



FUNCTIONAL OUTCOME OF INTRA-ARTICULAR FRACTURE PROXIMAL TIBIA MANAGED BY PLATE FIXATION VS JESS APPLICATION: A PROSPECTIVE COMPARATIVE STUDY

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ABSTRACT **Background:** One of the well-established methods for external fixation among the several treatment options for tibial plateau fractures is Joshi's external stabilization system (JESS). Closed reduction and JESS fixation offer the benefits of soft tissue preservation and early rehabilitation commencement, while open reduction and plate fixation provide superior reduction of articular fragments. **Aim:** The objective of this study was to compare the functional outcome between JESS and JESS application and Plate fixation for tibial plateau fractures of various grades. **Materials And Methods:** Out of total 60 patients, 18 and 36 patients were treated by JESS and Plating methods respectively and 6 were lost to follow-up. Patients were evaluated using the Modified Rasmussen Functional Score (MRFS) at every follow-up. Microsoft Excel and the statistical program SPSS 21 were used for the statistical analysis. To determine whether there was a significant difference between the groups, the student t-test was used. **Results:** The majority of the patients in the study were in the 20–30 age range (mean age: 35.72 years). Road traffic accidents were the primary cause (83.33% of cases), and males were more impacted than girls. There were 16 open fracture cases and 38 closed cases. Schatzker's type VI accounted for 62% of the total, while Schatzker's type V accounted for 18%. Six months was the follow-up period. When the two groups were compared at two and six weeks, a significant association was found (p value < 0.001). Both groups were equally effective at three, six, or the most recent follow-up periods, and the p -value was more than 0.05, indicating that the link was not significant. Both groups were significant at the most recent follow-up, with a p value of less than 0.001. **Conclusion:** According to this study, plating produces superior functional results than JESS when used to treat tibial plateau fractures.

KEYWORDS : Tibial Plateau Fracture, Schatzker classification, JESS, Plating, modified Rasmussen's Score

INTRODUCTION

Fractures involving the knee joint are quite grievous since they could lead to serious morbidity and a decline in quality of life. Tibial plateau fractures, also known as intra-articular proximal tibia fractures, make up about 1% of all fractures and are typically caused by axial stress in conjunction with certain varus and valgus forces¹.

The majority of proximal tibia fractures nowadays happen to people in the young age, ranging from 20 to 40 years old, and they are caused by falls from heights and high-speed motor-vehicle accidents.

There is currently no standard treatment plan for all kinds of complicated tibial plateau fractures. The main drawbacks of conservative therapy by plaster cast immobilization are insufficient articular surface reduction and poor control over limb orientation.² Although external fixation using the closed approach for fracture reduction encourages early mobilization and shortens hospital stays, closed reduction is not very effective in reducing fragments of fractures that are depressed and displaced. For the majority of displaced and unstable fractures, this calls for open reduction technique. By elevating the depressed articular fragment and fixing it with plates and screws, open fixation techniques achieve intra-articular congruency. The purpose of the current study was to evaluate the functional outcome of proximal tibia fractures treated with JESS in comparison to proximal tibia plating.

MATERIAL AND METHODS

This prospective comparative study was carried out in the Department of Orthopaedics, L.L.R. and associated hospitals, G.S.V.M. Medical College, Kanpur, Uttar Pradesh. It was conducted between December 2019 to November 2021.

Inclusion Criteria: All patients having proximal tibia fractures of <3 weeks duration including tibial plateau fractures, fractures with grade 3b or less Gustilo-Anderson classification with intact neurovascular status, skeletally mature individuals (>18 years age) of either sex, who gave consent for intervention and willing to come for regular follow-up were included in the study.

Exclusion Criteria: Patients with injury of >3 weeks duration, fractures of grade 3c Gustilo-Anderson classification, patients unfit for surgery and patients having pathological fracture were excluded from study.

METHOD:

As per the guidelines of institutional ethical committee, informed consent was taken from the patient on arrival in casualty / out-patient-department.

Following a comprehensive history and clinical assessment, patients underwent clinical and haematological investigations as well as a thorough pre-anaesthetic evaluation. Both lateral and AP radiographs of the afflicted tibia were obtained. CT scans performed when articular depression fractures are suspected. Schatzker's classification was used to categorize the fractures. During the preoperative phase, supportive interventions such as immobilization, knee aspiration to reduce hemarthrosis, limb elevation, etc were employed.

Operative care involved serially debriding fractures with compounding as needed prior to definitive surgical management.

Surgical technique for JESS application: Under C-arm guidance, comminuted articular fragments are reduced via Ligamentotaxis. Articular incongruity of more than 3 mm suggested open reduction with small incision. Once acceptable reduction is achieved, K-wires measuring 2-3 mm and 6.5 mm cancellous cannulated screws were inserted into the juxta-articular bone to preserve the reduction. Step two involves inserting three K-wires (2.5mm) at various angles into the juxta-articular bone parallel to the articular surface and three K-wires (3mm) parallel to one another in the distal tibia fragment. The mechanical axis was maintained and fragment rotation was avoided by adding more K-wires to the proximal and distal fragments, respectively. To create a stable JESS construct, all of the K-wires in the proximal and distal fragments were eventually joined to one another using JESS blocks and rods.

Surgical technique of proximal tibia plating: When feasible, reduction forceps were used to indirectly reduce articular displaced split

fractures under C-arm guidance; if not, open reduction was carried out. To preserve the reduction, subchondral screws were inserted using 3.5 mm cortical screws and temporary k-wires. To implant the locking plate submuscularly using an anterolateral approach, a lateral curving incision was made from Gerdy's tubercle that extended distally for roughly 5 cm. The position was verified using an image intensifier. Lastly, using the MIPPO (minimally invasive plate osteosynthesis) procedure, a plate is put to the anterolateral portion of the bone. When additional buttress was needed, posteromedial plating in the epiperiosteal plane was carried out in Schatzker's types IV, V, and VI.

Post-operative period: Both groups received the proper antibiotics at this time, and the JESS group had frequent pin tract dressings. On the day following surgery, passive knee flexion exercises were initiated. When pain was manageable, most patients began active range-of-motion activities at the knee and static quadriceps exercises on the third day. Quadriceps strengthening exercises came next. In both groups, partial weight bearing was initiated between weeks 8 and 10. Following clinical or radiological union, full weight bearing was permitted.

Follow-up period: PTB brace or stick support was advised based on patient needs. Following radiological or clinical union, the JESS was removed. For both groups, follow-ups were conducted at two, six, three and six months. The modified Rasmussen's functional score was used for each follow-up evaluation which included patient's complaints and progress.

Statistical Analysis: Microsoft excel and statistical software SPSS 21 was used for the analysis of data. Student t- test was applied to find if difference was significant between the groups. P value of <0.05 was considered to be statistically significant in the study.

RESULTS

Table 1: Demographic Characteristics

Age (Mean $\pm$ SD)	35.72 $\pm$ 11.56
Sex (Male/Female)	48/12
Mode of Injury	
RTA	50
Fall from height	5
Assault	2
Others	2
Side of the fracture	
Left	37
Right	23
Type of fracture	
Open	16
Closed	38

Table 1 shows about the demographic details of the study participants.

The mean age of the subjects was 35.72 $\pm$ 11.56 years. The sample included 48 males and 12 females. The majority of injuries were due to road traffic accidents (RTA) (50 cases), followed by falls from height (5), assaults (2), and other causes (2). Fractures were more common on the left side (37 cases) compared to the right (23). A higher proportion of fractures were closed (38 cases) than open (16 cases).

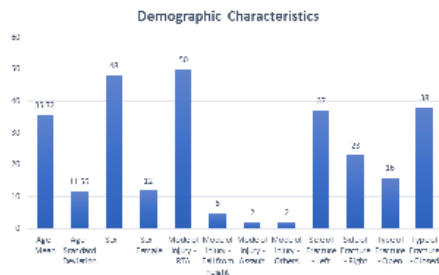


Table 2: Distribution Of Schatzker Types Of Fracture Among The Study Participants

Schatzker type	Frequency	Percentage
Type I	1	2
Type II	4	6
Type III	0	0
Type IV	7	12

Type V	11	18
Type VI	37	62
Total	60	100

Table 2: Distribution of Schatzker Types of Fracture among the Study Participants shows the frequency and percentage distribution of different Schatzker fracture types. The majority of fractures were classified as Type VI (62%), followed by Type V (18%), Type IV (12%), Type II (6%), and Type I (2%). No cases of Type III fractures were reported. In total, 60 participants were included in the study.

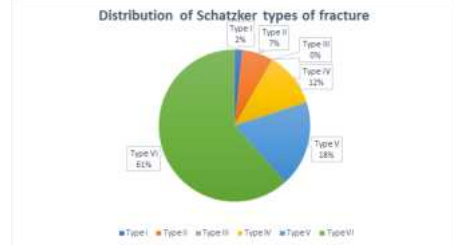


Table 3: Distribution Of Different Modes Of Stabilization

Schatzker type	Jess	Plating
Type I	0	1
Type II	0	2
Type III	0	0
Type IV	3	3
Type V	5	6
Type VI	8	26
Total	16	38

Table 3: Distribution of Different Modes of Stabilization shows the use of Jess and plating methods across different Schatzker fracture types. Plating was the most common method of stabilization, with 38 cases, while the Jess external fixation was used in 16 cases. Type VI fractures had the highest number of plating (26) and Jess (8) treatments. Types IV and V fractures also received a combination of both methods, with plating being more frequent. No cases of Type III fractures were treated with either method.

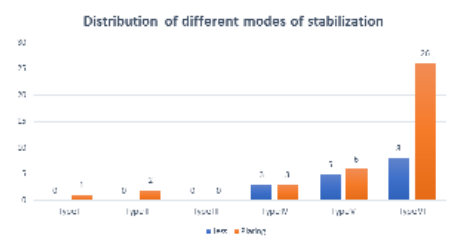


Table 4: Time To Weight Bearing

Mode of stabilisation	Average time in weeks
JESS	15.4
Plating	17.8
p-value < 0.001	

Table 4: Time to Weight Bearing compares the average time to weight bearing for different modes of stabilization. Patients treated with Jess external fixation achieved weight bearing in an average of 15.4 weeks, while those treated with plating took longer, with an average of 17.8 weeks. The difference between the two groups was statistically significant, with a p-value of <0.001.

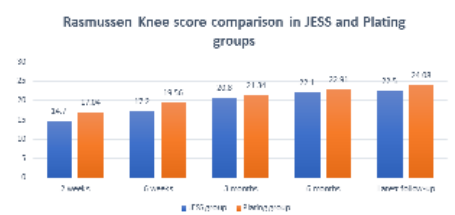
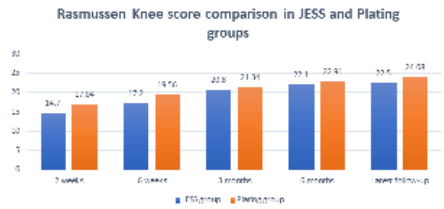


Table 5: Rasmussen Knee Score Comparison In Jess And Plating Groups

Time	JESS group Mean $\pm$ SD	Plating group Mean $\pm$ SD	t value	p-value
2 weeks	14.7 $\pm$ 0.674	17.04 $\pm$ 1.106	6.212	< 0.05
6 weeks	17.2 $\pm$ 1.135	19.56 $\pm$ 1.308	4.971	< 0.05
3 months	20.8 $\pm$ 1.932	21.34 $\pm$ 1.584	0.974	> 0.05

6 months	22.1 ± 1.37	22.91 ± 1.345	1.58	> 0.05
Latest follow-up	22.5 ± 1.715	24.08 ± 1.806	2.31	< 0.05

Table 5 shows that at 2 weeks and 6 weeks, the Plating group had significantly higher mean Rasmussen scores than the JESS group, with p-values < 0.05. However, no significant differences were observed at 3 months, 6 months, or the latest follow-up, where the scores between the groups were similar (p-values > 0.05). The latest follow-up showed a higher mean score for the Plating group (24.08 ± 1.806) compared to the JESS group (22.5 ± 1.715), with a statistically significant difference (p < 0.05).



Pain	
None	6
Occasional	5
Stabbing pain in certain position	3
Constant pain after activity	1
Significant rest pain	-3
Walking capacity	
Normal walking capacity for age	6
Walking outdoors more than one hour	5
Walking outdoor 15 mins – 1 hour	3
Walking outdoor <15 mins	1
Walking indoor only	0
Knee extension	
Lack of extension <10°	2
Lack of extension >10°	0
Lack of extension >20°	-2
Total range of motion	
Full	6
At least 120°	5
At least 90°	3
At least 60°	1
<60°	-3
Stability	
Normal stability in extension and 20° flexion	6
Abnormal instability in 20° flexion	4
Instability in extension <10°	2
Instability in extension >10°	0
Power of quadriceps	
Grade 5	2
Grade 3-4	1
Grade <3	-2
Maximum score	30
Excellent	28-30
Good	24-27
Fair	20-23
Poor	<20

Figure 1: Modified Rasmussen's score – clinical assessment

Cases

CASE NO. 1

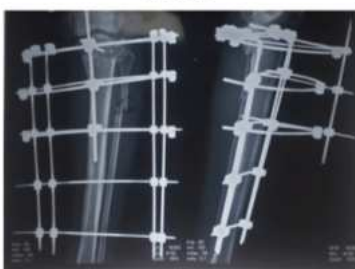
Mr. Ra; 30y/M

DOI: 18/11/2019 MOI: Fall from bike

Pre-op



Post-op



Follow-up (4 month)



Follow-up (10 months)



Range of motion



Knee flexion



Knee extension



Squatting



Cross-legged sitting

CASE NO. 2**Mr. C S; 40y/M****DOI: 13/1/2021 MOI: Tempo-bike collision****Pre-op****Post-op****Follow-up (9 months)****Range of motion****Knee flexion****Knee extension****Squatting****sitting****Cross-legged****DISCUSSION**

A total of 60 patients of Intra-articular fracture of proximal tibia were included in this study, categorized by Schatzker's classification and were followed up for a minimum period of 6 months. Out of which 6 were lost to follow-up. This was similar to the study by Biswas et al (2014)³, Herode et al (2016)⁴ but contrasted with studies by Z Yu et al (2009)⁵, CC Chan et al (2012)⁶, Shah et al (2017)⁷.

Table 6

Study	Sample size	Classification used
Biswas et al (2014) ³	30	Schatzker
Herode et al (2016) ⁴	50	Schatzker
Yu Z et al (2009) ⁵	65	AO
CC Chan et al (2012) ⁶	82	AO
Shah et al (2017) ⁷	70	AO
Harpreet Singh et al (2015) ⁸	20	Schatzker
Dwivedi A et al ²⁴	36	Schatzker
Huda N et al ²⁵	50	Schatzker

We studied 60 patients, out of which 36 patients were managed by plate fixation and 18 were managed by JESS fixation. Studies with similar and contrasting treatment modalities are mentioned in the below table.

Table 7

Herode et al (2016) ⁴	Various modalities (Canulated cancellous screw, Buttress plating, locked compression plate)
Yu Z et al (2009) ⁵	Double buttress plating
CC Chan et al (2012) ⁶	Hybrid External fixation versus Internal fixation
Harpreet Singh et al (2015) ⁸	JESS
Ramesh Chand et al (2015) ⁹	Intramedullary Nailing versus Proximal tibia plating
Sunil Kumar et al (2014) ¹⁰	JESS
Dwivedi A et al ²⁴	Plate osteosynthesis versus JESS
Huda N et al ²⁵	Plate osteosynthesis versus JESS

In this study, the patients were clinically assessed by modified Rasmussen score for functional assessment at 2 weeks, 6 weeks, 3 months and 6 months. This was comparable to the study by Biswas et al (2014)³, Herode et al (2016)⁴, CC Chan et al (2012)⁶ and Shah et al (2017)⁷. However, others assessed the outcome by different scoring variable as well.

Table 8

Study	Scoring system used
Yu Z et al (2009)	HSS score, Lysholm score, Knee Society Clinical Rating Score
CC Chan et al (2012)	Rasmussen Score
Biswas et al (2014)	Rasmussen Score
Sunil Kumar et al (2014)	Rick / Delamertier & Mason Hohl score
Harpreet Singh et al (2015)	Knee society score (KSS)
Herode et al (2016)	Rasmussen Score
Shah et al (2017)	Rasmussen Score
Patel et al (2017)	Knee society score (KSS)
Dwivedi A et al	Knee society score (KSS)
Huda N et al	Modified Rasmussen's functional score

With a mean age of 35.72 years, the majority of patients in our study (83.33%) have been injured in road traffic accidents, particularly involving two-wheelers. This can be explained by the fact that these age groups are more likely to be involved in high-energy vehicle accidents due to their livelihood activities, employment options, and vehicle mobility. Stannard JP et al. (2003), Ricci WM et al. (2004), Cole PA et al. (2004), Herode et al. (2016) and Sreenath Rao et al. (2018) conducted studies with that were consistent with this.

Table 9

Study	Mean age in years
Stannard JP et al (2003) ¹⁵	37
Cole PA et al (2004) ¹³	35
Ricci WM et al (2004) ¹⁴	40
Herode et al (2016) ⁴	38.50
Sreenath Rao et al (2018) ¹²	37.75
Dwivedi A et al (2021) ²⁴	47

According to this study, men are more impacted than women (80% vs. 20%). One possible explanation could be that, since men are typically the family's primary breadwinners, they must travel more, which raises the risk of accidents. The research conducted by Lee et al. (2007)¹⁶, Albuquerque et al. (2013)¹⁷, Herode et al. (2016)⁴, Biswas et al. (2016)³ were in agreement with this.

Table 10

Lee et al. (2007) ¹⁶	65.71% males
Albuquerque et al (2013) ¹⁷	70.3% males
Biswas et al (2016) ³	70% males
Herode et al (2016) ⁴	80% males

Similar to a study by Shah et al. (2017)¹⁷, our study found that 38 cases had closed fractures and the remaining 16 had open fractures based on Gustilo-Anderson type. The majority of fractures were Schatzker's type VI (61%) and type V (18%), which was comparable to research by Ruslan GS et al. (1998)¹⁸ and Yu Z et al. (2009)⁵. The average complete weight bearing duration in the plating group was 17.8 weeks, which is comparable to the 18.7-week research conducted by Yu Z et al. (2009)⁵. The study by Hitin Mathur et al. (2005)¹⁹ had a mean functional score of 25.062, which was in accordance with our study's mean modified Rasmussen score of 22.5 for JESS application and 24.08 for plate fixation.

Complications:

The delicate soft tissue covering and propensity for high energy trauma of the proximal tibia have a significant rate of complications, despite the fact that the conventional methods of open reduction and internal fixation have consistently been successful in restoring the osseous morphology. Our main issue during the study was that three patients experienced knee stiffness as a result of extended immobilization. There were two cases of JESS with pin tract infection and two cases of plate fixation with surgical site infection, one of which resulted in wound dehiscence and the other two of which resolved with routine dressing changes and intravenous antibiotics. During the subsequent follow-up, one case of neuropraxic nerve damage recovered.

The main goal is to protect soft tissue, and a study by Uhl et al. (2008)²⁰ found that the quantity of soft tissue incision required to sufficiently expose the fracture site for open reduction, which devitalizes the comminuted bone fragments, resulted in high complication rates. Reports by Young and Barrack²¹, Moore et al. (1987)²² and Mallik et al. (1992)²³ emphasized the dangers of traditional plate fixing because of the brittle soft tissue covering. For both plating and JESS, minimally invasive percutaneous reduction procedures have been preferred in our study. As JESS is minimally invasive, it led to less wound-related problems and early mobilization in our study (15.4 weeks for JESS and 17.8 weeks for plating). However, it did not reduce fragments in severe grade fractures very well. In our series, there were no documented fracture union issues.

Table 11

Study	Complication
Sunil Kumar et al (2014) ¹⁰	Pin tract infection(n=7), Non-union(n=1)
Harpreet Singh et al (2015) ⁸	Pin tract infection(n=2), Non-union(n=1)
Herode et al (2016) ⁴	Infection(n=1), Knee stiffness(n=1)
Patel et al (2017) ¹¹	Infection(n=2)
Shah et al (2017) ⁷	Infection(n=3), Malunion(n=6)
Huda N et al ²⁵	Superficial infection in 6 (24.0%) patients in JESS group and 2 (8.0%) patients in Plating group.

Summary

Our study revealed that there is a lower chance of soft tissue problems with JESS application, and early joint mobilization may reduce the likelihood of knee stiffness. Compared to patients treated with plate fixation, those treated with JESS fixation also began to bear weight earlier. Open reduction, however, improved the maintenance of articular congruity in plate fixation.

Overall, the plate fixation method produced better results in our investigation ($p < 0.05$), which is comparable to a study by Dwivedi et al.²⁴, who also showed earlier bone consolidation in the plate fixation group. Our findings contradict those of Huda N et al.²⁵

CONCLUSION

In the majority of proximal tibia intraarticular fractures, plate fixation is the preferred technique because it preserves articular congruity, improving functional result. Whereas, early joint mobilization and closed treatment of low-grade intra-articular fractures are benefits of JESS external fixation. Overall, 61% of the patients in our study were Schatzker's type VI, and 18% were Schatzker's type V. The findings indicated that plate fixation produced superior functional outcomes than JESS fixation. There were certain restrictions on our investigation. First, we had to include individuals with high grade Schatzker's fractures, primarily of types VI and V, and a wide range of ages. The second is the lack of long-term monitoring to assess how malalignment affects the progression of osteoarthritis in the knee.

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