

FUNCTIONAL OUTCOME EVALUATION AFTER DISTAL FEMORAL LOCKING PLATE FIXATION OF SUPRACONDYLAR FRACTURES OF FEMUR

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ABSTRACT

BACKGROUND

Supracondylar fractures of femur have a bimodal distribution. They account for 6% of all femur fractures. Nearly, 50% of distal femur intraarticular fractures are open fractures. Despite many changes and refinements in the surgical treatment of the supracondylar and intercondylar fractures of femur their surgical management remains challenging. Since the introduction of the condylar blade plate to the present retrograde supracondylar nailing and locking condylar plates, these fractures particularly if open and associated with severe fragmentation of the articular cartilage and in the elderly with severe osteoporosis continue to be a major unsolved surgical challenge. Improved imaging facilities rendered surgical results far better than those treated with long periods of traction on bed with accompanying complications. LCP along with isolated 6.5 mm cannulated cancellous screw systems are best suited for with unicondylar fractures of distal femur in young patient with good bone stock. The functional outcome is largely determined by the degree of accompanying soft tissue injury. Presence of a compound fracture leads to a higher incidence of infection. With good preoperative antibiotics and sterile surgical techniques along with stable fixation, infection can be brought under control and a good outcome can be achieved.

MATERIALS AND METHODS

Thirty supracondylar and intercondylar fractures of femur (Muller's type 'A', type 'B' and type 'C' fractures), which were treated with open reduction and internal fixation by locking compression plate were included in the study. The study was conducted at the Department of Orthopaedics, King George Hospital, Visakhapatnam, from August 2014 to November 2016. Among 30 patients, 5 patients were lost for follow up due to various reasons leaving 25 fractures from 25 patients for the study.

RESULTS

There were 16 males and 9 females. Age range was 19 years to 80 years with an average of 44.6 years. Average age for males was 28.9 years and average age for females was 25 years. 18 fractures were due to road traffic accidents and 5 were due to fall from varying heights. One case was due to bullet injury (classified as Gustilo Anderson type IIIB as it was a high velocity ballistic injury). We used Gustilo Anderson classification to classify open fractures. Among 25 cases, there were 3 compound fractures (12%) and in them 1 case was type I compound fracture (4%), 1 case was type II compound fracture (4%), another case was type IIIA compound fracture (4%). Fractures included in this study were Muller's type A, B and C fractures. Subgroups are type A1- 7 cases, A2- 5 cases, type A 3-4 cases, type B1- 1 case, type B2- 3 cases, type C1- 4 cases, type C2- 2 cases. There were no associated ligamentous injuries of knee, but there were ipsilateral fractures of both bones of leg, fractures of humerus and fractures of both bones of forearm. There were no tibial condylar fractures. Majority of the associated fractures were treated simultaneously. No vascular injuries were noted in this series. The average time between admission and operation was 7.3 days (range 5 days to 16 days). Delay in the operation for more than one week was attributable to multiple trauma and poor general condition of the patient. All these patients were involved in high energy trauma like road traffic accidents or fall from height and most of the patients came within hours of accidents (maximum was 2 days).

CONCLUSION

Standard open reduction and internal fixation with LCP is a very good method of treating distal femur fractures including the Muller/AO C3 variety. Soft tissue injury and intraarticular comminution compromised the patient outcome. Functional assessment with either Neer's or Sanders functional scoring systems have been found useful in evaluating the results. Favourable results can be obtained with strict adherence of principles of stabilisation with rigid internal fixation and early functional rehabilitation. LCP proved to be a good implant, which could take the challenges like poor bone stock, severe comminution both metaphyseal and articular. ORIF of distal femoral fractures with LCP coupled with properly timed early and optimal rehabilitative protocol yields excellent and good results.

KEYWORDS

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BACKGROUND

The goals of treatment of supracondylar fractures of femur were anatomic reduction of the articular surface, restoration of limb alignment, length and rotation and stable fixation that allows for early mobilisation. Nonetheless, internal fixation of the distal femur can be difficult for several reasons- thin cortices, a wide medullary canal, compromised bone stock and fracture comminution were those, which make stable internal fixation often difficult to achieve. The operative management of these difficult fractures was not uniformly successful. These factors which play a dynamic role in management, determine the "personality" of the fracture. Among these are amount of fracture displacement, degree of comminution, extent of soft tissue injury, associated neurovascular injuries, magnitude of joint involvement, degree of osteoporosis, presence of multiple trauma, complex ipsilateral injuries (i.e. patella or plateau fractures) and associated bone loss.

Aim and Objectives

1. To study the role of open reduction and internal fixation by locking compression plate and its functional evaluation in distal femoral fractures.
2. To assess range of motion of the knee and functional status of patients after union of fractures.
3. To assess the functional and radiological outcomes.

MATERIALS AND METHODS

Thirty supracondylar and intercondylar fractures of femur (Muller's type 'A', type 'B' and type 'C' fractures) were treated with open reduction and internal fixation by locking compression plate in the Department of Orthopaedics, King George Hospital, Visakhapatnam, from August 2014 to November 2016. Among them, 5 patients were lost for follow up due to various reasons leaving 25 fractures from 25 patients. For evaluation of the results, we used two evaluation systems one from Neer C.S.H. Grantham S.A. and Shelthor M.L. and the other was from Sanders functional evaluation scale (Tables 1 and 2).

- Excellent : More than 85 points.
- Good : 70 to 85 points.
- Fair : 5 to 69 points.
- Poor : Less than 55 points.

Functional (70 points)		Anatomical (30 points)	
a) Pain (20 points)		a) Gross Anatomy (15 points)	
• No pain		• Thickening only	15
• Intermittent	16	• 5 degrees angulation or 0.5 cm shortening	12
• With fatigue	12	• 10 degrees angulation or rotation, 2 cm shortening	9
• Limits function	8	• 15 degrees angulation or rotation, 3 cm shortening	6
• Constant or at exertion	4-	• Healed with considerable deformity	3
b) Walking Capacity (20 points)		• Nonunion or chronic infection	
• Same as before accident	20	b) Roentgenogram (15 points)	
• Mild restriction	16	• Near normal	15
• Restricted stair side ways	12	• 5 degrees angulation or 0.5 cm displacement	12
• Use crutches or other walking aids	4-0	• 10 degrees angulation or 1 cm displacement	9
c) Joint Movement (20 points)		• 15 degrees angulation or 2 cm displacement	6
• Normal or 135 degrees	20	• Union, but with greater deformity, spreading of condyles and osteoarthritis	3
• Up to 100 degrees	16	• Nonunion or chronic infection	0
• Up to 80 degrees	12		
• Up to 60 degrees	8		
• Up to 40 degrees	4		
• Up to 20 degrees	0		
d) Work Capacity (10 points)			
• Same as before accident	10		
• Regular, but with handicap	8		
• Alter work	6		
• Light work	4		
• No work	2-		

Table 1. Neer C.S.H., Grantham S. A. and Shelthor M.L. Criteria for Evaluation

Function	Result	Points
Range of motion (degrees) flexion		
>125	Excellent	6
100-125	Good	4
90-99	Fair	2
<90 extension	Poor	6
0	Excellent	3
<5	Good	2
6-10	Fair	1
Deformation angulation (degrees)	Poor	0
0	Excellent	3
<10	Good	2
10-15	Fair	1
>15 shortening	Poor	0
0	Excellent	6
<1.5	Good	4
1.5-2.5	Fair	2
>2.5 Pain	Poor	0
None	Excellent	10
Occasional or with changes in weather	Good	7
With fatigue	Fair	5
Constant	Poor	0
Walking ability		
Walking		
Unrestricted	Excellent	6
>30 min. to <60 min.	Good	4
Walks at home or is confined to wheelchair or bedridden star climbing	Poor	0
No limitation	Excellent	3
Holds rail	Good	2
One stair at a time	Fair	1
Elevator only	Poor	0

Table 2. Sanders Functional Evaluation Scale

A. Employed before Injury		
Return to preinjury job	Excellent	6
Returned to preinjury job with difficulty	Good	4
Altered full-time job	Fair	2
Part-time job or un employed	Poor	0
B. Retired before Injury		
Returned to preinjury lifestyle	Excellent	6
Need occasional help	Good	4
Need assistance at home with daily activities	Fair	2
Moved in with family or nursing home	Poor	0

Table 3. Return to Work (A or B)

- Excellent : 36 to 40 points.
- Good : 26 to 35 points.
- Fair : 16 to 25 points.
- Poor : 0 to 15 points.

Inclusion Criteria

1. Supracondylar and intraarticular fracture (Muller’s A1, A2, A3, B1, B2, C1, C2, C3).
2. Both sexes were included.
3. Age group 20 years to 70 years.

Exclusion Criteria

1. Active infection.
2. Severe contaminated open fractures.

3. Massively comminuted fracture with bone loss.
4. Fracture around a total knee replacement.
5. Age group less than 20 years and above 70 years.

RESULTS

Total numbers of cases were 30. Among them, 25 fractures from 25 cases were followed up till union occurred. All cases were unilateral. There were no associated vascular injuries. 18 fractures were due to high velocity road traffic accidents in the form of direct collision of vehicles or fall from moving vehicles or hitting to stationary objects like trees. Six cases were due to fall from various heights like tree and stairs. One case was due to bullet injury. According to Muller’s classification, there were 6 cases of A1 type (24%), 5 cases were A2 type (20%), 3 cases were A3 type (12%), 4 cases were C1 type (16%) and C2 type cases were 2 (8%), type C3 one case (4%), type B1 was 1 case (4%) and type B2 were 3 cases (12%). In brief, type ‘A’ 56%, type ‘B’ 16% and ‘C’ were 28% (Table 3). Among 25 cases, there were 3 cases of compound fractures of various grades (12%). There were 2 cases of Gustilo’s type 1 (8%) and 1 case of type IIIA (4%) compound fracture 15 cases were in right femur (60%) and 10 cases were in left femur (40%). Age incidence- 6 cases were in 20-30 group (24%), among them, 1 was a female and 5 were males. 9 cases were between 31-45 yrs. (36%) among which 3 were females and 6 were males. 6 cases were in 46-60 yrs. (24%) 5 were males and 1 was a female. 4 cases were above 60 yrs., among which 3 were females and 1 was a male (Table 4). All cases showed radiological and clinical union between 12 weeks to 24 weeks. Muller’s A1 type fractures took an average time of 14.7 weeks, maximum of 16 weeks and minimum of 14 weeks; A2 type fractures took an average of 17.6 weeks, maximum of 24 weeks and minimum of 18 weeks and A3 type fractures took average 17 weeks, maximum of 18 weeks and minimum of 15 weeks for healing. One case of B1 healed by 12 wks. Three cases of B2 healed by 13.4 wks. with maximum of 14 weeks and minimum of 12 weeks. C1 fractures took 15.5 weeks with minimum of 14 weeks and maximum of 18 weeks, C2 type fractures took average time of 17 weeks, maximum of 18 weeks and minimum of 16 weeks and for C3 type fractures have taken time of 18 weeks. An average total ‘A’ type fractures has taken 17.43 weeks for healing (14 out of 25), Muller’s type B fractures took 12.7 wks. (4 out of 25) and Muller’s ‘C’ type fractures has taken 16.24 weeks of average time (7 of 20 cases) and 25 cases has taken average time of 15.7 weeks for healing, range is 12 weeks to 24 weeks. According to age group, 20-30 age group took 15.7 weeks for average healing, (maximum of 24 weeks and minimum of 12 weeks), 31-45 age group took 13.7 weeks (max. 24 weeks and min. 14 weeks), 46-60 age group took 15.6 wks. (max. 22 and min. 14) weeks, above 60 yrs. took 16.2 weeks for radiological union. According to gender, there were 17 males (68%) and 8 females (32%) patients. In one case of Muller’s C2 fracture fixed with locking compression plate and superficial infection was noticed. The infection was controlled with appropriate antibiotic and daily dressings and delayed union was noticed.

Longest follow up case was 24 months and least follow up was 5 months. There were no deaths in our series. According to fracture type, average age relation is as follows- average for Muller's 'A' type fracture is 30.7 years and for 'C' type fracture is 35.7 years. According to fracture type and knee ROM- 12 cases of 'A' type fractures average knee ROM achieved was 105.7 degrees, 4 cases of 'B' achieved 95 degrees and for 7 cases of 'C' achieved 95 degrees and total average for this study was 92.6°. According to individual type of fracture- for 6 A1 type fracture average knee ROM is 104° (max. 120° and min. 90°); for 5 A2 type fractures, it is 96.25° (max. 110° and min. 80°); for 4 A3 type fractures, it is 95° (max. 100° and min. 90°) and for 4 C1 type fracture average ROM is 96.25° (max. 100° and min. 95°), for type B1 ROM achieved is 110 degrees and type B2 ROM achieved 96.7 degrees for C2 type fractures average ROM is 92.5° (max. 80° and min. 80°) and for C3 type fracture ROM is 90° (Table 5). Average time of partial weightbearing is 8.24 weeks and full weightbearing is 15.5 weeks. Cases which were treated with locking compression plate average partial weightbearing allowed at 7.2 weeks and full weightbearing was allowed at 14.8 weeks. There were no cases of implant failures and non-unions. In 8 cases, there is a shortening of less than 1 cm. In one case, 5° of varus angulation was noticed. In 14 cases, out of 25 patients had pain-free knee joint and except in 1 patient all have normal gait. In only 2 patients, walking was painful after 30 minutes. Out of 25 patients, 18 returned to their preinjury job, 5 patients had returned to their job with mild difficulty. Two patients lost their employment. Regarding stair climbing, 19 patients had free stair climbing and 4 patients hold the side rails while climbing and two patients can climb the steps with one step with each attempt. Total average hospital stay was 18.5 days with a minimum of 15 days and maximum of 27 days. Type 'A1' fractures took an average time of 6.5 weeks for partial weightbearing and 12.5 weeks for full weightbearing.

Type 'A2' fractures demonstrated partial weightbearing at 6 weeks and full weightbearing at 13.5 weeks on an average. In 'A3' fractures, average partial weightbearing time of 8 weeks and 13.9 weeks for full weightbearing was observed. In type B fractures, B1 took 6 weeks for partial weightbearing, 12 weeks for full weightbearing and B2 fractures took 6.5 weeks for partial weightbearing and 12 weeks for full weightbearing. In type C1 fractures, partial weightbearing started at 7.5 weeks and full weightbearing at 15 weeks. In two type C2 fractures, partial weightbearing has taken 7 weeks and 15.3 weeks for full weightbearing. In type C3 fractures, all but one fracture has taken 16 weeks for partial weightbearing and 17 weeks for full weightbearing. For 25 cases, average full weightbearing has taken 13.5 weeks. The average time gap between date of injury and date of surgery was 7.33 days. For functional evaluation, we have followed both Neer's and Sanders scoring system. With locking compression plate using Neer's criteria, there were 8 excellent results (32%) and 12 good results (48%) 4 fair (16%) results 1 poor (4%). Sanders showed 7 excellent (28%), 11 good result (44%), 6 fair (24%) results and 1 poor result (4%) (Table 6).

Fracture Type	No. of Fractures	Percentage
A1	6	15%
A2	5	25%
A3	3	20%
B1	1	5%
B2	3	20%
C1	4	20%
C2	2	15%
C3	1	5%

Table 4. Type of Fracture

Age (in Years)	Males	Percentage	Females	Percentage	Total No. of Cases	Percentages
20-30	5	20	1	4	6	24
31-45	6	24	3	12	9	36
46-60	5	20	1	4	5	20
>60	1	4	3	4	5	20
Total	18		7		25	100

Table 5. Age and Sex Incidence of Fractures

Fracture Type	No. of Cases	Average ROM in Degrees of Flexion	Minimum in Degrees of Flexion	Maximum in Degrees of Flexion
A1	6	104	120	90
A2	5	96.25	110	80
A3	3	95	100	90
B1	1	110	-	-
B2	3	96.7	120	50
C1	4	91.25	85	95
C2	2	87.5	95	80
C3	1	70	-	-

Table 6. Fracture Type Vs. ROM

Criteria	Excellent	Good	Fair	Poor
Neer's	8	12	4	1
Sander's	7	11	6	1

Table 7. Functional Evaluation Score

DISCUSSION

In a study by Schutz M, Muller M et al, internal fixation using the LISS was performed at an average of 5 days (range- 0-29 days) after the injury. 48 fractures were operated on within the first 24 hours. Revision operations were required for 2 cases of implant breakage. Four cases of implant loosening and 7 debridements due to infections were also reported by them. The study showed clearly that when working with LISS, primary cancellous bone grafting is not necessary.¹ Yeap E.J., and Deepak A.S. conducted a retrospective review on 11 patients who were treated for type A and C distal femoral fractures (based on AO classification) between January 2004 and December 2004. All fractures were fixed with titanium distal femoral locking compression plate. The patient's ages ranged from 15 to 85 with a mean of 44. Clinical assessment was conducted at least 6 months postoperatively using the Schatzker score system.² Vallier et al concluded that locking plates should only be used when conventional fixed-angle devices cannot be placed. They also noted the significant added cost of locking plates.³ Pemberton DJ and Evans PD used a new fixation device for this fracture type. They designed a precontoured carbon fibre plate reinforced with epoxy laminate. They reported encouraging results in terms of simpler surgical techniques, quicker union time, less need for bone grafting and lesser problems of stress protection.⁴ Marti et al compared the LISS plate with unicortical locking screws to the dynamic condylar screw and condylar buttress plate in axial loading and cyclic axial loading to failure in a cadaveric 1 cm fracture gap model. The LISS had more reversible and less irreversible deformation when compared to the other two constructs, which they attributed to the titanium composition and the unicortical screws.⁵ Ricci et al compared axial stiffness, load to failure and screw extraction torque for distal femoral locking plates with locked or non-locked diaphyseal fixation in a nonosteoporotic and osteoporotic cadaveric supracondylar femur fracture gap model. Testing showed that locked diaphyseal fixation was only advantageous in the osteoporotic model.⁶ M. Ahmad et al studied on biomechanics of locking compression plate. Consistent results were achieved in LCP constructs in which the plate was applied at or less than 2 mm from the bone. When applied 5 mm from the bone, the LCP demonstrated significantly increased plastic deformation during cyclical compression and required lower loads to induce construct failure.⁷ This implies that technical issues are more stringent with locking plating application and an associated steep learning curve with LCP fixation. The study clearly showed the superiority of locking plate fixation over the other modalities of fixation. E O Pearse et al studied 17 patients aged over 75 years with supracondylar femur fractures and concluded that total knee replacement for the treatment of supracondylar fractures of the distal femur in the elderly had advantages over internal fixation for the patient and economic advantages for healthcare providers.⁸ The present study did not include the patients aged above 70 years. Periprosthetics were also not included in the study. In the present study, outcome in the form of regaining the lost

knee function is assessed using Neer's score as well as Sanders functional evaluation scale. Overall, results of the study were comparable with review on study of distal femoral fractures by Forster MC, Komarsamy B and Davison.⁹

CONCLUSION

Standard open reduction and internal fixation with LCP is a very good method of treating distal femur fractures including the Muller/AO C3 variety. Soft tissue injury and intraarticular comminution compromised the patient outcome. Functional assessment with either Neer's or Sanders functional scoring systems have been found useful in evaluating the results. Favourable results can be obtained with strict adherence of principles of stabilisation with rigid internal fixation and early functional rehabilitation. LCP proved to be a good implant, which could take the challenges like poor bone stock, severe comminution both metaphyseal and articular. ORIF of distal femoral fractures with LCP coupled with properly timed early and optimal rehabilitative protocol yields excellent and good results.

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