ORIGINAL ARTICLE

Hip arthroplasty: Incidence and risk factors for surgical site infection

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ABSTRACT

Background: The number of surgical procedures for total hip arthroplasty has increased worldwide, in a direct proportion to the increase in life expectancy of the population. Surgical site infection is the main complication, with several related factors for its occurrence. The objective of this study was to evaluate the incidence of surgical site infection in patients undergoing elective total hip arthroplasty in a tertiary hospital in Brazil, and to identify possible risk factors involved in surgical site infections within the context of Brazilian healthcare.

Methods: A total of 130 patients who have undergone total hip arthroplasty, performed by two surgeons, between June of 2015 and April of 2017 were studied. The Cox regression model was used to identify which covariates among those surveyed influenced the follow-up time, and the hazard ratio was calculated.

Results: The incidence of SSI within 90 days after surgery was 5.4%, with all identified infections classified as superficial. A multivariate survival analysis indicated diabetes and previous hip surgery as risk factors for surgical site infection.

Conclusions: The knowledgement of the epidemiological aspects of orthopedic surgical site infection, are important for management of actions for infection prevention.

KEY WORDS:
Prognosis; risk factors; surgical wound infection; arthroplasty replacement hip

INTRODUCTION

Total hip arthroplasty (THA) is the treatment indicated for the functional restoration of degenerated joints, mainly caused by osteoarthrosis (1). The number of THA performed each year has been increasing worldwide, in a direct proportion to the increased life expectancy of the population (2). By 2030, is expected the rate of surgical site infection (SSI) in patients undergoing hip joint arthroplasty will increase from 2.18% to 6.5% (2,3).

Despite the advances achieved in recent years in relation to preventive measures for SSI, both in surgical practices (3) and in the quality of articular implants, some of the factors that contribute to the increased incidence of infections are the increase in the prevalence of conditions such as: obesity, senility, diabetes, and microbial multiresistance (4). The risk factors that favor the development of SSI are associated to the patient, surgical team, environment, or the technique used in the procedure. Although there are factors upon which professionals can intervene, such as nutritional status, tobacco use, antibiotic prophylaxis, and surgical technique, the conditions associated to patients often cannot be modified, such as age, sex, and most comorbidities (4,5).

The impact of i*nfectious complications* in hip arthroplasty affects social, occupational, and economic aspects, and is a major challenge for health professionals, patients, and the health services (6). Pain and the inability for locomotion limit activities of daily living and work, generating psychic and economic dependence and damages for patients (7,8). For the health services, the costs can increase by more than 300%, related mainly to the use of high cost antibiotic therapy, and the long hospital stay (8).

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Thus, the main strategy for SSI reduction and promotion of surgical patient safety is intervening on modifiable risk factors, (9) which make the identification of these factors a priority in research. Several studies have described the risk factors involved in the development of SSI, but methodological differences and sample size issues in the current research prevent a definitive conclusion on the issue. Factors such as the involved joint, drainage of secretion, and the diagnosis of superficial infection of the surgical wound are conditions associated with periprosthetic joint infection (10). A systematic review which collected 512,208 patients undergoing total joint arthroplasty, (11) identified several conditions (diabetes, rheumatoid arthritis, immunosuppressive and steroid use), previous joint surgery, and high body mass index (BMI) as risk factors for infection. On the other hand, the presence of drains, age, and alcohol consumption (11,12) remains controversial subjects.

Thus, the objective of this study was to evaluate the incidence of SSI in patients undergoing elective total hip arthroplasty in a tertiary hospital in Brazil, and to identify possible risk factors involved in surgical site infections within the context of Brazilian healthcare.

MATERIAL AND METHOD

One hundred and thirty patients undergoing elective THA surgery were studied. The procedures were performed by two orthopedic surgeons, between June of 2015 and April of 2017, in a large public hospital in Belo Horizonte, Minas Gerais (Brazil). It was the same population included in a clinical trial registered on *www.clinicalTrials.gov* (NCTO3001102).

The sample suitability for the proposed analysis was evaluated by applying the rule of Green (1991) (13). Thus, the 130 patients enrolled during the 22-month period of the clinical trial, previously described, allowed an analysis of SSI associated factors with a power of 88%, and precision of 8%, based on the SSI incidence rate of 12.8%, defined in a previous study conducted at this hospital (14).

The patients included were 18 years of age or older, of both sexes, underwent elective THA, primary or revision surgery, and had no infection at the surgical site at the time of surgery.

According to hospital protocol, and as a prerequisite prior to surgery, all patients underwent a cardiac and anaesthesia evaluation, including measurement of blood glucose levels. At this time, the need for referral to an intensive care unit postoperatively was defined, depending on the risk of complication estimated for each patient. Patients were hospitalized on the same day of surgery, and antibiotic prophylaxis was performed using cephalozine. The first dose was administered at the beginning of the anesthetic induction, with repetition every three hours while the surgical procedure lasted, and then every eight hours in the first 24 hours after surgery. Both antisepsis of the patient's skin and the preparation of the surgeon hands were performed with povidone-iodine antiseptic solution. All prostheses were fixed using polymethylmethacrylate (orthopedic cement). Due to the clinical study, during the study period, all patients were instructed by a research nurse, in a pre-surgical appointment, not to remove hair at the surgery site, and to take two baths, in the 24 hours before the surgical procedure.

For the patient's thermal control during the surgery, warm blankets were used covering the patient's trunk, and body temperature measured using trans-esophageal digital thermometers (central temperature), in patients undergoing general anesthesia, or external mercury thermometers, for patients with regional anesthetic block by spinal anesthesia. Hypothermia was considered to be temperatures below 36ºC and 36.5ºC (15) for peripheral and central measurement, respectively.

Detailed information about the patients, characteristics of their joint involvement, their comorbidities and all the procedures performed in the operating room were collected on a specific form by the researchers (nurse researcher and previously trained scientific initiation fellow), who were present throughout the procedure.

The criteria for definition of SSI were based on the NHSN/CDC-2017 recommendations (16), with the observation period for infectious complication being 90 days from the date of surgery. The presence of infection, identified by means of direct examination of the surgical wound during the first 30 days following surgery, was always notified by the same research nurse. After this period, telephone contact with patients was performed at 30, 60 and 90 days after surgery, and the researcher actively questioned the presence of SSI signs and symptoms, following a previously defined questionnaire. All patients were instructed to connect with the service in the event of any change in the operative wound.

Data were entered, using double entry, and analyses were conducted using the Statistical Package Social Sciences (SPSS) software, version 19. The level of significance was established at 0.05, and the confidence interval (CI) was 95%.

A descriptive analysis of the main characteristics of the population (absolute frequency, median, relative minimum and maximum values) was performed. The global SSI and topography incidence rates were calculated. Analysis of the distribution pattern of continuous variables was tested using the Shapiro-Wilk test.

For the investigation of the association between possible risk factors and SSI, a multivariate analysis was performed, including all factors that were associated with SSI in the univariate analysis, with $p < 0.20$. The COX regression model with time-dependent covariables was used to identify which covariates among those surveyed influenced the follow-up time, and the hazard ratio was calculated. The stepwise (backward) method was used to select the variables that remained in the final model ($p<0,05$).

This study (CAAE 30544114.0.0000.5149) was approved by the Research Ethics Committee of the Federal University of Minas Gerais (UFMG). The patients were only included after signing the Informed *Consent Form,* according to the norms of the National Health Council and Resolution 466/12.

RESULTS

Among the 130 elective THA surgeries studied, all were classified in terms of contamination potential as clean, and 121 (93.1%) were primary procedures. Two patients (1.5%) died in the postoperative period, due to non-infectious causes (cerebrovascular accident and arrhythmia), and the remaining 128 patients were followed for 90 days without any losses.

TABLE 1: Main characteristics of the patients and the total hip arthroplasty surgeries – Belo Horizonte, June 2015 to April 2017

Characteristics	n	%
Sex (female: male)	67:63	51:49
Age ≥ 60 years	82	63.1
BMI <18.5 kg/m^2	6	4.6
≥ 18.5 BMI < 25.0 kg/m^2	31	23.8
BMI ≥ 25.0 kg/m^2	93	71.6
Procedures using vancomycin mixed with orthopedic cement	9	6.9
Use of bone graft	50	38.5
Type of anesthesia (general: regional blockage)	41:89	32:68
Number of comorbidities		
0	27	20.8
1 – 2	61	46.9
≥3	42	32.3
Previous surgery	22	16.9
ASA classification		
I	22	16.9
II	94	72.3
III	14	10.8
Risk index for surgical infection		
0	61	46.9
1	60	46.1
2	9	6.9
Patients referred to the ICU after THA	27	20.8
Patients who required blood transfusion	17	13.1

ASA: American Society of Anesthesiologist; ICU: intensive care unit; THA: total hip arthroplasty; BMI: body mass index

Surgeon A performed 28.5% (37/130) of the procedures, and Surgeon B performed 71.5% (93/130). The main demographic characteristics of the patients are provided in Table 1.

No difference was identified in the male: female ratio or in the lateral aspect of the operated hip (right: left). The median age of the patients was 64 (18-87) years and the BMI ranged from 15.9 to 46.1 kg/m^2, with a median of 27.2 kg/m^2.

Most patients, 79.2% (103/130), had at least one comorbidity. The main pre-existing diseases identified were: hypertension (85/130, 65.4%), dyslipidemia (45/130, 34.6%), cardio pathologies (24/130, 18.5%), thyroid diseases (18/130, 13.8%), and diabetes (17/130, 13.1%). Twenty-two patients (16.9%) reported a previous hip surgery.

All 130 patients reported a bath, in the 24 hours before the surgery. Despite the orientation not to remove hair from the surgical site, 11.5% (15/130) of the patients had done so. Shaving of the surgical area was performed in 15.4% (20/130) of the patients, always immediately before the surgery, using an electric clipper.

The body temperature (central or peripheral temperature) varied according to the type of anesthesia performed. Thus, 68.5% (89/130) and 31.5% (41/130) of patients had peripheral and central temperature measurements, respectively, monitored during the surgical procedure. At the beginning of the surgery, 76.2% (99/130) of the patients were already hypothermic; at the end of the procedure, 90.8% (118/130) of the patients had a body temperature that was below the reference values, even with the use of heated blankets with heated airflow.

The median between bath and the skin incision was 130 min (43-379 min), the median time between the antibiotic administration and the skin incision was 52 min (23-116 min) minutes and the median duration of the surgeries was 119 min (68-265 min). The median fasting blood glucose in the preoperative period was 94.5 mg/dL (66-335 mg/dL) and the median of glycated hemoglobin (HgbA1c), measured exclusively in patients diagnosed with diabetes was 7.0% (6.0-13.3%).

In relation to the length of hospital stay, the median was three (2-31) days. The longest hospital stay (31 days) was observed in a patient who developed an immediate postoperative stroke, remaining in ICU until death. Seven patients presented SSI within 90 days after surgery, representing an incidence of 5.4% (7/130), 95%CI (2.2, 10.8).

In all seven patients, SSI was considered to be of a superficial incisional type, and was diagnosed between the 12th and 29th postoperative day, with a median of 14 days. Since they were infections affecting the superficial skin plane, obtaining biological material for the etiological diagnosis of the infection was not possible in most cases, except in one, with a small subcutaneous collection that allowed the aspiration of secretion in a closed system using a syringe, and *Staphylococcus aureus*, sensitive to meticillin, was isolated.

Despite the statistical significance observed in the univariate analysis, glycated hemoglobin dosage before surgery was not included in the multivariate analysis model, considering the small number of patients with the measure available, who were only subgroups of patients diagnosed with diabetes. In addition,

the variable "preoperative blood glucose dosage" was not included to guarantee the independence of co-variables, since "diabetes" was included in the model.

The results of the multivariate analysis using the COX regression model are presented in Table 2. The diagnosis of diabetes and the report of a previous hip surgery were identified as conditions significantly associated with SSI, with the respective hazard ratios: 10.1 (2.25- 45.20) and 4.60 (1.03-20.62), $p < 0.05$. In the same way, analyzing only patients submitted to primary THA, diabetes remained as the only factor related to the risk of infection (data not shown).

DISCUSSION

Despite extensive scientific publication on this topic, recognition of the factors related to the development of SSI after THA has not reached the level of consensus. The divergence of findings among the several studies is explained by methodological differences (especially in terms of outcome assessed, deep or superficial infections, and type of joint involved) and in the populations studied. Specifically, analysis of hip and knee procedures together may compromise the recognition of specific risk factors for each of these sites (10).

In this study, which included exclusively patients undergoing THA, no deep infections were identified, and our main contribution was confirming the influence of diabetes and previous surgery on the development of SSI.

Diabetes mellitus is one of the most common diseases in the world, with prevalence increasing in the last decades. Globally, 382 million people were living with diabetes in 2013, and this number is expected to increase to 592 million by 2035 (17). The number of diabetic patients undergoing arthroplasty has also been increasing, with an elevation in the survival of this population subgroup, with a recognized risk of developing osteoarthritis (18). According to previously published data, 18.7% of patients undergoing joint arthroplasty have some level of dysglycemia, and about one-third of them do not have

TABLE 2: Multivariate analysis of factors associated with surgical site infection in total hip arthroplasty Belo Horizonte, June 2015 to April 2017

	Univariate analysis				Multivariate analysis	
	SSI					
Covariables	Yes (n=7)	No (n=123)	HR [95%CI]	p value	HR [95%CI]	p value
Left hip surgery	6(85.7%)	61(49.6)	5.89[0.71-48.9]	0.101		
Diabetes	4(57.1%)	13(10.6%)	9.30[2.08-41.56]	0.004	10.1 [2.25-45.20]	0.003
Number of comorbidities ≥3	4(57.1%)	38(30.0%)	2.88[0.64-12.86]	0.166		
ASA ≥ 3	3(42.8%)	11(8.9)	6.47[1.45-28.95]	0.015		
Risk index for surgical infection ≥ 2	2(28.6%)	7(5.7%)	5.50[1.07-28.36]	0.042		
Hemotransfusion required	2(28.6%)	15(12.2%)	2.94[0.57-15.13]	0.198		
Previous surgery reported	3(42.8%)	19(15.4%)	4.06[0.91-18.13]	0.067	4.60 [1.03-20.62]	0.046
Axillary temperature at the end of surgery	35.1 (33.5-35)	35.1 (34.0-37.0)	0.39[0.11-1.46]	0.163		
Solution 1 used in preoperative bath	2(28.6)	42(34.1)	07.78[0.15-4.01]	0.765		
Solution 2 used in preoperative bath	3(42.9)	40(32.5)	1.47[0.33-6.59]	0.611		
Solution 3 used in preoperative bath	2(28.6)	41(33.3)	0.83[0.16-4.31]	0.831		

SSI: Surgical site infection; ASA–HR: hazard ratio; Cox regression

the metabolic disorder diagnosed prior to the procedure (19). A study involving 1,948 patients revealed that the rate of diabetes among the 101 patients with infectious complication was significantly higher (22%) than in the non-infected group (9%) (20).

In our series of cases, contrasting with 13% of diabetic patients in the total group undergoing the surgical procedure, 57.1% of these patients presenting SSI were diabetic, indicating a 10-fold increase in the risk of SSI, HR= 10.1 95%CI (2.25-45.20); p= 0.003.

According to our results, both the diagnosis of diabetes and the presence of pre-operative hyperglycemia were related to the risk of infection. At least in this population, evidence that adequate glycemic control is protective for infection was not identified, which may be related to the sample size and the poor representativeness we had of patients with inadequate glycemic control.

Our data also suggest that previous surgical manipulation of the joint represents a significant risk for superficial incisional SSI, HR=4.60, 95%CI (1.03-20.62), p=0.046. The same association was identified in a review, published in 2016, regarding the risk of deep infection RR=2.98, 95%CI (1.49-5.93) and patients who had a revision arthroplasty had a risk RR 2.26, 95%CI (1.30-3.92) (11). Several mechanisms may be involved with increased risk of infection in previously operated joints. When the surgical site is manipulated, the tissue environment around the wound may be compromised by replacement by fibrotic scar tissue, which increases surgical difficulty and the time of surgery, with a consequent increase in the risk of bacterial contamination (21).

Our results corroborate the recommendation of the International Consensus Meeting Group (ICG) on Periprosthetic Joint Infection, to routinely investigate the history of prior surgery and careful evaluation of the site to be incised (6). Based on the principle that patients should not be harmed by health care, measures that promote patient safety have taken a prominent part in quality improvement actions in several countries (22). Thus, the identification of factors related to the occurrence of surgical infections is the first step in approaching the problem, and is fundamental for its prevention.

CONCLUSION

Identification of infection risks, and knowledgement of the epidemiological aspects of orthopedic SSI, is important for management of actions for infection prevention. In this study, diabetic patients and those with prior hip surgery had an increased risk for SSI. The recognition of these conditions should increase the level of clinical suspicion of infectious complication in the postoperative period, as well as the promotion of patients with these factors to be preferred candidates for new studies evaluating prevention strategies.

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