Natural History of Moderate Coronary Artery Stenosis After Surgical Revascularization

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Background. **It remains controversial whether grafting moderately stenosed coronary arteries (MSCAs) influences native-vessel disease progression and whether grafting may protect against late myocardial ischemia.**

Methods. **From 1972 to 2011, 55,567 patients underwent primary isolated coronary artery bypass grafting (CABG); 1,902 had a single coronary artery with angiographically moderate (50% to 69%) stenosis and ≥1 postoperative angiogram. Disease progression was studied in 489 nongrafted, 371 internal thoracic artery (ITA)-grafted, and 957 saphenous vein (SV)-grafted MSCAs, as well as patency of 376 ITA and 1,016 SV grafts to these MSCAs.**

Results. **At 1, 5, 10, and 15 years, native-vessel disease progressed from moderate to severe stenosis/occlusion in 32%, 52%, 66%, and 72% of nongrafted MSCAs; 55%, 73%, 84%, and 87% of ITA-grafted MSCAs; and 67%, 82%, 90%, and 92% of SV-grafted MSCAs. After adjusting for patient characteristics, MSCA disease progressed 3.6 times faster with ITA and 10 times faster with SV grafting compared with nongrafting. At these same time points, occlusion of ITA grafts to MSCAs was 8%, 9%, 11%, and 15% and for SV grafts, 13%, 32%, 46%, and 56% for SV grafts; protection from myocardial ischemia by ITA-grafted versus nongrafted MSCAs was 29%, 47%, 59%, and 61%.**

Conclusions. **Most MSCAs progress to severe stenosis or occlusion in the long term. Progression is faster in grafted than nongrafted MSCAs, more so with SV than ITA grafts. However, ITA grafts to such arteries have excellent patency, providing long-term protection from myocardial ischemia. Therefore, ITA grafting of MSCAs should be considered.**

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Not uncommonly, patients referred for surgical revascularization have 1 or more coronary arteries with only moderate stenosis, and surgeons must decide whether to graft these vessels [1, 2]. Although internal thoracic artery (ITA) grafting of such coronary arteries is associated with better long-term survival than no grafting [2], little is known about the natural history of moderate coronary artery stenosis after coronary artery bypass grafting (CABG). Therefore, we sought to determine how grafting coronary arteries with angiographically moderate stenosis influenced native-vessel disease progression and whether grafting may protect patients from late myocardial ischemia.

Patients and Methods

From 1972 to 2011, 55,567 patients underwent primary isolated CABG at Cleveland Clinic. Of these, 8,513 (15%) had a single coronary artery with angiographically moderate (50% to 69%) stenosis, as defined by cardiologists. Results of at least 1 postoperative angiogram before any repeat coronary intervention were available for 1,902 (22%) of these 8,513 patients. Patients with multiple-system moderate stenosis, left main disease with greater than or equal to 50% stenosis, any bypassed lesion with less than 50% stenosis, incomplete revascularization of

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coronary systems with greater than or equal to 70% stenosis, or previous percutaneous coronary intervention (PCI) were excluded (Fig 1). Our rationale for this study design was that if multiple moderately stenosed arteries were present, the analysis would be confounded, particularly if each moderately stenosed lesion was managed differently, as would also be the case if severely stenosed coronary arteries were not grafted. Thus, we studied a single moderately stenosed coronary artery in isolation of these confounding factors.

Preoperative, operative, and postoperative variables were retrieved from the prospective Cleveland Clinic Cardiovascular Information Registry (Appendix E1). This database is populated concurrently with patient care and has been approved for use in research by the Cleveland Clinic institutional review board, with patient consent waived.

Coronary Artery Bypass Grafts

Moderate stenosis was present in the left anterior descending coronary artery (LAD) in 396 patients (21%), circumflex artery in 624 (33%), diagonals in 269 (14%), and right coronary artery (RCA) in 613 (32%; Table 1). Of the moderately stenosed coronary arteries, 489 were not grafted, 385 were ITA grafted, and 1,028 were saphenous vein (SV) grafted. Four general sites for graft anastomoses were defined: LAD, diagonal, circumflex, and RCA. Most ITA grafts went to the LAD (71%), followed by circumflex (13%), diagonals (8.0%), and RCA (8.0%), and most SV grafts went to the circumflex (39%) or RCA (38%), followed by diagonals (16%) and LAD (7.0%).

Among patients with nongrafted moderately stenosed coronary arteries, 254 (52%) received a single ITA and 15 (3.1%) received bilateral ITAs to other coronary arteries. Among patients with ITA-grafted moderately stenosed coronary arteries, 266 (69%) received a single ITA and 119 (31%) received bilateral ITAs. Among patients with SV-grafted moderately stenosed coronary arteries, 653 (64%) received a single ITA and 44 (4.3%) received bilateral ITAs to other coronary arteries.

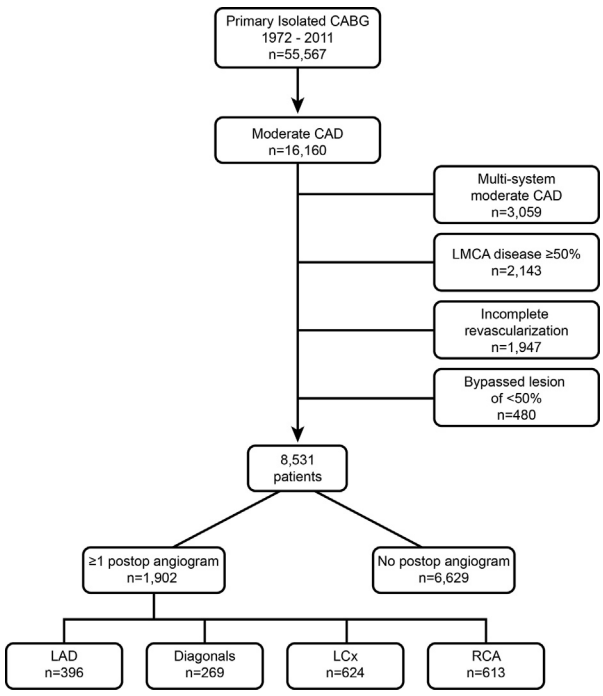

Fig 1. CONSORT-style diagram of study population. (CABG = coronary artery bypass grafting; CAD = coronary artery disease; LAD = left anterior descending coronary artery; LCx = left circumflex coronary artery; LMCA = left main coronary artery; postop = postoperative; RCA = right coronary artery.)

Postoperative Angiography

Patients underwent postoperative coronary angiography for a variety of reasons. Early in the series (1972 through 1975), they underwent a single planned angiogram at 1 year after CABG; subsequently, we presume angiography was performed for suspected ischemic symptoms. At follow-up angiogram, native-vessel disease progression information was available for 489 nongrafted, 371 ITA-grafted, and 957 SV-grafted moderately stenosed coronary arteries, and patency information was available for 376 ITA and 1,016 SV grafts to these moderately stenosed coronary arteries (Supplemental Table E1). Median time to first follow-up angiogram was 6.3 years (15th and 85th percentiles, 1 year and 13 years); 1,327 patients (70%) had 1 postoperative angiogram, 394 (21%) had 2, 120 (6.3%) had 3, and 61 (13%) had 4 or more, with 10% of angiograms available from 15 years after CABG.

Data Analysis

All analyses were performed using SAS statistical software (SAS version 9.2, SAS Institute, Cary, NC).

Native-Vessel Disease Progression

Postoperative angiograms were analyzed longitudinally for temporal pattern of change in native-vessel stenosis across time. The distribution of postoperative stenosis in these native vessels was analyzed as an ordinal outcome, with stenosis groups of less than or equal to 49%, 50% to 69%, 70% to 99%, and 100% occlusion. A nonlinear repeated-measures mixed-effects ordinal logistic regression model [3, 4] was used to resolve a number of phases by temporal decomposition and to estimate the shaping parameters for each. Variability within patients was captured as a random effect. Temporal pattern of prevalence of individual categories of stenosis was obtained by averaging patient-specific probability estimates. Progression of disease was assessed between bypassed and nonbypassed groups. Given known differences in patency of ITA and SV grafts, the bypass group variable was further evaluated with respect to conduit type, with 3 groups compared (not grafted versus ITA-grafted versus SV-grafted). Variables considered in the analysis are given in Appendix E1.

Graft Patency

Grafts tended to be either completely patent or occluded on follow-up angiography (Supplemental Fig E1). Therefore, for analysis of this unusual distribution, a graft