Searching for the Second-Best Coronary Artery Bypass Graft
Is It the Radial Artery?

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Virtually all cardiac surgeons and their referring cardiologists know that the most effective and reliable coronary artery bypass conduit is the pedicled internal thoracic (mammary) artery (LITA) when placed to the left anterior descending artery coronary artery (LAD). This first choice of bypass graft conduits is based on convincing evidence of improved survival in patients with critical LAD disease in whom an LITA graft has been placed.1,2 The importance of an LITA graft when bypassing the LAD is so well accepted that it is now used as a quality indicator in the assessment of the performance of cardiac surgery programs in coronary artery bypass graft surgery (CABG).3

The Radial Artery Patency Study: Phase 2
The investigators are commended for having put together and completing this creatively randomized trial that enrolled 561 patients. A full 78% of the study group, or 440 patients, underwent coronary angiography at \(\approx 12\) months after CABG surgery and are the subject of the present report. Each patient had triple-vessel coronary disease and received an LITA graft to the LAD. Each of the 440 patients who completed the 12-month angiographic review had both radial artery and saphenous vein grafts placed. In half, the right coronary artery was grafted with a radial artery and the circumflex territory received the saphenous vein graft. In the other half, the targets were reversed. Although each enrolled patient received both types of grafts, within-patient comparisons were not helpful; rather, the pooled performance of both grafts at 1 year and the thoroughly analyzed patient-specific factors and target-vessel characteristics provide some important new insights.

In their previous report, the investigators established that at \(\approx 1\) year after CABG, 8.2% of radial artery grafts and 13.6% of saphenous vein grafts were completely occluded \((P=0.009)\). Also noted was a significant difference in the finding of a “string sign,” or diffuse narrowing, in radial artery grafts (7.0%) compared with saphenous vein grafts (0.9%; \(P=0.001\)). In another recently published report by these investigators, they suggest that this diffuse narrowing of the radial artery grafts is of little or no clinical consequence.7 They base this opinion on the findings of quantitative angiograms performed on some of these narrowed radial artery grafts, in which Thrombolysis in Myocardial Infarction (TIMI) grade 2 or 3 flow was seen. Postoperative symptoms of inadequate graft flow were observed in only those 15 patients with a string-sign radial artery graft and TIMI grade 1 flow. On the basis of their estimates of TIMI flow, the authors dispute the apparent inadequacy of these diffusely narrowed radial artery grafts. They previously cited a report that inducible ischemia is uncommon in myocardial regions supplied by string-sign grafts and therefore of no apparent clinical consequence.8 Such dismissal of a diffusely narrowed radial artery graft as being clinically inconsequential is counterintuitive and is not consistent with how diffusely narrowed LITA grafts are judged. Furthermore, other experts consider a string-sign radial artery graft a failure.4,9 It may be true, as the authors assert in the earlier report, that the narrowed grafts may improve functionally late in follow-up. A diffusely narrowed graft of any type, however, may not be providing adequate blood flow to the targeted myocardial region, despite their estimates of TIMI flow categories. Clearly, this is an important consideration because including diffusely narrowed radial grafts with totally occluded
grafts seen on 12-month angiograms would eliminate the favorable benefit between adequately functioning radial artery and saphenous vein grafts. In this recalculation, 15.2% of radial artery grafts compared with 14.5% of saphenous vein grafts are seen to be occluded or functioning poorly at 1 year after CABG.

This major potential error in the interpretation of graft adequacy notwithstanding, their analyses of the 1-year post-CABG angiographic data are important and instructive. This is especially so when assessing the impact of the target coronary artery stenosis. Analysis of the radial artery graft failures revealed that radial graft patency was more likely in patients with progressively more severe proximal stenoses. This finding is especially noteworthy because entry into the study required a >70% proximal coronary artery stenosis. However, because the degree of stenosis before CABG was judged from single observer’s visual assessment, an observation thought to overestimate the degree of obstruction compared with quantitative angiography, one can conclude that radial artery grafting should not be considered in the setting of moderate (<90% proximal obstruction) or questionably severe target vessel obstructions.

There are at least 2 other unexpected findings that should affect the choice of a radial artery as a bypass conduit. First, in the female patients in the present study group, the saphenous vein occlusion rate at 1 year was 23.3% compared with only 5.3% occluded radial artery grafts. In men, the difference in occlusion rates was much narrower, 12.0% occluded saphenous vein versus 8.6% occluded radial artery grafts. Stated differently, the predicted radial artery patency for women was 97.0% versus 94.0% for men, whereas predicted vein graft patency was 73.3% for women versus 89.0% for men. Although other investigators have reported that women have higher radial artery graft failure rates than men, this current RAPS report may lessen the bias of some surgeons against using the radial artery, which is often diminutive, in women.

On the other hand, the striking impact of concomitant “peripheral vascular disease” on the fate of radial artery grafts and the lack of any comparable effect on saphenous vein graft patency dampen enthusiasm for choosing a radial artery graft for every patient. The authors note that patients were excluded from the present study if there was “a history of severe peripheral vascular disease” on the initial angiograms that are improved on later angiograms. One can conclude that radial artery grafting should not be considered in the setting of moderate (<90% proximal obstruction) or questionably severe target vessel obstructions.

More About the Radial Artery as a CABG Conduit
This question of whether radial arteries should be used routinely for CABG was addressed by some of the RAPS participants in a clinician update published in Circulation in 2004. In addition, there was a recently published meta-analysis that addressed this question: “Does the radial artery provide better long-term patency than the saphenous vein?” There were 12 published reports that made up this summary of “best evidence” for the durability and functionality of the radial artery coronary bypass graft. One of these 12 reports is the initial Desai et al5 article published in the New England Journal of Medicine in 2004 that summarizes the same 1-year angiographic results of the RAPS that appear in this issue of Circulation. Ten of these 12 reports, admittedly quite different in patient populations, duration of follow-up, indications for postoperative angiography, etc., demonstrate improved patency of radial artery versus saphenous vein grafts. Most reports also include finding diffusely narrowed radial artery grafts. There are also reports of string signs or graft spasm on initial angiograms that are improved on later angiograms.

It is notable that there are 2 reports from credible CABG surgery groups that describe frankly poor late results in radial artery compared with saphenous vein grafts. Khot et al11 reported on angiographic studies on patients at the Cleveland Clinic between 1996 and 2001. They found poorer patency in radial artery (51%) versus comparable saphenous vein (64%) grafts. In addition, women had significantly worse radial artery patency (39%) than men (56%). Both findings contrast dramatically with the RAPS results reported here. Furthermore, Buxton et al10 reported poorer cardiac event-free survival at 5 years in patients with radial artery versus saphenous vein grafts.

For the Second Coronary Bypass Conduit, What Should the Surgeon Choose and What Should the Patient Expect?
Perhaps the major shortcoming of the present report by Desai and associates, at least when comparing the choice of second-best CABG conduit between the radial artery and saphenous vein graft, is that the really relevant question is not even being raised. The right internal thoracic artery, when used as either a pedicled or free graft, might be the best second-choice bypass conduit on the basis of an extensive record of observational studies. The long-term benefit of bilateral internal thoracic artery use for bypass grafting has been demonstrated quite convincingly. In addition, a randomized trial being conducted in the United Kingdom is evaluating clinical and survival outcomes with bilateral internal thoracic artery use compared with LITA use only. In the meantime, on the basis of currently available data, cardiac surgeons will, or should, consider the right internal thoracic artery as the best option for the second bypass conduit in patients for whom long-term survival, ≥10 years, after CABG is likely.

The context for choosing between a radial artery and saphenous vein graft conduit may become a third-level choice. In that case, despite some information to the contrary, most studies comparing radial artery and saphenous vein graft patency sug-
gest that the radial arterial coronary bypass graft is superior. The major concern about the radial artery, however, is that it should not be used in many commonly encountered situations. This conclusion may be the most relevant new insight to be taken from the present report from Desai et al. If a surgeon proposes to perform an “all-arterial” CABG surgery in every patient and relies on the radial artery for ≥1 of these bypass grafts, some of those patients may be poorly served by such a focus on using an arterial graft under any circumstance.

The current report by the RAPS investigators reemphasized their previous report that in a carefully randomized prospective study, radial artery graft patency at 1 year is better than saphenous vein graft patency. This advantage, however, was reliably seen only when the degree of proximal coronary artery stenosis was severe, ie, > 90%. In addition, patients with “peripheral vascular disease” had poorer radial artery patency than seen in saphenous vein grafts. The authors noted much improved radial artery versus saphenous graft patency in women, as opposed to poorer radial artery patency in women in other reports. It may be important to note that this present RAPS report finding of significantly better radial artery reliability in women is based on only 57 women in the study of 440 patients, a meager 13% of the group.

Additional clarity about the usefulness and reliability of the radial artery bypass graft will have to come from late studies of radial artery graft function, especially angiographic studies ≥5 years after CABG. Although observational studies can be helpful, continued follow-up of the present study group will be very important. The RAPS investigators have a three-phase trial going on now, the intention of which is to examine radial artery versus saphenous vein grafts 5 years after CABG. The Radial Artery Patency and Clinical Outcomes Study also is continuing, and late follow-up, >5 years after CABG, can be expected from Buxton and his associates in Australia.

In the meantime, cardiac surgeons should conduct each CABG operation with those patient factors and target-vessel considerations that predict optimum outcome on the basis of all available evidence. Unfortunately, we do not have an unequivocal evidence basis for selecting bypass conduits beyond great confidence in the LITA-to-LAD coronary bypass graft. The right internal thoracic artery should be used when appropriate. Desai and his coinvestigators have further clarified the role of the radial artery graft. Under certain circumstances, it is clearly a better choice than a saphenous vein graft. We will benefit from the work of the RAPS investigators in their continued efforts to define the most appropriate circumstances in which to choose the radial artery as a bypass conduit.

Disclosures

None.

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