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Open Fractures of Distal end of Femur- Philosophy of approach, Technical Tips and Pearls

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Introduction

The fractures of the distal end of femur are relatively uncommon injuries accounting for about 7% of all femoral fractures [1].

There is a bimodal distribution of the incidence of the fractures. [2]. The incidence increases in the age group between 15-24 years and again in age group older than 75 years. The incidence in the young male age group is attributed to the high velocity injuries occurring in the motor vehicle accidents. The osteoporotic nature of bone accounts for the increased incidence of the fractures in cases of elderly people especially women.

Compound injuries of the distal end of the femur have higher chances of sepsis than do the simple injuries [3].In cases of open fractures immediate debridement and internal fixation of the fracture fragments has shown decreased chances of sepsis [4].

Biomechanics

The deformities that result from the fractures of distal end of femur are produced by two forces primarily: the initial trauma and the imbalance of the muscle pull. After the initial effect, the trauma has no further role. However, muscle pull exerts deforming forces continuously until union is strong enough to withstand these stresses.

Four large muscle group play dominant roles: the quadriceps, the adductors, the hamstrings and the gastrocnemius. In intercondylar and supracondylar fractures the gastrocnemius may produce joint incongruity by causing posterior angulation or displacement of the distal fragment or by rotating and spreading the condylar fragments.

The quadriceps and the hamstrings produce longitudinal tension which tends to produce overriding and angulation of the fragments, driving the proximal fragment into the suprapatellar pouch and causing further displacement and haemorrhage.

The adductors are a powerful group of muscles and the attachment of the muscle group may lead to varus or valgus deformity according to the fracture pattern. When instituting measures to correct these deformities and to prevent the recurrences, one must consider these dynamic forces acting on the fracture. In intercondylar fractures the proximal fragment may drive into the distal fragment wedging the condyles apart. This is usually due to the muscle forces. Anterior angulation or displacement is rare and can be managed by manipulation and traction.

Materials and Methods

We followed the following protocol for 25 cases of open fractures of distal end of femur from April 2007 till date. Patients with high-energy trauma, initial resuscitation was done with respect to Airway, Breathing and Circulation. Particular attention was paid to associated life threatening injuries like abdominal injuries, chest injuries, head injuries, and spinal injuries, especially when these resulted from fall or motor vehicle accidents. They were appropriately managed and then associated fractures were noted and primary treatment was given accordingly.

A thorough wash was given primarily to clean the wound as much as possible. Any loose bone pieces were discarded and those bone pieces which had some soft tissue attachment were retained and compression dressing was applied. Relevant clinical findings, and all the injuries were duly recorded, and appropriate primary management for them was done. After initial stabilization, patients were immobilized in an above knee posterior slab

Radiological evaluation- The full length anterioposterior and lateral roentograms of the femur were taken. The anterioposterior roentogram of pelvis with both hips was also taken. The anterioposterior and lateral roentograms of the involved knee joints were taken to understand the fracture pattern more clearly. In cases of fractures of type C2 and C3 the 3D CT scan of the distal end of femur along with the knee joint was done to understand the three dimensional orientation of the multiple bone fragments in the metaphysis and intraarticular area. CT scan also helps to classify the fracture pattern more accurately and helps in the pre-operative planning.

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Figure 1- angled knee frame to be used intraoperatively

All patients were taken for primary debridement as soon as possible depending upon medical fitness and the general condition of the patient. Pain was managed with anti-inflammatories like diclofenac injectable. All the patients were given injectable antibiotics preoperatively in the form of amikacin 500mg, and combination of sulbactum and cefoperazone 2 gm. To provide protection against anaerobic bacteria, injectable metronidazole was added to the regimen.

Surgical technique- The main aim of the primary debridement is to excise the dead, contused tissue and to thoroughly clean the wound and realign the articular surface of distal end of femur to as near anatomical position as possible.

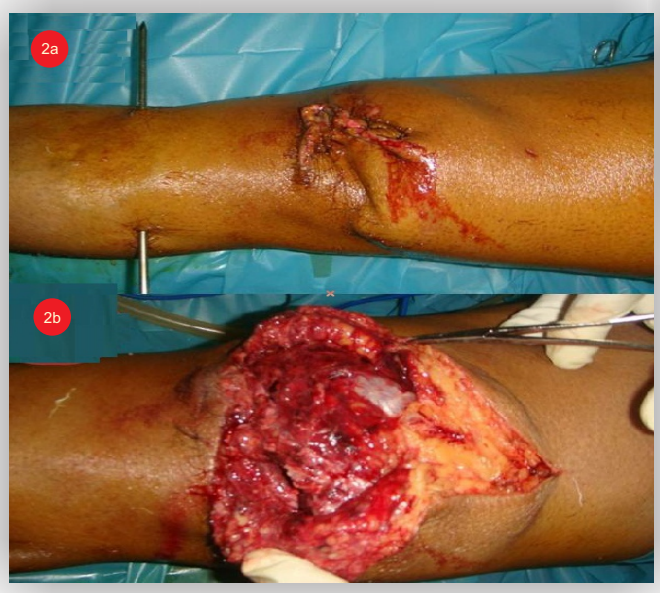

Figure 2a- Initial debridement done elsewhere under local anesthesia. 2b- Extension of the original wound for debridement.

Patient positioning: Patient is positioned in supine position on operative table with an angled wooden plank kept below the limb (Fig 1). The knee flexion frame is designed in such a way that it can be flexed in various amount of flexion. During the debridement of the injury the limb is kept in extension. To improve the visualization of the distal intraarticular surface of the femur the limb is kept in about 30 degrees of flexion. We experienced that the realignment of the intraarticular fragments is much easier and more accurate when there is better visualization of the fragments by keeping the limb flexed. Image intensifier is positioned to allow complete visualization of the distal femur and the knee joint in two orthogonal planes (Antero-Posterior and Lateral views).

Debridement: Most of the injuries are caused by road traffic accidents leading to the presence of contamination in the wound. Thorough debridement of the soft tissue is mandatory so as to prevent the chances of infection. The original wound was extended by taking longitudinal incision at the ends (Fig 2). The soft tissues were reviewed

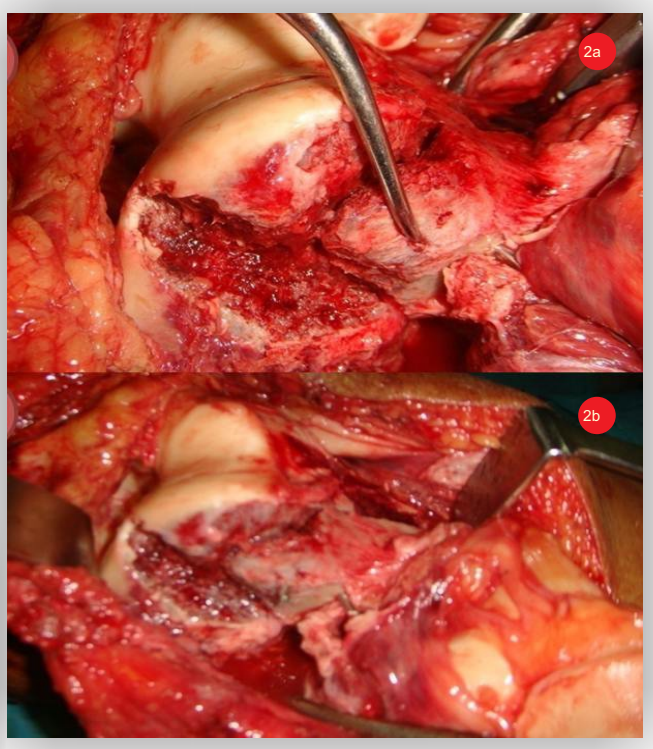

Figure 3a- Reduction of articular fragments. 3b- Fixation of intra articular fragments with Kirschner wires.

for presence of any foreign bodies. The muscles were screened for viability by looking for their colour, consistency, contraction and circulation. Those muscles which were doubtful to survive were excised till fresh bleeding was seen at the muscle edges. In cases where degloving injury was suspected, the incision was extended so as to debride the dead soft tissue. Any bone piece found devoid of any soft tissue was removed. Thorough wash was given by normal saline.

Figure 4a- Pre debridement AP and Lateral views of distal end femur. 4b- Post debridement x rays AP and lateral view.

Reconstruction of articular surface: One of the important steps in the management of compound fractures of distal end of femur was the reconstruction of the articular surface of the distal end of femur. The goal of the reconstruction at the time of primary debridement was to achieve a near anatomical position of the articular surface so that during the definitive fixation stage the alignment of the articular surface was much easier and accurate without much soft

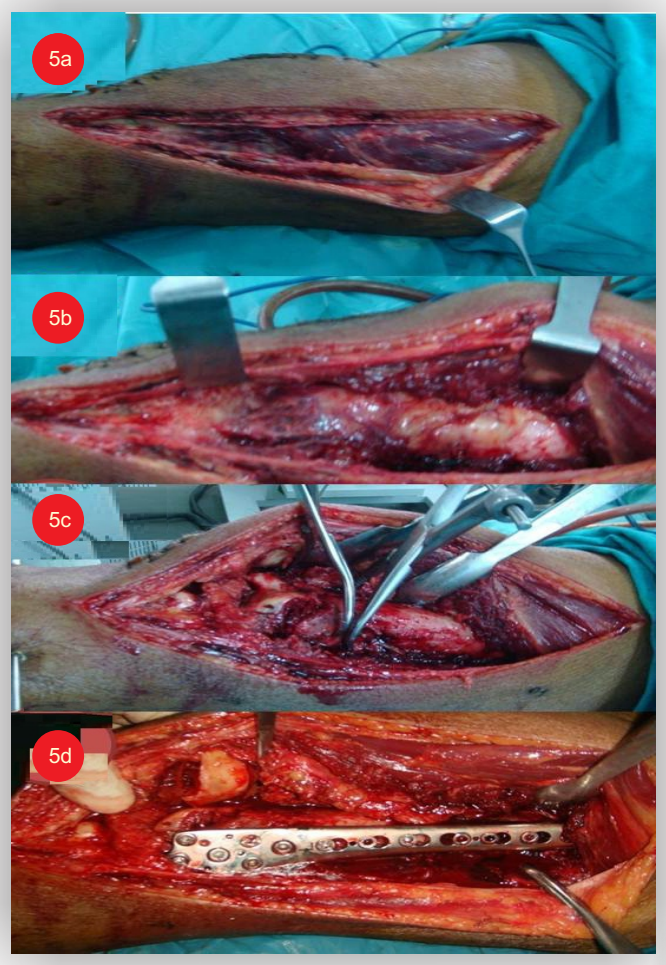

Figure 5a- Incision extending from tibial tuberosity to the lateral aspect of thigh. 5b- Submuscular approach to distal end of femur. 5c : Reduction of the fragments. 5d- Fixation of the fracture with a locking plate.

tissue damage. The femoral condyles were directly reduced by means of traction, application of large towel clips, and by joy stick maneuver by passing a Kirschner wire into one of the bone fragments (Fig 3a). After the articular surface was reduced to achieve an acceptable position, the fragments were fixed with Kirschner wire (Fig 3b). The metaphyseal comminution was also fixed with Kirschner wires so as to achieve a near anatomical alignment. A long Kirschner wire was passed from the metaphysis into the condyles so as to maintain the relation between them.

The incision was closed in layers using a vicryl and skin was closed over a vacuum suction drain by help of ethilon. A sterile dressing was applied over the wound. After the reconstruction of the articular surface was done, if necessary, a Steinman pin was passed through the upper end of tibia, which was incorporated into a below knee cast to form a Charnley's skeletal traction set assembly. On the post-operative day, three kilograms of traction was applied to the Steinmann pin so as to maintain longitudinal traction over the limb which maintained the alignment of the fracture fragment. The traction is continued for next two to three weeks so as to allow the fragment to become gluey. Serial radiographs are taken to monitor the alignment of the fracture fragments (Fig 4). The traction on the limb can be gradually increased to allow proper alignment of the fragments. The traction is continued till the alignment is satisfactory and soft tissues are healthy then plan for definitive fixation is carried out.

Definitive fixation: Once the original wound has healed up and the fragments have aligned satisfactorily the definitive fixation of the fracture can be carried out. A variety of implants are available for the internal fixation of fractures of distal end of femur viz. 95o dynamic condylar screw, distal femoral buttress locking plates. The choice of implants was based upon the amount of comminution at the articular region, osteoporosis of the involved bone and the amount of bone loss. In cases of comminuted and osteoporotic fractures the implant of choice was distal femoral buttress locking plates and in rest of the cases the 95o dynamic condylar screw is used as the implant.

Surgical technique: The goal of the definitive fixation is to achieve stable fixation of the fracture, to achieve normal alignment in the coronal, saggital and axial plane, to achieve the limb length and reconstruction of the articular surface. A tourniquet is applied at the proximal part of the thigh. The limb is draped from the mid-thigh level to the toes so that the foot is visible to get additional information about the rotational alignment of the lower limb. The ipsilateral iliac crest was prepared in cases where autografts were used. In cases where primary fibular struts were used

Figure 6a- Anterio-posterior and lateral radiograph of the primary fracture and fracture after debridement and articular reduction. 6b- Radiographs after definitive fixation and 23 months follow up radiograph showing union. 6c- clinical pictures at final follow up showing good knee range of motion.

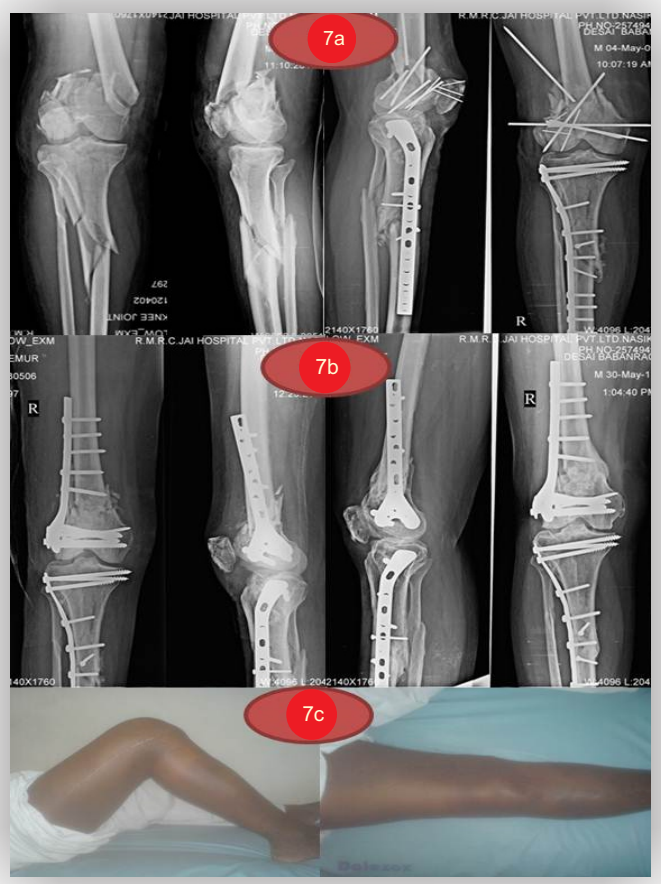

Figure 7a-Anterio-posterior and lateral radiograph of the primary fracture (a floating knee injury) and fracture after debridement and articular reduction. 6b-Radiographs after definitive fixation and 23 months follow up radiograph showing union. 6c- clinical pictures at final follow up showing good knee range of motion.

the opposite limb was also prepared to harvest the fibular graft of the required length. In cases where allografts were used to compensate for the bone loss, freeze dried gamma irradiated bone grafts were used. These bone grafts were soaked in betadine solution for an hour prior to using them and were washed thoroughly with normal saline prior to their use. Patient positioning is similar to that in debridement using angled wooden frame. A curved incision was taken from the tibial tuberosity, curving proximally and laterally to the lateral aspect of the thigh (Fig 5a). The superficial fascia was split and soft tissue dissection done to expose the belly of vastus lateralis muscle (Fig 5b). The vastus lateralis muscle was approached from the lateral side and it was reflected in its whole substance from the lateral aspect of the femur (Fig 5c). The suprapatellar pouch was also reflected from the anterior aspect of the femur without dissecting it so as to prevent any postoperative adhesions occurring due to open suprapatellar synovial pouch.The reduction of the metaphyseal fragments was done by using large Weber's forceps and Verbrugge's bone holding forceps. The reduction is held in place by the use of a reduction forceps with serrated jaws. The plate was slided under the forceps and fixed temporarily with Kirschner's wires. The reduction was stabilized with a lag screw in cases of oblique fracture lines. After the reduction of the metaphyseal and articular surface was confirmed, the plate was fixed to the bone using 4.5mm cortical screws (Fig 5d). The condylar segment of the femur was fixed with 6.5 mm cancellous screws. In cases where dynamic condylar screw was used as an implant, the tunnel for the condylar screw was made first in the femoral condyles and then the plate was placed over the screw and fixed with 4.5mm cortical screws. The void created due to the bone loss was filled up with the use of autografts harvested from the iliac crest. In cases where there was significant bone loss the use of autografts was supplemented with the use of allografts. In cases with medial comminution and in the fractures which had a tendency to collapse into varus, the fibular strut graft was used to prevent the varus collapse. Since November 2010, primary fibular strut grafting is used in three cases with primary bone loss. The fibular graft is introduced intramedullary and fixed to the femur by the screws passing through the plate. The incision is closed in layers over a suction drain and sterile dressing is applied.

Post-operative protocol: The limb is kept on a Bohler's frame with skin traction of 3 kilograms so as to prevent any undue rotational movement occurring at the fracture site which hampers the stability of the fracture. The drain is removed after 48 hours and dressing is applied. The injectable antibiotics are continued till the fifth post-operative day and on sixth day onwards oral antibiotics are started. The anteroposterior and lateral radiographs of the limb are taken on the seventh post-operative day. After confirming the position of the fracture fixation on the post-operative radiographs, passive range of motion are started by using continous passive motion machine. The patient is mobilized non weight bearing with the help of a walker. The knee flexion is gradually increased on a daily basis so as to achieve maximum range of movement. The patient is advised to continue physiotherapy and non-weight bearing walking till radiological union is seen (average 3 months).

Results

The mean duration of follow up was 23.36 months. The average time of union was about 16-18 weeks. Final results were assessed using the Neer's numerical scoring system. In our series we had 81% of excellent to satisfactory results.

FINAL SCORE ACCORDING TO NEER'S SYSTEM

Score	No. of cases	Percentage
Excellent	13	50%
Satisfactory	8	30.76%
Unsatisfactory	2	7.69%
Failure	3	11.55%

The final outcome was seen to be more favorable in cases where bony injury and soft tissue injury were of less severity. In our series we had 100% excellent to satisfactory results in cases with C1 type of injury and in cases with type A soft

RELATION BETWEEN FRACTURE TYPE AND RESULT		
Type of fracture	No of cases with excellent/satisfactory score	No of cases with unsatisfactory/failure score
C1	6	0
C2	9	1
C3	6	4

tissue injury. Also in cases which had initial bone loss, the final outcome was less favorable.

The chances of having satisfactory results were increased if the initial debridement was carried out within the first 24 hours of injury. In our series all the patients treated within the first 24 hours had excellent to satisfactory results.

COMPLICATIONS		
Complications	No. of cases	Percentage
Superficial infection	2	0.0769
Deep infection	2	0.0769
Malunion	3	0.1153
Implant failure	2	-

RELATION BETWEEN SOFT TISSUE INJURY AND RESULT		
Type of soft tissue injury	No of cases with excellent/satisfactory score	No of cases with unsatisfactory/failure score
Type I	3	0
Type II	6	1
Type IIIA	3	1
Type IIIB	9	3

The malunion was the most common (11.53%) complications in our study, followed by superficial infection, deep infection and implant failure (7.69%).

In both the cases where only allograft were used there was incidence of implant failure. Figure 6 and 7 show two cases of our series with follow up till about 2 years.

Conclusion

The technique involves primary debridement and minimal articular fixation with traction. After satisfactory wound healing a definitive fixation is done. The technique has yielded good and consistent results in these difficult to treat fractures.

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