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Corresponding Author
Naveen Sathiyaseelan
Saveetha Medical College and Hospital, Chennai, Tamilnadu, India

Author Designation
[1]Postgraduate Resident
khanmohasin18@gmail.com
[2]Assistant Professor
drmukuljain92@gmail.com
[3]Postgraduate Resident
kz.ctaj8@gmail.com
[4]Assistant Professor
spnaveen17@gmail.com
[5]Senior Professor and Head
drhkjain99@gmail.com

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Prospective Study on the Management and Outcomes of Compound Tibia Fractures in Adults Using Unreamed Solid Tibia Nails

[1]Mohsin Khan, [2]Mukul Jain, [3]Khem Raj Thory, [4]Naveen Sathiyaseelan and [5]Harish Kumar Jain
[1,2,3,5]Jhalawar Medical College and SRG Hospital, Jhalawar, Rajasthan, India
[4]Saveetha Medical College and Hospital, Chennai, Tamilnadu, India

ABSTRACT
Of all compound fracture sites, the tibial shaft accounts for 63% of all fractures. The best way to treat a compound tibia fracture is still up for debate; available alternatives include closed reduction and cast immobilization, open reduction and fixation using a plate or external fixation, or closed reduction using intramedullary nailing. This investigation involved 24 patients with compound tibia fractures treated at the orthopaedic department of a Tertiary Care Hospital with unreamed interlocking solid tibia nailing. Every case was recent and primarily distressing in nature. Following surgical preparedness, every case was operated as soon as possible. All cases were followed up on for at least 9 months and the functional outcome was evaluated using Johner and Wruh's criteria. When complex fractures of the tibia were treated with unreamed solid tibia nailing, 58.33% of cases had outstanding outcomes, 24.78% had good outcomes, 8.33% had fair outcomes and 8.33% had bad outcomes. In total, 91.33% of the patients demonstrated union within nine months, with a complete range of motion and prompt mobilization. According to the results of our study, unreamed solid tibia nailing is a good alternative for early fixation with the advantages of few complications, a high rate of union and early mobilisation.

INTRODUCTION

The most frequent long bone fractures seen by most orthopaedic surgeons are tibial diaphyseal fractures. There are roughly 26 tibial diaphyseal fractures per 1 lakh people annually in the normal population. With a male incidence of roughly 41 per 1 lakh per year and a female incidence of about 12 per 1 lakh per year, men are affected more frequently than women. Tibial fractures have a bimodal distribution, with young males predominating[1]. The tibia has more open fractures than any other major long bone because one-third of its surface is subcutaneous along the majority of its length. The tibia's blood supply is more vulnerable than that of bones encased in thick muscles[2].

Tibial diaphyseal fractures are typically caused by five different factors: falls, sports injuries, direct blows or assaults, automobile crashes and gunshot wounds[1]. The following factors serve a significant role in prognosis: (1) Initial displacement quantity, (2) Communition degree, (3) Ddevelopment of infection, and (4) Severity of soft tissue injury excluding infection[2].

Tibial fractures may be related to vascular, neurological, or compartment syndrome. Since the knee and ankle have hinge joints, rotatory deformity following fracture cannot be adjusted. Due to the high frequency of complications linked to these fractures, management is frequently challenging and the best course of action is still up for debate. To select the most suitable treatment for a specific pattern of injury, the management of the fractured tibia necessitates the broadest expertise, greatest wisdom and finest clinical judgement[3].

The treatment of open tibia fractures must accomplish three objectives. infection control, bony union and function restoration are the three main goals. These objectives depend on one another and are typically completed in the order indicated by the chronology. For instance, failing to stop an infection encourages delayed union or non-union and delays the limb's functional recovery.

The most common method of immobilisation in the past has been a plaster cast, although this method leaves the wound comparatively inaccessible and does not necessarily maintain the length of the tibia[4]. Unacceptably high rates of infection have been produced by open reduction and internal fixation with plates and screws[5-7]. With more serious or localised injuries, as well as concomitant displaced intra articular fractures of the knee and ankle, this approach may be chosen. Many truamatologists believe that external fixation is the best option but it has drawbacks such bulky frames, frequent pin track infections, non-unions and malunions[5,8].

Charley[9] in his text " closed treatment of common fractures" said that he believed that eventual solution to the tibial fractures would be a nonreamed intramedullary nail.

Since image intensifier has made closed intramedullary nailing possible, the choice of intramedullary nailing, whether locked or unlocked, has grown in popularity. A load-sharing tool, a nail is rigid to axial and torsional forces. In comparison to other types of internal fixation, closed nailing causes the least disruption to soft tissue, fracture hematoma and the natural process of bone healing. Open tibial fractures have been successfully treated with intramedullary nails like Lottes and Enders nails utilised without reaming and these implants have been linked to low incidence of post-operative infection. However, they are not recommended for communited fractures as these fractures frequently shorten or move around these tiny nails[8,10].

The incidence of communited fracture malunion is reduced by locking intramedullary nails to the main proximal and distal fragments. However, interlocking intramedullary nailing has historically required reaming, which cuts off the blood supply[11]. Most researchers advise against utilising intramedullary nailing with reaming for grade II and III open tibial fractures since the rate of infection following treatment of these fractures has been rather high. This prompted us to plan a trial in order to research the effectiveness of closed interlocking intramedullary nailing without reaming in the management of open tibial shaft fractures.

MATERIALS AND METHODS

After receiving ethical approval, the study was carried out at the orthopaedics department of a hospital providing tertiary care. Between August 2020 and March 2022, 24 patients with compound tibial shaft fractures underwent wound debridement and interlocking intramedullary solid tibia nailing without reaming. All of the cases involved trauma and were brought to the hospital within 24 hrs of the incident.

Study design: Prospective, Observational type of descriptive study

Inclusion criteria:

- Age more than 18 years and less than 65 years
- Tibial shaft fractures >5 cm distal to the tibial tuberosity and 7 cm proximal to the ankle joint with or without fibula fracture
- Open fractures type I, II, III-A according to Gustilo Anderson classification
- Duration between injury and admission is within 24 hrs

Exclusion criteria:

- Age less 18 years and not more than 65 years
- Associated intra-articular fractures of proximal/ distal tibia
- Closed fractures and Gustilo Anderson type III-B and type III-C fractures
- Pathological fractures

Surgical technique: Patients underwent surgery with anesthesia, lying supine on a radiolucent table (Fig. 1). The injured leg was flexed to relax muscles, while the other was adjusted for the image intensifier's movement. After prep, the limb was scrubbed and painted with povidone iodine. Sterile drapes covered the body. A vertical patellar tendon splitting incision was made from the center of the patella to the tibial tuberosity (Fig. 1). An entry portal aligned with the medullary canal (Fig. 2). After widening the proximal medullary canal by one-third, the fracture was manually reduced under C-arm guidance.

The unreamed tibial nail (UTN) was manually inserted, verified with an image intensifier, aided by a slotted hammer. The nail was placed just below the bone surface, confirmed in both AP and lateral views. The connecting screw secured the nail via the insertion handle and coupling block, guiding it into the tibia's medial side. After tightening, the insertor/extractor was attached and the nail was manually inserted, its position verified with the image intensifier.

Proximal locking was preferred but distal locking occurred first if there was a gap. The insertion handle located proximal locking bolts and an incision was made. The trocar and drill sleeve facilitated drilling through both cortices with an electric drill. Locking bolt length was determined with a depth gauge, with 2 mm added. The locking bolts were inserted with a hexagonal screwdriver (Fig. 2). For distal locking, the image intensifier guided a Steinmann pin's placement, drilling through both cortices and inserting and tightening the locking bolt, ensuring proper placement.

The incised wound was cleaned, the patellar tendon and skin sutured, sterile dressings applied, arterial pulsations checked and support applied based on the fracture pattern and reduction, with intravenous antibiotics for seven days. Rehabilitation started post-anesthesia recovery, including crutch walking, sutures removed on the 14th day and partial weight-bearing walking around the 28th day. Patients were followed up at six-week intervals, with assessments based on a specific proforma.

RESULTS

In this study, the majority of patients fell within the 28-37 years age group, comprising 37.5% of the cases. The youngest patient was 21 years old, while the oldest was 62 years. Males predominated the patient population, accounting for 66.67%, with females representing 33.33%. Pedestrian automobile accidents were the leading cause of fractures, responsible for 66.67% of cases. Among the fractures, right tibial fractures were most common, making up 66.67% of patients.

The Gustilo type II classification constituted the majority of compound tibial fractures at 50%. Commuted fracture patterns were predominant, occurring in 41.66% of cases. All surgeries were performed within 3 days of trauma, with 5 cases operated on within 12 hours. The majority of cases were conducted under spinal anesthesia (22 cases) and the remaining 2 under general anesthesia. A midline patellar tendon splitting approach was consistently used for nail insertion, with an average operation time of 75 min (ranging from 60-120 min) (Table 1).

Secondary procedures included dynamisation of nails in 4 cases (16.66%), broken screw extraction in 2 cases (8.33%) at 12 weeks postoperatively and skin split grafting in 2 cases (8.33%) at 14 days postoperatively. Union, defined as the presence of bridging callus on two radiographic views and the ability to bear full weight, was achieved in 91.66% of fractures within a time frame ranging from 3-9 months, with an average of 5 months (Case 1).

Knee motion results showed that 58.33% achieved full range at 12 weeks, with more than 80% motion in 41.67%. Ankle motion results at 24 weeks indicated that 66.66% achieved full range, while 25% achieved over 75% motion and 8.33% had less than 50% motion (Table 2).

Based on Johner and Wruh's criteria, excellent results were observed in 58.33% of cases, good results in 24.78%, fair results in 8.33% and poor outcomes in 8.33% (Table 3). Complications included infections in 2 patients, superficial in Gustilo type II and deep in type III-A, which were successfully treated with oral antibiotics and debridement in two cases. Additionally, two cases experienced locking screw/bolt breakage

Table 1: Statistics of surgery

Duration (hrs)	No. of patients	Percentage
<12	5	20.83
12-24	10	41.66
24-48	7	29.16
>48	2	8.33
Total	24	100.00

Table 2: Range of motion

Knee motion	No. of cases	Percentage
Full Range of motion	14	58.33
>80% knee motion	10	41.67
Total cases	24	100.00

Table 3: Functional outcome

Functional result	No. of patients	Percentage
Excellent	14	58.33
Good	6	24.78
Fair	2	8.33
Poor	2	8.33
Total	24	100.00

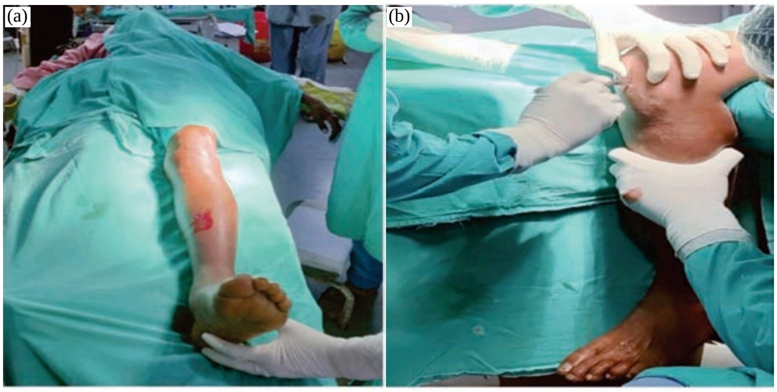

Fig. 1: Patient Positioning on OT table and Incision making (clinical pictures)

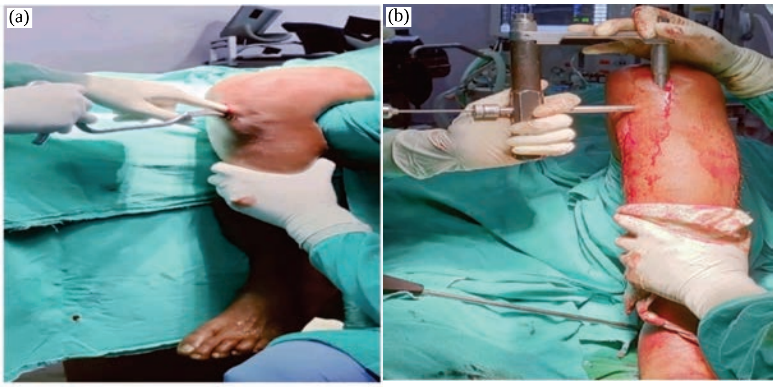

Fig.2: Making Entry with Awl and Proximal Locking of Nail (clinical pictures)

and 2 patients reported knee pain lasting up to 9 months. Malunion occurred in one case with valgus angulation and another with anterior angulation, both within the specified limits, while two patients exhibited shortening of more than 1 cm (Case 2).

DISCUSSIONS

Compound tibial shaft fractures pose management challenges due to issues like soft tissue problems and limited blood supply in the tibia. Recent advances in wound coverage and fixation have reduced complications but the ideal approach remains uncertain[12]. The severity of the fracture, including initial displacement, comminution and soft tissue injury, significantly affects outcomes. Tibial blood supply damage is another crucial factor in compound fractures, emphasizing the need to preserve endosteal vascularity.

The final outcomes of fractures' depend on two key factors: the severity of the fracture, characterized by initial displacement, comminution and soft tissue injury and the integrity of the tibial blood supply. Severe fractures lead to higher complication rates and longer healing times regardless of the fixation method. In compound fractures, both endosteal and periosteal circulation are disrupted due to soft tissue damage and stripping, highlighting the need to preserve endosteal vascularity through stabilization techniques to avoid further disruption.

The disadvantages of conventional plaster casting include infection rates, malunion and shortening. After treating 140 complex tibial fractures with a cast, Nicoll[13] found a 15% infection rate. According to Brown and Hansen[5], of 63 compound tibial shaft fractures, 27 percent had healed with a shortening of more than ten millimetres and 63% had healed with a shortening of more than thirty millimetres. More recently, he reported that a series of 24 open tibial fractures treated with cast had a malunion rate of 12.5%. As a result, stable fractures with little soft tissue damage should only be immobilised in a plaster cast.
Although plate osteosynthesis offers firm fixation, it may also cause infections. In a study by Smith *et al*.[8] of 219 open fractures treated the same day by internal fixation, delayed union and infection occurred in 48% and 20% of cases, respectively. Ruedi[7] reported a rate of 11% in their extensive series of open tibial fractures treated with a plate. The use of a plate is an

Case 1(a-d): Radiographic pictures (a) Pre-Op, (b) Immediate post-Op and (c) Follow-Up (1 month) and (d) Follow-Up (6 Month)

Case 2(a-c): Radiographic pictures (a) Pre-Op, (b) Fellow-Up 1 month and (c) Follow-up (3 months) union in progress undesirable therapeutic option, according to Johner[14], who found that non-union was twice as common and infection was five times more likely when compound fractures were treated with plating.

External fixation is valuable for highly comminuted open tibial fractures but often results in malunion[15]. Intramedullary nailing with reaming offers control over length, angulation and rotation but carries a high risk of infection due to vascular disruption.

The blood supply is less damaged and infection rates have historically been lower with intramedullary nailing without reaming. Holbrook *et al*.[9] investigated 28 compound tibial fractures treated with external fixation in a randomised, prospective trial comparing external fixation with Ender nails and discovered a 14% rate of deep infection, a 21% rate of pin tract infection and a 36% rate of malunions. They found a 7% infection rate and a 21% malunion rate for 29 similar complex fractures that were repaired with Ender nails. After using his nail to repair 256 compound tibial fractures without reaming, Lottes[16] observed a 7.2% infection rate. He explains how malunions can occur even with fractures that have been determined to be axially stable.

Closed unreamed interlocking intramedullary nailing combines the benefits of external fixation and non-locking nailing without reaming. It provides control over alignment and rotation while preserving some endosteal blood supply, reducing infection and malunion rates and expanding its use to more complex fractures.

In our series 18 fractures (75%) united with in the 18 weeks of injury and average union time is 20 weeks as compared to study by Bontas[17] average union time is 24 weeks. In another study by Singe and Kellam[18] average union time in 96% cases is 25 weeks.

In our study there were two superficial inections (8.33%) in type II compound fracture and two deep infection (8.33%) in type III-A compound fracture, which is comparable with the study by Joshi *et al*.[19] incident of infection is 10.7% all of which are type III open fracture and a study by Madhukar *et al*.[20] incident of infection is 15.33%.

Final outcome of our study are -14 cases (58.33%) had excellent results, 6 cases had good results (24.78%), 2 cases had fair results (8.33) and 2 cases had poor results (8.33%). In another study by Madhukar *et al*.[20] final outcome was 70% cases had excellent results, 15.5% cases had good results , 10.5% cases had fair results and 4% cases had poor results.

At the conclusion of the trial, each patient was questioned privately about the surgery and their restoration to their premorbid condition. Eight patients (33.33%) were satisfied, two patients (8.33%) were unhappy and 14 patients (58.67%) expressed their happiness.

CONCLUSION

Our study shows that in Gustilo Anderson type I, II and III-A compound shaft tibia fractures, emergency debridement and closed unreamed interlocking intramedullary nailing appear viable. This procedure has a number of benefits, including early patient mobilisation that aids in fracture healing and prevents joint stiffness, minimal blood loss, low infection risk, encourages early union, easier follow-up, short hospital stays and early return to activities, acceptable complications rates in comparison to other treatment modalities and overall decreased morbidity.

REFERENCES

1. Bucholz, R.W., J.D. Heckman, C.M. Court-Brown, C.A. Rockwood and D.P. Green, 2001. Rockwood and Green's Fractures in Adults. 205th Edn., Lipincott Williums and Wilkins, USA, Pages: 1994.
2. Canale, S.T.. 2003. Campbell's Operative Orthopaedics. 10Ed Edn., Mosby, ISBN-10: 9997619439, Pages: 1086.
3. Jones, W., 1998. Injuries of the Leg Chapter-32in Watson Jones Fractures and Joint Injuries. 6Th Edn., Wilson JN, New Delhi, Pages: 387.
4. Brown, P.W. and J.G. Urban, 1996. Early weight-bearing treatment of open fractures of the tibia. An end-result study of sixty-three cases J. Bone. Joint. Surg. Am., 51: 59-75.
5. Bach, A.W. S.T. Hansen, 1989. Plates versus external fixation in severe open tibial shaft fractures. A randomized trial. Clin. Orthop. Relat. Res., 241: 89-94.
6. Rüedi, T., J.K. Webb and M. Allgöwer, 1975. Experience with the dynamic compression plate (dcp) in 418 recent fractures of the tibial shaft. Injury, 7: 252-257.
7. Smith, J.E., 1974. Results of early and delayed internal fixation for tibial shaft fractures. A review of 470 fractures. J. Bone Joint Surg. Br., 56: 469-477.
8. Holbrook, J.L., M.F. Swiontkowski and R. Sanders, 1989. Treatment of open fractures of the tibial shaft: Ender nailing versus external fixation. a randomized, prospective comparison. J. Bone Joint Surg. Am., 71: 1231-1238.
9. Charnley, J., 2010. The closed treatment of common fractures. In: The Closed Treatment of Common Fractures., Charnley, J., (Ed.)., Cambridge University Press, ISBN-13: 9780511666520, pp: 197-204.
10. Rhinelander, F.W., 1974. tibial blood supply in relation to fracture healing. Clin. Orthop., 105: 34-81.
11. Gustilo, R.B., 1992. fractures of the Tibia and Fibula. Chapter-27 Fractures and Dislocations. In: Fractures and Dislocations, .Gustllo, R.B. and R.F. Kyle, (Eds.)., Mosby.

12. Henley, M.B., J.R. Chapman, J. Agel, E.J. Harvey, A.M. Whorton and M.F. Swiontkowski, 1998. Treatment of type II, IIIa, and IIIb open fractures of the tibial shaft: A prospective comparison of unreamed interlocking intramedullary nails and half-pin external fixators. J. Orthop. Trauma, 12: 1-7.
13. Nicoll, E.A., 1964. Fractures of the tibial shaft. a survey of 705 cases. J. Bone Joint Surg. Br., 46: 373-387.
14. Rhinelander, F.W., 1998. Effects of medullary nailing on the normal blood supply of diaphyseal cortex. Clin. Orthop. Relat. Res., 350: 5-17.
15. Ilizarov, G.A., 1990. Clinical application of the tension-stress effect for limb lengthening. Clin. Orthop. Relat. Res., 250: 8-26.
16. Chapman, M.W. and M. Mahoney, 1979. The role of early internal fixation in the management of open fractures. Clin. Orthop. Relat. Res., 138: 120-131.
17. Bonatus, T., S.A. Olson, S. Lee and M.W. Chapman, 1997. Nonreamed locking intramedullary nailing for open fractures of the tibia. Clin. Orthop. Related Res., 339: 58-64.
18. Singer, R.W. and J.F. Kellam, 1995. Open tibial diaphyseal fractures. results of unreamed locked intramedullary nailing. Clin. Orthop. Relat. Res., 315: 114-118.
19. Joshi, D., A. Ahmed, L. Krishna and Y. Lal, 2004. Unreamed interlocking nailing in open fractures of tibia. J. Orthop. Surg., 12: 216-221.
20. Madhukar, K.T., D. Mitra and S. Bhattacharya, 2015. Study of management of compound fractures of tibia with unreamed intramedullary interlocking nailing. J. Res. Orthop. Sports. Med., 1: 26-30.