Radial arteries for coronary angiography and coronary artery bypass surgery: Are two arteries enough?

Kevin R. An, BSc, Derrick Y. Tam, MD, Mario F. L. Gaudino, MD, and Stephen E. Fremes, MD, MSc

From the Division of Cardiac Surgery, Department of Surgery, Schulich Heart Centre, Sunnybrook Health Sciences Centre, University of Toronto, Toronto, Ontario, Canada; Department of Cardiovascular Sciences, Catholic University, Rome, Italy; and Department of Cardiothoracic Surgery, Weill Cornell Medical College, New York, NY.

Address for reprints: Stephen E. Fremes, MD, MSc, Dr Bernard S. Goldman Chair in Cardiovascular Surgery, Schulich Heart Centre, Sunnybrook Health Sciences Centre, 2075 Bayview Ave, Room H4 05, Toronto, Ontario, M4N 3M5 Canada (E-mail: stephen.fremes@sunnybrook.ca).

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The transradial artery (TRA) approach for coronary angiography and percutaneous coronary intervention has been shown to improve outcomes compared with the transfemoral artery (TFA) approach. This has led to an increase in the use of the TRA for not only elective cardiac catheterizations but especially so in acute coronary syndrome and ST elevation myocardial infarction (STEMI). From 2011 to 2014, the number of radial catheterizations for percutaneous coronary intervention in the United States jumped from 10.9% to 25.2%. TRA is the preferred access over a femoral approach in the European guidelines for routine catheterization and non-STEMI (Class I, level of evidence A) and for emergent percutaneous coronary intervention for STEMI (Class IIa, level of evidence A). Meanwhile, there is mounting evidence to suggest that multiarterial grafting may be the preferred strategy in selected patients undergoing coronary artery bypass grafting (CABG). The radial artery (RA) may be an equivalent arterial alternative to bilateral internal thoracic artery grafting, particularly if comorbidities or anatomic factors make the bilateral internal thoracic artery less favorable. The American guidelines committee considers the use of an RA as a Class IIa recommendation in patients with a good life expectancy; the European guidelines committee recommend total arterial revascularization for patients with poor saphenous vein options (Class I) or for patients with good life expectancy (Class IIa). In the context of increasing RA use for catheterizations and increasing evidence to suggest a benefit to multiarterial grafting, it becomes relevant to posit the following question: are 2 RAs enough?

In a timely and relevant review article by Gaudino and colleagues, an international consortium of interventional cardiologists and cardiac surgeons address the important benefits of TRA for interventional procedures and the benefits of using the RA as a second arterial graft in CABG. They present a thoughtful approach to the appropriate use of the RA for either procedure.

The evidence supporting a TRA approach over the TFA approach is well established and clear. A recent meta-analysis by Ferrante and colleagues looking at randomized trials and a total of 22,843 patients showed that TRA catheterization is associated with reduced all-cause mortality (odds ratio [OR], 0.71; 95% confidence interval [CI], 0.59-0.87, P = .001), reduced major adverse cardiovascular events (OR, 0.84; 95% CI, 0.75-0.94, P = .002), reduced major bleeding (OR, 0.53; 95% CI, 0.42-0.65, P < .001), and reduced vascular complications (OR, 0.23; 95% CI, 0.16-0.35, P < .001) compared with TFA. However, TFA can be considered in patients with lack of conduits to avoid potentially damaging the RA.

There exist potential ways to limit the damage to the femoral artery during catheterization, thereby improving the desirability of TFA catheterizations. A network meta-analysis of studies published since 2005 by Jiang and colleagues showed that advancements in femoral closure devices have led to a lower incidence of adverse vascular complications (risk ratio, 0.80; 95% CI, 0.71-0.90, P = .007). In the work of Durst and colleagues, patients undergoing diagnostic angiography who received a 4-Fr catheter compared with a 6-Fr catheter had a lower incidence of complications (10% vs 27%, P < .05). In addition, Seto and colleagues demonstrated that the use of ultrasound during TFA catheterization reduced vascular complications (1.4% vs 3.4%, P = .04). These technologies, along with
future advancements, could make femoral artery catheterization safer and an appropriate alternative to RA catheterization. In transcatheater aortic valve implantation performed via a percutaneous transfemoral approach, the use of smaller sheaths coupled with percutaneous closure devices have significantly reduced vascular complications.¹²

Unfortunately, TRA catheterization leads to significantly more intimal hyperplasia, adventitial inflammation on histologic analysis, as well as intimal tears and medial dissections with optical coherence tomography.¹³⁻¹⁵ In addition, catheterization leads to reduced vasomotor function and vessel diameter 6 months after procedure.¹⁶ In a single-center retrospective study by Kamiya and colleagues,¹² 67 patients undergoing RA grafting showed reduced angiographic graft patency (77% vs 98%, \(P = .017\)) at 1 month without any effect on early clinical outcomes. A clinically driven, angiographic single-center retrospective study of 215 patients undergoing RA grafting showed that patency was significantly reduced in previously catheterized radials compared with noncatheterized radials (59% vs 78%, \(P = .035\)) at late follow-up.¹⁷ In a histologic study comparing the distal and proximal ends of freshly catheterized radial grafts, intimal proliferation was present in 73.3% of distal ends as opposed to 36.7% of proximal ends of radial grafts.¹⁸

The evidence to support the use of the RA compared with the saphenous vein graft (SVG) or another arterial conduit has not been as robust as the evidence that favors TRA over TFA. Only 2 multicenter randomized controlled trials (RCTs) compared the RA with the SVG using angiographic outcomes. In the Radial Artery Patency Study, 561 patients were randomly assigned to a RA or SVG in the right coronary circulation with the other conduit grafted to the left circulation using a within-patient randomization strategy. At 1 year, trial-driven angiography in 440 patients showed a lower rate of complete graft occlusion in RA compared with SVG (8.2% vs 13.6%, \(P = .001\)).¹⁹ At a mean of 7.7 ± 1.5 years’ follow-up, angiography findings in 269 patients showed that 8.9% versus 18.6% (\(P = .03\)) of RA and SVGs, respectively, were completely occluded.⁵

However, in a study by Goldman and colleagues,²⁰ there was no significant difference in angiographic graft patency at 1 year (adjusted OR, 0.99; 95% CI, 0.56-1.74; \(P = .98\)) in 757 patients at 11 Veterans Affairs centers in the United States. A meta-analysis of the 6 RA versus SVG graft patency RCTs (\(n = 1860, 1188\) RA grafts, 1178 SVGs) reported a substantial reduction in RA graft failure (OR, 0.52; 95% CI, 0.37-0.73, \(P = .0002\)).²¹ However, a recent patient-level meta-analysis of the 6 RCTs comparing RA with SVG published in the *New England Journal of Medicine* subsequent to the review article in the *Journal of the American College of Cardiology* showed a lower incidence of adverse cardiac events (HR, 0.67; 95% CI, 0.49-0.90; \(P = .01\)) driven by less myocardial infarction (MI; HR, 0.72; 95% CI, 0.53-0.99; \(P = .04\)) and lower rates of repeat revascularization (HR, 0.50; 95% CI, 0.40-0.63; \(P < .0001\)) in the RA arm.²² Angiography was protocol driven in the RCTs included and may potentially inflate the number of repeat revascularization seen in the analysis.

Further observational studies demonstrate a disproportional clinical benefit of RA grafting in certain subgroups. In a substudy of the Radial Artery Patency Study in which investigators studied patients with diabetes, angiography findings in 83 patients at a mean of 7.7 ± 1.5 years follow-up showed 4.8% versus 25.3% of RAs and SVGs, respectively, were completely occluded.²³ Lin and colleagues²⁴ showed significant survival benefits at 12 years’ follow-up of RA versus SVG grafting, especially in patients with diabetes (HR, 0.59; 95% CI, 0.41-0.85, \(P = .005\)), women (HR, 0.62; 95% CI, 0.41-0.94, \(P = .02\)), and elderly patients (HR, 0.75; 95% CI, 0.57-0.98, \(P = .035\)). In the patient-level meta-analysis, a reduction in the primary outcome of death, MI, or repeat revascularization was seen with RA grafting in female patients (HR, 0.23; 95% CI, 0.09-0.56; \(P = .01\)) and those with a previous MI (HR, 0.51; 95% CI, 0.28-0.91; \(P = .37\)).²²

Studies demonstrate that only a minority of patients have subjective complaints of paresthesia and numbness 3 months after surgery, which typically subsides by 6 months. The use of RA should be avoided in those with poor ulnar artery collateralization, previous trauma, calcification, and collagen vascular disease.²⁵⁻²⁷ We routinely perform duplex arterial studies in patients before radial harvesting. Finally, RA patency is highly dependent on the severity of the target vessel stenosis due to competitive flow for both left coronary and right coronary targets; however, a critical stenosis is of particular importance for the right coronary.²⁸⁻²⁹

In most circumstances, the algorithm of catheterizing the right radial and harvesting the left RA as described by Gaudino and colleagues⁷ is reasonable. Given that most patients are right-hand dominant, the left RA is the preferred artery for CABG. In surgery, the left radial is easily harvested simultaneously while the left internal thoracic artery is harvested. During catheterization, the right radial is on the side of the table that allows the cardiologist ease of access. It appears that there is more than enough RA to go around in the most common of circumstances. Undoubtedly, there are situations in which the RA should be used for catheterization without further discussion. In patients with STEMI, time to balloon remains the most important factor to survival; thus, any approach that facilitates expedient access to the coronary system should be used. Furthermore, patients with STEMI are least likely to undergo CABG and in those who do require surgical management, the RA may not be the conduit of choice in these emergent situations.³⁰

At centers where radial harvesting is not routinely performed, there is less concern with favoring the TFA over
the TRA at the time of catheterization. Similarly, the interventional cardiologist should consider favoring the TFA over the TRA approach in centers that routinely use the RA as a CABG conduit. This recommendation is most important for patients undergoing coronary angiography with stable ischemic heart disease with otherwise good life expectancy than for patients with acute coronary syndrome. If a patient shows poor conduit availability on history (ie, previous vein stripping) and on physical examination (ie, varicose veins), the TRA should be avoided. There is limited evidence examining bilateral RA use in CABG, and bilateral RA use is particularly uncommon. Tatoulis and colleagues, however, showed that bilateral RA harvesting for CABG is safe and facilitates increased total arterial grafting.

Again, we commend the authors on tackling this timely and interesting topic. Although there may be enough RA for both specialties to use to achieve benefit for their patient with coronary artery disease, a thoughtful approach coupled with open dialogue remains key to ensuring that the limited resources of RAs are used efficiently in every patient. Thus, the heart team approach becomes central to the management of patients with coronary artery disease and begins before the first injection of dye into the coronary arteries.

Conflict of Interest Statement
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References