Comparison of 3-Year Outcomes for Coronary Artery Bypass Graft Surgery and Drug-Eluting Stents: Does Sex Matter?

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Background. **Several randomized controlled trials and observational studies have compared outcomes for coronary artery bypass graft (CABG) surgery and drug-eluting stents (DES), but these studies have not thoroughly investigated the relative difference in outcomes by sex. We aimed to compare 3-year outcomes (mortality, mortality/myocardial infarction/stroke, and repeat revascularization) for CABG surgery and percutaneous coronary interventions with DES by sex.**

Methods. **A total of 4,532 women (2,266 pairs of CABG and DES patients) and 11,768 men (5,884 pairs) were propensity matched separately using multiple patient risk factors and were compared with respect to 3-year outcomes.**

Results. **Both women and men receiving DES had significantly higher mortality rates (adjusted hazard ratio, 1.28; 95% confidence interval, 1.06 to 1.54 and adjusted hazard ratio, 1.22; 95% confidence interval, 1.06 to 1.41, respectively) and myocardial infarction/mortality/stroke rates (adjusted hazard ratio, 1.40; 95% confidence interval, 1.19 to 1.64 and adjusted hazard ratio, 1.36; 95% confidence interval, 1.20 to 1.54, respectively) with DES. The advantage for CABG surgery was also present for several preselected patient subgroups. Men had consistently lower adverse outcome rates than women for both procedures. For example, the mortality rates for CABG and DES for men were 8.0% and 9.1%, compared with respective rates of 11.8% and 13.7% for women.**

Conclusions. **For women, the advantage of CABG surgery over DES is very similar to what was found for men, and this advantage persisted for patients with and without high-risk characteristics.**

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For patients with multivessel coronary artery disease, the two most common interventions are coronary artery bypass graft (CABG) surgery, and percutaneous coronary interventions (PCI). Although there have been many randomized controlled trials and observational studies that have examined relative outcomes for these procedures in an effort to determine which procedure is preferable for whom, there is a continual need to update the studies because of the evolution of the two procedures [1–15].

It is also of interest to tailor the procedure to the specific patient of interest. This concern has resulted in substudies in which outcomes of the procedures are compared for specific groups such as patients with diabetes, lower ejection fractions, or high-risk features [11, 12, 15]. Patient sex is another characteristics of interest when examining relative outcomes, but few studies have examined relative differences for men and women [4, 9].

The purpose of this study is to compare patient outcomes for drug-eluting stents (DES) and CABG surgery for men and for women. Rather than developing the study so that patient sex is merely a subanalysis of a general study comparing the two procedures, we have analyzed differences in outcomes between the two procedures separately for males and for females.

Material and Methods

End Points

End points in the study included 3-year mortality, mortality/myocardial infarction (MI)/stroke, and repeat revascularization. The mean follow-up time was 2.5 years

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because all procedures between January 1, 2008, and December 31, 2010, were followed for 3 years or through December 31, 2011.

Databases

The primary databases used for the study were New York State's clinical registries for PCI and for CABG surgery, the Percutaneous Coronary Interventions Reporting System and the Cardiac Surgery Reporting System, respectively. These registries contain detailed information on patient demographics, risk factors, complications, procedure choices, provider identifiers, discharge status, and in-hospital adverse outcomes.

Completeness of data reporting is monitored by matching Percutaneous Coronary Interventions Reporting System to New York's acute care hospital discharge database, the Statewide Planning and Research Cooperative System, and to the Department of Health's Ambulatory Surgery Database, and identifying any cases reported in those databases that were not reported in the cardiac registries. The Statewide Planning and Research Cooperative System data were also used to identify subsequent emergency admissions with MI and stroke as the principal diagnosis because mortality/MI/stroke was one of the outcomes evaluated in the study.

Patient identifiers in the Percutaneous Coronary Interventions Reporting System and Cardiac Surgery Reporting System were used to link patients in the index revascularization procedure to future admissions in the Percutaneous Coronary Interventions Reporting System and Cardiac Surgery Reporting System to identify subsequent revascularization. In addition, patient identifiers were used to link the index procedure to New York State's vital statistics data to identify deaths that occur after discharge.

Patients and Hospitals

A total of 90,686 patients were confirmed to have undergone PCI with DES, and a total of 26,323 patients were confirmed to have undergone isolated CABG surgery between January 1, 2008, and December 31, 2010. Of these patients, we sequentially excluded those who had previous revascularization (n = 40,457), preprocedural cardiogenic shock (n = 101), left main disease (n = 8,170), or an MI within 24 hours before the index procedure (n = 8,851), and those who were from out of state (n = 1,966), had single-vessel disease (n = 26,626), or had multiple revascularizations in the same admission (n = 83). Also, staged PCI patients were excluded from the repeat revascularization outcome. All other patients undergoing revascularization between January 1, 2008, and Deember 31, 2010, in New York State (n = 30,755, of which 19,140 underwent DES and 11,615 underwent CABG surgery) were followed through the end of 2011 to compare the mortality, mortality/MI/stroke, and repeat revascularization for DES and CABG surgery procedures. The number of hospitals in which these patients underwent revascularization during this period was 59.

Statistical Analysis

The use of DES and CABG surgery for women and for men was compared for numerous patient risk factors contained in the registries. We determined significant differences in the use of the two types of revascularization for each patient characteristic with χ^2 tests.

Because patients were not randomly assigned to DES and CABG surgery, propensity score matching was used separately for women and for men to identify sets of DES and CABG surgery pairs matched on those characteristics for each sex so that the selection bias associated with our observational study could be minimized. Propensity score matching was chosen because various studies have shown that it reduces a greater proportion of systematic differences in the two comparison groups than other propensity methods, and although it suffers from reduction of sample size, we were fortunate to have a relatively large sample [16].

In the propensity score matching process, the propensity score for each sex was derived by developing a logistic regression model that predicted the probability that a given patient would receive CABG surgery on the basis of all patient characteristics available in the CABG and PCI registries. The propensity score was used to match patients without replacement on a 1-to-1 basis using a caliper width of 0.2 of the pooled standard deviation of the logit of the propensity score [17–21]. The propensity matched pairs were then used to analyze differences in outcomes between DES and CABG surgery. Remaining differences were further reduced by using Cox proportional hazards models for adjustment of the retained matched pairs along with robust standard errors to control for clustering of patients in matched pairs, taking into account that the samples were matched.

For each sex, adverse outcome rates for DES and CABG surgery were also compared for five preselected patient characteristics (age $\geq$75 years, diabetes, proximal left anterior descending disease [with stenosis $\geq$70%], generation of DES [first and second], and number of vessels diseased [two and three]). This was done for each characteristic by developing a new propensity score for patients having that characteristic. All tests were two-sided and conducted at the 0.05 level, and all analyses were conducted in SAS 9.1 (SAS Institute, Cary, NC).

Results

Both women and men receiving DES were more likely to be in the youngest and oldest age groups, more likely to be Hispanic and African American, had higher ejection fractions, were less likely to have experienced an MI, and were less likely to have had several different comorbidities.

A total of 9,054 female (5,964 DES and 3,090 CABG surgery) patients were subjected to propensity matching, and 4,532 patients (2,266 pairs and 73% of all CABG surgery patients) were propensity matched. Also, 21,701 male (13,176 DES and 8,525 CABG surgery) patients were