CORONARY ARTERY BYPASS GRAFT SURGERY : WIDENED SCOPE & CURRENT EXPECTATIONS

*Mohammad Ishaq**

In 1964 DeBakey & others used Coronary Artery ByPass Graft Surgery (CABG) as a bail out procedure. Later Favoloro & others used this technique as a therapeutic procedure in the late sixties. CABG has completed almost three decade & has over the years evolved as one of the most commonly performed operation in the industrialized world. Each year more than 300,000 Americans & 25,000 British undergo this procedure. Despite the introduction of Percutaneous Transluminal Coronary Angioplasty (PTCA) over the past two decades & tremendous innovation in the realm of interventional cardiology, CABG has survived as an important therapeutic option in the management of symptomatic Coronary Artery Disease (CAD). CABG has gone through a step wise evolution in term of patient selection, operation techniques & post operative care. The duration of symptomatic relief & long term survival has improved over the years mainly due to improvements in operative techniques & post operative care. At the same time scope of cardiac surgery has expended in relation to the patient selection. The patient population undergoing CABG now include increasing number of elderly patients with poor left ventricular function, patients with associated systemic diseases & patients requiring redo operations.
PJCTS 1999;1: 28-33

This article reviews recent status of CABG in the following contents.

1). CABG in the elderly.
2). CABG vs PTCA in multivessel CAD.
3). Emergency revascularization in Cardiogenic shock.
4). Coronary revascularization following Myocardial Infarction.
5). CABG in Patients with Left Ventricular Dysfunction.
6). Redo CABG operation.

1). CABG IN THE ELDERLY.

CABG is of increasing importance in the elderly because of the higher operative risks & because of the fact that these patients usually have multivessel disease for which PTCA may not be a suitable option. A number of recent studies have examined the effect of age on the results of coronary surgery. Kow et al (1) examined the importance in the quality of life & long term survival in elderly patients undergoing CABG. The study population consisted of a group of octogenarians from a single institution who opted to have either surgery or optimal medical therapy. It was shown in the follow up that the surgical patients had more consistent relief from their symptoms & an improved quality of life compared to medically treated group. Survival was also significantly improved in the surgical group. Guadagnolic et al (2) examined health related quality of life outcome in patients over the age of 65 years. The proportion of patients reporting cardiac related symptoms after CABG did not vary with age, & the quality of life score for both group did not differ except in mental health status outcome where elderly patients reported better function then younger subjects. It is possible that the benefits in terms of survival and quality of life may be offset by the higher risk of complications and hospital mortality in elderly patients. A recent review by Mohan et al, 7(a) stroke. (3) of 21 studies of CABG in the elderly patients performed between 1973 and 1991 suggested that although elderly patients have a higher risk of complication and hospital mortality than younger patients, the risk is only modestly higher. The general trend in the studies reviewed, revealed that postoperative relief

*Address for correspondence: Mohammad Ishaq FRCP
Associate Professor of Cardiology
National Institute of Cardiovascular Diseases
Karachi

of angina , a return to outdoor activities, and an independence from hospitalization were consistent findings in the elderly. Old age, however, appears to be the most important risk factor for the development of stroke, as a recent analysis of the Coronary Artery Surgery Study (CASS) experience showed (4). The most powerful predictor of 7(a) stroke on the day of coronary bypass surgery were old age, use of alpha-adrenergic receptor drugs after bypass, and longer duration of cardiopulmonary bypass. Since old age is an independent risk factor for increased operative mortality, there may be a myocardial factor in the elderly that increases the operative risk and renders the senescent myocardium less tolerant to cardioplegia (35). There is good evidence that mitochondrial oxidative metabolism becomes less efficient with increasing age, (36). It may be that, with increasing understanding of the biochemistry of the senescent myocarduim, specific protective strategies can be developed to improve intraoperative myocardial protection in this age group. Tuman et al. (7) studied the differential effects of advanced age on neurological and cardiac risks of coronary artery operations. They found that cardiac complications, except for low output state, did not differ between age groups but that the incidence of neurological complications in patients 75 years of age and older was 8.9%, more then twice that in patients aged 65 to 74 years (3.6%), and nine times greater than in patients aged younger than 65 years (0.9%). Thus the risk of neurological complications must be borne in mind when deciding to recommend CABG in the elderly, and patients should be made aware of this.

2). CABG VS PTCA IN MULTIVESSEL DISEASE

Despite initial euphoria PTCA has failed to decrease the overall need for CABG. The main reasons being.

a) Higher Restenosis Rate
b) Unsuitable Coronary Arteries for PTCA
c) Technical Failure of the procedure.

These appear to be the main limitations in the use of PTCA for treatment of multivessel CAD. However, there is a difference in the treatment strategies of the two techniques and this accounts for the difference in long-term outcome.

Let us examine recent trials comparing PTCA and CABG in multivessel disease, the difference in revascularization strategies, and their long-term outcome. In the late 1980s, several randomized trials comparing the long-term effects of PTCA and CABG began (8), data from the Randomised Intervention Treatment of Angina (RITA) trial (9) suggest that although recovery takes longer after CABG, there is less risk of angina and fewer diagnostic and therapeutic interventions compared with PTCA. Within 2 years of random assignment, an estimated 38% of PTCA patients experienced either a further PTCA, CABG, myocardial infarction, or death, compared with an estimated 11% of the CABG group. During the mean 2.5 years of follow-up, 31% of PTCA and 7% of CABG patients have had at least one repeat coronary arteriogram. A significant excess of patients with angina greater use of antianginal drugs in the PTCA group, compared with patients undergoing CABG (61% of PTCA and 34% patients were on at least one antianginal drug at 2 years). Unstable angina was also more frequent in PTCA patients. Although there was no significant difference in strokes between the CABG and PTCA groups, arrhythmia and cardiac failure were more common in CABG patients. Overall, there was no significant difference in exercise time between the two groups, although 1 month after the procedure, the mean exercise time was significantly greater in the PTCA group. It appears from this trial that patients who have undergone CABG have better relief of symptoms and require less medication. Similarly, the preliminary results from the German Angioplasty Bypass Investigation (GABI) (10) suggested that the rate of early reinterventions was higher with PTCA. However, CABG patients appear to be at overall greater risk of mortality, before and after the procedure. It is clear that they are not equivalent procedures, and that the two populations may be different in terms of coronary artery diseases & complications. The difference in cost between the two procedures, the ease of accessibility, and the reduced length of hospital stay for patients undergoing PTCA are important considerations in determining the choice of the of procedure.

3). EMERGENCY REVASCULARIZATION IN CARDIOGENIC SHOCK

Cardiogenic shock remains the leading cause of death following acute myocardial infarction. Mortality rates for cardiogenic shock have not significantly improved despite improved monitoring, better pharmacologic agents, and the availability of intra-aortic balloon device. Attempts to improve survival have involved reperfusion of ischemic myocardium with thrombolytic agents, PTCA, or coronary surgery. The importance of patency of the infarct-related artery in the long-term survival of patients admitted with acute myocardial infarction complicated by cardiogenic shock was examined by Benegtson et al. (11) in a consecutive series of 200 patients. Patency of the infarct-related artery was the most important independent predictor of long-term survival. The majority of the patients were treated with thrombolysis or coronary angioplasty and the results suggested that an aggressive interventional approach may improve survival. Similarly, Hibbard et al (9,12) and coronary angioplasty or coronary bypass surgery improves survival in this group of patients. Previous studies of emergency coronary surgery and coronary angioplasty in cardiogenic shock were recently reviewed by Bates and Topol (14). Of the total of 216 patients from the studies reviewed who underwent coronary surgery, there was an overall mortality of 40%. Similarly, there was total mortality of 44% in a total of 386 patients who underwent coronary angioplasty for cardiogenic shock. Three recent studies examined the use of PTCA in acute myocardial infarction (15-17). Although immediate angioplasty was not more effective than thrombolysis in preserving myocardium, it was more effective in restoring patency and preventing reocclusion of the infarct-related artery (18). However, patients with three-vessel disease do not benefit as greatly from coronary angioplasty, because of unsuitable lesions and coronary surgery may be more appropriate for these patients (19). A rational approach, therefore, to the management of cardiogenic shock following infarction is coronary angiography for all patients, PTCA of coronary lesions that are amenable, and coronary surgery in patients with three-vessel disease or the presence of unsuitable lesions that are not amenable to PTCA. Although the strategy of immediate angioplasty or coronary surgery for acute infarction may have limited application because of indequate resources (18), it is perhaps the only hope of survival in this group of patients.

4). CORONARY REVASCULARIZATION FOL LOWING INFARCTION

Long-term survival after myocardial infarction may be improved by revascularization of the infarct-related artery. This improvement in survival appears to be independent of left ventricular function. Taylor et al. (20) examined 6 year survival in 192 patients after coronary and early revascularization following acute myocardial infarction. Ninety-nine patients undertook coronary bypass surgery and 18 underwent coronary angioplasty. Multivariate analysis identified a closed-infarct artery, diabetes mellitus, and anterior location of the infarction as risk factors for late cardiac death among survivors of hospitalization. These results seem to support the "open artery hypothesis", i.e, that patients with an open coronary artery have a better long-term survival. Similarly, Moliterno et al. (21) examined 200 subjects, 148 were treated medically, whereas 20 had bypass grafting and 32 had angioplasty of the infarct-related artery. Twenty-four (16%) of the patients subjected to medical therapy had cardiac related mortality, compared with only one (2%) of the patients in the revascularized group. The difference between the two groups was highly significant. This study was also limited to analysis of subjects with disease only of the infarct-related coronary artery, and patients with multivessel coronary disease were not included.

5). CABG IN PATIENTS WITH IMPAIRED LEFT VENTRICULAR FUNCTION

Imparied left ventricular function is one of the most consistent predictor of high operative risk (22). In recent years severe left ventricular dysfunction, synonymous with high operative risk, has progressively been redefined in accordance with improved operative mortality and morbidity. In the CASS registry set up in the late 1970s (23), severe left ventricular dysfunction was defined as an ejection fraction of less than 36%. In contrast, in a recent paper detailing the effects of poor left ventricular function on the results of CABG, Chrisktakes et al. (22) de-

fined poor left ventricular function as an ejection fraction less than 20%. In their study, 12,471 patients undergoing isolated coronary artery bypass grafting were divided into three groups based on preoperative left ventricular ejection fraction, greater than 40%, 20% to 40% and less than 20%. Operative mortality rates in these groups were 2.3%, 4.8% and 9.8% respectively. Similar trends were also demonstrated for postoperative complications. Despite recent advancement, the mortality in patients with severe left ventricular dysfunction undergoing CABG is still relatively high. Current attention is focused on improved screening of these patients to select those who would benefit most from CABG. The ability to identify patients with poor left ventricular function who could benefit most from bypass surgery, in preference to cardiac transplantation, offers a strong economic reason to define this group of patients more precisely. There has been much recent interest in " hibernating myocardium," i.e, areas in which revascularization could be expected to improve contractility. In 21 of 23 patients with a preoperative left ventricular ejection fraction below 45%, Carrel et al. (24) demonstrated an improvement in ejection fraction after CABG from 34% to 52% at rest and 31% to 58% during exercise. Improvement in segmental and global ejection fraction correlate well with persisting metabolic activity and abnormal perfusion by 82 Rbfluorodeoxyglucose positron-emission tomography, suggesting the presence of hibernating myocardium. Thallium perfusion scanning is widely available and positron-emission tomography is becoming so. Both enhance patient selection for CABG, particularly in patients with severe left ventricular dysfunction following myocardial infarction.

6). REDO CABG OPERATION

Redo operations constitute about 14% of all CABG surgery. During the 1980s, reoperations were considered a relatively high risk procedure (25,26). Problems encountered during reoperation include damage to the heart and patent grafts while negotiating the adhesions from the previous surgery. Atheroma in patent grafts is friable and may form emboli, thus causing perioperative infarction. Performing CABG for the second or third time in the present day is associated with increased risk compared with first time procedures (27,28). Published mortality rates for reoperation commonly range from 1.2% to 6.9% (29.30). Actual survival rates of 90.4% and 88.4% at 5 and 10 years, respectively, are achievable, as are rates of freedom from angina at the same time points of 66.6% and 34.6% (27). The rate of reoperation increases over time. In a report by Rahimtoola et al. (31), the rate for reoperation was 0.6% per year for the first 5 postoperative years and 2% per year between years 6 to 15. The absence of an IMA graft to the left anterior descending artery was a significant predictor for reoperation. With the increasing number of CABG cases performed each year, we can expect that the proportion of reoperations will be far greater in the future than the 8% to 10% currently reported (27). Some patients may require a third CABG operation. This can be performed with modestly increased mortality (7.7%) and good symptomatic relief (28). To summarize reoperation can be offered with a resonable mortality and morbidity and with good symptomatic relief and functional outcome. The duration of benefit compares favorably with that of the initial surgery.

REFERENCES

1. KOW, GOLD JP, et al. Survival analysis of octogenarian patients with coronary artery disease managed by elective coronary artery bypass surgery versus conventional medical treatment. Circulation 1992, 86 (suppl 2). II-191-II-192.
2. GUADAGNOLI E, AYANIAN JZ, et al. Comparison of patient reported outcomes after elective coronary artery bypass grafting in patients aged greater than or equal to and less than 65 years. Am J Cardiol 1992, 70. 60-64.
3. MOHAN R, AMSEL BJ, et al. Coronary artery bypass grafting in the elderly: A review of studies on patients older than 64, 69 or 74 years. Cardiology 1992, 80.215-225.
4. FRYE RL, KNONMAL R, SCHAFF et al.

Stroke in coronary artery bypass graft surgery. An analysis of the CASS experience. Int J Cardiol 1993, 36.213.221.

5. MISARE BD, KRUKENKAMP IB, et al. Age-Dependent seneitivity to unprotected cardiac ischemia: The senescent myocardium. J Thorac cardiovasc surgery 1992, 103.60-65.
6. NAGLEY P, MCKAY IR, et al. Mitochondrial DNA Mutation Associted with Aging and Degenerative Disease. Ann NY Acad Sci 1992, 673.92-102.
7. TUMAN KJ, MCCARTHY RJ, NAJAFI H, IVANKOVICH AD: Differential Effects of Advanced age on Neurologic and Cardiac Risks of Coronary Artery Operations J Thorac Cardiovascular Surgery 1992b, 104.1510-1517.
8. BARI, CABRI, EAST, GABI, and RITA. Coronary Angioplasty on Trial (Editorial). Lancet 1990,335.1315-1316.
9. RITA TRIAL PARTICIPANTS, et al. Coronary Angioplasty Versus Coronary Artery Bypass Surgery. The Randomised Intervention.
10. HAMM CW, ISCHINGER T, et al. Angioplasty vs Bypass surgery in patients with Multi-vessel disease. In Hospital outcome in the GABI Trial. Circulation 1990, 82(suppl 1)1-373.
11. BENGTSON JR, KAPLAN AJ, et al. Prognosis in Cardiogenic Shock after Acute Myocardial Infarction in the Interventional Era. J Am Coll Cardiol 1990, 20.1482-1489.
12. HIBBARD MD, HOLMES DR JR, et al. Percutaneous Transluminal Angioplasty in Patients with Cardiogenic Shock J Am Coll Cardiol 1992, 19.639-646.
13. MOOSVI AR, KHAJA F, VILLANUEVA L, et al. Early Revascularization Improves Survial in Cardiogenic Shock Complicating Acute Myocardial Infarction. J Am Coll Cardiol 1992, 19.907-914.
14. BATES ER, TOPOL EJ. Limitations of thrombolytic Therapy for Acute Myocardial Infarction Complicated by Congestive Heart Failure and Cardiogenic Shock. J Am Coll Cardiol 1991, 18.1077-1084.
15. GRINES CL, BROWNE KF, et al. A Comparison of Immediate Angioplasty with Thrombolytic Therapy for Acute Myocardial Infarction. N Engl J Med 1993, 328.673-679.
16. ZIJLSTRA F, DE BOER MJ, et al. A Comparison of Immediate Coronary Angioplasty with Intravenous Streptokinase in Acute Myocardial Infarction N Engl J Med 1993, 328.680-684.
17. GIBBONS RJ, HOLMES DR, et al. Immediate Angioplasty Compared with the Administration of a Thrombolytic Agent Followed by Conservative Treatment for Myocardial Infarction N Engl J Med 1993, 328.685-691.
18. LANGE RA, HILLIS LD et al. Immediate Angioplasty for Acute Myocardial Infarction N Engl J Med 1973, 328.726-728.
19. O'NEILL WW. Angioplasty Therapy of Cardiogenic Shock Are Randomized Trials Necessary? J Am Coll Cardiol 1992, 19.915-917.
20. TAYLOR GJ, MOSES W, et al. Six-Year Survival after Coronary Thrombolysis and early Revascularization for Acute Myocardial Infarction. Am J Cardiol 1992, 70.26-30.
21. MOLITERNO DJ, LANGE RA, et al. Does Restoration of Antegrade flow in the Infarct-Related Coronary Artery days to weeks after Myocardial Infarction Improve long-term Survival? Coronary Artery disease 1992, 3.299-304.
22. CHRISTAKIS GT, WEISEL RD, et al. Coronary Artery Bypass Grafting in patients with poor Ventricular function J Thorc Cardiovas Surg. 1992, 103.1083-1092.
23. CASS PRINCIPAL INVESTIGATORS AND THEIR ASSOCIATES: Coronary Artery Surgery Study (CASS): A Randomized Trial of Coronary Artery Bypass Surgery Survival Data. Circulation 1983, 68.939-950.
24. CARREL T, JENNI R, HAUBOLD-REEUTER S, et al. Improvement of Severly Reduced left Ventricular Function after Surgical Revascularisation in patients with Preoperative Myocardial Infarction. Eur J Cardiothoracic Surg. 1992, 6.479-484.
25. FOSTER ED, FISHER LD, et al. Comparison of Operative Mortality and Morbidity for Initial and Repeat Coronary Artery Bypass Grafting. The Coronary Artery Surgery Study (CASS) Registry Experience. Ann Thorac Surg 1984, 38.563-570.
26. OSAKA S, OZDOGAN E, el al. Early and Late Results of Reoperation for Coronary Artery Disease. A 13 year Experience. Aust N Z J surg 1988, 58.573-541.

27. AKL ES, OZDOGAN E, et al. Early and Long-term Results of Reoperation for Coronary Artery Disease. Br Heart J 19923, 68.176-180.
28. MEFFIL WH, ELKINS CC, et al. Third-Time Coronary Artery Bypass Grafting: Mid-term Results. Ann Thorac surg 1993, 55.582-585.
29. HORTON DA, HICKS RG: Reoperation for Recurrent Coronary Artery Disease: A Ten year Experience. Ausrt N Z J Med 1992, 22.364-368.
30. SALOMON NW, PAGE US, et al. Reoperation Coronary Surgery. J Thorac Cardiovasc surg 1990, 100.250-260.
31. RAHIMTOOLA SH, FESSLER CL, et al. Survival 15 to 20 years after Coronary Bypass Surgery for Angina. J Am Coll Cardiol 1993, 21.151-157.