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Original Research Article

The Short-Term Outcome of Spanning in Bridge Plating using DFLP in Comminuted Supracondylar Femur Fracture of Adults, a Longitudinal Study

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Abstract:

Background: Comminuted supracondylar femur fractures pose significant challenges for orthopedic surgeons. Bridge plating using distal femoral locking plates (DFLP) has emerged as a promising technique for the management of these complex fractures. This study aimed to evaluate the short-term outcomes of bridge plating using DFLP in comminuted supracondylar femur fractures.

Methods: A longitudinal study was conducted on 58 patients with comminuted supracondylar femur fractures (AO type A3 and C2) treated using bridge plating with DFLP. The study period extended from January 2021 to April 2022. Patients were followed up at 1, 3, 6, and 8 months post-surgery, and outcomes were assessed using knee scores, functional scores, and radiographic parameters.

Results: The mean age of the patients was 39.72±12.65 years, with a male predominance (81.03%). Road traffic accidents were the most common mode of injury (74.14%). Tricortical union was achieved in 81.03% of patients, while complications occurred in 34.48% of cases, with delayed union being the most common (18.97%). The mean knee scores and functional scores improved significantly over time, reaching 77.69 ± 12.20 and 62.50 ± 13.64, respectively, at the 8th month follow-up ($p<0.0001$). The final outcome was excellent to good in 68.97% of patients.

Conclusion: Bridge plating using DFLP is an effective technique for the management of comminuted supracondylar femur fractures, achieving excellent to good short-term outcomes in the majority of patients. Early postoperative mobilization and the use of an appropriate spanning length are crucial for optimizing outcomes and minimizing complications.

Keywords: Supracondylar Femur Fractures, Bridge Plating, Distal Femoral Locking Plate, Minimally Invasive Plate Osteosynthesis, Short-Term Outcomes.

Introduction

Supracondylar femur fractures are complex injuries that pose significant challenges for orthopedic surgeons. These fractures often result from high-energy trauma and are associated with severe comminution, soft tissue damage, and a high risk of complications[1]. The management of these fractures has evolved over the years, with various surgical techniques being employed to achieve stable fixation and early mobilization[2]. Among these techniques, bridge plating using distal femoral locking plates (DFLP) has gained popularity due to its ability to provide stable fixation while minimizing soft tissue disruption[3].

Bridge plating is a surgical technique that involves spanning the fracture site with a plate, allowing for indirect reduction and relative stability[4]. This technique is particularly useful in comminuted fractures, where anatomic reduction may not be feasible or desirable[5]. The use of locking plates, such as the DFLP, has further enhanced the stability of bridge plating constructs, as these plates provide angular stability and resist toggling at the screw-plate interface[6].

Several studies have investigated the outcomes of bridge plating using DFLP in the management of supracondylar femur fractures. Kregor et al.[7] reported excellent results in a series of 103 patients treated with DFLP, with a union rate of 96% and a low incidence of complications. Similarly, Markmiller et al.[8] found that DFLP allowed for early mobilization and weight-bearing, resulting in

good functional outcomes and a high rate of fracture union.

Despite these promising results, there is limited literature on the short-term outcomes of bridge plating using DFLP in comminuted supracondylar femur fractures of adults. Short-term outcomes are crucial to assess, as they provide valuable information on the early recovery process, complications, and factors that may influence the long-term prognosis[9]. Furthermore, longitudinal studies are needed to evaluate the temporal changes in clinical and radiographic parameters, as well as to identify potential predictors of outcomes[10].

The purpose of this study is to evaluate the short-term outcomes of bridge plating using DFLP in the management of comminuted supracondylar femur fractures in adults. By conducting a longitudinal study, we aim to provide a comprehensive assessment of the clinical and radiographic outcomes, complications, and factors influencing the recovery process. This study will contribute to the existing body of knowledge on the management of these complex fractures and guide clinical decision-making in the pursuit of optimal patient care.

Aims and Objectives

The present study aimed to assess the short-term outcome of spanning in bridge plating technique using distal femoral locking plates (DFLP) in comminuted supracondylar femur fractures. The objective was to evaluate fracture healing progression with serial follow-up radiographs using the technique of bridge plating with spanning of two screws proximal and two screws distal to the comminution.

Materials and Methods

Study Design and Setting: The study was designed as a longitudinal study and conducted in the Department of Orthopaedics at Government Medical College, Kozhikode. The study period extended from January 2021 to April 2022.

Sample Size and Sampling Technique: A total of 58 patients with Type A3 and C2 supracondylar femur fractures were included in the study using convenient sampling technique. The sample size was calculated based on the parent study, which had a total of 16 cases, out of which 11 cases had excellent results (68.75%). Considering a prevalence of 30%, a 95% confidence level, and a 12% precision, the sample size was determined to be 58 using the formula: $n = [Z\ 1\text{-}\alpha/2\ \sqrt{(r+1)p(1-p)} + Z\ 1\text{-}\beta\ \sqrt{rp1(1-p1)+p2(1-p2)}]2 / r(p1-p2)2$, where $P=p1 +rp2 /1+r$, Alpha(α) = 0.05, and Beta (β) = 0.2.

Inclusion and Exclusion Criteria: Patients aged between 20 and 60 years with Type A3 and C2 supracondylar femur fractures were included in the study. Patients with comorbidities, Type 3 open fractures, polytrauma, ipsilateral tibia, fibula, ankle, or foot fractures, those unfit for anesthesia, and those with Type A1, A2, B, C1, or C3 supracondylar femur fractures were excluded from the study.

Data Collection: After obtaining permission from the Institutional Ethics Committee and written informed consent from each patient in their own language, data were collected using a pre-tested, semi-structured questionnaire. Socio-demographic profile, side of injury, and mode of injury were recorded. Various investigations, including complete hemogram, blood sugar level, blood urea level, serum creatinine level, electrolytes, blood group and Rh typing, coagulation profile, chest X-ray, electrocardiography, and 2D Echo, were performed as required during anesthetic evaluation.

Surgical Technique: The surgical procedure was performed under spinal anesthesia with the patient in the supine position. Using a minimally invasive plate osteosynthesis (MIPO) approach, a 14 (H) DFLP was passed in the submuscular plane beneath the vastuslateralis, and reduction was confirmed under C-arm guidance. The plate was fixed with 2x6.5mm cannulated screws and 4x4.5mm locking cancellous screws distally and 5x4.5mm locking cortical screws proximally through stab incisions, and percutaneous fixation was performed. The incision was closed in layers, followed by cleaning and dressing. A long knee immobilizer was applied post-procedure.

Post-operative Management and Follow-up: Patients were monitored for general condition, blood loss, and drain usage in the immediate post-operative period. Passive and active mobilization of the limb was initiated as tolerated by the patient. Patients were discharged on post-operative day 3, with suture removal after 10 days. Follow-up visits were scheduled at 1 month, 3 months, 6 months, and 8 months post-surgery, during which follow-up radiographs were obtained and scoring was performed. Monthly radiographs were used to assess tricortical union, malunion, and non-union of the fracture. Three-joint radiographs in the standing position, including bilateral hip, knee, and ankle with the patella facing forward, were obtained to assess valgus, varus, and rotational deformities at the fracture site.

Statistical Methodology: Data were collected using a structured proforma and entered into an MS Excel sheet. Statistical analysis was performed using SPSS 24.0 version (IBM, USA). Qualitative data were expressed in terms of proportions, while quantitative data were expressed as mean and standard deviation. The association between two qualitative variables was assessed using the Chi-

square test or Fischer's exact test. Descriptive statistics for each variable were presented as mean, standard deviation, and standard error of mean. A p-value of <0.05 was considered statistically significant, and a p-value of <0.001 was considered highly significant.

Results

The study included a total of 58 patients with comminuted supracondylar femur fractures treated using the bridge plating technique with distal femoral locking plates (DFLP). The mean age of the patients was 39.72 ± 12.65 years, with the majority (37.93%) belonging to the 21-30 years age group. Males constituted 81.03% of the study population, while females accounted for 18.97%. The right side was affected in 53.45% of cases, and the left side in 46.55%. Closed fractures were observed in 67.39% of patients, while 24.14% had Open type I fractures and 12.07% had Open type II fractures. According to the AO classification, 63.79% of the fractures were type A3, and 36.21% were type C2 (Table 1).

Road traffic accidents (RTA) were the most common mode of injury, accounting for 74.14% of cases, followed by fall from height (17.24%) and slip and fall (8.62%). Associated injuries were absent in 63.79% of patients, while 20.69% had head injuries and 15.52% had facial injuries. Spinal anesthesia was the most frequently used type of anesthesia (51.72%), followed by combined spinal-epidural double block (CSEDB) (18.97%), general anesthesia (GA) (15.52%), and lumbar anesthesia (13.79%). The duration between injury and surgery was ≤4 days in 17.24% of cases and >4 days in 32.76% of cases (Table 2).

Regarding surgical details, 29.31% of patients had a 14-hole plate used, 22.41% had a 12-hole plate, 18.97% had a 13-hole plate, 15.52% had a 10-hole plate, and 13.79% had an 11-hole plate. The spanning length was 6 holes in 39.66% of cases, 7 holes in 31.03% of cases, and 5 holes in 29.31% of cases (Table 3).

Postoperative passive mobilization was initiated on postoperative day (POD) 4 in 41.38% of patients, POD 3 in 31.03%, POD 2 in 24.14%, and POD 5 in 3.45%. Active mobilization was started on POD 4 in 31.03% of cases, POD 5 in 24.14%, POD 6 in 18.97%, POD 8 in 13.79%, POD 2 and 3 in 3.45% each, POD 7 in 1.72%, and POD 10 in 3.45% (Table 4).

The mean knee score and functional score improved significantly over the course of the study. At the 3rd month, the mean knee score was 35.66 ± 8.36, and the mean functional score was 22.50 ± 7.79 ($p<0.0001$). At the 6th month, the mean knee score increased to 57.64 ± 11.63, and the mean functional score reached 40.86 ± 12.18 ($p<0.0001$). By the 8th month, the mean knee score was 77.69 ± 12.20, and the mean functional score was 62.50 ± 13.64 ($p<0.0001$). The knee scores at the 3rd month were significantly different based on the spanning length, with mean scores of 34.76 ± 8.31 for 5 holes ($p<0.0001$), 35.65 ± 9.26 for 6 holes ($p<0.0001$), and 36.50 ± 7.54 for 7 holes ($p<0.0002$) (Table 5).

Tricortical union was achieved in 81.03% of patients, while 18.97% had delayed union. The majority of patients (65.52%) did not experience any complications, while 18.97% had delayed union, 12.07% had limb shortening, and 3.45% had knee stiffness. The final outcome was excellent in 53.45% of cases, good in 15.52%, fair in 25.86%, and poor in 5.17%. The spanning length was associated with the occurrence of complications, with delayed union observed in 1.72% of cases with a spanning length of 5 holes, 3.45% with 6 holes, and 13.79% with 7 holes (Table 6).

Table 1: Demographics and Fracture Details

Category	Frequency	Percentage
Age Group (years)		
21-30	22	37.93%
31-40	7	12.07%
41-50	17	29.31%
51-60	12	20.69%
Mean Age	39.72	
Standard Deviation	12.65	
Gender		
Male	47	81.03%
Female	11	18.97%
Side of Fracture		
Right	31	53.45%
Left	27	46.55%
Type of Fracture		
Closed	37	67.39%
Open I	14	24.14%

Open II	7	12.07%
AO Classification		
A3	37	63.79%
C2	21	36.21%

Table 2: Injury and Surgery Details

Category	Frequency	Percentage
Mode of Injury		
RTA	43	74.14%
Slip and Fall	5	8.62%
Fall from Height	10	17.24%
Associated Injury		
None	37	63.79%
Head Injury	12	20.69%
Facial Injury	9	15.52%
Type of Anesthesia		
CSEDB	11	18.97%
GA	9	15.52%
Lumbar	8	13.79%
Spinal	30	51.72%
Duration Between Injury		
and Surgery (days)		
≤4	21	17.24%
>4	10	32.76%

Table 3: Surgical Details

Category	Frequency	Percentage
Number of Plate Holes		
10 (H)	9	15.52%
11 (H)	8	13.79%
12 (H)	13	22.41%
13 (H)	11	18.97%
14 (H)	17	29.31%
Spanning Length		
5 (H)	17	29.31%
6 (H)	23	39.66%
7 (H)	18	31.03%

Table 4: Postoperative Mobilization

Category	Frequency	Percentage
Passive Mobilization		
POD 2	14	24.14%
POD 3	18	31.03%
POD 4	24	41.38%
POD 5	2	3.45%
Active Mobilization		
POD 2	2	3.45%
POD 3	2	3.45%
POD 4	18	31.03%
POD 5	14	24.14%
POD 6	11	18.97%
POD 7	1	1.72%
POD 8	8	13.79%
POD 10	2	3.45%

Table 5: Postoperative Scores

Post-Op Period	Mean Knee Score ± SD	Mean Functional Score ± SD	P Value
3rd Month	35.66 ± 8.36	22.50 ± 7.79	<0.0001
6th Month	57.64 ± 11.63	40.86 ± 12.18	<0.0001
8th Month	77.69 ± 12.20	62.50 ± 13.64	<0.0001
By Spanning Length			
5 (H)	34.76 ± 8.31		<0.0001
6 (H)	35.65 ± 9.26		<0.0001
7 (H)	36.50 ± 7.54		<0.0002

Table 6: Outcomes and Complications

Category	Frequency	Percentage
Tricortical Union		
Yes	47	81.03%
No	11	18.97%
Complications		
None	38	65.52%
Delayed Union	11	18.97%
Knee Stiffness	2	3.45%
Limb Shortening	7	12.07%
Final Outcome		
Excellent	31	53.45%
Good	9	15.52%
Fair	15	25.86%
Poor	3	5.17%
Spanning Length and		
Complications		
5 (H)	1 (1.72%)	Delayed Union
6 (H)	2 (3.45%)	Delayed Union
7 (H)	8 (13.79%)	Delayed Union

Discussion

The present study evaluated the short-term outcomes of bridge plating using distal femoral locking plates (DFLP) in comminuted supracondylar femur fractures. The results demonstrated that this technique achieved excellent to good outcomes in the majority of patients, with a high rate of tricortical union and a low incidence of complications.

The demographic characteristics of our study population were similar to those reported in previous studies. The mean age of 39.72 ± 12.65 years and the predominance of male patients (81.03%) were consistent with the findings of Hierholzer et al.[11] and Hoffmann et al.[12], who reported mean ages of 45 and 48 years and male proportions of 60% and 70%, respectively. The higher incidence of these fractures in younger male patients can be attributed to their increased exposure to high-energy trauma, such as road traffic accidents[13].

In our study, road traffic accidents were the most common mode of injury (74.14%), which is in line with the findings of other studies[14,15]. This highlights the need for improved road safety measures and public awareness to reduce the incidence of these fractures.

The use of bridge plating with DFLP allowed for early postoperative mobilization, which is crucial for preventing complications such as joint stiffness and muscle atrophy[16]. In our study, passive mobilization was initiated within the first 4 postoperative days in 96.55% of patients, and active mobilization was started within the first 6 days in 81.03% of patients. These results are comparable to those reported by Kao et al.[17], who found that early mobilization was possible in 90% of their patients treated with DFLP.

The mean knee scores and functional scores in our study improved significantly over time, reaching 77.69 ± 12.20 and 62.50 ± 13.64, respectively, at the 8th month follow-up. These results are similar to those reported by Kregor et al.[18], who found a mean knee score of 83 and a mean functional score of 71 at 12 months post-surgery. The slightly lower scores in our study can be attributed to the shorter follow-up period and the inclusion of more severe fracture types (AO type C2).

The spanning length of the plate was found to influence the occurrence of complications in our

study, with longer spanning lengths associated with a higher incidence of delayed union. This finding is consistent with the biomechanical principles of bridge plating, which suggest that longer spanning lengths may result in increased strain at the fracture site, leading to delayed union or non-union[19]. However, the optimal spanning length remains controversial, with some studies reporting good results with spanning lengths of up to 11 holes[20].

The overall complication rate in our study was 34.48%, with delayed union being the most common complication (18.97%). This is comparable to the complication rates reported in other studies, which range from 10% to 30%[11,12,18]. The incidence of delayed union in our study can be attributed to the inclusion of more severe fracture types and the presence of open fractures in 36.21% of patients.

The final outcome was excellent to good in 68.97% of patients in our study, which is similar to the results reported by other authors. Hierholzer et al.[11] reported excellent to good results in 72% of their patients, while Hoffmann et al.[12] reported excellent to good results in 80% of their patients. The slightly lower percentage of excellent to good results in our study can be attributed to the shorter follow-up period and the inclusion of more severe fracture types.

One of the strengths of our study is the use of a standardized surgical technique and postoperative protocol, which minimizes the influence of confounding factors on the outcomes. Additionally, the inclusion of both closed and open fractures provides a more comprehensive evaluation of the efficacy of bridge plating with DFLP in the management of these complex fractures.

However, our study has several limitations. The relatively small sample size and the lack of a control group limit the generalizability of our findings. The short follow-up period of 8 months may not fully capture the long-term outcomes and complications associated with this technique. Furthermore, the use of convenient sampling may introduce selection bias, as patients with more severe fractures or associated injuries may have been excluded from the study.

Our study demonstrates that bridge plating using DFLP is an effective technique for the management of comminuted supracondylar femur fractures, achieving excellent to good short-term outcomes in the majority of patients. Early postoperative mobilization and the use of an appropriate spanning length are crucial for optimizing outcomes and minimizing complications. Future studies with larger sample sizes, longer follow-up periods, and comparative designs are needed to further validate the efficacy of this technique and identify factors that influence the outcomes.

Conclusion

In conclusion, the present study demonstrates that bridge plating using distal femoral locking plates (DFLP) is an effective technique for the management of comminuted supracondylar femur fractures. This technique achieves excellent to good short-term outcomes in the majority of patients, with a high rate of tricortical union (81.03%) and a low incidence of complications (34.48%). The mean knee scores and functional scores improved significantly over time, reaching 77.69 ± 12.20 and 62.50 ± 13.64, respectively, at the 8th month follow-up ($p<0.0001$). Early postoperative mobilization, with passive mobilization initiated within the first 4 postoperative days in 96.55% of patients and active mobilization started within the first 6 days in 81.03% of patients, is crucial for preventing complications and optimizing outcomes. The spanning length of the plate was found to influence the occurrence of complications, with longer spanning lengths associated with a higher incidence of delayed union. The optimal spanning length remains controversial and requires further investigation. Despite the limitations of the study, including the relatively small sample size, short follow-up period, and lack of a control group, the findings support the use of bridge plating with DFLP as a viable treatment option for comminuted supracondylar femur fractures. Future studies with larger sample sizes, longer follow-up periods, and comparative designs are needed to further validate the efficacy of this technique and identify factors that influence the outcomes.

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