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ORIGINAL ARTICLE

Augmented Proximal Femoral Nail in Unstable Intertrochanteric Fracture Femur

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Abstract

Background: ***Trochanteric femur fractures are extracapsular fractures of the proximal femur, often treated with proximal femoral nails. Augments like screws, washers, cement, cerclage, plates, and screws can add stability, high pull-out strength, and reduce healing time and weight-bearing.***

Aim of the work: ***To document and assess the subjective and objective outcomes of various types of augmentation with proximal femoral nails in unstable intertrochanteric fractures.***

Patients and methods: ***We conduct prospective research on 20 cases with isolated intertrochanteric femur fractures. We divided the patients into three groups according to augmentation procedure: Group One consists of 6 patients treated by cerclage augmentation, Group Two of 7 patients treated with cement augmentation, and Group Three of 7 patients treated with gamma nail augmentation.***

Results: ***The mean age was 51.9±15.7 years; most were males, 13 and 7 were females. Most of our patients were right-handed 17, and only three were left-handed. Most of our patients suffered from swelling 15 patients and nine patients suffered from deformity, five patients suffered from other injuries, three patients suffered from skin changes, and at least one was in a neurovascular state.***

conclusion: ***Intramedullary fixation utilizing PFNA nails with augmentation represents a viable and secure therapeutic alternative for intertrochanteric fractures of the femur that cannot be repaired by closed anatomical reduction.***

Keywords: Proximal Femur; Femoral Nail; Intertochanteric Fracture Femur, Augmention

1. Introduction

Intertrochanteric femur fractures are extracapsular fractures of the proximal femur at the greater and lesser trochanter level, most commonly seen after falling to the ground in the elderly population.[1] Intertrochanteric hip fractures account for 42 % of all hip fractures, with a female: male ratio between 3:1.[2,3] Patient presented by pain, shortening, externally rotated lower extremity.[3] That may occur in the elderly with low-energy falls in osteoporotic patients or in young patients with high-energy trauma or a fall from height. [4]

Implants in this area often experience complications and must endure a long period of healing following a fracture and early weight bearing.[5] The powerful muscles deform the fracture and make reduction difficult; therefore, specially developed implants that can endure considerable muscular forces for extended healing periods are necessary for this condition.[6] The present standard of care for unstable intertrochanteric fractures combines conservative measures and surgical correction. If the trochanteric fracture is unstable, the best course of therapy is internal fixation, which includes techniques like gamma nails, dynamic hip screws (DHS), and proximal femoral nail augmentation (PFNA) to stabilize the bone and possible anatomic reduction. [7]

Proximal femoral nail is one of the standard methods of clinical treatment of unstable trochanteric fracture, and we may use augmentation as a screw, screw with washer, cement, cerclage, plate and screws to add more stable construct and high pull-out strength also to decrease fracture healing and weight-bearing duration.[7,8]

This research aimed to document and assess the subjective and objective outcomes of different types of augmentation with proximal femoral nails in unstable intertrochanteric fractures.

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2. Patients and methods

This was prospective research on 20 cases with isolated intertrochanteric femur fractures. The participants were collected from the emergency department ER and outpatient clinic OPC of Al-Hussein University Hospital. The study was started on 1 January 2022 and ended on 30 August 2022.

Inclusion criteria: Every patient who appears with trochanteric femoral fractures confirmed clinically and by radiography, elderly age groups (40-70 years), and both genders (male and female) were included in the study. Patients with modes of trauma, including low and high-energy power injury, were also included in the study.

Exclusion criteria: Patients who refused to participate, with pathological fracture, with poor mental and general condition, with unstable pelvic fracture or with open fractures were excluded from the study.

Preoperative management

The history taking included personal data and history. In addition to assessing the condition of the skin, which may have been affected by trauma, deformity, or swelling, the examination also encompassed the neurovascular system. The radiological assessment included a plain X-ray and CT scan. Laboratory testing included CBC, coagulation profile, INR, liver and renal function tests, blood glucose level, ECG, and echocardiography.

Classification of unstable trochanteric fracture

Stability is the most commonly used and reliable classification of two types: The posteromedial cortex is stable and resistant to medial compressive loads. Unstable fractures may collapse into varus or shaft, leading to comminuted or transtrochanteric fractures. Postoperative lateral wall thickness <20.5 mm suggests a risk of fracture. Treatment should be cephalomedullary nail—supine, on a traction tablet or in a lateral position. Closed reduction is usually achieved by Pulling in the direction of the long axis of the leg to distract the fragments and regain length. Adjust the internal rotation of the femoral shaft until the patella faces forward on an AP view of the knee joint. Open reduction: If percutaneous reduction fails, use a limited open reduction through a lateral approach. Enlarge the lateral incision as necessary, splitting the fascia lata along its length and retracting the vastus lateralis anteriorly and medially. Direct visualization of the anterior fracture is mandatory.

Assessment of reduction quality

I am imaging anterior-posterior and lateral imaging on the guide of the c-arm. Identify gaps or increased density due to overlapping of fragments. Follow the medial cortical line on the AP view and the anterior cortical line on the axial view. Identify any translational or angular malalignment. Acceptable reduction quality shows the following patterns: No gap or increased density visible along the fracture line in the AP view, Continuous medial cortical line, and no varus angulation. In the lateral view: Anteversion approximately 15°, Continuous anterior cortical line

The method of augmentation chosen depends on the type of fragment of the lateral femur wall fragment.

Operative procedures

The procedure involves a surgical procedure to insert a lag screw into the femoral shaft. The thread of the lag screw must terminate within the trabecular bone structures for sufficient purchase. Distal locking is essential for stability, and the surgeon determines the dynamic or static distal locking. A leg holder should support the patient while the uninjured limb is supine on the fracture table. The surgeon should also adduct and slightly flex the injured hip to facilitate nail penetration. For a closed reduction, the leg's long axis should be drawn inward to deflect fragments, lengthen the femoral shaft, and modify its internal rotation. The optimal neck-shaft angle is determined using an AP view of the uninjured hip. The procedure involves making an incision on the skin, locating the entry point, inserting the nail, opening the femur, reaming the medullary canal, insertion of the nail, guide-wire insertion, blade insertion, lag-screw insertion, and insertion of an end cap. The surgeon should ensure that the lag screw is positioned parallel to the neck's axis and that the blade and inserter are connected.

Methods of augmentations

Methods of augmentations are cement augmentation of intertrochanteric fractures, gamma nail (GN) augmentation of intertrochanteric fractures and cerclage augmentation of proximal femur fractures. This study aimed to limit cement fixation to the femoral head in patients with osteopenia-related fractures. However, only one union failure occurred, and limb deformity complications were developed in one case. Applying bone cement (Polymethylmethacrylate, PMMA) could reduce cutout complications and reoperations. Biomechanically, PFNA blade augmentation has shown benefits in preventing reoperations by strengthening the osteosynthesis construct and resisting symptomatic implant migration. There is a low risk of adverse biological side effects, such as pressure-induced avascular necrosis.

Radiological assessment: The study analyzed the radiological assessment of patients with fractures, including union, implant failure, and fixation failure. It found that 19 patients showed adequate fracture union in the first follow-up, with only one patient with the delayed union in the cement augmentation group that healed later. All patients healed without deformity, and 19 patients

healed without fixation failure. The key is to identify unstable fracture patterns and use specific implant designs for their management.

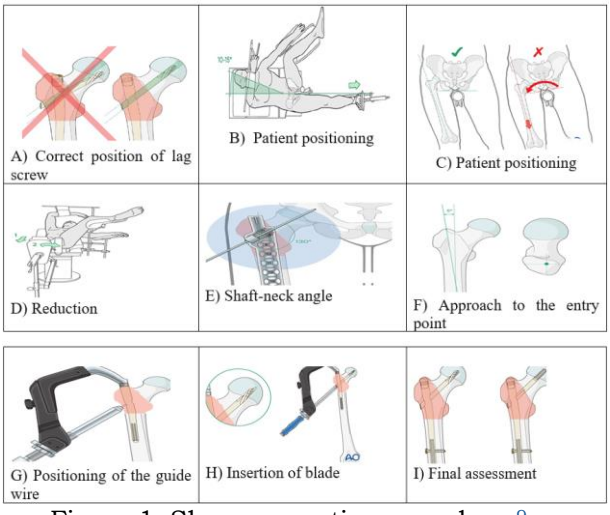

Figure 1. Shows operative procedure [9]

3. Results

We divided the patients in to 3 groups according to augmentation procedure: Group one consists of 6 patients treated by cerclage augmentation. Group two of 7 patients treated with cement augmentation. Group three of 7 patients treated with gamma nail augmentation. (Figure 2)

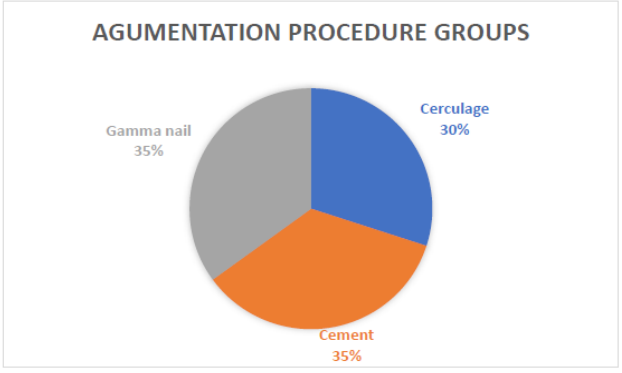

Figure 2. Augmentation procedure groups

19 patients showed adequate fracture union in first follow up and there was only one patient with delayed union in group two cement augmentation group that healed later one (Figure 3)

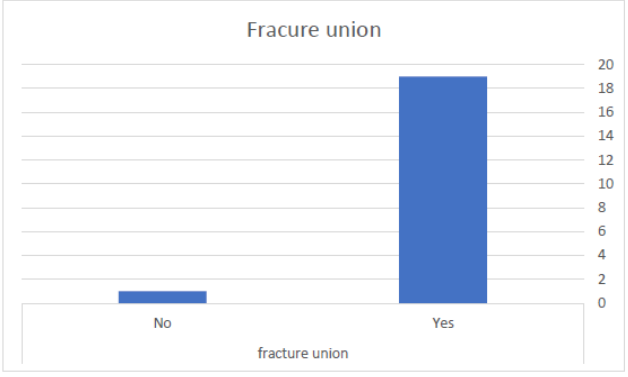

Figure 3. Fracture union

18 patients healed without deformity and two patietns suffered from deformity one in cement group and other in cerculag group (Figure 4).

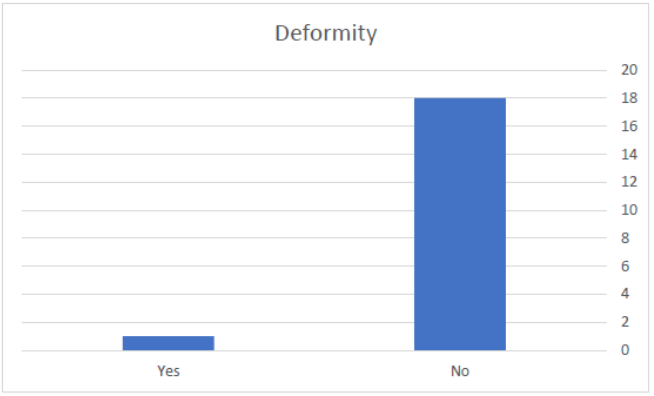

Figure 4. Deformity

19 patients healed without fixation failure and only one patient in gamma nail augmentation group suffered from fixation failure (Figure 5).

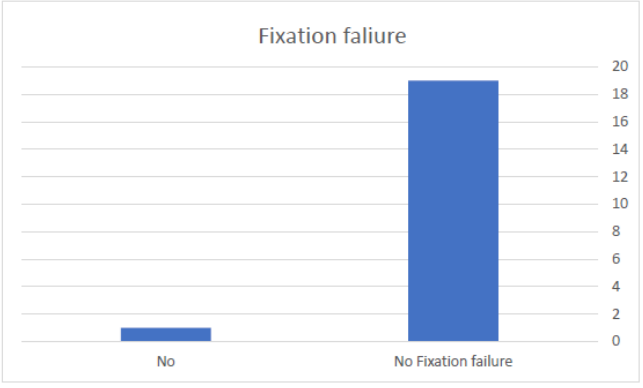

Figure 5. Fixation failure

19 patients showed adequate fracture union in first follow up and there is only one patient with delayed union in cement augmentation group that healed later one. (Figure 6).

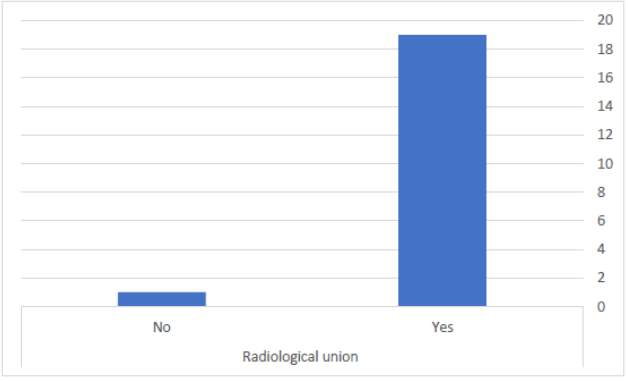

Figure 6. Radiological union

CASE PRESENTATION

Case No. 1

55 years old female had a fall injury. She presented to the emergency department on the same day of injury with a short and externally rotated lower extremity.

Treatment: Intermedullary short rod and screw fixation with cerclage augmentation

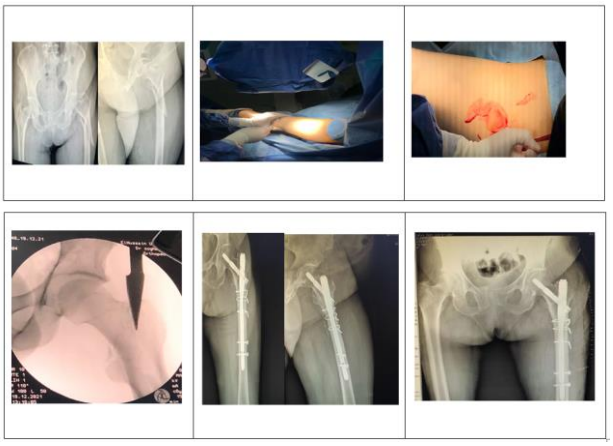

Figure 7. Shows case 1 Postoperative X-rays 2

4. Discussion

Trochanteric femur fractures, often seen in elderly patients, can be treated with stable fixation to reduce morbidity and mortality.[10,11] Various implants have been designed to strengthen the stability of fracture fixation, aiming for early mobilization and reduced morbidity.[12]

Regarding the demography, our study included 20 (7 females and 13 males), the mean age of whom was 51.9±15.7, who met the inclusion criteria they were operated upon using.

Matching with our results, in Khare et al.'s research, the patient's mean age was 57.7 years.[13] Against our results, in the research of Mohamed et al., females comprised nearly two-thirds of the patients. This proportion of females is comparable to that observed.[10]

According to the mechanism of trauma, we found that nine patients suffered from trauma due to falls and 11 patients due to direct trauma.

Our research discovered that there is no statistically significant variance among the two groups concerning age, sex, mode of trauma, and fracture side.

Comparing our results to Mohammed et al., Always present in cases of intertrochanteric fractures is a history in younger people, a high-energy trauma or a fall from a great height is the most frequent reason for intertrochanteric fractures.[10]

In our study, 19 patients showed adequate fracture union in the first follow, and there was only one patient with the delayed union in group two, the cement augmentation group, that healed later. We found that 18 patients healed without deformity, and two patients suffered from deformity, one in the cement group and the other in the circular group. All patients were healed without any shortening deformity. We found that 19 patients healed without fixation failure, and only one patient in the gamma nail augmentation group suffered from fixation failure.

In our study, 19 patients showed adequate fracture union in the first follow-up, and only one patient with the delayed union in the cement augmentation group healed later.

Domingo et al. discovered that the surgical method is easy and that the number of documented problems was acceptable in their research of 295 patients with unstable intertrochanteric fractures who were handled with the PFN.[11]

The study found that cement augmentation caused union failure, and one patient developed a limb deformity. Cement retention was inconsistent, and sliding devices were often converted to rigid nail devices.

When contrasting our findings with those of Kulachote et al., we observed that the augmented group achieved a considerably higher success rate (48 per cent) in Proximal Femoral Nail antirotation (RPAL) than the control group (29 per cent); these findings were consistent with those observed in prior research about hip fractures. The potential rationale for the elevated RPAL in the augmented group could be attributed to the enhanced mechanical stability of the fixation construct by cement augmentation, particularly in the severely osteoporotic bone. This improvement led to a notable reduction of pain throughout weight-bearing ambulation following surgery, facilitating an early return to functional activities.[14]

Among the postoperative complications investigated by Mohammed et al., there was no statistically significant distinction between the two groups concerning DVT, infection, implant failure, or non-union; nevertheless, there was a statistically significant distinction concerning union time (months).[10]

The study explores the impact of the cerclage on stability in subtrochanteric fractures, focusing on its ability to reduce proximal and distal fragments. It suggests improved reduction may reduce complication rates, as improper reduction can lead to more frequent failures. The study also highlights the importance of correct reduction and stable fixation for bone union and functional outcomes.

The PFNA blade can compact cortical bone, and its enhanced angular and rotational stability enables it to withstand both varus and rotational collapse of the cranium. Consequently, PFNA, a modified minimally invasive implant technique employed to secure internal fixation in elderly patients, has gained widespread acceptance in contemporary orthopaedic trauma treatment. Over time, numerous modifications to the intramedullary device design have been suggested, culminating in the introduction of PFNA.

Due to advancements in implant design, the use of PFNA to repair both stable and unstable intertrochanteric fractures has increased dramatically in recent years among emergent young orthopaedic surgeons.

Following contrasting PFNA with DHS in research involving 80 patients, Muzzafar et al. found no statistically significant distinction in the functional result. This line of inquiry confirms our previous results.[9]

In this research, no patients with PFNA experienced implant failure at 12 months. Any method's advocates would do well to consider the patient's clinical status in addition to the X-ray pattern of the fracture. Patients at high risk who require prolonged anaesthesia may benefit from this implant, as several studies have shown that the PFN group experiences reduced blood loss and shorter surgery times.

The key to accurately determining the nail insertion location and the procedure's effectiveness in our study was reducing the fracture anatomically, which was achieved by a small incision and wire application.

This anatomical decrease also improves load distribution among the implant and bone. The surgical fixation was made more stable and less prone to difficulties by utilizing wire to support the lateral wall, decreasing the width of the medullary canal and making the bone implant structure more robust. Our minimally invasive method reduced the risk of problems correlated with fracture union while conserving the original hematoma and maintaining the healing capacity of the fracture, both of which are crucial in the healing process.

This procedure has a minimal risk of fracture healing issues, and the results are excellent. Implant failure is a major factor in potential problems following PFNA surgery.

One patient was found to have developed a deformity in our case series. Our minimal cutout complications were a result of the significance we attributed to the lag screw's placement (exact middle location of the femoral neck in the lateral image and closeness of 10 mm to the articular cartilage in the AP image; closeness to the femoral calculus in the lower portion of the femoral neck).

It has been shown that when treating subtrochanteric fractures with an intramedullary nail, the load transmission is dependent on the medial wall support.

The critical component of sustained osteosynthesis has been identified as the medial buttress effect. Tensile stresses act on the medial wall, whereas axial loads acting on the proximal femur push on the medial wall. Medial load transmission is also lacking when anatomical reduction is not possible, leading to mechanical failure.

In our opinion, anatomical reduction before nail implantation is necessary for the intramedullary nail to achieve its biomechanical advantage. In our cases, the medial buttress effect was achieved by reconstructing the wire's medial wall. This minimized the varus bending stress in the fracture line and prevented anatomical lateralization.

In the treatment of fractures, bone-implant stability is crucial for facilitating early mobilization throughout the treatment course until bone union. Implant failure results from increased distance between the displaced fragments of a medial fracture, which increases the load on the implant and the time required for the fracture to heal. Additionally, it increases the duration of postoperative weight-bearing. We are enabling patients to bear weight initially due to the enhanced biomechanical stability achieved through the wire, which bolsters our contentment with clinical outcomes.

Based on our experience, we advise using wire in conjunction with intramedullary nails to treat suitable subtrochanteric fracture types. In addition to straightening the intramedullary canal and anatomically reducing the fracture before nail insertion, intraoperative wire utilization decreases the risk of varus-type union.

Controversy surrounded the notion of periosteal arteries supplying the significant portions of the femur with a continuous blood supply. The periosteal circulation exhibited a longitudinal extension, and wire implementation had an inconsequential impact on this phenomenon.[15]

Consistent with previous research, we discovered that the optimal application of wire had no adverse impact on fracture healing, as evidenced by the high union rates observed in our study. According to a study by Codesia et al., cerclage wiring correlates with improved functional outcomes and accelerated recovery with no additional complications.[16]

This investigation focused on osteoporotic femur fractures. Younger participants were also included in our study, and our findings revealed that cerclage wires improved the reduction of subtrochanteric fractures when closed procedures failed to achieve satisfactory results for the surgeons.

We are confident in our capacity to demonstrate the impact of wire implantation on the healing process of subtrochanteric femoral fractures, as the number of cases in our study is greater than that of previous research, which enhances its reliability and efficacy.

4. Conclusion

In circumstances where complete anatomical reduction is not possible, intramedullary fixation

with a PFNA nail and augmentation is a secure and efficient therapeutic option for inter-trochanteric fractures of the femur. Most patients in all groups achieved union at three months, and there was no significant disparity in the union rate across the groups. Likewise, the occurrence of complications following surgery was similar in both groups. All augmentation methods effectively treat patients with stable intertrochanteric fractures with equivalent results.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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