See Article page 2070.

Commentary: Complete or incomplete? Just use more arteries

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CENTRAL MESSAGE

Multiple arterial grafting and completeness of revascularization are 2 main pillars of improved outcomes in coronary artery bypass grafting.

One of the unique advantages of coronary artery bypass surgery (CABG) is the potential to decrease future myocardial infarction, not only by bypassing flow-limiting coronary lesions identified in angiography, but also by protecting a distal myocardial territory that could become ischemic by an eventual rupture and thrombosis of non-flow-limiting lesions from the proximal third of the bypassed vessel.¹ Hence, as Jones and Weintraub from Emory earlier mentioned in their landmark study evaluating completeness of coronary revascularization: “in the absence of a compelling technical limitation complete or nearly complete revascularization should be attempted with coronary operation.”² Besides completeness of revascularization, another strategy has been associated with improved long-term outcomes in CABG: the use of multiple arterial grafts (MAGs) instead of single arterial grafts (SAGs).³

In the current study, Rosenblum and colleagues⁴ investigated which of the 4 CABG strategies would be associated with better outcomes (MAG or SAG with or without complete revascularization) using inverse probability of treatment weighting (IPTW) to address baseline imbalances. At a median follow-up of 1366 days, MAG was associated with improved mid-term survival compared with SAG, regardless of completeness of revascularization.

The authors need to be congratulated for evaluating the unanswered question: “What is better for CABG patients: MAG or complete revascularization? Or both?” Nonetheless, this question is not easy to answer. Completeness of

revascularization is not a parameter that is simple to measure. There have been multiple attempts to define what constitutes a complete revascularization procedure: ratio between number of diseased vessels and number of bypasses, number diseased of coronary territories divided by number of revascularized territories (complete numeric revascularization) or revascularization of only areas with ischemic myocardium, not bypassing areas with no viable myocardium (complete functional revascularization).^{2,5-7} Despite multiple proposed definitions, there is no clearly accepted criteria to determine completeness of revascularization. In addition, the reasons for incomplete revascularization in any individual patient are multifactorial (patients’ instability, small targets, calcified coronaries, intramyocardial vessels, lack of conduits) and generally not well described, even in single-institutional reports with otherwise high-level data granularity.

The main advantage of using IPTW for baseline characteristics adjustment is the ability to calculate the average treatment effect using the entire data (unlike propensity score matching). To estimate the average treatment effect using IPTW, it is imperative that the population analyzed could undergo any of the 4 types of therapy. However, there was likely an important reason that patients who had incomplete revascularization did not get complete revascularization. Furthermore, the surgical strategy for the use of bilateral internal thoracic artery grafting at their institution excludes patients who are at greater risk of sternal infection. Also, 4 different group comparisons performed. Perhaps a method to adjust for multiplicity (Bonferroni or false-discovery rate correction) could have been employed to minimize the chances of a false-positive result.

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In regards to the comparison between MAG and SAG, the overwhelming majority of observational data has associated MAG with better outcomes.⁸ Nonetheless, retrospective studies will never be able to fully adjust unmeasured confounders that influence the surgeon's subjective decision to perform one technique over another.⁹ When analyzing the Emory hospital results post-IPTW adjustment, the incidence of hospital death was similar in the MAG and SAG cohorts. Nonetheless, postoperative intra-aortic balloon pump rates were lower in MAG versus SAG. Likewise, intensive care unit time was statistically shorter in MAG versus SAG. The early postoperative benefits are unlikely related to biological superiority of a MAG approach but rather suggest a residual imbalance between MAG versus SAG might have persisted despite statistical adjustments and could confound the clinical outcomes comparison.

Finally, the investigators observed no survival difference between MAG with or without complete revascularization in their follow-up (hazard ratio, 1.04; 95% confidence interval, 0.77-1.40, $P = .80$). Perhaps, if the follow-up is extended up to 5 to 10 years, we would observe a difference. Nonetheless, we would like to emphasize that completeness of revascularization should always be pursued and performing MAG does not exempt the surgeon to attempt to revascularize all possible diseased coronary vessels/territories. A relevant message from this study, that might likely impact patient care, is that if a conservative "non-MAG" surgeon believes completeness of revascularization cannot be accomplished in their case, they should at least attempt using MAG for this specific patient population.

The importance of incomplete revascularization can only be determined in observational studies with very granular operative and angiographic data such as Rosenblum and colleagues' provocative and well-designed retrospective study. In contrast, questions such as the role of MAG versus SAG CABG revascularization can probably be

answered in randomized studies such as ART (Arterial Revascularization Trial) and the ongoing ROMA (Randomized Comparison of the Clinical Outcome of Single Versus Multiple Arterial grafts) trial to appropriately evaluate this question.^{10,11}

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