



# CABG Continues To Be Treatment of Choice In Multivessel CAD

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## ABSTRACT

Coronary artery bypass grafting (CABG) and percutaneous coronary interventions (PCI) are alternative methods of revascularization in patients with coronary artery disease. Results of trials, comparing PCI and CABG indicate that rate of death or myocardial infarctions are similar with either treatment strategy. Management with PCI is, however associated with an increased requirement for subsequent, additional revascularization. In recent years there have been phenomenal technological advances both in cardiology and cardiac surgery. Cardiac surgery has seen development of off-pump coronary artery bypass (OPCAB) surgery, minimally invasive cardiac surgery, endoscopic and robotic surgery, similar changes have occurred in cardiology practice. It has evolved from simple angioplasty in single vessel disease to angioplasty combined with stenting to drug-coated stents and complex multivessel angioplasties.

Despite development of drug-eluting stents and newer platelet inhibitors there are still many contraindications to percutaneous interventions such as left main coronary artery disease, proximal diffusely diseased arteries with multiple lesions. Diabetes mellitus remains special challenge for both cardiologists and cardiac surgeons. All the randomized trials have depicted superior results of surgical revascularization in diabetic patients.

Use of newer antiplatelet agents such as clopidogrel and glycoprotein IIb / IIIa inhibitors would affect result of both PCI and CABG, only long-term prospective, randomized multicenter trials would show their long-term effects.

At present in a patient with multivessel disease with extensive coronary artery diseases, severe left ventricular dysfunction, left main coronary artery disease, diabetes, CABG / OPCAB is preferred approach for myocardial revascularization.

## INTRODUCTION

New techniques and technologies are being introduced in Cardiac Surgery and Cardiology at a phenomenal speed. Almost everyone is in the race for a 'first' new technique to etch their name in the historical records. In recent years while cardiac surgery has shifted from cardiopulmonary bypass (CPB) to off-pump coronary artery bypass (OPCAB) surgery; from sternotomy and complete exposure of the heart to minimally invasive small incisions, endoscopic and robotic surgery; the cardiology practice has seen the similar changes from simple angioplasty in single vessel disease to angioplasty combined with stenting to drug-coated stents and complex multi-vessel angioplasties.

The speed with which surgeons and cardiologists are adapting these techniques and technologies is alarming. Change is not only welcome, it is considered progressive. Yet the adoption of new techniques and technologies is to be taken with caution, because patient safety is of utmost importance for both cardiac surgeons and cardiologists.

For patients who have coronary anatomy suitable for either multivessel stenting or CABG, the question thus arises as to which is the better approach.

There is no difference in long-term mortality in patients randomized to either coronary artery bypass grafting (CABG) or percutaneous intervention (PCI), in large, randomized trials of multivessel balloon angioplasty versus CABG.<sup>1,2</sup> There is, however an increased need for subsequent percutaneous or surgical target vessel revascularization (TVR) in patients who initially undergo balloon angioplasty as compared with CABG.

In patients with diabetes mellitus, there is mortality benefit favouring CABG in patients with multivessel coronary artery disease.

Compared with balloon angioplasty, stenting reduces the need for TVR, but there has never been evidence from randomized trials that stents decrease mortality, compared with balloon angioplasty.<sup>3-7</sup> Infact, existing data suggest that stents may increase mortality, in both acute myocardial infarction (MI)<sup>8</sup> and chronic stable angina.<sup>9</sup> There is 'cheese grater' effect due to embolization of the plaque by stents,<sup>10</sup> leading to increased periprocedural MI.<sup>11</sup> Data are particularly strong for patients with multivessel disease, left ventricular dysfunction and left main coronary stenosis in favour of CABG.<sup>12</sup> However, CABG carries a greater risk of more subtle deficits in neurocognitive function,<sup>13</sup> but off-pump coronary artery bypass (OPCAB) has

**Fig. 1:** Bar diagram demonstrating growth of OPCAB and C-CAB surgeries at Escorts Heart Institute And Research Centre, New Delhi, India.

OPCAB – Off-pump coronary artery bypass  
C-CAB – Conventional Coronary artery bypass

**Table 1: Demographic Profile : OPCAB vs CCAB**

Variables	OPCAB Group (n = 11,747)	CCAB Group (n = 10,736)	p Value
Male	10,234 (87.1%)	9626 (89.7%)	<0.001
Female	1513 (12.9%)	1110 (10.3%)	<0.001
Diabetes	3947 (33.6%)	3199 (29.8%)	<0.001
Hypertension	5712 (48.6%)	5110 (47.6%)	0.126
Acute MI	223 (1.9%)	258 (2.4%)	0.010
History of CVA	188 (1.6%)	151 (1.4%)	0.256
Preoperative IABP	564 (4.8%)	462 (4.0%)	0.079
Aortic atheroma	2208 (18.8%)	322 (3.0%)	<0.001
COPD	963 (8.2%)	891 (8.3%)	0.801

significantly reduced the cognitive dysfunction noted with on-pump CABG.<sup>14,15</sup>

## CABG VERSUS STENTING FOR MULTIVESSEL CORONARY ARTERY DISEASE

### The Evidence

The arterial revascularization therapy study (ARTS) and stent or surgery (SOS) trials have tried to evaluate whether CABG or PCI would be better approach for multivessel disease.<sup>16,17</sup> The ARTS found that TVR rates were still higher in patients with stents as compared with CABG; however TVR rates were lower with stenting than they had been in previous trials of balloon angioplasty. The diabetic cohort did have a higher mortality in stenting arm than in the CABG arm of the trial.<sup>16</sup>

At one year the SoS study found a lower mortality in those undergoing CABG as compared with PCI (CABG 2% versus PCI 5%; hazard ratio 2.91%, 95% CI 1.29-6.53, P=0.01).<sup>17</sup> The increased mortality seen in the PCI patients cannot be attributed to diabetes, as the prevalence of diabetes was quite low

in SoS trial. Some intervention cardiologists have explained the results of SoS trial as ‘surprisingly low surgical mortality’ in the patients randomized to CABG, but with contemporary surgical techniques this mortality is not unreasonable. It is scientifically unjustified to dismiss outright the mortality difference observed in this randomized trial. Twenty one percent of patient in PCI group required additional revascularization procedures compared with 6% in CABG group (hazard ratio 3.85, 95% CI 2.5-5.79, P < 0.0001).<sup>17</sup>

### CABG in The Current Perspective: Escorts Heart Institute and Research Centre (EHIRC) Experience

In last five years, there has been development of new techniques on beating or arrested hearts, elimination of extra-corporeal circulation and designing “off-pump” operations, thus eliminating oxygenators, heart-lung bypass circuits and related procedures. For coronary revascularization Minimally Invasive Direct Coronary Artery Bypass (MIDCAB) and OPCAB are available. These procedures have further reduced the risks associated with conventional coronary artery bypass grafting (C-CAB). To improve myocardial blood supply in patients with ungraftable vessels, the techniques of Trans-Myocardial Laser revascularization (TMLR) and angiogenesis have provided new options. The application of robotic-assisted surgery and port access surgery have further widened the horizon of minimally invasive surgery.

The diffuse systemic inflammatory response (SIRS) to CPB has the potential of engendering a constellation of clinical, biochemical and radiological manifestations of multi-organ dysfunction. Attenuation of the complex multifaceted response can have tremendous prognostic implications; this has been achieved by elimination of CPB for coronary artery bypass operations and doing most of CABG as an OPCAB procedure. Since deliberate induction of global ischemia is unnecessary in OPCAB, it is logical to suppose that iatrogenic biochemical injury

**Table 2: Angiographic Profile: OPCAB vs. CCAB**

Variables	OPCAB Group (n=11,747)	CCAB Group (n=10,736)	p Value
SVD	1244 (10.6%)	902 (8.4%)	<0.001
DVD	3042 (25.9%)	2544 (23.7%)	<0.001
TVD	7461 (63.5%)	7290 (67.9%)	<0.001
Left main stenosis	975 (8.3%)	945 (8.8%)	0.186
LVEF			
<25%	3488 (29.7%)	3049 (28.4%)	0.034
25 - 45%	5122 (43.6%)	4477 (41.7%)	0.004
>45%	3137 (26.7%)	3210 (29.9%)	<0.001

**Table 3: Results: Postoperative Morbidity and 30 Days Mortality**

Variables	OPCAB Group (n =11,747)	OPCAB Group (n =11,747)	p- Value
Postop inotropes	247 (2.1%)	537 (5.0%)	<0.001
Blood & blood product transfusion	5192 (44.2%)	6055 (56.4%)	<0.001
Postoperative IABP	135 (1.1%)	301 (2.8%)	<0.001
Reop for bleeding	188 (1.6%)	303 (2.8%)	<0.001
Stroke	59 (0.5%)	96 (0.9%)	<0.001
Perioperative MI	176 (1.5%)	193 (1.8%)	0.087
Prolonged ventilation	435 (3.7%)	708 (6.6%)	<0.001
Renal dysfunction	134 (1.1%)	215 (2.0%)	<0.001
CU stay in hrs (mean ± SD)	20 ± 7	32 ± 8	<0.001
Operative mortality	135 (1.1%)	269 (2.5%)	<0.001
Hospital stay in days (mean ± SD)	6 ± 2	8 ± 3	<0.001

to myocardium would not occur. Akines et al first suggested that OPCAB preserved cardiac functions.<sup>18</sup> In different prospective randomized studies, Ascione, Yam Dijk, Bennets and Masuda and their collaborators reported minimal changes in biochemical markers of myocardial injury.<sup>19-22</sup>

OPCAB has been demonstrated to offer prognostic advantage in high risk patients requiring myocardial revascularization. Elderly patients with renal and neurological dysfunction, acute myocardial infarction, impaired ventricular functions have better outcome with OPCAB surgery.<sup>23-26</sup>

The techniques of OPCAB are constantly undergoing refinement and many areas of potential benefit are vigorously explored. Increased number of surgeons are expanding their OCPAB practice and offering many more patients this technique of myocardial revascularization. During the past 5 years the number of OPCAB surgeries performed at EHRC has increased from 4.95% in initial period to 96% recently with excellent and comparable results with other series (Fig. 1, Table 1-6).

Recently total endoscopic coronary bypass (TECAB) has been performed using Zeus da Vince Systems™ from Intuitive Surgical. This consists of three robotic arms that are attached

**Table 4: High Risk Group**

Variables	OPCAB (n = 11,747)	CCAB (n = 10,736)
High Risk	3548 (30.2%)	3414 (31.8%)
Age > 70 yrs	1510 (12.9%)	715 (6.8%)
LVEF < 25%	3488 (29.7%)	3049 (28.4%)
Hemodynamic instability	1738 (14.8%)	2340 (21.8%)
Neurological dysfunction	70 (0.6%)	97 (0.9%)
Renal dysfunction	59 (0.5%)	43 (0.4%)
Redo CABG	318 (2.7%)	193 (1.8%)

**Table 5: Results: Postoperative**

Variables	OPCAB Group (n = 3548)	CCAB Group (n = 3414)	p-Value
Postop inotropes	78 (2.2%)	191 (5.6%)	<0.001
Blood & blood product transfusion	1561 (44.0%)	1874 (54.9%)	<0.001
Postoperative IABP	46 (1.3%)	110 (3.2%)	<0.001
Reop for bleeding	67 (1.9%)	94 (2.8%)	0.020
Stroke	21 (0.6%)	38 (1.1%)	0.025
Prolonged ventilation	160 (4.5%)	266 (7.8%)	<0.001
Renal dysfunction	47 (1.3%)	75 (2.2%)	0.007
ICU stay in hrs (mean ± SD)	20 ± 8	36 ± 9	<0.001
Operative mortality	100 (2.8%)	143 (4.2%)	0.002
Hospital stay in days (mean ± SD)	6 ± 2	8 ± 3	<0.001

to a platform, a complex master – console system is used for replicating the arm and hand movements of the surgeon (Fig. 2). These robotic arms hold specially designed endoscopic instruments, which are placed through small ports (Fig. 3).

All these newer developments have reduced the morbidity associated with CABG tremendously and can provide better short-term and long-term outcome than PCI.

## Discussion

### CABG Vs PCI: The Indian Challenge

All the major trials comparing CABG and PCI have shown that there may not be a major difference in long-term mortality of patients with these procedures, but patients undergoing PCI required subsequent and many times repeated target vessel revascularization. This becomes important in Indian setting, since in this era of drug-coated stents one single drug-coated stent implantation may cost between 2.0 to 2.5 lac rupees. A multivessel drug eluting stenting procedure requiring three stents may cost whopping 5-7 lac rupees, whereas a multivessel CABG in the best of centers still costs between 1.5 to 2.0 lac rupees, and the cost is going down with the advent of OPCAB

**Table 6: Morbidity and Mortality Results at EHIRC and Compared to Recently Published Large Retrospective Series**

Author and Publication Year Study Period	Calafiore 2001 1997-2000	Sabik 2002 1997-2000	Macha 2002 1995-2000	Puskas 2001 1997-1999	Trehan 2003 1995-2003
Patient no.	1843	812	12,540	1200	27,232
OPCAB	919	406	1950	200	10,321
ONCAB	924	406	10,590	1000	10,563
CVA(%)	NS	NS	NS	-0.658	P<0.001
OPCAB	0.8	0.7	1.5	1.5	0.5.
ONCAB	1	1.2	2.2	2.3	0.9
AMI (%)	p-0.027	NS	NS	P=0.887	P=0.103
OPCAB	1.1	0.7	0.78	1.0	1.5
ONCAB	2.6	1.2	1.8	0.8	1.8
Renal Dysfunc (%)		P=0.03	P<0.001		P<0.001
OPCAB		0	2.6		1.1
ONCAB		1.5	3.9		2.0
Transfusion	P<0.001	P=0.002	P<0.001	P<0.001	P<0.001
OPCAB (%)	22	42	27.6	33	44.4
ONCAB (%)	30.8	53	53.8	70	56.8
LOS (days)	P<0.001	NS	P<0.001	P<0.001	P<0.001
OPCAB	4.2	6	5.95	3.9±2.6	6
ONCAB	4.9	6	7.33	5.7±5.3	8
Mortality	P=0.016	NS	P<0.001	P=0.407	P<0.001
OPCAB(%)	1.4	0.5	1.8	1.0	1.0
ONCAB(%)	3.1	1	3.8	2.2	2.4

**Table 7: Contraindications to Percutaneous Interventions**

1	Left main coronary artery disease
2	Too proximal disease
3	Too long disease
4	Proximity to major branch with diagonal, septal, obtuse marginal
5	Multiple lesions / diffuse disease
6	Chronic occlusion
7	? Diabetes

surgery. Moreover, the risk involved with CABG is reducing with OPCAB procedures.<sup>27</sup> The cost involved in multivessel stenting and the potential risks involved puts a big question mark on the face of multivessel PCI especially in an Indian perspective.

Incidence of diabetes mellitus is increasing progressively in Indian population and majority of coronary intervention patients are diabetic. All the major trials comparing CABG and PCI have shown there is mortality benefit favouring CABG in diabetic patients with multivessel coronary artery disease, and these patients are particularly more prone for subsequent reinterventions, perioperative myocardial infarctions and death.

In Western population, cumulative medical care cost during the first year after coronary angioplasty are 40-60% higher than the initial revascularization procedure itself because of procedural failure or restenosis requiring subsequent bypass surgery or repeat angioplasty.<sup>28-30</sup> This can be no different in Indian perspective although there are no such studies. The cost and the potential complications make multivessel PCI not a very suitable procedure for Indian population.

**Table 8: Advantages of CABG over PCI**

1	Complete revascularization
2	Low risk of early reintervention
3	High proportion of population angina-free
4	Reduced medication (complications and the cost involved with drugs)
5	Widely applicable

#### Contraindications to PCI and CABG

Despite development of drug-eluting stents and newer platelet inhibitors there are still many contraindications to percutaneous interventions (Table 7).

With more and more high risk cases done as OPCAB and with newer technologies there are virtually no contraindications to surgical myocardial revascularization procedures. Infact, surgical myocardial revascularization has potential advantages over PCI (Table 8).

#### Role of Newer Anti-Platelet Agents

In contemporary PCI, the role of concomitant glycoprotein (GP) IIb/IIIa inhibitor is firmly established. The evaluation of IIb/IIIa platelet inhibitor for stenting (EPISTENT) study demonstrated reduced mortality in patients receiving stents who were randomized to abciximab instead of placebo.<sup>31</sup> Although all three commercially available GP IIb/IIIa (abciximab, Tirofiban and Reopro) reduce periprocedural MI but they have potentially high incidence of GI and other visceral organ bleeding.

Prolonged dual antiplatelet therapy with aspirin plus clopidogrel could further decrease TVR and recurrent ischemic events in

both PCI and CABG/OPCAB<sup>32</sup>. Statin therapy, appropriate control of diabetes would improve outcome in both PCI and CABG patients.

## CONCLUSION

All the different lines of treatment of coronary artery disease PCI, CABG and medical therapy are improving. At present, in a patient with multivessel disease with extensive coronary artery disease, severe left ventricular dysfunction, left main coronary disease, diabetes, CABG/OPCAB is the preferred mode of revascularization. PCI may be performed when there more focal stenosis, although concomitant GP IIb/IIIa inhibition, inspite of its risks is essential. However, large randomized prospective, multicentre trials employing newer modalities of treatment in both the fields are required to settle the issue in favour of one or another.

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