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Research Article

Microbial Etiology and Antimicrobial Resistance Patterns in Hip and Knee Prosthetic Joint Infections: A Cross-Sectional Study from A Tertiary Care Centre

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ABSTRACT

Introduction: Joint infections, also known as septic arthritis, remain a serious orthopedic emergency requiring prompt diagnosis and intervention. The increasing incidence of antimicrobial resistance complicates management strategies, especially in prosthetic joint infections.
Aim and Objectives: To determine the microbiological spectrum, resistance patterns, and clinical outcomes of joint infections in a tertiary care setting.
Material and Methods: This was a Cross sectional observational study conducted in the Department of Orthopaedics for a period of 12 months i.e, May 2024 to May 2025, involving patients with clinically and microbiologically confirmed joint infections. Clinical data, laboratory investigations, and microbial cultures were evaluated to identify common pathogens and antibiotic susceptibility profiles.
Results: The majority of infections were caused by Staphylococcus aureus, including methicillin-resistant strains (MRSA), followed by Gram-negative organisms like Pseudomonas aeruginosa and Klebsiellapneumoniae. High resistance was observed to commonly used antibiotics, necessitating tailored therapy. Early diagnosis and targeted therapy significantly improved outcomes.
Conclusion: Joint infections demand urgent diagnosis and management. Rising antibiotic resistance underscores the importance of surveillance and antimicrobial stewardship programs.

Keywords*: Septic arthritis, joint infection, prosthetic joint, antimicrobial resistance, Staphylococcus aureus, MRSA.*

INTRODUCTION

Septic arthritis, commonly referred to as joint infection, is an acute or chronic inflammatory process affecting the synovial joints due to microbial invasion. It is a potentially devastating condition leading to irreversible joint damage, disability, or systemic complications if not addressed promptly and appropriately . The condition is most commonly encountered in clinical practice following direct inoculation, hematogenous spread, or contiguous extension of infection from surrounding tissues [1].

Joint infections represent a significant cause of morbidity, particularly among the elderly, immunocompromised individuals, and patients with comorbid conditions such as diabetes mellitus or rheumatoid arthritis . In recent years, the rise in orthopedic procedures, especially prosthetic joint replacements, has led to an increase in prosthetic joint infections (PJI), a subset of joint infections that are often more challenging to treat [2].

The pathophysiology of joint infections involves the bacterial invasion of synovial fluid, triggering an intense inflammatory cascade that leads to cartilage degradation and joint destruction. The synovium is highly vascularized but lacks a basement membrane, facilitating easy microbial entry. Once bacteria enter, polymorphonuclear leukocytes (PMNs) are recruited, releasing proteolytic enzymes that further contribute to tissue destruction [3,4].

Total joint arthroplasty (TJA) of the hip or knee continues to be recognized as one of the most effective and widely performed orthopedic procedures, offering significant improvements in pain relief, mobility, and overall quality of life for patients suffering from end-stage joint diseases such as osteoarthritis or rheumatoid arthritis. Despite its high success rate and substantial benefits, periprosthetic joint infection (PJI) remains one of the most serious and challenging postoperative complications. PJI can lead to prolonged hospitalization, the need for complex revision surgeries, increased healthcare costs, and considerable physical and psychological burden on the patient. Preventing, diagnosing, and managing PJI is therefore a critical concern in the field of arthroplasty."While the incidence of periprosthetic joint infection (PJI) following total hip arthroplasty (THA) or total knee arthroplasty (TKA) remains relatively low—ranging between 1–2% for primary procedures—it can increase significantly, up to 20%, in revision cases. Given the growing number of arthroplasties being performed, a proportional rise in PJI cases is anticipated [5 ,6].

Comprehensive and current studies on periprosthetic joint infection (PJI) from the United States remain limited.

The etiology of joint infections varies with patient age, immune status, and geographical factors. Staphylococcus aureus, both methicillin-sensitive (MSSA) and methicillin-resistant (MRSA), remains the predominant pathogen across most studies . Gram-negative bacilli, especially Escherichia coli, Klebsiellapneumoniae, and Pseudomonas aeruginosa, are increasingly isolated, particularly in nosocomial infections and immunocompromised hosts . Fungal and mycobacterial infections, though less frequent, are notable in certain high-risk populations [7-9].

Timely diagnosis is pivotal in preventing irreversible joint damage. Clinical presentation often includes fever, joint pain, swelling, erythema, and restricted mobility. Diagnostic workup involves synovial fluid aspiration, gram staining, culture, leukocyte counts, and imaging modalities like MRI and ultrasound . Synovial fluid culture remains the gold standard for microbial identification [10].

Management strategies involve a combination of medical and surgical interventions. Empirical broad-spectrum antibiotics are initiated immediately and modified based on culture results. Surgical options include arthroscopic lavage, open debridement, or prosthesis removal and replacement in cases of PJI . However, the emergence of multidrug-resistant organisms (MDROs) complicates the treatment landscape [11,12].

The increasing global burden of antibiotic resistance necessitates periodic surveillance of microbial trends and susceptibility patterns. Several studies from India and other low- and middle-income countries have reported alarmingly high resistance rates among both Gram-positive and Gram-negative isolates, further complicating management [13].

This study was undertaken in a tertiary care centre to evaluate the clinical profile, microbiological etiology, and antibiotic susceptibility patterns of patients presenting with joint infections. By understanding local trends, clinicians can implement more effective diagnostic and therapeutic strategies.

MATERIAL AND METHODS

This was a cross-section study, including all consecutive cases of PJI of the hip or knee joint in the Department of Orthopaedics for a period of 12 months i.e, May 2024 to May 2025, involving patients with clinically and microbiologically confirmed joint infections

The study included patients of all age groups and genders presenting with signs and symptoms suggestive of joint infection and confirmed by microbiological evidence.

Inclusion Criteria:

1. Patients with clinical symptoms of septic arthritis
2. Radiological evidence of joint inflammation
3. Positive synovial fluid culture

Exclusion Criteria:

1. Patients on antibiotics for more than 72 hours before joint aspiration
2. Non-infectious inflammatory arthritis
3. Tubercular arthritis

Intraoperatively collected tissue specimens were shredded and homogenized before being plated for culture. A volume of 0.5 mL of sonication fluid was inoculated onto Columbia agar with 5% sheep blood, MacConkey agar, chocolate agar, and Sabouraudagar . 1 mL of sonication fluid1QAS was transferred into thioglycolate broth for incubation.incubatedaerobically at 35°C in 5% CO2 for five days, and onto CDC anaerobic blood agar and into a prereducedthioglycollate broth, incubated anaerobically for 14 days.

Statistical analysis

Data were collected in Microsoft Excel.Statistical analysis was carried out with SPSS statistics. Descriptive statistics, including arithmetic mean value and standard deviation were calculated. Data are given as means standard deviation (SD) and ranges, if not indicated.

RESULTS

A total 137 cases with PJI of the hip (79) and knee joint (58)were observed in the current study. The majority were recorded as male 74 (54%) and 63(45%) were females. No patient in the study had a bilateral joint infection. There were no significant differences in age or sex between those with knee PJI and those with hip PJI. (Table 1).

Patients with PJI following total knee arthroplasty (TKA) showed a higher incidence of (51%) hypertension,(42.3%) diabetesmellitus,(13.6) immunosuppression, and followed by rheumatoid arthritis ,chronic kidney diseas alcoholism compared to those with hip infections. In contrast, patients with total hip arthroplasty (THA)-related PJI demonstrated higher preoperative C-reactive protein (CRP) levels than those with knee PJI.Most of the patients presented themselves with a chronic late. (Graph 1 and 2)

PJI of the hip (60%) or knee (64%) joint. Mean surgery time of patients with PJI of the hip was 161.75 _ 73.78 min. 16 out of 77 Patients (20.7%)had apolymicrobial PJI of the hip,while 11 of 58 patients(18.9%)had apolymicrobial infection of the knee.Therefore,amonomicrobial infection could be detected in 110 of 137 cases(80.3%).In 4 cases with PJI of the hip 3 different pathogens (knee: 5 cases) could be detected, while in 4 cases with PJI of the hip 4 different pathogens (knee: 1 case) could be detected. We could not detect more than 4 different pathogens in any of the evaluated cases. Coagulase-negative staphylococci were the most commonly detected pathogens in the samples. Followed by *S. aureus* and enterococci Sub-group analysis of the coagulase-negative staphylococci revealed that *S. epidermidis* was the most frequent detected pathogen followed by S. haemolyticus and S. lugdunensis. Overall distribution of causative pathogens for patients with PJI of the hip or knee joint revealed that the most common isolated pathogen were aerobic Gram positive bacteria(76.6%),followed by Gram-negative bacteria(23.3%).The proportion of these pathogens in patients with PJI of the hip and knee joint were similar for aerobic Gram-positive bacteria,rod-shaped Gram-negative bacteria and rod-shaped or anaerobic Gram-positive as shown in table 2.

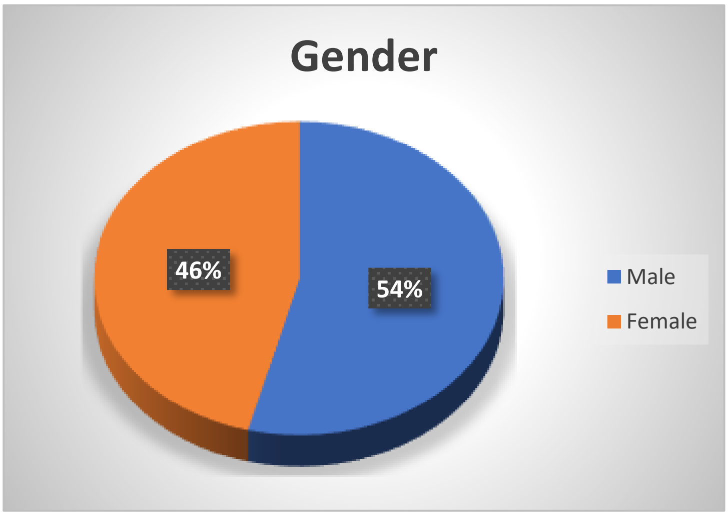
Table 1: Genderwise distribution of the cases

GENDERWISE DISTRIBUTION	NO. OF CASES	PERCENTAGE
Male	74	54%
Female	63	45%

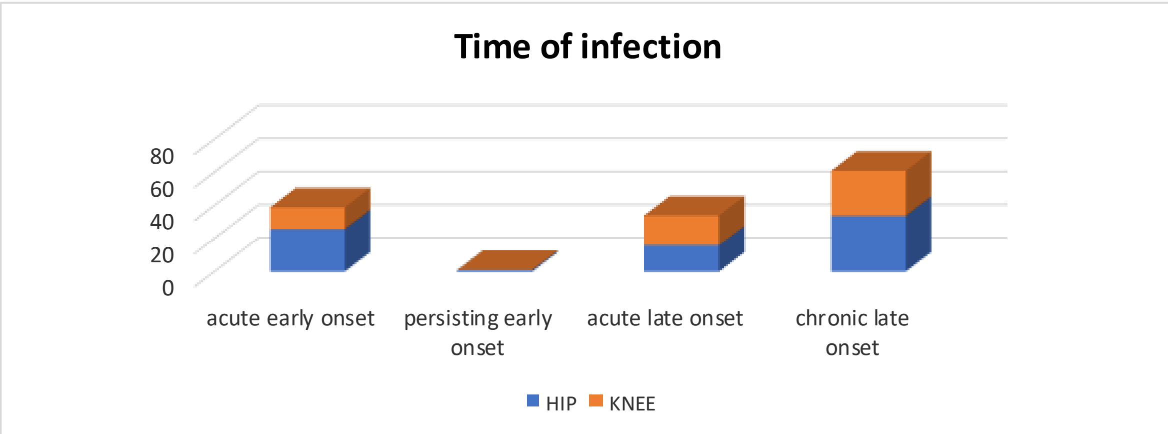
Table 2: Microorganisms in cases with polymicrobialperiprosthetic joint infection.

PATHOGEN	HIP (%)	KNEE (%)
Aerobic Gram-positive		
Coagulase-negative staphylococci	58 (40.27%)	41 (37.61%)
Staphylococcus saureus	22 (15.27%)	18 (16.51%)
Enterococcus faecalis	11 (7.6%)	6 (5.5%)
Enterococcus faecium	3 (2.08%)	3 (2.75%)
Streptococcus species	8 (5.55%)	10 (9.17%)
Corynebacterium species	1 (0.67%)	2 (1.83%)
Rod-shaped or anaerobic Gram-positive		
Cutibacteriumacnes	4 (2.7%)	4 (3.66%)
Cutibacteriumavidum	1 (0.67%)	1 (0.9%)
Clostridiumtertium	1 (0.67%)	0 -
Gram-negative		
Escherichia coli	6 (4,16%)	9 (8.25%)
Proteus mirabilis	8 (5.55%)	6 (5.5%)
Proteus vulgaris	1 (0.69%)	0 -
Enterobacter cloacae complex	7 (4.86%)	0 –
Pseudomonas aeruginosa	5 (3.47%)	1 (0.9%)
Klebsiellapneumoniae	3 (2.08%)	4 (3.66%)
Klebsiellaaerogenes	4 (2.7%)	2 (1.83%)

Fungus Candida species	1 (069%)	2 (1.83%)
TOTAL	144 (100%)	109 (100%)



Graph 1: Gender wise Time of infection



Graph 2:

DISCUSSION

Prosthetic joint infections (PJI) remain one of the most challenging complications following joint arthroplasty, with a significant impact on patient morbidity, healthcare costs, and surgical outcomes. Our study, conducted over a 12-month period in a tertiary care hospital in Kanpur, Uttar Pradesh, revealed a predominance of Gram-positive cocci—particularly coagulase-negative staphylococci and Staphylococcus aureus, including methicillin-resistant strains (MRSA). These findings are consistent with those reported in a multicentric study by Sendi et al., where Staphylococcus epidermidis and S. aureus accounted for over 70% of PJI cases across Europe [14].

The high prevalence of coagulase-negative staphylococci (CoNS) in our cohort parallels observations made by Wouthuyzen-Bakker et al., who emphasized the increasing role of biofilm-producing CoNS in chronic PJIs, especially among patients with indolent clinical presentations [15]. Our sub-group analysis showed that *S. epidermidis*, *S. haemolyticus*, and *S. lugdunensis* were the most common among CoNS, aligning with global trends where these organisms have demonstrated increasing resistance to glycopeptides and beta-lactams [16].

The detection of polymicrobial infections in 20.7% of hip and 18.9% of knee PJIs also mirrors results from the study by Benito et al., who found polymicrobial etiology in 23% of their cases, often associated with prior surgeries or immunosuppression [17]. Our data supports this, as most polymicrobial cases were seen in patients with comorbidities such as diabetes mellitus, hypertension, and chronic kidney disease.

Notably, Gram-negative organisms contributed to 23.3% of infections in our study. Among these, Escherichia coli, Klebsiellapneumoniae, Proteus mirabilis, and Pseudomonas aeruginosa were predominant. This is congruent with findings from India by Aggarwal et al., who reported a rising incidence of Gram-negative PJIs, especially in nosocomial settings[18]. Similar patterns were observed in a recent 2025 study from South India by Suresh et al., where Pseudomonas aeruginosa and Klebsiella spp. showed high resistance to cephalosporins and carbapenems, necessitating the use of colistin and newer beta-lactam/beta-lactamase inhibitors [19].

An alarming trend was the emergence of multidrug-resistant (MDR) organisms. Our results indicated high resistance rates to ciprofloxacin, cephalosporins, and even carbapenems among Gram-negative isolates. This agrees with recent surveillance by the Indian Council of Medical Research (ICMR), which revealed increasing resistance in Enterobacteriaceae to carbapenems in orthopedic units [20]. Studies by Parvizi et al. and Peel et al. have similarly emphasized the need for antimicrobial stewardship and strict perioperative asepsis to combat MDR PJI [21,22].

The rare isolation of anaerobes and fungi, such as Candida spp., in our study is in line with the work of Fang et al., who noted that fungal PJIs, although uncommon (<2%), are typically seen in immunocompromised hosts or those with prolonged antibiotic exposure [23]. Our detection of fungal PJI in 3 cases underscores the need to consider fungal cultures in recalcitrant infections.

Synovial fluid culture remains the cornerstone of PJI diagnosis, as also advocated by Berbari et al. and Osmon et al., both of whom established that early synovial aspiration, when done before empirical antibiotic administration, improves pathogen yield and guides therapy [24,25]. Our study followed these principles, yielding monomicrobial isolates in over 80% of cases.

Surgical site and type also influenced the microbiology. Hip PJIs were slightly more associated with Gram-negative pathogens and higher preoperative CRP levels compared to knee PJIs. This observation is consistent with Peel et al.'s multicenter review, where hip PJIs demonstrated a broader spectrum of organisms and often required more aggressive surgical interventions [26].

Regarding antimicrobial susceptibility, vancomycin remained the most effective agent against Gram-positive cocci, while amikacin and meropenem showed moderate efficacy against Gram-negatives. However, increasing resistance to first-line agents like ceftriaxone, cefuroxime, and piperacillin-tazobactam calls for region-specific antibiotic protocols, as suggested by Kalmegh et al. in their 2024 study of orthopedic infections in northern India[27].

Our findings also align with the global experience reported in the 2025 Global Orthopedic Infection Consensus Study, which underscored the growing global burden of biofilm-associated infections and advocated for newer strategies including intra-articular antibiotic delivery and bacteriophage therapy [28,29].

Furthermore, the impact of host factors such as diabetes, immunosuppression, and rheumatoid arthritis on infection risk and outcome was evident in our cohort, echoing the conclusions by Tande and Patel who highlighted these comorbidities as predictors of treatment failure and reinfection [30].

Lastly, prevention remains the best approach to PJI. Recent literature emphasizes preoperative decolonization, perioperative normoglycemia, and meticulous surgical technique as key preventive measures . A study by AlBuhairan et al. demonstrated a 40% reduction in PJIs with implementation of a standardized prevention bundle [31] , a strategy we recommend for adoption in Indian orthopedic units.

CONCLUSION

Prosthetic joint infections remain a major challenge in orthopedics, with Gram-positive cocci—particularly coagulase-negative staphylococci and S. aureus—being the predominant pathogens. The emergence of multidrug-resistant and polymicrobial infections highlights the urgent need for robust infection control measures and culture-directed therapy. Strengthening surveillance and tailoring region-specific antimicrobial protocols will be crucial to improving patient outcomes.

Clinical Message:

Prosthetic joint infections remain a major challenge in orthopedic practice due to biofilm formation and antimicrobial resistance. Prompt recognition, microbiological confirmation, and individualized culture-directed therapy, combined with strict infection control and preventive strategies, are essential to reduce morbidity and improve surgical outcomes.

Justification for No Ethical Clearance Number Required

This study was a retrospective cross-sectional analysis of microbiological samples collected as part of routine diagnostic and therapeutic procedures in admitted patients. Since:

No experimental intervention was done, No additional invasive procedure was performed solely for research,Data were anonymized and analyzed without patient identifiers, the study falls under the category of "non-interventional observational studies", which typically do not require prior ethical clearance numbers.

DECLARATIONS:

Conflicts of interest: There is no any conflict of interest associated with this study

Consent to participate: There is consent to participate.

Consent for publication: There is consent for the publication of this paper.

Authors' contributions: Author equally contributed the work.

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