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Original Research Article

Role of emergency coronary artery bypass grafting in the era of percutaneous interventions

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ABSTRACT

Background: In acute coronary syndrome, prompt restoration of myocardial blood flow is essential to optimize myocardial salvage and decrease mortality. Coronary artery reperfusion, if performed in a timely manner improves clinical outcomes compared to no reperfusion. Fibrinolysis and percutaneous interventions can restore blood flow in an acutely occluded coronary artery in most of the patients; but in a few subset of patients coronary artery bypass grafting (CABG) is needed to effectively restore blood flow.
Methods: A retrospective study was conducted among all CABGs performed during March 2016 - February 2018. During this period, 366 CABGs were performed and 57 patients underwent emergency CABG as per the inclusion criterias. Pre-operative, intra-operative and post-operative data was analysed of these patients. Patients were divided into four groups based on the time of surgery from the time of onset of myocardial infarction.
Results: 57 patients underwent emergency CABG with males constituting 94.7% of the study population. 78.9% of them had an ejection fraction less than 35%. 52% presented with low cardiac output status, 10% needed intra-aortic balloon pump support and 15% required mechanical ventilation prior to surgery. All patients received an average of 2.8 grafts. Mortality was 5%
Conclusions: Immediate surgical revascularisation of patients presenting with acute MI is feasible. Emergency CABG not only treats the culprit lesion but also achieves complete revascularization and offers a clear advantage for patients. The optimal timing of CABG for patients with acute MI remains difficult to establish.

Keywords: ACS, Emergency CABG, Failed PCI, Urgent CABG

INTRODUCTION

The prevalence of cardiovascular disease is on the rise in our country and worldwide due to stress, smoking, unfavorable genetics and unhealthy eating habits. Acute coronary syndrome (ACS) can manifest as ST elevation myocardial infarction (STEMI), Non ST elevation MI (NSTEMI) or unstable angina leading to morbidity and mortality, more so, when there is no timely intervention. 5-10 % of patients with acute myocardial infarction (AMI) develop cardiogenic shock and have high mortality rates.[1] Mechanical complications develop between second to seventh day following an episode of myocardial infarction.[2] Hence it becomes necessary to know when and how to intervene to salvage the myocardium. These patients need emergency coronary revascularisation either by drugs, percutaneous interventions or surgery. With the advent of percutaneous interventions (PCI), most patients with an acute event are subjected to them. Emergency coronary artery bypass grafting (CABG) is done in those few patients with critical left main stenosis, ongoing ischemia despite maximal medical management, failed PCI, unfavorable anatomy for PCI, mechanical complications of MI or angiographic accidents.[3] We conducted a retrospective study enrolling those patients who underwent emergency

CABG after satisfying the inclusion criteria. We analysed the pre-operative, intra-operative and post-operative data of these patients to see the outcomes of early surgical intervention.

METHODS

During the study period between March 2016 to February 2018, 366 patients underwent CABG surgery at Nayati Multi Superspeciality Hospital, Mathura and at Sri Jayadeva Institute of Cardiovascular Sciences and Research, Bengaluru under our unit. Among them, 57 people underwent emergency CABG and were enrolled in the study based on the inclusion criteria.

Inclusion criteria

Patients with acute myocardial ischemia with ongoing ischemia, patients with threatened occlusion putting a large area of myocardium at risk, patients with critical LMCA not amenable for stenting, critically stenosed triple vessel or double vessel disease patients with unstable angina or ongoing ischemia or hemodynamic instability and patients unfavourable for PCI or those with failed PCI.

Exclusion criteria

Patients who had mechanical complications of MI, patients who had an MI of more than 7 days duration, patients who had a failed PCI in the absence of ischemia or threatened occlusion, patients in whom revascularisation was impossible or futile because of poor targets or a no-reflow state or severely compromised left ventricular output status inspite of use of inotropes and IABP.

Majority of our patients presented to us with typical or atypical angina and few in cardiogenic shock. All these patients were managed as per the protocol of managing ACS and underwent coronary angiography. Those patients who were not subjected to PCI were taken up for emergency surgery after explaining the risks and taking informed consent. Based on the time period in which they were operated after the onset of MI, patients enrolled for this study were divided into four groups as <24 hours, 24-48 hours, 48-72 hours and 72-96 hours after onset of MI. None of them in the study group presented between 5-7 days after MI.

Feasibility of the procedure was determined by the amount of viable myocardium, size of the target vessels (minimum diameter of 1.5 mm), accessibility of the coronary vessel and the number of coronary vessels to be bypassed. Emergency CABG was not performed after failed PCI in the absence of ischemia or threatened occlusion, or if revascularization was impossible or futile because of poor target anatomy or a no-reflow state or severely compromised left ventricular output status inspite of use of inotropes and IABP.

Emergency CABG comes with inherent challenges since these patients are often loaded with high dose antiplatelet drugs, intravenous GP IIb/IIIa receptor antagonists. Myocardial oedema, acute presentation and these premedications increase the risk of intra-operative morbidity and mortality including bleeding and subsequent higher re-exploration rates. Though all patients were loaded with dual anti-platelets and some with GP IIb/IIIa receptor antagonists, they were discontinued immediately after being referred for emergent CABG and were started on intravenous heparin. The risk of high post-operative bleeding was anticipated and logistics to mitigate this problem was addressed.

All these patients were monitored closely because of the risk of haemodynamic instability. Haemodynamically unstable patients required institution of IABP (10.6%) and/or cardiopulmonary bypass (10 %) prior to conduit harvesting. 15% required mechanical ventilation and 52% required the use of inotropes. In patients requiring high dose vasopressors, the use of arterial artery bypass grafts was not considered because of the risk of perioperative spasm. The risk of excessive bleeds may be minimized with off-pump CABG due to a reduced heparin requirement, although haemodynamic instability may preclude this option.

After stabilizing the patient, under general anesthesia, sternotomy was done and LIMA was harvested. Proximal anastomoses were done first. Most of these patients had evidence of ACS in the form of hyperaemic, edematous or haemorrhagic territories depending on the blockage of the culprit vessel (Figures 2-5). This was the first anastomosis done in the sequence of grafting. Distal anastomoses to posterior targets requiring heart dislocation were done in the end. Starfish was not used during the procedure.

RESULTS

In this retrospective study conducted between March 2016 and February 2018, among all the CABGs we performed, 57 were enrolled for this study based on the inclusion criteria. 94.7% were men. The average age of the study population was 63 years, although the sample size varied between 44 -85 years. As expected, this cohort had multiple risk factors adding to their morbidity. 24 (42%) of them were diabetic, 30 (52%) were hypertensive and 21 (36%) had dyslipidemia. 24 of them (42%) had a previous episode of MI and 15 of them (26.3%) had undergone prior stenting. Dysfunction in other organ systems was also seen in some patients. 9 of them (15.6%) had renal dysfunction and previous episodes of cerebrovascular accidents; 12 of them (21%) were hypothyroid and 15 patients (26.3%) had chronic obstructive pulmonary disease. These co-morbidities often tilt the outcomes unfavourably by prolonging ICU requirement, time on ventilator, need for dialysis and eventually, increase the cost and length of hospital stay.

Table 1: Demographic characters of the patients (n=57).

Characteristics	N (%)
Male	54 (94.7)
Female	3 (5.3)
Mean age (range)	63 years (44-85)
Diabetes mellitus	24 (42)
Hypertension	30 (52.6)
Previous stenting	15 (26.3)
Dyslipidemia	21 (36.8)
Previous myocardial infarction	24 (42)
Chronic heart failure	9 (15.6)
Chronic obstructive pulmonary disease	15 (26.3)
Renal dysfunction	9 (15.6)
Previous cerebro-vascular accidents	9 (15.6)
Hypothyroidism	12 (21)

Majority of these patients were operated on second and third day following MI. As soon as the referral was given for emergency CABG, dual antiplatelets and GP IIb/IIIa receptor antagonists were stopped and intravenous heparin was started. 30 patients underwent emergency CABG during 24-48 hours after an episode of MI; 12 underwent surgery between 48-72 hours, 9 of them within 24 hours and 6 of them after 72 hours after MI.

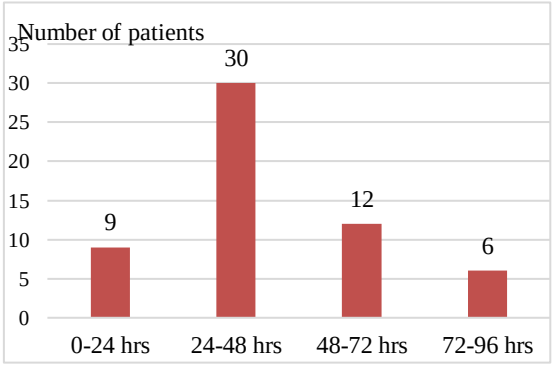

Figure 1: Number of patients operated during various timelines from the onset of MI.

Table 2: Pre-operative characteristics of the patients.

Time duration after onset of MI	<24 hours	24-48 hours	48-72 hours	72-96 hours
Number of patients undergoing surgery	9	30	12	6
PCI performed initially	3	6	0	0
Loading dose of aspirin and clopidogrel	9	30	12	6
GP IIb/IIIa receptor inhibitors given initially	0	18	3	3
IABP [pre-op]	3	3	0	0
Inotropic support	6	15	9	0
Mechanical ventilation	6	3	0	0
EF <35%	9	24	6	6
Low cardiac output	6	15	9	0
Coronary anatomy	LMCA- 6 TVD- 3	LMCA- 6 TVD- 21 DVD- 3	TVD- 12	TVD- 6
PCI intervention	POBA to culprit artery- 3	POBA to culprit artery- 6 Stent- 6	0	0

Most of the patients did not arrive at the hospital in the first 6 hours after MI. 9 patients (15.6%) underwent PCI initially. Of these patients, 3 underwent plain old balloon angioplasty (POBA) to the culprit lesion within the first 24 hours after MI. POBA was done in 6 patients (10%) who presented within 24-48 hours after MI, and they were all stented. All patients had received a loading dose of dual anti-platelets. 24 patients (42%) were given GP IIb/IIIa inhibitors. 6 patients (10.3%) had an IABP inserted while they were awaiting surgery and more than half of them required inotropic support. 9 patients (15%) required to be mechanically ventilated. 45 patients (78%) had low ejection fraction (EF <35%) and more than half of the total patients (52.6%) presented with low cardiac output. 12 patients (21%) had a left main coronary disease.

42 of them had a triple vessel disease. Thus, most of these patients constituted a high risk group for morbidity and mortality following surgery. In our data, a total of 51 patients (89%) underwent beating heart surgery and only 6 of them (10%) required conversion to on pump surgery. All patients received an average of 2.8 grafts, ensuring that all segments with flow limiting lesions with adequate target size received revascularisation.

Table 3: Intra-operative data.

Time duration after onset of MI	<24 hours	24-48 hours	48-72 hours	72-96 hours
No of people who underwent emergency CABG	6	30	12	6
OPCAB	6	27	12	6
On pump CABG	3	3	0	0
Grafts (LIMA and SVG)	2.6	3.2	2.5	3
IABP use (intra-op)	3	9	0	0
Bleeding	3	6	0	0
Re-exploration	3	3	0	0
Low cardiac output	3	6	0	0
Dialysis	3	3	0	0
Arrhythmia (AF)	3	6	0	0
In hospital death	0	3	0	0
Mechanical ventilation >24 hrs	3	9	0	0

All patients received a left internal mammary conduit. 9 of these patients (15%) had increased post-operative bleeding and 6 patients (10%) needed to be re-explored.

This is much higher than the patients undergoing elective CABG where the re-exploration rates is usually minimal for post-operative bleeding. 6 patients (10%) required an IABP to be inserted before shifting them to the operation theatre. Another 6 patients (10%) needed an IABP to beput intra-operatively. 6 patients (10%) required dialysis, 9 patients (15%) developed arrhythmias in the post-operative period and responded well to medication. 12 patients (21%) required mechanical ventilation of more than 24 hours duration. Mortality was 5% in thissample size. Death occurred due to multi-organ failure and intractable low cardiac output states in all the three patients.

Figure 2: Extensive hemorrhagic, friable and edematous myocardium on opening.

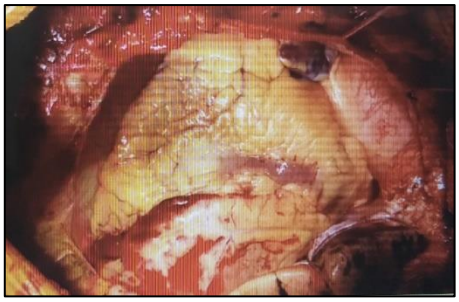

Figure 3: Features of ACS on anterior wall of left ventricle.

Figure 4: Features of ACS in the left circumflex artery territory.

Figure 5: Hemorrhagic areas in the left circumflex territory.

DISCUSSION

Treatment of ACS has traditionally been the domain of the interventional cardiologists. Most of the cases of STEMI and some cases of N-STEMI are being actively intervened by the cardiologists and dealt with effectively.[4] Only a small subset of these patients needs emergent surgical intervention. Emergency CABG is performed within hours of PCI to avoid unnecessary morbidity or death.[5] In our study, all patients underwent emergency surgery within 96 hours from the onset of MI. 30 patients (52%) underwent surgery within 24-48 hour period after MI.

Patients thus referred emergently have a constellation of high-risk factors that contribute to increased morbidity

and mortality.[6] These patients are often loaded with aspirin, clopidogrel or ticagrelor, heparin, statins, ACE inhibitors and may have been lysed with fibrinolytics. In our study, all patients had received dual antiplatelets. Thus, significant post-operative bleeding was seen in 9 patients (15%) and 6 (10%) needed to be re-explored. This is similar to a study by Mohammed et al which showed re-exploration rates for post-operative bleeding at 8% for emergency CABG cases and 2% in case of elective CABG cases.[7]

These patients have tight LMCA stenosis, multi-segment/ multi-vessel involvement, intractable arrhythmias, low ejection fraction or concomitant heart failure. 12 of our patients (21%) had significant LMCA disease with ongoing ischemia. Left main disease is an independent risk factor for operative mortality in emergency CABG.8 IABP was inserted in 6 of these patients prior to surgery and another 3 patients required it during surgery. Hata et al found that the use of IABP prior to surgery in those with left main disease helped survival rates.

Prior MI, prior cerebrovascular accidents, prior CABG add to bad prognosis. In our study, 24 patients (42%) had a previous episode of MI and 15 (26.3%) had undergone prior stenting. 9 of them (15.6%) had renal dysfunction and previous episodes of cerebrovascular accidents; 12 (21%) were hypothyroid and 15 (26.3%) had chronic obstructive pulmonary disease. Other co-morbidities like dyslipidemia, hypertension and uncontrolled diabetes tilt the outcomes towards unfavourability.[9] Postoperative myocardial infarction, renal dysfunction and cardiac arrhythmias contribute to mortality most often. Longer hospital stays, increased risk of perioperative MI and ventricular arrhythmias are frequently seen in this group.[9] Renal dysfunction was considered synonymous with raised serum creatinine values. However, it is now accepted that the estimated GFR (eGFR) is a much more sensitive predictor of renal dysfunction. Hillis et al in their study demonstrated that eGFR is a strong predictor of morbidity and mortality following CABG. They attributed 7.7% of deaths in their study to severe renal dysfunction.[10] Similar to their study, 6 of our patients (10%) developed acute renal failure in the post-operative period and required dialysis. 3 among them succumbed to multi-organ failure. Post-operative arrhythmias are usually tachyarrhythmias and can be due to various factors like ischemia/reperfusion injury, hypoxia, myocardial fibrosis, hypokalemia or hypomagnesemia, severe right coronary artery stenosis, sinus nodal or atrioventricular nodal branch disease, hypothermia and use of CPB. Self-terminating, transient arrhythmias need no intervention. Post-operative arrhythmias are usually atrial tachyarrhythmias; less often ventricular tachyarrhythmias or bradyarrhythmias. When associated with hemodynamic instability they need intervention and treatment.[11] 9 patients in our study (15%) developed post-operative arrhythmias and reverted to sinus after treatment with beta-blockers and amiodarone.

Emergency CABG group forms 3% of all patients undergoing CABG, however they contribute about 20% to all cause mortality in CABGs.[12] In our study, all cause mortality was 5% and all deaths occurred in the group that underwent surgery between 24-48 hours after MI. Multiple studies give variable mortality rates ranging between 7-20%. Outcomes of elective CABG in terms of mortality have improved in the last decade, however, mortality rates for emergency CABG have remained almost the same.

The optimal timing in more stable patients with indications for CABG is unclear, with some studies showing increased mortality when CABG was performed in the first 12 to 24 hours after acute myocardial infarction whereas recent studies favour early CABG with better outcomes.[13] Patients presenting within six hours after onset of symptoms should be operated emergently to maximize myocardial salvage.[14] The goal should be to completely revascularise within 12 hours of symptom onset. Stable patients who present later than six hours after onset of symptoms when myocardial necrosis has reached its peak should probably be delayed for three to four days to decrease mortality and morbidity, including bleeding complications. For patients with recurrent or intractable ischemia or reinfarction, particularly those with multivessel disease, CABG within 48 hours is a reasonable strategy compared to more delayed revascularization.[15]

Surgical patients are at increased risk of re-exploration when operated within the first three days. Despite a high incidence of surgical complications and multiple high-risk features at presentation, clinical outcome is excellent. Encouraging experience in multiple studies in high-risk patients undergoing emergency surgery are favouring OPCAB rather than conventional CABG.[16,17] Our study is limited by the fact that the sample size of 57 patients is very small in comparison to that of elective CABG. However, an attempt is made to study the short term outcomes following emergency CABG. Long term patency of grafts, quality of anastomoses and any major adverse cardiac and cerebral events following an emergent CABG over the next few years need to be studied during follow-up of our patients.

CONCLUSION

Early CABG provides revascularization of most of the epicardial vessels, including the culprit lesion. Successful CABG might, therefore, reduce the likelihood of future ischemic events in patients with ACS. ACS is an independent predictor of early mortality in patients undergoing CABG. Increased mortality rate in early CABG is related to the acuity of presentation. However, the long-term outcomes after surgery were similar between patients with ACS and stable angina pectoris, once patients survived the early postoperative period.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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