and the oldest one being 70 years old. The mean age of patients in Rai et al.,[10] study was 35.6 years; in Citaket al.,[11] study, it was 51.3 years and 51.2 years; and Biggiet al.,[12] study, the mean

age was 43 years. The mean age of the patients reported by Biggiet al.,[12] was similar to our study, while the mean ages reported by other authors varied from the present study.

Male preponderance was seen in our study. Studies done by Rademakerset al.,[13]Biggiet al.,[12] and Kumar et al.,[14]also reported a male preponderance, which supports our study's finding.These fractures are more common in males due to their increased outdoor activities and reckless driving behavior on the roads.

Right side was most commonly affected. Similar to our study's finding, Rasmussen et al.,[15] reported a higher prevalence of right side involvement (50.38%); and contrary to our finding, the studies done by Kumar et al.,[14] and Raj et al.,[10] reported a higher prevalence of left side involvement.

Road traffic accident accounted for the majority of the injuries in the present study. Studies done by Raj et al.,[10] and Biggiet al.,[12] reported that majority of the patients sustained injury due to road traffic accidents, which supports our study's finding. Contrary to our study's findings, the studies done by Rademakerset al.,[13] and Mardian et al.,[16] reported a lower prevalence of road traffic accidents.

Most of the fractures in our study were Schatzker type V and 28.1% were type VI. Contrary to our study's findings, the studies done by Youssef et al.,[17] Raj et al.,[10] and Kumar et al.,[14] reported a higher prevalence of Type VI fractures.

Hypertension and diabetes mellitus were seen in some of the patients, while most of the patients did not have any comorbidities.

Most of the patients achieved complete radiological union. While few patients showed malunion and in 1 patient there was non-union. In the studies done by Rohraet al.,[18]and Oh et al.,[19] most of their patients had achieved complete radiological union. In Rohraet al.[18] study, malunion was reported in 5 out of 34, and in Oh et al.[19] study, limb shortening by 1 cm and mild malalignment in 2 was reported.

The mean union time was 16.65 weeks. Most of the patients achieved union within 15-20 weeks.Biggiet al.,[12] reported a mean union time of 15.6 weeks; in Lee et al.[20] study, it was 18.8 weeks; and in Neogiet al.[21] study, it was 14 weeks. The mean union time was comparable with these studies.

The mean Oxford Knee Score at 1 month was 25.34 ± 4.12; at 3 months, it was 31.69 ± 5.43; and at 6 months, it was 37.31 ± 6.32. There was a significant improvement in mean Oxford Knee score from 1 month till 6 months ($p<0.05$).

At 6 months, according to Oxford Knee Scoring system, excellent results were obtained in 14 (43.8%); good results in 14 (43.8%); fair results in 3 (9.4%); and poor result in 1 (3.1%) patient. In Prasad et al.[22] study, excellent results were achieved in 40%, good in 40%, and fair in 20%. And in Khatri et al.[23]study, excellent results were achieved in 83%, good in 10.7%, fair in 4.6% and poor in 1.5% patients. Our results are comparable with that of Prasad et al.,[22] while Khatri et al.[23] reported a better outcome in comparison to our study.

Comparison of mean Oxford Knee score between the Schatzker Type V and VI tibial plateau fractures at different time intervals showed a significantly higher mean Oxford Knee score in Type V tibial plateau fracture in comparison to Type VI at 1 month ($p=0.046$); and at 6 months ($p=0.022$); while at 3 months, the mean Oxford Knee score was comparable between the two Schatzker types ($p=0.064$). But a statistically significant improvement was seen at 6 months when compared with 3 months and 1 months in both the Schatzker types ($p<0.001$).

The overall change in Oxford Knee Score over time was compared in the two groups using the Generalized Estimating Equations method, and was found to be statistically not significant ($p=0.090$).

Knee stiffness was seen in 18.8%, deep infection in 15.6% and compartment syndrome in 3.1% patient. Of the 18.8% (6) patients who developed knee stiffness, malunion was reported in 4 patients and 2 patients did not comply with the postoperative protocol. They started early weight bearing and also did not follow exercise and physiotherapy protocols. One patient who developed compartment syndrome underwent fasciotomy. This patient developed deep infection which led to implant failure and eventualnon-union. All the 15.6% patients who developed deep infection underwent surgical debridement and intravenous antibiotic treatment. All these patients responded

well the given treatment. Knee stiffness was the most common complication seen in the study done by Kumar et al.[14] which is similar to our study's finding. Superficial infection in 2 patients, articular depression in 1 and varus collapse in 1 was reported by Raj et al.[10]

The limitations of the study are: (a) a small sample size; (b) short follow-up duration (only 6 months); (c) surgery performed by different surgeons. With a short follow-up, long-term complications could not be evaluated and as the surgeries were performed by various surgeons, the outcome may vary according to the expertise of the operating surgery. Even though our study had limitations, the results obtained were comparable with the available literature.

Conclusion:-

In our study, we had treated Schtazker Type V and VI tibial plateau fractures with open reduction and internal fixation and found it to be effective in improving the functional outcome. Most of the patients had good to excellent functional outcome by 6 months. Complications were seen in only a few.

As the sample size of the present study was small, the data cannot be extrapolated to the general population. Hence, we recommend that a large, multicentric studies be conducted prior to generalizing the results.

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