grafts. Many choose the easier option of 1 radial, 1 thoracic, and 1 vein graft.

Dr Claudio Muneretto (*Brescia, Italy*). As you know, in the last few years there are many contradictory reports that jeopardize the use of the RA, probably because the coronary RA is sensitive to target location and target stenosis, and results could be jeopardized because the inlet may be a risk factor if you anastomose the artery to the aorta or you use the artery as a composite arterial graft. Now after so many years of experience, what do you suggest as the inlet of the RA, the aortic anastomosis or a composite arterial graft, and how do you select patients in relation to target location and target stenosis?

Dr Buxton. For the proximal site of the radial, we usually take it off the aorta, because we don't like anastomosing a 3- to 4-mm diameter RA with a 2-mm LAD artery, for several reasons. First, it is not a good match, and second, if there is any damage to the LITA as a result, the patient may suffer. So we attach it to the aorta rather than fashioning a composite graft.

Dr Muneretto. Yes. Any comments about target location and target stenosis?

Dr Buxton. We accept a native artery stenosis greater than 70%. But other surgeons, like Steve Fremes and his group, prefer a 90% stenosis before using the RA because of their concern about competitive flow.

EDITORIAL COMMENTARY

Total arterial revascularization: When will its time come?

Todd K. Rosengart, MD, FACS

Myocardial revascularization incorporating the exclusive use of arterial conduits remains stubbornly shunned by the cardiac surgery community despite a growing body of evidence that "total arterial revascularization" yields superior long-term survival results than coronary bypass incorporating saphenous vein grafts. For example, as recently as 2009, only 4% of coronary bypass procedures reported in the Society of Thoracic Surgeons database include the use of bilateral internal thoracic artery grafts.¹

In this issue of the *Journal*, Buxton and colleagues² add to the growing body of evidence supporting the long-term benefits of total arterial revascularization. They report a study cohort of approximately 3800 patients who underwent coronary bypass surgery from 1995 to 2010 and show that the patients who received total arterial revascularization had 30% superior long-term survival than the patients who underwent a single in situ internal thoracic artery and saphenous vein grafting. More specifically, in a 384 matched patient pair propensity score subset, they observed that the patient survival at 15 years was greater after total arterial revascularization than after internal

thoracic artery plus saphenous vein grafting (54% vs 41%; $P = .0004$). These data would seem to support an evidence-based shift in practice that even the most steadfast arterial conduit skeptic should have difficulty in refuting, but recent clinical practice trends do not encourage such expectations.

Other recent articles demonstrate similar benefits associated with arterial grafting. The Cleveland Clinic outcomes article by Raza and colleagues,³ also in this month's *Journal*, shows that bilateral late mortality at 7.8 years median follow-up was 21% less in patients who received bilateral internal thoracic artery grafts than in patients who received single internal thoracic artery grafts. Similar term follow-up data from Saswata and colleagues⁴ likewise demonstrated an approximately 50% reduction (odds ratio, 0.43; 95% confidence interval, 0.25-0.75; $P = .003$) in graft occlusion rates for radial artery. In this context, it is important to ask why these data are not affecting "real world" clinical practices, for until these obstacles are understood, it is unfortunately not reasonable to anticipate in the foreseeable future the changes in clinical practice seemingly mandated by this evidence.

The first and perhaps greatest issue in advancing this agenda has to be a consideration of data quality. As it has occurred in other areas to which changes to long-standing and previously well-accepted practices have been proposed, skepticism may well trump reason in the absence of "gold standard" prospective randomized control trials. The arena of total arterial revascularization unfortunately has not enjoyed the benefit of great amounts of such data. As a

From the Baylor College of Medicine, Houston, Tex.

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Address for reprints: Todd K. Rosengart, MD, FACS, Michael E. DeBakey

Department of Surgery, Baylor College of Medicine, One Baylor Plaza, BCM MS 390, Houston, TX 77030 (E-mail: todd.rosengart@bcm.edu)

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consequence, even cursory reviews of the available retrospective data readily identify “easy targets” of incongruous data typical of retrospective studies that offer a ready opportunity for discrediting the conclusions of these studies.

The study by Buxton and colleagues,² for example, reports clear differences in their patient groups: Those undergoing total arterial revascularization were usually younger, male, nondiabetic, and nonsmokers with higher ejection fractions compared with the single internal thoracic artery plus vein graft group. Survival benefits were largely nullified once propensity matching eliminated the most obvious differences in such patients’ risk factors. As with all retrospective studies, however, the skeptics will remain empowered to make the argument that such statistical corrections cannot entirely eliminate biases and unmeasured physiologic influences found in these clearly disparate populations. For example, the effect that diabetes has on small vessel disease and graft runoff is not considered as a covariate.

In the context of these limitations in study data, anecdotal experiences and other biases can take on greater weight in clinical practice decision making. The increased incidence in deep sternal wound infection after bilateral versus single internal thoracic artery grafting, reported as an approximately 3-fold increased risk by Raza and colleagues,³ represents one such argument against total arterial revascularization. In the current era of extremely favorable outcomes expectations for coronary bypass, such acute risks loom large, especially when compared with the relatively ephemeral promise of long-term benefit that may not materialize for approximately a decade after surgery. Whereas other, somewhat better received recent innovations, such as off-pump or minimally invasive surgery, have offered at least some element of “instant gratification” in short-term benefits, the lack of such perceived value seems to have dampened both patient and referring physician demand for total arterial revascularization. In this setting, the added time, effort, and perceived risk of using all arterial conduits may represent a formidable barrier to surgeons’ adoption of total arterial revascularization.

Given these obstacles, finally, anecdotal remembrances and biases come further into play. Uncontrolled experiences

of graft closure, recurrent angina, or other major adverse cardiac events presumably related to arterial grafting become reasons to apply the dogma of “if it ain’t broke, don’t fix it” to a decades-old success story that has now been further validated by the SYnergy Between PCI With TAXUS and Cardiac Surgery (SYNTAX), FREEDOM, and other randomized controlled trials. Lack of training and consequently comfort levels with the technical aspects of multiple arterial grafting then raise additional obstacles to adoption. In an era of fiercely competitive local marketplaces and therefore an impetus for risk aversion, it is easy to understand why adoption has been so low.

If total arterial revascularization is to gain traction, compelling data from randomized controlled trials; adequate education of surgeons, referring physicians, and patients alike about potentially favorable outcomes data; and appropriate training of surgeons will all be indispensable in advancing this practice. Compelling scientific confirmation of arterial graft protection of native vessels from disease progression otherwise induced by supraphysiologic coronary flow reported with vein grafting⁵ would provide a plausible added rational argument supporting the use of arterial grafts. If the medical community cannot embrace good data on its own, regulatory or reimbursement incentives ultimately may be the tools needed to enact such practice reform.

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