Operative Techniques in Thoracic and Cardiovascular Surgery

Off-Pump Coronary Artery Bypass Grafting

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Off-pump coronary artery bypass graft (OPCAB) constitutes a minority of surgical revascularization procedures performed world wide, but it remains an important tool in the surgical armamentarium. If surgeons can achieve a comparable quality of anastomosis and completeness of revascularization as an on-pump procedure, OPCAB has the potential to reduce in-hospital morbidity and mortality in select high-risk patients. In this review, we describe our operative technique for OPCAB including perioperative medical management, the use of intraoperative imaging to reduce the risk of stroke, the optimal use of adjuncts to achieve a near bloodless field to allow for the creation of a precise and reproducible anastomosis and specialized tools to confirm graft flow.
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Introduction

Off-pump coronary artery bypass graft (OPCAB) constitutes a minority of coronary artery bypass grafting procedures performed worldwide, but it remains an important tool for surgical revascularization.[1] The lack of broad adoption is primarily owing to the greater technical difficulty, the lack of clear mortality benefit in large randomized controlled trials and the suggestion of poorer long-term graft patency outcomes in some series.[2-5] For specialized surgeons, if complete revascularization can consistently be accomplished by OPCAB, then the morbidity attributable to aortic cannulation and clamping, cardioplegia, and the use of cardiopulmonary bypass would be avoided and the patient should benefit. For select high-risk patients such as those with a porcelain aorta, OPCAB is absolutely necessary to accomplish surgical revascularization. There are also vulnerable, high-risk patient cohorts such as women, those with dialysis-dependent renal failure, advanced age, and previous stroke or cerebrovascular disease who can benefit from an off-pump procedure.[6-8] Thus, OPCAB remains relevant for surgical revasculatization and every tertiary cardiac surgical program should have at least one surgeon who is facile at off-pump surgery.

A few points regarding our OPCAB protocol deserve mention. We give aspirin 325 mg PO on the night before surgery and another 325 mg is given per rectum after anesthetic induction in the operating room. Regarding anticoagulation, we use an initial half dose of heparin intravenous (1.5 mg/kg) 3 minutes before the internal thoracic artery is divided and maintain a continuous infusion of heparin 6000 units/h to keep the activated clotting time >300 seconds. During the procedure, the patient is kept normothermic to avoid platelet dysfunction and ventricular arrhythmias with the use of intravenous fluid warmers, warmed inhalational anesthetic agents, maintenance of warm operating room temperatures, and by the use of a convective forced-air warming Bair Hugger system (Arizant Healthcare, Eden Prairie, MN) underneath the patient.

Operative Technique

The operative technique is described in detail as shown in Figures 1-10.

There are a few final technical points that deserve mention. Some patient-related factors can make an OPCAB procedure very challenging and they include multiple basal lateral wall targets, cardiomegally, severe left ventricular dysfunction, intramyocardial coronary arteries, especially in high lateral wall targets, small or diffusely diseased coronary arteries, anticipated need for endarterectomy or plasty, aortic or mitral regurgitation, hemodynamic instability, pulmonary hypertension, left main coronary artery disease, or ischemic arrhythmia. Graft sequence in OPCAB should be individualized for each patient. As a general rule (1) the left anterior descending should be bypassed first in high-risk patients, as it can be exposed with minimal manipulation of the heart. (2) Completely occluded vessels can be revascularized with low risk of incremental ischemia. (3) Collateralized vessel (s) should be grafted before collateralizing vessels. (4) A

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short left internal thoracic artery-left anterior descending graft may require that this distal anastomosis be performed after lateral wall grafting to avoid undue tension on the left internal thoracic artery graft during lateral displacement of the heart.

We routinely perform intraoperative assessment of the aorta with transesophageal echocardiography, manual palpation, and epiaortic ultrasonography. Once bypasses are constructed, we routinely quantitate flow using an intraoperative transit-time doppler flow meter (Medistim, Oslo, Norway). Acceptable values are flow >15 mL/min, pulsatility index <5, and diastolic fraction $>50\%$ for left-sided grafts. Any values outside of this range should prompt careful examination of the anastomoses (including with high-resolution epivascular ultrasound imaging) and graft and consideration of revision. We do not accept suboptimal doppler results and revise or reconstruct either the distal or proximal anastomosis, unless characteristics of the conduit or native coronary artery can readily account for the doppler findings.

Compared with on-pump coronary artery bypass grafting with full-dose heparin and pump-associated platelet dysfunction and consumptive coagulopathy, patients undergoing OPCAB are relatively hypercoagulable owing to activation of an intact coagulation cascade and platelet function. For this reason, we use dual antiplatelet therapy with aspirin and plavix for 6 months post-OPCAB, then aspirin continued for life. We administer aspirin (162 mg) and clopidogrel (150 mg) either PO or per nasogastric tube, 2-6 hours postoperatively. In patients with high-volume chest tube drainage immediately after surgery, dual antiplatelet therapy is delayed until bleeding is minimal. Thereafter, clopidogrel 75 mg PO is administered daily for 6 months and aspirin 162 mg PO daily for life.