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A study for assessment of functional outcome after surgical management of extra articular proximal tibia fractures using xpert tibia nail and review of literature

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Abstract
Introduction: Nonarticular proximal-third fractures occur because of a variety of mechanisms and account for 5% to 11% of tibial fractures. Treatment is challenging and the rates of compartment syndrome and arterial injury are higher, especially for displaced fractures.
Materials and method: This is a prospective interventional study included 48 patients aged 21 to 68 years and were diagnosed as having a proximal tibial fracture with or without diaphyseal involvement. The fractures were stabilized with closed reduction and internal fixation with expert tibia nail of appropriate sizes at a tertiary trauma care centre from January 2019 to July 2020.
Result: Out of 48 patient 40 patient had no extension lag only 8 patient had extension lag more than 10 degree who had showed poor compliance to pain and physiotherapy Other than infection other complication included, delayed union (3) varus deformity(0), post traumatic arthritis in 2 patients. No complications like Compartment syndrome, DVT, Iatrogenic foot drop and Avascular necrosis. Out of 48 patients 22 patient had radiological union at 12 weeks with average time for union was 16 weeks. Majority of our patients 80% started walking without support in 18-20 weeks.
Discussion: Proximal tibia plays a crucial role in weight transmission via knee joint and is vital in knee joint mobility and function. Fractures in this region lead to significant morbidity and decreased quality of life, and are difficult to treat owing to subcutaneous anteromedial surface with high incidence of open fractures.
Conclusion: Management of extra articular proximal tibia fractures is technically challenging to manage due to subcutaneous bone anteromedially and poor soft tissue conditions and hence involves various postoperative complications. The low rates of delayed union, malalignment, and implant-related complications from our study suggest that use of the ETN (expert tibia nail) can result in equal or better outcomes than those reported following use of existing tibial intramedullary nail designs for fractures between and including the proximal metaphysis.

Keywords: proximal tibia, extraarticular, expert tibia nail, minimally inavasive, anterolateral, plating

Introduction

Nonarticular proximal-third fractures occur as a result of a variety of mechanisms and account for 5% to 11% of tibial fractures. Treatment is challenging and the rates of compartment syndrome and arterial injury are higher, especially for displaced fractures. [1]

Proximal tibia fractures were first described as car bumper fractures and are mostly caused by high energy road traffic accidents and fall from height. [2] Extraarticular are usually caused by secondary to direct bending forces acting on metadiaphyseal junction of upper leg. Direct axial compression, a valgus or varus moment and indirect shear forces also contribute to proximal tibia fractures. [2] Hence, this may lead to delayed union, non union, wound dehisence and infection. [3] For tibia shaft fractures, intramedullary nailing is the gold standard of care as it minimizes surgical insult to the fracture and soft tissue [4]. Yet high rates of primary and secondary malalignment leading to instability, delayed bone healing, and the need for reoperation are still reported for intramedullary nailing especially of proximal [4] and distal tibia fractures.Generally the advantages of intramedullary nail fixation and its minimally invasive technique cannot be universally applied to all tibia fracture types [4]. To improve the applicability of an intramedullary nailing system particularly to metaphyseal fractures, the Expert Tibia Nail (ETN; Synthes AG, Switzerland) was designed as an adaption of an original prototype previously shown to have high biomechanical stability when compared with conventional nails and different plate osteosynthesis techniques [5, 6]. The additional improvement of ETN's proximal and distal locking options has led to an implant that may be applied to all extraarticular tibia fractures. In the proximal part, five locking options in four planes allow the surgeon to achieve improved fixation and angle stable locking of the most proximal locking screw. At the distal end, ETN has four locking options in three planes, with the most

distal hole situated 5 mm proximal to the nail tip [7]. The aim of this present multicentre study was to present clinical experience and outcomes of intramedullary nailing of proximal tibia fractures with the ETN.

Materials and Method

This is a prospective interventional study included 48 patients aged 21 to 68 years and were diagnosed as having a proximal tibial fracture with or without diaphyseal involvement. The fractures were stabilized with closed reduction and internal fixation with expert tibia nail of appropriate sizes at a tertiary trauma care centre from January 2019 to July 2020.

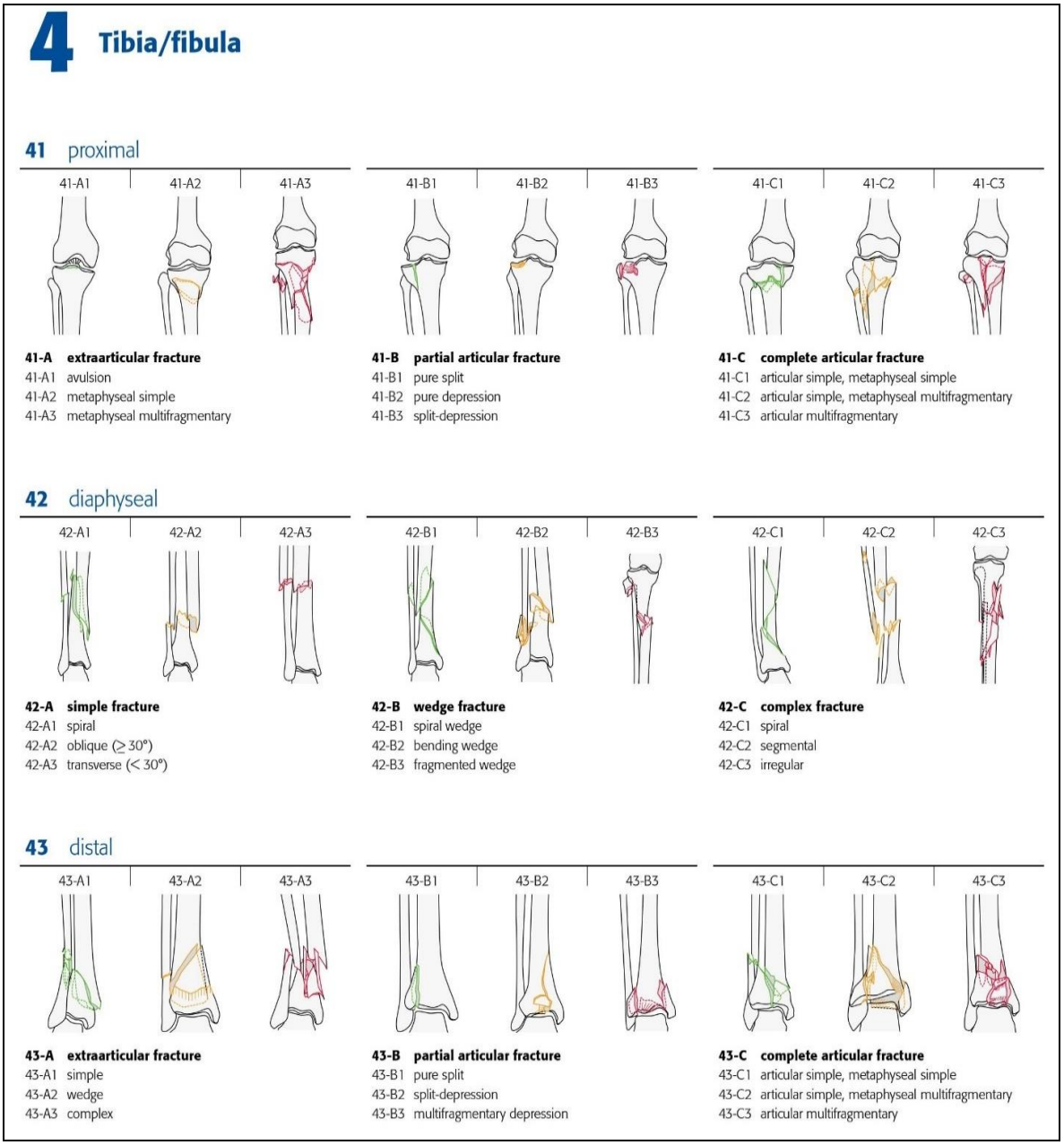

Fig 1

Inclusion criteria

1. Age more than 18 years and less than 75 years and willing for surgery.
2. Patients with competent neurological and vascular status of the affected limb. and patients who meet the medical standards for routine elective surgery.
3. Patients with fracture meeting the AO criteria (41-A), duration of injury < 2 weeks.

Exclusion Criteria

1. Patient with open fractures, intra articular extension, pathological fractures, poor medical health or who didn't give consent were excluded.
2. Patients with immature skeleton, segmental fracture of tibia, old injury were excluded.

Surgical procedure

Surgery was performed with the knee flexed at least 90–100 degree on a radiolucent or fracture table, with side placement of an image intensifier to allow viewing along the axis from the knee to the ankle joint. Closed reduction of the fracture was conducted, if necessary, with additional percutaneous techniques. The bone was opened in line with the medullary canal at the defined entry point for the ETN. In the anteroposterior (AP) view, the entry point is in line with the axis of the intramedullary canal and lateral intercondylar tubercle. In the mediolateral view, the entry point is at the ventral edge of the tibial plateau whilst remaining in line with the intramedullary canal The approach for ETN insertion was left to the discretion of the treating surgeon, but all utilized a cannulated nail with or without reaming of the medullary canal depending on the fracture type and soft tissue condition. Restoration of axis, length and rotation of the bone were controlled, if necessary, with towels, pointed clamps, poller screws or a distractor. In cases with extensions of the fracture into the knee or ankle joint, percutaneous screws were used to fix the joint before inserting the nail. Distal interlocking was performed free hand with the radiolucent drill. Any residual fracture gap was closed with a compression screw or backstroke technique. For proximal interlocking, the targeting device (zig) was used. Care was taken not to drill over the posterior cortex for the three most proximal locking options to prevent any damage to nerves or vessels in that area. In the case of a concomitant fibular fracture, plate fixation was made based on the surgeons' judgement. At the earliest time point of 6 weeks after fixation with ETN, dynamization was performed depending on the status of bone healing as observed on routine radiograph controls during the follow-up period.

Post-operative Care

Patients were monitored for vascularity, swelling, discoloration, and movement for first 48 hours, check dress was done on day 3 and then later Sutures will be removed on 14th day. The patients were placed in a well-padded posterior splint with the ankle neutral to prevent an equines deformity, during this period limb elevation and active toe movements were encouraged. Non-weight bearing mobilization was started with walker which progressed to partial weight bearing after four weeks at least, Full weightbearing was advised once considerable callus was visualised radiologically. Active range of movements of knee and ankle were initiated as soon as the patient's skin condition and pain permitted. Follow up: Plain radiograph was carried out post-operative, after two weeks, one month, two month, four month, and six month of surgery. Evaluation of clinical, and radiological outcomes was made.

Result

In our study, out of total 48 patients, the eldest patient in our study was 68-year-old whereas youngest patient was 21 year old. The mean age of all patients was 41.31+13.35 year. However, 56.2% of our patients were from 31-50 age group. The male gender was predominantly forming the sample size whereas females in the sample size. 32 patients had fracture due to road traffic accident, 8 had due to fall from height, 1 due to assault and 7 patients due to slip and fall. 2 patients had associated femur fracture and 30 patients did not have any associated injury. There were 30 patients with 41A2, 18 with 41A3 type of Fractures respectively. All patients were managed with ETN(expert tibia nail). There are disadvantages of these ETN (expert tibia nail)are costly, removal of nail is difficult. 2 Patients had superficial infection and 1 had deep infection. Rasmussen clinical and radiological scores were used to express the result at the end of last follow up which is basically based in functional improvement and radiological parameters. Good results were observed in 8 patients whereas 40 had excellent. In the present study, the range of knee flexion was 100 to 146 degrees, with a mean flexion of 136 degrees. Out of 48 patient 40 patient had no extension lag only 8 patient had extension lag more than 10 degree who had showed poor compliance to pain and physiotherapy Other than infection other complication included, delayed union (3) varus deformity(0), post traumatic arthritis in 2 patients. No complications like Compartment syndrome, DVT, Iatrogenic foot drop and Avascular necrosis. Out of 48 patients 22 patient had radiological union at 12 weeks with average time for union was 16 weeks. Majority of our patients 80% started walking in 18-20 weeks. Rdaiogarph 1 and 2 demonstrating alignment achieved after ETN nailing.

Table 1: Demographics and Fracture type.

Male/Female	***35/13***
Age (Range and Mean)	41.31+13.35 years (21 to 68 years)
Right/left side	29/19
Fracture type 41-A1	0
Fracture type 41-A2	30
Fracture type 41-A3	18
Distal fracture extension	7
Closed/Open injury	48/0

Table 2: Mechanism of Injury.

Motor Vehicle crash	**12**	**25%**
Fall	8	16.66%

Isolated Fracture	24	50%
Multiple Fracture	3	6.25%
Polytrauma	1	2.08%
TOTAL	48	100%

Table 3: Surgical Details.

Days till surgery in days	**8.2±2.3**
Days post-surgery (Hospital stay)	6.6±2.3
Surgical time in minutes	65±20
Estimated blood loss	30.5±20.5
Fluoroscopy time in minutes	20.3±6.3
Nail size (8/9/10 hole)	(28/10/10)
Time to union in weeks	3.2±1.3
Immobilization in days	8.5±2.6

Table 4: Post-operative Complications and Outcomes.

Radiographic Healing Time(months)	**2.1±1.1**
Delayed Union	3 cases
Non-Union	1 case
Valgus Malunion	2 (7 deg. & 8 deg.)
Varus Malunion	0
Secondary Loss of Reduction	0
Knee joint function ≥120 range of motion	40
Knee joint function ≤120 range of motion	8
Superficial wound infection	4
Implant removal	0

Table 5: Rasmussen's clinical Criteria for outcome assessment.

Subjective	Points
A. Subjective complaints	
a. Pain	
No pain	6
Occasional pain	5
Constant pain after activity	4
Significant rest pain	0
b. Walking capacity	
Normal walking capacity (in relation to age)	6
Walking outdoors for at least 1 h	4
Short walks outdoors for >15 min	2
Walking indoors only	1
Wheel-chair/bedridden	0
B. Clinical signs	
a. Extension	
Normal	6
Lack of extension (0–10°)	4
Lack of extension > 10°	2
b. Total range of motion	
≥140°	6
≥120°	5
≥90°	4
≥60°	2
≥30°	0
c. Stability	
Normal stability in extension and 20° of flexion	6
Abnormal instability 20° of flexion	5
Instability in extension < 10°	4
Instability in extension > 10°	2
Maximum	30
Excellent	27–30
Good	20–26
Fair	10–19
Poor	<10

Table 6: Outcome as per Rasmussen's criteria.

Range	Results	1 Month follow-up	2 Month follow-up
18	Excellent	10	40
12-17	Good	30	8
6-11	Fair	8	0
<6	Poor	0	0

Radiograp 1

Fig 2

Radiograph 2

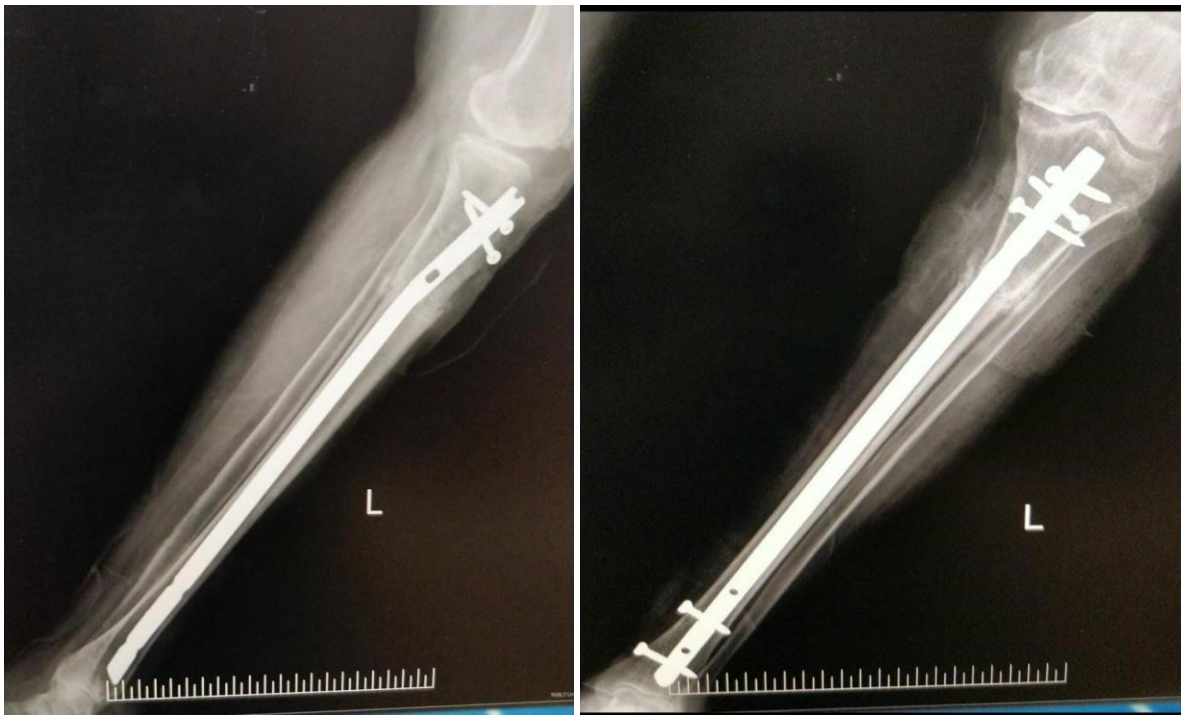

Fig 3

Discussion

This observational study is to present clinical experience and outcomes using the ETN for intramedullary nailing of tibia fractures. The data from our study validate the efficacy of ETN fixation of extraarticular and diaphyseal tibia fractures. Most patients achieved healing within 1 year after surgery. The rate of primary and secondary malalignment and risk of experiencing a complication directly related to the use of ETN were low [7, 8]. In addition, there were a small number of reoperations performed despite the overall delayed union rate of 12 %; this finding is consistent with other reports on intramedullary nailing of tibia fractures, where the proportions of required secondary interventions range from 6.3 to 48 % [9, 10].

Proximal tibia plays a crucial role in weight transmission via knee joint and is vital in knee joint mobility and function. Fractures in this region lead to significant morbidity and decreased quality of life and are difficult to treat owing to subcutaneous anteromedial surface with high incidence of open fractures. [11, 12]

The inner 2/3rd of cortical bone of tibia relies on intramedullary vessels whereas as outer 1/3rd cortex relies on extramedullary overlying soft tissues. In proximal tibia fractures the intramedullary vessels are disrupted and hence the bone relies on periosteal blood flow and surrounding soft tissues. To preserve these parameters, ETN with minimally invasive approach is used. [13]

Intramedullary nailing of proximal tibia fractures are associated with valgus deformity, apex anterior angulation and fracture displacement. External fixators usually lead to malunion, pin tract infections, restricted mobility at knee and poor patient satisfaction. [14, 15]

Open reduction and internal fixation with plating has been well accepted modality of surgical management of proximal tibia fractures,but also causes devitalization of surrounding soft tissue injury due to extensive dissection and loss of osteogenic fracture hematoma [15, 16].

Infection rates for open reduction and internal fixation were found to be approximately 20% whereas soft tissue infections decreased up to 0% with the use of limited internal fixation [17, 18].

Preservation of fracture hematoma, periosteal circulation and soft tissue integrity are key for better outcome [18].

The ETN demonstrated important benefits in the treatment of proximal and distal tibia fractures by reducing the risk of secondary malalignment. 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. To improve purchase in the spongy bone of the proximal tibia, the three most proximal locking screws are designed as cancellous screws. In addition, angular stable locking of the most proximal locking screw is achieved by inserting the corresponding end cap of the nail. Proximal tibia fractures are known to be particularly prone to malalignment. Lang *et al*. questioned the procedure of nailing proximal tibia fractures after reporting a very high malalignment rate of 84 %. The groups of Ahlers and Freedmann both reported similarly unacceptable high rates of 58 and 68 %, respectively [19, 20].

Some limitations to be considered for this study include the varied skills of the treating surgeons who were not intramedullary nailing experts and the fact that the type of surgical approach chosen was based on the surgeons' own judgement. Nevertheless, we believe the information generated from this study provides an objective view of our general clinical work and is representative of what might be anticipated from the surgical treatment of tibial fractures with ETN. We used the term delayed union but non-union at the 1-year follow-up if the fracture was not completely healed. This is because there was progress in healing and there was no need for reoperation. This includes all patients who have been reoperated to promote healing before but did not show complete healing at the time of follow-up after 1 year. The low rates of delayed union, malalignment, and implant-related complications from our study suggest that use of the ETN can result in equal or better outcomes than those reported following use of existing tibial intramedullary nail designs for fractures between and including the proximal and distal metaphysis

Conclusion

Management of extra articular proximal tibia fractures is technically challenging to manage due to subcutaneous bone anteromedially and poor soft tissue conditions and hence involves various postoperative complications. Expert tibia nail provides good surgical and functional outcome owing to preservation of fracture hematoma, soft tissue and periosteal blood supply with minimal incisions and decreased surgery time. Thus, preventing wound dehiscence and infection rates with better union and functional outcome. The union rates are better owing to use of Load shearing compared to other techniques even in comminuted metaphyseal fractures.

Funding

Nil

Conflict of interest

Nil

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