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STUDY AND CHARACTERIZATION OF BACTERIAL PATHOGENS AND THEIR SUSCEPTIBILITY/ RESISTANCE PATTERN IN ORTHOPAEDIC IMPLANT ASSOCIATED INFECTIONS

Orthopaedics

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ABSTRACT

Background: Orthopaedic implants are crucial for restoring musculoskeletal function and improving quality of life. However, implant-associated infections remain a significant challenge, leading to increased morbidity, prolonged hospital stays, and economic burden. This study aimed to characterize bacterial pathogens associated with Orthopaedic implant infections and analyze their susceptibility and resistance patterns to guide effective management strategies. **Methods:** A prospective observational study was conducted in the Departments of Orthopaedics and Microbiology at BRD Medical College from May 2023 to April 2024. Fifty patients with postoperative implant infections were included. Clinical data, laboratory findings, and demographic details were recorded. Specimens were collected aseptically and processed using standard bacteriological methods. Antibiotic susceptibility testing was performed to evaluate resistance patterns. **Results:** Among the 50 patients, males constituted 80%, and the most common age group was 31–40 years (24%). Diabetes mellitus was present in 26% of cases. Culture positivity was observed in 74% of subjects, with Staphylococcus aureus being the predominant pathogen (42%), followed by Escherichia coli (14%) and Klebsiella pneumoniae (14%). Susceptibility was highest for Clindamycine/Azithromycine (54.05%), followed by Imepenem/Gentamycine (29.73%). Resistance trends showed regional variations, emphasizing the importance of local antibiograms. **Conclusions:** The study highlights the need for targeted infection control measures and appropriate antibiotic use based on susceptibility patterns to reduce morbidity and improve patient outcomes. Multidisciplinary collaboration and extended follow-up studies are essential for developing effective protocols for the prevention and treatment of implant-associated infections.

KEYWORDS

Orthopaedic implants, bacterial pathogens, antimicrobial resistance, biofilm, Staphylococcus aureus.

INTRODUCTION

Orthopaedic implants have significantly advanced the treatment of musculoskeletal conditions, providing solutions for restoring mobility, stabilizing fractures, and improving patients' quality of life. However, implant-associated infections remain a formidable complication, leading to increased morbidity, extended hospital stays, and financial strain on healthcare systems.[1] These infections are particularly challenging due to the high potential for bacterial colonization on implant surfaces, the formation of biofilms, and the emergence of antibiotic resistance.

The reported infection rates in Orthopaedic implants vary, with primary joint replacements showing rates of 1–2%, increasing to 40% in revision surgeries and trauma-related procedures.[3] Gram-positive bacteria, particularly Staphylococcus aureus and coagulase-negative staphylococci (CoNS), are the leading pathogens, while Gram-negative organisms like Escherichia coli, Klebsiella spp., and Pseudomonas aeruginosa are also commonly isolated.[4,5] These pathogens often form biofilms on the implant surface, creating a barrier to both antibiotics and host immune responses, resulting in persistent infections and frequent relapses.[2]

The rise of multidrug-resistant organisms, including methicillin-resistant Staphylococcus aureus (MRSA) and extended-spectrum beta-lactamase (ESBL)-producing bacteria, has further complicated the management of these infections. Resistance to commonly used antibiotics like cephalosporins and aminoglycosides has necessitated the use of carbapenems and other advanced agents, which may not always be readily available or affordable in resource-limited settings.[1,6]

The selection of appropriate antibiotic therapy is critical for effective management and must be guided by local microbial profiles and susceptibility patterns. Regional studies have highlighted significant variations in resistance patterns, emphasizing the need for localized data to guide empirical therapy. [3,5] Understanding the common pathogens and their resistance mechanisms can aid in better management and prevention strategies for Orthopaedic implant infections.

This study aims to characterize the bacterial pathogens associated with Orthopaedic implant infections and evaluate their susceptibility and resistance patterns. By identifying local trends, the study seeks to provide valuable data to guide antibiotic selection, improve clinical outcomes, and reduce the burden of implant-associated infections in Orthopaedic practice.

MATERIAL AND METHODS

Study Site

The study was conducted in the Department of Orthopaedics in collaboration with the Department of Microbiology at BRD Medical College. Ethical approval was obtained from the institutional ethics committee, and informed written consent was collected from all participants.

Study Design And Duration

This was a prospective observational study conducted over a period of one year, from May 2023 to April 2024.

Study Population

The study included patients of all age groups who developed postoperative Orthopaedic implant infections. A total of 30 patients were recruited during the study period.

Inclusion Criteria

1. Patients with suspected or definite periprosthetic implant infections based on clinical data, including:

- Pain, swelling, warmth around the joint.

- Purulent discharge and fever, along with one or more of the following:

a) Elevated ESR.
b) Elevated C-reactive protein.
c) Leukocytosis (>12,000/mm³) or leucopenia (<4,000/mm³).

2. Purulent discharge from the incision site or drain, observed within one week post-surgery and up to one year after discharge.
3. Both male and female patients of all age groups were included.

Data Collection

The following parameters were documented for each patient:

- Age, address, date of admission, diagnosis at admission, and findings from physical examination.
- Duration of hospital stay, nutritional status, underlying illnesses (e.g., diabetes mellitus, uremia, chronic arthritis, or concurrent urinary tract infections).
- Type of implant, duration of the surgical procedure, history of smoking, alcoholism, or immunocompromised status.

Specimen Collection

1. Samples of pus or fragments of excised bone tissue were collected under strict aseptic precautions from infected wounds or sinuses.
2. Specimens were obtained from infected implant sites using sterile cotton swabs or implant wash fluid.
3. The following steps were followed to minimize contamination:

- The infected site was cleaned with normal saline after removal of dressings.
- Any eschar present was carefully removed using a sterile blade.
- The site was washed again with saline and allowed to dry.
- With slight pressure applied beside the infected site, a sterile cotton swab was rolled over the area and placed in a sterile bottle.
- Duplicate swabs were collected for each case and transported immediately to the microbiology laboratory for processing.

Microbiological Processing

Specimens were cultured for aerobes and facultative anaerobes using standard bacteriological techniques. Pus swabs were processed to identify causative organisms and assess their antimicrobial susceptibility patterns.

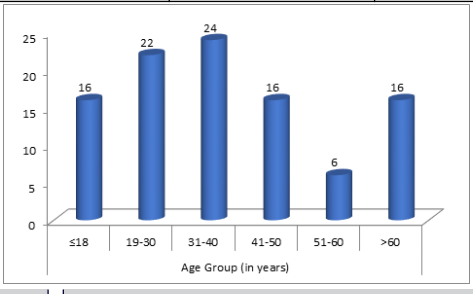
Data Analysis

The collected data were systematically recorded and subjected to statistical analysis for identifying patterns in bacterial pathogens and their susceptibility/resistance profiles.

RESULTS

Table 1 represents the age and gender distribution of study participants. The majority of subjects were male (80%), and the largest age group was 31-40 years (24%). Age groups ≤18 years, 41-50 years, and >60 years each contributed 16% of the population, while the smallest group was 51-60 years (6%).

Variables	Frequency (N)	Percentage (%)
Age Group (in years)		
≤18	8	16
19-30	11	22
31-40	12	24
41-50	8	16
51-60	3	6
>60	8	16
Total	50	100
Gender		
Male	40	80
Female	10	20
Total	50	100



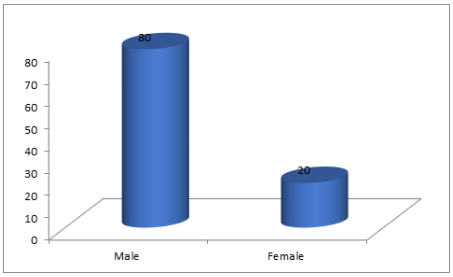


Table 2 represents the distribution of implants used among study subjects with Orthopaedic implant-associated infections. TILN was the most commonly used implant (20%), followed by TENS-NAIL (12%), while other implant types were utilized less frequently.

Implant	Frequency (N)	Percentage (%)
TILN	10	20.0
TENS- NAIL	6	12.0
Bipolar-Prosthesis	4	8.0
DFLCP	4	8.0
FILN	4	8.0
Proximal Tibia-Plate	4	8
Illizarov Ring	3	6.0
DCP	2	4.0
T-Butress	2	4
THR	2	4.0
Clavicle Plate	1	2.0
DHS	1	2.0
Distal Tibia PLA	1	2.0
HILN	1	2.0
K-NAIL	1	2.0
Long PFL	1	2.0
Modular Bipolar	1	2.0
Narrow DCP	1	2.0
TFN	1	2.0

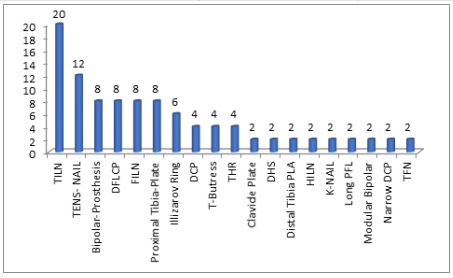
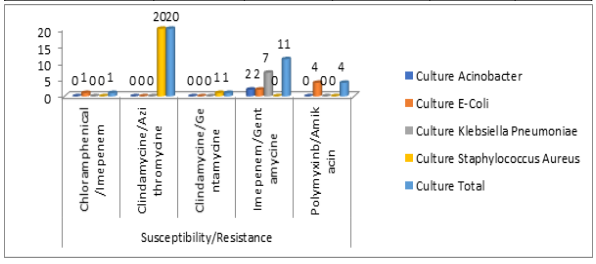


Table 3 represents the antibiotic susceptibility and resistance patterns observed in different bacterial cultures associated with Orthopaedic implant infections. Staphylococcus aureus showed the highest susceptibility to Clindamycine/Azithromycine, while Klebsiella pneumoniae was most susceptible to Imepenem/Gentamycine.

Culture		**Susceptibility/Resistance**		
	Chloramphenical/ Imepenem	**Clindamycine/Azithromycine**	**Clindamycine/Gentamycine**	**Imepenem/Gentamycine**	**Polymyxinb/Amikacin**
Acinobacter	0	0	0	2	0
E-Coli	1	0	0	2	4
Klebsiella Pneumoniae	0	0	0	7	0
Staphylococcus Aureus	0	20	1	0	0
Total	1	20	1	11	4



DISCUSSION

Orthopaedic implant surgeries have become increasingly common due to their success in restoring joint function. However, infections, although less frequent than aseptic failures, remain a devastating complication, leading to significant morbidity, economic burden, and potential relapse. Preventing infections is critical, but once established, aggressive treatment is necessary to reduce complications and restore function.

In the present study, 50 patients with post-operative Orthopaedic implant infections were evaluated for bacterial pathogens and their susceptibility/resistance patterns. Male patients constituted the majority (80%), with the most represented age group being 31–40 years (24%). This is consistent with findings by **M. Aditya et al.[7]** and **Khosravi et al.[8],** who reported a male predominance and similar age distributions. Diabetes was a comorbidity in 26% of the subjects, aligning closely with **Khosravi et al.'s [8]** findings of 20.6% diabetes prevalence in their study.

Culture positivity was observed in 74% of cases, similar to **Malhotra et al. [9]** (77.6%) but lower than **Khosravi et al.[8]** (93.9%) and **Zimmeli et al.[2]** (89%). The most commonly isolated organism was Staphylococcus aureus (42%), followed by E. coli (14%) and Klebsiella pneumoniae (14%). These findings are in agreement with studies by **Malhotra et al.[9],** where S. aureus was the predominant pathogen (23.17%), and **Khosravi et al[8].,** who reported a high prevalence of S. aureus and Klebsiella spp.. **Mussab et al.[10]** also identified S. aureus as the most common organism. Variations in pathogen distribution, such as higher E. coli and Pseudomonas spp. in studies by **Agrawal et al.[11],** may reflect differences in regional microbial flora and clinical settings.

Antibiotic susceptibility testing revealed the highest susceptibility/ resistance to Clindamycine/Azithromycine (54.05%), followed by Imepenem/Gentamycine (29.73%). Acinetobacter and Klebsiella pneumoniae were most susceptible/resistant to Imepenem/ Gentamycine, while E. coli showed maximum susceptibility to Polymyxinb/ Amikacin. S. aureus was most susceptible/resistant to Clindamycine/Azithromycine, corroborating with studies by **Aditya et al.[7],** which reported S. aureus sensitivity to clindamycin, vancomycin, and linezolid. Similar susceptibility patterns were also observed by **Shakthi et al.[12]** and **Khosravi et al.[8],** emphasizing the efficacy of imipenem, clindamycin, and vancomycin against S. aureus**.**

Overall studies by **Malhotra et al.[9]** highlighted methicillin resistance in 9.8% of S. aureus isolates, whereas **Khosravi et al.[8]** demonstrated high sensitivity of Streptococcus viridans to imipenem and clindamycin. Variations in resistance patterns across regions, such as the high susceptibility of Klebsiella spp. to imipenem reported by **Aditya et al.[7],** underscore the importance of understanding local resistance trends.

Recommendations

Strict implementation of infection control measures is essential to minimize the risk of Orthopaedic implant-associated infections. Antibiotic therapy should be selected based on local resistance patterns and patient-specific factors. Collaboration between Orthopaedic surgeons and microbiologists can help improve both prevention and management of these infections. Future studies with a larger sample size and extended follow-up are necessary to create more robust treatment and prevention protocols.

Limitations

This study was limited by its small sample size and being conducted in a single center, which may not reflect broader trends. Additionally, the lack of long-term follow-up restricted the ability to evaluate recurrence rates and the lasting effectiveness of treatments.

CONCLUSION

The high infection rate observed in our study highlights the urgent need for robust infection control measures to alleviate the financial burden on patients and hospital resources while reducing morbidity and mortality. Diabetes mellitus was identified as a significant risk factor in infected cases. The selection of empiric antibiotics should be guided by local pathogen prevalence and antimicrobial susceptibility patterns. This study provides valuable insights into aerobic bacterial profiles and antibiograms, aiding Orthopaedic surgeons in optimizing antibiotic prophylaxis and improving patient management. A multidisciplinary collaboration between Orthopaedic surgeons and clinical microbiologists is essential to further reduce infection rates. Future comprehensive studies with extended follow-up are necessary to establish effective protocols for the prevention and treatment of Orthopaedic implant infections.

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Consent: Written informed consent was obtained from all participants and securely archived.
Ethical Approval: The study received ethical clearance, adhering to the required institutional protocols.

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