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ORIGINAL STUDY

Plate augmentation combined with bone grafting for aseptic non-union of femoral shaft fractures following interlocking nails

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TThe aim of this study was to evaluate plate augmentation over previously inserted interlocking nails, combined with iliac bone grafting in treating aseptic femoral shaft non-unions. The research was conducted prospectively on 34 patients. A narrow dynamic compression plate was placed while the nail was retained. All the screws were directed posterior to the nail. There were 25 males and 9 females with mean age of 36.6 years old. The mean operative time was 95 minutes with 320ml blood loss. 28 patients showed solid healing by 6 months postoperatively (82%). By 8 months, all patients showed solid union (mean 6.3 months). Full range was regained in both hips and knees and all patients could walk bearing full weight without supportive devices by 8 months. Where non-union occurs over an interlocking nail, augmenting it with a plate and bone grafting appears to be an effective treatment method to obtain solid union.

Keywords : Femoral non-union ; Plate augmentation ; Retained nails.

INTRODUCTION

Fractures involving the femoral shaft occur commonly with high energy trauma such as motor vehicle accidents and falls from height. Antegrade intramedullary nailing following closed reduction is generally performed in such fractures with high fusion rates *(17)*.

However, non-unions have been reported, although uncommon, following such primary management. Risk factors include severity of the initial damage resulting in tissue de-vitalization, improper fracture reduction with distraction at fracture site and small nail size *(3,6,11,15)*.

When aseptic, surgeries are revised via several methods, the most popular being exchange nailing with larger diameter nails. Nails with narrow diameter do not provide rotational stability resulting in non-union. Replacing the nails with plates, bone grafting, dynamisation and plating while retaining the nail as augmentation have all been used in femoral non-unions *(1,5,6,16,18)*.

Plate augmentation with bone grafting over the retained nail is an effective and easy procedure in such situations, although not widely used *(4,12,13)*. The aim of this study was to evaluate the success of this method in treating femoral shaft non-unions following initial closed nailing.

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MATERIALS AND METHODS

In a prospective study, 34 patients with aseptic femoral shaft non-unions following antegrade interlocking nailing were treated via plate augmentation and bone grafting. All patients presented at least 6 months after the initial surgery. No further surgeries had been performed on them following the initial nailing. Non-union was confirmed both clinically, with ongoing pain at the fracture site, and radiologically, with lack of signs of progressive healing. Informed consents were obtained from all the patients. Non-unions after procedures other than nailing, infected non-unions and pathological fractures were excluded from this study. Only patients with isolated unilateral femoral shaft fractures were included. The demographic data, mode of trauma, fracture site and time elapsed between the two surgeries were all recorded.

The original nails were retained in situ to maintain fracture alignment. AO narrow dynamic compression plates (DCP) were placed as posterior as possible on the lateral femoral surface and the screws directed posterior to the retained nail. At least 3 screws were inserted on each side of the fracture site. The plates improved the rotational stability at the fracture site. Cortico-cancellous bone was harvested from the iliac crest and impacted at the fracture site, after being thoroughly cleaned from fibrous tissue and refreshed by drilling and decortication.

Mean operative time and blood loss were noted. Postoperatively, any complications were recorded and treated accordingly. Range of motion exercises for hip and knee were initiated once tolerated by patients. The femora were followed up by plain radiographs for union. Bony bridging across three of the four cortices was considered sign of fracture healing. The patients were followed up for at least a year following surgery with plain radiographs being performed immediately after surgery and at one month interval till 12 months postoperatively.

RESULTS

There were 25 males and 9 females. Their mean age was 36.6 years old (range 17.4- 56.8 years). 29 patients suffered the injury from motor vehicle accidents and 5 from falls from heights. Initially, all fractures were closed with 17 fractures involving the middle third of the femoral shaft, 7 the upper third and 10 the lower third. The mean time elapsed between the two surgeries was 8 months (6-12 months). Thirty two patients were referred to our institute after performing their primary surgery elsewhere. The mean operative time was 95 minutes with 320ml mean blood loss. Motion was observed at the fracture site on exposure in all cases. The motion was totally abolished after plating. No drill bits or tabs were broken during screws insertion.

Twenty eight patients in our study showed radiological evidence of solid healing by 6 months postoperatively (82%). By 8 months, all patients showed solid union on plain radiographs (mean 6.3 months). Full range was regained in both hips and knees and all patients could walk bearing full weight without supportive devices by 8 months. (Figures 1 & 2).

Two patients suffered from superficial wound infection which were treated successfully with antibiotics. Another three suffered from constant pain at graft donor site which resolved spontaneously after 3 to 4 months.

DISCUSSION

With interlocking nails becoming the standard in femoral shaft fractures, non-union rates decreased dramatically. It has been reported to be as low as 2% *(3,15)*. However, when encountered, it represents a severe burden on the patients' function, psychology and also economically.

Exchange nailing with reamed larger diameter nails is the preferred treatment method. Reaming biologically promotes healing and osteogenesis whereas larger nails provide greater mechanical stability. Success rates have been reported to vary from 53% to 100% with exchange nailing *(6,11,15)*.

Interlocking nails might not be the optimum solution in some fractures as their ability to resist rotational forces are limited *(10)*. This is especially true in highly comminuted fractures and distal femoral fractures where the medullary canal is wide, making insertion of snug fit nails at fracture sites impossible. In such cases use of exchange nailing might not be the optimum solution.

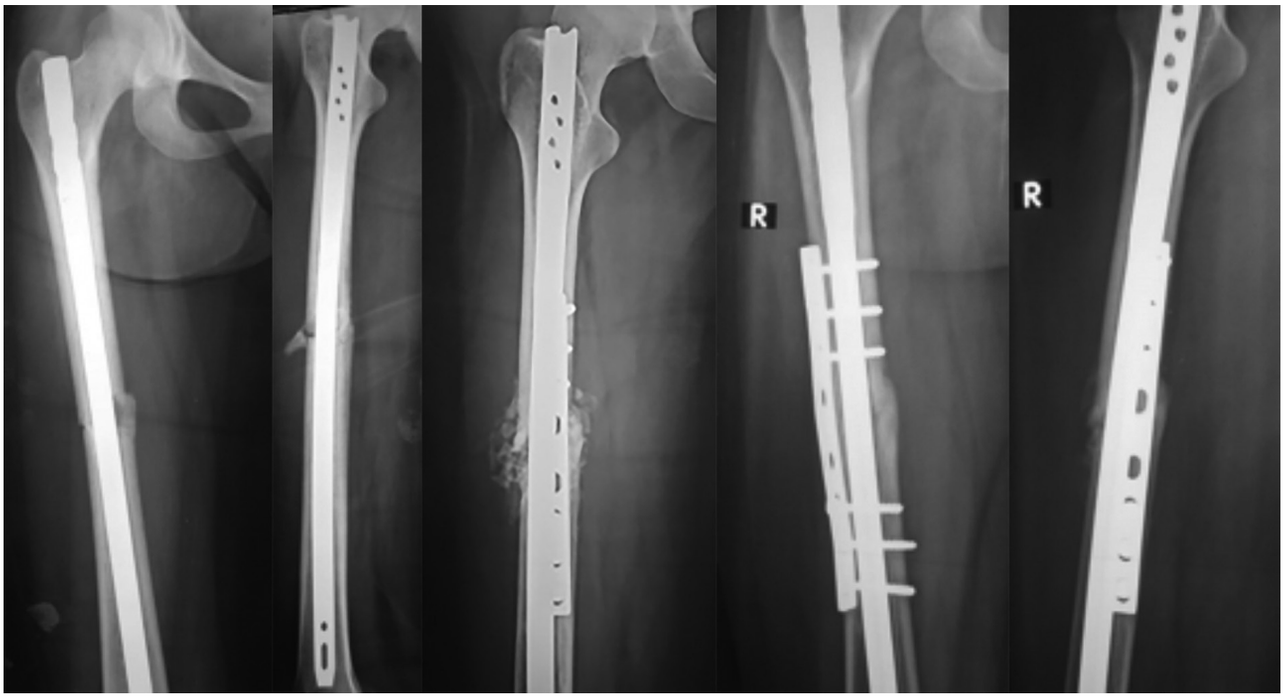

Fig. 1. — A 22 years old male suffered from fracture in mid-shaft femur after a road traffic accident. (A, B) He presented 8 months after an intramedullary nail was inserted with non-union. The original surgeon had inserted the nail without locking it either proximally or distally which we believe contributed to the non-union. (C) Augmentation with a plate for the nail in-situ was done with generous bone grafting. The screws were directed posterior to the retained nail. (D, E) Complete union after 7 months.

As an alternative, plate insertion augmenting the existing nail, combined with bone grafting could be a better option. Plate augmentation has shown to increase bending and torsional stiffness several folds in comparison to nails alone *(10)*. The use of bone grafts with this procedure is recommended in all cases by some *(4,9)*, whereas other recommend it only in selective cases with huge bone defects *(2,13)*. This procedure also carries the added advantage of avoiding radiation exposure to the surgeon and the patients as no image intensifier is required.

In our study, we performed plate augmentation of the nail combined with bone grafting in all cases and we obtained 100% union rates by 8 months postoperative. The average time to union (6.3 months) is similar to the studies conducted by other authors *(4,12,13,14)*. Vohra et al reported on 100% union rate in a series of 55 comminuted fractures at an average of 6.5 months *(14)*. Said et al reported on 100% union at a relatively earlier average of 4.3 months *(12)*.

Additionally, we used an AO narrow DCP for augmentation instead of the usually applied AO broad DCP as in other studies *(4,12,13,14)*, in order to direct all the screws posterior to the retained nail. The prominent linea aspra posteriorly provides adequate bone stock allowing easier application of screws. In addition, the retained nail usually occupies the medullary canal anteriorly due to its bowing. Thus, this technique allowed easier screws insertion obtaining rigid cortical purchase without any drill bit breakage. Drill bits, tab, screw breakage has been reported in 3 cases out of 14 in a study by Said et al where broad DCPs were used *(12)*. Application of narrow DCP also does not seem to compromise the required rotational stability to obtain union, as we could obtain 100% union rate at an average period of 6.3 months.

Augmenting the nail with a plate rather than removing the nail and replacing it allows early controlled weight bearing rather than delaying it till complete union. Leaving the nail in situ also

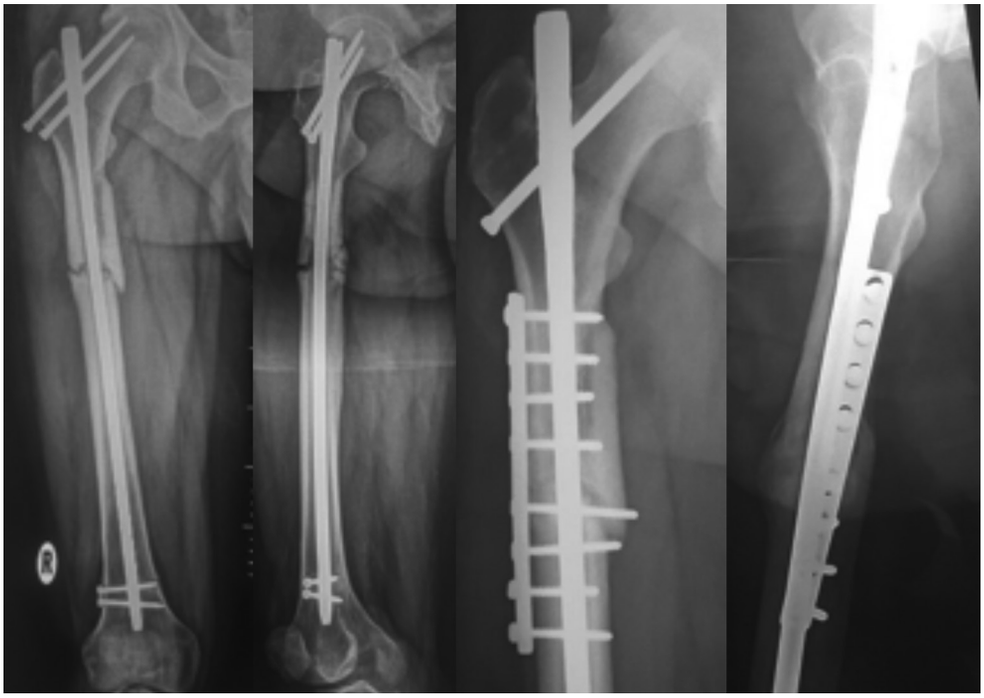

Fig. 2. — (A, B) A male patient 25 years old presented with aseptic femoral nonunion 6 months after a nail was placed. Plate augmentation with iliac bone grafting was performed to treat the nonunion. (C, D) 6 months after the surgery showing solid union.

maintains the fracture alignment. Surgery is also less extensive. It can still be performed without time loss in cases where nail removal is difficult as with broken nails and screws *(12,8)*.

In conclusion, where non-union occurs over an interlocking nail, augmenting it with a plate and bone grafting appears to be an effective treatment method to obtain solid union.

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