“ART ON, ART OFF”: The expanding horizon of ARTerial grafting

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Although coronary artery bypass grafting (CABG) is one of the oldest and most defining operations in the field of cardiac surgery, research and advancements remain ongoing, enabling surgeons to push and challenge the boundaries of convention for this operation. In terms of conduit options, accumulating evidence supports the use of multiarterial grafting in patients undergoing CABG over the traditional single-arterial or all-venous grafting strategy.¹⁻³

In contrast, the evidence supporting off-pump CABG (OPCAB) surgery over on-pump CABG (ONCAB) surgery is more controversial. Although there are theoretical advantages to avoiding cardiopulmonary bypass, these advantages have not translated into superior clinical outcomes. Rather, comparable^{4,5} (and sometimes inferior)⁶ clinical outcomes have been reported in patients undergoing OPCAB compared with those undergoing ONCAB. One factor contributing to this lack of improvement could be the graft patency associated with saphenous vein graft (SVG) occlusion.⁷ As such, in this issue of the *Journal*, Benedetto and colleagues report a study comparing different conduit strategies in ONCAB and OPCAB surgeries.⁸ More specifically, they performed a single-center, observational study of 12,633 patients (1818 with multiarterial OPCAB, 1208 with multiarterial ONCAB, 4412 with single-arterial OPCAB, and 5195 single-arterial ONCAB, considered the control group) undergoing primary isolated CABG surgery between 1996 and 2015, with a mean follow-up of 8.2 years. Using inverse probability of treatment weighting of propensity scores to adjust for baseline differences, they found similar adjusted 30-day mortality and stroke among the 4 groups, whereas the multiarterial OPCAB and ONCAB groups were associated with a significant fully adjusted 20% relative risk reduction in late mortality compared with standard single-arterial ONCAB. Furthermore, OPCAB was associated with a 2-fold increased risk of incomplete revascularization irrespective of the use of multiarterial or single-arterial grafting. In patients with complete revascularization, multiarterial grafting was associated with a late adjusted survival benefit, whereas in patients with incomplete revascularization, there were no

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Central Message

This commentary discusses the observational paper by Benedetto and colleagues, which compares multiarterial versus single-arterial grafting and on-pump versus off-pump coronary artery bypass graft surgery.

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significant differences in terms of late survival among the 4 groups.

This study raises some important points that merit discussion. First, although there has been growing support for multiarterial grafting, most studies reported to date have used predominantly an ONCAB strategy.^{1,3,9} To this end, Benedetto and colleagues have shown that multiarterial grafting is feasible in OPCAB and provides a long-term survival benefit compared with a conventional single-arterial strategy. SVG occlusion has been the Achilles heel of CABG, and a recent meta-analysis has shown that this may be exacerbated in OPCAB (a 41% increase in SVG occlusion in OPCAB compared with ONCAB); heparin use was identified as a possible factor in this finding.⁷

Furthermore, incomplete revascularization has always been an issue with OPCAB, as it was in this study.⁸ Moreover, the authors report that a multiarterial grafting strategy with complete revascularization was associated with better long-term survival in both ONCAB and OPCAB surgery. In contrast, a benefit was not observed in either of the incomplete revascularization groups. Although the authors did not directly compare incomplete and complete revascularization with respect to late survival, their findings nonetheless emphasize the importance of establishing complete revascularization. In other words, if complete revascularization is not achieved, then the potential benefit of arterial grafting may be negated by the sequelae of regional myocardial malperfusion. Of note, incomplete revascularization has not

been well quantified in surgical patients; using a standardized scale, such as the residual SYNTAX score, in surgical patients may be helpful in this regard.¹⁰

Finally, observational studies are inherently subject to important biases. The authors used multinomial propensity scores to adjust for the 4 groups (rather than the typical 2-group comparison) and an inverse probability of treatment weights, which has the advantage of retaining all of the subjects.¹¹ Despite this elegant statistical plan, however, the effective sample size was substantially smaller, and thus some of the secondary analyses likely were underpowered.

In conclusion, Benedetto and colleagues should be congratulated for performing this large observational study and using advanced statistical methods to adjust for confounding biases. This study further supports the use of multiarterial grafting in CABG, even in the setting of OPCAB. The study also serves as a gentle reminder of the utility of OPCAB, however. OPCAB is considered more technically challenging, and even in the high-volume OPCAB center where this study was performed, the authors found a higher rate of incomplete revascularization in OPCAB compared with ONCAB. Incomplete revascularization is known to be associated with reduced long-term survival¹²; as such, these results, although encouraging, should be considered cautiously, because they might not be generalizable to all institutions, but rather may be specific to highly specialized OPCAB centers.

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