Advanced hybrid coronary revascularization with robotic totally endoscopic triple bypass surgery and left main percutaneous intervention

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Robotic totally endoscopic coronary artery bypass (TECAB) allows closed-chest coronary artery bypass grafting of all coronary vessels on a beating or arrested heart. We present a case in which triple-vessel TECAB was for the first time combined with percutaneous coronary intervention (PCI) to achieve complete myocardial revascularization.

CLINICAL SUMMARY

The patient, a 57-year-old man with a history of myocardial infarction, left anterior descending coronary artery (LAD) stent, and occluded right coronary artery, automatic implantable cardiac defibrillator implantation, was seen because of ventricular tachycardia, acute non-ST segment elevation myocardial infarction, and automatic implantable cardiac defibrillator discharge. Workup identified anteroapical ischemia, complex 70% stenosis involving the distal left main coronary artery (LMCA) and all 3 major sub-branch ostia, and 30% in-stent restenosis of the LAD stent. Hybrid coronary revascularization was planned, including 3-vessel, all-arterial TECAB targeting the LAD, left circumflex coronary artery, and right posterior descending coronary artery systems with staged stenting of the distal LMCA and ramus. In the operating room, left ventricular ejection fraction was 20%; however, this was considered to be reversible because outpatient left ventricular ejection fraction was 45% and implantation of a prophylactic intra-aortic balloon pump resulted in significant improvement.

With the da Vinci telemanipulation system (Intuitive Surgical, Sunnyvale, Calif), bilateral internal thoracic arteries (ITAs) were harvested with simultaneous harvesting of the left radial artery. An end to side right ITA–radial artery Y anastomosis was created with robotic endoscopic

suturing. With remote access perfusion and aortic balloon endo-occlusion, the heart was then arrested with antegrade blood cardioplegia according to standard open coronary artery bypass grafting protocol. An end-to-side obtuse marginal–in-situ left ITA anastomosis was then performed. The acute margin of the heart was then lifted with the endostabilizer, exposing the right posterior descending coronary artery, and an end-to-side anastomosis was created with the radial artery limb of the Y graft. Finally, an end-to-side LAD–in-situ right ITA anastomosis was performed. Operative, bypass, and clamp times were 348, 115, and 90 minutes, respectively. All anastomoses were performed with 7-0 polypropylene suture.

On postoperative day 1, ejection fraction was 45% without inotropic support, and the patient was started on a regimen of aspirin and clopidogrel. On postoperative day 5, the patient received 300 mg clopidogrel. After completion angiography demonstrated all grafts to be widely patent with brisk runoff (**Figure 1**), PCI was performed, placing a 2.75×15 mm Xience V drug-eluting stent (Abbott Laboratories, Abbott Park, Ill) into the LMCA and ramus (**Figure 2**). The patient was discharged home on postoperative day 7 and resumed all activities, with no sternal precautions. He reports mowing his lawn and driving 2 weeks postoperatively.

DISCUSSION

This case demonstrates an expansion of the scope of patients who can be offered complete myocardial revascularization with hybrid cardiac revascularization techniques. Before this advance, patients with such complex, high-burden disease requiring 3 or more bypass grafts would typically be treated with standard coronary artery bypass grafting through a sternotomy. TECAB has been associated with early functional recovery, reduced pain, and superior cosmesis.^{1,2} Our patient had a fast recovery and early return to normal activities. Additionally, use of all arterial grafts and drug-eluting stents offers a durable therapy that is likely to match or even exceed a more traditional revascularization approach with venous grafts.

One major advantage of hybrid coronary revascularization is that it can convert complex PCI targets into relatively simple ones. This patient showed a difficult trifurcation stenosis in the LMCA which would have been inappropriate for PCI alone. The 2 in-situ ITAs offered functional protection

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Disclosures: Authors have nothing to disclose with regard to commercial support. J.D.L. and M.R.V. are joint first authors.

Received for publication March 9, 2012; revisions received May 4, 2012; accepted for publication May 17, 2012; available ahead of print June 19, 2012.

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J Thorac Cardiovasc Surg 2012;144:986-7
0022-5223/\$36.00

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<http://dx.doi.org/10.1016/j.jtcvs.2012.05.070>

FIGURE 1. Postoperative angiograms showing 3 widely patent grafts. A, Right internal thoracic artery (RIMA) to left anterior descending coronary artery (LAD) and radial artery (RA) Y graft to posterior descending coronary artery (PDA). B, Left internal thoracic artery (LIMA) to obtuse marginal (OM) circumflex.

to the LAD and left circumflex coronary artery, transitioning the complex trifurcation lesion to a straightforward lesion requiring a single stent covering the distal LMCA and proximal ramus. Stenting of a mother artery is commonly associated with decreased flow into daughter branches as a result of plaque shift and covering of the side branch ostium in “jailed” fashion. In the instance of a bypass grafted side branch, decreased antegrade flow into a jailed side branch visibly enhances graft contribution to coronary flow. High graft flow has been associated with graft maturation and is recognized to improve long-term patency. Whether jailing these grafted side branches by LMCA PCI will enhance long-term graft patency requires additional study.

An advantage of robotic TECAB relative to traditional open sternotomy coronary artery bypass grafting may be higher rates of bilateral ITA use in these patients. In our own series of 410 TECAB procedures performed from October 2001 through October 2010, 25% had bilateral ITA use,² and current bilateral ITA use during our last 200 consecutive cases now exceeds 60%. In comparison, of

541,368 CABG procedures reported by the Society of Thoracic Surgeons database from 2002 through 2005, only 21,620 (4%) had bilateral ITA use.³

We conclude that in experienced centers, complex coronary artery disease can be treated with a combination of robotic multivessel TECAB and PCI as an alternative to open coronary artery bypass grafting. With this strategy, both surgical invasiveness and complexity of PCI are reduced. Multiple arterial grafts, as well as drug-eluting stents, can be placed with complete preservation of sternal integrity, resulting in early return to normal activities.

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FIGURE 2. Placement of drug-eluting stent (Xience 2.75 × 15 mm; Abbott Laboratories, Abbott Park, Ill) left main coronary artery and ramus stent for complex trifurcation lesion under distal graft protection. PCI, Percutaneous coronary intervention; LAD, left anterior descending coronary artery; LM, left main; OM, obtuse marginal.