Peripheral Vascular Disease and Outcomes Following Coronary Artery Bypass Graft Surgery

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Hypothesis: There is an increased operative risk in patients with a history of peripheral vascular disease (PVD) who undergo coronary artery bypass grafting (CABG). There are also outcome differences associated with these patients.

Design: A study from a 10-year hospitalization cohort with prospective data collection.

Setting: Multiple hospitals in the Greater Cincinnati area with 1 surgical group of cardiac surgeons.

Participants: Cases were CABG patients with PVD, which was defined as having a history of type 1 neurologic injury, prior vascular surgery, or current vascular disease (n=1561). Controls were CABG patients without PVD (n=6328).

Interventions: The study examined 42 potential confounding risk factors and 16 outcome variables.

Results: Twenty-nine potential risk factors were found to be significantly different between CABG patients with and without PVD. Twenty-six confounding risk factors were correlated with 3 factors. Logistic regression analysis showed that even after controlling for sex, significant associative disorders, and other procedures, CABG patients with PVD still experienced more arrhythmias requiring treatment (odds ratio [OR], 1.7; 95% confidence interval [CI], 1.03-1.33; P=.01), neurological complications (OR, 1.7; 95% CI, 1.43-2.07; P<.001), pulmonary complications (OR, 1.4; 95% CI, 1.23-1.62; P<.001), low output (OR, 1.3; 95% CI, 1.09-1.45; P=.001), and intraoperative complications (OR, 1.39; 95% CI, 1.06-1.83; P=.02).

Conclusions: Patients with a PVD history undergoing CABG had more coexistent risk factors. These patients also exhibited higher rates of cardiac, systemic, renal, neurologic, and pulmonary complications.

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It has been well documented that a patient with known peripheral vascular disease (PVD) will face substantially increased mortality rates when compared with an individual with nonperipheral vascular disease. To this effect, Criqui et al reported a 3-fold increase in annual mortality rates in patients with the presence of large-vessel peripheral arterial disease. Because the majority of these documented cases had coronary artery disease and cardiovascular death, many authors have suggested “aggressive” treatment of coronary disease in this patient population, up to and including myocardial revascularization with coronary artery bypass grafting (CABG). Although this suggestion may seem relatively straightforward, there has been little effort to evaluate the operative risks that present themselves to both these patients and their surgeons. These complications may present both intraoperatively as well as postoperatively when procedures such as CABG are undertaken on a patient with known PVD.

It is crucial to understand the potential short- and long-term complications that may arise in patients with PVD undergoing CABG. Although the association between PVD and increased mortality rates in CABG patients has been generally accepted, there have been no large studies to specifically address this issue. Our study reviewed a cohort of nearly 8000 patients who underwent CABG performed by 1 surgical group.

METHODS

We conducted a cohort study from a 10-year hospitalization cohort (N=11 398) with pro-

See Invited Critique at end of article

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Univariate analysis on potential confounding risk factors revealed 29 significant risk factors (Table 3). Patients with PVD who underwent CABG were older (P<.001), had a higher creatinine level (P<.001) and a lower body surface area (P<.001), and required more vein grafts (P<.001). Patients with PVD who underwent CABG received fewer left internal mammary grafts (P<.001) and fewer other arterial grafts (P<.001). There were significantly more women than men undergoing CABG with PVD (P<.001). Patients with PVD who underwent CABG had more significant medical disorders (P<.001), chronic obstructive pulmonary disorder (P<.001), diabetes (P<.001), hypertension (P<.001), history of tobacco use (P<.001), history of neurological disorders (P=.01), and obesity (P=.001). Patients with PVD who underwent CABG tended to undergo surgery more frequently for congestive heart failure (P<.001), coronary anatomy (P=.03), left main greater than 50% cardiac pathologic abnormality (P=.01), 1-vessel cardiac pathologic abnormality (P=.02), aortic disease (P<.001), and other procedures (P<.001). These patients also were more likely to have abnormal left ventricular hypertrophy (P<.001), left ventricular ejection fraction of 39% or less (P<.001), and ascending aorta proximal site (P=.03). Patients with PVD who underwent CABG had less family history of coronary artery disease (P<.001), lower use of retrograde cardioplegia (P=.05), and lower New York Heart Association functional class (P=.01). They were less likely to have had surgery for angina or myocardial infarction (P<.001) and 2-vessel cardiac pathologic abnormality (P=.005). Patients with PVD who underwent CABG had fewer urgent surgical procedures (P<.001) than CABG patients without PVD. There was no significant difference between CABG patients with and without PVD for the remaining 13 potential confounding risk factors.

Correlation coefficients were calculated for the 29 significant confounding risk factors. Twenty of the risk factors were significantly correlated with sex. These factors include chronic obstructive pulmonary disorder, diabetes, hypertension, history of tobacco use, family history of coronary artery disease, obesity, coronary sinus cardioplegia site, surgery for congestive heart failure, surgery for coronary anatomy, urgent surgical procedure, New York Heart Association functional class, 3-vessel cardiac pathologic abnormality, 1-vessel cardiac pathologic abnormality, aortic disease, left ventricular hypertrophy, left ventricular ejection fraction estimate, ascending aorta proximal site, vein from vein proximal site, internal mammary artery from internal mammary artery proximal site, radial from internal mammary artery proximal site, and coronary quality. Table 1 lists the definitions for the potential confounding risk factors.

The 16 outcome variables were hours receiving ventilatory support, intensive care unit (ICU) length of stay, total length of hospitalization, arrhythmias requiring treatment, positive cultures, renal complications, sternal wound complications, neurological complications, pulmonary complications, gastrointestinal complications, low output, intra-aortic balloon pump, return to ICU, pulmonary hypertension, intraoperative complications, and mortality. Table 2 lists the definitions for each of the outcome variables.

To generate the unadjusted risks of each potential confounding risk factor, we performed χ² and t tests comparing men and women with each of the 42 variables. Correlation coefficients were computed among the significant confounding risk factors. We conducted χ² and t tests comparing men and women with each of the 16 outcomes. Logistic regression analysis was then used to investigate the adjusted risk between cases and controls with each of the significant outcome variables while controlling for the significant risk factors. We used SPSS statistical software (SPSS Inc, Chicago, Ill) to perform the analyses.

Table 1

Table 2

Table 3

Table 4
a longer ICU length of stay ($P=.001$) and a longer total length of hospitalization ($P<.001$). Patients with PVD who underwent CABG experienced more arrhythmias (odds ratio [OR], 1.5; 95% confidence interval [CI], 1.3-1.6; $P<.001$), positive cultures for organisms (OR, 1.7; 95% CI, 1.2-2.6; $P=.005$), renal complications (OR, 2.1; 95% CI, 1.6-2.6; $P<.001$), neurological complications (OR, 2.3; 95% CI, 1.9-2.7; $P<.001$), pulmonary complications (OR, 1.7; 95% CI, 1.3-1.9; $P<.001$), gastrointestinal tract complications (OR, 1.7; 95% CI, 1.1-2.6; $P=.02$), low output (OR, 1.6; 95% CI, 1.4-1.8; $P<.001$), return to ICU (OR, 1.6; 95% CI, 1.1-2.3; $P=.007$), pulmonary hypertension (OR, 1.5; 95% CI, 1.1-2.0; $P<.001$), intraoperative complications (OR, 1.6; 95% CI, 1.3-2.1; $P<.001$), and mortality (OR, 2.1; 95% CI, 1.5-2.8; $P<.001$). There was no significant difference between CABG patients with and without PVD for the remaining 3 outcomes.

Logistic regression analysis showed that even after controlling for sex, significant associative disorders, and other procedures, CABG patients with PVD still experience more...
negative outcomes. Patients with PVD who underwent CABG had more arrhythmias requiring treatment (OR, 1.7; 95% CI, 1.43-2.07; P<.001), neurological complications (OR, 1.4; 95% CI, 1.23-1.62; P=.001), pulmonary complications (OR, 1.39; 95% CI, 1.06-1.83; P=.02). They also experienced low output (OR, 1.3; 95% CI, 1.09-0.97; P<.001) and more intraoperative complications (OR, 1.39; 95% CI, 1.06-1.83; P=.02). There was a significant difference between CABG patients with and without PVD on total hospital stay (OR, 0.96; 95% CI, 0.94-0.97; P<.001) and ICU length of stay (OR, 1.002; 95% CI, 1.001-1.003; P<.001). After controlling for risk factors, there was no significant difference between CABG patients with and without PVD for mortality, intraoperative complications, pulmonary hypertension, gastrointestinal tract complications, renal complications, positive cultures for organisms, or return to ICU.
The presence of PVD plays a significant role in the potential morbidity and mortality of patients undergoing CABG. In this study of nearly 8000 patients who underwent CABG, patients with PVD fared significantly worse on 13 of the 16 outcomes examined. Even after controlling for significant risk factors, CABG patients with a PVD history were more likely to experience complications.

Of note, there are 2 previous studies by Birkmeyer et al. that obtained similar findings to our own. The first of these studies found that CABG patients with a PVD history had a nearly 20% five-year mortality while the same risk was roughly 8% for those without known PVD. Even after adjusting for confounding variables such as age and more advanced cardiac disease, it was still noted that patients with a history of PVD had a mortality rate nearly 2 times as high as those without. These findings hinged on data from an earlier study conducted by several of the same authors, which again found, after adjusting for confounding variables, that CABG patients with PVD showed a 71% increase in in-hospital mortality rate over that of those without. This study was undertaken with a cohort of little more than 3000 patients and found that in-hospital mortality rates with PVD were 2.4-fold higher in those with indicators of PVD vs those without. It is important to note that this study was composed of data from 5 separate tertiary care centers. Although these studies support our findings, they were each based on a cohort of approximately a quarter the size of our own study population. Potentially, patients with PVD may have an increased morbidity and mortality secondary to noncardiac issues such as strokes or macrovascular occlusions such as mesenteric ischemia.

There are several potential limitations to this study. One possible limitation is the actual classification of patients into the PVD group, defined as having history of type 1 neurological injury (transient ischemic attack within 3 months or stroke within 3 months), prior vascular surgery, or current vascular disease. Peripheral vascular disease included patients with prior vascular surgery or current vascular disease for carotid, vertebral, innominate, subclavian, thoracic aorta, abdominal aorta, visceral/femoral, upper extremity, or lower extremity. Some previous studies have included more than a dozen possible categories for PVD patients while others have included only 3 or 4 clinical or historical factors to describe the PVD category. These variances on what actually categorizes a patient as having a PVD history can serve to either overquantify or underquantify the number of PVD patients incorporated into the respective study. By keeping our requirements for PVD labeling relatively specific and obvious, if anything, we may have underspecified the number of PVD patients in our cohort.

Although a link between PVD and CABG complications had already been established, this study has aided in the further qualification of this association. This information could further prepare those who are trusted with the care of these patients to not only better treat but also better anticipate and possibly even prevent these potential complications.