e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2024; 16(1); 401-410

Original Research Article

Open Intra-Articular Distal Femur Fractures Managed Surgically by Primary Plating: A Clinico-Radiological and Functional Outcome Evaluation

Siddhartha Naru[1], Ayon Das[2*]

[1]Resident, Department of Orthopaedics, Peerless Hospital & B. K. Roy Research Centre, Kolkata, West Bengal, India

[2]Assistant Professor, Department of Orthopaedics, ESI-PGIMSR, ESIC Medical College & Hospital, Joka, Kolkata, West Bengal, India

Received: 25-10-2023 / Revised: 23-11-2023 / Accepted: 26-12-2023

Corresponding Author: Dr. Ayon Das

Conflict of interest: Nil

Abstract:

Background: Open intra-articular distal femur fractures are one of the challenges for the Orthopaedic surgeons because of an increased risk of infection and soft tissue-related problems as well as difficulties experienced in union. The present study was aimed to assess the functional outcome of open distal femur articular fractures treated with primary plate osteosynthesis.

Materials and Methods: Patients who underwent primary plate fixation for open post-traumatic distal femoral intra-articular fracture were included in the study. This was a prospective study conducted at a Tertiary care Private Hospital in Kolkata, between June 2018 to May 2019. All patients were followed up at an interval of 2 weeks, 6 weeks, 12 weeks, 6 months, 9 months, 1 year and 1.5 year. Radiological and functional results were classified as per Neer's scoring system.

Result: Outcome at final follow-up was assessed using Neer's scoring system. In a total of 31 patients, 23 (74.2%) showed Good to Excellent results whereas 5 (16.1%) patients had Fair outcome and 3 (9.7%) patients demonstrated Poor surgical result at the final follow-up. 18 patients (58.1%) did not develop any complications. The mean time for fracture union was 18.71 ± 3.33 weeks.

Conclusion: Early and thorough debridement along with definite rigid fixation after anatomical reduction and maintenance of articular congruity using DF-LCP gives good results in properly selected cases of open distal femoral intra-articular fractures. It allows early weight bearing and range of motion of knee with good functional outcome while preventing the need of multiple surgeries.

Keywords: Open fracture, Distal femur, Intra-articular fracture, Primary plate osteosynthesis, Locking plate, Functional outcome.

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0) and the Budapest Open Access Initiative (http://www.budapestopenaccessinitiative.org/read), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

Distal femoral fractures are reported to be less than 1% of all fractures and account for 7% of all femoral fractures [1, 2, 3, 4] of which 5%-10% are open fractures [5, 6, 7]. Open intra-articular fractures of distal femur occur either with high energy trauma or low energy trauma in osteoporotic bones [8, 9]. Management of these injuries presents a challenge to Orthopaedic surgeons as they usually result following high velocity trauma with associated severe soft tissue damage, intra-articular comminution, bone loss [4, 10], injury to quadriceps, extra-articular adhesions and instability, or may be due to a low velocity injury as in a domestic fall with concomitant osteopenia and arthritic changes.

In comparison with closed fractures, open fractures have an increased risk of infection, there are soft tissue-related problems and difficulties are experienced in union. With the addition of soft tissue and union problems, the need for repeated operations in these patients significantly reduces the quality of life and relatively low clinical scores are obtained at the end of treatment. As open fractures have inherent tendency towards infection and non-union (essentially the open grade III fractures), which has led to development and evolution of different methods for treating them [10].

Various treatment options like Ilizarov ring fixator or External fixator, Taylor's spatial frame [11] or Primary plating/nailing with primary or secondary wound closure [12] have been described in literature with advantages and disadvantages when compared to one another. Staged treatment in form of provisional external fixator followed by nailing or plating has also been mentioned by various

authors [12]. The classic indications for locking plate use are with fractures that are periarticular and/or involve osteoporotic bone [13]. They offer superior distal fragment fixation via multiple angular stable screws arranged in a periarticular cluster. Intra-articular fracture extension can be separately fixed or held through the plate as required.

As open fractures expose the fracture site to the environment, they urgently need to be cleansed and require immediate surgery. Debridement along with open reduction and internal fixation primarily with plate usually yield favourable outcome.

The purpose of study was to assess the functional outcome and result of surgical treatment of open distal femoral articular fractures treated with primary locking plate osteosynthesis, as treatment should benefit the patient just not in short term but also in long term. So, the study was done to evaluate the effectiveness of the device in achieving fracture union and to know the rate of complications associated with the device.

Material & Methods

This study was performed in accordance with the ethical standards of the institutional review board. 31 patients with post-traumatic open intra-articular distal femur fracture which were treated by primary plate osteosynthesis in the Department of Orthopaedics, Peerless Hospital and B. K. Roy Research Centre, Kolkata from June 2018 to May 2019 and fulfilling the inclusion criteria were considered in this study.

Inclusion criteria:

- Skeletally mature patients above 18 years of age
- Patients with open intra-articular AO type C distal femur fractures
- Fresh fractures (<24 hrs old)

Exclusion criteria:

- Closed fractures
- Associated fractures in ipsilateral and contralateral long bones of lower limb
- Associated head injury and axial skeletal injuries that definitely influence rehabilitation
- Polytrauma patients or patients with Pathological fractures due to metastasis, benign tumors or metabolic bone disorders or Periprosthetic fractures
- Extensive soft tissue injury requiring soft tissue flap closure (GA IIIB) or with neurovascular injuries (GA IIIC)

Operative Procedure:

All the patients with open fractures of distal femur brought to the casualty were carefully evaluated for mode of trauma, time of injury, size of wound, contamination of wound, distal neurovascular status, active bleeding, exposed bone or bone fragments, systemic shock, co-existing injuries etc. Primary treatment of all open fractures in casualty started with administration of tetanus toxoid, intravenous antibiotics, analgesics, fluid replacement, cleaning of the affected limb with adequate amount of normal saline. Exposed bone was reduced and accommodated in the wound after thorough cleaning and irrigation of wound. Devitalized bony fragments devoid of attached soft tissue and exposed to the external environment and loose bony particles flowing out of the wound during irrigation were all removed from the wound at the first site. A sterile, well-padded dressing with a posterior long leg slab from groin to toe was applied after this [14].

After stabilization, the patients were subjected to a thorough history, clinical examination and pre-operative routine laboratory investigations, which were supplemented by radiographs in antero-posterior and lateral view of the knee joint along with a CT scan with 3D reconstruction.

All patients were operated under Spinal anaesthesia. Patients were placed supine on a radiolucent table. The ipsilateral hip was elevated by a sand bag to avoid excessive external rotation of the distal femur. A sterile rolled-up sheet was placed under the supracondylar region of the distal femur to keep the knee flexed at about 300 which helped to relax the gastrocnemius and correct the associated hyperextension deformity at the articular block. The standard lateral approach was used in all cases. Incision was tailored in such a way to include the pre-existing lateral or anterior wound to facilitate debridement which was carried out as per standard protocol [9, 15] and if any medial-based traumatic wound [15] was present, it was not included and was debrided separately. The fascia lata was incised in line with the skin incision. At the knee, the iliotibial tract was incised and the incision was continued down through the joint capsule and synovium to expose the lateral femoral condyle. The vastus lateralis muscle was carefully elevated from the intermuscular septum and was retracted anteriorly and medially. First, in all patients, extensive debridement was carried out, including necrotic tissues and avascular bone fragments. Irrigation was then made with 3-6 litres of normal saline. Before and after irrigation, deep culture was taken from all patients. Then the intra-articular condylar fragments were reduced and stabilized using K-wires or/and lag screws. Fixation was done using a distal femoral locking compression plate (DF-LCP) with screw combinations appropriate to the fracture pattern (10). Implant positions were confirmed through fluoroscopy. Surgical wound was closed in layers

over an in-situ suction drain. Sterile dressings were applied to the surgical incisions and a long knee immobilizer was applied.

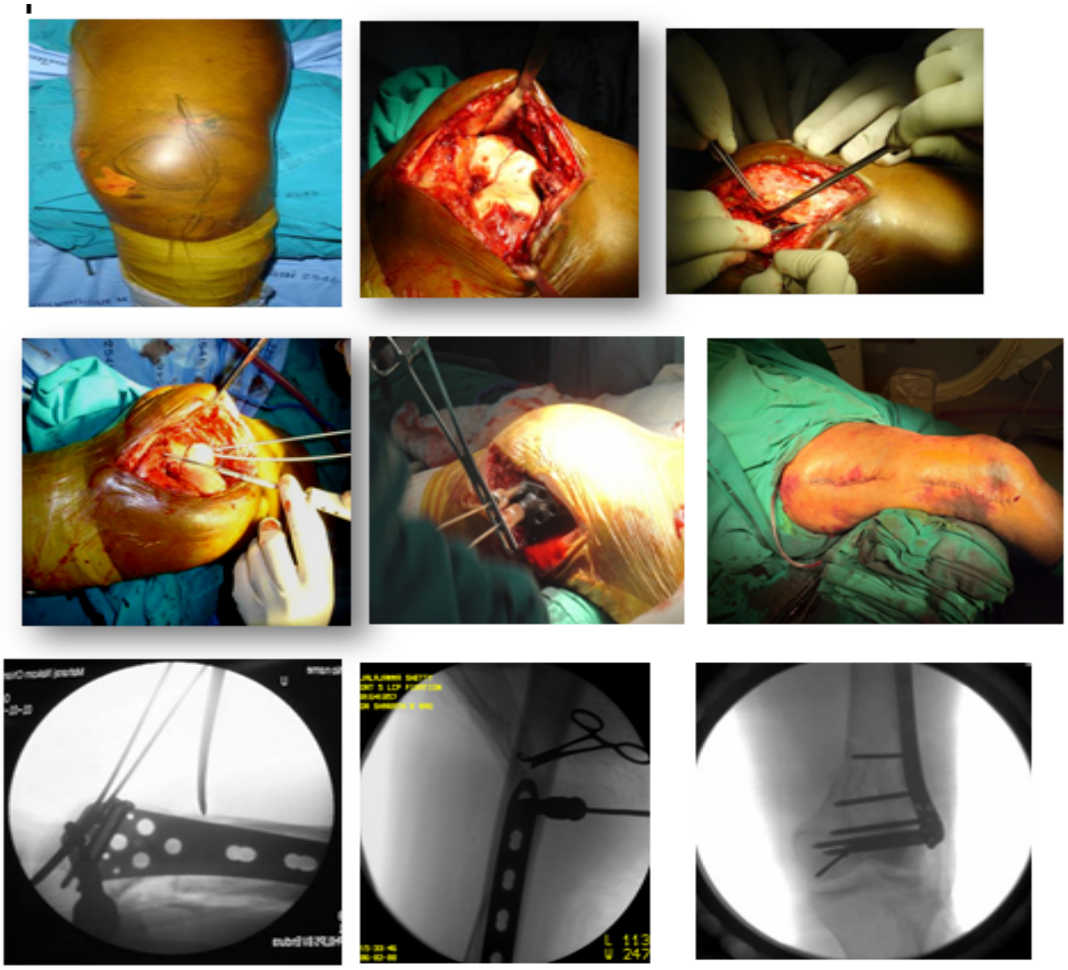

Figure 1:

Rehabilitation

Postoperatively, the patients were put in a long knee brace for 2 weeks. Ankle pumps, isometric quadriceps exercises and knee range of motion were encouraged from second day. Initially patients were allowed only non-weight bearing crutch/walker walking up to 6 weeks. Partial toe touch weight bearing using crutch/walker was started after 6 weeks and full weight bearing at the end of 12 weeks or after clinical and radiological union of the fracture. using crutch/walker was started after 6 weeks and full weight bearing at the end of 12 weeks or after clinical and radiological union of the fracture.

Follow-up:

The patients were regularly followed up for 1.5 years (2 weeks, 6 weeks, 12 weeks, 6 months, 9 months, 1 year and 1.5 year) for clinical as well as radiological evaluation. Except for the first visit, in which only range of motion and local wound condition was addressed, subsequent visits included thorough clinical and radiological assessment. Functional assessment of the patients was done at the final follow-up as per the Neer's scoring system [16].

Statistical analysis: The data was collected in Microsoft Excel (Windows 10; version 2016) and statistical software SPSS version 20 was used. Procedure of the data analysis was transcription, preliminary data inspection, content analysis and interpretation. Continuous variables like limp, pain, swelling etc. measurements were expressed as Mean ± Standard deviation and intergroup comparison done by one sample t-test at 0.05 level of significance. The categorical variables like age, sex, side, comorbidity was expressed as number of patients and the variable significant level was identified using Pearson's Chi Square test at 0.05 level of significance.

Results

Age Distribution: Age of the patients in this study ranges from 19 to 73 years. The mean age group in our study was 38.55 years. 30 years or less age group contain maximum no. of patient i.e. 15

(48.39%). 77.42% patients were between the age group of 19-50 years. It may be because younger and more active people involved in more outdoor activities which makes them more prone to injuries.

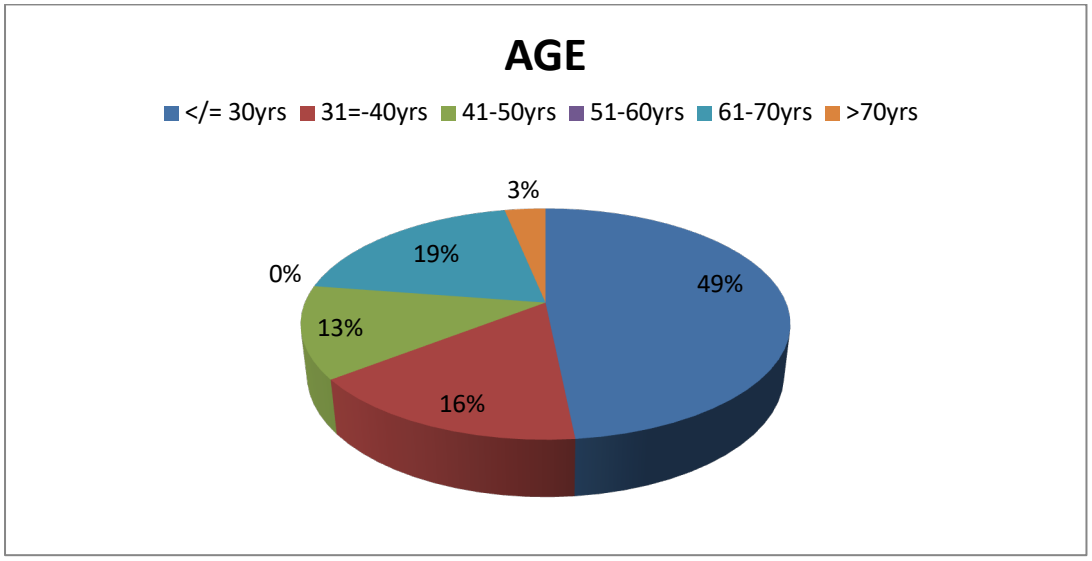

Figure 2: Age

Table 1: Sex Distribution

Sex	No. Of Patients	%
Male	23	74.2
Female	8	25.8
Total	31	100.0

In our study there were 23 males and 8 females. Incidence is more in male because more out-door activities make males more vulnerable to accidents.

Table 2: Side of injury Distribution

Side Of Injury	Frequency	%
Left	12	38.7
Right	19	61.3
Total	31	100.0

Out of 31 fractures, Left side was involved in 12 (38.7%) and Right side was involved in 19 (61.3%) patients.

Table 3: Mode of injury Distribution

AO Classification	Frequency	%
C1	8	25.8
C2	16	51.6
C3	7	22.6
TOTAL	31	100.0

In our study two modes of injury were noted. 6 (19.4%) fractures were due to low energy domestic fall and 25 (80.6%) were due to high energy road traffic accident.

Table 4: Type of fracture Distribution

		AO Classification			Total	p value
		C1	C2	C3		
Final Outcome	Poor	0(0)	1(6.25)	2(28.57)	3(9.68)	<0.018
	Fair	0(0)	2(12.5)	3(42.86)	5(16.13)	
	Good	2(25)	8(50)	2(28.57)	12(38.71)	
	Excellent	6(75)	5(31.25)	0(0)	11(35.48)	
Total		8	16	7	31(100)	

In this study, the intra-articular distal femur fractures (Type C) were classified as per AO Classification. Since C3 fractures are the most severe form of intra-articular fractures of the distal femur, the statistical analysis supports the fact that they have poorer outcome than C1 and C2 fractures which have got better results.

Table 5: Type of Open fracture Distribution

Classification	Frequency	%
GA type I	5	16.1
GA type II	16	51.6
GA type IIIA	10	32.3
TOTAL	31	100.0

In this study, the open fractures were classified according to Gustilo-Anderson's Classification.

Table 6: Gustilo-Anderson Classification

		Gustilo-Anderson Classification			Total	p value
		Type I	Type II	Type IIIA		
Final Outcome	Poor	1(20)	0(0)	2(20)	3(9.68)	0.163
	Fair	0	2(12.5)	3(30)	5(16.13)	
	Good	2(40)	6(37.5)	4(40)	12(38.71)	
	Excellent	2(40)	8(50)	1(10)	11(35.48)	
Total		5	16	10	31(100)	

The statistical analysis supports the fact that open fractures GA type IIIA have poorer outcome than type I and type II fractures which have got better results.

Interval between injury and surgery:

The mean interval between injury and surgery was 10.77 ± 4.92 hrs (range 6-24 hrs).The pre-operative setting-up time was less with those patients who had less pre-fracture co-morbidity. Poor local soft tissue condition also accounted for pre-operative delay. In elderly and co-morbid patients, surgeries were performed following appropriate medical and cardiological assessment after admission.

Time to radiological union:

The mean fracture union time in this study was 18.71 ± 3.33 weeks. Out of 31 patients, 3 patients went to delayed union whereas in 28 patients, the fracture united radiographically within 24 weeks.

Table 7: Radiological union (in weeks) according AO fracture classification:

AO classification	Mean	Median	Standard Deviation
C1	17.50	16.00	3.66
C2	18.00	16.00	2.53
C3	21.71	24.00	3.15
p value	0.031		

Table 8: Radiological union (in weeks) according to Open fracture classification:

Gustilo-Anderson classification	Mean	Median	Standard Deviation
I	18.40	16.00	3.58
II	17.25	16.00	2.82
IIIA	21.20	20.00	2.70
p Value	0.041		

Complications: In this study, 13 (41.9%) patients developed complications whereas rest 18 (58.1%) did not have any complications.

Table 9: Complications and Frequency

Complications	Frequency
Deep Infection	3
Superficial Infection	1
Stiffness	8
Delayed union	3
Extensor lag	3
Malalignment	5

Table 10: Complications

		Complications		Total	P Value
		No	Yes		
Final Outcome	Poor	0(0)	3(23.08)	3(9.68)	0.000
	Fair	0(0)	5(38.46)	5(16.13)	
	Good	7(38.89)	5(38.46)	12(38.71)	
	Excellent	11(61.11)	0(0)	11(35.48)	
Total		18(100)	13(100)	31(100)	

Neer's score:

Table 11:

	Mean	Median	Std Deviation	Minimum	Maximum
Pain	15.48	16.00	2.47	12	20
Walk Capacity	14.45	16.00	1.98	12	16
Joint Movement	14.71	16.00	4.05	8	20
Work Capacity	7.81	8.00	1.58	4	10
Gross Anatomy	12.58	12.00	2.38	6	15
Roentgenogram	12.58	12.00	2.38	6	15
Functional Score	52.71	56.00	9.30	32	66
Anatomical Score	25.16	24.00	4.75	12	30

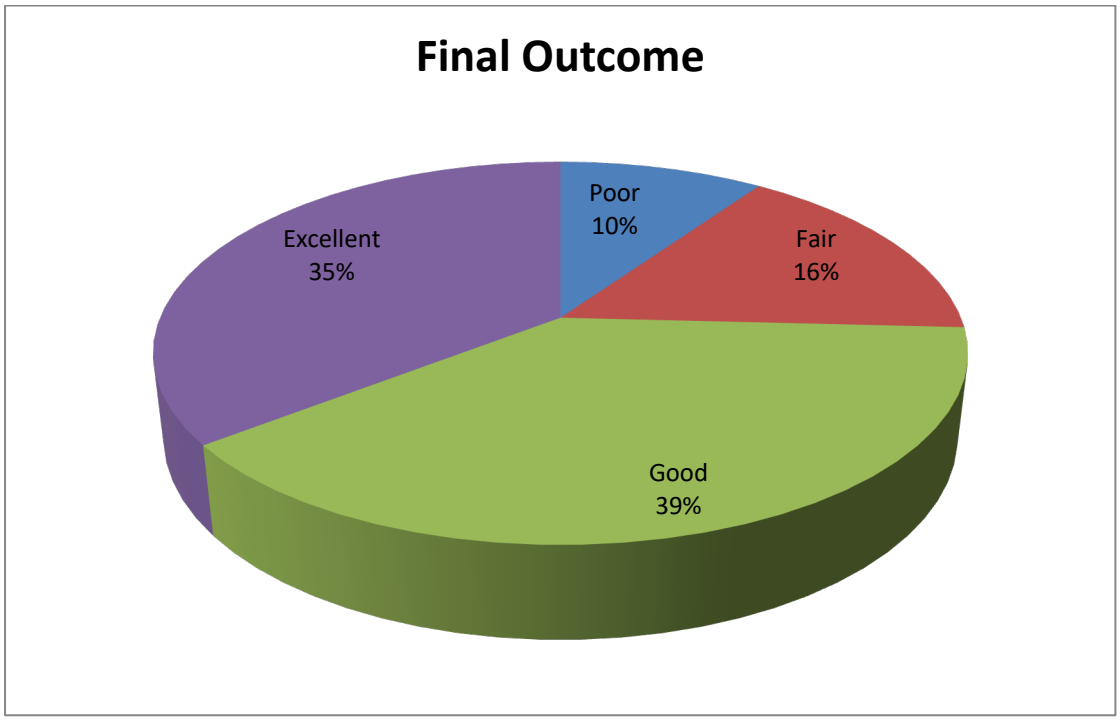

Figure 3: Final outcome

Discussion

Distal femur fractures are usually high velocity injuries compounded by intra-articular comminution, ligamentous injury and open wounds. These open fractures are associated with high complication rates causing infection, malalignment and post-traumatic osteoarthritis. Aggressive wound debridement and thorough lavage represents an important part of treatment for patients with open fractures. However, inadequate debridement can cause infection while overly aggressive debridement can lead to non-union. Open distal femur articular fracture, caused by high velocity trauma or low energy fall in osteoporotic bone, are treated in many ways. With subsequent advances in implant technology and surgical techniques, it is now accepted that these fractures are best treated with thorough debridement and surgical fixation to achieve a good functional outcome.

Thorough debridement along with open reduction and internal fixation with plate osteosynthesis is being considered one of the good treatment modalities in such fractures. In the present study, 31 cases of open distal femoral articular fractures have been managed by thorough debridement followed by surgical fixation with LC-DCP. The data collected in this study was assessed, analysed and compared with other series and the results were evaluated.

Table 12: Age incidence in Different Studies:

Series	Year	Mean(yrs)
Jagandeep Singh Virk et al. (9)	2016	36.64
Sarabjeet Kohli et al. (17)	2016	40.70
J. Ashok Vardhan Reddy et al. (18)	2016	40.00
Present study	2019	38.55

Table 13: Sex Distribution in Different Studies

Series	Year	Males (%)	Females (%)
G. N. Kiran Kumar et al. (19)	2014	78.26	21.74
J. Ashok Vardhan Reddy et al. (18)	2016	73.33	26.67
Rajnikant Machhi et al. (20)	2017	67	33
Swapna P Saikia et al. (21)	2017	73.3	26.7
Rushi Solanki et al. (4)	2018	73.08	26.92
Ram Avatar Saini et al. (22)	2018	73.53	26.47
Present study	2019	74.2	25.8

Table 14: Side of injury in Different Studies

Series	Year	Right (%)	Left (%)
Nirav P Trivedi et al. (16)	2015	60	40
Rajnikant Machhi et al. (20)	2017	65	35
Swapna P Saikia et al. (21)	2017	60	40
Jay Dhariwal et al. (23)	2017	58.97	38.46
Present Study	2019	61.3	38.7

Table 15: Mode of injury in Different Studies

Series	Year	RTA (%)	Direct Fall (%)
Jagandeep Singh Virk et al. (9)	2016	80	20
Rushi Solanki et al. (4)	2016	80	20
Jay Dhariwal et al. (23)	2017	75	25
Ram Avatar Saini et al. (22)	2018	75	25
Present Study	2019	80.6	19.4

Table 16: Classification of fracture in Different Studies

Series	Year	C1 (%)	C2 (%)	C3 (%)
Nirav P Trivedi et al. (16)	2015	20	40	40
Jay Dhariwal et al. (23)	2017	14.18	44.44	40.74
Y Bhanu Rekha et al. (24)	2017	21.14	64.28	14.28
Swapna P Saikia et al. (21)	2017	33.3	40	26.7
Rajnikant Machhi et al. (20)	2017	20	50	30
Present study	2019	25.8	51.6	22.6

Table 17: Classification of Open fracture in Different Studies

Series	Year	GA-I (%)	GA-II (%)	GA-IIIA (%)
Florian M. Kovar et al. (7)	2013	29	25	46
Nirav P Trivedi et al. (16)	2015	57.14	14.29	29.57
Y Bhanu Rekha et al. (24)	2017	50	20	30
Present study	2019	16.1	51.6	32.3

Table 18: Interval between injury and surgery in Different Studies

Series	Year	Delay (in days)
Ramji Lal Sahu. (25)	2015	1 - 8
Anand Tailor et al. (26)	2017	1 - 10
Ram Avatar Saini et al. (22)	2018	1 - 12
Present study	2019	0.25 - 1

Table 19: Time to radiological union in Different Studies

Series	Year	Mean duration (in weeks)
J. Ashok Vardhan Reddy et al. (18)	2016	15
Viswanath C et al. (27)	2016	18
Jagandeep Singh Virk et al. (9)	2016	20-22
Rajnikant Machhi et al. (20)	2017	20
Jay Dhariwal et al. (23)	2017	18.23
Anand Tailor et al. (26)	2017	17.99
Rushi Solanki et al. (4)	2018	18.4
Present study	2019	18.71

Table 20: Complication in Different Studies

Series	Year	(%) of patients	
		Present	Absent
Sarabjeet Kohli et al. (17)	2016	33.33	66.67
Viswanath C et al. (27)	2016	68	32
Rushi Solanki et al. (4)	2018	42.31	57.69
Present study	2019	41.9	58.1

Table 21: Neer's score and Final outcome in Different Studies

Series	Year	Final outcome in patients (%)			
		Excellent	Good	Fair	Poor
Rajnikant Machhi et al. (20)	2017	45	25	15	15
Swapna P Saikia et al. (21)	2017	43.3	23.3	16.7	16.7
Viswanath C et al. (27)	2018	38	40	16	6
Rushi Solanki et al. (4)	2018	34.62	42.31	13.46	9.61
Present study	2019	35.48	38.71	16.13	9.68

It can be seen that the various parameters of our study corroborate with the previously done studies.

Case 1

Figure 4: Case number-1

Case 2

Figure 5: Case number-2

Conclusion

An approach of primary definitive fixation with distal femoral locking compression plate secondary to early aggressive debridement in open distal femur fractures with articular involvement shows significant results in terms of functional and radiological outcome with some complications.

The locking plate provides stable rigid fixation while awaiting union and allows early knee range of motion with benefits of lesser number of surgeries, lesser hospital stay, and earlier post op rehabilitation with acceptable knee function. However, the selection of patients and timing of internal fixation is important in these open fractures to minimise complications and failure.

References

1. Kolmert L, Wulff K. Epidemiology and treatment of distal femoral fractures in adults. Acta Orthopaedica Scandinavica. 1982 Jan 1; 53(6): 957-62.
2. Arneson TJ, Melton LJ, Lewallen DG, et al. Epidemiology of diaphyseal and distal femoral fractures in Rochester, Minnesota, 1965-1984. Clin Orthop Relat Res. 1988; 234: 188-94.
3. Martinet O, Cordey J, Harder Y, Maier A, Bühler M, Barraud GE. The epidemiology of fractures of the distal femur. Injury. 2000 Sep 1; 31:86.
4. Solanki R, Tolani A, Asati S, Kansara H, Pathria V. AO type C distal femur fracture: results of operative management in 52 patients. International Journal of Orthopaedics. 2018; 4(4):73-7.
5. Court-Brown CM, Rimmer S, Prakash U, McQueen MM. The epidemiology of open long bone fractures. Injury. 1998 Sep 1; 29(7):529-34.
6. Court-Brown CM, Bugler KE, Clement ND, Duckworth AD, McQueen MM. The epidemiology of open fractures in adults. A 15-year review. Injury. 2012 Jun 1; 43(6):891-7.
7. Kovar FM, Jaindl M, Schuster R, Endler G, Platzer P. Incidence and analysis of open fractures of the midshaft and distal femur. Wiener klinische Wochenschrift. 2013 Jul 1; 125(13-14):396-401.
8. Higgins TF. Distal femoral fractures. Journal of Knee Surgery. 2007; 20(01): 56-66.
9. Virk JS, Garg SK, Gupta P, Jangira V, Singh J, Rana S. Distal femur locking plate: the answer to all distal femoral fractures. Journal of clinical and diagnostic research: JCDR. 2016 Oct; 10(10):RC01.
10. Tuhanioğlu Ü, Oğur HU, Çiçek H, Seyfettinoğlu F, Çiloğlu O, Kapukaya A. Noncon-

tact plating technique in an open fracture. Therapeutics and clinical risk management. 2017; 13:703.
11. Sala F, Thabet AM, Capitani P, Bove F, Abdelgawad AA, Lovisetti G. Open Supracondylar–Intercondylar Fractures of the Femur Treatment with Taylor Spatial Frame. Journal of orthopaedic trauma. 2017 Oct 1; 31(10):546-53.
12. Scharfenberger AV, Alabassi K, Smith S, Weber D, Dulai SK, Bergman JW, Beaupre LA. Primary wound closure after open fracture: a prospective cohort study examining nonunion and deep infection. Journal of orthopaedic trauma. 2017 Mar 1; 31(3):121-6.
13. Kubiak EN, Fulkerson E, Strauss E, Egol KA: The evolution of locked plates. J Bone Joint Surg Am 2006; 88(suppl 4): 189-200.
14. Thakkar CV, Dwivedi MS. Open distal femur fractures: Treatment principles. International Journal of Orthopaedics. 2018; 4(4):732-6.
15. Barei DP, Beingessner DM. Open distal femur fractures treated with lateral locked implants: union, secondary bone grafting, and predictive parameters. Orthopedics. 2012 Jun 1; 35(6): e843-6.
16. Trivedi NP, Chauhan RH, Padhiyar DR, Gandhi PS. Outcome of fracture of intra articular distal femur treated with distal femur locking compression plate. Int J Res Orthop. 2015 Dec; 1(1):22-7.
17. Kohli S, Chauhan S, Vishwakarma N, Salgotra K. Functional and radiological outcomes of distal femur intra articular fractures treated with locking compression plate. Int J Orthop Sci. 2016; 2: 17-21.
18. Reddy JA, Chary NB. Functional outcome of distal end of femur with locking compression plate: a prospective study. Ann Int Med Den Res. 2016; 2(1):362-5.
19. Kiran Kumar GN, Sharma G, Farooque K, Sharma V, Ratan R, Yadav S, Lakhotia D. Locking compression plate in distal femoral intra-articular fractures: our experience. International scholarly research notices. 2014; 2014.
20. Machhi R, Namsha B, Dindod V. Outcome of intra articular distal femur fracture treated with locking compression plate. International Journal of Orthopedics. 2017; 3(3): 503-7.
21. Saikia SP, Tahbildar P. Outcome Of Fracture Of Intraarticular Distal Femur Treated With Distal Femur Locking Compression Plate. Journal of Evidence Based Medicine and Healthcare. 2017 Jan 1;4(84):4972
22. Saini RA, Shah N, Sharma D. Functional outcome of distal femoral fractures treated with DF-LCP [Distal femur locking compression plate]. International Journal of Orthopedics. 2018; 4(1): 439-44.
23. Dhariwal J, Kumar A, Chhabra A, Yadav S, Dutta M, Mittal V, Sahu V. Clinical and functional outcomes of surgical management of distal femur fractures using distal femur locking compression plate. International Journal of Orthopedics. 2017; 3(2): 576-82.
24. Rekha YB, Reddy NB. A prospective study of treatment of distal femur fractures with locking condylar plate. International Journal of Research in Orthopedics. 2017 Oct 25; 3(6): 1117-21.
25. Sahu RL. Functional outcome following internal fixation of intraarticular fractures of the distal femur. Acta Orthopedic Belgica. 2015; 83: 215-22.
26. Tailor A, Gajjar S, Manthan Mandalia D, Patel Y, Saxena S. Results of locking compression plates in fractures of distal end of femur. International Journal of Orthopedics. 2017; 3(1): 360-3.
27. Vishwanath C, Harish K, Gunnaiah KG. Surgical outcome of distal femur fracture by locking compression plate. International Journal of Orthopaedics Sciences. 2016; 2(4):233-9.