Coronary artery bypass grafting (CABG) is one of the most frequently performed operations worldwide. Its application is expected to increase, particularly in the developing world, where the incidence of coronary heart disease continues to rise. Any improvement in the safety and efficacy of the procedure or any means to increase the rate of its application, however small, would have a major impact in absolute terms. One potential method for achieving some of these objectives is off-pump coronary artery bypass grafting (OPCAB), which appears to be gaining in popularity. Although this method is intellectually appealing, with many theoretical and practical advantages, there are still major concerns because the technique could have significant complications in both the short and the long term. These issues need to be addressed if the technique is to establish its identity and role in the treatment of coronary artery disease. In the last few years, there has been a rapid accumulation of knowledge relating to some, but not all, of these issues. This knowledge comes from observational reports, case-matched studies, and, importantly, from prospective, randomized trials. In this regard, the report by van Dijk and colleagues in this issue of Circulation is a welcome addition to the literature. In the present editorial, a systematic analysis of the available evidence on OPCAB-related issues is made.

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Application of OPCAB

To date, OPCAB has been used largely in selected patients, with the reported use of the procedure varying widely in different centers (between 0% and >90% of all patients undergoing coronary bypass grafting). The application of the technique has tended to increase dramatically since the introduction of devices for stabilizing the heart, such as the Octopus, which is used by many centers and was used in the trial by van Dijk and colleagues. Initially, the technique was reserved for young patients who had good left ventricular function and single or double coronary disease affecting accessible arteries with healthy distal vessels. The next group for which the technique was advocated was that of elderly patients with comorbid conditions that were perceived to make them poor candidates for cardiopulmonary bypass. With increasing experience, the technique now is being used for routine patients with multi-vessel disease requiring CABG. With few exceptions, the presence of clinical heart failure, hemodynamic instability, severe left ventricular dysfunction, significant cardiac enlargement, or frequent arrhythmias is regarded as an absolute contraindication to OPCAB. Other factors, such as urgent or emergency operation, female sex, and small or diffusely diseased vessels, are considered contraindications by most, but not all, physicians.

In the absence of solid data to guide selection, the rate of application of OPCAB currently depends on the attitude, experience, prediction, and biases of the surgical group. Further studies including control subjects, preferably in a prospective, randomized fashion, are required to clarify the exact indications and to guide the rate of application. In the excellent randomized trial by van Dijk et al, the rate of application is not mentioned. Although the indications are well described, they include the “judgment of the operating surgeon.” Although this is obviously an overriding consideration, more objective parameters need to be included for future analysis. Patients who require intraoperative conversion from OPCAB to cardiopulmonary bypass can develop increased morbidity and mortality, which highlights the importance of making the appropriate preoperative choices.

Early and Late Mortality

Perioperative crude mortality statistics for OPCAB in more recent series have been at least as good as those for conventional CABG. There have been, however, no studies addressing late survival, which could be affected by several factors, such as type and adequacy of revascularization, myocardial damage or lack thereof, and quality of graft function. The late survival statistics from the randomized trials should provide interesting and relevant information in the future.

Type and Adequacy of Revascularization

The type and adequacy of revascularization has caused, and to some extent, continues to cause concern about the use of OPCAB. This stems from the fact that many of the earlier reports supported the notion that, because of problems with accessibility, feasibility, and duration of surgery, OPCAB was associated with inadequate revascularization and a lower rate of arterial graft use. This perception, however, appears to have been corrected in more recent reports, with several of the randomized and case-matched studies reporting similar average numbers of grafts and use of arterial grafts.
Myocardial Injury and Postoperative Arrhythmias

Conventional CABG entails aorto cross-clamping, which is accompanied by the inherent risks of ischemia reperfusion, despite the recent advances in myocardial protection. OPCAB allows continuous perfusion of a beating heart, but it is with temporary occlusion of the target artery and, possibly, hemodynamic instability with subsequent reduction in coronary flow. Interestingly, data from both observational and randomized trials suggest that although the rates of Q-wave and non-Q-wave infarction appear to be comparable in both methods, other parameters of myocardial injury, such as troponin I, creatine phosphokinase of muscle band (CPK-MB), and myoglobin, are significantly lower in the OPCAB patients. The clinical relevance of these findings is still not clear. However, Califf et al found that higher CPK levels after balloon angioplasty are almost identical in the study reported by van Dijk and colleagues, suggesting a significantly lower incidence of AF after OPCAB, the incidence of AF was almost identical in the study reported by van Dijk and colleagues. This highlights the need for further studies and the importance of prophylactic use of β-blockers.

Total Body Inflammatory Response and Organ Damage

Operations involving cardiopulmonary bypass have been shown to activate both proinflammatory and antiinflammatory responses when compared with other operations. This is thought to contribute to multi-organ damage. Comparative studies between OPCAB and conventional cardiopulmonary bypass have shown that the cytokine response after the 2 types of surgery is different both quantitatively and qualitatively, with systemic inflammation documented in OPCAB. Activation of neutrophils appears to be limited only to patients undergoing conventional CABG using cardiopulmonary bypass. As suggested by Michael Vallely and colleagues, these findings should not be used alone to support the use of OPCAB instead of conventional bypass. Although observational studies have suggested a reduced incidence of pulmonary, renal and most importantly, neurological damage after OPCAB, prospective randomized trials, including the van Dijk study, have shown no detectable differences in end-organ damage. Neurological outcome was identical, as were neuropsychological and quality-of-life measures. This might be a result of the relatively small number of patients or, alternatively (and more likely), the fact that there is no difference between the 2 groups in that regard. Larger trials or meta-analysis of randomized trials could clarify this issue. Cardiopulmonary bypass is also known to interfere with blood coagulation and therefore can cause excessive blood loss. Several studies have documented reduced blood loss or need for blood products in OPCAB. The magnitude of these changes can vary greatly. In the study by van Dijk et al, the difference in blood loss was only 90 mL per patient.

OPCAB, at least in theory, involves less manipulation of the ascending aorta than does conventional CABG because of the lack of cannulation and cross-clamping of the aorta. Paradoxically, increased incidence of acute dissection of the ascending aorta has been reported in OPCAB. This is thought to be caused by the higher blood pressure and the increased pulsation present during placement of the aortic side clamp in OPCAB patients when compared with those who underwent conventional CABG. This issue may be addressed by introducing technical and pharmacological preventive measures.

Graft Function

One of the main concerns regarding OPCAB is the possibility of reduced quality of the anastomosis, particularly when the method is applied through a minithoracotomy. Although the more recent stabilizers, coupled with increasing experience and the more common use of median sternotomy, is thought to have had an impact on this issue, there is still paucity of data to fully support this notion. Intraoperative measurement of graft flow using electromagnetic flow and transit time flow measurement is cumbersome and has many limitations. More accurate angiographic characterization of graft function using semiquantitative measures such as TIMI flow rates and FitzGibbon et al’s grading of grafts needs to be applied more widely, particularly during the early phases of any center’s experience. Graft function can also be assessed indirectly by clinical follow-up, stress testing, recurrence of symptoms, and need for re-intervention. To date, the relatively limited amount of data available suggests that, with few exceptions, OPCAB has the potential to achieve consistent good graft function.

Length of Stay and Hospital Costs

Although some reports have claimed shorter intensive therapy unit and hospital stays coupled with reductions in cost for OPCAB, the data are relatively soft and need to be put into the context of the quality of the operation.

The Future

Current evidence suggests that OPCAB is gradually establishing its position in practice, but it should continue to be subjected to scrutiny in the foreseeable future.

References


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