

## Functional outcome of Closed Schatzker Type V and VI Tibial Plateau Fractures managed by Open Reduction and Internal Fixation: A Prospective study.

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### ABSTRACT:

**Background:** Tibial plateau fractures tend to occur in patients with polytrauma and in elderly patients with history of significant fall. This study was undertaken to evaluate and explore new generation implant fixation in tibial plateau fractures which is expected to provide a stable fixation with minimum exposure, early mobilization, less complications and a better quality of life. **Materials and Methods:** About 45 cases who had sustained tibial plateau fractures (Schatzker type IVI) and managed by open reduction and internal fixation were included. Follow-up of these patients was done at 6 weeks, 3 months, and 6 months after surgery. We analyzed all our subjects using IKDC score for functional outcome and plateau depression measurement for radiological outcome at 3 months and 6 months. **Results:** All the 45 fractures analyzed in this study were graded in accordance to the Schatzker classification. It was observed that most of these fractures, i.e., 17 out of 45 (37.2%) were type VI and 14 out of 45 (30.2%) type V. The average knee flexion at 3 months was  $105.7 \pm 8.49$  degrees and at 6 months  $120.6 \pm 8.61$  degrees. After evaluation, it was observed that at 6 months, 3 patients had extension lag (7%) out total 45 patients. Most of the patients had average IKDC score of  $80.2 \pm 7.91\%$  at 3 months which increased to average  $86.92 \pm 8.05\%$  at 6 months. **Conclusion:** Achieving and maintaining anatomical reduction with open reduction and internal fixation helps in early mobilization and hence obtaining good functional and radiological outcomes of tibial plateau fractures type VI and type V.

**Key words:** Schatzker type IV and type V, Mippro plating, biological fixation, indirect reduction, tibial fracture damage.

### INTRODUCTION:

The tibial plateau makes up the superior articular surface of the tibia constituting one of the most critical loadbearing areas in the human body. 1 Fractures of this region represent a wide spectrum of severity, which range from simple injuries with predictably excellent outcomes after non-operative treatment to complex fracture patterns that challenge even the most experienced surgeons. Complex biomechanics of its weight bearing position and complex ligamentous stability and articular congruency are the main reason why these fractures are of concern to surgeon. Tibial plateau fractures represent approximately 1% of fractures in adults. Most of these injuries (55-70%) affect lateral plateau. Isolated injuries to the medial plateau occur in 10-23% cases; whereas bicondylar fractures noted in 10-30% cases. 4 Tibia plateau

fractures are result from a combination of axial loading with varus or valgus stress during flexion and extension movements. 5 Various classification systems are available for classifying these fractures including Schatzker classification system and AO classification. Classifying the fractures for the purposes of selecting optimal treatment is of increased importance. The Schatzker classification defines pathoanatomic in AP radiograph and suggests treatment strategies and this classification remains central to the language of tibia plateau fractures. 5,6 The Schatzker classification system for tibial plateau fractures, which divides these fractures into six types, is widely recognized by orthopedic surgeons to assess the initial injury, plan management and predict a prognosis. Schatzker type IV, V and VI fractures are high energy fractures often accompanied by other local and systemic injuries. In the

current medical literature there is no consensus about the best approach to treat these fractures. The management of tibial plateau fracture has been controversial and the objective of stable, pain free knee joint with a good functional range of motion as well as good radiological restoration of tibial articular surface of knee joint eluded most of the management modalities. Among the different options available, the surgical methods most commonly in use are plating, C.C. screws as treatment modalities for internal fixation and hybrid external fixation. Non-operative modalities like cast, braces or traction are complicated by intrinsic risks of poor functional results and extended hospital stay, whereas open reduction and stable internal fixation helps in maintaining the articular surface and restoration of the mechanical alignment which allows early mobilization of knee. Open reduction and internal fixation have its own complications. The purpose of this study is to evaluate the functional outcome by using international knee documentation committee score and radiological outcome by measuring tibial plateau depression on follow up of patients. We prospectively collected results of open reduction and internal fixation with The aim of study was functional & radiological outcomes of tibial plateau fractures treated with open reduction and internal fixation.

**MATERIAL AND METHODS:**

Study site Department of Orthopedics at smimer hospital surat.

**Study population:** Patients admitted in department of orthopedics at smimer hospital surat for treatment of intra-articular fractures of proximal Tibia.

**Study design:** Observational, Prospective Study.

**Sample size** 45 patients admitted in smimer hospital surat for intraarticular fractures of the proximal tibia from September 2021 – January 2022 were selected for this study. In this study  $n$  (sample size) =  $z\alpha^2p(1-p)/e^2$  where  $p$  is proportion,  $e$  is precision. Here  $\alpha= 5\%$  hence  $z\alpha = 1.96$   $p = 1\%$   $e = 3\%$   $n$  is coming as 43. Hence at least 45 patients have been taken for the study.

**Inclusion criteria:**

1. Displaced and unstable tibial plateau fractures
2. Skeletally mature patients
3. Closed or Gustilo Anderson type 1 and type 2 open fracture
4. Operated within 3 weeks of injury

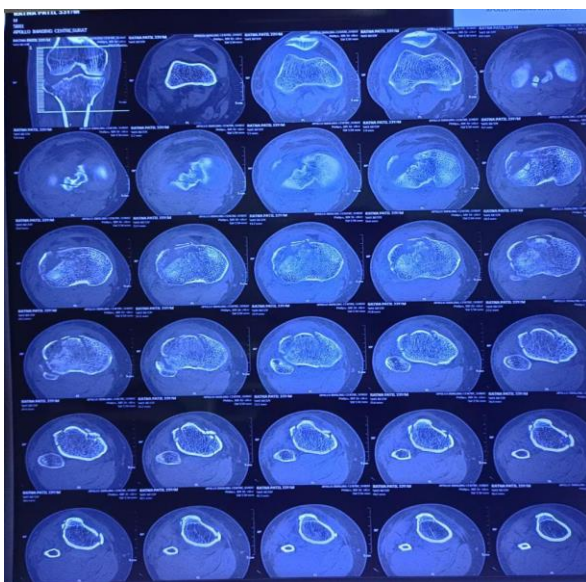
**Exclusion criteria:**

1. Pathological fractures
2. Open fracture with extensive soft tissue damage where plate cannot be covered with soft tissue
3. Concomitant lower limb fractures like patella, femur, ankle and pelvic fractures
4. Extra articular fracture of proximal tibia

After obtaining approval from our institutional scientific and ethical committee followed by informed consent getting duly signed, 45 adult patients with tibial plateau fractures of any grade were included in the study following the inclusion and exclusion criteria.

**Preparation of the patient in operation theatre:**

Anesthesia – All surgeries were performed under spinal anesthesia except in case with head injury in which general anesthesia was given.



**Pre op clinical photo**





### Pre-operation X-Ray

#### **Position:**

All the patients were operated in supine position with folded pillow under knee on a radiolucent fracture table. In all the patients a sponge pack was applied under the affected gluteal region in order to gain freedom in internal rotation of lower limb. The unaffected limb was kept in extended position. Pneumatic tourniquet was applied. The patient was prepared and draped, leaving the thigh exposed as required, for surgical incision and intra-operative evaluation of fracture alignment and image intensifier was positioned on the opposite side of the leg.

#### **Surgical approaches:**

There are two frequently used surgical approaches to reduce and internally fix tibia plateau fractures, which are anterolateral approach and posteromedial approach. They are used in isolation for fractures of lateral and medial tibial plateau respectively. At present other approaches like anteromedial, posterolateral have becomes unusual or reserved for special circumstances to fix proximal tibia fracture fragments. Sub meniscal incisions were given to expose the joint.

#### **Anterolateral approach:**

The lateral condyle fracture was approached anterolaterally. "S" shaped incision was made starting 5 cm proximal to joint line curving the incision anteriorly over gerdy's tubercle and extend it distally 1cm lateral to anterior border of tibia. Fascial incision parallel to the anterior border of the iliotibial tract was made. Underlying muscle was retracted laterally. Joint capsule

was incised. Tibialis anterior was elevated by blunt dissection.

#### **Posteromedial approach:**

Through posteromedial approach to proximal tibia with approximately 6 cm incision over posteromedial border of proximal tibia after opening subcutaneous fat, the long saphenous vein and saphenous nerve were identified and preserved. Pes anserinus expansions were identified. Tibia was approached after incising pes anserinus longitudinally in the line of skin incision. The gastrocnemius muscle was gently freed from posteromedial surface by blunt dissection. It has got the advantage of relatively good soft tissue cover and it is widely separated from the antero-lateral approach allowing these two approaches to be combined when necessary.

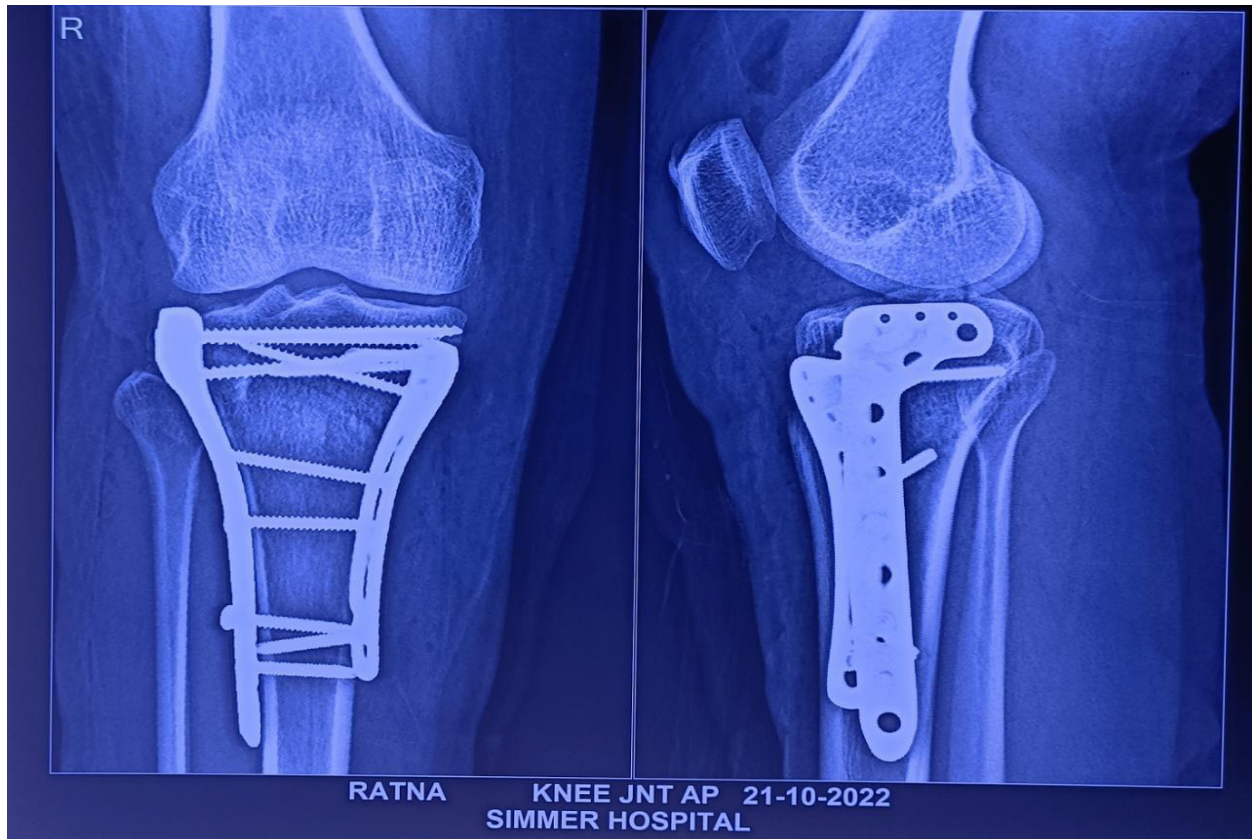
#### **Surgical technique:**

Fracture reduction was done under C-arm guidance by closed methods using ligamentotaxis for intraarticular fracture extending to metaphysical region. Combined traction with valgus or varus strain was done in flexion or extension of knee as per the need of the individual case depending upon the reduction. Sub meniscal arthrotomy was done for articular reduction under direct vision for severely depressed fractures. Compression bony clamp was used in cases to bring the fracture fragments together. Percutaneous K wires were used to hold the fragments in reduction. We typically fixed medial tibial condyle first. If medial condyle was comminuted then we fixed lateral condyle to achieve

length. The fragments were elevated and reduced, followed by temporary fixation with multiple small Kirschner wires in reduction position. If depression was present in articular surface, elevation followed by bone grafting using autologous bone graft or bone graft substitute was done. Anatomical contoured tibial locking plate for definitive fixation was then applied. Cortical screws (3.5/4.5mm) were used to attach the plate to the shaft of the tibia at distal most part. Then large locking head screws were inserted in the proximal part of the buttress plate, and the distal portion was completed with remaining cortical screws. The whole construct was checked under C-arm image intensifier, followed by closure of wound in layers.

**Post-operative protocol:**

Well-padded sterile dressing was done. Knee was not immobilized. Post-operative X-ray were done to document proper reduction and fixation of fracture fragments. Antibiotics (Intravenous/Oral) were continued till the wound condition necessitated. Active knee mobilization was encouraged as much as the patient could tolerate. Quadriceps exercises and ankle mobilization were started from 2nd or 3rd post operative day according to the tolerance of patients or associated injuries. Suture removal was done on 15th h post-operative day. Patient was discharged with non-weight bearing crutch walking. Progressive weight bearing was allowed according to the callus formation as assessed in follow up X Rays at 6 weeks.



**Follow up:**

We assessed the patients clinically and radiologically at regular follow up in OPD with X-rays done at 6 weeks, 3 months, and 6 months. During follow up post-operative complications related to procedure like infection, wound break down, arthrofibrosis and angular deformity were recorded. The final result was based on the functional and radiological outcome at 3months and 6 months. A preference for data collection of follow-up was post-op visits up to 6 months. The results were compiled and analysed using international knee documentation committee (IKDC) score for functional recovery at knee

joint and restoration of tibial articular surface by measuring plateau depression for radiological recovery after surgical intervention of fracture tibial plateau using anatomical contoured locking compression plate on final follow up at 6 months.

**IKDC score measures:**

IKDC is a subjective scale that provides patients with an overall function score. 14 The questionnaire looks at 3 categories: symptoms, sports activity, and knee function. The symptoms subscale helps to evaluate things such as pain, stiffness, swelling and giving-way of the knee.

Meanwhile, the sports activity subscale focuses on functions like going up and down the stairs, rising from a chair, squatting and jumping. Scores are obtained by summing the individual items, then transforming the crude total to a scaled number that ranges from 0 to 100. This final number is interpreted as a measure of function with higher scores representing higher levels of function and lower levels of symptoms. 14 2.15. Statistical analysis Categorical variables will be expressed as number of patients and percentage of patients and compared across groups using Pearson's Chi Square test for Independence of Attributes and Fisher's Exact Test as appropriate. Continuous variables will be expressed as Mean  $\pm$  Standard Deviation and compared across groups using unpaired t test/One Way ANOVA if the data follows normal distribution and Mann-Whitney U test/Kruskal Wallis Test if the data does not follow normal distribution. The statistical software SPSS version 20 will be used for the analysis. An alpha level of 5% has been taken, i.e. if any p value is less than 0.05 it will be considered as significant.

## **RESULTS:**

This was a prospective study to evaluate tibial plateau fractures managed with anatomical contoured locking compression plates. The study included 43 cases of fracture of tibial plateau presenting to the emergency and outpatient department of CMRI Hospital, Kolkata from 23rd September 2017 till 31st June 2018.

**Table 1: Age & sex distribution of subjects**

| Age    | Frequency | Percent |
|--------|-----------|---------|
| 21-30  | 2         | 4.7     |
| 31-40  | 25        | 55.8    |
| 41-50  | 14        | 30.2    |
| 51-60  | 3         | 7.0     |
| 61-70  | 1         | 2.3     |
| Sex    |           |         |
| Female | 8         | 16.3    |
| Male   | 37        | 83.7    |
| Total  | 43        | 100     |

**Table 2: Mode of injury [MOI] and side affected distribution**

| MOI   | Frequency | Percent |
|-------|-----------|---------|
| Fall  | 5         | 11.6    |
| RTA   | 40        | 88.4    |
| Side  |           |         |
| Left  | 29        | 65.1    |
| Right | 16        | 34.9    |
| Total | 43        | 100.0   |

## **Age incidence:**

It was observed in study, that fractures of tibial plateau were more common in younger (55.8%) and middle aged (30.2%) population with higher incidence in third and fourth decade. The age group of 31-40 years is perhaps the most productive period of one's life (Table 1). These severe injuries during this age are bound to have a negative effect on the life of this age group. Hence there is need for appropriate treatment of these injuries.

## **Gender distribution:**

Of the 45 patients analyzed 37 were males (83.7%) and 8 were females (16.3%). Road traffic accident was the common cause of fracture in all of these patients. The males being involved in outdoor activities in Indian settings makes them prone to vehicular accidents and hence the higher incidence of fractures was observed in them.

## **Mode of injury :**

The nature of injury was high velocity injury in 38 cases (88.4%) as it is explained by all patients sustaining road traffic accident. 5 (11.6%) cases had sustained injury as a result of trivial trauma and domestic fall as occurs in elderly with osteoporotic bone (Table 2).

### **Side of injury:**

Among the 45 patients analyzed in this study, 29 patients (65.1%) had left sided injury in tibia plateau fractures. The remaining 16 patients (34.9) had right sided tibial plateau fracture. In this study left side tibial plateau fracture was common being an important finding.

### **Injury to operation interval (time of surgery):**

The average period from day of injury to surgery was  $3\pm 0.98$  days with a range between 3 to 7 days (Table 3).

**Table 3: Injury operation interval**

|  | Mean | Median | Std. Deviation |
|--|------|--------|----------------|
|  | 3.74 | 3.00   | 0.98           |

### **Flexion of Knee joint:**

The average knee flexion at 3 months was  $105.7\pm 8.49$  degree and at 6 months  $120.6\pm 8.61$  degree. 14 patients 285 with single plate fixation showed movement more than 29 patients with dual plate due to less intraoperative soft tissue strip off. In our study it's noted that in all

patients flexion of knee was gradually improved at 6 months. The reason for fair range of motion in 8 patients was poor adherence to physiotherapy and late weight bearing and in 2 patients due to stiffness caused by infection. (Table 4).

**Table 4: Distribution of subject according to flexion movement at 3 and 6 months**

|              | Mean   | Median | Std. Deviation |
|--------------|--------|--------|----------------|
| Knee flexion |        |        |                |
| 3 months     | 105.70 | 110.00 | 8.49           |
| Knee flexion |        |        |                |
| 6 months     | 120.58 | 120.00 | 8.61           |
| p Value      |        |        |                |
| Significance |        |        | <0.0001        |
| Significant  |        |        |                |

### **Extension lags at knee:**

After evaluation, at 3 months extension lag of <10 degrees was observed in 4 patients (9.3%). It was improved in 1 patient at 6 months, remaining 3 patients with extension lag (7.0%) out of total 45 patients. Another important findings was that extension lag was more common in type VI fractures.

case of impaired stair climbing was due to painful knee stiffness.

### **Pain during activity:**

In our study, we observed that pain during mild and moderate activity gradually improved to pain on moderate or strenuous activity and no pain from 3 to 6 month follow up. Thirty five (35) patients out of 45 had no pain on final follow up. We also noted that pain in type V and VI with dual plate fixation on strenuous activity at 6 months (20.69%) is more than type I to IV with single plate fixation (7.14%).

### **Squatting:**

It was observed in our study of 43 subjects, that at 3 months squatting was impaired in 32 patients (74.42%), which were improved at 6 months follow up showing impaired in 17 patients (39.53%). In the study it's also signified that majority of patients with impaired squatting out of 17 at 6 months follow up were Type V 3(23.08%) and VI 11(68.75%) fractures.

3.12. IKDC score In our study, most of the patients average IKDC score was  $80.2\pm 7.91\%$  at 3 months which was increased to average  $86.92\pm 8.05\%$  at 6 months. Higher IKDC score is suggestive of higher level of functional outcome with lower level of symptoms. Another remarkable finding was in all patients mid-term follow up was good according to IKDC score which included symptoms, sports activity, and knee function.

### **Stair climbing:**

In our study stair climbing was impaired in 8 patients out of 45 (18.6%) at 3 months, which was improved to become 1 patient out of 43 (2.3%) at 6 months. In this

### **DISCUSSION:**

#### **Age and sex incidence:**



In this study of 45 subjects, it was observed that displaced and unstable fractures of tibia plateau were more prevalent in younger and middle aged population. The mean age being 44.86 years in unicondylar plateau fractures and 38.45 years in complex bicondylar plateau fractures (range 30-70 years). Males were more commonly affected than females (36 males and 7 females). In the study by Lee et al. (2007), 15 the mean age of the patients was 42 years (range 18 - 82 years). There were 23 male patients and 12 females. The mean age of the patients was 42 years (range 19-83) in the study by Stannard et al. (2004). 16 There were 25 males and 12 females in the same study. In another study by Schutz et al. (2003), 17 the patients included 6 women and 16 men aged between 22 and 59 years (mean age of 42 years). In a study by Sangwan et al. reported from North India (2002) 8 the average age of the patients was 35.5 years (range 21-50 years) with male to female ratio of 11.5: 1. Hence, proximal tibial fractures were seen in younger and middle aged population. Since this age group is involved in more outdoor activities in the Indian setting, so they are more prone for injury especially due to vehicular accidents.

#### **Mode of injury:**

In our study, we noted 5 out of 45 patients had domestic and accidental fall. Another 40 out of 45 patients suffered such fractures after high velocity road traffic accidents (88.4% of cases). In the study by Rademakers et al. (2007) 20 motor vehicle crash was the most common mechanism of injury present in 78% of cases. In the study by Lee et al. (2006), 15 the cause of the injury was an auto-versus- pedestrian accident in 17 patients, a motor vehicle accident in 11 patients, a fall in 4 patients, a blow in 2 and a shotgun injury in 1 patient. In the study by Stannard (2004), 16 patients sustained their fractures by the following mechanisms: motor vehicle accident; 21 fall; 11 motor vehicle versus pedestrian; 13 crush injury; 1 and airplane crash. 1 In the study by Sangwan et al. (2002), traffic accidents was the mechanism of injury in 21 patients while hit by an animal in 2 patients, fall in 1 patient and sport injury in 1 patient. Thus, proximal tibial fractures are more common after high energy trauma especially motor vehicular and bike accidents.

#### **Fracture class and type:**

All the 45 fractures analyzed in this study were graded in accordance to the Schatzker classification. We have met with all displaced and unstable fractures in that 1 type I fractures, 5 as type II, 5 as type III gross intraarticular lateral depression considered as it makes fracture configuration and joint unstable, commonly associated with meniscal trapping, 2 type IV fractures, 13 type V

fractures and 16 type VI fractures. In the study by Sangwan et al. (2002), 9 the fractures were graded using the criteria of Schatzker et al as type I in 9 patients, type II in 1 patient, type IV in 5 patients, type V in 2 patients and type VI in 8 patients. In another study by Rademakers et al. (2007), 20 70 patients had fracture of the lateral condyle (Schatzker I/II/III) and 7 had fracture of medial condyle (Schatzker IV). Fourteen (14%) had Schatzker type VI fracture. In the study of functional recovery by Gaston P et al. (2007) 21 reported the incidence of tibial plateau fracture according to Schatzker grading: 9 had type I, 23 had type II, 12 had type III, 11 had type IV, 3 had type V and 5 had type VI. This signified that majority of fractures in the study had severely comminuted intra-articular fractures. Higher grade of these fractures was attributed to high velocity trauma and low velocity trauma in osteoporotic bones even with low grade makes fracture unstable. 22–24 In our study out of 45 fractures, 9 fractures (18.6%) were open fractures and remaining 36 were closed fractures (81.4%). Open fractures indicate the severity of trauma associated with tibia plateau fractures. We have selected only Gustilo Anderson type 1 and 2 fractures. These are less severe soft tissue injury where after wound care internal fixation is sound option. We recorded that 7 out of 8 open fractures seen were type V and type VI fractures which is again suggestive towards high velocity of trauma mostly in RTA cases.

#### **Injury operation interval:**

The timing of surgery depended on the soft-tissue conditions. In our study of 45 fractures all underwent open reduction internal fixation within 3 weeks of injury. The average period from day of injury to surgery was 3 and half days in range of minimum 3 days to maximum 7 days. In study by Xu YQ et al. (2013), 25 wound complication incidences were 20.0%, 41.6%, 33.3%, 2.5%, and 16.7% within 4 hours, 4 hours to 3 days, 3-5 days, 5-8 days, and more than 8 days after injury respectively. They conclude optimal surgical timing is within 4 hours after trauma, for which no obvious swelling was observed in the limbs. This is followed by surgical timing within 5-8 days, after which trauma showed only subsided limb swelling. Girish H. et al. (2017), 26 conducted study of 32 cases of tibial plateau fractures with applying internal fixation system since injury within 4 hours of injury or 1 week after the injury, when the swelling and the inflammatory reactions have subsided. They noted only 3 cases of postoperative wound complication and infections. Final result in our study recorded that, there was no immediate postoperative wound complication in any patients after 3 and half day of injury operation interval. We have found

out that swelling and soft tissue tension reduced after 3 and half day from injury.

### **CONCLUSION:**

This was a prospective study to evaluate displaced and unstable tibial plateau fractures managed with anatomical contoured locking compression plates. In our study fractures of tibial plateau were more prevalent in younger and middle-aged population with male dominance. Left side involved in 65.1% and right side involved in 34.9%. All the fractures analyzed in this study were graded in accordance to the Schatzker classification. It was observed that most of these fractures i.e., 16 out of 43 (37.2%) were type VI and 13 out of 43(30.2%) type V. At final follow up we reported out of 45 cases 18.6% case having residual pain during activities and among these majorities of patient had pain on strenuous activities only. About 81.4% had no difficulty in any activities. The advent and development of anatomical contoured locking compression plates has effectively improved tibial plateau fractures fixation method. It is commonly seen, that most of the intraarticular proximal tibia fractures in developing countries are due to be RTA, which tends to be displaced and unstable fractures. At the same time surgical treatment options for the same are also being modified continuously. Achieving and maintaining anatomical reduction becomes easy with advanced design of these plates with less soft tissue dissection. So it helps in early mobilization and hence obtaining good functional and radiological outcomes of tibial plateau fractures. For rehabilitation following fixation there is no substitute for early physiotherapy.

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