ON-PUMP CORONARY ARTERY BYPASS GRAFT SURGERY
versus
OFF-PUMP CORONARY ARTERY BYPASS GRAFT SURGERY
-A COMPARATIVE STUDY

Dissertation submitted for

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BRANCH I – CARDIOTHORACIC SURGERY

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“learn to heal ’’

CERTIFICATE

This is to certify that the dissertation entitled **"ON-PUMP CORONARY ARTERY BYPASS GRAFT SURGERY VERSUS OFF-PUMP CORONARY ARTERY BYPASS SURGERY - A COMPARATIVE STUDY"** presented here is the original work done by **Dr.B.Prashant Kumar** in the department of cardio thoracic surgery, Government General Hospital, Madras Medical college, Chennai 600003, in partial fulfillment of the University rules and regulations for the award of M.Ch Cardiothoracic degree under our guidance and supervision during the academic period from 2006 - 2009.

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CONTENTS

Introduction

Cardiovascular disease had emerged as a major health burden worldwide. Heart disease contributed to a major chunk of deaths of which majority is from developing countries (1). A rise in the prevalence of cardiovascular diseases in the early twentieth century and a subsequent decline in the latter half has been well documented in the industrialized countries. However the scenario is reversed in developing countries especially India with a steady escalation in the prevalence of cardiovascular diseases (2). It has been consistently observed that Indians have premature CAD and that their risk for CAD is two to four times higher than European population (3) and ten times higher than that reported 40 years ago. The emerging trend of CAD in India shows that there is an increase of the disease in the young population. And occurring in younger patients, the disease pattern is severe. Within the Indian subcontinent also, there has been a rapid rise in CAD prevalence (4,5) .

CAD has a multifactorial etiology with many of the risk factors being influenced by lifestyle, prominent factors being dietary and smoking, diabetes mellitus, hypertension, obesity, COPD.

One of the most debated and polarizing issues in cardiac surgery has been whether coronary artery bypass grafting (CABG) without the use of cardiopulmonary bypass (CPB) or cardioplegia (off-pump CABG,

or OPCAB) is superior to that performed with the heart-lung machine and the heart being chemically arrested (standard CABG) (6).

Beating heart coronary artery bypass grafting is a technique developed to reduce usage of cardiopulmonary bypass. Till recently, CPB was considered to be the most important factor for creating a perfect vascular anastomosis in a quiet, motionless and bloodless field. Because of the many deleterious effects of CPB, recognized to be particularly important in the emerging scenario of an increasing number of elderly and high risk patients being taken up for CABG, off-pump bypass has gained importance. Many of the technical difficulties of the off-pump technique have been overcome by the development of devices such as stabilizers, snares, shunts, suction cones, etc (7).

Review of Literature

ANATOMY OF CORONARY ARTERIES

The coronary system divides naturally into two distributions, left and right. From surgical point of view, the coronary arterial system is divided into four parts

- The Left main coronary artery
- The Left anterior descending coronary artery and its branches
- The Left circumflex coronary artery and its branches
- The Right coronary artery and its branches

The major coronary arteries form a circle and a loop above the heart (7,8). The circle is formed by the Right coronary artery and Left circumflex arteries as they traverse the atrioventricular sulci. The loop is formed between the ventricles and at right angles to the circle and is formed by the Left anterior descending coronary artery and the Posterior descending coronary artery as they encircle the septum.

The Right coronary artery courses along the right atrioventricular groove just below the right atrial appendage and along the epicardial surface adjacent to the tricuspid valve annulus. It traverses along the tricuspid annulus until it reaches the posterior surface of the heart, where

it then becomes the Posterior descending artery and runs towards the apex of the left ventricle. Along its course, a number of branches emerge, most notably those that supply the sinus node and the atrioventricular node; hence, blockage of such vessels can lead to conduction abnormalities. In addition several major branches arise from Right coronary artery including conus branch, Acute marginal branches, branches to right atrium and right ventricle and the posterior descending artery. RCA provides blood supply to SA node (50-60%), AV node, RA, RV, crista supraventricularis, proximal bundle branches, inferoposterior septum. RCA forms collaterals to LAD via the conus and septal perforators.

On exiting the ascending aorta, the Left main coronary arteries typically bifurcate quickly into the Left circumflex and Left anterior descending arteries. The Left circumflex artery runs under the left atrial appendage on its way to the lateral wall of the left ventricle along the posterior atrioventricular sulcus and in 85% terminates in the obtuse margin of the LV. 10 – 15% terminate as the PDA. The Left circumflex supplies blood supply to SA node (40-50%), posterior and lateral walls of LV and the LA. PDA (10-15%) provides blood to the AV node, proximal branches and some inferoposterior septum (left dominant). Along the way, it spawns a number of branches that supply the left atrial and ventricular septum including the Right and Left bundle branches of the

myocardial conduction system and the anterior and apical portions of the left ventricle. The LAD travels in the anterior interventricular groove and terminates in the apex. It gives multiple branches including septal and diagonal branches and provides blood supply to the anterior 2/3 of the interventricular septum and the anterior, lateral and apical walls of the left ventricle. It also supplies blood to the Right and Left bundle branches (9).

Minimal criteria for normal coronary arteries (10)

- The aorta arises dually from the right and left coronary cusps (the ones adjacent to the aortopulmonary septum)
- The Right coronary artery follows the atrioventricular groove
- The Left coronary artery lies behind the pulmonary artery and has a main trunk of variable length that divides into two branches; the Left anterior descending and the circumflex coronary arteries. The Left anterior descending artery follows the interventricular groove and forms septal perforator branches, and the Circumflex follows the left atrioventricular groove.
- The Posterior descending branch originates from either the Right or the Left coronary artery, follows the posterior interventricular groove, and divides into septal perforator branches.

- The major coronary branches flow epicardially (extramurally)
- The coronary arteries terminate at the capillary (myocardial) level.

CORONARY ARTERY DISEASE

Coronary artery bypass grafting is one of the procedures with the highest impact in the history of medicine. No other operation has led to more lives prolonged and been better characterized with respect to its short and long term outcomes.

Chronic coronary artery disease is most commonly caused by obstruction of the coronary arteries by atheromatous plaque. The clinical presentations of CAD are highly variable. Chest discomfort is usually the predominant symptom in chronic (stable) angina, unstable angina, Prinzmetal (variant) angina, microvascular angina, and acute myocardial infarction. However, syndromes of CAD also occur in which ischemic chest discomfort is absent or not prominent, such as asymptomatic (silent) myocardial ischemia, congestive heart failure, cardiac arrhythmias, and sudden death. Obstructive CAD also has many nonatherosclerotic causes, including congenital abnormalities of the coronary vessels, myocardial bridging, coronary arteritis in association

with the systemic vasculitides, and radiation-induced coronary disease. Myocardial ischemia and angina pectoris may also occur in the absence of obstructive CAD, as in the case of aortic valve disease, hypertrophic cardiomyopathy and idiopathic dilated cardiomyopathy. Moreover, CAD may coexist with these other forms of heart disease (11).

The patient who presents with chest pain needs to be thoroughly evaluated. A complete history and physical examination is first undertaken, taking special care to note the presence of cardiac risk factors: history of premature family history of CAD, hypertension, diabetes, obesity, hypercholesterolemia and smoking. A physical examination should focus on the cardiovascular system, followed by laboratory assessment of cardiac enzymes (troponin, CPK-MB), a chest x-ray and electrocardiogram.

Suspicion of an acute coronary syndrome (unstable angina or acute myocardial infarction) requires oxygen therapy, nitrates and aspirin therapy (unless contraindicated), blood pressure therapy (first line therapy of acute coronary syndromes is beta-blockers) and serial electrocardiograms and cardiac enzymes. Evidence of an acute myocardial infarction by either enzyme analysis or electrocardiogram

usually requires immediate therapy with either thrombolytics or angioplasty.

The patient is observed on bed rest and medical therapy. For continued pain or evidence of ischemia, urgent revascularization, either with angioplasty or bypass, is usually indicated. If myocardial infarction can be ruled out on the basis of normal serial enzymes and no evolution of ECG, the patient most often is tested with cardiac stress testing (treadmill, stress echocardiogram or nuclear testing). Patients who pass this noninvasive evaluation (no ischemia or chest pain) are most often discharged with a diagnosis of non-cardiac chest pain. If the patient has a positive stress test (ST depression or chest pain), the patient is most often referred for cardiac catheterization (12).

The specific indications for coronary artery bypass grafting are as follows:

1) Triple vessel disease with or without decrease in ejection fraction (but particularly with a decrease in ejection fraction). Patients with reduced ejection fraction with coronary artery disease have a 5 year survival of approximately 75%, this increases to 90% in patients undergoing coronary artery bypass grafting.

2) Double vessel coronary artery disease with reduced ejection fraction. Coronary artery bypass surgery appears to increase long-term survival compared to medical management. However, double vessel disease with normal ventricular function probably can be managed as effectively with angioplasty or medical management.

3) Angina refractory to triple vessel therapy including nitrates, beta blockers and calcium channel blockers.

4) Compelling anatomy; this includes left main coronary artery disease in which the patients have a propensity to sudden death; also proximal Left anterior descending artery disease where there is calcification proximal to the first septal perforator. This instance is associated with a high incidence of sudden death and should be managed with angioplasty cautiously if at all. Life threatening ventricular arrhythmias after myocardial infarction even without a left ventricular aneurysm is an indication for coronary artery bypass surgery. Some type of anti-arrhythmic surgery, either endocardial ablation or placement of an automatic implantable cardioverter defibrillator, should be done as well. Unstable angina, i.e. crescendo angina, is an indication for coronary revascularization on a semi-urgent basis if full medical therapy is ineffective for up to several days (12) .

CONDUITS USED FOR CORONARY REVASCULARIZATION 12)

The two most commonly used conduits for a coronary revascularization are the greater saphenous vein and the internal mammary artery. Over the years, there has been no question that increased use of the internal mammary artery results in improved survival and improvement of angina free survival. This is because of the superior patency of the internal mammary artery graft compared to the saphenous vein graft. The 10 year patency of a saphenous vein graft is on the order of 50%. The 10 year patency of an internal mammary artery graft is on the order of 95%. The saphenous vein graft loses patency for the following reasons: Initially, intimal hyperplasia occurs as a remodeling process for the vein to adapt itself to the artery. This can result in occlusion of the graft. Later on atherosclerosis occurs within the vein graft, and this ultimately leads to the majority of saphenous vein graft occlusions.

The internal mammary artery graft has the advantage that it will not occlude by either of these methods since it does not undergo intimal hyperplasia and it does not undergo atherosclerosis. The left internal mammary artery is used most often and may be placed typically onto the left anterior descending artery or onto the obtuse marginal arteries

coming off the circumflex. The right internal mammary artery may be used for the anterior descending artery or may be brought to the right coronary artery. It may also be brought down through the transverse sinus to be placed onto the circumflex artery.

The mammary artery may also be used as a free conduit by transecting it proximally and attaching it separately onto the aortic root.In general, caution regarding the use of the internal mammary artery should be used in the following situations (12):

1) Diabetic patients in general may have one internal mammary artery taken down, however, two internal mammary arteries would probably be dangerous because of the decrease in vascularity of the chest wall, resulting in suboptimal wound healing.

2) Immunocompromised patients and patients in chronic renal failure likewise should undergo one internal mammary artery takedown at the most.

3) Extremely old patients who would most likely expire within the next 10 years would most likely not benefit from an internal mammary bypass graft.

4) Patients who have atherosclerotic subclavian arteries would most likely not benefit from an internal mammary artery because of the atherosclerosis which may progress to the

internal mammary artery, as well as the subclavian artery atherosclerosis which may impair flow to the mammary artery.

5) Patients requiring emergency surgery for cardiogenic shock generally should not be subjected to the increased time it takes for taking down the internal mammary artery.

6) Patients who have a severely calcified or extremely tiny target coronary artery generally would minimally benefit from an internal mammary artery graft because of severity of disease in the distal target.

7) Redo-coronary surgery patients who have had previous vein grafts should receive mammary arteries with caution. In particular, the situation in which a stenotic vein graft to a completely occluded large important coronary artery requires reoperation. In this case, it may not be wise to use the internal mammary artery since the entire blood flow to that large coronary artery depends on the vein graft, and the mammary artery may not be able to supply the large demand of the large coronary artery in the acute postoperative phase. It should be noted that one of the major problems with internal mammary artery grafts is the propensity for these grafts to go into spasm in the perioperative period which can result in acute infarction and hemodynamic destabilization. This is why nifedipine is given intraoperatively after an internal mammary artery is performed, as well as postoperatively.

Other possible conduits for coronary revascularization include the lesser saphenous vein and gastroepiploic artery, as well as inferior epigastric artery. The gastroepiploic and inferior epigastric arteries seem to have comparable patency to the internal mammary artery. The lesser saphenous has a patency comparable to the greater saphenous vein.

Arm veins have been used, however, have an extremely poor patency in the order of 50% after 2 years. Radial artery conduits are used as well

TECHNIQUE OF CORONARY ARTERY BYPASS (12)

The patient is brought to the operating room and an arterial line and Swan- Ganz catheter are placed for hemodynamic monitoring. The patient is induced under general endotracheal anesthesia. A Foley catheter is placed and the chest and legs are prepared and draped. A median sternotomy is performed. If the mammary needs to be taken, this is done with an internal mammary artery retractor. The vein is generally harvested from the right lower extremity during this time. The pericardium is opened. Heparin is given and purse strings applied. The aorta is cannulated. The right atrial appendage is cannulated with a two-stage venous cannula with one port going into the inferior vena cava and the proximal port in the right atrium.

An antegrade cardioplegia cannula/aortic root vent is placed in the aortic root, and a retrograde cannula is placed transatrially into the coronary sinus. Cardiopulmonary bypass is instituted, the aortic cross-clamp applied, and antegrade blood cardioplegia instilled through the aortic root until arrest occurs, then this is switched to retrograde. The chosen targets are then grafted with the saphenous vein graft. This includes grafting to the distal Right coronary, Posterior descending, Posterolateral branches or Acute Marginal for the Right coronary system. For the Left Anterior Descending system, this may include branches of the Diagonal as well. For the Circumflex system, this may include branches of the Obtuse Marginal, as well as Posterior ventricular branches in the case of a left dominant system.

The proximal coronary anastomosis onto the aortic root is performed either during the period of cross-clamping, or once the cross-clamp is released with an aortic side-biter clamp. Once the aortic cross-clamp comes off, 100 mg of Lidocaine is given to help limit the amount of arrhythmias. When the patient has gained a normal sinus rhythm, the bleeding has been controlled, and mixed venous saturation is adequate, weaning is instituted. At this point, the anesthesiologist ventilates the patient. One gram of calcium is given by the perfusionist and the following drugs administered to help limit the chance of a protamine

reaction . With weaning from bypass accomplished, the venous line is removed and protamine is given. Generally, 3 mg/kg of protamine is given (i.e. equivalent to the 3 mg/kg of heparin dose administered at the beginning of the case). The ACT which was initially greater than 400 prior to initiating bypass now comes down to approximately baseline, which is about 100 seconds. In the event that the patient has difficulty weaning from bypass, then cardiopulmonary bypass is re-instituted and the inotropes need to be raised. Initially, weaning from cardiopulmonary bypass is performed with 1 mcg/kg/min of nitroglycerin and between 2.5 and 5 mcg/kg/min of dopamine. This may need to be increased to higher levels of dopamine and/or epinephrine added. If epinephrine needs to be added, this is usually started at about 1 mcg/min and can be titrated up. If this fails, then other pharmacologic maneuvers may be in order. If the patient has an elevated pulmonary artery pressure and also has a low cardiac output, this may be helped with Amrinone, which has a positive inotropic effect, but also causes vasodilatation, particularly on the pulmonary circuit. The choice of drug used depends on the hemodynamic parameters, the systemic vascular resistance, the cardiac output, and the pulmonary artery pressures.

In the event weaning is still unsuccessful, an intra-aortic balloon pump may be necessary. If weaning is still unsuccessful, i.e. after two tries at weaning with elevated inotropic agents and a balloon pump in place, then additional mechanical support is warranted. This type of support depends on the findings. If there is elevated pulmonary wedge pressure yet a low cardiac index (less than 1.5 l/min/m2) and a low blood pressure (i.e. less than 90 mmHg), then it could be assumed that there is left ventricular failure and a LVAD is warranted. Conversely, if the patient has right ventricular failure, there will be elevated right atrial pressure and low left-sided filling pressures, as well as low cardiac output and low blood pressure, i.e. an inability to volume load the left heart despite an elevated right atrial pressure. In this event, an RVAD may be required. The LVAD is a partial bypass circuit from the left atrium to a biomedicus vortex pump which then pumps the blood into the aorta. This bypass circuit can be used to achieve nearly full flow and requires only mild to moderate heparinization at approximately an ACT level of 150 seconds for flows below two liters. The LVAD is positioned in the left atrium via the right superior pulmonary vein via a pledget purse string placed in the right superior pulmonary vein. The aortic cannula already in place in the aorta, can be used as the outflow for the LVAD. An RVAD is placed via the right atrial cannula in place which then drains blood

through the biomedicus vortex pump into a cannula positioned in the pulmonary artery. Placement of the LVAD can be life-saving. Its use is basically to support a stunned heart which will eventually recover.

MORBIDITY ASSOCIATED WITH BYPASS SURGERY (13)

Neurological Events

Neurological impairment after bypass surgery may be attributable to hypoxia, emboli, hemorrhage, and/or metabolic abnormalities. Postoperative neurological deficits have been divided into type 1 (associated with major focal neurological deficits, stupor, or coma) and type 2 (in which deterioration in intellectual function is evident). Adverse cerebral outcomes are observed in approximately 6% of patients after bypass surgery, divided equally between type 1 and type 2 deficits. Predictors of type 1 deficits include proximal aortic atherosclerosis (defined by the surgeon at operation), prior neurological disease, use of an intraaortic balloon pump (IABP), diabetes, hypertension, unstable angina, and increased age. Predictors of type 2 deficits include history of excess alcohol consumption, arrhythmias including atrial fibrillation, hypertension, prior bypass surgery, peripheral vascular disease, and congestive heart failure. Off-pump coronary artery bypass (OPCAB) avoids both aortic cannulation and cardiopulmonary bypass (CPB).

Accordingly, one would expect postoperative neurological deficits to be reduced in patients undergoing OPCAB. Three randomized controlled trials have not firmly established a significant change in neurological outcomes between OPCAB patients and conventional CABG patients. Each trial demonstrates problems inherent with small patient cohorts, differing definitions, and patient selection. At this point, there is insufficient evidence of a difference in neurological outcomes for patients undergoing OPCAB compared with those undergoing conventional CABG.

Mediastinitis

Deep sternal wound infection occurs in 1% to 4% of patients after bypass surgery and carries a mortality rate of approximately 25%. Predictors of this complication include obesity, reoperation, use of both internal mammary arteries at surgery, duration and complexity of surgery, and diabetes.

Renal Dysfunction

Postoperative renal dysfunction occurs in as many as 8% of patients. Among patients who develop postoperative renal dysfunction (defined as a postoperative serum creatinine level greater than 2.0 mg/dL

or an increase in baseline creatinine level of greater than 0.7 mg/dL), 18% require dialysis. Overall mortality among patients who develop postoperative renal dysfunction is 19% and approaches 67% among patients requiring dialysis.

Predictors of renal dysfunction include advanced age, history of moderate or severe congestive heart failure, prior bypass surgery, type 1 diabetes, and prior renal disease. Patients with advanced preoperative renal dysfunction who undergo CABG have an extraordinarily high risk for postoperative dialysis. Among patients with a preoperative creatinine level greater than 2.5 mg/dL, 40% to 50% require hemodialysis.

Predictors of poor long-term survival after bypass surgery include advanced age, poor LVEF, diabetes, number of diseased vessels, and female gender.

Additional predictors may include angina class, hypertension, prior myocardial infarction (MI), renal dysfunction, and clinical CHF. Predictors of the recurrence of angina, late MI, or any cardiac event also include obesity, lack of use of an internal mammary artery (IMA), and factors identified above. Of these events, the return of angina is the most common and is primarily related to late vein-graft atherosclerosis and occlusion.

Attenuation of the Systemic Consequences of Cardiopulmonary Bypass (13)

A variety of measures have been tried to reduce the systemic consequences of CPB, which elicits a diffuse inflammatory response that may cause transient or prolonged multisystem organ dysfunction. Administration of corticosteroids before CPB may reduce complement activation and release of proinflammatory cytokines. The administration of the serine protease inhibitor aprotinin may attenuate complement activation and cytokine release during extracorporeal circulation. Another method to reduce the inflammatory response is perioperative leukocyte depletion through hematologic filtration.

Prevention of Postoperative Arrhythmias (13)

Postoperative AF increases the length of stay after CABG up to 5 days and is associated with a 2- to 3-fold increase in postoperative stroke. There are several methods which reduce the risk of AF. First, withdrawal of preoperative beta-blockers in the postoperative period doubles the risk of AF after CABG. Thus, early reinitiation of beta-blockers is critical for avoidance of this complication. Prophylactic use of beta-blockers lowers the frequency of AF. For patients who have contraindications to beta-blockers, amiodarone is appropriate prophylactic therapy. Digoxin and

nondihydropyridine calcium-channel blockers have no consistent benefit for preventing AF after CABG, although they are frequently used to control the rate of AF if it does occur. The routine preoperative or early postoperative administration of beta-blockers is considered standard therapy to reduce the risk of AF after CABG.

KEYS TO SUCCESSFUL CABG (13)

PREOPERATIVE PERIOD: Risk versus Benefit

1. Establish the indication
2. Assess perioperative risk
3. Assess expected long-term outcome

PERIOPERATIVE PERIOD: Steps to Reduce Risks

Potential Complication	**Steps to Consider in Certain Cohorts**
4. Perioperative AF and stroke	■ Image ascending aorta ■ Anticoagulation for – Chronic AF – LV thrombus ■ Carotid screening
5. Low-output syndrome	■ Blood cardioplegia for acute ischemia/ syndrome LV dysfunction ■ Prophylactic IABP ■ Delay if acute right ventricular MI

6. Postoperative infection	■ Meticulous intraoperative steps ■ Preoperative antibiotics
7. Postoperative arrhythmias	■ Beta-blockers or alternate
8. Bleeding and transfusion risk	■ Consider discontinuing aspirin ■ Autodonation of blood

IN-HOSPITAL AND PREDISCHARGE PERIOD

9. Graft patency	■ Start aspirin ■ Assess/treat LDL-C if ≥100 mg/dL ■ Smoking cessation counseling/Rx
10. Functional recovery	■ Refer for cardiac rehabilitation ■ Evaluate for social isolation/depression ■ Arrange follow-up visit ■ Communication with all chronic care givers

Aims & Objectives

1. To study the epidemiology of Coronary artery disease in the local population.

2. To evaluate the outcome after treatment for coronary artery disease.

3. To compare the outcome measures in the on-pump versus the off-pump coronary artery bypass surgeries.

4. To compare our results with previous available studies.

5. To analyse the various complications of coronary artery bypass surgery.

6. To analyse and compare the advantages and disadvantages of on-pump versus off-pump bypass surgeries.

Materials and Methods

This study is a retrospective, nonrandomized observational study, based on coronary artery disease patients admitted in Government General Hospital, Chennai between January 2008 and December 2008, who underwent surgical intervention for coronary artery disease. Consecutive patients with diagnosis of coronary artery disease admitted in the cardiology and Cardiothoracic surgery departments , Government General Hospital, Chennai, were followed up and those patients who were taken up for surgical treatment were included in the study list. Medical records of these patients were analyzed for necessary data.

Of all there were 134 patients who underwent surgical treatment during January 2008 to December 2008 period. Treatment was based on prior review of coronary angiograms of the respective patients. Patients who were operated on an emergency basis and patients who had previous cardiac surgery were excluded from this study.

Patients were taken up for surgical management after obtaining informed consent; either on-pump or off-pump coronary artery bypass surgery. Decision was based on the opinions of the operating surgeons after reviewing the coronary angiograms of the patients. Triple, double and single vessel diseases were included in the study list.

The final decision whether to go ahead with OPCAB or ONCAB was made on the table after inspecting the vessels. The main criterion for deciding the method of operation was the technical feasibility of the procedure. No reduction in the number of grafts for the sake of performing OPCAB was accepted. Even if one of the planned grafts was difficult to do OPCAB, the patient was operated ONCAB. The major reasons for opting for onpump surgery were intramyocardial vessels, calcified vessels, difficult exposure for lateral wall arteries, diffuse disease and small vessels (<1 mm). 97 patients were treated with on-pump coronary artery bypass surgery, while the remaining 37 patients were planned for off-pump coronary artery bypass surgery. Of these 37 patients, 3 were converted to on-pump bypass surgery during the procedure, either due to unstable hemodynamics or inaccessible vessels for grafting. In all cases, the procedure was performed through midline sternotomy incision. Vessel grafts used were the left internal mammary artery and/or saphenous vein graft. During off-pump surgery, stabilization of the distal anastomotic site during anastomosis was done with octopus or star fish.Anastomosis was done using 6/0 and 7/0 prolene sutures.

Postoperative period was followed for the development of complications and the progress of the patients. Postoperative echocardiographic assessment was done for all the patients.

All the patients continued their preoperative medications till the morning of the surgery. The antiplatelet agents were stopped 5 to 7 days prior to the scheduled date of surgery. On the day of the surgery, patient was induced with midazolam, fentanyl and pancuronium. Intraoperative monitoring was done by using arterial blood pressure monitoring and central venous pressure monitoring and using a cardiac output monitor through out the surgery. The on-pump patients received heparin at a dose of 3mg/kg and an activated clotting time of > 400s was maintained. The off-pump patients were administered heparin at a dose of 1.5mg/kg and ACT was maintained at >250s. In all the patients , LIMA LAD anastomosis was constructed first.

The rest of the distal anastomosis were done serially and all proximal anastomoses were done with a partial clamping of the aorta. Coronary shunts were used when the vessel diameter were small. At the end of all anastomosis, protamine sulfate was administered at half the heparin dose.

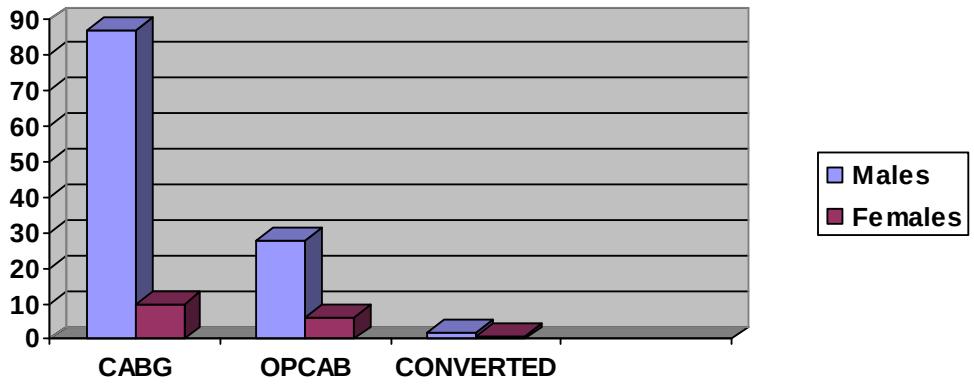
Statistical analysis was done by collecting preoperative clinical features, operative data and postoperative data and expressed as percentages, mean and standard deviations wherever applicable.

Observations

SEX DISTRIBUTION

	CABG	OFF PUMP	Converted
Males	87	28	2
Females	10	6	1

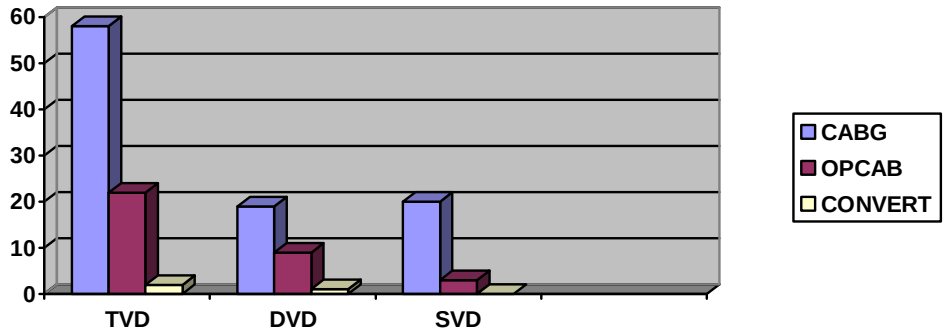
	CABG	OFFPUMP
Males	89%	82.35%
Females	11%	17.65%



Of the 97 ONCAB patients, 87 were male, remaining 10 being female patients. In the OPCAB group 28 were male patients, the remaining 6 being female patients. Including the converted group of patients, the total number of male patients in the on-pump group were 89 and the female patients 11. On calculation the percentage of the patients, 89% of the on-pump group were males, while 82.35% of the off pump group were males.

DISTRIBUTION OF CORONARY ARTERY DISEASE

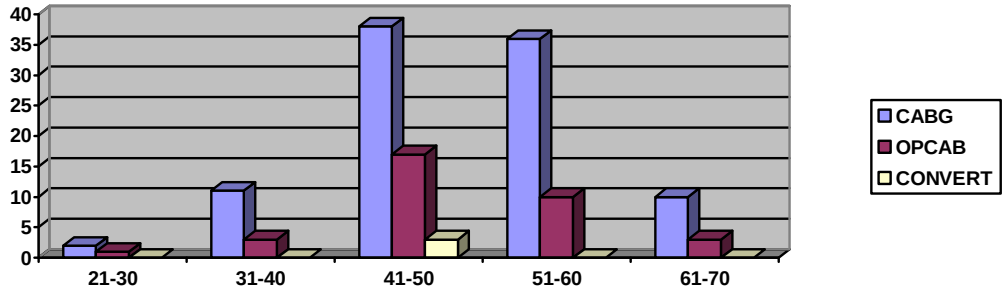
	TVD	DVD	SVD
CABG	58	19	20
OPCAB	22	9	3
CONVERTED	2	1	0



Among the distribution of the coronary artery disease, of the 134 patients, 61.19% had triple vessel disease, 21.64% had double vessel disease, and 17.16 % had single vessel disease. Of the 82 triple vessel disease patients, 73.17% had on-pump CABG including the converted surgeries and the remaining 26.83% had off-pump CABG. In the Double vessel patients, 68.96% had on-pump CABG, and the remaining 31.03% had off-pump surgery. 86.95% of patients had on-pump CABG, while the remaining 13.05% had off-pump surgery.

AGE DISTRIBUTION

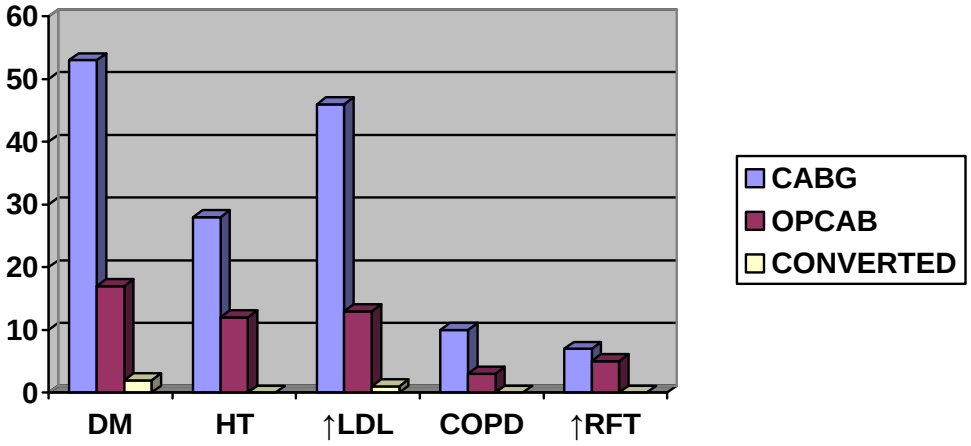
	21-30	31-40	41-50	51-60	61-70	71-80
CABG	2	11	38	36	10	0
OPCAB	1	3	17	10	3	0
CONVERT	0	0	3	0	0	0



The majority of patients in the present study belonged to the 41 to 60 years age groups, The mean age in the on-pump patients was 50.51 ± 8.22 years, while in the off-pump group it was 49.02 ± 8.03 years. The percentage of patients in the 41 to 50 years age group in the on-pump patients was 38% of on-pump patients, while in the off-pump group it was 50%. Patients between age of 51 to 60 years formed 36% of on-pump patients and 29.41% of the off-pump patients.

CO-MORBID FACTORS

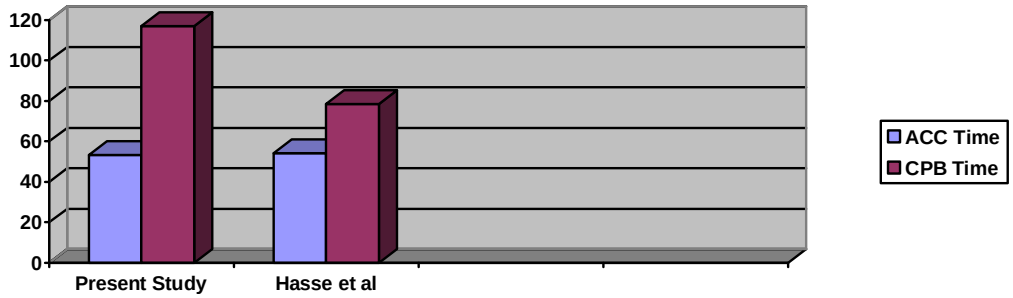
	DM	HT	Hyperlipid	COPD	↑RFT
CABG	53	28	46	10	7
OPCAB	17	12	13	3	5
CONVERTED	2	0	1	0	0



Among the most common co morbid diseases that have been analyzed it was found that 53.73% of the 134 patients had diabetes mellitus, 29.85% had hypertension, 44.77% had hyperlipidemia, 9.7% had COPD and 8.95% had preoperative renal dysfunction. Calculating for the operative groups separately, it was found that 55% had diabetes mellitus, 28% had hypertension, 47% had hyperlipidemia, 10% had COPD and 7% had preoperative renal dysfunction in the on-pump group. While for the off pump group, 50% had diabetes, 35.29% had hypertension, 8.82 % had COPD and 14.70% had renal dysfunction.

CARDIOPULMONARY BYPASS CONDUCTION

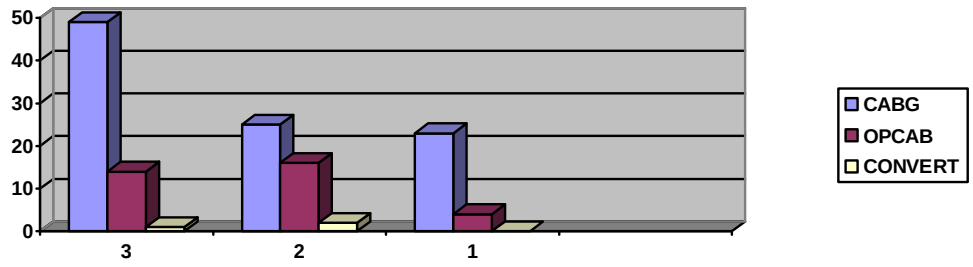
	Present Study	Hasse et al
ACC Time	53.4 ± 23.35 mins	54.3 ± 27.1 mins
CPB Time	117 ± 36.44 mins	78.6 ± 36 mins



In the conduction of the cardiopulmonary bypass in the on-pump patients in the present study, the mean aortic cross clamp time was 53.4 ± 23.35 minutes and the mean total cardiopulmonary bypass time was 117 ± 36.44 mins while comparison with the Hasse et al study where the mean aortic cross clamp time was 54.3 minutes and the mean cardiopulmonary bypass conduction time was 78.6 minutes.

NUMBER OF GRAFTS

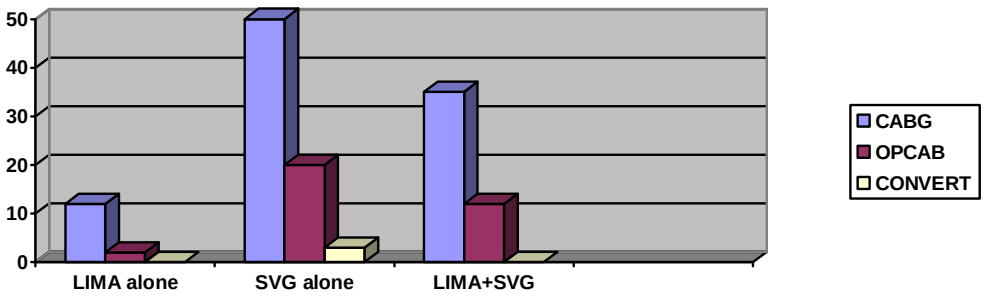
	THREE	TWO	ONE
CABG	49	25	23
OPCAB	14	16	4
CONVERTED	1	2	0



In the patients who had on-pump CABG, 50 % had 3 vessel grafts, 27% had 2 grafts and 23 % had single grafts. Of the patients who had off-pump surgery, 44.17% had 3 grafts, 47.05% had 2 vessel grafts and remaining 11.76% had single vessel graft.

TYPE OF GRAFTS

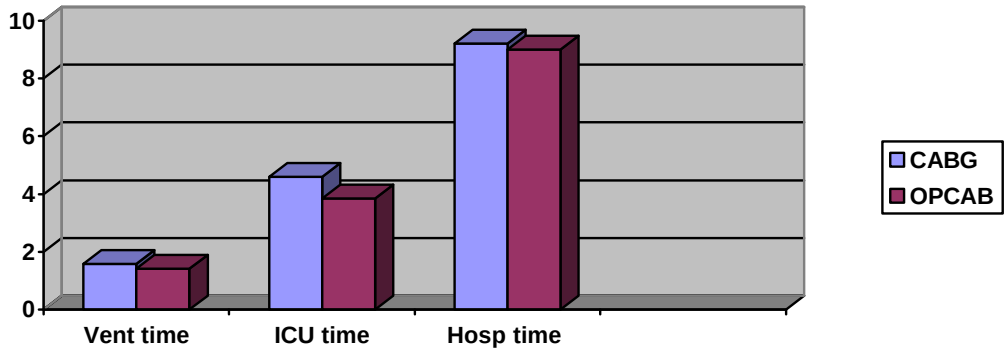
	LIMA alone	SVG alone	LIMA+SVG
CABG	12	50	35
OPCAB	2	20	12
CONVERTED	0	3	0



In the Present study, two types of vascular grafts were used. The left internal mammary artery graft and the great saphenous vein graft. Majority was using Saphenous vein graft alone, 50 patients in the on-pump group and 20 in the off-pump group. Next in strength were a combination of both grafts, i.e. 35 patients in the on-pump group, and 12 in the off-pump group. While LIMA alone was used in 12 patients who underwent on-pump bypass surgery, only 2 in the off-pump group had LIMA alone. It was interesting to note that LIMA usage was more in the on-pump group , probably given the lesser amount of strain involved as the patient is run on a cardiopulmonary bypass machine.

DURATION OF CARE

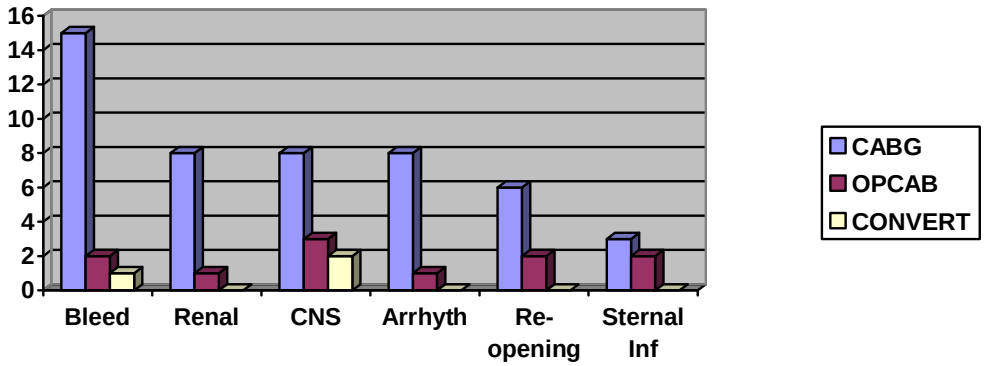
	Ventilation	ICU	Hospital
CABG	1.58 days	4.6 days	9.21 days
OPCAB	1.41 days	3.85 days	9 days



During the postoperative period, the duration of ventilation, intensive care and total hospital stay were noted. It was observed that the mean ventilation time was 1.58 ± 1.13 days in the on-pump group, while it was 1.41 ± 0.98 days in the off-pump group of patients. The duration of mean intensive care was 4.6 ± 2.8 days in the on-pump group, while it was 3.85 ± 1.9 days in the off-pump group. And the average hospital stay period was 9.21 ± 1.03 in patients in the on-pump group , while it was 9 ± 0.42 days in the off-pump group.

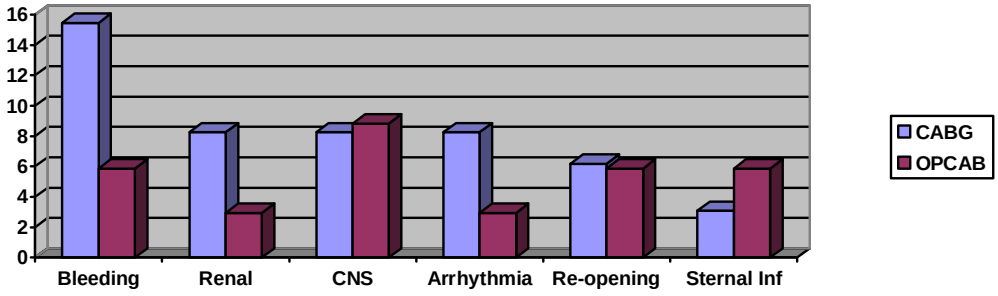
POSTOPERATIVE COMPLICATIONS

	Excess Drainage	Renal	CNS	Arrhy-thmia	Re-opening	Sternal Inf
CABG	15	8	8	8	6	3
OPCAB	2	1	3	1	2	2
CONVERTED	1	0	2	0	0	0



DISTRIBUTION OF COMPLICATIONS

	Excess Drainage	Renal	CNS	Arrhythmia	Re-opening	Sternal Inf
CABG	15.46%	8.25%	8.25%	8.25%	6.18%	3.09%
OPCAB	5.88%	2.94%	8.82%	2.94%	5.88%	5.88%



The most common postoperative complication was excess drainage. The mean quantity of postoperative bleeding was 479.60 ml in the on-pump bypass group with a standard deviation of 291.69 ml, while in the off-pump group it was 335.58ml with a standard deviation of 220.58 ml. While the range extended from 150 ml to 1500ml for the on-pump group, it was 150 to 1350 ml for the off-pump group , with only one patient in the off-pump group having more than 1000 ml drainage. Although 16 patients had significant bleeding, reopening for excess drainage as the primary cause was done for only 3 patients in the on-pump group, the remaining done for other various causes causing hemodynamic instability. In the off-pump group, reopening for bleeding as the primary cause was done in only 1 patient, the other reopening done for hemodynamic instability due to VT.

Other important primary complications studied were renal and CNS complications. Postoperative renal failure was seen in 8 patients in the on-pump group, of whom 6 had preoperative elevated renal parameters and were operated in consensus with nephrologist's opinion. 2 patients who had normal renal function preoperatively developed renal failure postoperatively, of whom one was treated medically and one required dialysis. There were 7 patients who had preoperative renal

dysfunction, of whom 6 had postoperative renal failure and the remaining one had no postoperative renal complication.

In the off pump group, 5 patients had preoperative compromised renal function, but only 1 patient developed renal failure postoperatively, while the remaining 4 and the rest of the group had no renal problems.

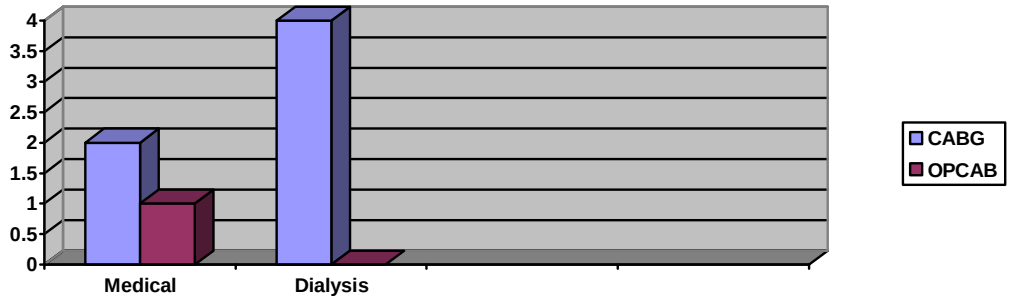
CNS COMPLICATIONS

With reference to neurological complications, among the 134 total patients, 13 patients developed neurological complications. Among these patients, 8 belonged to the on-pump group, 3 to the off-pump group and 2 belonged to the converted group. Approximately, 10% of the on-pump patients developed neurological complications, where as it was 9% in the off-pump group. The range of neurological complications varied from cerebrovascular accident like monoplegia, hemiplegia to Hypoxic encephalopathy. Among the 13 patients who developed neurological complications, 9 patients (69.23%) developed monoplegia and hemiplegia, while the remaining 4 patients (30.77%) developed hypoxic encephalopathy.

All neurological complications were referred to expert neurological opinion and guidance for management. Neurological impairment after bypass surgery may be attributable to hypoxia, emboli, hemorrhage, and/or metabolic abnormalities. Postoperative neurological deficits have been divided into type 1 (associated with major focal neurological deficits, stupor, or coma) and type 2 (in which deterioration in intellectual function is evident). Adverse cerebral outcomes are observed in approximately 6% of patients after bypass surgery, divided equally between type 1 and type 2 deficits. Predictors of type 1 deficits include proximal aortic atherosclerosis (defined by the surgeon at operation), prior neurological disease, use of an intraaortic balloon pump (IABP), diabetes, hypertension, unstable angina, and increased age. Predictors of type 2 deficits include history of excess alcohol consumption, arrhythmias including atrial fibrillation, hypertension, prior bypass surgery, peripheral vascular disease, and congestive heart failure.

POSTOPERATIVE RENAL FAILURE – MANAGEMENT

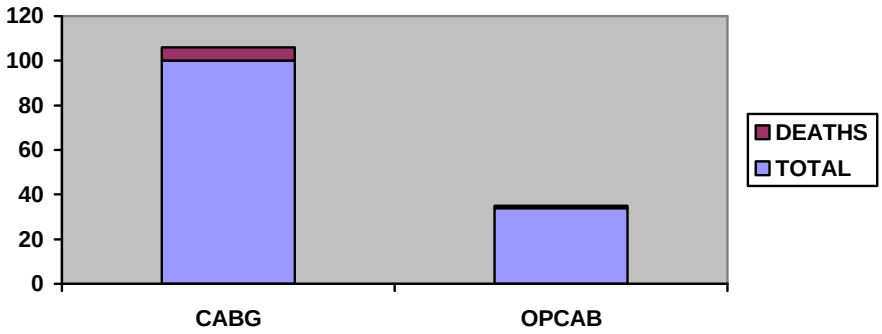
	Medical	Dialysis
CABG	2	4
OPCABG	1	0



Of the 100 patients who underwent on-pump bypass surgery, 6 patients developed postoperative complication of renal failure, while in the off- pump group, only 1 patient developed renal failure postoperatively. Of these total 7 patients, 2 in the on-pump group were treated medically successfully, while the remaining 4 in the on-pump group had undergone dialysis treatment for renal failure. A single patient in the off-pump group was treated medically.

MORTALITY

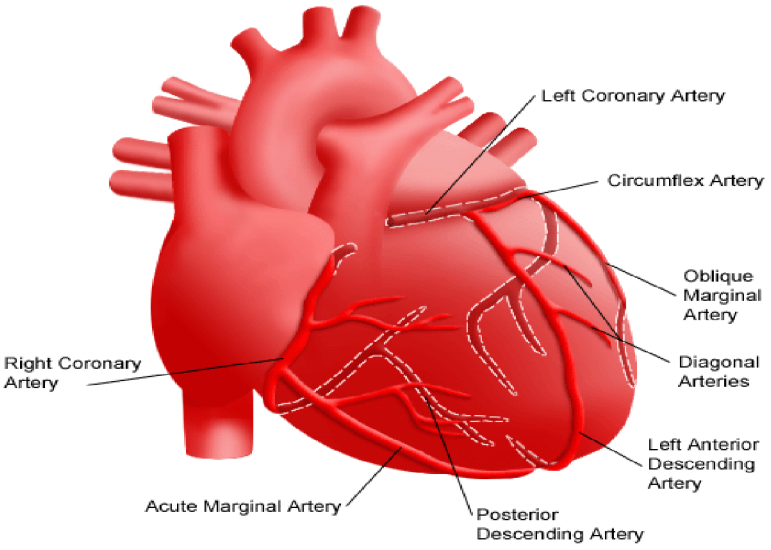
PATIENTS	CABG	OPCABG
TOTAL	100	34
DEATHS	6	1

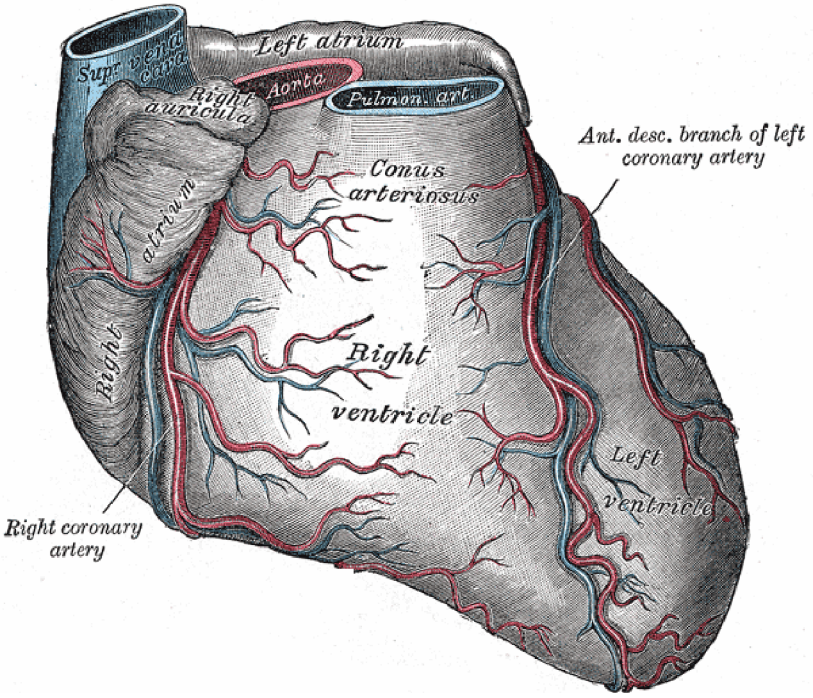


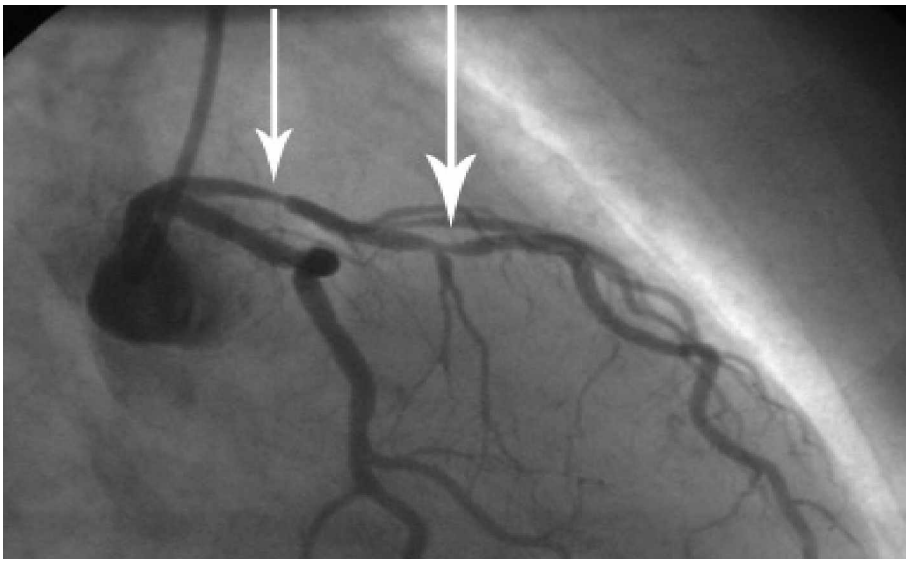
Of the total number of patients, 100 belonged to the on-pump group (including the 3 patients who were converted from off-pump to on-pump CABG) and 34 to the off-pump group. Of these, there was a mortality of 6 patients in the on-pump group, i.e. 6% of the on-pump patients, while in the off-pump patients there was one death, i.e. 2.9% of the 34 patients.

The deaths were due to low cardiac output syndrome with prolonged ventilator support and multiorgan failure in 5 patients and arrhythmia not amenable to medical management in two patients.

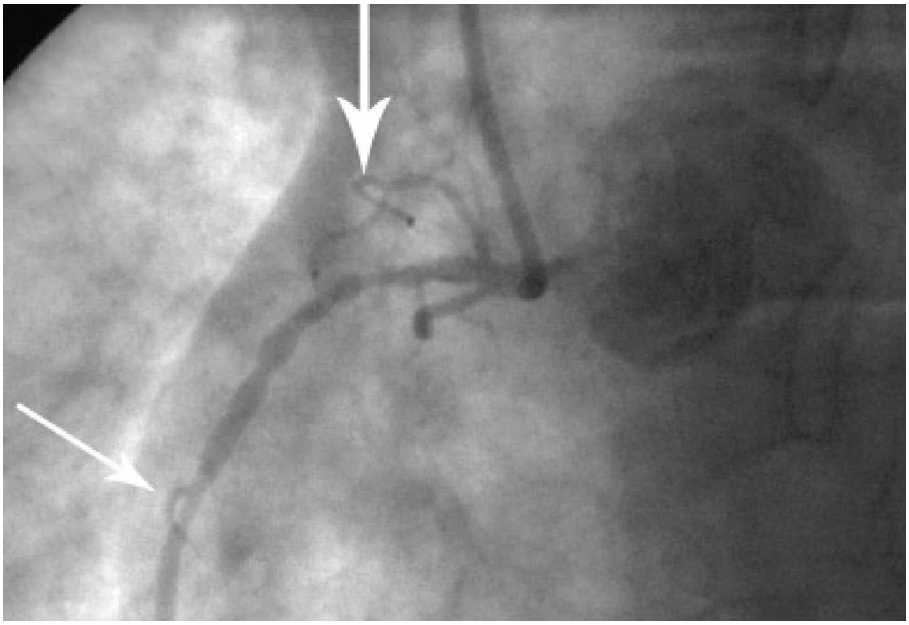
Coronary Arteries of the Heart



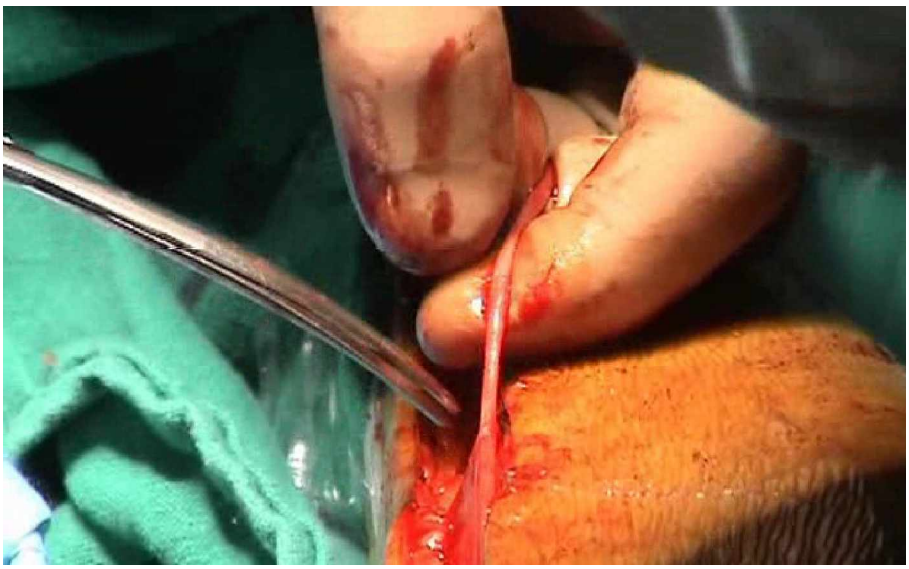




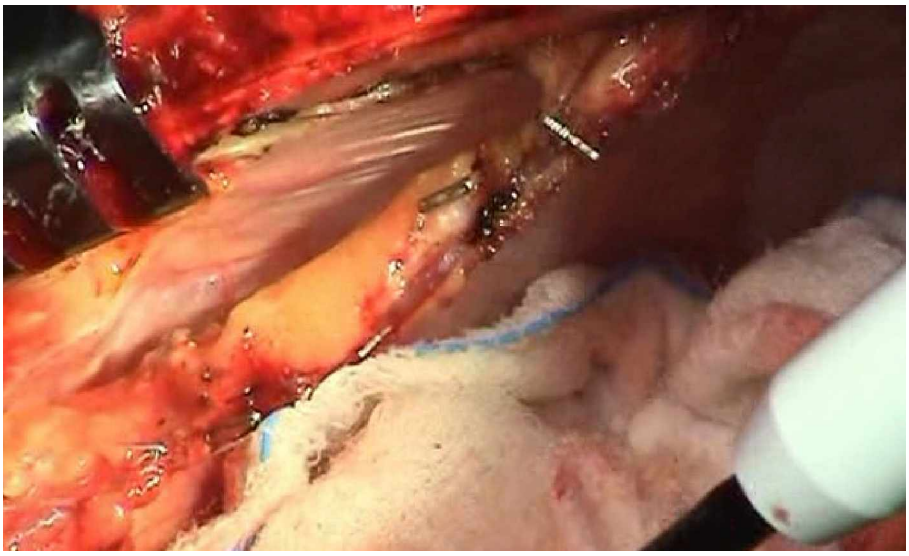
CORONARY ANGIOGRAM – LAD STENOSIS



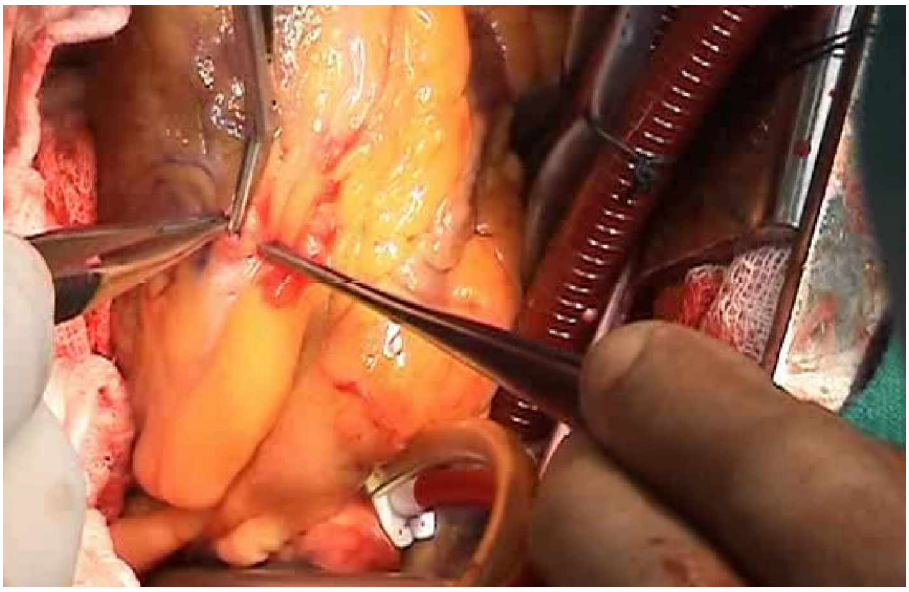
CORONARY ANGIOGRAM – RCA STENOSIS



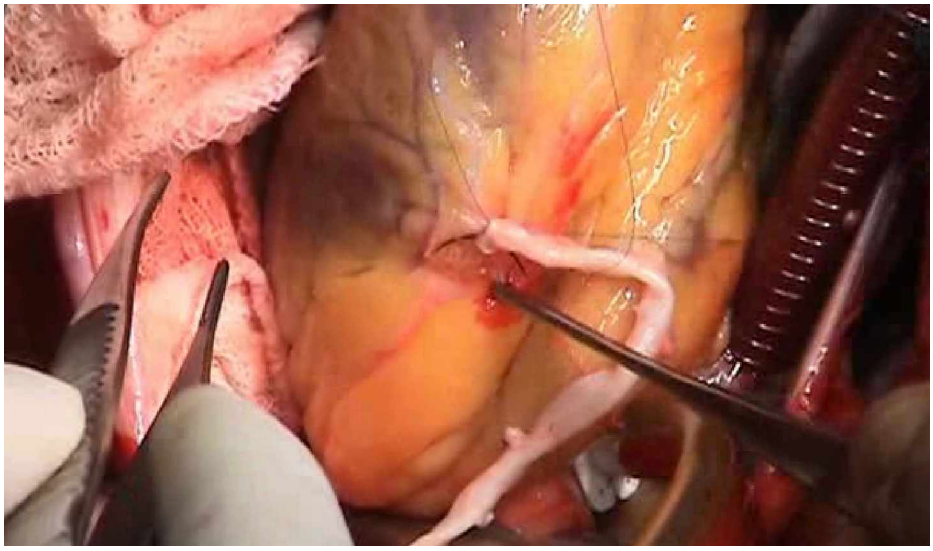
SAPHENOUS VEIN HARVESTING



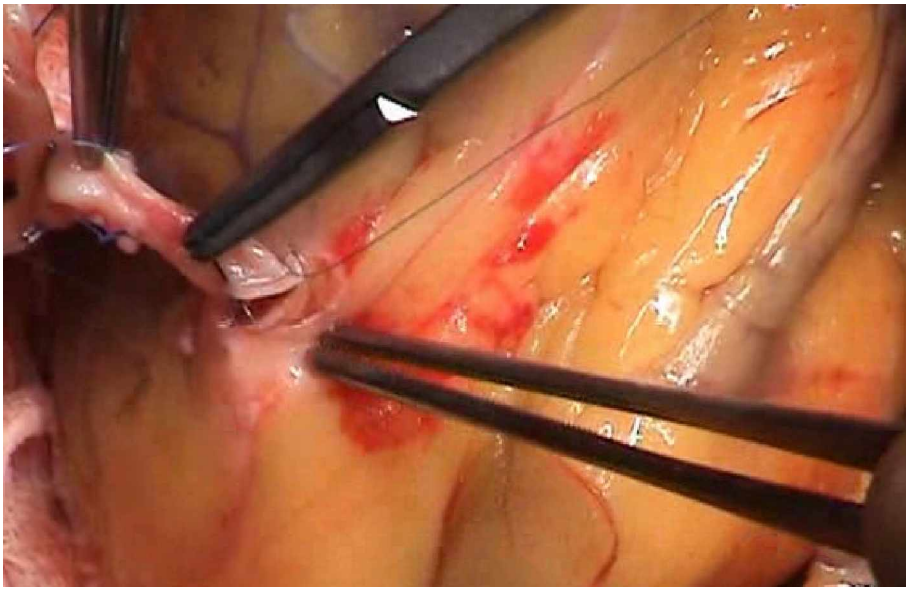
LEFT INTETRNAL MAMMARY ARTERY HARVESTING



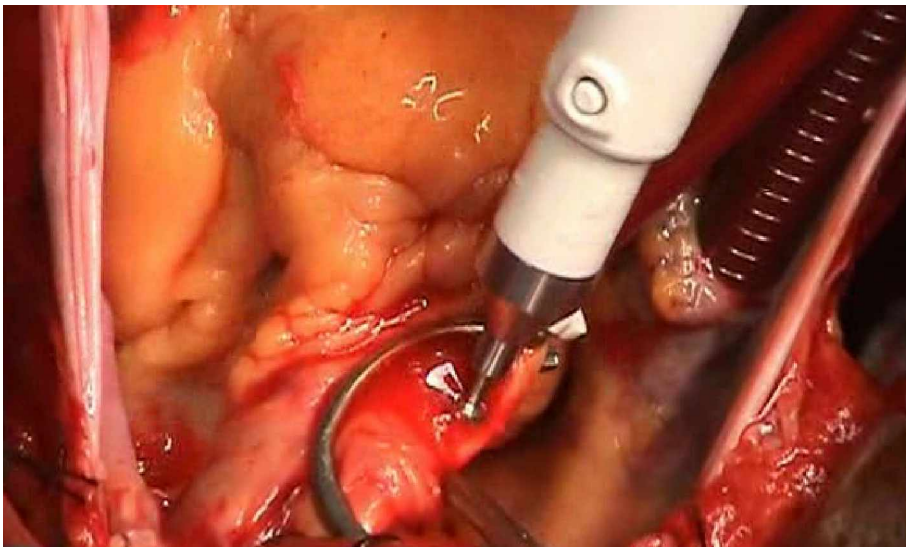
DISTAL CORONARY ARTERIOTOMY – DIAGONAL ARTERY



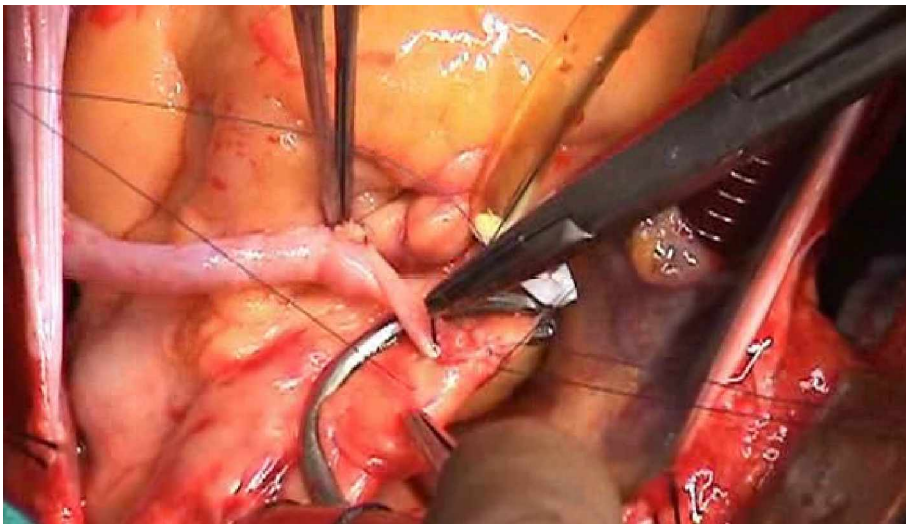
DISTAL ANASTOMOSIS – SAPHENOUS GRAFT



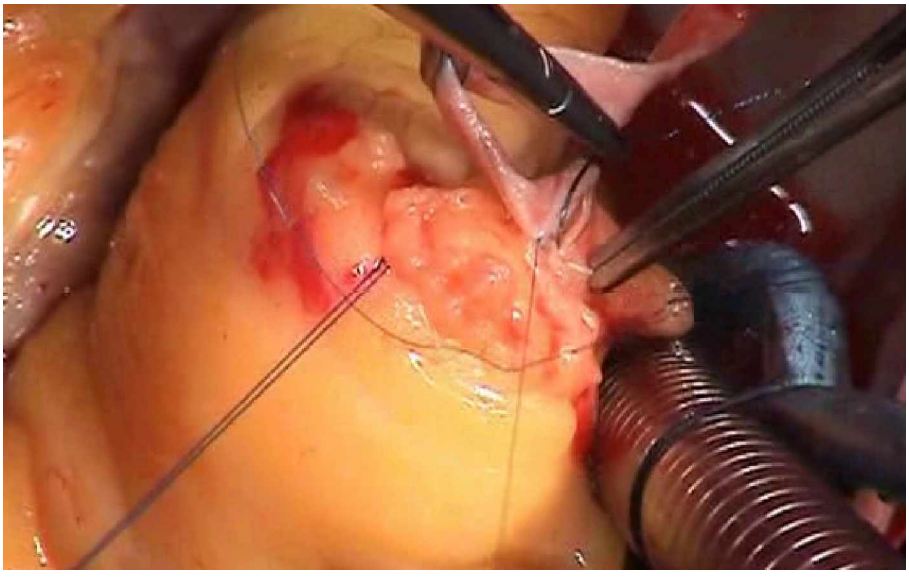
DISTAL ANASTOMOSIS – SAPHENOUS GRAFT



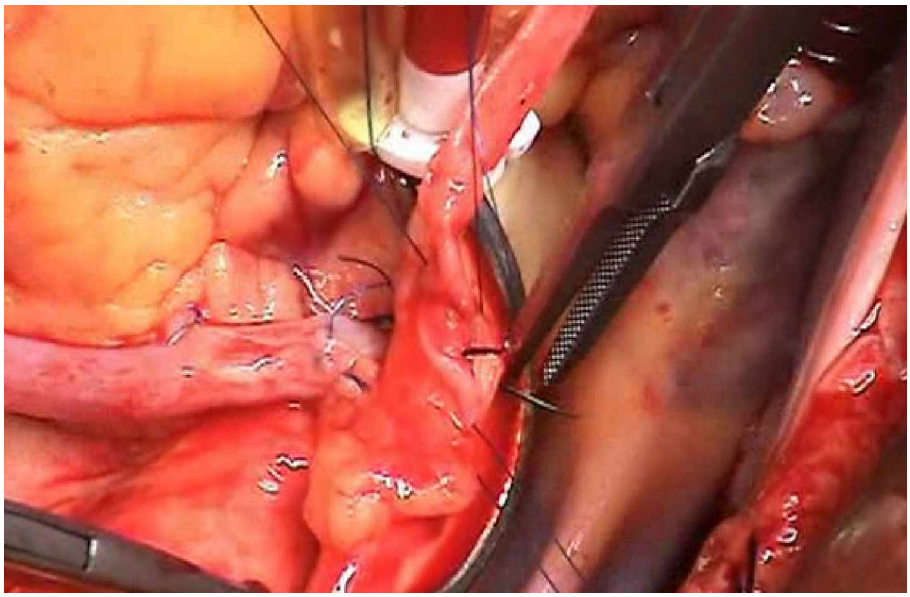
AORTIC PUNCH FOR PROXIMAL ANASTOMOSIS



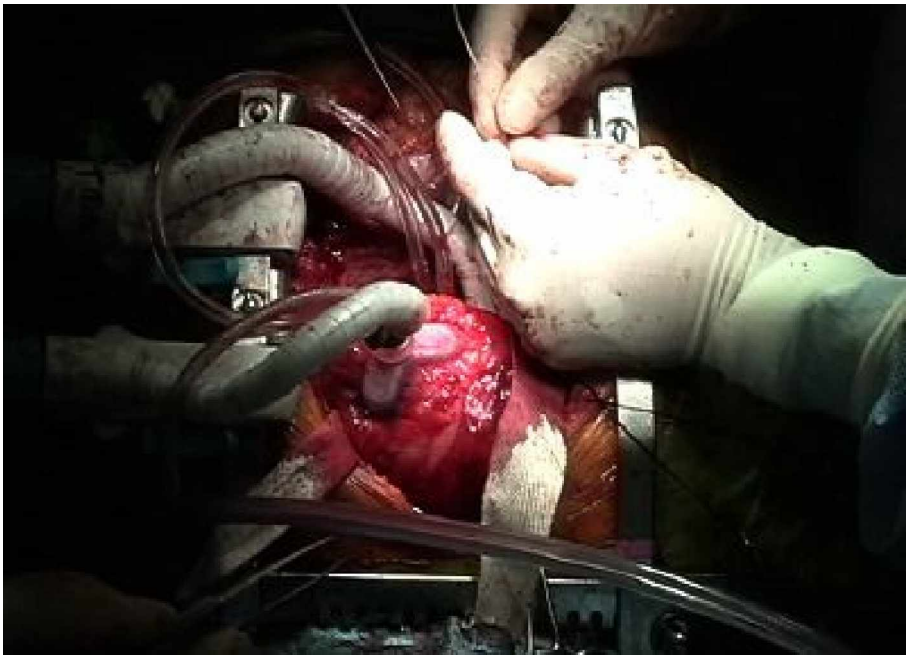
PROXIMAL ANASTOMOSIS – ONPUMP



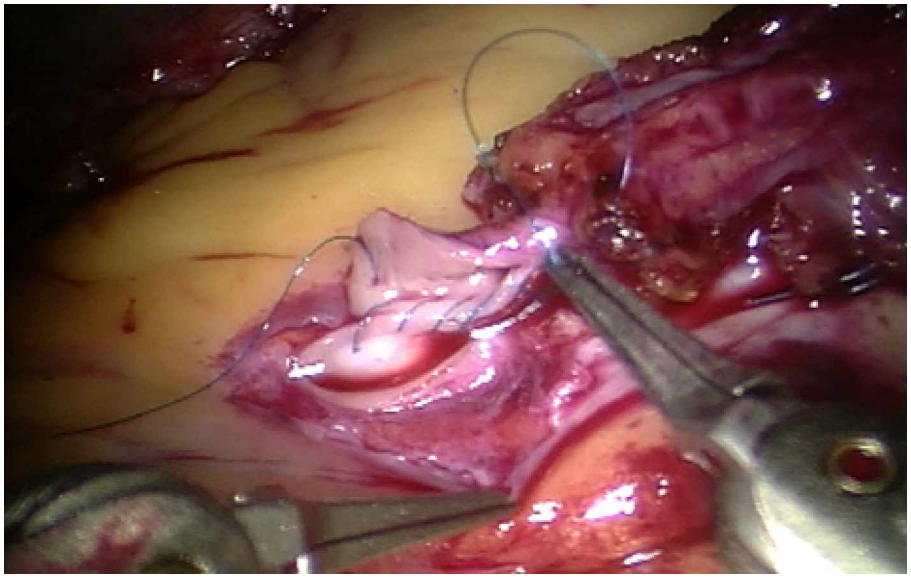
DISTAL ANASTOMOSIS – RCA –
SAPHENOUS GRAFT - ONPUMP



PROXIMAL ANASTOMOSIS – ONPUMP

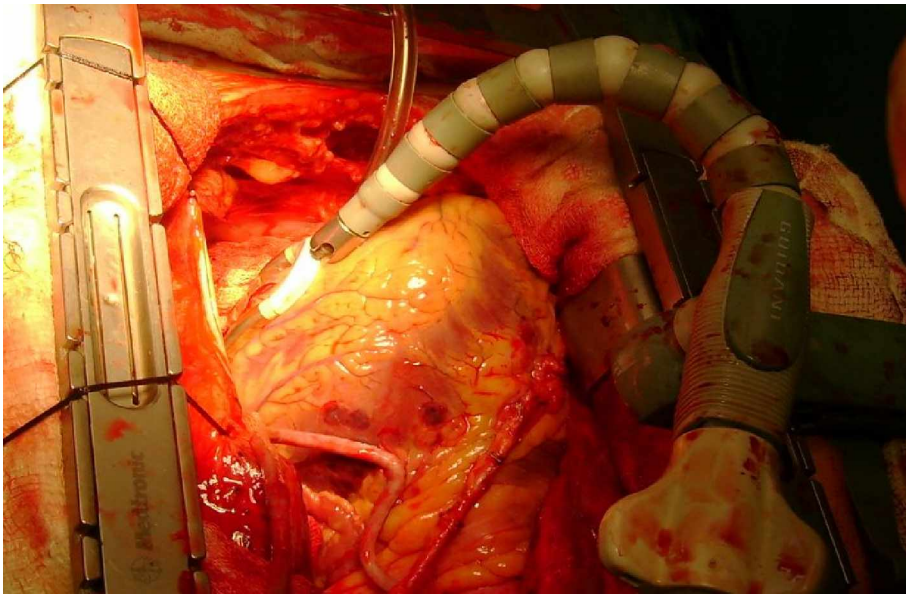


OPCAB IN PROGRESS

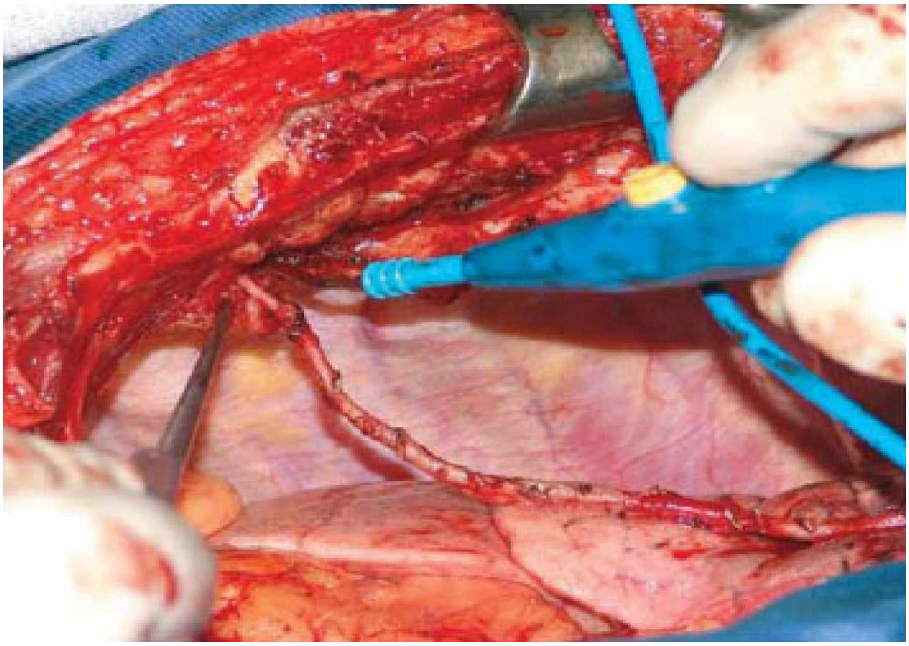


DISTAL ANASTOMOSIS USING LIMA

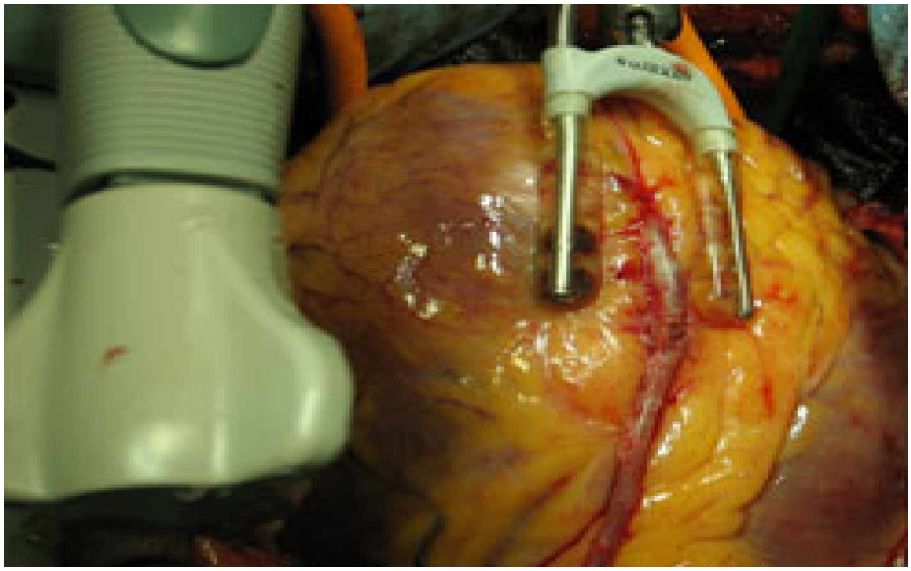
OFF-PUMP STABILIZING INSTRUMENTS



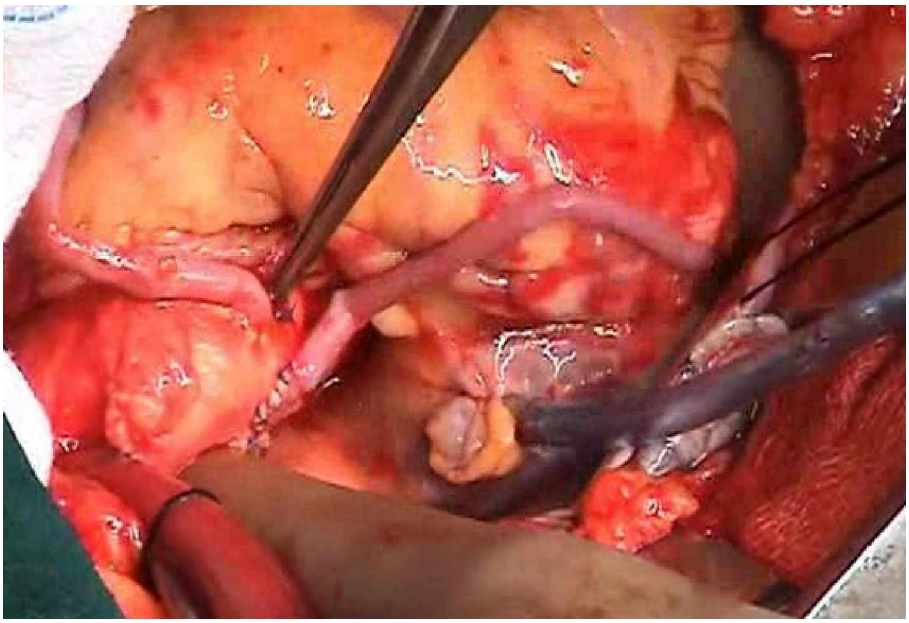
OPCABG IN PROGRESS



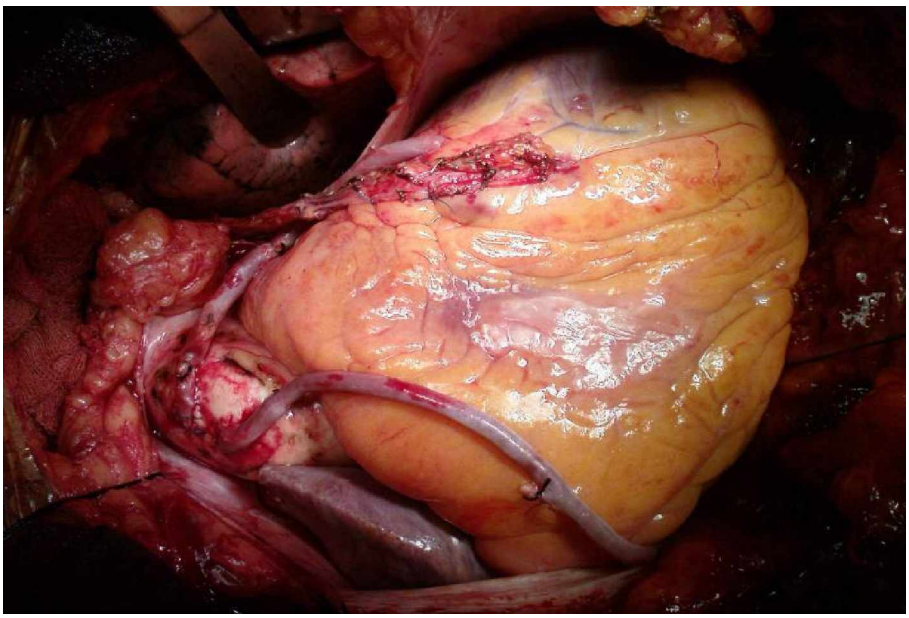
SKELETONISED LIMA



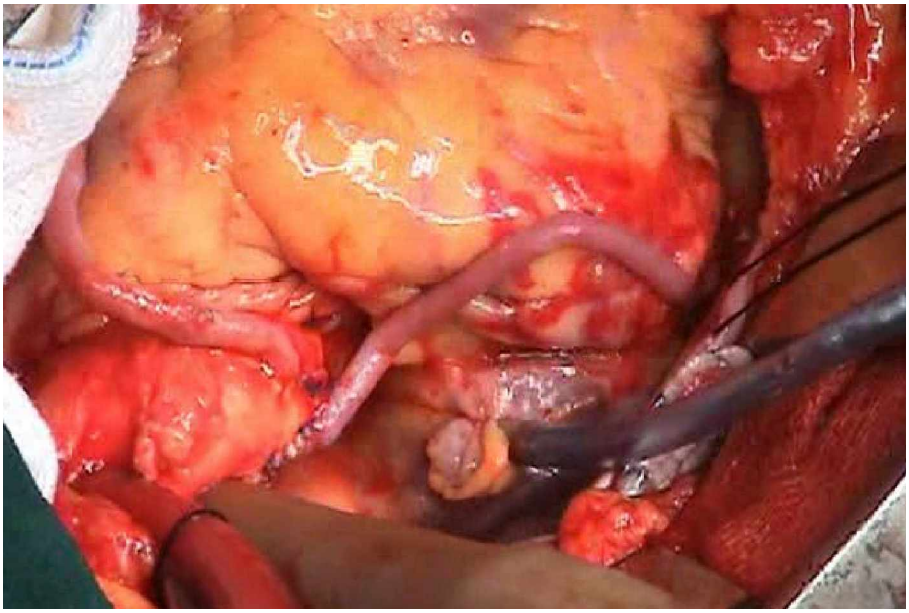
OPCABG – DISTAL ANASTOMOSIS



CHECKING HEMOSTASIS



POST CABG



POST CABG

Discussion

For decades the use of cardiopulmonary bypass has been recognized as the main cause of a complex systemic inflammatory response, which significantly contributes to several adverse postoperative outcomes, including renal, pulmonary, or neurological complications, bleeding, and even multiple organ dysfunction (14).

Coronary artery bypass graft (CABG) surgery is among the most common operations performed in the world and accounts for more resources expended in cardiovascular medicine than any other single procedure (13).

Beating heart operations were reintroduced to routine clinical practice 17 years ago as a last-resort technique limited to patients at high-risk of cardiopulmonary bypass–induced complications. The pioneering off-pump procedures, in which anastomoses were performed on moving and bloody coronary vessels, were technically demanding, and the revascularization of the lateral wall of the left ventricle was often not feasible. After the recent development of effective devices for target vessel exposure and stabilization, off-pump coronary artery bypass grafting (OPCAB) has gained widespread use as an alternative technique and is now challenging conventional on-pump grafting as the standard for surgical therapy in multivessel disease (14).

Seven core variables are the most consistent predictors of mortality after coronary artery surgery (13):

- Priority of operation
- Prior heart surgery
- Left ventricular ejection fraction (LVEF)
- Number of major coronary arteries with significant stenoses
- Advanced age
- Gender
- Percent stenosis of left main coronary artery

The present study being a retrospective non-randomized study, the total number of patients were 134, 100 belonging to the on-pump group and 34 belonging to off-pump group. Among the other studies used for comparison, Mack et al studied on 10118 on-pump patients and 7283 off-pump patients, while Cleveland Clinic study involved 406 each of on-pump and off-pump patients, Nathoe et al study involved 139 on-pump and 142 off-pump patients. A more relevant study with regard to local population, Raghuram et al involved 53 on-pump and 48 off-pump patients (15,17,6,22).

Mean age in the on-pump group was 50.51 while it was 49.02 in the off-pump patient group, when compared to Raghuram et al , which was 57.4 and 59.6 respectively. One western study by Hasse et al had a mean age of 64.7 and 65.9 respectively, indicating the earlier occurrence of coronary artery disease in the Indian population (15,6,19).

As per Raghuram et al, the sex distribution was 46:7 in the on-pump group and 48:0 in the off-pump group. In this study it was 89:11 and 28:6 respectively, compared with Hasse et al who showed a distribution of 66:24 and 56:34 respectively. This distribution indicates that when compared to the west, coronary artery disease is less prevalent in Indian female population (15,6,19).

In the analysis of the co morbid factors, diabetes, hypertension, chronic obstructive pulmonary disease and hyperlipidemia were given particular attention. In this study, there was a 53% incidence of diabetes in the on-pump group , while it was 50% in the off-pump group. As per Raghuram et al , it was 60.4% and 52.1% respectively and 32.2% and 20% respectively in Hasse et al study. The picture shows more prevalence of Diabetes in the Indian population (15,6,19).

Hypertension was present in 47.2% and 52.1% respectively in the on-pump and off-pump groups in the Raghuram et al study, while it was 28% and 35.29% respectively in this study. Chronic obstructive pulmonary disease was another co morbid risk factor analyzed in this study which was present in 10% of the on-pump patients and 8.82% of the off-pump patients, while it was 9.4% and 16.7% in Raghuram et al study and 11.1% and 11.1% respectively in the Hasse study (15,6,19).

Hyperlipidemia was present in 46% of on-pump patients and 38.23% of off-pump patients in this study, while it was 52.8% and 58.3% respectively in Raghuram et al study and 57% and 77.8% respectively in Hasse et al study (15,6,19).

The mean preoperative Left ventricular Ejection Fraction was 55.09% and 57.17% in the Present study, compared to 44.5 and 39.5% respectively in the Raghuram et al study. With regard to Hasse et al, there was a finding of 35.6% and 32.2% of patients who had LVEF < 50% in the on-pump and off-pump groups respectively (15,6,19).

In the present study 7% and 2.94% of the CABG and OPCABG respectively had preoperative renal dysfunction, compared to 7.5% and 10.4% respectively by Raghuram study. Preoperative renal dysfunction was present in 7% and 2.94 % in the on-pump group and off-pump group respectively in the present study, while it was 7.5% and 10.40% respectively according to Raghuram et al (15,19).

With regard to the operative particulars, the left internal mammary artery was used in 96.2% and 93.8% respectively in the on-pump and off-pump group in the Raghuram et al study, compared to 47% and 41.17% respectively in the present study. The average number of grafts used in this study was 2.25 in the On-pump group compared to 2.29 in the off-pump group, while it was 3.2 and 3.0 respectively in the Raghuram et al study.

With regard to the western studies, the average number of grafts was 2.7(on-pump) and 2.3 (off-pump) as per Straka et al, 3.4(on-pump) and 3.4(off-pump) in the Puskas et al study, 3.5(on-pump) and 2.8(off-pump) in the Cleveland Clinic study, 2.6 (on-pump) and 2.4(off-pump) in the Nathoe et al study, and 2.1(on-pump) and 2.1(off-pump) as per Hasse et al study (15, 17, 6, 19, 22, 23, 24, 25, 26).

While analyzing the average Aortic Cross clamp time and Cardiopulmonary bypass time in the on-pump groups, it was found to be 53.4 ± 23.35 minutes and 117.03 ± 35.44 minutes respectively, while as per Hasse et al it was 54.3 ± 27.1 minutes and 78.6 ± 36 minutes respectively. No statistics regarding the same was available in the more comparable Indian study by Raghuram et al for comparison (15,6,19).

In the statistical analysis of the post operative period, the average ventilation time was found to be 1.58 ± 1.13 days in the on-pump group, while it was 1.41 ± 0.98 days in the off-pump group, while in comparison it was 6.5± 4.5 hours (on-pump) and 6 ± 4.5 (off-pump) in the Raghuram et al study. There was no statistics in the western studies regarding the same for comparison except by Hasse et al who showed an average ventilation time of 11.25 hours (on-pump) and 11.45 hours (off-pump) (15,6,19).

Intensive care period was averagely 4.6 ± 2.8 days (on-pump) and 3.8±1.9days (off-pump) according to this present study statistics, while it was 1.4 (on-pump) and 1.2 (off-pump) respectively in the Raghuram et al study. Like the average ventilation time, not much statistics regarding the intensive care period was available in the western studies for comparison (15,19).

The average period of hospital stay in the present study was 9.21 ± 1.03 days (on-pump group) and 9.0 ± 0.43 days (off-pump group) , while in the Raghuram et al study it was 9.9 ± 3.4 days and 8.2 ± 0.7 days respectively. The total hospital stay period was comparable in the on-pump group while in the off-pump group, there was a difference of 1 day averagely between Raghuram et al and this present study (15).

When analyzing the postoperative complications, it was noted that excess drainage was the most common complication in the present study, the other complications being renal failure, neurological complications and Sternal wound infections. The other mentionable complication was arrhythmia. The average amount of drainage in this study was 476 ± 291 ml in the on-pump group and 335 ± 220 ml in the off-pump group, while in comparison it was 510 ± 348 ml (on-pump) and 488 ± 348 ml (off-pump) according to Raghuram et al (15,6).

Regarding the other complication of renal failure, it was seen in 6.18% (on-pump) and 2.94% (off-pump) respectively while in the Raghuram et al study it was 5.7% and 4.5% respectively. Comparing the other study reporting renal failure , the Cleveland Study reported a 1.5% of renal failure in the on-pump group, while no renal failure was noted in the off-pump group (15,6).

On analyzing the mortality data, it was calculated that in the present study in the on-pump group it was 6.18% and in the off-pump group it was 2.94%.

In comparison it was nil mortality in both the groups in the Raghuram et al study, while in the Mack et al study it was 3.5%(on-pump) and 1.9% (off-pump) and in the Gerola et al study it was 3.7% (on-pump) and 1.2% (off-pump) . With regard to the mortality statistics, the increased rate of mortality in the on-pump group in the present study is compounded by the fact that the off-pump converted to on-pump group is finally included in the on-pump group and the proportion of complications and mortality might be due to the increased morbidity due to the reasons for conversion from off-pump to the on-pump group (15,6,22,23).

	Racz et al		Mack et al		Cleveland Clinic	
	CABG	**OPCABG**	**CABG**	**OPCABG**	**CABG**	**OPCABG**
Strength			10118	7283	406	406
Age						
Sex(M:F)						
MI						
Diabetes						
Hypertension						
Smoker						
COPD						
Hyperlipid						
EF						
Renal dysfn						
Ht						
Peroperative						
LIMA						
No: grafts					3.5±1.1	2.8±1.0
Duration						
of surgery						
Postoperative						
Vent time						
RF					1.50%	0
Bleed	2.20%	1.60%				
LCO						
ICU stay						
Hosp stay						
Sternal inf					2%	0.20%
mortality			3.50%	1.90%		
Opn length						
CPB time						
ACC time						
Vent time						
STROKE	2%	1.60%				
GIT comp	0.90%	1.20%				
3yr followup	89.60%	88.80%				

	Gerola et al		Straka et al		Puskas et al	
	CABG	**OPCABG**	**CABG**	**OPCABG**	**CABG**	**OPCABG**
Strength						
Age						
Sex(M:F)						
MI						
Diabetes						
Hypertension						
Smoker						
COPD						
Hyperlipid						
EF						
Renal dysfn						
Ht						
Peroperative						
LIMA						
No: grafts			2.7	2.3	3.4±1.1	3.4±1.0
Duration						
of surgery						
Postoperative						
Vent time						
RF						
Bleed			680ml	560ml	898±434	1031±552
LCO						
ICU stay						
Hosp stay	8.0±3.1	7.6±3.4				
Sternal inf						
mortality	3.70%	1.20%				
Opn length						
CPB time						
ACC time						
Vent time						
STROKE						
GIT comp						
3yr followup						

	Raghuram et al		Hasse et al		Present Study	
	CA BG	**OPCA BG**	**CA BG**	**OPCA BG**	**CA BG**	**OPCA BG**
Strength	53	48			100	34
Age	57.4±6.25	59.6±6.58	64.7±9.3	65.9±9.1	50.5±8.22	49.0±8.0
Sex(M:F)	46/7	48/0	66/24	56/34	89/11	28/6
MI	56.60%	43.80%				
Diabetes	60.40%	52.10%	32.20%	20%	53%	50%
Hypertension	47.20%	52.10%			28%	35.29%
Smoker	34.60%	61.70%	11.10%	23.30%	22%	20.59%
COPD	9.40%	16.70%	11.10%	11.10%	10%	8.82%
Hyperlipid	52.80%	58.30%	57%	77.80%	46%	38.23%
EF	44.5±26.4%	39.5±30.8%	EF<50% 35.60%	32.20%	55.09%	57.17
Renal dysfn	7.50%	10.40%			7%	2.94%
Ht			252±80.8	213±56.7		
Preoperative						
LIMA	96.20%	93.80%				
No: grafts	3.2±0.9	3.0±0.9	2.1±0.8	2.1±0.8	2.25	2.29
Duration						
of surgery	3.66±0.98	3.56±0.77	252±80.8	213±56.7		
Postoperative						
Vent time	6.5±4.5	6±4.5			2.47 ± 2.9	2.02 ± 2.4
RF	5.70%	4.50%			6.2%	2.9%
Bleed	510±348	488±348			476	335
LCO						
ICU stay	1.4	1.2			4.6 ± 2.8	3.85 ± 1.9
Hosp stay	9.9±3.4	8.2±0.7	10.9±5.6	12.3±12.7	9.2 ± 1.03	9 ± 0.43
Sternal inf	0	0				
Mortality					6.18%	2.94%
Opn length						
CPB time			78.6±36		117±36	
ACC time			54.3±27.1		53.4±23.3	
Vent time			675.7±996	687±1183	2.47±2.9	2.09±2.45
STROKE						
GIT comp						
3yr followup						

Interpretation of Results

The incidence of coronary artery disease is observed to be more in males than the females in the local population.

Triple vessel disease is more common in the distribution of coronary artery disease in the study population compared to two vessel and single vessel disease.

The peak incidence of coronary artery disease was more in the fifth decade of life followed by the 51 to 60 age group when compared to the other age groups. This distribution is in stark contrast to the western population where coronary disease is more common after 60 years age indicating the shift of the disease to the younger age groups in the local population in India.

The morbidity of the disease is increased by the various range of co-morbid diseases that co-exist with coronary disease. Diabetes, hyperlipidemia and hypertension are the most common co-morbid diseases seen in the study population. The other lesser common ones are COPD and renal dysfunction.

Statistical analysis of the on-pump patients shows that the morbidity is more in patients who are converted from off-pump to on-pump, indication of the cause of the conversion being hemodynamic instability.

The most commonly used grafts were the left internal mammary artery graft and saphenous vein grafts.

The conduction of the bypass surgery was easier in the on-pump group due to the better convenience to manipulate the heart without compromising the hemodynamic status of the heart.

In the postoperative period, the mean ventilation time and intensive care time was marginally lesser in the off-pump patients. The overall hospital stay period shows very little difference between the two groups.

Among the postoperative complications, bleeding was the most common, followed by renal and CNS complications. The other lesser complications were arrhythmias , and sternal wound infection and mediastinitis. It is noteworthy to mention here that arrhythmias were primary complications in a lesser number of patients than noted and more secondary as a result of the other complications of the patients.

The calculated mortality was found to be more in the on-pump group compared to the off-pump group. But hidden within this fact is the probability that this increased rate was a result of bias on part of the operating surgeons to plan for on-pump surgery in the more complicated patients. But despite this bias, there is a noticeable difference in the mortality in the on-pump patients compared to the off-pump patients.

Conclusion

The result of this analysis indicates that off-pump surgery is associated with less operative mortality and morbidity than on-pump surgery and that the use of cardiopulmonary bypass is an independent risk factor for mortality.

Certain results are worthy of note. The first is that the use of cardiopulmonary bypass is an independent risk factor for mortality. Second, there appears to be a particular benefit of avoiding CPB in those subgroups generally considered high risk for CABG surgery, including the elderly, women, and patients undergoing reoperative operations. Third, as well as a mortality benefit, the performance of beating-heart surgery is associated with a significant decrease in perioperative morbidity including the need for blood transfusions, return to the operating room for bleeding, respiratory complications, and new-onset renal failure.

A further potential benefit of beating-heart surgery was hoped to be improved neurological outcomes.

This data despite its methodological shortcomings, support a benefit for OPCAB, which is consistent with numerous previous studies. In addition, OPCAB benefit persists despite elevated risk among those patients preferentially operated on off-pump. Ability to achieve superior

outcomes in high-risk patients in terms of mortality and across a number of morbidity variables clearly speaks to the potential clinical benefit of this operation.

Although not randomized, this study adds to the increasing body of patients and among sample sizes sufficient to form a generalized conclusion. The present study suggests that OPCABG reduces length of hospital stay, operative morbidity, and operative mortality as compared with on-pump coronary artery bypass surgery.

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Annexure

ANNEXURE – I

PROFORMA

Patient Name :

Age /Sex :

MRD No :

Address :

Date of Admission :

Date of Surgery :

Date of Discharge :

Chief complaints :

Cardiac Symptoms :

Past History :

General Examination : Pallor/ Cyanosis / Jaundice / Pedal Edema

PR: BP:

CARDIOVASCULAR SYSTEM :

RESPIRATORY SYSTEM :

INVESTIGATIONS

Hb: PCV: ESR:

Urea :

Creatinine :

Na+ :

K+ :

ECG :

CHEST X-RAY :

ECHO (TTE) :

CORONARY ANGIOGRAM :

DIAGNOSIS :

SURGERY :

No: of grafts :

Types of grafts :

ACC Time :

CPB Time :

POSTOPERATIVE :

Drainage :

Ventilation Time :

ICU Stay :

Hospital Stay :

COMPLICATIONS :

Renal :

Neurological :

Arrhythmias :

Re-opening :

Sternal Wound Infection :

OUTCOME

Discharged / Prolonged stay / Expired

ANNEXURE – II

ABBREVIATIONS

AF	-	Atrial Fibrillation
CABG	-	Coronary artery bypass grafting
CAD	-	Coronary artery disease
CHF	-	Congestive Heart Failure
COPD	-	Chronic obstructive pulmonary disease
CPB	-	Cardiopulmonary Bypass
IABP	-	Intra aortic balloon pump
LA	-	Left atrium
LAD	-	Left anterior descending artery
LCA	-	Left coronary artery
LIMA	-	Left internal mammary artery
LV	-	Left ventricle
LVAD	-	left ventricular assist device
MI	-	Myocardial infarction
ONCAB	-	On-pump coronary artery bypass grafting
OPCAB	-	Off-pump coronary artery bypass grafting

PDA	-	Posterior descending artery
RA	-	Right atrium
RCA	-	Right coronary artery
RV	-	Right ventricle
RVAD	-	Right ventricular assist device
VT	-	Ventricular tachycardia

Master Chart