Original Article

Frequency of Reoperation due to Bleeding and Its Related Factors After Adult Cardiac Surgeries

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ABSTRACT

Background: Reoperation due to bleeding in adult cardiac surgeries is an important postoperative complication that increases mortality and morbidity. Studying the risk factors and outcomes of reoperation in these patients is imperative.

Methods: The present descriptive (cross-sectional) study performed a 3-month assessment of patients that underwent elective cardiac surgeries (coronary or valve surgeries or both). The inclusion criterion was being an adult undergoing elective cardiac surgeries on cardiopulmonary bypass (coronary or valve surgeries or both), and the exclusion criteria consisted of congenital heart diseases, cardiac surgeries without cardiopulmonary bypass, emergency cardiac surgeries, aneurysm and aortic dissection surgeries, known causes of bleeding due to acquired or congenital diseases, and redo cardiac surgeries.

Results: Of 740 patients studied, 55 (7.43%) patients returned to the operating room due to bleeding. Of these 55 patients, 74.5% had bleeding due to surgical operations, 23.6% due to tamponade, and 1.8% due to coagulation disorders. Apropos risk factors, there was a significant relationship between the international normalized ratio (INR) and bleeding after cardiac surgeries leading to reoperation ($P = 0.05$).

Conclusions: In this study, 7.43% of the patients returned to the operating room because of bleeding, which is an acceptable percentage according to the literature. There was a significant relationship between preoperative INR and postoperative bleeding resulting in reoperation. ***(Iranian Heart Journal 2020; 21(4): 74-81)***

KEYWORDS: Cardiac surgery, Bleeding, Reoperation

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Studies have reported that about 2% to 8% of patients are transferred back to operating rooms due to bleeding after being admitted to the intensive care unit (ICU) following different cardiac surgical procedures.[1] Reoperation is an important complication due to bleeding in patients undergoing coronary artery bypass graft surgery, and a few studies have investigated the relevant risk factors and outcomes. [2] A team of French anesthesiologists and cardiac surgeons designed a method to define active bleeding independently of the volume of blood transfusion. The existing evidence has been related to post-cardiac bleeding. [3-5] Active bleeding is defined as a blood loss volume of greater than 1.5 mL/kg/h for 6 consecutive hours within the first 24 hours or in the case of reoperation for hemostasis during the first 12 postoperative hours. A previous study used an hourly blood loss index (2 mL/kg/h) during the first 3 hours or less to describe a bleeding score and reported that 7.5% to 8.2% of its patients met the criterion. [6] Excessive bleeding is defined as a chest tube drainage volume of more than 3 mL/kg/h in the first 3 hours that continues to more than 200 mL/h [7] or more than 200 mL/h in the first 4 hours. [8] The main causes of bleeding after surgery can be divided into surgical and medical reasons. [9] Studies have shown that the use of antithrombotic medications such as clopidogrel and glycoprotein IIb/IIIa inhibitors may increase reoperation due to postoperative bleeding in patients undergoing coronary artery bypass graft surgery. [10, 11] The risk factors suggested for postoperative bleeding include old age, a low body mass index (BMI) or body surface area, the time on extracorporeal circulation, 5 or more anastomoses, and nonelective surgical operations. [12] Reoperation can increase mortality by 2 to 6 times and can lead to an increase in morbidity due to renal and pulmonary dysfunction, sepsis, and arrhythmias.[13, 14] Postoperative bleeding can be in consequence of surgical or coagulopathy. [13] Patient-related factors also influence postoperative bleeding.

METHODS

The current descriptive (cross-sectional) study conducted a 3-month assessment of patients that underwent elective cardiac surgeries (coronary or valve surgeries or both). Patients who underwent reoperation due to bleeding after cardiac surgeries were studied. According to a checklist devised for the study, age, BMI, resistance to heparin during surgery, an ejection fraction of less than 35%, the duration of surgery, the duration of cardiopulmonary bypass (CPB), the duration of cross-clamping, the past medical history, anemia, preoperative coagulopathy, the use of preoperative anticoagulant drugs, the interval between admission to the ICU and re-admission to the operating room, consume blood products before reoperation, and the diagnosis of the cause of bleeding were considered. The inclusion criterion was being an adult undergoing elective cardiac surgeries on CPB (coronary or valve surgeries or both). Patients were excluded if they had one of the following criteria: congenital heart diseases, cardiac surgeries without CPB, emergency cardiac surgeries, aneurysm and aortic dissection surgeries, known causes of bleeding due to acquired or congenital diseases, and reoperation (redo cardiac surgeries).

RESULTS

In this study, patients who underwent elective cardiac surgeries (coronary or valve surgeries or both) were evaluated for 3 months. Of 740 patients studied, 55 (7.43%) returned to the operating room due to bleeding. Among these 55 patients, 74.5% had bleeding due to surgery, 23.6% due to

tamponade, and 1.8% due to coagulation disorders.

Regarding demographic variables, there were no significant relationships between age (P = 0.4) and BMI (P = 0.2) and postoperative bleeding (eg, tamponade and coagulopathy) leading to reoperation (Table 1), nor were there any significant relationships between co-existing diseases (eg, diabetes mellitus, chronic kidney disease, and thyroid disease) and postoperative bleeding leading to reoperation (Table 2).

The use of antiplatelets and anticoagulants in the patients was studied. Table 3 shows the relationships between the use of aspirin, clopidogrel (Plavix), and other anticoagulant drugs with postoperative bleeding. No significant relationship was observed between a high dose of heparin (5 mg/kg) during CPB and postoperative bleeding leading to reoperation (P = 0.2) (Table 2).

The patients had preoperative hemoglobin levels of above 8 g/dL because the surgeries were elective. There was no significant relationship between preoperative hemoglobin and hematocrit levels and postoperative bleeding leading to reoperation (Table 2). Additionally, there were no significant relationships between a low preoperative ejection fraction (< 35%) and the platelet count and postoperative bleeding (P > 0.05). The results also showed no statistically meaningful relationships between the prothrombin time and the partial thromboplastin time and postoperative bleeding leading to reoperation; as regards the international normalized ratio (INR), however, this relationship was significant (P = 0.05) (Table 4). There was also no significant relationship between blood transfusion and blood products and postoperative bleeding leading to reoperation (Table 5). The results revealed no statistically significant relationship between the duration of surgery (P = 0.7), CPB duration (P = 0.2), and cross-clamping duration (P = 0.7).

The average time interval between admission to the ICU and reoperation (in the patients undergoing reoperation because of bleeding due to surgery) was 4.5 ± 3.06 hours.

Table 1: Relationship between age and BMI and postoperative bleeding leading to reoperation

		Mean ± SD	Minimum	Maximum	Percentiles (25–75)	*P*-value
Age (y)	surgical	58.7 ± 13.4	28	79	63 (51.2-67)	0.4
	Tamponade	58.4 ± 13.7	32	79	60 (53.7–66.7)	
	Coagulation disorder	71				
BMI	Surgical	25.7 ± 4.4	16.8	37.7	25.4 (23.3–27.8)	0.2
	Tamponade	24.8 ± 2.02	21.2	27.7	24.9 (23.5–26.5)	
	Coagulation disorder	31.14				

BMI, Body mass index

Table 2: Relationship between variables with postoperative bleeding leading to reoperation

Variable	Surgical (n = 41)	Tamponade (n = 13)	Coagulation Disorder (n = 1)	*P*-value	Total
DM	10 (18.2%)	4 (7.3%)	0	0.7	14 (25.5%)
Hyperlipidemia	0	1 (1.8%)	0	0.1	1 (1.8%)
Hypothyroidism	7 (12.7%)	1 (1.8%)	0	0.6	8 (14.5%)
CKD	2 (3.6%)	1 (1.8%)	0	0.9	3 (5.5%)
Hb 8-12 (g/dL)	8 (14.5%)	2 (3.6%)	0	0.8	10 (18.2%)
Heparin >5 mg/kg during surgery	16 (29.1%)	8 (14.5%)	0	0.2	24 (43.6%)

Hb, Hemoglobin; DM, Diabetes mellitus; CKD, Chronic kidney disease; Hb, Hemoglobin

Table 3: Relationship between anticoagulant drugs and postoperative bleeding leading to reoperation

Variable	Surgical (n = 41)	Tamponade (n = 13)	Coagulation Disorder (n = 1)
Aspirin + clopidogrel	8(19.5%)	4(30.7%)	0
Aspirin	18(43.9%)	7(53.8%)	1
clopidogrel	5(12.1%)	0	0
Aspirin + warfarin	2(4.8%)	1(7.6%)	0
No drug	8(19.5%)	1(7.6%)	0

Table 4: Relationships between the platelet count, PT, PTT, and INR and postoperative bleeding leading to reoperation

Variable	Type of Bleeding	Mean ± SD	Minimum	Maximum	Percentiles (25–75)	*P*-value
Platelet Count	surgical	211414.6 ± 84226.7	100000	636000	193000 (159000-237500)	0.3
	tamponade	187615.3 ± 63406.8	131000	351000	170000 (142000-220000)	
	coagulation disorder	215000				
PT (s)	surgical	15.8 ± 6.6	1.15	51.1	14.4 (13.4 – 16.4)	0.1
	tamponade	15.7 ± 5.5	1.43	27.3	15.3 (15-17.8)	
	coagulation disorder	13.3				
PTT (s)	surgical	34.7 ± 10.8	26.9	90	33 (28.9 – 35.5)	0.2
	tamponade	36.6 ± 10.3	29.6	69	34.8 (31.8 – 35.4)	
	coagulation disorder	30				
INR	surgical	1.2 ± 0.4	1	3.8	1.1 (1.04 – 1.2)	0.05
	tamponade	1.31 ± 0.3	1.08	2.25	1.23 (1.1 – 1.3)	
	coagulation disorder	1.06				

PT, Prothrombin time; PTT, Partial thromboplastin time; INR, International normalized ratio

Table 5: Relationship between blood transfusion and blood products and postoperative bleeding leading to reoperation

Variable	Number	Surgical	Tamponade	Coagulation Disorder	*P*-value
Packed cell transfusion (unit)	0	9 (16.4%)	7 (12.7%)	0	0.2
	1	20 (36.4%)	1 (1.8%)	1 (1.8%)	
	2	7 (12.7%)	2 (3.6%)	0	
	3	1 (1.8%)	2 (3.6%)	0	
	4	3 (5.5)	1 (1.8)	0	
	5	1 (1.8%)	0	0	
Platelet transfusion (unit)	0	29 (52.7%	11 (20%)	1 (1.8%)	0.9
	1	2 (3.6%)	1 (1.8%)	0	
	2	8 (14.5%)	1 (1.8%)	0	
	3	1 (1.8%)	0	0	
	5	1 (1.8%)	0	0	
Fresh frozen plasma (unit)	0	22 (40%)	10 (18.2%)	0	0.7
	1	2 (3.6%)	0	0	
	2	14 (25.5%)	2 (3.6%)	1 (1.8%)	
	3	1 (1.8%)	1 (1.8%)	0	
	7	1 (1.8%)	0	0	
	8	1 (1.8%)	0	0	
PCC (unit)	0	35 (63.6%)	13 (23.6%)	1 (1.8%)	0.3
	2	6 (10.9%)	0	0	
Fibrinogen (unit)	0	37 (67.3%)	12 (21.8%)	1 (1.8%)	0.9
	1	2 (3.6%)	1 (1.8%)	0	
	2	2 (3.6%)	0	0	

PCC, Prothrombin complex concentrate

In the personality model, the value of the χ^2 is 1.15. The value of this index was less than 5, meaning that our model provided an adequate fit for our data. In addition, the value of the root mean square error of approximation (RMSEA) was 0.04. The fact that this value was less than 0.1 means that the model had an acceptable fit. The values of the goodness of fit index (GFI), the rock mass rating (RMR), the comparative fit index (CFI), the normed fit index (NFI), and the non-normed fit index (NNFI) also showed an adequate fit.

DISCUSSION

In the present study, of 740 patients assessed, 55 (7.43%) patients returned to the operating room due to bleeding. These patients suffered bleeding due to surgery, tamponade, and coagulation disorders. With respect to risk factors, there was a significant relationship between INR and post-cardiac surgery bleeding leading to reoperation (P = 0.05). Previous investigations have reported that about 2% to 8% of patients are transferred back to operating rooms as a result of bleeding after admission to the ICU following different cardiac surgical procedures, [1] which chimes in with our findings. Excessive bleeding is common after cardiac surgeries, and it can be a major cause of morbidity and mortality. Many studies have evaluated hemostatic disturbances caused by CPB and the varied strategies for blood conservation. The incidence of reoperation early after cardiac surgeries was reported to range from 2% to 6% in a previous study. [15] The major cause of early reoperation after open cardiac surgeries is bleeding. In studies before 1990, reoperation rates were as high as 14%; nonetheless, in recent studies, the rate has declined to 3%. The reasons for this could be reduced operation times, improved technologies, the construction of extracorporeal circulatory and oxygenator lines that can lead to a reduction in hematologic traumas, better perioperative evaluations of patients, and the transfusion of autologous blood components. Excessive bleeding may result in massive blood transfusion and also the complications of transfusion such as myocardial infarctions, low cardiac output syndrome, respiratory failure and pneumonia, severe arrhythmias, deep sternal wound infections, hepatic and renal failure, the need for hemofiltration, cardiac tamponade, and increased mortality. Mortality rates detected after revisions for bleeding are between 8% and 26% in some studies, but the incidence of wound infections after reoperations is nearly 2%. [16] In a multicenter (29 centers) investigation in 2016, according to the definition of postoperative bleeding (active bleeding was defined as a blood loss volume > 1.5 mL/kg/h for 6 consecutive hours within the first 24 hours or in the case of reoperation for hemostasis during the first 12 postoperative hours), patients undergoing cardiac surgeries were studied. The overall incidence rate of active bleeding was 2.6%, and the incidence rate of active bleeding differed from 0 to 16% between the centers. No significant correlation was detected between the number of cardiac surgery cases done and the number of active bleeding cases described during the study period in each center. Also in that study, a body surface area of 1.68 or more, preoperative creatinine levels, emergency surgeries, postoperative acidosis, and packed cell transfusion were the risk factors of postoperative complications. [17] Another study used an hourly blood loss criterion (2 mL/kg/h) during the first 3 hours or less to describe a bleeding score and reported that 7.5% to 8.2% of the study population had the criterion. [18] Blood loss is a better criterion for the evaluation of early postoperative bleeding, and it reduces viewer-related errors. Hence, an hourly evaluation of blood loss may improve the measurement of postoperative blood loss and confer enhanced real-time assessments. Previous studies have shown that adverse

outcomes are more frequent when patients wait for more than 12 hours for re-sternotomy. In the aforementioned multicenter study, [17] the median delay between arrival at the ICU and reoperation was less than 5 hours. The findings indicated that the decision to re-enter the operating room was not delayed, and reoperation did not have a significant effect on the ICU length of stay. Furthermore, no elements of the measures to control bleeding (surgery or hemostatic treatment) were significantly associated with postoperative complications. [17] According to an investigation in Odense University Hospital, [19] between 5% and 9% of all unselected cardiac surgical patients underwent reoperation due to massive bleeding. Additionally, reoperation increased mortality 3-fold, and a reduction in reoperation reduced mortality. According to the findings, pre- and intraoperative risk factors predicted reoperation due to bleeding after surgery; these risk factors consisted of a low ejection fraction, a high EuroSCORE, procedures other than isolated coronary artery bypass graft surgery, a prolonged pump time, low BMI, diabetes mellitus, and preoperative creatinine elevation. Also in that study, there were no relationships between hypertension, acute myocardial infarctions, percutaneous coronary interventions, and reoperation risk. [19] In a study by Karthiket al, [12] the risk factors that led to reoperation due to bleeding were low BMI, nonelective cardiac surgeries, increased numbers of grafts, and increased age. The main causes of bleeding after surgeries can be divided into surgical and medical reasons. Previous studies have shown that surgery accounted for 35% to 100% of postoperative bleeding,[8, 20, 21] which could be related to anastomotic sites (suture lines), the side branches of arterial or venous conduits, substernal soft tissues, sternal suture sites, the bone marrow, the periosteum, raw surfaces caused by previous surgeries, and pericarditis. The major medical reason for bleeding after complex surgical operations could be abnormal coagulation. The diagnosis of bleeding due to coagulopathy is hard, and there is a need for more inotropes with the alpha effect, resulting in greater incidence rates of low cardiac output syndrome, longer lengths of hospital stay, and more mortality. Therefore, the main goal in patients with high and unexpected drainage is to normalize coagulation profiles within 4 hours. [8] Many risk factors are associated with medical reasons for bleeding, including a low body surface area with a small blood circulation volume. Moreover, massive transfusions because of the further hemodilution and the use of higher total volumes in the CPB circuit are also of great significance in this regard. [22] Defects in platelet function due to the use of antiplatelet drugs in patients with acute coronary syndromes also significant contributors. Aspirin is a common antiplatelet drug, and clopidogrel is a drug that can cause high rates of reoperation. [23] Another risk factor for bleeding and massive transfusion after surgery is preoperative thrombocytopenia (< 100000). [24] The reasons for thrombocytopenia can be heparin-induced thrombocytopenia, hepatic failure, residual warfarin effects, defects in the function of the coagulation factors that are dependent on vitamin K, Von Willebrand disease, and thrombolytic therapy. All of these factors can cause bleeding after CPB. The main reason for intraoperative bleeding is CPB. A prolonged CPB period is an independent risk factor that can increase the mortality and morbidity rates after cardiac surgeries, and it is the salient reason for microvascular bleeding. The risk of bleeding increases with a prolonged CPB period of more than 120 minutes. [25] Through the release of alpha granules and changes in membranous platelet receptors, CPB leads to platelet dysfunction. Thrombocytopenia can progress with a prolonged CPB period. Protamine can reduce the platelet count to 30%, and hemodilution during CPB can reduce Factor V Leiden by up to 80%. The most common

reason for bleeding after CPB is heparin rebound, which is defined as the reappearance of hypocoagulopathy after the destruction of the heparin effect. The phenomenon is common in patients who use high-dose heparin such as obese patients. The reappearance of heparin in the circulation usually occurs between 1 and 8 hours after destruction with protamine. The heparin effect has been recognized in 43% of studied patients within 2 hours, in 31% within 4 hours, and in 37% within 8 hours. The reason for the phenomenon can be the reabsorption of heparin from extravascular depots to the circulation or the fast destruction of protamine. Research has indicated that antifibrinolytic therapy can diminish perioperative bleeding after cardiac surgeries. Concerning the rewarming of patients, coagulation is improved and bleeding is reduced when patients are normothermic before the end of CPB. Urgent reoperation should be done in patients with corrected coagulopathy but persistent mediastinal bleeding, in patients with sudden massive bleeding, in patients with the signs and symptoms of cardiac tamponade, and in patients with cardiac arrest with persistent mediastinal bleeding. Studies have demonstrated that delaying reoperation after 12 hours from the end of surgery leads to a longer length of stay in the ICU, a higher need for intra-aortic balloon pump support, and increased mortality in a population of patients having undergone coronary revascularization.[7]

CONCLUSIONS

In the present study, 7.43% of the patients returned to the operating room due to bleeding. In comparison with the rates reported in the existing literature, this percentage is acceptable. Our results revealed statistically significant relationships between INR and the use of aspirin and post-cardiac surgery bleeding leading to reoperation, which is concordant with previous studies. Massive bleeding can result in extensive transfusion and complications. The detection of the risk factors and the prevention and control of these risk factors can diminish the risk of bleeding, the need for blood products, and postoperative complications.

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