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Study Outcome of Surgical Management of Proximal 1/3rd Extra-Articular Fractures of Tibia Using Expert Tibia Nail.

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Abstract

Introduction

Extra-articular proximal tibia fractures account for approximately 5-11% of all tibial shaft fractures. A significant rate of malalignment has been reported with intramedullary nailing of such fractures. Malalignment presents as apex anterior and valgus angulation. The Expert Tibia Nail System (ETNS) is novel design aimed at reducing these problems. It features multi directional locking options in distal and proximal part of the nail. The unique biomechanical characteristic of ETNS is the more proximal placement of Herzog's bend which limits posterior displacement of fracture. The benefits of using ETNS include load sharing, sparing of the extraosseous blood supply, and avoidance of additional soft-tissue dissection, thereby minimizing the risk of postoperative complications.

Methods

Our study is a prospective interventional study conducted between December 2018 to December 2020. This study was conducted on 25 skeletally mature patients with proximal one third extra-articular fractures of the tibia treated with Expert Tibial Nail. Patients were evaluated clinically and radiologically according to modified KLEMM and Borner scoring at the interval of 6weeks, 6months and 18months.

Results

In our study, patients were in the age group of 20-80 years. The incidence of male was more compared to females (4:1) with left sided injury(60%) being more common than right side(40%). According to Modified KLEMM and Borner Scoring System, follow-up mean scores at 6weeks was 11.2, at 6months was 14.08 and at 18months was 15.84 with 76% patients having excellent results and rest 24% had good results.

Conclusion: *From this study, after evaluation of the score with Modified Klemm and Borner scoring system and counting the average of all sample size and after getting the p value, it has been concluded that Expert tibia nail can be considered a better surgical option as it offers advantages in terms of range of motion, hospital stay, full weight-bearing time and union time, infection rate. There is also significant difference in patient's clinical and radiological recovery at 6weeks and 6 months with the use of ETNS.*

Keywords: *expert tibia nail, multi-directional locking, proximal third extra-articular tibia fractures, intra-medullary nailing, surgical site infection.*

Abbreviations

ETNS – Expert Tibia Nailing System

KMB scoring – KLEMM and Borner scoring

Introduction

Tibia is frequently fractured long bone in the body with an annual incidence of tibial shaft fractures is 26 per 1,00,000 individuals [1]. Extra-articular proximal tibial fractures account for 5–10 % of all tibial shaft fractures [2,10] and typically are caused by a high-energy mechanism. Because of the location of these fractures in the highly vascular and muscular area of the lower extremity, there is a higher incidence of arterial injury, muscle damage, and compartment syndrome than in diaphyseal fractures. Due to its location, structural anatomy and sparse antero-medial soft tissue coverage the tibia is exposed to frequent injuries. Open fractures are also common in tibia than any other long bone in the body.

The AO/Orthopaedic Trauma Association [OTA] system is the most widely used system for classifying proximal tibial fractures. Type A fractures are extra-articular, type B fractures are partially articular, and type C fractures are articular with a metaphyseal component. Both IM nails and plates are appropriate for treating type A and simple intra-articular type C1 fracture patterns.

In treatment of proximal tibia fracture good results have been reported with both conservative and surgical methods. Early mobilization with functional exercises and walking activities are important. Conservative management of these fractures has resulted in malunion, nonunion, rotational deformity, or stiffness of adjacent joints [5,6] and this turn the tendency of patient toward surgical management. To reduce the complications associated with conservative treatment, tendency towards operative management of tibial fractures is in vogue. Options include half-pin external fixation, intramedullary implant, hybrid or thin-wire external fixation, plate fixation, or a combination of these techniques [7]. Temporary external fixation may be used, particularly if initial definitive soft-tissue coverage cannot be obtained or if the surgeon chooses to perform the definitive reduction and fixation under more ideal conditions. The available operative treatment for proximal tibia fractures are external fixators, plate internal fixation and intramedullary nailing. External fixators used in open fracture have high intensity of loosening and delayed union which further involves infection from pin, is common. Intramedullary nailing is the standard treatment for most patients with fractures of the tibial shaft. In recent years, closed reduction with minimally invasive plating and locked intramedullary nailing have both become widely used treatment modalities for proximal tibia extra-articular fractures [8,9].

The Expert Tibial Nail System [ETNS][3] is an intramedullary nailing system is indicated for fractures in the tibial shaft as well as for metaphyseal and certain intra-articular fractures of the tibial head and the pilon fracture. In addition to the standard static and dynamic locking options, the ETNS features multi

directional locking options in the distal and proximal part of the nail (Figure 1 and 2). End cap blocks the most proximal screw creating an angular stable construct. The expert tibia nail gives stable fixation and early mobilization which further result in early restoration of function without use of plaster. The rate of union in proximal tibia fractures is more due osteosynthesis initiated by expert tibia nail by inter-fragmentary compression due to its intramedullary support [11].

Hence this study is done to emphasize the importance of functional outcome of expert tibia nailing in management of extra-articular proximal third tibia fractures based on Modified KLEMM and BORNER scoring system [4].

Figure 1 – ETNS with 5 proximal locking holes**.**

Figure 2 – ETNS with 4 distal locking holes

Materials and Methods

The study was carried out on 25 patients with extra-articular Proximal 1/3rd tibial fractures presented to us between December 2018 to December 2020, which were treated operatively with ETNS. Ethical committee approval was obtained, and patients were recruited once written informed consent had been provided. The study included skeletally mature patients between 18-75 years of age with fresh extra-articular Proximal 1/3rd tibial fractures. The study was limited to Closed, Grade 1 and Grade II Gustillo Anderson isolated tibial metaphyseal fractures (AO 41A2/A3 and 42). The patients should have had knee flexion more than 90 degrees.

All patients with age less than 18 years with intra-articular fractures and Open fractures of Gustilo Anderson Grade III injuries were excluded. Patients with suspected and confirmed pathological fractures were also excluded.

All fractures were treated using Expert Tibial Interlocking Nail. It has an advanced nail design and 5 proximal locking options (three unique oblique and two medio-lateral locking options) and 4 distal locking options.

Post – operatively the patient was given intra-venous antibiotics for 3 days followed by oral antibiotics. The patient was kept non weight bearing till 2 weeks but wasn't given any form of immobilization. Post-operative x ray was advised. Physical therapy in the form of quadriceps strengthening exercises and knee and ankle mobilization exercises were started as soon as possible depending on fracture stability and patient tolerance. Partial weight bearing in the form of crutches was started after 2weeks with full weight bearing after union.

The patients were followed up in the outpatient department. Follow up was done at every 2 weeks for 3 months and every 6weeks thereafter for 2 years. Functional outcome was assessed based on Modified KLEMM and BORNER scoring system (Table 1).

Final score	Range of motion Knee & ankle	Muscle atrophy	Alignment	Pain	Union
Excellent	4	3	4	4	4
Good	3	2	3	3	3
Fair	2	1	2	2	2
Poor	1	0	1	1	1

Excellent: 15 – 19 Fair: 5 – 9 Good: 10 – 14 Poor: 0 – 5

Table 1 – Modified KLEMM and Borner scoring

Results and Discussion

There were 20 males and 5 females in our study with an average age of 39.36 years (Range 20-80yrs). Majority of patients sustained fracture both bone leg due to road side accidents (92%), followed by history of fall. 9 patients had AO Type 41A2.1, 4 had Type 41A2.3, 10 had Type 41A3.2 and 2 had Type 41A3.3 fractures. The AO Type 41A3.2 (40%) was the most common and AO type 41A3.3 (8%) was the least common. Reduction was achieved by closed method in 15 (60%) cases and polar screws were used for reduction in 10(40%) cases. the average time duration of surgery from positioning to final dressing was 139 minutes. Dynamisation was done in 3 (12%) patients. Complication of Proximal screw back-

out was also noted in 1 patient (4%). 5(20%) patients developed superficial wound infection in which 1 of them needed debridement, regular dressing and intravenous antibiotics and the other 4 patients healed with regular dressings and intravenous antibiotics. 1 patient had deep infection on the 14th day and needed implant removal and external fixation. 14(56%) patients had anterior knee pain which was managed with analgesics. Average interval of protected full weight bearing was 4 weeks, while average interval of unprotected full weight bearing was 9 (6-12) weeks. 3 patients had radiological signs of healing before 12 weeks and 22 patients had the signs at an average of 14.26 weeks. 19(76%) patients having excellent results and rest 6(24%) had good results in nailing. The follow-up mean scores at 6weeks was 11.2, at 6months was 14.08 and at 18months was 15.84 (Table 2). There was significant difference in means scores of 6weeks and 6 months with p value of 0.0004 which is less than 0.05.

Follow up months	Mean Score (Modified KLEMM and Borner scoring)
6 weeks	11.2
6 months	14.08
18 months	15.84

Table 2 - Mean Scores at follow-up

Discussion

Proximal tibia fractures are a result of combination of multiple forces namely, axial, loading and valgus stress. Most of these fractures occur due to high energy trauma like road traffic accidents and fall from height in young males but injuries due to low energy trauma like fall by slipping are also seen in elderly population.

The goals of surgical treatment are to achieve osseous union and to restore length, alignment, and rotation of the fractured tibia. The treatment of extra-articular proximal tibia fractures can be operative and non-operative. Non-operative treatment includes functional cast bracing but it has variety of complications. Patient related complications include complications of immobilization like decubitus ulcer, urinary tract infections, muscle atrophy, contractures leading to prolonged hospital stay. Other complications include malunion, non-union, rotational deformity or stiffness of adjacent joints. The advantages of operative treatment such as anatomical reduction and early mobilization have been emphasized in many recent reports. In the past, such fractures usually were treated with a cast, with good intermediate-term results in the majority of patients. Fracture union often occurs with some angulation after such treatment, and it has been suggested that this may predispose the patient to osteoarthritis by altering load transmission through the knee and ankle joints3. There has been a trend in recent years toward operative treatment of tibial shaft fractures, and such treatment has been associated with a lower incidence of angular malunion.

Operative treatment includes half pin external fixation, intramedullary implant, plate fixation or a combination of these techniques. In recent years, closed reduction with minimally invasive plating and locked intramedullary nailing have both become widely used treatment modalities for proximal tibia extra-articular fractures. However, intramedullary nailing offers the benefits of load sharing, sparing of extraosseous blood supply and avoidance of additional soft-tissue injury in a vulnerable injury zone. We note that the determining prognosis in high-energy proximal tibia fractures are the diaphyseal and metaphyseal communition and dissociation and the integrity of soft tissue envelope. The closed reduction of extra-articular proximal tibia fractures is difficult due to immense amount of deforming forces acting on it by the muscle attachments. These fractures need special attention as they have a greater propensity for malalignment. Malalignment typically consists of apex anterior and valgus angulation and is often accompanied by posterior displacement of the distal fragment. The shorter the fragment, the more difficult it is to obtain and maintain reduction. The close proximity of these fractures to the articular surface of the knee make fracture reduction and alignment crucial for the development of long term complications like knee pain and consequent development of knee arthritis. Biomechanical studies have demonstrated that closer the reduction alignment is to the joint axis of the knee; the more uniform the distribution of contact pressures is through the weight-bearing articular surfaces 61.

It is of utmost importance to understand the deforming forces acting on proximal and distal fragments and reducing them simultaneously to prevent malalignment. Increased awareness of the such complications associated with IM nailing of proximal tibia fractures has led to the use of specific nailing methods and reduction techniques that help to minimize these complications. There are several nailing methods and reduction techniques such as the use of a proper starting point and insertion angle, blocking screws, unicortical plates, a universal distractor, and alternative positioning and approaches. In recent years, the indications for use of the intramedullary nail system were expanded to include the treatment of a wide spectrum of tibial fractures. Extra articular proximal tibia fractures should be considered as a separate entity and considering the dynamic forces acting on the fracture, the implant used in the intramedullary nailing of such fractures should be unique. The conventional intramedullary nails used in diaphyseal tibial fractures cannot be used for extra-articular proximal tibia fractures as the Herzog curve in these nails lie at or is distal to the proximal tibial fracture site. This can lead to wedge effect that displaces the fracture.

The Expert Tibia Nail has unique biomechanical characteristics that maintain reduction and prevent malalignment of extra-articular proximal tibial fractures. The nail has a more proximal Herzog curve which is designed to limit posterior displacement of the fracture. This new, multidirectional locked intramedullary system involves multiple locking options in different planes at the proximal ends. The angular stability locking system in these nails enhance the axial and lateral stability of the fracture fragments and has also shown to increase construct stiffness and decrease interfragmentary motion [23]. Because of this modified design, the new system has advantages over the traditional tibial

intramedullary nail in dealing with proximal tibial fractures. A study by Laflamme et al .[21] showed that the addition of oblique interlocking screws significantly improved the stability of a nailed proximal tibia fracture and provides comparable stability to a plate osteosynthesis.

The broad medullary cavity of proximal tibia is responsible for its instability. This instability is addressed by the 2 transverse screws used in fixation. In terms of varus – valgus and flexion – extension, the appendage of oblique screws increased the angular stability. To improve purchase in the spongy bone of the proximal tibia, the three most proximal locking screws are designed as cancellous screws. The modified locking options are able to provide more planes for screw fixation at both ends of the implant, thereby increasing the stability between the implant and bone fragments [21]. The set-up involved antero-posterior locking option placed very distally, which allowed for optimized bone purchase and prevented damage to the soft tissue. These design modifications ensure that angular stability is retained. All of these design modifications allow for better fixation of proximal metaphyseal tibial segments through multiple interlocking holes in close proximity to proximal end of the nail. The use of multidirectional interlocking screws ensures that alignment can be maintained and that stability can be preserved despite a short proximal segment. These changes in proximal locking options has decreased the incidence of secondary malalignment.

In our study, the mean age of patients in present study was 41.7 years and majority of patients were males accounting for 20 males (80%) which was comparable with series by Lakhpat et al.[18] where the mean age was 42.8 years while in series of Duwelius et al.[19] mean age was 40.5 years.

In our study, Road traffic accidents being the commonest mode of injury leading to these high velocity fractures. In 80 % of cases, mode of trauma was road traffic accidents and in 12% of the cases, mode of trauma was assault while 8% of cases, mode of trauma was fall from standing height. Thus results of present study correlates with the study conducted by Barbieri et al.[22] in which they observed 75% due to high energy trauma (Table 3).

The mean interval of radiological union in the present study was 18.5 weeks while the average time of radiological union was 16.8 weeks in a study conducted by Lakhpat et al. [18] on 20 patients (Table 4).

In our study, joint mobilization and muscle strengthening exercises were started for all patients on post-operative day 1. Patient was allowed partial weight bearing depending on the fracture configuration, reduction and alignment. Full weight bearing was started after radiological and clinical evidence of union wherein 10 % of the patients were allowed partial weight bearing in 3rd week and 30% of the patients were allowed after 4 weeks and rest of the patients were allowed partial weight bearing after 6weeks with full weight bearing at 12 weeks. This was different from previous study by Kenganal et al.[16] wherein partial weight bearing was started after 6weeks irrespective of the fracture configuration (Table 5). Benefits of early mobilization gives better results in terms of good range of motion, less stiffness and also promotes healing.

Functional results were graded according to the criteria by Modified KLEMM and Borner classification. The mean at 6 weeks was 11.2 and mean at 6 months was 14.08. The p value of 0.0004 was significant. Thus, the results showed that the functional and radiological outcomes of patients treated with expert tibia nailing at 6 weeks and 6 months were statistically significant.

Complications resulting from expert tibia nailing in our study were superficial wound infection in 5 cases (20%), anterior knee pain in 8 cases (32%) and deep infection in 1 patient (4%). Anterior knee pain was the most common complication. None of the patients had wound dehiscence, deep vein thrombosis, compartment syndrome or non-union which was comparable with study conducted by Mohammed and Ramaswamy Saravanan[20], Akshay Phadke et al[15] and Lakhpat et al. [18]. The comparison of post-operative complications in various studies is summarized in Table 6.

Complication of Proximal screw back-out was also noted in 1 patient (4%) which was comparable with the study by Wiss et al. [21] who documented proximal screw backout in 3 % of cases. This was seen in proximal screw which was placed antero-posteriorly.

Parameters	Wiss et al[12] 1995	Vidyadhara et al[13]2006	Lindvall et al[9]2009	Hansen et al[14] 2012	Kenganal et al[16] 2019	Our study
Mean Age (years)	32	43	39.6	44	40.1	41.7
Male (%)	82	90.7	78.58	62	83.33	80
Female (%)	18	9.3	21.42	38	16.67	20
Left (%)	48	-	-	-	46.67	60
Right (%)	52	-	-	-	53.33	40
High energy trauma(%)	>90	100	82.4	59.1	80	92
Low energy trauma(%)	-	-	17.56	40.9	16.67	8

Table 3 - Comparison of demographics in different studies.

Parameter	Vidyadhara et al[13] 2006	Lakhpat et al. [18] 2016	Kenganal et al[16] 2019	Our study
Mean interval of radiological union (weeks)	18.68	16.8	20.33	18.5

Table 4 - Comparison of mean interval of radiological union in various studies.

Parameters	Kenganal et al[16] 2019	Our study
Partial weight bearing	6 weeks	6weeks
Full weight bearing	13.43 weeks	12weeks

Table 5 - Comparison of post-operative protocol in various studies.

Parameters	Wiss et al[12] 1995	Bhandari et al[8] 2003	Lindvall Etal[9] 2009	Kenganal et al[16] 2019	Our study
Superficial Infection(%)	2	3.51	28	13.33	20
Deep infection(%)	3	0	0	0	4
Knee pain(%)	11	-	5	30	32
Implant related(%)	3(proximal screw back out)	7.5(implant failure)	-	0	4(proximal screw back out)

Table 6 - Comparison of post-operative complications in various studies.

Conclusion

From this study, after evaluation of the score with Modified Klemm and Borner scoring system and counting the average of all sample size and after getting the p value, it has been concluded that Expert tibia nail can be considered a better surgical option as it offers advantages in terms of range of motion, hospital stay, full weight-bearing time and union time, infection rate. There is also significant difference in patient's clinical and radiological recovery at 6weeks and 6 months with the use of ETNS.

References

1. Rockwood CA, Bucholz RW, Court-Brown CM, Heckman JD, Tornetta P. Rockwood and Green's Fractures in Adults.7th ed. Philadelphia: Lippincott Williams & Wilkins; chapter 55, Tibia and Fibula fractures, 2001, 1867.

2. Court-Brown CM, McBirnie J. The epidemiology of tibial fractures. J Bone Jt Surg Br. 1995; 77(3):417-421

3. Kuhn S, Hansen M, Rommens PM. Extending the indications of intramedullary nailing with the Expert Tibial Nail. Acta Chir Orthop Traumatol Cech. 2008 Apr;75(2):77-87. PMID: 18454910.

4. Natarajan GB, Srinivasan DK, Vijayaraghavan P V. Comparison of clinical, radiological, and functional outcome of closed fracture of distal third tibia treated with nailing and plate osteosynthesis. Afr J Trauma [serial online] 2014 [cited 2021 Jan 10];3:68-72

5. DeCoster TA, Nepola JV, el-Khoury GY. Cast brace treatment of proximal tibia fractures. A 10-year followup study. Clin Orthop Relat Res. 1988; 231:196204

6. Milner SA, Davis TR, Muir KR, Greenwood DC,Doherty M. Long-term outcome after tibial shaft fracture: is malunion important? J Bone Jt Surg Am. 2002; 84-A(6):971-980

7. Nork SE, Barei DP, Schildhauer TA, Agel J, Holt SK, Schrick JL, et al. Intramedullary nailing of proximal quarter tibial fractures. J Orthop Trauma. 2006;20(8):523-528

8. Bhandari M, Audige L, Ellis T. Operative treatment of extraarticular proximal tibial fractures. J Orthop Trauma.2003; 17(8):591-595

9. Lindvall E, Sanders R, Dipasquale T, Herscovici D, Haidukewych G, Sagi C. Intramedullary nailing versus percutaneous locked plating of extra-articular proximal tibial fractures: comparison of 56 cases. J Orthop Trauma. 2009; 23:485-492

10. Freedman EL, Johnson EE. Radiographic analysis of tibial fracture malalignment following intramedullary nailing. Clin Orthop Relat Res. 1995; 315:25-33

11. Sharan AD, Jeshuran W, Mulligan M, McGuire K, Uhl R. Intramedullary nailing in a tibial shaft fracture with distal articularextension. Orthopaedics, 2005;28(6):571-2.

12. Wiss DA, Stetson WB. Unstable Fractures of the Tibia treated with a Reamed Intramedullary Interlocking nail. Clin Orthp. 1995; 315:56-63

13. Vidyadhara S, Sharath KR. Prospective study of the clinico-radiological outcome of interlocked nailing in proximal third tibial shaft fractures. Injury. 2006 Jun;37(6):536-42. doi: 10.1016/j.injury.2006.01.042Gupton M, Munjal A, Kang M. StatPearls. StatPearls Publishing; Treasure Island (FL): Aug 16, 2020. Anatomy, Bony Pelvis and Lower Limb, Fibula

14. Attal R, Hansen M, Kirjavainen M, Bail H, Hammer TO, Rosenberger R, Höntzsch D, Rommens PM. A multicentre case series of tibia fractures treated with the Expert Tibia Nail (ETN). Arch Orthop Trauma Surg. 2012 Jul;132(7):975-84. doi: 10.1007/s00402-012-1502-y.

15. Phadke, Akshay & Badole, Chandrashekhar & Thakur, Shailendra & Handa, Kriti. (2016). Interlocking nailing in fractures of distal tibia. International Journal of Research in Medical Sciences. 1132-1135. 10.18203/2320-6012.ijrms20160796.

16. Kenganal, Dr & Nayak, Dr & Kumar, Dr. (2019). Functional outcome of metaphyseal and diaphyseal fractures of tibia treated with expert tibial interlocking nail: A prospective study. International Journal of Orthopaedics Sciences. 5. 48-52. 10.22271/ortho.2019.v5.i1a.10.

17. Larsen P, Elsoe R, Hansen SH, Graven-Nielsen T, Laessoe U, Rasmussen S. Incidence and epidemiology of tibial shaft fractures. Injury. 2015 Apr;46(4):746-50

18. Lakhpat Yadav, Srivastava S, Rakesh Kumar et al. Functional Outcome of Expert Tibial Intramedullary Nailing for Metaphyseal and Diaphyseal Fractures of Tibia: IOSR Journal of Dental and Medical Sciences (IOSRJDMS) e-ISSN: 2279-0853, p-ISSN: 2279-0861.2016; 15(7):IX

19. Duwelius PJ, Schmidt AH, Rubinstein RA, Green JM. Non-reamed interlocked intramedullary tibial nailing. Clin Orthop. 1995; 315:104-13.

20. Mahmood A et al. Outcome of expert tibial nailing for distal third tibial fractures: Published By Orthopaedic Proceedings: Print ISSN 1358-992X: Published online, 2012, 14.

21. Laflamme GY, Heimlich D, Stephen D, Kreder HJ, Whyne CM. Proximal tibial fracture stability with intramedullary nail fixation using oblique interlocking screws. J Orthop Trauma. 2003 Aug;17(7):496-502. doi: 10.1097/00005131-200308000-00004

22. Barbieri R, Schenk R, Koval K, Aurori B. Surgery for distal tibial fracture. Clin Orthop. 1996; 332:16-22.

23. McKellop HA, Sigholm G, Redfern FC, Doyle B, Sarmiento A, Luck JV Sr: The effect of simulated fracture-angulations of the tibia on cartilage pressures in the knee joint. J Bone Joint Surg Am 1991;

73(9):1382-1391.