Active Bleeding after Valve Surgery under Extracorporeal Circulation: Incidence and Risk Factors? Prospective Observational Study on 59 Patients in a West African Country

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Abstract

Introduction: Active bleeding after cardiac surgery is defined as blood loss > 1.5 ml / kg / h for 6 consecutive hours within the first 24 hours or in case of re-operation for haemostasis within the first 12 hours postoperatively.

The aim of our work was to assess the incidence and risk factors for the occurrence of active bleeding in postoperative valve surgery with extracorporeal circulation.

Patients and methods: Prospective observational study, conducted over 5 months at the Dakar cardiac Centre. All patients who underwent valve surgery under extracorporeal circulation were included. Exclusion criteria were: death in the operating room or during the first 6 hours, incomplete medical records.

Results: Our work included 59 patients, with a predominance of females (sex ratio = 0.6) and a mean age of 31 years. All patients underwent scheduled surgery, and none of them were in acute cardiac decompensation. Only 25.4% of the patients were on LMWH, which was stopped 24 hours before the operation . Preoperatively, 11.8% of patients had moderate anemia, 3.4% had mild thrombocytopenia, 30.5% had low prothrombin levels (40-70%), 5.1% had an impaired left ventricular ejection fraction, 8.5% had moderate right ventricular systolic dysfunction, and more than half (54.2%) had severe pulmonary arterial hypertension (PAH). Intraoperatively: Intravenous induction was predominant (79.6%), all patients received tranexamic acid, priming of the extracorporeal circulation (ECC) was done with crystalloids alone in 83% of cases, the mean duration of the ECC was 140 min, sympathomimetics were used in 72.3% of patients and transfusion was performed in 45.7% of patients. The incidence of active bleeding in the ICU was 52.5% with the main risk factors being low age, low BMI, preoperative anticoagulant treatment, long bypass surgery and low prothrombin level.

Conclusion: Active bleeding is a serious complication in cardiac surgery and may be responsible for an increase in perioperative morbidity and mortality.

Keywords: Active bleeding; Valve surgery; Incidence

Abbreviations: ECC: Extracorporeal Circulation; LVEF: Left Ventricular Ejection Fraction; TAPSE: Tricuspid Annular Plane Systolic Excursion; MVR: Mitral Valve Replacement; TP : Tricuspid Plasty; MP : Mitral Plasty; TVR : Tricuspid Valve Replacement; AVR : Aortic Valve Replacement; PAH: Pulmonary Arterial Hypertension; LMWH : Low Molecular Weight Heparin; SPAP: Systolic Pulmonary Arterial Pressure

Introduction

Active bleeding after cardiac surgery is defined as blood loss > 1.5 ml/kg/hr for 6 consecutive hours in the first 24 hours or in case of re-operation for haemostasis in the first 12 hours postoperatively [1]. This is a major and serious complication feared by the resuscitating anesthetist and surgeons, which may be responsible for anemia and transfusion, leading to an increase in peri-operative morbidity and mortality [2,3]. The aim of our study was to evaluate the incidence and risk factors for the occurrence of active bleeding after valve surgery under extracorporeal circulation (ECC).

Patients and Methods

This was an observational, prospective, descriptive and analytical study of patients operated on for valve surgery in the cardiac department of the Fann University Hospital in Dakar over a 5-month period from 12/10/2021 to 08/03/2022.

All patients scheduled for valve surgery under ECC were included in the study.

Exclusion criteria were: patients who died intraoperatively or during the first 6 hours, patients with incomplete or unusable records. All patients included in the study had a cardiology consultation with systematic electrocardiogram and transthoracic cardiac ultrasound. They also had a cardiac surgery consultation before being sent for the pre-an aesthetic consultation. After confirmation of suitability for anesthesia, patients were included in the surgical programme.

Upon arrival in the operating room, patients were routinely monitored with an electrocardioscope, non-invasive blood pressure and peripheral oxygen saturation. In addition to this standard monitoring, patients were routinely fitted with a central venous line and an arterial catheter. These were used to measure central venous pressure and invasive arterial pressure

respectively. A trans-oesophageal ultrasound was systematically performed intraoperatively either by a cardiologist or by the anesthetist. A blood-sparing strategy was systematically carried out with the administration of tranexamic acid. Antibiotic prophylaxis was also administered to all patients. At the end of the operation, all patients were systematically transferred to the intensive care unit.

The software used for the descriptive and analytical statistical analysis of the data and for the production of the figures are the following: Epi Info, SPSS, Stata, Excel table.

Descriptive Results

Our study included 59 patients with a predominance of women, i.e. a sex ratio of 0.6. The average age was 31 years with extremes of 08 and 76 years. Determination of the body mass index (BMI) before the operation revealed that 5.1% of patients were overweight and 37.3% were thin. No previous history or comorbidities were noted in 45.7% of patients. Hospitalization for acute cardiac decompensation was reported in 19 patients (32%), including 03 episodes in 07 patients, 02 episodes in 03 patients, 01 episode in 09 patients. The most common cause was hypertension (6.7%), followed by smoking with 5% of cases (See Figure 1).
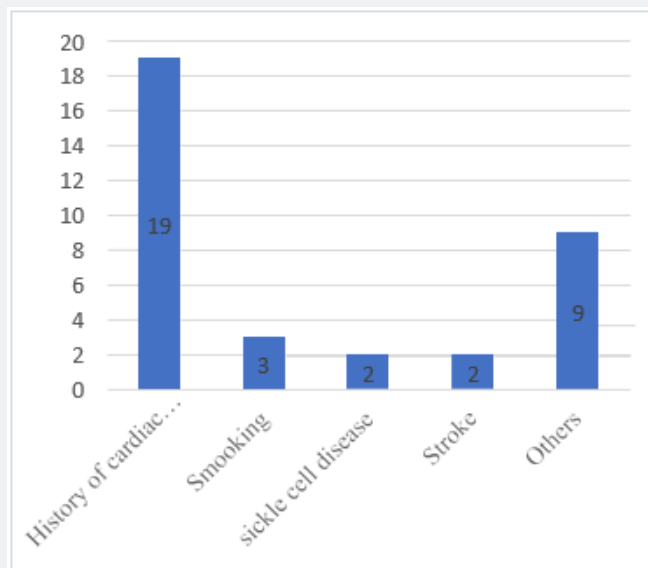

Figure 1: Distribution of patients according to medical history.

Previous cardiac surgery was noted in 03 patients including 02 cases of mitral valve replacement (MVR) and 01 case of mitral plasty (MP). Only 25.4% of the patients were on anticoagulant therapy with low molecular weight heparin (LMWH), which was stopped 24 hours prior to surgery. Preoperatively, there were 11.8% cases of moderate anemia with hemoglobin (Hb) between 8-10g/dL, 3.4% mild thrombocytopenia (130,000-150,000/mm3), 30.5% low prothrombin levels (40-70%), impaired left ventricular ejection fraction (LVEF) in 5.1% of patients (LVEF

between 33-50%), moderate right ventricular systolic dysfunction in 8.5% of cases with a TAPSE between 11-15 mm, severe pulmonary arterial hypertension (SPAP > 50mmHg) in more than half of our population (54.2%)

Intraoperative phase:

The most common procedure was mitral valve replacement (MVR) combined with tricuspid plasty (TP) with a rate of 33.9%, followed by isolated MVR with 23.7% (see procedure distribution

in Table 1). All patients received general anesthesia with orotracheal intubation. Intravenous induction was predominant with 79.6% compared to 20.4% for the inhalation route (see Figure 2). All patients received tranexamic acid intraoperatively either in 3 boluses of 15mg/kg (91.5%) or continuously at 10mg/kg/hour after a bolus of 10mg/kg (8.4%). Regarding extracorporeal circulation, priming was carried out in 83% of cases with crystalloids alone and in 20% with a combination of crystalloids and colloids, the average duration of the ECC was 140 min [61-372 min]. Hemodynamically, norepinephrine was used in 43 patients (72.8%), dobutamine in 10 patients (16.9%) and milrinone in 23 patients (38.9%). Twenty-seven of our patients (45.7%) were transfused intraoperatively (see Figure 3). All our patients received protamine sulphate after the cessation of the ECC in order to antagonize the effect of heparin (protamine dose = cumulative heparin dose).

Table 1: Distribution of patients according to the surgical procedure.

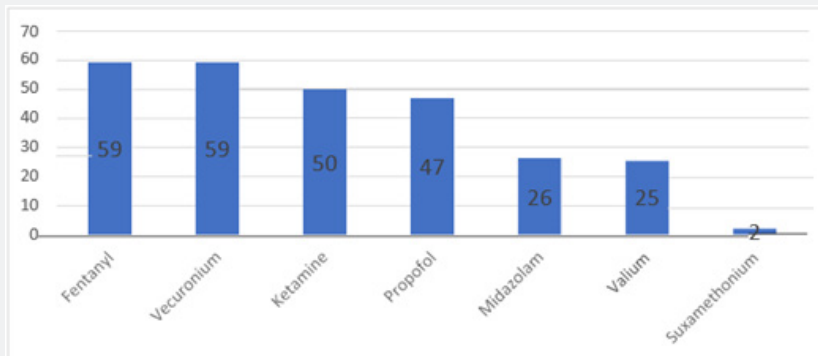| Surgical procedure	Frequency	Percentage
MP	1	1,7%
MP+TP	2	3,4%
AVR	3	5,1%
AVR+TP	2	3,4%
MVR	14	23,7%
MVR+TP	20	33,9%
MVR+AVR	9	15,3%
MVR+AVR+TP	6	10,2%
MVR+AVR+TVR	1	1,7%
MVR+TVR	1	1,7%
Total	59	100,0%

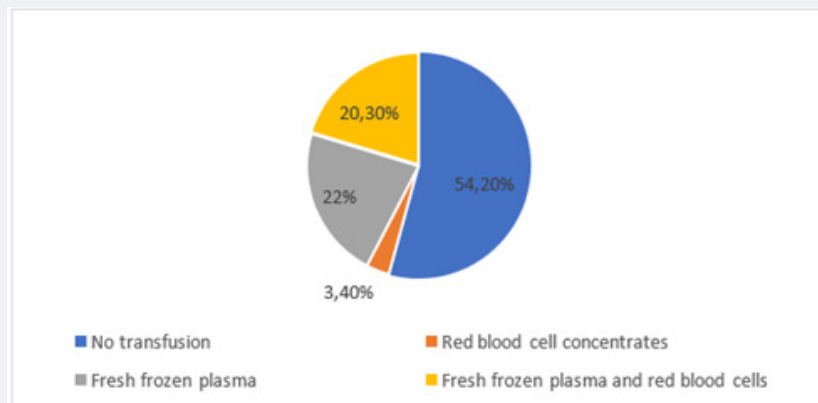**Figure 2:** Distribution according to anaesthetic products used.

Figure 3: Distribution of patients according to blood products administered.

Post-operative phase:

The biological assessment carried out at at the first hour of admission to the intensive care unit revealed: anaemia with an Hb level < 10g/dl in 42.4% of cases, 37.3% thrombocytopenia (platelet level < 150,000/mm3), a drop in the prothrombin level (<70%) in 61% of cases The cardiac echodoppler in the immediate postoperative period revealed: severe alteration of the systolic function of the left ventricle (LVEF < 40%) in 16.9% of cases; systolic dysfunction of the right ventricle (TAPSE < 10 mm) in 40.7%, severe PAH in 6 patients (SPAP > 50mmhg), i.e. 10.2%. Fifteen patients received tranexamic acid immediately postoperatively, i.e. 24.4%. Transfusion of labile blood products was performed in 25 patients, i.e. 42.3%.

Active bleeding was observed in 31 patients, i.e. an incidence of 52.5% with bleeding over the first six hours > 1.5ml/kg/h. Of these patients, 03 were taken back to the operating room for haemostasis.

The outcome was favorable in 89.8% of patients despite active bleeding postoperatively. The overall mortality was 10.1% or 6 patients, distributed as follows:

i. Two of our deaths (3.38%) were directly related to the severe acute bleeding syndrome; Two of our patients died at day 4 and day 5 following sepsis from nosocomial pneumonia;

ii. One of the patients developed a stroke followed by sepsis from nosocomial pneumonia and died at day 8; One death at day 5 was related to acute kidney injury;

iii. None of the patients who required revision surgery died.

Analytical Results: Statistical Correlations

Epidemiological data

Patients who experienced an active bleed had a mean age of 25.68 years compared to 39.32 years for those who did not experience an active bleed (p = 0.001), suggesting that a younger age may be a risk factor for the occurrence of an active bleed.

Patients with a low BMI (<18 kg/m^2) had a 3.9-fold greater risk of active bleeding than patients with a BMI greater than 18 kg/m^2 (Odds Ratio = 3.906; p=0.019).

Patients who were on LMWH also had a 4.4 times greater risk of active bleeding than patients who were not on anticoagulation (Odds Ratio = 4.367; p=0.02).

Differences in other parameters such as gender, history, biology or preoperative treatment were not significant (see Table 2).

Table 2: Preoperative data and active bleeding.

Pre-operative	No active bleeding	Active bleeding	P value
Age	39,32	25,68	
Under or = 25 years	5 (17,9%)	14 (45,2%)	0,001
Sup to 25 years	23 (82,1%)	17 (54,8%)	
Gender			
Male	12 (42,9 %)	11 (35,5 %)	0,562
Female	16 (57,1 %)	20 (64,5 %)	
BMI			
<18	6 (21,4 %)	16 (51,6 %)	
18-25	19 (67,9 %)	15 (48,4 %)	0,019
25-30	3 (10,7 %)	0 (0 %)	
Background			
High blood pressure	2 (7,1 %)	2 (6,5 %)	0,916
Cardiac decompensation	6 (21,4%)	11 (35,5 %)	0,234
Anticoagulant treatment			
LMWH	11 (39,3 %)	4 (12,9%)	0,020
Preoperative biology			
Hb (g/dl)			
< 10	2 (7,1 %)	5 (16,1%)	0,286
> 10	26 (92,9 %)	26 (83,9 %)	
Prothrombin level (%)			
< 70%.	11 (39,3%)	7 (22,6 %)	0,164
>70%	17 (60,7 %)	24 (77,4 %)	

Blood platelets (/mm3)			
<15.000	1 (3,6%)	1 (3,2 %)	0,942
>15000	27 (96,4 %)	30 (96,8 %)	
Cardiac ultrasound			
LVEF <50%.	1 (3,5%)	2 (6,4%)	0,615
LVEF >50%.	27(96,4%)	29 (93,5%)	
TAPSE < 15mm	1 (3,5%)	4 (12,9%)	0,356
TAPSE >15mm	27 (96,4%)	27 (87%)	
SPAP < 50mmHg	13 (46,4%)	12 (38,7%)	0,272
SPAP>50mmHg	15 (53,5%)	19 (61,2%)	

Intraoperative data

Of the parameters studied intraoperatively (see Table 3) to detect a risk factor for active bleeding intraoperatively, the duration of the bypass surgery was the only determining parameter. Patients with a ECC duration of more than 130min had a higher risk of active bleeding with an odds ratio of 3.88.

Table 3: Intraoperative parameters and active bleeding.

Per-operative	No active bleeding	Active bleeding	p-value
Type of surgery			
MVR	10 (16,9%)	4 (10,3%)	0,400
MVR + TP	10 (16,9%)	10 (16,9%)	0,791
MVR + AVR	3 (5,1 %)	6 (10,2 %)	0,477
MVR+AVR+TP	2 (3,4%)	4 (6,8 %)	0,673
Isolated gestures	12(20,3%)	6 (10,2 %)	0,088
Multiple gestures	16 (27,1 %)	25 (42,4 %)	
Tranexamic acid	28 (100 %)	30 (96,8 %)	0,338
Bolus	26 (92,9 %)	28 (90,3 %)	0,727
Continue	4 (14,3 %)	1 (3,2 %)	0,128
ECC duration in minutes	114,54	145,45	0,003
Satisfactory haemostasis			
Yes	24 (85,7%)	25 (80,6 %)	0,604
No	4 (14,3 %)	6 (19,4 %)	
Intraoperative transfusion			
Yes	10 (35,7 %)	18 (58,1%)	0,086
No	18 (64,3 %)	13 (41,9 %)	

Post-operative data

Among the postoperative parameters (see Table 4), only a low prothrombin count seemed to have an impact on the occurrence of active bleeding with a p=0.029.

Discussion

In our study, the mean age of the patients operated on was 31 years with extremes of 8 and 76 years. The median age was 30 years. Moreover, in most series from poor countries, a similar average age is reported, with a more frequent occurrence in school-age subjects [4,5]. In contrast to the low age found in our work as a determining factor, it is the advanced age > 60- 70 years that has been cited in the literature [6,7]. Patients with a low BMI <18 kg/m² had a 3.9-fold higher risk of active bleeding than patients with a BMI >18 kg/m² (Odds Ratio = 3.906; p=0.019). Our results are consistent with some studies that clearly show that the higher the BMI, the lower the risk of bleeding or repeat surgery for haemostasis in post cardiac surgery [6-8]. The female predominance in our series has been observed in other studies and is very common in mitral stenosis [5,9]. Although in our study there was a statistically significant relationship between

anticoagulant therapy and the risk of active postoperative bleeding, our sample of patients on LMWH was small (CI 1.196-15.951) and few studies have established a clear causal relationship because there is a lack of robust scientific data. Although PAH has been shown to increase operative risk in some series [10,11], we did not find a correlation between PAH and the occurrence of active bleeding postoperatively.

To limit the risk of acute bleeding, tranexamic acid was used intraoperatively in all our patients. This product has anti-fibrinolytic effects, which have been widely demonstrated to reduce postoperative bleeding. This product has anti-fibrinolytic effects, the effectiveness of which has been widely demonstrated on the reduction of postoperative bleeding, the rate of transfusion and re-intervention for haemorrhage [12]. A long duration of bypass surgery was found in our work to be a determining factor in the occurrence of active bleeding. This is consistent with the literature [7,13,14]. Moreover, Stalis et al. [13] have shown an increase in the time spent on bypass surgery to be an independent factor in repeat surgery for bleeding, and Despotis et al. [14] have shown that there is a 25% increase in the risk of transfusion for cardiac surgery lasting more than 145 minutes.

In our study, thirty-one of our patients had active bleeding postoperatively, i.e. 52.5%, which is a very high bleeding rate compared to other studies of bleeding in cardiac surgery, where the incidences range from 1 to 15% [15,16]. However, only three of our patients (5.1%) required revision surgery. This incidence of revision surgery is similar to the study by Tirilomis et al. [17], where re-explorations after cardiac surgery in adults were 4.8%. It is also in general agreement with the results of the literature which found a rate of re-exploration of around 3% [15,18]. We have identified low prothrombin levels as a factor independently associated with postoperative bleeding. However, although widely studied in the literature [7,19], there has been no evidence of an association between postoperative prothrombin count.

and postoperative bleeding in cardiac surgery. All our patients who presented with active bleeding received transfusion of packed red blood cells and fresh frozen plasma in a 1:1 or 1:2 ratio based on the patient's hemoglobin level, platelet count, clinical status and hemodynamic status. The acceptable hemoglobin level after cardiac surgery is uncertain. A level of 7 g/dl is sufficient to cover oxygen requirements, perhaps even less in the healthy individual, and this level appears to be transferable to the critical clinical situation [20,21]. Overcompensation is detrimental as haematocrit levels above 34% at ICU entry after cardiac surgery are associated with excess mortality and increased morbidity after coronary bypass surgery [22]. In addition, the criteria for transfusion are better defined on the basis of decision algorithms [23] that integrate coagulation tests and, in particular, delocalised tests. The latter make it possible to mechanically reduce the volume of transfusion [14,24,25].

The overall death rate in our study was 10.1%, i.e. 6 patients, of which two deaths (3.38%) were directly related to active bleeding. The mortality reported in the series varies considerably according to geographical location. In underdeveloped countries, rates between 1 and 7.8% have been reported [26-28].

Limitations of the study

There is no consensus definition of early postoperative bleeding in cardiac surgery. As the universal definition of perioperative bleeding [30] lacks precision in characterizing postoperative bleeding, we based ourselves on the definition proposed by a French team [1]. This study is one of the few to evaluate postoperative bleeding based on the quantity of blood drained by the redons or the need for revision surgery for hemostasis. It was therefore difficult to compare all our results with those in the literature. Due to the small sample size, the sample size was not representative enough.

Fibrinogenemia and the use of fibrinogen were not studied in our work, due to its cost and availability. This element would have been interesting to analyze, because the literature has shown that a low level (<2.5g/l) both preoperatively and postoperatively would have an important influence on postoperative bleeding. And it would be a protective factor for bleeding and reoperation for haemostasis, without having any influence on the transfusion rate when it becomes higher than 3.6g/l. Some studies recommend systematic preoperative supplementation with fibrinogen, particularly if the level is less than 1.5 g/l, as recommended by the Formalized Recommendations of Experts [31].

Conclusion

Valve pathologies are an important part of cardiovascular disease in Africa. With the advent of cardiac surgery and extracorporeal circulation in Senegal, a major step forward has been made, allowing early and appropriate on-site management. However, this surgery is fraught with complications during and after the operation. These include active bleeding, which is a complication much feared by anesthetists and surgeons, as it may be responsible for re-operation, anemia and transfusion of labile blood products, all of which are factors that increase morbidity and mortality.

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