Update for Coronary Artery Bypass Graft Surgery

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1. Preamble and introduction

Surgical revascularization for atherosclerotic heart disease is one of the great stories of success in medicine. Relief of angina after revascularization, improvement in exercise tolerance, and the realization of survival benefit have attended the operation since the early stages of development.

Coronary artery bypass graft (CABG) surgery is one of the most commonly performed operations in the world. The American College of Cardiology (ACC) and the American Heart Association (AHA) have jointly engaged guidelines for CABG since 1980. Since the initial guidelines for CABG surgery were updated and published in 1991, there has been additional evolution in the surgical approach to coronary disease; at the same time there have been significant advancement in preventive, medical, and percutaneous catheter approaches to the therapy. These practical guidelines are intended to assist healthcare providers in clinical decision making by describing a range of generally acceptable approaches for the diagnosis, management, or prevention of specific diseases or conditions. The ACC/AHA 2004 Guidelines Update for CABG was approved for publication by the ACCF Board of Trustees in March 2004 and the AHA Science and Advisory Coordinating Committee in June 2004 and was published in the August 31, 2004 issue of Circulation and the September 1, 2004 issue of the Journal of the American College of Cardiology.[1] Full-text guidelines are posted on the websites of ACC (www.acc.org) and AHA (www.americanheart.org).

The committee reviewed pertinent publications, special attention was devoted to the identification of randomized trials. The relative levels of evidence favoring Class I, II, and III indications were noted. Also, the level of evidence, either an A, B, or C, for each recommendation is now provided.

Classification of recommendations

Class I : Conditions for which there is evidence and/or general agreement that a given procedure or treatment is beneficial, useful, and effective.

Class II : Conditions for which there is conflicting evidence and/or divergence of opinion about the usefulness/efficacy of a procedure or treatment.

Class IIa : Weight of evidence/opinion is in favor of usefulness/efficacy.

Class IIb : Usefulness/efficacy is less well established by evidence/opinion.

Class III : Conditions for which there is evidence and/or general agreement that a procedure/treatment is not useful/effective and in some cases may be harmful.

Level of evidence

Level A Data derived from multiple randomized clinical trials or meta-analyses.

Level B Data derived from a single randomized trial, or nonrandomized studies.

Level C Only consensus opinion of experts, case studies, or standard-of-care

Patients with triple-vessel disease and left main disease, patients with ischemic left ventricular dysfunction were found to benefit from the operation, relative to medical therapy. These results led to the application of coronary bypass to progressively worsening patients[m1] in the 1980s. The improvement of operative techniques, myocardial protection, perioperative monitoring techniques and cardiac anesthesia allowed increasingly more difficult cases to survive. In addition to the improvements of short-term outcomes, the evolving technology has contributed to the betterment of long-term results. The widespread use of IMA and other arterial conduits, long-term antiplatelet therapy, lipid management and finally the application of CABG without CPB (heart-lung machine) have presented a prospect of further reductions in perioperative morbidity.

2. Outcomes

2.1 Hospital outcomes

2.1.1 Predicting hospital mortality

Class IIa : It is reasonable that statistical risk models be used to obtain objective estimates of CABG operative mortality (Level of Evidence: C).

It is important for us to be able to predict hospital mortality resulting from a procedure, and evaluate the risk of the major complications of CABG including cerebrovascular accidents, major wound infection, and renal dysfunction.

Seven variables (urgency of operation, age, prior heart surgery, sex, LVEF, percent stenosis of the left main coronary artery, and number of major coronary arteries with more than 70% stenosis) were found to be predictive of mortality after CABG in a review of seven large data sets, representing more than 172,000 patients who underwent surgery between 1986 and 1994.[2]

Coronary artery surgery in the presence of or immediately after an acute MI is controversial. Fibrinolytic therapy and/or PCI appears to be the preferable first-line therapy. CABG surgery is reserved for patients with evidence of ongoing ischemia despite these interventions.

2.1.2 Morbidity associated with CABG: adverse cerebral outcomes

Class I : Significant atherosclerosis of the ascending aorta mandates a surgical approach that will minimize the possibility of arteriosclerotic emboli (Level of Evidence: C)

Postoperative neurological deficits have been divided into two types, namely: type 1 deficits are those associated with major, focal neurological deficits, stupor, and coma; type 2 deficits are characterized by deterioration in intellectual function or memory. At this point, there is in sufficient evidence of a difference in neurological outcomes for patients undergoing off-pump coronary artery bypass (OPCAB) compared with those undergoing conventional CABG.[3]

Predictors of type 1 deficits include the presence of proximal aortic atherosclerosis, a history of prior neurological disease, use of intra-aortic balloon pump, diabetes, a history of hypertension, a history of unstable angina, and increasing age.

Factors predictive of type 2 deficits include history of alcohol consumption, dysrhythmia, hypertension, prior CABG, PVD, or CHF.

Adverse cerebral outcomes occurred in 6.1% (3.1% in type 1, and 3.0% in type 2). The influence of these complications included 21% mortality in those with type 1 deficits and 10% mortality in those with type 2.

2.1.3 Morbidity associated with CABG: mediastinitis

Deep sternal wound infection has been reported to occur in 1% to 4% of patients after CABG and carries a mortality rate of nearly 25%. Predictors include obesity, diabetes (blood glucose > 200 mg/dL), prior to cardiac surgery.

2.1.4 Morbidity associated with CABG: renal dysfunction

Postoperative renal dysfunction (PRD) is defined as a postoperative serum creatinine level of >= 2.0 mg/dL. PRD occurred in 7.7% (from 2,222 patients who underwent CABG with CPB) and 18% required dialysis. The mortality rates were 0.9% among patients who did not develop PRD, 19% in patients with PRD who did not required dialysis, and 63% among those who required dialysis.

Several preoperative risk factors for PRD included advanced age, history of moderate to severe CHF, prior CABG, type 1 diabetes mellitus, and preexisting renal disease (preoperative creatinine levels >1.4 mg/dL). Patients older than 70 years with a creatinine level >=2.6 mg/dL are at extreme risk for dialysis dependency after CABG.

2.2 Comparison of medical therapies versus surgical revascularization

2.2.1 Overview

There were three major randomized trials that were reported to have similar outcomes. In general the improvement in survival with CABG compared with medical treatment is 4.3 months at 10-year follow-up (p = 0.003). In patients with left main disease, their survival benefit is 19.3 months. Subset analyses for other subgroups show statistical benefit for those with 3-vessel disease, and those with 1- or 2-vessel disease including LAD. Relative risk reductions were similar with abnormal or normal LV function. However, a similar relative risk reduction is associated with a greater absolute survival benefit in the high-risk population with depressed LV function. The survival benefit of CABG surgery for individuals with 1- and 2-vessel disease without LAD involvement is small, particularly in the setting of normal LV function.

2.2.2 Location and severity of stenoses

2.2.2.1 Left main disease (>50% diameter stenosis by contrast angiography)

The benefit of surgery over medical treatment for patients with significant left main stenosis is little argued. The median survival for surgically treated patients is 13.3 years versus 6.6 years in medically treated patients. Left main equivalent disease, defined as severe (>=70%) diameter stenosis of the proximal LAD and proximal left circumflex disease, appears to behave similarly to true left main disease. Median survival for surgical patients is 13.1 years versus 6.2 years for medically assigned patients.

2.2.2.2 Three-vessel disease (>50% diameter stenosis)

The outcomes of patients with 3-vessel CAD assigned to surgical or medical treatment is similar at 10-year follow-up. The more severe the symptoms, the more proximal the LAD stenosis, and the worse the LV function, the greater is the benefit from surgery. The relative risk reduction for surgery at 5 years is 42% and at 10 years is 24%, with an increase in survival of 5.7 months at 10-year follow-up.

2.2.2.3 Proximal LAD disease (>50% diameter stenosis)

The relative risk reduction of CABG is 42% at five years and 22% at ten years. In LAD disease without proximal involvement, the relative risk reduction is 34% at 5 years, and 10% at 10 years. In the presence of depressed LV function, the absolute benefit of surgery is greater because of the risk of this population.

2.2.2.4 LV systolic function

Systolic dysfunction that is a result of chronic hypoperfusion (hibernating) and not a result of infarction can now be identified noninvasively by positron emission tomographic scanning, radioisotope imaging, or dobutamine echocardiography. Patients with large areas of myocardial viability may benefit from revascularization. The poorer the LV function, the greater is the potential benefit of surgery.

2.3 Comparison with percutaneous techniques

In general, PTCA is less invasive and requires shorter hospitalization and recovery time than does bypass surgery. However, the disadvantages of PTCA include restenosis of treated lesions and, compared with CABG, a lesser ability to revascularize all lesions patients with multivessel disease.

Nine randomized, clinical trials comparing PTCA and CABG have been published. The largest is the BARI study.[4] The average postprocedure length of stay was shorter with PTCA (3 versus 7 days). The rate of in-hospital Q-wave MI was higher for CABG than for PTCA (4.6% versus 2.1%, $p<0.05$). At a mean follow-up of 5.4 years, there was no statistically significant difference in long-term survival or freedom from MI, but PTCA patients had more hospitalizations and required repeated revascularization procedures.

2.3.1 Acute outcome

Procedural complications including death (1% to 2%) and Q-wave MI (up to 10%) were low for both procedures but tended to be higher in CABG. The cost and length of stay were lower (50%) in PTCA than in CABG. Patients having PTCA returned to work sooner and were able to exercise more at one month. The extent of revascularization achieved with CABG was higher than with PTCA (99% versus 75%).

2.3.2 Long-term outcome

There was no significant difference in survival in eight of nine randomized trials that compared PTCA and CABG at follow-up periods ranging from one to eight years. The combined end point of cardiac mortality and MI was similar at five years with both treatments. An update of the BARI trial results with a mean follow-up of 7.8 years has now demonstrated a survival advantage in the overall study (84.4% with CABG versus 80.9% with PTCA (p=0.043). Most trials found that CABG resulted in greater freedom from angina. The most striking difference between the treatments was in the need for subsequent procedures. The rate was 4- to 10-fold higher for PTCA in every trial. Eight percent of CABG patients required additional revascularization within five years in the BARI, compared with 54% of PTCA patients.

Comparison with stents

The Arterial Revascularization Therapies Study Group (ARTS) randomized trial enrolled 1,205 patients with multivessel coronary disease, and they reported that there was no difference at one year in the combined rate of death, MI, and stroke between the two revascularization strategies. However, repeated revascularization rates were higher with stenting (16.8% versus 3.5% with surgery), with a net cost savings of $2,973 per patient favoring the stent approach. In diabetic patients (n=198), the difference in repeated revascularization rates was even more disparate (22.3% with stents versus 3.1% with CABG), although overall event-free survival was similar.

2.4 On-and off-pump coronary artery bypass surgery

The American Heart Associations scientific statement published on the 31st May, 2005 in circulation, was based on a review of the best available clinical trial data. The data included reports of a meta-analysis of 53 studies and other prospective and retrospective trials.

Patients may receive an excellent outcome with either type of the procedures, and individuals outcomes are more likely depending on factors other than whether or not they underwent standard on-pump CABG or off-pump CABG. Mortality varies between less than 1% to greater than 6% in most databases. The cost is about the same for the two procedures.

On-pump CABG is less technically demanding; it has a shorter learning curve for the surgeon, and possibly results in better long-term graft patency, and may result in more bypass grafts being constructed.

Off-pump CABG probably has more short-term benefits, such as less blood loss and need for transfusion, shorter hospital stay and less short-term neurocognitive dysfunction. However, patients who switched from off-pump to on-pump revascularization during surgery had a much greater risk of mortality, postoperative cardiac arrest and multisystem organ failure compared to patients who initially underwent on-pump CABG. The most conclusive benefit of off-pump CABG over on-pump CABG was for patients with a severely calcified or diseased aorta in which clamping the aorta can be associated with neurological consequences.

REFERENCES

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