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Study of outcome of treatment for nonunion of femoral shaft fractures: A case series

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Abstract
Introduction: Nonunion of femoral shaft fractures continues to hinder the successful outcome femur fracture treatment in spite of increased understanding of biomechanics and improvements of implant design. Nonunion of femur fracture presents a difficult treatment challenge for the surgeon and a disastrous personal and economic hardship for the patient.
Method and Material: 20 consecutive cases of fractures shaft of femur non-union were admitted to the Orthopaedics Department, Dhiraj Hospital, Waghodia were included in this study. All patients underwent revision surgery in form of exchange nailing with autologous cancellous bone graft with plate augmentation in required cases.
Results: Out of 20 patients maximum belonged to the age group of 31-40(8). 13 (65%) patient had hypertrophic non-union and 7 (35%) had atrophic non-union. Average follow up of patients was upto 14 months post operatively. Out of 20 patients, 14 (70%) patient achieved union at their last follow up. Radiological signs of bone union was observed at a average of 7.5 months (5.5 to 11 months).
Discussion and Conclusion: The use of plate augmentation and bone grafting for the treatment of femoral shaft nonunion, along with exchange interlocking intramedullary nail, to remove the rotational instability of the nonunion site increased the chances of union. Bone grafting performed simultaneously filled the bony defect and stimulated healing.

Keywords: Nonunion, femur fracture, exchange nailing, bone graft

Introduction
Intramedullary nailing is considered the gold standard treatment of femoral shaft fractures resulting in excellent union [1]. Interlocking nailing provides adequate rotational stability for fixation of the fracture [2, 3]. Nonunion of femoral shaft fractures continues to hinder the treatment of these injuries in spite of increased understanding of biomechanics and improvements of implant design. Femoral nonunion presents a difficult treatment challenge for the surgeon and a formidable personal and economic hardship for the patient [4, 7]. The treatment of femoral shaft fractures has been extensively described in the orthopedic literature, but the data regarding treatment of femoral shaft nonunions are sparse and conflicting, as most of the reported series consisted of a small number of cases. The causes of nonunion of femoral shaft fracture are based on age of the patient, mode of trauma, open injuries, presence of distraction at fracture site after internal fixation and several others [6]. There are various surgical options for treating femoral shaft nonunion after interlocking nailing include nail exchange, bone grafting, dynamization and plate augmentation [7]. In our case series we have evaluated the functional and radiological outcome of exchange nailing with bone grafting along, with augmentation plating wherever required, in 20 cases of non-union of shaft femur fractures.

Material and Methods
Twenty consecutive cases of fractures shaft of femur non-union were admitted to the Department of Orthopaedics, DHIRAJ HOSPITAL, WAGHODIA were included in this study. This was a hospital-based descriptive study recruited patients, and their informed consent were obtained for the procedure.

Inclusion criteria

1. All patients who were aged 18 years and above
2. All patients who had initially closed fractures of the shaft femur
3. All patients who had one or more times previous surgical treatment with IM NAIL or plate, with or without broken implants.
4. All patients who had nonunion on clinical and radiological assessment performed at 9 months or later after the last surgery.

Exclusion criteria

1. Patients with infected non-unions
2. Patients not willing for surgery

Operative Procedure

After spinal anesthesia, patients were placed in supine position on fracture table. A small incision was given extending four cm up from the tip of greater trochanter. The insitu intramedullary nail was removed, and medullary canal of the femur was reamed with gradual increments up to 1 mm above the previous nail size using flexible reamers. Those patients with failed primary plate fixation, the plate was removed through a lateral approach and the canal was reamed with appropriate sized reamers. The fracture site was freshened and reduction was held with clamp. Then a proper size interlocking IM nail, one mm smaller diameter than the last reamer used, was inserted over the guide wire using the nail jig assembly. Proximal locking was done using the jig and distal screws for locking were inserted free hand under image IITV guidance followed by autologous cancellous bone grafting obtained from ipsilateral iliac crest. In cases where the canal diameter was found to be wider than the largest available nail, we used a 3.5mm DCP for fixation across the fracture in addition to the intramedullary implant.

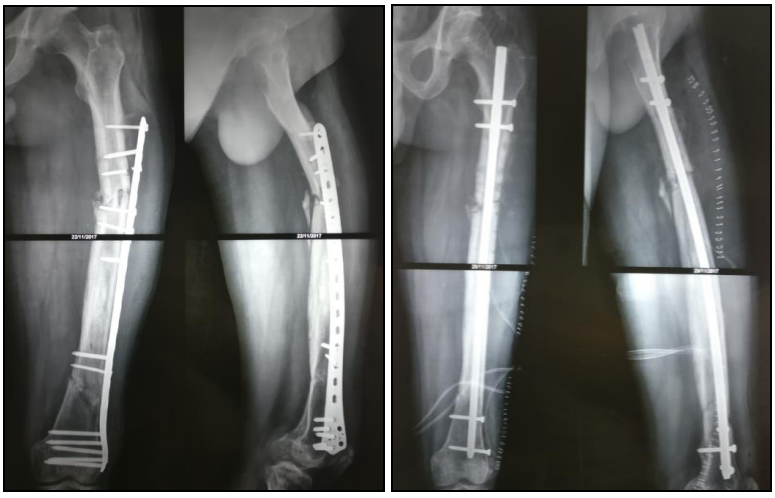
Postoperatively, all patients were allowed to ambulate with protected weight bearing as soon as possible. Quadriceps strengthening as well as knee range of motion exercise was encouraged from post op day one. Patients were discharged home on 12 postoperative day after suture removal. Patients were followed up regularly for clinical and radiological checkup at one month intervals for minimum period of 1 year after the surgery or till time when bone healing at non-union site has occurred. The fracture was considered healed when it showed radiological evidence of healing. Relevant information regarding patients' age and gender, type of non-union as to whether atrophic or hypertrophic, characteristics like femur fracture location, duration of fracture healing after exchange interlocking nailing, period of postoperative follow up period and complication were recorded and analyzed.

Results

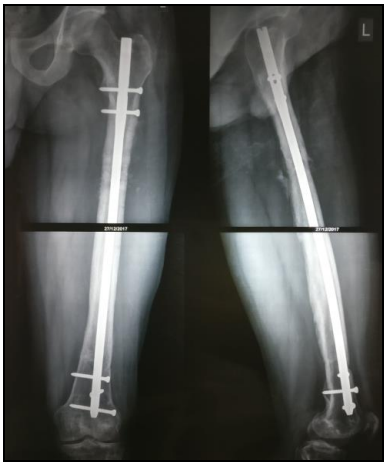
Out of 20 patients maximum belonged to the age group of 31-40 (8). Out of 20 patient 18 were male and 2 were female. 12 (60%) out of 20 patients had injury on right side and 8 (40%) on left side. 13 (65%) patient had hypertrophic non-union and 7 (35%) had atrophic non-union.11 (55%) cases had non-union at mid shaft femur, 5 (25%) at distal shaft femur, 4(20%) at proximal shaft femur. Out of 20 patients who had undergone exchange nail with bone graft, 3 had plate augmentation done for additional rotational stability during 1st surgery. Average follow up of patients was upto 14 months post operatively. Out of 20 patients, 14(70%) patient achieved union at their last follow up. Radiological signs of bone union was observed at a average of 7.5 months (5.5 to 11 months). Out of 6 patients, which had persistent non-union, 5 underwent 2nd surgery in which cancellous bone grafting with plate augmentation was done, whilst 1 refused for 2nd surgery. 4 patients had superficial infection at suture line which was treated by appropriate antibiotics as per culture and sensitivity.

Age-and previously used implants with their present surgery

Age	Cases	Primary treatment	Treated with (no. of patients)
18-20	4	3-K nail 1-plating	Intramedullary nail + bone graft (4)
21-30	6	3- intermedullary nail 2-K nail 1-Plating	Intramedullary nail + bone graft (5) Intramedullary nail + bone graft+ plate (1)
31-40	8	5-plating 3-K nail	Intramedullary nail + bone graft (6) Intramedullary nail + bone graft + plate (2)
41-50	2	1-K nail 1-plating	Intramedullary nail + bone graft(2)



Pre Op radiograph Immediate post Op Radiograph



Final Followup radiograph

Discussion

Non-union is defined by US Food and Drug Adminstration as a fracture that has not completely healed within 9 months of trauma and that has not shown progression towards healing over 3 consecutive months on serial radiographs [1, 7]. The exact time frame depends on the fractured bone and location within the bone, soft tissue condition, and fracture type [1, 2, 4]. Factors favouring fracture healing are no distraction at non-union site, provision of adequate stability, and adeqaute blood supply to the fracture fragments ends [11].

Exchange nailing is known to be the treatment of choice for femoral shaft nonunion [3, 4]. Exchange nailing allows early weight bearing with low morbidity. However, all femoral shaft nonunions for which intramedullary nailing has failed were not considered appropriate for exchange nailing [5, 7]. The rate of union rate ranged from 53% to 78% after the first exchange intramedullary nailing and 87% to 95% after the second procedure. There are questions regarding outcomes of exchange nailing for femoral shaft nonunion [6, 7, 8].

According to the study reported by Johnston *et al*, the rotational stability of the interlocking intramedullary nailing was 3% of that of the normal femur. Rotation of 10-15 degree occurred at the fracture site without resistance in the femur with intramedullary fixation [10]. This means that there was some limitation in the rotational stability.

The use of plate augmentation and bone grafting for the treatment of femoral shaft nonunion, along with exchange interlocking intramedullary nail, to remove the rotational instability of the nonunion site increased the chances of union. Bone grafting performed simultaneously filled the bony defect and stimulated healing. When nailing has failed, augmentative plating with exchange intramedullary nailing results in a 96% union rate as compared to 73% in the isolated exchange nailing [8].

Other modalities for treatment of nonunion like Dynamisation produced a significant instability at the nonunion site and femoral shortening. Femoral shaft nonunion is no longer treated with just dynamization. Nolte PA *et al*. conducted a study to analyze the results of Low-intensity pulsed ultrasound in the treatment of nonunions, which showed good to excellent outcome. But this modality produced variable outcomes and it could not be used as sole modality of management [9].

Conclusion

Failure of femoral shaft fixation occurs due to combination of biologic, mechanical, and technical problems. A careful diagnostic approach is required in all cases, no matter how clear the diagnosis may appear on X-ray examination. Exchange femoral nailing with bone grafting and augmentation plate can resolve the majority of aseptic nonunions. The present study provides evidence for excellent outcomes for this modality of management, however larger group studies can help further validate the results.

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