

## Original Research Article

# A COMPARATIVE ANALYSIS IN THE SURGICAL OUTCOME OF BICONDYLAR TIBIAL PLATEAU FRACTURES TREATED WITH DUAL PLATING AND LATERAL LOCKING PLATE.

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### ABSTRACT

**Background:** Management of tibial plate fracture represents a challenging problem in developing countries. The objective of the current study is to analyze the functional and radiological outcome of bicondylar plateau fractures treated with dual plating and locking plate.

**Materials and Methods:** This is a randomized controlled prospective study conducted in the Department of Orthopedics and Radiology at Mahatma Gandhi Government Hospital and Govt. K.A.P.V Medical College, Trichy on patients with closed Schatzker Type V and VI undergoing surgical fixation from October 2020 to September 2021. All the eligible subjects were recruited into the study consecutively by convenient sampling till the sample size is reached.

**Results:** A total of 20 patients with Type V and VI Schatzker fracture undergoing surgery are divided into two groups with one group undergoing dual plating and the other lateral locking plate. The mean age was  $49.1 \pm 8.44$  years in Dual plating group and  $41.1 \pm 8.74$  years in Locking plate group. In Dual plating group, the functional knee society score was excellent 30%, good for 40% and fair for 30%. In locking plate group, excellent for 40%, good for 40% and fair for 20%.

**Conclusion:** There was no statistically significant difference in functional knee society score and radiological score and outcome between the study groups ( $p$  value  $> 0.05$ ). For the treatment of bicondylar tibial plateau fractures, lateral locking plate fixation may yield clinical and radiological outcomes that are comparable to dual locking plate fixation.

**Keywords:** Bicondylar, Tibial Plateau Fracture, Schatzker Types, Malunion, Dual Plating, Lateral Locking Plate.

## INTRODUCTION

Tibial plateau fractures (TPFs) are common and difficult-to-treat injuries that can occur as a result of high- or low-energy trauma. Pedestrians and workers who are involved in work-related incidents are more likely to get complicated knee fractures. The main mechanism of injury is a varus or valgus load along with or without an axial load. Fractures of the tibial plateau can be lateral, medial, or bicondylar. The most common injury to the lateral section of the tibial plateau occurs as a result of a direct impact to the

lateral side of the knee. High-energy mechanisms such as axial load from falling from a height and landing on the foot, motor vehicle crashes, and other causes of direct trauma can cause injuries to the medial plateau. Bicondylar fractures are more prevalent than isolated medial plateau fractures in high-energy processes like these. Low-energy processes are more prone to cause tibial plateau fractures in the elderly or other groups suffering from osteoporosis. Only 1% of all fractures are tibial plateau fractures. Tibial plateau fractures occur 10.3 times per 100,000 persons each year. Patients with

tibial plateau fractures are on average 52.6 years old. Tibial plateau fractures have a bimodal distribution, with men under the age of 50 being more prone to sustain them by high-energy processes, which are usually connected with soft tissue injuries. Women over 70 are more prone to have tibial plateau insufficiency fractures as a result of falls. Orthopedic surgeons utilise the Schatzker classification system for tibial plateau fractures to diagnose the initial injury, plan therapy, and predict prognosis. The evaluation and restoration of the articular cartilage is the focus of treatment for type I, II, and III fractures. Type V and VI Schatzker fractures are high-energy fractures that are frequently accompanied by additional injuries and consequences, such as postoperative inflammation, wound issues, and infections. They usually have a bad prognosis. To treat Schatzker type V and VI fractures, a variety of surgical methods and fixation procedures have been devised. For faster fracture reduction and improved wound healing, the anterolateral single incision and anteromedial/posterolateral bilateral incisions have been the recommended surgical methods. The goals of operative treatment of these fractures include anatomic reduction with restoration of articular congruity, and rigid fixation to allow early motion. The treatment of these complicated fractures has evolved over time, and there is still a lot of debate over which fixation architecture is best.

Historically, displaced bicondylar fractures were treated with separate lateral and medial plates. A single, midline incision provided a convenient approach to dual plating of these fractures. However, the amount of soft tissue dissection needed to adequately expose the fracture through this approach devitalizes comminuted bone fragments and has been shown to have a high complication rate. Deep infection rate has been reported to be 73% to 80%. The advent of locking plate technology offered further hope of preserving soft tissues by using one implant applied through a single, lateral incision. Locking plates form a fixed angle device which should, at least theoretically, act as a cantilever to prevent the collapse of the medial condyle which occurs when non-locking screws move in relation to the side plate. Youssef et al surgically treated bicondylar tibial plateau fractures with the single lateral locked plate and got a good functional and anatomical outcome. They thought it was a good approach for fracture stabilisation as long as the right surgical technique was applied. A retrospective study on patients with bicondylar tibial plateau fracture (Schatzker V–VI) without posteromedial fragment, who underwent surgical treatment as the lateral locking plate fixation approach exhibited similar clinical and radiological results as the dual locking plate fixation technique in bicondylar tibial plateau fractures. A prospective study comparing the clinical results in single locked plating versus dual plating using two incision approaches reported that double plating through two incisions resulted in a better limb alignment and joint reduction with an acceptable soft tissue complication

rate. The purpose of this randomized controlled prospective study is to analyze the functional and radiological outcome of consecutive high-energy tibial plateau fractures, Schatzker type V or type VI, treated using a unilateral peri-articular locking plate and classic dual buttress plates.

## MATERIAL AND METHODS

### Study site

This study was conducted in the Department of Orthopaedics and Radiology at Mahatma Gandhi Government Hospital and Govt. K.A.P.V Medical College, Trichy.

**Study population:** All the eligible patients aged 18 to 60 years with closed fractures, Type V and VI Schatzker. And Compound fractures (Gustilo and Anderson Grade I and II) attended in the Department of Orthopaedics and Radiology at Mahatma Gandhi Government Hospital and Govt. K.A.P.V Medical College were considered as study population. Study design: The current study was a randomized controlled prospective study

**Sample size:** 20

**Sampling method:** All the eligible subjects were recruited into the study consecutively by convenient sampling till the sample size is reached.

**Study duration:** The data collection for the study was done between October 2020 to September 2021 for a period of 13 months.

### Inclusion Criteria

1. Age 18-60 Years.
2. Closed fractures.
3. Type V and VI Schatzker.
4. Compound fractures (Gustilo and Anderson Grade I and II)

### Exclusion Criteria

1. Compound fractures (Gustilo and Anderson Grade III)
2. Type I to IV schatzker
3. Age <18 and >60 years.
4. Compartment syndrome.

**Ethical considerations:** Study was approved by institutional human ethics committee. Informed written consent was obtained from all the study participants and only those participants willing to sign the informed consent were included in the study. The risks and benefits involved in the study and voluntary nature of participation were explained to the participants before obtaining consent. Confidentiality of the study participants was maintained.

**Data collection tools:** All the relevant parameters were documented in a structured study proforma.

### Methodology

#### Pre-Operative Protocol

- Routine Blood & Radiological Investigations & Anaesthetic Workup
- **Timing of Surgery:** Depending upon the skin condition of the patient Surgery

- SUPINE POSITION under Antibiotic Cover & Tourniquet control
- **Anaesthesia:** General or Regional
- **Implant:** Anatomical Lateral Locking plate, L & T buttress, Posteromedial plate, Hockey stick plate, Raft plate, 6.5 mm Cannulated Cancellous Screws.
- **Approach:** Anterolateral Approach, Posteromedial /Medial approach to tibial plateau.

#### Post-Operative Protocol

- Broad spectrum i.v antibiotics for 5 days.
- X ray will be taken for all cases after surgery.
- Suture removal was done on 14th post-operative day
- Patients were followed up fortnightly for one month followed by monthly interval for 6 months and functional outcome was analysed by knee society score & Fracture Union by Radiological score.

#### Follow Up

- During every visit pain, range of knee motion and angular deformity was assessed. Check x-ray was taken. Data obtained was filled in the proforma.
- Partial weight bearing started after 6-12 weeks.
- Full weight bearing started after 12- 16 weeks.

#### Assessment

- Functional assessment was done using KNEE SOCIETY score.

Excellent 80 Points – 100 Points

GOOD 70 - 79 POINTS

FAIR 60 -69 POINTS

POOR < 60 POINTS

#### Radiological Assessment Based On Cortical Union

- POOR ----- NO UNION
- GOOD ----- 2 CORTICAL UNION
- EXCELLENT--- 3 or 4 CORTICAL UNION

#### Study Technique

A. Clinical evaluation was done by knee society score

B. Radiological evaluation was done based on cortical union in post-operative period.

C. Statistical analysis was done thereafter.

Conclusion was given based on the observation.

#### Statistical Method

Function knee score, radiological score and outcome etc., were considered as primary outcome variables. Study group (A v/s B) was considered as primary explanatory variable. All Quantitative variables were checked for normal distribution within each category of explanatory variable by using visual inspection of histograms and normality Q-Q plots. Shapiro-wilk test was also conducted to assess normal distribution. Shapiro-wilk test p value of >0.05 was considered as normal distribution. For normally distributed Quantitative parameters the mean values were compared between study groups using independent samples t test and for non-normally distributed Quantitative parameters the median values were

compared between study groups using Mann Whitney U test. Data was also represented using clustered bar chart and box plot. Categorical outcomes were compared between study groups using Chi square test /Fisher's Exact test (If the overall sample size was < 20 or if the expected number in any one of the cells is < 5, Fisher's exact test was used. P value < 0.05 was considered statistically significant. IBM SPSS version 22 was used for statistical analysis.

## RESULTS

A total of 20 participants were included in the final analysis with 10 participants in each group.

There were 1 (10%) females and 9 (90%) males in Dual plating group and 1 (10%) females and 9 (90%) males in Locking plate group. There was not a statistically significant difference in gender between study group (P Value>0.05).

The side of injury was left for 3 (30%) participants and right for 7 (70%) participants in Dual plating group. The side of injury was left for 3 (30%) participants and right for 7 (70%) participants in Locking plate group. There was not a statistically significant difference in side of injury between study group (P Value>0.05).

In Dual plating group, the mode of injury was accidental fall for 1 (10%) participants and RTA for 9 (90%) participants. In locking plate group, the mode of injury was accidental fall for no participant and RTA for 10 (100%) participants.

The median time interval for surgery was 6 (4.75 to 7.25) days in Dual plating group and 5 (5 to 6) days in locking plate group. The median duration of surgery was 88 (80 to 95.75) minutes in Dual plating group and 52 (45 to 60) minutes in locking plate group. The median blood loss was 250 (200 to 262.50) ml in Dual plating group and 150 (150 to 200) ml in locking plate group. The median time for union was 13 (12 to 14) weeks in Dual plating group and 12 (10 to 12.25) weeks in locking plate group. The median follow up was 6 (4.75 to 6) months in Dual plating group and 5.50 (4.75 to 6) months in locking plate group. There was not a statistically significant difference in median time interval for surgery and follow up between study group (P Value>0.05). There was a statistically significant difference in median duration of surgery, blood loss and time for union between study group (P Value<0.05).

In Dual plating group, the bone grafting was for 3 (30%) participants and in locking plate group, the bone grafting was for 2 (20%) participants. There was not a statistically significant difference in bone grafting between study group (P Value>0.05).

In Dual plating group, the initial method of immobilization was pop for 8 (80%) participants and skeletal traction for 2 (20%) participants. In locking plate group, the initial method of immobilization was pop for 9 (90%) participants and skeletal traction for

1 (10%) participants. There was not a statistically significant difference in initial method of immobilization between study group (P Value>0.05). In Dual plating group, the post op complications were pain for 3 (30%) participants, knee stiffness for 2 (20%) participants and infection for 1 (10%) participants. In locking plate group, the post op complications were pain for 2 (20%) participants, knee stiffness for 2 (20%) participants and infection for 1 (10%) participants. No post op complications were observed for 40% participants in dual plating group and 50% participants in locking plate group. There was not a statistically significant difference in post op complications between study group (P Value>0.05).

In Dual plating group, the outcome was excellent for 3 (30%) participants, good for 4 (40%) participants and fair for 3 (30%) participants. In locking plate group, the outcome was excellent for 3 (30%) participants, good for 5 (50%) participants and fair for 2 (20%) participants. There was not a statistically significant difference in outcome between study group (P Value>0.05).

## DISCUSSION

The knee being a biomechanically complicated joint and the fracture patterns are frequently paired with injuries to the surrounding soft tissue, bicondylar TPFs remain a difficult challenge for most surgeons. A well-designed preoperative surgical plan with minimal needless soft tissue harm is required to get the best possible outcome. In recent years, a number of treatment alternatives have been developed, including simple skin traction, cast immobilisation, external skeletal fixation, open reduction, and internal fixation with different implants. In the operational treatment of tibial plateau fractures, rigorous adherence to the principles of anatomical reduction, rigid fixation, and early mobilisation has been emphasised. Visual reduction and proximal tibial alignment are advantages of the dual plate procedure, however soft tissue problems and injury to the periosteal blood supply are important concerns with this method of internal fixation. According to some experts, a single lateral locking plate can lower the risk of soft tissue injury and wound infection, but it is insufficient for multipart fractures. The current randomized controlled prospective study is conducted to analyze the functional and radiological outcome of bicondylar plateau fractures treated with dual plating and locking plate. A total of 20 patients with Type V and VI Schatzker fracture undergoing surgery divided into two groups with one group undergoing dual plating and the other lateral locking plate are included in the study. In the dual plating group, out of 10 cases, six were Schatzker type V and four were Schatzker type VI fractures. In the lateral locking plate group, three were Schatzker type V and seven Schatzker type VI fractures. There were no significant differences between the two groups in

terms of gender ratio, mean age, injured limb, or trauma mechanism. Joginath et al. had nonsignificant descriptive data differences among the two groups in their study where they examined a series of high-energy tibial plateau fractures with a bicondylar component that were treated with a unilateral periarticular locking plate, traditional dual buttress plates, or hybrid dual plates (combination of locking plate and buttress plate).<sup>69</sup> Citak et al. also reported no significant differences between dual plate group and lateral locking plate group in terms of patient age, sex, fracture type, fracture side, time from injury to operation ( $p > 0.05$ ). Both groups were similar in relation to the age distribution, mechanism of injury, fracture pattern and soft tissue injury in Neogi et al.'s study. Arouca et al.'s study had greater balance regarding the number of patients classified with Schatzker V or VI (44.7 and 55.3%, respectively) in Double-plate group than single lateral plate group (18.75% Schatzker V and 81.25% Schatzker VI), with a  $p = 0.0873$  as did our study where the distribution is 60%-40% in dual plating group and 30%-70% in lateral locking plate group with regards to Schatzker V and VI.

### Mean age and fracture type across studies between the two groups

Our study included preponderance of male patients in both groups with 90% and the mode of injury is road traffic accident except for one case of accidental fall. Patil et al., reported males to female ratio 3:1 and the most common mode of injury was motor vehicle accidents (in 63.3% patients), and the rest were injured by fall from height (23.3%) and domestic falls (13.3%) in their study. In Joginath et al.'s study, major mechanism of injury was motor vehicle accident in both groups. There was not a statistically significant difference in median time interval for surgery and follow up between study groups in our study ( $p$  Value>0.05). The lateral locking plate method reduced the operative time effectively with less blood loss. The median duration of surgery was 88 (80 to 95.75) minutes in dual plating group and 52 (45 to 60) minutes in locking plate group in our study. The median blood loss was 250 (200 to 262.50) ml in Dual plating group and 150 (150 to 200) ml in locking plate group. There was a statistically significant difference in median duration of surgery, blood loss and time for union between study groups ( $p$  value<0.05). Similar to our observation, Joginath et al.'s study showed a reduced operative time for lateral locking plate at  $76.6 \pm 14$ . while the dual plate surgery had mean operative time of  $101.4 \pm 18.23$  minutes. Mean blood loss in lateral locking plate group was  $69.3 \pm 14.36$  and  $69.3 \pm 24.31$  in dual plating group. Soft tissue dissection, surgery time, and hospitalisation time are all reduced using the single lateral approach technique for TPF with a precontour locking plate. In a meta-analysis of 559 patients,

Chang et al. found that a single lateral locking plate requires less surgical and bonding time, has less skin necrosis, and has a higher rate of loss of reduction;

other problems and radiographic outcomes were not statistically significant. Timeline of hospital stay and surgery were significantly shorter, and blood loss significantly less, in the lateral plate group than in the dual plate group ( $P=0.045;0.038;0.031$ ) as reported by Yao et al. in their study. Operative time and hospitalization period was shorter in case of fractures fixed with lateral locking plate in Kumar et al.'s study. In concordance with all the above studies, Neogi et al. also reported reduced surgical time for lateral locking plate.<sup>[12]</sup> In their study, Lee et al. also found that the single lateral approach technique with locking plate results in less operation time and less hospitalization period. Fracture recovery may be improved with the use of a single incision and minimize soft tissue damage, as in the lateral locking plate fixation approach. In the dual plating group, 20% had knee stiffness, 30% complained of pain and 10% had infection in the postoperative period. In the lateral locking plate group, 20% had pain 20% had knee stiffness, and 10% developed infection as postoperative complication. Joginath et al.'s study recorded no significant differences in complications between the two groups in their study namely Infection, Knee stiffness, Posttraumatic Arthritis, Malunion, Non- Union, Hardware Impingement, Refracture, and Implant failure.<sup>69</sup> Citak et al. discovered no cases of deep infection, 10% superficial tissue infection in the dual plate group and no signs of infection in the lateral plating group. Neogi et al. noted 6.69% having superficial infection the lateral plate group and 12.5 % in the dual plate group. In dual plate group, 13.3% had superficial skin necrosis and 13.3% had infection in Patil et al.'s study. The nonunion of bicondylar tibial plateau fractures occurs around 4% of the time. This problem can be caused by nutrient vascular damage, a bone defect, or a lack of proper fixation. There is no incidence of non-union but the median time for union was slightly longer at 13 (12 to 14) weeks in dual plating group as compared to 12 (10 to 12.25) weeks in the locking plate group.

Similarly, Citak et al. reported no nonunion in their study, which is related to the preservation of blood circulation of tissues during surgery. The rate of delayed-union was considerably lower in the lateral locking plate group than in the dual plate group ( $P=0.023$ ), according to Yao et al. There was no significant difference of union rate between the two groups in Kumar et al.'s study.<sup>70</sup> Mean time of union was 12.8 weeks in both groups with a standard deviation of 2.5 in lateral locking plate and 2.4 in dual plate group in Patil et al.'s study.

In tibial plateau fractures, a spongy bone defect is common. The mechanical support is protected by the bone transplant, which prevents late collapse. In our study, bone grafting was needed in 30% of patients in the dual plate group and 20% in the locking plate group, with no statistically significant difference between study groups ( $p$  value  $>0.05$ ). One patient in lateral locking plate group required bone graft in Citak et al.'s study.

Functional outcome is measured using the functional knee society score and it was excellent for 30% participants, good for 40% participants and fair for 30% participants in the dual plating group. In the locking plate group, the functional knee society score was excellent for 40% participants, good for 40% participants and fair for 20% participants. There was no statistically significant difference in functional knee society score and radiological score between study groups ( $p$  value  $>0.05$ ) in our study. There was no statistically significant difference in outcome between study groups ( $P$  Value  $>0.05$ ). Comparisons of the functional outcome in Joginath et al.'s study using the WOMAC score, disclosed better physical function with bilateral plating. They measured the functional outcome used WOMAC score, with the mean WOMAC score being  $36.5 \pm 5.88$  in the dual plating group and  $34.1 \pm 4.91$  in the lateral locking plate group. Patel et al. analysed the functional outcomes in patients treated with posteromedial buttress plate and reported excellent outcome in 67%, good in 26%, fair in 7%.

In Arouca et al.'s study, the radiographic characteristics studied (coronal and sagittal alignments, condylar enlargement, and joint reduction) revealed statistically significant differences between the two groups in the immediate postoperative period and six months following follow-up. Their study concluded that in the presence of a large and non-marginal medial fragment, a medial condyle in bone contact, no osteoporosis, and no fractures in the coronal plane, the single lateral locked plate is a good option, whereas the double-plate is still the gold standard for the restoration of cases of complex fragmentation. In concordance with our observations, Citak et al. also did not note significant differences in functional and clinical results between the groups. Similar observations are made by Yao et al. stating that both dual-plate and lateral locking-plate fixation produced satisfactory clinical and radiographic results. When the medial tibial condyle is relatively intact, a lateral locking plate can provide stability similar to a dual plate while reducing operative time and soft-tissue complications, which can aid fracture healing and shorten hospital stay. Kumar et al. measured the functional outcome using Rasmussen's score and 66.6% had excellent outcome, 25% good and 8.3% had fair outcome in the dual plating group while 62.5% had excellent outcome and 37.5% had good outcome in the lateral locking plate group. Lee et al.'s study was a rare study comparing conventional dual plates with hybrid dual plates and showed similar functional outcome when compared with a locking plate. For the treatment of bicondylar plateau fractures, lateral locking plate fixation may yield clinical and radiological outcomes that are comparable to dual locking plate fixation. There are no significant statistical differences in union rate or functional outcome between the two methods. The advantages of using single lateral locking plate in bicondylar fracture of knee are rigid fixation,

minimal exposure, less blood loss, minimal operation time and less chance of infection. Though there was no statistically significant difference in the outcome between the two groups, the important limitation is bicondylartibial plateau fracture with large posteromedial fragment needs to be separately and hence dual plating is preferred in the study.

## CONCLUSION

A total of 20 patients with Type V and VI Schatzker fracture undergoing surgery divided into two groups with one group undergoing dual plating and the other lateral locking plate are included in the study.

- In the dual plating group, out of 10 cases, six were Schatzker type V and four were Schatzker type VI fractures. In the lateral locking plate group, three were Schatzker type V and seven Schatzker type VI fractures.
- There were no significant differences between the two groups in terms of gender ratio, mean age, injured limb, or trauma mechanism.
- Our study included a preponderance of male patients in both groups with 90% and the mode of injury is road traffic accident except for one case of accidental fall.
- There was not a statistically significant difference in median time interval for surgery and follow up between study groups in our study (p Value>0.05).
- There was a statistically significant difference in median duration of surgery, blood loss and time for union between study groups (p value<0.05). Operative time and blood loss are relatively less in lateral locking plate surgeries.
- There was no statistically significant difference in functional knee society score and radiological score between study groups (p value>0.05) in our study.
- There was no statistically significant difference in outcome between study groups (P Value>0.05).
- There are no significant statistical differences in union rate or functional outcome between the two methods. Though there was no statistically significant difference in the outcome between the two groups, the important limitation is bicondylartibial plateau fracture with large posteromedial fragment needs to be separately and hence dual plating is preferred in the study.
- The advantages of using single lateral locking plate in bicondylar fracture of knee are rigid fixation, minimal exposure, less blood loss, minimal operation time and less chance of infection.

### Limitations and recommendations

Small sample size is a limitation of our study. The final follow-up evaluation was only 6 months after the surgery and long term consequences are not known. Further studies with greater sample, randomization and follow-up periods are recommended for a clearer picture.

## Summary

Management of bicondylartibial plateau fracture dislocations is a serious challenge in terms of soft-tissue complications, fracture morphology, early mobilization, and maintenance of alignment and reduction postoperatively. The gold standard technique for Schatzker type V and VI fractures is double-plate fixation. The usage of lateral locking plates, on the other hand, is steadily growing and getting some support in the literature. The current study is conducted in the Department of Orthopaedics and Radiology at Mahatma Gandhi Government Hospital and Govt. K.A.P.V Medical College, Trichy. This is a randomized controlled prospective study on patients with closed Schatzker Type V and VI undergoing surgical fixation from October 2020 to September 2021 in the orthopedic department. Functional knee score, radiological score and outcome etc., were considered as primary outcome variables. Study groups dual plating and lateral locking plate are considered as primary explanatory variable. A total of 20 patients with Type V and VI Schatzker fracture undergoing surgery are divided into two groups with one group undergoing dual plating and the other lateral locking plate. There were no significant differences between the two groups in terms of gender ratio, mean age, injured limb, or trauma mechanism. There was a statistically significant difference in median duration of surgery, blood loss and time for union between study groups (p value<0.05). There was no statistically significant difference in functional knee society score and radiological score and outcome between the study groups (p value>0.05). For the treatment of bicondylar plateau fractures, lateral locking plate fixation may yield clinical and radiological outcomes that are comparable to dual locking plate fixation. The advantages of using single lateral locking plate in bicondylar fracture of knee are rigid fixation, minimal exposure, less blood loss, minimal operation time and less chance of infection.

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