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Original Research Article

Combination of exchange nailing augmented with plate and allograft in treating femoral shaft nonunion after intramedullary nailing – Our experience

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ABSTRACT

Introduction: Risk factors for femoral nonunion after intramedullary nailing are open fracture, delay in weight bearing, and tobacco use. The treatment of nonunion with a statically locked intramedullary nail in place is either bone grafting in situ, dynamization of the nail by locking screw removal, or exchange nailing. We combined exchange nailing augmented with plate and bone grafting to study its usefulness in treating femur shaft nonunions after nailing.

Materials and Methods: We did a retrospective study. Cases were collected between Aug 2020-June 2022. 15 patients were collected. They had undergone intramedullary nailing for femur fracture. Infection was ruled out. Mean period for presentation of nonunion - 20 months after primary surgery. Initially old nail was removed. Then we freshened the ends of the nonunion till the ends bled. Then we passed a nail, did distal interlocking and then added a plate. We used a muller device to compress the nonunion, added a bone graft & then finally locked proximally.

Results: All 15 of the patients achieved postoperative bony union uneventfully at a mean time of 22.1 weeks (range, 12–40 weeks). The mean operative time was 105 minutes (range, 60–150 minutes), and the mean blood loss was 340 ml (range, 150–700 ml). All of the patients could walk bearing full weight without pain within 3 months. There were no significant complications such as broken hardware, implant back-out, axial or rotational malalignment, or deep infections.

Conclusion: Exchange nailing with plate and graft augmentation is a good option in treating femur shaft nonunions after open reduction and internal fixation with intramedullary nailing. We used exchange nailing augmented with plate and bone graft and found it to lead to union in 100% cases.

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1. Introduction

Femur is the largest bone in the body. Fractures of the femoral shaft often are the result of high energy trauma and may be associated with multiple injuries.¹ Main goal of treatment is restoration of length, alignment, rotation, and preservation of blood supply and avoiding infection.² There are various modalities for management of femur shaft fractures such as closed reduction and cast immobilization, skeletal traction, intramedullary

nailing, interlocking intramedullary nailing (antegrade or retrograde) and plating. Locked intramedullary nailing is currently considered to be the treatment of choice for most femoral shaft fractures.³ Intramedullary nailing is preferred as plating has higher risk of infection and nonunion.⁴ Risk factors for femoral nonunion after intramedullary nailing are open fracture, fracture in distal third of femur treated with antegrade nailing, delay in weight bearing, and tobacco use.⁵ The treatment of nonunion with a statically locked intramedullary nail in place is either bone grafting in situ, dynamization of the nail by locking bolt removal, or exchange nailing.⁶ We combined exchange

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Table 1: The patient profiles are shown below

S.No.	Age	Sex	Site	Non-Union Time [month]	Solid union time [wk.]	Operation Time [min]	Intraoperative blood loss[ml]	Remark
1	30	M	M/3	18	24	120	190	Kuntscher nail
2	28	F	M/3	22	18	150	250	IM locking nail
3	40	M	L/3	25	22	180	500	IM locking nail
4	33	M	U/3	20	21	125	350	Broken screw
5	25	M	M/3	18	18	122	300	IM locking nail
6	60	M	L/3	19	27	130	250	Distal dynamized
7	32	M	U/3	20	20	140	400	IM locking nail
8	28	M	U/3	22	18	130	300	IM locking nail
9	35	M	M/3	15	18	120	280	Distal dynamized
10	56	F	M/3	16	19	90	250	IM locking nail
11	39	M	M/3	22	15	130	350	Distal dynamized
12	36	F	M/3	23	22	140	300	IM locking nail
13	29	M	L/3	20	18	120	450	IM locking nail
14	33	F	L/3	21	20	100	340	IM locking nail
15	37	F	L/3	20	21	130	320	Failed to unite.

nailing augmented with plate and allografting to study its usefulness in treating femur shaft nonunion after nailing.

2. Materials and Methods

We did a retrospective study. Cases were collected between Aug 2020-June 2022. 15 patients were collected, 10 men and 5 women. They had undergone intramedullary nailing for femur fracture. Fractures which went into nonunion after intramedullary nailing were typically either juxta-articular fractures i.e., either subtrochanteric fracture of femur or fractures in distal third of femur treated with antegrade femoral nailing with only 2 interlocking bolts in distal fragment. Infection was ruled out. Mean period for presentation of nonunion - 20 months after primary surgery. All the patients had uninfected nonunion. 10 patients had undergone intramedullary nailing with proximal and distal bolts locked, 3 had distal dynamized intramedullary nailing, 1 had breakage of proximal bolt of intramedullary nail and 1 had Kuntscher nail. Initially the old nail was removed. Reaming was done. Then we freshened the ends of the nonunion till the ends bled. Then we passed a nail, did distal interlocking with three bolts (two transverse and one anteroposterior) and then added a plate. Plate used was 4.5mm system 8–10-hole DCP contoured for femur. We used a muller device over the plate to compress the nonunion and added an allograft when needed. Minimum 3 screws in plate on either side of fracture were aimed. The nail was finally locked proximally.

2.1. Another patient with femur non-union

3. Results

Table 2: Distribution depending on age

Age in years	Frequency	Percentage
<30	4	26.6
30-50	9	60
>50	2	13.3
Total	15	100

Table 3: Distribution depending on sex

Gender	Frequency	Percentage
Male	10	66.66
Female	5	33.33
Total	15	100

Table 4: Distribution depending on site of nonunion

Site of femur Nonunion	Frequency	Percentage
Upper 1/3	3	20
Middle 1/3	7	46.6
Lower 1/3	5	33.3
Total	15	100

All but one patient achieved postoperative bony union uneventfully at a mean time of 22.1 weeks (range, 12–40 weeks). The mean operative time was 105 minutes (range, 60–150 minutes), and the mean blood loss was 300 ml (range, 150–500 ml). Immediate weight bearing started as tolerated by patient. The 14 patients could walk bearing

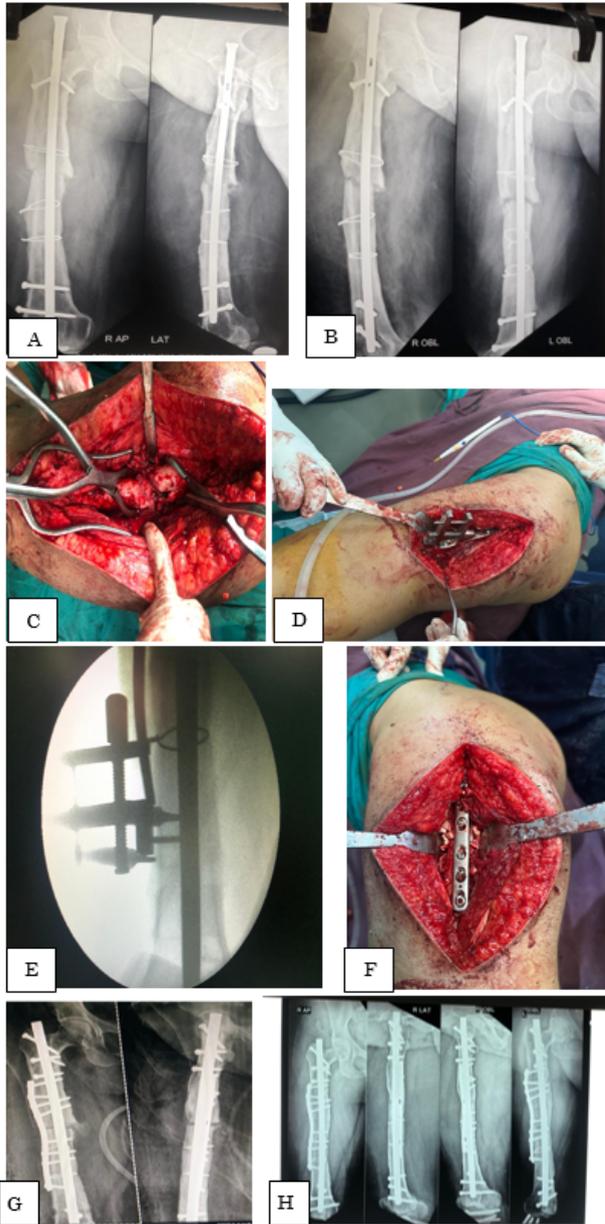


Fig. 1: A, B, C): X-ray AP, LAT, OBLIQUE views on Initial presentation of patient with femur non-union with nail in situ with cerclage wires 18 months after primary surgery; C): Fracture site opened with freshening of edges; D): Mullers device over plate used to achieve compression at fracture site; E – C): Arm image showing compression achieved over fracture site with mullers device; F): After application of derotation plate and Allografts at nonunion; G): Immediate postoperative x-ray; H): X-ray showing full union after 18 months in all views

Nonunion Femur 17-05-19



Fig. 2: Preoperative x-ray

Post-op X-ray 01-06-2019



Fig. 3: Immediate postop

Table 5: Distribution depending on non-union time

Non-union time in months	Frequency	Percentage
10-19	5	33.33
20-30	10	66.66
Total	15	100

full weight without pain within 3 months. There were no significant complications such as broken hardware, implant back-out, axial or rotational malalignment, or deep infections in the successful united patient. One patient did not achieve union after the procedure.

4. Discussion

Achieving union of long bone diaphyseal fractures, away from isthmus of bone, where the medullary cavity is wide, remains a challenge.⁷ This is especially true when

After 1 yr 6 months 08-12-2020

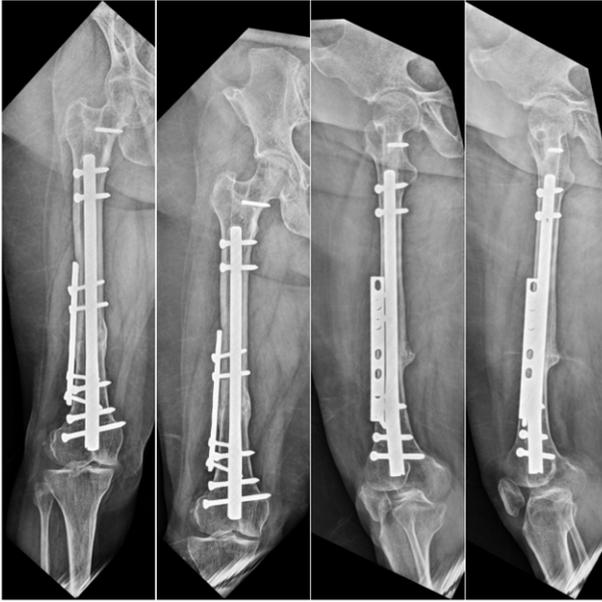
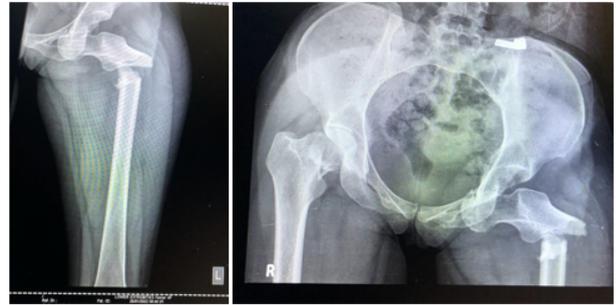


Fig. 4: 18 month follow-up x-ray



Fig. 5: Clinical pictures of patient showing range of motion and scar

treated with intramedullary nailing. Because nailing is a load sharing device and provides only relative stability.⁸ Therefore, not adequate rotational stability is present where medullary canal is wide. On the other hand, plating does provide rigid fixation avoiding rotational instability.⁹ With plating, chances of implant breakage remain an issue as it is a load bearing implant.¹⁰ Both nail and plate alone are inadequate in treating nonunion of juxta articular long bone fractures. Combining plate which provides torsional stability with nail which provides axial and bending stability provides best chance of treating



A. Preoperative x-ray showing subtrochanteric fracture



B. CT Scan of the subtrochanteric fracture



C. X-ray after intramedullary nailing which went into nonunion



D. X-ray after retaining the nail and augmenting with plate and allograft

Fig. 6: One patient presented with subtrochanteric fracture which was treated with intramedullary nail and went into nonunion



Fig. 7: Muller device used for compression

these nonunion. It is well-established that to treat femur non unions one can go for exchange nailing augmented with plating. We combined the above with allograft to ensure union and avoid patient the pain of repeat surgery preventing additional morbidities associated with surgery. We used allograft when there was gap at fracture after nibbling of sclerosed edges of nonunion, and used local hypertrophic cancellous bone when gap was minimal. One should be generous while removing the sclerosed ends as failure to do so would prevent union despite of reaming exchange nailing augmented plating and allografting. We learnt this the hard way which led to one failure to unite in our study. Using Judet's technique (1963), osteoperiosteal flaps were raised. This elevation of cortical chips that remains attached to the periosteum surrounding the non-union site physiologically helped in increasing the decorticated surface area (which acts as multiple fractures and induces bone formation), exposure of vascular subcortical Haversian system, Osteogenic stimulation by inflammation of mechanical origin and acts as 'in situ' vascularized autogenous bone graft. Other similar studies were done by Kre-echam, where they used exchange nailing and augmented plating as a combined procedure in two cases and achieved union in both; Wang et al. where they used thick interlocking nail augmented with plate fixed with unicortical screws only; and Sancheti et al. where they used exchange K-nailing augmented with plating fixed with bicortical screws and autograft. But our study differs from these in that we used interlocking nail and a mullers device to approximate the fracture ends and an allograft.

5. Conclusion

Exchange nailing with plate and graft augmentation is a good option in treating femur shaft nonunion after open reduction and internal fixation with intramedullary nailing. We used exchange nailing augmented with plate and bone graft and found it to lead to union in 93.3% cases.

6. Source of Funding

None.

7. Conflict of Interest

None.

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