

Original Research Article

A prospective study on surgical fixation of complex supracondylar femur fracture with distal femoral locking compression plate: our experiences at a tertiary care centre

Rajesh Kumar Sharma^{1*}, Anuradha Upadhyay², Rahul Parmar¹

¹Department of Orthopaedics, Govt. Medical College, Kota, Rajasthan, India

²Department of Physiology, S. K. Govt. Medical College, Sikar, Rajasthan, India

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*Correspondence:

Dr. Rajesh Kumar Sharma,

E-mail: drrajeshsharma1986@gmail.com

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ABSTRACT

Background: The optimal treatment of complex supracondylar femur fractures remains always challenging and controversial. The purpose of this prospective study was to evaluate the efficacy of distal femoral locking compression plate (DF-LCP) in terms of functional outcome and union rate for highly unstable complex supracondylar femur fractures and to determine the influencing factors of an unfavourable outcome.

Methods: After obtaining approval from institutional ethics committee, 45 patients with complex supracondylar femur fractures were managed by open reduction and internal fixation with DF-LCP through lateral approach and as per standard protocol. The follow-up results were analysed clinically and radiologically, using the “Schatzker and Lambert criteria” at once in a month for first three months, once in three months up to one year and once in six months thereafter up to 2 years post-operatively.

Results: In the present study, average duration of radiological union was 16 (range 12-22) weeks. The average range of motion of knee joint was 105 degrees. Out of 45 patients, clinical results were excellent in 48.9%, good in 17.8%, fair in 22.2% and poor in 11.1% patients according to Schatzker and Lambert criteria. Knee stiffness (7 cases), secondary arthritis (5 cases), and non-union (4 cases) were the main complications observed in this study, which were treated accordingly.

Conclusions: DF-LCP holds the metaphyseal bone strongly and prevents metaphyseal collapse and mal-rotation in complex or highly unstable supracondylar femur fractures and simultaneously, it provides stable fixation to promote fracture union and allows early rehabilitation with acceptable complications.

Keywords: Supracondylar, DF-LCP, Lateral approach, Schatzker and Lambert criteria

INTRODUCTION

Supracondylar femur fractures are usually challenging injuries for the treating orthopaedic surgeons. Overall incidence rate of these fractures is 4-6% of all femoral fractures.^{1,2} These fractures have a bimodal age group distribution. High energy injuries like road traffic accidents, sport's injuries and fall from height are the

prominent causes in younger patients while in elderly patients it usually occurs with low energy injuries like simple fall during walking and other household injuries.^{3,4} Supracondylar femur fractures usually associated with compound injuries, high grade comminution and bone loss. On the other hand, proximity to knee joint and unstable nature of the fracture makes it more prone for adverse functional outcome. Inadequate management of such fracture has high incidences of

infection, mal-union, non-union and implant failure, which may produce consequential disability.⁵

The management plan of these fractures depends on patient age, fracture grading, soft tissue injuries, and other associated injuries.⁶ For treating Orthopaedic surgeon the ideal surgical goals are anatomic reduction of the fracture fragments, restoration of limb length, alignment and rotation and rigid fixation that allows early mobilization and rehabilitation for the patient.

Prior to 1970s most of the supracondylar femur fractures were treated conservatively with traction, casting or combination of both. Due to prolonged bed rest, complications such as persistent angular deformity, bed sores and loss of knee range of motion were encountered in most of the patients with these conservative methods.^{7,8} After the arrival of AO group, and up to late 90s, many internal fixation devices have been used for the treatment of supracondylar femur fractures in which the dynamic condylar screw (DCS), or angled blade plate (ABP), condylar buttress plates, retrograde supracondylar interlocking nails were the main implants.⁹⁻¹¹ Although early mobilization was an advantage, but rigid fixation in osteoporotic fractures and in severe metaphyseal comminutions were the main challenges to these conventional methods. Other disadvantages were periosteal stripping and stress on implant lead to unfavourable outcomes, e.g. non-unions and implant failures.

DF-LCP was designed to overcome all these disadvantages. For highly comminuted and osteoporotic supracondylar femur fractures, open reduction and internal fixation (ORIF) with pre-contoured DF-LCP is one of the most acceptable surgical procedure nowadays. It allows both locking and compression screw fixation of the femur shaft. The pull-out strength of locking screws is significantly higher than that of typical screws, and it's arduous for one screw to pull out or fail unless all adjoining screws do the same. The favourable benefits of DF-LCP include angular stable fixation of fragments regardless of bone quality, reduced impairment of periosteal blood supply of the bone due to limited plate-bone contact, rigid fixation, early and active mobilization even in osteoporotic and highly comminuted supracondylar femur fractures.¹²⁻¹⁴

The purpose of this study was to assess the functional outcome, and post-operative complications in highly unstable complex supracondylar femur fractures treated with open reduction and internal fixation with DF-LCP using Schatzker and Lambert criteria.¹³

METHODS

This study was conducted during the years 2015 to 2018 in the department of Orthopaedics, Government Medical College, Kota, Rajasthan. Prior to initiation of this study, approval of institutional ethical committee was received.

We designed a prospective study with sample size of 45 patients with supracondylar femur fractures, who met with inclusion criteria.

Inclusion criteria

Skeletally matured patients with complex supracondylar femur fractures (spiral, oblique, transverse and butterfly fragment with intra-articular extension and open fractures grade I & II, as per Gustilo-Anderson classification, osteoporotic fractures and had preparedness to take part in the study, were included.¹⁵

Exclusion criteria

Polytrauma patients, pathological fractures, periprosthetic fractures, existing deformity of same limb, any active infection, open fractures grade III and IV, as per Gustilo-Anderson classification and fractures with neurovascular injuries were excluded from the study.

All the mandatory preoperative routine investigations (blood and urine) were done. To understand the morphology of fracture, an adequate radiological assessment and 3-dimensional CT scan (especially in intra-articular femoral condyle fractures) were carried out before the surgery. Lower tibial skeletal traction with proper weight was applied, in the situation of delayed surgery. We obtained the written informed consent from all patients before they underwent for the surgery (ORIF with DFLCP).

Surgical technique

All surgeries were performed by the same surgical team under spinal or combined spinal epidural anaesthesia. On the operating table, patient was placed in supine position. Intravenous antibiotic (1 gm of cephalosporin) was injected 30 min before the surgery. A pillow was placed under the ipsilateral hip, and another was placed under the knee to obtain flexed position of the knee. Depending on length of femur and proximal extension of fracture, a pneumatic tourniquet was applied at the upper thigh in some patients. Routine preparations such as scrubbing and draping of injured limb were done.

Lateral standard approach was used in all patients. A lateral incision parallel to the shaft of femur extending across the midpoint of lateral femoral condyle, anterior to lateral collateral ligament, across the knee and gently curved anteriorly along the lateral border of the patella and up-to lateral to tibial tuberosity. The Vastus lateralis was elevated from the lateral intermuscular septum and retracted anteriorly and medially exposing the distal femur. Adequate exposure of articular surface, particularly, medial femoral condyle or coronal plane anatomy was managed by extension of incision as per necessity.

The condyles were reduced and stabilised temporarily by k wires and fixed with 6.5mm cannulated cancellous screws. Supracondylar part was reduced and distal femoral locking compression plate was placed. After putting a suction drain, wound closer was done in a standard manner.

Post-operative follow-up

Post-operatively intravenous antibiotics were given for 5 days followed by oral antibiotics. Wound dressing was checked on second post-operative day. Routine post-operative X-rays were done before discharge. From 3rd post-operative day, continuous passive knee mobilization exercises twice daily were given to all the patients. Our purpose was to obtain at least 90 degree of knee flexion at the time of discharge. For initial six post-operative weeks, all the patients were directed to perform quadriceps, hamstring and knee bending exercises properly. After six weeks, once satisfactory clinical union was ensured on examination, partial weight bearing with long leg knee brace support was allowed. In our study, clinical union was considered satisfactory if fracture site was pain free and two plane stability was present clinically at the fracture site. After 12 weeks, once enough radiological signs of fracture union were detected in plane X-rays, full weight bearing was allowed. It was considered satisfactory radiological union, if plain radiographs showed at least three cortices of the bone or bone trabeculae crossing the fracture site. Although, above mentioned protocol was delayed in case of delayed union.

Follow-ups were done regularly, once in a month for first three months, once in three months up-to one year and once in six months thereafter up to 2 years. At each follow-up, check X-rays were taken and all the information regarding postoperative complications, union time of fracture, partial weight bearing time, full weight bearing time of fracture were recorded. Final assessment of all the patients was done at two years' post-operatively. For grading of the results, Schatzker and Lambert criteria was followed in this study.¹³

Statistical analysis

Statistical analysis was performed using SPSS software version 16.0 and MS Excel 2013. In the present study, qualitative variables were demonstrated in proportion and quantitative variables were presented by mean and standard deviation.

RESULTS

Forty-five eligible patients were operated during the study period, from the years 2015 to 2018. Out of 45 patients, 32 were male and 13 were female, with mean age of 41.5 years (range 18-73). The mode of injury in 29 patients was road traffic accident, in 11 patients was fall

from height, and in rest 5 patients was simple fall during walking (Table 1).

Table 1: Demographic variables of the study.

Demographic variables		Features
Study design		Prospective study
Study period (years)		2015 - 2018
Total number of the patients		45
Male:female		32:13
Mean age (range in years)		41.5 (18-73)
Mode of injury	Road Traffic Accident	29
	Fall from height	11
	Simple fall during walking	5

These fractures were closed in 39 cases and open in 6 cases (5 were Gustilo and Anderson grade I, 1 was grade II). The mean delay from injury to surgery was 6 (range 1-12 days). Mean duration of surgery was 85 (range 60-115 min). Average preoperative blood loss was 270 (range 150-450 ml). The mean days of hospital stay were 10 (range 7- 14 days).

Various functional and radiological outcomes of our study e.g. the average time to weight bearing, radiological union, ROM, and study results are presented here in tabulated form (Table 2-4) and figures (Figure 1-5).

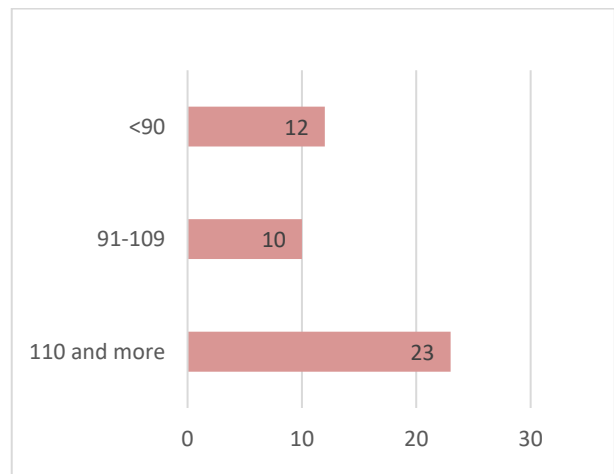


Figure 1: Post-operative knee ROM in our study group.

Table 2: Various outcomes of the study.

Functional Outcome	Average duration (range in weeks)
Full weight bearing	14 (12-20)
Radiological union	16 (12-22)

Table 3: Knee range of motion in post-operative patients (n=45).

Post-op knee ROM* (in degree)	Functional Outcome	No. of patients (%)
110 and more	Good to excellent	23 (51.1)
91-109	Satisfactory	10 (22.2)
<90	Unsatisfactory	12 (26.7)

*ROM: Range Of Motion

Table 4: Functional outcome of the study (n=45).

Results (according to Schatzker and Lambert criteria)	N	%
Excellent	22	48.9
Good	8	17.8
Fair	10	22.2
Poor	5	11.1

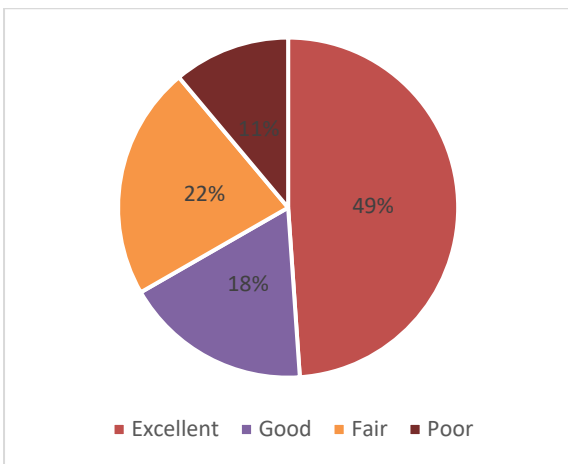


Figure 2: Results of the study according to Schatzker and Lambert criteria.

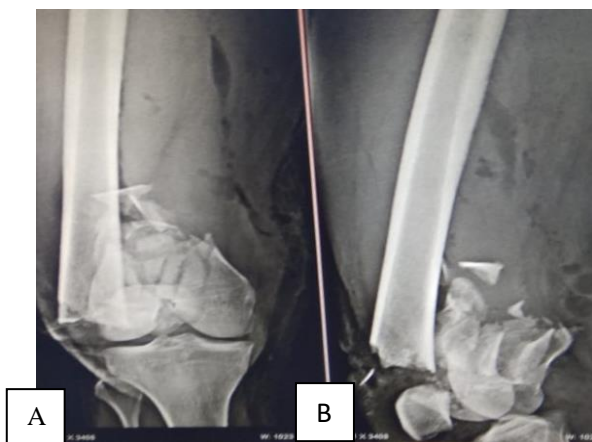


Figure 3 (A and B): Pre-op radiographs (AP and Lateral views) of a complex supracondylar femur fracture.

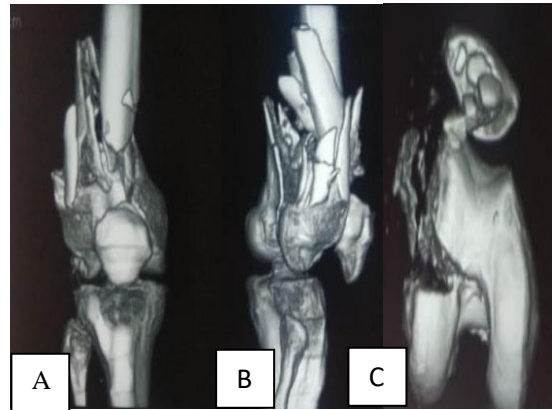


Figure 4: Showing pre-op CT (Coronal, Sagittal and Axial sections) of the complex supracondylar femur fracture.



Figure 5 (A and B): Post-op radiographs (AP and Lateral views) of the complex supracondylar femur fracture, treated with DF-LCP plate fixation.

Complications of the study

We encountered some complications at the follow-ups of the patients. The most common complication of our study was knee stiffness, observed in 7 (15.5%) patients. All the complications are expressed here in tabulated form (Table 5).

Table 5: Showing the complications of the study (n=45).

Complications	N (%)
Superficial surgical site infection	2 (4.4)
Deep infection	1 (2.2)
Delayed union	2 (4.4)
Knee stiffness	7 (15.5)
Implant failure	3 (6.7)
Non-union	4 (8.9)
Secondary arthritis	5 (11.1)

DISCUSSION

Surgical treatment methods for supracondylar femur fractures are still controversial and dependent on fracture type and the surgeon's choice. Distal femoral locking compression plates (DFLCP) have become the most commonly used procedure for internal fixation of distal 1/3rd femur fractures with or without intercondylar extension.¹⁶⁻¹⁸ In DFLCP, sum of all screw- bone interfaces, gives the strength of fixation and makes it a 'single beam construct'. This plate has higher biological advantages than a conventional plate.¹⁹ It doesn't hamper the blood supply to the bone and maintains cortical thickness of the bone unlike conventional plate.

In the present study, the mean age of patients was 41.5 (range 18-73) years. This finding is comparable with the study of Siliski et al. in which they reported the mean age of their study population as 42.2 years.²⁰ Males were affected more commonly than females. In present study, out of 45 patients, 32 patients (71.1%) were male and 13 (28.9%) patients were female. It can be explained in such way that working adult male are more involved in outdoor activities in country like India and acquire such fractures more commonly. Similarly, 63% were male patients in the study of Yeap et al.²¹

In the present study, average time of full weight bearing was 14 (range 12-20) weeks and radiological union was 16 (range 12-22) weeks. Although, delayed union was also observed in two cases (4.4%), in which late union occurred at the end of 22 weeks post-operatively. Our study results are comparable with the results of previous studies of Rajaiah et al.²² and Kim et al.²³

In our study, out of 45 patients, ROM of knee joint at final follow-up (2 year) was 110 degree and more in 23 (51.1%) patients with good to excellent functional outcome. In 10 (22.2%) patients we succeed to achieve 91-109 degree ROM with satisfactory functional outcome. Although, we were failed to achieve a satisfactory ROM in 12 (26.7%) patients up-to their final follow-up, some of these patients underwent knee mobilization under short GA. They refused for any additional surgery to increase ROM and continued with non-operative care. The average range of motion of knee joint was 105 degrees in our study. The average ROM of knee joint was 110 degrees in the study of Markmiller et al.²⁴

In the present study, the results were expressed according to the according to Schatzker & Lambert criteria.¹³ In this study, out of total 45 cases, results were as excellent in 22 (48.9%) cases, good in 8 (17.8%) cases, fair in 10 (22.2%) cases and poor in 5 (11.1%) cases. Paknikar et al reported their study result as excellent in 32%, good in 28%, fair in 34% and poor in 6%.²⁵ In the study of Padha et al they described their results as excellent in 44%, well in 32%, fair in 16% and failure in 8% patients.²⁶

In the present study, out of 45 cases, 2 (4.4%) patients had post-operative superficial surgical site infection, which were successfully treated with proper dressings and oral antibiotics. Although, there was no long term bad effect on fracture healing or rehabilitation of these patients due to this superficial infection. We observed one case (2.2%) with deep infection, which was successfully managed with debridement, adequate lavage and intravenous antibiotics. Kregor et al reported in their study that deep infection manifested in 3% of their patients.²⁷

Knee stiffness was the most common post-operative complication of our study. It was observed in 7 (15.5%) patients. We observed total 3 (6.7%) patients with implant failure within first 12 weeks of primary surgery. Out of 45 patients, we noticed 4 (8.9%) patients with non-union at their one year follow-ups. All these patients underwent revision surgery. The procedure carried out was- implant removal and re-fixation with longer DFLCP with autologous bone grafting. The bone graft was obtained from ipsilateral iliac crest of the same patient and satisfactory functional outcome was achieved following the revision surgery. Out of 45 patients, we noted secondary arthritis in 5 (11.1%) patients, for which some of these patients have to go knee arthroplasty at later stage. All these complications were comparable with the complications mentioned in the previous studies.²⁸⁻³⁰

Limitations of the study

One of the major limitations of our study was small sample size. The small sample size has an influence on the evaluation of outcomes, as it can overrate the results. Furthermore, the study includes solitary method of fracture fixation with DF-LCP only while other various fixation methods could have also been used for comparison and to conclude more significant results.

CONCLUSION

With proper patient selection, the pre-contoured DF-LCP offers favourable clinical and radiological outcome in the treatment of complex or highly unstable supracondylar femur fractures with acceptable complication rates. It reduces impairment of periosteal blood supply due to limited plate-bone contact, provides angular stability and rigid fixation of fragments regardless of bone quality, promotes early mobilization and early weight bearing even in osteoporotic, and severe comminuted supracondylar femur fractures.

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Conflict of interest: None declared

Ethical approval: The study was approved by the institutional ethics committee

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