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EDITORIAL COMMENTARY

Should off-pump coronary artery bypass surgery be abandoned? A potential solution

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See related article on pages 1820-9.

In this issue of the *Journal*, in a meta-analysis of 22 studies enrolling more than 100,000 patients, Takagi and coworkers¹ conclude that coronary artery bypass grafting surgery (CABG) performed off-pump (OPCAB) is associated with worse long-term (>5 years) survival than on-pump CABG (ONCAB).¹ The number of grafts performed per patient and the index of completeness of

revascularization were significantly greater for ONCAB than OPCAB patients. Furthermore, the need for repeat revascularization, recurrent angina, and rehospitalization for cardiac-related issues were also more frequent in the OPCAB group.

Previous studies have shown a 37% reduction in late mortality in patients undergoing CABG who have had a complete versus an incomplete revascularization.² Several studies have reported a higher incidence of incomplete revascularization with OPCAB techniques, and this has been proposed as a mechanism for the decreased long-term survival in these patients.²⁻⁷ OPCAB has also been associated with decreased graft patency, which may be responsible for decreased long-term survival and an increased need for repeated revascularization procedures.⁸ The results of the study by Takagi and coworkers¹ are similar to a recent Cochrane pooled analysis of data from more than 80 trials of ONCAB versus OPCAB that shows superior short-term and midterm survival with the ONCAB technique.⁹

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Proponents of OPCAB have argued that OPCAB surgeons perform fewer grafts because they are asked to perform OPCAB on patients with primarily single- or double-vessel disease. In their study, however, Takagi and coworkers control for this variable by including those studies in which an index of completeness of revascularization was reported. Proponents of OPCAB have also suggested that data from earlier studies did not include the use of modern stabilizers, heart positioning devices, or intracoronary shunts, and that the experience of the surgeons was inadequate. In 2 recent large randomized trials involving OPCAB surgeons who had at least 2 years of experience and who had performed at least 100 cases, however, there was no difference in mortality or major adverse cardiac event (MACE) rate between OPCAB and ONCAB techniques.^{10,11} Similarly, in the German Off-Pump Coronary Artery Bypass Grafting in Elderly Patients Study, which involved experienced OPCAB surgeons performing surgery on patients aged 75 years or older, there was no difference in mortality or MACE rate between OPCAB and ONCAB techniques.¹² Additional revascularization procedures within 30 days were more frequent in patients undergoing OPCAB, however, and they also received fewer grafts. The increased need for early revascularization and the decreased graft per patient index in the OPCAB group raised concerns that this could lead to an increased MACE incidence in these elderly patients.

The results of these trials may be responsible for the decline in OPCAB procedures in the United States, which peaked at 23% in 2002 and have now declined to 17% in 2012.¹³ Furthermore, the decline in OPCAB appears to be driven by a decrease in high-volume centers by high-volume surgeons, a group that has been the principal advocate of this technique.

In view of these negative studies, should OPCAB surgery be abandoned?¹⁴ In the hands of surgeons who are experts in OPCAB and have enthusiastically adopted this technique, there appears to be no difference in outcomes relative to ONCAB surgery.¹⁵ In fact, throughout Asia and particularly in India, the vast majority of CABG surgery is performed off pump. Furthermore, there are younger surgeons who may wish to learn these techniques. OPCAB may also play a role for patients with heavily diseased ascending aortas.

Clearly, all evidence suggests that OPCAB is not superior to ONCAB. Surgeons who perform OPCAB therefore must demonstrate that they can achieve short- and long-term outcomes comparable to those of ONCAB, which is the criterion standard for coronary surgical revascularization. To accomplish this, guidelines should be established for performing OPCAB surgery, and an OPCAB registry must be maintained to ensure that outcomes comparable to ONCAB are achieved by individual surgeons. This is no different from any other new surgical procedure that

differs from established criterion standard surgical techniques, such as transcatheter aortic valve replacement, or any specialized procedure, such as mechanical assist devices, where guidelines and registries are already established to ensure that properly trained surgeons perform the proper procedures to achieve optimal outcomes.

I propose that the major cardiac surgical societies develop guidelines for the practice of OPCAB. There would be criteria for surgeon training, patient selection, institutional requirements, standardization of operative techniques, and postoperative management. Surgeons would be required to perform 100 OPCAB procedures during a 2-year period and be mentored by an expert OPCAB surgeon who has had at least 2 years of experience with this technique. Patients should be carefully selected. Only those patients in whom a complete revascularization can be performed should undergo OPCAB procedures. In those cases where the coronary anatomy is unattractive (diffuse small-vessel disease), in whom cardiomegaly may limit exposure and result in hemodynamic instability, or in whom other issues (chronic obstructive pulmonary disease, reoperation, presence of pericarditis) limit exposure of coronary vessels, OPCAB should not be attempted. Because it is well documented that converting from OPCAB to ONCAB on an emergency basis is associated with increased morbidity and mortality, whereas doing so on an elective basis is not, it is imperative that criteria be established in the guidelines for the safe conversion of OPCAB to ONCAB surgery.^{16,17} This would include more frequent use of elective intra-aortic balloon pumps and determining from previous studies which patients are more apt to require conversion to ONCAB to avoid hemodynamic collapse. Institutions in which OPCAB is performed should provide teams of health care professionals who are consistently involved in these procedures. These include dedicated anesthesiologists who are adept at handling the hemodynamic variability associated with this technique, nursing personnel who are familiar with the various equipment required for this surgery, and adequate perfusion standby. Equipment must be made available to perform these techniques properly; this equipment includes sternal retractors with platforms for stabilizers, coronary artery shunts, anastomotic connectors, and carbon dioxide blowers. Protocols should be available for dealing with the degree of anticoagulation during the procedure and its reversal afterward, methods to regulate the patient's temperature, and the administration of antiplatelet agents after the procedure. A catheterization laboratory should be available in the event that emergency angiography or percutaneous intervention is necessary.

Registries should be established to monitor both the early (30-day) and long-term (5-year) outcomes for all planned OPCAB procedures. This would include not only mortality but important MACEs, such as myocardial infarction,

graft occlusion, recurrent angina, need for any repeat revascularization, and rehospitalization for acute coronary syndromes. This information would be available to the public and referring physicians, as is now the case with CABG registries in several states (New York and Massachusetts). Unplanned OPCAB procedures, such as those for unexpectedly severe ascending aortic disease, would be excluded.

The goal of all surgical revascularization procedures is to perform a technical procedure with minimal morbidity and mortality, enhanced long-term survival, and maximal freedom from recurrent angina, acute coronary syndromes, and the need for further revascularization procedures. ONCAB continues to be the criterion standard to achieve these goals. Developing guidelines and registries for OPCAB surgery will ensure that those surgeons who perform alternative CABG techniques continue to meet those goals.

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