

Risk factors and outcomes for nosocomial infection after prosthetic vascular grafts

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ABSTRACT

Objective: The objective of this study was to determine risk factors for nosocomial infections (NIs) and predictors of mortality in patients with prosthetic vascular grafts (PVGs).

Methods: This was a prospective cohort study of all consecutive patients who underwent PVG of the abdominal aorta with or without iliac-femoral involvement and peripheral PVG from April 2008 to August 2009 at a university hospital. Patients younger than 15 years and those with severe immunodeficiency were excluded. The follow-up period was until 3 years after surgery or until death.

Results: There were 261 patients included; 230 (88.12%) were male, and the mean age was 67.57 (standard deviation, 10.82) years. The reason for operation was aortic aneurysm in 49 (18.77%) patients or lower limb arteriopathy in 212 (81.23%) patients. NIs occurred in 71 (27.20%) patients. Of these, 42 were surgical site infections (SSIs), of which 61.9% occurred in the lower extremities (14 superficial, 10 deep, and 2 PVG infections) and 38.1% in the abdomen (7 superficial, 7 deep, and 2 PVG infections); 15 were respiratory tract infections; and 15 were urinary tract infections. Active lower extremity skin and soft tissue infection (SSTI) at the time of surgery was a significant predictor of NI for both types of PVG (abdominal aortic PVG: adjusted odds ratio [OR], 12.6; 95% confidence interval [CI], 1.15-138.19; peripheral PVG: adjusted OR, 2.43; 95% CI, 1.08-5.47). Other independent predictors of NI were mechanical ventilation (adjusted OR, 55.96; 95% CI, 3.9-802.39) for abdominal aortic PVG and low hemoglobin levels on admission (adjusted OR, 0.84; 95% CI, 0.71-0.99) and emergent surgery (adjusted OR, 4.39; 95% CI, 1.51-12.74) for peripheral PVG. The in-hospital mortality rate was 1.92%. The probability of surviving the first month was 0.96, and significant predictors of mortality were active lower extremity SSTI (adjusted risk ratio [RR], 12.07; 95% CI, 1.04-154.75), high postsurgical glucose levels (adjusted RR, 1.02; 95% CI, 1.00-1.04), and noninfectious surgical complications (adjusted RR, 19.38; 95% CI, 2.25-167.29). The long-term mortality rate was 11.88%. The probability of surviving at 12, 24, and 36 months was 0.94, 0.92, and 0.87, respectively. Variables significantly associated with long-term death were older age (adjusted RR, 1.08; 95% CI, 1.01-1.15), high values of creatinine on discharge (adjusted RR, 1.91; 95% CI, 1.08-3.38), and an SSI with the highest adjusted RR (6.35; 95% CI, 1.87-21.53).

Conclusions: SSI was the primary NI. The risk of NI depended primarily on the presence of a lower extremity SSTI at the time of surgery, whereas mortality was determined by age, surgical complications during the operation, and SSI. These findings suggest that in those cases in which surgery is reasonably delayed, surgery should be deferred until the lower extremity SSTIs are resolved. (*J Vasc Surg* 2017;■:1-10.)

Prosthetic vascular grafts (PVGs) have been widely used for treating patients with peripheral arterial disease or limb ischemia.^{1,2} During the past several years, the growing prevalence of atherosclerosis and diabetes has resulted in increased use of PVGs.¹⁻³

A well-known complication of PVG surgery is graft infection.⁴⁻¹⁰ In peripheral endovascular procedures, the incidence of PVG infection (PVG-I) is minimal, ranging

from <1% for abdominal aortic vascular grafts to >6% for infrainguinal vascular grafts.^{4,8-10} However, the incidence of other nosocomial infections (NIs), such as respiratory tract infections and urinary tract infections (UTIs), in patients undergoing PVG surgery remains unclear,¹¹ as has been determined in other groups of patients after surgery, such as patients undergoing general surgery, cardiac surgery, or lung surgery.¹²⁻¹⁴ In addition, although few studies have reported risk factors for surgical site infection (SSI) after vascular surgery, no prospective studies have investigated other NIs.^{15,16}

Factors influencing outcomes in patients with NIs after surgery are complex, involving not only the patient's personal condition but also intraoperative and postoperative events. Urgent operation, postoperative complications, age >70 years, and aortic PVG-I have been identified as independent prognostic factors for in-hospital mortality in patients with PVG-I.^{3,5,10,16-19} However, there is limited information about the relationship between other NIs and outcome of patients who underwent PVG surgery.

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In view of these findings, a prospective cohort study was designed to assess the incidence and risk factors of NIs as well as the outcome of patients who underwent abdominal aortic or peripheral PVG to determine predictors of in-hospital and long-term (36 months) mortality.

METHODS

Study population. A prospective cohort study was performed from April 2008 to August 2009 in the Hospital Universitario Marqués de Valdecilla, Santander, Spain, a tertiary university hospital with 900 beds. The study included patients who underwent PVG of the abdominal aorta with or without iliac-femoral involvement and peripheral PVG (infrainguinal arterial grafts). The follow-up period was 36 months. Patients younger than 15 years and those with severe immunodeficiency (eg, hematologic neoplasm, transplant, human immunodeficiency virus infection, congenital immunodeficiency) were excluded. Sample size was previously calculated; a total of 224 patients was estimated to allow the detection of a significant P value $< .05$ of a risk ratio (RR) of 3 with a statistical power of .8 for exposures, with a frequency of 10% in the nonexposed group. We anticipated a dropout rate of 10%.

For all study patients, the following characteristics were recorded at the time of admission or during hospitalization: age, sex, body mass index, smoking history, alcohol consumption, surgery in the previous year, active infections at the time of PVG surgery, and comorbidities. Comorbidities included the presence of chronic obstructive pulmonary disease, diabetes mellitus, renal failure (creatinine level ≥ 1.2 mg/dL), heart failure, acute stroke, ischemic cardiopathy, and arrhythmia due to atrial fibrillation. Data recorded for surgery included the following: emergency or regular surgery, administration of antibiotic prophylaxis (1 g of cefazolin 30 minutes before anesthesia and then every 8 hours until 24 hours after operation), preoperative American Society of Anesthesiologists risk score, surgeon who performed the operation, occurrence of surgical complications, blood transfusions, and requirement of hemodialysis or intra-aortic balloon counterpulsation. Data recorded for the postoperative period included duration of intensive care unit stay, mechanical ventilation, nasogastric intubation, urinary tract catheter, and wound drain insertion.

Definitions. NIs were defined according to the Centers for Disease Control and Prevention criteria.²⁰ In the absence of a uniform criterion and an internationally accepted definition for a PVGI, we adapted the Centers for Disease Control and Prevention definitions of organ-space SSIs corresponding to group 3 of the Szilagyi classification and the definitions by Legout et al and Erbs et al.^{9,10,20-22} We considered a patient to have a PVGI if, at a minimum, one of the following criteria were met: (1) the patient had an isolated microorganism that

ARTICLE HIGHLIGHTS

- **Type of Research:** Prospective cohort study
- **Take Home Message:** In 261 patients who underwent prosthetic vascular graft implantations, skin and soft tissue infection at the time of surgery was the principal risk factor for nosocomial infection, whereas mortality was determined by age, surgical complications, and surgical site infection.
- **Recommendation:** Data suggest that in patients with skin and soft tissue infection, placement of a prosthetic graft should be delayed if possible until infection is resolved.

was aseptically obtained from a biopsy specimen or swab of the immediate area around the graft; (2) there was histopathologic or radiologic evidence of an infection involving the graft and the surrounding tissue; or (3) the patient had continuous bacteremia in the presence of a graft with no other apparent focus of infection. When potential contaminants such as coagulase-negative staphylococci or *Propionibacterium acnes* were present, the infection had to meet either criterion 1 or criterion 2.

Patients who developed NIs were receiving postoperative antibiotics according to the source of infection, the isolated microorganism, and the discretion of the treating physician, which followed international²³⁻²⁵ and Spanish²⁶⁻²⁸ treatment guidelines adapted to local data on antimicrobial susceptibility.

In-hospital patient mortality was defined as any death, regardless of its cause, occurring during hospitalization in our center. Long-term mortality was defined as any death within a period of 36 months since hospital admission.

Postdischarge surveillance was conducted by reviewing all the emergency department forms, by outpatient interviews conducted by the surgeon in the surgery clinic, and by brief telephone interview of patients or their family members.

Statistical analysis. Mean and standard deviation were calculated for quantitative variables, whereas qualitative variables were summarized by frequencies and percentages. A bivariate analysis of each variable as a function of NI, in-hospital mortality rate, or long-term mortality rate was performed. Contingency tables were created for qualitative variables, and a χ^2 test or Fisher exact test was used. To compare quantitative variables, Student t -test was used. Independent risk factors for NI were identified using a multivariate logistic stepwise regression analysis. A mortality curve was obtained by the Kaplan-Meier method by calculating survival rates for the time elapsed between surgery and death. The heterogeneity of the curves was tested with a log-rank test for those

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