

# { Beating Heart } *Surgery*

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## **Introduction**

The coronary artery bypass graft operation (CABG) is one of the most comprehensively studied single procedures in the history of surgery. Its use has massive implications, not just for the health of a nation, but also for national economies. For the overwhelming majority of patients with left main coronary disease, CABG surgery is the preferred option but it is also the procedure of choice for most patients with triple vessel disease, left ventricular dysfunction and diffuse disease, and perhaps diabetes. These patients comprise the highest risk group of patients with coronary artery disease, with complete revascularisation an important objective in many and essential in some.

With the introduction of percutaneous angioplasty in 1977 the use of less invasive methods of coronary revascularisation has rapidly expanded. Technological advances of PTCA and stenting now offer an alternative option for the patient with multivessel disease. The recently reported BARI trial, a five-year prospective comparison of CABG and angioplasty in patients with multivessel disease, concluded that there was no significant difference in survival between the two treatment strategies. However, the rate of need for reintervention or subsequent revascularisation was 42% in the angioplasty group versus 3% in the CABG group and 31% of the patients initially undergoing angioplasty ultimately underwent CABG anyway.

Of great interest also is the finding that patients with treated diabetes were found to have a significant advantage in survival with CABG over angioplasty. Even this trial is now somewhat out of date as the vast majority of patients now have stents placed at the time of angioplasty and the use of stents, The Benestent II trial, has recorded a 16% restenosis rate at six months for angioplasty and stenting.

CABG surgery has also advanced with extended benefit now proven with use of bilateral internal mammary arteries and radial arteries instead of vein grafts.

As advances in medical therapy, CABG surgery and transcatheter technologies continue, it is evident that we are dealing with a constantly moving target in trying to compare and define treatment modalities in coronary artery disease.

## **Beating heart surgery: why move from traditional to beating heart CABG?**

Traditional CABG surgery is performed with the patient's heart stopped and placed on the cardiopulmonary bypass system (CPB). The CPB circuit temporarily functions as the patient's heart and lungs, while providing a still and bloodless field on which the surgeon can perform the delicate suturing of the coronary arteries. This method has allowed coronary revascularisation to become an established procedure that offers excellent long-term patency rates and low mortality. So why change an operation that offers excellent results in the vast majority?

Stopping the heart and temporarily replacing its functions with cardiopulmonary bypass, however, has risks associated with it. Circulating the blood through the artificial surfaces of the cardiopulmonary bypass circuit may cause bleeding complications, systemic inflammation

**Table 1**  
**Patients at increased risk of morbidity and mortality with cardiopulmonary bypass**

- cerebrovascular disease
- peripheral vascular disease
- COPD
- renal failure
- aortic atherosclerosis

(which affects the lungs and kidneys and other organs of the body), and stroke. Most patients demonstrate minimal clinical evidence of these problems, but when they do occur, they (particularly neurological dysfunction) can be disabling for the patient and very costly to the healthcare system. When further considering the use of transfusions, pain, and slow return to normal daily activities, it is easy to see why surgeons are seeking alternatives to conventional methods.

**Table 2**  
**Complications of conventional cardiopulmonary bypass (morbidity)**

- neurological complications
- haemolysis
- atrial fibrillation
- bleeding complications
- heparin rebound phenomenon
- immune system compromise
- systemic inflammatory response

### **Neurological abnormalities after conventional bypass procedures**

A recent study by Roach et al in the *New England Journal of Medicine* (1997) reported an incidence of 6% of patients experiencing adverse cerebral outcomes following CABG with CPB. Patients with adverse cerebral outcomes were five to 10 times more likely to die in hospital and spent two to three times longer in the ICU. They had twice the postoperative length of stay and were four to six times more likely to be discharged to intermediate or long-term care facilities.

### **Stroke**

The incidence of completed CVA in conventional CABG has varied in the literature from 0.7-5% (1992 Lynn – 1,000 patients CABG - 2.7% had CVA; Smith - 710 patients - 0.8% had CVA). In those older than 75 years, the incidence was increased to 9%. In the presence of a previous history of stroke the incidence trebled and a previous history of stroke in an elderly patient increased the incidence nine-fold. A Cleveland autopsy study demonstrated atheroembolism in 16.3% of brains post coronary artery bypass grafts.

### **Neuropsychological impairment**

Results of studies on neuropsychological impairment have shown extraordinarily differing results depending on methodology, the test battery chosen and method of statistical analysis. Testing has been done on verbal memory, visual memory, language, attention, visuconstruction, psychomotor speed, motor speed, executive function with impairment being reported with an inci-

dence of 0-79%. A frequently quoted study of Venn demonstrated that 35% had a deficit at one year post-operation.

This is contrary to the study of Townes in 1989 who demonstrated improved patient performance over pretest levels in 90 patients. An important study from the Hammersmith by Taylor demonstrated significant swelling of the brain two hours after bypass due to the inflammatory response.

### **Inflammatory response to conventional cardiopulmonary bypass**

With cardiopulmonary bypass there is a whole body inflammatory response with activation of the inflammatory cascades. There is complement activation with activation of the coagulation pathways, the fibrinolytic and kallikrein cascade and neutrophils with formation and synthesis of cytokines. In the lungs and gastrointestinal tract there is increased capillary permeability and accumulation of interstitial fluid.

### **Off-pump coronary artery bypass (OPCAB) and stabilisation technology**

Beating heart surgery has initially been attempted through an anterior thoracotomy. While there are still many proponents of MIDCAB (minimally invasive direct vision CAB) via a small anterior thoracotomy, many surgeons would feel that the disadvantages are too great. The visibility is limited through the incision, there is no control of bleeding, the incision limits access to multiple vessels and there are increasing reports of the diagonal vessels being grafted mistakenly for the left anterior descending coronary artery.

OPCAB, on the other hand, is now a more favoured technique. A full sternotomy has the advantage of providing wide exposure and access to all coronary arteries.

**Table 3**  
**Deleterious effects of postoperative atrial fibrillation (27% coronary artery bypass grafting with conventional cardiopulmonary bypass versus 12% with off-pump coronary artery grafting)**

- x2 rate of stroke
- x2 rate of perioperative myocardial infarct
- x4 rate of ICU readmission
- x3 rate of persistent CCF
- x3 rate of reintubation and ventilatory support
- x2 30 day mortality and x 2 6 month mortality
- increased ICU length of stay
- increased postoperative length of stay

The key to success is minimization of the surface motion of the heart in order to provide a still field on which to suture and the insertion of conduit stents into the anastomotic site to allow the distal heart to be perfused while the anastomosis is being fashioned.

There are novel stabilisation devices which have the ability to hold a local area of the heart motionless while allowing the rest of the heart to freely beat. The device consists of parallel tracks of small suckers which are applied on either side of the coronary artery and serve to stabilise the area of the anastomosis. Prior to the introduction of this suction device other techniques involved fork-like compression to press down on the cardiac surface, but these devices cause a reduction in cardiac output.

## Candidates for beating heart surgery

Beating heart surgery is an area in which there have been technological advances that now make it a safe, simple alternative to conventional OPCAB graft surgery in most patients. The introduction of the suction stabilisation and small conduit stents have allowed this advance to take place. Some criteria which may preclude the technique include the ability of the patient's heart to tolerate the manipulation needed to expose the target coronary vessels, the accessibility of vessels (not intramyocardial coronaries) and the quality of the vessels (not calcified throughout their length).

**Table 4**

### Benefits of beating heart CABG over CABG with CPB

- fewer neurologic complications
- fewer arrhythmias postoperatively
- reduced systemic inflammatory response
- less likelihood of low output syndrome
- shorter time with ventilatory support
- less blood loss and need for transfusions
- shorter postoperative hospital stays

Importantly, research has indicated that beating heart CABG is not associated with increased rates of mortality or perioperative myocardial infarction when compared to coronary artery bypass grafts with cardiopulmonary bypass.

OPCAB surgery is most certainly an advance and will lessen the risk of cerebral complications in a significant number of patients. In Harefield Hospital, England, consecutive patients are being treated with OPCAB and only two of the last 130 patients have required a conversion to conventional bypass.

In conclusion, OPCAB grafting can be regarded as an advance due to improved technology which lessens the potential and real complications of conventional coronary artery bypass grafting.

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#### BRIEF PRESCRIBING INFORMATION

##### EUCARDIC (carvedilol)

**Indications:** Adjunctive therapy for treatment of symptomatic congestive heart failure to reduce morbidity and increase patient well-being. Treatment of hypertension. **Dosage and administration:**

**Symptomatic CHF:** Adults (including elderly). Recommended starting dose is 3.125mg twice daily for 2 weeks. Dose should be increased at intervals of not less than 2 weeks, to 6.25mg twice daily, followed by 12.5mg twice daily and thereafter 25mg twice daily. Recommended maximum dose is 25mg twice daily (50mg twice daily in patients weighing > 85kg). **Hypertension:** Adults. Recommended starting dose is 12.5mg once a day for 2 days. Thereafter the recommended dose is 25mg once a day. (Maximum dose 50mg once a day or in divided doses). **Elderly:** Initially 12.5mg daily. If necessary, titrate up to maximum of 50mg once a day or in divided doses. **Contra-indications:** NYHA Class IV decompensated heart failure requiring intravenous inotropic support. Patients with obstructive airways disease, liver dysfunction, hypersensitivity to carvedilol, asthma, 2nd and 3rd degree A-V heart block, severe bradycardia (<50 b.p.m.), cardiogenic shock, sick sinus syndrome (including sino-atrial block), severe hypotension (systolic BP < 85mmHg). **Side-effects:** CHF patients: Dizziness, bradycardia, postural hypotension, hypotension, gastrointestinal effects, oedema, vision abnormalities, thrombocytopenia, hyperglycaemia, (in diabetic patients), weight increase and hypercholesterolaemia. Infrequently, syncope, A-V block or cardiac failure during up-titration, acute renal failure and renal abnormalities in patients with diffuse vascular disease and/or impaired renal function. **Hypertension patients:** Symptomatic postural hypotension, dizziness, headache, fatigue, gastrointestinal upset, bradycardia, hypotension (infrequently syncope), pain in the extremities, reduced lacrimation, asthma and dyspnoea (in predisposed patients). Infrequently, depressed mood, sleep disturbance, paraesthesia, diminished peripheral circulation, peripheral oedema. Rare cases of skin reactions (allergic exanthema, urticaria, pruritus, lichen-planus like reactions, psoriatic skin reactions). Rarely, A-V block, angina pectoris, exacerbation of symptoms of intermittent claudication, Raynaud's phenomenon, progression of heart failure. Isolated cases of changes in serum transaminases, thrombocytopenia and leucopenia. Rare cases of sexual impotence, disturbed vision, eye irritation, flu-like symptoms, stuffy nose, dryness of the mouth and disturbances of micturition.

**Precautions:** If worsening heart failure or fluid retention occurs during up-titration, dose of diuretic should be adjusted and dose of Eucardic should not be increased until clinical stability resumes. Care in patients with poor cardiac reserve. Care in hypertensive patients patients who have CHF controlled with digoxin, diuretics and/or an ACE inhibitor. Renal function should be monitored in patients with systolic BP < 100mmHg, ischaemic heart disease, diffuse vascular disease and/or underlying renal insufficiency. Possibility of reduced lacrimation. Discontinuation of treatment should be gradual. Eucardic may mask symptoms of thyrotoxicosis. Reduce dose if pulse rate is < 55 b.p.m. Care in patients with a history of serious hypersensitivity reactions, Raynaud's phenomenon, psoriasis, phaeochromocytoma, diabetes mellitus or Prinzmetal's variant angina. **Interactions:** Eucardic may potentiate the effect of other anti-hypertensive agents. Care when co-administering calcium channel blockers, e.g. verapamil or Class I antiarrhythmic drugs, which should not be administered intravenously with Eucardic. Effects of insulin or oral hypoglycaemics may be intensified. Increased monitoring of digoxin levels is recommended when initiating, adjusting or discontinuing Eucardic. When co-treatment with clonidine is to be terminated, Eucardic should be discontinued first. Care when co-administered with inhibitors or inducers of mixed function oxidases or anaesthetic drugs. **Pregnancy and lactation:** Do not use during pregnancy or lactation unless benefits outweigh risk. **Overdose:** Profound cardiovascular effects such as hypotension and bradycardia. Heart failure, cardiogenic shock and cardiac arrest may follow as well as respiratory problems, bronchospasm, vomiting, disturbed consciousness and generalised seizures. **Legal Category:** Limited to sale or supply on prescription only by the terms of the marketing Authorisation. Marketing Authorisation Numbers and Presentations: Eucardic 6.25 (6.25mg) (28 tablets) - PA 130/18/4. Eucardic 12.5 (12.5mg) (28 tablets) - PA 130/18/1. Eucardic 25 (25mg) (28 tablets) - PA 130/18/2. **Product Licence Holder:** Boehringer Mannheim (UK) Limited, 40 Broadwater Road, Welwyn Garden City Hertfordshire, AL7 3AY. **Distributor:** Roche Pharmaceuticals (Ireland) Limited, 3 Richview Clonskeagh, Dublin 14. Full prescribing information is available on request. Eucardic is a registered trade mark. **Date of Preparation:** February 1999. **REFERENCES:** 1 Bristow MR & Gilbert EM. *Eur Heart J*. 1995; **16** (Suppl F): 20-31. 2 Cohn JN et al. *New Engl J. Med.* 1984; **311**: 819-823. 3 Australia/New Zealand Heart Failure Research Collaborative Group. *Lancet* 1997; **349**: 375-380. 4 Metra M et al. *J Am. Coll. Cardiol.* 1994; **24** (7): 1678-1687. 5 Packer M et al. *New Engl J. Med.* 1996; **334**: 1349-1355. 6 Bristow MR et al. *Circulation.* 1996; **94** (11): 2807-2816. 7. Colucci WS, Packer M, Bristow MR et al. *Circ.* 1996; **94** (11): 2800-2806.

Further information is available from: Roche Pharmaceuticals (Ireland) Limited, 3 Richview, Clonskeagh, Dublin 14.

