Comparative Study of Locking Plate Fixation versus Intramedullary Nail Fixation for a Displaced Extra Articular Fracture of Distal Tibia in Adults

Dr. Manish Kumar Jangir[1§], Dr. Jakir Hussain[2], Dr. R.C. Meena[3], Dr. Rakesh Kumar[4], Dr. Amit Sharma[5]

[1]Residents, Department of Orthopaedics, S.M.S. Medical College, Jaipur (Rajasthan) India
[2,4]Assistant Professor, Department of Orthopaedics, S.M.S. Medical College, Jaipur (Rajasthan) India
[3]Senior Professor, Department of Orthopaedics, S.M.S. Medical College, Jaipur (Rajasthan) India
[5]Senior Resident, Department of Orthopaedics, S.M.S. Medical College, Jaipur (Rajasthan) India
§Corresponding author's Email: manishjangir.mj@gmail.com

Abstract— *Tibial fractures are the most common long bone fracture. Among tibial fractures distal tibial fractures are quite common. There are many modalities tried to manage distal tibial fractures. This study was conducted on 60 distal tibial fracture cases to compare results of Intramedullary Nail Fixation (IMNF) and Distal Tibia Locking Compression Plate Fixation (DTLCPF) for Displaced Extra Articular Fracture of Distal Tibia in Adults. It was found that in intramedullary nail (IMNF) group full mean weight wearing time was significantly lesser than DTLCPF i.e. 7.70 weeks in IMNF group and 14.87 weeks in DTLCPF group. Mean time at which visible callous was seen was also lesser in IMNF group than DTLCPF i.e 9.30 weeks v/s 11.90 weeks. Mean time of union was without significant difference i.e. 16.13 weeks in IMNF and 17.43 weeks in DTLCPF. Mean value of DRI score is 13.00 in IMNF and 17.53 DTLCPF group. Complication rate was similar (16.67%) in both the groups. Although infections are more in IMNF group and mal-union was more in DTLCPF group but type of complication were no varies with significant difference. According to Johner and wruh's criteria IMNF group 76.66% had good results whereas in DTLCPF 83.33% had good results which was without significant difference. It can be concluded from study that both procedure manage these type of fractures and results are well comparable without significant difference.*

Keywords: Displaced Extra Articular Fracture of Distal Tibia, Locking Plate Fixation, Intramedullary Nail Fixation.

I. INTRODUCTION

Tibial fractures are the most common long bone fracture and occur at a frequency of about 26 fractures per 100,000 populations per year. They are approximately three times more common in males and are usually due to high energy trauma such as motor vehicle accidents. The frequency of their occurrence increases again later in life with the development of osteopenia and osteoporosis.[1]

Fractures of the distal third tibia are unique in that the bone is subcutaneous with depleted muscular cover; the consequent decreased vascularity leads to complications like delayed bone union, wound complications such as dehiscence and infection.

The presence of hinge joints at the knee and the ankle allows no adjustment for rotary deformity after fracture, and special care is necessary during reduction to correct such deformity. Delayed union, nonunion, and infection are relatively common complications of distal tibial fractures.

Non-operative treatment now is generally reserved for closed, stable, isolated, minimally displaced fractures caused by low-energy trauma and some stable low-velocity gunshot fractures. Operative

treatment is indicated for most tibial fractures caused by high-energy trauma. These fractures usually are unstable, comminuted, and associated with varying degrees of soft-tissue trauma. Operative treatment allows early motion, provides soft-tissue access, and avoids complications associated with immobilization. The goals of treatment are to obtain a healed, well-aligned fracture; pain-free weight bearing; and functional range of motion of the knee and ankle joints. The optimal treatment method should assist in meeting these goals, while minimizing complications, especially infection. These goals may not be attainable in severely injured limbs.[2]

Surgical treatment options are expanding and include locked intramedullary nails, plate and screw fixation, as well as external fixator systems including the Ilizarov frame and hybrid fixators. External fixators may be beneficial in selected cases—particularly those with severe soft tissue injuries. Mid-shaft fractures of the tibia are generally successfully treated with locked intramedullary nails. However, in the more distal metaphyseal region of the tibia, the fixation may be less stable.[3] The nail or screws that are inserted into the nail may break,[4] mal-alignment may occur,[5] and there is a risk that the nail will penetrate into the ankle joint.[6,7]

The development of 'locking' plates (where a thread on the head of the screws locks into the holes in the plate to create a 'fixed-angle' construct) has led to a recent increase in the use of plate fixation. However, plates are not without risks, they require greater soft tissue dissection, which carries a risk of infection, wound breakdown and devitalisation of the surrounding tissue.[8]

So this study was conducted to compare Locking Plate Fixation and Intramedullary Nail Fixation for Displaced Extra Articular Fracture of Distal Tibia in Adults.

II. METHODOLOGY

This comparative Study of Locking Plate Fixation versus Intramedullary Nail Fixation for a Displaced Extra Articular Fracture of Tibia was conducted on 60 Distal Tibia in Adults patients at SMS Medical college, Jaipur (Rjasthan) India, from April 2016 to November 2017.

For study group, 18-65 years aged cases of closed fracture involving distal tibia (between 4-11 cm from ankle joint) (AO type A1, A2 and A3) were taken. Out of which, cases with other diseases and who did not give consent for study were excluded from study. Thus finally 60 cases were taken as study subjects. They were allocated either of group as per chit box with replacement method.

Distal tibia locking compression plate (DTLCPF) is used in one group and intamedulary interlock nail (IMNF) tibia is used in another group. Each group consist of 30 study subjects. Randomization done for first case with 'chit box' method and then alternate allocation method for further participants.

After doing respective surgeries, X-ray of the involved leg was taken post operatively including both knee and ankle joint. After suture removal a patellar tendon bearing cast was given to all patient and physiotherapy advised in the form of knee bending, calf stretching static quadriceps and active toe movements. Partial weight bearing is started after clinical examination of discomfort or localized tenderness and the radiographic appearance of the fracture at follow-up.

Patients were followed up clinically and radiographically at 4 , 8 and 16 weeks and every month up to 6 months. Data was collected by verbal communication, clinical examination, and radiographic features.

Clinically the ability to fully weight bear with no pain at the fracture will be considered to represent clinical union. Radiological examination will be on first post-operative day, 6 and 12 weeks and

thereafter as per the follow-up visit schedule. Radiographically, bridging of three out of four cortices on standard anteroposterior (AP) and lateral views will be represent radiographic union.

At the end of six months, the range of movement at knee (flexion and extension), ankle (dorsiflexion and planter flexion) was determined. Partial & full weight bearing time and union time was also assessed and compared. A clinical evaluation for the functional assessment was obtained by using Disability Rating Index (DRI) Score[9]. Complications were also found in both groups and compared. Results of both groups were assessed and compared by Johner and Wruhs' criteria.[10]

Statistical analysis: Categorical data was expressed as proportion and difference in proportion was analyzed using Chi square test. Quantitative data was expressed as mean and standard deviation and the difference in mean between two groups was inferred using unpaired 't' test. Probability was considered to be significant if less than 0.05.

III. RESULTS

This study was conducted on 60 Displaced Extra Articular Fracture of Distal Tibia cases. Out of these 60 cases, on 30 cases IMNF was performed whereas on other 30 DTLCPF was performed. Both these groups were comparable (p>0.05) in age, sex, side of fracture and type of fracture as per AO classification distribution. (Table 1)

Table 1
Comparison of characteristics in IMNF and DTLCPF group

Characteristics	IMNF group (N=30)	DTLCPF group (N=30)	P Value LS
Age (Mean±SD) in years	40.50±12.88	36.24±12.24	0.193 NS
M:F	20:10	23:7	0.390 NS
Right:Left	15:15	14:16	0.796 NS
Type of Fracture A1:A2:A3	8:11:11	6:10:14	0.707 NS

These both groups were comparable (p>0.05) in type of fixation used for associated fibula fracture. (Table 2)

Table 2
Comparison of Fixation of associated fibula fracture in IMNF and DTLCPF group

Characteristics	IMNF group (N=30) No (%)	DTLCPF group (N=30) No (%)	P Value LS
K -wire	15 (50)	13 (43.33)	0.724 NS
Plating	11(36.67)	14 (46.67)	
No	4(13.33)	3 (10)	

When results of both procedures i.e. IMNF and DTLCPF were compared it was found that mean time of partial weight bearing time was significantly (p=0.0003) lesser in IMNF than in DTLCPF i.e. 2.40 weeks in IMNF and 6 weeks in DTLCPF. Likewise mean time of full weight bearing time was significantly (p=0.0004) lesser in IMNF than in DTLCPF i.e. 7.7 weeks in IMNF and 14.87 weeks in DTLCPF. (Table 3)

Table 3
Comparison of weight bearing in IMNF and DTLCPF group

Weight bearing	IMNF group (N=30) Mean±SD	DTLCPF group (N=30) Mean±SD	P Value LS
Partial (in weeks)	2.4±0.81	6±0	0.0003 S
Full (in weeks)	7.7±1.47	14.87±1.38	0.0004 S

When results of IMNF and DTLCPF were compared as per radiological findings it was found that mean time at which visible callous was seen was significantly earlier in IMNF group than DTLCPF i.e. 9.30 weeks in IMNF and 1.90 weeks in DTLCPF group. But mean time of union was without significant difference in both the groups i.e. 16.13 weeks in IMNF and 17.43 weeks in DTLCPF group. (Table 4)

Table 4
Comparison of Radiological findings in IMNF and DTLCPF group

Radiological Findings	IMNF group (N=30) Mean±SD	DTLCPF group (N=30) Mean±SD	P Value LS
Visible Callous (in weeks)	9.3±2.84	11.9±2.68	0.00058 S
Time of union (in weeks)	16.13±4.75	17.43±3.57	0.235 NS

When DSI scores were compared in both groups it was found without significant difference (p=0.071) i.e. 13±9.26 in IMNF and 17.53±9.85 in DTLCPF. (Figure 1)

When complication rate was compared in both groups it was found similar i.e. in 5 out of 30 i.e. 16.67%. Although infections were more in group DTLCPF and mal-union and non-union is more in group IMNF but this distribution of type of complication was also without significant difference (p=0.531). (Figure 2)

Figure 1

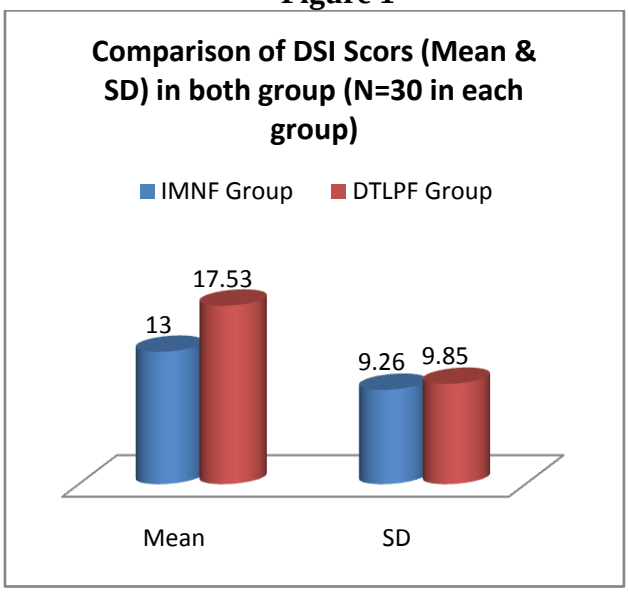
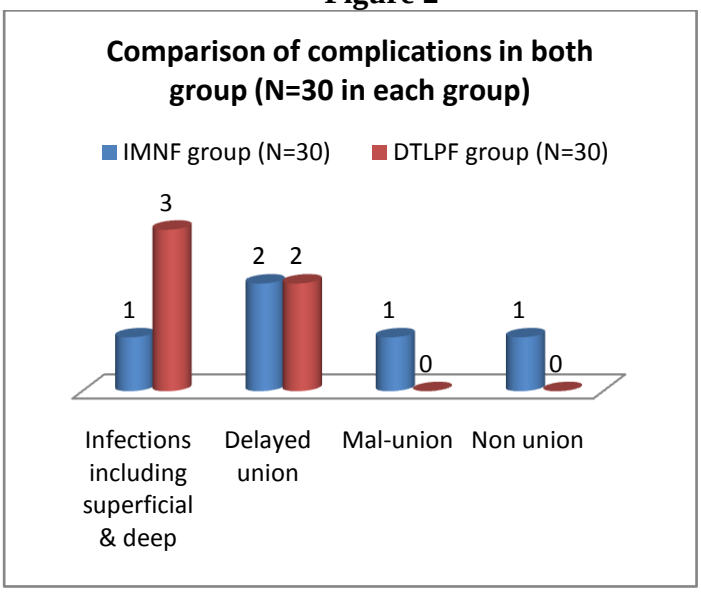


Figure 2



On comparison of results according to Johner and Wruhs' criteria both groups were found comparable (p>0.05). Both procedures showed maximally good results i.e. in 76.67% in IMNF and 83.33% in DTLCPF group. (Table 5)

Table 5
Comparison of Results according to Johner and Wruhs' criteria in IMNF and DTLCPF group

Characteristics	IMNF group (N=30) No (%)	DTLCPF group (N=30) No (%)	P Value LS
Excellent	4 (13.33)	2 (6.67)	0.678 NS
Good	23 (76.67)	25 (83.33)	
Fair	3 (10)	3 (10)	

IV. DISCUSSION

Sixty patients who had fracture of distal tibia associated with or without fibula fracture who were treated in Department of Orthopaedic SMS Medical College, Jaipur. Thirty patients were treated by Interlock nail tibia and other thirty patients treated with Distal tibia locking plate. Randomization was done for first case with 'chit box' method and then alternate allocation method for further participants. And both groups were comparable as per age, sex, side and type of fracture.

It was found that in intramedullary nail (IMNF) group full mean weight wearing time was significantly less i.e. 7.70 weeks in IMNF group and 14.87 weeks in distal tibia plating (DTLCPF) group. Mean time at which visible callous was seen was also less in IMNF group than DTLCPF i.e 9.30 weeks v/s 11.90 weeks. Mean time of union was without significant difference i.e. 16.13 weeks in IMNF and 17.43 weeks in DTLCPF. Mean value of DRI score is 13.00 in IMNF and 17.53 DTLCPF group. Complication rate was similar (16.67%) in both the groups. Although infections are more in IMNF group and malunion was more in DTLCPF group but type of complication were no varies with significant difference. According to Johner and wruh's criteria IMNF group had 13.33% excellent results, 76.66% had good results and 10.00% had fair results. And in DTLCPF group 6.66% had excellent results, 83.33% had good results and 10.00% had fair results.

Associated fibula fracture was present in all patients of IMNF group and DTLCPF. Decision for Fixation of fibula fracture was done according to location of fracture. Only those fibular fractures which are within 6 centimetre from distal tibio fibular syndesmosis were fixed. Proximal fibular fractures need not to be fixed as they unite very well in conservative treatment. Fibula fixation was done by K-wire or one third tubular plate. Fibula fixation helps in maintaining the length and stability of ankle mortise. Kumar et al reported that an intact fibula or fibular plate fixation provides initial rotational stability and minimizes varus or valgus angulation in distal tibia fractures treated with either nailing or plating group.[11]

Costa ML[12,13] Among 321 randomized patients (mean age, 45 years [SD, 16.2]; men, 197 [61%]; had experienced traumatic injury after a fall, 223 [69%]), 258 completed the study. There was no statistically significant difference in the DRI score at 6 months between groups (mean score, 29.8 in the nail group vs 33.8 in the plate group; adjusted difference, 4.0 [95% CI, -1.0 to 9.0], P = .11). There was a statistically significant difference in the DRI score at 3 months in favor of nail fixation (mean score, 44.2 in the nail group and 52.6 in the plate group; adjusted difference, 8.8 [95% CI, 4.3 to 13.2], P < .001), but not at 12 months (mean score, 23.1 in the nail group and 24.0 in the plate group; adjusted difference, 1.9 [95% CI, -3.2 to 6.9], P = .47). Secondary outcomes showed the same pattern, including a statistically significant difference in mean OMAS at 3 and 6 months in favor of nail fixation. There were no statistically significant differences in complications, including the number of postoperative infections (9% in the nail group vs 13% in the plate group). Further surgery was more common in the plate group

at 12 months (8% in nail group vs 12% in plate group). They also concluded the almost similar results of both these procedure in distal tibial fractures.[12,13]

Mauffrey etall[14] reported an adjusted difference of 13 points in the Disability Rating Index in favour of the intramedullary nail after 6 months. However, this was not statistically significant in this pilot trial (p = 0.498). fractures.[12,13]

Lib B[15] at all done a systemic review of eight studies, with 270 patients in the intramedullary nailing and 217 patients in the plates fixation group. Time for bone union was comparable between intramedullary fixation and plate fixation. In contrast to present findings in this study complication rate was significant higher for intramedullary nailing compared with plate fixation (44.5 vs. 25.8 %, P < 0.001). Similarly, the rate of minor complications was higher for intramedullary nailing than that for plate fixation (35.9 vs. 21.2 % P < 0.001). Major complication rate was 8.52 % for intramedullary nailing and 4.6 % for plate fixation, but the difference had no statistical significance (P = 0.06). Among these complications, malunion and anterior knee pain were more common in intramedullary nailing than in plate fixation (20.1 vs. 4.5 %, P < 0.001; 4.2 vs. 0.45 %, P = 0.02, respectively). They concluded that plate fixation, especially minimally invasive percutaneous plating osteosynthesis technique would be preferred for extra-articular distal tibia fractures because of its low complication rate. Nevertheless, intramedullary fixation should be taken priority for distal tibia fractures with serious soft tissue injuries.

V. CONCLUSION

It was concluded from this study that although partial and full weight bearing was earlier in IMNF than DTLCPF but union time was without significant difference in both the groups. Likewise DSI score and Johner and wruh's criteria wise also both procedures were comparable.

CONFLICT OF INTEREST

None declared till now.

REFERENCES

[1] Editors: Bucholz, Robert W.; Heckman, James D.; Court-Brown, Charles M.; Tornetta, PaulTitle: Rockwood And Green's Fractures In Adults, 7th Edition Copyright ©2010 Lippincott Williams & Wilkins> Table of Contents > Section Four - Lower Extremity > 55 - Tibia and Fibula Fractures

[2] Teeny S.M., Wiss D.A. Open reduction and internal fixation of tibial plafond fractures. Variables contributing to poor results and complications. Clin Orthop Relat Res. 1993; 292:108–117.

[3] Drosos G, Karnezis IA, Bishay M, et al. Initial rotational stability of distal tibial fractures nailed without proximal locking: the importance of fracture type and degree of cortical contact. Injury 2001;32:137–43

[4] Kneifel T, Buckley R. A comparison of one versus two distal locking screws in tibial fractures treated with unreamed tibial nails: a prospective randomized clinical trial. Injury 1996;27:271–3.

[5] Obremskey WT, Medina M. Comparison of intramedullary nailing of distal third tibial shaft fractures: before and after traumatologists. Orthopedics 2004;27:1180–4.

[6] Boenisch UW, de Boer PG, Journeaux SF. Unreamed intramedullary tibial nailing–fatigue of locking bolts. Injury 1996;27:265–70.

[7] Mosheiff R, Safran O, Segal D, et al. The unreamed tibial nail in the treatment of distal metaphyseal fractures. Injury 1999;30:83–90.

[8] Teeny SM, Wiss DA. Open reduction and internal fixation of tibial plafond fractures. Variables contributing to poor results and complications. Clin Orthop Relat Res 1993;292:108–17.

[9] Salen BA, Spangfort EV, Nygren AL, Nordemar R. The Disability Rating Index: An instrument for the assessment of disability in clinical settings. J. Clin Epidemiol. 1994 Dec;47(12):1423-35

[10] Kumar A, Charlebois SJ, Cain EL, et al. Effect of fibular plate fixation on rotational stability of simulated distal fractures treated with intramedullary nailing. J Bone J Surg (Am)2004;85:604-8

[11] Criteria for evaluation of final results of tibial shaft fractures according to Johner and Wruh's criteria Strategies Trauma Limb Reconstr. 2016 Apr; 11(1): 25–29

[12] *Costa ML, Achten J, Griffin J, Petrou S, Pallister I, Lamb SE, Parsons NR.* Effect of Locking Plate Fixation vs Intramedullary Nail Fixation on 6-Month Disability Among Adults With Displaced Fracture of the Distal Tibia: The UK FixDT Randomized Clinical Trial. *FixDT Trial Investigators..JAMA. 2017 Nov 14; 318(18):1767-1776*

[13] *Costa ML, Achten J, Hennings S, Boota N, Griffin J, Petrou S, Maredza M, Dritsaki M, Wood T, Masters J, et al.* Intramedullary nail fixation versus locking plate fixation for adults with a fracture of the distal tibia: the UK FixDT RCT. *Health Technol Assess. 2018 May; 22(25):1-148*

[14] *Mauffrey C, McGuinness K, Parsons N, Achten J, Costa ML.* A randomised pilot trial of "locking plate" fixation versus intramedullary nailing for extra-articular fractures of the distal tibia. *J Bone Joint Surg Br. 2012 May; 94(5):704-8*

[15] *Li B, Yang Y, Jiang LS.* Plate fixation versus intramedullary nailing for displaced extra-articular distal tibia fractures: a system review. *Eur J Orthop Surg Traumatol. 2015 Jan; 25(1):53-63. Epub 2013 Nov 20*