



Rate of Infection in Open Fracture of Long Bones with Delayed Debridement

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ABSTRACT

Background

The spectrum of open fracture ranges from small puncture wounds to extensive soft tissue injuries, periosteal stripping, and comminution of bone. Traditionally, timing of surgical debridement has been within 6 hours of injury often referred as “6-hour rule”. Though there is consensus on early debridement, there are various reasons for delay in surgical debridement, particularly in developing countries. This study aimed to assess the rate of infection in open fractures of long bones with delayed debridement.

Methods

This was observational study of retrospective data of 76 open fractures of long bones in adults. Data from all the patients with open fractures of long bones admitted and managed with delayed debridement (>6 hours) in between August 2018-January 2023 were collected and analyzed. Descriptive statistics was used to calculate frequency and percentage. Rate of infection in open fracture with delayed debridement was the main outcome assessed.

Results

The mean time of injury to surgical debridement was 28.18 hours (range 8-120, SD±24.61). Overall infection rate in open fractures with delayed debridement was 18.42% (n=14). The rate of infection in Gustilo Anderson grade I, II and III open fracture was 12.5% (n=2), 13.15% (n=5) and 31.81% (n=7) respectively.

Conclusions

The present study revealed a higher rate of infection associated with delayed debridement. Despite unique logistical challenges encountered in developing countries, the timely debridement by experienced surgeon may contribute to reduction in infection rate in open fractures.

Keywords: delayed debridement; rate of infection; open fracture.

INTRODUCTION

Spectrum of open fracture ranges from small puncture wounds to extensive soft tissue injuries, periosteal stripping, and comminution of bone.¹ Open fractures pose a risk of infection due to contamination and extensive soft tissue injury.² Infection rate range from 5-50%.³ Hence, timely management is crucial to minimize infection. Traditionally, timing of surgical debridement has been within 6 hours of injury often referred to as “6-hour rule”.⁴ Though there is consensus of early debridement, there are various reasons for delay in surgical debridement.^{1,5} Delays can occur

due to transfer of patient, case overload, polytrauma injuries, unavailability of staffs 24/7, and comorbidities of patient.⁶ Recent studies have challenged the concept of conventional 6-hour rule suggesting that the timing of surgical debridement may not be the sole determinant of infection risk.⁶⁻⁹ So, this study aimed to assess the rate of infection in open fractures of long bones with delayed debridement.

METHODS

This was retrospective observational study of conducted among 76 open fractures of long bones conducted

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at College of Medical Sciences and Teaching Hospital after approval from Institutional Review Committee (IRC No. COMSTH- IRC/2023-69). Inclusion criteria was all open fractures classified as Gustilo Anderson (GA) I, II, IIIA, IIIB of long bones of upper and lower limbs in patients with age >16 years, admitted and managed in between August 2018 to January 2023. Exclusion Criteria were hand and foot open fractures, open GA IIIC fractures, debridement done within 6 hours of trauma, primary debridement carried out at other center, unsalvageable limbs requiring urgent amputation and pediatric fracture aged <16 years. All patients with open fracture received intravenous antibiotics injection cefuroxime 750 mg and tetanus prophylaxis in Emergency room at the time of arrival. Injection gentamycin was added in open fracture GA III. Debridement was performed as soon as possible following the standard surgical protocol. Patients were examined clinically and hematological and microbiological investigations were collected to ascertain evidence of infection during in-patient stay and OPD follow up till 6 weeks of index operation. Infection was established by clinical criteria and laboratory value. Clinical criteria were oozing out of pus or serous fluid from the wound with local signs of inflammation, spontaneous and deep wound dehiscence with a fever of more than 38 degree Celsius or oozing of frank pus.¹⁰ Clinical criteria was supported by laboratory value of raised Erythrocyte Sedimentation Rate (ESR), C-Reactive Protein (CRP) and growth of organism in the culture of the sample taken from pus, swab, fluid or tissue.⁷ Demographic data, clinical characteristics of fractures and peri and post-operative details were collected from case chart. Follow up data, along with additional clinical and laboratory markers of infection were collected from Outpatient department (OPD) follow-up records. All the clinical and laboratory data were entered into the Excel master chart. SPSS 20 software were used for data analysis. Descriptive statistics was used for the analysis. Frequency and percentage were calculated for the categorical variables and mean, median, standard deviation, and range were calculated for the continuous variables as applicable.

RESULTS

There were total of 76 open fractures of long bones in this study. Mean age of patient was 35.47 years (range 17-70) with male 84.21% (n=64) and female 15.79% (n=12). Distribution of open fractures according to GA grading and location is presented in Table 1.

Table 1. Distribution of open fracture according to GA grading and location.	
Grading	Frequency (%)
GAI	16 (21.05)
GAI	38 (50.0)
GAI	22(28.94)
Bones	
Tibia	48 (63.15)
Femur	18 (23.68)
Fibula	2(2.63)
Radius	3 (3.94)
Ulna	5(6.57)

The mean time of injury to surgical debridement was 28.18 hours (range 8-120, SD±24.61). Overall infection rate was 18.42% (n=14). Infection was seen in tibia open fractures (n=10) and femur open fractures (n=4). Distribution of infection in open fractures according to GA grading is presented in Table 2. Infection was common in GA III followed by GAI.

Table 2. Distribution of infection in open fractures according to GA grading.	
GA grading	Frequency (%)
I	2(12.5)
II	5(13.15)
III	7(31.81)

Among infective cases, pseudomonas aeruginosa was the most common isolated organism (Table 3).

Table 3. Distribution of causative organism among infective cases.	
Organism isolated	Frequency (%)
Culture negative	4 (28.57)
Culture Positive	10 (71.42)
Pseudomonas Aeruginosa	8 (57.14)
Enterobacteria	2 (14.28)

DISCUSSION

The overall rate of infection in open fractures of long bones with delayed treatment was higher in the present study. The experimental study in guinea pig conducted by Friedrich in 19th century was established as benchmark for surgical debridement

within 6 hours of injury.⁴ It is important to note that this guideline of 6-hour rule was established before the advent of modern antibiotics.¹¹ Subsequent to Friedrich work, numerous studies have emerged challenging the correlation between timing of debridement and infection in open fractures.⁷⁻⁹ The mean age of patient and male predominance in this study were comparable to that of other studies.^{1, 6, 9, 12} Tibia fracture was the common fracture in the current study which is similar to the findings of study done by Hull et al.¹³ The open tibia fracture was the most commonly infected bone in the present study. Overall rate of infection was relatively higher in our study in comparison to other studies. Fernandes et al found 13.24% of infection rate in long bone open fractures with delayed debridement.⁷ Heckman et al reported infection rate of 13.3%, 17.2% and 9.1% in open tibia fractures with debridement done in <24 hours, 24-48 hours and >48 hours respectively.⁶ Hull et al found 10% of infection rate with delayed debridement.¹³ Kamat et al reported infection rate of 12.1% in open tibia fractures with delayed debridement.¹⁴ Harley et al reported infection rate of 8.8% in open fractures of long bones with mean time to surgical debridement of 8.25 hours.¹⁵ Dellinger et al reported infection rate of 16% in open fractures of arm and leg with delayed debridement.¹⁶ Ashford et al reported infection rate of 17% in open tibia fractures with delayed debridement.¹⁷ Spencer et al reported infection rate of 10.8% in open long bone fractures with delayed debridement.¹⁸ The higher infection rate in this study could probably be due to debridement carried out by residents and junior consultants in most of the cases. Highest percentage of infection was found in GA

III followed by GA II and GA I, a similar trend to other studies.^{1, 8, 13} Tahir et al found infection rate of 9.7%, 19.3% and 28.4% in GA I, GA II and GA III in open fractures debrided in between 49-72 hours.¹ Li et al reported infection rate of 8.3%, 7.1% and 20% in GA I, II and III in fractures debrided in between 12-24 hour.⁸ Similarly, they reported infection rate of 0%, 8.3% and 33.3% in GA I, II and III open fractures respectively debrided after 24 hours. Hull et al reported infection rate of 0%, 6.9% and 10% in open fractures GA I, II and III respectively.¹³

Pseudomonas aeruginosa was most common organism isolated in our study similar to study done by Nobert et al.¹⁹ In contrast to our study, khatod et al reported staphylococcus as main causative organism of infection.²⁰ Dellinger et al reported streptococcus viridans followed by staphylococcus aureus as main causative organism of infection.¹⁶

CONCLUSIONS

The present study revealed a higher rate of infection associated with delayed debridement. Despite unique logistical challenges encountered in developing countries, the timely debridement by experienced surgeon may contribute to reduction in infection rate in open fractures. A multicenter prospective study with comparison group is recommended to substantiate our findings.

Limitations

This study was a retrospective in nature, relatively smaller sample size and no comparison group, so the finding of this study can not be generalized.

Conflict of interest: None

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REFERENCES

1. Tahir M, Ahmed N, Shaikh SA, Jamali AR, Choudry UK, Khan S. Delay in Initial Debridement for Open Tibial Fractures and Its Possible Impact on Patient Outcomes: A Single-Center Prospective Cohort Study. *JB JS Open Access*. 2021;6(1). [DOI]
2. Elnewishy A. An Updated Evidence About the Role of Timing to Debridement on Infection Rate of Open Tibial Fractures: A Meta-Analysis. *Cureus*. 2020;12(9):e10379.[DOI]
3. Singh J, Rambani R, Hashim Z, Raman R, Sharma HK. The relationship between time to surgical debridement and incidence of infection in grade III open fractures. *Strategies in Trauma and Limb Reconstruction*. 2012;7(1):33-7. [DOI]
4. Crowley DJ, Kanakaris NK, Giannoudis PV. Debridement and wound closure of open fractures: the impact of the time factor on

- infection rates. *Injury*. 2007;38(8):879-89. [DOI]
5. Spiegel DA, Gosselin RA, Coughlin RR, Joshipura M, Browner BD, Dormans JP. The burden of musculoskeletal injury in low and middle-income countries: challenges and opportunities. *J Bone Joint Surg Am*. 2008;90(4):915-23. [DOI]
 6. Heckmann ND, Davis JA, Mombell KW, Bradley A, Chung BC, Husak L, et al. Delayed debridement of open tibia fractures beyond 24 and 48 h does not appear to increase infection and reoperation risk. *European Journal of Orthopaedic Surgery & Traumatology*. 2021;32:953 - 8. [DOI]
 7. Fernandes Mde C, Peres LR, de Queiroz AC, Jr., Lima JQ, Jr., Turíbio FM, Matsumoto MH. Open fractures and the incidence of infection in the surgical debridement 6 hours after trauma. *Acta Ortop Bras*. 2015;23(1):38-42. [DOI]
 8. Li J, Wang Q, Lu Y, Feng Q, He X, Li M, Zhong, et al. Relationship Between Time to Surgical Debridement and the Incidence of Infection in Patients with Open Tibial Fractures. *Orthopaedic Surgery*. 2020;12(2):524-32. [DOI]
 9. Srour M, Inaba K, Okoye O, Chan C, Skiada D, Schnüriger B, et al. Prospective Evaluation of Treatment of Open Fractures: Effect of Time to Irrigation and Debridement. *JAMA Surgery*. 2015;150(4):332-6. [DOI]
 10. Alidou T, Mbende A, Niaoré S, Christelle M-A, Daouda S, Rebecca B, et al. Intramedullary Nailing of Type I and Type II Open Leg Fractures after 6 Hours at Yopougon Teaching Hospital. *Open Journal of Orthopedics*. 2016;06:227-33. [DOI]
 11. Werner CM, Pierpont Y, Pollak AN. The urgency of surgical débridement in the management of open fractures. *J Am Acad Orthop Surg*. 2008;16(7):369-75. [DOI]
 12. Joseph CM, Jpegnanam TS, Ramasamy B, Cherian VM, Nithyananth M, Sudarsanam TD, et al. Time to debridement in open high-grade lower limb fractures and its effect on union and infections: A prospective study in a tropical setting. *Journal of Orthopaedic Surgery*. 2020;28(1):2309499020907558. [DOI]
 13. Hull PD, Johnson SC, Stephen DJG, Kreder HJ, Jenkinson RJ. Delayed debridement of severe open fractures is associated with a higher rate of deep infection. *The Bone & Joint Journal*. 2014;96-B(3):379-84.[DOI]
 14. Kamat AS. Infection Rates in Open Fractures of the Tibia: Is the 6-Hour Rule Fact or Fiction? *Advances in Orthopedics*. 2011;2011:943495. [DOI]
 15. Harley BJ, Beaupre LA, Jones CA, Dulai SK, Weber DW. The Effect of Time to Definitive Treatment on the Rate of Nonunion and Infection in Open Fractures. *Journal of Orthopaedic Trauma*. 2002;16(7):484-90. [DOI]
 16. 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;123(11):1320-7. [DOI]
 17. Ashford RU, Mehta JA, Cripps R. Delayed presentation is no barrier to satisfactory outcome in the management of open tibial fractures. *Injury*. 2004;35(4):411-6. [DOI]
 18. 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. *Ann R Coll Surg Engl*. 2004;86(2):108-12. [DOI]
 19. Nobert N, Moremi N, Seni J, Dass RM, Ngayomela IH, Mshana SE, et al. The effect of early versus delayed surgical debridement on the outcome of open long bone fractures at Bugando Medical Centre, Mwanza, Tanzania. *J Trauma Manag Outcomes*. 2016;10:6. [DOI]
 20. Khatod M, Botte MJ, Hoyt DB, Meyer RS, Smith JM, Akeson WH. Outcomes in open tibia fractures: relationship between delay in treatment and infection. *J Trauma*. 2003;55(5):949-54. [DOI]

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