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Management of infected distal femur non-union: A two step surgery

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Abstract
Background: Incidence of distal femur fractures is approximately 37/ one lakh person-years. Distal femoral fractures mainly arise from two different injury mechanisms by high energy trauma and low energy trauma.
Objective: To find out the causes of Non Union of distal femur and progress of such nonunion.
Methodology: Total 35 cases of distal femur fracture nonunion satisfying inclusion and exclusion criteria treated and followed up in post graduate institute of swasthiyog pratishthan, miraj from May 2012 to September 2014 are taken in the study and all patients were followed up according to post-operative follow up protocol.
Results: Among the 35 cases 31 were male and 04 were female. The mean age of case presenting to us at the detection of Non Union was 38.5 years. Symmetrical distribution of cases in the age group from 20-49 years which accounted for 29 cases (82.85%). Right limb was involved in more number of cases. Accidents were noted to be the main cause of primary fractures. Most of the cases had a compound injury initially. Aseptic Non Union was seen in 60% and infected Non Union in 40% of cases. The most common cause of non-union was found to be infection
Conclusion: Commonest cause of non-union was found to be infection and most common injury associated was found to be Ipsilateral lower limb injuries.

Keywords: Non-union, distal femur, Road traffic accident, domestic fall

Introduction
Distal femur non- unions are difficult to treat and associated with patient disability. The distal femur or the supracondylar area of the femur is defined as the zone between the femoral condyles and the junction of metaphysic with the femoral diaphysis. In diaphyseal fractures of major long bones in adults, the diagnosis of nonunion should not be made until 6 months after the fracture. [1, 2] Radiographically, a nonunion shows no evidence of bone bridging the fracture site. Finally, the diagnosis of nonunion infers that the fracture will not go on to union without some type of therapeutic intervention, either nonoperative or surgical. The objective in the treatment of non-unions is to achieve solid union of the fracture site, one that will ensure and allow the patient to regain a good level of function. The latter requires that the limb be left with little or no shortening or malalignment, and that sufficient joint range of motion, muscle strength, and neurovascular function be restored that the limb is useful to the patient. If these objectives are reached, but the patient continues to have chronic disabling pain, then treatment may have been fruitless. The primary source of pain in most cases, however, is the nonunion itself. Healing of the nonunion usually resolves any pain problems. Non-unions can be broadly divided into aseptic and infected nonunion. However the treatment of both is different, the principle of the treatment is to provide a painless limb with good functional outcome. Henceforth this study aims to evaluate the different causes of Non unions of distal femur, the progress of such nonunion (both aseptic and infected).

Materials & Methods
This observational study was conducted at Post Graduate Institute of Swasthiyog Pratishthan, Miraj. Consent was taken from all study population.

We studied 35 patients of distal femur fracture non-union satisfying inclusion and exclusion criteria treated and followed up according to post-operative follow up protocol from May 2012 to September 2014. The mean follow up period was fourteen months and patients were assessed for functional capacity and radiological fracture healing capacity per month.

Protocol was observed for patients with nonunion lower end of femur on arrival-

1. Local and systemic examination, thorough assessment of patient to rule out any injury.
2. Evaluation of patients in terms of age, sex, mode of primary trauma, period between injury and primary surgery, to rule out associated fractures, to know neurovascular status.
3. Radiological assessment: AP& lateral views of injured limb,
4. Sinogram with Urograffin dye in cases of infected nonunions with discharging sinuses.
5. CT Scan is necessary to diagnose a missed hoffas fragment.

Inclusion criteria

1. Patients > 18 years age and managed surgically
2. Distal femoral fractures non unions with or without osteoporotic changes patients.

Exclusion criteria

1. Children with distal femoral fractures and growth plate is open.
2. Cases lost in follow – up.

Implant Used

- The 5- 14 holed locking compression plates are available. 4.5 mm thickness plate for lower end of femur
- Anatomically precontoured plate head with soft edges.
- Locking screws in the head of the plate.
- The head of the locking screw is threaded which gets locked to the plate when it is tightened.

Preoperative investigation

Haemogram- Hb, CBC, TLC, ESR, Blood sugar level, Blood urea level, Serum Creatinine level, LFT, Blood group and Rh typing, Bleeding time, clotting time, C - reactive protein, Chest X-ray PA view, ECG, 2Decho
done in all patients

Preoperative planning and preparation

Fractures were classified with the help of radiographs. preoperative calculation was done to ascertain the plate size, size of locking, cortical and cancellous screws after subtraction of the magnification factor. If the diagnosis of non union was not confirmed or if we suspected a Hoffa's fragment then CT Scans were done.

Surgical Procedure

With the knee in flexion with a triangular pillow below the knee joint Patient is placed supine on a table. The injured extremity with contralateral iliac crest were prepared and draped. Tourniquet applied and inflated.

Lateral incision was taken over the previous scar mark if the same incision could be utilized or a new incision is taken parallel to the shaft of the femur, beginning at the Gerdys tubercle and extending proximally far enough to permit the plate application. Longitudinal incision is made through the fascia lata, and extended distally into the iliotibial band.

In the old operated cases, the approach is taken through the fibrous tissue carefully using an electrocautery to reach the nonunion site. When the dye is injected through the sinus, the dissection is done in the plane of the dye to reach the non union site. In an untreated case, the fascia overlying the vastus lateralis is incised, the muscle reflected anteriorly off the intermuscular septum and perforating vessels are identified and ligated or coagulated.

After reaching the non union site, the old implants are removed carefully making sure that no screw or part of plate remains intact inside. A through wash is then given using normal saline. The fracture site mobility is checked. Soft tissue if any is removed from the fracture site. Freshening of the fracture site is performed. This is followed by shingling using a small osteotome and a hammer to remove the sclerosed bone till punctuate bleeding is visible. A small drill can also be used to drill at the fracture site. It is necessary for the tourniquet to be deflated during this step. Minimal Stripping of soft tissue is done. Vascularity is preserved.

By applying traction to the leg with the knee flexed, femur shaft was wedged between two condyles; wedged shaft of femur is displaced. the patella are reflected medially to expose the entire lower end of the femur.

Reduction of condyles

The lateral surface of the lateral condyle was drilled a Steinmann. A similar pin was placed in the medial condylar fragment.

Using these pins as levers, manipulation and reduction of the two major condylar fragments was done. With multiple 2-mm Kirschner wires, both condyles were fixed together. Both condyles together were fixed with 6.5-mm cancellous screws directed lateral to medial. Second screw was placed without a washer, slightly anterior and proximal to the first. for temporary fixation Kirschner wires used, were removed.

The compression screw draws the bone towards the plate and uses the contour of the plate to reduce the fracture in the coronal plane when using the plate as a reduction aid. Reduction of the fracture was assisted keeping folded pillow below the knee which prevented posterior angulation of distal fragment with manual traction. After reduction of fracture, supplemental locking screws were then added to create a fixed-angle construct.

Results

Among the 35 patients 31(88.57%) were male and 04(11.43%) were female. The mean age of patients presenting to us at the detection of non union was 38.5 years with mean of 39.3 years for aseptic femur non unions and 37.1 years for infected non unions. We observed an almost symmetrical distribution of 29 cases (82.85%) in the age group from 20-49 years, the youngest case was 20 years and the oldest patient being 63 years old.

Table 1: Age Distribution

Age (in years)	Number	Percentage
20-29	10	28.57
30-39	09	25.71
40-49	10	28.57
50-59	04	11.43
Above 60	02	5.71
Total	35	100

Right limb (51.43%) was involved in marginally more number of patients than the left limb (48.57). Road traffic accidents were noted to be the main cause of primary fractures (82.85%) and the rest being Domestic fall (17.15%).

Table 2: Relation Between age & Mode of Injury

Mode of Injury	Number	Percentage
Road Traffic Accident	29	82.86
Domestic Fall	06	17.14
Total	35	100

Most of the cases (21 cases; 60%) of non union had a compound injury initially. Aseptic non union was seen in 21 cases (60%) and infected non union in 14 cases (40%) in our study.

Table 3: Various Type of Primary Injury

Type of Fracture	Number	Percentage
Closed	14	40
Grade I Compound	2	5.72
Grade II Compound	6	17.14
Grade III Compound	13	37.14
TOTAL	35	100

In majority of cases, the primary treatment was plating (24 cases; 68.57%) followed by nailing in 5 cases (14.29%), untreated in 4 cases (11.43%) and external fixator in the remaining 2 cases (5.71%). The most common injury associated with the primary fracture was found to be Ipsilateral lower limb injuries in 10 cases (28.57%) and were dealt with accordingly during the initial surgery.

Infection was the commonest cause of non-union (82.85%) in 11 cases (31.4%), followed by Improper reduction, mechanical failure, Missed Hoffas, Non compliance and untreated in 25.7%, 22.9%, 8.6%, 2.8% and 8.6% respectively. Although there may be multiple causes of non union in a single case, we have taken into account the single most relavent cause for each case.

Table 4: Causes of Non union

Causes	Number	Percentage
Infection	11	31.4
Improper Reduction	9	25.7
Mechanical Faliure	8	22.9
Missed Hoffas	3	8.6
Non compliance	1	2.8
Untreated	3	8.6
Total	35	100

In all the cases of aseptic non unions, incision was taken over the previous scar mark if the same incision could be utilized or a new lateral parapatellar incision was taken. Intraoperatively k wires were used to temporarily hold the reduction. 6.5 mm cancellous screws and Herbert screws were used to hold the articular fragments and maintain the joint congruity. The principle of compression plating was followed during the plate application. A standard LCP (SYNTHES and Indian made) was used for plating. On the basis of type of fracture the size of plate (7 & 9 holed)/implant was selected.

All cases of infected non-unions were primarily treated with implant removal and thorough debridement. Antibiotic cement beads (Vancomycin + Supacef) were kept and antibiotic cement spacer was used if the defect was found to be huge.

Discussion

Comparing our results with standard studies, in a study by Ebraheim NA *et al* [3], Researcher reviewed 19 studies published over the last 12 years in which there were patients with nonunion of the distal femur and treatment. It was found that the most common fracture pattern involved metaphyseal comminution, most common initial treatment was open reduction and internal fixation with plating. This reviewed reports suggest that this form of treatment has a successful union rate of 97.4% and average time to heal of 7.8 months

Bellabarba C *et al* **[4]** researched results of indirect reduction and plating of distal femoral non-unions. In their study all 20 non-unions healed without further intervention at 14 weeks postoperatively. Average operative time was 154 minutes (range 90 to 240 minutes).

Chapman MW *et al* [5] found the results of single and double-plate fixation combined with bone grafting from the iliac crest performed by one surgeon for treatment of supracondylar nonunion of the femur. They noted that all 18 non-unions had healed. One case had needed repeat double-plate fixation and autologous bone-grafting.

Prasarn ML *et al* **[6]** studied Management of infected femoral nonunions with a single-staged protocol utilizing internal fixation in 13 patients. All patients had united and resolved their infections. 10 patients healed their nonunions with the fixation placed at the time of initial revision. 5 patients required re-interventions. Four patients had additional bone grafting procedures.

Wang JW *et al* [7] performed a retrospective study to analyze the results of treatment of nonunions of the distal part of the femur with internal fixation combined with cortical allograft struts and autogenous bone-grafting in 13 patients. In their study, all nonunions united, at an average of five months.

Gardner MJ *et al* [8] performed a study to evaluate the outcome of patients who underwent treatment of a distal femoral nonunion using a standardized treatment plan that included open reduction, internal fixation, supplemental bone graft, lag screw placement, and arthrolysis in 31 patients. They noted that at final follow-up the union rate was 97%, and the average time to heal was 15.9 weeks. In our study we treated 35 cases of distal femur fracture non union with an average age of 38.5 years. The average union time was 22.6 weeks with persistence on non union in 11.4% cases, 11.4% showing deep infection, 8.6% with superficial infection, 8.6% with varus malalignment.

Thonse and Conway [9] have studied cases of INU with bone defects in 20 patients. They were able to achieve primary union by primary use of ABN in all cases,

Babhulkar and colleagues [10] achieved 100% union in their series of 29 cases with a two-staged procedure. There were no patients with persistent infection.

Shahcheraghi and Bayatpoor [11] also noted 100% union in their series of 58, especially those treated with intramedullary nail and bone grafting. They have also had 33% of persistent infection in their series. In our series, we noted persistent infection in 5 (3.04%) patients. Shyam and coworker [12] in their series of 25 patients treated with antibiotic nail, had only three patients of type 1 who did not require a secondary procedure and none of the cases with type 3 INU achieved infection controls.

Conclusion: It was concluded that the most common cause of non-union was found to be infection, Improper reduction, mechanical failure, Missed Hoffas, Non compliance and

untreated in 25.7%, 22.9%, 8.6%, 2.8% and 8.6% respectively. The most common injury associated with the primary fracture was found to be Ipsilateral lower limb injuries

All cases of infected non-unions were primarily treated with implant removal and thorough debridement. Antibiotic cement beads (Vancomycin + Supacef) were kept and antibiotic cement spacer was used if the defect was found to be huge. The operative time ranged from 90 min to 240 min with an average of 140 min.

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