Outcome of open tibial shaft fractures treated by using external fixation as a primary and definitive treatment in Tibebe Ghion specialized hospital, Bahir Dar University, Ethiopia

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Research Article

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Abstract

Background: The treatment of open tibial shaft fracture is very challenging especially in developing counters like Ethiopia where medical equipment's, orthopedic experts are scarce, and poor economy and health seeking behavior. In orthopedics and trauma surgery, external fixation is comparatively safe in treating tibial open injuries, meanwhile it has advantage of minimal disruption, convenient subsequent soft tissue repair and easy application. However, the procedure is accompanied by a serious of problems in bone healing and alignment. Therefore, this study aimed to assess the outcome of open tibial shaft fractures treated by using external fixation as a primary and definitive treatment in Tibebe Ghion specialized hospital, Bahir Dar University, Ethiopia.

Methods: This is a cross-sectional study with a retrospective facility-based data collection technique. All patients who were managed for open tibial shaft facture from September 2018 to February 2021 were included. The patient's chart number were collected from the Orthopedics surgery morning register sheet and their case folders were retrieved from the medical record department. We used a structured and pretested checklist, and chart review for data collection. The collected data was cleaned, coded, and entered into EPI-Info version 7 and exported to SPSS version 24 for analysis. Binary logistic regression analysis was used to identify factors associated with a pelvic fracture.

Result: We studied 53 cases of open tibial shaft fracture during the study period. The majority of cases were from rural area (66%), and open tibial shaft fracture were common among males (67.9%). The mean age of patients was 34 ± 14 SD years, and the commonly affected age group was between 21 to 40 years (49.1%) followed by 41-60years (32.1%). The leading cause of the open tibial fracture was road traffic accident 19(35.8%) followed by bullet injury in 15(28.3%) of patients. For more than 2/3 of the patients debridement was done within 24 hours of injury and antibiotics was provided for 98.1% of patients. More than half (58%) were categorized under GAIIIB, the average time for hospitalization was 2-14 days, and the mean follow up time was 18±6 SD months. Among the included patients 64% developed surgical site infection, 15.1% developed mal-union, and 24.5% developed non-union after the procedure. Additionally, the mean time of bone union was 20.1±4 weeks and the mean duration of external fixation use was 18 weeks.

Conclusion: the majority of patients with open tibial fracture were rural residents, male and younger population. The leading cause of the open tibial fracture was road traffic accident followed by bullet injury. The majority of open tibial fracture patients in this study were diagnosed as GAIIIB fracture. Using external fixation as a definitive treatment for open tibial fracture results a high rate of infection, bone mal-union, and non-union. Thus, health facilities and health care professionals working on this area should revise the procedure to promote better stability, to decrease the risk of surgical site infection, and miss alignment and delayed union. Additionally, to reduce tibial fracture and its complication, interventional programs to reduce car accident, and effective treatment, characterization of thee fracture is crucial to guide the decision making process for better management of patients for survival, healing, improvement of patients, and for better clinical outcome in patients with open tibial fracture.

Background

Tibial bone fracture is occurred in approximately 15% of all adult fractures, mostly caused by direct or indirect traumas due to slimness of the skin and subcutaneous tissue on the anterior tibial shaft(1, 2). Every year, an estimated 11.5 per 100,000 people had open long bone fracture with 40% occurring in the lower limbs, commonly at the tibial bone. Additionally, open fractures comprises 23.5% of all tibial fractures and are frequently accompanied by damage to neurovascular structure, soft tissue, and organ which could result life threatening complications (3, 4). Due to the anatomical location of tibia as well as its poor blood supply open tibial fractures are more prone to further complications including infection, amputation, non-union, mal-union which in turn promote readmission and reoperation(5, 6).

The initial evaluation of Patients with open fracture of tibial bone should follow the principles and guideline of Advanced Trauma Life Support System (ATLSS)(7), despite the optimal definitive management remains controversial and challenging for orthopedic and trauma surgeons. Traditional treatments of injuries includes splint, plate and screw, nailing, external fixation or a combination of these. Intramedullary nail fixation acts as a golden standard, while external fixation is the next preferred method (8-10).

Timely and appropriate treatment protocol which includes debridement, early and stable fixation, accurate reduction, repair of soft tissues, and administration of effective antibiotics has been widely accepted and used by health facilities as a protocol to reduce complications and to increase healing, recovery and bony union (11-13).

The fixation protocol for open tibial fracture have evolved over years and remained controversial. The DCO (Damage Control Orthopedics) with external fixation followed by definitive fixation with nailing or plating is a popular strategy for significantly decreased complications(6, 14). However, the procedure of secondary fixation resulted physical, economical, psychological consequences and making the procedure less acceptable for the treatment of open tibial fracture(15). As a result, external fixation is applied as the definitive management in cases like proper condition of soft tissue or patient non-compliance for the staged surgeries (16, 17).

Postoperative outcomes are dependent on many factors including patients age, sex, medical condition, status of the surgeon, antibiotic provision, severity of fracture as to the classification of Gustilo and Andorson (GA)(18), site of fracture, severity score of the injury(ISS)(19), time of debridement, reamed versus undreamed nailing, and existence of superficial of pin-tract infection(15, 20).

The main and goal and outcome of open tibial fracture is to restore the extremity to its previous status using treatment that enable for a timely return to work and social fife and without devastating complication. External fixation as a definitive treatment needs attention for possible complications and issues like unsatisfactory alignment, pin-rack infection, poor union and leading to unplanned secondary fixation procedures and subsequent additional burdens for patients, families, health facilities, and the community (11, 14, 21). Therefore, this study aimed to assess the outcome of open tibial shaft fractures

treated by using external fixation as a primary and definitive treatment in Tibebe Ghion specialized hospital, Bahir Dar University, Ethiopia.

Methods

Study area and period

We conducted a retrospective cross sectional study design from September 2018 to February 2021 in TGSH, Bahir Dar University, Bahir Dar Ethiopia. TGSH is a University hospital, and one of the 43 governmental hospitals in Amhara region. The hospital serves more than five million populations in the catchment area. This teaching hospital has more than 500 beds, and 2000 patients per day in both inpatient and outpatient services. The Department of orthopedic surgery has both inpatient and outpatient services. There are 66 beds in the inpatient, a total of 14 orthopedic surgeons (2 of them are on fellowship), and 40 orthopedic specializing residents. Operations were done 4 days a week as elective cases and daily for emergency cases. The department has its own major operation room with three operating tables.

Study design

A facility-based retrospective cross-sectional study design was used.

Source population

The patient's admitted and treated at TGSH from September 2018 to February 2021.

Study Population

Patients with open tibial fracture and treated by external fixation from September 2018 to February 2021

Inclusion and exclusion criteria

Inclusion criteria

Patients with open tibial fracture and managed at TGSH were included.

Exclusion criteria

Patients referred from other health facilities TGSH for complications like blood transfusion, amputation, intensive care unit admission, and patients with missed medical chart were excluded. Additionally, those who died within minutes after arrival of orthopedic emergency were excluded.

Data collection

In our hospital the standard protocol for the treatment of open tibial fracture is; patient stabilization and patient management, wound cleaning, dressing, and immobilization with a temporary back slab in causality. Antibiotics are commenced for causality based on surgeon's grading of the fracture using GA grading system. The data was collected by two doctors of trained General Practitioners. The folder number of patients with pelvic fracture who present at TGSH from September 2018 to February 2021 were collected from the orthopedic morning section register sheets. Moreover, the medical charts was retrieved from the medical record department, and a structured checklist was used to collect the variables like socio-demographic variables (age, sex, residency), GA classification recorded on the chart, facture site, ISS, mechanism of injury, time from injury to debridement and fixation, duration of fixation, radiologic image, condition on discharge, and the number of days or months on treatment from chart review was extracted by the data collectors.

Statistical analysis

The collected data was cleaned code and entered into the Epi-info version 7 and then exported to SPSS version 24. Descriptive statistics and chi-square were used, and graphical presentations such as tables, bar, and pie charts were used to present the result findings.

Data quality control

The checklist was pretested before the actual data collection, and modified based on the pretest result. The training was given to data collectors on how to collect the data and confidentiality of patient's information.

Operational definition

> Normal healing- healing with in 6months (1).

> The union status was evaluated using radiography during the final follow up and fracture were considered as united when the patient walks without pain. On radiologic image, union was defined as callus on two radiologic views with disappearance of the fracture line. Additionally, delayed union was considered when healing between 6 and 9 months, and non-union was considered when fractured bone

that did not completely heal within 9 months of injury, as well as showing in apparent progression towards healing over three consecutive months on serial radiographs(22).

> Shortness and angulation deformity: evaluated in the anterolateral and lateral othoroentegenographs by independent examiner(23).

> open fracture- fracture in which there is an open wound or break in the skin near the site of the broken bone(24).

> Gustilo and Anderson classification of open tibial fractures(18).

Type I: open fracture with a wound less than 1 cm long and clean

Type II: open fracture with a wound more than 1 cm long and without extensive soft-tissue damage, flaps or avulsion

Type III: open fracture with extensive soft tissue damage, or a traumatic amputation. Additionally, type III is classified into 3 for proper management of patient's (Type IIIA: adequate soft-tissue coverage of a fracture bone despite extensive soft tissue laceration or flaps or high, Type IIIB: extensive soft tissue injury with periosteal stripping and bony exposure and associated with massive contamination, and Type IIIC: Open fracture- associate d with arterial injury requiring repair).

Results

Socio-demographic characteristics of study participants

In this study seven patients (one died from chest injury, two with knee amputation, and four lost chart) were excluded from the study. Thus, a total of 53 patients with were involved in this study. The majority of the cases 36(67.9%) were male, and 17(32.1%) were female. Majority of patients were from rural area (66%), and the mean age of patients was 34 ± 14 SD years, and the commonly affected age group was between 21 to 40 years (49.1%) followed by 41-60years (32.1%) (Table 1). The leading cause of the tibial fracture was road traffic accident 19(35.8%) followed by bullet injury in 15(28.3%) of patients. For more than 2/3 of the patients debridement was done within 24 hours of injury and antibiotics was provided for 98.1% of patients. The average time for hospitalization was 2-14 days, and the mean follow up time was 18±6 SD months.

Table 1

Socio-demographic and treatment characteristics of study participants

Variable	Frequency	percentage
Age(years)		
Less than 20	8	15.1
21-40	26	49.1
41-60	17	32.1
Greater than 61	2	3.8
sex		
Male	36	67.9
Female	17	32.1
Address		
Urban	18	34.0
Rural	35	66.0
Mechanism of injury		
Bullet	15	28.3
FDA	10	18.9
RTA	19	35.8
Others	9	17.0
Antibiotics		
Yes	52	98.1
No	1	1.9
Time of debridement		
<8hours	9	17
8-24hours	29	54.7
>24hrs	15	28.3
Type of fixation		
Uniplanar	50	94.3
Biplanar	1	1.9
Delta frame	2	3.8
Time of fixation		

<6wks	5	9.4
6-12wks	12	22.6
>12wks	36	67.9

The incidence of open tibial fracture among the Study Participants

This was a facility-based retrospective cross-sectional study for the cases of open tibial fracture admitted and treated at the emergency of TGSH. We identified 3250 patients during the study period from September 2018 to February 2021, and there were 53 cases of open tibial fracture, making the incidence 0.02%. Regarding the GA classification of open tibial facture and treated with external fixation in Tibebe Ghion specialized hospital, more than half (58%) were categorized under GAIIIB, 19% were GAIIIC, 17% were GAIIIA, and only 6% were categorized under GAII (Figure 1).

Outcome of open tibial facture treated with external fixation

Among patients with open tibial fracture 15.1% developed mal-union and 24.5% developed non-union after external fixation was performed. Additionally, 64.2% of patients developed surgical site infection among those 51.4% developed pin site infection, 40% superficial, and 8.6% developed deep surgical site infection (Table 2). During follow up of patients, in 15.1% of patients knee mobility was affected while in 30.2% ankle mobility was affected. Additionally, 62.3% patients complained that they have mild pain and 11.3% complain moderate pain after the procedure. Regarding limb alignment, 47.2% healed with normal limb alignment, and 41.5% patient had insignificant alignment complication while 11.3% had significant limb alignment complication after surgery. Additionally, 67% of patients needed revision surgery and 17% of them changed their procedure to intra-medullary nailing.

Table 2

Outcome of open tibial facture treated with external fixation

Variables	Frequency	Percentage
Postoperative infection		
Yes	34	64.2
no	19	35.8
Infection type		
Pin site	18	51.4
Superficial	13	40.0
deep	3	8.6
Mal-union		
Yes	8	15.1
No	45	84.9
Non-union		
Yes	13	24.5
no	40	75.5
Joint mobility		
Knee normal	45	84.9
Knee mobility affected	8	15.1
Ankle normal	37	69.8
Ankle mobility affected	16	30.2
Pain		
No	13	24.5
mild	33	62.3
Moderate	6	11.3
Sever	1	1.9
Limb Alignment		
Normal	25	47.2
Insignificant effect	22	41.5
Significant effect	6	11.3
Revision surgery		

Yes	36	67.9
no	17	32.1
Changed to IMN(intra-medulary nailing)		
Yes	9	17.0
no	44	83.0

Discussion

In this study there were 53 patients with open tibial shaft fracture, 36 were male and 17 were female included making the prevalence of open tibial fracture 0.02% during the study period. The age distribution of open tibial fracture in TGSH was a mean of 34 ± 14 SD years, and the commonly affected age group was between 21 to 40 years with male predominance (87.5%). This result is supported by a systematic review conducted in Saudi Arabia (>80%) (25) and cohort study in Turkey(26). The possible reason might be in Ethiopia, the majority of the population is young, and males predominantly run the economy of the household which in turn increases accidents and open tibial fracture among men and the young age group. The other possible reason might be the continuous war in Northern Ethiopia and the major participants and militaries were male and younger ones.

The leading cause of the tibial fracture was road traffic accident in 35.8% followed by bullet injury 28.3%. The result was in line with study done in United Kingdom(27), in Tanzania RTA accounts for 80% (28) so did in west Africa in which RTA accounts for 79% (29), Taiwan (62%)(30), and Turkey(26). This could be explained as road traffic accident, gunshot, and war is a common public health problem in Ethiopia, and the World health organization categorized Ethiopia as one of the worst countries in the world(31).

Among patients with open tibial fracture 15.1% developed mal-union and 24.5% developed non-union after external fixation. This result was higher than other studies conducted in Norway(32) Australia(3) nonunion was found in 14.71% patients and mal-union in 2.94% patients, and Turkey(26) where no mal-union and non-union was occurred after external fixation. The possible reason for the difference might be the material used during the procedure, the time and duration of the procedure, the doctors level of expertise, as in our study setup is lack of materials and lack of experts on the procedure. Moreover, this study includes all Gustilo-Anderson grade fractures but in Turkey the study excluded Gustilo-Anderson grade 3C fractures because of their poor result according to the Johner-Wruhs criteria due to neurovascular deficit.

Additionally, 64.2% of patients developed surgical site infection among those 51.4% developed pin site infection and 40% superficial developed deep surgical site infection. The result is higher than study conducted in Serbian 3.13% developed pin tract infection(33), China 1.04% (17), Johns Hopkins University School of Medicine(3) where pin tract infection developed in 19.12% patients, and Finland no infection was occurred(34). The possible reason might be poor health seeking behavior, poor economy,

and poor procedural practice due to lack of f materials and experts. The other possible reason might be in Ethiopia many patients visited traditional healers before visiting the hospital and prone to infection after hospitalization.

During follow up of patients, in 15.1% of patients knee mobility was affected while in 30.2% ankle mobility was affected. Additionally, limb alignment was determined by angulation, rotation, and shortening, and 41.5% patient had insignificant alignment while 11.3% had significant complication on limb alignment after surgery. The result was supported by many studies (34-36), a study conducted in Turkey (26), and USA(37).

Additionally, 62.3% patients complained that they have mild pain and 11.3% reported moderate pain after the procedure. This is quite higher than a study conducted in Turkey (26) and a previous study of Dickson et al (38). Apart from this, 37% of patients needed revision surgery and 17% of them changed their procedure to intra-medullary nailing. Higher than a systematic review(25), This is quite higher than a study conducted in Turkey (26), Queen Elizabeth Medical Centre, Edgbaston, Birmingham(21), and Zalavras G, et al (11). This could be explained as type GA type 3C were included in external fixation at which the procedure is difficult even previously amputation was recommended.

Conclusion

The majority of patients with open tibial fracture were rural residents, male and younger population. The leading cause of the open tibial fracture was road traffic accident followed by bullet injury. The majority of open tibial fracture patients in this study were diagnosed as GAIIIB fracture. Using external fixation as a definitive treatment for open tibial fracture results a high rate of infection, bone mal-union, and non-union. Thus, health facilities and health care professionals working on this area should revise the procedure to promote better stability, to decrease the risk of surgical site infection, and miss alignment and delayed union. Additionally, to reduce tibial fracture and its complication, interventional programs to reduce car accident, and effective treatment, characterization of thee fracture is crucial to guide the decision making process for better management of patients for survival, healing, improvement of patients, and for better clinical outcome in patients with open tibial fracture.

Limitation

As this study was retrospective in its design, 5 medical charts were missed and excluded from the study and the sample size was small. Additionally, treatment regimens could have been different among the included patents.

Abbreviations

BDU- Bahir Dar University

EXFIX- External fixation

GA- Gustillo Anderson

IM- Intramedullary

RTA- Road Traffic Accident

TGSH- Tibebe Ghion Specialized Hospital

Declarations

Data sharing statement

All necessary information are available from the corresponding author on reasonable request through amanuelbiruk0077@gmail.com.

Ethical Consideration

Ethical clearance for this study was obtained from Bahir Dar University College of medicine and health science Ethical Review Board (IRB) office. The letter of support was written by the Orthopedic and Trauma department to Tibebe Ghion Specialized Hospital managing director and card office for supporting data collectors by providing medical chart and other necessary information. Information from patient medical chart and orthopedic morning registering sheet was used only for the purpose of this research and confidentiality was kept during the study and dissemination of the results.

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Author’s contribution

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

All three authors declared that they have no competing interest

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Figures

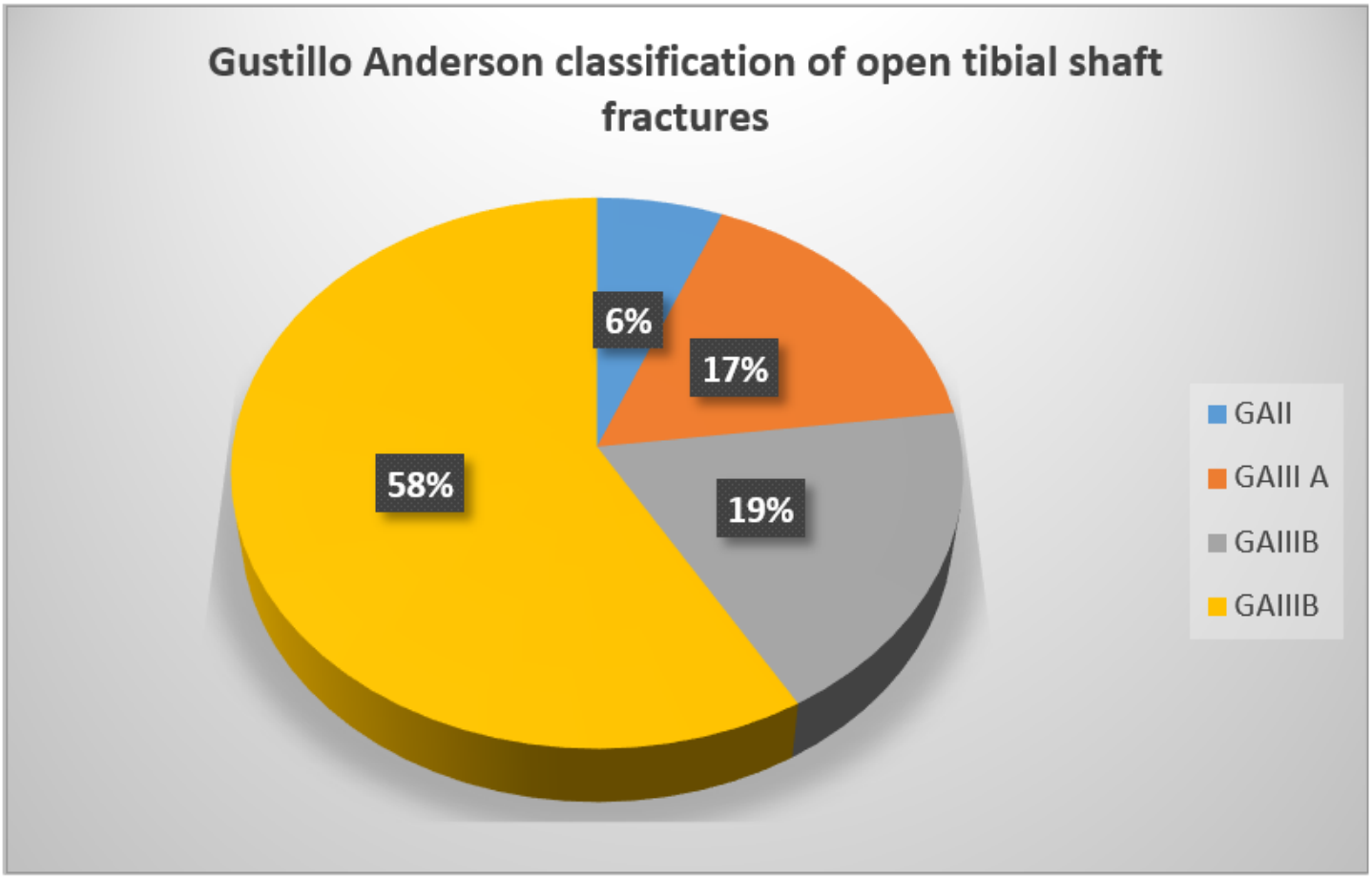

Figure 1

Gustillo Anderson classification of open tibial shaft fractures treated in Tibebe Ghion specialized hospital.