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Non-union femur Fractures: Effectiveness of augment plating

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Abstract
Background: Intramedullary nails have been widely used to treat long bone fractures, most of which heal within the expected time. However, in some cases union fails to occur by the expected time due to various reasons. After treatment with intramedullary nails, fractures located at the metaphysis of long bones are especially prone for non-union. The main reason for the non-union is instability (rotational) at the fracture site. The treatment options available to deal with such a situation include exchange nailing, removal of nail and re-osteosynthesis with plating, or Ilizarov fixation.
Materials and Method: Our study is a prospective study conducted from AUG 2016 to AUG 2018, involving 10 patients. Patients with fracture shaft of femur treated primarily with intramedullary nailing were included in the study were included in the study.
Results: All cases were followed up monthly upto 4 month and then every three months upto 1 year. All cases started showing signs of healing from eight weeks onwards and the fracture united radiologically at the end of 4 months.
Conclusion: Our study concludes that augmentation plating gives excellent mechanical stability and improves the biology for fracture healing and when combined with exchange nailing it has a very high success rate and is a reasonably good, effective and safe procedure for non-unions following intramedullary nailing of femur shaft fractures.

Keywords: Fractures, Effectiveness, Fractures, intramedullary

Introduction

Fracture of femoral shaft is a most common injury which is usually caused by high-energy trauma like road traffic accidents (RTA) or sometimes after low energy trauma like by orthopaedic surgeons [1]. For treatment of acute femur shaft fractures Interlock nailing is a standard and accepted method with a success rate of more than 90% [2, 3]. Non-union after intramedullary nail fixation of femur shaft fractures is rare but quite challenging to treat [4]. The treatment methods include removal of nail and re-osteosynthesis with plating, or Ilizarov fixation and exchange nailing [5]. Among thesethe most accepted method for the non-union of femur shaft fracturesis exchange nailing [6], but it has not shown consistent results across literature [7, 8]. Dynamisationhas only a marginal effect on union so is not applicable in all cases [9]. Bone grafting alone does not address the problem of rotational instability which is a major factor in non-union following interlock nailing. Augmentation plating has promising results in non-union following intramedullary nailing [10-12]. but retaining the same intramedullary nail in a case of where it has not worked once adds to the prevailing confusion. Also it is not unusual to find the broken implant in cases of non-union shaft femur, where it is possible to rely simply on augmentation plating. This study presents our experience in augmentation plating combined with exchange nailing for femoral non-unions initially treated with intramedullary nailing.

Materials and Method

Our study is a prospective study conducted from AUG 2016 to AUG 2018, involving 10 patients with fracture shaft of femur treated primarily with intramedullary nailing aseptic were included in the study. Nine patients showed non-union which was considered when the patient had pain on weight bearing, or there was gross motion and pain at the fracture site on physical examination with obvious radiographic signs of bone healing cessation at 6 months postoperatively. One patient had implant failure. Written informed consent was obtained from all the patients.

Operative Technique

The patients were operated under spinal anesthesia on a traction table. Exchange nailing was carried out first. The Implant was removed by means of its extraction devise. In cases with broken implant, a special broken nail extraction set was used. After removal of the nail a guide wire was inserted into the medullary canal. The canal was reamed by progressively increasing sized reamers with a goal of inserting the nail which has a diameter of 2 mm more than the initial nail diameter or of at least 12 mm. Following exchange nailing, distal interlocking screws were inserted first. The fracture ends were compressed with the help of a back hammering device. This was followed by locking of the

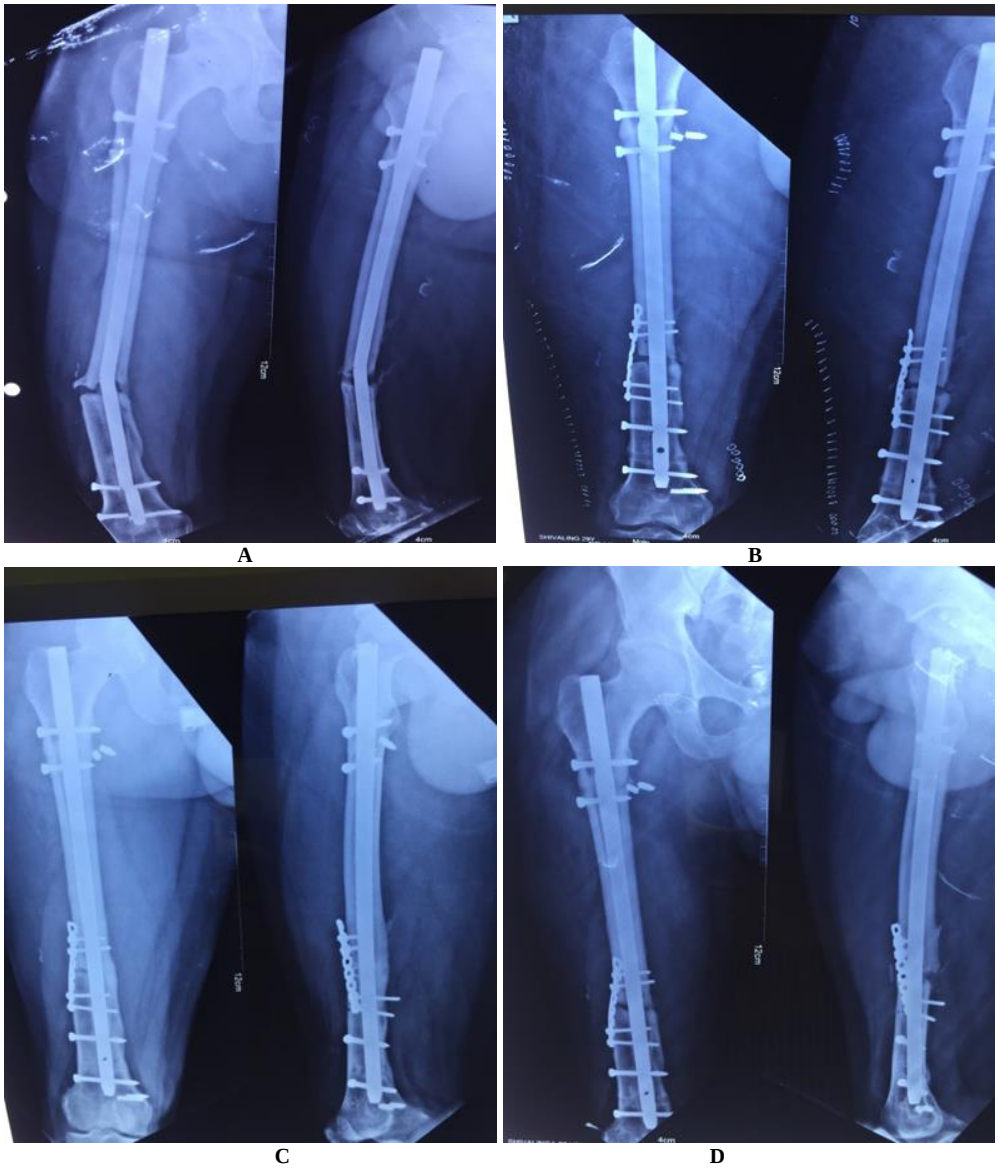
proximal interlocking screws. Rotational stability of the interlocking nail was assessed by applying an external rotation force at the distal thigh. Rotational instability at the non-union site was detected in all patients and was considered to be the main underlying cause of non-union.Then through lateral approach, non-union site was exposed. Rotational instability at the non union site was visualized. Femoral exchange nailing with reaming with recon plate was done in 9 cases,. One patient had implant failure at 7 month where nail removal with reaming with fracture site freshening and exchange nailing with bone graft and plating was done.Then after pain subsided, post-Operative active and passive Knee bending exercises weredone after which patients were allowed partial weight bearing with crutches immediately and from the next post operative daythey were put on knee and hip exercises with weight bearing was allowed as tolerated, after removal of the suction drainage. Sutures were removed on the 14th post op day.

Follow Up

All cases were followed up monthly upto 4 month and then three monthly upto 1 year.Cases started showing signs of healing from eight weeks onwards and the fracture unitedradiologically at the end of 4 months. Union was defined clinically by absence of pain at site and radiologically by the appearance of satisfactory bridging callus across three cortices in two different views.

Results

There were 3 females and seven males in the present study with the mean age of 40 years (range 28–50 years).All cases started showing signs of healing from 8 weeks onwards and the fracture united radiologically at the end of 4 months. Complete clinical and radiological union was achieved in all cases in a mean duration of 7 months (range 3–9 months).No neurovascular complications were noticed after the surgical procedure; one patient developed surgical site infection which required the additional procedure of debridement.In this patient wound healed completely in three weeks.All the patients retained had knee range of motion with flexion upto 130^{0}and extension to 0^0 at final follow up. None of the implants showed a failure on follow-up radiographs.



A **B**

C **D**

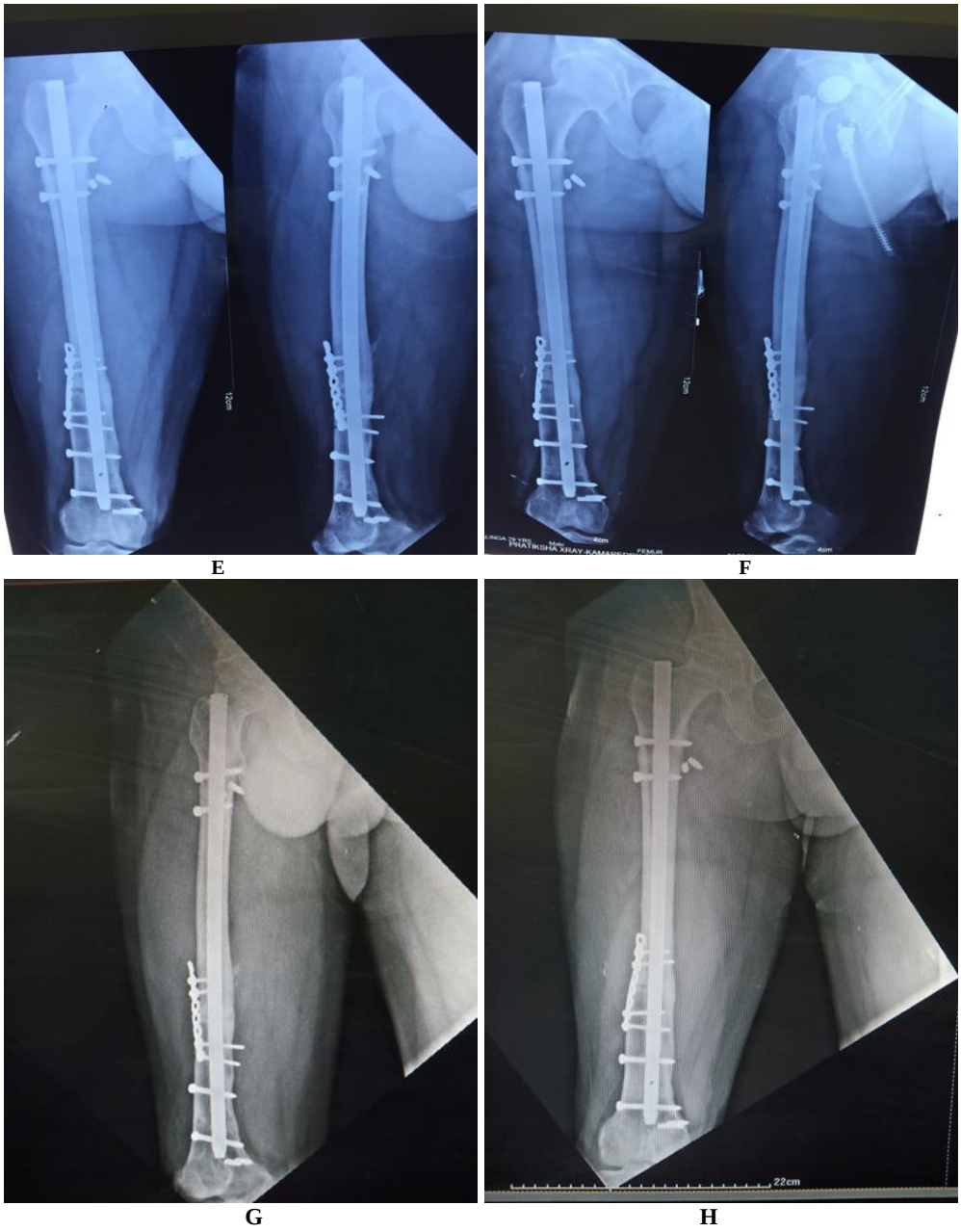


Fig 1: Femoral non-union with implant failure. X-rays at (A)At time of presentation (B) Postop (C & D) At 1 month follow up (E) 3 Month follow up (F)4 Month follow up (G&H)1 Year follow up.

A


23cm

B


23cm

C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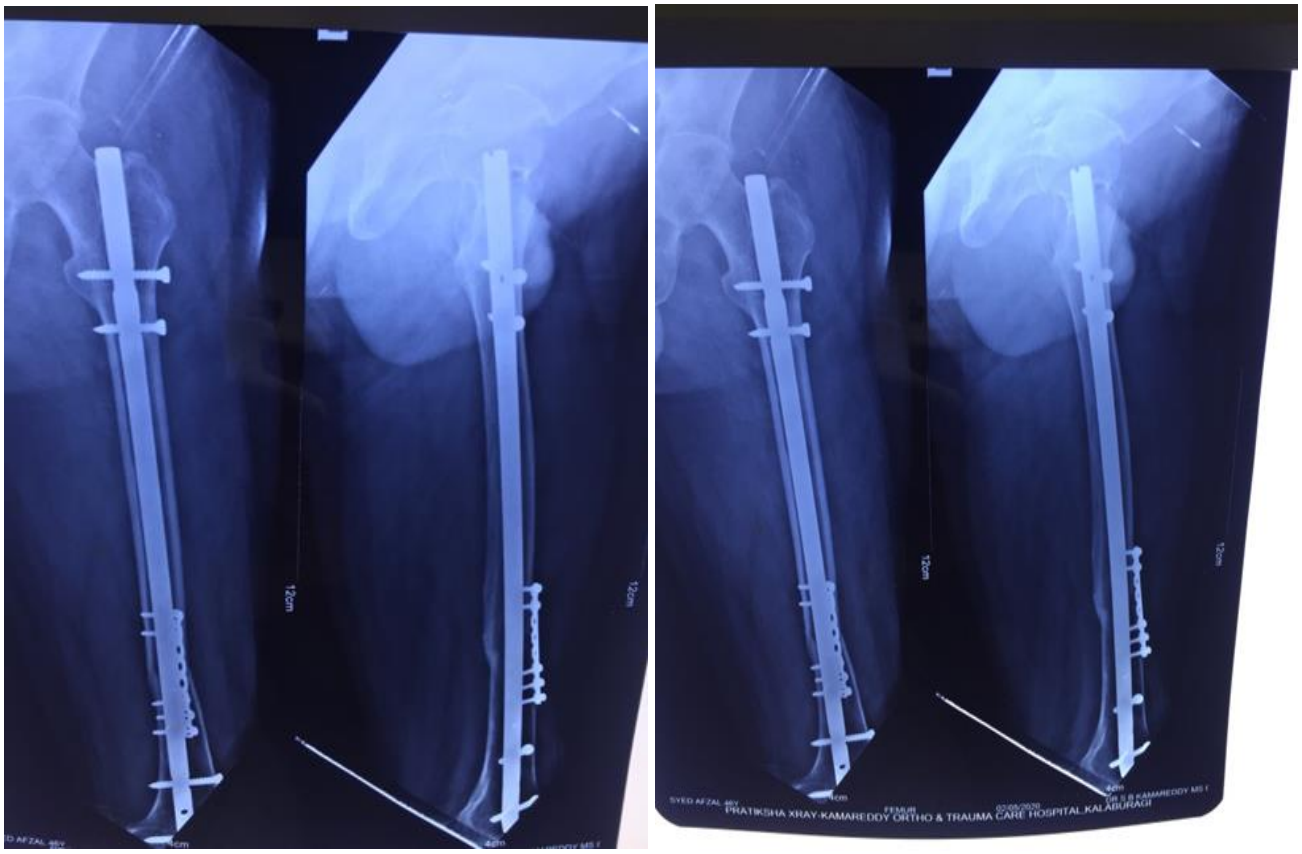
D



E **F**

Fig 2: Femoral non-union. (A) X-rays at time of presentation and (B& C)post-op (D)3 Month follow up (E)6 Month follow up(F)1yr follow up

Discussion

Despite recent developments and advances in surgical techniques, implant designs and adjuncts to healing, femoral non-union following intramedullary nailing are still encountered and continues to pose a clinical challenge and has been a dilemma for orthopaedic surgeons [13-20]. Various biological or mechanical factors such as poor bone quality, comminution, bone loss, soft tissue damage, infection, insufficient mechanical stabilization, multiple surgeries, or smoking may lead to non-union.[21,22]Rotational instability constitutes a major componentwhen we consider the implant related factors. Johnston reported rotational instability of the interlocking intramedullary nailing [23]. Various methods of surgical treatment have been advocated for the treatment of femoral non-union. Exchange nailing is known to be the most acceptable method of treatment for femoral non-union [24]. The thicker nail provides better bending and rotational stability and also the reaming of the canal promotes osteogenesis [25]. Ilizarov's ring fixation after nail removal is also used for non-union of femur shaft fractures with good results [26]. Though Dynamisation is a simple procedure and is more commonly done but the results are unreliable [27].

A concern of combining exchange nailing with plate augmentation was the loss of vascularity of the fracture ends. Cole examined the vascular supply of the femur after intramedullary nailing and showed the whole vascular supply of the femur was restored within 2 weeks after nailing [28]. Our study utilized a biological approach for plate augmentation, with limited soft tissue dissection and periosteal stripping of the fracture ends.

Problems of these ununited fractures can bebroken implants, undersized nail, proximal or distal location of the fractures inthe respective bones or extensive comminution [29]. All these factors lead to loss of rotational control at the fracture site even though axial and translational alignment has been suitably restored. Thereby it becomes paramount to control this rotational instability at fracture site by additional stabilizing mechanism.

Use of augmentation plates over existing nonunion of long bones is been done by few workers. Ueng *et al*. in his study of 17 femoral nonunions showed union of all fractures at 7 months by using augmentation plates. Bone grafting was performed only in seven patients based on oligotrophic nature of nonunions. They used standard AO plates for augmentation. The same authors also showed superior results of the same procedure when used for management of femoral nonunions with broken interlocking nail. Both these studies showed results for nonunions of femoral fractures only [30-31].

All cases showed complete clinical and radiological union at an average of 7 months. Exchange nailing alone has shown variable results in the hands of different researchers.[32-34]This variability may be due to the rotational instability which persisted despite use of a larger diameter nail. Augmentation plating eliminates rotational instability in non-unions following intramedullary nailing ensures rigid immobilization of the fracture ends and along with the intramedullary nail neutralizes the shearing, axial and rotational forces across the fracture. This provides an easy, less extensive and effective solution to a challenging clinical

problem. It is quiet common to find cases of femur shaft non-unions with the nail or its interlocking screws broken. Retaining such implants may not be possible or may jeopardize the stability of the construct. Rigid immobilization with or without bone grafting is the essence of treatment of non-union[35]. Augmentation plating combined with exchange nailing offers the best possible answer to this principle.

Conclusion

Our study concludes that augmentation plating gives excellent mechanical stability and improves the biology for fracture healing and when combined with exchange nailing it has a very high success rate andis a reasonably good, effective and safe procedurefor non-unions following intramedullary nailing of femur shaft fractures.

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