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Research Article

The Impact of Re-Opening Post Cardiac Surgery on Short and Long- Term Outcomes: 11 Years Follow Up

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Abstract

Objective: Re opening immediately post major cardiac surgery is a problematic complication. Studies suggest bleeding and/or tamponade post cardiac surgery significantly affects in hospital mortality and length of stay. The primary objective of this study was to compare the short- and long-term outcomes of patients who were reopened with those who were not reopened (Control) following cardiac surgery using propensity matched analysis.

Methods: In total, 7960 patients underwent cardiac surgery. 539 (6.8%) were reopened immediately post cardiac surgery for either bleeding or tamponade. Patients were propensity score matched (525 reopened versus 525 control) by age, gender, operative priority, preoperative arrhythmia, Ejection Fraction, Euroscores, logistic Euroscores, type of cardiac operation, Body Mass Index, bypass time and cross clamp times. Data were collected prospectively and follow up obtained to date on all patients. Statistical analysis was performed using IBM SPSS version 22.

Results: The overall rate of re exploration was 6.8%. After propensity score matching the baseline demographics, pre-operative and intra operative variables were comparable between the two groups. Therefore, patients with similar risk profiles were compared between RE and Control group.

Significantly higher rate of post-operative arrhythmias, myocardial infarctions, renal complications, wound infections, cerebrovascular accidentsm, ulatnisdystem failure were observed in the RE group compared to Control group ($p>0.001$). RE group on average had longer ICU stay and total hospital stay ($p>0.001$). RE group had significantly higher 30-day mortality 23.4% (*vs*. 6.3% $p<0.001$) and long term mortality 37% (*vs*. 22.9% log rank <0.001) compared to Control group. However, patients who were discharged alive had a comparable long-term survival 82.4% *vs*. 84.9% between the RE and Control group (log rank <0.396). Significant predictors of reopening post cardiac operation were; poor left ventricular function, pre-operative Intra-Aortic Balloon Pump (IABP), and post-operative arrhythmias ($p<0.001$). However, reopening in itself was a significant predictor of in hospital mortality ($p<0.001$).

Conclusion: Reopening for bleeding and/or Tamponade saves lives. However, in this propensity matched study we have shown that reopening is also associated with a significantly higher rate of post-operative complications; hospital stay, short- and long-term mortality compared to similar risk profile patients who were not reopened. Re opening post cardiac operation is an independent predictor of in hospital mortality. Meticulous haemostasis is required to reduce risk of bleeding/tamponade and prevent re opening post cardiac surgery.

Keywords: Cardiac surgery; Reopening; Meticulous haemostasis

Introduction

Reopening after cardiac surgery remains a frequent complication with increased mortality and major morbidity, including sternal wound infection, stroke, sepsis, need for prolonged ventilation, and longer intensive care unit (ICU) and postoperative hospital stays [1]. Rate of reopening is reported between 2-6% [2-4]. The main indications are: bleeding, tamponade and dysrhythmia [3,4]. Old age, low body mass index (BMI), long cardiopulmonary bypass (CPB) duration, high number of distal anastomoses, and the preoperative use of antiplatelet agents and heparin infusions have been associated with higher risk of re-exploration [1,5]. Several studies have been published to compare outcomes in patients who are re-opening immediately post cardiac operation. They fail to account for the high-risk profile of these patients who are re-opened immediately post cardiac operation. In this study, we used propensity score matching to compare patients with similar pre-operative and intra operative risks in the RE group versus Control group. The primary objective was to find out post-operative morbidity together with short- and long-term mortality.

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Methods

All patients undergoing routine cardiac operations such as coronary artery bypass grafting (CABG), valve surgery (Aortic, Mitral or Tricuspid), Aortic Surgery and other cardiac operations (Such as Atrial Septal Defect, Ventricular Septal Defect and Atrial Myxomas) at Castle Hill Hospital, Cottingham United Kingdom between April 2004 and April 2015 were included. Re opening immediately post cardiac operation was recorded after skin closure in theatre until patient's discharge from the hospital.

Follow up and data handling

Retrospective analysis of data (the patient's demographics, perioperative variables, and types of operations) registered prospectively on to the cardiothoracic directorate database at Castle Hill Hospital (Patient Analysis Tracking System and Patient Administration System) was carried out. The mortality status and date of death is updated every 24 hours from the Central National Health Service (NHS) Spine. This data were collected prospectively until August 2015. All patients were reviewed at 8 weeks following the original or subsequent surgery which included full history, clinical examination, Electrocardiogram (ECG) and Chest Radiograph (CXR).

Statistical analysis

Statistical analysis of the data was carried out using IBM SPSS Statistics Version 23. Continuous variables are presented as mean +/- standard deviation and nominal variables are presented as frequency (%). Fisher's exact test was used to study any differences between the two groups for categorical data. Kaplan-Meier survival analysis was performed to study the trend in the survival of patients who underwent AVR using either suture technique. P values of <0.05 was considered as statistically significant differences between the groups.

Results

In total, 7960 patients underwent cardiac surgery. Of these 539 (6.8%) were reopened immediately post cardiac surgery for either bleeding or tamponade. Patients were propensity score matched (525 reopened versus 525 control) by age, gender, operative priority, preoperative arrhythmia, Ejection Fraction, Euroscores, logistic Euroscores, type of cardiac operation, Body Mass Index, bypass time and cross clamp times. 14 patients could not be matched and therefore were excluded from the comparison.

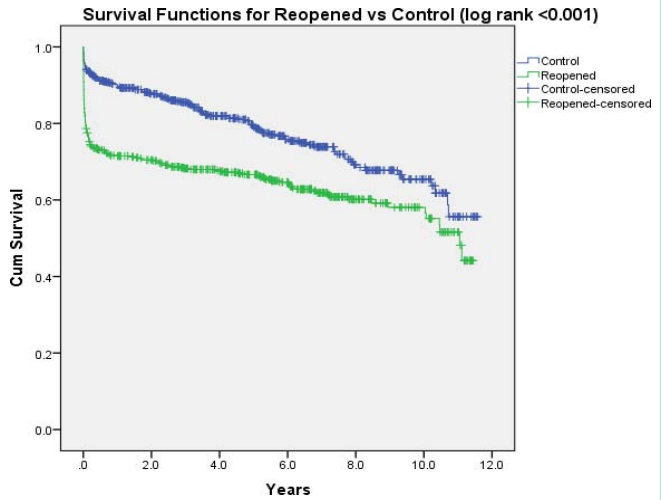

Figure 1: Survival at 11 years follow up log rank <0.001.
Survival at 11 years follow-up:
Reopened group: 63%
Control group: 77.1%

After propensity score matching the baseline demographics, pre-operative and intra operative variables were comparable between the two groups (Table 1 and 2).

There were statistically significant higher rates of post-operative morbidities including Major Adverse Cerebrovascular and Cardiovascular Events (MACCE) in RE group compared to the Control group (p<0.001) (Table 3).

Mean CICU stay in days (6.9 +/- 12 *vs.* 3.3 +/- 7; p<0.001) and mean hospital stay in days (22.3 +/- 28.3 *vs.* 17.5 +/- 25; p<0.001) were significantly higher in the RE group compared to the Control group. The study shows a statistically significant higher rate of 30 day mortality (23.4% *vs.* 6.3%; p<0.001) and long term mortality (37.0% *vs.* 22.9%; log rank <0.001) in the RE group compared to the Control group (Table 4). However, long term survival after being discharged alive is comparable between the two groups as evidenced by the Kaplanmeier survival curve (Figure 1 and Table 5) and (Figure 2 and Table 6).

Multivariate analysis revealed that poor LV, preoperative use of IABP and post op arrhythmias were the significant (p<0.001) determinants of reopening post cardiac surgery (Table 7).

Table 1: Baseline characteristics of patients in Control *vs.* Reopened groups after matching.

Variables	Control (525)	Reopened (525)	P value
Mean Age (+/-SD) years	68.9 (11)	68.4 (10)	0.481
Sex (Numbers)			
Male	395 (75%)	387 (74%)	0.572
Female	130 (25%)	138 (26%)	
Operative Urgency (numbers)			
Elective	314	312	0.9
Urgent	181	183	
Emergency/Salvage	30	30	
Pre Op arrhythmia (Numbers)			
Sinus rhythm	416	406	0.921
AF/ Flutter	88	102	
Hearth Block	12	10	
VF/VT	9	7	
Ejection Fraction (Numbers)			
Good > 50%	306 (58%)	337 (64%)	0.309
Fair 30-49%	161 (31%)	122 (23%)	
Poor <30%	58 (11%)	66 (13%)	
Euroscore (Mean)	6.89 (3.8)	6.89 (3.7)	0.987
Logistic Euroscore (mean)	11.60	11.57 (14.7)	0.97
BMI (Mean+/-SD)	27.30 (4.5)	27.50 (4.9)	0.48

Table 2: Peri-operative variables of patients in Control *vs.* Reopened groups after matching.

Variables	Control (525)	Reopened (525)	P value
Diabetes			
Yes	117	106	0.407
No	408	419	
HTN			
Yes	349	363	0.356
No	176	162	
COPD			
Yes	86	98	0.395
No	439	437	
Renal Disease			
Yes	21	32	0.272
No	501	493	
PVD			
Yes	103	75	0.021
No	422	450	
Neurological Deficit			
Yes	71	79	0.481
No	454	446	
Cardiac Operations			
CABG only	236	208	0.792
Valve only	115	146	
CABG + Valve	84	86	
Aortic Surgery	41	45	
Others	49	40	
Pre Op IV Ionotropes			
Yes	13	14	0.846
No	511	508	
Unknown	1	3	
Pre Op IABP			
Yes	49	79	0.005
No	474	437	
Unknown	2	9	
Mean cross clamp time (+/-SD) mins	55.09 (28.5)	57.21 (32.0)	0.258
Mean Bypass time (+/-SD) mins	92.91 (43.9)	95.78 (50.0)	0.323

In this study, significant predictors of in hospital mortality were reopening in itself, post-operative Myocardial Infarction, post-operative multisystem failure, wound infection and prolonged bypass and cross clamp times (p<0.001) (Table 8).

Discussion

Re-exploration after cardiac surgery has been considered as an adverse event that affects the patient's morbidity and mortality. However, patients who need re-exploration, especially after post-operative haemorrhage, may not necessarily have a poor outcome. While it is true that various factors associated with re-exploration have been found to individually affect the patient's outcome rather than the re-exploration itself, we present a study comparing two groups after a careful propensity match score to elucidate the implications related to the re-opening itself after haemorrhage and tamponade.

Table 3: Post operative outcomes.

Variables	Control (525)	Reopened (525)	P value
Post Op Arrhythmia			
Sinus Rhythm	234	164	0.0001
AF/Flutter	266	287	
Heart Block	18	51	
VF/VT	7	23	
Post op MI			
Yes	6	59	0.0001
No	506	425	
Unknown	13	41	
Post op renal complications			
Yes	74	177	0.0001
No	451	348	
Post op wound infection			
Yes	51	86	0.0001
No	474	439	
Multisystem failure			
Yes	23	94	0.0001
No	490	402	
Unknown	12	29	
Post Op Neurological Deficit			
Stroke	9	17	0.009
TIA	4	12	
None	480	454	
Confusion (Acute)	32	42	

Table 4: Post op outcomes.

Outcomes	Control (525)	Reopened (525)	P value
Mean CICU stay (days) +/-SD	3.3 (7)	6.9 (12)	P<0.0001
Mean Hospital stay (days) +/-SD	17.5 (25)	22.3 (28.3)	P<0.0001
30-day mortality	6.30%	23.40%	P<0.001
Long term mortality	22.90%	37%	Log rank <0.001
Long term mortality after being discharged alive	15.10%	17.60%	Log rank <0.396

Data varies across the globe in different cardiac surgery centers. Incidence of urgent resternotomy for bleeding after cardiac operation has been reported to be 2-6%. Smarason et al. [10] showed an 8% reoperation rate for bleeding, which was higher compared to other studies. In our study we found the overall re-exploration rate to be 6.8% which was comparable to most of the studies.

In terms of differentiating morbidity and mortality, we found different results depending on the studies observed. Kathik et al. [1] demonstrated worse outcomes in terms of morbidity after surgical exploration (low cardiac output, renal failure, prolonged mechanical

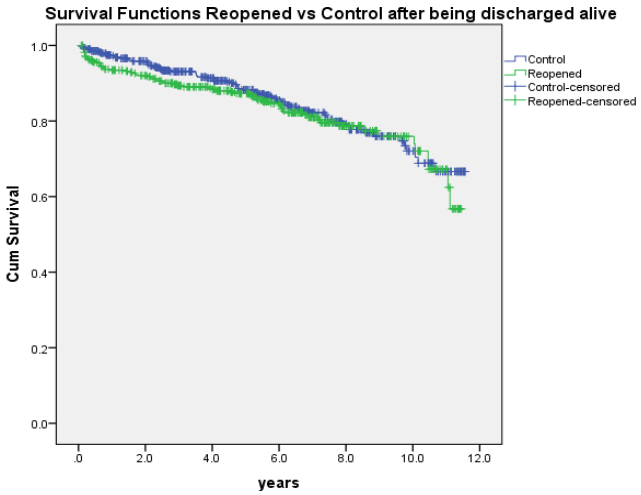

Figure 2: Survival at 11 years follow up after being discharged alive.
Survival at 11 years follow-up:
Reopened group: 82.4%
Control group: 84.9%
Log rank <0.396

Table 5: Survival at 11 years follow up log rank <0.001.

Number at risk					
Reopened: 503	301	224	133	60	23
Control: 484	336	230	139	70	23

Table 6: Survival at 11 years follow up after being discharged alive.

Numbers at risk					
Reopened: 371	294	222	132	59	22
Control: 452	354	255	162	83	25

Table 7: Predictors of reopening.

Variable	P value	Hazard ratio
Pre op IABP	0.001	2.243
BMI	0.598	1.009
Poor LV	0.001	0.747
Post op arrhythmia	0.001	1.59

ventilation and ICU/hospital stay) but not significantly higher mortality rate. Conversely, Moulton et al. [6] found a significantly higher mortality rate in addition to an increased risk of sepsis, renal failure, and prolonged ventilation. There was the need of conducting large population studies, and Ranucci and co-workers [11] analyzed a large population in a retrospective manner, finding the following: Firstly, the mortality is double than expected in patients requiring surgical exploration because of post-operative bleeding. Secondly, the number of units of blood transfused is an independent risk factor for morbidity (low cardiac output, acute renal failure, sepsis) and mortality. Thirdly, the timing of the re exploration is not associated with increased morbidity or mortality. However, the latter statement was refused by Chong and co-workers [2] demonstrating that re-exploration after 12 hours from the end of the procedure has a higher need or intra-aortic balloon pump support, longer ICU stay, and increased mortality.

Table 8: Predictors of in hospital mortality.

Variable	P value	Hazard ratio
Reopening	0.001	3.19
Multisystem failure	0.001	20.01
Post op MI	0.001	7.16
Post op wound infection	0.001	0.07
Bypass time	0.001	1.01
Xclamp time	0.001	0.98

In our study, we focused on the two main causes of re-exploration, which are post-operative haemorrhage and cardiac tamponade. A Japanese study by Kubota and co-workers [12] showed that when re-exploration due to bleeding was required, the mortality increased significantly over non-haemorrhagic indications for re-opening. Moreover, it showed there was not significant difference in the interval time between the operation and death according to whether re-exploration for bleeding had been performed. Our study is one of the few that performed a propensity matched score between patients re-opened for bleeding, meaning that the only difference among the two groups is whether or not a re-exploration was performed, and our results should be attributed to the events following a reopening.

We acknowledge the work of Ranucci and Vivacqua [11,13] on demonstrating independent association between greater transfusion and reoperation with major mortality and morbidity, but this was not included in our study as cases followed expert consensus transfusion strategies. All our re-explorations were carried out either in the ICU or theatre, and the results correlate well with other international studies. In our study, place of re- exploration is not a factor affecting outcome.

In our series, the incidence of re-exploration, its complications and outcome was independent to the age and sex of the patient. The propensity score matching of the baseline demographics revealed comparability among the two groups without any outstanding differences.

Preoperatively, multivariate analysis identified poor LV, preoperative use of IABP and post op arrhythmias as significant ($p<0.001$) determinants of reopening.

Patients with pre op intra-aortic balloon pump (IABP) and intravenous inotropes were most re explored ($p=0.846$ and $p=0.005$), respectively, among groups. We could identify IABP as a predictor of re-opening by itself ($p=0.001$, HR 2.243). We suspect that in a larger series this significance would have an impact in the outcome of the patient, although in our study the level of support to the heart required prior to the re-opening did not necessarily affect the final outcome of the patient.

Dacey et al. [9] showed in their study association of prolonged CPB time with increased incidence of re exploration. In our study, the groups are matched by cross-clamp and bypass time ($p=0.258$ and $p=0.323$, respectively), hence the difference is not significant. However, there were statistically higher rates of post-operative morbidities including Major Adverse Cerebrovascular and Cardiovascular events (MACCE) and renal failure in the re-explored group compared to the control group ($p<0.0001$).

Fröjd and co-workers [14] recorded up to a twofold increased early postoperative mortality rate. The mortality rate in our study in re-explored patients at 30 days was higher in the reopened group versus the control group (23.4% *vs.* 6.3%). Brown et al. [15] described in a recent cohort a worse long-term survival in those who had cardiac re exploration, however a Kaplan-Meier survival estimation and multivariable Cox regression analysis were performed to assess the impact of re-exploration on survival.

So, as per the results of this study, the long-term survival (up to 11 years follow up) was isolated and it showed 63.0% in the reopened group compared to 77.1% in control group (Log Rank <0.0001). Interestingly, patients who were discharged alive, had a comparable long-term survival 82.4% versus 84.9% in Reopened and control groups respectively (Log Rank = 0.396).

Conclusion

Reopening for bleeding and/or Tamponade saves lives. However, in this propensity matched study we have shown that reopening is also associated with a significantly higher rate of post-operative complications; hospital stay, short- and long-term mortality compared to similar risk profile patients who were not reopened. Re opening post cardiac operation is an independent predictor of in hospital mortality. Meticulous haemostasis is required to reduce risk of bleeding/tamponade and prevent re opening post cardiac surgery.

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