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Comparative Study of Functional and Radiological Outcome in Distal Femur Communited Fracture with Lateral Plate vs Bicolumnar Plate Technique

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ABSTRACT
Distal femoral fractures are mostly caused by high-energy injury, such as falling injury and traffic accidents and fractures are often severely comminuted, which may be associated with injuries to knee joint structural and other parts, such as tibial plateau fractures and pelvic fractures. To study the effectiveness of lateral versus bicolumnar plating method in distal femur communited fracture. The study was conducted in the outpatient and inpatient department of orthopaedics at RG Kar Medical College and Hospital. All the patients presenting to the outpatient department of RG Kar Medical College and hospital. In Bicolumnar Plate, the mean Hospital stay (Mean±S.D.) of patients was 5.2000±1.9322. The mean Hospital stay (Mean±S.D.) of patients was 5.5000±1.7918.Distribution of mean Hospital stay with Group was not statistically significant (p = 0.6767). We found that, in Bicolumnar Plate group, the mean age of patients was 41.1000 years. In Lateral Plate group, the mean age of patients was 42.0500 years. This was not statistically significant.

INTRODUCTION

Distal femoral fractures are mostly caused by high-energy injury, such as falling injury and traffic accidents and fractures are often severely comminuted, which may be associated with injuries to knee joint structural and other parts, such as tibial plateau fractures and pelvic fractures. At present, the distal femoral fractures are mainly fixed by the lateral anatomical locking plate, but lateral and medial double-plating fixation is also suggested by some researchers.

The pull-out strength of locking screws is higher than the conventional screws and is particularly useful in osteoporotic bones. These plates are designed to apply in minimally invasive fashion to preserve local biology and avoid problems with fracture healing and infection.

The purpose of this study was to evaluate functional and radiological outcome, fracture healing and the complications of distal femoral intra-articular fractures using locking compression plates.

Supracondylar femur fractures are commonly associated with severe comminution and significant soft tissue injury. Distal femoral fractures are mostly caused by high-energy injuries, such as falling injury and traffic accidents and fractures are often severely comminuted. Despite the recent advances in techniques and implants, the treatment of intra-articular multi-fragmentary distal femoral fractures remains a challenge. Long-term disability can occur in patients with extensive articular cartilage damage and marked comminution. Distal femur fractures in the elderly are complicated by poor bone quality (severe osteoporosis), a distal segment that is too short for adequate fixation, blood loss, malunion and non-union and increased mortality[1].

Locked plating is one of the best and modern options for treating supracondylar femur fractures with relatively low failure rates. Single lateral plating of distal femur fractures was often found to have a relatively higher failure rate[2].

MATERIALS AND METHOD

Study area: The study was conducted in the outpatient and inpatient department of orthopaedics at RG Kar Medical College and Hospital

Study population: All the patients presenting to the outpatient department of RG Kar Medical College and hospital

Inclusion criteria:

- Parties giving informed consent for the procedure
- Patient age above 18
- Closed fracture

Exclusion criteria:

- Open fracture
- Patient age above 80 years to exclude pathological fracture

Study design: Simple random sampling

Study type: Prospective observational study

Sample size: Based on previous studies a sample size of 30 patients have been taken.

Sample size has been calculated with help of Epi Info (TM) 3.5.3. EPI INFO which is a trademark of the Centers for Disease Control and Prevention (CDC). For statistical analysis data were entered into a Microsoft excel spreadsheet and then analyzed by SPSS 27.0. and Graph Pad Prism version 5. Data had been summarized as mean and standard deviation for numerical variables and count and percentages for categorical variables. Unpaired proportions were compared by Chi-square test or Fischer's exact test, as appropriate. Two-sample t-tests for a difference in mean involved independent samples or unpaired samples. p-value $\leq$ 0.05 was considered for statistically significant.

Sample Size Justification: One study found that the incidence of distal femur fractures was 8.7%. So, for this study p = 0.087.

Thus, the number of patients required for this study was 30 with power 87%. The formula used for sample size calculation was as follows:

$$n = 4pq / (L^2)$$

Where, n is required sample size, p = 0.087 (as per the study by Elsoe *et al.*)[75], q = 1-p, L = Loss % (Loss of information)

Calculation: Here, p = 0.087, q = 1-p = 1- 0.087 = 0.913, 4pq = 4×0.087×0.913 = 0.31772, L^2 = 0.01059, L = 0.1029, Loss of information percentage = 10.29%, n = 4pq / (L^2) = 0.31772/0.01059 = 30.00 = 30

Study group: 30 patients were taken.

Study period: The study was conducted from April 2020 to June 2021

Study tools:

- Written Patient Consent
- Pre designed proforma
- Other accessory instruments
- Pre and post-operative x rays
- Functional scores: Knee society scoring system

Study technique: After getting ethical clearance, patients with distal femur fracture diagnosed with radio logically presenting to the emergency department of orthopaedic will be studied after taking

informed consent, subjected to pre-operative assessment using radiographs and other relevant tests, operated upon and followed up post operatively for functional and radiological improvement of the disease and compared with the existing standard.

Plan for analysis of data: All data was collected, compiled and analysed using suitable statistical methods, pre op and post op x-rays and score (KSS) and presented with the help of tables, charts, pictographs.

Radiological assessment

Pre and post-operative radiographs will be assessed based on: Plain film was performed every 3 months after operation for monitoring the fracture healing and whether there was loss of reduction and rupture of plate(s) and screws. Each patient was followed up until the fracture union and no less than one year. According to the plain film and condition of the patient, it was determined when partially loaded walking should be started and how to exercise step by step. Knee function was evaluated by Kolmert' standard, one year after surgery.

RESULT

In Bicolumnar Plate, all patients [10 (100.0%)] were RTA in Type of Injury. In Lateral Plate, all patients [20 (100.0%)] were RTA in Type of Injury. In Bicolumnar Plate, all patients [10 (100.0%)] were Union (Table 1). In Lateral Plate, all patients [20 (100.0%)] were Union. In Bicolumnar Plate, 1 (10.0%) patient had Stiffness and 1 (10.0%) patient had Superficial infection (Table 2). In Lateral Plate, 4 (20.0%) patients had Superficial infection and 1 (5.0%) patient had Complication (Table 3). Association of Complication with Group was not statistically significant (p = 0.4039).

In Bicolumnar Plate, the mean Hospital stay (Mean±S.D.) of patients was 5.2000±1.9322. In Lateral Plate, the mean Hospital stay (Mean±S.D.) of patients was 5.5000±1.7918.

Distribution of mean Hospital stay with Group was not statistically significant (p = 0.6767) (Table 4).

Table 1: Association between Type of Injury: Group

Type of Injury	Bicolumnar Plate	Lateral Plate	Total
RTA	10	20	30
Row %	33.3	66.7	100.0
Col %	100.0	100.0	100.0
TOTAL	10	20	30
Row %	33.3	66.7	100.0
Col %	100.0	100.0	100.0

Table 2: Association between Union/ Non Union : Group

Union/ Non Union	Bicolumnar Plate	Lateral Plate	Total
Union	10	20	30
Row %	33.3	66.7	100.0
Col %	100.0	100.0	100.0
TOTAL	10	20	30
Row %	33.3	66.7	100.0
Col %	100.0	100.0	100.0

Table 3: Association between Complication: Group

Complication	Bicolumnar Plate	Lateral Plate	Total
No	8	15	23
row %	34.8	65.2	100.0
col %	80.0	75.0	76.7
Stiffness	1	0	1
Row %	100.0	0.0	100.0
Col %	10.0	0.0	3.3
Superficial infection	1	4	5
Row %	20.0	80.0	100.0
Col %	10.0	20.0	16.7
Yes	0	1	1
row %	0.0	100.0	100.0
col %	0.0	5.0	3.3
Total	10	20	30
row %	33.3	66.7	100.0
col %	100.0	100.0	100.0

Table 4: Distribution of mean Hospital stay: Group

Hospital stay	Number	Mean	SD	Minimum	Maximum	Median	p-value
Bicolumnar Plate	10	5.2000	1.9322	2.0000	8.0000	5.5000	0.6767
Lateral Plate	20	5.5000	1.7918	2.0000	8.0000	5.5000	

DISCUSSION

This prospective and retrospective observational study was conducted in the outpatient and inpatient department of orthopaedics at RG Kar Medical College and Hospital from April 2020 to June 2021.

Parties giving informed consent for the procedure, Patient age above 18 and closed fracture were included in this study.

Pre and post-operative radiographs were assessed based on Plain film was performed every 3 months after operation for monitoring the fracture healing and whether there was loss of reduction and rupture of plate(s) and screws. Each patient was followed up until the fracture union and no less than one year. According to the plain film and condition of the patient, it was determined when partially loaded walking should be started and how to exercise step by step. Knee function was evaluated by Kolmert' standard, one year after surgery.

Total 30 patients were present in this study. Present study showed that, in Bicolumnar Plate, 4 (40.0%) patients were ≤30 years old, 3 (30.0%) patients were 31-40 years old and 3 (30.0%) patients were >40 years old and in Lateral Plate, 8 (40.0%) patients were ≤30 years old, 7 (35.0%) patients were 31-40 years old and 5 (25.0%) patients were >40 years old which was not statistically significant (p = 0.9453).

We observed that, in Bicolumnar Plate, 5 (50.0%) patients were Female and 5 (50.0%) patients were Male and in Lateral Plate, 9 (45.0%) patients were Female and 11 (55.0%) patients were Male which was not statistically significant (p = 0.7958).

Khalil *et al*.[3] found that mechanism of injury was road traffic accident (RTA) in nine patients and fall

from height in the other three cases. Eight cases were operated during the first week and four cases during the second week after injury. Mean follow-up was 13.7 months (range 11-18 months). Mean radiological healing time was 18.3 weeks (range 12-28 weeks) and all cases had good radiological healing without recorded non-union or malunion. Clinically, two cases (16.7 %) had excellent results, five cases (41.7 %) had good results, three cases (25 %) had fair results and two cases (16.7%) had poor results. We examined that, in Bicolumnar Plate, all patients [10 (100.0%)] were RTA in Type of Injury and in Lateral Plate, all patients [20 (100.0%)] were RTA in Type of Injury.

Ricci *et al*.[4] found that independent risk factors for reoperation to promote union and deep infection included diabetes and open fracture. Risk factors for proximal implant failure included open fracture, smoking, increased body mass index and shorter plate length. The identified risk factors for reoperation to promote union and complications included open fracture, diabetes, smoking, increased body mass index and shorter plate length. Most factors are out of surgeon control but are useful when considering prognosis. Use of relatively long plates is a technical factor that can reduce risk for fixation failure.

Ehlinger *et al*.[5] present a technique of minimally invasive internal fixation of the distal extra-articular femur using a locking plate and present the tricks of the trade to obtain successful reduction and achieve union. The hardware used includes plate fixation with a large fragment locking screw. This minimally invasive surgery combines stability of the internal fixation device with the principles of closed surgery, allowing early mobilization and immediate weight bearing to warrant good functional recovery.

Kumar *et al*.[6] found that the mean time for radiological union was 12 weeks (range 10-18) except 2 patients which had gone for non-union. At the latest follow up ROM is noted in 32 patients, 90-Use of standard lateral approach for simple intra-articular distal femoral fractures (C1) and transarticular/ minimally invasive techniques for complex intra-articular fractures (C2/C3) results in improved exposure of the knee joint and better union rates with low incidence of bone grafting.

Our study showed that, in Bicolumnar Plate, all patients [10 (100.0%)] were Union and in Lateral Plate, all patients [20 (100.0%)] were Union.

Sain *et al*.[7] found that dual-plating of the distal femur is required in some cases to achieve stable fixation. The indications of a medial plate in addition to the lateral plate are medial supracondylar bone loss, low trans-condylar bicondylar fractures, medial Hoffa fracture, peri-prosthetic distal femur fractures, non-union after failed fixation with single lateral plate, poor bone quality and comminuted distal femur fractures (AO type C3). They recommend orthogonal plate configuration with locked plates by a single incision or dual incision approach as per surgeon choice.

Present study showed that, in Bicolumnar Plate, 1 (10.0%) patient had Stiffness and 1 (10.0%) patient had Superficial infection and in Lateral Plate, 4 (20.0%) patients had Superficial infection and 1 (5.0%) patient had Complication which was not statistically significant (p = 0.4039).

We observed that, in Bicolumnar Plate, the mean Age (Mean±S.D.) of patients was 41.1000±13.9240 and in Lateral Plate, the mean Age (Mean±S.D.) of patients was 42.0500±12.9512 which was not statistically significant (p = 0.8547).

Attempts by researchers in past to correlate the functional outcomes with the various fixation construct such as bipillar plating, only posterior buttress and additional medial antiglide plating have not been found satisfactory.

Lee *et al*.[8] compared the outcome of tibial plateau fractures among three groups, wherein Group I (n = 15) isolated lateral tibial plating, Group II (n = 19) classic dual plating and Group III (n = 11) with hybrid dual plates (one lateral approach locking compression plate + medial anti-gliding plate) were assessed using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scoring for at least 18 months. They demonstrated no significant differences in those scores. Contrary to this, our study revealed a significant difference in objective and functional KSS at 1-year follow up which implies a better outcome in the dual plating. Difference could be explained by the fact that the former study did not specifically define the posterior condylar fixation.

Rohra *et al*. prospectively followed 34 patients for 3 years to determine functional and radiological outcome and the complications of Schatzker V and VI tibial plateau fractures treated with bicolumnar plating using the KSS and radiological outcomes by modified Rasmussen assessment criteria. They found that only 3% of patients were of poor functional KSS and nearly 6% of patients had fair radiological outcome. However, these results were not compared with a control population because of relative scarcity of such fracture pattern. Barei *et al*., in a retrospective study, using a rank-order analysis, found that no significant relation existed between severity of injury (injury severity score) and achieving articular reduction in bicondylar tibial fractures. They also found improved functional outcomes by musculoskeletal functional assessment scoring with medial anti-glide plate group.

Saad *et al*.[9] patients were randomly allocated for treatment with either: Group I managed by single lateral plate, or group II managed by double plating.

There were insignificant differences between the two groups regarding range of movement, pain, knee society score and complications. Although both lateral and double plating fixation using dual approach for type C2 and C3 distal femoral fractures were efficient and safe methods of management, double plating recommended in these cases, i.e. medial supracondylar bone loss, low trans condylar bicondylar fracture, medial Hoffa fracture, per prosthetic distal femur fractures, non-union after failed fixation with single lateral plate, poor bone quality and comminuted distal femur fractures C3.

Present study showed that, in Bicolumnar Plate, the mean KSS score Immediate (Mean±S.D.) of patients was 16.3000±3.5917 and in Lateral Plate, the mean KSS score Immediate (Mean±S.D.) of patients was 16.4500±4.6845 which was not statistically significant (p = 0.9299), in Bicolumnar Plate, the mean KSS score 1 Month (Mean±S.D.) of patients was 26.1000±2.9231 and in Lateral Plate, the mean KSS score 1 Month (Mean±S.D.) of patients was 35.0500±1.9324 which was statistically significant (p<0.0001). In Bicolumnar Plate, the mean KSS score 6 month (Mean±S.D.) of patients was 165.8000±4.2635, in Lateral Plate, the mean KSS score 6 month (Mean±S.D.) of patients was 183.3000±4.9958 which was statistically significant (p<0.0001) and in Bicolumnar Plate, the mean KSS score 12 month (Mean±S.D.) of patients was 175.6000±2.7968 and in Lateral Plate, the mean KSS score 12 month (Mean±S.D.) of patients was 192.1000±5.3302 which was statistically significant (p<0.0001).

Xing *et al*.[10] showed that the mean duration of surgery in nailing group was 68±12.2 minutes while it was 81±11.6 minutes in plating group which was statistically significant (p-value = 0.025). Average fracture union time was better in nailing (15.2±1.2 weeks) than plating group (18±1.4 weeks) as assessed both clinically and radiologically (p-value = 0.0001). The average knee flexion was better in nailing (104.8±9.4) than plating (91.4±8.9) (p-value = 0.0042). Post-operative Neer's score was higher in nailing (86.2±10.6) than the plating group (63.8±9.4) which was statistically significant.

Yao et al. followed 86 patients treated with either dual buttress plates (DP group) or a lateral locking plate (LP group). Durations of hospital stay and operation were significantly shorter and blood loss was significantly less, in the LP group than in the DP group, in their observations.

Another meta-analysis conducted by Chang et al. showed lower surgical time, hospital stay, union time and incision necrosis in single-plate group as compared to the dual-plate group. The 12-month Hospital for Special Surgery scoring was better in single-plate group in this analysis.

We examined that, in Bicolumnar Plate, the mean Hospital stay of patients was 5.2000±1.9322 and in Lateral Plate, the mean Hospital stay was 5.5000±1.7918 which was not statistically significant (p = 0.6767).

We found that, in Bicolumnar Plate, the mean Surgery Time of patients was 152.0000±21.4994 and in Lateral Plate, the mean Surgery Time was 114.4000±7.1701 which was statistically significant (p<0.0001).

CONCLUSION

We found that, in Bicolumnar Plate group, the mean age of patients was 41.1000 years. In Lateral Plate group, the mean age of patients was 42.0500 years. This was not statistically significant. In our study male population was higher than the Female population. It was found that RTA were the most common injury in our study. We observed that Complication was less in Lateral Plate compared to Bicolumnar Plate group patients which was not statistically significant. Present study showed that Surgery Time was more significant with Bicolumnar Plate group compared to Lateral Plate patients. We examined that KSS score at 1 Month, at 6 month and at 12 month were significantly increased in Lateral Plate group patients compared to Bicolumnar Plate group patients. It was found that Hospital stay had no significant difference with Bicolumnar Plate group and Lateral Plate group. We concluded that the lateral plate technique should be considered in the surgeon's armamentarium for the treatment of distal femur communited fracture with less complication.

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