Evaluation of Treatment of Distal Tibia Fracture with an Intramedullary Interlocking Nail and Single Poller Screw

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ABSTRACT

Introduction: Distal tibia fracture tends to angulate while using a standard intramedullary interlocking nail. By using a single Poller screw, the medullary cavity's functional diameter is reduced. This leads to angulation correction and three-point fixations, which improve the mechanical stability of the nail-bone construct. **Aims:** To assess the functional and radiological results of the intramedullary interlocking nail and poller screw in management of adult distal tibia fracture. **Methods**: All patients with distal tibia fractures age more than 18 years, treated with intramedullary interlocking nails and a single poller screw at Nepalgunj Medical College between January 2022 and April 2023 were included in this prospective study. Radiological examination involved measuring sagittal and coronal plane angulation pre and postoperatively, while functional outcome was assessed using the Karlstorm- Olerud score. Ethical clearance was obtained from Institutional Review Committee. **Results**: Total 30 patients, 19 male and 11 females with mean age of 32.37 ± 11.02 (range 18 to 62 years) were treated. Mean difference of diameter between isthmus and fracture site was statistically significant. There was significant reduction in coronal and sagittal plane angulation after surgery which was maintained till union. All fractures united at an average of 17.60 ± 2.25 weeks, with 90% having good to excellent results. **Conclusion**: Using a poller screw with an intramedullary interlocking nail can greatly alleviate the angulation issue with the distal fragment for distal tibia fracture.

Keywords: Distal tibia fracture, intramedullary interlocking nail, poller screw

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INTRODUCTION

Adult tibia fracture accounts for roughly 17% of all lower extremity fractures and numerous treatment techniques have been published in literatures.[1] Intramedullary nailing in tibia fracture has been considered gold standard because of its load sharing properties, preservation of extra osseous blood supply, less surgical dissection, early weight bearing and faster return to normal activities.[2] However, their use in distal tibial fracture is debatable because of sagittal and coronal plane misalignment of these smaller fragments. Additionally, there is a mismatch in the diameter of the isthmus and distal tibial flare, which prevents the nail from making contact with the cortex and allows movement laterally along coronally positioned locking screws, resulting in an angular deformity of distal part. Poller screw prevents this off-tracking trajectory of intramedullary nail.[2-4]

This concept of poller screw was inspired by traffic barrier known as “Poller pullert” which is metal bollards designed to block or guide traffic. It was introduced by Krettek et al. as an important adjunct to close reduction.[4,5] It narrows the width of medullary cavity at distal aspect, by acting as an additional cortex. This design increase mechanical stiffness of bone – implant construct by three point fixation, at the same time it also prevents deviation of axis of nail.[2,6,7] Poller screw controls deforming effect of muscle and ligamentous tension, which was a typical issue when nailing distal tibia fractures, this lessens the angular deformity.[8,9] The aim of this study is to evaluate the functional and radiological outcomes of the intramedullary interlocking nail and Poller screw in the treatment of adult distal tibia fracture.

METHODS

This is a hospital based prospective observational study was

conducted at Nepalgunj Medical College between January 2022 and April 2023. All patients with distal third extra articular tibial fractures (AO type 4.3. A) managed with a standard hollow intramedullary nail and a single Poller screw were included in this study.[10] Exclusion criteria included proximal and middle third tibial fracture, intra articular fracture, open fracture, pathological fracture and revision surgery for nonunion. In order to avoid selection bias, even grades 1 and 2 open fractures were left out of the study. This is because an open injury can be a significant confounding factor for infection. Preoperatively radiological characteristics like deformity in coronal plane (varus / valgus angulation) and deformity in sagittal plane (antecurvatum / recurvatum angulation), diameter at isthmus and diameter at fracture site were measured using AGFA (American Genre Film Archive) musica acquisition workstation software shown in (Figure 1).

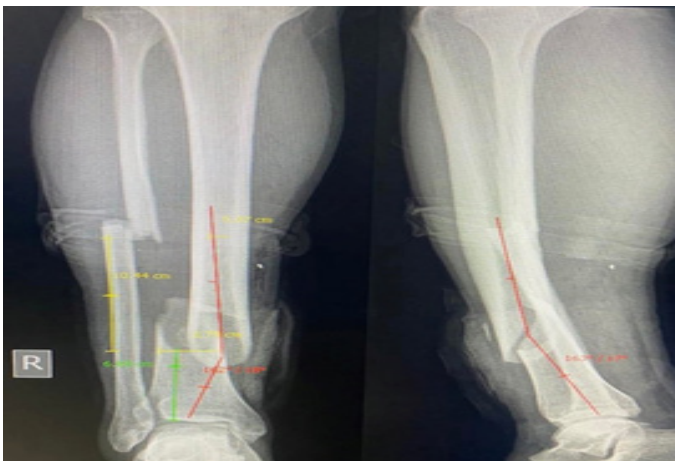

Figure 1: Calculation of coronal and sagittal plane angulation using AGFA (American Genre Film Archive) musica acquisition workstation software

All fibula fracture near the tibia fracture (within two centimeter from tibial fracture) was stabilized with an intramedullary K wire.[11] By using the transtendinous patellar tendon method, an olive tip guide wire was inserted, while the fracture was manually reduced with traction. The blocking screw's location was established at distal metaphysis region towards the concave side of deformity approximately 0.5 to 1 centimeter distal to the fracture and along the line of inner cortex of the diaphysis.[2,5,11] The screw was placed so that it retains the achieved reduction while keeping the wire central. Then medullary canal was gradually reamed. At all times, reaming of the medullary canal should end before the blocking screw and the broad metaphyseal area.[2,5] The ball tip guide wire was changed with straight guide wire centered to prevent displacement and angulation at the fracture site, the wire needs to be placed in the distal tibial metaphysis in the center. The nail length should then be measured and nail's diameter must be one millimeter less than that of the previous reamer. The nail was then inserted and the two distal locking screws were fixed first, then the two proximal locking screws. Post operatively patients were encouraged for range of motion exercise and isometric muscle strengthening exercise. Weight bearing was started after 14 days, as tolerated by the patient and was increased gradually. All patients were followed every month till three months and at three months interval then after till nine months. (Figure 2)

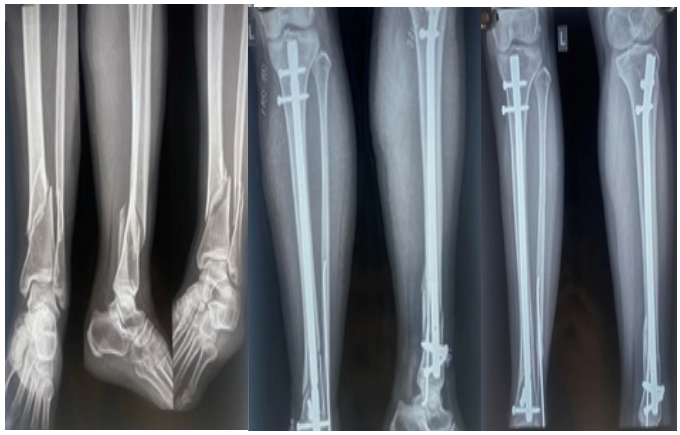

Figure 2: Serial X-ray of distal tibia fracture managed with intramedullary interlocking nail with poller screw

Union was defined as absence of pain at fracture site and radiological evidence of callus in three cortices.[12] At final follow up functional outcome was evaluated using Karlstorm-Olerud score.[13] Statistical analysis was done using Statistical Package for the Social Sciences (SPSS) version 25. Data was presented as Mean ± Standard deviation and comparisons of means of study population before and after was done with paired sample T test. P value less than 0.05 was considered as statistically significant.

RESULTS

There were 19 males with mean age of 31.42 ± 11.85 years and 11 females with an average age of 34 ± 9.74 years. Mean diameter at isthmus was 1.23 ± 0.26 centimeter and similarly mean diameter at fracture site was 2.24 ± 0.34 centimeter. Most of the patients had AO type A2 fracture. (Figure 3)

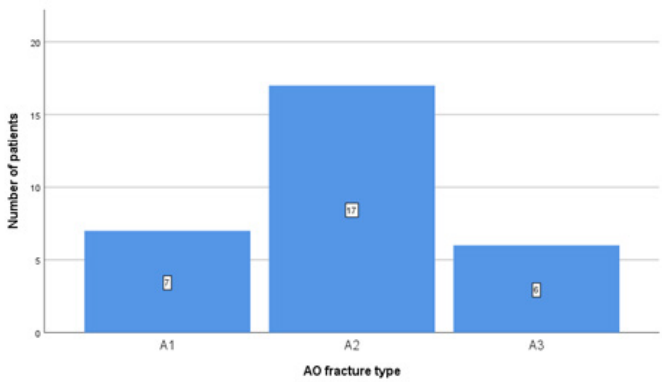

Figure 3: Number of patients according to AO classification

All patients were followed up in the outpatient clinic every month till three months and at three months interval then after till nine months. The average preoperative coronal plane angulation was 2 ± 11.33 degrees varus while mean postoperative coronal plane angulation was 0.13 ± 2.88 valgus which remained unchanged till union. (Table I)

Mean varus valgus angulation					
	Number	Minimum angulation	Maximum angulation	Mean angulation	Std. deviation
Pre-operative	30	-20	14	2.00	11.335
Post-operative	30	-5	5	-.13	2.886
At union	30	-5	5	-.13	2.886

(- varus / + valgus angulation)

Table I: Average of change in coronal plane angulation

Similarly average preoperative sagittal plane angulation was 4.77 ± 4.79 degree antecurvatum while mean postoperative sagittal plane angulation was 0.63 ± 1.09 degree of antecurvatum which stayed the same till union (Table II)

Mean antecurvatum/ recurvatum angulation					
	Number	Minimum	Maximum	Mean	Std. Deviation
Pre-operative	30	-3	15	4.77	4.790
Post-operative	30	0	3	.63	1.098
At union	30	0	3	.63	1.098

(- antecurvatum/ + recurvatum angulation)

Table II: Average of change in sagittal plane angulation

The difference in mean value of coronal and sagittal plane angulation before and after the surgery was found to be statistically significant with a p value < 0.05 in both the planes which remained unchanged till union.

All fractures united at an average of 17.60 ± 2.25 weeks . Final assessment was done at nine months for the evaluation of functional outcome. Twenty patients (66.7%) having an excellent outcome and seven patients (23.3%) exhibited good result. (Figure 4)

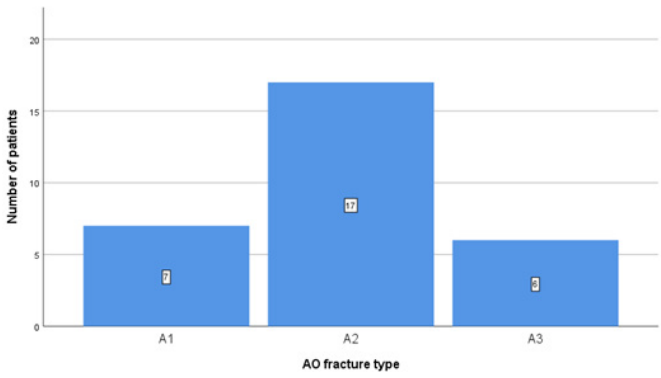

Figure 4: Functional outcome of distal tibia fracture treated with intramedullary interlocking nail and poller screw

Three cases were dynamized with removal of proximal static locking screws at three months postoperatively where there was no progressive increase of callus in subsequent radiographs. Two patients had an anterior knee pain due to nail prominence where nail was prominent postoperatively; one had superficial infection at proximal bolt site which healed with dressing and antibiotics. Nail caps were not used during surgery.

DISCUSSION

Intramedullary interlocking nails are considered standard method of treatment in diaphyseal tibia fracture.[1] These nails are load sharing implants which requires less surgical dissection with better biomechanical stability as compared to plating. These advantages have lured orthopedic surgeons to extend its use beyond a mid diaphyseal fracture.[14] However when treating more distal fractures, smaller distal fragment and wide bone diameter at metaphyseal region above the plafond make the fracture more amenable to varus/ valgus angulation. With the discovery of poller screw insertion technique initially described by Hahn et al, Krettek et al, Sean et al, the screw provides a point of support on the side of nail serving as an additional cortex which enhances bone-implant interface by providing a three point fixation as was initially described by Charnley, which in turn increases the mechanical strength of fracture fixation.[2,4,6,15] We used poller screw insertion technique described by Krettek et al and Hannah et al.[4,8]

Ahlers and Lssendorff examined 386 tibia fractures with intramedullary nailing, of which 32 were proximal third fractures and 138 were distal tibia fracture. One-quarter to one-third of both groups showed varus-valgus abnormalities of more than four degrees in there study when managed with intramedullary interlocking nail alone.[16]

Similarly Egol et al evaluated the alignment loss in distal tibial fractures treated with intramedullary nailing both alone and in conjunction with fibular plating. In three of the cases where they were only treated with nailing, they experienced post-operative malalignment right away, which was subsequently fixed with blocking screws.[17]

In our study using a poller screw significantly reduced the sagittal and coronal plane angulation during and after the surgery, which was maintained till union. No further intervention was required with the use of poller screw. The results were consistent with that of Krettek et al, Abd El-monaem et al, Seyhan et al, Bhangadiya et al.[18-21]

Moongilpatti et al concluded adding a poller screw increased intrinsic stability in tibial intramedullary nail constructs in distal third diaphyseal fractures than those without isthmal support.[9]

Stedtfeld et al described that poller screw reduces the effective diameter at the metaphysis. In fact it supports nail during insertion till union providing a three point fixation. The screw, the anchorage point at the end of the nail, and the isthmus of the long bone are the three points.[6]

Adding a poller screw in our study helped to achieve reduction and maintain it which was also described in several studies.[6,9]

All fractures united at an average of 17.60 ± 2.25 weeks, the results were consistent with that of Ravishanka et al, Sean et al, Krettek et al, Fan et al.[3,15,18,22]

Whittle et al. in their quest to evaluate influence of fibular fracture on malalignment concluded correlation between malunioun and associated unstabilized fibular fractures that occur at the same level (within 2 cm of tibial fracture). In their study (61%) unfixed same-level fibular fractures and one of 13(8%) different-level fibular fractures were associated with malalignment. In our study twenty patients had associated fibula fracture where 13 had fibula fracture at same level.[11]

In our study all patients with fibula fracture at the same level with tibial fracture were stabilized with K wires. Three (10%) patients whose fibula fracture was more than two cm proximal to tibial fracture and were not stabilized with K wire developed slight angulation (less than five degree), post operatively and did not change till union, had fair functional outcome. Remainder of patients with intact fibula, fibula fracture stabilized with K wire and fibula fracture more than two cm proximal from fracture site exhibited good to excellent result.

LIMITATIONS

One of the drawbacks was the absence of comparison with plating group or intramedullary interlocking nail without the use of poller screw group of patients, having similar fracture pattern, which would have led to a more insightful result. Another limitation can be exclusion of grade 1 and 2 open injuries which could have been managed with similar technique.

CONCLUSION

The use of a Poller screw in conjunction with an intramedullary inters locking nail aids to achieve greater stability by providing a three point contact and maintaining the angulation until union. The surgery is reproducible and can be done with locally available implants.

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