Ann Med Res 2021;28(6):1099-102

Annals of Medical Research

DOI: 10.5455/annalsmedres.2020.04.345

Original Article

Periprosthetic joint infections are different from osteosynthesis-associated infections

Guzelali Ozdemir, Niyazi Erdem Yasar, Alper Deveci, Olgun Bingol, Erman Ceyhan, Sualp Turan

Clinic of Orthopedics and Traumatology, Ankara City Hospital, Ankara, Turkey

Abstract

Aim: The aim of the study is comparing the treatment results and showing the differences between periprosthetic joint infections and osteosynthesis-associated infections.

Materials and Methods: We retrospectively reviewed the cases of orthopedic implant-associated infections. All patients were categorized into two groups; Group A has consisted of osteosynthesis-associated infections, and Group B has consisted of periprosthetic joint infection. The time interval between implantation and infection, length of hospitalization, number of operations, the status of preoperative and postoperative intensive care unit, and number of outpatient clinic applications were recorded. Culture data from intraoperative deep tissue samples were also recorded.

Results: There were 28 patients in Group A and 20 patients in Group B. The age distributions and operation numbers were significantly different between the two study groups (p=0.000 and p=0.05, respectively). There was a significant difference between the number of outpatient clinic applications and the success of treatment (p=0.016). There was a significant difference between the post-operatively intensive care unit status and success of treatment (p=0.002).

Conclusion: Periprosthetic joint infection patients were older and had a higher number of operations, however orthopedic implant-associated infections were more likely outpatient clinic applications and post-operatively intensive care unit status.

Keywords: Orthopaedic implant-associated infection; osteosynthesis associated infection; prosthetic joint infection

INTRODUCTION

Following orthopedic surgery, secondary soft tissue and implant-associated bone infections are still the most important negative aspects and limiting factors of success, leading to significant morbidity (1). Management of orthopedic implant-associated infections is an ongoing dilemma.

The term osteosynthesis-associated infection (OAI) is defined as an infection occurring after surgical fixation of fractures with internally placed implants. On the other hand, OAI is different from periprosthetic joint infection (PJI). The time interval between implantation and infection, the volume of the potential dead space, and treatment strategy are different from each other (2-4). The OAI rate is 0.4-16.1% and, the PJI rate is 0.3-5% (5-9). Before we end up getting started at this study, we saw that studies considered these groups as separate diseases and treated differently as well as expected. When we investigated about orthopedic implant associated infections, there were almost 1600 studies about only PJI and total 3600 studies. Knowing their differences in all aspects, we aim to approach from a different perspective and compare epidemiological, bacteriological, treatment successes and intensive care hospitalizations.

Our hospital is a reference center, and we want to share our results about the OAI and PJI. The aim of the study is comparing the treatment results and showing the differences and similarities of PJI between OAI.

MATERIALS and METHODS

We retrospectively reviewed the cases of orthopedic implant-associated infections between November 2012 to July 2016. The study was approved by the Institutional Review Board (E-18-2438). We searched the database for patients who were returned to our clinic for orthopedic implant-associated infections.

Infections occurred after surgical fixation of fractures with internally placed implants were defined as OAI and included to the study. On the other hand, PJI was defined as infection occurred after arthroplasty surgery and included to the study. Total knee arthroplasty, total hip arthroplasty, and partial hip arthroplasty infections were implied to the study.

Received: 16.04.2020 **Accepted:** 10.06.2020 **Available online:** 21.06.2021
Corresponding Author: Niyazi Erdem Yasar, Clinic of Orthopedics and Traumatology, Ankara City Hospital, Ankara, Turkey
E-mail: erdem__yasar@hotmail.com

Fractures treated definitively with external fixators, spine surgery and sports traumatology cases were excluded from the present study, due to a small number of cases. Patients without regular follow-ups and revisited and treated at the outher centers were also excluded from the study.

All patients were categorized into two groups; Group A has consisted of OAI patients, and Group B has consisted of PJI patients.

Orthopaedic OAI infection was diagnosed clinically and microbiologically. PJI's diagnosis made according to the Workgroup of the Musculoskeletal Infection Society Criteria, which was actual at the onset of the current study (10).

In the surgical debridement, all grossly infected soft tissues including any sinuses were excised. Tissue samples were obtained and sent for cultures intra-operatively. After the debridement to macroscopically healthy tissues, the surgical site was irrigated with saline. If the hardware was providing much stability to the fracture, it was retained until fracture union in OAI. Loose implants were removed or revised in OAI. Modular parts, such as polyethylene insert or femoral head, were exchanged in the acute setting (≤4 weeks) of PJI group. Two-stage revision arthroplasty was applied to the chronic (>4 weeks) PJI.

After culture specimens were obtained, postoperatively a parenteral antibiotic begun to cover clinically suspected pathogens. Once the microorganism was identified, the treatment modified according to the sensitivity with an infectious disease specialist. In patients with normal CRP and ESR levels, the antibiotic treatment was continued 4 weeks. However, in patients with high CRP and ESR levels, the antibiotic treatment was continued until it returned to the normal levels.

Fracture union was diagnosed with bridging bone across the fracture on plain radiographs and painless weight bearing of the patient.

Success was defined as fracture union achieved with the osteosynthesis hardware and without infection in group A (OAI). Also, success was defined as retention of the prosthetic implant without infection in group B (PJI).

The outpatient clinic applications were defined as; the number of control admissions of patients within the management of orthopedic implant-associated infections.

The time interval between implantation and infection, length of hospitalization, number of operations, the status of preoperative and postoperative intensive care unit (ICU), and number of outpatient clinic applications were recorded. Culture data from intraoperative deep tissue samples were also recorded.

Statistical Analysis

Statistical evaluation was made using SPSS software version 22.0 for Windows. Descriptive statistics were stated as mean, standard deviation and min-max values for numerical variables and as number and percentage for categorical data. Independent Samples test for normally distributed data, Mann Whitney U test for non-normal distributed data, and Ki-Square test for categorical variables were applied. A $p<0.05$ was considered statistically significant.

RESULTS

The number of patients in our clinic was 3856 within the specified time period; between November 2012 to July 2016. In this case, our orthopaedic implant-associated infection rate was 1.25% (n = 48). There were 28 patients in Group A (OAI) and 20 patients in Group B (PJI). Patient demographic and clinical characteristics are listed in Table 1 and 2 (Table 1 and 2).

Table 1. Numerical patient demographic and clinical characteristics

Variables	Group A OAI*	Group B PJI**
Age (year)	41.6±3.7	67.4±2.3
Number of operations (month)	2.32±0.15	2.25±0.47
Number of outpatient clinic applications	84.3±14.6	77.9±19.7
Time interval between implantetion and infection (month)	4.35±0.50	7.6±3.05
Length of hospitalization (day)	42.1±5.5	32.4±8.2
Preoperative intensive care unit (day)	0.21±0.21	1.1±1.1
Postoperative intensive care unit (day)	3.89±2.18	0.25±0.25

*OAI: Osteosynthesis-Associated Infection; **PJI: Periprosthetic Joint Infection

The age distributions and operation numbers were significantly different between two study groups (p=0.000, and p=0.05, respectively). The mean age of the patients was 41.6±16.9 in Group A and was 67.4±12.5 in Group B. The time interval between implantation and infection was 5.7±9.05 (1-60) months in our study (for group A was 4.35±0.50, and group B was 7.6±3.05). The number of operations (month) in group A was 2.32±0.15 and for group B 2.25±0.47. Length of hospitalization (day) in group A was 42.1±5.5 and for group B was 32.4±8.2. (Table 1).

There was a significant difference between the number of outpatient clinic applications and success of treatment (p=0.016). The mean number of outpatient clinic applications was 84.3±77.4 in Group A and was 77.9±88.12 in Group B. (Table 1).

There was a significant difference between the post-operatively ICU status and success of treatment (p=0.002). (Table 1).

The bacterias were not detected in 11(%22.92) cases. On the other hand; it was polymicrobial in 9 (%18.75) cases, and most detected bacteria was Staphylococcus aureus (n=15, %31.25). (Table 3).

Table 2. Categorical patient demographic and clinical characteristics		
Variables	**Frequency**	**Percentage**
Gender		
Female	25	%52.1
Male	23	%47.9
Side		
Left	26	%54.2
Right	22	%45.8
Status of culture		
Positive	37	%77.1
Negative	11	%22.9
Success of treatment		
Successfull	38	%77.1
Unsuccessfull	10	%22.9

Table 3. Distribution of cases by organism present in culture		
Bacteria	**Number**	**Percentage**
Staphilococcus aureus	15	%31.25
Coagulase (-) staphilococcus	8	%16.66
Pseudomonas	5	%10.42
Acinetobacterium	5	%10.42
Escherichia coli	4	%8.33
Corynebacterium	4	%8.33
Proteus	3	%6.25
Klebsiella	1	%2.08
Morganella	1	%2.08
Citrobacter	1	%2.08
Polymicrobial	9	%18.75
No bacteria isolated	11	%22.92

DISCUSSION

This study revealed that our orthopedic implant-associated infection ratio was %1.25 (n = 48), and this is an acceptable ratio within the literature. The OAI rate was reported as %0.4-16.1 , PJI rate as %0.3-5 (5-9).

The age distributions were significantly different as expected between the OAI and PJI at the present study (41.6±16.9 and 67.4±12.5, respectively). PJI patients were older than OAI patients. This consisted with the literature; the mean age of the patients with OAI were 35-52 years (3,11), although was 67.4 years in patients with PJI (12-14).

The majority of patients will require more than two or three debridements (3). Literature propound re-exploration and debridement should be performed every 2-3 days (15). In our study, the number of operations were significantly different between the OAI and PJI (p=0.05). The patients with PJI were more likely operated than patients with OAI. Although it is known that these two groups should develop different treatments and strategies, periprosthetic joint infections require more surgical procedures. There were not any study comparing at this point within the literature.

We know that age and the surgical procedure applied to the groups can also change the results. As we know epidemiologically and the course of the diseases, it is known that different surgical treatments should be applied and completely different stragies should be used. We think that these two group contains different risk groups that concern completely different age groups. But when all these can be viewed from an outside view, in the heading of orthopedic implant related infections, we think that similarities and differences can be revealed and our treatment differences can be justified.

The majority of OAI occurs within 10 weeks from the primary surgery (16). The time interval between implantation and infection was 5.7±9.05 (1-60) months in our study. Because our hospital is a reference center, many patients were sent from other centers. Therefore, the average time interval between implantation and infection was higher. Late infections occur more than 10 weeks after implantation and are either caused by hematogenous seeding or by a recurrence of inadequately treated early infection. So our findings can be commented on as late infections (17).

The rate of successful hardware retention with debridement and systemic antibiotics is %68-71 in OAI (2,3). In a systematic review of 34 case series, a fracture union rate of %66–100 is generally achievable. However, up to %60 of patients may have persistence of infection after fracture union (18). The chance of a successful union is %80 when these situations are adequately managed with antibiotics (19). In our study, we successfully treated the number of 38 patient (%77.1) and our findings consisted with literature.

Pharmacological treatment of infection is mandatory. In the selection of antibiotics, bacterial susceptibility, bone penetration, and side effects should be considered (15). First of all, the detection of the responsible bacteria is very important. Infecting microorganism is a strong predictor of treatment success for PJI (20,21). Orthopedic implant-associated infections are associated with skin microorganism, such as staphylococcus aureus. In the present study, the most detected bacteria was staphylococcus aureus and this consisted with the literature (3,7,22,23).

Late hematogenous infection is common in PJI, although early infection is more common in OAI. There is large potential joint space in PJI, but potential dead space is limited in OAI. For late PJI, the success rate of implant retention is low, while the rate of success is higher with hardware retention in OAI (2-4). In the current study, time intervals between implantation and infection were high in OAI and PJI groups (4.35±0.50, and 7.6±3.05 respectively). In the current study, we treated late OAIs and PJIs.

In our study, the mean number of outpatient clinic applications were significantly different between OAI and PJI. The patients with OAI were more likely outpatient clinic applications than patients with PJI. The success of the treatment of orthopedic implant-associated infections was related to the number of outpatient clinic applications. There were not any study comparing at this point within the literature.

In our study, the mean post-operatively ICU stay was significantly different between OAI and PJI. The patients with OAI were more likely post-operatively stay at ICU than patients with PJI. Trauma patients ICU acceptance could be found more reasonable. When we compare our all data for ICU and PJI, it is more likely to find that patients ICU acceptance is a risk factor for implant-associated infection.

In terms of outpatient application and intensive care hospitalization times, there are no descriptive articles about orthopedic implant related infections. We found it important in this respect.

LIMITATIONS

The present study has several limitations. First, success was defined according to clinical and radiological parameters. Second, our sample size was small. Third, this was a retrospectively designed study.

CONCLUSION

PJI patients were older than OAI patients and had a higher number of operations. The success of the treatment of orthopedic implant-associated infections was related to the number of outpatient clinic applications and the post-operatively ICU status. The patients with OAI were more likely outpatient clinic applications and post-operatively stay at ICU; than patients with PJI. The characteristics and treatments of both PJI and OAI are different. Orthopaedicians who plans to treat PJI and OAI should have to remember these differences.

Competing interests: The authors declare that they have no competing interest.
Financial Disclosure: There are no financial supports.
Ethical approval: The study was approved by Ankara Numune Training and Research Hospital, Clinical Research Ethics Committee Presidency (E-18-2438).

REFERENCES

1. Yano MH, Klautau GB, Da Silva CB, et al. Improved diagnosis of infection associated with osteosynthesis by use of sonication of fracture fixation implants. J Clin Microbial 2014;52:4176-82.
2. Berkes M, Obremskey WT, Scannell B, et al. Southeast Fracture Consortium. Maintenance of hardware after early postoperative infection following fracture internal fixation. J Bone Joint Surg Am 2010;92:823-8.
3. Rightmire E, Zurakowski D, Vrahas M. Acute infections after fracture repair: management with hardware in place. Clin Orthop Relat Res 2008;466:466-72.
4. Romano CL, Manzi G, Logoluso N, et al. Value of debridement and irrigation for the treatment of peri-prosthetic infections. A systematic review. Hip Int 2012;22:19-24.
5. Gustilo RB, Merkow RL, Templeman D. The management of open fractures. J Bone Joint Surg Am 1990;72:299-304.
6. Zimmerli W. Antibiotic prophylaxis. In: Ruedi T et al, eds. AO Principles of Fracture Management. New York: Thieme 2007;425-33.
7. Arciola CR, An YH, Campoccia D, et al. Etiology of implant orthopedic infections: a survey on 1027 clinical isolates. Int J Artif Organs 2005;28:1091-100.
8. Brady RA, Leid JG, Calhoun JH, et al. Osteomyelitis and the role of biofilms in chronic infection. FEMS Immunol Med Microbiol 2008;52:13-22.
9. Otto M. Staphylococcal biofilms. Curr Top Microbiol Immunol 2008;322:207-28.
10. Parvizi J, Zmistowski B, Berbari EF, et al. New definition for periprosthetic joint infection: from the Workgroup of the Musculoskeletal Infection Society. Clin Orthop Relat Res 2011;469:2992-4.
11. Xu YQ, Zhu YL, Fan XY,et al. Implant-related infection in the tibia: Surgical revision strategy with vancomycin cement. Sci World J 2014;2014:124864.
12. Kim JH, Chun SK, Yoon YC, et al. Efficacy of debridement for early periprosthetic joint infection after hip arthroplasty. Hip Pelvis 2014;26:227-34.
13. Murdoch DR, Roberts SA, Fowler VG, et al. Infection of orthopedic prostheses after staphylococcus aureus bacteremia. Clin Infect Dis 2001;32:647-9.
14. R Sevimli, O Aslanturk, K Ertem, et all. An investigation of infection rate and seasonal effect level in total joint replacement cases, Med-Science 2018;7:210-3.
15. Fang C, Wong TW, To KK, et al. Infection after fracture osteosynthesis-Part II. J Orthop Surg (Hong Kong) 2017;25:2309499017692714.
16. Torbert JT, Joshi M, Moraff A, et al. Current bacterial speciation and antibiotic resistance in deep infections after operative fixation of fractures. J Orthop Trauma 2015;29:7-17.
17. Ochsner PE, Sirkin MS, Trampuz A. Acute Infections. In: Ruedi TP, Buckely RE, Moran CG, eds. AO Principles of Fracture Management (vol 1). Stuttgart and New York: Thieme, 2007;520-40.
18. Struijs PA, Poolman RW, Bhandari M. Infected nonunion of the long bones. J Orthop Trauma 2007;21:507-11.
19. Olszewski D, Streubel PN, Stucken C, et al. The fate of patients with a "surprise" positive culture after nonunion surgery. J Orthop Trauma 2016;30:19-23.
20. Aggarwal VK, Bakhshi H, Ecker NU, et al. Organism profile in periprothetic joint infection: pathogens differ at two arthroplasty infection referral centers in Europe and in the United States. J Knee Surg 2014;27:399-406.
21. Y Duman, R Sevimli. Investigation of the presence of pantone-valentine leukocidin in Staphylococcus aureus strains isolated from orthopedic surgical site infections. Mikrobiyoloji Bulteni 2018;52:340-7.
22. Vuong C, Otto M. Staphylococcus epidermidis infections. Microbes Infect 2002;4:481-9.
23. Qasim SN, 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.