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Review Article

A review on percutaneous coronary intervention vs. coronary artery bypass graft surgery.

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Introduction

A practicing physician of the new millennium should have some knowledge of the evidence-based medicine. There are numerous randomized trials on percutaneous coronary intervention (PCI) and coronary artery bypass graft surgery (CABG). These studies carried out in the reputed institutions of different parts of the world give us some ideas about the present position of these very expensive interventions. Almost all the patients are made to believe that they get rid of their disease completely. Most of the physicians know very well that this is not true. In this review article, the known facts about the revascularisation procedures will be discussed.

Coronary artery disease is the number one killer in the western world. Out of the top ten non-communicable diseases of Nepal, coronary artery disease ranks fourth in number[1]. Over 1.5 million percutaneous revascularisation procedures are performed worldwide [2]. The facility of doing percutaneous transluminal coronary angioplasty (PTCA) is now available in Nepal. Unfortunately most of the patients needing it cannot afford. The more experienced the cardiologist in doing angioplasty; the better will be the result of PTCA. The minimum annual number of PTCA recommended to maintain competence in the United Kingdom is 60[3].

Why patients prefer PCI?

Most of the patients with coronary disease are afraid of dying suddenly. Their fear of death is made more convincing by the cardiologist. After having studied the various trials on PCI and CABG, we should find out how much one is benefited by these interventions in the long run. The desire of living long is so great that affording patients undergo intervention without any hesitation. Compared to CABG, PTCA is less expensive and invasive. Therefore the patients prefer it.

What happens after PCI?

Stretch of the coronary artery in a stent is a major contributor to neointima formation. [4] Balloon inflation produces circumferential and longitudinal splits in the plaque. The combination of endothelial damage and severe coronary stenosis induces cyclic coronary flow variations due to platelet aggregates. Repetitive coronary microembolisation following PTCA may be responsible for chronic heart failure, and increased atrial natriuretic peptide factor (ANF). [5] Normal B type natriuretic peptide (BNP) is a very effective way of ruling out heart failure or left ventricular systolic dysfunction[6].

Sphingosine is believed to be responsible for myocardial dysfunction. Saphenous vein grafts thrombus are much larger and more friable with very high risk of distal embolisation after PCI.[7] Intravascular ultrasound (IVUS) guided coronary intervention has been shown to improve long term out come[8].

After coronary angioplasty for acute myocardial infarction, Thrombolysis In Myocardial infarction (TIMI) 0-2 grade coronary flow is associated with more complications compared with TIMI 3 grade flow. TIMI grade 0 refers to no distal ante grade vessel opacification, grade 1 means minimal distal flow, grade 2 partial perfusion and grade 3 complete reperfusion.

Angiographic no-reflow is defined as TIMI grade flow of less than 3 grades. No-reflow phenomenon can also be studied by contrast myocardial echocardiography.[9] Despite successful recanalisation, PCI induced distal microembolisation may lead to inadequate myocardial perfusion. This is known as no reflow phenomenon.[10] Because of the preferential streaming of micro emboli to well perfused and viable myocardium, microembolisation kills potentially salvageable myocardium. Infarclets, inflammation and LV dysfunction resulting from microembolisation in unstable as well as stable angina causes arrhythmias.

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Different kinds of treatment like intra-coronary urokinase, extraction coronary atherectomy, angiojet rapid thrombetomy, ultrasound thrombolysis and laser angioplasty have been tried with no significant reduction in distal embolisation.

Abciximab, (Reopro) is a monoclonal antibody, which binds with glycoprotein receptors. Evaluation of 7E3 for the prevention of ischaemic complications (EPIC), Evaluation in PTCA to improve Long term outcome with abciximab Glycoprotein 11b/111a blockade (EPILOG), Evaluation of platelet 11b/111a inhibitor for stenting (EPISTENT), Abciximab before Direct Angioplasty and stenting in Myocardial Infarction Regarding Acute and Long term follow up (ADMIRAL), and C7E3 Fab Antiplatelet Therapy in unstable Refractory Angina (CAPTURE) trials have revealed beneficial effect of abciximab in patients undergoing PCI. [11] Thrombocytopenia is a known side effect of abciximab therapy in 0.4 – 1.1 % of patients.

Use of beta-blockers, Glycoprotein IIb/IIIa receptor inhibitors and statins have been found to be effective in the prevention of peri-interventional myocardial infarction[12,13]. Intravenous Glycoprotein IIb/IIIa inhibitors like Eptifibatide, Tirofiban, and Laifiban have proven effective adjunct therapy during PCI[14,15]. Oral Glycoprotein 11b/111a inhibitors like Xemilofiban, Sibrafiban, and Fradafiban have been found to have no role in PCI.[11] Balloon occlusion devices with or without filter have been tried in some centers. AngioGuard device consists of an angioplasty guide wire with an expandable porous filter at the distal tip. Saphenous Vein graft Angioplasty Free of Emboli Randomized trial (SAFER) conducted in USA at 47 sites has shown encouraging results.

Both aspirin and Clopidogrel are very useful antiplatelet agents in the prevention of coronary artery disease. Cyclooxygenase transforms arachidonic acid to thromboxane A2 and in the vascular wall to prostacycline. Aspirin inhibits cyclooxygenase and thus prevents the formation of Thromboxane A2, which is known to increase platelet adhesion. Low dose aspirin is supposed to inhibit Thromboxane A2 without affecting Prostacycline and prevent platelet aggregation. Oral clopidagrol, which inhibits the platelet ADP receptor, should also be given in acute coronary syndrome (Cure study – Clopidagrol in Unstable angina to prevent Recurrent Events trial).

Andreas R. Gruentzig
(1939-1985)

What is the present position of restenosis?

In September 1977, in Zurich Switzerland, Gruentzig performed the first coronary angioplasty on an awake human. With ballon angioplasty the incidence of restenosis was high[16]. With the onset of stenting it has decreased due to avoidance of elastic recoil of vessel and vessel wall remodeling. Still 10-30 % selected patients develop in-stent stenosis (ISS) due to neointimal proliferation. The incidence of early occlusion at target site has been reduced by more frequent use of glycoprotein IIa/IIIb receptor antagonist[11]. The use of these agents has been shown to reduce periprocedural events, particularly in high risk lesion where in stent stenosis was described to be up to 59 %.[17,18] Total occlusion, saphenous vein graft, coronary artery lesion in diabetic patients and small vessel disease are considered high-risk lesions[15]. The use of Rapamycin[19,20,21], Paclitaxel and Brachytherapy [22,23] has further reduced the incidence of in-stent stenosis. With drug eluting stent, the incidence of in-stent stenosis has been reduced to 0-9 % at 6 and 12 months [19] in insurance sales man with severe angina pectoris. Now this procedure has become so popular all over the world that cardio-thoracic surgeon may not get opportunity to perform coronary artery bypass graft surgery in future. The first clinical application of the Rapamycin coated (serolimus) stent was performed in SaoPaulo and Rotterdam. Rapamycin binds to immunophyllins. It also interacts with mammalian target of Rapamycin (mTOR) and inhibits its activation. The inhibition of mTOR suppresses T cell proliferation. Proliferation and migration of smooth muscle cells are also prevented.[19] A raised pre-procedural WBC count in patients undergoing PCI is associated with an increased risk of long term death[24].

R.G Favaloro
(1923-2000)

Cardiopulmonary bypass (CPB) was introduced by R.G Favaloro in 1967.[25] He was the first person to describe the use of saphenous vein to bypass a diseased coronary artery in 1969.[26] Initially internal mammary artery was implanted into the cardiac muscles – the Vineberg procedure.[25] Minimally invasive direct coronary artery bypass (MIDCAB) and Hybrid procedures are becoming more popular in the recent years. Minimally invasive refers to surgery on beating heart with smaller sternal incision without the use of bypass.[27] PTCA with stenting and MIDCAB procedures are combined in the Hybrid procedures. Off-pump bypass surgery does not produce cerebral embolisation and is becoming popular.[25] Higher the risk of operation, greater is the benefit of surgery over medical treatment. In left main coronary artery disease, survival rate of medically treated patients has been described by Dacosta and associates to be around 50 % after three years, with a 19 % annual mortality rate.[28] In surgically treated patients with left main coronary artery disease five year survival has been reported to be 86.8 % with early post operative mortality rate of 4.7 %[29].

Patients with left main stem of more than 50 % stenosis, significant proximal stenosis of the three major coronary arteries and presence of impaired left ventricular function have better prognosis with surgery. Surgery is also known to produce better result in diabetic patients. Mortality in diabetic patients assigned to PCI and stenting has been found to be twice as high as among those assigned to undergo CABG. The patency rate of vein graft is around 50 % at 10 years.[28] Over 90 % of internal mammary artery grafts continue to function at 15 years. In patients with high grade lesions of left anterior descending artery, both minimally invasive surgery and stenting are effective. Stenting yields excellent results with fewer periprocedural adverse events but surgery is superior with regard to the need of repeated intervention in target vessel and freedom from angina at 6 months[27].

Bypass Angioplasty Revascularisation Investigation (BARI), Coronary Angioplasty versus Bypass Revascularisation Investigation (CABRI) Randomised Intervention Treatment of Angina-RITA and Artery Revascularisation Strategy Study-ARTS have shown no significant difference Between PCI and CABG group of patients as far as the long-term survival is concerned.

Conclusions

The recent advances in cardiovascular medicine are beyond our imagination. Very expensive modalities of treatment requiring highly specialized training are now available. A good physician should give importance not only to anatomical indication for interventions but also consider many more things including the socio-economic condition and wish of the patients and their relatives before advising revascularisation procedures. Patients and relatives should be briefed about the long-term benefit and cost of the procedures. CABG is still the treatment of choice in left main stem coronary artery disease and diabetic patients.

Those patients not willing to undergo revascularisation procedures should be encouraged to change life style and take regular medicine. The Almighty God already fixes the fate of every human being. Patients with coronary disease are no exception. They can live a very long and useful life even without revascularisation procedures provided they change their life style.

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