Journal of Cardiovascular Disease Research
ISSN: 0975-3583, 0976-2833 VOL 15, ISSUE 08, 2024

A RETROSPECTIVE STUDY OF CLINICAL PROFILE, RISK FACTORS, MANAGEMENT AND TREATMENT OUTCOME OF PATIENTS WITH PERIPROSTHETIC JOINT INFECTIONS (PJIS) IN A TERTIARY CARE, TELANGANA, INDIA.

Dr Karthik Manchala[1], Dr.Avinash Kumar Katukam[2], Dr.GudaRajkamal[3], Dr.Doddoju Veera Bhadreshwara Anusha[4*]

[1]Associate Professor, Department of Orthopaedic surgery, RVM institute of medical sciences and research centre, Siddipet, Telangana.

[2]Associate Professor, Department of Orthopaedic surgery, RVM institute of medical sciences and research centre, Siddipet, Telangana.

[3]Assistant Professor, Department of Orthopaedic surgery, RVM institute of medical sciences and research centre, Siddipet, Telangana.

[4*]Associate professor, Department of Community Medicine, RVM institute of medical sciences and research centre, Siddipet, Telangana.

Corresponding Author: Dr Doddoju Veera Bhadreshwara Anusha
Associate professor, Department of Community Medicine, RVM institute of medical sciences and research centre.

Abstract:

Introduction: Infections associated with orthopaedic implants, especially prosthetic joint infections (PJIs) are increasing with advancement in joint arthroplasty. The reported prevalence of PJI out to 2 years after hip replacement is 1.63% and after knee replacement is 1.55%.PJI for the individual patient is devastating with increased rate of mortality, increased risk of morbidity, decreased quality of life, and potential for decreased level of mobility and ambulation. Rapid detection of infection is of paramount importance because delaying the start of treatment of PJI may result in the loss of the device. The consequence of PJI is quite severe at the patient as well as the healthcare system level. Hence this study was done to understand clinical profile, risk factors, and treatment outcome which can guide clinicians in appropriate management.

Methodology: A retrospective study was done in cohort of patients in a tertiary care diagnosed as periprosthetic joint infections as per guidelines by infectious disease society of America. All the patients' records holding diagnosis as PJIs during January 2021 to December 2023 were included. After obtaining permission from institutional ethical committee clearance, data from patient's medical records were collected and analysed. Data on patients' socio-demographic characteristics, clinical profile, investigations, treatment modalities and outcome were retrieved. A total of 50 such patients' records were analysed. The data were analyzed using statistical package for the social sciences (SPSS) version 20. Chi square test and students t test was used with $P<0.05$ considered as statistically significant.

Results: Commonest symptom was joint swelling in 100%, followed by pain in joint in 86%, erythema in 84% and fever in 40%. Other symptoms were outflow around the scar and fistula in 8% and 16% respectively.PJIs were early onset, delay onset and late onset in 64%, 24%

and 12% respectively. Culturally positive PJIs were 80%. On culture microbes identified were staphylococcus aureus in 44%, pseudomonas in 16%, Gram negative organisms in 16% and Enterococci in 4%. Management done with debridement, antibiotics, implant retention (DAIR), 1 stage implant exchange, 2 stage implant exchange, arthrodesis and amputation in 78%, 8%, 4%, 4% and 6% patients respectively. Function was restored in 76% and death seen in 4% of patients respectively.

Conclusion: Mean haemoglobin, mean serum albumin, mean serum calcium was found to be significantly less in patients with delayed or late onset PI when compared to early onset PJI. Leucocyte count of synovial fluid and mean CRP was significantly higher in patients with delayed or late onset PJI when compared to early onset PJI.

Keywords: Prosthetic joint infections, clinical profile, management, DAIR, outcome, tertiary care.

INTRODUCTION

Orthopaedic implants are mainly used for bone fixation and joint replacement.[1] Internal fixation devices are only temporarily needed and can be removed after healing of a bone fracture. Prosthetic joints replace the irreversibly damaged articulation, mainly in patients with osteoarthritis or inflammatory arthritis.[2]

With the aging cohort and continued advancement in joint arthroplasty, the demand for hip and knee replacement is expected to continue to rise. [3,4] With the demand for these surgeries is also an expectation for an increased prevalence of periprosthetic joint infection (PJI) requiring revision surgery. [5,6]

PJIs are commonly classified as early-onset, delay-onset, and late-onset infections, with infections occurring in the first 3 months, between 3 and 12–24 months, or after 24 months, respectively.[7,8] Causative pathogens consist of virulent microorganisms (e.g., Staphylococcus aureus, Enterococcus spp., Gram-negative bacilli) in case of early-onset infections, while low-virulence pathogens, e.g., coagulase-negative staphylococci (CoNS), Propionibacterium acnes, are mostly involved in delayed- and late-onset infections [7,8]. Furthermore, it is important to recognize the resistance pattern of involved pathogens, considering that methicillin-resistant S. aureus (MRSA) strains may account for 25–50% of isolates [9]. Notably, S. aureus represent the leading causative pathogen in infections associated with orthopaedic implants, exhibiting remarkable virulence, particularly in patients with multiple comorbidities, and being involved in both early-onset and delayed- or late-onset cases [10].

The reported prevalence of PJI out to 2 years after hip replacement is 1.63%[7] and after knee replacement is 1.55%.[11] Both procedures likely have a prevalence over 2% at 10 years.[11,12]

PJI for the individual patient is devastating with increased rate of mortality, increased risk of morbidity, decreased quality of life, and potential for decreased level of mobility and ambulation. [13,14,15,16]

Rapid detection of infection is of paramount importance because delaying the start of treatment of PJI may result in the loss of the device. [3,17]

The consequence of PJI is quite severe at the patient as well as the healthcare system level. Hence this study was done to understand clinical profile, risk factors, and treatment outcome which can guide clinicians in appropriate management.

METHODOLOGY

A retrospective study was done in cohort of patients in a tertiary care diagnosed as periprosthetic joint infections as per guidelines by infectious disease society of America. All the patients' records holding diagnosis as PJIs during January 2021 to December 2023 were included. After obtaining permission from institutional ethical committee clearance, data from patient's medical records were collected and analysed. Data on patients' socio-demographic characteristics, clinical profile, investigations, treatment modalities and outcome were retrieved. A total of 50 such patients' records were analysed.

Table 1. Diagnostic criteria for periprosthetic joint infection (PJI) [18]

● Presence of a sinus tract communicating with the prosthetic joint
● Presence of purulence without another known aetiology surrounding the prosthetic device
● Acute inflammation consistent with infection on histopathological examination of periprosthetic tissue
● Elevated leukocyte count in the synovial fluid and/or predominance of neutrophils
● Growth of identical microorganisms in at least two intraoperative cultures or a combination of preoperative aspiration and intraoperative cultures in the case of a microorganism of low virulence (e.g. coagulase-negative staphylococci, Propionibacterium acnes). In the case of a virulent microorganism (e.g. Staphylococcus aureus, Escherichia coli), growth in a single specimen from synovial fluid, periprosthetic tissue and/or sonication fluid may also represent PJI. However, if there is growth only in one single specimen, other criteria for infection must be present.

Prosthetic joint infection symptoms assessed were pain, fever, fistula, outflow around the scar, erythema, or swelling and a microbiologically documented infection.

The criterion for microbiologic identification of the causative agent from surgical samples was a minimum of two bacterial cultures of different samples obtained during the same surgical procedure that yielded the same pathogen.

Primary antibiotic therapy was any antibiotic that was administered between 72 hours after debridement, antibiotics, and implant retention (DAIR) and up to 6 weeks afterward. Suppressive (chronic) antibiotic therapy (SAT) included any antibiotics that were provided beyond 6 weeks after DAIR.

Selection of antibiotics was based (when available) on the pathogen identified, and for all patients, infectious disease input was sought. Treatment of PJI was based on the Infectious Diseases Society of America guidelines for prosthetic joint infections [18,19].

Statistical analysis: The categorical variables were expressed as frequencies and percentages, and continuous variables as mean and standard deviation. The data were analyzed using statistical package for the social sciences (SPSS) version 20. Chi square test and students t test was used with $P<0.05$ considered as statistically significant.

RESULTS

Majority of patients with PJIs belonged to the age group of 41-60years (48%), followed by 61 years and above (34%). Mean age was 49.5 and range 19 – 72 years. Females andmales were 58% and 42%.Residence was rural in 56%. SES I,II,III and IV in 38%, 36%,24% and 2% respectively. Most common comorbidity was Overweight and obesity (38%) followed by hypertension (16%), diabetes mellitus (12%), chronic liver disease (4%), coronary artery disease (2%).(table 1)

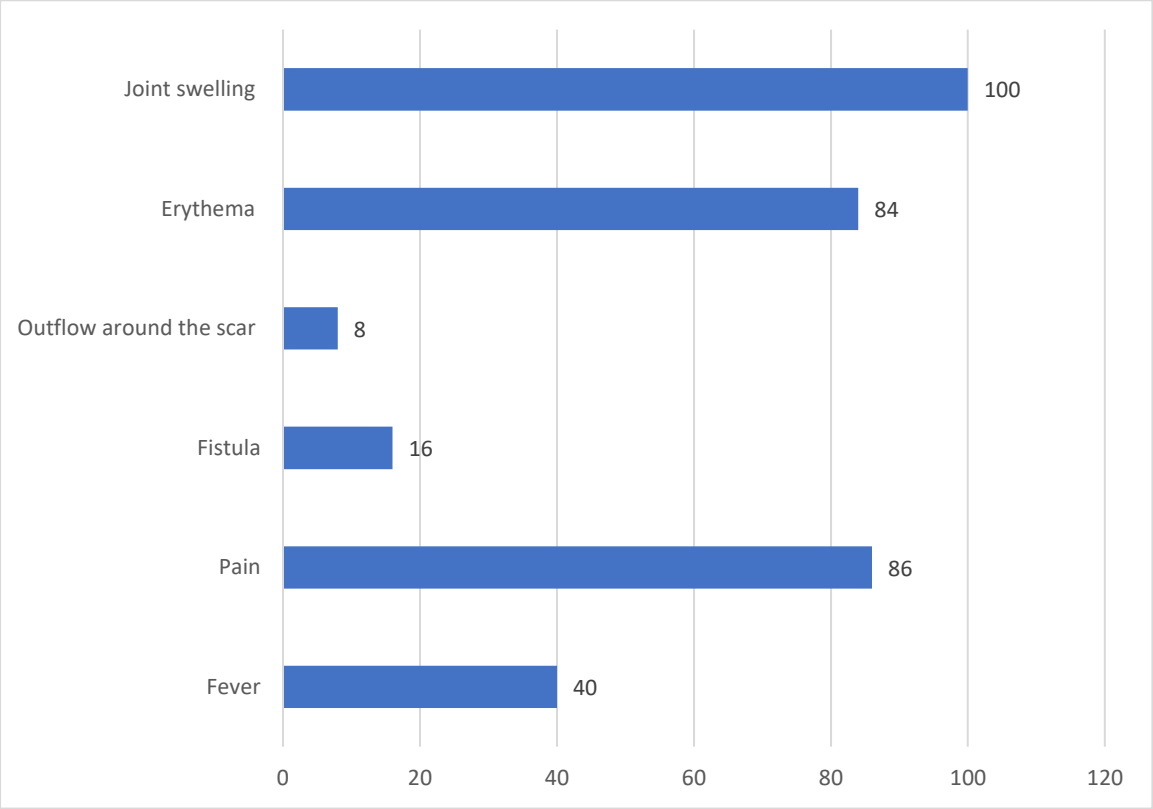
Table 1: Distribution of patients as per variables assessed

PARAMETERS	Sub- group	Frequency	Percentage
Age in years	18-40 years	9	18
	41 - 60 years	24	48
	61years and above	17	34
Age (years) Mean±SD/ range		49.5 ± 11.3 years/ 19-72 years	
Sex	Female	29	58
	Male	21	42
Residence	Rural	28	56
	Urban	22	44
Socio-economic status	Upper classI	19	38
	Upper middle classII	18	36
	Lower middle classIII	12	24
	Upper lower classIV	1	2
History of Comorbidities	Hypertension	8	16
	Diabetes Mellitus	6	12
	Chronic liver disease	2	4
	Coronary artery disease	1	2

	Overweight and obesity	19	38
	none	13	26

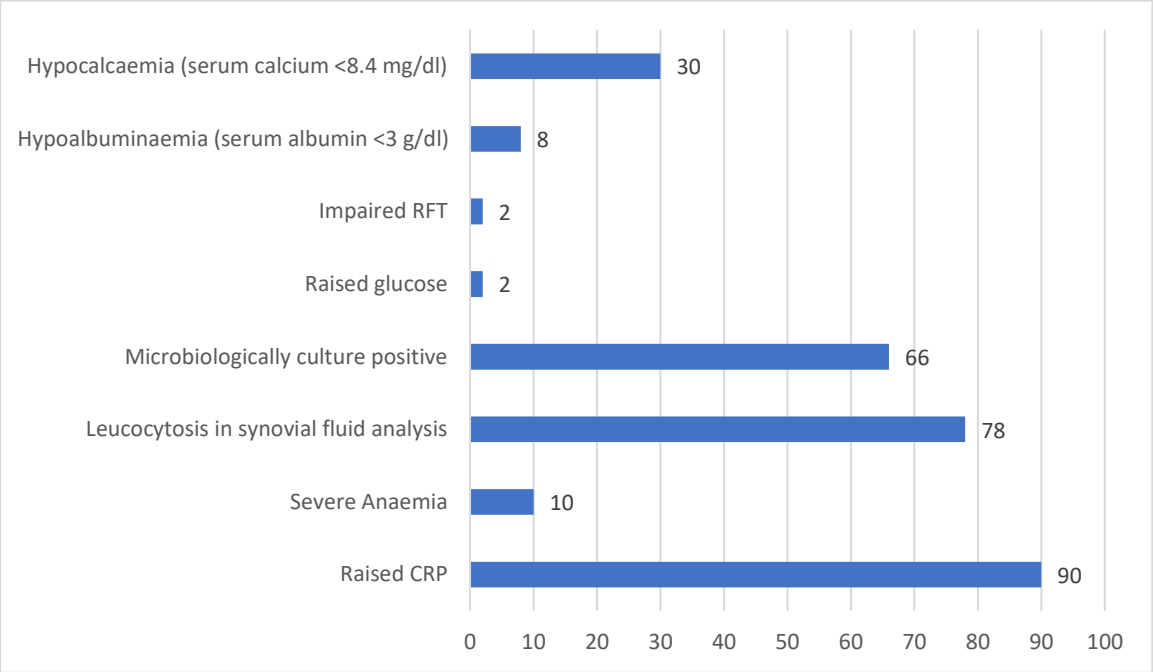
Commonest symptom was joint swelling in 100% followed by pain in joint in86% , erythema in 84% andfever in 40%. Other symptoms were outflow around the scar and fistula in 8% and 16% respectively. (figure1)

Figure 1: Proportion of patients with clinical symptoms



Lab investigations showed, raised Serum CRP in 90% patients, anaemia in 10%, leucocytosis of synovial fluid in 78%, microbiologically culture positive in 66%, raised glucose and impaired RFT in 2% each, hypoalbuminemia (serum albumin <3 g/dl)in8%, and hypocalcaemia (serum calcium <8.4 mg/dl)in 30 %.

Figure 2: Proportion of patients with abnormal tests



PJIs were early onset, delay onset and late onset in64%, 24% and 12% respectively.Culturally positive PJIs were 80%. On culture microbes identified were staphylococcus aureus in 44%, pseudomonas in 16%, Gram negative organisms in 16% and Enterococci in 4%. Management done with DAIR + suppressive antibiotic therapy, 1 stage implant exchange,2 stage implant exchange, arthrodesis and amputation in58%, 20%, 8%, 4%, 4% and 6% patients respectively.Antibiotics used were injectables initially switched over to orals, which included ceftriaxone, cefepime, vancomycin, meropenem, daptomycin,doxycycline andtrimethoprim-sulfamethoxazole. Function was restored in 76% and death seen in 4% of patients respectively.(table 2)

Table 2: Distribution of patients by type, culture findings, management and outcome of PJI

Variable	Sub category	Frequency (N=200)	Percentage
PJIs classification	Early onset	32	64
	Delayed onset	12	24
	Late onset	6	12
Microbiology Culture findings	Staphylococcus aureus	22	44
	Pseudomonas	8	16
	Gram negative organisms	8	16
	Enterococci	2	4
	Culture negative	10	20
Management done	DAIR with suppressive antibiotic therapy	39	78
	1 stage implant exchange	4	8

	2 stage implant exchange	2	4
	Arthrodesis	2	4
	Amputation	3	6
Outcome	Function restored	38	76
	Impairment of function	10	20
	Death	2	4

Mean age of patients (55.1) with delayed or late onset PJI was significantly more than patients with early onset PJI(47.2) patients. Males and females' association with onset of PJI was similar. PJIwas not significantly different in early onset PJI versus delayed/late onset PJI, in patients with hypertension, diabetes mellitus, overweight or obesity.No significant different in early onset PJI versus delayed/late onset PJI, with respect to culture findings.Mean haemoglobin, mean serum albumin, mean serum calcium was found to be significantly less in patients with delayed or late onset PI when compared to early onset PJI.Leucocyte count of synovial fluid and mean CRP was significantly higher in patients with delayed or late onset PJI when compared to early onset PJI.DAIR + SAT was done in 31(79.5%) patients with early onset PJI and 8(20.5%) patients with late/delayed onset PJI. Implant exchange, arthrodesis, amputation was done in 1(9.1%) patient with early onset PJI and 10(91.9%)patients with late onset PJI.Outcome was function restored in 38 patients, of which 30 (78.9%) patients had early onset PJI and 8 (21.1%) patients had late/ delayed onset PJI. Impaired function in 10 patients, of which 1(10%) patient with early onset PJI and 9 (90%) patients with late onset PJI. Death in 2patients with one belonging to early onset and delayed/late onset each. (table 3)

Table 3: Risk factors of early onset PJI versus delayed/late onset PJI.

Factor assessed	**Sub category**	**Early onset PJI (32)**	**Delayed/ late onset PJI (18)**	**P value**
Mean Age in years		47.2±14.3	55.1±8.4	P =0.03/ t=2.13
Gender	Male (21)	13 (61.9%)	9 (38.1%)	P=0.221 X^2=0.63
	Female (29)	19(65.5%)	10 (34.5%)	
Hypertension	Yes (8)	6 (75%)	2(25%)	P=0.47 X^2=0.5
	No (42)	26 (61.9%)	16 (28.1%)	
Diabetes Mellitus	Yes (6)	3 (50%)	3(50%)	P=0.44 X2=0.58
	No (44)	29 (65.9%)	15 (34.1%)	
Overweight and obesity	Yes (19)	8 (52.6%)	11 (47.4%)	P=0.1 X2=6.37
	No (31)	24 (38.7%)	7 (61.3%)	
Mean haemoglobin (g/dl)		12.2± 2.3	9.7 ± 3.4	P=0.0001 t=15.9
Mean Leucocye count of synovial fluid (cells/cumm)		9800 ± 2300	12000 ± 4500	P=0.0033 t =3.09

Mean CRP		5.6 ± 2.1	7.8 ± 3.5	P=0.0076 t=2.78
Culture positive	Yes (40)	28 (70%)	12 (30%)	P=0.071 X2=3.125
	No (10)	4 (40%)	6 (60%)	
Mean serum albumin mg/dl		2.8 ± 1.3	2.2 ± 0.8	P=0.08 t=1.77
Mean serum calcium mg/dl		32.2 ± 4.5	27.9 ± 5.4	P=0.0037 t=3.05
Management	DAIR + SAT (39)	31(79.5%)	8(20.5%)	P=0.000017 X2=18.5
	Implant exchange, arthrodesis, amputation (11)	1(9.1%)	10(91.9%)	
Outcome	Function restored (38)	30 (78.9%)	8 (21.1%)	P=<0.00026 X2=16.51
	Impaired function (10)	1(10%)	9 (90%)	
	Death (2)	1(50%)	1(50%)	

DISCUSSION

Despite current advances in orthopaedic adult reconstruction practices, PJI still represents one of the most devastating complications in implant surgery.[20] Optimal treatment of PJI remains controversial. The most widely used management strategies are one-stage and two-stage revisions.[20]DAIR (debridement, antibiotics, and implant retention) is also indicated for early or acute infections. Other strategies, with specific indications, which are less popular and produce poorer results, include antibiotic suppression, arthrodesis, and even amputation.[21] The cost of management of PJI patients is quite high when compared to primary arthroplasties.[22,23]

In this study majority were females (58%). Mean age of study participants was 49.5. Similarly in study by Tai DGB et al,majority were female (58%, n = 296) with a mean age of 70.4 years (SD, 11). In study by Shah NB et al, a total of 108 patients were included in the study, where 44% were female. The mean age was 67.5 years.[19] In this study most common comorbidity was Overweight and obesity (38%) followed by hypertension (16%), diabetes mellitus (12%), chronic liver disease (4%), coronary artery disease (2%).In study by Tai DGB diabetes mellitus was the most common comorbidity with a prevalence of 20% (n = 102).[24]In study by Shah NB et al, 17% of patients had diabetes mellitus, and the mean BMI of the patient population was 33.9 kg/m^2.[19]

In this study PJIs were early onset, delay onset and late onset in 64%, 24% and 12% respectively. Culturally positive PJIs were 80%. On culture microbes identified were staphylococcus aureus in 44%, pseudomonas in 16%, Gram negative organisms in 16% and Enterococci in 4%. In study by Tai DGBthe majority of cases were early acute infections (62%, n = 365) while the mean duration of symptoms was 6.8 days (SD, 7). Staphylococcus aureus was the most common causative microorganism (38%, n = 194) identified. [24]In study by Shah NB et al, early acute in 30 out of 66 and late acute in 36 out of 66. [19]

In this study lab investigations showed, raised Serum CRP in 90% patients, anaemia in 10%, leucocytosis of synovial fluid in 78%, microbiologically culture positive in 66%, raised glucose and impaired RFT in 2% each, hypoalbuminemia (serum albumin <3 g/dl) in 8%, and hypocalcaemia (serum calcium <8.4 mg/dl) in 30 %. In study by Shah NB et al, Acute PJI was noted in 33% (36) of patients.[19]

In this study on culture microbes identified were staphylococcus aureus in 44%, pseudomonas in 16%, Gram negative organisms in 16%, Enterococci in 4% and culture negative in 20%.In study by Shah NB et al of the 108 patients included in their study, 52% had staphylococcal infections (58% of these were methicillin-susceptible S. aureus, 29% were methicillin-resistant S. aureus, and 13% were coagulase-negative staphylococci), 8% had streptococcal infections (including groups A, B, C, G,andviridans streptococci),10% were gram-negative infections (Serratia, Enterobacter, Escherichia coli, Pasteurella, and Pseudomonas species), and 5% had infection with enterococci. One patient (1%) had an infection with diphtheroid. The remainder (24%) were culture-negative infections.[19] In study by Wang B et al, S. aureus, Pseudomonas spp., CoNS, Enterobacter spp. and Actinobacteria spp. were the five most common pathogens. [25]In study by Abdel Karim et al, Culture-negative PJI, reported in 5%–42% of cases. [26]

In this study antibiotics used were injectables initially switched over to orals, which included ceftriaxone, cefepime, vancomycin, meropenem, daptomycin, doxycycline and trimethoprim-sulfamethoxazole. In study by Shah NB et al, most common agents used in the primary treatment period were vancomycin (72), rifampin (31), cefazolin (26), and ceftriaxone (21). [19]In study by Shah NB et al, the most common antibiotics used for suppressive therapy in the chronic period were cephalexin (23), trimethoprim-sulfamethoxazole (12), and doxycycline (6). All 108 patients received perioperative antibiotic therapy. Fifty-seven received only primary therapy (up to 6 weeks of antibiotics), while 51 received antibiotics for >6 weeks. A total of 7 patients required a switch in their oral suppressive antibiotic therapy due to AEs.[19]

In this study commonest symptom was joint swelling in 100% followed by pain in joint in 86%, erythema in 84% and fever in 40%. Other symptoms were outflow around the scar and fistula in 8% and 16% respectively. In study by Nelason SB et al, most common presenting symptom of chronic PJI is pain, which overlaps with many noninfectious diagnoses, including polyethylene wear, aseptic loosening, and adverse local tissue reaction to metal (ALTR). [27]

In this study DAIR + SAT was done in 31(79.5%) patients with early onset PJI and 8(20.5%) patients with late/delayed onset PJI. Implant exchange, arthrodesis, amputation was done in 1(9.1%) patient with early onset PJI and 10(91.9%) patients with late onset PJI. Outcome was function restored in 38 patients, of which 30 (78.9%) patients had early onset PJI and 8 (21.1%) patients had late/ delayed onset PJI. Impaired function in 10 patients, of which 1(10%) patient with early onset PJI and 9 (90%) patients with late onset PJI. Death in 2patients with one belonging to early onset and delayed/late onset each. In study by Bernard et al, The initial surgical management of prosthetic joint infection among the 404 patients

was débridement with implant retention in 167 (41.3% [82 patients in the 6-week group and 85 in the 12-week group]), one-stage implant exchange in 150 (37.1% [77 patients in the 6-week group and 73 in the 12-week group]), and two-stage implant exchange in 87 (21.5% [44 patients in the 6-week group and 43 in the 12-week group]). [28,29]

Study by Qasim et al opined that A DAIR procedure with a retention of the implant has the obvious advantage that the relatively high morbidity of (staged) complete implant revision can be avoided with decent infection control in around 50–70% of patients [30]

A systematic review and meta-analysis by, Kunutsor et al reported an overall 61.4% pooled estimate for rate of infection control for DAIR.[23]

DAIR, one-stage and two-stage revision surgery strategies have different indications and are not uniform techniques, with the relevant importance of their various parameters and steps remaining to be evaluated. [20]DAIR, one-stage and two-stage revision strategies are not unique surgical techniques. Infection control rates for the above strategies vary from 75% to 90%, but comparisons are difficult because different indications and patient selection criteria are used in each strategy.

CONCLUSION

Mean haemoglobin, mean serum albumin, mean serum calcium was found to be significantly less in patients with delayed or late onset PI when compared to early onset PJI. Leucocyte count of synovial fluid and mean CRP was significantly higher in patients with delayed or late onset PJI when compared to early onset PJI.For early and acute infections, a DAIR procedure with the exchange of all modular components (DAIR plus) results in satisfactory infection control while for chronic infections, a two-stage exchange with removal of all implant components yields good long-term infection control.

REFERENCES

1. Kurtz SM, Lau E, Schmier J et al. Infection burden for hip and knee arthroplasty in the United States. J Arthroplasty 2008; 23: 984–91.

2. Jamsen E, Virta LJ, Hakala M et al. The decline in joint replacement surgery in rheumatoid arthritis is associated with a concomitant increase in the intensity of anti-rheumatic therapy: a nationwide register-based study from 1995 through 2010. Acta Orthop 2013; 84: 331–7.

3. Tubb, Creighton C. MD; Polkowksi, Gregory G. MD; Krause, Barbara. Diagnosis and Prevention of Periprosthetic Joint Infections. Journal of the American Academy of Orthopaedic Surgeons 28(8):p e340-e348, April 15, 2020. | DOI: 10.5435/JAAOS-D-19-00405

4. Kurtz S, Ong K, Lau E, Mowat F, Halpern M: Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. J Bone Joint Surg Am 2007;89:780-785.

5. Cram P, Lu X, Kates S, Singh J, Li Y, Wolf R: Total knee arthroplasty volume, utilization, and outcomes among Medicare beneficiaries, 1991-2010. JAMA 2012;308:1227-1236.

6. 4. Kurtz S, Ong K, Schmier J, et al.: Future clinical and economic impact of revision total hip and knee arthroplasty. J Bone Joint Surg Am 2007;89(suppl 3):144-151.

7. Trampuz A., Widmer A.F. Infections Associated with Orthopedic Implants. Curr. Opin. Infect. Dis. 2006;19:349–356. doi: 10.1097/01.qco.0000235161.85925.e8. [PubMed] [CrossRef] [Google Scholar]

8. Zimmerli W., Trampuz A., Ochsner P.E. Prosthetic-Joint Infections. N. Engl. J. Med. 2004;351:1645–1654. doi: 10.1056/NEJMra040181. [PubMed] [CrossRef] [Google Scholar]

9. Peel T.N., Cheng A.C., Buising K.L., Choong P.F.M. Microbiological Aetiology, Epidemiology, and Clinical Profile of Prosthetic Joint Infections: Are Current Antibiotic Prophylaxis Guidelines Effective? Antimicrob. Agents Chemother. 2012;56:2386–2391. doi: 10.1128/AAC.06246-11.

10. Tande A.J., Patel R. Prosthetic Joint Infection. Clin. Microbiol. Rev. 2014;27:302–345. doi: 10.1128/CMR.00111-13.

11. Kurtz SM, Ong KL, Lau E, Bozic KJ, Berry D, Parvizi J: Prosthetic joint infection risk after TKA in the Medicare population. Clin OrthopRelat Res 2010;468:52-56.

12. Ong K, Kurtz S, Lau E, Bozic K, Berry D, Parvizi J: Prosthetic joint infection risk after total hip arthroplasty in the Medicare population. J Arthroplasty 2009;24(6 suppl):105-109.

13. Zmistowski B, Karam JA, Durinka JB, Casper DS, Parvizi J: Periprosthetic joint infection increases the risk of one-year mortality. J Bone Joint Surg Am 2013;95:2177-2184.

14. Boddapati V, Fu M, Tetreault M, Blevins J, Richardson S, Su E: Short-term complications after hip arthroplasty for prosthetic joint infections are increased relative to noninfectious revisions. J Arthroplasty 2018;33:2997-3002.

15. Helwig P, Morlock J, Oberst M, et al.: Periprosthetic joint infection—Effect on quality of life. Int Orthop2014;38:1077-1081.

16. Cahill J, Shadbolt B, Scarvell J: Quality of life after infection in total joint replacement. J OrthopSurg (Hong Kong) 2008;16:58-65.

17. Zimmerli, W. (2014). Clinical presentation and treatment of orthopaedic implant-associated infection. Journal of Internal Medicine, 276(2), 111-119. https://doi.org/10.1111/joim.12233

18. Osmon DR, Berbari EF, Berendt AR, Lew D, Zimmerli W, SteckelbergJM et al. Diagnosis and management of prosthetic joint infection: clinical practice guidelines by the Infectious Diseases Society of America. Clin Infect Dis. 2013; 56:e1–e25.

19. Shah NB, Hersh BL, Kreger A, Sayeed A, Bullock AG, Rothenberger SD, Klatt B, Hamlin B, Urish KL. Benefits and Adverse Events Associated With Extended Antibiotic Use in Total Knee Arthroplasty Periprosthetic Joint Infection. Clin Infect Dis. 2020 Feb 3;70(4):559-565. doi: 10.1093/cid/ciz261. PMID: 30944931; PMCID: PMC7768747.

20. Karachalios T, Komnos GA. Management strategies for prosthetic joint infection: long-term infection control rates, overall survival rates, functional and quality of life outcomes. EFORT Open Rev. 2021 Sep 14;6(9):727-734. doi: 10.1302/2058-5241.6.210008. PMID: 34667643; PMCID: PMC8489477.

21. Karachalios T, Koutalos A, Komnos G. Management strategies for infected total hip arthroplasty: a critical appreciation of problems and techniques. Hip Int 2014;24:S44–S47

22. Tansey R, Mirza Y, Sukeik M, Shaath M, Haddad FS. Definition of periprosthetic hip and knee joint infections and the economic burden. Open Orthop J 2016;10:662–668.

23. Akindolire J, Morcos MW, Marsh JD, Howard JL, Lanting BA, Vasarhelyi EM. The economic impact of periprosthetic infection in total hip arthroplasty. Can J Surg 2020;63:E52–E56.

24. Tai DBG, Tande AJ, Langworthy B, Abdel MP, Berbari EF, Ten Have B, Jutte P, Soriano A, Suh GA, Zijlstra W, Wouthuyzen-Bakker M. Role of Routine Suppressive Antibiotic Therapy After Debridement, Antibiotics, and Implant Retention for Acute Periprosthetic Joint Infections. Open Forum Infect Dis. 2024 Apr 17;11(5):ofae216. doi: 10.1093/ofid/ofae216. PMID: 38778861; PMCID: PMC11109604.

25. Wang, B., Wang, Q., Hamushan, M. et al. Trends in microbiological epidemiology of orthopedic infections: a large retrospective study from 2008 to 2021. BMC Infect Dis 23, 567 (2023). https://doi.org/10.1186/s12879-023-08471-x

26. Abdel Karim M, Andrawis J, Bengoa F, et al. Hip and knee section, diagnosis, algorithm: Proceedings of International Consensus on Orthopedic Infections. J Arthroplasty 2019; 34:S339–50.

27. Nelson SB, Pinkney JA, Chen AF, Tande AJ. Periprosthetic Joint Infection: Current Clinical Challenges. Clin Infect Dis. 2023 Oct 5;77(7):e34-e45. doi: 10.1093/cid/ciad360. PMID: 37434369; PMCID: PMC11004930

28. Bernard, L.; Arvieux, C.; Brunschweiler, B.; Touchais, S.; Ansart, S.; Bru, J.P.; Oziol, E.; Boeri, C.; Gras, G.; Druon, J.; et al. Antibiotic Therapy for 6 or 12 Weeks for Prosthetic Joint Infection. N. Engl. J. Med 2021, 384, 1991–2001.

29. Theil C, Bockholt S, Gosheger G, Dieckmann R, Schwarze J, Schulze M, Puetzler J, Moellenbeck B. Surgical Management of Periprosthetic Joint Infections in Hip and Knee Megaprostheses. Medicina. 2024; 60(4):583. https://doi.org/10.3390/medicina60040583

30. Qasim, S.N.; Swann, A.; Ashford, R. The DAIR (debridement, antibiotics and implant retention) procedure for infected total knee replacement—A literature review. SICOT J. 2017, 3, 2

31. Kunutsor SK, Beswick AD, Whitehouse MR, Wylde V, Blom AW. Debridement, antibiotics and implant retention for periprosthetic joint infections: a systematic review and meta-analysis of treatment outcomes. J Infect 2018;77:479–488.