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TREATMENT OF COMPOUND DIAPHYSEAL TIBIA FRACTURES TREATED WITH EXTERNAL FIXATOR COMBINED WITH INTRAMEDULLARY TENS NAIL FOR LIMITED INTERNAL FIXATION AS DEFINITIVE PROCEDURE

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Abstract

Background –Treating open fractures in the tibia has always been a challenge for orthopedic surgeons due to the complexities of the injury. External fixators are used in the treatment of these types of fractures as an initial stabilization method, followed by definitive surgical procedures. Several authors have used external fixators as a definitive method for the treatment of fractures, but there were difficulties in initial reduction and maintaining the reduction, thereby increasing the chances of malreduction, malunion, and non-union. Some authors used limited internal fixation to increase the biomechanical stability of the construct with good results, but very few have been reported in the literature. In our study, we used intramedullary tens nails along with external fixators as a method to improve the stability of the structure. and evaluated the outcome in terms of union, limb alignment, and infection.

Methods – We have operated on 20 cases of compound tibial diaphyseal fractures with external fixators along with intramedullary TENS nails. The patients were followed over a period of 9 months, and various parameters like limb alignment in the form of varus or valgus, anteroposterior angulation, limb shortening, status of union, and complications like pin tract infection, superficial and deep infection, and time to full weight bearing were assessed.

Results – In our study, we could achieve a union rate of 65% and a non-union rate of 15%. According

to the modified Anderson and Hutchins criteria, good limb alignment could be achieved in 65%, moderate in 30%, and poor in 5%. Complications were only pin tract infections in 1 case. It took an average of 4.83 months for full weight bearing to be achieved.

Conclusion - As a definitive technique, external fixators paired with intramedullary TENS nails efficiently treat compound tibial diaphyseal fractures. Increased stability, an improved initial reduction, assistance in maintaining the reduction and length, a decreased risk of malalignment, and a delayed union are all provided without raising infection risk.

Keywords – Definitive fixation, External fixator, Limited internal fixation, TENS nail

Introduction

It is reported that 40% of open fractures are open tibial fractures, which can result in harm to delicate tissues such as the skin, muscles, and neurovascular structures. (1). These injuries are highly susceptible to serious complications like infection, malunion, and non-union.

The treatment options for open fractures in the tibia have evolved over time and remain a topic of debate (3).

When managing an open fracture, the goals are to prevent infection, provide coverage for soft tissue, promote bone healing, and restore function. Key principles include the use of antibiotics, timely surgical intervention, thorough debridement, appropriate closure of the wound, and proper alignment and fixation of the fracture (4).

One popular approach to managing open fracture is through damage control orthopaedics (DCO), which begins with external fixation and is followed by definitive internal fixation through nailing or plating. However, this secondary fixation procedure can lead to various burdens, including economic, physical, and psychological, making this strategy less than ideal (5).

Intramedullary interlocking nailing is commonly used for treatment of open tibia fractures. However, unreamed nails are more prone to issues like delayed union or non-union, and implant breakage. On the other hand, reamed nails have been associated with a high infection rate. Delayed intramedullary nailing has also been linked to a higher incidence of infection, according to studies. (6)

In some cases, external fixator can be used as an alternative to definitive fixation. This is particularly useful when there are issues with soft tissues or if the patient is unable to comply with staged surgeries. However, studies have shown that using external fixation as a definitive treatment option can lead to potential problems such as pin-tract infection, poor alignment, and weak union. This can result in the need for additional unplanned fixation procedures which can be challenging for patients both physically and financially. (7)

In some literature, it has been suggested to use cortical screws and Kirschner wires for limited internal fixation to enhance the function and performance of external fixation (8, 9). However, the combination of these techniques may lead to increased risk of infection. There are only a few studies on this matter, which is why our present study aims to prospectively assess the functional outcome of using an AO-type external fixator with limited internal fixation via an intramedullary TENS nail in the treatment of compound tibial diaphyseal fractures.

Material and methods

This prospective study was conducted from January 2018 to June 2022 in a rural hospital in central India. It included all open shaft tibial fractures that met the specified criteria.

Inclusion criteria

- Compound shaft tibial fractures: Gustilo Anderson type 2, type 3a, and type 3b
- age more than 18 years

Exclusion criteria

- Type 1 compound fractures
- Polytrauma cases
- Ipsilateral injury to the lower limb
- Compound fractures with bone loss
- Patient who are not willing to be a part of the study.

All patients were examined for injuries and primarily stabilized using skeletal traction, limb elevation on a BB splint, IV fluids, blood transfusions, and vasopressors if necessary.
The patient was given anti-tetanus prophylaxis and started on intravenous antibiotics covering both gram-positive and gram-negative organisms. The wound was thoroughly cleaned and debrided, followed by primary closure if possible or stay sutures. After stabilizing, the fracture anatomy was evaluated through X-rays in both anteroposterior and lateral views. Under spinal anesthesia, all patients underwent surgery.
Under C ARM guidance, by applying traction and manipulation, a trial of reduction is given. Entry for two TENS nails was taken under C ARM from the medial and lateral condyles of the tibia below the articular surface. The TENS nail was negotiated through the fracture site into the distal fragment under C ARM guidance, keeping the fracture reduced using traction and the application of a reduction clamp either percutaneously on the bone or through the wound over the fracture site. After completing the TENS insertion, an AO-type external fixator is applied in various configurations (joint-spanning or unilateral).

Image 1: Intraoperative C ARM images

If necessary, a secondary debridement was performed and closure was attempted. If closure was not possible, releasing incisions were made for primary closures. We did not require any skin grafting or flap procedures Antibiotics were adjusted based on the culture and sensitivity report.

After surgery, patients began ankle-toe movements the following day and were taught non-weight-bearing mobilization with the help of a walker. Static quadriceps and hamstring exercises were also initiated. Pin site dressing done every other day with the use of betadine. Partial weight bearing typically began around 4-8 weeks. Full weight bearing was permitted once there was sufficient callus present on the radiograph. The fracture is fully healed when a bridging callus appears in at least three cortices on the radiograph and there is no pain or tenderness in the fracture area. External fixator was removed after the fracture had fully healed. The external fixator was dynamically adjusted by

loosening the AO clamp screws that were connected to the short fragment's connecting rods. Dynamization was done for transverse and short oblique fractures at 4-6 weeks. Following dynamization, partial weight bearing was resumed.

For comminuted fractures, the fixator is not dynamized and is removed after union as an outpatient procedure.

Patients were monitored at 3, 6, 8, 12 weeks, and every 2 months thereafter until fracture union or up to 9 months for outcome evaluation.

We assessed the following indicators:

- presence of infection
- Time to union: normal healing occurs within 6 months; delayed union for healing after 6 months. Non-union is defined as the absence of healing progression over 3 consecutive months on serial radiographs after 9 months of injury. (10,11)
- Limb alignment

The modified Anderson and Hutchins criteria were used to assess limb length discrepancy and degree of deformity as follows:

Table 1: Modified Anderson & Huntchins Criteria to assess degree of deformity & limb length discrepancy (12)

Results	Shortening	Grade of deformity in Angulation (Malunion)
Good	<1 cm	Up to 5 degree Varus / Valgus up to 10 degree Anterior / Posterior
Moderate	1-2cm	5-10 degree Varus / Valgus 10-20 degree Anterior / Posterior
Poor	> 2cm	> 10 degree Varus / Valgus > 20 degree anterior / Posterior

Results

In our study out of 20 cases there were 15 male patients and 5 female patients and the most frequently occurring mode of injury was RTA. Only one case had a history of falling into the gutter. 9 cases were grade 3, and 11 cases were grade 2, according to Gustillo Anderson's classification. The right side tibia was most commonly involved (right 14, left 6). In our study average age was 41.7 years, and the length of stay in the hospital was 12.8 days. Additional surgical procedures were required in the form of skin grafting in one patient, whose hospital stay was maximum (34 days).

We operated on all the patients in a mean of 5.3 days. It took an average of 4.83 months for the patient to be able to fully bear weight. The fixator was removed after a mean duration of 5.03 months.

We observed three cases of non-union in our study, with an average union time of 5.71 months. (N = 17). There was no significant shortening during the follow-up. In all cases, the shortening was less than 1 cm.

12 patients had angulation in the AP view. The mean varus angulation was 3.48 degrees. The maximum varus malalignment was 11 degrees. There was no valgus malalignment. 15 patients had anteroposterior angulation. The mean anteroposterior angulation was 3.95 degrees. Maximum anterior angulation was 11 degrees in one patient.

According to modified Anderson and Hutchins criteria, 13 patients (65%) had good limb alignment, 6 patients (30%) had moderate alignment, and 1 patient (5%) had poor limb alignment.

We encountered 3 cases (15%) of non-union and 4 cases (20%) of delayed union in our study. There were also pin tract infections in 2 cases (10%).

Image 2: Preoperative xray AP/LAT

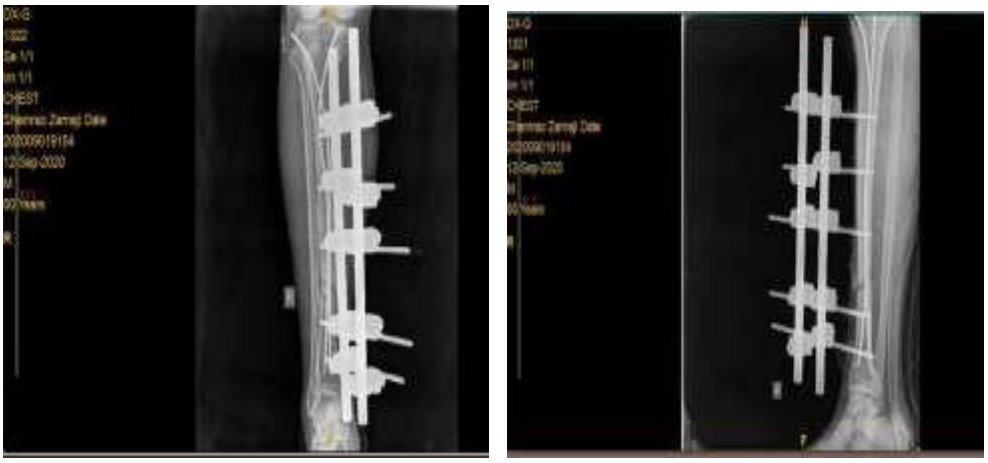

Image 3: Immediate postoperative xray AP/LAT

Image 4:- 6 months follow up Complication -

Image 5 – non union (was treated with intramedullary nailing as definitive procedure)

Table: 2 Outcome of study

Status of union	Union -13 (65%)	Delayed union -4 (20%)	Nonunion – 3(15%)
Limb alignment	Good -13 (65%)	Moderate – 6(30%)	Poor -1 (5%)
Complication	Pin tract infection -2 (10%)	Superficial infection -0	Deep infection -0

Discussion

Open tibial shaft fractures treated with external fixation have high rates of complications in reduction, alignment, and bone healing. (3).

Researchers Holbrook et al. [13] addressed 28 open fractures of the tibial shaft through simple external fixation. Unfortunately, their results showed a high incidence of pin-track infection (21%), reduction loss (11%), malunion (36%), delayed union (21%), and non-union (11%).

Henley et al. [10] reported on 70 patients with type II, IIIA, and IIIB open fractures of the tibial shaft, and found delayed union in 17.1%, non-union in 4.3%, pin track infection in 50.0%, and malunion in 31.0% after external fixation. Additionally, 17.0% of the fractures required a change in fixation due to delay in healing or loss of reduction [10].

Additional minimal internal implant, such as cortical screws, have been recommended to increase biomechanical stability of external fixation for managing open tibial fractures (14).

A retrospective cohort study conducted by Zi-chen et al. (15) compared the treatment of tibial diaphyseal fractures using external fixation alone versus external fixation combined with limited internal fixation. The study found that the latter method was more reliable in managing open tibial fractures.

In our study also we could achieve a good result by combining intramedullary TENS nail to the external fixator. Early rehabilitation and rapid healing are facilitated by initial reduction and subsequent fixation stability while maintaining limb alignment. (65%) had good limb alignment, (30%) had moderate alignment, and (6%) had poor limb alignment. In our study, the presence of an internal implant did not significantly raise the risk of infection (only 10%).

According to reports by authors Valazev and Fleming, delayed union occurred in 12.5% of cases [16]. Meanwhile, in a study conducted by Giannoudis et al on 536 open tibia fractures treated with an external fixator (where 82% were Grade III open injuries), the incidence of delayed union was 24% [17]. In our own study, we observed 4 cases (20%) of delayed union.

Conclusion

External fixator combined with the limited internal fixator in the form of intramedullary TENS nail increased the stability of the construct and helps to maintain the reduction and good limb alignment, thereby reducing the incidence of malunion and non-union. This method can be effectively used as a definitive procedure in the treatment of open tibial diaphyseal fractures without significantly increasing the risk of infection.

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