used.1−7 Hence it is important for cardiac surgeons to focus on the long-term outcomes.

In this meta-analysis, the average patient age at surgery was 60 years. The potential life span of this cohort in many communities is an additional 20 to 25 years. Hence, any strategy that improves survival, especially if it is relatively morbidity-free, is welcome.

The important findings by Formica and colleagues7 are that even with BITA, adding an RA resulted in 3 more patients being alive at 10 years and 5 more alive at 15 years for every 100 undergoing operation. A very worthwhile result, especially because the operative time would be the same because the left RA can be harvested simultaneously with the left ITA, or the right RA harvested concurrently with the right ITA.

In coronary practice, if a patient is to undergo BITA and needs a further graft to a tightly stenosed significant artery supplying a substantial amount of viable myocardium, then an RA may be the optimal choice given that it will enhance long-term survival as reported by this analysis.

Formica and colleagues7 provide further evidence to support multiarterial grafting with a BITA + RA strategy. Although a 5% difference between 83% and 78% survival at 15 years may sound minor, it means that 5 more humans will be alive—an important outcome for those individuals and their families.

Commentary: How radical is radial? A tale of 2 grafts

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References

Although coronary artery bypass grafting (CABG) surgery remains the optimal revascularization strategy for patients with severe triple-vessel coronary artery disease, optimal conduit selection remains controversial. The 2018 European Society of Cardiology/European Association for Cardio-Thoracic Surgery guidelines on myocardial revascularization have endorsed, with a Class 1B recommendation, the use of the radial artery over the saphenous vein in patients with a high-grade coronary artery stenosis, primarily on the basis of an individual patient-level meta-analysis of randomized controlled trials (RCTs), and prospective studies favoring radial artery grafting over saphenous vein grafting. Furthermore, in patients not at high risk of sternal wound infections, the use of bilateral internal thoracic artery (BITA) grafting has been issued a Class 2A recommendation in the interest of maximizing long-term graft patency. However, limited robust data are known about the role of the radial artery as a third arterial graft.

In this issue of the Journal, Formica and colleagues elucidate the long-term survival influence of adding the radial artery to BITA grafting in a systematic review and meta-analysis. Among 2500 patients from 6 propensity score-matched studies, at a mean follow-up time ranging between 7.5 and 12 years, BITA and radial artery grafting, compared with BITA and saphenous vein grafting, was associated with significantly decreased long-term mortality (hazard ratio, 0.71; 95% confidence interval [CI], 0.50-0.91). This benefit was achieved in patients with excellent long-term survival given that all patients had BITA, likely to the 2 most important targets. The survival rate for BITA and radial artery grafting versus BITA and saphenous vein grafting at 5, 10, and 15 years was 96.2% (95% CI, 94.9%-97.1%) versus 94.8% (95% CI, 93.3%-95.9%), 88.9% (95% CI, 86.9%-90.7%) versus 87.4% (95% CI, 85.1%-89.3%), and 83% (95% CI, 79.9%-85.6%) versus 77.9% (95% CI, 74.4%-81%), respectively. Importantly, there was no signal of significant early mortality occurring within 30 days or during index hospitalization (odds ratio, 0.90; 95% CI, 0.36-2.28). As well, meta-regression analyses demonstrated that the primary end point was not influenced by any major patient baseline characteristics.

The authors should be commended for undertaking a thorough meta-analysis with important and meaningful clinical implications. Although there is reason for cautious optimism that radial artery versus saphenous vein grafting in addition to BITA grafting is associated with superior long-term survival, these findings must be interpreted carefully. First, the majority of patients included in this meta-analysis were younger than age 70 years, a relatively young and healthy population that theoretically should benefit the most from a third arterial graft. Thus, whether these findings would apply to older patients remains uncertain. In a secondary analysis of 10-year data from the Arterial Revascularization Trial, subgroup analyses restricted to patients between ages 50 to 70 years demonstrated that BITA grafting had a significantly lower incidence in major adverse events (all-cause mortality, myocardial infarction, or stroke) when compared with single ITA (SITA) grafting. However, no overall effect of age on the treatment effect of BITA versus SITA grafting was observed. Second, a limitation of pooling observational studies is that the findings may be subject to significant treatment allocation bias, or confounding by indication (or contraindication). Surgeons are inherently guided by the baseline clinical status, surgical risk, and cardiovascular anatomy of their patients in determining surgical approaches. Therefore, despite the appropriate attempts of included studies to propensity score match patients with similar characteristics, residual bias is likely given the presence of unmeasured and unknown

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**FIGURE 1.** Contraindications and favorable indications of radial artery grafting.

<table>
<thead>
<tr>
<th>Contraindications</th>
<th>Favorable Indications</th>
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<tr>
<td>Recent angiography</td>
<td>High grade coronary stenosis</td>
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<tr>
<td>Previous trauma</td>
<td>Expected long-term survival</td>
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<tr>
<td>Morphologic or circulatory pathology (vasculopathies, dialysis, etc.)</td>
<td>Ease of harvesting and anastomosis</td>
</tr>
<tr>
<td>High expected pressor requirements (increased propensity to spasm)</td>
<td>Good wound healing</td>
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<tr>
<td>Emergent surgery</td>
<td>Obesity</td>
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<td></td>
<td>Diabetes</td>
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confounders, such as target vessel stenosis severity and myocardial territory, which greatly influence a surgeon’s decision. Finally, authors elected to only include propensity score-matched studies in their analysis and excluded those that may have adjusted for confounding by other means. By restricting the systematic review and meta-analysis to propensity score-matched studies, the authors may have excluded relevant multivariable regression or inverse propensity score weighting-adjusted studies.9-11

Long-term survival outcomes of CABG surgery are largely predicated by the completeness of revascularization and the durable patency of grafts, which may be influenced by conduit selection. The elasticity of arterial grafts, coupled with their inherent propensity to minimize intimal and medial hyperplasia, which in vein grafts would otherwise result in atherothrombosis and a reduction of patency, has long served as premises that they are the optimal conduit candidates for a complete and long-term revascularization. Previous large observational studies and meta-analyses of propensity score-matched studies have supported this hypothesis, and are consistent with the findings of this meta-analysis.12-14 In fact, 1 large propensity score-matched analysis found the use of saphenous vein grafts to be independently and incrementally associated with reduced survival after CABG surgery.15 However, these findings have yet to be confirmed by a large RCT with sufficient long-term follow-up, which may be why total arterial revascularization or the use of multiple arterial grafts, in patients with triple-vessel coronary artery disease, is far from routine surgical practice. In the largest trial of BITA versus SITA grafting, there was no significant difference in mortality or the rates of major adverse events at 10-year follow-up.16 While we await RCTs with sufficient long-term data, the known and potential benefits of radial artery grafting in addition to BITA grafting warrants further consideration in patients with a very long anticipated life expectancy, especially because it appears to outweigh any known and potential risks. As CABG surgery’s journey continues to unfold, so too will the tale of the arterial and venous grafts that perfuse it.

References