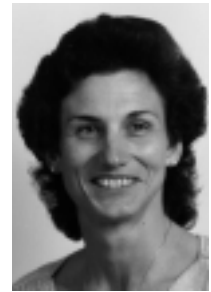


Minimally Invasive Approaches to Coronary Revascularization in High-Risk Patients

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INTRODUCTION

There is an increased occurrence of adverse events in high-risk patients undergoing coronary revascularization. Off-pump coronary artery bypass (OPCAB) has been found to be beneficial in high-risk groups [Yokoyama 2000, Hart 2001]. Although in general the off-pump approach is effective, different types of patients warrant different surgical approaches tailored to the specific target vessels or the patient's comorbidities. Port access coronary revascularization using cardiopulmonary bypass [Groh 2000] is another minimally invasive approach for bypass surgery, but it has not been as frequently used for high-risk patients and will not be covered in this discussion. Beating-heart surgery through various incisional approaches such as median sternotomy, left anterior thoracotomy (MIDCAB) [Benetti 1991, Caliafore 1998, Mack 2000], left posterolateral thoracotomy, and xiphoid MIDCAB will be discussed.

METHODS

Various high-risk groups of patients undergoing coronary bypass surgery have been identified, among them elderly patients, those undergoing reoperations, and patients with low ejection fractions (EF), left ventricular (LV) failure, left main disease, neurologic dysfunction, acute myocardial infarctions (MI), female gender, renal failure, inability to receive blood transfusions, and diabetes. These patients benefited from OPCAB when the surgical approach was tailored to the patient's specific situation. Preoperative use of the intra-aortic balloon pump (IABP) and intraoperative maneuvers such as the placement of positioning devices and shunting are important to maintain optimal stability during the operation.

Median Sternotomy

The skin incision can be limited to starting at the manubrium, but the entire sternum should be opened. This gives the

best access for multivessel grafting in all high-risk groups. For patients with LV failure [Radovancevic 2000], proximal multivessel obstruction, recent MI, cerebral vascular disease, and cardiomegaly-cardiomyopathy, elective preoperative IABP is indicated [Craver 2001]. The use of preoperative phosphodiesterase inhibitors also will stabilize the patient for a smoother course of operation. Gentle manipulation of the heart during positioning is also critical to maintaining hemodynamic stability and preventing excessive pharmacologic manipulation by the anesthesiologist. Positioning devices also allow easy access to the target vessels for the entire heart and entail less hemodynamic compromise [Dullum 2000] (See Figures 2 and 3, ⊙). In left main disease, gentle elevation of the heart by the "glove technique" (see Figure 1, ⊙) allows for initial grafting of the left anterior descending artery (LAD). This early revascularization of the LAD territory including the septal perforators results in improved patient stability for the completion of the rest of the grafts. The use of intracoronary shunts [Rivetti 1998] and a proper graft sequence are likewise important in maintaining hemodynamic stability. Elective graft perfusion [Guyton 2000] has also been shown to be beneficial in these patients. Another incisional approach that may be considered for multivessel beating heart grafting is a distal ministernotomy [Lichtenberg 2000].

MIDCAB

A left anterior thoracotomy approach allows for grafting of the LAD and possibly the diagonal artery. There is a learning curve for this procedure, with a higher risk of left internal mammary artery (LIMA) trauma than that posed by a sternotomy. By elimination of the median sternotomy, the patient usually has a faster recovery. The MIDCAB approach can be used in reoperations (redos) requiring LAD grafting if the LIMA has not previously been used. If the LIMA is not available, a "homegrown" LIMA can be constructed with a conduit (radial artery or vein) being attached to the axillary artery for inflow. [Bonatti 2000]. Other variations of the MIDCAB approach for high-risk patients, such as the "H" graft [Cohn 1988] and the "T-MIDCAB" [Coulson 1998], use an extension graft from the undisturbed LIMA to the LAD. Another variation of the MIDCAB is through a xiphoid approach [Benetti 1999, Dullum 1999]. This method allows for harvesting the distal LIMA and grafting it to the

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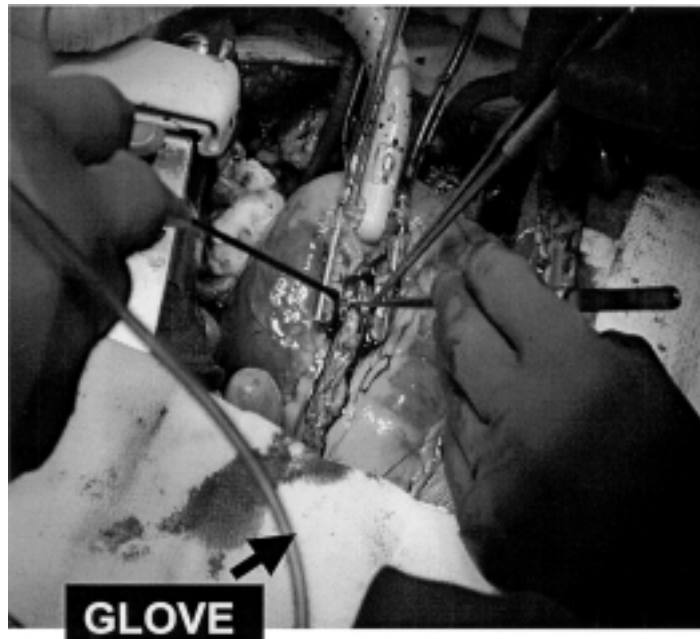


Figure 1. Positioning the heart of a patient with critical left main disease with a glove.



Figure 2. Inferior wall positioning with the Xpose™.

mid- or distal LAD, a procedure which results in minimal morbidity, especially in elderly patients.

Left Lateral Thoracotomy

The left lateral thoracotomy is the best approach when grafting vessels of the circumflex system. This is a safe approach in redos [Byrne 2001], especially with patent LIMAs. The chest is entered through the fifth intercostal space, and minimal dissection is required to expose the vessels. The proximal anastomosis is made to the descending thoracic aorta coursing below the inferior pulmonary liga-

ment. See Figure 4 (©). One reason for caution with this proximal anastomosis is that there may be atherosclerosis and grumous material in the descending aorta that could influence the inflow. The patient should be positioned to allow for femoral cannulation if necessary. External defibrillation pads should also be placed prior to starting the procedure, and the conduits may need to be harvested before placing the patient in the right lateral decubitus position. This approach is indicated primarily for grafting of the circumflex system but it may also be possible to reach the right coronary and LAD systems if the anatomy is favorable. See Figure 5 (©).



Figure 3. Lateral wall positioning with the Xpose™.

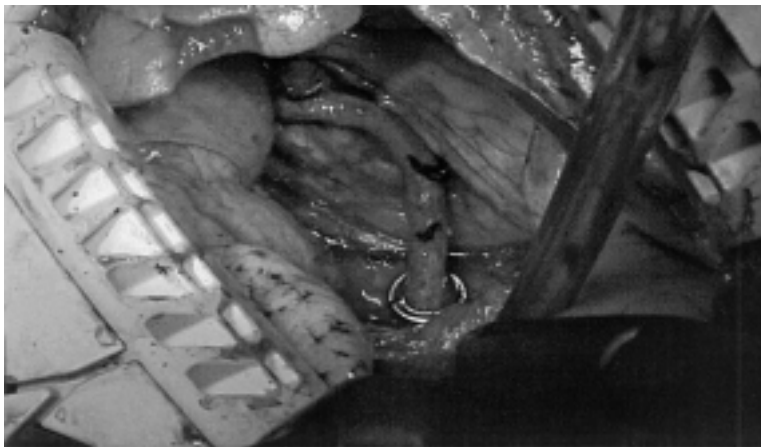


Figure 4. Circumflex grafting through a left thoracotomy.



Figure 5. Multivessel grafting through a left thoracotomy.

RESULTS

OPCAB has been shown to be safe in patients with low ejection fractions [Arom 2000] and safe and effective for critical left main disease [Yeatman 2001]. In addition, off-pump surgery significantly reduces transfusion needs and shows a consistent trend in reducing morbidity and mortality overall for high-risk subjects [Yokoyama 2000]. On the other hand, neurologic events are not eliminated by OPCAB, and even brain injury may not be reduced by this approach [Stump 2000].

CONCLUSION

Minimally invasive surgical approaches to coronary revascularization in high-risk patients are indicated and safe, but the question whether less neurologic morbidity can be expected is still being investigated [Murkin 1999]. Proper patient selection [Diegler 1999] and the use of adjunctive measures such as the IABP and positioning techniques are crucial for improved outcomes.

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