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Short term outcome of Gustilo Anderson open type 3A mid shaft tibia fractures using intramedullary interlocking nail and external fixator: A prospective Cohort study

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Abstract---Aim: The purpose of the present study is to assess the outcome of treating Gustilo Anderson open Type 3A mid shaft tibia fracture with intramedullary interlocking nail as well as external fixator. Methodology: In this prospective cohort study, adult patients (≥ 18 years-old) with Gustilo 3A open tibia shaft fractures treated by either intramedullary nail or external fixation (EF) were involved. This study was directed for a period of twelve months from March 2021 to February 2022. After registration, patients were followed-up at 2, 6, 10, 14, and 18 weeks postoperatively. At these appointments, degree of callus formation at fracture site and surgical problems (e.g. infection, limb length discrepancy, malalignment) were assessed. Results: Out of 50 patients registered in the study, 26 were treated by IM nail and 24 by external fixation. Twenty-four patients (92.3%) in the IM nail group and 6 (25%) in the external fixation group had

callus formation by the 10th week. The mean times to callus formation in the IM nail group and external fixation group were 8.2 ± 2.6 weeks and 14.7 ± 3.3 weeks, individually ($p=0.000$). Two (7.7%) patients in the IM nail group and 3 (12.5%) in the external fixation group developed infection ($p=0.661$). No IM nail patients had limb length discrepancy. However, 2 (8.3%) external fixation patients had limb shortening between 2-3cm. No patients had limb length shortening of >3 cm. No malalignment was observed in IM nail patients, but 3 (12.5%) external fixation patients developed malalignment and required reoperation. Conclusion: Interlocking intramedullary nail seems to be an improved option for the treatment of Gustilo 3A open tibia shaft fractures as related to uniplanar external fixation.

Keywords---open tibia fractures, orthopaedic surgery, intramedullary nail, external fixation.

Introduction

Tibia is one of the main weight bearing bones of the body. The knee joint with anatomical constraint in rotational movements is more predisposed to fracture in twisting injuries. Treatment of tibial fractures has changed over the time and currently surgical fixation is the generally acknowledged treatment modality with slighter complications in case of closed fractures.¹ But the treatment of open tibia fractures is problematic and broadly controversial. With infection being the utmost feared complication in any surgery, treating open tibia fracture with internal fixation is still debatable.² Supplementary options like by means of an external fixator such as Ilizarov or LRS as decisive fixation device are also regularly done. But they have their own disadvantages and problems.³ A two staged procedure with initial external fixation and secondary internal fixation is the most favoured option in open fractures. Primary IMIL nailing even if advocated, it has still not been fully acknowledged mainly due to the fear of infection. Unvaryingly primary debridement plays a significant role in treatment of these fractures. Open fractures are fractures that interconnect with the external environment through a skin wound.⁴ With the discovery and use of antibiotics following injuries, infection still continues to be a significant issue in open fractures which leads to longer hospital stays, augmented cost of treatment, morbidity and mortality.⁵ Profound fracture-site infection often leads to chronic osteomyelitis, non-union, loss of function, or even limb loss. Open tibial fractures are mostly classified using the system given by Gustilo and Anderson⁶ and consequently modified by Gustilo and colleagues.⁶ Gustilo et al⁷ categorized open fractures into three categories: Type I, II and III. Gustilo Anderson Type III open tibial fracture is the commonest type of open tibia fracture.^{8,9} Type III tibia fracture is further split into three subgroups; IIIA: adequate soft tissue coverage of a fractured bone despite widespread soft tissue laceration or flaps, or high energy trauma regardless of the size of the wound; IIIB: extensive soft tissue injury loss with periosteal stripping and bone exposure typically related with huge contamination; and IIIC: open fractures related with arterial injury necessitating repair. Despite reported poor inter-observer agreement in its use, this system is

prognostic with respect to complications associated with open fractures.¹⁰ The major aim of management of open fractures is to halt bacterial proliferation in the wound, remove dead and nonviable tissues by extensive wound debridement, ensure adequate coverage of exposed bone and achieve stable skeletal fixation to allow for fracture healing.¹¹ Following Gustilo Anderson type III tibial fractures, most common technique of skeletal stabilization is the use of external fixators.¹² External fixation is popular because of the relative ease of application, facilitation of immediate stabilization, provision of space for treatment of related soft tissue injuries and the limited effect on the blood supply of the tibia.¹³⁻¹⁵ Soft tissue bone cover may be achieved by delayed primary closure, split thickness skin graft, local muscle flap rotation, or free tissue transfer with microvascular anastomosis. Gustilo and Anderson Type III open tibial fracture is uptight with infection and other complications. Predominantly the bacteria isolated in the pre-debridement are mostly contaminants. There is need to evaluate the importance of post-debridement bacteria isolate with the progress of wound infection as a guide to the use of experimental antibiotics. Furthermore, it is significant to measure the management outcome.

Aim of the present study

The purpose of the present study is to assess the outcome of treating Gustilo Anderson open Type 3A mid shaft tibia fracture with intramedullary interlocking nail as well as external fixator.

Methodology

This study was a prospective cohort study conducted from March 2021 to February 2022. Ethical clearance was attained from the institutional review board. Patients over the age of 18 years who had Gustilo Type 3A open tibia diaphyseal fractures were included in the study. Exclusion criteria comprised of bilateral open tibia fractures, comminuted femur fractures of the contralateral limb, important comorbidities such as diabetes or known vascular disease, previous ipsilateral lower limb injury, or lower limb deformities. Anteroposterior and lateral views radiographs of the fracture site were taken to authorize a diaphyseal shaft fracture of the tibia. Subsequently, patients were managed with either interlocking intramedullary nail or external fixation based on the choice of the treating surgeon. External fixation was done by utilizing an AO single bar uniplanar device with two proximal and two distal screws. Nailing was done with the Surgical Implant Generation Network (SIGN) nail and without the use of an image intensifier; two proximal and two distal interlocking screws were utilized for all nail patients. SIGN nail was selected because it is fabricated in treatment of long bone lower extremity injuries, even if no c-arm is accessible.¹⁶ Postoperative control X-rays were attained and evaluated for alignment and fracture reduction. Moreover, limb length, rotational deformity, and status of the wound were assessed. Wound checks were made at 2 weeks. Further continued evaluations were undertaken at 6, 10, 14, and 18 weeks post-operatively.

Results

A total of 54 patients were enrolled in the study. There were 40 (80%) males and 10 (20%) females (male-to-female ratio of 4:1). The age varied from 18 to 76 years with a mean age of 33.7 ± 11.8 years. Twenty-eight patients were treated with intramedullary (IM) nail and 26 received external fixation. The most predominant cause of open tibial shaft fracture was motorcycle crash (75.8%). The other causes included motor vehicle crash (20.4%) and fall from height or bicycle crash (3.8%). Pin-tract infection developed in 12 (46.2%) external fixation patients as determined by clinical judgement upon visual inspection of the pin sites and assessment of radiographic findings. In all cases, the infection was successfully managed by oral antibiotics and daily pin-tract care. The rate of callus formation was higher in patients who were treated by intramedullary nail at all follow-up time points as measured by mean RUST scores ($p < 0.001$). The mean time to callus formation in the IM nail and external fixation group was 8.2 ± 2.6 and 14.7 ± 3.3 weeks, respectively ($p < 0.001$). Twenty-four (92.3%) patients in the IM nail group had callus formation by the 10th week. (Table 1) Patients who were treated by intramedullary nail attained full weight bearing earlier than those treated by external fixation. At 10 weeks, 88.5% of IM nail patients were on full weight bearing status. (Table 2) The IM nail demonstrated statistically significant better outcomes in limb alignment. There were no IM nail patients who developed limb length discrepancy.

Discussion

Management of open tibia fracture is not an easy treatment. Multiple factors like degree of contamination, soft tissue and bone loss, fracture pattern and comminution play a significant role in the conclusion. Risk of infection being the utmost decisive factor in the treatment, most favoured treating modality is primary stabilization with external fixator with wound management and a secondary definitive fixation based on the wound grade. Even though risk of infection is lessened, external fixator has its own problems and disadvantages.¹⁷ Golubović et al showed that complications such as osteitis (infection), non-union, pin site infection, malunion are frequent with external fixation devices. Furthermore, other factors such as extended duration of treatment and need for a secondary procedure and also the acceptance with the external fixation has its own harmful effect on the overall outcome. Shanon et al showed that 23.3% (n=7) needed re-surgery in external fixator group related 6.67% (n=2) needed re-surgery in un-reamed nailing.¹⁸ Henley et al concluded that IMN was more stable and effective in maintaining the alignment compared to external fixator.¹⁹ Internal fixation can reduce most of these problems if done early along with proper debridement and wound lavage. While this reduces the complications, many issues influence the final outcome. The timing of the primary surgery since injury plays a major role in the outcome. In the past the golden period for fixing an open fracture was considered to be 8 hours from injury.²⁰ Hertel et al presented a smaller sample size based comparative study with a mean follow-up of 47 months comparing immediate versus delayed fixation of open tibial fractures. They came across increased mean rates of infection (4 versus none) as well as the increased mean rate of secondary surgical procedures (3.9 versus 1.6) in the cases where fixation was delayed using standard protocols, compared with those operated with

immediate fixation and wound coverage.²¹ IM nail patients in this study also reached full weight bearing earlier than our external fixation (EF) patients. Considerable evidence in the literature exists to back this finding. For instance, Shannon et al¹⁸ found that the mean time to full weight bearing was 37.4 weeks (EF) versus 22.2 weeks (IM). Furthermore, a similar result was reported by Alberts et al²² where return to weight bearing was 21 weeks in IM group versus 34 weeks in the EF group. However, our results support the notion that IM nail is better at restoring weight function early on.

Conclusion

Short-term outcomes of Gustilo 3A open tibia shaft fractures appear to be superior when treated by intramedullary nail as compared to uniplanar external fixation. Future studies are warranted to more definitively assess the best treatment option for Gustilo 3A open tibia fractures.

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Tables

Table 1- Weight bearing status between IM nail compared with external fixation

Follow-up (Weeks)	None		Partial		Full		P value
	IM n(%)	EF n (%)	IM n(%)	EF n (%)	IM n(%)	EF n (%)	
6	2 (7.7)	12 (50.0)	7 (26.9)	11(45.8)	17 (65.4)	1 (4.2)	0.000
10	0 (0.0)	2 (8.3)	3 (11.5)	12 (50.0)	23 (88.5)	10 (41.7)	0.001
14	0 (0.0)	1 (4.2)	2 (7.7)	8 (33.3)	24 (92.3)	15 (62.5)	0.021
18	0 (0.0)	2 (8.3)	0 (0.0)	6 (25.0)	26 (100.0)	16 (66.7)	0.001

Table 2-Comparison of limb lengths at 18 weeks (p=0.046)

	Normal n (%)	Limb shortening	
		1-2cm n (%)	2-3cm n (%)
IM	26 (100.0)	0 (0.0)	0 (0.0)
EF	20 (83.4)	2 (8.3)	2 (8.3)