ORIGINAL ARTICLE

Use of Poller Screws in Proximal and Distal Metaphyseal Fractures of Tibia: A Prospective Study

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Abstract

Background: ***Intramedullary nailing is considered a superior method for treating patients with extra-articular tibial fractures. However, achieving and maintaining control of the distal fragment during the procedure can present significant challenges. The use of Poller screws has been shown to create a stable mechanical environment, thereby facilitating the healing process for acute fractures.***

Aim of study: ***To assess the efficacy of intramedullary nailing with the use of poller screws for the treatment of tibial metaphyseal fractures.***

Patients and methods: ***This prospective cohort study included 30 patients with displaced proximal or distal tibial metaphyseal fractures. All participants underwent intramedullary nailing enhanced by the application of Poller screws. The follow-up assessment focused on the range of motion in the knee and ankle, time to union, postoperative complications, and overall satisfaction with the treatment outcomes.***

Results: ***The age of included patients was 35.5±3.5 years old. Tibial fractures were united in all cases. Knee range of motion was more than 120° in 50%, from 90-120° in 46.6%. The range of ankle plantar flexion was > 30° in 57% and 20-30° in 33.3%. The results were satisfied in the majority of patients. The most observed postoperative complications in were ankle swelling (20%) followed by pain (17%).***

Conclusion: ***The incorporation of Poller screws into the intramedullary nailing technique for tibial metaphyseal fractures proved effective in achieving optimal fracture alignment.***

Keywords: Intramedullary Nailing; Metaphyseal Fractures; Tibia; Poller Screws

1. Introduction

The tibia is vulnerable to frequent injuries because of its location. Metaphyseal tibial fractures comprise 15% of all fractures of the distal third of the tibia.[1]

Treatment of metaphyseal fractures of the tibia remains a challenge. Treatment options include medullary implants, half pin, thin wire, or hybrid external fixation, plate fixation, or combination techniques. The ordinary nails were only suitable for fixing midshaft fractures. The recent introduction of interlocking nails has extended the scope of fixation in tibial fractures to include the proximal and distal thirds.[2]

Interlocking nails have the advantage over traditional nails in providing more stability, especially against rotational stresses, preserving the length of comminuted bones, and they can be used for most fractures extending near the metaphysis.. In addition to being a closed technique, it is considered a safe procedure in low-grade open fractures. Interlocking intramedullary nailing is proven to be effective for comminuted segmental and unstable tibial fractures, especially in patients with multiple injuries.[3]

Nailing of metaphyseal fractures with short proximal or distal fragments is associated with an increase in malalignment, particularly in the coronal plane, nonunion, and need for secondary procedures to achieve union.[4] Various techniques have been recommended to improve nailing the metaphyseal fractures, such as blocking screws (poller screw) and temporary unicortical plating.[5]

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Poller screws promote a stable mechanical environment for the healing of acute fractures, nonunions, deformity, and corrective osteotomies if used correctly. Poller screws are a recently developed adjunct for intramedullary (IM) nailing of long bones. Proper positioning of poller screws aims to form a corridor for the IM nail to functionally reduce the width of the medullary cavity, neutralise shearing forces, and increase compression forces to promote union of fractures.[6] The current study aimed to evaluate the mechanical and clinical outcomes of using poller screws in proximal and distal metaphyseal fractures of the tibia.

2. Patients and methods

This prospective cohort study included 30 patients with displaced proximal or distal tibial metaphyseal fractures who underwent fixation using poller screws at the orthopedic surgery department of Al-Azhar Cairo University Hospitals. The duration of follow-up ranged from 6 months. Inclusion criteria were adult patients with displaced tibial metaphyseal fractures of the proximal or distal third, skeletally mature. Exclusion criteria were tibial diaphyseal fractures, pathological fractures, malignancy, and patients' refusal to participate.

The study protocol was approved by the Local Ethics Committee and written informed consents are obtained. Informed consent was obtained from the patients before enrollment of the study.

Baseline characters of included patients were reported as age, sex, mechanism of injury, previous medical history of associated disease. All patients were subjected to both clinical and radiological examination on admission to the hospital. Anteroposterior and lateral radiographs for the affected tibia were made. The X- ray films were examined for The level of the fracture, The shape of fracture and its classification, Other skeletal injuries.

All patients received preoperative prophylactic antibiotics. Measurements of the proposed interlocking medullary nail (length and width) were determined both clinically from the tip of the tibial tuberosity to the tip of the medial malleolus and radiologically using X-ray templates for the tibial nail.

Intramedullary nailing augmented with a poller screw:

The procedure was performed under spinal or general anesthesia, with the patient positioned supine and the thigh flexed over a padded bolster for support. A 5 cm incision was made to split the patellar tendon, and a curved awl was used to open the medullary canal proximal to the tibial tuberosity, typically positioned slightly medial to the patellar tendon. The selected intramedullary rod was introduced to the fracture site using a guide rod holder, and its proper placement was confirmed through anteroposterior and lateral imaging. In cases where the medullary canal was obstructed due to older fractures, a small incision was made over the fracture site to curette fibrous tissue, facilitating reduction and insertion of the guide rod. For distal third tibial fractures, the knee was fully flexed during nail insertion, while a slight flexion was utilized for proximal third fractures to prevent patellar impingement and anterior angulation. A blocking screw was inserted on the concave side.

For distal third tibial fractures with a short nail, two blocking screws could be employed: one near the fracture on the concave side and another anteroposteriorly distal to the fracture on the convex side to prevent varus or valgus deformity. In instances of small-diameter nails, two blocking screws were placed on the concave side, one above and one below the fracture, to correct malalignment. In proximal third tibial fractures, varus or valgus deformities were addressed by placing a blocking screw on the concave side near the fracture, guided by C-arm imaging. Anterior angulation was prevented by making a small incision on the medial side of the leg and inserting a screw from medial to lateral to narrow the medullary cavity, followed by the completion of the surgical procedure.

In the immediate postoperative period, a compression bandage was applied from the toes to the knee, and the limb was elevated to minimize edema and swelling. A postoperative antibiotic regimen was implemented, and control radiographs were obtained to assess the surgical outcome. Patients were encouraged to engage in early partial weight-bearing activities and to perform active exercises to promote recovery.

Clinical and radiological examination done 1 month postoperative and then monthly till union was achieved. In each visit the following data was recorded: Limb length, Range of knee and ankle motion, time to union, The presence of any deformity and its degree and postoperative complications.

The results were evaluated according to a modified system of Ekland et al. 1988 based on the following clinicoradiological data: tibial malalignment and shortening, range of knee motion, range of ankle motion, foot motion as a fraction of the normal range of motion, the presence of pain or swelling, and bony union. The result was considered satisfactory when all items in the table were satisfactory; if one item was unsatisfactory, the case would be considered unsatisfactory.

Statistical analysis: All statistical analysis was conducted using SPSS version 27. Continuous data were represented as mean and standard

deviation. Categorical data were represented as events and percentages. Exact fisher test were used to comparing between categorical data.

3. Results

The age of included patients was 35.5±3.5 years old, the majority of included patients were males. The majority of included patients had distal third fractures caused by traffic accident (Table 1).

Table 1. baseline characters

	MEAN±SD	
AGE (YEARS)	35.5±3.5	
SEX	N	%
MALES	26	86.67%
FEMALES	4	13.43%
MECHANISM OF INJURY		
ROAD TRAFFIC	18	60 %
SLIDING INJURY	8	26.6 %
OTHER CAUSES OF TRAUMA	4	13.43 %
AFFECTED SIDE		
LEFT SIDE	17	56.6%
RIGHT	13	43.3%
LEVEL OF THE FRACTURE		
DISTAL THIRD FRACTURES	24	80%
PROXIMAL THIRD FRACTURES	6	20%
TYPE OF FRACTURE		
CLOSED	23	76.6%
OPEN	7	23.3%

All the cases of proximal and distal third tibia treated with interlocking nail and blocking screws united. 8(26.6%) united after four months post-operative. 13(43.3%) cases united after five months. 9(30%) united after six months from time of surgery. The range of motion was more than 120° in 15 patients (50%), from 90-120° in 14 patient (46.6%). Less than 90° in 1 patient (3.3%). Extension lag > 15° in 2 patient (6.67%). The range of ankle planter flexion was > 30° in 17 patients and 20-30° in 10 patients, and < 20° in 3 patients. The range of ankle dorsiflexion was >20° in 11 patients and from 10-20° in 16 patients and < 10° in 3 patients (Table 2).

Table 2. post-operative knee motion in included patients

	N	%
KNEE RANGE OF MOTION		
LESS THAN 90°	1	3.3%
90-120°	14	46.67%
MORE THAN 120°	15	50%
EXTENSION LAG		
EXTENSION LAG > 15°	2	6.67%
EXTENSION LAG < 15°	3	10%
NO EXTENSION LAG	25	83.3%
ANKLE RANGE OF MOTION		
ANKLE PLANTER FLEXION		
< 20°	3	10
20-30°	10	33.3
> 30°	17	56.67
ANKLE DORSIFLEXION		
< 10°	3	10
10-20°	16	53.3
>20°	11	36.67

The overall results were satisfactory in 26 patients (86.67%) and unsatisfactory in 4 patients (13.3%). All patients younger than 25 years were satisfied. Out of 24 cases that were older than 25 years, only 20 cases were satisfied (Table 3).

Table 3. Relation between post-operative level of satisfaction and age.

AGE GROUP	SATISFACTORY		UNSATISFACTORY		TOTAL
	No.	%	No.	%	
< 25 YEARS	6	23.1	0	0.0	6
25 – 35 YEARS	8	30.8	3	75	11
>35-45	8	30.8	1	25	9
>45	4	15.38	0	0.0	4
TOTAL	26		4		30
X^2	14.2				
P	0.007*				

Shortening about 2 cm in one case due to comminution and can be avoided in other cases by delayed weight bearing. 6 cases show mild swelling relieved within 2 months. Intermittent pain in 5 cases relieved within 2 months. Superficial infection in one case treated by proper daily dressing and good antibiotic according to culture and sensitivity test (Table 4).

Table 4. Post-operative complications

	N	%
SUPERFICIAL INFECTION	1	3.33%
PAIN	5	16.67%
ANKLE SWELLING	6	20%
SHORTENING (2 CM)	1	3.33%

Case 1: A male patient aged 45 years old, he was involved in a road traffic accident which caused proximal third tibial fracture (AO type C2.1). The fracture was treated with interlocking nail with blocking screws inserted during the first month after trauma and the fracture united after six month.

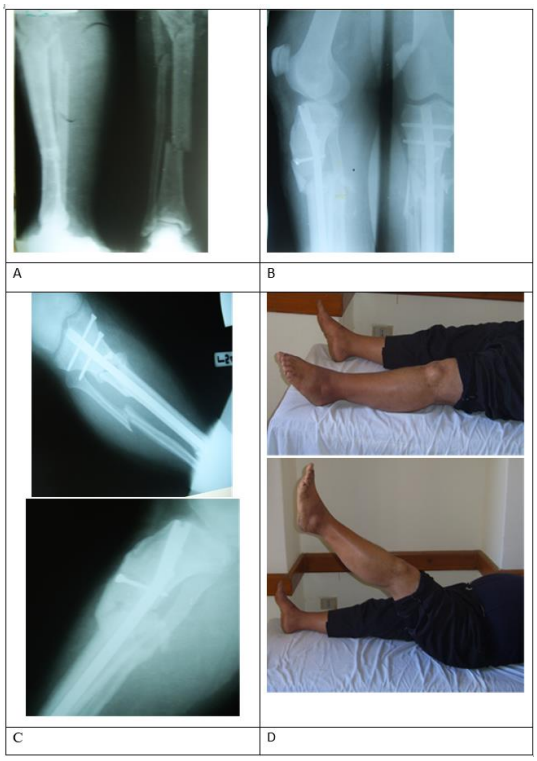

Figure 1. figures of first case: A) X- ray preoperative; B) one month postoperative; C) X-ray AP and lateral views after six months; D) full range of movements of left lower limb after full union.

Case 2: A male patient aged 50 years old, he was involved in a road traffic accident which caused proximal BBL AO Type B2, that was treated by interlocking nail with blocking screws during the first day after trauma and the fracture united after six month.

Figure 2. figures of first case: A) X- ray preoperative; B) postoperative; C) X- ray AP and lateral views after six months; D) full range of movements of left lower limb after full union.

4. Discussion

Intramedullary nailing is recognized as a superior option for patients with extra-articular distal tibia fractures, facilitating early weight bearing.[7] However, there is a notable risk of axial displacement and angular malalignment of the short fragment, particularly due to the cancellous nature of the metaphysis, which complicates the maintenance of control over the distal fragment during the procedure.[8,9] Previous studies have demonstrated the utility of blocking screws in correcting alignment post-nail insertion, enhancing stability, and improving healing outcomes. .[8,10] This study was conducted to evaluate the efficacy of intramedullary nailing with Poller screws for tibial metaphyseal fractures.

The average age of participants in our study was 35.5 ± 3.5 years, predominantly male, with the majority sustaining injuries from high-energy mechanisms such as traffic accidents (60%) and presenting with distal third fractures (80%). These demographics align with findings from Stephens et al.,[9] and Kawalkar et al.[7]. Distal tibial fractures are frequently encountered in physically active young adults, often resulting from road traffic accidents.[11] Mohamed et al. [12] reported a similar mean age of 36.25 years, with various mechanisms of injury.

All tibial fractures in our cohort achieved union, with 70% uniting in less than six months. This is consistent with studies by Moongilpatti Sengodan et al.,[13] and Mohamed et al.,[12] where union was also achieved in all cases treated with intramedullary nailing and blocking screws. Ravishankar et al.[11] noted that most fractures united within 20 weeks, with an average union time of 20.47 weeks.

Poller screws play a critical role in enhancing fracture reduction, directing nail insertion, controlling angular deformity, and improving the stability of the bone-implant construct. [8,14]

The primary indication for Poller screws is in oblique long bone fractures at the metaphyseal-diaphyseal junction, where intramedullary nailing is associated with significant malalignment and axial displacement. [15]

Our study observed a marked improvement in postoperative range of motion, with 50% of patients achieving knee motion greater than 120° and 83.3% exhibiting no extension lag. Ankle plantar flexion was over 30° in 57% of patients, while dorsiflexion was greater than 20° in 37%. These findings are corroborated by Moongilpatti Sengodan et al.,[13] who also reported improvements in motion and alignment post-surgery.

Ricci et al.[16] highlighted the efficacy of blocking screws in maintaining alignment in proximal third tibial fractures treated with intramedullary nails. Hussain et al.[17] reported healing within an average of 4.2 months, with an excellent outcome for the majority of patients.

Our findings indicate satisfactory results in most patients, consistent with Ravishankar et al.[11] who found excellent results in 93.3% of cases according to Klemm and Bornner criteria, and Moongilpatti Sengodan et al.[13] who reported similarly high functional outcomes.

Recent meta-analyses have confirmed the advantages of combining intramedullary nailing with blocking screws, noting improved clinical efficacy, higher healing rates, shorter healing times, and fewer complications.[18]

The use of Poller screws alongside intramedullary nailing significantly reduces complication rates related to nonunion, malunion, and the need for secondary procedures.[19]

Our study identified a significant negative correlation between satisfaction and age, aligning with Mohamed et al.[12] who noted that younger patients typically achieved better outcomes.

Postoperative complications primarily included ankle swelling and pain. Ravishankar et al.[11] reported a 6.7% infection rate, with superficial infections managed successfully with dressings and antibiotics. Anterior knee pain was observed in two patients, attributed to nail positioning and

potential heterotrophic ossification. The advantages of rapid rehabilitation and minimal complications support the recommendation for this technique in treating distal tibia fractures.

A systematic review indicated a low complication rate associated with intramedullary nailing augmented with Poller screws, with rates of nonunion (4%), coronal plane malunion (5%), deep infections (5%), superficial infections (6%), and secondary procedures (8%).[20]

4. Conclusion

In conclusion, the addition of Poller screws to intramedullary nailing for metaphyseal tibial fractures is effective for achieving fracture alignment, enhancing stability, and maintaining reduction until union. Thus, we advocate for the stabilization of metaphyseal tibial fractures using this combined approach.

The study has several limitations that may affect the generalizability and robustness of its findings. The small sample size (n=30) and single-center design at Al-Azhar Cairo University Hospitals introduce potential selection and institutional biases, while the lack of a control group limits the ability to compare outcomes with alternative treatments. The follow-up duration of 6 months is insufficient to assess long-term complications or functional recovery, and the reliance on subjective outcome measures, such as patient satisfaction and range of motion, may introduce bias. Additionally, the study population was predominantly young males, which restricts the applicability of the results to older or female patients. The absence of standardized radiographic assessments, cost-effectiveness analysis, and consideration of confounding factors (e.g., smoking, comorbidities) further limits the study's comprehensiveness. Finally, the lack of randomization, blinding, and long-term complication reporting underscores the need for larger, multicenter, randomized controlled trials with extended follow-up to validate these findings and evaluate the durability and broader applicability of Poller screws in tibial metaphyseal fracture management.

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