

Postoperative Infection Following Open Reduction and Internal Fixation of Fractures: Risk Factors and Outcomes

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ABSTRACT

Background: Postoperative surgical site infections after ORIF of fractures cause high patient morbidity, prolonged hospital stays, and complications related to implants and recovery. The study aimed to identify the prevalence, trend, and risk factors of postoperative infections after ORIF of fractures in a tertiary care centre in Bangladesh. **Methods & Materials:** This prospective observational study was carried out at the 250 Bedded District Hospital- Kurigram, Bangladesh, between February 2024 and January 2025. Patients with closed or open fractures treated with ORIF were recruited. Cases that had active infection before, had undergone antibiotic treatment within 48 hours or had a follow-up of less than 6 weeks were excluded. Postoperative SSIs were defined per CDC criteria. Data were entered and analysed using SPSS version 26. **Findings:** The mean age of the participants was 39.8 ± 12.1 years, and a male majority (70%). Infection after surgery was experienced by 23.3% patients, with 64.3% and 35.7% having superficial and deep SSIs, respectively. The most common isolate was *Staphylococcus aureus* (42.9%). The major risk factors were diabetes mellitus ($p=0.019$), open fracture ($p=0.018$), and operation time longer than 120 minutes ($p=0.041$). Infected patients had significantly longer hospital stays (14.8 ± 5.2 vs. 8.1 ± 2.9 days; $p<0.001$), higher rates of delayed wound healing (71.4% vs. 13.0%; $p<0.001$), and poorer functional outcomes (50% vs. 13%; $p=0.006$). **Conclusion:** Postoperative infection after ORIF has serious outcomes. Modifiable risk factors include diabetes mellitus, open fractures, and prolonged operative time. Appropriate perioperative measures are needed to reduce surgical site infections and improve surgical outcomes.

Keywords: Open reduction and internal fixation, Surgical site infection, Postoperative infection, Risk factors.

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INTRODUCTION

Surgical management of fractures is a major orthopaedic burden in most countries across the globe, especially in low- and middle-income nations where road traffic injuries and work-related injuries are still common [1]. Open reduction and internal fixation (ORIF) is a long-standing method of treating displaced, unstable, or intra-articular fractures, which allows anatomical reduction and fixation that allows early mobilisation and functional recovery [2]. Nevertheless, even with the improvement of surgical practice, implant design, and perioperative care, postoperative infections are a clinically important and potentially devastating complication of ORIF [3]. Post-fracture fixation surgical site infections (SSIs) are linked to extended hospitalisation, high healthcare expenses, implant failure, non-union, osteomyelitis, and in extreme situations, amputation or death [4]. The study on the reported incidence of SSIs after ORIF is quite diverse, with the incidence ranging between 1% and 30%, depending on the type of fracture, comorbidities of the patient, surgical procedure, and the quality of perioperative care [5]. Open fractures, specifically, are associated with a significantly increased risk of infection because of contamination of the wound,

devitalized soft tissue, and impaired vascularity [6]. Several patient and surgical risk factors have been found to predispose to postoperative infections following ORIF. One of the most consistently involved systemic factors is diabetes mellitus, which compromises immune responses, microvascular circulation, and wound healing [7]. Obesity, smoking, long operative time, late surgical intervention, insufficient antibiotic prophylaxis, and use of some types of implants are other known risk factors [8]. The causative organism spectrum has also changed over time, with methicillin-resistant *Staphylococcus aureus* (MRSA) and gram-negative pathogens becoming more and more prominent in hospital-acquired SSIs [3]. In Bangladesh, like in most developing nations, the fracture burden is further complicated by late referral to tertiary care, poor nutritional status, and inadequate access to formal perioperative guidelines [9]. Although this is the background, local data that investigates the incidence, bacteriological profile, and risk factor pattern of postoperative infections following ORIF in this population, in particular, is lacking. The local epidemiology is crucial to understanding the context-specific infection control measures and clinical guidelines [10]. The aim of this study was therefore to

establish the frequency, pattern, and risk factors of postoperative infections after ORIF of fractures to assess their effects on clinical outcomes such as hospital stay, wound healing, and functional status.

METHODS & MATERIALS

This prospective observational study was carried out at 250 Bedded District Hospital- Kurigram, Bangladesh, between February 2024 and January 2025. Patients who underwent ORIF for closed or open fractures of any long bone during the study period and gave written informed consent were included in the study. There was a minimum of 6 weeks of postoperative follow-up. Patients with pre-existing active infection at or near the surgical site, those who had received systemic antibiotic therapy within 48 hours before surgery for any reason, patients with pathological fractures, immunocompromised patients on immunosuppressive therapy, and those lost to follow-up within 6 weeks were excluded from the study. The sampling method was consecutive, and 60 patients who fit the eligibility criteria were recruited for this study. A structured questionnaire was used to collect data. Sociodemographic factors such as age, sex, residence, occupation, and monthly family income were noted. Clinical variables were BMI, comorbidities

(diabetes mellitus, hypertension, smoking history, anaemia), mechanism of injury, fracture type (open or closed), time interval between injury and surgery, duration of operation, anaesthesia type, implant used, preoperative hospital stay, antibiotic prophylaxis use within one hour of surgery, and postoperative drain use. The definition and classification of postoperative surgical site infections were based on the Centres for Disease Control and Prevention (CDC) criteria as superficial SSI (involving skin and subcutaneous tissue) and deep SSI (involving deep soft tissue). Infected sites were swabbed with wound swabs and

cultured and sensitised. Clinical outcomes measured were postoperative hospital stay, wound healing status, secondary procedures (debridement or reoperation), implant status, fracture healing, and functional outcome at follow-up. All data were input and analysed in SPSS version 26.0. Frequencies, percentages, and mean SD were used to describe the statistics. The chi-square test was used to determine associations between categorical risk factors and postoperative infection status. A p-value of <0.05 was considered statistically significant.

RESULTS

Table I represents the socio-demographic characteristics of the study population. The mean age was 39.8 ± 12.1 years, with the 31-40 years age group being most prevalent (30%). The majority of patients were males (70%), and the majority of patients lived in rural regions (63.3%). The most common occupational group (35%) was farmers and manual labourers. In terms of income, 40.0% of the participants indicated that their family income was BDT 15,000-30,000 per month, which is a low-to-middle income group.

Table I
Socio-demographic Characteristics of the Study Participants, n=60.

Category	Variable	Frequency (n)	Percentage (%)
Age group (years)	18-30	16	26.7
	31-40	18	30.0
	41-50	14	23.3
	51-60	8	13.3
	>60	4	6.7
	Mean age	39.8 ± 12.1	-
Sex	Male	42	70.0
	Female	18	30.0
Residence	Urban	22	36.7
	Rural	38	63.3
Occupation	Service holder	11	18.3
	Business	10	16.7
	Farmer/manual labourer	21	35.0
	Homemaker	12	20.0
	Student	6	10.0
Monthly family income (BDT)	<15,000	15	25.0
	15,000-30,000	24	40.0
	>30,000	21	35.0

The clinical and fracture-related profile is described in Table II. The proportion of participants with normal BMI was 46.7%, overweight 36.7%, and obese 16.7%. The

prevalence of diabetes mellitus was 26.7%, and the smoking history was 31.7%. The most common mechanism of injury was road traffic accidents (48.3%), then falls

(35%). These results indicate a population that has several possible risk modifiers of postoperative infection.

Table II
Baseline Clinical and Fracture-related Characteristics.

Category	Variable	Frequency (n)	Percentage (%)
BMI (kg/m²)	Normal (18.5-24.9)	28	46.7
	Overweight (25.0-29.9)	22	36.7
	Obese (≥30)	10	16.7
Comorbidities	Diabetes mellitus	16	26.7
	Hypertension	14	23.3
	Smoking history	19	31.7
	Anemia (Hb <10 g/dL)	13	21.7
Mechanism of injury	Road traffic accident	29	48.3
	Fall from height/ground	21	35.0
	Assault/others	10	16.7

Table III is a summary of the perioperative and surgical characteristics. The majority of patients were operated on within 4-7 days of injury (40%), and the duration of operation was 90-120 minutes in 41.7% of cases. 60%

of the procedures were performed under general anaesthesia, and the most frequent implant was plate and screws (51.7%). It is important to note that 90% of patients were given proper antibiotic prophylaxis within

one hour of surgery, which is good compliance with infection prevention measures.

Table III
Perioperative and Surgical Profile of the Study Participants.

Category	Variable	Frequency (n)	Percentage (%)
Time from injury to surgery	≤3 days	20	33.3
	4-7 days	24	40.0
	>7 days	16	26.7
Duration of operation	<90 minutes	17	28.3
	90-120 minutes	25	41.7
	>120 minutes	18	30.0
Type of anesthesia	General anesthesia	36	60.0
	Regional anesthesia	24	40.0
Implant used	Plate and screws	31	51.7
	Intramedullary nail	16	26.7
	K-wire/tension band	8	13.3
	External fixator converted to ORIF	5	8.3
Preoperative hospital stays	≤3 days	26	43.3
	4-7 days	21	35.0
	>7 days	13	21.7
Antibiotic prophylaxis within 1 hour before surgery	Yes	54	90.0
	No	6	10.0
Postoperative drain use	Yes	18	30.0
	No	42	70.0

The frequency of infection and microbiological profile are represented in Table IV. Infection after surgery was identified in 14 out of 60 patients (23.3%),

and superficial SSIs were the most common (64.3%). Most of the infections were diagnosed in the first four weeks. The most commonly isolated organism was

Staphylococcus aureus (42.9%), which highlights its ongoing importance as a leading pathogen in orthopaedic surgical site infections.

Table IV
Frequency and Pattern of Postoperative Infection Following ORIF.

Category	Variable	Frequency (n)	Percentage (%)
Postoperative infection status	Infection present	14	23.3
	No infection	46	76.7
Type of infection (n=14)	Superficial surgical site infection	9	64.3
	Deep surgical site infection	5	35.7
Time of diagnosis (n=14)	Within 2 weeks	6	42.9
	2-4 weeks	5	35.7
	>4 weeks	3	21.4
Organism isolated (n=14)	Staphylococcus aureus	6	42.9
	Pseudomonas aeruginosa	3	21.4
	Escherichia coli	2	14.3
	Mixed growth/no growth	3	21.4

Table V shows the comparison of clinical outcomes in infected and non-infected patients. The mean hospital stays (14.8 ± 5.2 vs. 8.1 ± 2.9 days; $p < 0.001$), delayed wound healing (71.4% vs. 13.0%; $p = 0.001$), and

secondary procedures (debridement or reoperation) were significantly longer and more frequent in patients with postoperative infection (42.9% vs. 4.3%). The incidence of poor functional outcomes was also much

higher in the infected group (50.0% vs. 13.0%; $p = 0.006$), which underscores the significant clinical consequences of postoperative infection.

Table V
Clinical Outcomes According to Infection Status.

Category	Variable	Infection present, n=14	No infection, n=46	p-value
Hospital stays after surgery	Mean $\pm$ SD, days	14.8 ± 5.2	8.1 ± 2.9	<0.001
Wound healing status	Delayed wound healing, n (%)	10 (71.4)	6 (13.0)	<0.001
Secondary procedure	Needed debridement/reoperation, n (%)	6 (42.9)	2 (4.3)	0.001
Implant status	Implant failure/loosening, n (%)	3 (21.4)	1 (2.2)	0.020
Fracture healing	Delayed union/non-union, n (%)	5 (35.7)	4 (8.7)	0.018
Functional outcome at follow-up	Poor outcome, n (%)	7 (50.0)	6 (13.0)	0.006

Table VI demonstrated the relationship between the risk factors of choice and postoperative infection. Statistically significant relationships were found between diabetes mellitus ($p = 0.019$), open

fracture ($p = 0.018$), and operation time longer than 120 minutes ($p = 0.041$) and the occurrence of postoperative SSI. Conversely, smoking history ($p = 0.124$), delay of surgery beyond 7 days ($p = 0.213$)

and obesity ($p = 0.274$) were not statistically significant in this sample, but they are clinically plausible contributory factors.

Table VI
Association of Selected Risk Factors with Postoperative Infection Following ORIF.

Category	Variable	Infection present, n=14	No infection, n=46	p-value
Diabetes mellitus	Yes	6	10	0.019
	No	8	36	
Open fracture	Yes	7	12	0.018
	No	7	34	
Smoking history	Yes	5	14	0.124
	No	9	32	
Operation duration (>120 minutes)	Yes	6	12	0.041
	No	8	34	
Delay of surgery (>7 days)	Yes	4	12	0.213
	No	10	34	
Obesity (BMI ≥30 kg/m²)	Yes	3	7	0.274
	No	11	39	

DISCUSSION

This study demonstrated the incidence, patterns, risk factors, and clinical outcomes of postoperative infections after ORIF of fractures in a tertiary care hospital in Dhaka, Bangladesh. The total SSI rate of 23.3% in our study is greater than that in high-income countries but similar to other South Asian and sub-Saharan African centres, where delayed presentation, resource limitations, and patient comorbidities are contributing factors to high infection risk [11]. These results highlight the significance of assessing the burden of SSI in particular clinical and geographic settings. The fact that superficial SSIs (64.3%) are more common than deep SSIs (35.7%) in this group is in line with Mangram et al., who showed that superficial wound infections usually represent a higher percentage of postoperative complications [12]. Most of the infections were observed during the first four weeks of surgery, which corresponds to the biological wound healing process and the normal incubation period of the causative organisms. The most frequently isolated pathogen was *Staphylococcus aureus* (42.9%), which is supported by Zimmerli et al., with *Staphylococcus species* (coagulase-positive and coagulase-negative) always prevailing in the microbial profile of implant-associated infections [13]. In this study, diabetes mellitus became a major risk factor of SSI (p=0.019). Hyperglycemia affects neutrophil activity, opsonisation, and the microvascular blood flow required to support proper wound perfusion and immune surveillance [14]. This observation agrees with Shohat et al., who showed diabetic patients undergoing orthopedic surgery are at a significantly increased risk of infection, and justifies the focus on preoperative glycemic optimization as a surgical risk factor that can be modified [15]. The strong correlation between open fracture and SSI (p=0.018) is not surprising, as the contamination of open wounds, tissue devitalization, and the weakening of the soft tissue envelope that defines such injuries are inherent to them

[16]. Open fracture management is a fine balance between emergent wound debridement, fracture stabilisation, and infection prophylaxis, and despite the best care, the risk of infection is still significantly greater than in closed fractures. Long operative time (>120 minutes) was also a major risk factor (p=0.041), which possibly indicates the higher tissue trauma, blood loss, and length of anaesthetic exposure in complex, technically challenging procedures [17]. Although smoking, delayed surgery, and obesity were not statistically significant in our study, these factors have well-established biological plausibility as modifiers of infection risk. The sample size (n=60) is relatively small and might not have sufficient statistical power to identify associations of moderate effect size of these factors. Smoking affects tissue oxygenation and immune responses by causing vasoconstriction with nicotine and haemoglobin dysfunction with carbon monoxide, and obesity poses technical difficulties in surgery and wound healing because of the relative avascularity of adipose tissue [18]. The results of clinical outcomes in this study describe the significant burden of postoperative infection. The hospital stay of infected patients was almost twice (14.8 vs. 8.1 days), the rate of delayed wound healing was significantly higher, reoperation was more necessary, and functional outcomes were significantly worse at follow-up. These results underscore the downstream effects of SSIs not only on the individual patients but also on the resources of the healthcare system, especially in an environment where there is a shortage of hospital beds and surgical capacity. The poor functional outcomes in the infected group (50% vs. 13%) are possibly multifactorial, which is the sum of the effects of infection, implant complications, delayed fracture healing, and long-term immobilisation [19]. Regarding prevention, the timely antibiotic prophylaxis (90%) in our study is impressive and indicates compliance with evidence-based

perioperative practices. Non-compliance of 10% and the presence of infection in 23.3% of the participants, however, highlight that prophylaxis is not enough. It is necessary to have a multidisciplinary approach to glycemic control, nutritional status, operative efficiency, and wound care. SSI surveillance programs and context-specific infection control bundles have proven to be effective in decreasing the rate of SSI in resource-limited environments [20,21].

LIMITATIONS

This is a single-centred study with a relatively small sample size (n=60), which could limit the generalizability of the results and the statistical power to identify relationships between less common risk factors. Also, the short minimum follow-up time might have underestimated late-onset infections and long-term functional outcomes.

CONCLUSION

Surgical site infections in the postoperative period of ORIF of fractures are a major clinical problem in tertiary care hospitals in Bangladesh, and the overall incidence of this study is 23.3%. The most common causative pathogen is *Staphylococcus aureus*. Statistically significant risk factors of SSI development were diabetes mellitus, open fracture nature, and long operative time (>120 minutes). The outcomes of infected patients were significantly worse, with a longer hospital stay, slower wound healing, increased reoperation rates, and worse functional recovery. These results highlight the urgent necessity of the development of perioperative infection prevention plans that are specific to the local patient demographics and institutional setting. The preoperative optimisation of modifiable risk factors, especially glycemic control, coupled with careful surgical practice and standardised infection control measures, is crucial to enhancing postoperative outcomes in patients undergoing fracture fixation surgery.

RECOMMENDATION

It is suggested that future multicenter, prospective research with larger sample sizes and longer follow-up durations should be conducted to confirm the identified risk factors, describe the patterns of antimicrobial resistance of causative organisms, and assess the efficacy of structured SSI prevention bundles in the local setting.

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CONFLICT OF INTEREST

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REFERENCES

1. Cordero DM, Miclau TA, Paul AV, Morshed S, Miclau III T, Martin C, Shearer DW. The global burden of musculoskeletal injury in low and lower-middle income countries: a systematic literature review. *OTA International*. 2020 Jun 1;3(2):e062.
2. Metsemakers WJ, Kuehl R, Moriarty TF, Richards RG, Verhofstad MH, Borens O, Kates S, Morgenstern M. Infection after fracture fixation: current surgical and microbiological concepts. *Injury*. 2018 Mar 1;49(3):511-22.
3. Trampuz A, Zimmerli W. Diagnosis and treatment of implant-associated septic arthritis and osteomyelitis. *Current infectious disease reports*. 2008 Sep;10(5):394-403.
4. Bilgili F, Balci HI, Karaytug K, Sariyilmaz K, Atalar AC, Bozdog E, Tuna M, Bilgic B, Gurler N. Can normal fracture healing be achieved when the implant is retained due to infection? an experimental animal model. *Clinical Orthopaedics and Related Research®*. 2015 Oct;473(10):3190-6.
5. Slobogean GP, Kennedy SA, Davidson D, O'Brien PJ. Single-versus multiple-dose antibiotic prophylaxis in the surgical treatment of closed fractures: a meta-analysis. *Journal of Orthopaedic Trauma*. 2008 Apr 1;22(4):264-9.
6. Patzakis MJ, Zalavras CG. Chronic posttraumatic osteomyelitis and infected nonunion of the tibia: current management concepts. *JAAOS-Journal of the American Academy of Orthopaedic Surgeons*. 2005 Oct 1;13(6):417-27.
7. Jämsen E, Nevalainen P, Eskelinen A, Huotari K, Kalliovalkama J, Moilanen T. Obesity, diabetes, and preoperative hyperglycemia as predictors of periprosthetic joint infection: a single-centre analysis of 7181 primary hip and knee replacements for osteoarthritis. *JBJS*. 2012 Jul 18;94(14):e101.
8. Korim MT, Payne R, Bhatia M. A case-control study of surgical site infection following operative fixation of fractures of the ankle in a large UK trauma unit. *The bone & joint journal*. 2014 May 1;96(5):636-40.
9. Islam MS, Rahman MF, Islam MA. Patterns and Outcome of Traumatic Brain Injury Patients: A Study in a Tertiary Level Military Hospital. *Journal of Armed Forces Medical College, Bangladesh*. 2019;15(1):75-8.
10. Sun R, Li M, Wang X, Li X, Wu L, Chen Z, Chen K. Surgical site infection following open reduction and internal fixation of a closed ankle fractures: a retrospective multicenter cohort study. *International journal of surgery*. 2017 Dec 1;48:86-91.
11. Ikegwuonu OE, Okeke CC, Zubair A, Okereke PU, Igboanugo SA, Oladeji EO, Ebiekuraju OE, Ikegwuonu O. A systematic review of the incidence and pattern of surgical site infection in orthopedic surgery in Africa. *Cureus*. 2024 Oct 8;16(10).
12. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR, Hospital Infection Control Practices Advisory Committee. Guideline for prevention of surgical site infection, 1999. *Infection Control & Hospital Epidemiology*. 1999 Apr;20(4):247-80.
13. Zimmerli W, Trampuz A, Ochsner PE. Prosthetic-joint infections. *New England journal of medicine*. 2004 Oct 14;351(16):1645-54.
14. Man SL, Chau WW, Chung KY, Ho KK. Hypoalbuminemia and obesity class II are reliable predictors of peri-prosthetic joint infection in patient undergoing elective total knee arthroplasty. *Knee surgery & related research*. 2020 May 11;32(1):21.
15. Shohat N, Muhsen K, Gilat R, Rondon AJ, Chen AF, Parvizi J. Inadequate glycemic control is associated with increased surgical site infection in total joint arthroplasty: a systematic review and meta-analysis. *The Journal of arthroplasty*. 2018 Jul 1;33(7):2312-21.
16. Zalavras CG. Prevention of infection in open fractures. *Infectious Disease Clinics*. 2017 Jun 1;31(2):339-52.
17. Watters W, Rethman MP, Hanson NB, Abt E, Anderson PA, Carroll KC, Futrell HC, Garvin K, Glenn SO, Hellstein J, Hewlett A. Prevention of orthopaedic implant infection in patients undergoing dental procedures. *JAAOS-Journal of the American Academy of Orthopaedic Surgeons*. 2013 Mar 1;21(3):180-9.
18. Zhao H, Meng J, Sun T, Wan Z, Qin S, Zhang F, Hou Z. Risk factors for deep surgical site infection following surgically treated peri-ankle fractures: a case-control study based on propensity score matching. *Journal of orthopaedic surgery and research*. 2022 Dec 15;17(1):542.
19. Metsemakers WJ, Kuehl R, Moriarty TF, Richards RG, Verhofstad MH, Borens O, Kates S, Morgenstern M. Infection after fracture fixation: current surgical and microbiological concepts. *Injury*. 2018 Mar 1;49(3):511-22.
20. Allegranzi B, Bischoff P, De Jonge S, Kubilay NZ, Zayed B, Gomes SM, Abbas M, Atema JJ, Gans S, van Rijen M, Boermeester MA. New WHO recommendations on preoperative measures for surgical site infection prevention: an evidence-based global perspective. *The Lancet Infectious Diseases*. 2016 Dec 1;16(12):e276-87.
21. Ban KA, Minei JP, Laronga C, Harbrecht BG, Jensen EH, Fry DE, Itani KM, Dellinger PE, Ko CY, Duane TM. American College of Surgeons and Surgical Infection Society: surgical site infection guidelines, 2016 update. *Journal of the American College of Surgeons*. 2017 Jan 1;224(1):59-74.