



## Management of Complex Open Distal Femur Fractures with Fibula and Cancellous Graft: Case Series

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**Received:** January 22, 2024

**Published:** February 26, 2024

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### Abstract

**Purpose:** To report functional and radiological outcomes of using lateral plate and debridement in stage 1 followed by fibular strut graft together with cancellous graft and medial plating in second stage after 3-4 weeks in distal femoral fractures. In 5 cases, 3 were operated in staged manner and 2 cases with single stage bone grafting and plating amongst which one case (33-A3) with vascular injury operated with single lateral plate and fibula and cancellous graft in second stage.

**Method:** A retrospective study on 5 patients with comminuted distal femoral open grade fractures managed single/dual stage single/dual plate and fibula and cancellous grafting by Swashbuckler approach has been conducted. Only distal femoral fractures type 33-A3, 33-C2, and 33-C3, were included. The patient's mean age was 25.2 years. Evaluation included operative time, blood loss, time to union, knee range of motion, Sanders scoring, and presence of complications.

**Results:** All patients had no postoperative knee stiffness with a range of motion (90-120°) during follow-up. The time for radiological union was at 3 months, with no cases of non-union. The average follow-up period was 3 to 4 months and 6 month and yearly follow up are yet to come. Mean intraoperative blood loss was 325 ml, and mean operative time was 76.87 min without anaesthesia. All patients had a knee range of motion (90-120°) during follow-up. Time for union at 3 months, with no cases of non-union. A total of 5 patients 3 (60%) showed excellent functional outcomes, and the remaining 2 (40%) showed good functional outcomes according to the Sanders scoring system. Only one cases had late infections (1yr post op) managed by implant removal after 1 year. No post-operative deformity, loss of reduction, or implant failure was observed until the end of follow-up period

**Conclusion:** Staged debridement with single plate f/b 2nd fibular grafting and medial plate in more contaminated and single staged procedure in non-contaminated cases BG and dual plating of comminuted distal femur fractures in patients is an effective technique with higher rates of union and lower re-operation rates compared to other fixation modalities.

**Keywords:** Open Distal Femur Fractures; Fibula; Cancellous Graft

### Introduction

Distal femoral fractures are high-energy injuries that account for 5% to 10% of all open fractures. Patients with these fractures frequently exhibit critical bone defects caused by high-energy trauma in the supracondylar areas.

Critical bone defects have been characterized in the literature as defects with a length of >1 to 2 or >2 cm and circumferential loss of >50% [1]. Current treatment methods include bone transplantation, distraction osteogenesis, and the induced membrane technique (Masquelet technique) [2].

We herein present a case involving a patient who underwent treatment of an acute bone defect with a fibular graft and was followed up for 3-4 month and further yearly follow up is going on. Informed consent was obtained prior to treatment, and the case was registered.

The purpose of this paper is to present a treatment option for patients with this type of severe femoral injury.

### Materials and Methods

A retrospective study of patients with distal femur fractures was conducted. We searched our medical records for patients with dis-

tal femur fractures managed by double plating and fibular grafting technique with 2 stage or single staged procedure.

Inclusion criteria included all age, displaced isolated or with polytrauma distal femoral fracture with metaphyseal comminution (AO/OTA 33-A3, 33-C2, 33-C3) fractures.

Exclusion criteria were polytrauma patients with severe head injury, open fractures with non-coverable open wounds, pathological fractures, patients not fit for surgery, and non-ambulatory patients.

Patient charts and radiographs collected from the electronic medical record were reviewed for demographic data, AO/OTA classification, operative time, intraoperative blood loss, time to union, complications, reinterventions, and functional outcome scoring at the end of follow-up was evaluated according to the Sanders scoring system [3].

5 patients met the inclusion criteria between 2016 and 2019 and were enrolled in this study, 0 females and 5 males, with a mean age of 25.2 years. Informed written consent was taken regarding the study. 1 patient was classified as 33-A3, 1 patient 33-C3, and the majority were classified as 33-C2 (3 patients). The average time of surgery was 76.87 minutes. Demographic data of the studied patients are as listed in table 1.

Sr. No.	Age	Sex	Ao/OTA classification	Follow up
1	19	Male	33-C2	3 M and 7 M
2	20	Male	33-C2	3 M
3	22	Male	33-A3	6 M and 6yr
4	26	Male	33-C3	3 M
5	39	Male	33-C2	1yr and 1yr 1 month

**Table 1:** Sr no 2,4 are recently operated and needed 6 M and Yearly follow ups.

### Surgical technique

The procedure was done under combined spinal anaesthesia. The surgery was done on a translucent orthopaedic table in a supine position with a bolster underneath the knee. No tourniquet was used. One gram of third generation cephalosporins was given at induction and continued for 3-4 days post-operatively.

All the patients are operated by mod swashbuckler approach. The patient is usually positioned supine with the knee flexed with

a roll or triangle. A midline anterior knee incision is made from above the fracture laterally across the patella. The incision is extended directly down to the fascia of the quadriceps and incised in line with the skin incision. The iliotibial band is bluntly retracted from the vastus lateralis muscle laterally. The vastus lateralis muscle is then detached from lateral intermuscular septum and quadriceps muscle is displaced medially to access distal femur. Further exposure distally includes lateral parapatellar arthrotomy to expose the femoral condyles [4]. Perforating vessels may be ligated and vastus lateralis is elevated to completely expose the distal femur [5].

The modified Swashbuckler approach is proposed by defining patellar anastomotic ring ‘safety margins’ while performing knee arthrotomy. So, in modified approach, arthrotomy is done with a minimum margin of 2 cm from the lateral border of the patellar tendon and at the base of the patella the incision deviated slightly, aiming for the posterior depression of the vastus lateralis till it reached the anterolateral aspect of the thigh [5,6]. In the case of the Mini-swashbuckler approach, we can use a 12 cm incision from the lateral edge of the tibial tubercle upwards to the superolateral margin of patella. Full-thickness skin flaps are elevated to identify the underlying lateral patellar retinaculum. To expose the knee joint, a trapezoidal-shaped incision is made in the patellar retinaculum which remains within the lateral retinaculum and does not violate the vastus muscle belly. For extending proximally traditional Swashbuckler approach may be used [5].

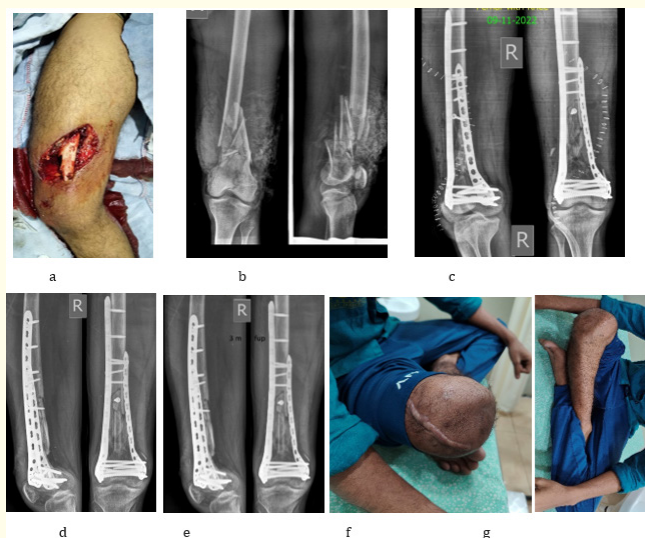
First, thorough debridement and anatomical reduction of the articular surface with preliminary k wiring and interfragmentary screws is done, followed by reduction and fixation by lateral plate aiming for anatomical shaft/condyle relation regarding length, varus/valgus alignment aided by image intensifier and distal femoral locked plate fixed with screws. All loose avascular pieces removed. Regarding the metaphyseal comminution gap kept as it is or one big piece with attachment kept at medial border of fracture which can be fixed by one screw from lateral plate hole.

Ipsilateral or opposite fibular graft harvest was done either using a standard protocol. A lateral incision over the fibula according to the desired length of the graft is made, keeping in mind to be 5 cm distal to the neck fibula proximally and 10 cm proximal to lateral malleolus distally to avoid complications. After fascial incision, retraction of peroneal muscles and incision of fibular periosteum is done. All muscles were subperiosteally dissected off using periosteum elevator; careful dissection is mandatory proximally to avoid damaging the peroneal nerve, then a bone saw is used to harvest

the graft. The harvested fibular graft is then fashioned according to fracture gap.



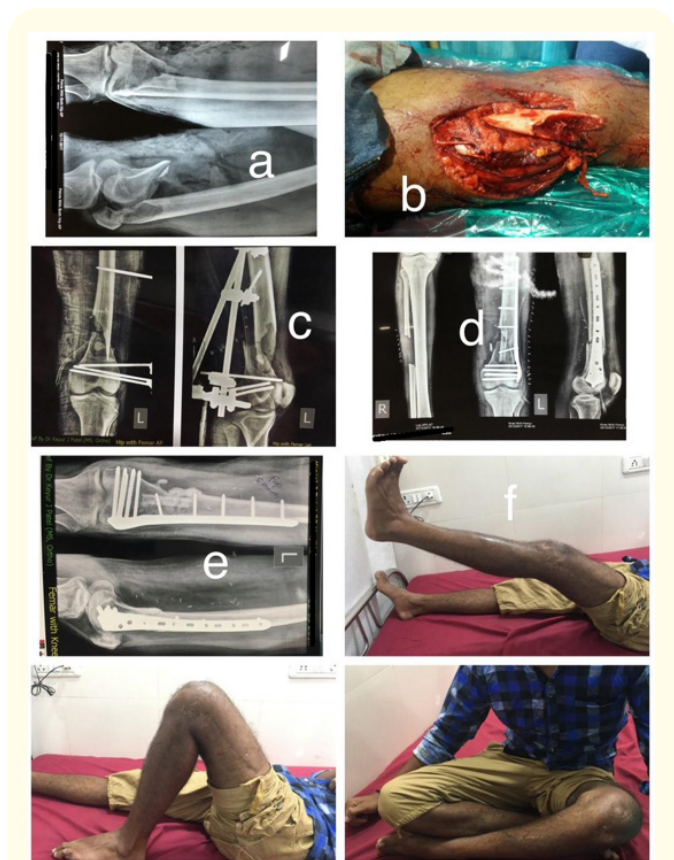
**Figure 1:** Male patient 19 years old 33-C2, Sanders functional scoring 37 points with ROM 110°, no pain, and unrestricted walking at the end of the follow-up period (07 months). a: Clinical picture. b, c: Pre op x rays. d: Comminution and huge gap following anatomical reduction. e, f: At Second stage huge gap and the fashioned fibular graft according to gap size. g: Post op x ray second stage with fibular graft and TCP granules. h: Post op 2month. i: Clinical image at 2 months. j: Post-operative x ray shows good union. k, l: Clinical images at 7 month Follow up.



**Figure 2:** Male patient 20 years old 33-C2, Sanders functional scoring 40 points with ROM 130°(Full), no pain, and unrestricted walking at the end of the follow-up period (03 months). a Clinical pe op picture. b. Pre op x rays. c. Post op x rays with metaphyseal bone loss d. At Second stage (4 weeks) the fashioned fibular graft according to gap size. e Post op x ray at 3 Months. F, g Clinical images at 3 month Follow up.



**Figure 3:** Male patient 26 years old 33-C3, Sanders functional scoring 31 points with ROM 130°(Full), no pain, and unrestricted walking at the end of the follow-up period (03 months). a. Pre op x rays. b. Post op x rays with fibula and cancellous graft c. Post op x ray at 3 Months.



**Figure 4:** Male patient 22 years old 33-A3, Sanders functional scoring 38 points with ROM 120°, no pain, and unrestricted walking at the end of the follow-up period (03 months). a Pre op x rays. b. Clinical pre op picture. c. Post op x rays with Ex Fix as there was vascular injury. d. At Second stage (4 weeks) the fashioned fibular graft according to gap size and lateral plate. e Post op x ray at 3 Months. F Clinical images at 3 month Follow up.



**Figure 5:** a. Male patient 39 years old 33-C2 operated before 1 year with plating and fibula grafting single stage with sanders score 25. Came with hot swelling around surgical area. b Post implant removal with debridement immediate post op x rays. c. union increased at 1 month Follow up.

Closure of the extensor mechanism was done with knee flexed 90° in a watertight manner after drain insertion, followed by subcutaneous and skin closure in layers without tension.

Post-operatively, post-operative plain X-rays were done, and quadriceps strengthening exercises started immediately from the second post-operative day. An enhanced rehabilitation program with early range of motion using continuous passive motion (CPM) device gradually increased daily as tolerated reaching 90° at three weeks and progressing to the full range at six weeks compared to the other side. Non weight bearing walking was encouraged starting from the first week. Full weight-bearing was initiated at 2-2.5 months whether callus formation was evident or not.

Follow-up protocol After their discharge, patients were followed up in the outpatient clinic at weekly to ensure incision healing. All stitch removal done at 15-18 days. Radiological follow-up in the 3-4 weeks was done and admitted for second stage procedure in staged plan patients. Radiological follow-up was done monthly for 3 -4 months to assess any loss of reduction with early-assisted weight-bearing, followed by a plain X-ray advised for six months, and then every six months until the end of follow-up period. Fracture union was defined by bridging callus at least in three out of four cortices and no pain clinically at fracture site.

**Results**

Sr no	Operated time stage1/2 (min)	Blood loss (ml)	Time to union (months)	Sander's scoring
1	90/60	350/300	3	37
2	100/65	325/300	3	40
3	20/70	300/200	3	31
4	120	525	3	38
5	90	300	United	25

**Table 2**

All patients had no postoperative knee stiffness with a range of motion (90-120°) during follow-up. The time for radiological union was at 3 months, with no cases of non-union.

The average follow-up period was 3 to 4 months and 6month and yearly follow up are yet to come. Mean intraoperative blood loss was 325 ml, and mean operative time was 76.87 min without anaesthesia. All patients had a knee range of motion (90-120°) during follow-up. Time for union at 3 months, with no cases of non-union. A total of 5 patients 3 (60%) showed excellent functional outcomes, and the remaining 2 (40%) showed good functional

outcomes according to the Sanders scoring system. Only one case had late infections (1yr post op) managed by implant removal after 1 year. No post-operative deformity, loss of reduction, or implant failure was observed until the end of follow-up period.

## Discussion

Ongoing studies are being done on optimal management of distal femoral osteoporotic fractures in elderly, as fractures ultimately lead to exacerbation of underlying comorbidities, resulting in increased mortality. Faced by reduced healing and remodeling ability, challenges of fixation and attaining union in this population have been reported by several studies [7,8], with nonunion rates up to 25% and implant failure rates up to 16% in some recent reports of locked lateral plating alone [7-9]. Peschiera, *et al.* [9], in their study to detect predictive factors for fixation failure in distal femoral fractures found that lack of bone support with metaphyseal comminution, malalignment, and inadequate fixation were the main causes.

Dual plating was proven by several investigators to provide superior stability by decreasing the lever arm acting on femoral axis thus lowering applied load on the fracture [10,11]. Also, stabilizing both columns and providing a stronger fixation in osteoporotic comminuted distal femur fractures [12]. In a recent biomechanical study, artificial femora simulating osteoporotic bone with fixed distal femoral fractures were subjected to axial, torsional, and quasi-static loading, and dual plating showed significantly lesser longitudinal and shear displacement than single plating [13]. Another earlier biomechanical study by Prayson, *et al.* [14] on synthetic bone stated that in highly comminuted metaphyseal fractures, supplementing the medial column by medial plating is highly recommended to prevent varus collapse.

Using Hak, *et al.* [15] and Lujan, *et al.* [16] recommendations regarding the effect of a large comminution gap in decreasing callus formation, primary grafting can abolish that effect and promote healing, thus reduces incidence of implant failure and the need for secondary intervention. Zlowodzki, *et al.* [17] also documented that performing primary grafting is better in cases with severe comminution and stated that delaying secondary bone grafting was the main cause for fixation failure.

To the best of the author's knowledge, no previous studies discussed using two staged debridement and lateral distal femur locking plate in first stage and fibular grafting combined with cancellous and medial plate in second stage in contaminated OG 3B (33-C3) for distal femoral fractures, added to that the paucity of

available literature discussing double plating in distal femur fractures.

In the current study, Mod Swashbuckler approach was used for fracture reduction and fixation, and it allowed better visualization, especially the intraarticular extension, avoiding malalignment, and better assessment of comminution gap to determine size of needed fibular graft.

The autogenous fibular graft served several purposes during our 2<sup>nd</sup> stage surgical technique. Once in situ, the fibula acted as a bone substitute to fill the metaphyseal void, bony strut supporting medial and lateral cortices, and additional cortices enhancing screw fixation. Addition of cancellous graft from same side ASIS or TCP granules adds gap filling around fibula and ensures union. Full weight-bearing was allowed after nearly 2 months not restricted to bony union as being a cortical strut; the fibula compared to iliac graft used in previous studies had no potential for resorption. Afterward, the fibula was used to assess progression of union and alignment.

Staged procedure to ensure that bone graft remains uninfected and 2nd stage allows arthrolysis and intra-articular fibrotic band-like adhesions, found in some cases, were released using a sharp dissection. In all the cases there were extra-articular as well as intra-articular adhesions which was released in second stage. The vastus intermedius was released and excised extraperiosteally in all cases.

Vastus lateralis and vastus medialis were released at least up to the upper third of the thigh if needed. Gentle manipulation was performed to achieve at least more than 90° knee flexion. This adds golden improvement in ROM of knee.

Our results are highly comparable to previous studies in operative time, blood loss, and postoperative range of motion, but superior in an earlier full weight-bearing at two months and union period around 12-16 weeks with better functional outcome scoring, with no cases of delayed or non-union.

Our study has limited number of patients and further follow up is ongoing.

## Conclusion

Staged debridement with single plate f/b 2<sup>nd</sup> stage fibular grafting and medial plate in more contaminated and single staged procedure in non-contaminated cases BG and dual plating of commi-

nuted distal femur fractures in patients is an effective technique with higher rates of union and lower re-operation rates compared to other fixation modalities.

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