

ORIGINAL INVESTIGATIONS

Influence of Diabetes on Long-Term Coronary Artery Bypass Graft Patency



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ABSTRACT

BACKGROUND Nearly 50% of patients undergoing coronary artery bypass grafting have diabetes. However, little is known about the influence of diabetes on long-term patency of bypass grafts. Because patients with diabetes have more severe coronary artery stenosis, we hypothesized that graft patency is worse in patients with than without diabetes.

OBJECTIVES This study sought to examine the influence of diabetes on long-term patency of bypass grafts.

METHODS From 1972 to 2011, 57,961 patients underwent primary isolated coronary artery bypass grafting. Of these, 1,372 pharmacologically treated patients with diabetes and 10,147 patients without diabetes had 15,887 postoperative angiograms; stenosis was quantified for 7,903 internal thoracic artery (ITA) grafts and 20,066 saphenous vein grafts. Status of graft patency across time was analyzed by longitudinal nonlinear mixed-effects modeling.

RESULTS ITA graft patency was stable over time and similar in patients with and without diabetes: at 1, 5, 10, and 20 years, 97%, 97%, 96%, and 96% in patients with diabetes, and 96%, 96%, 95%, and 93% in patients without diabetes, respectively (early $p = 0.20$; late $p = 0.30$). In contrast, saphenous vein graft patency declined over time and similarly in patients with and without diabetes: at 1, 5, 10, and 20 years, 78%, 70%, 57%, and 42% in patients with diabetes, and 82%, 72%, 58%, and 41% in patients without diabetes, respectively (early $p < 0.002$; late $p = 0.60$). After adjusting for patient characteristics, diabetes was associated with higher early patency of ITA grafts (odds ratio: 0.63; 95% confidence limits: 0.43 to 0.91; $p = 0.013$), but late patency of ITA grafts was similar in patients with and without diabetes ($p = 0.80$). Early and late patency of saphenous vein grafts were similar in patients with and without diabetes (early $p = 0.90$; late $p = 0.80$).

CONCLUSIONS Contrary to our hypothesis, diabetes did not influence long-term patency of bypass grafts. Use of ITA grafts should be maximized in patients undergoing coronary artery bypass grafting because they have excellent patency in patients with and without diabetes even after 20 years. (J Am Coll Cardiol 2017;70:515–24) © 2017 by the American College of Cardiology Foundation.



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**ABBREVIATIONS
AND ACRONYMS****CABG** = coronary artery bypass
grafting**ITA** = internal thoracic artery**LAD** = left anterior descending
coronary artery**SV** = saphenous vein

The FREEDOM (Future Revascularization Evaluation in Patients with Diabetes Mellitus: Optimal Management of Multivessel Disease) trial demonstrated fewer deaths and myocardial infarctions in patients with diabetes and multivessel coronary artery disease after coronary artery bypass grafting (CABG) than after percutaneous coronary intervention (1). Today, nearly 50% of patients undergoing CABG have diabetes (2,3). However, little is known about bypass graft patency in patients with versus without diabetes (4-9). We hypothesized that because patients with diabetes have more severe coronary artery stenosis (10,11), stenosis in their bypass grafts would also be more severe than in patients without diabetes, resulting in lower graft patency. To test this hypothesis, we compared patency of the 2 most commonly used bypass grafts, internal thoracic arteries (ITA) and saphenous veins (SV), in patients with versus without diabetes.

SEE PAGE 525

METHODS

PATIENTS. From January 1, 1972, to January 1, 2011, a total of 57,961 patients underwent primary isolated CABG at Cleveland Clinic. Patients were included in this study if the following information was available: 1) knowledge of whether pharmacologically treated diabetes mellitus was present (treated with insulin or oral hypoglycemic agents); 2) detailed pre-operative angiographic data describing location and severity of native coronary system stenosis; 3) results of at least 1 post-operative angiogram before any repeat coronary intervention; and 4) quantitative information on degree of angiographic stenosis of bypass grafts. These criteria were met for 11,519 patients, 1,372 with pharmacologically treated diabetes and 10,147 without (Figure 1, Online Table 1). Pre-operative, operative, and post-operative variables (Online Appendix 1) were retrieved from the Cardiovascular Information Registry. Use of these data for research was approved by the Institutional Review Board, with patient consent waived. Compared with excluded patients, studied patients were younger, operated on in earlier years, had fewer comorbidities, fewer received bilateral ITA grafts, and more had incomplete revascularization (Online Table 2).

CORONARY ARTERY BYPASS GRAFTS. In the study group, 28,876 coronary artery bypasses were performed, 3,881 in patients with diabetes and 24,995 in patients without diabetes (Online Table 3). These

included 8,124 ITA grafts and 20,376 SV grafts. Use of ITA grafting substantially increased in the 1980s (Figure 2). Most grafts were used as single conduits: 95.5% of ITA grafts in patients with diabetes and 96.5% in patients without diabetes, and 82% of SV grafts in patients with diabetes and 86% in patients without diabetes. Four general sites for graft anastomoses were defined: 1) left anterior descending (LAD); 2) diagonal; 3) left circumflex; and 4) right coronary artery.

POST-OPERATIVE ANGIOGRAPHY. Patients underwent post-operative coronary angiography for a variety of reasons. Early in the series, they underwent a single planned angiogram at 1 year after CABG; subsequently, we presume angiography was performed for suspected ischemic symptoms.

From 1972 to 2011, 15,887 post-operative angiograms were performed in the study group, with 38,753 individual graft observations (Online Figures 1 and 2, Online Table 4); 8,387 patients (73%) had 1 post-operative angiogram, 2,267 (20%) had 2 post-operative angiograms, 623 (5.4%) had 3 post-operative angiograms, and 242 (2.1%) had 4 or more. These angiograms recorded stenosis for 27,969 unique grafts: 7,903 ITA grafts (1,132 in patients with diabetes and 6,771 in patients without diabetes) and 20,066 SV grafts (2,512 in patients with diabetes and 17,554 in patients without diabetes). These 27,969 grafts were the unit of analysis, not the patient.

To investigate possible underestimation of graft patency caused by patients' reluctance to undergo angiography unless symptomatic, we studied a subgroup of 985 patients who underwent CABG from 1972 through 1975 and had a single planned angiogram at 1 year (11 to 13 months). These angiograms recorded stenosis for 1,883 unique grafts; 433 ITA grafts (27 in patients with diabetes and 406 in patients without diabetes), and 1,450 SV grafts (88 in patients with diabetes and 1,362 in patients without diabetes).

GRAFT PATENCY. Grafts, particularly SV grafts, tended to be either completely patent or occluded (Figure 3). Therefore, for analysis of this bimodal distribution, a graft was defined as patent if not occluded on follow-up angiography.

Because date of graft occlusion is rarely known, rendering time-to-event (Kaplan-Meier) analysis nonapplicable, we used longitudinal data analysis to study bypass graft patency. The objective of this method was to estimate ensemble average patency across time after CABG from multiple angiographic "snapshots" of the status of patients' grafts, much as one would do for multiple blood pressure readings across time. The patient was a random effect to

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