Original Article | Journal of Clinical Orthopaedics | 2026 January-June; 11(1):-60-64

A Prospective Clinical Study of Microbiological Profile and Antibiotic Sensitivity Patterns of Surgical Site Infections in Orthopaedic Patients at a Tertiary Care Hospital

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Abstract

Background: Surgical site wound infection is the infection that occurs after surgery in the part of the body where surgery has taken place. It is the third most common nosocomial infection in hospital population. It is the highest cause of morbidity and mortality. It is worst in the case of orthopaedic practice as it is difficult to get rid of bone and joint infection. Therefore, this study is focused on studying the aerobic organisms present in surgical site wound infections of orthopaedic patients.

Materials and Methods: In a Tertiary Care Hospital, 200 probable cases of surgical site infections (SSI) in orthopaedic patients from August 2019 to July 2020 were studied. The samples were processed aerobically following the standard microbiology procedures. Antibiotic susceptibility testing was done using the Kirby Baeur's disk diffusion method. The antibiotics were chosen based on the organism isolated, and zone size was measured, results were interpreted following the Clinical and Laboratory Standards Institute guidelines.

Results: Out of 200 probable samples, 16 samples were positive. The incidence was 8%. The most common bacteria isolated were Staphylococcus aureus. Open fracture patients and patients who underwent emergency surgery showed a high incidence of infection as compared to patients who underwent elective surgery. The most effective antibiotic was seen to be Tetracycline and Gentamicin. Multidrug-resistant isolates were only seen in patients with open fracture.

Conclusion: An initiative for improved hospital infection control policy and improved antimicrobial prescribing guidelines should be implemented. Furthermore, pre-operative bathing and screening for methicillin-resistant S. aureus should be mandatory. Proper training to the patient's relatives in terms of wound dressing should be given so as to avoid SSI.

Keywords: Surgical site infection, antibiotic susceptibility testing, Kirby-Bauer's disk diffusion.

Introduction

Surgical site infections (SSIs) are those infections that are developed on the site of surgical incision within 30 days of operation or in a year after implant. Orthopaedic infection creates a stressful situation for the patient as well as the healthcare system. [1]. As per CDC (centers for disease control and prevention (CDC), surgical wound is classified into four categories, i.e., clean wound, clean-contaminated wound, contaminated wound, and dirty infected wound. [2]. There are many factors that may influence the orthopaedic surgery wound healing, other than the contamination at the incision site. Those include patient factors such as diet, lifestyle, comorbidities, and immune status, as well as the post-operative care taken at the hospital and after discharge. [3, 4]. In case if it is pathogenic, the pathogen source can be either endogenous or exogenous. The most commonly isolated bacterial pathogens are Staphylococcus aureus, Enterobacteriaceae, coagulase coagulase-negativeStaphylococcus (CoNS), Enterococcus, and

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Submitted Date: 11-06-2025, Review Date: 05-07-2025, Accepted Date: 03-02-2026 & Published Date: 10-05-2026

Journal of Clinical Orthopaedics | Available on www.jcorth.com | DOI: https://doi.org/10.13107/jcorth.2026.v11.i01.840

Pseudomonas aeruginosa. In the recent years, the prevalence of gram-negative organisms is increasing over Gram Gram-positive bacteria as an agent of serious nosocomial infections. [4].

According to the Health Management Information System total of 1,88,82,734 surgeries were carried out in 2019–2020 in India, out of which 23,286 people experienced Surgical Site InfectionSSI [5]. It is very important to prevent SSI as it is one of the leading causes of hospital hospital-acquired infection [6]. CDC's advice to prevent SSI emphasizes on maintenance of aseptic procedures, post-operative care, surgical technique, hospital care etc., [7].

Moreover, the overuse of antibiotics, and unnecessary administration of reserve antibiotics leads to multidrug-resistant (MDR) strains development. It is therefore important to set an antimicrobial stewardship policy for every hospital [8]. Our study focused on recognizing the sensitivity pattern of organism in relation to the type of wound, and also helped us understand the importance of methicillin-resistant S. aureus (MRSA) screening for health care workers, as well as it helped with the implementation of antibiotic policy.

Materials and Methods

The study was approved by the Institutional Ethics Committee, and the Consents were obtained from each of the participants of the study. This descriptive and prospective study was conducted from August 2019 to July 2020 in MGM Hospital Kamothe, Navi Mumbai.

Sample size and sampling technique:

Pus samples were collected from 200 patients of all age groups who underwent surgery and had some signs of discharge, irritation, or inflammation at the site of surgery. Collection was performed using strict aseptic conditions.

Transportation:

Collected specimens were transported using Amie's transport medium.

Processing:

All samples underwent preliminary examination by gross examination and microscopic examination using Gram's staining technique, followed by culturing on Sterile Blood agar, Sterile Mac Conkey agar, and Sterile Mannitol Salt agar using streak culture method. Bacterial identification was carried out using conventional methods.

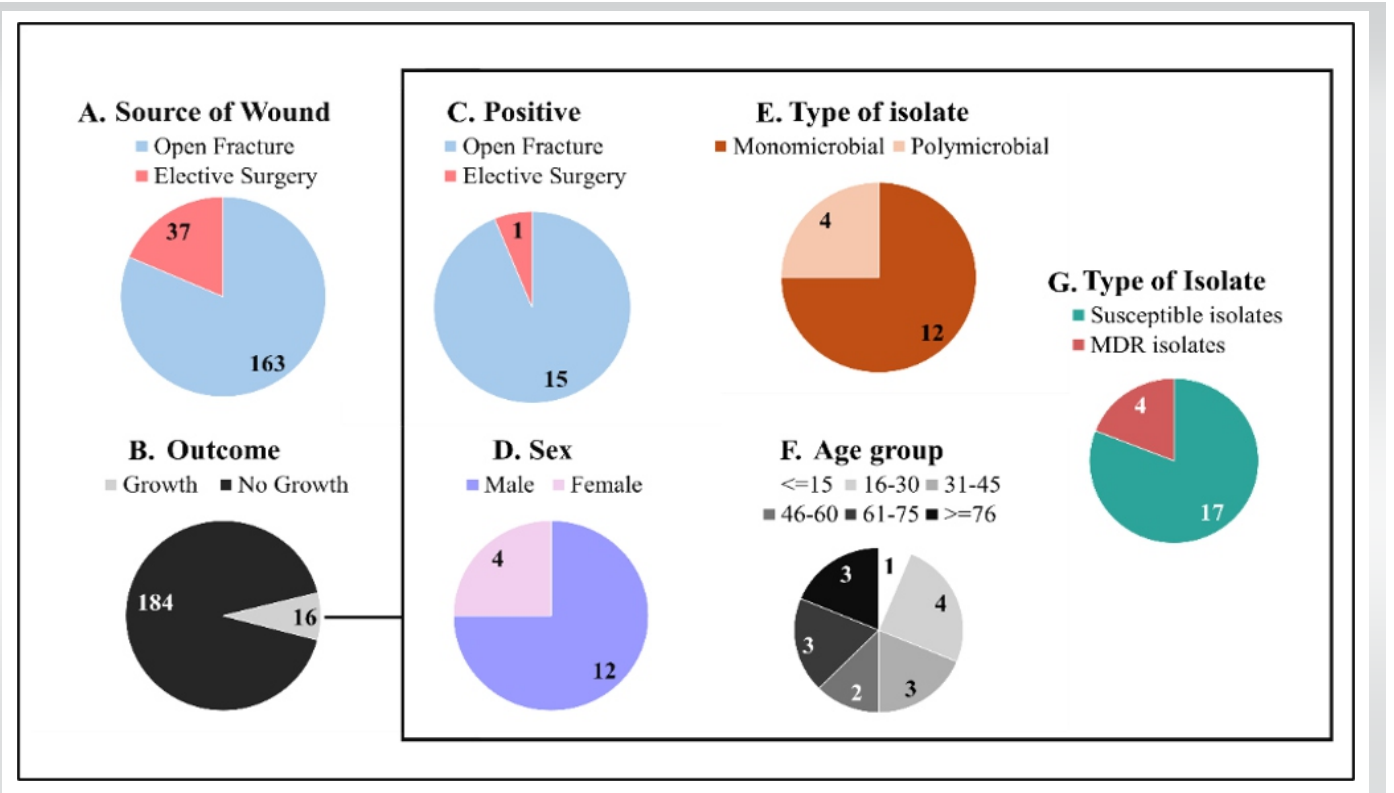

Figure 1: Pie chart representation of clinical and microbiological data from wound samples. (a) Distribution of wound sources, predominantly open fractures. (b) Culture outcomes showing majority microbial growth. (c) Breakdown of positive cases by wound type. (d) Sex distribution among culture-positive patients. (e) Classification of isolates into monomicrobial and polymicrobial types. (f) Age-wise distribution of patients with positive cultures. (g) Distribution of isolates based on antibiotic susceptibility testing pattern (n = 21).

Table 1: The antibiotics selected for AST of Gram-positive isolates obtained from the wounds

Gram nature	Antibiotic	Concentration
Gram positive	Augmentin (AMC)	30 µg
	Cefuroxime (CU/CXM)	30 µg
	Gentamicin (G/GEN)	10 µg
	Ciprofloxacin (CIP)	5 µg
	Penicillin (P)	10 µg
	Co- Trimoxazole (COT)	25 µg
	Clindamycin (CD)	2 µg
	Cefoxitin (CX)	30 µg
	Roxithromycin (RO)	15 µg
	Tetracycline (TE)	30 µg
	Cefazolin (CZ)	30 µg
	Azithromycin (AZM)	15 µg
	Clarithromycin (CLR)	15 µg
	Linezolid (LZ)	30 µg
	Levofloxacin (LE)	5 µg
	Vancomycin (VA)	30 µg
	Rifampicin (RIF)	5 µg
	Meropenem (MRP)	10 µg
	Cefotaxime (CTX)	30 µg
	Netilmicin (NET)	30 µg

AST: Antibiotic susceptibility testing

Susceptibility testing:

All the bacterial isolates were subjected to antibiotic susceptibility testing (AST) by Kirby Baeu-Bauer's Disk Diffusion method. The antibiotics used were specific according to the Gram's nature of the isolate also there were first first-line as well as reserve antibiotics for which the testing was done. The list of antibiotics used are is listed in Tables 1 and 2.

The interpretation was done using CLSIClinical and Laboratory Standards Institute guidelines [9, 10]. The rate of Surgical site infectionSSI in our study was calculated using the following formula [11].

SSI rate= (No. of Surgical Site Infection)/(No surgeries done) X 100

$$SSI\ rate = \frac{No.of\ surgical\ site\ infection}{No\ surgeries\ done} \times 100$$

Results

In this study, a total of 200 samples were collected and processed from the orthopaedics department. Among these, 16 samples (8%) showed growth as shown in Figure. 1. In comparison to our study, Adrita Das et al. (2025) reported that out of the samples processed, 7.9% were culture positive [12].

After colony characterization, every unique isolate was streaked on new growth media for further characterization. A total of 21 isolates were identified, out of which Gram-negative bacteria were 11 of the total isolates compared to Gram -positive, which were 10. The breakdown of isolates is mentioned in Table 3.

Discussion

The total number of organisms isolated from 16 samples were was 21, out of which 17 (80.95%) showed sensitivity towards first first-line drugs and 04 (19.95%) were Multi drug resistant, as shown in Figure. 1 g. In a similar study conducted by Daginent Alelign (2022)et al., 67.1% isolates were multi drug resistant [3].

In our study, the Staphylococcus. aureus isolates showed a higher degree of resistance towards Penicillin (67%); The isolated CONS showed resistance towards Penicillin (67%) and azithromycin (67%); Streptococcus pyogenes isolates showed complete resistance towards Penicillin (100%). Only 01 isolate (Staphylococcus. aureus) among the Gram-positive isolated organisms was MDR but it showed complete sensitivity towards second line antibiotics Linezolid (100%), Vancomycin (100%),

Table 2: The antibiotics selected for AST of Gram-negative isolates obtained from the wounds

Gram nature	Antibiotic	Concentration
Gram negative	Amikacin (AK)	20/10 µg
	Ciprofloxacin (CIP)	5 µg
	Cefotaxime (CF/CTX)	30 µg
	Cefuroxime (CU/CXM)	30 µg
	Augmentin (AU/AMC)	30 µg
	Ceftazidime (CA/CAZ)	30 µg
	Cefoperazone (CS/CPZ)	75 µg
	Gentamicin(G/GEN)	10 µg
	Ofloxacin (OF)	5 µg
	Tobramycin (TOB)	10 µg
	Cefazolin (CZ)	30 µg
	Tetracycline (TE)	30 µg
	Ceftazidime/Tazobactam (CAT)	30/10 µg
	Imipenem (IPM)	10 µg
	Ceftriaxone/Sulbactam (CIS)	75/30 µg
	Meropenem (MRP)	10 µg
	Cefoperazone /Sulbactam (CFS)	75/30 µg
	Levofloxacin (LE)	5 µg
	Cefixime/Clavulanic acid (CMC)	5/10 µg
	Prulifloxacin (PRU)	5 µg
	Piperacillin/Tazobactam (PIT)	100/10 µg
	Cefotaxime/ Clavulanic acid (CEC)	30/10 µg
	Ticarcillin/Clavulanic acid (TCC)	75/10 µg
	Cefepime (CPM)	30 µg

AST: Antibiotic susceptibility testing

Table 3: Number of organisms isolated		
Gram's nature	**Organism name**	**Number of isolates out of 21**
Gram positive (47.61%)	*Staphylococcus aureus*	6
	CONS	3
	Streptococcus pyogenes	1
Gram negative (52.39%)	*Escherichia coli*	3
	Klebsiella pneumoniae	2
	Citrobacter diversus	2
	Pseudomonas aeruginosa	2
	Acinetobacter	2
CONS: Coagulase negative*Staphylococcus*		

Clarithromycin (100%), Levofloxacin (100%), Rifampicin (100%), Meropenem (100%), Cefotaxime (100%), and Netilmicin (100%). Out of 06 isolated Staphylococcus. aureus, only 01 isolate was MRSA based on cefoxitin resistance. All CONS isolates were methicillin sensitive. Apart from the resistance, the Gram-positive isolates showed a high degree of sensitivity towards Gentamicin (100%), Tetracycline (100%), Clindamycin (94%), Cefazolin (94%), Cefoxitin (94%), Ciprofloxacin (94%), followed by Roxithromycin (88.86%), Co-Trimoxazole (83.33%), Cefuroxime (83.33%).

In a similar study, Staphylococcus. aureus were 77% sensitive to gentamicin, 90% to vancomycin, 91% to tigecycline, 95% to Linezolid, 100% to Teicoplanin, and 95.5% were resistant to Penicillin, followed by 45% to ciprofloxacin and 45.5% to cotrimoxazole. Around 63.3% were methicillin-sensitive Staphylococcus. aureus (MSSA), and 36.3% were methicillin-resistant Staphylococcus aureus (MRSA) [12].

In our study, the Escherichia coli isolates showed the highest resistance towards Amoxiclav (100%), Cefazolin (100%); Pseudomonas. aeruginosa showed the highest resistance towards Cefuroxime (100%), Amoxiclav (100%); Klebsiella pneumoniae is the most resistant bacteria and is resistant to almost all antibiotics. Citrobacter and Acinetobacter was were comparatively sensitive to most of the antibiotics. Among all the Gram-negative isolates, 03 of them were MDR (02 K.lebsiella pneumoniae and 01 Acinetobacter). Out of the Klebsiella isolated, 01 showed resistance towards Ceftazidime /Tazobactam.

Despite all the resistance, the Gram-negative isolates showed a high degree of sensitivity towards Tetracycline (100%), Tobramycin (73.33%), Gentamicin (73.33%), Ciprofloxacin (73.33%), Amikacin (70%), Cefotaxime (70%), Ceftazidime (70%), Ofloxacin (70%), and cefoperazone (63.33%).

In a similar study conducted by Adrita Das et al. (2025), Klebsiella K. pneumoniae were sensitive to Amikacin (66%) and resistant to Amoxyclav (87%), Cefuroxime (87%), Ceftriaxone (84%), and Cefepime (84%) [12].

Conclusion

This study highlights the incidence of surgical site infectionSSI and their bacteriological profile. The most common isolated pathogen was Staphylococcus. aureus and CONS, followed by Escherichia. coli. MDR organisms were few but still remains a major concern as the resistance pattern is such that it is against commonly used antibiotics. SSI is one of the major hospital acquired infection and increases financial as well as physical burden for the patient. Pre-operative bathing and screening for Staphylococcus. aureus (Methicillin-resistant) should be mandatory. Surgical antimicrobial prophylaxis should be taken. Right. The right choice, right timing, right dosage, and right frequency of antimicrobial agents should be administered timely.

Post-operative aseptic non-touch technique, surgical dressing, and hand hygiene should be practiced avoiding Surgical Site infectionSSI.

Clinical relevance

This study provides valuable insights into the microbiological profile of surgical site infections (SSIs) in orthopaedic patients, which is crucial for several reasons:

1. Targeted antibiotic therapy: By knowing the prevalent pathogens and their antibiotic resistance patterns, clinicians can make informed decisions about empirical antibiotic treatment, reducing the risk of treatment failure and promoting better patient outcomes.
2. Infection control strategies: Understanding the common pathogens and their transmission patterns can help healthcare providers develop targeted interventions to reduce SSI rates, such as enhanced sterilization protocols or improved surgical techniques.
3. Improved patient care: SSIs are a significant cause of morbidity, mortality, and increased healthcare costs. By optimizing prevention and treatment strategies, clinicians can reduce the burden of SSIs, improve patient quality of life, and reduce healthcare expenditures.
4. Antimicrobial stewardship: The study''s findings can inform antimicrobial stewardship initiatives, promote judicious use of antibiotics, and reduce the emergence of antibiotic-resistant pathogens.
5. Context-specific guidelines: The study''s results can contribute to the development of context-specific guidelines for the management of SSIs in orthopaedic patients, taking into account local microbiological patterns and resistance trends.

By shedding light on the microbiological profile of SSIs in orthopaedic patients, this study has the potential to inform evidence-based practices, ultimately improving patient care and

outcomes.

Limitations and future prospects

Our study and its findings have few following limitations

1. As a single-centrecenter study conducted over a one1-year period, the generalizability of our data to other healthcare settings with different patient populations and infection control protocols may be limited.
2. While 200 suspected SSI cases were screened, the final number of culture-positive isolates was relatively small (n = 16). This limited sample size affects the robustness of statistical stratification. In future studies, the sample size can be expanded up-to 1500 to obtain a positive sample size of up to 100 (based on our prevalence finding of 8%)
3. Our microbiological evaluation relied on standard phenotypic methods. We did not employ molecular techniques (e.g., polymerase chain reactionPCR) to detect specific resistance genes, nor did we evaluate anaerobic organisms, which may have underestimated the total microbial burden.
4. From a clinical perspective, we did not stratify infections by depth (superficial vs. deep), nor did we assess long-term outcomes (e.g., implant retention) or host-specific risk factors (e.g., diabetes, smoking). While we emphasize the importance of infection control, screening for healthcare worker colonization was outside the scope of this study. Despite these constraints, this surveillance provides a vital baseline of the local antibiogram and resistance patterns, which is are essential for guiding empirical antibiotic therapy in our orthopaedic unit.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

Conflict of Interest: NIL; **Source of Support:** NIL

References

1. Global Guidelines for the Prevention of Surgical Site Infection (WHO Guidelines Approved by the Guidelines Review Committee). Geneva: World Health Organization; 2018. Available from: https://www.ncbi.nlm.nih.gov/books/NBK536404 [Last accessed on 2025 Sep 20].
2. Borchardt RA, Tzizik D. Update on surgical site infections: The new CDC guidelines. JAAPA 2018;31:52-4.
3. Alelign D, Tena T, Tadesse D, Tessema M, Seid M, Oumer Y, et al. Bacteriological profiles, antimicrobial susceptibility patterns, and associated factors in patients undergoing orthopedic surgery with suspicion of surgical site infection at Arba minch general hospital in Southern Ethiopia. Infect Drug Resist 2022;15:2427-43.
4. McNally M, Corrigan R, Sliepen J, Dudareva M, Rentenaar R, IJpma F, et al. What factors affect outcome in the treatment of fracture-related infection? Antibiotics 2022;11:946.
5. Vatavati SR, Kampli MS. Surgeries and surgical site infection in India: A analysis of health management information system 2019-2020. J Surg Surg Res 2020;6:146-8.
6. Raoofi S, Kan FP, Rafiei S, Hosseinipalangi Z, Mejareh ZN, Khani S, et al. Global prevalence of nosocomial infection: A systematic review and meta-analysis. PLoS One 2023;18:e0274248.
7. Keely Boyle K, Rachala S, Nodzo SR. Centers for disease control and prevention 2017 guidelines for prevention of surgical site infections: Review and relevant recommendations. Curr Rev Musculoskelet Med 2018;11:357-69.
8. Walia K, Ohri VC, Madhumathi J, Ramasubramanian V. Policy document on antimicrobial stewardship practices in India. Indian J Med Res 2019;149:180-4.
9. Firesbhat A, Tigabu A, Tegene B, Gelaw B. Bacterial profile of high-touch surfaces, leftover drugs and antiseptics together with their antimicrobial susceptibility patterns at University of Gondar comprehensive specialized hospital, Northwest Ethiopia. BMC Microbiol 2021;21:309.
10. Weinstein MP, Lewis JS 2nd. The clinical and laboratory standards institute subcommittee on antimicrobial susceptibility testing: Background, organization, functions, and processes. J Clin Microbiol 2020;58:e01864-19.
11. Mohan N, Gnanasekar D, Sowmya TK, Ignatious A. Prevalence and risk factors of surgical site infections in a teaching medical college in the Trichy District of India. Cureus 2023;15:e39465.
12. Das A, Tripathy SK, Mohapatra I, Poddar N, Pattnaik D, Sayashi S, et al. Microbiological profile and outcome of surgical site infections following orthopedic surgeries in a tertiary care hospital. Cureus 2025;17:e76874.

Conflict of Interest: NIL
Source of Support: NIL

How to Cite this Article

Shete M, Salgotra KR, Kar H, Ather S. A Prospective Clinical Study of Microbiological Profile and Antibiotic Sensitivity Patterns of Surgical Site Infections in Orthopaedic Patients at a Tertiary Care Hospital. Journal of Clinical Orthopaedics January-June 2026;11(1):60-64.