

Assessment of Infection Rates in Open Fractures in Tertiary Care HospitalMani Kant Anand¹, Amar Kumar², Vikash Kumar³¹Assistant Professor, Department of Orthopedics, Lord Buddha Koshi Medical College, and Hospital, Saharsa, Bihar, India²Assistant Professor, Department of Orthopedics, Lord Buddha Koshi Medical College and Hospital, Saharsa, Bihar, India³Assistant Professor, Department of Orthopedics, Lord Buddha Koshi Medical College and Hospital, Saharsa, Bihar, India

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Conflict of interest: Nil

Abstract:

Background: Open tibial fractures are highly susceptible to infection due to bone exposure and soft tissue damage. Postoperative infections increase patient morbidity, prolong hospitalization, and may delay or impede healing. The prevalence of multidrug-resistant bacteria in tertiary care hospitals further complicates management. **Objective:** To conduct evaluation of the infection rates, the microbial profiles, and the efficiency of surgical debridement in cases of open tibial fractures patients.

Methodology: A cross-sectional study was conducted on 628 patients with fresh open tibial fractures at the Department of Orthopedics, Lord Buddha Koshi Medical College and Hospital, Saharsa, Bihar. Wound specimens were collected at three time points: upon admission, post-debridement in the operating room, and on postoperative days 12–14. Samples underwent culture and sensitivity testing. Data on contamination trends, infection rates, and organism-specific responses to debridement were analyzed.

Results: Initial wound contamination was 38.5%, reduced to 26.4% after debridement. Postoperative infection rate was 45.1%, predominantly due to multidrug-resistant Gram-negative bacteria (*Pseudomonas*, *E. coli*, *Klebsiella*). Debridement effectively reduced *Staphylococcus aureus* contamination by 78.6% but had limited effect on Gram-negative organisms. Patients with initial contamination had a higher risk of infection (66.1%).

Conclusion: Debridement efficiently manages initial contamination, particularly Gram-positive bacteria, but postoperative infections remain high due to resistant Gram-negative organisms. Strict aseptic practices combined with targeted antibiotic therapy can significantly reduce infection rates and improve clinical outcomes.

Keywords: Antibiotic resistance, Debridement, Gram-negative bacteria, Open tibial fracture, Postoperative infection, *Staphylococcus aureus*.

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Introduction

Open fractures are still considered to be one of the toughest orthopedic emergencies because not only bone integrity is destroyed but also the surrounding soft tissue envelope is violated at the same time [1]. In contrast to closed fractures, in open fractures the bone is directly exposed to the outside and this exposure markedly elevates the risk of microbial colonization, deep infections, and long-term functional impairments [2]. These injuries are typically caused by high energy traumas like auto accidents, industrial accidents, farm accidents, or in some cases, by low-energy falls in elderly patients with poor bone quality.

The situation where bone is exposed, dead tissues are present, and there is contamination becomes a very conducive environment for the growth of microorganisms; therefore, infection has become one of the main factors that determine the success of

treatment [3]. Worldwide, the rates of infection in open fractures are very different from one place to another, and they can be as low as 5% in clean Type I injuries and as high as over 50% in severely contaminated Type III fractures, which varies according to the cause of the injury, the duration of the treatment, and the effectiveness of wound management [4].

Open fractures in a tertiary care hospital setting where cases usually consist of polytrauma, high-velocity injuries and referrals from peripheral centers are more often and complicated than in primary or secondary healthcare facilities [5]. These centers have an important role in the processes of early resuscitation, aggressive debridement, stabilization, and timely soft-tissue coverage, which are all considered important in the reduction of infection rates. Though there has been considerable improvement in

the areas of surgical techniques, antibiotic stewardship, and wound care protocols, still, infection following open fractures would be major cause of prolonged hospitalization, delayed union, non-union, osteomyelitis, and increased healthcare costs [6]. The existence of multidrug-resistant organisms in the environments of tertiary-care hospitals make the management even harder and this necessitates the continual assessment of the microbial patterns.

Infection rates determination is another important point since infection is not just a postoperative complication but, often, a result of multiple pre-treatment factors. Such factors include the duration of time between the injury and the start of prophylactic antibiotic treatment, the quality and speed of initial debridement, soft tissue handling, type of fracture (Gustilo–Anderson), patient's risk factors including diabetes or smoking, and the degree of contamination at the site of the injury [7]. Moreover, the developing treatment guidelines require early wound coverage within 48–72 hours, negative pressure wound therapy, and staged reconstruction as the techniques, which are intended to restrict bacterial growth and facilitate healing [7].

In India, where road traffic accidents are still a serious public health problem and tertiary hospitals get a lot of trauma cases, the monitoring of infection trends in open fractures is of great significance [8]. Many patients come late because of referral problems or insufficient primary wound care that may even raise the risk of infection. Knowing these patterns allows doctors to change their protocols, improve their triage systems, and control infections more efficiently, thus allowing better distribution of resources [9]. This also provides useful evidence to determine the empirical antibiotic therapy depending on the dominant organisms.

Hence, monitoring the infection rates of open fractures in a high-level hospital is a prerequisite for progress in patient care and modification of clinical management pathways. This research intends to offer evidence-based insights through the evaluation of the incidence, microbiological profile, risk factors, and outcomes, which can then be used to bolster infection prevention strategies, quicken the process of getting the right treatments and lessen the long-term consequences of impairment after open fractures.

Methodology:

Study Design: The research involved the execution of a cross-sectional observational study in the Department of Orthopedics at Lord Buddha Koshi Medical College and Hospital, Saharsa, Bihar.

Study Area: The research was performed at the Department of Orthopedics, Lord Buddha Koshi Medical College and Hospital, Saharsa, Bihar, India

Study Duration and Population: The research took place during the period between 12 months. The number of patients with open tibial fractures who were recruited for the study reached 628. All age groups and both sexes with recent open fractures were accepted as subjects, whereas those with bone diseases, chronic infection, or partial follow-up were not included.

Selections Criteria

Inclusion Criteria

- Patients with fresh open tibial fractures presenting to the hospital during the study period.

Exclusion Criteria

- Patients with pathological fractures.
- Patients with chronic osteomyelitis.
- Patients lost to follow-up or with incomplete clinical data.

Data Collection: In a cross-sectional observational design, data were obtained. At the time of presentation, comprehensive demographic data, type of injury, and clinical findings were noted. All the patients had three microbiological assessments done successively: the emergency room at presentation for the first sample collection, the operating theatre after the surgical debridement for the second, and the ward between 12–14 days post-operatively for the third. All samples underwent the standard culture and sensitivity testing for the purpose of checking microbial contamination, measuring the effectiveness of debridement, and diagnosing post-operative infection.

Procedure: The treatment of open fractures was conducted in accordance with the standard protocols which comprised of wound irrigation, meticulous debridement, stabilization of the fracture, and the use of correct antibiotics. Swabs or tissue samples were collected in a sterile manner at the three stages, brought to the microbiology lab, and then, by standard laboratory practices, were processed for bacterial identification and antibiotic susceptibility testing.

Statistical Analysis: Data was analyzed using standard statistical software. Continuous variables were expressed as mean \pm standard deviation, while categorical variables were expressed as frequencies and percentages. Comparisons of pre- and post-debridement contamination rates were made, with P-value <0.05 considered statistically significant.

Result

Sampling Stage	Positive Cultures (n)	Percentage (%)
Emergency Room (Initial)	242	38.5
After Debridement (Theatre)	166	26.4
Ward (Post-op Day 12–14)	283	45.1

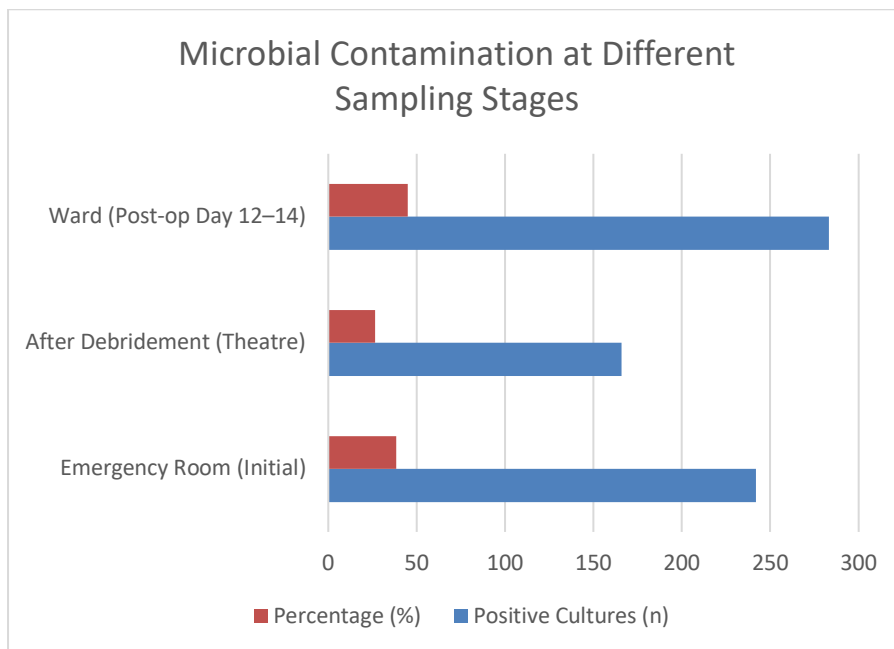


Figure 1: Shows that Microbial Contamination at Different Sampling Stages

Microbial contamination during the postoperative ward period was higher than during the initial stages of management as seen in Table 1 and Figure 1. When the patients came in 38.5% of wounds were culture-positive, which lowered to 26.4% after debridement, thus verifying the surgical cleansing as an effective method for the further reduction of microbial load. However, on days 12-14 after surgery,

contamination jumped up to 45.1%, which was an alarming sign of hospital-acquired infections. Overall, the trend indicates that ward environment is a critical point where strict aseptic measures are required to prevent secondary infection even though debridement reduces initial contamination in open tibial fractures.

Organism	Number of Cases	Percentage (%)
Pseudomonas spp.	88	31.1
Escherichia coli	72	25.4
Klebsiella spp.	55	19.4
Acinetobacter spp.	32	11.3
Enterobacter spp.	18	6.4
Proteus spp.	14	4.9
Staphylococcus aureus	4	1.4

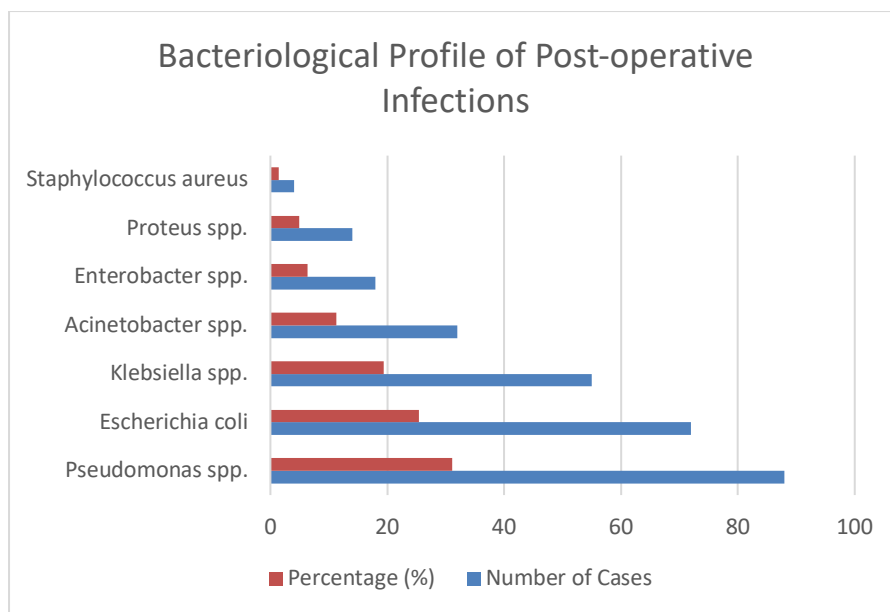


Figure 2: Shows Bacteriological Profile of Post-operative Infections.

Multidrug-resistant Gram-negative bacteria were responsible for most postoperative infections as indicated in Table 2. The most frequent pathogens were Pseudomonas spp. (31.1%) and Escherichia coli (25.4%). Among the isolated bacteria were Klebsiella spp. (19.4%) and Acinetobacter spp.

(11.3%). Enterobacter spp. (6.4%) and Proteus spp. (4.9%) were less common. Staphylococcus aureus was of little importance (1.4%), thus it was confirmed that Gram-negative organisms were the primary cause of infections after the surgery conducted on the open tibial fractures.

Parameter	Observation
Initial contamination (ER)	38.50%
After debridement (Theatre)	26.40%
Infection rate in ward	45.10%
Predominant organisms	Multidrug-resistant Gram-negative bacteria
Parameter	Observation

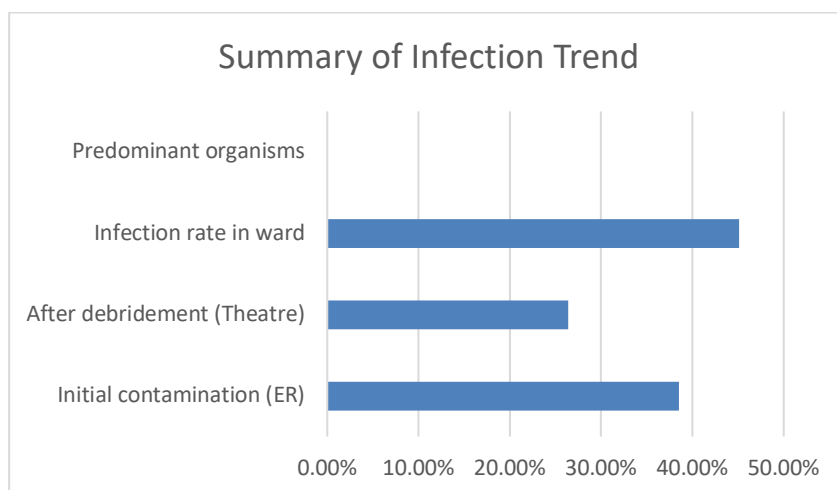


Figure 3: Shows that Summary of Infection Trend

The information presented in Table 3 and Figure 3 indicates the same pattern of infection progression during the management of open tibial fractures quite clearly. The contamination initially detected in the Emergency Room was considerably high at 38.5%,

but this rate was reduced to 26.4% post-surgery, thus confirming the effectiveness of early wound cleaning. Nevertheless, the infection rate grew rapidly up to 45.1% during the ward stay which means that the hospital-acquired infections were coming up. The

trend reveals that even though debridement does reduce the initial microbial load, the postoperative care in the ward continues to be the most crucial period, where most infections are due to multidrug-

resistant Gram-negative organisms, thus, the need for strict aseptic precautions and targeted antibiotic strategies being emphasized.

Initial ER Contamination	Number of Patients	Infection in Ward (n)	Infection Rate (%)
Contaminated	242	160	66.1
Non-contaminated	386	123	31.9

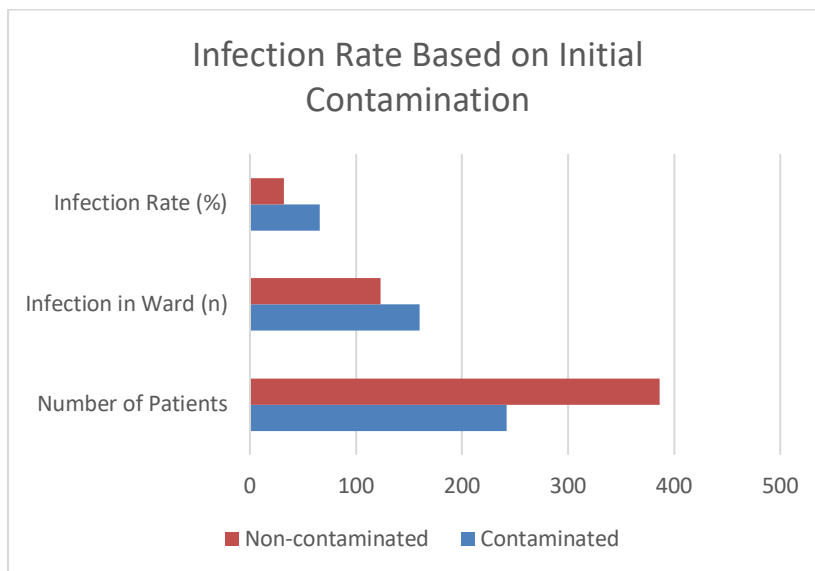


Figure 4: Shows that Infection Rate Based on Initial Contamination

According to Table 4, the occurrence of microbial contamination in patients already waiting to be treated in the Emergency Room had a strong connection over developing postoperative infections. Out of the 242 cases that were contaminated at first, 66.1% eventually turned into an infection during their stay in the ward while, in contrast, only 31.9% of the non-contaminated 386 cases suffered from infections. The notable difference here suggests that the initial contamination of the wound is a very

strong predictor for the future infection, and though debridement does lower the contamination risks, the patients with early infection are still subjected to a much higher risk of complications in the postoperative period. Thus, the findings highlight the necessity for very swift initial wound care, along with antibiotic therapy that is quick, and elevating the strict aseptic precautions throughout the entire postoperative period.

Organism	ER Sample Positive (n)	Post-Debridement Positive (n)	Reduction (%)
Staphylococcus aureus	42	9	78.6
Pseudomonas spp.	72	65	9.7
Escherichia coli	60	50	16.7
Klebsiella spp.	48	40	16.7
Acinetobacter spp.	24	20	16.7

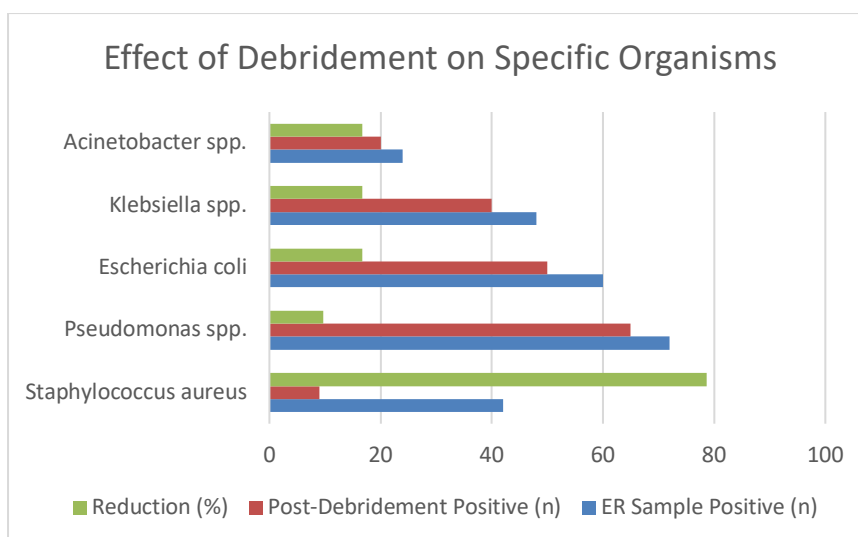


Figure 5: Shows that Effect of Debridement on Specific Organisms

Debridement has varying effects on the different microorganisms as is clearly indicated in Table 5 and Figure 5. The most pronounced reduction (78.6%) was observed for *Staphylococcus aureus*; hence, debridement is highly effective against Gram-positive contamination. On the other hand, Gram-negative organisms (*Pseudomonas*, *E. coli*, *Klebsiella*, and *Acinetobacter*) only experienced small reductions (9.7-16.7%) which means that they are still quite strong and resistant. The figure and the table suggest that, even though debridement has a significant impact on the reduction of *S. aureus*, it does not have the same effect on the multidrug-resistant Gram-negative bacteria that are still a major infection risk in the postoperative setting.

Discussion

The present research analyzed the infection patterns, microbial profiles, and the influence of surgical intervention on 628 patients with open fractures of the tibia. It is possible to say that the findings emphasize the intricate interaction between the first environmental contamination, the efficiency of the early surgical management, and the significant impact of hospital-related infections during the postoperative care.

Initial microbial contamination was noticed in 38.5% of patients on arrival, which is in agreement with Wenker et al. (2014) results that worldwide trends observed in very high-energy trauma settings, especially road traffic accidents, [10]. Changwe et al. (2021) showed that the Open tibial fractures are very commonly infected due to little soft tissue covering, and exposure to soil, dirt, and outside pollution. The contamination rate detected is in line with earlier studies reporting that 30–60% of such fractures are infected with bacteria at the time of admission [11].

A remarkable decline to 26.4% following debridement highlights the necessity of surgical

intervention done properly and promptly. Debridement, as Sendi et al. (2021) pointed out, is still the principal method in the treatment of open fractures and is done to get rid of dead tissue and to lessen the number of bacteria at the beginning [12]. Seshadri et al. (2016) conducted research and pointed out that debridement influenced Gram-positive bacteria mostly, particularly *Staphylococcus aureus*, which experienced a 78.6% reduction after debridement. This conveys the well-established perception that Gram-positive bacteria normally live on the surface and are very vulnerable to surgical cleansing and the application of first-line antibiotics at the very beginning [13].

On the other hand, the study from Bassetti et al., (2011) showed that Gram-negative bacteria such as *Pseudomonas*, *E. coli*, *Klebsiella*, *Acinetobacter*, and *Proteus* species—demonstrated just slight reductions (9-17%) [14]. The biofilm formation, possession of intrinsic resistance mechanisms, and deep tissue colonization make these bacteria hard to get rid of through surgical methods alone. Their continual presence in postoperative infections indicates that hospital environmental contamination is a main factor at play.

The 45.1% rate of postoperative infection, which is above the levels of both initial and post-debridement contamination, indicates that secondary or nosocomial infections were the main reason for the complications. According to Rafferty et al. (2021), this is consistent with the facets observed in other tertiary care centers where the aforementioned factors, along with overcrowding, prolonged stay in the hospital, and dressing changes, have created an environment conducive to ward-based contamination. Moreover, the authors have also pointed out the possible shortcomings in sterilization, wound-care handling, and the aseptic precautions taken by medical personnel in infection control.

The link between the first contamination and the infection risk at a later stage—66.1% in the case of patients who were initially contaminated against 31.9% in the case of initially clean wounds—indicates that even though the influence of hospital factors is predominant, the initial microbial burden still has an impact on the vulnerability. This reinforces the idea that the presence of microorganisms prior to the infection forms a basis for the spread of hospital bacteria, particularly in instances where the extent of soft-tissue injury is great or the immune system is weakened.

The profile of bacteria is very alarming because most postoperative infections reported by Tilahun et al., (2022) were caused by multidrug-resistant Gram-negative bacteria [16]. Facciola et al., (2019) stated that these microbes have a talent for staying alive in hospitals, taking over medical instruments and surfaces, and being resistant to multiple antibiotics while Hatlen et al., (2021) showed that their prevalence calls for strict antibiotic stewardship and targeted therapy according to culture and sensitivity results, instead of random empirical use of broad-spectrum drugs that might worsen resistance patterns [17,18].

Overall, the study points out that even though emergency care and debridement are highly effective in terms of the early contamination reduction, postoperative infection control is still the weakest link. Regular disinfection of the ward, compliance with hand hygiene, reduction of dressing manipulation, and best patient isolation protocols are things that should be done. Furthermore, microbiological monitoring and evidence-based antibiotic therapy can lead to a significant improvement in outcomes.

Conclusion

This research proves that infections in open tibia fractures are still one of the main problems to be solved, as almost 50% of the patients who received proper cleaning developed infections after surgery. While contamination at the outset occurs quite often, most of the infections that have become established are from hospital-acquired, multi-drug-resistant Gram-negative bacteria. Proper cleaning of wounds minimizes the presence of Gram-positive bacteria but has only a small impact on Gram-negative organisms. The substantial increase in infection rates during hospital stay indicates the necessity for better postoperative care, more rigorous aseptic protocols, and appropriate antimicrobial strategies. Improved infection control measures in the world and implementation of antibiotics based on research could lead to the infection burden being lessened significantly and the clinical outcomes being better in the management of open tibial fractures.

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