



ORIGINAL ARTICLE

Retrospective Evaluation of Post-Hip Arthroplasty and Knee Infections: Frequency, Associated Risk Factors and Developments

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Abstract

Background: Infections in orthopedic procedures are difficult to eradicate and persist until the implant removal.

Methods: Control-case study of 390 patients who underwent to primary hip and knee arthroplasty, from January 2007 to December 2011 at the Hospital and Clinics, Federal University of Minas Gerais. Risk factors and frequency of surgical site infection (SSI) were assessed, beyond the clinical outcome after a year of procedure.

Results: In 16 cases of infection, we observed that obesity has configured as a risk factor, and the preoperative bathing as a protective factor for ISC. The SSI rate was approximately 4% and the main microorganisms identified were Gram-negative, especially *Acinetobacter baumannii* to carbapenems. From infected patients, 85.7% underwent revision of prosthesis in two surgical times and there were no associated deaths.

Conclusion: Obese patients have a higher risk for developing SSI and the found rates are above the reported in the literature, probably associated with the greater number of Gram-negative bacteria.

Keywords

Surgical site infections, Risk factors, Orthopedic surgery

Background

The related infection to the orthopedic prosthesis implant is the main cause of faults or failures associated with arthroplasties and include aseptic loosening, dislocation, prosthesis or bone fracture. These infections are difficult to eradicate and persist until the removal of the foreign body [1].

The objective of this work is to make a descriptive analysis of cases of primary arthroplasty of the hip and knee and the possible risk factors associated with surgical site infection (SSI).

Method

This is a control-case retrospective study performed at the Hospital and Clinics, Federal University of Minas Gerais, Brazil. The study involved all patients who underwent to primary total hip arthroplasty (THA) and knee (TKA), from January 2007 to December 2011, identified through the database of the Committee on Hospital Infection Control of institution. Patients were analyzed through medical records and queries to the database of the institution's laboratory for analysis of microbiological cultures.

Infections in revision arthroplasty of the hip and knee in patients treated for SSI and who did not undergo the procedure in the operating room of the institution were excluded.

The diagnostic criteria of infection associated with arthroplasty were established as recommended by the Center for Disease Control and Prevention (CDC), according to the National Healthcare Safety Network (NHSN, 2009) methodology.

Among the variables studied, the related parameters were evaluated in patients, such as sex, age, comorbidities (obesity, diabetes mellitus, HIV, prior use of corticosteroids, rheumatoid arthritis and smoking) and the indication that determined the need for primary hip arthroplasty and knee. With regard to procedure, preoperative bathing, surgical time > 150 minutes, and the use of antibiotic prophylaxis were evaluated. Nevertheless, about the outcome, incidence and topography of the SSI, the microorganisms identified in the cultures, the surgical therapy of choice for the treatment of infection were analyzed. It was still analyzed if there was a review of the prosthesis in one or two surgical times and if there was also deaths associated with SSI

Statistical Analysis

The collected data were analyzed in the software Statistical Package for the Social Sciences (SPSS®) version 15 (Chicago, Illinois). Order to compare proportions, we used the Fisher exact test or chi-square (X^2), and the Pearson. Order to compare the median, we used the Mann-Whitney U test.

The pairing of the control-case study was performed in the ratio 1:4, being selected prior to and after each case sequential patients, considering each type of procedure and the date of surgery.

In all analyzes, we considered the level of statistical significance when $p < 0.05$ bilaterally, and a confidence interval of 95%.

Results

From 390 patients, 16 (4.1%) developed SSI, being 11 cases associated with TKA and 5 to THA.

In patients who underwent to TKA, 44 controls were analyzed for 11 cases of SSI. There was a female predominance in 67.3% of the sample, and 70.9% of patients were aged over 65 years. Between patients diagnosed with SSI, this was more common in female patients ($n = 6$) than in males ($n = 5$). Among the risk factors related to the patient, highlighting the present obesity in five of 11 infected patients, setting as a risk factor (95% CI 1.6 to 45.4) statistically significant ($p = 0.016$) for SSI.

The preoperative hospitalization with less than 24 hours represented 81.8% of the sample, and from these patients, nine evolved with SSI. The greater surgical time than 150 minutes occurred in 40% of procedures analyzed; five were diagnosed with SSI. Preoperative bathing was performed in 37 of patients in the sample (74%) and it was configured as a protective factor (95% CI 0.03 to 0.6) statistically significant ($p = 0.012$). The prophylactic antibiotics were administered to all patients, and in 37 patients (68.5%), this antibiotic was administered among 30 and 60 minutes before the incision. From these, six (16.2%) were diagnosed with SSI. Thus, prophylactic antibiotics were administered to five patients with SSI, at or after the beginning of the surgical incision (Table 1).

In a study of patients undergoing THA, 25 patients were analyzed, being 20 controls and 5 cases of SSI. It was observed in this sample the predominance of males (56.0%), with 60% of patients older than 50 years. The SSI was present mostly in male patients ($n = 4$) than in females ($n = 1$). Analyzing the risk factors related to the patient, obesity (30% of the sample) and the diagnosis of diabetes mellitus (8% of the sample) were most representative, but without statistical significance.

The preoperative hospitalization with less than 24 hours accounted for 72% of the sample, and three patients were diagnosed with SSI. The greater than 150 minutes surgical time occurred in seven (28%) evaluated procedures, and one (14.3%) procedure progressed with SSI. Preoperative bathing was performed in 22 patients (91.7%) analyzed, and four progressed to SSI. The prophylactic antibiotics were administered to all patients. In 19 patients (79.2%), this antibiotic was administered among 30 and 60 minutes before surgical incision, and two patients (10.5%) developed SSI. Thus, the prophylactic antibiotic was administered in three patients diagnosed with SSI in the moment or after the start of the surgical incision (Table 2).

The identified infectious agents were *Staphylococcus aureus* (33.3%), *Acinetobacter baumannii* (25%), *Enterococcus faecalis* (16.7%), *Klebsiella sp* (25%), *Proteus mirabilis* (16.7%), *Enterobacter cloacae* (8.3%),

Table 1: Risk factors associated with SSI in primary knee arthroplasty - Belo Horizonte, 2007-2011.

Features	Surgical Site Infection				Total		p	Odds Ratio	
	Yes		No		n = 55	%		Estimate	IC 95%
	n = 11	%	n = 44	%					
Sex									
Female	6	16.2	31	83.8	37	67.3	0.473	(ref)	
Male	5	27.8	13	72.2	18	32.7		2.0	0.5-7.7
Age (years)									
< 50	0	0.0	2	100.0	2	3.6	0.796	(ref)	
50 a 64	2	14.3	12	85.7	14	25.5		-	-
65 a 79	7	23.3	23	76.7	30	54.5		-	-
≥ 80	2	22.2	7	77.8	9	16.4		-	-
Obesity	5	55.6	4	44.4	9	22.5	0.016	8.4	1.6-45.4
<i>Diabetes mellitus</i>	2	33.3	4	66.7	6	10.9	0.588	2.2	0.4-14.1
Smoking	0	0.0	2	100.0	2	4.2	1	-	-
Corticosteroid > 1 week	0	0.0	5	100.0	5	9.8	0.569	-	-
Immunosuppressant	0	0.0	2	100.0	2	3.6	1	-	-
Preoperative hospitalization < 24 h	9	20.0	36	80.0	45	81.8	1	1	0.2-5.6
Surgery time > 150 minutes	5	22.7	17	77.3	22	40.0	0.739	1.3	0.4-5.0
Preoperative bathing	4	10.8	33	89.2	37	74.0	0.012	0.1	0.03-0.6
Prophylactic TBA 30 to 60 minutes before the surgery incision	6	16.2	31	83.8	37	68.5	0.707	0.6	0.2-2.6
Prophylactic TBA with 24 suspended	8	15.7	43	84.3	51	94.4	0.085	0.1	0.01-1.2

Table 2: Risk factors associated with SSI in primary hip arthroplasty - Belo Horizonte, 2007-2011.

Features	Surgical Site Infection				Total		p	Odds Ratio	
	Yes		No		n = 25	%		Estimative	IC 95%
	n = 5	%	n = 20	%					
Sex									
Male	4	28.6	10	71.4	14	56.0	0.341	(ref)	
Female	1	9.1	10	90.9	11	44.0		4.0	0.4-42.4
Age (Years)									
< 50	2	20.0	8	80.0	10	40.0	0.400	(ref)	
50 a 64	2	28.6	5	71.4	7	28.0		0.6	0.1-6.0
65 a 79	0	0.0	6	100.0	6	24.0		-	-
≥ 80	1	50.0	1	50.0	2	80.0		0.3	0.01-6.0
Obesity	1	16.7	5	83.3	6	30.0	1	1.2	0.1-16.4
<i>Diabetes mellitus</i>	1	50.0	1	50.0	2	8.0	0.367	4.7	0.2-93.0
Smoking	0	0.0	3	100.0	3	13.0	1	-	-
Preoperative hospitalization < 24 h	3	16.7	15	83.3	18	72.0	0.597	0.5	0.1-3.9
Surgery time > 150 minutes	1	14.3	6	85.7	7	28.0	1	0.6	0.1-6.4
Preoperative bathing	4	18.2	18	81.8	22	91.7	0.380	0.2	0.01-4.4
Prophylactic TBA 30 to 60 minutes before the surgery incision	2	10.5	17	89.5	19	79.2	0.179	0.2	0.02-1.8
Prophylactic TBA with 24 suspended	4	17.4	19	82.6	23	95.8	1	-	-

Table 3: Microorganisms identified in cultures of intraoperative tissue - Belo Horizonte, 2007-2011.

Identified Microorganisms	Resistance profile	Total	%
Gram-positive			
<i>Staphylococcus aureus</i>	2	4	33.3
<i>Enterococcus faecalis</i>	0	2	16.7
Gram-negative			
<i>Acinetobacter baumannii</i>	3	3	25.0
<i>Klebsiella pneumoniae</i> ESBL	2	2	16.7
<i>Proteus mirabilis</i>	1	2	16.7
<i>Enterobacter cloacae</i>	0	1	8.3
<i>Escherichia coli</i> ESBL	1	1	8.3
<i>Klebsiella oxytoca</i>	0	1	8.3
<i>Serratia marcescens</i>	0	1	8.3

Escherichia coli (8.3%) e *Serratia marcescens* (8.3%) (Table 3).

According to the time elapsed between surgery and the onset of signs and symptoms, 10 patients (62.5%) had subacute infection (among 3 and 24 months after the procedure).

Regarding surgical therapy for infected arthroplasty, the two-step review was done in 12 patients (85.7%) and one-step review in two patients (14.3%). There were no deaths associated with infection.

Discussion

The development of joint prosthesis is a major breakthrough in biomedical technology, and thereby, the implants have been increasingly used. It's estimated that 150,000 hip arthroplasties are performed annually in the United States, and for the year 2030, 4.5 million procedures are planned, with the frequency of arthroplasty in the world of approximately 400 thousand/year [2].

Despite the improvement in the safety of orthopedic implants, infection rates in arthroplasties have shown increasing. According to the Institute for Healthcare Improvement (IHI), the post-knee arthroplasty and hip rates vary respectively, depending on the patient's risk of 0.68% to 1.6% and from 0.67% to 2.4%. Thus, it's estimated that 6,000 to 20,000 ISC in hip and knee arthroplasties occur annually in the United States [3].

Among the years 2006 and 2008, the National Healthcare Safety Network (NHSN) registered average rates of SSI ranged from 0.67 to 2.4% for hip prosthesis and 0.58 to 1.6% for knee prosthesis [4].

In this study, the infection rate was approximately 4% in both procedures and probably reflects a sample composed of patients with comorbidities such as obesity, advanced age and polymicrobial infection caused by bacteria of most resistance. One should add that with

regard to the etiology, there was a predominance of gram-negative bacteria, especially *Acinetobacter baumannii*, resistant to carbapenems, what differs from literature, where the Gram-positive bacilli are described as major involved in this kind of infection.

Furthermore, from the 16 infected patients, 62.5% were classified as subacute infection, and 37.5% as early. In subacute infections, the bacteria adhered to the surface of the implants produce biofilms; not being possible the mechanical removal of the prosthesis, from which its withdrawal is indicated along with all foreign material⁵.

In these infections, the main identified microorganisms were Gram-negative bacteria. Nevertheless, the early infections are those that occur within three months after surgery, and usually involve bacteria from the hospital environment, resulting from perioperative contamination by *Staphylococcus aureus* and Gram-negative bacteria, as found in this study [5].

In the analysis, female patients who underwent to TKA were at risk for the development of infection, whereas the male patients were underwent to the THA, although not statistically significant, probably due to the small number of patients infected. Some authors suggest the male gender as a risk factor for SSI in orthopedic surgery [6]. Nevertheless, with regard to women, the incidence of SSI in this population may be associated with greater number of procedures when compared to men, probably due to the greater presence of chronic diseases, which leads to higher number of surgical interventions [7].

The average age of patients was 63 years. It's known that with increase in the elderly population, the number of orthopedic surgical procedures has increased because the frequency of fractures is higher in this population, probably either by fall or by pathogenic conditions [8].

Obesity is a risk factor and it's related to wound complications, as demonstrated by Winiarsky, et al. [9], where a group of obese patients had 22% of surgical wound infection and a higher prevalence of deep infection.

Other risk factors associated to the procedure, such as surgical time > 150 minutes were considered relevant among those patients diagnosed with SSI. The increased surgical time favors technical failures due to wear of the team and the decrease in systemic defenses of the patient's body, increasing the risk of wound contamination by microorganisms present in the operating room environment [10].

Nevertheless, compared to the preoperative bathing, recent publications demonstrate the shield impact of clorexidina in SSI prevention. In 2013, Bhaven, et al. [11] demonstrated a reduction in SSI rate of those patients who underwent to knee arthroplasty with decreased treatment costs, hospitalization and

decreased morbidity/mortality, after applying moist towelette, impregnated with chlorhexidine, at night and in the morning before the procedure. The SSI rate decreased from 1% to 0.6%, resulting in a net savings of \$ 0.5 million [11]. There is also scientific evidence that patients undergoing THA and TKA may benefit from chlorhexidine bath when held over three days prior to the procedure [3].

Whereas surgical prophylaxis, choice of antimicrobial, and the infusion time of suspension were evaluated. In all procedures, cefazolin was the prophylactic antibiotic of choice it has been suspended, and 24 hours after onset. From infected patients, 50% had received prophylactic antibiotic at or after the start of the surgical incision. The prophylactic administration must be initiated between 30 and 60 minutes before the incision so that there is bactericidal tissue levels for the bacteria to the skin of the patient may be appropriately removed from the wound, significantly reducing the risk of infection [12].

In the sample, 85.7% of infected patients underwent surgical revision in two stages. This choice may have been based on the microbial flora found in the cultures of infected tissues and the time between diagnosis and the procedure. There were no deaths associated with the SSI, probably due to the small number of patients infected.

Other Brazilian studies found a mortality rate of 14.6% [13] and 19.2% [13] in elderly patients, patients with hip fractures, and most were male. These studies also emphasize that when the elderly patient develops an SSI, the mortality risk increases four times (OR = 4.65; IC 95% = 1.97 - 10.98, $p < 0.001$) [14].

Conclusion

The rates reported above were found in the literature, probably due to the type of microorganisms detected, particularly the Gram-negatives. In addition, obese patients present eight times the risk for developing SSI and the preoperative bathing has configured as a protective factor.

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