

## THERAPEUTIC UPDATE

# ASSESSING PATIENTS FOR CORONARY ARTERY BYPASS SURGERY

B L Chia  
L K A Tan

### INTRODUCTION

Coronary artery disease is today one of the most important causes of deaths in our community (1). The clinical manifestations of this disease are varied but the 3 most important presentations are (i) angina pectoris (ii) acute myocardial infarction and (iii) sudden death. Acute myocardial infarction and sudden death usually strike with little warning and those who are afflicted are frequently in the prime of their lives.

### THE HUMAN CORONARY CIRCULATION

In humans, the coronary circulation consists of the left and right coronary arteries and their branches (Fig. 1). In nearly every instance, the left coronary artery is much more important as it supplies the majority of the left ventricular myocardium. The segment of the left coronary artery from its origin to its bifurcation into the left circumflex and left anterior descending artery is termed the left main coronary artery. This is a vital segment because when it is critically narrowed, a large portion of the left ventricular myocardium is in serious jeopardy of infarction. Coronary artery disease is popularly assessed as involving either the left main coronary artery - "left main coronary stenosis" or any of the following 3 arteries occurring either singly or in combination - left anterior descending artery, left circumflex artery, and right coronary artery. The patient is diagnosed as having 1 vessel disease when one of these 3 arteries is involved, 2 vessel disease when 2 arteries are involved and 3 vessel disease when 3 arteries are involved. This classification is not entirely satisfactory. For example the significance of a proximal stenosis of a large left anterior descending artery with multiple large diagonal branches is obviously much more significant than stenosis of a small circumflex artery. However, since this classification is still widely used, it will be adhered to in this paper.

### TREATMENT OF CORONARY ARTERY DISEASE

There are broadly two main therapeutic approaches to patients suffering from coronary artery disease. The first involves the use of pharmacological agents such as beta blockers, nitrates, calcium antagonists etc and the correction of risk factors such as cigarette smoking, hypertension, lack of exercise, hypercholesterolaemia etc. The second approach is to try and improve the myocardial perfusion by revascularization, employing various surgical techniques.

University Department of Medicine (II)  
Singapore General Hospital  
Outram Road  
Singapore 0316

B L Chia, MBBS, AM, FRACP, FACC  
Professor & Head

Department of Diagnostic Radiology  
Singapore General Hospital

L K A Tan, MBBS, AM, FRCR  
Senior Radiologist

**CORONARY ARTERY BYPASS GRAFTING (CABG)**

The first attempts at myocardial revascularization were indirect techniques and consisted of sympathectomy, pericardial adhesions, vascular myocardial implants etc. None of these procedures became popular or successful until saphenous vein bypass grafting to the coronary arteries was introduced by Dr Rene Favaloro at the Cleveland Clinic in 1967 (2). In this operation, a segment of the patient's saphenous vein is used. One end of this vein is anastomosed to the aortic root and the other end to the coronary artery beyond the stenosed area. In this way, the saphenous vein functions as a conduit which allows blood to flow from the aorta to the coronary artery beyond the blocked area (Fig. 2) (3).

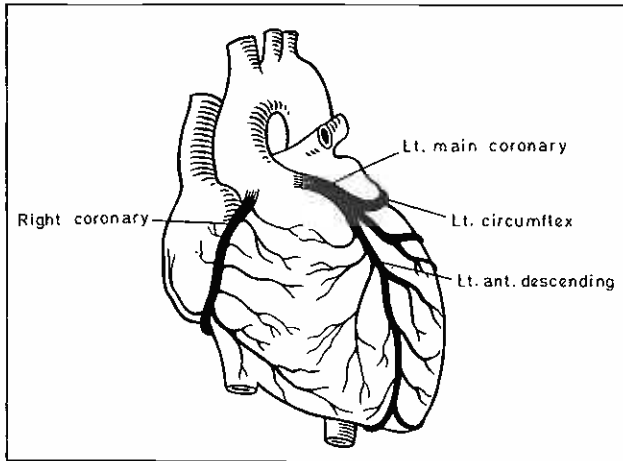


Figure 1 The human coronary circulation. Lt = left Ant = anterior

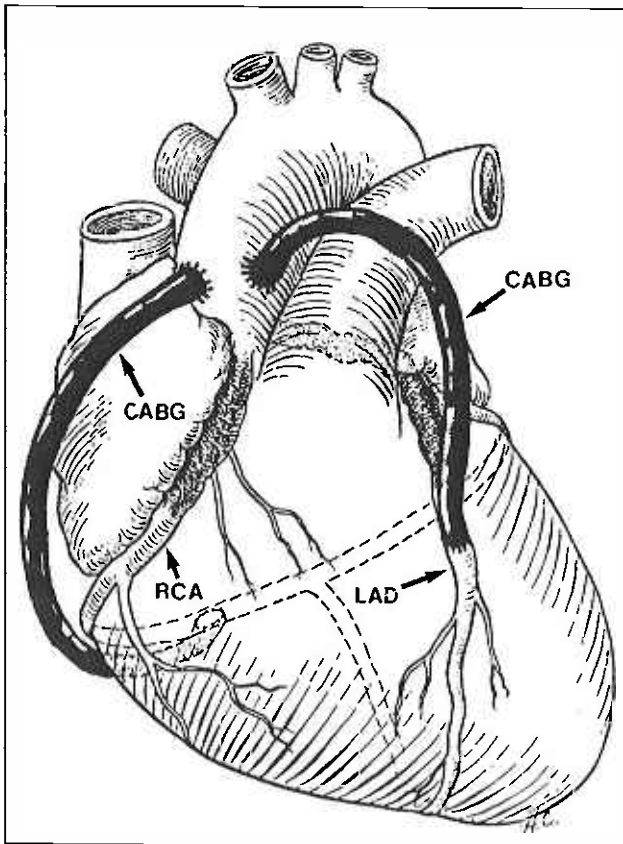


Figure 2 Diagram showing saphenous vein bypass grafting to stenosed coronary arteries. CABG = saphenous vein bypass grafts. RCA = right coronary artery. LAD = left anterior descending artery. (Modified from Guthaner and Wexler<sup>3</sup>)

Currently CABG is one of the most popular operations in the United States of America, and more than 100,000 cases are done yearly (4). Coronary artery bypass surgery began in Singapore in 1976. To date, a total of 25 cases have been performed (5). Despite this popularity, controversy still rages as to its value and its indications. One extreme view is that CABG is little better than placebo therapy and to submit patients to CABG is akin to submitting them to butchery of the heart. A dramatically opposite but equally extreme view is that CABG is God's gift to all patients suffering from coronary artery disease and is a panacea for this condition. Like all things where there are extremes of opinion, the truth probably lies somewhere in the middle. Coronary artery bypass grafting is by no means a panacea for coronary artery disease, but in certain carefully selected patients it is of considerable value in ameliorating angina and in prolonging life.

In general, the mortality of CABG in good hands is low (approximately 1-2%). About 80-90% of the grafts are patent at 1 year after operation and in these patients, the likelihood of future graft occlusion is small. A small percentage of patients (about 5%) suffer acute myocardial infarction during CABG.

**AIMS OF CORONARY ARTERY BYPASS GRAFTING**

What then are the aims of CABG? These can be briefly summarised as follows: (a) Relief of angina pectoris (b) Prolongation of life (c) Prevention of myocardial infarction (d) Improvement of myocardial function (e) Rehabilitation of the patient to his previous work and way of life.

**Relief of angina pectoris**

Coronary artery bypass grafting is today the most effective mode of treatment for relieving angina and therefore can be recommended with no reservations to patients with severe intractable angina. The threshold for labelling a patient as having intractable angina varies from physician to physician but the diagnosis should be made only after maximal medical therapy consisting of weight reduction, correction of hypertension, cessation of cigarette smoking and an adequate trial of beta blockers, nitrates and calcium antagonists.

Approximately 80 - 90% of patients with intractable angina will improve after CABG, and in some this improvement can be quite dramatic. There have been several reasons given for this improvement. The more sceptical amongst the physicians suggest that the mechanism for the alleviation of chest pain is either a placebo effect, creation of myocardial infarction, or sectioning of the pain fibres in the mediastinum. The majority however (and these includes the authors) believe that the relief of pain in most instances is indeed the result of better myocardial perfusion. In many patients, objective evidence of improved myocardial blood flow can be demonstrated. Figure 3 is the exercise stress test of one such patient. Before CABG, the patient, a 63 year old man, experienced very frequent effort angina which was unresponsive to maximal medical therapy. A treadmill exercise stress

test provoked angina and a 4 mm horizontal ST segment depression at a heart rate of 110/min. After CABG however, the patient became angina free. There was marked improvement in his treadmill exercise stress test carried out 1 month after operation which showed only junctional ST segment depression at a heart rate of 155/min. It is clear that in this patient the improvement of his angina must be due to better myocardial blood flow. Figures 4 to 7 show this patient's coronary arteriograms which were performed at the cardiovascular laboratory of the Singapore General Hospital. These demonstrated a 99% stenosis of the left main coronary artery and a complete blockage of the circumflex artery just after the origin of the first obtuse marginal branch. The left anterior descending artery was totally occluded. The right coronary artery was slightly irregular with a 75% obstruction of the mid posterior descending branch. Injection of the right coronary artery showed outlining of the circumflex and left anterior descending artery by collaterals. Saphenous vein grafting was applied with a sequential graft to the first, second and third diagonal branches and a sequential graft to the first and second marginal branches of the circumflex artery and a separate graft to the posterior descending branch of the right coronary artery. The left anterior descending artery was totally occluded and had essentially no lumen.

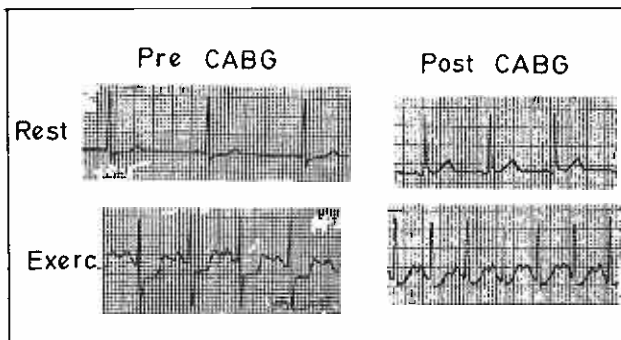


Figure 3 Treadmill exercise stress testing in a patient with critical left main coronary artery stenosis. Pre CABG = before bypass surgery. Post CABG = 1 month after bypass surgery. Exerc = during peak exercise. Before surgery, patient experienced angina and exhibited 4 mm horizontal ST depression at a heart rate of 110/min. After surgery, no angina was seen at peak exercise and only junctional ST segment depression was seen at a heart rate of 155/min.

### Prolongation of life

The greatest current controversy regarding CABG concerns whether this procedure significantly prolongs the life span of the individual. This is a vital issue because if CABG indeed prolongs the life span of patients suffering from coronary artery disease, then its indications will be enormously widened and its application must also include patients who do not suffer from intractable angina. Many studies have been carried out in the past to try and answer this very important question. Most of these trials, except for a few, were uncontrolled and the validity of their conclusions have therefore been seriously challenged. However, it has become abundantly clear in the past few years that symptomatic patients with significant

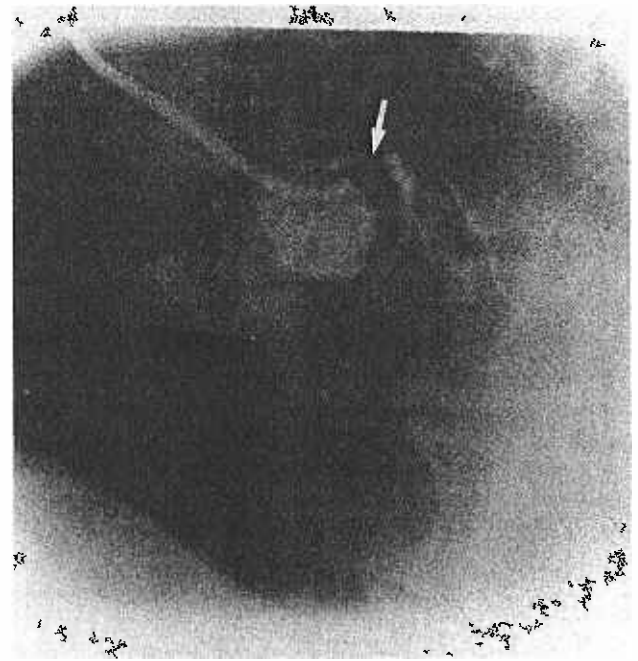


Figure 4 Left coronary angiogram done in the left anterior oblique position showing 99% stenosis of the left main coronary artery (arrow).

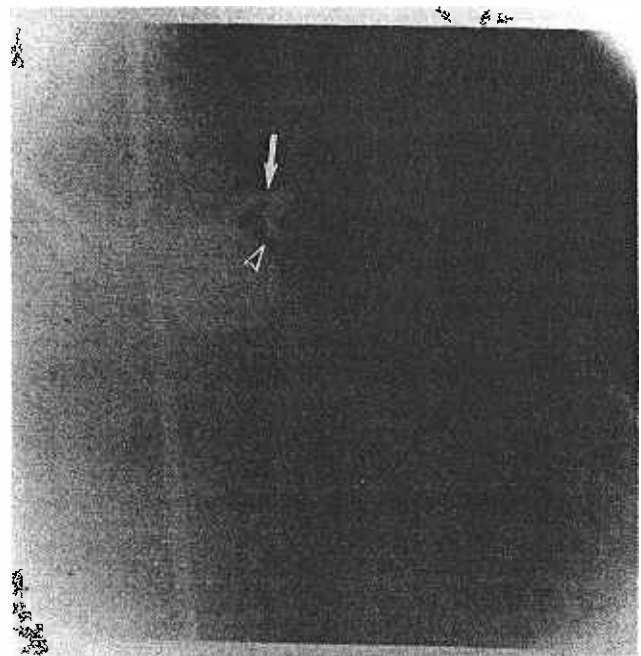


Figure 5 Left coronary angiogram done in the right anterior oblique position showing severe narrowing of the left main coronary artery just before its bifurcation (arrow). The circumflex artery is completely occluded just after the origin of the first obtuse marginal branch (arrow head).

stenoses of their left main coronary artery have much better survival rates when treated surgically (mortality about 7% per year) as compared to medical treatment (mortality about 15% per year). Left main coronary artery stenosis is a unique and life threatening situation where a large amount of myocardium is in serious jeopardy of infarction. This lesion has been popularly and appropriately termed "widow-maker's disease" because women whose husbands suffer from this condition will soon become widows unless something is done quickly. It is today generally agreed by most

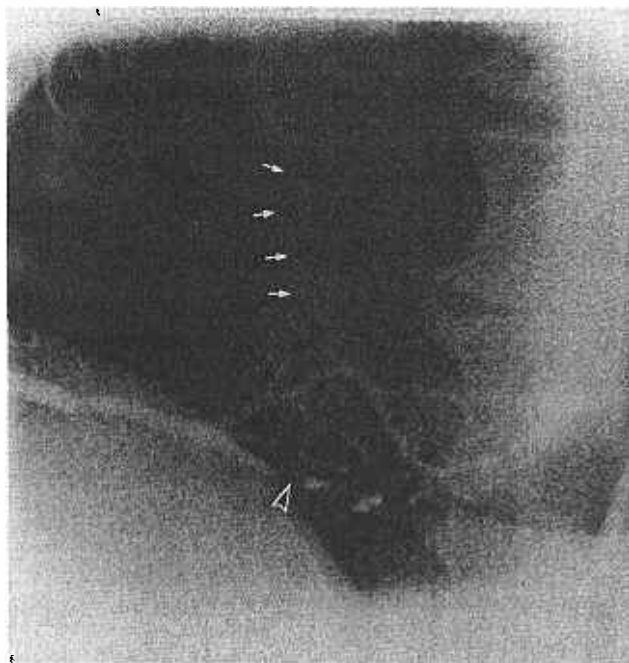


Figure 6 Right coronary angiogram in the left anterior oblique position showing an irregular right coronary artery with a 75% obstruction of the mid posterior descending branch (arrow head). The distal left anterior descending artery is filled by collateral circulation (arrows).



Figure 7 Right coronary angiogram in the right anterior oblique position showing filling of the distal circumflex artery via collaterals (arrow).

experts that such patients should undergo CABG wherever possible.

With regard to lesser degrees of coronary artery stenosis, controversy still rages. It is likely that life span is prolonged with CABG even in patients suffering from 3 vessel disease. However the beneficial effects of surgery on survival in this subset of patients is clearly less dramatic than that in left main coronary artery stenosis. In an individual situation, it is difficult to advise whether such a patient should undergo CABG or not. The decision must depend largely on the

degree of surgical expertise which is available. We believe that in situations where good surgery is available, such patients will indeed survive longer with CABG and should therefore be operated upon.

The beneficial effect of CABG on survival in patients with 2 or 1 vessel disease has not been proven and such cases are probably best treated medically except when there is intractable angina.

#### INDICATIONS FOR CORONARY ARTERIOGRAPHY

The remarkable progress of coronary bypass surgery has brought great joy to practising cardiologists and physicians but has also brought in its wake new problems in assessment of patients with coronary artery disease, in particular regarding indications for coronary arteriography. In the past, the only strong indication for CABG is intractable angina and therefore in general only such patients need be submitted for coronary arteriography to determine their suitability for surgery. The recent finding that patients with left main stenosis and three vessel disease survive longer with CABG has created new difficulties for cardiologists regarding indications for coronary arteriography. This is so because not all such patients have intractable angina. In many instances, their resting electrocardiograms are normal or show only minimal changes. Although the exercise stress test frequently shows markedly positive findings (e.g. 2 mm or more ST segment depression), this degree of abnormality may not be present in many patients. Currently, the greatest problem is that non invasive tests (and this includes nuclear cardiac imaging) are not sufficiently accurate to consistently diagnose or exclude left main or three vessel disease in many instances. One approach would of course be to perform coronary arteriography liberally in nearly all symptomatic patients with known coronary artery disease as is the practice in the Cleveland Clinic, USA. Such an approach will be ideal if coronary arteriography is a simple non invasive and also a cheap procedure. Unfortunately however, although coronary arteriography is generally safe, it carries with it a small but definite morbidity and mortality and it is also quite expensive. Today the mortality in the best overseas centres is around 0.1%. So far about 400 coronary arteriograms have been performed at the cardiovascular laboratory at the Singapore General Hospital, and there has been one death. Like in the case of CABG, the current indications for coronary arteriography vary widely from centre to centre depending largely on the personal beliefs of the doctors, the availability of expertise in coronary arteriography and in CABG and the existing socio-economic status of the country. The authors' own current indications for coronary arteriography are as follows (a) Patients with intractable angina who are potential candidates for CABG (b) Patients with symptomatic coronary artery disease who do not have intractable angina but whose stress test is markedly positive occurring particularly at low heart rates and at the early stages of the exercise stress test. The indication is even greater if there is associated hypotension during the test. (c) Patients whose exercise thallium scan indicate multiple vessel disease (d)

Patients after myocardial infarction who have continuing angina pectoris or whose exercise stress test shows ST segment depression in leads other than those of the infarction site (e) Patients with coronary artery disease younger than 40 years old (f) Patients with valvular disease who are surgical candidates and who either have chest pain or who are over the age of 50 years (g) Patients where the diagnosis of coronary artery disease is in doubt after clinical and non invasive cardiac assessment and especially when their jobs depend on freedom of cardiac disease (e.g. pilots).

The actual procedure of coronary arteriography involves selective catheterization and opacification of the left and right coronary arteries which are filmed in many projections using a cine camera. The whole of the coronary tree can therefore be clearly defined and stenosis of any artery can be identified clearly. A narrowing is considered to be haemodynamically significant only if the stenosis is 75% or greater. The calibre of the artery beyond the stenosed segment can also be assessed to see whether it is of an adequate calibre to permit grafting of a saphenous vein. A left ventriculogram to assess left ventricular function is also always done in the same sitting.

#### CONCLUSIONS

At the present state of the art, the following conclusions can be made regarding CABG (a) Despite much scepticism amongst many physicians during the early years of its development, CABG has today come of age, and is currently one of the most important modalities of treatment in certain selected patients with coronary artery disease (b) In experienced hands,

the mortality of CABG is low (1 – 2%) and the patency rate of grafts is high (80 – 90% in 1 year) (c) It is extremely effective for relieving chest pain in patients who suffer from intractable angina, which currently is the most important and least controversial indication for CABG (d) It significantly prolongs the life span of patients with left main coronary stenosis and also, although to a lesser extent, of patients with three vessel disease (e) The exact indications for CABG are difficult to define and must vary from country to country and from patient to patient, depending largely on the availability of expertise for coronary arteriography and CABG and also importantly on the socio-economic status of the country (6) Given a situation where expertise for both coronary arteriography and CABG are readily available, we believe that CABG should be offered to patients with intractable angina pectoris and also to patients with left main coronary stenosis and three vessel disease even though the latter two may not have intractable angina.

#### REFERENCES

1. Chen AJ: Recent trends in the mortality and morbidity of cardiovascular disease. *Ann Acad Med* 1980; 9: 411-45.
2. Favaloro RG, Effler DB, Groves LK, Sheldon WG, Sones FM Jr: Severe segmental obstruction of the left main coronary artery and its divisions. Surgical treatment by the saphenous vein technique. *J. Cardiovasc Surg* 1970; 60: 469-72.
3. Guthaner D, Wexler L: The radiological evaluation of patients with coronary bypass. *Curr Probl Diagn Radiol* 1976; 6: 1-40.
4. McIntosh H, Garcia J: The first decade of aortocoronary bypass grafting of 1967-1977. *Circulation* 1978; 57: 405-31.

## NOTICE

### IV TH INTERNATIONAL SYMPOSIUM ON NASOPHARYNGEAL CARCINOMA

September 27th — 29th, 1982  
Kuala Lumpur, Malaysia

Correspondence:-

Prof U Prasad  
Secretariat, NPC International Symposium  
Department of ENT  
Faculty of Medicine  
University of Malaya  
Kuala Lumpur 22-11  
Malaysia