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Study on management of extra articular distal tibial metaphyseal fractures by intramedullary interlocking nailing

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ABSTRACT

Background: Fractures of the tibia remain a controversial subject despite advances in both non-operative and operative care. The goal in expert care is to realign the fracture, realign limb length, and early functional recovery. To analyze the short-term results of intramedullary interlocking nailing in the management of extra-articular distal tibial metaphyseal fractures done.
Methods: This is a prospective comparative on-randomized study of 28 patients with distal tibial metaphyseal fractures in govt. dist. headquarters hospital Nagapattinam with a follow-up ranging from September 2018 to January 2019 4 months. Injury With more than 3 weeks, nonunion, and patient with multiple injuries or a history of previous knee or ankle pathology were not included as were patients who sustained high energy axial load injury-causing disruption or impaction of the ankle plafond.
Results: The average distance between the distal tip of the nail and the articular surface of the plafond was 12 mm (range, 4 to 15 mm). Fibular plating was done in 10 patients. Two distal locking bolts were used in 26 patients; 2 patients had three distal locking bolts.
Conclusions: Intramedullary nailing is a safe and effective technique for the treatment of extra-articular distal metaphyseal tibial fractures if careful preoperative planning is allied with the meticulous surgical technique.

Keywords: Distal tibia fractures, Extra-articular, Pilon fractures, Interlocked nailing

INTRODUCTION

Fractures of the tibia remain a controversial subject despite advances in both non-operative and operative care. The goal in expert care is to realign the fracture, realign limb length, and early functionalrecovery.[1] Treatment of distal tibial metaphyseal fractures can be challenging. Fractures in this region have not been clearly distinguished from pilon fractures, and the literature contains relatively little information on their treatment.[2] The mechanism of injury, treatment principles, and prognosis for these fractures is a different form and must be distinguished from those for both proximal diaphyseal fractures and distal intra-articular pilon fractures.[3] Treatment selection is influenced by the proximity of the fracture to the plafond, fracture displacement, comminution, and injury to the soft-tissue envelope. Traditional methods of surgical fixation, such as open reduction and internal fixation have been associated with poor results, including soft tissue devitalization, skin slough, and infection.[4] Conservative treatment in an attempt to avoid these complications has resulted in unacceptable deformity and loss of ankle range of motion. Minimally invasive surgical techniques have been developed to avoid soft tissue complications while providing the stability and alignment offered with internal fixation. Several techniques have emerged: hybrid external fixation, external fixation with limited internal fixation, percutaneous plate osteosynthesis, and intramedullary nailing.[5] Intramedullary nailing of open and closed tibial shaft fractures has been associated with high rates of radiographic and clinical success, but the use of this procedure has not become widely accepted for distal metaphyseal fractures. Because fractures distal to the tibial diaphysis and within 5-6 cm of the ankle joint may represent a different injury, they have been excluded from reports on intramedullary nailing of tibial shaft fractures.[4] The distal segment of these fractures is more difficult to control with intramedullary implants because of the metaphyseal flare above the plafond which amplifies the bendingmoment.[5] Recent changes in intramedullary nail design have extended the spectrum of fractures amenable to this type of fixation. But there are concerns about using intramedullary nailing as a treatment for distal metaphyseal fractures because of difficulties with reduction, risk of distal propagation of the fracture, hardware failure, and inadequate distal fixation leading to loss of reduction and malalignment.[6] Only a few studies have assessed the use of intramedullary nailing in dealing with fractures below the tibialisthmus.[7]

METHODS

This is a prospective comparative on-randomized study of 28 Patients with distal tibial metaphyseal fractures in govt. dist. headquarters hospital Nagapattinam with a follow-up ranging from September 2018 to January 2019 for 4 months. Injuries with more than 3 weeks, nonunion, and patient with multiple injuries or a history of previous knee or ankle pathology were not included as were patients who sustained high energy axial load injury-causing disruption or impaction of the ankle plafond. Patients suffering from open fractures underwent debridement and primary closure followed by stabilization. Inclusion criteria were, fracture sustained within the past 1-week, skeletal maturity, fracture center in the distal metaphysis of tibia involving the distal 5 cm, associated fibular fracture, and treatment with an intramedullary nail of the fracture pattern that allowed placement of at least 2 distal interlocking screws through the nail. There were 24 men and 4 women with a mean age of 33 years (19 to 55). All fractures were classified by the AO system Muller et al, and the classification by Robinson et al. The severity of the soft-tissue injury in the open fractures were recorded on the Gustilo system, and closed fractures were recorded on the Tscherne system. Biplanar injury radiography was evaluated to determine the fracture location and involvement of the distal part of the tibia by applying the AO system of rule of squares. In all cases, the fracture extended to within 5.5 cm of the ankle joint and there was an associated fibular fracture. Low energy motor vehicle accident and fall from height causing a torsional or bending force was the mechanism of injury in the majority of the patients. All the fractures were treated with a primary reamed intramedullary nailing system that increased the distal fixation with up to 3 biplanar distal interlocking screws passing through the distal 4 cm of the nail. The surgery was done using a standard radiolucent table under c-arm guidance with manual traction alone. The decision for adjunctive fibular stabilization as well as the number and orientation of the distal locking bolts were made at the surgeon's discretion. In general, 2 medial to lateral locking bolts were preferred. Open reduction of the fracture was done in 8 patients. Patients suffering from open fractures underwent debridement and primary closure followed by stabilization. Closed fractures were initially managed by reduction and application of splint followed by operative treatment to decrease the soft tissue swelling. All patients were given I.V. third-generation cephalosporin during induction which was continued for 3-5 days postoperatively. The average time from the moment of injury to the operative fixation of fracture was 12 days (range 6 hours to 20 days).

RESULTS

Table 1 shows patients' age ranged from 19 to 55 years, average: 32. In our series, male predominated with the ratio of 6:1. In our series, the Right side was more common in our series, RTA is the predominant cause of injury. In RTA, pedestrian vs 2-wheeler was the most common subtype

Table 1: Age incidence.

Age (years)	No. of patients
11-20	1
21-30	10
31-40	8
41-50	7
51-60	2
Total	28

Table 2: Fracture classification.

Fracture type		No. of patients
Open	Gustilo type I	5
	Gustilo type II	3
Closed	There type I	14
	There type II	6

Table 2 shows that in our study, eight fractures were open: five were classified as Gustilo type I and three as type II. Of the remaining closed fractures, fourteen were classified as Tscherne type I and six as type II.

Table 3: AO/OTA classification.

AO/OTA type	No. of patients
43 A1	16
43 A2	9
43 A3	3

Table 3 shows that according to AO/OTA guidelines, there were sixteen 43A1, nine 43A2, and three 43A3 fractures.

Table 4 shows that on using the classification of Robinson et al seventeen patients had type I and eleven patients had type IIA fractures.

Table 4: Robinson classification.

Robinson type	No. of patients
I	17
III	11

Table 5: Fracture configuration.

Type of tibia fracture	Level of fibula fracture	No. of patients
Transverse	Same level	9
	Proximal level	6
Oblique	Same level	4
	Proximal level	2
Comminuted	Same level	5
	Proximal/segmental	2

Table 5 shows that in our series, nearly 60% of fractures were transverse. The decision for adjunctive fibular stabilization as well as the number and orientation of the distal locking bolts were made at the surgeon's discretion. Fibular plating was done in 10 patients. Two distal locking bolts were used in 26 patients; 2 patients had three distal locking bolts. Acceptable alignment was obtained in 26 patients. The two patients who had immediate malalignment in the form of 10° valgus deformity had a transverse fracture of tibia with the same level fibular fracture (AO43A1 and Robinson type 1). In both, the cases fibula was not stabilized. One patient underwent corrective surgery with fibular plating and the other patient denied surgery and was eventually lost for follow up. In total out of the 28 patients in our study, two were lost to follow-up. Out of the remaining 26 patients, 25 had radiographic evidence of healing at the time of follow-up. The mean time for the union was 19 weeks (range 12-26 weeks). The mean IOWA ankle functional assessment score was 82 (good) (range 68-94) of the two patients who were lost to follow-up, one had comminuted fracture with segmental fibular fracture and the other had transverse fracture with a same level fibula fracture. The fracture patterns and immediate postoperative alignment in these patients were not significantly different from those in the remaining.

DISCUSSION

Treatment principles for extra-articular distal tibial metaphyseal fractures are different forms and must be distinguished from those for both proximal diaphyseal fractures and distal intra-articular pilonfractures.[8] Muller defined the distal tibial metaphysis by constructing a square, with the sides of length defined by the widest portion of the tibial plafond. In our review, we considered fractures within 5.5 cm of the tibial plafond without extension to the plafond to be distal metaphysealfractures.[9] The major difficulty in selecting candidates for intra medullary fixation of a distal tibial fracture is in differentiating low energy tibial fractures from axial high energy loading injuries with or without primary articular involvement Published studies often include fractures with intra articular extension and they utilize AO/OTA classification of tibial pilon fractures for classification which is inadequate, does not address the fibula and does not differentiate high energy axial load fractures with low energy extra-articular fractures.[10] Our study, all patients had the primary fracture center being located in the metaphysis, without articular extension with an associated fibular fracture. We utilized both AO/OTA classification for comparison and the new classification by Gorczyca et al.[11] The shortcomings we observed in this new classification were that the fracture patterns described were not common in our set up, it included an intra articular and malleolar extension group which is difficult to recognize by X rays and does not address stabilization offibula.[12] Nailing of extra-articular distal tibia fractures is challenging, technically demanding, and should be approached with caution. Apart from malalignment which is recognized in the immediate postoperative period, primarily due to difficulty in controlling the short distal fragment and technical errors, loss of reduction can occur during the follow up due to unrecognized instability. [13] Thorough critical surgical tenets such as central placement of the guide wire and reamers, maintenance of the reduction at the time of nail passage and placement of nail in the sub chondral region, are described to avoid intra operative malalignment, very few studies explore the causes and prevention of loss of reduction during follow up.[14] In our study we found that the loss of reduction and malunion was more-8 patients (25%). Konrath et al performed a meta-analysis of the English-language literature to assess the complications and healing rates associated with the different techniques used to treat this injury. The results of this review revealed that the highest complication rates were in the intramedullary nailing group with a malunion rate of 16.2%.[15] In the study by Krettek et al, on fractures located within 5 cm of the ankle joint treated by nailing an 8% rate of malunion was reported. No patient demonstrated loss of alignment during the follow-up period. The better results reflected in this series were related at least partly to the common use of multiple screws in the distal fragment and ipsilateral fibular plating. Therefore, excluding patient-related causes for late malalignment, the two major factors which appear to affect the fracture construct stability are adjunct fibular stabilization and the number and orientation of the distal locking bolts.[16] Kumar et al reported on the effect that fibular plating of the same level tibia-fibula fractures has on the rotational stability of distal tibial fractures treated with an IM nail. Fibular plate reduced axial rotation by approximately 1.5 deg when a torque of 1 to 5 N was applied to the proximal end of the tibia.[17] In the multivariate-adjusted analysis, plating of the fibular fracture was significantly associated with the maintenance of reduction. The authors found that the use of at least two distal locking bolts also was protective against the loss of reduction. In our experience, we found fibular plating a useful adjunct in the setting where the associated fibular fracture is in the same level with displaced transverse or oblique fracture of the tibia and in the presence of significant metaphyseal comminution in which rotational and sagittal alignment may be difficult to maintain with nail fixation alone.[19] Fibular plating also aids in obtaining and maintaining the reduction of a distal tibia fracture with significant valgus angulation before intramedullary nailing thereby potentially reducing the risk of a malalignment. Two distal locking bolts certainly add strength to fracture stability but there is some discrepancy in the literature regarding its orientation on fracture construct stability.[20] This is in contrast to the study by Morrison et al which found a significant difference in stability between constructs locked with bolts in parallel versus those placed perpendicular with 2 parallel locking bolts being a better construct. Our study had both types of constructs; both had a failure to maintain alignment.[21] Some researchers have advocated the use of adjunctive blocking screws to obtain the reduction and alignment. These screws were not used in our series because the patients were treated with alternative reduction methods, including plate fixation of the fibula before intramedullary nailing, reduction with a percutaneous clamp, and manual manipulation. In our study, all the 26 patients had a union of the fracture and the meantime for the union was 19 weeks (range 12-26 weeks).[22] No bone-grafting procedures were required to obtain union in any patient. One patient with delayed union underwent a dynamization procedure following which the fracture united. This result is comparable to other studies on the management of such fractures by interlocking nailing. Anterior knee pain was noticed in four patients. The mean IOWA ankle functional assessment score was 82 (good) (range, 68-94).[23] Many studies stress the importance of obtaining and maintaining a reduction of distal tibial fractures with stable fixation allowing for early rehabilitation. But till now there have been no prospective, randomized trials on the types of treatment of this injury. The ability to differentiate which fractures are appropriate for intramedullary nailing with adjunctive fibular stabilization was largely qualitative and based on experience and an understanding of the fracturepattern.[24,25]

CONCLUSION

Intramedullary nailing is a safe and effective technique for the treatment of extra-articular distal metaphyseal tibial fractures if careful preoperative planning is allied with the meticulous surgical technique. Acceptable alignment of the short distal fragment during surgery is necessary for a good functional outcome. Knowledge and recognition of inherent instability of the short distal fragment are necessary to enable stable fixation and avoid loss of reduction on follow up. We propose a new classification to aid stable fixation of the distal fragment by fibular plating. Prospective, randomized, clinical trials are needed to determine the outcomes of methods of internal fixation in the management of extra- articular distal metaphyseal tibial fractures.

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