

## Original Research Article

# Efficacy of proximal femoral nail augmentation in unstable intertrochanteric fracture

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### ABSTRACT

**Background:** To assess the short term functional and radiological outcome of unstable intertrochanteric fracture fixation using proximal femoral nail with augmentation using Cannulated Cancellous (CC) screw or Stainless Steel (SS) wiring.

**Methods:** A prospective study was conducted with 20 cases of unstable intertrochanteric femoral fractures from May 2017 to March 2019. Six females and fourteen male patients in the age group between 40 and 80 years were included in this study. There were 8 cases of AO31A2 and 12 cases of AO31 A3. Fracture were fixed by proximal femoral nail with augmentation by an additional CC screw or encirclage with SS wires to strengthen the lateral trochanteric wall.

**Results:** Fracture union was achieved in all cases with a mean period of 15.4 weeks. Patients were followed up for a period of 6 months. At the end of follow up the Modified Harris Hip Score was found to be more than 90 % in 16 cases.

**Conclusion:** Augmentation of proximal femoral nail in unstable intertrochanteric fracture with additional screw or cerclage wire increases the efficacy and stability of construct, aiding union and expedition of time to union.

**Keywords:** Proximal femoral nail, Augmentation, Unstable intertrochanteric fracture

### INTRODUCTION

Per trochanteric hip fractures still are a major orthopedic challenge, and those that are unstable have the poorest prognosis. Fracture collapse is one of the postoperative complications reported in association with these fractures. Despite high union rate, the functional outcome still tends to be disappointing.<sup>1,2</sup> Recently the use of the posteromedial fracture fragment as the benchmark of fracture stability is being questioned.<sup>3,4</sup> Further it has been suggested that it is the integrity of the lateral trochanteric wall after the fracture reduction that ultimately determines fracture stability and avoidance of excessive collapse which commonly happens. Intact lateral wall plays a key role in stabilization of unstable trochanteric fracture by

providing a lateral buttress for proximal fragment and its deficiency leads to excessive collapse and various mal positioning. It is likely a combination of the posteromedial cortex and lateral trochanteric wall that is important in fracture stability because modern fixation devices allow fracture impaction in both in lateral and an axial direction. The treating surgeons must recognize the potential for excessive fracture displacement with axial loading in both of these directions and adjust treatment accordingly. Dynamic hip screw with trochanteric buttress plate stabilizes the inter trochanteric fracture addressing the lateral wall, but we have to open the Fracture site which causes significant blood loss.<sup>6</sup>

Unstable trochanteric fracture are best treated with an intramedullary implant and it has become a popular method of stabilization.<sup>7,8</sup> Benefits of intramedullary nails over side-plate device include improved biomechanics (short lever arm), decreased blood loss, smaller incision and decreased femoral neck shortening. Biomechanically it is a better choice of implant for fixation of unstable fracture as nail itself gives support to posteromedial wall and resists excessive collapse.<sup>9,10</sup> Still there are some pitfalls as implant failure does occur in proximal femoral nail due to specific imbalanced biomechanical force acting around hip joint. A complication of the proximal femoral nail surgery is implant failure, which can be due to the back-out of screw, cut out of implant through bone, “Z” effect and “reverse Z” effect, or breakage of implant.<sup>11</sup> There are many options to treat these injuries are available to the surgeon, from the sliding hip screw, intramedullary nails to primary arthroplasty. Proximal femoral nails have now been accepted as the better modality of treatment for unstable trochanteric fractures. However, the reconstruction of the lateral wall and posteromedial buttress remains an unanswered question in these fractures. Methods of fixation like trochanteric stabilization plates and proximal femoral locking plates have been used with limited success. Thus, augmentation of proximal femoral nail fixation with screws or cerclage wires possibly aids at reducing the reoperation rates by reducing the failure rates. Hence, we have taken up this study to know the efficacy of augmenting the proximal femoral nail with screws or wires. Considering the fact that these fractures take up to 6 months to unite in some cases, we have chosen to evaluate it by 6 months. In our study we have used cerclage wire and lag screws to augment the fixation of the proximal femoral nail for unstable fractures, by evaluating radio logically and functionally.

The objective of our study is to see efficacy of augmentation of Proximal Femoral Nail with Cannulated Cancellous (CC) screw or Stainless Steel (SS) wire to support the lateral wall and prevent complications.

## METHODS

It is a prospective study done from May 2017 to March 2019 includes 20 patients of unstable intertrochanteric fracture aged between 40 to 80 (mean 60) years who were operated for unstable intertrochanteric fracture with augmentation at Department of Orthopedics , Bangalore Medical college and Research Institute , Bengaluru. Out of 20 patients 14 were males and 6 were females. 8 had right side and 12 had left side unstable intertrochanteric fracture. The AO/ OTA (Arbeit gemeinschaft für Osteosynthesefragen Orthopedic Trauma Association) classification was used to classify the fractures. The implants used were Proximal Femoral Nail, (180 and 250 mm length, with 8 mm & 6 mm lag screws and 4.9 mm locking bolt). Augmentation with 4 mm locking screws or 18 gauge SS wires. Functional outcome asses by using Modified Harris Hip Score.<sup>12</sup> Ethical approval taken from

the Bangalore Medical College and Research Institute. Stata 14 (statistical tool) was used for statistical analysis.

### *Inclusion criteria*

Age above 18 years. Willingness and written informed consent of the patient to participate in the study. All type 2 and 3 unstable intertrochanteric fractures as per AO/OTA classification.

### *Exclusion criteria*

Patients not willing for proposed procedure. All patients with stable intertrochanteric fracture. Pathological fracture. Stroke and hemiplegic patients. Patients not willing to give informed consent

### *Surgery and postoperative management*

Proximal femoral nail, (nail length:180 mm for A2 fractures, 250 mm and long PFN for A3 fractures) having a proximal diameter of 15 mm with 8 mm compression and 6.4 mm de-rotation screw, was used. The nail has a 6 degree Medio-lateral angle for easy insertion and tapered distal tip to avoid stress generation. The nail has 4.9mm distal locking option.

Average delay from time of injury to fixation was 3 days (range of 2-12 days), which was mostly due to the delay in reporting to the hospital. After the patient was selected for surgery as per the criteria, appropriate anesthesia was administered, and the patient was placed in a supine position over the traction table. Fracture was reduced by closed means in most of the case. Few cases required limited open reduction to achieve anatomical or near anatomical reduction. A 5 cm skin incision was initially made from tip of greater trochanter, and an entry point was made on the medial part of tip of the greater trochanter; a guide wire was passed with help of T-handle through the medial part of the tip of greater trochanter distally by confirming with C arm images. It was followed by trochanteric reaming over the guide wire. After deciding on the appropriate nail , Implantation of PFN was done in the standard fashion with proper placement of screw keeping the Tip- Apex Distance (TAD) within 20 mm .In a reverse oblique fracture, the lateral wall was stabilized by introducing CC screw at the lower pole of trochanter. The decision to add a circumferential wire was often made in spiral or oblique fracture. Long PFN was used in case of highly unstable fracture with metaphyseal extension of fracture line and osteoporotic bone. Dynamic and Static locking was done as per the fracture pattern after the reduction. Intraoperative details like operative time, blood loss and number of blood units transfused were recorded.

### *Stainless steel wire application*

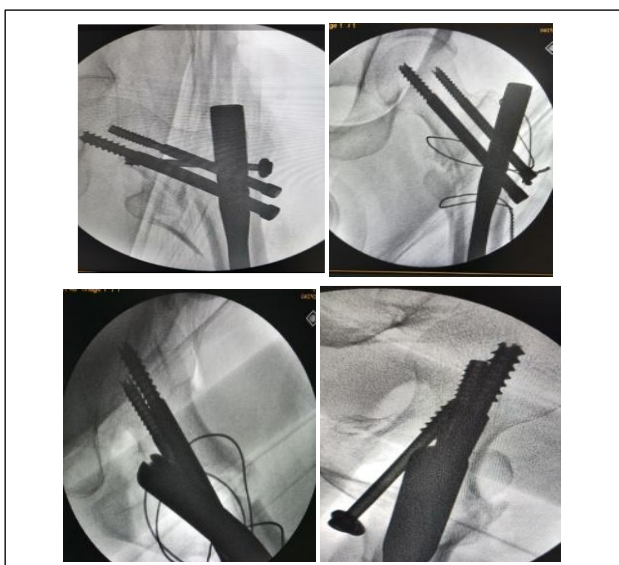
After extending the incision over the trochanteric region, on the lateral side of the thigh, a cerclage wire (stainless steel (SS) wire) is passed using a wire passing instrument

holding the broken lateral fragment to the main part of the trochanter. The two ends of the wire which project in the wound are held and tensioned. The excess wire is cut and the knot bent and tapped inside the wound.

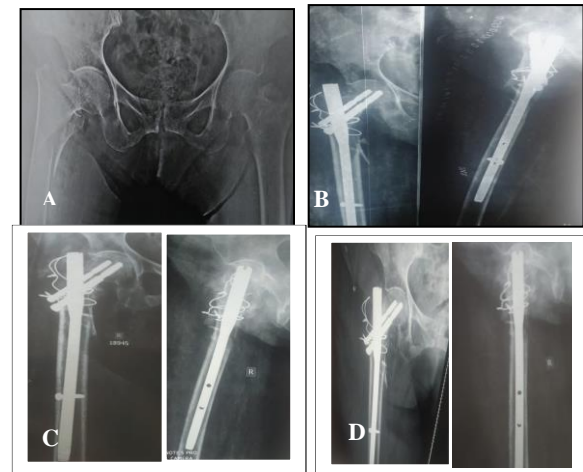
**Cannulated cancellous screw application**

Fractures with coronal split of the greater trochanter were augmented with this technique using cannulated cancellous (CC) screw under C-arm guidance, the proper entry point of the screw is determined, and a stab incision is made on the antero-lateral aspect of the thigh. Using a 3.2 mm drill bit with sleeve, a hole is drilled in the greater trochanter with desired direction. A 4 mm CC screw with washer is then passed in an antero-posterior direction after measuring the length required. The length and position are again verified under C-arm. The surgical procedure completed with appropriate wound closure and dressing.

Post operatively the patients were encouraged to sit in bed and perform static exercises with the affected limb on the next day of operation. An X-ray examination was performed on the second postoperative day. At around 14 day postoperatively the stitches were removed. Touch down weight bearing with the help of a walker or crutches begun 2 to 3 weeks' time after the surgery as per the geometry of fracture and stability of fixation. One month after the surgery, progressive weight bearing was encouraged as tolerated. Full weight bearing was encouraged 8 to 12 weeks after surgery, based on the evidence of stability of construct and callus formation on radiographs. Patients were followed up clinically and radiologically at regular interval to look for progress of union and possible complications. All patients were followed up for a period of 6 months. Clinical outcome was rated as per Modified Harris Hip score at the time of final follow up.<sup>12</sup>



**Figure 1: Intra operative anteroposterior and lateral C arm images of stainless-steel wire and cannulated cancellous screw application.**



**Figure 2: 78-year-old Female. (A) Pre-Operative X-ray: the initial preoperative radiographs. (B) Post-operative radiographs. (C) 3 months and 6 months follow up radiographs.**

**RESULTS**

The follow up period of our study was 6 months. Postoperative X-ray examination showed anatomical and acceptable reduction. Clinico-radiological consolidation of the fracture was observed in all 20 cases at an average of 15.4 weeks.



**Figure 3: 62-year-old-male, (A) Pre-operative x-ray: the initial preoperative radiographs. (B) post-operative radiographs. (C) 3 months and 6 months follow up radiographs.**

Mean age distribution was found to be 53.3 year. In our study male were more commonly involved. Majority of the patients were males (14) and only 6 were females. Majority of the patients had left side of hip involvement (12) and other (8) patients had right side of hip involvement. Majority of the patients had history of trivial

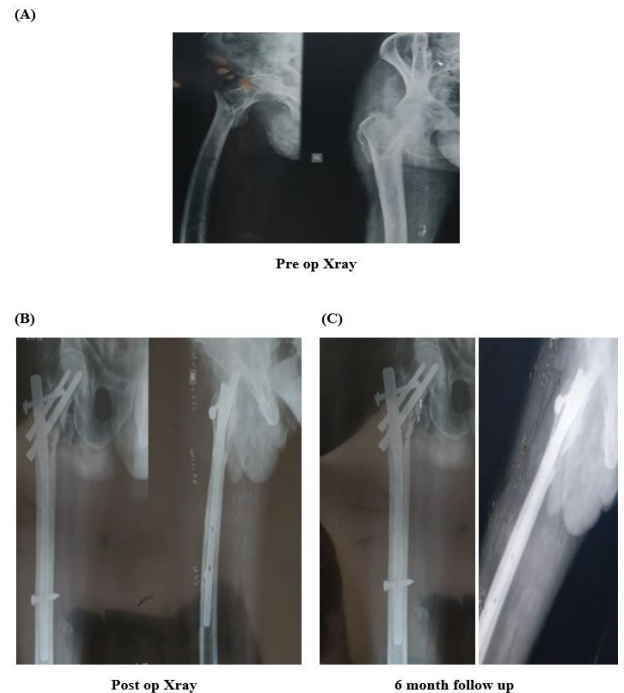
fall (TF) (10), followed by road traffic accident (RTA) (8) and fall from height (FFH) (2).

Mean length of incision was found to be 8.2. Mean Radiological Union Score for Hip was 25.5. Mean time of union was 15.4 weeks. Mean Post-Operative walking was 3 days. Mean days taken to return normal activity was 56.4. No case of nonunion or implant breakage was observed. Delayed union was found in two cases, two case of Varus malunion was encountered, in one case shortening of >1 cm was found. Functional results were determined by Modified Harris Hip Score calculated at the interval of 6 weeks, 3 months and 6 months follow up. At the end of follow up Modified Harris Hip Score was found to be more than 90.

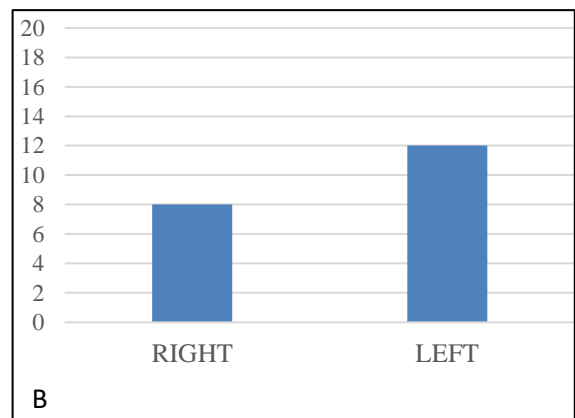
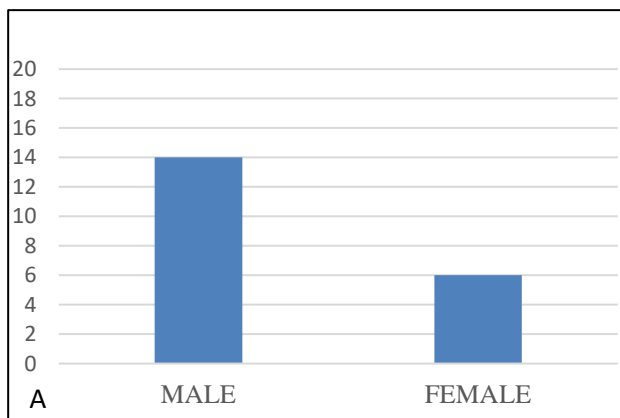


**Figure 4: 58-year-old-male. (A) Pre-operative x-ray: the initial preoperative radiographs. (B) 3 Month follow up radiographs. (C) 6 months follow up radiographs.**

In the total of 20 cases, augmentation with SS wire was done in 11 cases and 9 cases CC screws were used as a augmentation method. Mean duration of surgery was 71.3 minutes (45-90) in all the patients. We had a greater operating time in the beginning which reduced greatly in the later part of the study. Mean intraoperative blood loss was 90 ml (60-120 ml). Blood loss was counted approximately by counting 50 ml/mop used

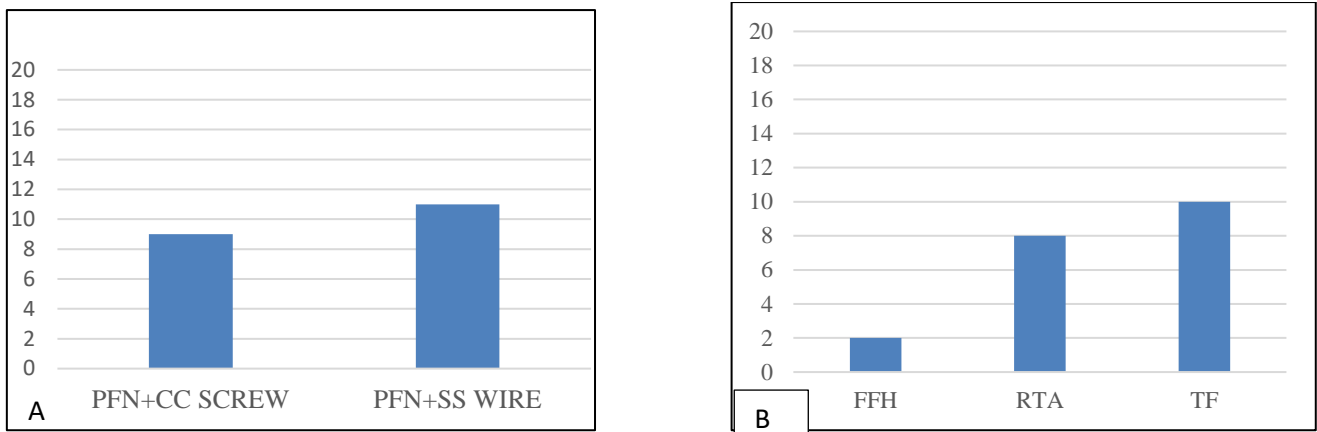


**Figure 5: 60 year-oldFemale. (A) The initial preoperative radiographs. (B) Post-operative radiographs(C) 6 months follow up radiographs.**

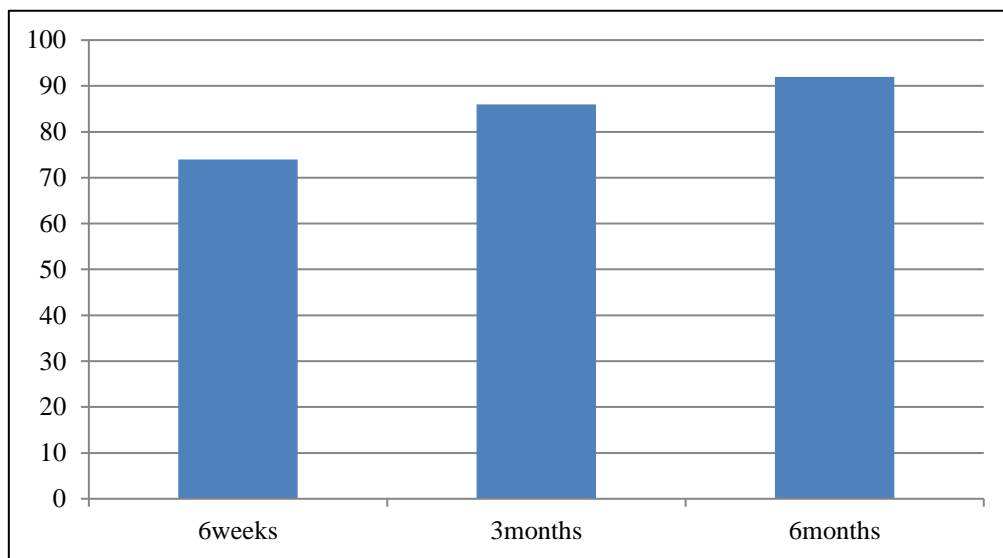


**Figure 6: (A) Gender distribution. (B) Side distribution.**





**Figure 7: (A) Showing Method of augmentation (PFN + CC Screw = Proximal Femoral Nail augmentation with Cannulated Cancellous Screw & PFN + SS wire = Proximal Femoral Nail augmentation with Stainless Steel wire). (B) Showing Mode of injury (FFH = Fall from Height, RTA = Road Traffic Accident, TF= Trivial Fall).**



**Figure 8: Bar diagram showing improvement in modified Harris hip score at an interval of 6 weeks, 3 months and 6 months**

## DISCUSSION

Intertrochanteric fractures are common in Geriatric population owing to osteoporosis and in younger people because of high energy trauma. Dynamic Hip Screw is considered gold standard for treating stable intertrochanteric fracture, but excessive collapse with shortening and high failure rates are a matter of concern when used in unstable intertrochanteric fracture. In unstable intertrochanteric fractures, intramedullary devices have an advantage of load sharing function with smaller bending moments allowing early weight bearing and preventing excessive collapse.

For unstable intertrochanteric fractures, intramedullary implants generally present biomechanical advantages over their extramedullary counterparts and numerous studies have demonstrated satisfactory result following the use of such implants.<sup>13,14</sup> The PFN was devised by the AO/ASIF

(Arbeitsgemeinschaft für Osteosynthesefragen) / (Association of the Study of Internal Fixation) group in 1996 with two proximal screws including an antirotation screw with the aim of increasing the stability of the fracture fixation. However, important complications include lateral protrusion of screw, screw breakage, cut through of screw, Z or reverse Z effect and fracture of lateral intertrochanteric wall.<sup>14</sup>

Traditionally the medial and posteromedial fracture fragment have been considered to be important element in determining the severity and instability of intertrochanteric hip fracture.<sup>15</sup> However, preoperative or intraoperative fracture of the lateral femoral wall in addition to posteromedial void increases the instability and is an important predictor for reoperation in Dynamic Hip Screw. Recent workers stated that the lateral femoral wall was found to be the main predictor for a reoperation after an intertrochanteric fracture.<sup>16,17</sup>

Fagognolo et al. showed a complication rate of about 23.4% with the use of Proximal Femoral Nail for treatment of unstable fracture.<sup>18</sup> In another study done by Uzun et al. non-union was seen in 5.7%, secondary Varus collapse in 25.7% cut out of proximal screw in 5.7% and reoperation in 14.3% cases.<sup>19</sup>

Gadegone et al. in their study observed that 5 patients had lateral screw migration, 1 patient had Z effect, 1 patient had breakage of interlocking bolt.<sup>20</sup> No case of nonunion or implant breakage was observed. 3 of the patients complained of persistent pain in the hip region because of impingement of the proximal screw which was scheduled for hardware removal and no limb length discrepancy was observed in any of our cases with anatomical reduction.<sup>20</sup>

The proximal femoral nail compensates for a posteromedial defect acting as a buttress to prevent medialization but fails to provide stability on the lateral side if the lateral wall is compromised. All cases of implant failure show Varus collapse invariably as the lateral wall fails to provide enough support to the implant. Hence restoration of the lateral wall is of paramount importance to prevent Varus collapse and further complications. In unstable intertrochanteric fractures, the integrity of the lateral femoral wall can be restored with augmentation of PFN with an additional screw or cerclage wire to prevent complication. In our series, complications are fewer when compared to the technical and mechanical complication described in the literature. We thus observe that augmentation has a positive impact on functional outcome of the patient apart from early radiological union. However, the limitations of the study are short term follow up, small sample size, unknown biomechanical principle of augmentation.

## CONCLUSION

Augmentation of Proximal Femoral Nail with Cannulated Cancellous or Stainless-Steel wire is useful technique in the treatment of unstable trochanteric femoral fracture ensuring significant reduction in excessive collapse and subsequently reduced limb length discrepancy. It creates a biomechanically stable construct allowing reconstruction of the lateral wall to maintain adequate lever arm and abductor strength thus allowing for early radiological union. Superior overall functional and radiological outcome in patient with unstable intertrochanteric fracture does indicate that the combination of Proximal Femoral Nail with augmentation is likely to be a better option in the management of these fracture as compared to Proximal Femoral Nail alone. However, the limitations of the study are short term follow up, small sample size, unknown biomechanical principal of augmentation, and lack of a control group for comparison. These are some drawbacks which need to be addressed in order to throw more light upon the concept of lateral wall augmentation.

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*Ethical approval: The study was approved by the institutional ethics committee*

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