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Anesthetic Challenges in off Pump Coronary Artery Bypass Surgery: A Surgeons Perspective

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Abstract

Recent surgical advances have made it possible for multiple grafts without going on Cardio Pulmonary Bypass (CPB). The major Anesthetic challenge is the maintenance of hemodynamic stability during manipulation of the heart. Proven benefits of Off-pump Coronary Artery Bypass (OPCAB) include a reduction in requirement for blood and blood products and benefit to high risk patient. Good communication between surgeon and anaesthetist is vital for a successful outcome. The rationale for avoiding CPB in favour of Off-pump Coronary Artery Bypass (OPCAB), has been the avoidance of the complications of CPB including systemic inflammatory response, coagulopathies, platelet dysfunction, accelerated fibrinolysis, depletion of clotting factors, neurological injury and renal impairment. With the improvement of surgical techniques and the development of cardiac stabilizing retractors, OPCAB has become an established procedure. Over the last 3 years at the Karen hospital we have done 64 OPCABG with good outcome. This technique could be a good alternative to conventional Coronary Artery Bypass Surgery (CABG), where centres with restricted surgical packages.

Keywords: OPCABG; CABG; off pump coronary artery bypass surgery; Cardio pulmonary bypass; CPB.

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Introduction

Off-pump coronary artery surgery was first developed in the 1960s. The subsequent introduction of Cardiopulmonary Bypass (CPB) and cardioplegia resulted in CPB becoming the preferred technique for coronary artery bypass grafting. Renewed interest in off-pump surgery occurred in the 1980s, especially in centres with limited resources.

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The rationale for avoiding CPB in favor of Off-pump Coronary Artery Bypass (OPCAB), has been the avoidance of the complications of CPB including systemic inflammatory response, coagulopathies associated with platelet dysfunction, neurological injury and renal impairment etc.Proven benefits of Off-pump Coronary Artery Bypass (OPCAB) include a reduction in requirement for blood and blood products. With the improvement of surgical techniques and the development of cardiac stabilizing retractors, OPCAB has become an established procedure. Surgical advances have made it possible for multiple grafts in all coronary territories.

The major Anesthetic challenge is the maintenance of hemodynamic stability during the procedure. OPCAB may be of more benefit to high risk rather than low risk patient.

Materials and Methods

From 2017 till today 64 patients underwent CABG at our hospital, of which 60 were off pump CABG. Four cases were converted to pump supported beating heart CABG as they had hemodynamic compromise. The average number of grafts were 2. All the patients had LIMA to LAD, and saphenous vein grafts to other vessels. Patients were extubated within 4 to 6 hours' time and ICU stay was not more than 48 hrs. 2 patients had superficial leg wound infection and 2 had post of dialysis on a short term. There were total of 3 mortalities in the post op period. One patient had massive GI bleed on day 6, and the other 2 died of renal failure as they had existing chronic Kidney Diseses.The average duration of discharge 5–7 days.

The key to successful OPCAB surgery is effective local cardiac wall stabilization to allow anastomotic suturing. Stabilizers placed on the epicardium over the planned site of arteriotomy reduce cardiac motion. The Octopus stabilization system (Medtronic Inc., Minneapolis, USA), which consists of two paddles with suction domes, has the advantage of lifting the anastomotic site, as opposed to depressing the site, thereby impairing ventricular filling (1). Cardiac displacement allows the exposure of posterior, lateral and inferior targets and can be achieved either by the placement of deep pericardial retraction sutures or using wet mops under the heart.

Bleeding from the arteriotomy site during anastomotic suturing is prevented by the use of intracoronary shunts that maintain coronary perfusion, prevent ischaemia and reduce back bleeding during suturing. A double limb shunt, which fits into the proximal and distal ends of the open coronary artery, is most commonly used. The use of shunts also prevents suture bites on the posterior arterial wall.

Anesthesia Management

- The Anesthetic goals of management of OPCAB surgery are: The provision of safe induction and maintenance of anesthesia using a technique that offers maximum cardiac protection.
- The maintenance of hemodynamic stability throughout surgery with the help of adequate monitoring and pharmacological support.
- Early ambulation in association with excellent postoperative analgesia. Avoiding CPB does not shorten the surgical procedure but it can accelerate immediate postoperative recovery and shorten ICU length of stay.

Conventionally high dose opioids in association with a combination of volatile agents and propofol, are often used when OPCAB is utilized (2) Whilst thoracic epidural anesthesia has been shown to dilate epicardial arteries and decrease myocardial oxygen demand at the same time as providing good postoperative analgesia, studies have failed to demonstrate any benefit from a combined technique over general anesthesia alone, except for earlier extubation (3) Techniques resulting in extubation in the operating room have not demonstrated any additional benefit or to be cost effective (4).

In contrast to CPB surgery, beating heart surgery requires the anaesthetist to maintain stable hemodynamic and rhythm in an environment that changes rapidly because of regional ischemia and cardiac manipulation. Good communication between the surgeon and anesthetist is essential. Adequate premedication is required and tachycardia should be avoided during induction of anesthesia.

There is some experimental evidence indicating that isoflurane and sevoflurane induce significant preconditioning giving some protection against ischemia; therefore, they may be particularly appropriate for OPCAB (5). Bradycardia was relied upon to provide the surgeon with a stable field. This has the added advantage of a reduction in myocardial oxygen consumption, especially at a time when supply may be compromised. Esmolol has the advantage of being cardio selective, with a rapid elimination half-life, allowing for rapid control of rate and quick return to normal hemodynamic on stopping the drug.

Cardiac displacement increases the risk of intraoperative arrhythmias, especially reperfusion arrhythmias. Therefore, serum potassium is maintained at >4.5 mmol litre^{-1}. Magnesium 5g may also be given after induction of anesthesia to decrease the risk of arrhythmia. Anticoagulation is required during OPCAB; the Activated Clotting Time (ACT) is maintained at 250–300. Heparin 1–2 mg kg^{-1} is usually sufficient before division of the internal mammary artery. It can be reversed with protamine. Hypothermia should be avoided by the use of warm fluids, warming blankets and a heat exchange device on the fresh gas flow.

Monitoring and Management of hemodynamic Challenges during surgery

The three causes of hemodynamic changes during surgery are, (1) displacement of the heart has

significant hemodynamic consequences, including a reduction in cardiac output associated with alterations in the right heart pressures. Greater than normal filling pressures are required to maintain ventricular filling (2). Hemodynamic changes is pressure exerted by the retractor on the ventricular wall which restricts wall motion locally and reduces ventricular dimensions (3). The vertical position of the heart distorts the mitral and tricuspid valves. Using a β-blocker, increased myocardial oxygen consumption with tachycardia can be reduced.

Bradycardia results from manipulation can be corrected with pacing. Maintaining a high perfusion pressure (MAP >70 mm Hg) and low myocardial oxygen consumption is vital when the heart is tilted; MAP is then maintained using the Trendelenburg position, administration of fluids and infusion of a vasopressor.

Invasive arterial blood pressure monitoring is mandatory and Svo2 is a useful tool to evaluate cardiac output and also demonstrate adequacy of tissue oxygenation. The use of a 12 lead ECG, with simultaneous monitoring of lead II and the lateral precordial (V4 and V5) leads increases the efficacy of ischaemia detection. The addition of ST segment trending may further aid the early detection of ischaemia.

Whilst transoesophageal echocardiography (TOE) rapidly demonstrates regional wall motion abnormalities, which may indicate regional ischaemia and inotropes can be titrated as per the need.

Discussion

OPCABG/Results

Morbidity	Mortality
• 2 Superficial wound infection	• 1 HAD GI bleed on 6th post OP day
• 2 Post OP dialysis	• 2 HAD renal failure leading to multi organ failure

OPCABG Statistics

- Total of 64 cases in 3 year period (2017-2020)
- 60 HAD OPCABG
- 4 Cases converted on pump with beating heart due to Hemodynamic compramise

National Adult Cardiac Surgery Database OPCAB procedures shows a reduction in risk adjusted mortality from 2.9% in CABG to 2.3% for OPCAB. The complication rate was also reduced from 12% (CABG) to 8% (OPCAB) (6). Other studies have not demonstrated a difference in mortality or morbidity.

Studies have shown a reduction in the need for transfusion of blood and blood products in OPCAB compared with CPB (8). Duration of ventilatory support and ICU stay are reduced in OPCAB with a consequent reduction in costs (9). Alteration in the coagulation system after coronary artery surgery are well accepted. Both coagulation factors and platelets are affected by extracorporeal circulation and hypothermia.

Neurological dysfunction after cardiac surgery is a major morbidity. The causes are probably macro or micro embolic events as a result of the manipulation of the ascending aorta. The need for manipulation is reduced in beating heart surgery. CPB results in the activation of a generalized inflammatory response with a rise in the postoperative markers such as C3a, C5a, and TNF-α and the interleukins IL-6 and IL-8. A possible advantage of OPCAB may be in the high risk patient group with significant co-morbidities and an expected risk of more than 5%.

Conclusion

OPCABG is ideal for patients with high risk co morbidities like chronic kidney disease, poor LV function etc. This is a viable option in cases where you want to keep the expenses to minimum (11). With ideal Anesthetic management good results can be achieved in high risk patients.

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