DOI: https://doi.org/10.47648/jswmc2023v13-02-73

Original Article

Relationship between Time to Surgical Debridement and Rate of Wound Infection in Open Tibia Fracture in a Tertiary Care Hospital

*Manjur M[1], Rahaman MS[2], Chowdhury TN[3], Biswas BK[4], Mahmud R[5], Islam SS[6]

Abstract:

Background: The most frequent open long bone injury requiring immediate surgical intervention is an open tibial fracture. Within 6 hours of the injury, emergent surgical debridement of an open tibia fracture is advised by current guidelines. Recently, the 6-hour rule became challenged and delaying in debridement of an open fracture may be unethical.

Methods: This cross-sectional study was carried out to assess the relationship between time of surgical debridement and rate of infection after open fracture tibia at National Institute of Traumatology and Orthopedic Rehabilitation (NITOR) on 608 patients with open fracture tibia (all Gustilo types) within 24 hours of injury from January 2018 to October 2019.

Results: The mean age of the 608 patients was 36.2±15.5 years. The foremost mechanism of injury was road traffic accident (72.0%) and among the associated injuries, concomitant soft tissue injury (32.5%) was prevalent. Gustilo III was predominant injury (72.1%) and infection rates among the Gustilo subtype II was predominant (31.3%). After debridement 73 (12.0%) patients were contamination free. A significant association was found in the contamination rate between surveillance culture and post-debridement culture (p=0.000). Positive correlation found between debridement done ≥6 hours and infection present in 3rd culture from ward (r=0.237).

Conclusion: The study insights that injury characteristics, infection pattern and infection rate of open fracture tibia. Delay in debridement has a significant relationship with wound infection, with more virulent multidrug resistance phenotypes.

Keywords: Surgical debridement, Wound infection, Tibia fracture, Bangladesh.

JSWMC 2023 [13(02)] P: 30-35

Introduction:

Since the last century, there has been much improvement in the field of treatment of open fracture, but, infection still represents one of the major complications.

Corresponding author: Mushfique Manjur,
Assistant Professor, Department of Orthopaedic Surgery, Monno Medical College Hospital, Manikganj, Dhaka 1840, Bangladesh.
Email: mushfiquemanjur7@gmail.com

1. *Mushfique Manjur, Assistant Professor, Department of Orthopaedic Surgery, Monno Medical College Hospital, Manikganj, Dhaka 1840, Bangladesh.
2. Md. Syedur Rahaman, Medical Officer, Department of Orthopaedic Surgery, National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka 1207, Bangladesh.
3. Tanvir Naz Chowdhury, Assistant Registrar, Department of Orthopaedic Surgery, National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka 1207, Bangladesh.
4. Bappy Kumer Biswas, Assistant Registrar, Department of Orthopaedic Surgery, National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka 1207, Bangladesh.
5. Reaz Mahmud, Junior Consultant, Department of Orthopaedic Surgery, Sreenagar Upazila Health Complex, Munshiganj, Dhaka 1550, Bangladesh.
6. Syed Shahidul Islam, Senior Consultant, Department of Orthopaedic Surgery, Evercare Hospital, Dhaka 1229, Bangladesh.

Break down of the tissue barrier between the fracture zone and the environment leaves the underlying bone prone to direct contact with contaminating agents, mirrored in positive wound cultures up to 60-70%.[1] Majority of open fractures usually results from high velocity trauma and commonly endangers life.[2,3] Open fracture defined as fracture having communication with the external environment with various level of soft tissue injury; and it leads contamination of the fracture site with external microorganisms and also outline of foreign bodies into the wound.[3] The microbiological pattern at the wound site is influenced by mechanism of initial trauma to a great extent. It is also conspicuous that many infections in open fractures are often nosocomial in origin. Because in several occasions causative micro-organisms found in ward sample cultures

differ from initial surveillance cultures at admission.[1,4,5] Thus, infection rates can also be positively altered by operative technique (e.g. debridement, instrumentation, fracture stabilization, irrigation etc.) as well as indoor environment of the ward.[6-8]

In a cohort study, a higher prevalence rates of nosocomial infections found in the orthopaedic settings.[9] The Gustilo and Anderson classification system is the universally accepted and routinely used fracture grading system, which was initially introduced by Gustilo and Anderson in 1976, and later modified in 1984.[10-13] The infection rate of open fractures varies with the fracture characteristic. Infection rates progressively increased from 0-2% for type-I, 2-10% for type-II, and 10-50% for type-III.[12] Fracture of the tibial shaft represents 2% of all fractures[14], and occupies 25% of all open fractures in adults.[15]

Open fractures are orthopaedic emergency and requiring urgent surgical intervention.[16-18] Healing complications and increased risk of infection are very common due to exposure of bone and soft tissue.[12,13] The basic principle of open fracture management comprises of assessment of the patient, classification of the injury, antibiotic therapy, debridement and wound management, fracture stabilization, early bone grafting, and supplemental procedures to achieve healing.[8,19]

It is considered that injury characteristics, site of fracture and time delay, each of these factors has important impact in the management of open fracture. Timely and proper surgical debridement is considered as the most important procedure in open lower limb fracture management. Appropriate irrigation after debridement is very crucial for successful management in open fracture. Prevention of infection by means of operative irrigation and debridement within 6 hours after the injury is a widely accepted standard of care.[20,21] The present study has evaluated the relationship between time of surgical debridement and rate of wound infection after open tibia fracture at a tertiary care centre.

Methods

Study design and settings

This is a cross-sectional study was commenced to assess the relationship between time of surgical debridement and rate of infection after open fracture tibia at a tertiary care hospital named National Institute of Traumatology and Orthopedic Rehabilitation (NITOR), Dhaka 1207, Bangladesh.

Sample selection

Participants were conveniently selected 608 patients with open fracture tibia (all Gustilo types) within 24 hours of injury and admitted in the hospital from January 2018 to October 2019. Patients with closed tibia fracture, open fracture tibia presented already with infection at admission, those required amputation of lower extremity at emergency theater and open fracture tibia along with open fracture elsewhere in the body were excluded from this study.

Data collection procedures

During initial resuscitation at emergency room, surveillance culture sample (from wound before prophylactic antibiotic) was collected and sent. Prophylactic antibiotics (Intravenous Flucloxacillin and 3rd generation Cephalosporin) were administered. Then patients were sent to emergency theater for wound debridement, fracture stabilization and soft tissue care. Debridement was done following current practice at NITOR using Chlorhexidine (Hexi scrub), normal saline, Hydrogen peroxide and Povidone-iodine solution. A second post debridement culture (last saline wash from the wound at emergency theater) was sent. From the theater after initial fracture stabilization, stable patients were sent to post-operative ward followed by to general ward. A third infection culture sample after admission in the ward after 7-10 days and was sent for culture sensitivity and identification of organism. A pretested semi-structured questionnaire was filled up by the investigator containing information regarding demographic variables, mechanism and time of injury, time of wound debridement (time elapsed since injury in hours), Gustilo types and subtypes of fracture characteristic along with the results of three successive culture sensitivity tests.

ISSN: 2708-2857 (P), 2710-0405 (O)
2023 July; Volume 13; Issue 02

Statistical analysis

The data were checked and cleaned followed by making a template, categorizing data, coding and recoding into IBM SPSS v23. Descriptive statistics such as mean, standard deviation and percent were computed for continuous variables of the participants. Chi-square test was used to assess the significance of associations between two nominal variables and a p-value of <0.05 at a 95% confidence interval was taken as significant. The results were presented in tables and charts.

Ethical approval

Informed written consent was obtained from each participant. Confidentiality of data was ensured and unauthorized access to data was not allowed. Ethical approval was obtained from the Institutional Review Board (IRB) of the National Institute of Traumatology and Orthopedic Rehabilitation (NITOR), Dhaka 1207, Bangladesh. (Reference: NITOR/Academy/2018/172/KA)

Results

Table 1 depicts the particulars of the patients. The mean age of the 608 patients with open fracture tibia, presented to emergency department within 24 hours was 36.2±15.5 years and more than half (54.5%) of them were in the age group 21-40 years. Male patients (90.0%) were predominant among the attending patients.

Table 1: Particulars of the patients (n=608)

	Frequency	Percent
Age (years)		
<20	84	13.9
20-40	331	54.5
41-60	147	24.2
>60	46	7.5
Mean± SD		36.2±15.5
Gender		
Male	547	90.0
Female	61	10.0

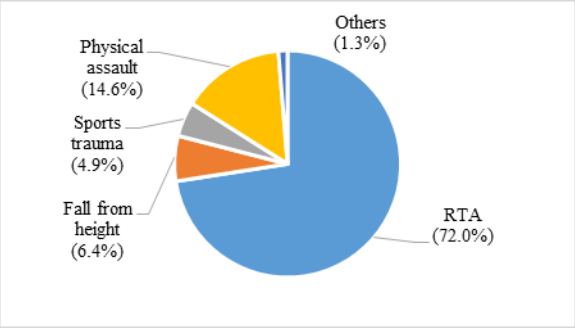

Figure 1: Mechanism of injuries (n=608)

Figure 1 shows foremost mechanism of injury was road traffic accident (72.0%) followed by physical assault (14.6%), sports trauma (4.9%), fall from height (6.4%) and others (1.3%). Figure 2 illustrates demonstrates that among the associated injuries concomitant soft tissue injury (32.5%) was prevalent.

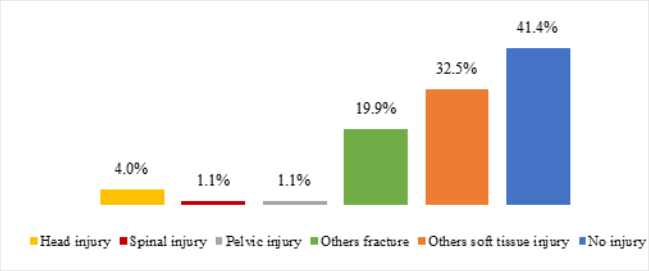

Figure 2: Associated other injuries (n=608)

Table 2: Injury characteristics and infection rate according to Gustilo classification (n=608)

Variables	n(%)
Type of fracture	
Gustilo I	24(4.1)
Gustilo II	145(23.8)
Gustilo III	438(72.1)
Infection rate	
Gustilo I	86(14.1)
Gustilo II	190(31.3)
Gustilo IIIA	163(26.8)
Gustilo IIIB	147(24.2)
Gustilo IIIC	22(3.6)

Table 2 demonstrations that Gustilo III was predominant injury (72.1%) and infection rates among the Gustilo subtype II was predominant (31.3%). Table 3 interprets a positive surveillance culture 232 (38.2%) patients at admission. Contamination rate decreased to

26.2% after debridement. After debridement 73 (12.0%) patients were contamination free. A significant association was found in the contamination rate between surveillance culture and post-debridement culture (p=0.000).

Table 3: Contamination present on surveillance culture and post-debridement culture (n=608)

Culture		Post-debridement culture			χ2 value	p-value
		Present	Absent	Total		
		n(%)	n(%)	n(%)		
Surveillance culture	Present	232(38.2)	376(61.8)	608(100)	194.1	*0.000
	Absent	159(26.2)	449(73.8)	608(100)		

Table 4: Effects of debridement time on infection (n=160)

Debridement time	Infection
Injury to debridement time <6 hours	37(23.1)
Injury to debridement time ≥6 hours	123(76.9)

Table 4 indications that infection rate was more in patients who had debridement in more than 6 hours (76.88%). Table 5 demonstrates that a significant positive correlation found between debridement done ≥6 hours and infection present in 3rd culture from ward (r = 0.237).

Table 5: Correlation between debridement done in ≥6 hours and infection present in 3rd culture from ward

Correlation		Infection present in 3rd culture from ward
Debridement done in ≥6 hours	Pearson Correlation	0.237
	Sig. (2-tailed)	0 .000

*Pearson correlation test

Discussion

Open fractures are often considered as orthopaedic emergencies. Debridement is recommended within the first six hours, however the exact time frame is unclear.[22]

In this study, the mean age of the patient was 36.2±15.5 years and more than half (54.5%) of them were in the age group 21-40 years. A study on tibia fracture, found mean age 38.4±14.5 years.[15] In the study on open tibia fracture, mean age was found 34.0 years in NITOR, Bangladesh[23] and 36±12.6 years in Brazil.[24] These study results are similar to this study.

The foremost mechanism of injury was road traffic accident (72.0%) followed by physical assault (14.6%), sports trauma (4.9%), fall from height (6.4%) and others (1.3%). A study on 389 cases found road traffic accidents as the most common causes (62%) of fractures.[25] In Finland road traffic accident was found as the second most common injury mechanism.[14] Among the associated injuries concomitant soft tissue injury (32.5%) was prevalent. A large scale study reported ankle, ribs/sternum and spine are the three most common accompanying injuries.[26] These may be due to variation of social structure and custom of using the vehicles as both cases motor vehicle accidents are predominant cause.

In the current study, Gustilo III was predominant injury (72.1%) and infection rates among the Gustilo subtype II was predominant (31.3%). A positive surveillance culture 38.2% patients at admission. Contamination rate decreased to 26.2% after debridement. After debridement 12.0% patients were contamination free. A significant association was found in the contamination rate between surveillance culture and post-debridement culture (p=0.000). A study conducted at Hospital de Pronto Socorro de Canoas found similar type of finding with highest (72.0%) infection rate in Gustilo type III fracture.[24] A Spanish study in the year 2013 reported infection rate highest in Gustilo type III fractures. This finding is similar to our study but they differ in infection rate of subtypes where they found Gustilo type IIIA having the highest rate.[27]

In this study, the infection rate was more in patients who had debridement in more than 6 hours (76.88%). A significant positive correlation found between debridement done ≥6 hours and infection present in 3rd culture from ward (r=0.237). A retrospective study on consecutive open tibia fracture, 62 patients were taken to theatre for surgical debridement within 6 hours and 41 after 6 hours.[28] The infection rate was more in patients who had debridement in

more than 6 hours (76.88%) than less than 6 hours (23.12%). So, delay in debridement time is a very influential contributing factor for infection. A prospective study suggested that open long-bone fractures should be treated with debridement and fixation within 6 hours of injury.[19] Every hour of delay to debridement is associated with a small, added increase in the likelihood of infection. So, all these studies emphasize on early surgical debridement.

Conclusion

A potential risk factor for infection in an open tibia fracture is a delay in the debridement process. There should be no purposeful delay in addressing this, and every effort should be made to do so. According to this study, there is a strong positive link between infection and the amount of time from the injury before debridement. It is essential to transport quickly to a trauma hospital and finish performing CPR quickly.

Acknowledgments: The authors are thankful to all the participants and hospital authorities for their heartfelt cooperation.

Competing interests: All the authors declared no competing interest.

Funding: This study did not receive any grants.

References:

1. Neubauer T, Bayer GS, Wagner M. Open fractures and infection. Acta Chirurgiae Orthopaedicae et Traumatologiae Cechoslovaca. 2006;73(5):301-12.
2. Court-Brown CM, Bugler KE, Clement ND, Duckworth AD, McQueen MM. The epidemiology of open fractures in adults. A 15-year review. Injury. 2012;43(6):891-7.
3. Zalavras CG. Prevention of infection in open fractures. Infectious Disease Clinics. 2017;31(2):339-52.
4. Merritt K. Factors increasing the risk of infection in patients with open fractures. Journal of Trauma and Acute Care Surgery. 1988;28(6):823-7.
5. Lee J. Efficacy of cultures in the management of open fractures. Clinical Orthopaedics and Related Research (1976-2007). 1997;339:71-5.
6. Al-Mulhim FA, Baragbah MA, Sadat-Ali M, Alomran AS, Azam MQ. Prevalence of surgical site infection in orthopedic surgery: a 5-year analysis. International Surgery. 2014;99(3):264-8.
7. Malhotra AK, Goldberg S, Graham J, Malhotra NR, Willis MC, Mounasamy V, Guilford K, Duane TM, Aboutanos MB, Mayglothling J, Ivatury RR. Open extremity fractures: impact of delay in operative debridement and irrigation. Journal of Trauma and Acute Care Surgery. 2014;76(5):1201-7.
8. Fernandes MD, Peres LR, Queiroz Neto AC, Lima Neto JQ, Turíbio FM, Matsumoto MH. Open fractures and the incidence of infection in the surgical debridement 6 hours after trauma. Acta Ortopedica Brasileira. 2015;23:38-42.
9. Maksimovic J, Markovic-Denic L, Bumbaširevic M, Marinkovic J, Vlajinac H. Surgical site infections in orthopedic patients: prospective cohort study. Croatian Medical Journal. 2008;49(1):58-65.
10. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: Retrospective and prospective analyses. The Journal of Bone and Joint Surgery. 2002;84(4):682.
11. Gustilo RB, Mendoza RM, Williams DN. Problems in the management of type III (severe) open fractures: a new classification of type III open fractures. The Journal of Trauma. 1984;24(8):742-6.
12. Zalavras CG, Marcus RE, Levin LS, Patzakis MJ. Management of open fractures and subsequent complications. The Journal of Bone and Joint Surgery. 2007;89(4):884-95.
13. Kim PH, Leopold SS. 2012. In brief: Gustilo-Anderson classification. Clinical Orthopaedics and Related Research. 2012;470(11):3270-4.
14. Laurila J, Huttunen TT, Kannus P, Kaariainen M, Mattila VM. Tibial shaft fractures in Finland between 1997 and 2014. Injury. 2019;50(4):973-7.
15. Lua JY, Tan VH, Sivasubramanian H, Kwek EB. Complications of open tibial fracture management: risk factors and

treatment. Malaysian Orthopaedic Journal. 2017;11(1):18-22.
16. Pollak AN, Jones AL, Castillo RC, Bosse MJ, MacKenzie EJ, LEAP Study Group. The relationship between time to surgical debridement and incidence of infection after open high-energy lower extremity trauma. The Journal of Bone and Joint Surgery. 2010;92(1):7-15.
17. Schenker ML, Yannascoli S, Baldwin KD, Ahn J, Mehta S. Does Timing to operative debridement affect infectious complications in open long-bone fractures?: a systematic review. The Journal of Bone and Joint Surgery. 2012;94(12):1057-64.
18. Zhou C, Chen X, Wu L, Qu J. Distribution of drug-resistant bacteria and rational use of clinical antimicrobial agents. Experimental and Therapeutic Medicine. 2016;11(6):2229-32.
19. Spencer J, Smith A, Woods D. The effect of time delay on infection in open long-bone fractures: a 5-year prospective audit from a district general hospital. Annals of the Royal College of Surgeons of England. 2004;86(2):108-12.
20. Rodriguez L, Jung HS, Goulet JA, Cicalo A, Machado-Aranda DA, Napolitano LM. Evidence-based protocol for prophylactic antibiotics in open fractures: improved antibiotic stewardship with no increase in infection rates. Journal of Trauma and Acute Care Surgery. 2014;77(3):400-8
21. Otchwemah R, Grams V, Tjardes T, Shafizadeh S, Bäthis H, Maegele M, Messler S, Bouillon B, Probst C. Bacterial contamination of open fractures–pathogens, antibiotic resistances and therapeutic regimes in four hospitals of the trauma network Cologne, Germany. Injury. 2015;46:S104-8.
22. Sikka R, Mann JK, Vashist MG, Chaudhary U, Deep A. Prevalence and antibiotic sensitivity pattern of bacteria isolated from nosocomial infections in orthopaedic patients. Journal of Orthopaedics. 2010;7(2):3.
23. Ali A, Rahman M, Faruquee SR, Islam T, Rahim ZZ, Yusuf A. Treatment of open fracture of shaft of tibia-fibula Gustilo type III-B by SIGN interlocking nail and wound coverage by muscle flap within 72 hours of injury. International Journal of Research in Orthopaedics. 2017;3(5):898-903.
24. Guerra MT, Gregio FM, Bernardi A, Castro CC. Infection rate in adult patients with open fractures treated at the emergency hospital and at the ULBRA university hospital in Canoas, Rio Grande do Sul, Brazil. Revista Brasileira de Ortopedia. 2017;52:544-8.
25. Konbaz FM, Alassiri SS, Al Eissa SI, Taha WS, Al Helal FH, Al Jehani RM. Does delay in surgical debridement increase the risk of infection in open tibia fractures in Saudi patients? A retrospective cohort study. Journal of Clinical Orthopaedics and Trauma. 2019;10(2):305-9.
26. Anandasivam NS, Russo GS, Swallow MS, Basques BA, Samuel AM, Ondeck NT, Chung SH, Fischer JM, Bohl DD, Grauer JN. Tibial shaft fracture: a large-scale study defining the injured population and associated injuries. Journal of Clinical Orthopaedics and Trauma. 2017;8(3):225-31.
27. Almeida Matos M, Catro-Filho RN, Pinto da Silva BV. Risk factors associated with infection in tibial open fractures. Revista Facultad de Ciencias Medicas. 2013;70(1):14-18.
28. Kamat AS. 2011. Infection Rates in Open Fractures of the Tibia: Is the 6-Hour Rule Fact or Fiction?. Advances in Orthopedics. 2011:1-4.