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Clinical And Radiological Outcome Of Distal Femur Metaphyseal Non-Union Treated With Double Implant And Bone Grafting.

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ABSTRACT

Distal femoral fractures occur within 9 cm of the femoral condyle joint surface line and account for 0.4% of all fractures and 4% to 6% of all femoral fractures.2–5 Surgery is the preferred treatment because of its benefits over nonsurgical options. However, the nonunion rate for distal femoral fractures ranges from 5% to 10% after fixation. Despite adopting modern staged fixation methods, including implants and lateral fixation, the nonhealing rate of distal femoral fractures still ranges from 0% to 6%. The objective of this study is to assess the effectiveness of double-implant fixation combined with bone graft in the treatment for the distal femur metaphyseal nonunion. This prospective observational study was performed from January 2022 to December 2023 and involved ten patients who presented with distal femur metaphyseal nonunion. They were treated with intramedullary nailing and a lateral locking plate combined with the bone grafting technique. Postoperative follow-up was performed to observe the healing time, and functional outcomes were evaluated using the Lower Extremity Functional Scale (LEFS). Overall union rate after revision surgery with double implant was 90%.The mean time to achieve bony union was 4.78 months (range 4-6months).At the last follow-up, the mean LEFS score was 71.2/80 and the mean knee flexion was 109 degrees. Our study demonstrates that combining intramedullary nailing and a lateral locking plate with the bone grafting technique enhances biological properties, provides good structural support, and achieves good union and functional results in the management of nonunion of the distal femur.

Keywords: Resistant nonunion, distal femoral fracture, nail/plate construct, reamer-irrigator-aspirator, healing time, functional outcome.

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INTRODUCTION

Distal femoral fractures account for 3–6% of all femoral fractures [1, 2] with less than 10% being comminuted [3]. The population sustaining distal femoral fractures is increasingly older with over half occurring in patients over 60 years old [3]. Retrograde intramedullary nail (rIMN) and lateral locking compression plate (LCP) are common surgical treatments for distal femoral fractures. Healing difficulties following locking plate are not uncommonon. Rates of non-union are up to 19% and rates of implant failure are up to 20% [4]. Depending on the degree of comminution, patient characteristics. Despite adopting modern staged fixation methods, including implants and lateral fixation, the nonhealing rate of distal femoral fractures still ranges from 0% to 6%.9–12 Nonunion that occur after fractures of long bones can affect the patient's daily life and cause psychological problems due to the inadequate use of the limb [5]. In order to increase the patient's quality of life, the appropriate treatment modality should be determined and applied. Studies have shown that stability has a major impact on fracture healing [8].

Little research to date has focused on the management of resistant distal femoral nonunion, although several articles have described management techniques for distal femoral nonunion such as medial plate application, biological supplementation procedures, plating over an existing intramedullary nail, lateral fixation with an Ilizarov device, application of a combined nail/plate construct, and use of new prostheses with bone grafting. 12–14 Distal femoral metaphysealnonunion is challenging to treat because it requires reconstruction of postsurgical structural flaws and improvement of the biology to promote fracture healing.13,15 Regarding osteogenic and osteoconductive factors, some studies describe simple additional fixation, while others report the use of autografts, vascularized bone grafts, and allografts [3,5]. The overall reported union rates in those surgeries are favorable [2, 4–6].

This study aims to investigate the ten cases of successful treatment of distal femoral metaphyseal nonunion with a combined nail/plate construct
and the autologous bone graft technique

Inclusion Criteria

- Age between 18-70
- Patients with Distal femur metaphyseal non union

Exclusion Criteria

- Infected nonunions (Infections were determined according to wound site discharge and blood parameters)
- Patients treated with Ilizarov external fixator,
- Patients treated with Lmb reconstructive system
- Patients with Comorbidities that disrupted bone mineralization

MATERIALS AND METHODS

Written informed consent for treatment was obtained from all patients before surgery.From January 2022 to December 2023, a nail/plate construct with the autologous technique was used to treat ten patients who presented with distal femoral nonunion.Nonunion was considered as nonunion within the first nine months after initial treatment, no progression in union for three months during monthly follow-up, and failure of implants.

The study included four men and one woman with a mean age of 52 years (range, 22–74 years). All patients primarily had closed injuries; six were extra-articular, and four were intraarticular. All patients were referred to our hospital for treatment after multiple surgical procedures had resulted in nonhealing.

Surgical Technique

The patients were placed supine on a fluo roscopic surgical bed and received general or epidural anesthesia. First, the nonunion site was exposed using the same incision as in the previous surgery. The prior implant, fibrous scar tissue, and necrotic bone tissue at the fracture site were removed. Two Schanz

nails were placed distal and proximal to the fracture, and limb alignment was corrected using bracing under fluoroscopy and compared with the healthy side.

A locking plate was then placed on the lateral side of the femur, and three single cortical locking screws were inserted distally and proximally to maintain limb alignment and resist rotation.

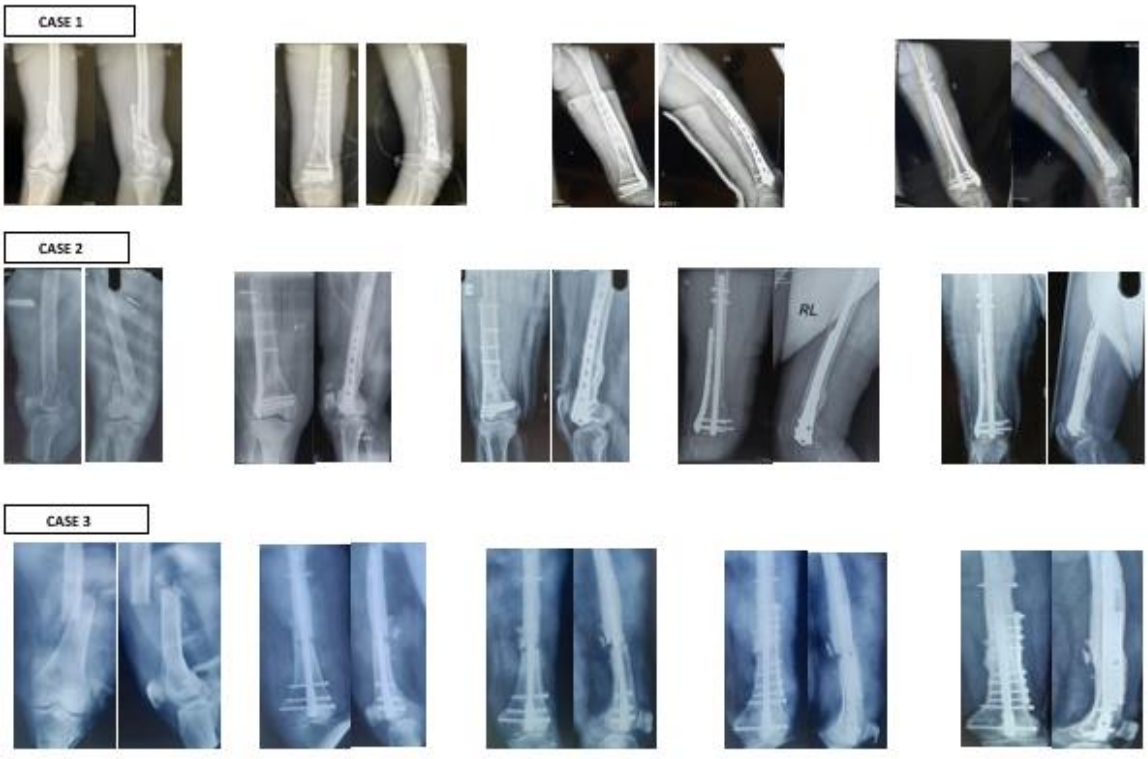
After restoring the anatomical axis, a retrograde intramedullary nail of appropriate length and diameter as implanted. An appropriately sized retrograde nail was selected according to the diameter of the femoral isthmus. If the retrograde intramedullary nail was hindered by the three proximal screws of the lateral locked plate, the length of the screws was reduced. Cancellous bone graft from the ipsilateral iliac crest was considered and implant it in the medial cortical defect area. Postoperatively, rotational stability was confirmed. The fascia lata, subcutaneous tissue, and skin were repaired sequentially over a suction drainage. . In contrast to primary plate fixation for femoral fracture, there is no need for extended exposure of the nonunion site and the plate can be applied with soft tissue and vascular supply preservation.

Immediate partial weight bearing and knee range of motion were prescribed, and patients were visited at regular intervals until bony union could be demonstrated radiographically and on physical examination, with the disappearance of lucencies between segments and painless full weight bearing on ambulation. Clinical evaluation of the patients was performed using the Lower Extremity Functional Scale (LEFS). Bone union was evaluated radiologically with bone callus formation and bone bridges in at least three cortices and clinically regression of pain in the fracture site.

RESULTS

All patients were followed up for a period of 10.5 to 14.0 months after surgery, with a mean follow-up time of 11.9 months. Solid bony union was observed in all cases, with a mean healing time of 4.8 months (range, 2.5–8.5 months). At the last follow-up, the mean knee flexion was 109 degrees (range, 80–130 degrees), and the patients had good functional outcomes with a mean Lower Extremity Functional Scale (LEFS) score of 71.2 (range, 59–80).

Poor wound healing occurred in one older patient and was successfully treated with resuturing and nutritional support. At the end of the first year, all patients were able to perform all activities and had good functional outcomes.



DISCUSSION

Nonunions of long bones may cause patients pain and loss of function. When this becomes a chronic condition, it may lead to psychological problems [10]. Surgeons must determine the most appropriate treatment method for each nonunion. The challenge for the surgeons remains in the balance of providing stable fixation to support physiological loading until union while allowing necessary micromotion for callus formation. Numerous surgical options are available for treating extra-articular fractures of the distal femur, and various studies have concluded that there is no discernible superiority among different fixation methods in terms of overall fracture healing rates [17-19]. However, nonunion has emerged as the most common postoperative complication associated with distal femoral fractures. Although reported nonunion rates were <6% in the early literature [8], recent studies have indicated that the rates can be as high as 17% to 21% [6]. Both iatrogenic and noniatrogenic factors contribute to nonunion. Noniatrogenic factors include age, osteoporosis, steroid use, diabetes, smoking, body mass index, comminuted fractures, open fractures, and fracture infection [20, 21]. In our patients, the mean body mass index was 21.1 kg/m2 , which may not have been a significant factor in nonhealing. However, three of the five patients had a smoking history, suggesting that smoking may be a risk factor for nonunion. Iatrogenic factors include open surgery, inadequate medial structural support, use of stainless-steel plates, a shorter plate working length, higher construct rigidity scores, and purely locking screw constructs [20, 21]. In our typical case (Figures 1–3), the initial surgery failed because of inadequate medial structural support, a short plate, higher construct rigidity scores, and a lower average number of unfilled holes adjacent to the fracture. Peschiera et al [20]. found that malreduction associated with unbalanced fixation and medial cortical defects, especially axillary defects, was the main risk factor for nonunion, and stated that structural support should be performed for medial defects of >2 cm in length.

In our case, a significant structural defect was present in the medial femoral cortex after the initial surgery. Moreover, the plate length should be three times the fracture length, and the ratio of the number of screws to the number of nail holes in the plate should be 0.4 to 0.5.8 However, this ratio in the initial surgery in our case was 0.76 (13/17). Our analysis suggests that inadequate medial structural support contributed to the nonunion. A distal femoral lateral locking plate is an eccentric fixation. Thus, the variables and stresses of compression and bending are relatively small at the fracture end near the plate. However, the fractured end on the other side of the plate (medial femur) is affected by relatively large compressive and bending variables and stresses. In cases of insufficient structural support, the compressive and bending strength of lateral plate fixation alone is defective. Consequently, plate screws are prone to bending, loosening, or fracture [21-14]. The management of nonunion in the absence of a unionized workforce focuses on the biological and structural support aspects of fracture union. Various therapeutic techniques have been reported to treat distal femoral nonunion. Varus collapse caused by distal femoral fracture nonunion is possible, given the mechanical axis of the lower extremity. This situation is perfectly suited to medial column support with plating, and medial plating is frequently used to supplement intact indwelling lateral fixation. One study revealed a 95% union rate in 22 patients with distal femoral nonunion after placement of a medial plate [25]. Plating over an existing intramedullary nail is a reliable option for the treatment of metaphyseal and diaphyseal femoral fracture nonunion.In one study, this plate augmentation technique was used over a retained nail in 30 cases, including those involving the distal femur, and union was achieved in every case [27]. Another effective method for treating nonunion is lateral fixation using an Ilizarov device. In one study, a 100% union rate was achieved in cases involving complicated distal femoral fractures nonunion [28]. Exchange nailing has much lower success rates than the above-mentioned methods for treating distal femoral nonunion [29].

If severe stiffness causes nonunion, switching to an intramedullary nail may be an alternate technique to promote secondary healing [30].

A combination nail/plate construct with autogenous bone grafting was used in a study of 10 patients with distal femoral nonunion, and all patients achieved union following initial nonunion [31]. Another study achieved a 100% union rate (7 of 7 cases) when diaphyseal femoral fracture nonunion was treated with large fragmented compression plating and bone grafting following intramedullary nail fixation [32]. Treatment of Distal femur metaphyseal nonunion is a challenge for orthopedic surgeons because of complications such as low bone reserve, disuse osteoporosis, joint contracture, and internal fixation failure [13, 15]. Two key components need to be considered in addressing this issue: delivering structural support and improving biology. The combined nail/ plate construct and bone graft technique provide a solution to both. Before performing revision surgery, it is crucial to thoroughly evaluate the patient's bone reserve,

lower extremity alignment, and medial cortical defects to determine the most appropriate technique. In our study, we decided to use a combination of plating and nails to enhance axial loading, fracture alignment, nail reaming, and torsional force resistance. The combination of intramedullary nail fixation and a plate provides additional distal fragment fixation and stiffness, allowing patients to move without complications. Furthermore, this technique reduces the incidence of varus collapse and metaphyseal screw cutout, which commonly occur with intramedullary nailing.

In summary, we believe that for successful treatment of distal femoral fractures, it is crucial to perform meticulous initial fixation, choose an appropriate lateral plate length and number and distribution of screws, and achieve optimal repositioning and limb alignment during the operation. Moreover, factors associated with postoperative nonunion should be thoroughly evaluated to determine whether they are iatrogenic or noniatrogenic. After a diagnosis of nonunion, the revision method should be determined based on the patient's bone reserve, fixation effectiveness, lower limb alignment, and bone defects. This study had two main limitations.

First, it involved a small number of patients. Second, the diagnosis of union was based on a surgeon's evaluation of radiographs. To further validate our findings, a long-term randomized controlled trial with a larger patient population and the inclusion of control groups and other revision methods should be conducted.

CONCLUSION

Combining intramedullary nailing and additional lateral plate with the bone grafting technique enhances biological properties, provides good structural support, and achieves good union and functional outcomes in the management of resistant nonunion of the distal femur. Retrograde intramedullary nailing and a lateral locking plate combined with the Bone graft technique may be an alternative approach for patients with distal femur metaphyseal nonunion.

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