

A Comparison of the Outcomes of Locking Plate Fixation Versus Closed Intramedullary Interlocking Nails in the Treatment of Extra Articular Distal Tibial Fractures

Neeraj Kumar

Senior Resident, Department of Orthopaedics, All India Institute of Medical Science,
Patna, Bihar, India

Received: 17-04-2021 / Revised: 21-05-2021 / Accepted: 19-06-2021

Corresponding author: Dr. Neeraj Kumar

Conflict of interest: Nil

Abstract

Aim: To compare the outcome of locking plate fixation and closed intramedullary interlocking nail in the management of extra articular distal tibial fractures. **Methods:** The prospective clinical study was conducted in the Department of Orthopaedics, All India Institute of Medical Science, Patna, Bihar, India for 2 years. 40 Patients aged between 18- and 50-years presence of distal fragment of at least 3 cm in length without articular incongruity duration of injury <2 weeks no involvement of neurovascular status was include in the study. Patients with open fractures intra articular extension, pathological fractures were excluded from the study. Poor medical health was excluded from study. **Results:** The classification of fractures 43 A.1– 10 (50%) ILN, and 10 (50%) plating 43 A.2–6 (30%) ILN, 4 (20%) plating, 43A.3–4 (20%) ILN, 4 (30%) plating. Duration of surgery 40–60 min 14 (70%) ILN, 8 (40%) plating, 61–80 min 6 (30%) ILN, 8(40%) plating, and >80 min 4 (20%) only in plating surgery. duration of total weight bearing after surgery 8–10 weeks 14 (70%) in ILN, 3 (15%) in plating, 11–12 weeks 6 (30%) ILN, 6 (30%) plating, 13–14 weeks 8 (40%) in plating, and >14 weeks 3 (15%) observed only in plating duration of fracture union (radiological study) – 17.12 (SD ± 1.57) ILN 21.28 (SD ± 1.78) plating t-test –6.2 P < 0.001 (P-value was highly significant). study of post-surgical complications – pain in anterior knee – 5 (25%) in ILN, Superficial infection – 1 (5%) in plating Deep infection, 3 (15%) in plating valgus (angulations) >50 4 (20%) in ILN, 3 (15%) plating stiffness of knee 3 (15%) in ILN, stiffness of ankle 1 (5%) in ILN, 5 (25%) in plating, non-union 1 (5%) in IUN, implant irritation 5 (25%) in plating, and implant failure 5 in ILN. **Conclusion:** Both closed intramedullary nailing and locking plate fixations are equally safe and effective for the management of extra-articular distal tibia fractures. However, it is observed that interlocking nailing is better in terms of early weight bearing, fast union, and decreased risks of complications.

Keywords: Locking Plate, Tibia Fractures, Intermedullary Nailing

This is an Open Access article that uses a fund-ing model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

As tibial fractures are commonly associated with soft tissue injury, if these are not properly treated these can cause substantial disability to the patient. High energy motor vehicle trauma constitutes the commonest cause[1] followed by falls, direct blow, and sports injury. The incidence of distal tibia fractures in most series is 0.6%, and it constitutes to about 10%–13% of all tibial fractures[2]. Distal tibial metaphysis is defined as by constructing a square, with sides of length defined by widest portion of tibial plafond[3]. Because of its subcutaneous location, poor blood supply and decreased muscular cover anteriorly, complications such as delayed union, nonunion, wound infection, and wound dehiscence are often seen as a great challenge to the surgeon. Minimally invasive plate osteosynthesis (MIPO) and intramedullary interlocking nail (IMLN) are two well-accepted and effective methods, but each has been historically related to complications. Malalignment and knee pain are frequently reported after IMLN[4,5] whereas wound complications, and implant prominence have been associated with tibial plating in some series[6]. However, intramedullary management of distal tibia metaphyseal fractures is accompanied by its own complications, including malalignment, hardware failure, and the risk of fracture propagation into the ankle joint[7]. Locked plate designs act as fixed-angle devices whose stability is provided by the axial and angular stability at the screw-plate interface instead of relying on the frictional force between the plate and bone, which is thought to preserve the periosteal blood supply around the fracture site[8,9]. Locked plates are indicated for fracture management in osteoporotic bone and in periarticular fracture patterns, making them a feasible treatment option for distal tibia metaphyseal fractures.

Material and methods

The prospective clinical study was conducted in the Department of Orthopaedics, All India Institute of Medical Science, Patna, Bihar, India for 2 years. 40 Patients aged between 18- and 50-years presence of distal fragment of at least 3 cm in length without articular incongruity duration of injury <2 weeks no involvement of neuro-vascular status was include in the study. Patients with open fractures intra articular extension, pathological fractures were excluded from the study. Poor medical health was excluded from study.

Methods

40 with distal tibia extra articular fractures Ao type 43A out of 40 patients 20 were operated with interlocking nailing and 13 with locking plate. Radiographic examination was done antero- posterior (AP) view and lateral view of the defected limb. Patients were operated under spinal anesthesia. Antibiotic of third generation cephalosporin was given intravenously 15 min before surgery. Pneumatic tourniquet/Esmarch rubber tourniquet was used in all patients. The affected limb was thoroughly scrubbed from mid-thigh to foot with Betadine scrub and savlon. The limb was painted with Betadine solution from mid-thigh to foot. Rest of the body and other limb was properly draped with sterile drapes. Cases in which fibula was fixed in addition nailing or plating of tibia, were done either with a one-third semi tubular plate, a reconstruction plate or a rush nail. In cases fixed with plating incision were taken just posterior to fibula soft a tissue was dissected and the reduction of the fracture fragments was achieved after cleaning the fracture site. The fracture was fixed with six- or seven-hole plate with screws. In cases of rush nail fixation, it was passed percutaneous over a stab incision at the tip of lateral malleolus after reduction of fracture manually. The passage and location of the nail were checked under image intensifier.

Surgical Technique for Intermedullary Nailing

A vertical patellar tendon splitting incision over skin extending from center of the inferior pole of patella to the tibial tuberosity was made about 3 cm long. The patellar tendon was split vertically, in its middle and retracted to reach the proximal part of tibial tuberosity. Next step was to determine the point of insertion. Essential for the success of procedure is the correct choice of insertion point. After selecting the point of insertion curved bone awl used to breach in the proximal tibial cortex. In the metaphyseal cancellous bone on entry portal was created, making sure it was in line with center of medullary canal. After widening the medullary canal with a curved awl, a guide wire of size 3 mm diameter \times 950 mm length was passed into the medullary canal of the proximal fragment.

Accurate closed reduction of fracture was verified under image intensifier before insertion of the guide wire in the distal tibial metaphysis. After reduction, the tip of the guide wire was passed till it enters the subchondral bone of distal tibia. Exact length of nail was measured from length of the guide wire remaining inside the medullary canal from the entry point.

Size of the nail was assessed as 1 mm less than the diameter of the last reamer and passed into medullary canal over the guide wire. Screw positions were confirmed under C-arm image intensifier. After this Zig was removed and stability was checked by performing flexion and extension at knee and ankle joint all incisions were closed in layers. Sterile dressing was applied over the wound. Surgical technique for locking plate fixation - The concept of this approach was to preserve the soft tissues and blood supply in the metaphyseal fractures area. A straight or slightly curved skin incision was performed on the medial aspect of the distal tibia. The length of the incision varied from 3 cm to 5 cm depending on the type of the planned plate.

The incision was ended distally at the tip of medial malleolus. The incision was carried

out straight across the sub-cutaneous fat preserving great saphenous vein and saphenous nerve. They were held anteriorly with a blunt retractor. The dissection advanced down on to the periosteum, which was completely preserved. In this anatomical space, the tunneling toward the diaphysis was achieved with blunt tip of the plate. For the insertion of the proximal screws in the diaphysis separate stab, incisions were made. The plate was inserted after proximal tunneling with the plate itself. It is important that the plate and the proximal screw be centered on the tibia, particularly if locking head screwed is planned.

Temporary fixation was performed with wires through the screw holes to approximate the final plate position before the screw insertion. For spiral and short oblique fracture patterns were anatomically reduced and lag screws were placed to enhance the stability. The screw was placed independent of the plate conventional screw and was inserted in one of the most distal plate holes to approximate the plate close to bone after achieving accurate position of the plate. All the incisions were closed in the layers. Sterile dressing was applied over the wound plaster slab was applied below the knee in all patients.

Postoperatively radiographs were taken. Passive knee and ankle range of motion were started in the 1st post-operative week depending on type of fracture and stability of fixation. Active moments started in the 2nd week once pain had subsided. The weight bearing was planned as per the type of fractures fixation and general condition of patient. Initially partial weight bearing was advised between 4 and 8 weeks and then full weight bearing was advised when there was formation of callus and union of fracture process was observed radiologically.

Clinical follow-up examination was at 4 weeks, 6 weeks, 10 weeks, 3 months, 6 months, and 1 year. Every patient was assessed clinically radiologically to rule out tenderness

at fracture site, abnormal mobility, infection, and pain on movement of knee and ankle joint.

Statistical Analysis

The results were compared with percentage and duration of union of fracture was compared with Z test. The statistical data were performed in SPSS software 21.0. The ratio of males and females was 1.67:1.

Results

Table 1: show the classification of fractures 43 A.1– 10 (50%) ILN, and 10 (50%) plating 43 A.2–6 (30%) ILN, 4 (20%) plating, 43A.3–4 (20%) ILN, 4 (30%) plating

Table 2 shows duration of surgery 40–60 min – 14 (70%) ILN, 8 (40%) plating, 61–80 min 6 (30%) ILN, 8(40%) plating, and >80 min 4 (20%) only in plating surgery.

Table 3 shows duration of total weight bearing after surgery 8–10 weeks 14 (70%) in ILN, 3 (15%) in plating, 11–12 weeks 6 (30%) ILN, 6 (30%) plating, 13–14 weeks 8 (40%) in plating, and >14 weeks 3 (15%) observed only in plating.

Table 4 shows duration of fracture union (radiological study) – 17.12 (SD \pm 1.57) ILN 21.28 (SD \pm 1.78) plating t-test –6.2 P < 0.001 (P-value was highly significant).

Table 5 shows study of post-surgical complications – pain in anterior knee – 5 (25%) in ILN, Superficial infection – 1 (5%) in plating Deep infection, 3 (15%) in plating valgus (angulations) >50 4 (20%) in ILN, 3 (15%) plating stiffness of knee 3 (15%) in ILN, stiffness of ankle 1 (5%) in ILN, 5 (25%) in plating, non-union 1 (5%) in IUN, implant irritation 5 (25%) in plating, and implant failure 5 in ILN

Table 1: AO classification of fractures

Types of AO	Group					
	ILN (20) %		Plating (20) %		Total (40) %	
43A.1	10	50	10	50	20	50
43A.2	6	30	4	20	10	25
43A.3	4	20	6	30	10	25

Table 2: Comparison duration of surgery in both techniques

Duration (In minutes)	ILN		Plating		Total	
	N=20	%	N=20	%	N=40	%
40–60	14	70	8	40	22	55
61–80	6	30	8	40	14	35
>80	00	-	4	20	4	10

Table 3: Comparison duration of total weight bearing after surgery in both techniques

Duration (in minutes) (weeks)	ILN		Plating		Total	
	N=20	%	N=20	%	N=40	%
8–10	14	70	3	15	17	42.5
11–12	6	30	6	30	12	30
13–14	0	—	8	40	8	20
>14	0	—	3	15	3	7.50

Table 4: Comparison duration of fracture union (radiological)

ILN	Plating	t-test	P-value
17.12 (SD \pm 1.57)	21.28 (SD \pm 1.78)	6.2	<0.001

Table 5: Comparative study of post-surgical complications

Details	ILN=20	%	Plating=20	%
Pain in anterior knee	5	25	0	
Superficial infection	0	—	1	5
Deep infection	0	—	3	15
Valgus >50 (angulation)	4	20	3	15
Stiffness of knee	3	15	0	
Stiffness of ankle	1	5	5	25
Non-union	1	5	—	—
Implant irritation	0	—	5	25
Implant failure	1	5	0	—

Discussion

Present comparative study of locking plate fixation and closed intramedullary ILN in the management of extra-articular distal tibia fractures 43A.1–10 (50%) ILN, and 10 (50%) plating 43A.2–6 (30%) ILN, 4 (20%) plating, 43A.3–4 (20%) ILN, 4 (30%) plating. duration of surgery 40–60 min – 14 (70%) ILN, 8 (40%) plating, 61–80 min 6 (30%) ILN, 8 (40%) plating, and >80 min 4 (20%) only in plating surgery. duration of total weight bearing after surgery 8–10 weeks 14 (70%) in ILN, 3 (15%) in plating, 11–12 weeks 6 (30%) ILN, 6 (30%) plating, 13–14 weeks 8 (40%) in plating, and >14 weeks 3 (15%) observed only in plating. duration of fracture union (radiological study) – 17.12 (SD±1.57) ILN 21.28 (SD±1.78) plating t -test $-6.2 P < 0.001$ (P -value was highly significant). study of post-surgical complications – pain in anterior knee – 5 (25%) in ILN, Superficial infection – 1 (5%) in plating Deep infection, 3 (15%) in plating valgus (angulations) >50 4 (20%) in ILN, 3 (15%) plating stiffness of knee 3 (15%) in ILN, stiffness of ankle 1 (5%) in ILN, 5 (25%) in plating, non-union 1 (5%) in IUN, implant irritation 5 (25%) in plating, and implant failure 5 in ILN. These findings are more or less in agreement with the previous studies.¹⁰⁻¹² Distal tibial fractures are one of the most challenging fractures experienced by

orthopedicians. It is due to sub-cutaneous location, minimal vascularity and reduced muscular cover. There are chances of complications such as non-union, delayed union, infection, and dehiscence [13,14]. The methods ILN and plating are popularly used to treat distal tibial fractures, but these procedures are also associated with various complications. Non-operative treatment is also used in the case of stable fractures with severe morbidities but complications such as delayed union, malunion, and joint stiffness are very common. Locking plate fixation gives good rigid construct, anatomical reduction and biomechanical superior to intramedullary nailing [15]. However, it results in extensive soft-tissue dissection resulting in wound complications and infections. Hardware complications are more in locking plates warranting implant removal more frequently. With use of minimally invasive techniques, the complications have significantly reduced.

Conclusion

The present study concluded that both closed intramedullary nailing and locking plate fixation are equally safe and effective for the management of extra-articular distal tibia fractures. However, it is observed that interlocking nailing is better in terms of early weightbearing, fast union, and decreased risks of complications.

Reference

1. Schatzker J, Tile M. The Rationale of Operative Fracture Care. 3rd ed. Springer-Verlag Berlin Heidelberg; 2005. pp. 475–6.
2. Bucholz R, Court-Brown C, Rockwood C. Rockwood and Green's Fractures in Adults. New York: Lippincott; 2015. p. 98.
3. Müller M, Nazarian S, Koch P, Schatzker J. The Comprehensive Classification of Fractures of Long Bones. Berlin: Springer-Verlag; 1990.
4. Duda GN, Mandruzzato F, Heller M, Goldhahn J, Moser R, Hehli M, et al. Mechanical boundary conditions of fracture healing: Borderline indications in the treatment of unreamed tibial nailing. *J Biomech.* 2001; 34:639–50.
5. Haberneck H, Kwasny O, Schmid L, Ortner F. Complications of interlocking nailing for lower leg fractures: A 3-year follow up of 102 cases. *J Trauma.* 1992; 33:863–9.
6. Borrelli J, Jr, Prickett W, Song E, Becker D, Ricci W. Extraosseous blood supply of the tibia and the effects of different plating techniques: A human cadaveric study. *J Orthop Trauma.* 2002; 16:691–5.
7. Haberneck H, Kwasny O, Schmid L. Complications of interlocking nailing for lower leg fractures: A 3 year followup of 102 cases. *Journal of Trauma.* 1992; 33:863-869.
8. Leung FK, Law TW. Application of minimally invasive locking compression plate in treatment of distal tibia fractures. *Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi.* 2009; 23 (11):1323-5.
9. Perren SM. Evolution of the internal fixation of long bone fractures. The scientific basis of biological internal fixation:choosing a new balance between stability and biology. *Journal Bone Joint Surgery.* 2002; 84(8):1093-110.
10. Schatzker J, Tile M. Rationale of Operative Fracture Care. 3rd ed. Berlin, Heidelberg: Springer-Verlag; 2005. p. 475-6.
11. Bucholz R, Broun CC. Rockwood and Greens Fractures in Adults. New York: Lippincott; 2015. p. 98-101.
12. Muller M, Nazarian S. The Comprehensive Classification of Fractures of Long Bones. Berlin: Springer Verlag; 1990. p. 88-94.
13. Labranci PJ, Franco JS. Treatment of distal fractures of tibia. *Acta Orthop Bras* 2009; 17:40-5.
14. Sarmento A, Latta LL. 450 closed fractures of distal third of tibia treated with a functional brace. *Clin Orthop Relat Res* 2004; 428:261-71.
15. Hasenboehler DE, Rikli R. Locking compression plate with minimally invasive plate osteosynthesis in diaphysis and distal tibia fracture. A retrospective study of 32 patients. *Injury* 2007; 38:365-70.