Peertechz

CLINICAL GROUP

OPEN JOURNAL OF Trauma OPEN ACCESS JOURNAL

ISSN: 2640-7949 DOI: https://dx.doi.org/10.17352/ojt

Research Article

Evaluation of the treatment outcome of tibia shaft fracture by close reduction and internal fixation with interlocking intramedullary nail, Freetown, Sierra Leone, 2023

Desmond Maada Kangbai[1,2]*, Nella Clemens-Kangbai[2,3] and Isaac Olufemi Smalle[2,4]

[1]Trauma and Orthopedics, University of Edinburgh, Scotland

[2]Ministry of Health, Sierra Leone

[3]Pediatric and Child Health, University of Nairobi, Kenya

[4]College of Medicine and Allied Health Sciences, University of Sierra Leone, Sierra Leone

Received: 21 February, 2024
Accepted: 27 March, 2024
Published: 28 March, 2024

***Corresponding author:** Desmond Maada Kangbai, Trauma and Orthopedics, University of Edinburgh, Scotland, Email: desmakay@yahoo.com

ORCiD: https://orcid.org/0000-0002-2543-349X

Keywords: Infection; Wound; Intramedullary nail; Tibia shaft; Emergency hospital; Sierra Leone; Internal fixation

https://www.clinsurggroup.us

Check for updates

Abstract

Introduction: The tibia shaft is a common site for bone fractures and open fractures. Tibia shaft fracture is mostly caused by high-energy trauma such as a fall from a height or a road traffic accident. The objective of this study was to evaluate the treatment outcome of tibia shaft fracture managed by close reduction and internal fixation with interlocking Intramedullary Nails (IMN) and to determine factors that are associated with tibia fracture infection.

Methods: This retrospective study was conducted at the Emergency Trauma Hospital, Freetown, Sierra Leone. We analyzed the medical records of a mixed cohort of patients who were treated for, tibia shaft fracture by closed reduction and internal fixation with interlocking intramedullary nails for the period January 2020 to January 2022; with at least 15 months of follow-up. We later used both bivariate and multivariate logistic regressions to determine the factors that are associated with wound infection post-internal fixation.

Results: A total of Ninety (n = 90) patients' medical records were reviewed of which 79 were included for analysis. The median age was 30 years (Inter Quartile Range: 16-67 years). The average hospital stay was 20 days (Inter Quartile Range: 6-156 days). The mean fracture nailing time was 11 days. Infection and non-union rates were at 18.99% and 3.8% respectively. Type of tibia shaft fracture (AOR = 25.51, 95% CI = 2.06-422.75,) and characteristics of wound (AOR = 29.51, 95% CI = 2.06-422.75) were significantly associated with wound infection. The treatment outcome categorization of IMN was successful in 88.61% of the patients.

Conclusion: This study concludes that the type of tibia shaft fracture and characteristics of the wound are major predictors of wound infection. The findings of this study suggest that IMN fixation of closed and Gustilo type 1 Tibia shaft fracture led to successful healing in the majority of the cases with a low non-union rate.

Citation: Kangbai DM, Clemens-Kangbai N, Smalle IO (2024) Evaluation of the treatment outcome of tibia shaft fracture by close reduction and internal fixation with interlocking intramedullary nail, Freetown, Sierra Leone, 2023. Open J Trauma 8(1): 011-020. DOI: https://dx.doi.org/10.17352/ojt.000045

Abbreviations

IMN: Intramedullary Nail; IQR: Interquartile Range; CI: Confidence Interval; COR: Crude Odds Ratio; AOR: Adjusted Odds Ratio

Introduction

The tibia shaft is the most common site of long-bone fractures and is also the most common site of open fractures [1]. The most common mechanism that leads to tibia shaft fracture is high-energy trauma such as a fall from a height, severe physical injuries from sports, or fatal road traffic accidents [2]. Tibia shaft fractures are major injuries and can result in severe permanent disability, such as mal-alignment and limb shortening, as well as amputation [2,3]. Based on the type of tibial fracture, whether closed or open, proximal to the knee joint or ankle joint, displaced or un-displaced, generally, infections, compartment syndrome, and non-union are other well-recognized complications of fractures of the tibia [2,4,5]

The overall infection rate after surgical intervention of these injuries is about 1% - 4% [6]. Deep infection rates range from 1% after surgical fixation of closed low-energy fractures up to 30% in complex open tibia fractures [7,8]. The rates of nonunion can be up to 17% according to data from large teaching centers [9] and these numbers are higher when open fractures are involved [6,8].

The most appropriate treatment option depends on thoughtful analysis of the morphology of the fracture, the severity of the injury, the mechanical characteristics of bone, the age and general condition of the patient, and most importantly the status of soft tissues. Of the various fixation methods that have been used to treat these fractures, intramedullary nails, and external fixation devices have delivered the most promising results [10]. An Intramedullary Nail (IMN) consists of a metal rod, which is inserted, usually from the upper side of the tibia into the inner cavity of the tibia [2,10]. It is generally held in place by screws [2]. Intramedullary interlocking nails are very commonly used in trauma practice for tibial fractures, especially in the treatment of closed mid-shaft and Gustilo 1 fractures of the tibial [4]

Intramedullary nailing of the tibial delivers consistently good results in terms of fracture union and functional outcomes, minimal surgical dissection with appropriate preservation of blood supply to the fracture [3]. Recent data suggest that early internal fixation of closed long bone fractures is associated with improved outcomes, early weight bearing, less hospital stay, and early return to daily normal activities [2,9-11].

In Sierra Leone, due to poor roads, poor transportation, and weak road transport policies, the burden of road traffic accidents is high and not properly quantified. Even though intramedullary nails have shown good treatment outcomes in developed countries, several factors have not been studied to determine their influence on the outcome of these operations, especially in poor-income countries. Little or no research has been done to evaluate treatment outcomes. This research sought to evaluate the treatment outcome of tibial shaft fractures treated operatively by close reduction and internal fixation with Interlocking Intramedullary Nail.

Methods

Study design, population and setting

This retrospective study was conducted at the Emergency Orthopedic and Trauma Centre located at Goderich, Freetown from July to September 2023. It is the only major trauma unit in Sierra Leone. The Western Area covers an area of 13 km^2 and is the most populous district in Sierra Leone with a population of 1,050,301 residents. There are three other major hospitals in Freetown; the Ola during Pediatrics Hospital, Princess Christianity Maternity Hospital, and the Connaught Teaching Hospital. The study population included all sexes treated for the following tibia shaft fractures: stable or unstable, displaced or un-displaced, and Open Gustilo type 1 or closed tibial shaft fracture by closed reduction and internal fixation with interlocking intramedullary nail between January 2020 to January 2022 with at least 15 months of follow-up post-surgery.

Inclusion criteria

- Patient with stable or unstable tibial shaft fracture
- Displaced or undisplaced tibial shaft fracture
- Open Gustilo type 1/closed tibial shaft fracture.

Exclusion criteria

- Patients with a follow-up period of fewer than 12 months
- Patient below 16 years or above 70 years
- Patients with signs and/or symptoms of infection even though might have been treated with antibiotics before surgery
- Patients living in camps or prisons, re-surgeries,
- Patients with incomplete records
- Open Gustilo of the tibial type 2 or 3.

Sample size determination

All cases treated operatively for Tibial Shaft Fracture by Close Reduction and Internal fixation with Interlocking Intramedullary Nail at the emergency hospital between January 2020 to January 2022 were included in this study.

Data collection technique and tool

The secondary data were collected with the guide of a checklist that took into consideration all the variables of interest. The data were collected from patients' admission books or registers, outpatient registers, theatre registers, discharge registers, patient individual admission books, and follow-up notes. Similarly, the patient's X-rays on admission, after surgery, and throughout the follow-up were reviewed.

Citation: Kangbai DM, Clemens-Kangbai N, Smalle IO (2024) Evaluation of the treatment outcome of tibia shaft fracture by close reduction and internal fixation with interlocking intramedullary nail, Freetown, Sierra Leone, 2023. Open J Trauma 8(1): 011-020. DOI: https://dx.doi.org/10.17352/ojt.000045

Operational definitions

- Superficial wound infection: signs of infection above the fascia in the first 30 days after surgery [12]
- A deep infection was defined as an infection involving deeper tissues as muscular fascia and bone, which could necessitate the removal of the Intramedullary nail [13]
- Non-union is the non-healing or no sign of healing of a fracture and is declared between 6 and 8 months following the fracture unless loss of bone is present [14].
- This study defined Satisfactory as those tibia fracture cases that healed within 15 months of follow-up.
- This study defined Unsatisfactory are those tibia fracture cases that fail to heal within 15 months of follow-up; in such cases, the nail was removed.

Dependent variables: For this study, the outcome of interest was wound infection after surgery, a binary variable classified as Yes or No. The rate of Non-union was determined as a dependent variable.

Independent variables: The independent variables were the patient's sociodemographic characteristics such as age, sex, ethnicity, marital status, religion, education level attainment, occupation, past medical history, tobacco use, mode/mechanism of injury, fracture type, open fractures, Gustilo type 1, fracture nailing time/interval, duration of admission, associated fractures. Patients were further reclassified according to the treatment outcome after 15 months of follow-up as satisfactory and unsatisfactory.

Data management and analysis

The data were entered into MS Excel 2020 and cleaned. Editing was done to ensure the patient's data were complete. Patients with incomplete data were removed from the dataset. The variables were coded for the data analysis. Each variable was allocated a numeric code. The analysis was done using Stata IC 15.0, College Station, TX: Stata Corp LLC. Some variables were further recorded using Stata 15.0 IC for ease of analysis.

For descriptive statistics; the independent and dependent variables were analyzed and presented in frequency tables and percentages. Normality was tested for continuous variables (age) and the median (IQR) was estimated if the distribution was not normal. To estimate the effect of the independent variable on the dependent variable (Developed infection after surgery (Yes/No), bivariate and multivariate logistic regression models were constructed. A significant association level set, p - value < 0.05. The Crude Odds Ratio (COR), 95% Confidence Interval (CI), and p - value were estimated. All independent variables that showed a significant association were included in the multivariate binary regression model for which the Adjusted Odds Ratio (AOR), 95% Confidence Interval, and p - value were estimated.

Ethical clearance

Ethical approval was obtained from the Sierra Leone Scientific and Ethics Committee of the Ministry of Health and Sanitation (SLESRC No: 023/08/2023). Permission was also sought from the Emergency Pediatric and Trauma Centre. The hospital was assured of patient and data confidentiality. The data was collected without the names of the patients. This study was conducted per the local Institutional Review Board regulations.

Results

Sociodemographic characteristics of patients

A total of ninety (n = 90) patients' case files were reviewed of which 79 were included for analysis due to missing variables. These 79 case files were patients admitted and operated on at the Emergency Pediatric and Trauma Centre with an Intramedullary Nail following closed or Gustilo 1 fracture of the tibial shaft from January 2020 to January 2022. The diagnosis was made by history, clinical examination, and radiological evidence. The median age of the patients was 30 years (Inter Quartile Range: 16-67 years). The average hospital stay from admission to discharge was 20 days (Inter Quartile Range: 6-156 days). The mean fracture nailing time was 11 days Inter Quartile (range: 1 to 120 days). The majority (49.49 %, n = 47/79) belonged to the age group 25-45 years, 21.52 % (n = 17/79) were <25 years and 18.99 % (n = 15/79) were > 45 years. The majority 62.03 % (n = 49/79) of the patients were male; 46.84 % (n = 37/79), 43.04 % (n = 34/79), and 10.13 % (n = 8/79) were single, married, and divorced/separated/widowed respectively (Table 1). The majority (53.16%, n = 42/79) of the patients were Muslims, some (41.77 %, n = 33/79) belonged to the Temne ethnic group, while few belonged to the Mende (17.72 %, n = 14/79), and Creoles (10.13 %, n = 8/79); the rest (30.38 %, n24/79) belong to other ethnic groups. Taking into consideration the education level attained, few (15.19 %, n = 12/79) of the patients had no educational level, 29.11 % (n = 23/79) had primary level education, 34.18 % (n = 27/79) had secondary level education, and 21.52 % (n = 17/79) had tertiary/vocational level of education. Few (15.19 %, n = 12/79) were motor vehicle drivers or motorbike riders, 22.78 % (n = 18/79) were students, 17.72 % (n = 14/79) were traders, 12.66 % (n = 10/79) were construction workers, and 31.65 % (n = 25/79) others.

Health behavior of patients treated with IMN

Of the total patients operated on, 91.14% (72/79) had no past medical history of any chronic disease. With regards to tobacco use, 10.13% had a history of tobacco use. The mode of injury in the majority (77.22%) of the patients was by road traffic accident and 22.78% by a fall from a height or playing football. Of the total patients who operated, 54.43% presented with a Gustilo type 1 fracture of the tibia shaft, and the rest closed the tibial shaft fracture. With regards to fracture nailing interval, 44.30% of patients were operated on within six days

Citation: Kangbai DM, Clemens-Kangbai N, Smalle IO (2024) Evaluation of the treatment outcome of tibia shaft fracture by close reduction and internal fixation with interlocking intramedullary nail, Freetown, Sierra Leone, 2023. Open J Trauma 8(1): 011-020. DOI: https://dx.doi.org/10.17352/ojt.000045

of injury, 43.04% were operated on within 7 to 15 days of injury, and 12.66% were operated on after 15 days of injury. The characteristics of the wound were determined by inspection of the wound at the time of the first visit, 45.57% of patients had no wound, 39.24% had a clean wound, and 15.19% had a wound contaminated with soil or foreign bodies. The majority (77.22%) of the patients had no associated fracture apart from the tibial/fibula fracture while 22.78% had associated fractures of other limbs or the same (Table 2).

Distribution of patient by complication

Of the total patients operated on, the majority (81.01%, *n* = 64/79) did not develop Surgical Site Infection (SSI), while only 18.99 % (*n* = 15/79) developed SSI (Table 3). Of the total 15 patients that developed SSI, superficial wound infection occurred in 60.00 % (*n* = 9/15) of the patients while deep wound infection occurred in 40.00 % (*n* = 6/15) patients. The deep wound infection prompted the removal of the nail; non-union occurred in 3.8 % (*n* = 3/79) of the patient-operated.

Table 1: Sociodemographic characteristics of patients treated with Intramedullary Nail of the Tibial, Emergency Hospital, Freetown, Sierra Leone, 2023.

Characteristics	Number (*n* = 79)	Percentage (%)
Age (years)		
< 25	17	21.52
25-45	47	59.49
> 45	15	18.99
Sex		
Male	49	62.03
Female	30	37.97
Marital Status		
Single	37	46.84
Married	34	43.04
Divorced/Separated/Widowed	8	10.13
Religion		
Christian	37	46.84
Muslim	42	53.16
Ethnicity		
Mende	14	17.72
Temne	33	41.77
Creole	8	10.13
others	24	30.38
Education level attainment		
None	12	15.19
Primary	23	29.11
Secondary	27	34.18
Tertiary/Vocational	17	21.52
Occupation		
Driver/Rider	12	15.19
Student	18	22.78
Trader	14	17.72
Construction worker	10	12.66
Others	25	31.65

Table 2: Health Behaviour of Patients treated with Intramedullary Nail of the Tibial, Emergency Hospital, Freetown, Sierra Leone, 2023.

Characteristics	Number (*n* = 79)	Percentage (%)
Past Medical History		
No	72	91.14
Yes	7	8.86
Tobacco use		
No	71	89.89
Yes	8	10.13
Mode of Injury		
Fall	18	22.78
Road Traffic Injury	61	77.22
Type of Fracture		
Closed	36	45.57
Open/Gustilo 1	43	54.43
Fracture Nailing Interval		
< 7 days	35	44.3
7-15 days	34	43.04
> 15 days	10	12.66
Characteristics of Wound		
No Wound	36	45.57
Clean	31	39.24
Contaminated	12	15.19
Duration of Hospital Stay		
< 15 days	28	35.44
15-20 days	30	37.97
> 20 days	21	26.58
Associated Fractures		
No	61	77.22
Yes	18	22.78

Table 3: Distribution of patients by complication, Emergency Hospital, Freetown, Sierra Leone, 2023.

Complication	Number (*n* = 79)	Percentage (%)
Infection		
No	64	81.01
Yes	15	18.99
Non-Union		
No	76	96.20
Yes	3	3.80

Bivariate and Multivariate analysis of determinants of wound infection

As shown in Table 4, of the 79 patients treated with IM nail of the tibia, 15 reported superficial or deep infection of the surgical site. With regards to age, 66.67 % (10/15) of wound infections occurred among the age group 24 to 45 years followed by age group > 45 years and < 25 years with 20.00% (3/15) and 13.33% (2/15) respectively. The majority 66.67% (10/15) of wound infections occurred in men. Wound infection occurred the least 20.00% (3/15) in the divorced patient compared to single and married patients with 40.00% (6/15)

Citation: Kangbai DM, Clemens-Kangbai N, Smalle IO (2024) Evaluation of the treatment outcome of tibia shaft fracture by close reduction and internal fixation with interlocking intramedullary nail, Freetown, Sierra Leone, 2023. Open J Trauma 8(1): 011-020. DOI: https://dx.doi.org/10.17352/ojt.000045

each respectively. Regarding religion, the majority 80.00% (12/15) of the wound infections occurred in Muslims compared to 20.00% (3/15) in Christians. With regards to the level of education attained, 40.00% (6/15) of the wound infections occurred in patients with a secondary level of education and 20.00% (3/15) each with None, Primary and Tertiary/vocational level of education respectively. The majority of the wound infections occurred in patients with no past medical history of any chronic disease or tobacco use with 93.33% (14/15) and 80.00% (12/15) respectively. Taking into consideration the mode of injury, 73.33% (11/15) of the wound infections occurred in patients who suffered a road traffic accident compared to 26.67% (4/15) of those who suffered a fall. The majority 86.67% (13/15) of the wound infections occurred in patients with open or Gustilo Type 1 fracture compared to 13.3% (2/15) of those with closed tibia fracture. The majority of the infections occurred in fractures that were nailed between 7 to 15 days after injury compared to those nailed within 6 days and above 15 days. With regards to the characteristics of the wound if present, the majority 60.00% (9/15) of the wound infections or surgical site infections occurred in patients with contaminated wounds on admission compared to those with clean and no wounds with 26.67% (4/15) and 13.30% (2/150 respectively. Wound infection after nailing was found to be higher at 66.67% (10/15) in patients with more than 20 days of hospital stay, 26.67% (4/15) in patients with 15 to 20 days of hospital stay, and 6.67% (1/15) in a patient with less than 15 days of hospital admission. Wound infection was found to be higher in patients with no associated fracture other than the tibia fracture compared to patients with an associated fracture other than the tibia fracture.

Using a simple logistic regression model, there was no statistically significant association between the age of the patient and wound infection post intramedullary nail fixation of the tibia. Patients above 45 years of age had 1.88 times increased odds of wound infection as compared to those below 25 years which was not statistically significant (COR = 1.88, 95 % CI = 0.27-13.09). Similarly, patients 25 to 45 years had 2.03 times increased odds of wound infection compared to those below 25 years which was not statistically significant (COR = 2.03, 95% CI = 0.40-10.37). There was no statistically significant association between sex and wound infection. Females had an increased odds of wound infection compared to males which was statistically not significant (COR = 0.78, 95% CI = 0.24-2.55). There was no statistically significant association between marital status and wound infection. Divorced patients had increased odds of wound infection compared to single patients (COR = 3.10, 95% CI = 0.58-16.59). Similarly, married patients have 1.11 times increased odds of wound infection as compared to single patients (COR = 1.11, 95% CI = 0.32-3.83).

There was a statistically significant association between religion and wound infection. Muslim patients had 4.53 times increased odds of wound infection as compared to Christian which was found to be statistically significant (COR = 4.53, 95% CI = 1.17-17.16). However, this association was not statistically significant after controlling for the effect of other variables. Even though Muslims had increased odds of infection post-surgery the association was not statistically significant (AOR = 5.85, 95% CI = 0.89-38.45).

There was no statistically significant association between the education levels attained by the patient and wound infection. Patients with a tertiary level of education were less likely to develop a wound infection as compared to those with no education level attainment (COR = 0.64, 95% CI = 0.11-3.91). Patients with a secondary level of education were less likely to develop a wound infection as compared to those with no education level attainment (COR = 0.86, 95% CI = 0.17-4.20). Similarly, Patients with a primary level of education were less likely to develop a wound infection as compared to those with no education level attainment (COR = 0.45, 95% CI = 0.08-2.68).

There was no statistically significant association between the patient occupation and wound infection. Construction workers had 1.29 times increased odds of wound infection as compared to drivers or riders which was not statistically significant (COR = 1.29, 95% CI = 0.20-8.43). Traders were less likely to develop a wound infection as compared to drivers or riders which was not statistically significant (COR = 0.23, 95% CI = 0.02-2.59). Students were less likely to develop a wound infection as compared to drivers or riders which was not statistically significant (COR = 0.60, 95% CI = 0.10-3.63). Similarly, those classified as others were less likely to develop a wound infection as compared to drivers or riders which was found not to be statistically significant (COR = 0.75, 95% CI = 0.15-3.84).

The past medical history of patients was not significantly associated with a wound or surgical site infection. Patients with past medical history were less likely to develop wound infection as compared to those with no past medical history (COR = 0.69, 95% CI = 0.08-6.21). Tobacco use was not significantly associated with wound infection. Those who smoked tobacco were less likely to develop wound infection as compared to those who did not smoke (COR = 0.69, 95% CI = 0.08-6.21).

The mode/mechanism of injury was not statistically associated with wound infection. Patients who sustained their injury through road traffic accidents were less likely to develop wound infection as compared to those through a fall (COR = 0.77, 95% CI = 0.21-2.79). At the bivariate level, there was a statistically significant association between type of fracture and wound infection. Patients with open or Gustilo 1 fracture of the tibia had over seven-fold increased odds of wound infection as compared to patients with closed fracture of the tibia (COR = 7.36, 95% CI = 1.54-35.32). This association remained statistically significant after controlling for the effect of the other variables. Patients with open or Gustilo 1 fracture of the tibia had over twenty-five-fold increased odds of wound infection as compared to patients with closed fracture of the tibia (AOR = 25.51, 95% CI = 2.06-422.75).

Fracture nailing interval was significantly associated with wound infection. Patients who were nailed after 15 days of injury had over fourteen-fold increased odds of wound infection as compared to those nailed in less than seven days

Citation: Kangbai DM, Clemens-Kangbai N, Smalle IO (2024) Evaluation of the treatment outcome of tibia shaft fracture by close reduction and internal fixation with interlocking intramedullary nail, Freetown, Sierra Leone, 2023. Open J Trauma 8(1): 011-020. DOI: https://dx.doi.org/10.17352/ojt.000045

Table 4: Bivariate and Multivariate analysis of determinants of wound infection, Emergency Hospital, Freetown, Sierra Leone, 2023.

Variable	Infection		COR (95% CI)	AOR (95% CI)
	No *n* = 64 (%)	Yes *n* = 15 (%)		
Age (years)				
< 25	15(23.44)	2(13.33)	1.00	
25-45	37(57.82)	10(66.67)	2.03(0.40-10.37)	
> 45	12(18.75)	3(20.00)	1.88(0.27-13.09)	
Sex				
Male	39(60.94)	10(66.67)	1.00	
Female	25(39.06)	5(33.33)	0.78(0.24-2.55)	
Marital Status				
Single	31(48.44)	6(40.00)	1.00	
Married	28(43.75)	6(40.00)	1.11(0.32-3.83)	
Divorced/Separated/ Widowed	5(7.81)	3(20.00)	3.10(0.58-16.59)	
Religion				
Christian	34(53.12)	3(20.00)	1.00	1.00
Muslim	80(46.88)	12(80)	4.53(1.17-17.61)*	5.85(0.89-38.45)
Education level attainment				
None	9(14.06)	3(20.00)	1.00	
Primary	20(31.25)	3(20.00)	0.45(0.08-2.68)	
Secondary	21(32.81)	6(40.00)	0.86(0.17-4.20)	
Tertiary/Vocational	14(21.88)	3(20.00)	0.64(0.11-3.91)	
Occupation				
Driver/Rider	9(14.06)	3(20.00)	1.00	
Student	15(23.44)	3(20.00)	0.60(0.10-3.63)	
Trader	13(20.31)	1(6.67)	0.23(0.02-2.59)	
Construction worker	7(10.94)	3(20.00)	1.29(0.20-8.43)	
Others	20(31.25)	5(33.33)	0.75(0.15-3.84)	
Past Medical History				
No	58(90.62)	14(93.33)	1.00	
Yes	6(9.38)	1(6.67)	0.69(0.08-6.21)	
Tobacco Use				
No	59(92.19)	12(80.00)	1.00	
Yes	5(7.81)	3(20.00)	0.69(0.08-6.21)	
Mode of Injury				
Fall	14(21.88)	4(26.67)	1.00	
Road Traffic Injury	50(78.12)	11(73.33)	0.77(0.21-2.79)	
Type of Fracture				
Closed	34(53.12)	2(13.3)	1.00	1.00
Open/Gustilo 1	30(46.88)	13(86.67)	7.36(1.54-35.32)*	25.51(2.06-422.75)*
Fracture Nailing Interval				
< 7 days	34(53.12)	1(6.67)	1.00	1.00
7-15 days	23(35.94)	11(73.33)	16.26(1.96-134.71)*	4.02(0.32-49.89)
> 15 days	7(10.94)	3(20.00)	14.57(1.32-161.42)*	1.49(0.06-34.49)
Characteristics of Wound				
No Wound	34(53.12)	2(13.30)	1.00	1.00
Clean	27(42.19)	4(26.67)	2.52(0.43-14.80)	1.26(0.16-10.15)
Contaminated	3(4.69)	9(60.00)	51.00(7.37-352.83)*	29.51(2.06-422.75)*
Duration of Hospital Stay				
<15 days	27(42.19)	1(6.67)	1.00	1.00
15-20 days	26(40.62)	4(26.67)	4.15(0.43-39.67)	4.02(0.21-83.35)
>20 days	11(17.19)	10(66.67)	24.54(2.80-215.38)*	10.93(0.54-217.37)
Associated Fractures				
No	48(75.00)	13(86.67)	1.00	
Yes	16(25.00)	2(13.3)	0.46(0.09-2.27)	

*Significant association at $p < 0.05$

(COR = 14.57, 95% CI = 1.32-161.42). Similarly, Patients who were nailed between 7 to 15 days of injury had over sixteen-fold increased odds of wound infection as compared to those nailed in less than seven days (COR = 16.26, 95% CI = 1.96-134.71). After controlling for the effect of the other variables, fracture nailing interval was not significantly associated with wound infection. Patients who were nailed after 15 days of injury had 1.49 times increased odds of wound infection as compared to those nailed in less than seven days (AOR = 1.49, 95% CI = 0.06-34.49). Similarly, Patients who were nailed between 7 to 15 days of injury had 4.02 times increased odds of wound infection as compared to those nailed in less than seven days (AOR = 4.02, 95% CI = 0.32-49.89).

The characteristic of the wound was significantly associated with wound infection. Patients who had wounds contaminated with soil or other foreign bodies on admission had 51.00 times increased odds of wound infection as compared to those patients with no wounds which was found to be statistically significant (COR = 51.00, 95% CI = 7.37-352.83). Patients who had a clean wound on admission had over two-fold increased odds of wound infection as compared to those patients with no wound which was found not to be statistically significant (COR = 2.52, 95% CI = 0.43-14.80). After controlling for the effect of other variables, the characteristic of the wound remained significantly associated with wound infection. Patients with contaminated wounds were more likely to develop wound or surgical site infection as compared to those with no wound which was found to be statistically significant (AOR = 29.51, 95% CI = 2.06-422.75). Patients who had clean wounds were more likely to develop wound infection as compared to those with no wound which was found not to be statistically significant (AOR = 1.26, 95% CI = 0.16-10.15).

The duration of hospital stay was significantly associated with the outcome of wound infection. Patients admitted for more than 20 days post-nailing had over 24-fold increased odds of wound infection as compared to patients admitted for less than fifteen days which was found to be statistically significant (COR = 24.54, 95% CI = 2.80-215.38). Patients admitted for 15 to 20 days post-nailing had over 4-fold increased odds of wound infection as compared to patients admitted for less than fifteen days which was found not to be statistically significant (COR = 4.15, 95% CI = 0.43-39.67). After controlling for the

Citation: Kangbai DM, Clemens-Kangbai N, Smalle IO (2024) Evaluation of the treatment outcome of tibia shaft fracture by close reduction and internal fixation with interlocking intramedullary nail, Freetown, Sierra Leone, 2023. Open J Trauma 8(1): 011-020. DOI: https://dx.doi.org/10.17352/ojt.000045

effect of other variables at the multivariate level, the duration of hospital stay was not significantly associated with wound infection. Patients admitted for more than 20 days post-nailing had 10.93 times increased odds of wound infection as compared to patients admitted for less than fifteen days which was found not to be statistically significant (AOR = 10.93, 95% CI = 0.54-217.37). Similarly, Patients admitted for 15 to 20 days post-nailing had over 4-fold increased odds of wound infection as compared to patients admitted for less than fifteen days which was found not to be statistically significant (COR = 4.02, 95% CI = 0.21-83.35).

There was no significant association between patients with associated fractures other than the tibial fracture and wound infection. Patients who had associated fractures other than the tibial fracture were less likely to develop wound infection as compared to patients with no associated fracture which was found not to be statistically significant (COR = 4.02, 95% CI = 0.21-83.35).

Treatment outcome categorization of patients treated with IMN

Figure 1 below shows the treatment outcome of the 79 patients operated at the Emergency Surgical Center after a minimum of 15 months of follow-up. The treatment outcome was successful in 88.61% (70/79) of the patients and unsatisfactory in 11.39% (9/79). The unsatisfactory cases include the 6 patients with the deep infection for which the nail was removed and the 3 non-union cases.

Discussion

This study evaluated the treatment outcome of the management of Tibial Shaft Fracture by Close Reduction and Internal fixation with Interlocking Intramedullary nails conducted at the Emergency Trauma Centre in Freetown, Sierra Leone. This chapter will discuss the results of this study concerning the objects and compare or contrast with other studies. It will examine the patient's demographics, individual characteristics, and the effect of these on the outcome variable.

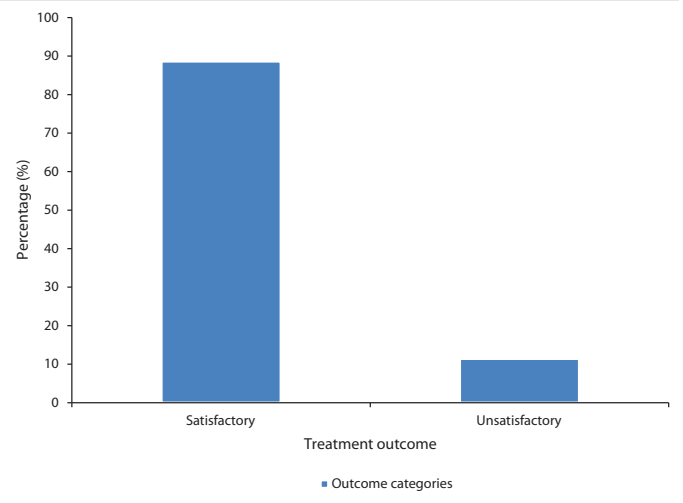

Figure 1: Percentage distribution of patients by treatment outcome, Emergency Hospital, 2023.

Sociodemographic characteristics of patients

This study found that the age group most affected by tibial shaft fracture was 25 to 45 years followed by those less than 25 years and those above 45 years of age respectively. The median age was 30 years (Range: 16-67 years. A study conducted in Bangladesh by Khaleque, et al. found the age group 25-34 years to be most affected by tibial shaft fracture followed by the age group 18 to 24 years. The range of their study was 18 to 55 years with a mean of 31.8 years [1]. In another study conducted in Edinburgh by Court-brown, et al. the mean age of the patient was 32.4 years with a range of 16 to 18 years. The findings of this study are similar to the above two studies. The stated age group is more prone to road traffic accidents and falls as they are mostly involved in activities that place them at high risk. Most drivers, riders, and people involved in high-risk occupations are found between the age group 25 to 45 years. The finding of this study suggests that the majority (62.03%) of the patients with tibial shaft fractures were male compared to female which is similar to other studies [4,13]. In a study conducted by Smith, et al. 61.00% of the cases were male [16]. According to Metsemakers, et al. 70.40% of their cases were male [8]. In another study conducted in Iraq, 55.2% were male [17]. This may be because males are mostly the breadwinners in our communities and are most involved in high-risk jobs like driving, riding, and construction work among others. Even though males were mostly affected women represented 37.97% of the total cases. In our communities, women are involved in street trading and petit trading which put them at risk of road traffic accidents. This study further found that the majority of the patients with tibial shaft fractures were either single or married compared to the divorced.

The findings of this study revealed that tibial shaft fracture was more common among Muslims compared to Christians. This could be attributed to the fact that Sierra Leone is Muslim-dominant. According to the International Religious Freedom Report 2019, 77% of the Sierra Leone population are Muslims [18]. It further revealed that the majority of the fractures occurred in the Temne ethnic group. This study is conducted in the capital Freetown where the above ethnic group is predominant and mostly involved in trading which puts them at high risk of road traffic accidents. According to this study, 34.18% and 29.11% of the fractures occurred in patients with primary and secondary levels of education respectively. This correlates with the occupation of the patients, 22.78% are students, 17.72% are traders, 15.19% are drivers/riders, 12.66% are construction workers and 15.19% have no education. According to the Sierra Leone Demographic and Health Survey 2019, urban residents are more likely to be educated, and 39% of females and 29% of males in Sierra Leone have no education [19].

This differs from the findings of this study because this study is conducted in the capital city of Sierra Leone where the level of education is much higher and the percentage given by the Sierra Leone statistics accounts for both urban and rural areas,

Citation: Kangbai DM, Clemens-Kangbai N, Smalle IO (2024) Evaluation of the treatment outcome of tibia shaft fracture by close reduction and internal fixation with interlocking intramedullary nail, Freetown, Sierra Leone, 2023. Open J Trauma 8(1): 011-020. DOI: https://dx.doi.org/10.17352/ojt.000045

Health behavior of patients treated with IMN

According to the findings of this study, 91.14% of patients had no past medical history of any chronic disease while 8.86% had a history of chronic diseases such as hypertension and Diabetes mellitus. According to a similar study conducted by Metsemakers, et al. 5.21% of their cases had Diabetes mellitus and 10.40% were obese [8]. In another study conducted in England by Galvain, et al. 6.20 % of the cases had chronic diseases of which 3.40% had Diabetes Mellitus, 1.00% Chronic Obstructive pulmonary disease, 0.3% Congestive heart failure, and 1.5 Hypertension [20]. Even though the sample size of our study is smaller compared to the above-referenced studies the findings are more or less similar. In our settings, there is a gradual shift from infectious diseases to chronic diseases or conditions. The findings of this study suggest that 10.13% of the patients who suffered tibial shaft fractures were active smokers at the time of admission. This proportion is less than similar studies conducted in England and Belgium where 31.8% and 30.4% of the cases were active smokers respectively [8,15]. The proportion of smokers in our communities may be lesser than in the European communities because our religious and cultural practices see the habit of smoking as a taboo. As a result, most young people who smoke do not accept or say it in public. In this study, road traffic accidents accounted for the majority (77.22%) of the fractures. In a study conducted by Khaleque, et al. road accidents accounted for 70.00% of the fractures [1]. In a similar study, 43.10% of the injuries followed traffic accidents [8]. In this study, [9], 40.00% of the injuries followed motor vehicle accidents. This finding is similar to other studies that road traffic accident accounts for the majority of injuries. In Sierra Leone the reason for this may be attributed to the poor road conditions, vehicles are not regularly checked for roadworthiness, drivers are not well trained, and driving licenses are easy to acquire among others. According to the findings of our study, the average hospital stay from admission to discharge was 20 days (Range: 6-156 days). In another study, the average hospital stay was 38.5 days (range 6 to 98 days) for polytrauma and 7.1 days (2 to 48) for solely tibial fracture [15]. In the study [21], the mean hospital stay was 15.2 days (range 6 to 50 days) for solely tibial fracture. In a study conducted by Khaleque, et al. the mean hospital stay was 5 days (range 2 to 15 days). The average hospital stay is longer in our study compared to the others because ours included patients with polytrauma, and this may be due to the higher rate of wound infections. Also, the limited number of surgeons or senior medical officers to provide adequate or immediate surgical intervention may be responsible for the prolonged stay. In this series, the mean nailing time from injury to fracture fixation with an IMN was 11 days (range 1 to 120). The majority of the cases 44.30% and 43.04% were nailed in less than 7 days and within 7 to 15 days respectively. A few were nailed after 15 days. In the study [1], 60.00% were nailed within 8 to 15 days, and 40.00% were nailed within 2 to 7 days. The longer period of nailing may be attributed to several reasons; a limited number of surgeons, a limited number of hospital beds for post-surgical cases, contaminated wounds are not nailed immediately and depends on the progress of the wound, the presence of secondary pathologies or illness or polytrauma among others. Our study found that the majority (54.43%) of the patients had an open tibial fracture of which 39.24% had a clean wound and 15.19% had a wound contaminated with soil or other foreign bodies.

Distribution of patient by complication

The principal outcome variable of this study was wound infection as a complication. We looked at the distribution of wound infection across different variables and how these variables influenced the presence or not of wound infection. Our study suggests an infection rate of 18.99% (15/79) of which 60.00% (9/15) were superficial wound infections and 40% (6/15) were deep wound infections. Of the total infections 86.67% (13/15) occurred in patients with open fractures and 13.3% (2/15) in patients with closed fractures. In a similar study conducted by Smith, et al. a 6% infection rate was reported after open tibia intramedullary nailing and 2.7% after closed nailing [16]. In another study, 21 (4.3%) developed infections of which 7 were deep infections [8]. In a prospective literature review by Coles, et al. 3 superficial wound infections were reported out of 60 cases [9]. Court-Brown, et al. reported an infection rate of 1.6% [15]. In a study conducted by Al-Sharaa, et al. superficial infection occurred in 1.5% of the total cases [17]. Even though the sample size of our study is small the infection rate is higher compared to the above studies. This high infection rate could be attributed to the fact that the majority occurred in open fractures of which 69% were comminated with soil or foreign bodies. The prolonged hospital stay could be another factor responsible for wound infection as the majority of the infections occurred in patients with more than 20 days of hospital stay. Also, personal hygiene may be a contributing factor. This study further reported a non-union rate of 3.80%. The finding of our study is similar to one conducted by Patel, et al. with a 4% non-union [22] and lower than a study conducted by Metsemakers, et al. the rate of non-union was 11.90%. Mahmood, et al. reported a 5% non-union which is slightly higher than our findings [23].

Bivariate and multivariate analysis of determinants of wound infection

The bivariate analyses suggest that Religion, type of fracture (close/open), fracture nailing interval, characteristics of the wound, and duration of hospital stay are significantly associated with wound infection. Metsemakers, et al. reported bivariate analyses in which open fracture was a predictor variable of wound infection [8]. In the multivariate analysis type of fracture and characteristics of the wound remained significantly associated with wound infection.

Treatment outcome categorization of patients treated with IMN

Our study findings suggest that IMN of the tibial was successful in 88.61% of the cases treated. This is similar to [1], a stated success rate of 90.00%, and a study conducted by Patel, et al. 82% excellent result [22].

Citation: Kangbai DM, Clemens-Kangbai N, Smalle IO (2024) Evaluation of the treatment outcome of tibia shaft fracture by close reduction and internal fixation with interlocking intramedullary nail, Freetown, Sierra Leone, 2023. Open J Trauma 8(1): 011-020. DOI: https://dx.doi.org/10.17352/ojt.000045

Limitation

We accept that this retrospective study has some limitations, not all potential variables have been included such as reamed or un-reamed IMN, fracture gap, corticosteroid, and antibiotic use. Therefore, our conclusions are limited to the variables analyzed. The sample size and the age group of our study make it difficult for our findings to be generalized to the entire population. Due to incomplete data or classification, some patients were called over the phone to get some information from them about their demographics or the extent of the wound. Some had difficulty recalling which led to the exclusion of some patients. Our study did not compare the outcome of the different management of Tibial shaft fracture. This could be an area for future studies.

Conclusion

We conclude that the majority of infections occurred in males, patients 25-45 years old, patients with contaminated wounds, and those with a duration of hospital stay of more than 20 days. Our findings indicate that the type of fracture and characteristics of a wound are major predictors of wound infection. The findings of this study suggest that IMN fixation of closed and Gustilo type 1 Tibial shaft fracture led to successful healing in the majority of the cases.

To facilitate better outcomes, and reduce surgery waiting time and prolonged hospital stays, the Ministry of Health and Sanitation should post more medical doctors to the Emergency hospital. We further recommend that the emergency hospital put structures in place that will ensure better recording of patients' case files and different procedures conducted.

Supplementary information

Additional file 1: Dataset used for analysis

Additional file 2: Ethical and scientific approval.

(Click here)

Acknowledgment

Our sincere appreciation goes to all staff of the Ministry of Health and the Emergency Pediatric and Trauma Hospital. I further extend our gratitude to the Merck Foundation and the University of Edinburgh.

Authors' contributions

Conceptualization and design: DMK, NCK, IOS. Data collection: DMK, IOS. Analysis and report writing: DMK, NCK, IOS Drafting manuscript: DMK, NCK, IOS. All authors read and approved the final manuscript.

Availability of data and materials

All data generated or analyzed during this study are included in this published article and its supplementary information files.

Declarations

I, Desmond Maada Kangbai, declare that except for other people's work which has been duly acknowledged, this thesis is the result of my original research undertaken under the supervision and that it has neither in whole nor in part been presented for another degree in this university or elsewhere.

Ethical clearance

Ethical approval was obtained from the Sierra Leone Scientific and Ethics Committee of the Ministry of Health and Sanitation (SLESRC No: 023/08/2023). Permission was also sought from the Emergency Pediatric and Trauma Centre. The hospital was assured of patient and data confidentiality. The data was collected without the names of the patients. This study was conducted per the local Institutional Review Board regulations.

References

1. Khaleque A, Aslam MM, Islam MN. Evaluation of the Outcome of Tibial Shaft Fracture by Close Reduction and Internal Fixation with Interlocking Intramedullary Nail. Saudi J Med Pharm Sci. 2020; 06: 64–71. doi: 10.36348/sjmps.2020.v06i01.011.

2. Duan X, Al-Qwbani M, Zeng Y, Zhang W, Xiang Z. Intramedullary nailing for tibial shaft fractures in adults. Cochrane Database Syst Rev. 2012. doi: 10.1002/14651858.cd008241.pub2.

3. Zelle BA, Boni G. Safe surgical technique: Intramedullary nail fixation of tibial shaft fractures. Patient Saf Surg. 2015; 9. doi: 10.1186/s13037-015-0086-1.

4. Karaarslan AA, Acar N, Aycan H, Sesli E. The functional results of tibial shaft fractures treated with intramedullary nail compressed by proximal tube. Strateg Trauma Limb Reconstr. 2016; 11: 25–29. doi: 10.1007/s11751-016-0242-x.

5. Sellei RM, Kobbe P, Dadgar A, Pfeifer R, Behrens M, von Oldenburg G, Pape HC. External fixation design evolution enhances biomechanical frame performance. Injury. 2015 Sep;46 Suppl 3:S23-6. doi: 10.1016/S0020-1383(15)30007-3. PMID: 26458295.

6. Gaebler C, Berger U, Schandelmaier P, Greitbauer M, Schauwecker HH, Applegate B, Zych G, Vécsei V. Rates and odds ratios for complications in closed and open tibial fractures treated with unreamed, small diameter tibial nails: a multicenter analysis of 467 cases. J Orthop Trauma. 2001 Aug;15(6):415-23. doi: 10.1097/00005131-200108000-00006. PMID: 11514768.

7. Boxma H, Broekhuizen T, Patka P, Oosting H. Randomised controlled trial of single-dose antibiotic prophylaxis in surgical treatment of closed fractures: the Dutch Trauma Trial. Lancet. 1996 Apr 27;347(9009):1133-7. doi: 10.1016/s0140-6736(96)90606-6. PMID: 8609746.

8. Metsemakers WJ, Handojo K, Reynders P, Sermon A, Vanderschot P, Nijs S. Individual risk factors for deep infection and compromised fracture healing after intramedullary nailing of tibial shaft fractures: a single centre experience of 480 patients. Injury. 2015 Apr;46(4):740-5. doi: 10.1016/j.injury.2014.12.018. Epub 2014 Dec 27. PMID: 25583638.

9. Coles CP, Gross M. Closed tibial shaft fractures: management and treatment complications. A review of the prospective literature. Can J Surg. 2000 Aug;43(4):256-62. PMID: 10948685; PMCID: PMC3695213.

10. Gee AO, Israelite CL. Intramedullary Nail Fixation of Tibial Shaft Fractures. G Gloved Orthop Introd to Common Proced. 2008; 8: 314–323. doi: 10.1016/B978-1-4160-4820-6.50034-0.

Citation: Kangbai DM, Clemens-Kangbai N, Smalle IO (2024) Evaluation of the treatment outcome of tibia shaft fracture by close reduction and internal fixation with interlocking intramedullary nail, Freetown, Sierra Leone, 2023. Open J Trauma 8(1): 011-020. DOI: https://dx.doi.org/10.17352/ojt.000045

11. Elniel AR, Giannoudis PV. Open fractures of the lower extremity: Current management and clinical outcomes. EFORT Open Rev. 2018; 3: 316–325. doi: 10.1302/2058-5241.3.170072.

12. Guirro P, Hinarejos P, Pelfort X, Leal-Blanquet J, Torres-Claramunt R, Puig-Verdie L. Long term follow-up of successfully treated superficial wound infections following TKA. J Arthroplasty. 2015; 30: 101-103. doi: 10.1016/j.arth.2014.08.019.

13. Dellinger EP, Miller SD, Wertz MJ, Grypma M, Droppert B, Anderson PA. Risk of infection after open fracture of the arm or leg. Arch Surg. 1988 Nov;123(11):1320-7. doi: 10.1001/archsurg.1988.01400350034004. PMID: 3178479.

14. Panagiotis M. Classification of non-union. 2005. doi: 10.1016/j.injury.2005.10.008.

15. Court-Brown CM, Christie J, McQueen MM. Closed intramedullary tibial nailing. Its use in closed and type I open fractures. J Bone Joint Surg Br. 1990 Jul;72(4):605-11. doi: 10.1302/0301-620X.72B4.2380211. PMID: 2380211.

16. Smith EJ, Kuang X, Pandarinath R. Comparing hospital outcomes between open and closed tibia fractures treated with intramedullary fixation. Injury. 2017; 48: 1609–1612.

17. Al-Sharaa MB, Hashim FW, Al-Edanni MS. Functional outcome of interlocked intramedullary nailing fixation in management of closed tibia shaft fractures. Rawal Med J. 2021; 46: 890-893.

18. International Religious Freedom, "Madagascar 2019 International Religious Freedom Report. 2019.

19. DHS. Sierra Leone Demographic and Health Survey. Africa Yearb. 2019; 16: 176–183. doi: 10.1163/9789004430013_019.

20. Galvain T, Chitnis A, Paparouni K, Tong C, Holy CE, Giannoudis PV. The economic burden of infections following intramedullary nailing for a tibial shaft fracture in England. 2020; 1-11. doi: 10.1136/bmjopen-2019-035404.

21. De Smet K, Mostert AK, De Witte J, De Brauwer V, Verdonk R. Closed intramedullary tibial nailing using the Marchetti-Vicenzi nail Its use in closed and open fractures. Injury. 2000; 31: 597–603. doi: 10.1016/S0020-1383(00)00058-9.

22. Patel DJ. Study of interlocking nail in shaft tibia fracture. Int J Orthop Sci. 2019; 5: 354–358.

23. Mahmood T, Chishti MK, Ahmad S, Rasool A, Tariq MA. Outcome of closed reduction and interlock nailing of tibial shaft fractures: TM distractor versus manual traction. Pakistan J Med Heal Sci. 2021; 15: 1121–1123. https://www.embase.com/search/results?subaction=viewrecord&id=L2011993865&from=export

Citation: Kangbai DM, Clemens-Kangbai N, Smalle IO (2024) Evaluation of the treatment outcome of tibia shaft fracture by close reduction and internal fixation with interlocking intramedullary nail, Freetown, Sierra Leone, 2023. Open J Trauma 8(1): 011-020. DOI: https://dx.doi.org/10.17352/ojt.000045