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Microbiological Profiles and Antibiotic Resistance of Periprosthetic Knee and Hip Infections: A Retrospective Study

Periprostetik Diz ve Kalça Enfeksiyonlarının Mikrobiyolojik Profilleri ve Antibiyotik Direnci: Retrospektif Bir Çalışma

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ABSTRACT

Objectives: The aim of this study was to investigate microbiological profiles and antimicrobial resistance of hip and knee periprosthetic joint infection (PJI).

Methods: Patients over 18 years of age who underwent hip or knee primary arthroplasty between September 2018 and January 2022 were screened from the hospital database and retrospectively included in the study. Patients' demographic data, periprosthetic tissue culture, and joint fluids' antimicrobial resistances were evaluated.

Results: A total of 51 patients with 66.7% being female were enrolled. The hip joint was infected in 62.7% of the patients. The most common causative pathogen identified was *Coagulase-negative staphylococci* (CoNS) (41.2%), followed by *Staphylococcus aureus* (23.5%) and *Acinetobacter baumanii* (23.5%). The proportion of *A. baumanii* in hip PJI was higher than that in knee PJI (p=0.02). Twenty-five of the detected Acinetobacter strains were resistant to carbapenems. The distribution of Gram-positive or Gram-negative microorganisms between the knee and hip PJI groups was not statistically significant (p>0.05). The infection was monobacterial in 56.9% of the patients. Polymicrobial pathogens were more likely to occur in the hip prosthetic joint than in the knee prosthetic joint, but no statistical difference was observed between the two groups (p>0.05).

Conclusion: The predominant bacteria usually differ among different geographic area and location of the prosthesis. Knowing the causative agents and antimicrobial resistance is the basic strategy in infection management. Considering that there are limited evidence in literature about PJI's, further studies are needed to accumulate knowledge and to analyze better microbiological profiles of PJIs.

Keywords: Hip; knee; microorganism; pathogen; prosthetic joint infection; resistance; susceptibility.

ÖZET

Amaç: Bu çalışmanın amacı, kalça ve diz periprostetik eklem enfeksiyonlarının mikrobiyolojik profillerini ve antimikrobiyal direncini araştırmaktır.

Yöntem: Eylül 2018-Ocak 2022 tarihleri arasında kalça veya diz primer artoplastisi geçiren 18 yaş üzeri hastalar hastanenin veri tabanından tarandı ve çalışmaya dahil edildi. Hastaların demografik verileri, periprostetik doku kültürü ve eklem sıvılarının antimikrobiyal dirençleri değerlendirildi.

Bulgular: Çalışmaya %66,7'si kadın olmak üzere toplam 51 hasta dahil edildi. Hastaların %62,7'sinde kalça ekleminin enfekte olduğu görüldü. En yaygın patojen koagülaz-negatif stafilokok (%41,2) olarak saptanmış olup, bunu *Staphylococcus aureus* (%23,5) ve *Acinetobacter baumannii* (%23,5) izledi. *A.baumannii*'nin oranı kalça periprostetik eklem enfeksiyonlarında diz periprostetik eklem enfeksiyonlarından daha yüksek saptandı (p=0,02). Saptanan *Acinetobacter* türlerinin %25'i karbapenemlere karşı dirençlidir. Diz ve kalça periprostetik eklem enfeksiyonları gruları arasında gram-pozitif veya gram-negatif mikroorganizmaların dağılımı istatistiksel olarak anlamlı değildir (p>0,05). Hastaların %56,9'unda enfeksiyon monobakteriyeldir. Patojenlerin polimikrobiyal olma olasılığı kalça protezlerinde diz protezlerine göre daha fazla olmasına rağmen iki grup arasındaki fark istatistiksel olarak anlamlı değildir (p>0,05).

Sonuç: Dominant bakteri genellikle farklı coğrafi bölgelere ve protez lokasyonuna göre değişmektedir. Enfeksiyona neden olan ajanın izole edilmesi ve antimikrobiyal direncin bilinmesi, enfeksiyon yönetiminde temel stratejidir. Literatürde periprostetik eklem enfeksiyonları konusunda bulguların sınırlı olduğu göz önüne alındığında bilgi birikimi ve periprostetik eklem enfeksiyonlarının mikrobiyolojik profillerinin daha iyi analiz edilmesi için daha fazla çalışma gereklidir.

Anahtar sözcükler: Direnç; diz; duyarlılık; kalça; mikroorganizma; patojen; protez eklem enfeksiyonu.

In recent years, periprosthetic joint infection (PJI) has become a crucial focus of orthopedic surgeons all over the world, because it seriously affects the implanted joint, with an important physical, psychological, and economic burden on both patients and health-care systems. In the elderly population, the number of prosthetic joint implantations is also increasing due to the increase in life expectancy, change in lifestyle, and the desire to lead a more active life. This increase also brings with a concomitant increase in the number of PJI cases.[1]

The prosthetic surgery is a procedure that improves the lives of millions of people every year. Most patients who had joint arthroplasty, experience good results, but rarely PJI can develop as a devastating surgical complication in some patients.[2,3] The incidence of PJI due to primary arthroplasty is estimated to be 1% for the hip joint and 2% for the knee joint.[1,3,4] This infection, which causes a high rate of morbidity with prolonged hospitalizations and antimicrobial treatments and repetitive surgical interventions, is difficult to manage and requires a multidisciplinary approach.[1,3-6] For a successful treatment, it is important to identify the microorganisms causing the infection and the antimicrobial susceptibility patterns, and to choose the most effective, safe, and narrow-spectrum antimicrobial agent in the fight against infection.[1,4,7,8] The aim of this study was to investigate microbiological profiles and antimicrobial resistance of hip and knee PJI.

Methods

Setting, study design, and patients

This single-center and retrospective study was conducted in the Medeniyet University Goztepe Training and Research Hospital. The study was approved by the Local Ethic Committee of our hospital with the June 30, 2021 dated and 2021/0351 umbered decision. Patients aged above 18 years of age, who underwent hip and knee primary arthroplasty and were diagnosed with PJI between September 2018 and January 2022 were retrospectively screening from the hospital database and included in the study. Patients who were diagnosed before the beginning of the study, relapsed, had primary septic arthritis, and operated due to periprosthetic fractures were excluded from the study.

Definition of PJI

Definition of PJI was made based on The New 2018 International Consensus Meeting definition of PJI criteria.[9] Accordingly, definite PJI was considered to be if one of two major criteria or three of five minor criteria exist. The presence of a sinus tract communicating with the prosthesis or two positive periprosthetic cultures with identical organism is called the major criteria; while elevated ESR (Acute PJI: no threshold, Chronic PJI: >30 mm/h) or CRP (Acute PJI: >100 mg/L, Chronic: PJI >10 mg/L), elevated SF WBC count (Acute PJI: 10,000 cells/μL, Chronic PJI: 3000 cells/μL) or changes in leukocyte esterase strip (Acute PJI: + or ++, Chronic PJI: + or ++), elevated SF PMN % (Acute PJI: 90%, Chronic PJI: 80%), positive histologic analysis of the periprosthetic tissue (Acute PJI: >5 neutrophils per high-power field in 5 high-power fields (×400), Chronic PJI: >5 neutrophils per high-power field in 5 high-power fields (×400)), and a single positive culture are called minor criteria.[9]

PJI was considered monomicrobial if only one bacterial species had grown and polymicrobial if more than one species was isolated from periprosthetic tissue and fluid cultures. The patients were classified according to onset of the infection "after joint arthroplasty" as early (<3 months), delayed (3–12 months), and late-onset (>12 months). Cefazolin was administered as surgical prophylaxis, and clindamycin or vancomycin was administered to patients with penicillin allergy.

Microbiological analysis

For each patient, 3–5 periprosthetic tissue and joint fluid samples which were taken intraoperatively during the first debridement surgery were sent to the laboratory for microbiological evaluation. The samples were inoculated on chocolate agar, 5% sheep blood agar and thioglycolate medium and incubated at 37°C for 48 h. Growing microorganisms were studied with Vitek 2 compact (bioMérieux, Marcy l'Etoile, France) device. The results were evaluated according to the criteria of The European Committee on Antimicrobial Susceptibility Testing. Antibiotic sensitivities to meropenem were studied in accordance with antibiotic gradient test (E-test, bioMérieux, France) and CLSI standards.

Data collection

Patients' demographic characteristics, comorbidities, joint undergoing arthroplasty, onset time of infection, length of hospital stay, causative pathogens, and number of debridements were recorded.

Statistical analysis

Descriptive statistics were presented as numbers and percentages (%), mean±standard deviation (mean±SD), or median with interquartile range (25–75% percentile). Categorical variables were compared with Pearson Chi-square test or Fisher's exact test. Normality was assessed with Shapiro–Wilk test. Non-normal distributed continuous variables were compared with Mann–Whitney U test. Double-sided p-values of <0.05 were considered statistically significant. We analyzed data with R version 4.0.2 (https://www.r-project.org/).

Results

Demographics

A total of 51 PJI (female gender: 66.7%, n=34) was included in the study. The mean age was 72.8±12.5 (minimum: 48, maximum: 94). There were 19 knee PJI patients (37.3%) and 32 hip PJI patients (62.7%). Of the total patients, 62.7% (n=32) was early-onset PJI. The percentages for monobacterial PJI and polybacterial PJI were 56.9% and 39.2%, respectively. In two cases, cultures were sterile. About 86.3% of the patients (n=44) had underlying comorbidities.

Table 1 presents the comparison of the knee PJI group and hip PJI group. The proportion of diabetes mellitus was higher in the patients with knee PJI when compared to the patients with hip PJI (68.4% versus 31.2%, p=0.02). In terms of demographic characteristics, length of hospital stay, and time

Table 1. Comparison of hip and knee prosthetic joint infection groups

	Total	Knee (n=19)	Hip (n=32)	p-value
Gender, n (%)				0.26†
Male	17 (33.3)	4 (21.1)	13 (40.6)	
Female	34 (66.7)	15 (78.9)	19 (59.4)	
Age, mean±SD	72.8 (12.5)	74.9 (10.6)	71.6 (13.5)	0.44‡
Co-morbidity, n (%)	44 (86.3)	18 (94.7)	26 (81.2)	0.24†
Diabetes mellitus	23 (45.1)	13 (68.4)	10 (31.2)	0.02*†
Hypertension	31 (60.8)	15 (78.9)	16 (50.0)	0.08†
Cardiovascular disease	17 (33.3)	7 (36.8)	10 (31.2)	0.92†
Malignity	9 (17.6)	2 (10.5)	7 (21.9)	0.46†
Chronic renal failure	5 (9.8)	2 (10.5)	3 (9.4)	>0.99†
Length of hospital stay, median (25–75%)	3 (1–16)	3 (2–16)	4 (1–10)	0.42‡
Time of infection, n (%)				
Early onset infection	32 (62.7)	9 (47.4)	23 (71.9)	0.15†
Delayed onset infection	9 (17.6)	6 (31.6)	3 (9.3)	0.06†
Late onset infection	10 (19.6)	4 (21)	6 (18.8)	>0.99†
Monobacterial infection, n (%)	29 (56.9)	13 (68.4)	16 (50)	0.32†
Polybacterial infection, n (%)	20 (39.2)	5 (26.3)	15 (46.9)	0.25†
Total number of debridement, median (25–75%)	4 (2–19)	5 (2–14)	4 (2–19)	0.17‡

*P<0.05, †Chi-square test, ‡Mann–Whitney U test.

of infection; no statistical difference was observed between the two groups. In our study, polymicrobial pathogens were more likely to occur in the hip prosthetic joint than in the knee prosthetic joint (5 vs. 15). In the hip polymicrobial PJIs, there were 6 cases (6/15, 40%) with two causative micro-organisms, 5 cases (5/20, 25%) with three causative micro-organisms, 2 cases (2/15, 13.33%) with four, 1 case (1/15, 6.67%) with five, and 1 case (1/15, 6.67%) with six causative agents. The number of bacteria isolated was higher in the hip PJI compared to the knee PJI but there is no statistical difference that was observed between the two groups.

Table 2. Distribution of microorganisms between hip and knee prosthetic joint infection groups

Causative pathogen	Total	Knee (n=19)	Hip (n=32)	p-value
Gram positive, n (%)	37 (72.5)	15 (78.9)	22 (68.8)	0.64
CoNS	21 (41.2)	10 (52.6)	11 (34.4)	0.32
Staphylococcus aureus	12 (23.5)	3 (15.8)	9 (28.1)	0.50
Enterococcus fecalis	4 (7.8)	0 (0)	4 (12.5)	0.28
Corynebacterium striatum	4 (7.8)	1 (5.3)	3 (9.4)	>0.99
Streptococcus dysgalactiae	2 (3.9)	1 (5.3)	1 (3.1)	>0.99
Gram negative, n (%)	26 (51)	7 (36.8)	19 (59.4)	0.21
Acinetobacter baumanii	12 (23.5)	1 (5.3)	11 (34.4)	0.02*
Klebsiella pneumoniae	10 (19.6)	3 (15.8)	7 (21.9)	0.73
Pseudomonas aeruginosa	8 (15.7)	3 (15.8)	5 (15.6)	>0.99
Escherichia coli	5 (9.8)	1 (5.26)	4 (12.5)	0.64
Enterobacter cloaca	5 (9.8)	0 (0)	5 (15.6)	0.14
Achromobacter denitrificans	1 (1.96)	0 (0)	1 (3.1)	>0.99
Delftia acidovorans	1 (1.96)	1 (5.3)	0 (0)	0.37
Enterobacteriaceae	17 (33.3)	4 (21.1)	13 (40.6)	0.26
Candida albicans, n (%)	3 (5.9)	2 (10.5)	1 (3.1)	0.55

*P<0.05, †Chi-square test. CoNS: *Coagulase-negative staphylococci*; *Enterobacteriacea: Klebsiella pneumoniae* and *Escherichia coli* and *Enterobacter cloaca*.

Table 3. Antimicrobial sensitivity of causative Gram-positive microorganisms in the knee and hip prosthetic joint infections

	S. aureus		CoNS		*E. faecalis*		*S. dysgalactiae*	
	Knee (n=3)	Hip (n=9)	Knee (n=10)	Hip (n=11)	Knee (n=0)	Hip (n=4)	Knee (n=1)	Hip (n=1)
Ampicillin	-	-	-	-	-	2 (50)	-	-
Ampicillin-Sulbactam	-	-	-	-	-	2 (50)	-	-
Fusidic acid	2 (66.7)	8 (88.9)	4 (40)	4 (36.3)	-	-	-	-
Penicillin	-	-	-	-	-	-	1 (100)	1 (100)
Ciprofloxacin	3 (100)	3 (33.3)	1 (10)	6 (54.5)	-	2 (50)	-	-
Clindamycin	3 (100)	6 (66.7)	3 (30)	5 (45.5)	-	-	-	-
Gentamicin	3 (100)	7 (77.8)	3 (30)	7 (63.6)	-	-	-	-
Tetracycline	3 (100)	7 (77.8)	3 (30)	7 (63.6)	-	-	0 (0)	0 (0)
Trimethoprim-sulfamethoxazole	3 (100)	8 (88.9)	7 (70.0)	8 (72.7)	-	0 (0)	1 (100)	1 (100)
Vancomycin	3 (100)	9 (100)	10 (100)	11 (100)	-	4 (100)	1 (100)	1 (100)
Daptomycin	3 (100)	9 (100)	10 (100)	11 (100)	-	-	-	-
Linezolid	3 (100)	9 (100)	10 (100)	11 (100)	-	4 (100)	1 (100)	1 (100)
Cefoxitin	3 (100)	6 (66.7)	2 (20)	4 (36.3)	-	-	-	-

S. aureus: *Staphylococcus aureus, CoNS: Coagulase-negative staphylococci, E .faecalis: Enterococcus faecalis, S. dysgalactiae: Streptococcus dysgalactiae*. Results were presented as column percentages (n, %).

Table 4. Comparison of methicillin resistance between the knee and hip staphylococcal prosthetic joint infections

	Knee PJI	Hip PJI	p†-value
S. aureus, n (%)			
Methicillin-resistant	0 (0)	3 (33.3)	0.76
Methcillin-sensitive	3 (100)	6 (66.7)	
CoNS, n (%)			
Methicillin-resistant	8 (80)	7 (63.6)	0.75
Methcillin-sensitive	2 (20)	4 (36.4)	

†Chi-square test. PJI: Prosthetic joint infection; *S. aureus: Staphylococcus aureus*; CoNS: Coagulase-negative *staphylococci*.

Microbiology

The most common causative pathogen was coagulase negative *staphylococci* (CoNS) (41.2%; n=21), followed by *Staphylococcus aureus* (23.5%; n=12) and *Acinetobacter baumanii* (23.5%; n=12). The proportion of *A. baumanii* in hip PJI was higher than that in knee PJI (34.4% versus 5.3%, p=0.02). The distribution of gram-positive or negative microorganisms between the knee and hip PJI groups was not statistically significant (Table 2).

Antimicrobial resistance of Gram-positive bacteria isolated from hip and knee joints is shown in Table 3. While methicillin resistance was found to be 54.5% among staphylococcal species; it was found 25% in *S. aureus* strains and 71.4% in coagulase negative *Staphylococcus*. Sensitivity of fucidic acid found as 54.4%, 51.5% in clindamycin, 79% in sulfamethoxazole, and 100% in vancomycin, linezolid, and daptomycin.

There was no statistical difference in methicillin-resistant staphylococcal PJI between knee and hip (p=0.76 and p=0.75, respectively) (Table 4).

Antimicrobial resistance status for the most seen five difference Gram-negative bacteria isolated from the hip and knee joints is shown in Table 5. Extended spectrum beta lactamase (ESBL) positivity rate in Enterobacteriacea (*Klebsiella pneumoniae* n=5, *Escherichia coli* n=2 and *Enterobacter cloaca* n=1) strains was 40%. Carbepenem resistance was found to be 26.7% when all strains of *Klebsiella pneumoniae* (n=3), *A. baumanii* (n=3) and *Pseudomonas aeruginosa* (n=2) were considered, and 25% when only *A. baumanii* was evaluated (Table 5).

Discussion

This study is one of the few studies evaluating the differences between microbiological characteristics of hip and knee PJIs. In our study, no significant difference was found between the hip and knee PJIs in terms of demographics and laboratory parameters. In addition, in our study, the number of bacteria isolated was higher in the hip PJI compared to the knee PJI.

Several risk factors have been showed for developing of PJIs which are including increased body-mass index, previously underwent joint surgery, steroid use, and comorbidi-

Table 5. Antimicrobial sensitivity of causative Gram-negative microorganisms in the knee and hip prosthetic joint infections

	K. pneumoniae		*P. aeruginosa*		*A. baumanii*		*E. coli*		*E. cloaca*	
	Knee (n=3)	Hip (n=7)	Knee (n=3)	Hip (n=5)	Knee (n=1)	Hip (n=11)	Knee (n=1)	Hip (n=4)	Knee (n=0)	Hip (n=5)
Gentamicin	2 (66.7)	4 (57.1)	1 (33.3)	3 (60)	0 (0)	6 (54.6)	1 (100)	3 (75)	-	5 (100)
Amikacin	1 (33.3)	6 (85.7)	2 (66.7)	3 (60)	0 (0)	7 (63.6)	1 (100)	4 (100)	-	5 (100)
Ceftazidime	1(33.3)	4 (57.1)	2 (66.7)	3(60.0)	0 (0)	5 (45.4)	0 (0)	3 (75)	-	4 (80)
Ciprofloxacin	1 (33.3)	2 (28.6)	1 (33.3)	2 (40)	0 (0)	2 (18.2)	0 (0)	1 (25)	-	3 (60)
Tazobactam piperacillin	2 (66.7)	4 (57.1)	1 (33.3)	3(60)	0 (0)	5 (45.4)	0 (0)	4 (100)	-	4 (80)
Meropenem	2 (66.7)	5 (71.4)	3 (100)	3 (60)	1 (100)	8 (72.7)	1 (100)	4 (100)	-	5 (100)
Tigecycline	2 (66.7)	6 (85.7)	-	-	1 (100)	9 (81.8)	1 (100)	4 (100)	-	5 (100)
Colistin	3 (100)	6 (85.7)	3 (100)	5 (100)	1 (100)	11 (100)	1 (100)	4 (100)	-	5 (100)
Trimethoprim-sulfamethoxazole	1 (33.3)	2 (28.6)	-	-	0 (0)	6 (54.6)	0 (0)	2(50)	-	5 (100)

K. pneumoniae: Klebsiella Pneumoniae, P. aeruginosa: Pseudomonas aeruginosa, A. Baumanii: Acinetobacter baumanii, E. coli: Escherichia coli, E. cloaca: Enterobacter cloaca. Results were presented as column percentages (n, %).

ties such as diabetes mellitus and rheumatoid arthritis.[10] In the present study, the presence of diabetes mellitus was significantly higher among patients with knee PJI (72.2%) compared to those with hip PJI (38.5%).

Microorganisms causing PJI vary according to the geographic region where studies are conducted. Several publications have demonstrated that microbiological profile may differ in different countries.[11] In a study conducted by Tsai et al.[12] in Taiwan, *S. aureus (S. aureus)* was the most common causative organism (29.9%), followed by *Coagulase negative Staphylococci* (CoNS) and *Enterococci* (16.7%) and (9.7%), respectively. Pursuant to a retrospective research by Aggarwall et al.[13] which were studied in 2014 and includes two high-capacity infection disease referral center in the United States and Europe, *S. aureus* was found as the most common microorganism in the United States' center (31.0%) compared to the European center (13.0%). Holleyman et al.[14] found that *Staphylococcus* was the most common organism isolated after the revision of a primary implant for infection. In the present study, the most common causative microorganism responsible for PJI was found as coagulase negative staphylococci (41.2%) followed by *S. aureus* (23.5%) and *A. baumanii* (23.5%). In another study from China, the most common organisms were staphylococcal species. In the same study, the prevalence of PJI-causing organisms was found to be different between infected hip and knee joints: Anaerobes, Gram-negative bacilli, and polymicrobial pathogens were more likely to occur in hip prosthetic joints than in knee PJIs.[15] In our study, no statistically significant difference was found between the knee and hip PJIs in terms of Gram (+) and Gram (-) microorganisms just as, in the study which is conducted by Tsai et al.[11] and clarified that no significant difference was found between the joint locations in terms of Gram (+) and Gram (-) bacteria.

Polymicrobial PJIs tend to occur earlier following arthroplasty surgery compared to monomicrobial PJIs.[16] Polymicrobial PJIs occur in in <20% of cases.[5,17] However, there are other studies reporting higher prevalence at 37%. In the same study, polymicrobial PJIs occurred more frequently in the early post-operative period.[18] We found that the frequency of polymicrobial PJI to be 43.1% and 62.7% of our patients was in the early post-operative period. In our study, polymicrobial pathogens were more likely to occur in the hip prosthetic joint than in the knee prosthetic joint (15 vs. 5). The number of knee polymicrobial PJIs was lower than that of hip PJI. Only five knee joints had polymicrobial involvement. However, the difference did not reach statistical significance.

In the study of Peng et al.[15] occurrence of MRS (methicillin resistant *staphylococci*) was high with 76% of CoNS and 40% of *S. aureus* being methicillin resistant. In the present study, the rate of MRS was 25% in *S. aureus* strains and 71.4% in CoNS. There was no statistical difference in methicillin-resistant staphylococcal PJI between knee and hip. All isolates were suspectible to vancomycin, daptomycin, and linezolide and were options for empirical treatment. The susceptibility rates against trimethoprim sulfamethoxazole, fusidic acid, and clindamycin were 89%, 54.5%, and 51.5%, respectively, and these agents were among the alternative treatment options that can be used as antibiotics.

Resistance of gram-negative bacteria is increasing in as PJI agents. Benito et al.[19] reported an increase in Gram-negative infections from 2003 to 2012 and multi-drug infections mainly due to the increase in resistant Gram-negative bacilli. In our study, the most abundant Gram-negative microorganism was 23.5% *Acinetobacter baumannii*, followed by *Klebsiella pneumoniae*. Acinetobacter strains played a more significant role in hips than in knees. We found the ESBL ratio among *Enterobacteriacae spp* isolates as 40%. Carbepenem resistance (three *Klebsiella pneumoniae*, three *A. baumanii*, and two *Pseudomonas aeruginosa*) was 26.7%. Drago et al.[20] found the rate of ESBL positive *Enterobacteriacea* as 8.3%, and carbapenem resistance in only three isolates (one *Klebsiella pnuemoniae* and two *A. baumanii*). ESBL positivity among *Enterobacteriacea* isolates was found as 8% by Rodríguez-Pardo et al.,[21] while *Escherichia coli* producing ESBL was found as 86% by Ortego-Pena et al.[22] However, since these rates were from the local results, neither a definitive conclusion could be drawn nor the outcomes could be generalized. Nevertheless, the increase in resistant microorganisms is worrisome and causes increased mortality, morbidity, and economic burden. Knowing the antimicrobial resistance rates in etiology is essential in the management of treatment. Local resistance rates vary and it guides the selection of empirical treatment until culture results are available.

Study limitations

This study has some limitations. First, it has a retrospective design with a relatively small number of patients. Second, it was conducted in a single center. These limitations indicate the need for further comprehensive studies in the future. We believe that our results will be guiding for potential studies on PJIs.

In the present study, the most commonly isolated microorganism was coagulase negative staphylococci followed by *S. aureus* and *A. baumanii*, although the predominant bacteria differ among different geographic areas and anatomic location of the prosthesis. The rate of MRS was found as 54.4% Given scarce evidence in the literature on PJIs, further studies are warranted in order to accumulate knowledge and to better analyze microbiological profiles and antibiotic resistance rates of PJIs.

Ethics approval

The study was approved by the Local Ethic Committee of our hospital with the June 30, 2021 dated and 2021/0351 umbered decision.

Disclosures

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Conflict of Interest: None declared.

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