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Determining Factors of Periprosthetic Infection: A Proposal for a Cross-Cutting Study in An Ecuadorian Referral Hospital

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Abstract

The objective of this research was to determine the factors associated with the development of periprosthetic infection in patients undergoing prosthetic joint replacement. A descriptive and retrospective study was conducted with 478 patients who underwent surgery at a Specialty Hospital in Quito, Ecuador, between January 2010 and December 2015. The results showed that 3.8% of the patients presented periprosthetic infection, and a significant association was found between infection and urinary tract infection and smoking. In addition, the National Nosocomial Infections Surveillance Index (NNIS) showed that patients with moderate-high risk had a 7.47 times higher risk of infection. In conclusion, there are modifiable factors associated with periprosthetic infection, and the NNIS index can provide a quick and easy estimate of the risk of developing this complication.

Keywords: *Prosthetic joint replacement, Infection, Risk factors*

1. Introduction

The advancement of surgical practice has undoubtedly brought immense improvement in our quality of life. For an aging population, arthroplasty or internal joint prosthesis is the treatment of choice in degenerative and inflammatory arthropathies (1), (2), (3) improving quality of life, providing symptom relief, with recovery of joint function, mobility and independence for patients with a variety of musculoskeletal disorders (4).

Infection of the joint prosthesis or periprosthetic infection (IPA) is one of the main complications of arthroplasties, but considered the most serious, most feared and catastrophic, which can cause severe physical damage in patients, and generate high economic costs. In general, infection rates are reported during the first 2 years of the postoperative period, in primary hip replacement arthroplasty (PTC) with 1.5%; in total knee prosthesis (PTR) 2.5%; and in revision arthroplasty it is reported up to double. Periprosthetic infection has a relatively low mortality of between 2 and 7% in patients over 80 years of age (5); However, it represents a great morbidity for the patient, impact on the health system, with an additional cost estimated at more than 50,000 dollars for each infected arthroplasty. (5, 6)

Revision procedures due to periprosthetic infection are associated with longer operative time, greater blood loss, greater number of complications, and increased healthcare costs. Successful treatment of IPA is often difficult and often involves multiple surgical interventions, in addition to a prolonged course of antibiotics. (4, 6)

Prevention is the most important strategy for dealing with this disabling complication, and should begin with identifying patient-related risk factors; such as morbid obesity, malnutrition,

hyperglycemia, uncontrolled diabetes mellitus, rheumatoid arthritis, chronic renal failure, smoking, alcohol abuse and other clinical factors that should be evaluated and optimized before surgery (7). Understanding the risk factors of IPA allows the application of strategies that aim to reverse some of these potential risk factors and reduce the burden of infection.

It is for all this that it is necessary to create preventive programs that face this health problem, with studies in each locality that determine the factors that are associated with the development of IPA. Despite the significant progress that has been made in recent decades to identify these risk factors, some uncertainty still persists. (8). Hence the importance of the research, which aims to determine the factors associated with the development of periprosthetic infection in patients undergoing prosthetic joint replacement.

2. Materials And Methods

An analytical, observational and cross-sectional study was carried out with the objective of examining the demographic, clinical and microbiological characteristics of patients presenting joint prosthesis infection. All patients undergoing prosthetic joint replacement at the Armed Forces Specialty Hospital No. 1 during the period between 2010 and 2015 were included, provided they met the established inclusion and exclusion criteria. The collected data were analyzed using descriptive statistical techniques, such as frequency and percentage tables. In addition, chi-square was used to identify possible associations between variables. Data were entered into the SPSS version 20 system for analysis.

The chi-square test is a statistical technique used to determine whether there is a significant association between two categorical variables. It is based on comparing the values observed in a contingency table with the expected values under the assumption of independence between the variables.

The process begins by constructing a contingency table, which is a matrix that shows the frequency of joint occurrence of the two variables being studied. Once you have the contingency table, you calculate the expected values assuming that there is no association between the variables. This is achieved by applying the principle of independence and calculating the expected frequencies under that premise. Then, the chi-square formula is used to obtain a statistical value that compares the observed and expected values.

The value obtained is compared with a chi-square distribution with degrees of freedom determined by the dimensions of the contingency table. If the calculated value is greater than the corresponding critical value in the chi-square distribution, it is concluded that there is a significant association between the variables. In other words, the null hypothesis of independence between the variables is rejected and it is suggested that there is a relationship between them.

3. Results and Discussion

The study included 478 patients who underwent prosthetic joint replacement, of whom 62.6% (n=299) were women. The median age was 70.34±13.63 with a range between 20 and 102 years. The mean age of women was 72.2±12.37 and that of men 67.22±15.04, with a statistically significant difference ($p<0.01$). The incidence of prosthetic infection was 3.8% (n=18). The mean age of patients with infection was 71.22±19.44 years, and 66.7% (n=12) were women. Gram-negative germs were the most frequent 40% (n=9), followed by Gram-positive 22.2% (n=4). Escherichia coli (E. coli) was the most frequently identified Gram-negative germ, there were 2 cases in which no germs were identified; Resistant germs were isolated from total infections (n=15).

Variables associated with joint prosthetic infection when comparing age, gender, surgical time and body mass index between infected and non-infected patients, no significant differences were found, see Table 1.

Table 1. Relationship of Age, Surgical Time and Body Mass Index with the development of periprosthetic infection.

n=478	Infection Prosthesis	No Infection	Statistical Test t-Student
Age	71.22±19.44	70.30±13.38	p=0.77

Surgical Time	151.89±74.68	126.72±46.20	p=0.17
Body Mass Index (BMI)	27.35±5.62	04.28±0.4	p=0.6

Source: Statistical data of the study. Own elaboration.

Clinical variables and presence of prosthetic infection when comparing the clinical history and the presence of prosthetic infection, it was found that smoking and the presence of urinary tract infection (UTI) are associated with periprosthetic infection, see Table 2.

Table 2. Clinical variables and their relationship with periprosthetic infection.

n=478	No Infection	Infection Prosthesis	Statistical Test Chi-square
Smoking	N=47	N=5	p=0.01
Alcoholism	N=15	N=1	
Diabetes	N=52	N=4	p=0.15
IRC	N=16	N=1	
Liver	N=4	N=0	
Preliminary procedure	N=87	N=5	p=0.35
Rheumatoid arthritis	N=29	N=2	p=0.41
Cancer	N=21	N=2	p=0.20
Immunosuppression	N=22	N=2	p=0.22
IVU	N=24	N=5	p=0.001
Intravenous Drugs	N=0	N=1	

Source: Statistical data from the study, 2017. Own elaboration

Variables related to surgery and presence of prosthetic infection when comparing the type of Arthroplasty (Total, Partial or Revision) and the presence of prosthetic joint infection, no statistically significant differences were found X^2 (2, 1.48) p = 0.47, proportionally the presence of infection is the same according to the type of arthroplasty performed. 11.3% (n=54) of the surgeries were performed in patients with surgical risk ASA greater than II. When comparing the presence of infection with the ASA value divided into two groups (ASA I and II versus ASA III, IV, V) a statistically significant difference was found, X^2 (1,9.06) p=0.003; proportionally, patients with ASA III or more have a greater presence of IPA with an OR 4.29 (95% CI 1.54-11.95).

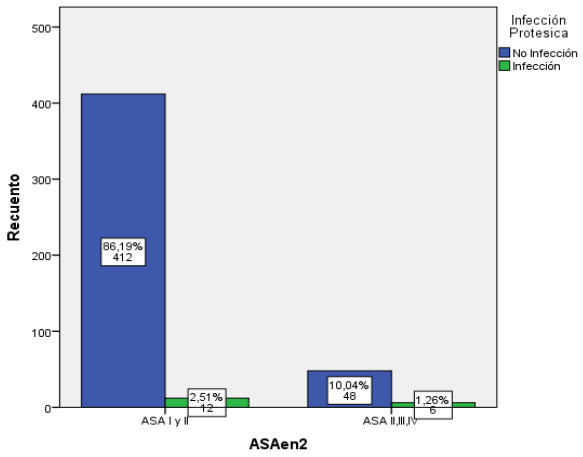

Figure 1. Comparison between two surgical risk groups ASA and presence of periprosthetic infection. Source: Statistical data from the study, 2017. Own elaboration

Surgical Time and Periprosthetic Infection: The 75th percentile of surgical time in the Military Hospital was 150 minutes, and 26.78% (n=128) of surgeries had a time greater than or equal to this value. When comparing the presence of infection with surgical time divided into two groups (greater or less than the 75th percentile) no statistically significant difference was found, X^2 (1, 1.39) p=0.23.

Contaminated Surgery and Periprosthetic Infection: 2.7% (n=13) of surgical interventions were considered as Contaminated and Dirty Surgeries. When comparing the presence of infection with the Type of surgery divided into two groups (Clean and Clean contaminated versus Contaminated and

Dirty) a statistically significant difference was found, X^2 (1,9.06) p = 0.003; proportionally Contaminated and Dirty surgery patients have a greater presence of infections, with an OR 5.1 (95% CI 1.04-24.95).

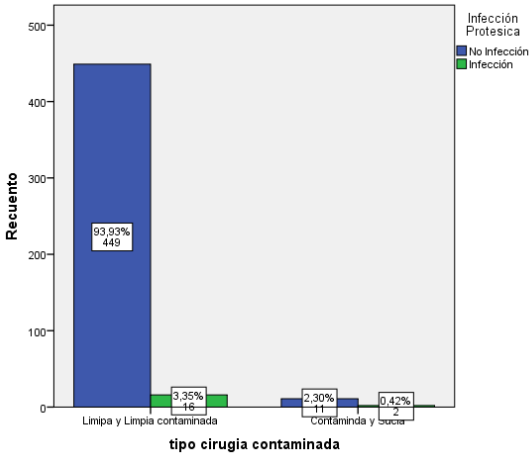

Figure 2. Type of surgical wound divided into 2 comparable groups and its relationship with the development of periprosthetic infection. Source: Statistical data from the study, 2017. Own elaboration

National Nosocomial Infections Surveillance (NNIS) Index. NNIS is a risk index in the prediction of Surgical Site Infection, when calculating it was found that 62.6% (n = 299) of the interventions had a Low risk and only 3.1% (n = 15) presented a Medium-High risk, no surgeries with High risk were found. However, when comparing the presence of infection with the value of the NNIS index, a statistically significant difference was found, X^2 (2, 14.80) p=0.001; proportionally, patients with medium-high risk of NNIS, have a higher presence of infections than those of medium and low risk. The risk of having prosthetic infection with an Intermediate-High NNIS is 7.47 (95% CI 1.91-29.26).

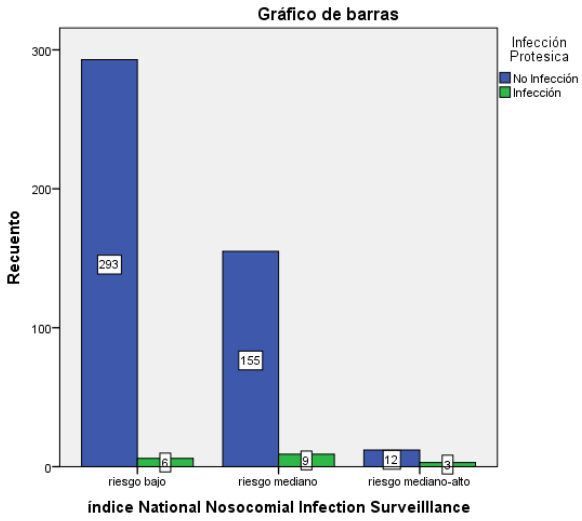

Figure 3. Risk of joint prosthetic infection according to the NNIS index. Source: Statistical data from the Study. Own elaboration

In recent decades, prosthetic joint replacement has been an important improvement in the functional capacity of patients with arthropathies. More than one million arthroplasties are performed each year in the world; However, it is not an intervention without complications, of which one of the most feared is infection. Its presence implies a significant decrease in the quality of life of patients and a high economic cost, therefore, its prevention must be a priority; Knowing in advance the risk factors that can cause infection can help prevent it.

Taking into account the widely fluctuating nature of the epidemiology of these infections around the world, and considering the Armed Forces Specialty Hospital No. 1 as a reference institution at the national level, the study was carried out with the purpose of identifying the factors associated with the development of prosthetic joint infection at the local level.

Joint prosthetic infection occurred in 3.8% of all arthroplasties, somewhat more frequent than described in the literature (5, 6, 9), in international studies (5) and similar to other publications (10), which could be explained by involving revision arthroplasties within the analysis, which even present twice the PI compared to a primary prosthesis. In addition, patients with IPA have an average age of 71.22 years, they occur somewhat more frequently in women.

When comparing the demographic variables between patients with and without joint prosthetic infection, it was found that age is not associated with periprosthetic infection as described (11), although some authors indicate advanced age (>75 years) as a protective factor (12); Similarly, no association was found with the male gender, which is a factor reported by some studies. (11, 13), but not verified by others (9), The biological cause of this association is uncertain (8), which can be equated in both genders to ten years of follow-up. (14)

Several researchers indicate the association of obesity (7, 13, 15) and malnutrition (7, 11, 13) with the development of IPA, which was not determined in this analysis. This could be because malnutrition is not only defined by body mass index (BMI<18.5), as it consists of several nutritional parameters. (13) not taken into account in the study.

Within the clinical history, the history of smoking and UTI (days before surgery and during hospitalization) were significantly related to the development of IPA. The first is a known factor associated with increased postoperative morbidity and mortality. (7, 13) and by delaying wound healing through nicotine-mediated vasoconstriction contributes to the development of this infection (11, 14-16). Urinary tract infections such as cystitis with pyuria are extra-articular sources of infection that are associated with the development of surgical site infection and result in IPA (8, 12), but no clinical studies have been conducted comparing this association directly with periprosthetic infection.

In the present study, no association of diabetes mellitus with the development of IPA was achieved, as described in the literature. (7, 15, 16), but not all studies indicate a clear risk relationship (8). The International Consensus on Periprosthetic Infection at the 2014 meeting (13), establishes poorly controlled diabetes (glucose> 200 mg/L or HbA1C>7%) as a risk factor for the presence of surgical site infection and IPA; which would justify the result because most of the patients in this study had adequate metabolic control. The consumption of alcohol, intravenous drugs, the history of rheumatoid arthritis, chronic renal failure (CRF), liver disease, cancer, immunosuppression and previous surgery did not present a significant association with IPA, which is comparable with previous reports that its relationship with the development of infection is controversial (7, 8, 13, 14).

The NNIS score is a risk scoring system that attempts to aggregate a series of factors or variables on a single scale, which includes the preoperative assessment offered by the American Society of Anaesthesiology (ASA), the type of surgical wound and the surgical time. Regarding ASA, it was divided into two groups (ASA I and II versus ASA III, IV, V), where a statistically significant difference was found, providing patients with ASA III or more with an OR 4.29 (95% CI 1.54-11.95); Also demonstrated by a systematic review and meta-analysis (12). Regarding the classification of the surgical wound, in the same way, two groups were compared (clean wound and clean contaminated versus contaminated and dirty) giving patients with Contaminated and Dirty surgery, greater risk of presenting IPA with an OR of 5.1 (95% CI 1.04-24.95); with a significant association (p<0.001).

And finally, when comparing the presence of infection with the value of NNIS, a statistically significant difference was found (p = 0.001); that is, patients with NNIS 2 or medium-high risk have 7.47 (95% CI 1.91-29.26) times more risk of presenting periprosthetic joint infection than patients with medium and low risk; similarly in a large case-control study, the highest NNIS score (5) correlated with 5 times more likely to be infected, a finding that persists after multivariate analysis (8).

4. Conclusion

A significant series of patients submitted to synthetic joint prostheses at the Specialty Hospital No. 1 of the Armed Forces is described, during 5 years determined demographic, clinical and surgical procedure-related factors. Periprosthetic infection was determined globally in 3.8% of arthroplasties, with a frequency similar to that reported in the literature; Patients who developed periprosthetic infection had a high average age (71.22 years), with a higher percentage of infection in the female gender and with a slightly higher average body mass index (overweight), however, no significant difference was found when compared with uninfected patients.

History of smoking and urinary tract infection are clinical factors that were significantly associated with the development of joint periprosthetic infection. Clinical factors such as diabetes mellitus, neoplasms, rheumatoid arthritis, immunosuppression and history of surgery in the same joint are reported more frequently in patients with periprosthetic infection, but a direct relationship with the development of infection was not achieved. The factors related to surgery were not determinant, therefore, the type of surgery, the type of arthroplasty, the surgical time and the type of joint operated on are not associated with the development of prosthetic joint infection. The collection of clinical and surgical variables in a single scale such as the score of the National Nosocomial Infection Surveillance System (NNIS), determined that patients with moderate-high risk have 7.47 greater presence of infections than patients of medium and low risk.

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