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ORIGINAL RESEARCH

Evaluation of radiological and functional outcomes of Schatzker type V and VI tibial plateau fractures treated by dual-plate osteosynthesis via two incisions

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Abstract

Introduction: The management of Schatzker type V and VI tibial plateau fractures remains a challenging task despite the advent of various new devices and techniques. The goals of treatment are to obtain a stable, painless, and mobile joint; and also to prevent secondary degenerative arthritis. Anatomic reduction of the articular surface, restoration of axial alignment, and stable internal fixation are essential prerequisites to attain this objective, and it can be well realized by open reduction and internal fixation by dual plates through two incisions. **Objective:** To study the radiological and functional outcomes of Schatzker type V and VI tibial plateau fractures treated by open reduction and internal fixation by dual plates via two incisions. **Materials and methods:** 30 patients within the age group 21-59 years with Schatzker type V and VI tibial plateau fractures were included in the study. It was a prospective study conducted at B.L. Kapur Superspeciality Hospital, New Delhi, between August 2019 and January 2021. All patients underwent open reduction and internal fixation by dual plates using two incisions . The follow-up period varied from minimum 24 weeks to maximum 48 weeks . The results were analyased using Rasmussen's anatomical and functional grading systems. **Results:** The percentage of excellent , good and fair outcomes were 56.7,36.7 and 6.7 respectively as per Rasmussen's radiological criteria; and 36.7 , 53.3 and 10.0 respectively as per Rasmussen's functional criteria . There was no poor result in this study. The average duration for radiological fracture union was 18.4 weeks . 90% patients had at least 90^{o} knee flexion . **Conclusion:** Dual-plate osteosynthesis via two incisions is an effective and safe method of treatment of Schatzker type V and VI tibial plateau fractures, as it provides adequate exposure for restoration of congruity of tibial articular surface and stable internal fixation of fracture fragments under direct vision with minimum soft-tissue striping and complications.

INTRODUCTION

Tibial plateau fractures account for 1-2% of all fractures and about 8% of fractures in the elderly [1]. Schatzker type V and VI freatures comprise about 23% of them [2]. In younger population , high-energy trauma such as road-traffic accident or fall from height is the predominant mode of injury , while low energy trauma such as trivial fall is responsible for the fractures in elderly people with osteoporotic bones. These fracture have high potential for unsatisfactory outcome owing to the involvement of articular surface and subarticular cancellous bone, and also because of frequently occurring concurrent injuries to the skin , subcutaneous tissue , ligaments , menisci, vessels and nerves. The majority of Schatzker type V and VI tibial plateau fractures are caused by high-energy trauma and present with varying degrees of comminution, depression and displacement of one or both tibial condyles with or without disassociation of metaphysis from the diaphysis .

The optimal treatment of Schatzker V and VI tibial plateau fractures is debatable. Various treatment strategies have been advocated by different authors ,each with its merits and demerits . The commonly employed treatment methods include definitive external fixation , staged fixation (temporary external fixation followed by internal fixation), external fixation with limited internal fixation , percutaneous

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screw fixation , MIPO (minimally invasive plate osteosynthesis) and open reduction and internal fixation (single lateral plate construct or dual-plate osteosynthesis) . Traditional techniques of external fixation (e.g. Ilizarov) or hybrid external fixation have the advantage of preservation of the delicate soft-tissue envelope of proximal tibia , but are associated with risk of complications like pin site infection , septic arthritis of knee, as well as poor patient compliance . Single lateral locking plate avoids striping of soft tissues on the medical side but is associated with higher rates of postoperative varus collapse of the posteromedial fragment .

Dual plating is biomechanically proven to be the best stabilization option for Schatzker type V and VI tibial plateau fractures and can be performed either through a single midline incision or via two separate incisions . The single-incision technique involves extensive dissection of the delicate soft-tissue envelope of proximal tibia whereas dual-incision technique provides for better intraoperative visualization of the fracture geometry and stable fixation of the fracture fragments .

This study aims to determine the radiological and functional outcome of Schatzker type V and VI tibial plateau fractures managed by dual plating via two-incison technique.

MATERIALS AND METHODS

This study was conducted on 30 patients with Schatzker V and VI tibial plateau fractures treated in the Department of Orthopaedic Surgery , Dr. B.L. Kapur Superspeciality Hospital , New Delhi, during the period August 2019 to January 2021 . All patients underwent dual plate osteosynthesis through two incisions. Inclusion criteria included skeletally matured patients above 18 years of age presenting with closed or Gustilo Grade I compound unstable biocondylar tibial plateau fractures (Schatzker type V and VI) . Exclusion criteria included children below 18 years of age, Gustilo Grade II and III compound fractures, associated neurovascular injuries , late cases with infection, patients with serious comorbidities, and pathological fractures.

On admission, a through clinical examination was done to assess the general condition of the patient. Thereafter, the injured limb was subjected to detailed examination with particular attention to fracture geometry, swelling, skin condition, joint effusion, distal neurovascular status and signs of impending compartment syndrome. Standard anteroposterior, lateral and oblique radiographs of the knee joint and full length of tibia were taken. If fracture geometry could not be adequately assessed with radiographs, CT scan with 3D reconstruction was done. MRI of the knee was done in cases of suspected meniscus and ligament injuries. All tibial plateau fractures were classfied as per Schatzker classification and only those patients were selected who satisfied the inclusion criteria. Knee aspiration was performed under asceptic conditions in patients with tense knee effusion. If there was extensive soft-tissue injury,as indicated by tense edema or blisters , surgery was delayed. Calcaneal or lower tibial traction was applied and the limb was kept elevated on a Bohler -Braun splint till settling of tissue edema (appearance of wrinkles). Limb elevation helped in the reduction of swelling and lessened the chances of skin necrosis and compartment syndrome. Patients were subjected to definitive fixation when the general and local conditions were favourable.

Patients were operated in supine position with a sandbag under the gluteal region . Pneumatic tourniquet was applied in the upper thigh. Preliminary reduction and provisional fixation was done under C-arm image intensifier guidance. Definitive fixation was done later. Medial column fixation was done first. In case of severe communication of medial condyle, lateral condyle was fixed first. Articular depression was elevated by bone lever with compact cancellous bone beneath it, and the metaphyseal void thus created was filled with analogous cancellous bone grafts taken from ipsilateral iliac crest. Most commonly used approaches were anterolateral and posteromedial. 4.5 mm T or L buttress (locking or round hole) plate was used on the medial side. 4.5 mm anatomically contoured lateral proximal tibial locking plate was used to fix the lateral column. Surgical site was washed thoroughly with normal saline. Suction drain was inserted and the wound was closed in layers. Tourniquet was released and sterile dressings were applied. The lower limb was supported by a well-padded above knee POP slab.

Static quandriceps exercise was stated form the first day as tolerated by the patient. The suction drain was removed on the third postoperative day. Once the pain and tension in the operation site came down, gentle assited range-of-motion exercise of the knee was commenced. By the end of the first week, active range-of-motion exercise was started. Stitches were removed on the 14th postoperative day and the slab was replaced by above knee ROM knee brace. The patient was taught non-weight-bearing walking with axillary crutches and was advised to continue active exercises at home.Patients were were asked to attend OPD for follow-up.

First review was done at 6 weeks, and thereafter, every 6 weeks up to 24 weeks, and every 12 weeks upto 48 weeks. At each follow-up visit standard anteroposterior and lateral check X-rays were taken to assess the progress of union and any loss of reduction due to loosling or breakage of the implant. Other complications like wound infection (superficial or deep), wound dehiscence , hardware prominence and deformity were looked for. Data was obtained regarding pain, wound healing, range-of-motion of knee, and any secondary surgical procedure. Partial weight-bearing was allowed when the sings of radiological union started appearing, usually at 12 to 16 weeks, gradually progressing to full weight-

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bearing. After clinical and radiological union, data regarding functional recovery such as walking, ability to climb and descend stairs, and performance of daily activities was recorded . Return to pre-injury employment and ability to participate in sporting activity were also noted. Final radiological and functional outcomes were assessed with Rasmussen's anatomical and functional grading systems.

RESULTS

This study was conducted on 30 patients who satisfied the inclusion criteria. All of them underwent dual-plate osteosynthesis via two incisions. Results were analysed using Rasmussen's anatomical and functional grading systems.

Statistical analysis was conducted with SPSS version 20 software. Radiological and functional outcomes were compared with each other using chi-square test, taking p-value < 0.05 as significant.

Age distribution

The youngest patient was aged 21 yrs and the oldest patient was aged 59 yrs. Maximum number of patients belonged to the age group 31-40 yrs. The mean age was 37.2 $\pm$ SD 8.482 yrs. Age distribution is shown in Table.

Age groups	Frequency	Percentage
21-30 yrs	5	16.7
31-40 yrs	13	43.3
41-50 yrs	10	33.3
51-60 yrs	2	6.7

Table 1. Age distribution

Sex distribution: There were 24 male and 6 female patients in this study. Sex distribution is shown in Table 2.

Sex	Frequency	Percentage
Male	24	80
Female	6	20

Table 2. Sex distribution

Side involved: Right side was involved in 23 cases and the left side in remaining 7 cases. This observation is shown in Table 3.

Side involved	Frequency	Percentage
Right	23	76.7
Left	7	23.3

Table 3. Side involved

Mode of injury: The commonest mode of injury was RTA, being the cause of fracture in 26 cases. Ramaining 4 fractures were caused by fall from height. This observation is shown in Table 4.

Mode of Injury	Frequency	Percentage
RTA	26	86.7
Fall	4	13.3

Table 4. Mode of injury

Schatzker fracture type: 19 out of 30 patients had Schatzker type VI fractures, while remaining 11 had Schatzker type V fractures This incidence is shown in Table 5.

Schatzker classification type	Frequency	Percentage
VI	19	63.3
V	11	36.7

Table 5. Schatzker fracture type

Time taken for radiological union: 13 out of 30 fractures had radiological union within 12-18 weeks, while remaining 17 fractures united within 18-24 weeks. This observation is shown in Table 6. Mean time taken for radiological union was 18.4 $\pm$ SD 3.802 weeks.

Time taken for radiological union (weeks)	Frequency	Percentage
12-18	13	43.3
18-24	17	56.7

Table 6. Time taken for radiological union

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Range of motion: The range of motion of knee joint was $>140^0$ in 9 patients, 120^0 -140^0 in 11 patients, 90^0-120^o in 7 patients, and 60^0-90^0 in 3 patients. This observation is shown in Table 7. Mean ROM was 124.0+ SD 20.694 degrees.

Range of motion	Frequency	Percentage
$>140^0$	9	30.0
120^0-140^0	11	36.7
90^0-120^0	7	23.3
60^0-90^0	3	10.0

Table 7. Range of motion

Time taken for full weight-bearing: 9 out of 30 patients started unsupported walking between 12-18 weeks, 19 patients did so within 18-24 weeks, while remaining 2 patients commenced full weight-bearing between 24-36 weeks. This data is shown in Table 8. Mean time taken for full weight-bearing was 19.2+ SD 3.546 weeks.

Time taken for full weight-bearing (weeks)	Frequency	Percentage
12-18	9	30.0
18-24	19	63.3
24-36	2	6.7

Table 8. Time taken for full weight-bearing

Complications: 22 out of 30 patients developed some sort of complication. Supereficial infection was the most common complication. The different complications observed in this study are shown in table 9.

S.N.	Complications	Number of patients
1	Superficial infection	7
2	Deep infection	3
3	Wound dehiscence	1
4	Hardware impingement	2
5	Secondary surgical procedure	4
6	Knee stiffness	3
7	Malunion	2

Table 9.Complications

Radiological outcome: Radiological outcome was excellent in 17, good in 11, and fair in 2 cases. There was no poor result in this study The radiological outcome is shown in Table 10.

Radiological outcome grade	Frequency	Percentage
Excellent	17	56.7
Good	11	36.7
Fair	2	6.7
Poor	0	-

Table 10. Radiological outcome

Functional outcome: Functional outcome was excellent in 11, good in 16, and fair in 3 cases. There was no poor outcome in this study. Functional outcome is shown in Table 11.

Functional outcome grade	Frequency	Percentage
Excellent	11	36.7
Good	16	53.3
Fair	3	10.0
Poor	0	-

Table 11. Functional outcome

Correlation between Schatzker fracture type and radiological outcome: Among 11 cases with Schatzker type V fractures, radiological outcome was excellent in 6, and good in 5 cases. Among 19 cases with Schatzker type VI fractures , the radiological outcome was excellent in 11, good in 6 , and fair in 2 cases. These observations are shown in Graph1.

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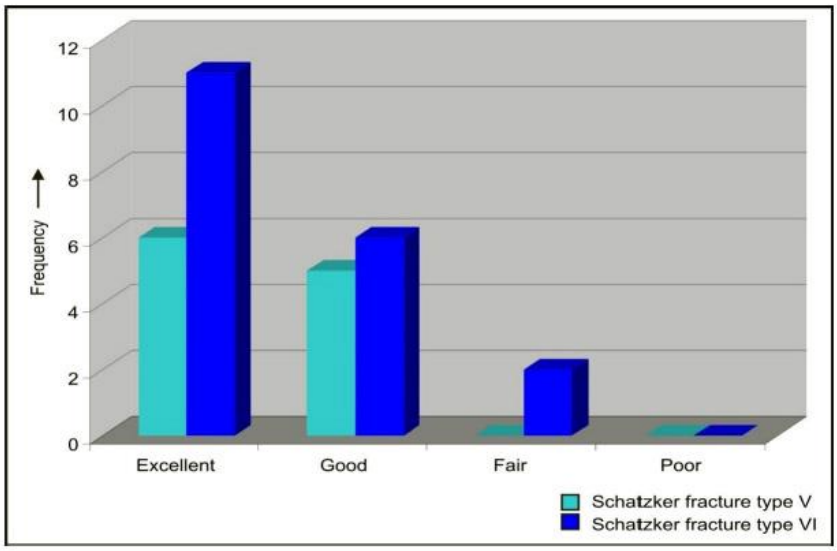
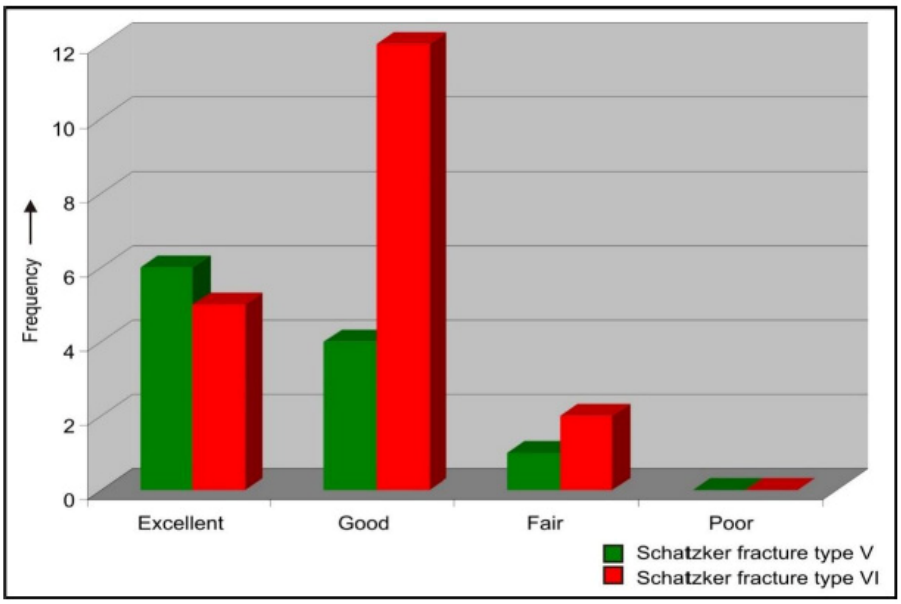


Graph 1. Correlation between Schatzker fracture type and radiological outcome

Correlation between Schatzker fracture type and functional outcome

Out of 11 patients with Schatzker type V fractures, functional outcome was excellent in 6, good in 4, and fair in 1 patient. Among 19 cases with Schatzker type VI fractures , the functional outcome was excellent in 5, good in 12, and fair in 2 cases. These observations are shown in Graph2.



Graph 2. Correlation between Schatzker fracture type and functional outcome

Correlation between radiological and functional outcomes: Among the 30 patients studied, the number of excellent, good, fair and poor grades in radiological outcome were 17,11,2and 0 respectively. In functional outcome, the number of these grades were 11,16,3 and 0 respectively. These observations are shown in Graph 3. However, overall satisfactory (excellent + good) radiological and functional outcomes were 28(93.3%) and 27(90%) respectively. Overall unsatisfactory (fair + poor) radiological and functional outcomes were 2(6.7%), and 3(10%) respectively. These differences are not statistically significant (p-value 0.626), and both these groups are comparable.

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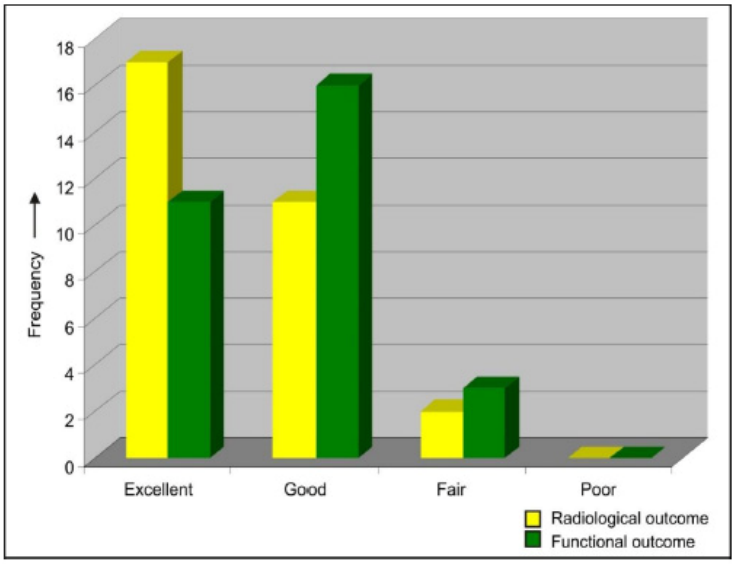
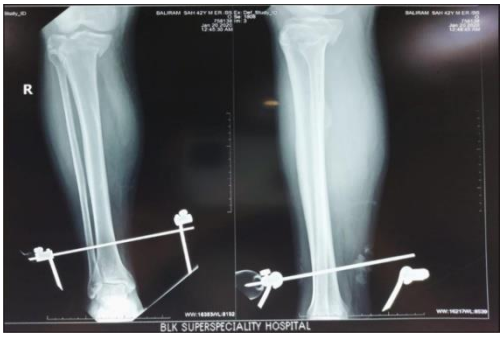


Graph 3. Correlation between radiological and functional outcomes

CASES:

1) Case no.1 -



1a. Pre-operative X-ray

1b. Post-operative X-ray

Fig.- Follow-up clinical picture of the patient showing healed scar with no extension lag

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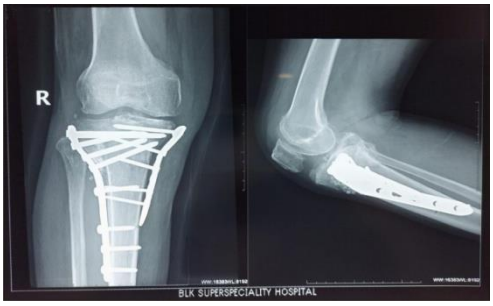
Fig.- Patient is able to walk without any pain with range of motion at knee joint rangingfrom 0 to 130 degrees

2) Case no.2 –

2a. Pre-operative X-ray



2b. Post-operative X-ray

Fig.- Intra-operative picture of the case (Schatzker type VI fracture treated with dual plating)

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3) Case no.3 –

3a. Pre-operative X-ray

3b. Post-operative X-ray

4) Case no.4 –

4a. Pre-operative X-ray

Fig.- Pre-operative 3D CT Scan

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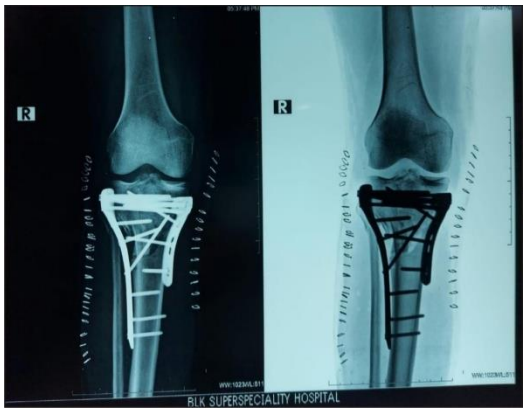

4b. Post-operative X-ray

DISCUSSION

Bicondylar Schatzker type V and VI tibial plateau fractures commonly occur in young persons as a result of high-energy trauma such as motor vehicle accident or fall from height. These injuries have complex fracture patterns due to severe articular and metaphyseal comminution and are often associated with soft-tissue injuries.

The management of these fractures is an arduous challenge to the orthopaedic surgeon because of high rate of complications like joint stiffness, infection, malunion, nonunion and post-traumatic degenerative arthritis.

The knee joint is a major weight-bearing joint and the aim of treatment should be to regain knee function to pre-injury level. Anatomical restoration of the articular congruity, proper alignment of axis of the knee in sagittal and coronal planes and stable internal fixation to permit early range of motion exercises, are essential to achieve this goal.

Several operative techniques such as unilateral locked plating, LISS plating, circular external fixation, hybrid external fixation, arthroscopy-assisted reduction and internal fixation, dual plate fixation using single or double incisions, have been developed to treat these injuries. All these methods have their merits and demerits. However, the best method of treatment of Schatzker type V and VI fractures is still debated.

The goal of our study was to evaluate the outcome of dual plating with two incisions and compare it with other studies to find out if this technique is better than the other techniques used.

Age Distribution: In our study, the mean age of patients who sustained tibial plateau fractures Schatzker type V and Vl came out to be37.2years with a standard deviation of 8.482 years. It was comparable with mean age of 37.7 years in study by Zhang Y et al [3]. The study conducted by Ebrahim Ghayem Hassankhani et al. [4] showed the mean age to be 35 which was also comparable to our study. Thus, our results came out to be consistent with earlier studies and indicated that these fractures are more common in younger age group.

Sex Distribution: In our study total 30 patients were taken, out of which 24 (80%) patients were male and rest 6 (20%) patients were females. In the study conducted by Thiruvengita Prasad et al. [5], there were 33 (82.5%) male patients and 7 (17.5%) female patients indicating a comparable result of both the studies with a clear male dominance in these type of fractures.

Mode of injury: In study conducted by Zhang Y et al. [3], 71 (89.9%) cases were of road traffic accidents, and 8 (10.1 %) cases were due to minor falls.Our study showed that 26 (86.7%) patients sustained fractures due to road traffic accidents and 4 (13.3%) patients were injured in simple falls or low energy trauma.This shows RTA as the major cause of such fractures and fall from height also contributing towards the mode of injury.

Type of fracture: 19 (63.3%) patients in our study sustained Schatzker type VI fracture and 11 (36.7 %) sustained Schatzker type V showing that type VI is more common than type V fractures.

Side involved: Frequency of right side getting affected was 23 (76.7%) and left side getting affected was 7 (23.3%) showing affiliation of the fractures more towards right side.

Complications: Out of the 30 patients studied, 7 patients developed superficial infection which subsided on its own with antibiotic therapy and dressings. Deep infection was encountered in 3 patients. Wound dehiscence occurred in 1 patient while 2 patients complained of hardware impingement. Knee stiffness was noted in 3 patients. 2 patients had malunion. There was no instance of implant failure, nonunion or post-traumatic arthritis. Ebrahim Ghayem Hassankhani et al.[4] in their study of treatment of proximal tibial fractures by double plate fixation recorded skin infection in 2 out of 22 patients.

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Yao et al. [6] advocate that a single lateral locked plate can be used to stabilize both tibial condyles. They argued that it avoids extensive soft tissue dissection and thus preserves the vitality of the delicate soft-tissue cover of proximal tibia which is largely subcutaneous. It has the advantage over classical buttress plate that it can be fixed by minimally invasive plate
osteosynthesis (MIPO) technique. This reduces the operation time and hospital stay effectively.

Many authors, however, do not share this view. Their studies have shown that adequate fixation of large posteromedial fragment, often present in these complex fractures, is not possible by this approach. Besides, fixation of medial fragment by screws alone is not stable and liable to varus collapse under axial loading.

In our study using dual plates with two incisions, this problem of posteromedial fragment fixation was well dealt with by applying medial plate and there was no varus collapse seen in any patient post operatively. Thus, it can be concluded that fixation with dual plates leads to less chances of varus collapse and results in a better fixation.

Egol KA et al. [7] reported 38 patients with complex bicondylar tibial plateau fractures treated with LISS plating system and concluded that it provides stable fixation of both condyles allowing early knee ROM exercises and results in favourable clinical outcome.

Gosling et al. [8] on the other hand, evaluated the outcome of LISS plating in 69 bicondylar tibial plateau fractures and reported that 16 patients had significant malreduction and 9 patients had substantial post-operative loss of reduction.

In contrast, our study evaluated the outcome of dual plating in 30 patients out of which only 2patients had malunion and no patient suffered post-operative loss of reduction thus indicating a significantly lower complication rates of dual plating in comparison with LISS plating system.

Lee MH et al. [9] in a study of 76 patients with Schatzker type V and VI tibial plateau fractures, treated with three methods (Group I – unilateral locked plating, Group II – classical dual buttress plates and Group III - hybrid dual plates : lateral locking compression plate and medial anti-gliding buttress plate), observed post-operative malalignment in about 20%,15.8% and 9.1% patients in group I, II and III respectively. They concluded that single lateral plate fixation results in lesser operation time and shorter hospitalization, but cannot always achieve stable fixation of the medial fragment. If the medial buttress cannot be established byreduction of lateral fracture, then open reduction of the medial side and buttressing the medial
fragment was necessary. Maximum incidence of malalignment in Group I occurred due to thepresence of posteromedial fragment which could not be fixed adequately by unilateral lateral locking plate fixation method. Barei et al. [10] and Ali et al. [11] also subscribe to the view that single lateral locked plating may not be as effective as dual plating in managing bicondylar tibial plateau fractures.

Barei et al. [12] and Higgins et al. [13] reported that the incidence rate of posteromedial fragments in patients with bicondylar tibial platean fractures was 28.8-59%. The presentation of posteromedial fragment makes reduction and fixation of complex tibial plateau fractures more difficult, especially when a single fixed-angle plate is used. Higgins et al. [14] in his biomechanical study on bicondylar tibial plateau cadaveric model, concluded that dual-plate fixation allows less subsidence when compared to isolated locked lateral plates. Lee TC et al [15] in a study of 15 patients with bicondylar tibial plateau fracture observed malreduction in 1 patient (6.7%) while fixation loss occurred in 3 patients (20%) with subsidence of the posteromedial fragment and varus alignment. They concluded that unilateral plating has limitations in patients with selective patterns of bicondylar tibial plateau fractures.

The results of our study correlates strongly with the above literature showing very less incidence of fixation loss or subsidence of posteromedial fragment and varus alignment with dual plating.

Gross et al. [16] reported a retrospective study of 40 patients with Schatzker type V and VI tibial plateau fractures treated by hybrid external fixators. They observed a low deep infection rate (2.5%) and 80% union but 52% patients had malunion. The functional result of these patients was identical to other studies. They cited the advantages of hybrid external fixation as: shorter operative time, less bleeding, shorter hospital stay and lower infection rate.

As compared, our study showed 3 deep infection (10%), with 100% union and only 2 malunion (6.67%) indicating much better radiological outcome as compared to hybrid external fixators.

Catagni et al. [17] reported a series of 59 patients treated with external circular fixation combined with limited internal fixation. The results were evaluated as excellent in 30 patients(50.85%), good in 27 patients (45.76%), fair in 1 patient (1.659%) and poor in another 1
1.695%). They concluded that their method enabled excellent to good results in most cases of complex tibial plateau fractures.

Barbary et al. [18] reported a study of 30 patients with Schatzker type VI fractures with Ilizarov fixator. In 18 fractures, they combined the treatment with minimal internal fixation. They observed excelled, good, fair and poor results in 18, 7, 1 and 2 patients respectively and concluded that such a strategy was clinically successful and had low morbidity associated with it.

In contrast, our study showed excellent, good, fair and poor radiological outcome as 17,11,2 and 0 respectively and clinical outcome as 11,16,3 and 0

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respectively. Overall satisfactory radiological and clinical outcome were 28 (93.3%) and 27 (90%) and unsatisfactory were 2 (6.7%) and 3 (10%) respectively. This concluded that our method also gave excellent to good results in majority of these complex fracture fixation.

However, external fixation system has two major disadvantages in the form of high incidence of pin tract infection and poor patient compliance due to external constructs, which are not faced in our treatment method.

Burdin [19] is of the opinion that arthroscopy-assisted percutaneous fixation with 6.5 mm cannulated screws is successful in Schatzker fractures types I-IV, but not in complex bicondylar Schatzker type V and VI fractures. However, arthroscopy may aid in reduction of articular surface and obviate the need of extensive arthrotomy. Complementary stable fixation is crucial and should allow early motilization to reap the benefits of arthroscopic assistance.

This discussion leads us to the view that less invasive techniques such as lateral internal fixation (LISS plating or locked compression plating), circular and hybrid external fixation, arthroscopy-assisted reduction and limited internal fixation, can be performed with less soft- tissue stripping than traditional medial and lateral plate constructs; however, reduction of articular surface is more difficult and the fixation is not so stable as to resist axial loading. The problems of pin track infection and poor patient compliance persist with external fixationdevices.

Buttressing of both medial and lateral compartments with dual plating is the gold standard for managing bicondylar tibial plateau fractures because they provide sufficiently rigid fixation to prevent medial collapse and subsequent varus deformity. It has been biomechamically proven as an effective method for stabilization after reduction of both fracture fragments and articular surfaces.

Cho et al. [20] used midline longitudinal incision for dual plate fixation in the treatment of high- energy Schatzker type V and VI tibial plateau fractures, and observed satisfactory clinical and radiological outcome. Hassankhani et al.[47] reported their study of 22 patients of Schatzker type V and VI tibial plateau fractures operated by dual plating using a single midline approach. Only 2 patients developed superficial infection, but none had deep infection.

Proponents of osteosynthesis of bicondylar Schatzker type V and VI tibial plateau fracturesby dual plating using two incision argue that single midline incision involves extensive soft- tissue dissection and compromises the vascularity of delicate soft-tissue envelope of proximal tibia resulting in unacceptably high rates of complications like delayed wound healing, superficial infection, deep infection and nonunion. Open reduction and internal fixation by dual plates via two incisions has lowest infection rates and other complications. Hence this strategy achieves all the goals of treatment of complex bicondylar Schatzker type V and VI tibial plateau fractures.

Oh et al. [21] reported the outcome of double plating through two small incisions by MIPO technique in a series of 23 unstable proximal tibial fractures. 21 patients had excellent or good clinical and radiological outcome. There was only 1 case of superficial infection and no deep infection was noted.

Prasad et al. [5] noted 80% satisfactory results of dual plating of high-energy tibial plateau fractures with minimal soft tissue complications. They used minimally invasive approach on the medial side in 36 out of 40 cases and open posteromedial approach in remaining 4 cases when the medial fragment was more posterior.

Khatri et al. [22] in a study of 30 cases of Schatzker type V and VI fractures treated by dual plating through two incisions, observed satisfactory (excellent + good) functional outcome in 28 cases and satisfactory radiological outcome in all cases.

The present study was conducted on 30 patients with Schatzker type V and VI fractures treated with dual plating via two incisions. The radiological outcome was satisfactory (excellent + good) in 28 cases and the functional outcome was satisfactory in 27 cases. There results compare favourably with other studies on these injuries treated by the same treatment modality.

CONCLUSION

From the present study, it can be concluded that

- Schatzker type V and VI tibial plateau fractures treated by dual plating via two incisions have predominantly excellent to good clinical outcome.
- The rate of complications is very low.
- Rigid internal fixation of both tibial condyles allows early range of motion exercises which is crucial to functional recovery.
- Weight bearing should be allowed only after solid radiological bony union to prevent secondary articular collapse.
- If the skin and soft-tissue conditions are good, ORIF should be done without further delay.
- Prognostic factors are : age of the patient, degree of comminution, skin and soft-tissue condition, associated injuries, co-morbidities, interval between injury and operation and patient's compliance to vigorous post-operative range of motion exercise programme.
- The incidence of excellent result was higher in radiological outcome than functional outcome. This difference was mainly due to knee stiffness, residual pain and restriction ofwalking

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capacity.

- There are certain limitations of this study, viz.:
  - The study comprises only 30 patients which is insufficient for drawing major conclusions.
  - The follow-up period is also small. A longer follow-up period of 5-10 years is desirable because post-traumatic degenerative arthritis takes several years to develop.

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