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Review Article

Off-pump coronary artery bypass grafting in India

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ABSTRACT

Off-pump Coronary Artery Bypass Grafting (OPCAB) is the latest innovation in cardiac surgery. However OPCAB is not adopted universally. Even there have been suggestions of abandoning OPCAB in a special report. In India, OPCAB has been successfully adopted across the board. There are various evidences which favor OPCAB and are discussed in this review. The purpose of this review is to put forward the perspective of the OPCAB surgeons of our country and critically look at the suggestion of abandoning OPCAB.

1. Introduction

Off-pump coronary artery bypass grafting (OPCAB) continues to flourish in India. There are concerns about the long-term results of this procedure and this has led to poor acceptance of this technique in North America. In North America it peaked to 25% and there has been a steady decline after that. There have been suggestions that OPCAB should be abandoned as it made surgeons lose their focus as regards to surgical revascularization.[1]

We, surgeons of India, continue to evolve the technique of OPCAB. Many of us had adopted this technique after starting practice with on pump coronary artery bypass grafting (ONCAB). Newer generations of surgeons have successfully adopted this technique right from the beginning of their career. In a country with limited resources and very poor health insurance cover, it is commendable and praiseworthy that surgeons have successfully innovated the technique of OPCAB which reduces the cost of CABG. This suits the need of the underprivileged population of the country suffering from an epidemic of coronary artery disease. However our colleagues from privileged parts of the world have been reluctant to adopt this technique.

The purpose of this review is to put forward the perspective of the OPCAB surgeons of our country and critically look at the suggestion of abandoning OPCAB.

2. OPCAB and conversion to ONCAB

Rate of OPCAB conversion to ONCAB is inversely proportional to the surgeons experience and OPCAB volume in a center. One can argue that many of these conversions are attributable to the panic reaction of inexperienced surgeons. We reported that near zero OPCAB conversion to ONCAB in unselected consecutive patients can be achieved by following a standardized protocol for hemodynamic stability and by judicious

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use of intra-aortic balloon pump (IABP) rather than ONCAB.[2] Similar protocol is reported from other parts of India.[3] Surgeons in our country including the author are routinely performing OPCAB with MI <24 h, critical left main disease, poor left ventricular ejection fraction, dilated heart, ischemic mitral regurgitation and reoperative CABG. It is universal practice in India to use IABP for hemodynamic compromise refractory to inotropic therapy. Conversion is reserved for intractable ventricular arrhythmia refractory to IABP, medical therapy, multiple shocks and corrections of precipitating factors, if any. Moreover there are no studies of timely use of inotropic therapy and IABP on rate of conversion of OPCAB to ONCAB.

Majority of the surgeons practicing OPCABs have not converted to ONCAB for years.[4] Similar results have been reported by our younger colleagues who have learned OPCAB from us. This shows that very low rate of OPCAB conversion can be easily achieved by change of mindset. OPCAB conversion is history and cannot be used as a point against OPCAB.

3. OPCAB and graft patency

Randomized controlled studies BHACAS[5] and SMART[6] have conclusively proven that OPCAB and ONCAB have similar graft patency. Multicenter CORONARY[7] showed similar result at 1 year in spite of high OPCAB to ONCAB conversion rate (7.9%). This results are not duplicated in ROOBY trial[8] which has 12.4% OPCAB conversion rate. Such high conversion rate proves the inexperience of the OPCAB surgeon and this explains the lower graft patency.

Graft patency is dependent on many factors. Surgeon dependent factors will be how gently the conduit is handled and harvested, anastomosis technique and various other technical factors. All these will not vary for a particular surgeon because his basic technique will remain the same in both OPCAB and ONCAB. SMART[6] has conclusively proven that when performed by the same surgeon there were no differences in the long term graft patency. If OPCAB was inferior, it would have been reflected in the SMART trial. But in a very biased review,[1] it was concluded that OPCAB by an expert did not demonstrate superiority of OPCAB. It will be pertinent to argue, if one surgeon in the United States has been able to achieve OPCAB results comparable to ONCAB then why is the rest of the community not following? Is it inability to retrain or relearn? Majority of the OPCAB surgeons in India did observe very few OPCAB in their training period. But they have been able to retrain themselves in this technique. It may be argued it is the technique and experience of the surgeon that determines graft patency rather than OPCAB or ONCAB. So inferior graft patency rate cannot be a valid argument against OPCAB.

4. OPCAB and complete revascularization

There are concerns about complete revascularization during OPCAB. It is noted in SMART[6] trial that complete revascularization is possible during OPCAB. Earlier revascularization of posterolateral and inferior vessels used to be considered difficult. But with refinement of the technique these vessels are routinely grafted during OPCAB. Actually, grafting these vessels are easier during OPCAB as no assistance is required to retract the heart like in ONCAB.

We have reported average of 4.18 grafts per patient and 71.1% patients received 4 or more grafts.[2] The author had successfully performed upto 9 grafts in a patient with diffuse coronary artery disease. We feel that in absence of the stress of increasing aortic cross clamp time or cardiopulmonary bypass time, complete revascularization is performed more often than not. This is particularly true in patients with small vessels and diffuse coronary artery disease. We sometimes even have to cut across severely diseased segment and perform a long anastomosis using on-lay patch technique. The methodology of this is well documented in literature[3] but still has been ignored by our colleagues from United States. It is common sense that a long anastomosis will increase the cardiopulmonary bypass and clamp time and deter surgeons from performing complete revascularization. With off-pump my personal threshold for sequentially grafting the LAD has become low—for distal LAD disease we are using sequential LIMA to graft mid and distal LAD while the ONCAB surgeons are inclined to leave the distal LAD disease to medical management.

Same argument will hold for deep intra-myocardial coronary artery and small sized coronary vessel. If a deep intra-myocardial vessel is not visible easily, during ONCAB one will be inclined not to graft that vessel. But during OPCAB we can search the vessel and if required relook at the angiography in the middle of the surgery. This luxury is not available during ONCAB. Innovative techniques[9] reported from our country to tackle intra-myocardial arteries are often ignored by our western colleagues. The author feels that marsupialization can be performed during OPCAB as there is no stress of increasing pump time.

However the rare cases of intracavitory coronary artery cannot be grafted during OPCAB. So presence of intracavitary coronary artery is a contraindication to OPCAB.

Diffuse CAD is prevalent in our part of the world particularly in young patients.[3] The spectrum of diffuse CAD which we have to treat frequently in our part of the world will often be labeled inoperable elsewhere. Various innovative techniques have been developed like on-lay patch plasty of distal disease which is routinely practiced by many OPCAB surgeons. Performing comparable revascularization during ONCAB will result in longer bypass and ischemic time. Coronary endarterectomy can be easily performed if required, during OPCAB. Fig. 1 shows a specimen removed from LAD of a very young patient with excellent early result (Fig. 2 and Fig. 3). It is not infrequent to find a patient who requires multiple endarterectomies to be performed (Fig. 4) and it has been found out it is easier to perform coronary endarterectomy during OPCAB.

Lateral wall revascularization difficulty during OPCAB is history. We are routinely revascularizing lateral wall vessels without any hemodynamic instability. Even ramus intermedius near AV groove can be easily grafted. Patients with dilated heart and poor ventricle benefit most from OPCAB and these are routinely performed in our country.

Re-operative CABG is not a contraindication to OPCAB even in presence of low EF. This is adopted universally by the

Fig. 1 – Atheroma removed from LAD during OPCAB.

surgeons in our part of the world. Present Prime Minister of India underwent redo CABG using off-pump technique (first CABG was done outside India several years back.) This proves a point in favor of the advanced level of refinement of the OPCAB technique in our country.

5. OPCAB and stroke

It is now well established that avoiding cardiopulmonary bypass is not enough to avoid stroke after CABG. All recent trials had conclusively proven that stroke is a major drawback of CABG when compared with PCI. Stroke is probably the most devastating complication after CABG and in an otherwise healthy patient can be worse than dying. OPCAB with aortic-no-touch can drastically reduce the incidence of stoke.[10]

6. OPCAB and arterial graft

There is conclusive evidence that bilateral IMA is superior to single IMA.[10,11] OPCAB with LIMA-RIMA y graft is widely practiced in India. This technique has been pioneered by Dr

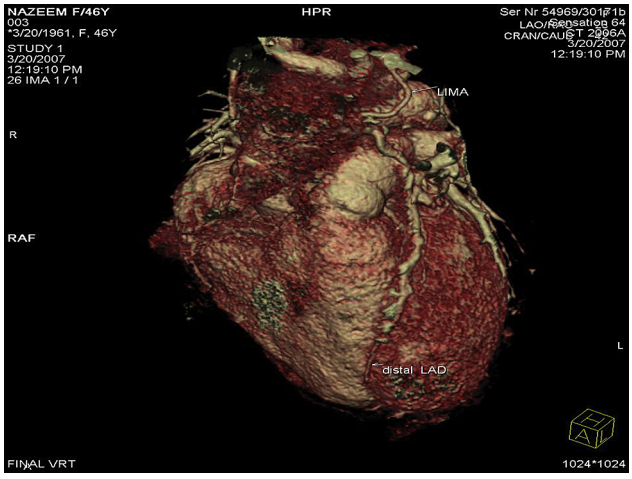

Fig. 2 – CT coronary angio followup showing patent LIMA to LAD.

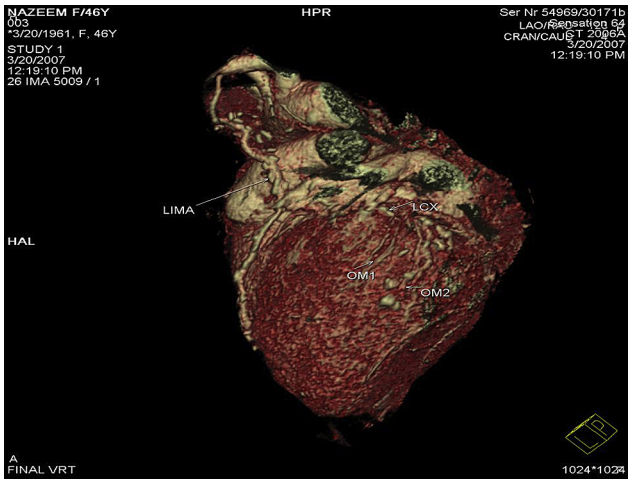

Fig. 3 – CT coronary angio followup showing patent LIMA to LAD.

Sudhanshu Bhattacharia from Mumbai and has been successfully used by him. His results in OPCAB with bilateral IMA have become a bench mark in India for all OPCAB surgeons to emulate.

We have reported a simple technique of OPCAB with aortic-no-touch[12,13] which is technically less demanding and easily reproducible. IMA has best patency rate and OPCAB with aortic-no-touch which also has least incidence of stroke could be considered theoretically the best surgical revascularization.

7. Medical therapy after OPCAB

OPCAB like any other major surgery produces hypercoagulable state which may affect graft patency. In ONCAB, cardiopulmonary bypass induced coagulopathy provides some protection against graft thrombosis. The trials showing inferior graft patency after OPCAB may have resulted from any

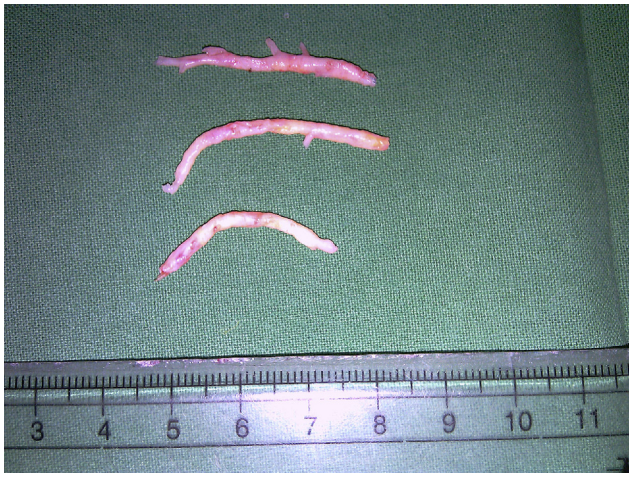

Fig. 4 – Three coronary endarterectomy performed in a 39-year-old on beating heart.

one or combinations of the following medical factors other than deficient surgical technique

a) delayed or absent potent antiplatelet therapy after OPCAB
b) hypercoaguable state induced by OPCAB (like any major surgery)
c) absence of protective effect of coagulopathy induced by cardiopulmonary bypass.

Recent meta-analysis suggests dual antiplatelet therapy improves graft patency[14] after CABG. This meta-analysis analysed 5 randomized controlled trials and 6 observational studies involving 25728 patients. The conclusion of the meta-analysis:

Early SVG occlusion rate was reduced with dual antiplatelet ($p = 0.02$).

In-hospital 30 day mortality was lower with aspirin and clopidogrel ($p < 0.0001$).

In a pooled analysis of studies involving off-pump CABG compared to aspirin alone, dual antiplatelet therapy reduced the risk of perioperative myocardial infarction and saphenous graft occlusion by 68% (47%–71%) and 55% (2%–79%) respectively.

Randomized controlled trial[15] concluded that clopidogrel plus aspirin is beneficial after OPCAB. It has been our practice to use clopidogrel early after OPCAB to improve graft patency. In patients with small vessels, diffuse distal disease or where coronary endarterectomy has been performed, clopidogrel may be started as early as 2 h. As a personal preference, starting of aspirin is delayed for few days to avoid gastric intolerance. The author has been using dual antiplatelet therapy for almost a decade and strongly advocates this after OPCAB.

According to current guidelines, dual antiplatelet therapy (DAPT) that includes aspirin and clopidogrel are recommended after percutaneous coronary intervention (PCI). It has been proven to be safe. Post CABG, in the hospital set up, it is safer as patients are well monitored and any bleeding can be easily detected. In our country, vessels are smaller & diffusely diseased and they are more prone to occlusion in hypercoagulable state. There is no apparent downside of giving the OPCAB patients dual antiplatelet therapy.

8. OPCAB and cost

There is no study in our country comparing cost of OPCAB and ONCAB but the Canadian registry shows lower cost of OPCAB.[16] Cost is a major factor in India particularly when a large number of people have to pay for their treatment in absence of government funded healthcare. CABG is often offered as a package in our country – but almost all hospitals put a limit on the cost of medicines and consumables permitted in the package. The cost of oxygenator, tubing pack, cannulae and sutures that are used during ONCAB are billed to the patient. Whereas in OPCAB the stabilizer that is used can be reused after ETO sterilization[4] and the price is divided among a number of patients usually 10 (range is 5–25 depending on the hospital). Moreover there are additional savings because of shorter ICU stay and ventilation along with lower blood and blood product usage.[17,18] So the final bill of an OPCAB patient is always on the lower side when compared to that of an ONCAB patient. Significantly lower OPCAB costs compared to ONCAB – have helped in competitive pricing of CABG surgery in private healthcare sector in India.

9. OPCAB vs ONCAB trials

ONCAB is a standard safe procedure with low complication rate in normal risk patients. To observe a significant difference in complication rate, large number of operations will be required. This has been clearly depicted in the CORONARY[7] trial. Studies comparing high risk patient between OPCAB vs ONCAB has proved better outcome with OPCAB patient.[19–21]

10. Blood and blood product usage

All studies have conclusively proven that use of blood and products requirements are significantly lower for OPCAB as compared to ONCAB.[17] Studies have proven that early 30 days postoperative mortality is inversely proportional to transfusion requirement. Moreover, this has an immense impact in development of OPCAB in tier 2 city and smaller hospitals in metro city without in-hospital blood bank facility. OPCAB can also be easily performed in patients on potent antiplatelet agents or thrombolytic therapy after acute MI.

11. Conclusion

OPCAB is here to stay. Numbers of OPCAB have been increasing in India. This technique has been successfully adopted by the younger surgeons in India – which proves this is a reproducible technique. Moreover, higher incidence of OPCAB in highly competitive private healthcare sector proves superior results with this technique. Personally the author believes that in absence of the stress of increasing cardiopulmonary bypass time or aortic cross clamp time, it is possible to perform as many grafts required even for small vessels and also more precise anastomosis can be done. Similar operation during ONCAB will prolong cardiopulmonary bypass and aortic cross clamp time with its detrimental effects.[2] Published articles have proven that complete revascularization is possible using OPCAB technique.[22]

In patients with dilated heart it is possible to perform OPCAB without any difficulty. Moreover in patients with poor left ventricular ejection fraction, it is often easier to perform OPCAB because of less movement of the heart facilitates precise anastomosis. During OPCAB we often use both IMA and aortic-no-touch technique. OPCAB with aortic-no-touch has a low stroke rate after CABG which is comparable to PCI. We also believe that OPCAB with aortic-no-touch using both IMA is far more cost effective than multi-vessel PCI in a country like India where patient has to pay for their treatment.

Hypercoagulable state after OPCAB may contribute to poor graft patency rate in some of the studies. This aspect has never been looked into so far and needs further study.

OPCAB when performed by competent surgeon has proven long term graft patency which is similar to ONCAB.[6] Poorly performed OPCAB with high conversion rate by surgeon inexperienced with the technique cannot be the excuse to abandon OPCAB.[8] Any surgeon with suboptimal result with OPCAB should get retrained in OPCAB. Benefit of OPCAB is proven in high risk patients because of lower incidence of complications. OPCAB with aortic-no-touch (least incidence of stroke) is the best surgical revascularization technique with least complications as on today.

Conflicts of interest

The author has none to declare.

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