



PERI-PROSTHETIC JOINT INFECTION - A DIAGNOSTIC AND TREATMENT HOSPITAL ANALYSIS -

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Abstract. Peri-prosthetic joint infection (PJI) is a major and severe complication after joint replacement. Although it occurs in a small percentage (1-3%) of patients undertaking arthroplasty it results in substantial morbidity and a decline of the final functional outcome. Therefore, deep peri-prosthetic joint infections lead to a significant both clinic, but also economic burden regarding diagnosis and treatment. **Paper goal.** The aim of the present article is to retrospectively analyse and evaluate the rate, diagnosis procedures and treatment management and results of the peri-prosthetic joint infections (PJI) in our hospital. **Material and method.** Between 2007 and 2010, in the Clinical Hospital of Orthopaedics and Traumatology "Foişor", we identified a total of 96 peri-prosthetic joint infection (PJI) episodes in 89 patients. We analysed the cases from diagnostic and treatment management point of view and withdraw conclusions reported to the actual peri-prosthetic joint infection (PJI) guideline. **Results.** The overall prevalence rate of peri-prosthetic joint infection (PJI) after THR and TKR together was 2.87%, but however higher in TKR (3.30%) than in THR (2.70%). The diagnostic protocol led to a specific antibiogram in 90% of the cases. Except early infections cases, the treatment attitude was "two-stage" revision for late, haematogenous or intraoperative infection, with a success rate of 87.50%. **Conclusions.** The "two stage" exchange revision arthroplasty seems to be a successful procedure in the treatment of peri-prosthetic joint infection (PJI) and therefore we recommend this surgical attitude in similar cases of infection. As final remark, early recognition and proper management of these infections is important, not only from a medico-legal standpoint, but also from the significant implications of this pathologic entity upon public health and economic costs.

Keywords: peri-prosthetic joint infection, joint replacement, arthroplasty

Introduction

Total hip replacement (THR) and total knee replacement (TKR) are nowadays considered the most successful surgery procedures in articular pathology. In the same time, peri-prosthetic joint infection has devastating effects upon patient and implant. With an incidence of 1-3%, the infection of a prosthetic implant leads to unacceptable functional results of an arthroplasty and is financial demanding for the hospital unit which treats it. The risk of developing peri-prosthetic joint infection was estimated at 1.5% for primary THR and 2.5% after primary TKR [1]. This risk gets double

after revision THR or TKR – 3.2%, respective 5.6%. For revision THR, the Scandinavian Arthroplasty registers demonstrated infection rates between 7 and 16% [2,3].

The peri-prosthetic joint infection leads to increased morbidity, which increase the financial cost of the global treatment. Also, the mortality secondary surgical intervention(s) for peri-prosthetic joint infection (PJI) was correlated with the patient age in the elderly – 0.4-1.2% for 65 years-old patients and 2-7% for 80 years-old patients [4]. The same author reports a 2-fold increase in death probability during the first 3 months after resection arthroplasty.

The estimated cost for treating each episode of an infected arthroplasty is more than \$ 50.000, thus leading to a financial burden to the hospital department which deals with such an orthopaedic pathology [5].

Despite the risk inherent in joint replacement

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procedures, especially THR and TKR, both are now safer procedures than in the past. For decades, the infection rate was about 10%. Nowadays, measures including attentive preoperative aseptic surgical procedures, use of laminar air flow operating theatre and judicious perioperative antibiotics, have reduced the risk of infection to 0.3% in THR and 0.5% in TKR [6].

This article aim is to analyse the rate, diagnosis procedures and treatment management as outcome results regarding peri-prosthetic joint infections in our clinical hospital.

Material and method

Study design and study population

Following the data of Romanian National Endo-prosthetic Registry (RNE), The Clinical Hospital of Orthopaedics and Traumatology “Foisor” (Bucharest, Romania), performs yearly a mean of: 579 primary THR and 66 revision THR (2007-2010) and 220 primary TKR and 5 revision TKR yearly (2007-2010).

The clinic serves as local and national reference centre for difficult-to-treat orthopaedic conditions, including peri-prosthetic joint infections (PJI). Through a retrospective study between 2007 and 2010 using the clinical registry and the data from the follow-up records we identified 89 patients with peri-prosthetic joint infections, who have been treated in The Clinical Hospital of Orthopaedics “Foisor”. In this retrospective cohort study, the medical and surgical therapies were not standardized, management decisions being made individually by the treating physicians. Statistical analysis was carried out with the help of Excel databases and

sustained by online OpenEpi (<http://www.openepi.com/OE2.3/>).

Definitions and classification

Peri-prosthetic joint infection (PJI) is one of the most challenging complications of lower extremity joint (hip and knee) arthroplasty. However, there is more than one set of diagnosis criteria accepted to define peri-prosthetic joint infection (PJI). A consensus of the Musculoskeletal Infection Society (MSIS) workgroup lead to a new definition of peri-prosthetic joint infection (PJI), as mentioned in Parvizi's scientific paper [7] (Table I).

The classification of the peri-prosthetic joint infection (PJI) used in this study (Table 2) was that developed by Cowentry [8] and improved by Tsukayama [9,10]:

The peri-prosthetic joint infection diagnosis was sustained respecting an algorithm in which clinical evaluation (presence or absence of sinus tract) was associated with laboratory tests (WBC and inflammatory tests: ESR, CRP and fibrinogen). Imagistic findings (*radiographs*) in late (chronic) infections were also relevant in the context of modified inflammatory tests – *prosthetic defixation*. A few times *echography* was made to reveal a peri-prosthetic abscess. Only three symptomatic patients (pain, redness and warmth) suspicioned of late infection, with borderline inflammatory tests, but with no radiological signs of prosthetic defixation undertook *In¹¹¹ labelled leukocytes bone scintigraphy*, which was relevant in one case – positive intraoperative cultures.

Above all these, in more than 80% of the cases, intraoperative bacteriologic and histopathologic tests were undertaken.

Crt. (OR between)	Description of defining diagnosis set criteria
(1)	There is a sinus tract communicating with the prosthesis;
(2)	A pathogen is isolated by culture from at least two separate tissue or fluid samples obtained from the affected prosthetic joint;
(3)	Presence of four from the following six criteria: <ol style="list-style-type: none"> Elevated serum erythrocyte sedimentation rate (ESR) and serum C-reactive protein (CRP) concentration (and also fibrinogen), Elevated synovial leukocyte count, Elevated synovial neutrophil percentage (PMN%), Presence of purulence in the affected joint, Isolation of a microorganism in one culture of periprosthetic tissue or fluid, or Greater than five neutrophils per high-power field in five high-power fields observed from histologic analysis of periprosthetic tissue at x400 magnification.

Table I. Peri-prosthetic joint infection (PJI) definition

Type	Presentation	Definition	Treatment
I.	Early/Acute Postoperative Infection	Acute infection within the first 4 to 6 weeks	Attempt at debridement and prosthetic retention
II.	Late /Chronic Infection	Chronic indolent infection regardless of when it presents (more than 4-6 weeks)	Prosthetic removal – 2 stage revision surgery (+ antibiotic cement spacer)
III.	Acute haematogenous infection	Acute onset (suddenly occur) in a otherwise well-functioning joint replacement	Attempt at debridement and prosthetic retention or prosthetic removal
IV.	Positive intraoperative cultures	> 2 positive intraoperative cultures	Appropriate antibiotic therapy

Table II. Peri-prosthetic Joint Infection (PJI) Classification System

For microbiologic diagnosis – bacteriologic identification and specific antibiogram –, antibiotic treatment was stopped for at least 2 weeks prior surgery. Each time when possible a joint aspiration was also performed before planned surgery, in order to get an idea on the aetiology of infection. During surgery, we drew samples from 10 sites, 5 from each prosthetic component, for aetiological confirmation. In those cases where preoperative antibiotic therapy was sustained, we used special bacteriologic culture mediums from National Institute of Infectious Diseases “Prof. dr. Matei Balş”. The cultures were kept and evaluated for 15-21 days.

Treatment management

The orthopaedic surgery treatment attitude was retaining the implant in early infections and “two-stage” revision in haematogenous and late infections, associated with specific antibiotherapy. One stage prosthesis exchange was rarely used, only in very well selected cases. Regarding “two-stage” revision, manually manufactured or preformed antibiotic loaded spacers were used – 2 g Vacomicine ± Gentamicine for each package of polymethyl-methacrylate (PMMA) cement. In these cases, the postoperative usage of drainage was avoided when possible, because suction would decrease the local antibiotic concentration. After surgery, antibiotic therapy was sustained for at least 6 weeks, with a minimum of 2 weeks of parenteral administration (i.v.), followed by other 4 weeks of oral administration (p.o.). Timing for “second stage” (prosthesis reimplantation) was considered to be a mean interval between 6 weeks and 3 months from the initial procedure (spacer antibiotic loose).

We defined as healing the absence of clinical and radiological and, if applicable, postoperative signs and symptoms of peri-prosthetic joint infection (PJI) with sterile culture samples from intraoperative specimens obtained at the reimplantation of the prosthesis or at any other surgical procedure

involving the joint during a follow-up time of at least 2 years (20-24 months)[11].

Results

Demographic and clinical characteristics

This retrospective study identified a total of 96 peri-prosthetic joint infection (PJI) episodes in 89 patients treated at the Clinical Hospital of Orthopaedics and Traumatology “Foişor”, on an almost 4 years interval, between 2007 and 2010 (Table III).

The patient age varied between 30 and 80 years, with a mean value of 63.62 years (CI 95%: 61,30 – 65,94) and the sex ratio was 1:1 (45 female : 44 male).

The hip was mainly affected by peri-prosthetic joint infection – 60 patients (comparative with those with knee infection – 29 patients). The overall prevalence rate of peri-prosthetic joint infection (PJI) after THR and TKR together was 2.87%, but however higher in TKR (3.30%) than in THR (2.70%).

The implantation prosthesis site was identified to be for 29 patients (32%) the study centre, the rest of 54 patients (61%) coming from external orthopaedic centres. A number of 6 patients (7%) presented incomplete clinical records and therefore the provenience centre could not be established.

Regarding the repartition of the cohort study patients after the type of peri-prosthetic joint infection (PJI), according to the proposed to be used classification [9], taking also into account the arthroplasty site (hip or knee), the data reveals the following:

- I. 60 THR infections:
 - 10 early infections, 27 late infections, 19 haematogenous infections and
 - 4 intraoperative infections (Figure 1 A).
- II. 29 TKR infections:
 - 7 early infections, 9 late infections, 10 haematogenous infections and
 - 3 intraoperative infections (Figure 1 B).

Year	HIP			KNEE			TOTAL Hip & Knee PJI per year
	Hip PJI	Primary THR	Revision THR	Knee PJI	Primary TKR	Revision TKR	
2007	12	372	19	5	55	1	17
2008	17	583	78	5	221	7	22
2009	14	617	81	12	305	5	26
2010	17	648	79	7	297	7	24
PJI episodes	65			31			96
Retrospective Study PJI [2007-2010]							
Patients - TOTAL	60	2220	257	29	878	20	89
Mean value of arthroplasties/ year		555	64		220	5	
PJI Rate	2.70%			3.30%			2.87%

Table III. PJI epidemiological data of the cases enrolled in our retrospective study

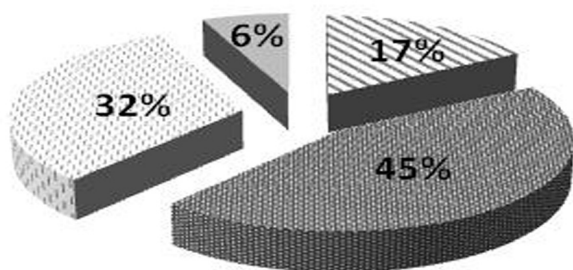


Figure 1A. Hip peri-prosthetic joint infection (PJI)

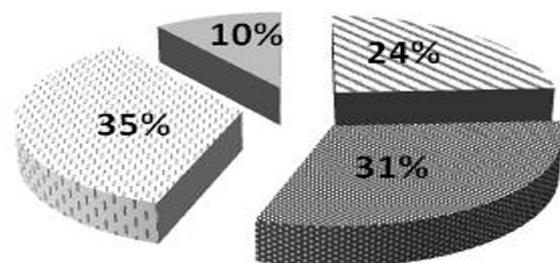


Figure 1B. Knee peri-prosthetic joint infection (PJI)

Legend.

- Std I (17%) - early infection
- Std II (45%) - late infection
- Std III (32%) - haematogenous infection
- Std IV (6%) - intraoperative infection

Legend.

- Std I (24%) - early infection
- Std II (31%) - late infection
- Std III (35%) - haematogenous infection
- Std IV (10%) - intraoperative infection

Microbiologic diagnostic

Microbiologic diagnosis, each time when possible, was sustained by a joint aspiration performed before planned surgery, in order to get an idea on the aetiology of infection. Although the recommendation of joint aspiration in the context of positive inflammatory tests is stated in the diagnostic peri-prosthetic joint infection (PJI) AAOS Guideline as strong [12], 44% of the joint punctures were false negative. In these cases, we appreciate it might be a vice of aspiration procedure – missing the joint, negative aspiration. In the false negative cases if there is a discrepancy between the probability of peri-prosthetic joint infection (PJI) and the initial culture result the test should be repeated. Farther, from the rest of 56% positive joint punctures, almost one fourth (26%) were found to be contaminated – the bacteriologic outcome of the intraoperative specimens was different from the germ culture obtained through joint aspiration.

In 5 cases preoperative antibiotic therapy was sus-

tained requiring special bacteriologic culture mediums from National Institute of Infectious Diseases “Prof. dr. Matei Balș”. The microbiologic results suggested in the cohort study patients the following aetiology for peri-prosthetic joint infections (PJI) (Figure 2).

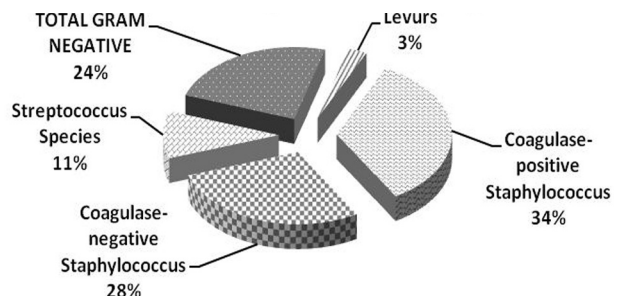


Figure 2. The microbiologic aetiology of peri-prosthetic joint infection (PJI) in the studied patients cohort

In addition, the analysis of the microbiologic results revealed that the most frequent cause of

peri-prosthetic infection (PJI) on hip and knee were staphylococci, followed by Gram negative bacteria as the general tendency mentioned in the literature [6]. Some studies suggest that coagulase-negative staphylococci infections are increasing in prevalence, while Gram negative infections are decreasing [13].

Treatment protocol

The results of this investigation protocol led to a specific antibiogram in 90% of the cases, which completed debridement associated with retaining prosthesis attitude in early infections (15 patients – 16.85%) respectively, with the spacer's (joint distractor) local antibiotherapy in the "two-stage" revision for late, haematogenous or intraoperative infection (72 patients – 80.90%). The rest of two patients (2 patients – 2.25%) have supported one stage prosthesis exchange (Figure 3).

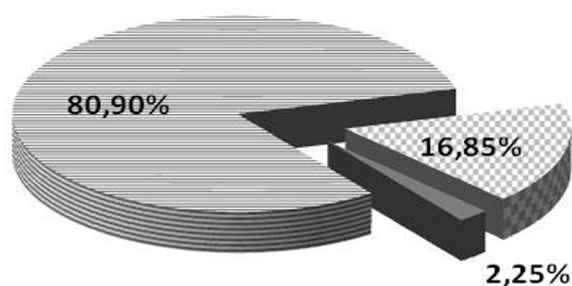


Figure 3. Surgical attitude in PJI treatment management

Legend.

16.85% - debridement and prosthetic retainment
 2.25% - "One-stage" prosthetic exchange
 80.90% - "Two-stage" revision arthroplasty in PJI

The "two stage" revision prosthetic exchange was, as seen above, the most commonly pursued surgical procedure in the treatment management of peri-prosthetic infection (PJI) in our clinic. The "two stage" revision arthroplasty was always used in knee (TKR) peri-prosthetic joint infection (PJI), practically "one stage" exchange being met only in hip (THR) peri-prosthetic infections (PJI) – 2 cases (2.25%). In consequence, 60% of the patients received "the second" prosthesis after an interval between 6 weeks to 12 weeks from the first step of "two stage" revision, except for the reinfection situations. The eligibility for the "new" prosthesis was established on 3 negative consecutive laboratory inflammatory tests, performed every 1 week, associated in 3 patients with *negative leucocyte In¹¹¹ labeled scintigraphy*. The rest of 40% of the patients undertook either surgery after a longer period or a second debridement with spacer replacement.

Results

Our retrospective study mean rate of peri-prosthetic joint infection (PJI) after total joint replacement (TJR) of the lower extremity (hip and knee) was 2.87%: 3.30% after TKR and 2.70% after THR.

Starting spring 2009, laminar air-flow was introduced in the operating theatre of our clinic and AAOS PJI Guideline [12] antibiotherapy was accepted as standard intern protocol, but also, with these changes, our hospital become an Orthopaedic Reference Centre and had to face more external peri-prosthetic joint infection (PJI) patients.

The treatment success rate was one key-point aspect seen in our retrospective study. The "healing" success rate was analysed upon surgical procedure attitude:

For the "one stage" exchange procedure in peri-prosthetic joint infection (PJI) of the hip the success rate was 50%, one case form two requiring a second look surgery with spacer conversion.

For the "two stage" exchange procedure the success rate was 87.50% (63 patients) – 9 cases presenting treatment failure that lead to persisting infection or to a new/ added infection (12.50% of all patients) (Figure 4.) From these 9 patients, the number of new/ added infections registered was 7 cases – 9.72% of the group with "two stage" procedure patients and 7.87% of all infected patients enrolled in the study. These 7 cases proved to be *polymicrobial infections* (Figure 5).

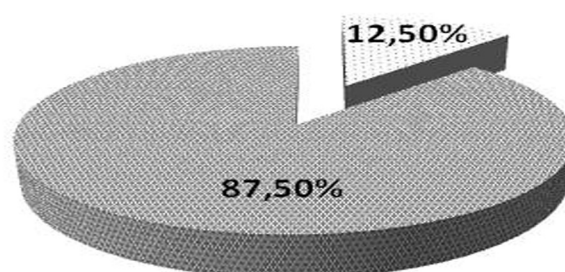


Figure 4. Success rate for „two stage” surgical treatment procedure in peri-prosthetic joint infections (PJI)

Legend.

12.50% - failed treatment
 87.50% - Successful treatment

From orthopaedic point of view, *management of the bone stock deficiency* at the time of revision – "second stage", using uncemented long stem prosthesis is almost always a problem. The need of *struts and morcellate bone grafts, cage and/or tantal augments* usage is mandatory for adequate reconstruction, mainly for acetabular defects – at least Paproski type IIIA deficiency [14], but also for femoral one [15].



Figure 5. Polymicrobial infected THR with intrapelvic cup loosening, with difficult therapeutic response and challenging reconstruction options

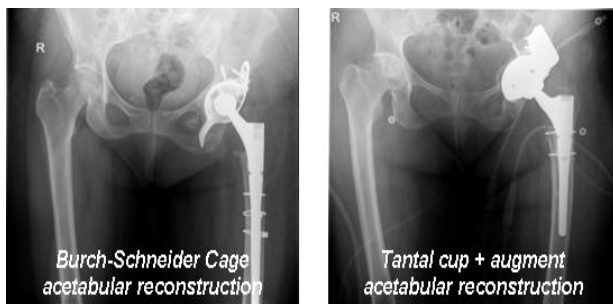


Figure 6. Acetabular and femoral reconstructions at the „second stage” revision surgery

Discussions

The importance of this local hospital analysis is that of reporting, for the first time, as far as the authors know, the results of *peri-prosthetic joint infection (PJI)* rates in a Romanian orthopaedics clinical hospital, specialized in joint replacement. A comparison to the literature *peri-prosthetic joint infection (PJI)* prevalence rates could be made.

The limitation of the present study is that of being only a level IV study - a retrospective, descriptive study, analysing the rates of infection in joint arthroplasty according to the diagnostic and therapeutically management conducted in this orthopaedic health unit.

Aside from these issues, the study demonstrates that in The Clinical Hospital of Orthopaedics and Traumatology “Foişor” (Bucharest, Romania) *peri-prosthetic joint infection (PJI)* rate follows the literature incidence risk of this pathologic entity - 3.30% for the knee arthroplasty (TKR) and 2.70% for the hip arthroplasty (THR) -, being just 1% far from the rates mentioned by Hansen [1].

Regarding surgical attitude, “two stage” exchange

revision was mostly used for the treatment of peri-prosthetic joint infections (PJI), which leads to 87.50% good results.

This method presumes the use of dedicated long stem revision prosthesis, with bone stock reconstruction possibilities or, sometimes, cements fixation prosthesis, but afterwards also a complex rehabilitation program.

The main difficulties with this procedure are:

- mobility rehabilitation and limb length discrepancy control;
- neurologic complications (superficial peroneus nerve palsy);
- acetabular or proximal femoral reconstruction in revision total hip replacement (THR) or tibial bone stock reconstruction in revision TKR (the use of Tantal augments and/or cortico-spongiuous bone grafts).

In the context that the economic burden of infections is expected to exceed 50% of the inpatient resources available for revisions by 2025 for total hip replacement (THR) and by 2016 for total knee replacement (TKR) [16], diagnosis and treatment management for peri-prosthetic joint infections (PJI) is an important and subject to review issue.

Conclusions

Our retrospective study found that treatment of peri-prosthetic joint infections (PJI) in accordance with currently recommended algorithms is associated with a significant better outcome.

The results using a correct diagnosis protocol led to a specific antibiogram in 90% of the cases, which completed the spacer’s (joint distractor) local antibiotherapy.

The “two stage” exchange revision arthroplasty seems to be a successful procedure in the treatment of peri-prosthetic joint infection (PJI) and therefore we recommend this surgical attitude in similar cases of infection. Although, there are advocates for “one stage” prosthetic exchange as periprosthetic joint infection (PJI) treatment as a method of reducing financial costs and patient mechanical complications after surgery, literature studies [17] suggest that “one stage” exchange is less likely to be more cost-effective than “two stage” exchange because of its inherent higher probability for reinfection [18].

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