International Surgery Journal
Arora KK et al. Int Surg J. 2023 Aug;10(8):1366-1372
http://www.ijsurgery.com
pISSN 2349-3305 | eISSN 2349-2902

DOI: https://dx.doi.org/10.18203/2349-2902.isj20232334

Case Series

Functional and radiological outcome of distal tibia fractures managed with expert tibia nail: a prospective clinical study

Kamal K. Arora[1], Rajesh Kapila[1], Priti Chaudhary[2]*, Rahul Singla[1], Lakshay Sanan[1]

[1]Department of Orthopaedics, Government Medical College, Amritsar, Punjab, India
[2]Department of Anatomy, All India Institute of Medical Sciences, Bathinda, Punjab, India

Received: 22 May 2023
Revised: 19 June 2023
Accepted: 29 June 2023

***Correspondence:**
Dr. Priti Chaudhary,
E-mail: drpritiarora@gmail.com

ABSTRACT

Leg bone fractures come at the top because it is actively involved in locomotive system with distal tibia fractures having second highest incidence due to its subcutaneous location with very less muscle mass around it. Such fractures are mostly comminuted fractures with extensive soft tissue injuries. These are the fractures which extend within approximately 4 cm. from the tibial plafond. As these fractures occur in proximity of weight bearing surface of ankle joint, a slight maladjustment may lead to permanent disability. Non operative treatment/ open reduction and internal fixation with medial or anterolateral plating of these fractures is associated with multiple post-operative complications like infection, wound dehiscence and non-union. Operative treatment allows proper length and anatomical alignment of the limb, early mobilization and hence excellent final results. The present study of 25 cases was done to evaluate the clinical and radiological functional outcome of extra-articular AO type A simple and compound (Gustilo type I and type II) fractures of distal tibia managed with expert tibial nail and complications (post-operative) if any of patients of either sex, same demographic profile admitted through emergency in a tertiary institute of Punjab. Clinico-radiologically results were assessed using Johner and Wruh's criteria. Authors got excellent results in 88%, good to fair in 08% of the cases. Expert tibia nail provides good mechanical and rotational stability due to multiple, multidirectional distal locking options available in distal tibia fractures.

Keywords: Distal tibia fractures, Johner and Wruh's criteria, Expert tibia nail

INTRODUCTION

As industrialization and urbanization are progressing year by year with rapid increase in high-speed vehicular traffic, leg bone fractures come at the top because it is actively involved in locomotive system.[1] On basis of fracture location, distal tibia fracture have second highest incidence.[2] Distal tibial metaphyseal fractures are the fractures which extend within approximately 4 cm from the tibial plafond.[3] The presence of hinge joints at knee and ankle, allows no adjustment for rotatory deformity after union of fracture.[4] As these fractures occur in proximity of weight bearing surface of ankle joint, a slight maladjustment in inclination of ankle joint may lead to permanent disability.

Non-operative treatment of these fractures is usually indicated in medically unfit patients for surgery, in patients with very high anesthetic risk, fractures with excellent initial alignment Non operative treatment is associated with various problems such as improper reduction, frequent loss of reduction, prolonged immobilization which may lead to joint stiffness.

Operative treatment allows proper length and anatomical alignment of the limb, early mobilization and hence excellent final results. Various methods of operative

treatment are plate osteosynthesis, minimally invasive percutaneous plate osteosynthesis (MIPPO), intra medullary nailing system.

Expert tibia nail is becoming quite popular due to increased angular locking options. It provides extra stability in comparison to conventional intra medullary tibial nail due to multi-axial locking system with 5 proximal locking options and 4 distal locking options. The distal tibiofibular joint along with syndesmotic ligaments of the ankle are also important in the fact that they help in maintaining the alignment of distal tibia during fracture healing.[5]

The present study was done to evaluate the clinical and radiological functional outcome of extra-articular [(AO type A) with no extension of fracture line into the tibial plafond].[6] Simple and compound (Gustilo type I and type II) fractures of distal tibia managed with expert tibial nail and complications (post-operative) if any, associated with it.

CASE SERIES

This was a prospective study of 25 cases of distal tibial fractures based on the patients of either sex, same demographic profile admitted through emergency in a tertiary institute of Punjab from August 2020 till October 2022, after the approval of ethical committee of the institution and after having the informed consent of the patient.

Fractures involving the distal metaphyseal region [(extraarticular 4-9 cm above the articular margin), AO type 43A1/A2/A3], fractures <4 weeks duration, skeletally mature patients >18 years, compound type (I and II Gustilo Anderson) were included in the study while the patients having distal tibial metaphyseal fractures within 4 cm from distal articular surface of tibia, AO type 43B, 43C, skeletally immature patients <18 year, pathological tibial fractures, compound fractures Gustilo Anderson type III, medically unfit patients, patients with neuromuscular disorders, patients with pre-existing deformities of tibia were excluded from the study.

Proper history of patients after admission regarding mechanism of injury, drug history, personal history, associated injuries was recorded followed by their systemic examination/local examination to rule out any other skeletal/visceral injury and to record the swelling, tenderness, crepitus, deformity, distal neurovascular status of the involved limb.

After initial stabilization, basic routine investigations and standard AP and lateral radiographs of involved leg with ankle and knee joint were taken and to classify fractures according to AO classification and for simple fractures, Gustilo and Anderson classification for compound fractures. CT scan were done as and when required. Involved limb was elevated, given proper immobilization till surgery, analgesics were given to control pain and inflammation. Preanesthetic checkup for general anesthesia/spinal anesthesia and surgery was done. Written informed consent was taken before surgery.

After administration of anesthesia (spinal or general) and broad-spectrum antibiotic prophylaxis, the patient was cleaned, draped and placed in supine position on the radiolucent table ensuring that the knee of the injured leg can be flexed until at least 90-110 degree. Closed reduction was performed. Trafton`s criteria were used to accept the reduction. Nail size was determined and inserted.

In case of distal one-third fractures of fibula which are associated with unstable comminuted fractures of tibia where reduction of tibial fractures was difficult or was associated with syndesmotic disruption or spiral fractures of tibia, the fibula was fixed first to maintain the length and rotational stability either by intramedullary flexi nail or by plating depending upon the fracture configuration.

Standard anteroposterior and lateral check radiographs were taken to confirm the position of nail and fracture reduction at the end of surgery. Patient was mobilized on crutches/walker non-weight bearing on first postoperative day, intravenous antibiotics were given for three days followed by oral antibiotics up to 5 days.

First follow up was done at 2 weeks to check wound infection /tenderness/DNVS, sutures were removed, patient was advised physiotherapy, weight bearing with crutches whenever possible. Subsequent follow-ups were done at 4, 8, 12, 16, 20, 24 weeks to check for evidence of union (clinically and radiologically), any pain, range of motion especially at ankle and knee joint, malalignment if any. At 6 weeks and successive follow ups, dynamization was done as and when required. Clinically pain and tenderness were assessed using VAS score. The varus/valgus, procurvatum/recurvatum angles were calculated from the immediate postoperative radiograph and the final follow-up radiograph by the Paley and Tetsworth method.[7] Lines were drawn horizontally over the tibial plateau and tibial plafond. Their midpoints were identified and connected with a vertical line. Then a perpendicular was drawn to the horizontal line over the tibial plafond. The angle formed between the perpendicular and line joining the midpoints of the plateau and plafond was considered as the varus/valgus angle based on lateral or medial angulation respectively.

The diagnostic criteria for radiological assessment of distal tibia fractures, consistent bony union, were based on two criteria i.e., the ability of the patient to bear weight without pain, and visible bridging callus on three out of four cortices across the fracture in the anteroposterior/lateral radiographs.

Malunion (varus or valgus deformity more than 5 degrees, an anteroposterior angulation more than 10 degrees, a shortening of the limb more than 1 cm), delayed union

(failure of fracture union by 6 months after surgery), non-union (failure of fracture union within 9 months of surgery) were noted. At fourth week taking in to the consideration fracture morphology and stability of fixation partial weight bearing was started. Clinico-radiological assessment was made and results was checked by using Johner and Wruh's criteria.

In the present study, out of 25 patients, 12 patients (48%) were with a mean age of 42.3 years range (31-50 years), followed by 7 (28%) patients with a mean age of 54.2 years range (51-60), showing bimodal distribution. There was male preponderance due to more outdoor activities [M: F: 19 (76%): 6 (24%)]. In (n=13, 52%) patients left side was involved and in (n=12 (48%) right side involved. Majority of the patients (n=18, 72%) were having AO 43-A1 type of distal tibia fracture with an associated fibula fracture [in 10 patients' fibula was fixed using flexinail, in 4 patients with semi tubular plate and in 4 patients fibula was not fixed]. The mean time of the surgery was 60.6±16.41 minutes. The average time of hospital stay was 5.92 days.

At the 12-weeks follow-up 76% of the patients were pain free with VAS score 0. At 20-weeks follow-up (n 23, 92%) patients were pain free. At the final follow-up (n=24. 96%) of the patients were pain free. There was a significant improvement with the complaint of pain from second week follow-up to 20 weeks follow-up with p value of 0.001. Severity of pain (VAS score) gradually decreased from moderate pain (n=10, 40%) at 2 weeks to no pain (n=24, 96%) at the end of 24 weeks.

At the 12 weeks of follow-up (n 2, 8%) of the patients were having 81-90% R.O.M, at 16 weeks of follow-up n (10, 40%) and at the 20 weeks of follow-up (n=11, 88%) of the patients were having 91-100% R.O.M. at ankle. There is a significant improvement in the R.O.M. at ankle between third and 16 weeks with p value of 0.001.

At the 12 weeks of follow-up (n=11, 88%) of the patients were able to perform more than 91% of R.O.M. at knee. At final follow-up, (n=24, 96% of the patients was having full range of motion at knee.

At the 12 weeks follow-up (n 17, 68%) of the patients were having 1 cortex united, while at the 20 weeks follow-up (n=21, 84%) of the patients showed complete union. At the 24 weeks follow-up (n=24, 96%) of the patients showed complete radiological union. n=01, 04% was having only 2 cortices united was again followed up at 9 months and didn't show any improvement and was declared as non-union.

The overall average time of union was 20.16 weeks. There was no significant co-relation between fibula fixation and average time of union since none of the comparative sub groups showed p value <0.005.

N=22, 88% of the patients had excellent outcome with no varus or valgus deformity. N=23, 92% of the patients showed less than 5^{o} of recurvatum deformity which is acceptable as excellent according to Johner and Wruhs criteria. N=24, 96% of the patients showed no rotational deformity. N=22, 88% of the patients were having full range of motions at ankle. N=03, 12% of the patients were having >75% range of motions at subtalar. Strenuous activities like squatting, climbing stairs, jogging was possible in (N=22, 88%) of the patients.

Table 1: Severity of pain (VAS score).

Severity of pain (VAS score)	Number of patients						
	Immediate post-operatively	At 4 weeks	At 8 weeks	At 12 weeks	At 16 weeks	At 20 weeks	At 24 weeks
No pain (0)	00	00	04	19	22	23	24
Mild (1-3)	16	23	21	06	03	02	01
Moderate (4-6)	09	02	00	00	00	00	00
Severe (7-10)	00	00	00	00	00	00	00
Total	25	25	25	25	25	25	25
P value	0.110	0.107	0.107	0.001	0.748	0.973	0.949

Table 2: Comparison of range of motion at ankle and knee (subsequent follow-ups).

Range of motion at ankle (% of c/l limb)	Number of patients											
	At 4 weeks		At 8 weeks		At 12 weeks		At 16 weeks		At 20 weeks		At 24 weeks	
	Ankle	Knee	Ankle	Knee	Ankle	Knee	Ank-le	Knee	An-kle	Knee	An-kle	Knee
50-60	03	00	02	00	02	00	01	00	01	00	01	00
61-70	20	03	07	02	03	02	01	01	01	01	01	00
71-80	02	00	16	01	18	01	01	02	01	02	01	00
81-90	00	00	00	00	02	00	12	00	00	00	00	01
91-100	00	22	00	22	00	22	10	22	22	22	22	24
Total	25	25	25	25	25	25	25	25	25	25	25	25

Table 3: Radiological evidence of union.

Evidence of union	Number of cases					
	4 weeks	8 weeks	12 weeks	16 weeks	20 weeks	24 weeks
1 cortex	0	7	17	6	0	0
2 cortices	0	0	7	17	4	1
≥3 cortices	0	0	0	2	21	24
Total	25	25	25	25	25	25
P value	4 weeks/8 weeks=0.043					
	8 weeks/12 weeks=0.001					
	12 weeks/16 weeks=0.001					
	16 weeks/20 weeks=0.001					
	20 weeks/24 weeks=0.572					

Table 4: Weight bearing.

Weight bearing	At 4 weeks		At 8 weeks		At 12 weeks		At 16 weeks		At 20 weeks		At 24 weeks	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
No weight bearing	12	48	16	40	wq	12.00	3	12.0	3	12.00	1	4.00
Partial	13	52	15	60	22	88.00	20	80.00	1	4.00	0	0.00
Full	0	0	0	0	0	0.00	2	8.00	21	84.00	24	96.00
P value	4 weeks/8 weeks=0.850											
	8 weeks/12 weeks=0.078											
	12 weeks/16 weeks=0.350											
	16 weeks/20 weeks=0.001											
	20 weeks/24 weeks=0.332											

Table 5: Impact of fibula fixation on union.

Fibula fixation	Average time of union	
Fibula intact	21.14 weeks	
Fibula fracture but not fixed	21.32 weeks	
Fibula fixed with STP/FN	19.14 weeks	
Overall average time	20.16 weeks	
P value	Fibula intact/fibula fracture (not fixed)	0.952
	Fibula fracture (not fixed)/fibula fixed (STP/FN)	0.356
	Fibula intact /overall average time	0.516
	Fibula fracture (not fixed)/overall average time	0.577
	Fibula fixed (STP/FN)/overall average time	0.373

Table 6: Radiological assessment (deformity).

Coronal			Saggital			Rotational	
Varus/valgus	N	%	Procurvatum/recurvatum	N	%	N	%
None	22	88.0	$0\text{-}5^0$	23	92.0	24	96.0
$2\text{-}5^0$	01	04.0	$6\text{-}11^0$	02	08.0	01	04.0
$6\text{-}10^0$	01	04.0	$11\text{-}20^0$	00	00.0	00	00.0
$>10^0$	01	04.0	$>20^0$	00	00.0	00	00.0

Table 7: Range of motion.

Knee joint			Ankle joint			Subtalar joint			Sternous activity		
Full	24	96.0%	Full	22	88.0%	>75	22	88.0%	Limited	03	12.0%
>80%	01	04.0%	>80%	01	04.0%	51 -75	01	04.0%			
>75%	00	00.0%	>75%	01	04.0%	<50	02	08.0%	Possible	22	88.0%
<75%	00	00.0%	**<75%**	01	04.0%	-	-	-			

Continued.

Knee joint			Ankle joint			Subtalar joint			Sternous activity		
Total	25	100.0%	Total	25	100.0%	Total	25	100.0	Total	25	100.0

Table 8: Complications.

Complications	No. of cases	%
Malunion	2	8.00
Non-union	1	4.00
Superficial infection	3	12.00
Deep tissue infection	1	4.00

DISCUSSION

Orthopedic surgeons have different opinions and options to fix distal tibia fractures. Expert tibia nail contains multiple locking options at distal end of the nail. Despite short distal fragment these multiple locking options and their multidirectional alignment ensure more stability, evidenced previously by Gorczyca et al where they removed 1 cm from the tip of a routine interlocking tibia nail, which allowed placement of a greater number of distal locking screws in short distal fragment as compare to routine tibia nail.[8,9] Attal et al also found that the modified locking options in expert tibia nail are able to provide more plains for screw fixation at both the ends of this implant and therefore providing more stability between the implant and fracture fragment.[10] Similar results evidenced by study done by Li et al.[11] The average age of patients in present study was 45.2 years which is comparable to Bhaskar et al and Gupta et al where the average age of the patient was 48.4 years, 41.35 years respectively.[8,12] This clearly signifies that the middle age group involved in outdoor occupation has higher incidence of tibia fractures. Authors observed that there were more male patients (N=19, 76%) as compared to females (N=06, 24%). Comparable to Brown et al with male incidence 81.3% while the female incidence was 20.7%; and echoed Hooper et al who noted male incidence at 82% and female incidence at 18%.[13,14] And also, in line with Thanigaimani et al who noted the predominant male incidence of 69.5% and female incidence of 30.46%.[15] This is possibly due to male dominance in outdoor activities. Most of the fractures in present study were due to road traffic accident (76%) followed by history of fall (24%) comparable to Thanigaimanni et al having 91.3% patients with a history of RSA and 8.7% patients having history of fall.[15] In present study left leg was affected in (N=13, 52%) patients and right leg was affected in (N=12, 48%) patients, comparable to Thanigaimani et al in which left leg was affected in 10 patients (43.4%) and right leg in 13 patients (56.6%).[15] There was an associated fracture of fibula in (n=18, 72%) patients in present study which is comparable to study done by Thanigaimani et al who reported fibula fracture in (N=19, 82.6%) patients.[15] The mean time of surgery was 60.6±16.41 minutes which is well in line with Bhaskar et al having mean time of surgery of 61.76 minutes (minimum average time was reported by Pawar et al (57.20 min) and the maximum time was reported by Li et al).[8,11,16] The average duration of hospital stay was 5.92±1.38 days, comparable to Li et al where average hospital stay was 5.8±2.1 days.[11] In present study, average time taken by the patients for fracture union was 20.16 weeks, which is comparable to Bhaskar et al (18.46 weeks) and also to Li et al, Roshan et al, Im et al, Vallier et al (21.3 weeks, 19.2 weeks, 20 weeks, 22.6 weeks respectively).[8,11,17-19] In present study, (N 24, 96% of our patients achieved union in normal time limit and (N=1, 04%) went into non-union, which is well in line with Duwelius et al, Gregory et al who reported union rates of 97% and also to Memon et al, Badami et al (union rates of 90%).[20-23] Nine case series have been published on nailing in distal tibia fractures which reports a total of 332 fractures. The average rate of union was 96.7% for a mean union time of 17.7 weeks which is analogous to results of present study (N=24, 96% bone union in a mean time of 20.16 weeks).[24-27] In our study (N=18, 72%) of the patients had associated fibula fracture out of which (N=14, 56%), it was fixed, [using flexinail in {n=10, 40%} patients and with STP in {n=04, 16%} of the patients]. In present study authors did not find any statistically significant correlation of fibula fixation on duration of fracture union comparable to similar outcome reported by Badami et al.[23] In present study authors allowed the patient to ambulate without bearing weight on operated limb for first 2-4 weeks and at first month follow-up, partial weight bearing using crutch/ walker, was allowed in (n=13, (52%) patients. At 12 weeks (N=22, 88%) were able to bear partial weight. Full weight bearing was allowed after radiological union was achieved in 3 out of 4 cortices. At final follow up (n=24, 96%) of the patients were able to bear full body weight. At 16th week follow-up (N=10, 40%) patients had full ROM at ankle which doubled at 24th week follow-up with (n=22, 88%) patients having full ROM at ankle. At 4th week follow-up (N=22, 88%) patients had full ROM at knee which increased to (N=24, 96%) at final follow-up. In (N=5 (20%) patients, having no evidence of union at 8th week, secondary intervention like dynamization, was done which is comparable to Ehlinger et al in which they required secondary interventions in 12.3% patients out of which 11.07% were dynamizations.[28] Significant malalignment rate in our study was (N=02, 08%) which is comparable to Egol et al and Attal el al having malalignment rate of 10% and 5.4% respectively.[10,29] Superficial infection occurred in (N=03, 12%) patients and is comparable to study done by Bhaskar et al.[8] None of our patients reported with implant failure, screw breakage which is comparable to Badami et al possibly due to higher fatigue strength and a double lead thread screw design.[23] ETN locking screw also have a larger diameter, higher bending stability and has stronger contact with the bone interface as compared to the locking bolts of regular interlocking tibial nail.[10] Final functional assessment was done using Johner and Wruhs criteria which shows in (N=22, 88%) excellent results comparable to Duwelius et al (85% excellent and 15% good, fair and poor), Li et al (excellent results in 73.9% and good results in 26.1%).[11,20]

Limitations

The main limitation of our study is limited sample size.

CONCLUSION

ETN provides good mechanical and rotational stability due to multiple, multidirectional distal locking options available in distal tibia fractures. As a result, management with ETN is associated with lesser hospital stay, early functional recovery including weight bearing and union within acceptable, reasonable period of time as expected in distal tibia fractures. Therefore, it can be used extensively as a primary mode of treatment for distal tibia fractures.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Tornetta P, Court-Brown C, Heckman JD, McKee M, McQueen MM, Ricci W, et al. Rockwood, Green, and Wilkins fractures in adults and children: Eighth edition. 2014;4026.
2. Tornetta P, Court-Brown C, Heckman JD, McKee M, McQueen MM, Ricci W, et al. Rockwood, Green, and Wilkins fractures in adults and children: Eighth edition. 2014;4026.
3. Court-Brown CM, Birnie MCJ. The epidemiology of tibia fractures. J Bone Joint Surg. 1995;77B:417-21.
4. Gupta SKV, Prabhu B, Goud VA, Shekhar S. Comparative study of functional outcome between expert tibial nailing and conventional IMIL nailing for proximal and distal tibial fractures in adults. Orthop Surg Traumatol. 2018;2(1).
5. Trueta J. Blood supply and the rate of healing of tibial fractures. Clin Orthop Relat Res. 1974;105:11-26.
6. Crock HV, Crock MC. The Blood supply of Lower limb bones in Man. E&S Livingstone ltd. 1967.
7. Macnab I, De Haas WG. The role of periosteal blood supply in the healing of fractures of the tibia. Clin Orthop Relat Res. 1974;(105):27-33.
8. Casstevens C, Le T, Archdeacon MT, Wyrick JD. Management of Extra- articular Fractures of the Distal Tibia: Intramedullary Nailing Versus Plate Fixation. J Am Acad Orthop Surg. 2012;20(11):675-83.
9. Marsh JL. OTA Fracture Classification. J Orthop Trauma. 2009;23(8):551.
10. Attal R, Hansen M, Kirjavainen M, Bail H, Hammer TO, Rosenberger R, et al. A multicentre case series of tibia fractures treated with the Expert Tibia Nail (ETN). Arch Orthop Trauma Surg. 2012;132(7):975-84.
11. Li Y, Liu T, Tang X, Pei F, Wang G, Fang Y. Comparison of low, multidirectional locked nailing and plating in the treatment of distal tibial metadiaphyseal fractures. Int Orthop. 2012;36(7):1457-62.
12. Gupta SKV, Prabhu B, Goud VA, Shekhar S. Comparative study of functional outcome between expert tibial nailing and conventional IMIL nailing for proximal and distal tibial fractures in adults. Orthop Surg Traumatol. 2018;2(1).
13. Court-Brown CM, Will E, Christie J, McQueen MM. Reamed or unreamed nailing for closed tibial fractures. A prospective study in Tscherne C1 fractures. J Bone Joint Surg Br. 1996;78(4):580-3.
14. Hooper GJ, Keddell RG. Penny ID. Conservative management or closed nailing for tibial shaft fractures. A randomised prospective trial. J Bone Joint Surg. 1991;73(1):83-5.
15. Thanigaimani K. Functional outcome in distal third tibial fractures treated with interlocking nailing. Int J Res Orthop. 2016;2(3):91.
16. Pawar ED, Agrawal SR, Patil AW, Choudhary S, Asadi G. A comparative study of intramedullary interlocking nail and locking plate fixation in the management of extra articular distal tibial fractures. J Evol Med Dent Sci. 2014;3(24):6812-27.
17. Roshan RKM. Kumar NR, Manoharan M. Comparison of functional outcome between expert tibial nail and distal tibial medial locking plate by mippo technique for closed extra articular distal tibial fracture. Int J Orthop Sci. 2019;5(3):257-62.
18. Im GI, Tae SK. Distal metaphyseal fractures of tibia: a prospective randomized trial of closed reduction and intramedullary nail versus open reduction and plate and screws fixation. J Trauma. 2005;59(5):1219-23.
19. Vallier HA, Cureton BA, Patterson BM. Randomized, Prospective Comparison of Plate versus Intramedullary Nail Fixation for Distal Tibia Shaft Fractures: J Orthop Trauma. 2011;25(12):736-41.
20. Duwelius PJ, Schmidt AH, Rubinstein RA, Green JM. Nonreamed interlocked intramedullary tibial nailing. One community's experience. Clin Orthop Relat Res. 1995;315:104-13.
21. Gregory P, Sanders R. The treatment of closed, unstable tibial shaft fractures with unreamed interlocking nails. Clin Orthop Relat Res. 1995;315:48-55.
22. Memon R, Patel D. Functional Outcome of Expert Tibial Intramedulary Nailing for Metaphyseal Distal One Third Fractures of Tibia. Asian J Orthop Res. 2020;21-5.
23. Badami RN, Shetty MS, Kumar MA. Management of distal tibial metaphyseal fractures by expert tibial nail. Indian J Orthop Surg. 2017;3(3):229-33.
24. Chen AL, Tejwani NC, Joseph TN, Kummer FJ, Koval KJ. The effect of distal screw orientation on the intrinsic stability of a tibial intramedullary nail. Bull Hosp Jt Dis. 2001;60(2):80-3.
25. Lucas, Brennen L, Alexander CM, Chong BRB, Jones TL, Wooley PH. Biomechanical comparison of distal locking screws for distal tibia fracture

intramedullary nailing. J Biomed Sci Eng. 2011;23541.
26. Venkateswaran B, Warner RM, Hunt N, Shaw DL, Tulwa N, Deacon P. An easy and accurate preoperative method for determining tibial nail lengths. Injury. 2003;34(10):752-5.
27. Ehlinger M, Adam P, Gabrion A, Jeunet L, Dujardin F, Asencio G. Distal quarter leg fractures fixation: The intramedullary nailing alone option. Orthop Traumatol Surg Res. 2010;96(6):674-82.
28. Vallier HA, Cureton BA, Patterson BM. Randomized, prospective comparison of plate versus intramedullary nail fixation for distal tibia shaft fractures. J Orthop Trauma. 2011;25(12):736-41.
29. Egol KA, Weisz R, Hiebert R, Tejwani NC, Koval KJ, Sanders RW. Does Fibular Plating Improve Alignment After Intramedullary Nailing of Distal Metaphyseal Tibia Fractures? J Orthop Trauma. 2006;20(2):94-103.

Cite this article as: Arora KK, Kapila R, Chaudhary P, Singla R, Sanan L. Functional and radiological outcome of distal tibia fractures managed with expert tibia nail - a prospective clinical study. Int Surg J 2023;10:1366-72.