

## Retrospective Cohort Study

## Preoperative and postoperative risk factors for periprosthetic joint infection in primary total hip arthroplasty: A 1-year experience

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**Abstract****BACKGROUND**

Periprosthetic joint infection (PJI) in primary total hip replacement (THR) is one of the most important threats in orthopedic surgery, so one important surgeon's target is to avoid or early diagnose a PJI. Although the incidence of PJI is very low (0.69%) in our department, with an average follow-up of 595 d, this infection poses a serious threat due to the difficulties of treatment and the lower functional outcomes after healing.

**AIM**

To study the incidence of PJI in all operations occurring in the year 2016 in our department to look for predictive signs of potential infection.

**METHODS**

We counted 583 THR for 578 patients and observed only 4 cases of infection (0.69%) with a mean follow-up of 596 d (min 30, max 1451). We reviewed all medical records to collect the data: duration and time of the surgery, presence, type and duration of the antibiotic therapy, preoperative diagnosis, blood values before and after surgery, transfusions, presence of preoperative drugs (in particular anticoagulants and antiaggregant, corticosteroids and immunosuppressants), presence of some comorbidities (high body mass index, blood hypertension, chronic obstructive pulmonary disease, cardiac ischemia, diabetes, rheumatological conditions, previous local infections).

**RESULTS**

No preoperative, intraoperative, or postoperative analysis showed a higher

incidence of PJI. We did not find any class with evident major odds of PJI. In our study, we did not find any border value to predict PJI and all patients had similar values in both groups (non-PJI and PJI). Only some categories, such as female patients, showed more frequency of PJI, but this difference related to sex was not statistically significant.

### CONCLUSION

We did not find any category with a higher risk of PJI in THR, probably due to the lack of few cases of infection.

**Key Words:** Primary total hip replacement; Periprosthetic joint infection; Preoperative risk factors; Postoperative risk factors; Preoperative and postoperative blood value; Total hip arthroplasty

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**Core Tip:** In this study, we evaluated the incidence of periprosthetic joint infection in all interventions occurring in the year 2016 at our department at IRCCS Istituto Ortopedico Rizzoli. We reviewed all operated patients to look for predictive signs of potential infection to explore methodological approaches that could better inform daily orthopedic practice. We reviewed the duration and time of surgery, presence, type and duration of antibiotic therapy, preoperative diagnosis, some blood values before and after surgery, transfusions, the presence of preoperative drugs, and the presence of some comorbidities.

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## INTRODUCTION

Periprosthetic joint infection (PJI) in primary total hip replacement (THR) is one of the most important threats in orthopedic surgery. When it occurs, many types of treatment are proposed[1-7] and different studies have reported similar odds of healing[1,3,7]. In this study, we evaluated the incidence of PJI in all interventions occurring in the year 2016 at our department. We counted 583 primary THR in 578 patients. We observed only four cases of infection with a minimum of 20 d to a maximum of 390 d after the THR. We reviewed all operated patients trying to look for predictive signs of potential infection. We reviewed the duration and time of surgery, presence, type and duration of antibiotic therapy, preoperative diagnosis, blood value before and after surgery, transfusions, presence of preoperative drugs (in particularly anticoagulants and antiaggregant, corticosteroids and immunosuppressants), presence of some comorbidities (high body mass index [BMI], blood hypertension, chronic obstructive pulmonary disease [COPD], cardiac ischemia, diabetes, rheumatological conditions, previous local infections). We tried to identify some values to predict or early diagnose PJI analyzing all data collected from surgeries occurring in 1 year.

## MATERIALS AND METHODS

With agreement of the ethics committee of the Rizzoli Orthopedic Institute (Bologna, Italy), we reviewed all patients who had undergone total hip replacement (THR) in 2016. Categorical data were analyzed with use of the Fisher's test and  $\chi^2$  test and continuous data with the *t*-test. Level of significance was set at 0.05. There were 583 THR on 578 patients. Only 4 cases reported PJI (0.69%) and were re-operated. We reviewed all medical records to collect the data. All of these patients were visited at the hospital and in all authorized external clinics with the presence of a Rizzoli's doctor for follow-up. We had a mean follow-up of 595 d (min 30, max 1451). There were 320 females 54.9% and 263 males 45.1%, with a mean age of 62.2 years (min 17, max 88). The mean age for the 4 patients with infection was 62.8 age (min 51, max 69) ( $P = 0.98$ , *t* test) and included 3 females and 1 male ( $P = 0.63$ , Fisher's test). Differences in frequencies of infection for different BMI groups were not statistically significant ( $P = 0.455$ ;  $\chi^2$  test). All patients received preoperative antibiotic therapy, 564 with cefazolin 2 g (96.9%) and 18 with clindamycin (3.1%); one case was lost. In the PJI group, all patients were treated with cefazolin ( $P = 1.00$ , Fisher's test). Twenty-one patients underwent further antibiotic treatment (see [Table 1](#)) with

Table 1 Patients' characteristics according to periprosthetic joint infection

Covariate	Infection (yes)	Infection (not)	P value
Age, mean (min-max)	62.8 (51-69)	62.8 (17-88)	$P = 0.98$ ; T-test
Sex			
Female (%)	3 (75.0)	317 (54.7)	$P = 0.63$ ; Fisher's test
Male (%)	1 (25.0)	262 (45.3)	
BMI			
Underweight (%)	-	4 (0.7)	$P = 0.455$ ; $\chi^2$ test
Normal (%)	1 (25.0)	208 (36.0)	
Overweight (%)	1 (25.0)	259 (44.8)	
Obese (%)	2 (50.0)	107 (18.5)	
Antibiotic therapy			
Cefazolin (%)	4 (100.0)	560 (96.9)	$P = 1.00$ ; Fisher's test
Clindamycin (%)	-	18 (3.1)	
Additional antibiotic doses			
Yes (%)	1 (25.0)	20 (3.5)	$P = 0.137$ ; Fisher's test
Not (%)	3 (75.0)	559 (96.5)	
Diagnosis			
Coxartrosis (%)	3 (75.0)	370 (97.6)	$P = 1.00$ ; Fisher's test
Dysplasia (%)	1 (25.0)	9 (2.4)	
Bearings			
Cer-cer (%)	4 (100.0)	522 (90.2)	$P = 0.001$ ; $\chi^2$ test
Cer-pol (%)	-	8 (1.4)	
Met-pol (%)	-	49 (8.5)	
Steroid			
Yes (%)	1 (25.0)	14 (2.4)	$P = 0.1$ ; Fisher's test
Not (%)	3 (75.0)	562 (97.6)	
Immunosuppressants			
Yes (%)	-	13 (2.3)	$P = 0.1$ ; Fisher's test
Not (%)	4 (100.0)	564 (97.7)	
Antiaggregant drugs			
Yes (%)	1 (25.0)	116 (20.1)	$P = 1.00$ ; Fisher's test
Not (%)	3 (75.0)	460 (79.9)	
Local surgery before the operation			
Yes (%)	-	66 (11.5)	$P = 1.00$ ; Fisher's test
Not (%)	4 (100.0)	507 (88.5)	
COPD			
Yes (%)	-	78 (13.5)	$P = 1.00$ ; Fisher's test
Not (%)	4 (100.0)	500 (86.5)	
Chronic renal insufficiency			
Yes (%)	1 (25.0)	20 (3.5)	$P = 0.137$ ; Fisher's test
Not (%)	3 (75.0)	558 (96.5)	
Preexisting heart ischemic conditions			

Yes (%)	1 (25.0)	51 (8.8)	$P = 0.313$ ; Fisher's test
Not (%)	3 (75.0)	527 (91.2)	
Diabetes			
Yes (%)	-	44 (7.6)	$P = 1.00$ ; Fisher's test
Not (%)	4 (100.0)	533 (92.4)	
Rheumatological conditions			
Yes (%)	-	12 (2.1)	$P = 1.00$ ; Fisher's test
Not (%)	4 (100.0)	565 (97.9)	
Previously local septic conditions			
Yes (%)	-	6 (1.0)	$P = 1.00$ ; Fisher's test
Not (%)	4 (100.0)	571 (99.1)	
Blood transfusion			
Yes (%)	1 (25.0)	98 (16.9)	$P = 1.00$ ; Fisher's test
Not (%)	3 (75.0)	468 (80.8)	
Prosthesis fixation			
Uncemented (%)	4 (100.0)	570 (98.4)	$P = 1.00$ ; Fisher's test
Cemented stem and uncemented cup (%)	-	9 (1.6)	
Time of intervention			
(07-12) (%)	4 (100.0)	442 (76.3)	$P = 0.578$ ; Fisher's test
(12-19) (%)	0	137 (23.7)	

Cer-Cer: Ceramic on ceramic; Cer-pol; Ceramic on polyethylene; COPD: Chronic obstructive pulmonary disease; Cup: Met-pol: Metal on polyethylene.

different types of drugs and doses, of whom one patient had a PJI. In the PJI group (see [Table 1](#)), 3 patients underwent THR for primary arthrosis and 1 for hip dysplasia ( $P = 1.00$ , Fisher's test). Regarding the bearing, 526 were ceramic on ceramic (90.2%), 8 were ceramics on polyethylene (1.4%), and 49 were metal on polyethylene (8.4%). In the PJI group, they were all ceramic on ceramic ( $P = 0.001$ ,  $\chi^2$  test). Five hundred and seventy stems were uncemented (98.4%) and only nine were cemented (1.6%). All PJIs occurred in the prosthesis with uncemented stems. ( $P = 1.000$ , Fisher's test). Regarding the use of drugs, 565 patients (97.4%) did not use steroids and only 15 (2.6%) used them before surgery. In the PJI group, only 1 patient used drugs before intervention ( $P = 0.1$ , Fisher's test). Five hundred and sixty-eight patients (97.8%) did not use immunosuppressants and only thirteen (2.2%) used them before and after the intervention. In the PJI group, no patient used immunosuppressants ( $P = 0.1$ , Fisher's test). Four hundred and sixty-three patients (79.8%) did not use antiaggregant and one hundred and seventeen (20.2%) used it before intervention. In the PJI group, only 1 was using antiaggregant ( $P = 1.000$ , Fisher's test). Five hundred and eleven patients (88.6%) did not have local surgery before the operation and sixty-six did (11.4%). In the PJI group, none of the patients did ( $P = 1.000$ , Fisher's test). Considering the preoperative hemoglobin value, we found that it was less than 12 g/dL in 25 cases (4.3%) and higher in 557 cases (95.7%). In the PJI group, all patients had a value superior to 12 g/dL.

We considered the incidence of PJI in relation to COPD, and there were 504 cases (86.6%) without lung disease and 78 with COPD (13.4%). PJI occurred in all patients without COPD ( $P = 1.000$ , Fisher's test). Five hundred and sixty-one patients (96.4%) did not have chronic renal insufficiency (CRI) and twenty-one had CRI (3.6%); data were missing for one patient. In the PJI group, 3 patients suffered from CRI and 1 did not ( $P = 0.137$ , Fisher's test).

Considering the incidence of PJI in relation to preexisting heart ischemic conditions, 530 patients (91.1%) did not have heart disease before and after the operation, 52 patients (8.9%) had different degrees of ischemic condition preoperatively. For 1 patient, the data were missing. Only 1 patient with this comorbidity had PJI and the other 3 did not have any heart disease ( $P = 0.313$ , Fisher's test). Considering the incidence of PJI in relation of diabetes, there were 537 cases (92.4%) without diabetes and 44 with the disease (7.6%). The data were missing for 2 patients. We were not able to recognize the degree and type of the disease. PJIs occurred in all patients without diabetes ( $P = 1.000$ , Fisher's test). Considering the incidence of PJI in relation to rheumatological conditions, there were 569 cases (97.9%) without and 12 with rheumatological disease (2.1%). The data were missing for 2 patients. PJI patients did not suffer from/have any rheumatological condition ( $P = 1.000$ , Fisher's test). Considering the

incidence of PJI in relation to previously local septic conditions, there were 575 cases (99%) without previous septic conditions and 6 with them (1%). The data were missing for 2 patients. PJI was present in all patients without previous septic conditions ( $P = 1.000$ , Fisher's test). Laboratory data are summarized in [Table 1](#).

For the erythrocyte sedimentation rate (ESR) value, the preoperative mean was 11.1 mm (the data were missing in 2 cases): 11.1 mm for all cases without PJI and 11 mm for cases with PJI. For the C-reactive protein (CRP) value, the preoperative mean was 0.9 mg/dL (data were missing in 16 cases): 0.9 mg/dL for all cases without PJI and 0.5 mg/dL for cases with PJI. For the WBC count, the preoperative mean was  $7199.5 \times 10^6/L$  (the data were missing in 20 cases):  $7192.55 \times 10^6/L$  for all cases without PJI and  $8177.55 \times 10^6/L$  for cases with PJI. For the Hb value, the preoperative mean was 13.9 g/dL (the data were missing in 16 cases): 13.9 g/dL for all cases without PJI and 14.6 g/dL for cases with PJI (see [Table 2](#)).

We analyzed the same parameters in the postoperative period: the day after surgery, the last day of hospitalization, and a random day between these days. We did not have these three parameters for all patients and many others had more than three values. In the last case, we picked up the lowest data. Analyses of the data showed that the average Hb value the day after the operation was 11.1 g/dL: 11.1 g/dL for all cases without PJI and 11.0 g/dL for the 4 cases with PJI (the data were missing for 2 patients). The average WBC count was  $9804.5 \times 10^6/L$ :  $9821.5 \times 10^6/L$  for cases without PJI and  $7360.0 \times 10^6/L$  for cases with PJI (see [Table 2](#)).

Analyses of the data showed that the average Hb value of the intermediate sample was 10.0 g/dL: 10.0 g/dL for all cases without PJI and 10.6 g/dL for the 4 cases with PJI (the data were missing for 33 patients). The intermediate average of WBC count was  $8984.9 \times 10^6/L$ :  $8997.6 \times 10^6/L$  for cases without PJI and  $7257.5 \times 10^6/L$  for cases with PJI. The samples on the last day of hospitalization showed that the average Hb value for all patients was 10.1 g/dL: 10.1 g/dL for all cases without PJI and 10.7 g/dL for the 4 cases with PJI. On the last day of hospitalization, the average WBC count was  $7759.1 \times 10^6/L$ :  $7764.4 \times 10^6/L$  for cases without PJI and  $7764.4 \times 10^6/L$  for cases with PJI (data were missing in 42 patients) (See [Tables 1 and 2](#)).

Regarding blood transfusion, 450 patients (77.2%) did not have a blood transfusion, 3 of whom were part of the PJI group, 133 (22.8%) had one or more homologous blood sack, only 1 had PJI ( $P = 1.000$ , Fisher's test). The average time of operation was 01:17:42 (min 00:37:00 max 04:03:00): 01:17:38 (min 00:37:00 max 04:03:00) for patients without PJI and 01:26:45 (min 00:56:00 max 02:31:00) for patients with PJI. Four hundred and forty-six patients (76.5%) were operated on between 07:00 and 12:00 and 137 (23.5%) between 12:00 to 19:00. All PJI patients were operated from 07:00 to 12:00.

## RESULTS

Infections are classified according to their temporal appearance[4], even though many systems proposed are not always accepted[8]. We defined acute infection as symptoms lasting less than 4 wk, and chronic as lasting more than 4 wk. Many kinds of treatments have been proposed with different indications and results[2-6]. All surgeons agree with the difficulties of the different approaches to treat a PJI (surgery and drugs with multidisciplinary approaches)[4-6,9]. For these reasons, we reviewed all cases of THR treated in 2016 in our Department of Orthopedic Surgery to identify preoperative and postoperative signs to predict a PJI.

All cases were operated on by no more than 10 different surgeons at our department in the same operating room with laminar airflow. All cases underwent the same type of surgery: lateral approach with detachment of the gluteus minimus and medius and reconstruction of the hip capsule. All cases had the drainage removed within 24 h after surgery. Standard procedures of antibiotic prophylaxis were followed: cefazolin 2 g in most of the patients and clindamycin 600 mg in allergic patients.

Four patients had a PJI: two within 30 d, one 6 mo later, and one 13 mo later. All patients were surgically treated with deep or superficial debridement first[2]. One of these patients underwent a two-stage revision after this surgical procedure. Analyzing sex, we founded that PJI incidence was higher in females than men (see [Table 1](#)), but data were not statistically significant as in many other studies[10]. Regarding age (see [Table 1](#)), no differences were observed between the two groups, as previously reported[11].

Analyzing antibiotic therapy (see [Table 1](#)), all patients with PJI were treated with single-dose cefazolin 2 g before surgery. After surgery, many patients had postoperative antibiotic treatment (see [Table 1](#)), 1 of whom developed a PJI. Even in this case, we did not find a difference between the two groups. Regarding the indications that led to the operation, no category showed a higher risk than another. Analyses of the bearings and different types of prostheses did not show a difference in the incidence of PJI. Analyses of the use of drugs such as steroids, immunosuppressors, and anticoagulants showed that PJI did not have a higher incidence in any patient, which disagrees with a previous study [12]. We did not find differences in Hb value and WBC count between the two groups of patients (see [Table 2](#)). We did not analyze the CRP and ESR due to the lack of values for many patients.

**Table 2** Blood values according to periprosthetic joint infection

	Infection (yes)				Infection (not)			
	Pre	T1	T2	Last	Pre	T1	T2	Last
Hemoglobin	14.6	11.0	10.6	10.7	13.9	11.1	10.0	10.1
White blood cells	8177.5	7360.0	7257.5	7040.0	7192.5	9821.5	8997.6	7764.4

Data are means.

In the analysis of blood transfusions in relation to PJI, 133 patients were transfused with one or more blood sacks, and 450 did not receive any transfusion. PJI occurred in 3 of the non-transfused patients and in 1 transfused patient. Analyses of the blood transfusions showed a higher incidence of PJI in transfused patients but it was not statistically significant, in disagreement with a previous study[13]. Analyzing the time of surgery, we divided the patients in two groups: 7.00 am to 12.00 and 12.00 to 19.00. All cases of PJI occurred in patients in the first group (7.00-12.00). There were no statistically significant differences in any of those groups, in disagreement with a previously study[12] (Table 1).

## DISCUSSION

One of the most difficult and important targets in surgery is to avoid or early diagnose a PJI. Although the incidence of PJI is very low (0.69%) in our department, with an average follow-up of 595 d, this infection poses a serious threat due to the difficulties of treatment and the lower functional outcomes after healing[1]. We did not find any class with an evident major risk of PJI. In our study, we did not find any border value to predict PJI and all patients had similar parameters in both groups (non-PJI and PJI), in contrast to a previous study[14]. For some categories, such as sex, we observed a higher frequency of PJI in females than in males, but this difference was not statistically significant. Other authors have reported a higher incidence in males[12,15]. We did not find other studies with the control of blood values preoperatively and postoperatively in relation to the likelihood of PJI. Due to the lack of a sufficient number of patients, especially in the PJI group, we could not demonstrate a statistically significant difference between non-PJI patients and PJI ones. Maybe PJI has a multifactorial etiology[16] and our few cases of PJI could not demonstrate a higher incidence despite the reports in other studies[9, 14,17,18]. Furthermore, we were unable to analyze other data such as urinary screening[19], which may also play a role in the prediction of a PJI, even though some authors have expressed doubts[20,21]. Some studies[20,21] have emphasized the increasing baseline risk of PJI with the increasing number of comorbidities. Another limit of this study was the inability to grade the severity of comorbidities. Many studies have reported different prognoses for different types and degrees of preexisting diseases[22]. All of these detailed analyses could not be carried out in our study, which is a limitation. The percentage of PJI was very low in our patients, and worldwide its incidence is decreasing due to surgical and drug management. Nonetheless, preoperative and postoperative THR surveillance needs to be more accurate in the future[23].

## CONCLUSION

From the experience of all operations for THR performed at our department in the year 2016 we did not find any data that could help us avoid, predict, or early diagnose a PJI. This disagrees with other studies [14,16] and many accepted and undiscussed scientific convictions. The difference between our study and others may have been due to the low number of cases, especially in the PJI group (only 4 cases).

## ARTICLE HIGHLIGHTS

### Research background

Periprosthetic joint infection (PJI) in primary total hip replacement (THR) is one of the most important challenges in orthopedic surgery, so one important surgeon's goal is to avoid or diagnose a PJI early.

### Research motivation

The incidence of PJI is very low (0.69%) in our department, with an average follow-up of 595 d. This infection poses a serious threat due to the difficulties of treatment and the lower functional outcomes



after healing.

### **Research objectives**

We tried to identify predictive signs of potential infection with the goal of exploring methodological approaches that could better inform daily orthopedic practice.

### **Research methods**

We counted 583 THR for 578 patients and observed only 4 cases of infection (0.69%) with a mean follow-up of 596 d (min 30 max 1451). We reviewed duration and time of the surgery, presence, type and duration of the antibiotic therapy, preoperative diagnosis, blood values before and after surgery, transfusions, presence of preoperative drugs, and presence of some comorbidities to look for statistically significant differences between the patients that did and did not develop a PJI.

### **Research results**

No preoperative, intraoperative, or postoperative analysis showed a higher incidence of PJI. We did not find any class with evident major risk of PJI. Some categories, such as female patients, showed a higher frequency of PJI, but this difference related to sex was not statistically significant.

### **Research conclusions**

We did not find any category with a higher risk of PJI in THR, probably due to the lack of few cases of infection.

### **Research perspectives**

PJI is an important topic and more research about the subject is needed. Probably due to the low number of cases, especially in the PJI group (4 cases), we did not attain the results we were expecting. Future studies are needed to add new information to the scientific literature, for example, data spanning 5 years or combined from multiple centers.

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## **FOOTNOTES**

**Author contributions:** Tella GF, Donadono C, Castagnini F, Bordini B, Cosentino M, Di Liddo M, and Traina F contributed equally to all aspects of this work.

**Institutional review board statement:** The study was reviewed and approved by the Comitato Etico di Area Vasta Emilia Centro della Regione Emilia-Romagna (CE-AVEC), Approval No. 0005172.

**Informed consent statement:** Informed written consent was obtained from the patient.

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**Data sharing statement:** Technical appendix, statistical code, and dataset available from the corresponding author at [c.donadono@gmail.com](mailto:c.donadono@gmail.com). Consent was not supposed to be obtained because of the characteristics of the study and the impossibility to contact the patient but by the way the presented data are anonymized and risk of identification is low.

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