

RESEARCH ARTICLE

Benefits of Poller Screw in Improving Radiological Outcomes after Intra-Medullary Nailing for Distal Tibia Fractures; A Retrospective Cohort Study

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Received: 24 April 2024

Accepted: 20 July 2024

Abstract

Objectives: To compare the radiological outcomes after fixation of distal tibia fractures with IM nail between patients in whom poller screw was used vs those in whom it was not used.

Methods: A retrospective cohort study was conducted between 1st January 2009 to 31st June 2019 including patients treated with IM nail for distal tibial metaphyseal fractures. Patients were divided into 2 groups based on whether a poller screw was placed during surgery or not. The exposed group consisted of patients who underwent augmentation of IM nail with a poller screw, while control group included patients who underwent fixation with nail alone. All adult patients aged ≥ 18 years were included and patients with pathological fractures, known metabolic bone disease were excluded from the study. Follow-up x-rays were viewed through our hospital database and fracture healing was classified as either union, malunion or non-union based on radiographic parameters. A Radiographic Union Score in Tibia (RUST) score was calculated and a score of ≥ 9 was considered conclusive for complete union.

Results: 93 patients were included in the study with 21 patients in the exposed and 72 in the control group. According to the analysis, there were no significant differences in baseline characteristics of the study participants. The exposed group was found to be associated with increased rates of union and decreased non-union and mal-union rates compared to control group (P-value = 0.003). Mean RUST score was also noted to be significantly higher in exposed group compared to control group with a P-value of 0.025.

Conclusion: Use of poller screw with IM nail in treatment of distal tibial fractures is important in improving post-operative outcomes and decreasing mal-union and non-union.

Level of evidence: IV

Keywords: Distal tibia fracture, Distal tibia fracture intramedullary nailing, Improving outcome, Poller Screw, RUST Score

Introduction

Distal tibial fractures account for about 7 to 9 % of all lower extremity fractures,¹ and their management poses a great challenge for orthopedic surgeons around the globe.² Whether intra- or extra-articular, the goals of treatment in cases of distal tibial fractures include restoration of normal anatomy, fixation of the epi-metaphyseal block with the diaphyseal region and prevention of complications.³

The close proximity of extra-articular distal tibia fractures

to the ankle joint makes their management complicated compared to mid-shaft fractures.⁴ These fractures can either be managed conservatively with cast immobilization or require surgical fixation. Optimal treatment methods have still not been determined definitively and many surgical options can be utilized,⁵ these include treatment with external fixator, intra-medullary (IM) nailing or plate fixation, with each option having its own advantages and disadvantages.⁴

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THE ONLINE VERSION OF THIS ARTICLE
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Currently, IM nailing can be considered the gold standard of treatment,⁶ however it is also associated with certain pitfalls. A major cause of concern in nail fixation for distal tibial fractures is the discrepancy in diaphyseal and metaphyseal diameter of tibia with the metaphyseal region having a broader medullary canal.⁷ This difference leads to loss of nail to cortex contact at the metaphyseal region and can cause translation of the nail along the coronally placed distal screws, thereby resulting in malalignment of the fracture.⁸

Use of blocking screws, also known as 'Poller screws', have been described in international literature to prevent lateral translation of tibial nail.⁹ Their use was first reported in 1994, and since then have gained in popularity.^{9,10} The objective of a poller screw is to functionally reduce the diameter of the metaphyseal medullary canal thus preventing nail displacement and increasing strength of the overall construct.⁹ Various studies have showed the efficacy of poller screws combined with IM nail in treating femoral and tibial fractures.¹¹

Although, the use of poller screw provides additional stability and decreases complication rates, there is considerable lack of literature from our part of the world with regards to studies evaluating its outcomes and any associated complications.¹² Specifically, no study was found from our part of the world. Hence, the objective of this study was to compare the radiological outcomes after fixation of distal tibia fractures with IM nail between patients in whom poller screw was used vs those in whom it was not used.

Materials and Methods

A retrospective cohort study was conducted at our institution, a tertiary care center in Pakistan, including patients treated with IM nailing for distal tibia fractures from January 1, 2009 to June 31, 2019. Distal tibia fractures were classified as having a fracture at the metaphyseal region within the last 10cms of the tibial pylon. All adult patients aged ≥ 18 years were included. Patients with pathological fractures, known metabolic bone disease and those who were lost to follow-up or did not have X-rays in our hospital database were excluded from the study. Approval was obtained from the Ethical Review Committee (ERC) at our institution prior to conduct of the study.

All included patients were divided into 2 groups based on whether a poller screw was placed during surgery or not. The exposed group consisted of patients who underwent augmentation of IM nail with a poller screw, while control group included patients who underwent fixation with nail alone. Patient medical record files were reviewed for each included patient and baseline demographic characteristics were noted including age, gender, height, weight, and ASA status and fracture classification. Use of poller screw was determined from the surgical notes. Follow-up x-rays were viewed by the treating Orthopedic Surgeon at 3 months postoperatively through our hospital database and fracture healing was classified as either union, malunion or non-union based on radiographic parameters. A Radiographic Union Score in Tibia (RUST) score was calculated and a score of ≥ 9 was considered conclusive for complete union. The RUST system shown in Table 1 assigns a score to a given set of anteroposterior and lateral radiographs based on the

assessment of healing at each of the four cortices visible on X-ray projections (i.e., medial and lateral cortices on the anteroposterior X-ray, anterior and posterior cortices on the lateral X-ray). Each cortex receives a score of 1 point, if it is deemed to have a fracture line with no callus; 2 points, if there is callus present but a fracture line is still visible; and 3 points, if there is bridging callus with no evidence of a fracture line. The individual cortical scores are added to give a total for the set of films with 4 being the minimum score indicating that the fracture is definitely not healed and 12 being the maximum score indicating that the fracture is definitely healed.¹³

Data was analyzed using SPSS software version 21. All qualitative variables e.g. gender, ASA status, fracture classification were represented as percentages while quantitative variables e.g. age, height and weight were expressed as mean \pm standard deviation. Chi-square test was applied to compare categorical variables between both groups while continuous variables were compared using Independent Sample T-test. A p-value of <0.05 was considered significant. Inter and Intra-observer variation in calculating lateral distal tibial angle was calculated using Intraclass correlation coefficient (ICC).

Results

In total, 99 patients were identified but 6 were excluded as they had pathological fractures. 93 patients were included in the study with 21 (22.6%) patients in the exposed group and 72 (72.4%) patients in the control group. Baseline characteristics for both groups are summarized in Table 1 and were found to be similar amongst both groups [Table 1]. Mean age of patients in the exposed group was noted to be 23.6 ± 17.8 years, while that of control group was 42.3 ± 15.3 years, with the difference being statistically insignificant (P -value = 0.73). The BMI was also found to be comparable between the exposed and control groups (25.1 vs 26.2 respectively) with a P -value of 0.28. With respect to fracture type, majority of the fractures were closed and most common fracture pattern was noted to be AO type 43A-1 in both groups as shown in [Table 1].

A statistically significant difference was noted in healing status between both groups as shown in [Table 2]. The exposed group was found to be associated with increased rates of union and decreased non-union and mal-union rates compared to control group (P value = 0.003). Mean RUST score was also noted to be significantly higher in exposed group (9.81 ± 1.47) compared to control group (8.85 ± 2.27) with a P -value of 0.025. With regards to post-operative lateral distal tibial angle and length of hospital stay, no statistically significant difference was observed between both groups as shown in [Table 2].

Out of the 93 patients, lateral distal tibial angle was recalculated for 15 patients by the same observer as well as a different observer not part of the study. The ICC value for intra-observer correlation was noted to be 0.95 while that for inter-observer correlation was 0.94 indicating excellent results.

Discussion

Adequate reduction and fixation of metaphyseal fractures with IM nail requires careful pre-operative planning and use of various techniques including useful adjuncts such as poller

screws.¹⁴ Fixation of distal tibial fractures with IM nail has been shown to provide better structural stability and reduced inter-fragmentary movement compared to plating, and hence, is considered to be treatment of choice.¹⁵

However, due to the risk of complications including non-union or mal-union associated with IM nailing, use of poller screws has gained popularity to increase the overall stability of fixation.¹²

Table 1. Baseline characteristics of study population. Exposed implies patients with poller screw placement, and Control implies those who did not

Characteristics	Group (%)		P-value
	Exposed	Control	
Gender			
Male	18 (25)	54 (75)	0.30
Female	3 (14.3)	18 (85.7)	
Age	23.6 ± 17.8	42.3 ± 15.3	0.73s
ASA Status			
I	14 (27.5)	37 (72.5)	0.43
II	4 (14.8)	23 (85.2)	
III	3 (20)	12 (77.4)	
AO Classification			
A1	9 (22.5)	31 (77.5)	0.81
A2	8 (25.8)	23 (74.2)	
A3	4 (18.2)	18 (81.8)	
Fracture Type			
Open	6 (20)	24 (80.0)	0.69
Closed	15 (23.8)	48 (76.2)	

Table 2. Comparison of outcome measures between exposed (poller) and control groups

Outcome measure	Group (%)		P-value
	Exposed	Control	
Healing status			
Complete Union	19 (34.5)	36 (65.5)	0.003
Non-union	1 (3.3)	29 (96.7)	
Mal-union	1 (12.5)	7 (87.5)	
RUST score	9.81 ± 1.47	8.85 ± 2.27	0.025
Lateral Distal Tibial Angle (°)	90.3 ± 8.03	89.6 ± 5.74	0.59
Length of hospital stay (days)	4.76 ± 3.02	5.28 ± 4.1	0.68

Recently, a study was conducted in Cairo to evaluate the mechanical effects of poller screw after fixation of tibial metaphyseal fractures with IM nail. Post-operative alignment and RUST scores were observed within the 20 patients included in the study at follow-up visits. They concluded that poller screws play an important role in augmenting fracture healing as well as neutralizing the deforming forces that are responsible for mal-union in fractures treated with IM nail alone.¹⁶ In another cohort study conducted by Guo J et.al in 2021, use of poller screws was shown to significantly increase fracture healing and reduce rates of mal-union and need for secondary surgery in the treatment of distal tibia and femur fractures with IM nail. They also concluded that use of poller screws as an adjunct with IM nail results in better outcomes.¹⁷

Similar to the results of prior international studies, the current study also shows significantly higher union rates with the use poller screws along with IM nail in treatment of distal tibial fractures compared to fixation with IM nail alone.

Additionally, mean RUST score was also shown to be significantly higher in the poller screw group (P-value = 0.025). Other parameters including lateral distal tibial angle and length of hospital stay also showed favorable results with the use of poller screws, although the difference was not statistically significant. These findings are further complimented by the results of a systematic review conducted in 2020 to evaluate the outcomes of IM nail fixation of long bone fractures augmented with poller screw. The results showed significantly reduced rates of all complications including non-union, mal-union, surgical site infections and requirement of re-do surgery with the use of poller screw.¹²

In contrast, in a study conducted recently in 2020 to assess the biomechanics of fixation of distal tibia fractures within 3 treatment groups; tibial plate, tibial nail and tibial nail with poller screw, significantly improved axial stiffness and interfragmentary movement was noted with tibial nail and nail with poller screw group compared to tibial plate.

However, no significant difference was found when tibial nail was compared to fixation with nail and poller screw.¹⁵ This has led us to believe that there is still room for further large-scale studies to compare both clinical and biomechanical outcomes of fixation of metaphyseal fractures using poller screw as an adjunct.

The results of the current study, however, indicate that use of poller screws is associated with improved post-operative outcomes even in developing countries where there is considerable lack of resources and expertise compared to the developed part of the world. The deficiency of advanced surgical tools in the developing world, in fact, makes it more important for us to utilize all available options to achieve better post-operative results, including the use of poller screws as shown here.

The current results add valuable data to the existing literature, especially from the developing part of the world where the use of poller screw is not well studied. However, one of the limitations of this study is its retrospective design which makes it prone to information bias. In addition, this is only a single center study with a limited sample size and small treatment group. Therefore, the authors believe that further large-scale prospective trials are still required to establish definitive conclusions regarding the use of poller screws as an adjunct to treatment of distal tibial extra-articular fractures with IM nail.

Conclusion

Use of poller screw with IM nail in treatment of distal tibial fractures is important in improving post-operative outcomes and decreasing mal-union and non-union.

Acknowledgement

N/A

Authors Contribution:

Akeel Ahmed: participated in study design, data collection, and analysis of X-rays, manuscript write-up and approval of final manuscript.

Moiz Ali: Data Collection, Analysis of x-rays and Manuscript write-up.

Muhammad Omer Farooq: Data Collection, Analysis of x-rays and Manuscript write-up.

Muhammad Ahsan Sulaiman: Analysis of x-rays, manuscript write-up and final manuscript approval and submission.

Tashfeen Ahmad: study design, interpretation of data, manuscript write up and approval of final manuscript.

Haroon Rashid: study design and idea, interpretation of data, supervision of manuscript write- up and approval of final manuscript.

Declaration of Conflict of Interest: All authors have no conflict of interest.

Declaration of Funding: The author received NO financial support for the preparation, research, authorship, and publication of this manuscript.

Declaration of Ethical Approval for Study: Approval from the Ethical Committee at Aga Khan University was obtained before proceeding with the study. (No. 2020-5217-15212)

Declaration of Informed Consent: There is no information (names, initials, hospital identification numbers, or photographs) in the submitted manuscript that can be used to identify patients.

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