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Functional Outcome of Proximal Tibia Fracture Treated with Lateral Locking Compression Plate

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ABSTRACT

The proximal tibia fractures are one of the commonest fractures in Orthopaedic practice representing 1.2% of all fractures. These injuries are divided into two categories, high velocity injury fractures and low velocity injury fractures. Most of tibia plateau fractures are secondary to high velocity accidents and fall from height , Where proximal tibia fracture resulted from direct axial compression usually with a varus or valgus force and indirect shearing forces across the knee. To study the functional outcomes of proximal tibial fracture treated with lateral locking compression plate (LCP). This observational study is hospital based and is to be conducted in the Department of Orthopaedics at Sri Balaji Action Medical Institute, PaschimVihar and New Delhi. Patients will be selected who underwent surgery of proximal tibial fracture treated with lateral LCP. Clearance from ethical committee of institute is to be obtained. Written informed consent will be obtained from all the patients or legal representatives for participation in the study. In Excellent, 18 (43.9%) had left lateralty and 23 (56.1%) right. One (25.0%) Fair patient had left lateralty and three (75.0%) had right. In Good, 4 (33.3%) had left lateralty and 8 (66.7%) right. Poor patients had 1 (50.0%) left and 1 (50.0%) right lateralty. Laterality had no significant effect on 24-week clinical findings ($p = 0.8195$).Two (50.0%) Fair patients were infected and one (25.0%) was stiff. One patient (8.3%) had mild stiffness and one had stiffness in Good. Poor patients had 1 implant failure and 1 infection. The correlation between complications and clinical outcomes at 24 weeks was strong ($p<0.0001$). The observation of a male predominance, with a ratio of 4.36:1, was a notable demographic finding. The study found important correlations between different types of Schatzker fractures and their respective outcomes, highlighting the practical importance of fracture categorization. The timing of surgery and the type of implant used did not have a significant effect on the outcomes.

INTRODUCTION

The proximal tibia fractures are one of the commonest fractures in Orthopaedic practice representing 1.2% of all fractures. These injuries are divided into two categories, high velocity injury fractures and low velocity injury fractures. Most of tibia plateau fractures are secondary to high velocity accidents and fall from height[1], Where proximal tibia fracture resulted from direct axial compression usually with a varus or valgus force and indirect shearing forces across the knee[2].

Proximal tibia fracture classification done by Schatzker in 6 different types:

- Lateral condyle split fracture
- Lateral condyle split with depression
- Pure central depression
- Medial plateau fracture
- Bicondylar fracture
- Bicondylar fracture with metaphyseal extension

The extent of soft tissue involvement, bone quality, age of the patient, and post traumatic knee stiffness are important associated factors which influence the functional outcome[3,4].

While dealing with these fractures their goals of treatment are re-establishment of joint congruity, normal limb alignment, a stable knee, functional range of motion of knee and healing and union of fracture site[5].

The role of conservative management while dealing with these fractures are limited and they often result in mal-union nonunion, rotational deformity, knee stiffness So there has been huge change towards the treatment options and hence operative management of these fractures come in a role.

Operative modalities include simple external fixation, hybrid or thin-wire external fixation, intra-medullary nailing, plate fixation including locking compression plate or a combination of all techniques together[6].

Locked plating (LCP) has become popular in recent times and has clear biomechanical advantages when compared with conventional plating. The locking compression plate system combines the principles of conventional plate osteosynthesis with those of internal fixator systems. It uses both of standard screws and locking head screws which give fixed angle stability[7].

Locking compression plate as an internal fixator is a construct in which the screws are locked in the plate (frame). Forces are transferred from the bone to the fixator across the screw plate threaded connection. Locking the screw in the fixator increases its stability and thus decreases the risk of reduction loss.

The advantage of using locking compression plate is that it does not compromise the blood supply to the bone as no contact between the fixator and the bone is needed. Plates and screws are the most common implants used in the fixation of tibia plateau fractures. Manufacturers have available pre-contoured peri-articular plates as well as locking plates that are designed to fit against the proximal tibia surface[8].

MATERIALS AND METHODS

Study Area and Population: This observational study is hospital based and is to be conducted in the Department of Orthopaedics at Sri Balaji Action Medical Institute, PaschimVihar and New Delhi. Patients will be selected who underwent surgery of proximal tibial fracture treated with lateral LCP. Clearance from ethical committee of institute is to be obtained. Written informed consent will be obtained from all the patients or legal representatives for participation in the study.

Study Design: Prospective Observational study.

Study Duration: 12 months (6 months enrolment and 6 month follow-up).

Sample Size: Sixty patients having proximal tibia and or juxta-articular fractures of proximal part of tibia were included in the study using AO classification system.

Statistical Methods Applied: Previously researchers have performed studies on functional outcome of tibial plateau fractures fixation by plating. The functional outcome of good to excellent results in these articles ranges between 70 - 95%. Therefore, assuming (p)=80% as the functional outcome with 15% margin of error, the minimum required sample size at 5% level of significance is 51 patients.

Formula Used: Using formula for sample size (n) calculation:

$$n = 1.962 \times p \times q / e2$$

Where, p = 20%, q = 100 - p = 80, Taking e, absolute error, e = 11, n = 50.79 ≈ 51

Minimum 51 cases should be taken for the study as per the formula. However, to avoid loss of data and to enhance reliability of the study total of 60 subjects will be taken.

Inclusion criteria: The entire patient with proximal tibia fracture above the age of 18 years operated with lateral plate LCP.

Exclusion criteria:

- Patient with pathological proximal tibia fracture
- Patient with multiple fracture of the same limb
- Pure medial and medio- lateral fracture

RESULT AND DISCUSSIONS

Age in Group: In Excellent, 6 (14.6%) patients were 21-30 years of age, 18 (43.9%) patients were 31-40 years of age and 14 (34.1%) patient were 41-50 years of age and 3 (7.3%) patients were ≥51 years of age (Table 1).

In Fair, 2 (50.0%) patients were 31-40 years of age, 1 (25.0%) patient was 41-50 years of age and 1 (25.0%) patient was ≥51 years of age.

In Good, 2 (50.0%) patients were 21-30 years of age, 3 (25.0%) patients were 31-40 years of age and 4 (33.3%) patient were 41-50 years of age and 3 (25.0%) patients were ≥51 years of age.

In Poor, 1 (50.0%) patient was 41-50 years of age and 1 (50.0%) patient was ≥51 years of age.

Association of Age in group with clinical results at 24 week was not statistically significant (p = 0.5724).

MOI:

- In Excellent, 9 (22.0%) patientswereFALL and 32 (78.0%) patients were RTA
- In Fair,4 (100.0%) patients were RTA
- In Good,2 (16.7%) patientswereFALL and 10 (83.3%) patients were RTA
- In Poor, 2 (100.0%) patients were FALL
- Association of MOI with clinical results at 24 week was statistically significant (p = 0.0383)

Lateralty:

- In Excellent, 18 (43.9%) patients had left lateralty and 23 (56.1%) patients had right lateralty
- In Fair,1 (25.0%) patient had left lateralty and 3 (75.0%) patients had right lateralty
- In Good, 4 (33.3%) patients had left lateralty and 8 (66.7%) patients had right lateralty
- In poor, 1 (50.0%) patients had left lateralty and 1(50.0%) patients had right lateralty
- Association of lateralty with clinical results at 24 week was not statistically significant (p = 0.8195)

Time to Surgery:

- In Excellent, 25 (61.0%) patients were surgery after 24 hour and16 (39.0%) patients were surgery same day
- In Fair, 2 (50.0%) patients were surgery after 24 hour and 2 (50.0%) patients were surgery same day
- In Good, 9 (75.0%) patients were surgery after 24 hour and 3 (25.0%) patients were surgery same day.
- In Poor, 2 (100.0%) patients were surgery after 24 hour

Table 1: Association between CLINICAL RESULTS AT 24 WEEK with all parameters

	Clinical Results at 24 Week					
Parameters	Excellent	Fair	Good	Poor	Total	p-value
Age in group						
21-30	6	0	2	0	8	0.5724
Row %	75	0	25	0	100	
Col %	14.6	0	16.7	0	13.6	
31-40	18	2	3	0	23	
Row %	78.3	8.7	13	0	100	
Col %	43.9	50	25	0	39	
41-50	14	1	4	1	20	
Row %	70	5	20	5	100	
Col %	34.1	25	33.3	50	33.9	
≥51	3	1	3	1	8	
Row %	37.5	12.5	37.5	12.5	100	
Col %	7.3	25	25	50	13.6	
TOTAL	41	4	12	2	59	
Row %	69.5	6.8	20.3	3.4	100	
Col %	100	100	100	100	100	
MOI						
FALL	9	0	2	2	13	0.0383
Row %	69.2	0	15.4	15.4	100	
Col %	22	0	16.7	100	22	
RTA	32	4	10	0	46	
Row %	69.6	8.7	21.7	0	100	
Col %	78	100	83.3	0	78	
Total	41	4	12	2	59	
Row %	69.5	6.8	20.3	3.4	100	
Col %	100	100	100	100	100	
Lateralty						
Left	18	1	4	1	24	0.8195
Row %	75	4.2	16.7	4.2	100	
Col %	43.9	25	33.3	50	40.7	
Right	23	3	8	1	35	
Row %	65.7	8.6	22.9	2.9	100	
Col %	56.1	75	66.7	50	59.3	
Total	41	4	12	2	59	
Row %	69.5	6.8	20.3	3.4	100	
Col %	100	100	100	100	100	
Time To Surgery						
After 24 Hr	25	2	9	2	38	0.5192
Row %	65.8	5.3	23.7	5.3	100	
Col %	61	50	75	100	64.4	
Same Day	16	2	3	0	21	
Row %	76.2	9.5	14.3	0	100	
Col %	39	50	25	0	35.6	
Total	41	4	12	2	59	
Row %	69.5	6.8	20.3	3.4	100	
Col %	100	100	100	100	100	
Complications						
Implant Fail	0	0	0	1	1	<0.0001
Row %	0	0	0	100	100	
Col %	0	0	0	50	1.7	
Infection	0	2	0	1	3	
Row %	0	66.7	0	33.3	100	
Col %	0	50	0	50	5.1	
Mild Stiffness	0	0	1	0	1	
Row %	0	0	100	0	100	
Col %	0	0	8.3	0	1.7	
Nil	41	1	9	0	51	
Row %	80.4	2	17.6	0	100	
Col %	100	25	75	0	86.4	
Nil	0	0	1	0	1	
Row %	0	0	100	0	100	
Col %	0	0	8.3	0	1.7	
Stiffness	0	1	1	0	2	
Row %	0	50	50	0	100	
Col %	0	25	8.3	0	3.4	
Total	41	4	12	2	59	
Row %	69.5	6.8	20.3	3.4	100	
Col %	100	100	100	100	100	

- Association of Time to Surgery with clinical results at 24 week was not statistically significant (p = 0.5192).

Table 2: Distribution of mean with different time interval

Hospital stay							
Excellent	41	4.1220	0.7809	3.0000	6.0000	4.0000	0.9297
Fair	4	4.2500	1.5000	3.0000	6.0000	4.0000	
Good	12	4.1667	0.8348	3.0000	5.0000	4.0000	
Poor	2	4.5000	0.7071	4.0000	5.0000	4.5000	
Rasmussen's score at 6 week							
Excellent	41	14.7073	1.8199	10.0000	20.0000	14.0000	<0.0001
Fair	4	10.5000	1.0000	10.0000	12.0000	10.0000	
Good	12	13.4167	1.8320	10.0000	16.0000	14.0000	
Poor	2	5.0000	1.4142	4.0000	6.0000	5.0000	
Rasmussen's score at 12 week							
Excellent	41	21.4146	1.6275	18.0000	24.0000	22.0000	<0.0001
Fair	4	17.0000	3.4641	14.0000	22.0000	16.0000	
Good	12	18.9167	1.8809	17.0000	24.0000	18.0000	
Poor	2	6.5000	0.7071	6.0000	7.0000	6.5000	
Rasmussen's score at 24 week							
Excellent	41	28.2683	1.1837	26.0000	30.0000	28.0000	<0.0001
Fair	4	20.0000	4.0000	18.0000	26.0000	18.0000	
Good	12	25.1667	1.3371	22.0000	26.0000	26.0000	
Poor	2	9.0000	0.0000	9.0000	9.0000	9.0000	

Complications:

- In Fair,2 (50.0%) patients were infected and1 (25.0%) patient had stiffness
- In Good,1 (8.3%) patient had mild stiffness and 1 (8.3%) patient had stiffness
- In poor, 1 (50.0%) patient was implant fail and 1 (50.0%) patient was infected
- Association of Complications with clinical results at 24 week was statistically significant (p<0.0001)

Hospital Stay:

- In Excellent, the mean Hospital stay (MEAN±S.D.) of patients was 4.1220±.7809
- In Fair, the mean Hospital stay (MEAN±S.D.) of patients was 4.2500±1.5000
- In Good, the mean Hospital stay (MEAN±S.D.) of patients was 4.1667±.8348
- In Poor, the mean Hospital stay (MEAN±S.D.) of patients was 4.5000±.7071
- Distribution of mean Hospital stay with clinical results at 24 week was not statistically significant (p = 0.9297).

Rasmussen's Score at 6 Week:

- In Excellent, the mean Rasmussen's score at 6 week (MEAN±S.D.) of patients was 14.7073±1.8199
- In Fair, the mean Rasmussen's score at 6 week (MEAN±S.D.) of patients was 10.5000±1.0000
- In Good, the mean Rasmussen's score at 6 week (MEAN±S.D.) of patients was 13.4167±1.8320
- In Poor, the mean Rasmussen's score at 6 week (MEAN±S.D.) of patients was 5.0000±1.4142
- Distribution of mean Rasmussen's score at 6 week with clinical results at 24 week was statistically significant (p<0.0001)

Rasmussen's Score at 12 Week:

- In Excellent, the mean Rasmussen's score at 12 week (MEAN±S.D.) of patients was 21.4146±1.6275
- In Fair, the mean Rasmussen's score at 12 week (MEAN±S.D.) of patients was 17.0000±3.4641
- In Good, the mean Rasmussen's score at 12 week (MEAN±S.D.) of patients was 18.9167±1.8809
- In Poor, the mean Rasmussen's score at 12 week (MEAN±S.D.) of patients was 6.5000±.7071 (Table 2)
- Distribution of mean Rasmussen's score at 12 week with clinical results at 24 week was statistically significant (p<0.0001)

Rasmussen's Score at 24 Week:

- In Excellent, the mean Rasmussen's score at 24week (MEAN±S.D.) of patients was 28.2683±1.1837
- In Fair, the mean Rasmussen's score at 24week (MEAN±S.D.) of patients was 20.0000±4.0000
- In Good, the mean Rasmussen's score at 24week (MEAN±S.D.) of patients was 25.1667±1.3371
- In Poor, the mean Rasmussen's score at 24week (MEAN±S.D.) of patients was 9.0000±.0000
- Distribution of mean Rasmussen's score at 24 week with clinical results at 24 week was statistically significant (p<0.0001)

The present study was a Prospective Observational study. This Study was conducted for 18 months at Department of Orthopaedics at Sri Balaji Action Medical Institute, PaschimVihar, New Delhi. Total 59 patients were included in this study.

Biyani *et al*.[9] found that they retrospectively reviewed 32 elderly patients (mean age 71.7 years, range 66-83 years) with displaced tibial plateau fractures after a mean of 3.7 years (range 1-7 years) after operative treatment. There was no significant correlation between the final radiographic appearance and clinical outcome. Fourteen patients mobilized postoperatively on a continuous passive motion machine followed by a cast brace had a better result than those mobilized in a cast brace alone, but the difference was not statistically significant (p = 0.29).

In our study, out of 59 patients, most of the patients were 31-40 years of age [23 (39.0%)]. 18 (43.9%) patients were 31-40 years of age in Excellent group, 2 (50.0%) patients were 31-40 years of age in Fair group, 4 (33.3%) patient were 41-50 years of age in Good group and 1 patient had 41-50 years of age and ≥51 years of age in poor group but this was not statistically significant (p = 0.5724). The mean Age was more [54.0000±7.0711] in Poor group compared to Good group [41.8333±9.7592], Fair group [41.7500±10.2103] and Excellent group [38.2927±8.5885] but this was not statistically significant (p = 0.0816).

Sethiya *et al*.[10] found that fractures of proximal tibia have always been difficult to treat because of the

subcutaneous location of its anteromedial surface. These days significant attention has been paid to the condition of soft tissue envelope. Ethics committee approval was obtained. Informed written consent was taken. Data was collected from the patients. Majority of the patients (30%) were in the age group of 31-40 years. There was male preponderance (80%) in the study while female patients constituted 20% of the study group. Road Traffic Accident was found to be the most common cause of fracture.

We found that, male [48(81.4%)] population was higher than the female [11(18.6%)] population. In Excellent, Fair, Good and poor group, male were higher than female which were not statistically significant (p = 0.3408).

It was found that, higher number of patients had [32 (78.0%)] RTA in Excellent group compared to good group [10 (83.3%)] and fair group [4 (100.0%)] which was statistically significant (p = 0.0383).

We observed that, lower number of patient had [1 (50.0%)] left and right laterality in poor group compared to fair group [3 (75.0%)], good group [4 (33.3%)] and Excellent group [18 (43.9%)] and it was not statistically significant (p = 0.8195).

Our study showed that, In Excellent, 12 (29.3%) patients had Type 1 Schatzkers, 12 (29.3%) patients had Type 2 Schatzkers, 8 (19.5%) patients had Type 3 Schatzkers, 1 (2.4%) patient had Type 5 Schatzkers and 8 (19.5%) patients had Type 6 Schatzkers. In Fair, 1 (25.0%) patient had Type 1 Schatzkers and 3 (75.0%) patients had Type 2 Schatzkers. In Good, 5 (41.7%) patients had Type 1 Schatzkers, 3 (25.0%) patients had Type 2 Schatzkers, 2 (16.7%) patients had Type 3 Schatzkers and 2 (16.7%) patients had Type 6 Schatzkers. In Poor, (50.0%) patient had Type 3 Schatzkers and 1 (50.0%) patient had Type 6 Schatzkers. Which was statistically significant (p = 0.0383).

Koval *et al*.[11] found that the goal of tibial plateau fracture management is a stable, well-aligned, congruent joint, with a painless range of motion and function. The timing of surgery and the handling of the soft tissue in this region are critical to treatment success. After restoration of a congruent joint surface, bone grafting and buttress plating are usually needed to allow early range of motion and optimization of treatment outcome.

Völk *et al*.[12] showed that this study was to evaluate the clinical and/or radiologic outcome using different poly-axial locking plates for the treatment of proximal tibia fractures, the Non-Contact-Bridging plate or the Variable Angle Locking Compression Plate (VA-LCP®). After a time interval of 12 months postoperative they conducted clinical (e.g the Rasmussen score) and radiological (e.g. primary/secondary loss of reduction) follow-ups. Patients provided with the NCB-PT® (9 patients) showed longer operation time, use of longer implants, longer interval from injury to surgery and lower clinical scores after the 12 months follow-up compared with the VA-LCP® group (19 patients). Interestingly, the results showed no significant differences regarding the clinical and radiologic outcome. The small number of patients as well as the heterogeneity of fractures constitute a limitation of this study.

In our study, more number of patients [25 (61.0%)] were surgery after 24 hour in Excellent group compared to Good group [9 (75.0%)], poor [2 (100.0%)] and Fair group [2 (50.0%)] but this was not statistically significant (p = 0.5192).

Patil *et al*.[13] found that management of tibial plate fracture represents a challenging problem in developing countries. To compare the results of treatment of tibial plateau fractures with conventional nonlocking buttress plates and locking compression plates (LCPs). The results were graded in accordance with Poul S. Rasmussen's grading system. During the follow-up, 73.3% in LCP group and 66.6% in buttress group had no pain after clinical union. 66.6% patients in LCP group and 73.3% in buttress group could perform normal walking. About 86.6%in each group had no lack of extension. Nine patients (60%) in LCP group and 10 patients (66.6%) had flexion of up to at least 140°. About 86.6% in LCP group and 80% in buttress group had a stable joint in extension.

We found that, majority number of patients were [41(100.0%)] LCP implanted in Excellent group compared to Good group [12 (100.0%)], Fair group [4 (100.0%)] and Poor group [2 (100.0%)].

It was found that, lower number of patient [1 (50.0%)] was implant fail and infected in poor group compared to Fair group [1 (25.0%)] and Good group [1 (8.3%)] which was statistically significant (p<0.0001).

Kumar *et al*.[14] found that tibial plateau fractures represent the fractures involving the articular surface of proximal part of the tibia bone i.e. It was a prospective study conducted on 30 patients with tibial plateau fractures at a tertiary care hospital in New Delhi, India. Patients were operated with locking compression plates and followed up for 18 months. Union was checked with serial radiographs and functional outcome was assessed with Rasmussen Functional Knee Score.

We observed that, Hospital stay was higher in Poor group [4.5000±.7071] compared to Fair group [4.2500±1.5000], Good group [4.1667±.8348] and Excellent group [4.1220±.7809] but this was not statistically significant (p = 0.9297).

Nikolaou *et al*.[15] found that between 2004 and 2009, 60 patients with proximal tibial fractures were included in this prospective study. No plate fractured and no screw cut out was noted. There was one case of

lateral joint collapse (>10°) in a patient with open bicondylar plateau fracture. The mean Knee Society Score at the time of final follow-up was 91 points and the mean functional score was 89 points. The polyaxial locking-plate system provided stable fixation of extra-articular and intra-articular proximal tibial fractures and good functional outcomes with a low complication rate.

Our study showed that, Rasmussen's score at 6 week was significantly lower in Poor group [5.0000±1.4142] compared to Fair group [10.5000±1.0000], Good group [13.4167±1.8320] and Excellent group [14.7073±1.8199] (p<0.0001).

Kim *et al*.[16] found that relatively few studies have addressed plate osteosynthesis for open proximal tibial fractures by now. The mean Knee Society score was 88.7 at final follow-up visits, 23 patients achieved an excellent result and 7 a good result. There were 3 superficial and 5 deep infections, but none required early implant removal. Functional results were similar for primary and staged MIPO (p = 0.113). Fracture pattern (p = 0.089) and open fracture grade (p = 0.079) were not found to influence the results. If soft tissue coverage is adequately performed, MIPO could be regarded as an acceptable method for the treatment of open proximal tibial fracture.

In our study, Rasmussen's score at 12 week was significantly more in Excellent group [21.4146±1.6275] compared to Good group [18.9167±1.8809], Fair group [17.0000±3.4641] and poor group [6.5000±.7071] (p<0.0001).

We found that, Rasmussen's score at 24 week was higher in Excellent group [28.2683±1.1837] compared to Good group [25.1667±1.3371], Fair group [20.0000±4.0000] and poor group [9.0000±.0000] which was statistically significant (p<0.0001).

CONCLUSION

Age did not have a statistically significant impact on clinical outcomes at the 24-week period in this extensive analysis of 59 participants. Although the age difference was not statistically significant, there was a noticeable trend where the group with bad outcomes had a higher average age (54.00±7.0711) compared to the other result groups. The observation of a male predominance, with a ratio of 4.36:1, was a notable demographic finding. The study found important correlations between different types of Schatzker fractures and their respective outcomes, highlighting the practical importance of fracture categorization. The timing of surgery and the type of implant used did not have a significant effect on the outcomes. However, it was observed that a longer duration of hospital stay was associated with worse outcomes. Rasmussen's score shown a substantial difference at 6, 12 and 24 weeks, highlighting its potential as a helpful prognostic predictor.

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