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Original Research Article

Early chest re-exploration after adult cardiac surgery

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ABSTRACT

Background: Aim of the study was to determine the rate, causes, consequences of early re-sternotomy after cardiac surgery and to compare between re-opening in the operative theatre and re-opening in the intensive care unit (ICU).
Methods: This is an observational retrospective study of adult cardiac surgical patients presenting for cardiac surgery at Queen Alia heart institute in the between September 2023 and February 2024. Incidence, risk factors, causes, site and consequences of early re-sternotomy are studied.
Results: Data from 182 patients was analysed. Male patients were 82.4% and female patients were 17.6%. Reopening was needed in 12.1%. Incidence of reopening was highest after combined procedures (33.3%) and aortic surgery (33.3%). Reopening was performed in the operative theatre in 72.3% of cases, while 27.3% had reopening in the ICU. Risk factors for re-opening were longer average CPB (127 minutes vs 107 minutes) and aortic clamp times (71 vs 65 minutes). Patients who had reopening spent on average 55.45 hours on mechanical ventilation, while those who did not were extubated after 32 hours. The overall mortality rate was 11%; however, mortality in the reopening group was much higher (36.4%). Those who were reopened in ICU were at an older age (mean 61.6 vs 56.9 years), required more blood transfusions (mean 2.4 units vs 1.5 units) and had higher mortality (mean 60% vs 23.5%).
Conclusions: Incidence of re-opening after cardiac surgery was 12.1%. The two main causes of re-opening were excessive bleeding and haemodynamic instability. Higher incidence of mortality was seen when re-opening took place in the ICU. Predictors for re-opening are old age, more complex (combined) procedures, aortic surgeries and prolonged cardiopulmonary bypass (CPB) and aortic cross clamp (ACC) durations.

Keywords: Bleeding, Cardiac, CPB, ICU, Mortality, Re-opening

INTRODUCTION

Early re-sternotomy (also known as re-opening or re-exploration) is a surgical procedure sometimes needed in the first hours (or days) after cardiac surgery. Re-opening of sternum after cardiac surgery remains a frequent complication with increased mortality and major morbidity, including sternal wound infections, sepsis, stroke, massive blood transfusion, need for prolonged ventilation, and longer ICU and postoperative hospital stays.[1,2] The incidence of reopening post adult cardiac surgery varies in literature between 2 and 16%.[3] Indications for re-exploration of the chest are postoperative bleeding, cardiac tamponade, haemodynamic instability or a forgotten foreign body (extremely rare).[4] Although several precautions are usually taken to prevent/ and (or) decrease postoperative blood loss after cardiac surgery, it is still one the most common early complications of cardiac surgery. The quantification of active bleeding (excessive bleeding) can be made by measuring the shed blood in chest drains (bottles), the number of red blood cells units transfused, the drop in haematocrit or using echocardiography.[5] The commonly

used criteria for diagnosing excessive bleeding post cardiac surgery are the Kirklin and Barratt-Boyes criteria which include one or more the following findings: (1) drainage of more than 500ml blood during the first hour after cardiac surgery, more than 400 ml during each of the first two hours, more than 300 ml during each of the first three hours, more than one litre in total during the first four hours, and more than 1200ml in total during the first five postoperative hours; (2) excessive bleeding that restarts (indicating a possible surgical cause); and/or (3) sudden massive bleeding.[6,7] Other causes of early re-sternotomy after cardiac surgery are haemodynamic instability which may be due to accumulation of blood in the mediastinum causing cardiac tamponade, coronary graft occlusion or right ventricular dysfunction. The haemodynamic instability can be manifested as low cardiac output, low blood pressure or dysrhythmias.[8] Associated signs can be a decrease in urinary output, high central venous pressure, muffled heart sounds, cold extremities, delayed capillary refill or evidenced by transthoracic or transoesophageal echocardiography signs.[9]

For most of the patients the re-sternotomy takes place in the operative theatre; however, for the unstable patients who are at high risk for transport to theatre the procedure is performed in the ICU.[10]

METHODS

This is retrospective observational study of adult cardiac surgical patients who presented for surgery for different cardiac pathologies took place at Queen Alia heart institute/ Amman, Jordan in the period of time between September 2023 and February 2024. Patients' data is collected using Google Forms and retrospectively analysed using Microsoft excel. Incidence, risk factors, causes and consequences of early re-sternotomy post cardiac surgery are studied. Comparison between operative theatre and intensive care reopening in terms of duration of mechanical ventilation, ICU stay and hospital stay are made. Ethical committee approval obtained from the hospital's IRB.

RESULTS

Data from 182 adult cardiac surgical patients was analysed. Male patients were 150 (82.4%) and female patients were 32 (17.6%). Patients' demographic, clinical and perioperative characteristics are given in Table 1. Reopening of sternum postoperatively was needed in 22 patients (12.1%) (Figure 1). Incidence of reopening was highest after combined procedures (valve + coronary surgery) (33.30%) and aortic surgery (Bentall procedure) (33.30%). Reopening after CABG was 12.59% and was lowest after mitral valve replacement (MVR) (9.1%) (Figure 2). Reopening was performed in the operative theatre in 16 patients (72.7%), while 6 patients (27.3%) had sternum reopened in the ICU (Figure 3). Main risk factors for re-opening were longer average CPB (127 minutes versus 107 minutes) and ACC times (71 versus 65 minutes). Patients who had reopening of sternum postoperatively spent on average 55.45 hours on mechanical ventilation, while those who did not need reopening were extubated after 32 hours. The ICU length of stay and hospitalisation period was slightly prolonged in the reopening group (5.6 days and 12.6 days) in comparison with the non-reopening group (5.4 days and 11.9 days, respectively) (Figure 4). The overall mortality rate was 11%; however, mortality in the reopening group was much higher 36.4% than in the non-reopening group 7.5%. In comparison between operative theatre and ICU re-opening; those who were reopened in ICU were at an older age (mean 61.6 years versus 56.9 years), required more blood transfusions (mean 2.4 units vs 1.5 units) and had higher mortality (mean 60% vs 23.5%) indicating more severe cases and worse outcome in ICU re-openings. Planned re-opening (delayed sternal closure) was performed in 5 patients (22.7%).

Table 1: Comparison between the re-opening group and non-re-opening group.

Variables	Re-opening group	Non-re-opening group	Total
Number of patients (%)	22 (12.08)	160 (87.91)	182 (100)
Average age (in years)	57.77	56.92	57.02
Male (%)	19 (86.36)	131 (81.87)	150 (82.4)
Female (%)	3 (13.63)	29 (18.125)	32 (17.6)
Average BMI (kg/m²)	29.6	28.47	28.59
CABG (%)	18, (11.2)	143 (88.8)	161 (88.46)
Off-pump CABG (%)	0 (0)	3 (100)	3 (1.87)
Average pump time (min)	127.05	109.13	111.33
Average cross clamp time (min)	70.95	65.8	66.4
Average blood transfused (units)	2.07	2.04	2.05
Average pre-op haematocrit (%)	39.08	38.63	38.68
Average post-op haematocrit (%)	29.36	30.36	30.24
Average length of ICU stay (days)	5.62	5.40	5.43
Average length of hospital stay (days)	12.53	11.9	12.4
Mortality rate (%)	8 (36.36)	12 (7.5)	20 (10.99)

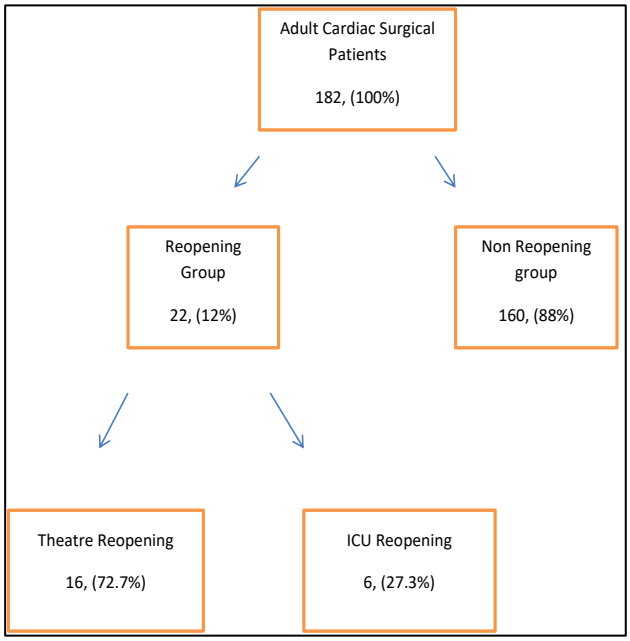

Figure 1: Flow chart of the study.

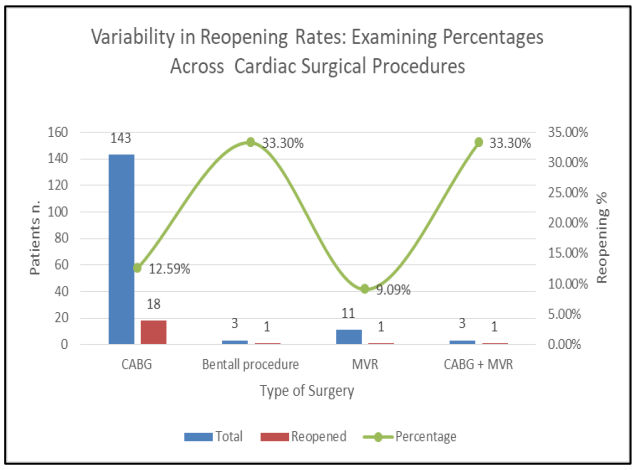

Figure 2: Variability in re-opening rate according to the type of surgery.

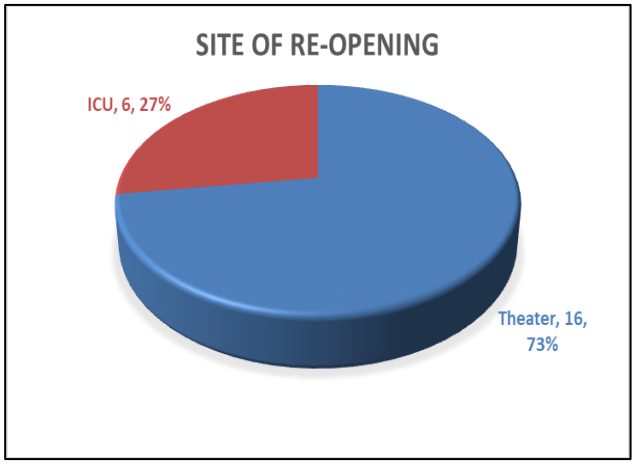

Figure 3: Site of re-sternotomy (re-opening).

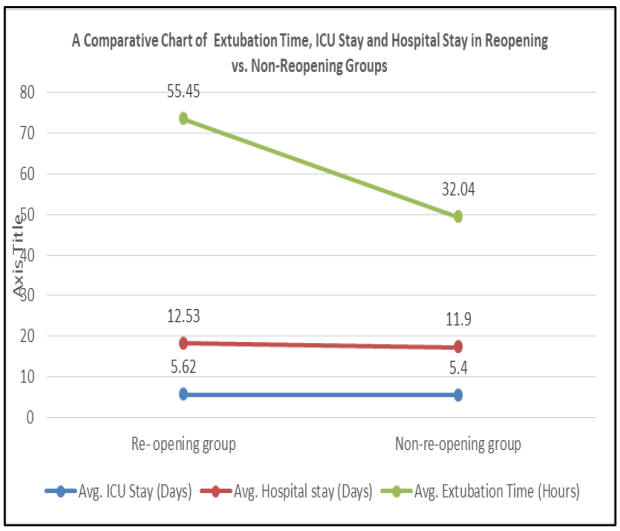

Figure 4: Comparative cart of ICU stay, extubation time and hospital stay in reopening vs. non-reopening groups.

DISCUSSION

Re-opening (re-sternotomy) in the early postoperative period is a frequent complication after cardiac surgery; it has an incidence that varies in the literature between 2% to 16%.[11] In our study, the incidence of re-opening was 12.1% which is relatively high. The average age of patients in the reopening group is slightly higher than in the non-re-opening group, suggesting a potential correlation between age and the likelihood of needing reopening postoperatively. Older age as a risk factor for the need of sternal reopening was found by several studies.[12] The re-opening group also had a higher percentage of male patients. This could be indicative of gender-based differences in cardiac health or surgery outcomes, but further analysis would be required for a definitive conclusion.[13]

Surgical factors that had an impact on the incidence of re-opening were more complex surgeries; such as combined procedures of valve replacement with coronary grafting or aortic surgeries such as the Bentall procedure (both had incidence of 33.3%). Isolated on-pump coronary arteries bypass grafting (CABG) and mitral valve replacement surgeries had a lower incidence of re-opening (12.6% and 9.1%, respectively). On the other hand; the Off-pump CABG (OPCAB) had zero rate of re-opening (Figure 2). The incidence of bleeding and re-opening after OPCAB was found to be less in several studies.[14-16] We also found in our study that the longer durations of CPB and ACC were risk factors for early re-sternotomy (re-opening) after cardiac surgery, as patients in the re-opening group had on average longer duration of CPB and ACC. Similar results were found by Khouri et al as they attributed the haemostatic dysfunction induced by CPB to be due, in part, to platelet dysfunction evidenced by a postoperative extension of the bleeding time.[17] Wahba et al also concluded that the duration of CPB affects thrombin

(factor II) formation as well as platelet count and function.[18] Causes of re-opening of sternum in our study were excessive postoperative bleeding or haemodynamic instability, with frequent overlapping of both causes. When excessive bleeding is suspected the decision to perform re-opening after cardiac surgery is made according to the Kirklin and Barratt-Boyes criteria for re-exploration.[19] Patients with severe haemodynamic instability had re-sternotomy (re-opening) in the intensive care (27.3%) as they were unstable for theatre transfer. We found that ICU re-opening was associated with significantly higher mortality rates (60%), indicating a higher risk and severity in these cases; while operative theatre re-openings had lower (23.53%); suggesting better outcomes. The significant finding of higher mortality rate in the reopening group underscores the serious nature of requiring reopening after cardiac surgery and possibly reflects the increased risk and complexity associated with these cases. Planned re-exploration was performed in five cases in the re-opening group (22.7%), in such cases the patient is transferred to the ICU with open sternum. The delayed sternal closure (keeping the sternum open) is a therapeutic option that is rarely used after cardiac procedures with severe heart impairment, uncontrollable bleeding, and re-perfusion heart oedema or when transthoracic intra-aortic balloon pump or central extra-corporeal membrane oxygenation (ECMO) are used.[20]

Limitations of this study are the observational nature of the study, the relatively small number of patients and being a single centre study.

CONCLUSION

Re-opening was needed after 12.1% of adult cardiac surgeries. Re-opening increased time of mechanical ventilation and was associated with higher mortality rates. Re-opening in the ICU carried worst prognosis and higher mortality. Main risk factors for re-opening are older age, more complex (combined) procedures, aortic surgeries and prolonged CPB and ACC durations.

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

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