



International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2019; 5(4): 297-301
© 2019 IJOS
www.orthopaper.com
Received: 07-08-2019
Accepted: 09-09-2019

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The outcome following fixation of complex open distal femur fractures

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DOI: <https://doi.org/10.22271/ortho.2019.v5.i4f.1688>

Abstract

Background: Distal femur fractures account for less than 1% of all fractures and 4%–6% of all femur fractures. Soft tissue damage, comminution and articular extension makes the treatment difficult and they often result in unsatisfactory outcome and poor knee function. Open fractures further complicate the situation. In our study we compared functional outcome, time of union and complications of open complex distal femoral fractures treated with delayed plating or primary Ilizarov ring fixator.

Material and Methods: we retrospectively reviewed 23 cases presented at department of Orthopedics, from January 2011 to January 2017. All skeletally mature patients with AO type C distal femur fractures and up to Gustilo Anderson grade IIIA were included. Pathological fractures, types IIIB and IIIC open fractures and patients with other fractures in the ipsilateral limb were excluded from the study. Patients in group A were treated with delayed plating and in group B with primary Ilizarov.

Result: Out of the 23 cases, all cases in both groups showed radiological union between 16-22 weeks. 3 cases of group A showed shortening of >2 cm while Ilizarov group had none. In 5 cases of group A, primary bone grafting done during surgery having severe comminution (C3 type) and in one case secondary bone grafting done after 5 months for delayed union. Out of 12 cases of group A, 5 patients (42%) achieved full flexion. In group B limited knee flexion was seen in all cases with mean flexion at final follow-up of 92°.

Conclusion: Delayed fixation with autologous fibular grafting and distal femoral locking plate provides adequate restoration of knee motion and early knee mobilization with high risk of infection. Whereas Ilizarov fixator shows better outcome in terms of infection control, LLD management, lesser number of surgeries, lesser hospital stay, earlier post-op rehabilitation and acceptable knee function.

Keywords: Ilizarov, distal femur, delayed plating, complex fracture, AO type C, open fracture

Introduction

Distal femoral fractures account for less than 1% of all fractures & comprise 4% - 6% of all femoral fractures. Open fractures comprise approximately 10% of these fractures^[1]. Soft tissue damage, comminution and articular extension make complex distal femoral fractures difficult to treat and often with unsatisfactory results due to malunion and poor knee function^[2]. Moreover open fractures with damaged soft tissue envelop and wound contamination further complicates the situation. Successful treatment of intra-articular fractures, especially in weight bearing joints requires restoration and maintenance of the congruity of the two articular surfaces^[3-9]. Variable treatment modalities has been described in the literature including different plate and screws constructs, intra-medullary nailing, and external fixators^[10]. Distal femoral locking compression plate is a widely used implant in such scenarios with reported good outcome^[11]. Staged treatment of open fractures of distal femur has been described by various authors, in which they have achieved good outcomes^[12-20]. Being the workhorse for skeletal stabilization in open fractures, external fixator like Ilizarov is a reasonable treatment option. The Ilizarov circular fixator provides adequate stability, preserves biology by percutaneous fixation and allows early weight-bearing with functional limb use^[21-23]. However there are very few studies describing the use of Ilizarov ring fixator in complex open distal femur fractures^[5, 24]. In this study we evaluated and compared the functional outcome, time of union and complications of complex open distal femoral fractures treated by delayed internal fixation with locked plate and primary Ilizarov ring fixator.

Material and Methods

It is a retrospective study of 23 cases presented at the department of Orthopaedics from January 2011 to January 2017 with complex open fracture of the distal femur with or without bone loss within 24 hours of injury.

Inclusion Criteria

1. AO type C distal femur fractures
2. Up to Gustilo Anderson grade IIIA [25].
3. All skeletally mature patients.

Exclusion Criteria

1. Pathological fractures
2. Gustilo Anderson grade IIIB and IIIC open fractures and
3. Patients with any fractures other than the distal femur in the ipsilateral limb.

X ray of the affected femur with hip and knee and CT scans (3D) was done to assess the fracture type and intra-articular extension, and to know the amount of displacement, depression, angulation and aid in surgical planning [26, 27].

Delayed ORIF and Primary Ilizarov fixation represents two of the most common treatment methods for fixation of such fractures in our institute. According to the treatment modality the patients were divided into two groups i.e. group A treated with delayed plating and group B with primary Ilizarov.

For group A, initial debridement was done at the time of admission, with removal of loose pieces of bone followed by copious lavage with normal saline. Under C arm guidance condylar elements were fixed with percutaneously placed k wires or cannulated cancellous screws to reconstruct the articular surface. None of the patients had significant skin loss, so the skin margins were freshened and approximated with widely placed sutures. Subsequently, the limb was stabilised on a Thomas splint with proximal tibial skeletal traction. Broad spectrum intravenous antibiotics were administered and regular antiseptic dressing was done. Pin tract care and dressings were done as per established regimes [28]. Wound cultures were done on the second and fifth days after admission. After 14 to 21 days when the debrided wound healed with negative cultures, open reduction and internal fixation was performed. CT scan with 3D reconstruction was done in all patients for surgical planning. The fracture was opened by the lateral approach or Swashbuckler approaches. Distal femur locking compression plate was applied after reducing the condylar elements to the shaft to complete the fracture fixation. Whenever severe comminutions were encountered, primary bone grafting was done. Cortico-cancellous grafts were used in cases where the defect was not extensive (n=2). For segmental bone losses, primary shortening of 1.5-2 cm was done. We managed longer segmental defects or extensive medial bone loss with free fibular grafts (n=3). Length of the plate used was judged based on the extent of fracture of distal femur and fixed proximally using minimally invasive techniques. Post-operatively quadriceps strengthening, active and assisted knee Range of Motion (ROM) exercises were initiated as early as possible. Parenteral antibiotics were administered up to the 5th day and then switched to oral antibiotics till suture removal on 10-12th day. Patients were kept in the hospital after surgical procedure according to post-operative wound status, usually for 5-10 days. Crutch assisted touchdown weight bearing ambulation was allowed after the surgical procedure but patients were advised full weight bearing only after radiological evidence of union.

In group B, primary Ilizarov ring fixator was applied following debridement in a single setting. For satisfactory articular reduction, in some cases, limited open reduction and internal fixation with cannulated screws or K- wires were done when needed & alignment was checked by fluoroscopy. Counter opposed olive wires were passed through the condyles from the posterolateral and posteromedial sides and also at times, horizontal counter-opposed olives on the same ring and another as drop wire applied as the fracture configurations demanded, so as to get the strongest fixation in such small fragments. If space allowed, 2 rings were applied for the distal fragment. After completing the frame assembly, knee joint stability as well as the stability of the reduction was assessed. If found unstable, a proximal tibial ring was added to make the frame knee spanning (n=3). Such knee spanning proximal tibia rings were removed on an average of 6 weeks post-op. Physiotherapy & weight bearing started on the following postoperative day or as per patient's pain tolerance. In Ilizarov group the wounds were kept open or closed primarily as the soft tissue condition demanded.

Patients were followed up till union. Parameters analysed included demographics, time to radiographic fracture union, knee range of motion, and functional outcome measured by Neer's criteria.

The statistical analysis of data was performed using the computer program, Statistical Package for Social Sciences (SPSS for Windows, version 20.0. Chicago, SPSS Inc.) And Microsoft Excel 2010. Results on continuous measurements are presented as mean \pm standard deviation are compared using student's t test. Discrete data are expressed as number (%) and are analysed using Chi square test and Fischer's exact test (where the cell counts were <5 or 0). For all analyses, the statistical significance was fixed at 5% level (p value <0.05).

Result

There were no significant differences in age, gender or fracture distribution between patients who delayed plating or primary Ilizarov fixation. The mean age of 23 cases in our study was 34.55 years, Range 18-48 years with group A (34.42 ± 7.82) and group B (34.88 ± 8.28) years (Table 1). There was no significant difference (p= 0.92) between the groups with respect to the mode of injury. Road traffic accident (n=16) was found to be the most common mode of injury followed by fall from height (n=5).

Table 1: Patient Demographics, Distribution of Fracture Types and Mode of Injury

Parameter	Group A	Group B	p value
Mean age	34.42 \pm 7.82	34.88 \pm 8.28	0.89
Gender			1
Male	10	11	
Female	2	1	
Fracture type			0.76
C1	5	3	
C2	2	2	
	5	6	
GA grade			0.57
I	7	4	
II	2	3	
	3	4	
Mode of injury			0.92
RTA	8	8	
FFH	3	2	
	1	1	

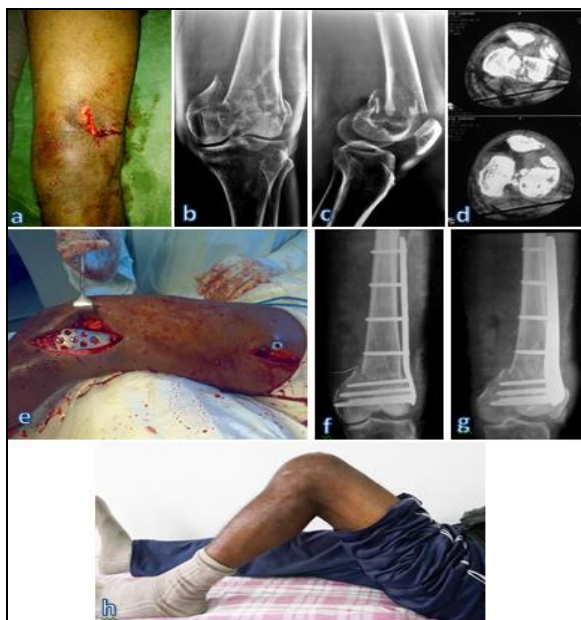


Fig 1(a, b, c): AO C3/GA II fracture (d) CT scan (e) intra-operative reduction (f, g) immediate post-op x-ray (h) 20 weeks post-op knee function.

All the cases of both groups showed radiological union between 16 -22 weeks. The average time of union in Group A was 20.83 ± 4.04 weeks and in Group B 20.00 ± 1.79 weeks. In 5 cases of group A, primary bone grafting was done during surgery having severe comminution (C3 type) and in one case secondary bone grafting done after 5 months for delayed union. Out of 12 cases of group A, 5 patients (42%) achieved full flexion of (130 degrees). Better outcome was observed in terms of range of motion at knee joint in fractures treated with distal femur locking plate. The mean ROM in all 12 patients of group A was 109° . Limited knee flexion was seen in all cases of group B. The mean range of motion at final follow-up was 92° , however, full extension was achieved in all patients.

Average hospital stay in group A (3.06 ± 0.40 weeks, range: 2.5 to 4) was significantly longer ($p < 0.0001$) than patients in group B (1.32 ± 0.46 weeks, range: 1-2). The average number of surgeries required in group A were 2 to 4 (2.33 ± 0.65) and for group B 1 to 2 (1.36 ± 0.50). The difference between two groups in terms of average number of surgeries was found to be statistically significant ($p = 0.0007$, table 2).

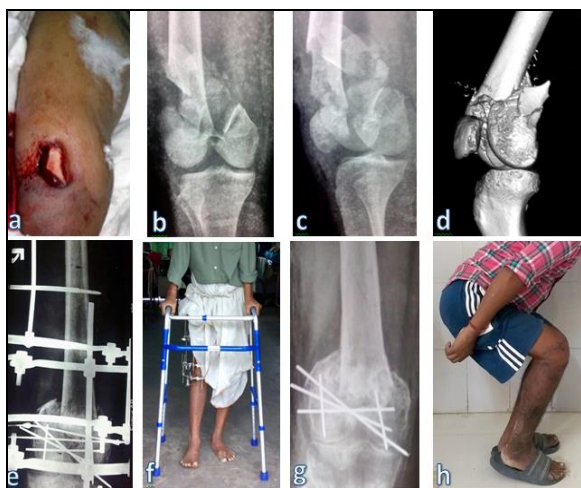


Fig 2(a, b, c, d): AO C3/GA type IIIA fracture (e) immediate post-op x-ray (f) crutch assisted ambulation 6 weeks post-op (g, h) 18 weeks post-op x-ray and knee function.

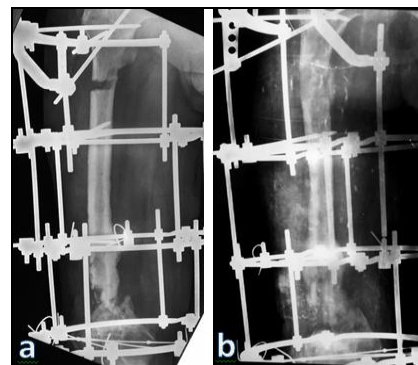


Fig 3: (a) Corticotomy and lengthening (b) consolidation after 14 weeks

As per Neer's criteria, pain, range of motion, walking and work capacity, anatomy and X-ray findings score at 6 months was calculated & results were summarized into excellent, satisfactory, unsatisfactory & poor [29]. G denotes good result (total score, >85); S satisfactory results (70-85); US unsatisfactory result (55-69); P poor result (<55). Good result were seen in 5 cases of group A and 3 cases of group B. Four patients in each group had satisfactory results and 2 cases of each group had unsatisfactory result. There was no statistically significant difference between the two groups in terms of functional outcome ($p = 0.85$).

Table 2: Comparison of Different Outcome Parameters, Hospital Stay and Number of Surgeries Which Influence the Cost

parameter	Group A	Group B	p value
Mean time of union (weeks)	20.83 ± 4.04	20.00 ± 1.79	0.52
Mean ROM	109.17 ± 26.36	92.27 ± 10.34	0.68
Average hospital stay	3.06 ± 0.40	1.32 ± 0.46	0.0001
Number of surgeries	2.33 ± 0.65	1.36 ± 0.50	0.0007
Neer's grade			
Good	5	3	0.85
Satisfactory	4	4	
Unsatisfactory	2	2	
Poor	1	2	

One case from both group showed superficial infection, both were treated with regular dressing and intravenous antibiotics and resolved uneventfully. Three cases of group A had deep infection for which further debridement was done, finally infection subsided once implant removal was done after union. Minor pin-track infection occurred in three patients and resolved after oral antibiotics and care of the pin sites (table 3). No cases of shortening > 2 cm were present in the Ilizarov group as corticotomy and lengthening was performed 6 weeks after the initial surgery. There were 3 such cases where acute shortening during the primary surgery and subsequent re-lengthening was done. Twelve to fifteen weeks' time was required for lengthening & consolidation. In group A, 3 cases showed shortening of >2 cm (2.5-3 cm).



Fig 4: (a, b) immediate post-op x-rays of delayed internal fixation (c) x-ray at 20 weeks showing infected osteosynthesis (d) discharging sinus with stiff knee (e, f) x-rays after plate removal

Table 3: Patients who developed Complications

Complication	Group A	Group B	p value
Superficial infection	1	1	1
Deep infection	3	0	0.21
Shortening > 2cm	3	0	0.21

Discussion

AO type C distal femoral fractures are difficult to treat fractures. These complex and debilitating injuries present a challenging task to the orthopaedic surgeon while managing such fractures, because of intra-articular involvement, soft tissue disruption, bone loss and severe comminution which compromises fixation quality^[30]. These fractures often result in unsatisfactory outcome, with non-anatomical reduction, prolonged confinement to bed, and poor function of the knee, that is commonly encountered following traditional treatment with traction^[30]. Various methods has been described in the literature regarding articular reconstruction and stabilisation to restore articular congruity of knee joint and achieve fracture union, while providing adequate stability and early mobilization to reduce the complications like joint stiffness. There are no studies available in the literature comparing the two modalities of treatment as in our study. Since the utilization of plates for the distal femur began in the 1960s, numerous enhancements in trauma management, implant biomechanics, surgical techniques and the use of prophylactic antibiotics have improved the outcomes. Most of the closed fractures of the distal femur can be treated by open reduction and internal fixation with reduced complication rates^[31-33]. There are studies showing promising early results with relatively low complication rates using minimally invasive plating techniques for the fractures of distal femur^[7, 18, 34]. Staged treatment of open fractures of distal femur has been described by various authors, in which they have achieved good outcomes^[12-20].

Mohan M *et al.* concluded that delayed primary surgery, using autologous non vascularised free fibular graft in conjunction with a locking compression plate, with autogenous cortico-cancellous graft is an effective, less technically demanding and cost effective method of treating complex open fractures of the distal femur with an overall acceptable results in terms of fracture union and restoration of knee motion and early rehabilitation^[18]. Though different authors have advocated the use of knee spanning external fixator before going for the definitive internal fixation, in our study proximal tibial skeletal traction was used over a Thomas splint to stabilise the affected limb. In group A patients of our study, initial debridement, fixation of condylar elements were done using k wires and screws to get back the articular congruity. Delayed internal fixation with distal femoral locking plate was done, and to address the bony defects, autogenous nonvascularised free fibular graft and corticocancellous grafts were used.

Lawal *et al.* in their series on use of non-vascularized autologous fibula strut graft in the treatment of segmental bone loss addressed stability with external fixator and concluded autologous free, non-vascularized fibula and cancellous graft is a useful addition to the armamentarium of orthopaedic surgeon in developing countries attempting to manage segmental bone loss, whether created by trauma or excision of tumours^[7]. Ramesh *et al.* in their series demonstrated that surgical repair with fibular strut, cortico-cancellous graft, and Ilizarov ring fixation is a suitable option for treatment of C3 distal femoral fractures^[5]. They concluded that the use of a fibular strut and corticocancellous

graft helped to bridge the fragments with severe comminution, maintain limb length and counteract the relatively unstable distal femoral block from varus/valgus collapse. Relative lack of expertise in Ilizarov application and patient acceptance are major drawbacks of this method. In our study no bone graft was used in the Ilizarov group. To address the bony defect primary docking was done in the metaphyseal-diaphyseal area, and if the shortening due to primary docking was more than 2 cm, corticotomy and re-lengthening was undertaken 6 weeks later. There were 3 such cases in group B, the Ilizarov group, where a second surgery in the form of a corticotomy was required to address limb length inequality. Shortening of >2 cm was present in 3 cases of group A even after bone grafting and they were managed with shoe raise. In Group A Wound debridement in three of the cases was done for deep infection and in one case secondary bone grafting was needed for delayed union. So, the number of surgeries required in group A patients were 2 to 4 (2.33 ± 0.65) which was much higher than in group B; 1 to 2 (1.36 ± 0.50). The hospital stay for the group A patients averaged (3.06 ± 0.04) weeks, (range 2.5 to 4); while for group B it was (1.32 ± 0.46) weeks (range 1 to 2) weeks.

Ilizarov ring fixator has certain advantages like a minimally invasive technique, versatile frame assembly which can be tailored as per fracture geometry and facilitates bone transport, deformity correction, and correction of malalignment during the entire process of fracture healing^[24, 35]. Diverging olive wires provide stable fixation and compression of condyles sometimes even when this fragment is quite small for plate and screws. Ilizarov ring fixator provides better mechanical stability by three dimensional construct^[24, 35, 36]. In our study, half pins were used in the proximal femoral construct that are better tolerated by patients and are comparatively easy for fixation^[24, 35, 37]. In the majority of cases (n=10), limited open reduction was required due to severe comminution. It has been described by various authors that wires and pins in the femur pass through the quadriceps muscle, thereby acting as a check rein to the movement of the knee while the fixator is applied. The severity of soft tissue injury will also add to knee stiffness as well as the fracture pattern^[38]. To reduce this complication, we operated all the cases with moderate flexion of the knee which can stretch quadriceps mechanism and proximal tibia ring was removed 6 weeks later as an outpatient procedure & knee mobilization exercises were initiated.

Conclusion

Delayed primary fixation with autologous fibular graft stabilized with distal femoral locking plate provides stable fixation and slightly better knee function but with high risk of infection. Whereas Ilizarov ring fixator shows better outcome in terms of infection control, limb length inequality management, avoidance of graft donor site morbidities, lesser number of surgeries, lesser hospital stay, and earlier post op rehabilitation with acceptable knee function.

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