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Bicolumnar reconstruction with Medial Titanium Elastic Nailing System in Distal Femur Fractures

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ABSTRACT

Background: Distal femur fractures are often unstable, comminuted and are associated with complications like mal-alignment, non-union, infections. In this study we report functional outcome of 34 patients managed in our centre with lateral locking compression plate and medial TENS nail.

Methods: Prospective observational cross sectional study of functional radiological outcome of 34 patients of comminuted distal femur fracture was done. These patients were operated with lateral locking compression plate and medial TENS nail and followed up for 12-18 months and functional outcome was assessed using Schatzker and Lambert scoring system.

Results: Complications were observed in 14.71% (5 participants) of the cases, while 85.29% (29 participants) experienced no complications after surgery. The most common complications were arthritis (8.83%, 3 cases) and infection (5.88%, 2 cases).

Conclusion: Using a TENS nail to manage a medial femoral comminution alongside a distal femoral locking compression plate may eliminate the requirement for a plate on the medial side.

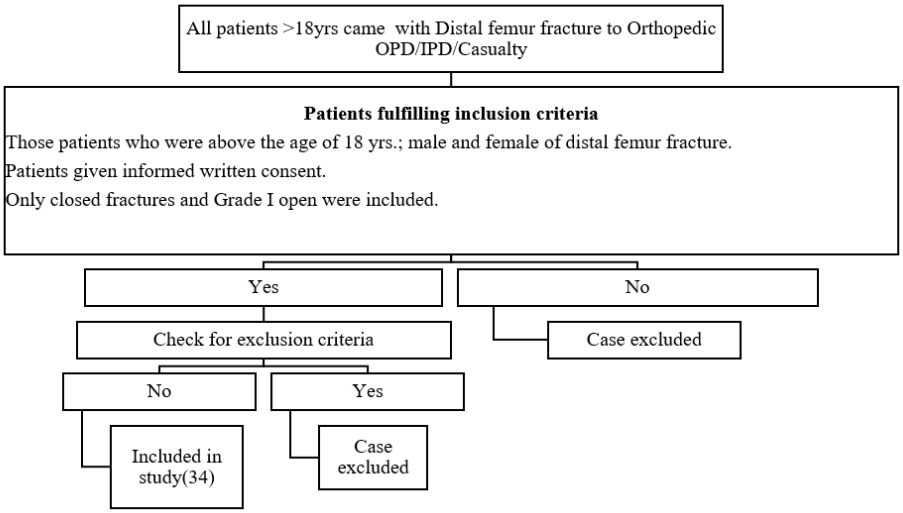
Key Words - TENS Nail, distal femur fracture, varus angulation, medial femoral comminution

INTRODUCTION

High energy trauma is typically the cause of distal femur fractures. They are frequently associated with high rate of complications and are challenging to cure. These fractures account for 0.4% of all fractures and 3-6 % of femur fractures [1]. There is a bimodal distribution, with the highest proportion of women over 50 years old and teenage boys and men between the ages of 15 and 24[2]. Intraarticular involvement in these fractures may make it difficult to regain complete function and range of motion [3]. Treatment for fractures of the distal femur has changed from non-operative to surgical with fixation of the distal femur medial and lateral columns. These methods aim to avoid varus or valgus angulation, re-establish stable fixation, and restore anatomical reduction of the joint. Its usage was discouraged due to the high incidence of complications with bi-columnar plate fixations like infections, loosening of implant and non-union [4]. In order to support the medial column and prevent varus angulation, our study aimed to assess the effectiveness of both column fixations: a locking compression plate on the lateral side and a titanium elastic nailing system (TENS) on the medial side [5].

MATERIALS AND METHODS

A prospective observational cross-sectional study of 34 patients with distal femur fractures was conducted at a tertiary care centre in Mumbai from October 2023 to September 2024. The patients were recruited from both the casualty and orthopaedic ward. They were operated on using a lateral locking compression plate and a medial TENS nail within a mean of 5.4 days (range: 7–10 days) after becoming haemodynamically stable. Patients were followed up for a mean duration of 14.2 months (range: 12–18 months), and the functional outcome was assessed using NEER's scoring system.



Approach:
Modified Swashbuckler approach was used with a midline incision over anterior distal thigh just above fracture and extended distally 2 cm medial to patella towards tibial tuberosity [6]. Knee joint arthrotomy was done and vastus lateralis reflected medially and fracture site exposed. Intra-articular reduction was achieved and fixation was done using 6.5mm partially threaded cancellous cannulated screw. Distal femur locking plate of appropriate size was selected and applied over bone and locking screws were inserted through plate after confirmation of reduction. Incision was taken over medial condyle of femur and under C arm guidance TENS nail of 4mm was inserted. **(Figure 2)**

Post-op protocol:
Static quadriceps and hamstring stretching exercises along with ankle pumps were started on second day after relieving of pain [7]. Active knee range of motion was started on fourth day and nil weight bearing mobilisation done with walker. Suture removal done in14 days. Patient was allowed to walk partial weight bearing with walker after 6-8 weeks once radiological signs of union seen and thereafter full weight bearing walk started.

The final outcome was assessed using NEER's scoring system and graded as Excellent, Good and Poor. Outcome was graded as Excellent if patient had full extension, no varus or valgus deformity, no pain and joint congruity (<2mm intra-articular step) is present. Good result includes not more than one of following like loss of length not more than 1.2 cm, less than 10° varus or valgus deformity, flexion loss not more than 20° and minimal pain. Failure result includes any of the following: flexion to 90°; varus or valgus deformity more than 15°, joint incongruency, disabling pain.

RESULT

Table 1: Distribution of study participants according to age Group and gender.

Age Group	Male(n)	Female(n)	Total (N%)
25-40 Years	09	03	12(35.29 %)
41-55 Years	09	00	09(26.47 %)
56-70 Years	05	06	11(32.35 %)
>70 Years	01	01	02(05.88 %)
Total	24(70.59%)	10(29.41%)	34(100%)

The study included 34 participants, distributed across four age groups. The majority of participants were aged between 25-40 years (35.29%), followed by those aged 41-55 years (26.47%), 56-70 years (32.35%), and those over 70 years (5.88%). The gender distribution showed that 70.59% of participants were male (24 individuals), while 29.41% were female (10 individuals). **(Table 1)**

Table 2: Distribution of study participants according to Mode of injury.

Mode of injury	N	%
Fall	18	52.94%
RTA	16	47.06%
Total	**34**	**100%**

The most common mode of injury was a fall, accounting for 52.94% (18 cases), while 47.06% (16 cases) were due to road traffic accidents (RTA).**(Table 2)**

Table 3: Distribution of study participants according to Type of fracture using Muller AO classification.

Type of fracture	**N**	**%**
AO A1	05	14.70%
AO A2	16	47.05%
AO A3	07	20.59%
AO B2	02	05.88%
AO C1	03	08.82%
AO C2	01	02.94%
Total	**34**	**100%**

Fractures were categorized according to the Muller AO classification. The majority of participants had an AO A2 fracture (47.05%, 16 cases), followed by AO A3 (20.59%, 7 cases), AO A1 (14.70%, 5 cases), AO B2 (5.88%, 2 cases), AO C1 (8.82%, 3 cases), and AO C2 (2.94%, 1 case). **(Table 3)(Figure 1)**

Table 4: Distribution of study participants according to frequency and type of complication after surgery.

Complication after surgery	**N**	**%**
No	29	85.29%
Yes	05	14.71%
Total	**34**	**100%**
Type of complication	**05**	**14.71%**
Arthritis	03	08.83%
Infection	02	05.88%

Complications were observed in 14.71% (5 participants) of the cases, while 85.29% (29 participants) experienced no complications after surgery. The most common complications were arthritis (8.83%, 3 cases) and infection (5.88%, 2 cases). **(Table 4)**

Table 5: Distribution of study participants according to Functional outcome following surgery.(NEER'S score)

NEER'S score	At 6 weeks	At 12 weeks	At 24 weeks
Excellent	00(0%)	09(26.47%)	22(64.70%)
Good	15(44.11%)	18(52.94%)	08(23.59%)
Fair	15(44.11%)	06(17.65%)	04(11.76%)
Poor	04(11.78%)	01(02.94%)	00(0%)
Total	**34(100%)**	**34(100%)**	**34(100%)**

The functional outcomes were measured using NEER'S score at different time points. At 6 weeks post-surgery, 44.11% of participants had a "Good" or "Fair" outcome. By 12 weeks, the proportion of participants with a "Good" outcome increased to 52.94%, while the percentage with an "Excellent" outcome was 26.47%. At 24 weeks, 64.70% of participants had an "Excellent" outcome, and the percentage of "Good" outcomes decreased to 23.59%. There were no participants with a "Poor" outcome at 24 weeks. **(Table 5) (Figure 4)**

Table 6: Distribution of study participants according to outcome of Surgery.

Outcome of Surgery	**N**	**%**
Healed	32	94.11%
Not healed	02	05.89%
Total	**34**	**100%**

The majority of participants (94.11%, 32 cases) achieved a healed outcome following surgery, while 5.89% (2 participants) did not heal after the surgery. **(Table 6) (Figure 3)**

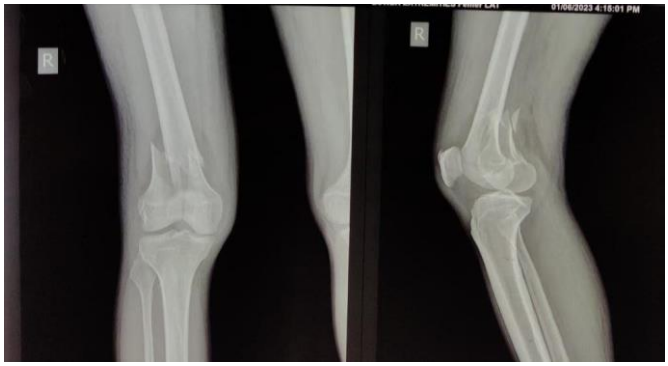


Figure 1 pre-operative x-ray

A 38-year-old male patient with a history of a road traffic accident, presenting with an X-ray that reveals a right distal femur fracture, classified as AO type 33-C1.

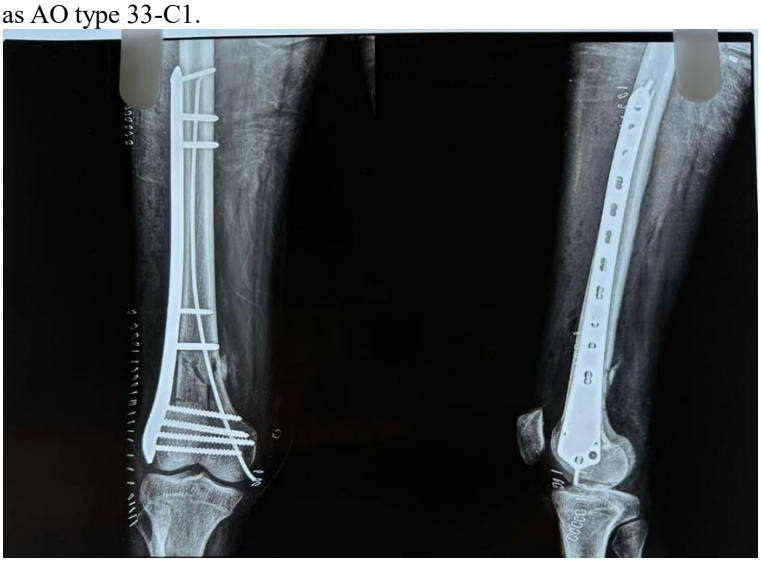


Figure 2 immediate post operative x-ray

The patient was managed with open reduction and internal fixation, utilizing a lateral locking plate and a medial TENS nail.

Figure 3 : 3 months post op x-ray

The X-ray taken 3 months post-operatively shows early signs of fracture healing with callus formation and good intra-articular reduction and alignment.

Figure 4: 12 months post op x-ray

Twelve months post-operative X-rays demonstrate complete fracture union, with the patient walking fully weight-bearing and achieving a range of motion from 0 to 110 degrees.

DISCUSSION

A distal femur intra-articular fracture refers to a fracture in the lower end of the femur bone that extends into the joint surface of the knee. Intra-articular fractures are particularly challenging because they involve damage to the joint surface, which can affect the function and stability of the knee. The mode of trauma typically involves high-energy forces, such as those seen in severe varus, valgus, or rotational impacts combined with axial loading. These fractures commonly occur in scenarios like road traffic accidents in young individuals or minor slips or falls on a flexed knee in the elderly.

The primary aim is to expedite bone healing and restore full function to the affected limb while ensuring stability as quickly as possible **[9]**. Distal femoral fractures are categorized by Muller (AO) into extra-articular, partial articular, and intraarticular types **[10]**. The typical mode of trauma in distal femoral fractures includes severe varus, valgus, or rotational forces with axial loading, which can occur in young individuals due to high-energy trauma such as road traffic accidents, and in the elderly due to minor slips or falls on a flexed knee. Intercondylar fractures may result in rotational malalignment due to the separate attachments of the gastrocnemius muscle to each condyle.

Complications associated with distal femoral fractures may include malunion, non-union, varus angulation, limb length discrepancy, infections, and secondary osteoarthritis of the patellofemoral and tibiofemoral joints **[11]**. The treatment approach for these fractures involves restoring the continuity of the bone, maintaining proper alignment, achieving congruity of the joint surfaces, and preserving a good range of motion. Previously, fractures treated non-surgically often resulted in angular deformities, joint incongruity, knee stiffness, and delayed patient mobilization. Various fixation devices have been employed, including angle blade plates (Schatzker 1979)**[12]**, Rush rods (Shelbourne 1981)[13], Enders nails (Kolmert 1986)[14], and the Zickel device. However, these devices were technically demanding and did not consistently provide stable fixation of the joint surfaces. Dual plating used in comminuted fractures often led to extensive stripping of soft tissue on both sides of the femur, compromising blood supply and resulting in delayed or failed union and implant failure. Callus formation was irregular and inconsistent with these plates.

The average time for union was 13.8 weeks in the study by Markmiller et al **[15].** while it was 16.2 weeks in our study. Our study observed no evidence of disability, which is consistent with the findings of Schultz et al **[16].** The benefits of fixation include the ability to initiate active range of motion exercises earlier, preservation of maximum range of motion, prevention of malunion due to stable internal fixation, maintenance of joint congruity, and reduced risk of implant failure and hospitalization.

Limitations of the Study

The study was limited to 34 patients, which reduces the statistical power and generalizability of the findings. A larger cohort would provide more robust conclusions. Conducted at a single tertiary care centre in Mumbai, the results may not be applicable to other settings with different surgical expertise, patient populations, or post-operative protocols. This study did not include a comparison group treated with alternative fixation methods (e.g., lateral plating alone, dual plating, or intramedullary nailing), which limits the ability to assess the true efficacy of bicolumnar fixation with medial TENS nail.

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Conflict of interest: None

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