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ORIGINAL RESEARCH

Effectiveness of Poller Screws in Tibial Metaphyseal Fracture Fixation: A Prospective Study

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ABSTRACT

Background: Tibial fractures are common long bone injuries caused by high-energy trauma such as road traffic accidents or falls. Managing fractures, particularly in the proximal and distal metaphyseal regions, is challenging due to complex biomechanics and the risk of malalignment. Poller screws (blocking screws) have been introduced as an adjunct to intramedullary nailing (IMN) to improve alignment and stability.**Objectives:** This study evaluates the effectiveness of Poller screws in stabilizing tibial metaphyseal fractures by assessing their impact on alignment, healing time, and functional outcomes.**Material and Method:** This prospective study, conducted over two years at a tertiary orthopedic center, included 40 patients with tibial metaphyseal fractures who met specific inclusion criteria. All patients underwent IMN with Poller screw augmentation. Data on fracture alignment, healing time, and functional outcomes were analyzed using statistical methods.**Results:** The mean age of the 40 patients was 38.2 years, with 80% of injuries caused by road traffic accidents. Postoperatively, varus/valgus angulation improved from 9.8° to 1.5° and remained stable at 1.7° at union. The mean union time was 11.2 weeks, with delayed union in 12.5% of cases. Functional outcomes were favorable, with 70% of patients achieving excellent results, 20% good, and 10% fair. No non-union cases were reported.**Conclusion:** Poller screws significantly improve fracture alignment, reduce malalignment risks, enhance biomechanical stability, and promote faster healing. Their use should be considered a standard adjunct in tibial metaphyseal fracture fixation.

Keywords: Tibial fractures, Poller screws, intramedullary nailing, fracture alignment, functional outcomes

INTRODUCTION

Tibial fractures are among the most common long bone injuries, often resulting from high-energy trauma such as road traffic accidents or falls. Managing these fractures, especially those involving the proximal and distal metaphyseal regions, presents significant challenges due to the complex biomechanics and the propensity for malalignment during treatment[1].

Intramedullary nailing (IMN) is a widely accepted method for stabilizing tibial fractures due to its minimally invasive nature and biomechanical advantages. However, in metaphyseal fractures, achieving and maintaining proper alignment with IMN alone can be challenging. This difficulty arises from the widened metaphyseal region, which provides less cortical support, leading to an increased risk of malalignment[1,2].

To address these challenges, the use of poller screws (also known as blocking screws) has been introduced as an adjunct to IMN. First described by Krettek et al. in 1999, poller screws function by reducing the effective width of the medullary canal, guiding the nail during insertion, and preventing malalignment. They act as mechanical guides, directing the nail along the desired path and enhancing the stability of the bone-implant construct[1,2].

Recent studies have highlighted the benefits of incorporating poller screws in the treatment of metaphyseal tibial fractures. A systematic review by Tennyson et al. found that the use of poller screws in conjunction with IMN resulted in lower rates of nonunion and coronal malalignment compared to IMN alone[2,4,5].

Despite these promising findings, there remains a need for further research to establish standardized

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guidelines for the optimal use of poller screws, including their placement and the specific fracture patterns that would benefit most from their application. This study aims to evaluate the effectiveness of poller screws in stabilizing proximal and distal metaphyseal tibial fractures by analyzing their impact on alignment, healing time, and functional outcomes.

MATERIAL AND METHOD

Study Design

This prospective study was conducted over a period of two years at department of orthopedics,, F.H. Medical College Agra. Ethical clearance was obtained from the institutional ethics board. Informed consent was taken from all patients before enrollment.

Patient Selection

A total of 40 patients diagnosed with tibial metaphyseal fractures were included in the study based on the following inclusion and exclusion criteria:

Inclusion Criteria: Patients aged 18 years and older, with displaced fractures in the proximal or distal third of the tibia. Closed or open fractures (Grade I and II) suitable for internal fixation were included, and patients with no previous history of tibial fractures were considered.

Exclusion Criteria: Pathological fractures, fractures extending into the diaphysis or requiring additional stabilization methods such as fibular plating, patients with severe comorbid conditions precluding surgical intervention, and Grade III open fractures were excluded.

Preoperative Planning

Standard anteroposterior (AP) and lateral radiographs were taken to assess the fracture pattern and determine the appropriate surgical approach. The fracture site, degree of comminution, and alignment were evaluated. The diameter of the medullary canal was measured to determine the appropriate nail size. The entry point and placement of poller screws were preoperatively planned to aid in fracture alignment.

Surgical Technique

All patients underwent intramedullary nailing under fluoroscopic guidance. The procedure was performed under spinal or general anesthesia in a supine position with a radiolucent table. The tibial nail was inserted using a patellar tendon-splitting approach for proximal fractures and a transpatellar or medial parapatellar approach for distal fractures.

Reduction Method: Manual traction or percutaneous reduction tools (such as Schanz pins) were used to achieve alignment before nail insertion.

Poller Screw Placement: Poller screws were placed either proximally or distally in relation to the fracture site to guide the nail into an optimal position.

Nail Fixation: Statically locked intramedullary nails were used, with proximal and distal locking screws placed as required.

Closure and Postoperative Protocol: The wound was closed in layers, and a sterile dressing was applied. Immediate postoperative radiographs were taken to confirm fracture alignment and implant position. Patients were advised non-weight-bearing ambulation with crutches for the initial postoperative period.

Postoperative Care and Rehabilitation

Partial weight-bearing was initiated at two weeks postoperatively. Full weight-bearing was allowed based on clinical and radiological evidence of healing. Follow-up visits were scheduled at 4, 8, and 12 weeks, with radiographic assessments at each visit to evaluate fracture union and alignment. The Karlstrom-Olerud scoring system was used to assess functional outcomes.

Data Collection and Statistical Analysis

Patient demographics, fracture characteristics, surgical details, and postoperative outcomes were recorded in a structured format. Alignment was assessed using standard radiographic parameters for varus/valgus and anteroposterior angulation. Functional outcomes were categorized based on the Karlstrom-Olerud score. Statistical analysis was performed using SPSS software, with significance set at $p < 0.05$.

RESULTS

The study included 40 patients with a mean age of 38.2 years (range 20–65 years), of whom 75% (30) were males and 25% (10) were females. The primary cause of injury was road traffic accidents (RTA) in 80% (32) of cases, followed by falls in 12.5% (5) and trauma in 7.5% (3). Fractures were more frequently right-sided (55%, 22 cases) than left-sided (45%, 18 cases). Based on the AO/OTA classification, Type B fractures were the most common (50%, 20 cases), while Type A and Type C fractures were equally distributed (25% each, 10 cases each).

Regarding fracture characteristics, 70% (28 cases) were closed fractures, while 15% (6) were Grade I open fractures and 15% (6) were Grade II. The distal third was the most frequently affected site, accounting for 75% (30) of cases, compared to 25% (10) involving the proximal third. The mean fracture length was 3.8 cm (range 2.5–6.0 cm). Preoperative varus/valgus angulation averaged 9.8° (range 6–14°), which significantly improved postoperatively to 1.5°

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(range 0–3°) and remained stable at union with a mean of 1.7° (range 0–4°).

Fracture healing showed a mean time to union of 11.2 weeks (range 9–15 weeks), with delayed union (>12 weeks) occurring in 12.5% (5 cases). Secondary procedures such as dynamization were required in 5% (2 cases), and there were no cases of non-union. Functional outcomes were excellent in 70% (28 cases), good in 20% (8 cases), and fair in 10% (4 cases), with no patients (0%) reporting poor outcomes. Overall, 90% of patients had favorable functional outcomes, indicating a high success rate of fracture management.

Table 1: Patient Demographics

Parameter	Value
Mean Age	38.2 years (range 20-65)
Gender	30 males, 10 females
Mechanism of Injury	32 RTA, 5 fall, 3 trauma
Laterality	22 right, 18 left

Table 2: Fracture Classification

Fracture Type	Count
AO/OTA Type A	10(25%)
AO/OTA Type B	20(50%)
AO/OTA Type C	10(25%)

Table 3: Fracture Characteristics

Parameter	Value
Open fractures	28 closed, 6 Grade I, 6 Grade II
Fracture location	10 proximal third, 30 distal third
Mean fracture length	3.8 cm (range 2.5-6.0 cm)

Table 4: Fracture Alignment

Alignment Stage	Mean Varus/Valgus (°)
Preoperative	9.8 (6-14)
Postoperative	1.5 (0-3)
At Union	1.7 (0-4)

Table 5: Fracture Healing

Parameter	Value (weeks)
Mean time to union	11.2 (9-15)
Delayed union (>12 weeks)	5(12.5%) cases
Secondary procedures (dynamization)	2 (5%)cases
Non-union	0 cases

Table 6: Functional Outcomes

Outcome	Patients (%)
Excellent	28 (70%)
Good	8 (20%)
Fair	4 (10%)
Poor	0 (0%)

DISCUSSION

Tibial metaphyseal fractures present a major challenge in orthopedic trauma due to their high risk of malalignment and instability. While intramedullary nailing (IMN) is the standard treatment for long bone fractures, its effectiveness in metaphyseal fractures is often compromised due to the wider medullary canal and reduced cortical support. Poller screws (blocking screws) have emerged as a valuable solution, guiding the nail placement and improving overall fracture stability.

The present study evaluated 40 patients with tibial metaphyseal fractures, with an average age of 38.2 years. Most patients were male (75%), and road traffic accidents (80%) were the primary cause of injury. Similarly, Ravi et al. (2023)[4] analyzed 25 patients, also predominantly male, with an average age of 45.92 years. Their injuries were also largely due to high-energy trauma.Rohit et al. (2022)[5] focused on 42 patients, with the majority aged between 18 and 30 years. This study included both proximal and distal tibial fractures, with 60% of cases involving the distal third.In contrast, Krettek et al. (1999)[1] provided the

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first scientific documentation of Poller screws, highlighting their ability to prevent nail translation and improve alignment. Tan et al. (2023)[6] conducted a biomechanical study, using computational modeling to assess the effects of Poller screws, while Ahmed et al. (2023)[7] compared 50 patients treated with and without Poller screws to evaluate their impact on fracture healing.Across all studies, a consistent pattern emerged: high-energy trauma (such as RTAs) was the primary cause of injury, and young to middle-aged males were the most affected group.

Achieving proper fracture alignment is crucial in tibial metaphyseal fractures. The present study found that preoperative varus/valgus angulation averaged 9.8° (ranging from 6° to 14°). After surgery, this was significantly reduced to 1.5° (0° to 3°), and it remained stable at 1.7° at final union.Ravi et al. (2023)[4] did not specify exact pre- and post-operative angles but reported significant alignment improvement following the use of Poller screws. Rohit et al. (2022)[5] observed that 80% of patients achieved alignment within 5° deviation, and by the time of fracture union, 83% had maintained an acceptable alignment.Ahmed et al. (2023)[6] provided a direct comparison between patients treated with and without Poller screws. Their study revealed that 92% of the Poller screw group had less than 5° of malalignment, while those treated with IMN alone had a significantly higher risk of postoperative deformity.

A computational study by Tan et al. (2023)[6] reinforced these clinical findings, demonstrating that Poller screws improve axial stability and reduce interfragmentary motion, which helps maintain alignment throughout the healing process.The evidence clearly shows that Poller screws play a crucial role in preventing malalignment and ensuring long-term stability.

Healing time is a critical factor in orthopedic trauma management. The present study found that the mean time to union was 11.2 weeks (ranging from 9 to 15 weeks). Only 12.5% of cases experienced delayed union (>12 weeks), and no cases of non-union were observed.Similarly, Ravi et al. (2023)[4] reported an average healing time of 11.45 weeks, with most patients starting full weight-bearing by the 7th postoperative week. Rohit et al. (2022)[5], however, observed a longer healing period, with an average union time of 5.24 months (approximately 21 weeks). This longer recovery time may be attributed to differences in surgical technique or patient selection.Ahmed et al. (2023)[7] provided a comparative perspective, showing that patients treated with Poller screws had higher RUST (Radiographic Union Scale for Tibia) scores, indicating faster and more reliable healing compared to those treated with IMN alone.Tan et al. (2023)[6] explained why Poller screws accelerate healing: they increase construct stability, reduce stress on the implant, and improve load distribution, all of which contribute to earlier callus formation and more efficient bone healing.Taken together, these studies indicate that Poller screws enhance the fracture healing process and reduce the risk of delayed union.

Functional recovery is one of the most important aspects of post-surgical evaluation. The present study found that 70% of patients achieved excellent functional outcomes, 20% had good outcomes, and 10% had fair results. No patients experienced poor outcomes.Ravi et al. (2023)[4] used Sanders' functional score and found similar results, with 9 patients achieving excellent outcomes, 11 showing good results, and 5 reporting fair recovery.Rohit et al. (2022)[5] assessed recovery using the Karlstrom-Olerud scoring system. Their results were slightly lower, with 17% of patients classified as having excellent recovery, 37.1% good, 21.8% satisfactory, 2.9% moderate, and 2.9% poor functional outcomes.Ahmed et al. (2023)[7] reported better functional mobility and higher postoperative scores in the Poller screw group compared to IMN alone, further reinforcing the notion that better alignment leads to better function.

Overall, Poller screws consistently resulted in superior functional outcomes compared to IMN alone, ensuring better mobility, alignment retention, and faster rehabilitation.

Despite their advantages, the use of Poller screws is not without challenges. The present study reported no cases of non-union and only a 5% rate of secondary procedures, such as dynamization. Minor infections were observed but resolved with antibiotics.

Ravi et al. (2023)[4] encountered 5 cases of minor infection but no significant complications like implant failure or compartment syndrome. Rohit et al. (2022)[5] observed mild anterior knee pain in a few patients, which resolved with conservative treatment.

Ahmed et al. (2023)[7] highlighted that Poller screws reduced the incidence of malalignment-related complications. However, some patients experienced discomfort due to screw placement, particularly when screws were positioned too close to the joint.

Tan et al. (2023)[6] confirmed that Poller screws improve mechanical stability without increasing stress on surrounding bone, reducing the risk of implant failure.

Collectively, these studies indicate that Poller screws are a safe and effective adjunct in tibial fracture fixation, with minimal risk of complications when used properly.

CONCLUSION

The present study, along with supporting literature, provides strong evidence that Poller screws play a critical role in the surgical management of tibial metaphyseal fractures. Their use significantly improves fracture alignment, reduces malalignment risks, enhances biomechanical stability, and promotes faster healing. Additionally, they contribute to superior functional outcomes with minimal surgical risk.

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Studies like those by Ravi et al. (2023), Rohit et al. (2022), Ahmed et al. (2023), and the biomechanical study by Tan et al. (2023) reinforce the value of Poller screws, showing that they not only improve immediate fracture alignment but also ensure long-term functional benefits.

Given this overwhelming evidence, Poller screws should be a standard adjunct in the fixation of tibial metaphyseal fractures, particularly for cases where achieving alignment is challenging.

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