

Evaluation of Causes of Reexploration for Bleeding or Hemodynamic Instability in Immediate Postoperative Period in Cardiac Surgery ICU

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Abstract

Introduction: Throughout the world, up to five percent of postoperative cardiac surgery patients undergo reexploration. In our institution the reexploration rate is quite high and we hypothesise, being a training institute it is such. The aim of our study is to find the causes of reexploration so we can modify our operative approach. *Materials and Methods:* 2792 non randomised post operative patients were studied prospectively and was done from October 2010 to March 2016. Patients who underwent reexplorations following coronary artery bypass surgery both offpump or onpump, valvular heart surgery, surgery for congenital acyanotic heart disease, cardiac myxomas were included in the study. Cyanotic heart disease, redo surgery, aortic surgery or other complex surgery cases were excluded. 287 patients were reexplored for excessive bleeding or cardiac tamponade and arrhythmia in post operative cardiac surgery ICU. *Statistical Analysis:* All normally distributed numerical variables were analysed by Kolmogorov-Smirnov test. Categorical variables were compared by Binomial test. p - value less than or equal to 0.05 was considered significant. *Results:* Maximum reexploration was done in CABG with valve cases (33%). 252 patients (87.8%) were reexplored for bleeding and the rest (12.2%) for tamponade. 219 patients (87%) were found to have surgical causes of bleeding, and the rest (13%) had diffuse, non-surgical type of bleeding. The sternal wire site bleeding and bleeding from left internal mammary artery bed were in very high percentage. *Conclusions:* Reexploration for bleeding is a great concern especially in a high volume training centre like ours. Meticulous and careful surgical approach and a responsible hemostasis and closure may cut down the reexploration rate significantly.

Keywords: Bleeding; Reexploration; Training Institute.

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Introduction

Throughout the world, upto five percent of postoperative cardiac surgery patients undergo

reexploration. Bleeding and features of cardiac tamponade like persistant hypotension or hemodynamic instability, arrhythmia, cardiac arrest are the important causes of reexploration. Patients exposed to cardiopulmonary bypass use to have postoperative bleeding even upto twelve percent.

In our institution the reexploration rate is higher than the data given in various literatures. In this context, searching the causes of reexploration is very important. Our institute has the wide drainage area of eastern Indian population and also a prime

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center for cardiac surgery training since 1971. We hypothesise, being a training institute our reexploration rate is higher. Finding the causes of higher reexploration rate and addressing the cause is the aim of our study. As per literature such study has not been done yet, obviously not in our institute and amongst this demographic population.

Materials and Methods

Two thousand seven hundred ninety two (2792) nonrandomized postoperative patients were studied prospectively considering the following inclusion and exclusion criteria. The study was done over five and half years period from October 2010 to March 2016. Our Institutional Ethics committee approved this research project and reviewed the additional document of informed consent.

Inclusion criteria

Patients who underwent reopening preceded by elective open heart surgeries done under Cardio-Pulmonary Bypass (CPB) were included in the study.

All patients with ischemia and triple vessel disease and valvular heart disease, congenital acyanotic heart disease e.g., Atrial Septal Defect (ASD), Ventricular Septal Defect (VSD), and other heart conditions like cardiac tumours (myxomas) were included in the study.

Our study included On-pump Coronary Artery Bypass surgeries (ONCAB) and also Off-Pump Coronary Artery Bypass surgery (OPCAB) cases as OPCAB highly out numbers ONCABs in our center and there was a considerable number of reexplorations on post OPCAB patients.

Exclusion criteria

Surgeries for cyanotic heart disease were excluded as cyanosis deranges the coagulation profile.

Our study did not include aortic surgery as it is a complex procedure and often requires extensive CPB support.

Closed mitral commissurotomy, surgery for constrictive pericarditis were excluded as they do not need CPB support.

Patients with prior cardiac surgeries like redo valve and redo coronary artery bypass surgeries, post closed-mitral-commissurotomy mitral valve replacement and all emergency cardiac procedures like postmyocardial infarction ventricular septal

rupture repair were excluded from the study.

Patients with history of taking Sildenafil were excluded as it increases the chance of postoperative bleeding. Demographic data e.g., age, gender, body mass index (BMI), comorbidities like pulmonary and renal function, liver enzymes and coagulation profile, arterial and pulmonary hypertension and cerebrovascular disease, other medical, surgical and drug history were sought out. Preoperative Trans Thoracic Echocardiography (TTE) were also evaluated. Shows as in Table 1 patients underwent reexploration for excessive bleeding or clinical suspicion and echo based diagnosis of cardiac tamponade and arrhythmia. Operation characteristics, indications of reexploration, blood loss, timing and findings at reopening all were noted. We also recorded the clinical outcome like total Intensive Care Unit (ICU) stay and rate of wound infection and mortality (Table 2). The loading dose of heparin sodium was 3 mg/kg of body weight and anticoagulation was adjusted such that Activated Clotting Time (ACT) was maintained at > 480 seconds during bypass and for OPCABs it was 1 mg/kg of body weight and > 200 secs respectively. Heparin was reversed with protamine sulphate in both ONCAB and OPCAB cases in accordance with initial heparin dose.

The decision for reexploration was taken by surgeon responsible and was adhered to Kirklin and Barratt-Boyes criteria for amount of blood loss and reopening as given in Table 5, hemodynamic status of the patient, blood gas analysis and laboratory parameters and TTE findings. All patients were in sinus rhythm except 26 patients. Amongst these 26 patients, six patients were reopened for impending cardiac arrest and the rest were having frequent ventricular ectopics or spells of ventricular tachycardia. The suspicion of cardiac tamponade was made on the basis of rapid hemodynamic deterioration of the patients with increased central venous pressure, tachycardia, decreased arterial pressure not responding to increased inotropic support and was confirmed by echocardiography. All reexplorations were done in postoperative cardiac surgery ICU.

Statistical Analysis

All statistical analysis were done by standard statistical software SPSS 20. All normally distributed numerical variables were analyzed by Kolmogorov-Smirnov test. Categorical variables were compared by Binomial test. All analysis were two tailed. In all cases, a p - value of ≤ 0.05 was considered to be significant.

Results

In our institute, we conducted 2016 elective procedures with help of CPB and 776 OPCABs with above mentioned *inclusion* and *exclusion criteria* within the said period. Among 287 patients (10.27%) who were reexplored, 178 patients were male (62.02%). Different types of surgeries done and their respective percentage of reexplorations were analyzed in Table 3 and it showed, maximum was done in CABG with valve cases (33%). Considering CABGs, the OPCAB cases had almost 2.6 times higher rate of reexplorations than ONCAB cases.

Regarding pre and peroperative data, only BMI and number of CPB runs were found to be significant ($p = 0.008$ and 0.006 respectively), total CPB time and cross clamp time were found not to be significant. Regarding reexploration, amount

of bleeding ($p = 0.002$), presence of arrhythmia ($p = 0.000$), activated partial thromboplastin time ($p = 0.016$) and prothrombin time ($p = 0.000$) were found to be significant.

Among 287 cases of total reexplorations, 252 patients (87.8%) were reexplored for bleeding and the rest (12.2%) was for tamponade. Patients who were reexplored for bleeding, 219 patients (87%) were found to have surgical causes of bleeding, and the rest (13%) had diffuse, nonsurgical type of bleeding. The sternal wire site bleeding and bleeding from left internal mammary artery bed were found to be in very high percentage (Table 4).

The increased postoperative morbidity from bleeding and consequent reopening were reflected in significant wound infection rate ($p = 0.001$), prolonged hospital stay ($p = 0.046$) and increased mortality ($p = 0.015$).

Table 1: Demographic data and pre and peroperative criteria of reexplored patients

Characteristics	Mean value	Standard Deviation	p - value
Age (years)	40.66	± 17.85	0.385
Body weight (Kg)	48.0	± 14.46	0.963
BMI (kg/m ²)	1.10	± 0.21	0.008
Ejection Fraction (%)	53.55	± 10.35	0.538
ALT (Alanine Transaminase) (units/L)	51.33	± 19.22	0.657
AST (Aspartate Transaminase) (units/L)	49.60	± 17.00	0.841
INR	1.02	± 0.40	0.054
Systolic blood pressure (mm of Hg)	128.19	± 12.89	0.472
Serum creatinine (mg/dl)	1.02	± 0.35	0.518
Total Surgery Time (mins)	240.45	± 71.65	0.639
Total CPB Time (mins)	102.74	± 71.37	0.488
Cross-clamp Time (mins)	74.53	± 57.57	0.454
No. of CPB run	0.97	± 0.75	0.006

Table 2: Parameters during reexploration and outcome

Characteristics	Mean	Standard Deviation	p - value
Amount of Bleeding (ml)	762.0	± 430.0	0.002
Incidence of Hypotension	0.39	± 0.49	0.256
Incidence of Arrhythmia	0.18	± 0.39	0.000
Time of reopening from shifting to ICU (hrs)	9.22	± 7.15	0.093
APTT (secs)	24.46	± 22.87	0.016
PT (secs)	13.04	± 4.09	0.000
INR (International Normalized Ratio)			
1.02	± 0.43	0.052	
ICU Stay (in days)	8.70	± 1.40	0.046
Wound Infection	0.21	± 0.41	0.001
Mortality	1.75	± 0.45	0.015

Table 3: Types of operations taken into account for the study and respective reexplorations given in percentages

Types of operation	Total Number	Number of Reexploration in Percentages
On-pump CABG	149	8%
Off-pump CABG	776	21%
Valve operations	777	24.6%
CABG + Valve	49	33%
ASD	332	3.3%
VSD	115	2.8%
Tumors (Myxomas)	26	2.1%
Others	570	5.2%

Table 4: Surgical sources of bleeding found at re-exploration presented in percentage

Surgical Sites	Percentage
Sternal wire site bleeding	32%
LIMA bed bleeding	15%
From the body of the grafts	15%
From Proximal anastomosis	7%
From Distal anastomosis	7%
Cannulation Site	5.7%
Innominate vein injury	3%
LV (Left Ventricle) adhesion site	1.7%
RA (Right Atrium) suture line	1.3%
From pericardium	1.3%

Table 5: Kirklin and Barrett-Boyes criteria for reexploration for bleeding

1. Drainages of:
(a) More than 500 ml during the first hour
(b) More than 400 ml during each of the first two hours
(c) More than 300 ml during each of the first three hours
(d) More than 1000 ml during the first four hours
(e) More than 1200 ml in total during the first five hours
2. Excessive bleeding that restarts (indicating a possible surgical cause)
3. Sudden massive bleeding

Discussion

Postoperative bleeding is a major concern for all patients undergoing cardiac surgery.¹ World wide, as many as 3.4% to 5% such patients undergo reexplorations for bleeding, hemodynamic instability and cardiac arrest.^{2,3} Literatures also depicts, open heart surgeries done under CPB have a higher reexploration rate upto 12%.³

In our institute, a five and half year long prospective study shows the postoperative cardiac surgery reexploration rate is 10.27% which is quite higher than the world statistics, though this rate includes surgery without CPB that is OPCAB and excludes surgery on cyanotic heart disease patients.⁴ Our center as being a high volume center and the oldest and the most reputed cardiac surgery

training center in eastern India, it scores higher reexploration rate than the world wide average rate of reexploration. To find the cause of such hiatus was the main motivation of this study.

The percentage calculation and statistical analysis of our study-data shows postoperative bleeding is the predominant cause of reexploration in cardiac surgery patients.^{1-3,5} Combined procedure like CABG with valve surgery with prolonged CPB time has the higher reexploration rate and goes well with traditional data.^{6,7} Moreover, our study showed morbidity like wound infection, prolonged hospital stay and mortality are significantly high in reexplored patients.⁸⁻¹⁰ These are also a traditionally accepted facts.

Our study found two exceptions: (1) Off-Pump CABG reexploration rate is higher than the On-

Pump CABG reexploration rate.¹¹ (2) On analysis of surgical site bleeding, our study found sternal-wire-site bleeding is the leading cause, then comes left internal mammary artery (LIMA) bed bleeding. Whereas, bleeding from the stem of the grafts is the commonest surgical site bleeding in CABGs world-wide^{1,2} but it is the third most common cause in our study. The explanation of these facts may be sternotomy at the beginning of operation and hemostasis and sternal closure at the end of the operation are done by trainee surgeons. Saphenous vein and LIMA harvesting are also done by trainee surgeons. Cannulation and going to CPB are also done by trainee surgeons especially, in adult cardiac cases. With the help of the data derived from our study, we hypothesize, a properly done and dry midline sternotomy, more careful and methodical graft harvesting, meticulous hemostasis including LIMA bed check and proper wire site bleeding control and moreover, application of extra reinforcement stitches taken at all the cannulation sites along with the conventional purse-string sutures may cut down the reexploration rate in our center in a great extent.

Conclusion

Reexploration for bleeding is a great concern especially in a high-volume training center like ours. Reexploration increases overall morbidity and mortality of the postcardiac surgery patients. As sternal site bleeding is the most common cause of reexploration, a more meticulous and careful surgical approach and a responsible hemostasis and closure may cut down the reexploration rate in such patients.

Conflicts of Interest: None declared.

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