



Original Article

Plate augmentation with retention of intramedullary nail is effective for resistant femoral shaft non-union



Raju Vaishya, Amit Kumar Agarwal*, Nishint Gupta, Vipul Vijay

Department of Orthopaedics and Joint Replacement Surgery, Indraprastha Apollo Hospitals, New Delhi 110076, India

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ABSTRACT

Objective: Non-union after intramedullary nail fixation of femur shaft fractures is although infrequent but a challenging condition to treat. The treatment options available to deal with such a situation include exchange nailing, removal of nail and re-osteosynthesis with plating, or Ilizarov fixation. We believe that rotational instability, in the presence of a nail, is one of the main reasons for most of the non-union. We present our experience of plate augmentation leaving the nail in situ for non-union of femoral shaft fracture.

Methods: In this retrospective study, we had operated 16 cases of the femoral shaft non-union, which were treated by plate augmentation and bone grafting (if needed) with retention of the intramedullary interlocking nail in situ. The cases of infected non-union and any fracture less than one-year duration were excluded from the study.

Results: Bone grafting was done only in 4 cases with atrophic non-union. We could achieve union in all the cases at an average time of 6.25 months. The average time of surgery between the primary surgery of interlocking nail fixation and the plate augmentation was 13 months. Mean surgical time for plate augmentation and bone grafting was 71 min. No major complication or implant failure was encountered. An average residual shortening of the limb was 0.9 cm and average range of motion of the knee was 115°.

Conclusion: Plate augmentation seems an effective, reliable, safe and an easy procedure for the treatment of femoral shaft non-union after an intramedullary nailing.

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1. Introduction

The fracture of femoral shaft is a commonly seen injury in Orthopaedic practice and is often caused by high-energy trauma like road traffic accidents (RTA) or sometimes after low energy trauma.¹ The treatment of choice for these fractures is closed intramedullary nailing as they have shown excellent union results.² Non-union after intramedullary nail fixation of femur shaft fractures is although infrequent but quite challenging to treat.³ The treatment options available to deal with such situation include exchange nailing, removal of nail and re-osteosynthesis with plating, or Ilizarov fixation.⁴ An exchange nailing is considered as the most accepted method for the non-union of

femur shaft fractures.⁵ However, the results with this technique are inconsistent.⁶ Also the removal of nail and re-osteosynthesis with the plate constitute a well-known method but requires extensive soft tissue and vascular compromise, which hampers union.⁷ The use of Ilizarov fixation is a cumbersome procedure and is not favoured routinely especially in the thigh, by most surgeons.

We believe that rotational instability, in the presence of a nail, is one of the main reasons for most of the non-union. We present our experience of plate augmentation leaving the nail in situ for non-union of femoral shaft fracture. It is an efficient technique, which provides additional rotational stability at the non-union site, and leaving the nail in situ protects the plate from bending forces. The additional advantages of this technique are that it can be done with minimally invasive technique, allows early rehabilitation of the patient and carries lesser morbidity.

2. Materials and methods

In this retrospective study, we had operated 16 cases of the femoral shaft non-union (Table 1), which were treated by plate

* Corresponding author at: Department of Orthopaedics, Indraprastha Apollo Hospital, Delhi Mathura Road, Sarita Vihar, Delhi 110076, India. Tel.: +91 9968578514.

E-mail addresses: raju.vaishya@gmail.com (R. Vaishya), amitorthopgi@yahoo.co.in (A.K. Agarwal), nishintgupta@gmail.com (N. Gupta), dr_vipulvijay@yahoo.com (V. Vijay).

Table 1
Patient demographics.

Cases	Age in years	Sex	Average blood loss (ml)	Type of non union	Time between 1st and 2nd surgery (months)	Duration of plate augmentation surgery (min)	Average duration of follow up post plate augmentation surgery (months)	Average union time (months)	Complications
1	30	F	150	Hypertrophic	14	60	9	6	Nil
2	28	F	200	Hypertrophic	13	75	9	5	Nil
3	31	M	150	Hypertrophic	12	60	9	6	Nil
4	26	F	120	Hypertrophic	12	55	7	4	Nil
5	47	F	200	Oligotrophic	15	80	10	8	Nil
6	30	F	150	Hypertrophic	14	65	10	6	Nil
7	32	F	180	Hypertrophic	13	65	9	6	Nil
8	40	M	300	Hypertrophic	12	95	9	6	Nil
9	55	F	180	Oligotrophic	13	70	12	8	Nil
10	32	M	120	Hypertrophic	12	60	9	6	Nil
11	42	F	220	Hypertrophic	13	90	10	6	Nil
12	34	F	250	Hypertrophic	13	80	9	6	Nil
13	28	M	150	Oligotrophic	14	70	8	4	Nil
14	50	F	250	Oligotrophic	12	65	15	9	Infection
15	41	M	120	Hypertrophic	14	60	10	7	Nil
16	30	F	150	Hypertrophic	12	70	9	6	Nil

augmentation and bone grafting (only in oligotrophic non union) with retention of the intramedullary interlocking nail in situ. Fourteen out of 16 patients were referred from other centres, whereas two patients were operated primarily in our centre. In 12 cases, a prior dynamisation was done, and in other 4 cases, no procedure was done after the primary surgery. All of these fractures progressed to non-union. We have not selected the patients for dynamization as it should be done in early stages (usually 10–24 weeks). Once the patient presented to us after almost a year we have directly gone for the plate augmentation

process. The patients were assessed clinically and radiologically for the presence of infection, limb length, range of knee motion and status of the union. Only the cases of femoral shaft non-union with an intramedullary nail in situ and minimum duration of 1 year or more from the primary surgery were included in this study. Twelve out of sixteen patients had evidence of hypertrophic non-union (Fig. 1a) while four showed oligotrophic non-union (Fig. 2a). All the patients had blood investigations including complete blood count (CBC), erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP). The cases of infected non-union and any fracture of less than

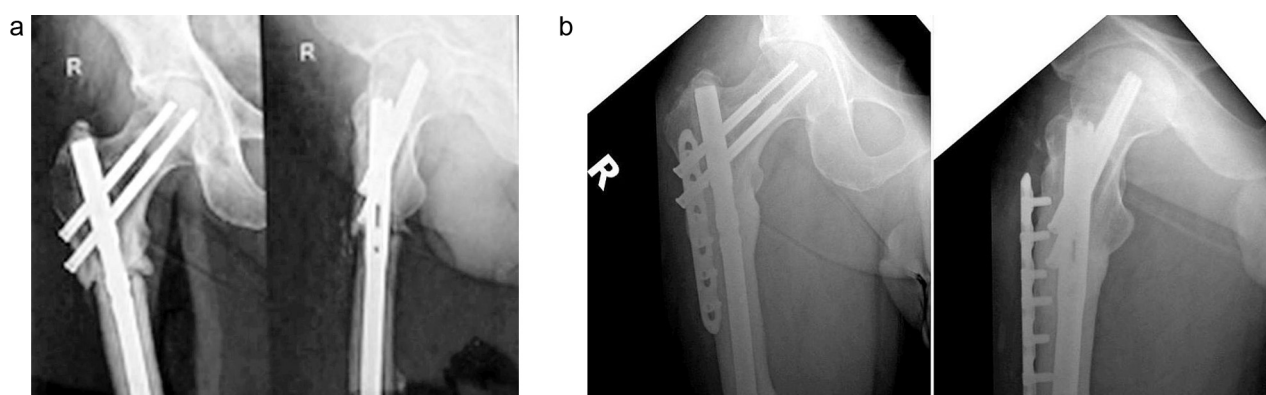


Fig. 1. (a) Radiographs showing anteroposterior (AP) and lateral view of proximal femur hypertrophic non-union with intramedullary nail in situ. (b) Post-operative radiographs AP and lateral view of proximal femur fracture showing solid union of the fracture with augmentation of the plate.

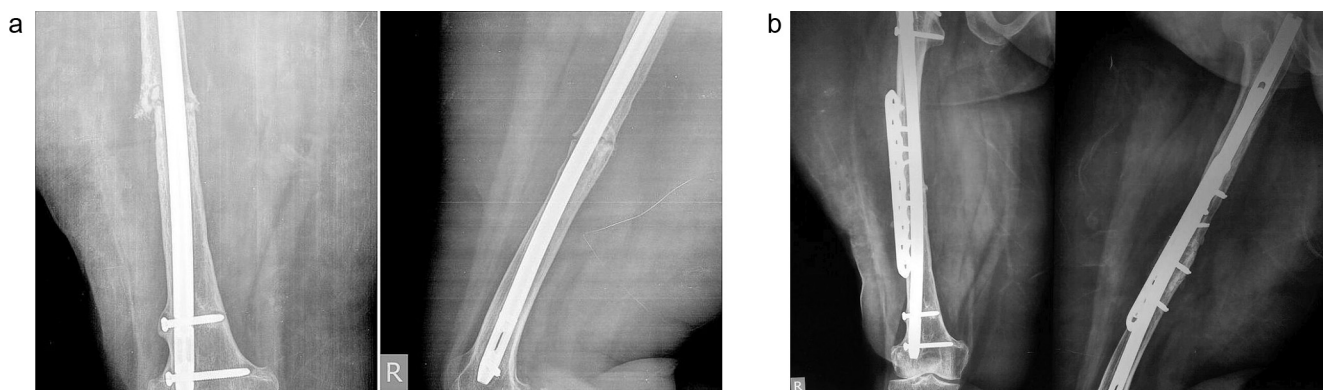


Fig. 2. (a) Radiographs showing AP and lateral view of femur shaft oligotrophic non-union with intramedullary nail in situ. (b) Post-operative radiographs AP and lateral view of femur shaft showing solid union of the fracture with augmentation of the plate and bone grafting.

one-year duration were excluded from the study. All the cases were operated by the senior author (RV), where an augmentation plating was done and retaining the existing intramedullary nail. Bone-grafting was performed in only four patients with atrophic non-union. Postoperatively active and passive range of knee exercises were started on the 2nd postoperative day, after removal of the drain from the surgical site. Early non-weight bearing mobilisation with a walking aid was allowed. The weight bearing was delayed for six weeks. All the patients were followed up clinically and radiologically at regular intervals.

3. Surgical technique

Surgery was performed in lateral decubitus, using a direct lateral approach by splitting the tensor fascia lata and vastus lateralis muscles to reach the non-union site.⁸ Intraoperatively, we noticed rotational instability at the fracture site in all cases. The periosteum was not stripped from the bone to preserve the periosteal blood supply. The fixation of fracture was done with a 6–10 holes, 4.5 mm titanium (locking) low contact dynamic compression plate (LCDCP, SynthesTM), using mostly unicortical screws and wherever possible bicortical screws. Cortico-cancellous bone grafts from ipsilateral iliac crest were harvested simultaneously by another surgical team and used around the fracture site in 4 cases of atrophic non-union. The knee was mobilised immediately in post operative period and no splintage was used.

4. Results

There were 11 females and five males in the present study with the average age of 36 years (range 26–55 years). The average time of surgery between the primary surgery of interlocking nail fixation and the plate augmentation was 13 months (range 12–15 months). Mean surgical time for plate augmentation and bone grafting was 71 min (range 55–95 min). The average blood loss during the surgery was around 180 ml (range 120–300 ml). 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. The average duration of follow-up was 9.62 months (range 7–15 months). We could

achieve union in all cases (Figs. 1b and 2b) with an average time to radiographic union of 6.25 months (range 4–9 months). An average residual shortening of the limb was 0.9 cm (range 0.5–2.0 cm) and average range of motion of the knee was 115° (range 100–135°). None of the implants showed a failure on follow-up radiographs.

5. Discussion

The use of intramedullary interlocking nail for the femoral shaft fractures has shown excellent results in the literature. However, the critical situation arises, when these fractures fail to unite with intramedullary nails. The known causes of failure include comminuted fracture pattern or significant displacement of fragments and mechanical factors (like small diameter of the nail, insufficient locking) and malalignment of fragments.⁹ In the present study, we found that rotational instability at the fracture site and comminution of fracture were the leading causes of non-union.

Various methods of surgical treatment have been advocated for the treatment of femoral non-union. They are associated with various advantages and disadvantages (Table 2). Exchange nailing is known to be the most acceptable method of treatment for femoral non-union.¹⁰ The thicker nail provides better bending and rotational stability and also the reaming of the canal promotes osteogenesis.¹¹ However the results of the union after exchange nailing vary significantly in the literature, and high failure rate has been reported.¹² Also, the exchange nailing in comminuted and distal femur fractures is not advised as the nail does not provide adequate stability in the wide distal fragment.¹³ Ilizarov's ring fixation after nail removal is also described for non-union of femur shaft fractures with good results.¹⁴ However it is a troublesome and time-consuming procedure for the patient and is associated with several complications namely pin tract infection, malrotation, etc. Thus, Ilizarov fixation is not a routinely performed surgery in aseptic femur fracture non-union. Dynamisation is more routinely done as it is a simple procedure. However, the results are unreliable. Also, it may lead to further instability of the fragment.¹⁵ Removal of nail and reduction of the fragments followed by fixation by conventional plate requires a long incision, extensive approach with significant soft tissue and vascular compromise; also, it delays the rehabilitation of the patient as the removal of nail causes increased bending force on the plate which may lead to

Table 2
Comparison of pros and cons between different surgical techniques of fracture shaft femur non-union.

Technique	Pros	Cons
Exchange nailing	<ul style="list-style-type: none"> • Stable fixation • Reaming promotes osteogenesis • Early rehabilitation • Less blood loss 	<ul style="list-style-type: none"> • Inconsistent results • Do not provide adequate stability in distal femur non unions. • Radiation exposure
Plate reosteosynthesis	<ul style="list-style-type: none"> • Proper reduction of fragments • Allow rigid fixation • Bicortical purchase of all the screws 	<ul style="list-style-type: none"> • Longer incision • Extensive approach • Significant soft tissue and vascular compromise • Delayed rehabilitation
Dynamisation	<ul style="list-style-type: none"> • Easy day care procedure. • Low cost. 	<ul style="list-style-type: none"> • Poor, unreliable results • Predispose to shortening
Ilizarov fixation	<ul style="list-style-type: none"> • Provides stable fixation • Allow early weight bearing 	<ul style="list-style-type: none"> • Complications such as pin tract infection and malrotation are commonly seen. • Long learning curve • Cumbersome for the patient
Plate augmentation	<ul style="list-style-type: none"> • Provides additional rotational stability especially in distal femoral non union • Nail in situ prevents bending load on the plate • Minimal incision • Does not require extensive approach • Lesser blood loss • Early rehabilitation 	<ul style="list-style-type: none"> • Very few screws with bicortical purchase • Does not allow correction of deformity with presence of intact nail

failure of plate, thus the weight bearing has to be protected. Plate augmentation is equally effective for proximal, middle and distal third femoral fractures. We have used locking plate, as it gives good purchase even with unicortical screws.

We agree with Choi and Kim¹⁶ that plate augmentation allows additional rotational stability at the fracture site, where the plate holds the fragments in place thus preventing their macro motion. The advantage of leaving the nail in situ is that it helps in neutralising the bending forces on the plate and maintaining alignment of the fracture fragments. Furthermore, plate augmentation can be performed with a minimal incision and it does not require an extensive surgical approach to the bone, as does the conventional plate technique. The blood loss during the surgery is also less. We believe that the post-operative rehabilitation time is significantly reduced in plate augmentation because of the additional support of the nail in situ.

In the present study, we could achieve bony union in all the 16 cases with no significant complication and no implant failure. Very few studies have been done on plate augmentation with a nail in situ, and they have shown results comparable to the present study.^{17–21} We believe that plate augmentation in the non-union femoral shaft fractures leaving the nail in situ is a useful and easy technique to adopt with good results and is associated with only minimal complications. Bone grafting is only required, in addition, in fractures with atrophic type of non-union.

Conflicts of interest

The authors have none to declare.

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