Extra-Articular Proximal and Distal Metaphyseal Tibial Fracture Fixation by Intramedullary Expert Nail and Locking Plate: A Prospective Study

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Abstract

Background: Extra-articular proximal and distal metaphyseal fractures of tibia pose a significant challenge to the surgeons. Debate continues regarding choice of fixation devices. Evaluate these fractures fixation with intramedullary expert tibial nail and extramedullary locking plate and screws.

Materials and methods: This is a prospective interventional study which had been conducted in the Department of Orthopaedics & Traumatology, Chittagong Medical College Hospital, Chattogram from July, 2018 to June, 2019. Total 60 cases (30 cases in each group) with proximal and distal metaphyseal tibial fractures (AO/OTA 41A2 to A3 and 43A1 to A3) were taken. Functional assessment was done atleast 6th month of surgery using Tegner Lysholm knee scoring scale and Kaikkonen ankle scale.

Results: According to assessment scale, excellent outcome was observed in 20 (66.7%) patients, good in 05 (16.7%), fair in 03 (9.9%) and poor in 2 (6.7%) patients in ETN group while in LPS group, 18 (60%) patients were excellent, 05 (16.7%) good, 04 (14.3%) fair and 03 (9.9%) patients were poor. Difference in functional outcome in both the groups was statistically non-significant.

Conclusions: There was no significant difference statistically in functional outcome of patients treated with intramedullary and extramedullary fixation method.

Key words: Expert Tibial Nail (ETN); Extra articular; Kaikkonen ankle scale; Locking Plate and Screw (LPS); Poller screws; Tegner lysholm knee scoring.

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Introduction

Tibia accounts for the long bone with the highest prevalence of fractures due to its location, structural anatomy and sparse anteromedial soft tissue coverage.[1] Extra-articular metaphyseal fractures of proximal and distal tibia account for 3.3 % and 15.3% of all tibial fractures respectively.[2] The proximity of these fractures to knee and ankle joints respectively lead to more complications than are seen with mid diaphyseal injuries.[3] Conservative management of these fractures often result in malunion, non-union, rotational deformity, or stiffness of adjacent joints; so there has been a shift towards operative management for these fractures in recent times.[4]

Fractures of extra-articular proximal metaphyseal area of tibia are best classified according to Revised Orthopaedic Trauma Association classification system as AO/OTA 41A into groups A1, A2, and A3. A2 fractures involve simple fracture which may be spiral A2.1, oblique A2.2 or transverseA2.3. A3 fractures are intact wedge A3.1, fragmentary wedge A3.2 and multifragmentary fracture A3.3[5].

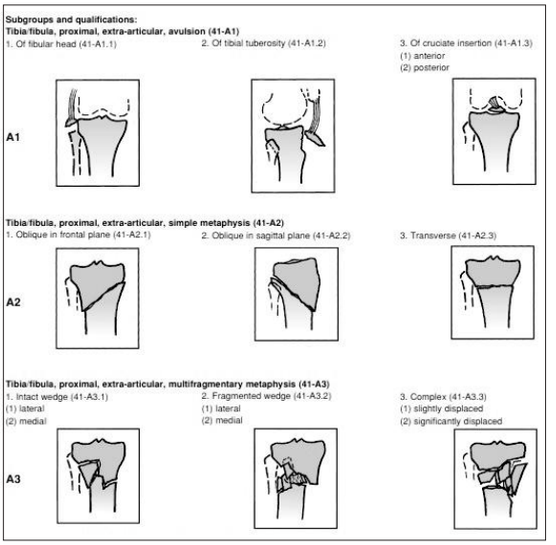

Image 1 : OTA/ AO classification of proximal Tibial fracture classification[5].

Fractures of extra-articular distal metaphyseal area of tibia are classified as AO/OTA 43A which are subdivided into groups A1, A2, and A3. A1 fractures are simple which may be spiral A1.1, oblique A1.2 or transverse A1.3. A2 are wedge fractures including posterolateral impaction A2.1, anteromedial wedge A2.2 and fracture extending into diaphysis A2.3. A3 fractures are multifragmentary with 3 intermediate fragments A3.1, more than 3 intermediate fragments A3.2 and fracture extending into diaphysis A3.3 [5].

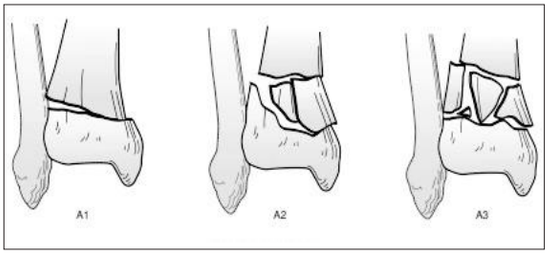

Image 2 : OTA/ AO classification of Extra articular Tibial fracture classification[5]

Various treatment options have been evolved each having its own advantages and disadvantages: half-pin external fixation, hybrid or thin-wire external fixation, plate fixation, intramedullary implant or a combination of these techniques.[6] But optimal method of fixation still remains debatable.

It was observed that open reduction and internal fixation with plate and screw has its own issue of devascularizing the bony fragments, injury to soft tissue and higher rate of infection while Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) threatens secondary skin necrosis due to the prominence of precontoured and angular stable plates.[7,8]

Intramedullary fixation with standard interlocking nail has been found to be less invasive, load sharing, sparing extra-osseous blood supply and fracture hematoma by with early mobilization of patients with faster rehabilitation.[9-11] Earlier the use of intramedullary tibial nail for metaphyseal fractures was not suggested by many series due to higher incidence of malalignment. Most common deformities in proximal tibial metaphyseal fractures as an apex anterior and valgus deformity due to pull of extensor mechanism in flexed position and forces of pull by hamstrings and iliotibial band along with spacious medullary canal at this level respectively.[12] To overcome these deformities, various techniques for intramedullary interlocking nailing like proximal and lateral entry point, use of the semi extended position, poller screws, temporary unicortical plates, clamps and provisional K-wire reduction.[12-15]

Due to the technical limitations of the available implants such as the Unreamed tibial nail for the stabilization of metaphyseal fractures, new intramedullary tibial implants have been developed. Proximal tibial nail, designed in 1999, offered proximal locking options in three different planes with near angular stability of the nail-screw construct and double threaded, 5mm enlarged core cancellous screw for better purchase in trabecular bone of the metaphysis.[16] In 2004 Tibial Nailing System (TNS) was evolved in which four distal multidirectional locking options were available in addition to five proximal locking options. It was further modified by adding a 2° inclination to the 8° Herzog's bend for easier insertion and a better fit in the wider medullary canal in metaphyseal region and hence termed as Expert Tibial Nail.[17,21,22]

Materials and methods

This prospective interventional study was carried out in Department of Orthopedic Surgery of Chittagong Medical College, Chattogram, Bangladesh from July, 2018 to June, 2019. Purposive type of non-probability sampling technique was used and approval taken from the Ethical and Research Committee of Chittagong Medical College Hospital.

Total 60 cases (30 cases in each group) with proximal and distal metaphyseal tibial fractures (AO/OTA 41A2 to A3 and 43A1 to A3) were taken. Functional assessment was done atleast 6th month of surgery using Tegner Lysholm knee scoring scale and Kaikkonen ankle scale. Among the 30 cases of extra articular devises, 15 cases were proximal tibial fracture and 15 cases were distal tibial fracture.

Regarding inclusion criteria, patients with AO/OTA 41A2 to A3 & 43A1 to A3 fractures, 18 years & below 60 years of age and fracture age less than 2 weeks were considered while in exclusion criteria, closed fracture with Oestern and Tsherene grade II & III, open fracture with Gustilo and Anderson grade IIIB & IIIC, polytrauma patient (ISS > 16) pathological fracture other than osteoporosis, fracture with failure of treatment with other fixation devices.

As extra articular implants and fracture patterns are different for proximal and distal tibial fractures, may be done by another study for it. In this study our main concern was to find out the outcome between Extra articular and Intramedullary device.

Functional outcome assessment by Tegner Lysholm knee scoring scale for proximal metaphyseal tibial fracture and Kaikkonen ankle scale for distal tibial metaphyseal fracture were done at 1st, 3rd and 6th months follow up.

Data presented on categorical scale were expressed as frequency and corresponding percentage and were compared by chi-square test, while the quantitative data were presented as mean and Standard Deviation (SD) and were compared by student's t-test. For all analyses, level of significance was set at 0.05 and p-value <0.05 was considered as significant.

Results

While considering age, most patients (63.33%) were in between 20 to 40 ages in both groups. Out of 60 patients, 48(80%) were male and 12(20%) were female. Among the patients 18(30%) were service holder, 05(8.3%) students, 08(13.33%) house wife. Regarding fracture type 20 % (12) were 41A2, 30 %(18) were 41A3, 15 %(09) in both 43A2-43A3 and 20% (12). Involvement of right side 48.3% (29) and left side 51.7% (31) was almost equal.

Mean (± SD) duration of operation was 85.33 (± 15.48) minutes for ETN group whereas in LPS group it was 99.00 (± 17.88) minutes which is statistically highly significant (p = 0.001). The mean (±SD) time taken for radiological union in ETN and LPS groups were 18.46 (±3.010) weeks and 20.00 (±3.16) weeks respectively.

Table I : Comparison of clinical outcome after 6 months

	Expert tibial nail(n=30)	Locking plate & screws(n=30) Proximal (15) Distal (15)	Total (n=60)	p value
Mechanism of injury				
RTA	83.3%(25)	86.7%(26)	85%(51)	0.72^{ns}
Fall from height	10%(03)	10%(03)	10%(06)	
Physical assault	6.7%(02)	3.3%(01)	05%(03)	
Complications				
Soft tissue infection	13.3%(04)	26.7%(08)	20%(12)	0.20^{ns}
Deep seated infection	6.7%(02)	16.7%(05)	11.7%(07)	0.23^{ns}
Implant failure/non union	6.7%(02)	10%(03)	8.3%(05)	0.64^{ns}
Delayed union	16.7%(05)	23.3%(07)	20%(12)	0.52^{ns}
Knee stiffness	6.7%(02)	26.7%(04)	20%(06)	0.36^{ns}
Ankle stiffness	20%(03)	26.7%(04)	23.3%(07)	0.67^{ns}
Radiological union time				
Mean ± SD (Weeks)	18.46± 3.01	20.00± 3.16	19.22± 3.15	0.082^{ns}

No significant statistical difference between expert tibial nail and locking plate and screws groups according to mechanism (p=0.72) side (p=0.80) and type (p=0.56) of injury. There was no significant difference between intervals from injury to operation time (p=1.00) in two groups.

Table II : Comparison of functional outcome after 6 months

Category	Expert tibial nail		Plate and screw		Total		p value
	n	%	n	%	n	%	
Excellent	20	66.7	18	60	38	63.3	
Good	05	16.7	05	16.7	10	16.7	
Fair	03	9.9	04	13.3	07	11.7	0.866^{ns}
Poor	02	6.7	03	9.9	05	8.3	
Total	30	100	30	100	60	100	

- Statistical analysis was done by Chi-square test.
- p value > 0.05 indicates non-significant.
- ns= non-significant.

Fig 1 : Pre-operative X-ray (Intramedullary Expert Tibial Nail)

Fig 2 : Follow-up X-ray after 6 months (Intramedullary Expert Tibial Nail)

Fig 3 : Pre-operative X-ray (Plate and Screw)

Fig 4 : Follow-up X-ray after 6 months (Plate and Screw)

Discussion

In this study, mean (± SD) age of the participants was 36.13 (± 10.88) years within a range of 20-57 years which was compared favorably with other studies.[2,18,19] This study had 48 (80%) male and 12 (20%) female which matched with other studies.[18-20] According to side of injury, 29(48.3%) patients had injury on right side and 31(51.7%) on left side which is statistically not significant (p = 0.80) and similar to others.[20].

Regarding the mechanism of injury, in ETN group, 51(85%) patients suffered from RTA, 06 (10%) from fall from height and 03(05%) from physical assault. So, RTA was the major cause of extraarticular proximal and distal fracture.[20]

Regarding time taken for radiological union, mean radiological union time in ETN group was 18.46(± 3.01) weeks in contrast to 20.00 (±3.16) weeks in LPS group. The result is statistically non-significant (p = 0.082). While other studies noted the average union time in between 16 to 20.8 weeks.[18,19,20,24]

This study represents that, in ETN group 04 (13.3%) patients suffered from soft tissue infection, 02 patients (6.7%) from deep seated infection, 05 patients (16.7%) from delayed union, 02 patients (6.7%) from implant failure/non union and 02 patients (13.3%) from knee stiffness and 03 patients (20%) from ankle stiffness. In contrast, soft tissue infection was in 08 patients (26.7%), deep seated infection in 05 patients (16.7%), delayed union in 07 patients (23.3%), implant failure/non union in 03 patients ((10%), knee stiffness in 04 patients (26.7%) in Proximal locking plate and ankle stiffness in 04 patients (26.7%) was observed in LPS group in Distal tibial locking plate that matched with others studies.[18,19,21,22]

At 6th month follow up functional outcome of patients from both groups were divided into 4 categories- excellent, good, fare and poor according to Tegner Lysholm knee scoring scale and Kaikkonen ankle scale. In ETN group, 20 (66.7%) patient's functional outcome was excellent, 05 (16.7%) good, 03 (9.9%) fair and 02 (6.7%) poor. In contrast, 18 (60%) patients were excellent, 05 (16.7%) good, 04 (13.3%) fair and 03 (9.9%) poor in LPS group. According to p value (0.866), functional outcome was non-significant between both fixation groups. This result is similar to the findings of other studies.[18,19,23]

Limitations

The main weakness of the study were :-

- Small sample size.
- Shorter duration of follow up.
- Uses of other implant for operative treatment.
- Outcome between proximal and distal locking plate system were not evaluated.

Conclusion

The current study demonstrated statistically no significant difference in post-operative follow up findings between both groups at the end of 6 months after surgery although mean radiological union time was non-significantly shorter in ETN group.

Recommendations

Both expert tibial nailing and locking plating may be an adequate treatment option for extra-articular proximal and distal metaphyseal tibial fractures. Multi center studies with larger sample size and longer period of follow up can be undertaken to draw any definitive conclusion. Also Extra articular implant for proximal and distal tibial fracture should be done in a separate study.

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Contribution of authors

MMRC - Conception design, acquisition of data, manuscript writing & final approval.

MMR - Acquisition of data, data analysis, drafting & final approval.

MAR - Acquisition of data, interpretation of data, critical revision & final approval.

JJ - Data analysis, critical revision & final approval.

MQM - Interpretation of data, critical revision & final approval.

Disclosure

All authors declared no competing interest.

References

1. Merchant, T.C.& Dietz, F.R. 1989, 'Long-term follow-up after fractures of tibial and fibular shafts'. The Journal of Bone Joint Surgery Am. 1989;71:599-606.

2. Court-Brown, C.M.& McBirnie, J. 'The Epidemiology of Tibial Fracture'. The Journal of Bone and Joint Surgery Br. 1995;77:417-421.

3. Mauffrey, C., McGuinness, K., Parsons, N., Achten, J.& Costa, M.L. 'A randomised pilot trial of "locking plate" fixation versus intramedullary nailing for extra-articular fractures of the distal tibia'. The Journal of Bone Joint Surgery Br. 2012;94:704–708.

4. DeCoster, T.A., Nepola, J.V.& el-Khoury, G.Y. 'Cast brace treatment of proximal tibia fractures: A 10-year follow-up study'. Clinical Orthopaedics and Related Research. 1988;231:196–204.

5. Rockwood, C. A. & Green, D. P. Rockwood and Green's Fractures inAdults, 8th edition, Wolters Kluwer Health, Philadelphia, USA. 2015.

6. Badami, R.M., Shetty, M.S.& Kumar, M.A. 'Management of distal tibial metaphyseal fractures by expert tibial nail'. Indian Journal of Orthopaedics Surgery. 2015;3(3):229-233.

7. Newman, S.D., Mauffrey, C.P. & Krikler, S. 'Distal metadiaphyseal tibial fractures'. Injury. 2011; 42:975–984.

8. Hazarika, S., Chakravarthy, J. & Cooper, J. 'Minimally invasive locking plate osteosynthesis for fractures of the distal tibia: Results in 20 patients'. Injury. 2006;37(9): 877-887.

9. Johnson, K.D. 'Management of malunion and nonunion of the tibia'. Orthopedic Clinics of North America. 1987;18:157–171.

10. Batten, R.L., Donaldson, L.J.& Aldridge, M.J. 'Experience with the AO method in the treatment of 142 cases of fresh fracture of the tibial shaft treated in the UK'. Injury. 1978;10:108–114.

11. Blachut, P.A., O'Brien, P.J., Meek, R.N. & Broekhuyse, H.M. 'Interlocking intramedullary nailing with and without reaming for the treatment of closed fractures of the tibial shaft: A prospective, randomized study'. The Journal of Bone & Joint Surgery Am. 1997;79:640–646.

12. Freedman, E.L.& Johnson, E.E. 'Radiographic analysis of tibial fracture malalignment following intramedullary nailing'. Clinical Orthopaedics and Related Research. 1995;315:25–33.

13. Tornetta, P.& Collins, E. 'Semiextended position of intramedullary nailing of the proximal tibia'. Clinical Orthopaedics and Related Research. 1996;328:185–189.

14. Krettek, C., Miclau, T., Schandelmaier, P et al. 'The mechanical effect ofblocking screws in stabilizing tibia fractures with short proximal or distal fragments after insertion of small-diameter intramedullary nails'. Journal of Orthopaedic Trauma. 1999;13:550–553.

15. Dunbar, R.P., Nork, S.E., Barei, D.P et al. 'Provisional plating of Type III open tibia fractures prior to intramedullary nailing'. Journal of Orthopaedic Trauma. 2005;19:415–417.

16. Henley, M.B., Meier, M.&Tencer, A.F. 'Influences of some design parameters on the biomechanics of the unreamed tibial intramedullary nail'. Journal of Orthopaedic Trauma. 1993; 7: 311–319.

17. Kuhn, S., Hansen, M.&Rommens, P.M. 'Extending the indications of intramedullary nailing with the Expert Tibial Nail'. Acta Chirurgiae Orthopaedicae Et Traumatologiae echosl. 2008;75: 77–87.

18. Court-Brown, C.M. & Mo-Queen, M.M. 'Locked intramedullary nailing of open tibial fractures'. The Journal of Bone and Joint Surgery. 1991;I73:959-964.

19. Ekeland. A & Bjorn. O.T. 'Interlocking intramedullary nailing in the treatment of tibial fractures'. Clinical. 1988;231:205-215.

20. Gawatre, P., Moradiya, N., Patel, K & Desai, T.V. 'Proximal and distal metaphyseo-diaphyseal fractures of tibia in adults treated with tibia interlock nail with multiaxial locking (A Study of 30 Cases)'. Indian Journal of Orthopaedics Surgery. 2017;3(1):308-313.

21. Prasad PNVSV., Nemade A., Anjum R & Joshi N. 'Extra-articular distal tibial fractures, is interlocking nailing an option? A prospective study of 147 cases'. Chinese Journal of Traumatology. 2019;22(2)103-107.

22. Chen F., Huang X., Ya Y., Ma F., Qian Z., Shi J., Guo S & Baoqing Yu B. 'Finite element analysis of intramedullary nailing and double locking plate for treating extra-articular proximal tibial fractures'. Journal of orthopedic and research. 2018;13:2-8.

23. Memon R & Patel D. 'Functional Outcome of Expert Tibial Intramedulary Nailing for Metaphyseal Distal One Third Fractures of Tibia Published'. Asian Journal of Orthopaedic Research. 2020; 3(1): 21-25.

24. Mostafa A, Ibrahim, Yassin IA, & Mohammed AS. 'Comparative Study between Interlocking Nail and Locked Plate in Distal Tibial Fractures Fixation'. OPEN AIMJ ORIGINAL ARTICLE. 2021;286-292.