Radial artery grafting in women improves 15-year survival

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Objectives: Radial artery (RA) grafting has a clear survival advantage after coronary artery bypass grafting (CABG) in studies with predominantly male populations, but the impact on women's long-term survival is unclear. We sought to determine if the reported long-term survival benefit of RA versus saphenous vein (SV) grafting in the general CABG population is valid for women.

Methods: Between 1995 and 2010, 1339 female patients were alive 30 days after primary, isolated CABG with left internal thoracic artery (LITA) and additional RA or SV conduits as needed. Patients were evaluated based on RA use: 332 patients had RA and 1007 patients had SV. Of these, 283 RA patients were matched to SV counterparts using a nonparsimonious propensity model based on 45 patient variables.

Results: Kaplan-Meier estimated survivals for the matched RA women at 1, 5, 10, and 15 years were 99%, 93%, 80%, and 70% versus 97%, 87%, 72%, and 58% for the SV women (log rank, $P = .018$). For symptomatic patients, overall RA patency was 80%, which was not different from the LITA patency rate of 84% but was superior to the SV conduits patency rate of 56% ($P < .001$).

Conclusions: In women undergoing CABG with LITA grafting, use of an RA graft improves survival compared with use of an SV graft. (J Thorac Cardiovasc Surg 2013;146:1467-73)

ACD

Women have been reported to have increased hospital mortality and morbidity after coronary artery bypass grafting (CABG), in part attributed to referral bias, smaller coronary vessels, smaller body size, more advanced coronary artery disease, older age at presentation, markedly higher risk profile, higher transfusion rate, gender differences in molecular remodeling in pressure overload hypertrophy, and a higher incidence of metabolic syndrome.[1] However, intermediate and long-term survivals have been reported to be better in women and the use of 2 or more arterial grafts in women is associated with improved long-term survival.[2] Thus, the addition of a second arterial conduit may be an important determinate of survival in women after CABG.

Use of a radial artery (RA) conduit in addition to the left internal thoracic artery (LITA) improves patients' long-term survival after CABG.[3-7] In these reports, however, only 10% to 23% of the study populations were women, and it is unclear whether, and to what extent, this observed RA survival benefit extends to women. In our previous report,[3] we were not able to show a survival benefit for RA grafting in women compared with men in a secondary analysis. However, women comprised only 17% of our patients and there were very few patients at risk after 8 years. Thus, in this study, we specifically sought to determine the effect of RA grafting on long-term survival after CABG in women by comparing propensity-matched women revascularized with LITA and RA versus women receiving LITA and only saphenous vein (SV) grafts.

METHODS

Patients

From January 1995 to December 2010, 1367 women had isolated, primary CABG with LITA and additional grafts as needed after excluding patients with single CABG (n = 4), only SV grafts (n = 8), or only bilateral internal thoracic artery (BITA) grafts (n = 9). At 30 days, 1339 women were alive and were included in the analysis. Of these, 332 patients received an RA conduit (RA group), and 1007 received SV conduits. The primary factors involved in the decision to use an RA conduit included the result of the Allen test, perceived patient lifespan (patients <65 years), nonemergency nature of the operation, and a target vessel stenosis of at least 70%. Unavailable or unsuitable SV conduits accounted for RA use in older patients. Most RA grafts were used to bypass the circumflex (73%) and diagonal (21%) arteries. Only 6% received an RA to the right coronary artery. Renal failure was considered a contraindication for RA harvest owing to concern for the need for possible upper limb dialysis access.

All data were prospectively collected as part of the New York State Department of Health mandatory reporting system and maintained in a separate database at our institution. Institutional review board approval was obtained and written informed consent was waived.

Graft Patency

The New York State Department of Health Cardiac Surgery Reporting System and the Percutaneous Coronary Intervention Reporting System databases were used to identify patients who had undergone coronary reintervention after CABG in our institution. Symptom driven after CABG angiograms was identified and analyzed by 2 observers independently.

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Abbreviations and Acronyms

BITA = bilateral internal thoracic artery
CABG = coronary artery bypass grafting
CI = confidence interval
HR = hazard ratio
LITA = left internal thoracic artery
RA = radial artery
SV = saphenous vein

Surgical Technique

CABG was mostly performed using cold blood cardioplegic arrest and a single period of aortic crossclamping. RAs were used as aorta–coronary bypasses and sequential or Y grafts. Off-pump procedures were performed in 2.5% of all patients (2.6% of the SV patients and 0.9% of the RA patients) generally owing to an unclampable or heavily diseased ascending aorta. None of the propensity-matched patients had off-pump surgery. Before 1999, the RA was harvested using an open no-touch technique; since 2000, all RA conduits in our institution have been harvested exclusively using an endoscopic technique. The RA is readily harvested endoscopically via a small wrist incision.[8] It is 15 to 25 cm long, easily reaches any vessel on the heart, and is a better size match to the native coronary arteries than is the SV. Sequential or Y grafting increases the number of arterial grafts per patient. Diltiazem is administered by intravenous infusion after induction of anesthesia and is continued until the first postoperative day, when oral nitrates or diltiazem is substituted and continued wherever possible for at least 6 months. Intraoperative Allen test and pulse oximetry were used to confirm adequate collateral blood flow to the hand. Less than 2% of screened RAs could not be harvested. No postoperative hand ischemia has been detected. A rare harvested RA had to be discarded because of unsuspected severe wall thickening or calcific disease. After division, the RA was cannulated at the proximal end and placed in a solution of 1% papaverine mixed with the patient's heparinized venous blood, which contains diltiazem.

Statistical Methods

All available risk factors (Table 1) were included in a nonparsimonious multivariable logistic regression model that predicted the probability of treatment with the RA rather than the SV conduit.[9] On the basis of the number of grafts used for CABG, the year of CABG, and the value of the propensity score as a composite variable, RA patients were matched to SV patients using the nearest neighbor matching method. We compared the balance of all baseline characteristics in Table 1 before and after the matching using the standardized difference. Our model was well calibrated and discriminated effectively between RA and non-RA patients at baseline (c-statistic = 0.821). Patients on hemodialysis and with a creatinine level greater than 2.5 mg/dL (53 in the SV group and 3 in the RA) were excluded from the matching process.

Statistical analysis was performed with the Zelig/CRAN 2.14.01 (http://cran.r-project.org)[10] and XLSTAT software. Continuous variables were expressed as mean and standard deviation. Categorical variables were expressed as numbers and percentages. Dichotomous variables were analyzed using the χ^2 test and Fisher's exact test, and continuous variables were analyzed using the t test. The primary end point was all-cause mortality obtained using the Social Security Death Index, which was searched in May 2011. The overall difference in survival between RA and SV patients was estimated by comparing the Kaplan-Meier survival curves for the matched patients. The overall hazard ratios (HR) for death after CABG were obtained by fitting a Cox proportional hazards model, stratifying on the matched pairs of patients. Inasmuch as CABG is a factor influencing early death, the patients who died in the hospital or within 30 days after CABG were excluded from the matching and survival analysis.

Statistical analysis of graft patency was performed with STATA system version 12.1 (StataCorp LP, College Station, Tex). The primary end point was graft failure, defined as graft occlusion or a 50% stenosis or greater. The Cox proportional hazard model was used to assess differences in the HR between groups defined by graft type. Because patients contributed 1 or more grafts to the analysis, robust standard errors and confidence limits for the HRs were achieved by adjusting for 244 female patients' clusters within the data.

RESULTS

Demographic Characteristics

Table 1 shows that unmatched RA women (n = 332) compared with SV women (n = 1035) were younger (average age, 59.5 years vs 70 years), more obese (body mass index, 29.7 vs 27.7; body surface area, 1.83 vs 1.77), had higher ejection fractions (average, 54% vs 50%), and fewer cases of preoperative myocardial infarction, chronic obstructive pulmonary disease, peripheral vascular disease, stroke, hypertension, and congestive heart failure (Table 1). Also, RA women were more likely to have diabetes (53% vs 47.5%), receive more grafts (average, 3.6 vs 3.4), and have longer crossclamp and bypass times.

Propensity matching yielded 283 pairs of women revascularized with either an RA or an SV. The propensity matching model was well calibrated. Table 1 shows that the standardized differences in the prevalence of all baseline characteristics between RA and SV women were all less than or equal to 2% and were not statistically different.

Hospital Outcomes

There were no hospital and 30-day deaths in the unmatched RA group and 28 (2.7%) deaths in the SV group ($P < .0001$). These hospital and early deaths were excluded from the propensity matching model and survival analysis. Table 1 shows that in the matched patients, rates of postoperative stroke, postoperative myocardial infarction, renal failure, and sternal wound infection were similar. There was a trend toward a higher incidence of respiratory failure in the SV group compared with the RA group ($P = .06$).

Long-Term Survival

During the follow-up period, 70 (25%) deaths were observed among the 283 matched SV patients and 48 (17%) deaths among the 283 matched RA patients ($P = .023$). Figure 1 shows that the Kaplan-Meier estimated survivals for the matched RA women at 1, 5, 10, and 15 years were 99% (confidence interval [CI], 98%-100%), 93% (CI, 96%-98%), 80% (CI, 72%-87%), and 70% (CI, 60%-79%) versus 97% (CI, 96%-100%), 87% (CI, 82%-92%), 72% (CI, 63%-80%), and 58% (CI, 38%-65%) for the SV women (log rank, $P = .018$).

The average survival time for the RA female patients after CABG was 13 ± 0.3 years (range, 12.2-13.8 years) and