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Research Article

# Plate augmentation of fracture nonunion with ILN *in situ*- A retrospective observational study

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**Statistics**

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Abstract

Background: Fracture shaft femur is common orthopedic trauma. The most preferred method of treatment for fracture femur is interlocking nail as it has many advantages, but it also has one uncommon disadvantage of non-union which may be due to many reasons. We present our experience of plate augmentation leaving the nail *in situ* for nonunion of femoral shaft fracture. It is an efficient technique, which provides rotational stability and protects the plate from bending forces.

Methods: This retrospective observational study was conducted in the department of orthopedics at SMS hospital. 16 Cases of femoral shaft nonunion with an intramedullary nail *in situ* were included in this study. All the patients were followed up clinically and radiologically at 1 month, 3 months and 6 months postoperatively.

Result: All patients of non-union included in study achieve union with full range of motion. Patients can start walking without support after 3 months and radiologically union can be seen after 6 months.

Conclusion: Plate augmentation in nonunion femur shaft fracture with ILN *in situ* is effective treatment which has many advantages over other available methods.

Keywords: Non-union fracture femur; plate augmentation; ILN *in situ*

## INTRODUCTION

Femoral shaft fractures are frequent injuries in orthopedics trauma, often caused by either high-energy trauma such as road traffic accidents, or low-energy trauma such as fractures in the elderly due to osteoporosis [1]. Gold standard treatment for Femoral shaft fractures is Interlocked Intramedullary Nailing (IMN) with good results of union [2]. Non-union after intramedullary nail fixation of femur shaft fractures is although uncommon but quite challenging to treat [3]. Cause of non-union may depend on various factors like mechanical factors (such as insufficient stability due to small nail size, rotational instability, improper locking, comminuted fracture or mal aligned fracture reduction) and biological factors (such as the severe soft tissue damage, open fractures, large displacement of fragments, fragments interposition, smoking, diabetes, neuropathies, alcoholism, corticosteroids, malnutrition, or previous radiotherapy) [4].

The treatment options available to deal with such a situation include exchange nailing, removal of nails and re-osteosynthesis with plating, or Ilizarov fixation [5]. The most accepted method for the non-union of femur shaft fractures is exchange nailing in which previously *in situ* nail is exchanged by bigger size nail [6]. However, the results of this technique are inconsistent [7]. Another method is previous nail removal and rigid fixation done with plate constitutes a well-known method but it may cause extensive soft tissue damage and periosteal stripping which may cause vascular compromise and may hamper union [8]. The use of Ilizarov fixation is a cumbersome procedure and is not favored routinely, especially. in the thigh, by most surgeons.

However, instability at the fracture site and shear stress seems to be a major risk factor of non-union. The main treatment goals to achieve union in these cases are the restoration of stability and maintaining the alignment in fractures. We present our experience of plate augmentation leaving the nail *in situ* for nonunion of femoral shaft fracture as this method can provide 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 a minimally invasive technique, allows early rehabilitation of the patient, and carries lesser morbidity. One major advantage to this technique is that surgical exposure of the fracture site will permit the surgeon to remove the fibrous tissue and freshen the fracture ends as a stimulus for healing, there is also an opportunity for direct bone grafting at the surgeon's choice.

## MATERIAL AND METHOD

This retrospective observational study was conducted in the department of orthopedics at SMS Medical College and Attaching Hospital Jaipur, all the 16 patients who have undergone plate augmentation with interlocking intramedullary nail *in situ* in fracture shaft of femur nonunion from august 2021 to august 2022 were enrolled in our study. Cases of femoral shaft nonunion with an intramedullary nail *in situ* and a minimum duration of 1 year or longer after the primary surgery were included in this study. Cases with any sign of infection were excluded from the study which was diagnosed by preoperative blood investigation (ESR, CRP, blood counts) or clinically (through discharging sinuses, swelling, etc). All the cases were operated with an augmentation with a plate retaining the existing intramedullary nail. Bone grafting was performed in 11 patients with atrophic/oligotrophic non-union. In 8 cases, a prior dynamization was already done and in other 8 cases, no procedure was done before it was presented to us. All of these fractures progressed to non-union which was confirmed clinically and radiologically. We have not selected the patients for dynamization as it should be done in the early stages (usually 10 weeks–24 weeks). Once the patient presented to us after one year or more, we went directly for the plate augmentation process. Patients were assessed clinically (range of knee motion, and status of the union), radiologically, and blood investigations were done to detect any presence of infection. Postoperatively active and passive range of knee exercises were started on the 2nd day after the procedure. The weight bearing was delayed for six weeks. Weight bearing mobilization with the support of walking aids was allowed after six weeks. All the patients were followed up clinically and radiologically at 1 month, 3 months and 6 months postoperatively.

### SURGICAL TECHNIQUE

Surgery was performed in the supine position, using a direct lateral approach by splitting the tensor fascia lata and vastus lateralis muscles to reach the non-union site [9]. The periosteum was not stripped from the bone to preserve the periosteal blood supply. The fixation of fracture was done with 6 holes–10 holes, 4.5 mm Low Contact Dynamic Compression Plate (LCDCP), using mostly unicortical screws and wherever possible bicortical screws. Cortico-cancellous bone grafts from the ipsilateral iliac crest were harvested and used around the fracture site in cases of oligotrophic/atrophic non-union. Bone petaling was also done in oligotrophic/atrophic cases. The knee was mobilized immediately in the postoperative period and no splintage was used.

## RESULTS

A total of 16 patients were included in the study (Table 1). Most of them 93.8% (15/16) were male and the rest 6.3% (1/16) were female. The position of fracture was distal femur in almost half (56.3%, 9/16) of cases, and the rest (43.7%, 7/16) patients had mid-shaft fractures. The majority of the patients (68.8%, 11/16) patients had an oligotrophic/atrophic type of non-union, and bone grafting was done in all patients with oligotrophic/atrophic non-union, while rest (31.3%, 5/16) patients were with a hypertrophic non-union. Half of the patients had treatment with a dynamization process before coming to us and another half of the patients had not gone for any dynamization process.

The mean time interval of the union on X-ray was 6.56 months with a standard deviation of 0.81 and the mean time interval of full weight bearing without support was 3.38 months with a standard deviation of 0.62.

The mean time taken in surgery was 60.63 minutes ± 15.59 minutes with an average blood loss during each surgery was 206.25 ml ± 68 ml. All patients had almost full range (i.e 0° to 130°) of motion as previously when compared to the contralateral limb. And none of the patients had any complications, with only one exception, who had a superficial infection of the skin immediately after a few days of surgery which was treated with dressings and antibiotics, and resolved completely.

## DISCUSSION

The most common treatment modality for femoral fracture is Intramedullary Interlocking Nail which shows excellent results and has many advantages like short hospital stay, less exposure or damage to soft tissue and early weight bearing. But trouble arises when the shaft of femur fracture treated with an interlocking nail fails to unite. Diaphyseal nonunion in the femur is estimated to occur in 4.6%-8% of patients after intramedullary nailing of a closed fracture, while an even much higher risk in an open fracture [10]. Among closed femur fractures, known causes of nonunion are comminuted fracture patterns or significant displacement of fragments or mechanical factors like small diameter of nails, insufficient locking, and mal-alignment of fragments or a combination of more than one cause. In our study, the lead cause of nonunion in the distal femur was rotational instability, and in midshaft fracture, it was a comminuted fracture or fracture gap. There are many modalities available for the treatment of fracture nonunion like exchange nailing, dynamization, plate osteo synthesis, and Ilizarov fixation.

From all these options available, an exchange nail is a very popular and most accepted method for the treatment of fracture nonunion. All these methods have their advantages and disadvantages for the treatment of fractures of long bones.

The dynamization method is a short procedure but a very unreliable method and it can only be done before 24 weeks. This method is not helpful when the cause of non- union is rotational instability. The popular exchange nail procedure provides good stability against bending force on using bigger size nails and also increases osteogenesis on reaming. But this method does not provide stability in fracture at the junction of

**Table 1.** Disposition of subjects

| Parameter | Number of cases |
|---|---|
| Total no. of cases | 16 |
| Males | 15 |
| Females | 1 |
| **Position of fracture** | |
| Mid shaft | 7 |
| Distal femur | 9 |
| **Type of non-union** | |
| Oligotrophic | 8 |
| Atrophic | 3 |
| Hypertrophic | 5 |
| **If dynamization done** | |
| Yes | 8 |
| No | 8 |
| **Time interval between two surgeries (Months)** | |
| 10 months | 4 ( dynamization done at 8 weeks) |
| 11 months | 4 ( dynamization at 12 weeks) |
| 12 months | 3 |
| 13 months | 1 |
| 14 months | 2 |
| 15 months | 1 |
| 16 months | 1 |
| **Time taken in surgery (minutes)** | |
| 40 min-50 min | 9 |
| 51 min-60 min | 3 |
| >60 min | 4 |
| **Average blood loss during surgery (ml)** | |
| 120 ml-200 ml | 13 |
| >200 ml | 3 |
| **Bone graft done** | |
| Yes | 11 |
| No | 5 |
| **Time interval of full weight bearing without support (Months)** | |
| 3 months | 11 |
| 4 months | 4 |
| 5 months | 1 |
| **Time interval of union on x-ray (Months)** | |
| 5 months | 1 |
| 6 months | 7 |
| 7 months | 5 |
| 8 months | 3 |
| **Complications** | |
| none | |
| **Range of motion** | |
| full | 17 |
| Partial | 1 |

isthmus and distal femur where size of isthmus is smaller than the distal part, and rotational stability is the main cause of nonunion. And, also exchanging nails is not a good modality in nonunion due to comminuted fractures. The plate osteo synthesis method is another method after removal of previous nails, it provides rigid fixation at fracture site and inhibits macro motions at fracture site which in turn helps in the union but it has its disadvantages like long exposure and extensive soft tissue loss and blood loss. This method also requires long rehabilitation as the bending force on plate is large which delays weight bearing and mobilization, which is unsatisfactory for patients in second surgery.

**Fig. 1.** Men standing with support at 1.5 month

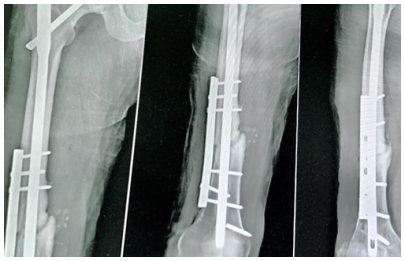

**Fig. 2.** X-ray at 3 month

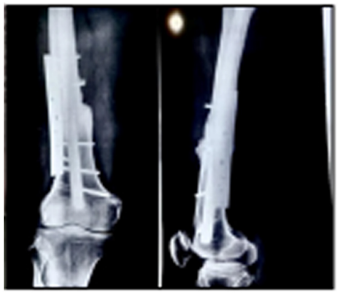

**Fig. 3.** X-Ray at six months

The third option is Ilizarov fixation which helps in early weight bearing and mobilization can be allowed but it is a very time-consuming procedure with many other complications like pin track infection, and also many surgeons are not comfortable or experienced with pin insertion at thigh due to large muscle mass at thigh.

In the present study, we found a method of augmenting non-union sites with plating with nails in *situ* which had overcome the disadvantages of other methods. As it requires less exposure, less soft tissue damage, and decreases blood loss. Due to nail in situ bending force on the plate is also less and hence early weight bearing mobilization and rehabilitation. It also stabilizes fracture sites so can be used in distal femur fracture non-union and comminuted fracture nonunion.

In our study, we achieved bony union in all 16 cases within 6 months on X-ray (Figure 1), and weight bearing at 3 months without support with no other significant complication and implant failure (Figure 2). Also all patients have a complete range of motion (0° to 130°) and can do squatting and sitting cross leg. Bone grafting and petaling may be required in some of the cases with an atrophic or oligotrophic type of non-union (Figure 3).

## CONCLUSION

Plate augmentation in patients of non-union of femur fracture shaft with the nail in *situ* showed an overall higher union rate which required less soft tissue dissection and less blood loss and also with an advantage of early weight bearing and early mobilization. This method of treatment is most helpful in non-union cases where rotational instability and comminution is the main factor of non-union.

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