Review Article: Coronary Revascularization

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Abstract:

Coronary revascularization with prospects to improve both quality and duration of life is rapidly expanding and one of the most frequently used procedures in modern medical practice. Coronary artery by pass graft (CABG) is the most rewarding procedure for high risk patients with stable coronary syndrome (those with significant left main coronary artery disease (LMCA), LV dysfunction, three vessel disease (3VD) and those with proximal lesions of the left anterior descending artery (LAD) with percutaneous coronary intervention (PCI) using drug eluting stent [DES] as an alternative procedure. The current SYNRAX study is comparing CABG and DES in such groups of patients.

PCI is a life saving procedure in patients with acute ST elevation myocardial infarction (STEMI).

In other subsets of patients both procedures may be equally effective to improve the patient's symptoms, with PCI being less invasive and readily available.

There is a recent interest in hybrid procedures in multi vessel disease with minimally invasive surgery for the LAD and PCI for other lesions.

The rapid developments in PCI, CABG and adjuvant medications make any recommendations and guidelines on the move and alert the practicing clinicians to maintain a breast of current literature and to perceive the change.

Key words: Coronary artery bypass graft (CABG), percutaneous coronary intervention (PCI)

Historic Background

The methods currently involved in coronary revascularization are coronary bypass grafting surgery and catheter based modalities. The first selective coronary angiography was done by Sones in 1959[1]. Pre-shaped selective right and left coronary catheter was introduced in 1967[2]. Coronary artery bypass graft (CABG) was first used in 1964. The use of internal mammary artery (IMA) graft was pioneered in 1967[3, 4].

After more than a decade of CABG, percutaneous coronary intervention (PCI) was first performed[5]. The advent of PCI may have blunted the growth of CABG and it out numbers CABG by a factor of 2-4[5-7].

Overview of CABG and PCI

CABG is one of the most frequently performed operations. Grafts are either arterial or venous conduits. Arterial conduit is commonly taken from the left internal mammary artery (LIMA), it appears to have immunity from hyperplasia and less liability for atherosclerosis which is usually formed in the venous conduits[6, 7]. The arterial grafts are mainly for the left coronary system preferably to the left anterior descending (LAD) or the diagonal[7] where as the venous conduits, which are commonly taken from the saphenous vein are carried out for the distal branches on the right or left coronary tree.

Renewed interest in coronary bypass grafting without cardiopulmonary bypass i.e. the off pump coronary bypass on a beating heart is gaining encouragement in order to avoid blood transfusion, economically to reduce the cost and avoid the damaging neurological effect of cardiopulmonary bypass in the elderly. It is also attractive and has encouraging preliminary results in patients with heavily calcified aorta, for multi-vessel grafting and for those with diffuse atherosclerosis[8, 9].

Recent advances include minimally invasive surgery for grafting LIMA to the LAD, e.g. minimally invasive direct coronary artery bypass [MINCAB] and totally endoscopic coronary artery bypass (TECAB)[10, 11].

PCI was initially advocated for symptomatic relief in patients with stable angina who had single vessel disease and favorable lesion morphology. The original ACC/AHA criteria had grouped the lesions as A, B and C with higher successful rates and low complications in group A (Tab 1). The original procedure was by means of balloon angioplasty (PTCA) which achieved good results in about 70% of the cases with two major problems, acute closure[due to dissection or acute thrombosis] and the late restenosis. Stents which were originally introduced as bail out procedure for acute closure following balloon angioplasty with very good results, have now become a default catheter based strategy for revascularization[12], as they also lessened the rate of repeat revascularization due to late restenosis but still in stent restenosis (ISR) (which is almost in all cases due to neo-intimal proliferation within the axial stent length) is a limiting problem for liberal usage of PCI[13]. The development of drug eluted stents (DES) had achieved more better results regarding ISR but revealed the major problem associated with stents i.e. the late in stent thrombosis (IST) (especially after the

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discontinuation of clopidogrel treatment), which is fatal in about 50% of cases. This problem is a cross road point in the use of stents and currently it is an area of intensive research, with bio tents under focus and reflects the struggle to overcome the challenges and keep PCI on the move [14, 15].

The practice of interventional cardiology has changed radically during the last 10 years with more inclination towards PCI procedures following the wide spread use of stents, the introduction of the new platelet inhibitors (GPIIb/IIIa) and the development of other devices like Rot ablator and atherectomy[16].

A real break thorough was the inclusion of ST elevation MI (STEMI), for which PCI is a life saving procedure and of proven prognostic value. It may be done as a primary (direct) angioplasty following acute myocardial infarction, where it had been found to be associated with high patency rate of the infarct related vessel compared with thrombolysis and significant reduction in total and hemorrhagic stroke, with shorter length of hospital stay and reduced cost. It may also be done as a rescue procedure for failed thrombolysis, as adjuvant therapy to thrombolysis (facilitated) or as strategy in the sub acute period (2-7days) in patients who didn't receive thrombolysis[17-19].

Summary of indication for revascularization:

Depending on the clinical data; the patient's general condition and co- morbidities, symptoms, LV dysfunction and the angiographic data; the number and type of vessels involved and the characteristics of the lesion (table 1) plus the logistics, patient preference and the local resources and experience, the following guide lines for both prognostic and symptomatic revascularization were established (table 2) [20].

1- Regardless of the severity of the symptoms, patients with significant left main CAD, patients with LV dysfunction, patients with three vessel disease and those with proximal left anterior descending artery (LAD) may benefit from revascularization from a prognostic point of view[21].
2- Symptomatic patients with single or two vessel disease despite optimal medical therapy.
3- Patients with moderate to severe ischemic symptoms who are dissatisfied with medical therapy.
4- The role of revascularization in patients whose dominant clinical picture is heart failure without severe angina is less well defined, but should be considered in patients who also have evidence of severe ischemia

The choice between PTCA and CABG:

1- Single vessel disease:

The result of the trials which compared PTCA and CABG revealed that both are highly effective in preventing symptoms, but they did not change the mortality. However, the cost in long term is high with PTCA due to a relatively higher rate of re-interventions. In spite of that, if the lesion is suitable, PCI is generally preferred over bypass surgery[22, 23].

2- Multi-vessel disease:

Many trials[24] had shown that CABG is initially associated with greater improvement in angina. Repeat revascularizations are more frequent after PTCA, although the use of stents may reduce the need for that.

Provided that the LV function is preserved with multi-vessel disease (with suitable lesions), PCI is reasonable as initial procedure.

Patients with left ventricular dysfunction and multi-vessel disease the advantage of CABG over PCI is complete revascularization.

a) In patients with borderline (mild) LV dysfunction (EF% >40-<50%) and single vessel disease PCI may provide adequate revascularization.

3- Patient with diabetes mellitus:

In ARTS trial; one year mortality in diabetics who received PCI and stenting was double of those under going CABG[25]. In general revascularization strategy for diabetic patient should be based on the number of vessel diseased, type of lesion, the caliper of the distal vessel, the presence or absences of LV dysfunction and the related technical factors.

4- The great enthusiasm in drug eluted stents had led to creeping up of PCI over CABG in complex subsets of patients e.g. patients with multi-vessel or LMCA disease. The SYNTAX trail was designed to compare the results of DES and CABG in such type of patients and had divided them into three groups, those who are eligible for both treatment options are randomized between them while patients who are eligible for only one treatment option were enrolled in the registry tracked for it. The trial is in progress but the growing up problem of in stent thrombosis may throw shades on it.
5- There is a recent interest in Hybrid procedures for multi-vessel disease involving the proximal LAD with minimally invasive surgery to graft LIMA to the LAD and PCI to other lesions.

Adjunct medications for PCI

Dual anti-platelet therapy with aspirin and clopidogrel is the default strategy for patients going for PCI (CREDO trial). Usually the patient will be already on aspirin which is recommended to continue for life while clopidogrel is initiated pre procedural (at least 2hrs with a high loading dose) but the duration of treatment is under research. Initially it was started for 3 months but with the problem of late ISR (especially with DES), it has been extended to one year which is the current policy

Unfractionated heparin (UFH) is the default drug during PCI, while glycoprotein (GPIIb/ IIIa) receptors antagonists are recommended in high risk NSTE-ACS (Tab2). Recently, Has and REPLACE-2 trials concluded that the direct thrombin inhibitor bivalirudin is as effective as the combination of heparin and GP 11b and 111a inhibitors in preventing ischaemic complications but has a lower risk for major bleeding[20,26-28].

Conclusion

The current guidelines are in favor of CABG to improve symptoms and prognosis in patients with poor prognostic markers i.e. patients with LMCA, 3VD involving proximal LAD, LV dysfunction and diabetics with PCI as an alternative while for other subtypes of patients PCI may be a reasonable initial procedure. The problem of acute closure following PCI was largely solved by the use of stents but the problems of late in stent restenosis or thrombosis are still awaiting new developments in stent technology. The surgical trends are in favor of off pump and mini invasive surgery while hybrid procedures are promising new comers..

The rapid developments in PCI and CABG, as well as adjunct medications have generated the need for large randomized clinical trails comparing the different treatment options in different subsets of patients and validating the value of the new devices and techniques and led to the integration of the medical practice, research and industry which became a leading area for evidence bases medicine [EBM] and made the revascularization issue on the move which mandate the need for regular revision and updating of these guidelines.

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