RESEARCH

22(89), January - February, 2018

ISSN
2321–7359
EISSN
2321–7367

Medical Science

The effects of the usage of blood and blood products in open heart surgery patients and the risk of postoperative atrial fibrillation development

Ali Kemal Gür[1☼], Arzu Esen Tekeli[2], Esra Eker[3], Mehmet Coşkun Aykaç[4]

1.Assistant Prof. Dr,Yuzuncu Yil University, Medicine Faculty, Department of Cardiovascular Surgery, Van, Turkey. Email: dralikemal@gmail.com
2.Assistant Prof. Dr,Yuzuncu Yil University, Medicine Faculty, Department of Anesthesiology and Reanimation, Van, Turkey. Email: esentekeli190807@hotmail.com
3.Specialist Dr, Medical Science University, Education and Research Hospital, Department of Anesthesiology and Reanimation, Van, Turkey. Email: dresoseker@hotmail.com
4.Specialist Dr, Erciş, Government Hospital Department of Emergency, Van, Turkey. Email: drmcoskun@gmail.com

☼**Corresponding Address:**
Asistant Prof.Dr.Ali Kemal Gür
Yuzuncu Yil University, Medicine Faculty,
Department of Cardiovascular Surgery, Campus, Van, Turkey.
Mobile:+90536 563 26 71
Email: dralikemal@gmail.com

Author's contribution to the manuscript
Ali Kemal Gür: He made design of the study. He has made contribution acquisition of datas, analysis and drafting of the manuscript.
Arzu Esen Tekeli: She has made contribution to acquisition of datas, analysis and drafting of the manuscript. She has made a substantial contribution to interpretation of datas and revising the manuscript for intellectual content. She prepared the manuscript.
Esra Eker: She has made contribution to acquisition of datas, analysis and drafting of the manuscript.
Mehmet Coşkun Aykaç: He has made contribution acquisition of datas, analysis and drafting of the manuscript.

Conflict of interest
All authors read and approved the final manuscript. Also, the authors declare that they have no conflicts of interest.

Article History
Received: 04 October 2017
Accepted: 11 November 2017

RESEARCH ARTICLE

Published: January-February 2018

Citation

Ali Kemal Gür, Arzu Esen Tekeli, Esra Eker, Mehmet Coşkun Aykaç. The effects of the usage of blood and blood products in open heart surgery patients and the risk of postoperative atrial fibrillation development. *Medical Science*, 2018, 22(89), 31-37

ABSTRACT

Background: The current study explains the relationship between blood and blood-products that are used during surgery and AF.

Material and Methods: A total of 260 patients who underwent elective isolated coronary artery bypass grafting (CABG) between January 2015 and March 2017 were included in the study, retrospectively. The study subjects were divided into two groups; patients whom we used blood products during surgery (Group I) and patients whom we didn't use blood products during surgery (Group II). In Group I there were 140 patients (54 female, 86 male), in Group 2 there were 120 patients (45 female, 75 male). AF rates, peri-operative and postoperative blood usage rates and preoperative demographic characteristics were recorded and studied in both groups.

Results: AF developed in 95 (36%) of 260 patients who underwent isolated coronary bypass surgery. AF developed in 64 (45%) patients in group I and 31 (25%) in group II. The incidence of AF was found to be statistically significantly lower in the group which we the blood products weren't used (p> 0,05). There was no significant difference between the groups in terms of smoking habits, chronic obstructive pulmonary disease (COPD), diabetes mellitus (DM) and hypertension (HT). The mean age was 63.2 ± 9.2 years in Group I and 60.5 ± 8.3 years in Group II. Aortic cross clamping (ACK) duration in patients with cardiopulmonary bypass was 65.2 ± 33.1 minutes in Group I, In the Group 2 mean duration was 59.7 ± 25.4 minutes (p <0,05). The mean number of distal anastomoses was 3.1 ± 2.3 in Group I and 3.5 ± 2.7 in Group II (p <0,05). 1 bag of blood and blood products were given to 75 patients (53.5%), 2 bags to 38 patients (27.1%) and 3 bags were given to 27 patients (19.2%). The mean duration of hospitalization in intensive care unit was 3.2 ± 1.6 days in Group I and 2.1 ± 1.1 days in Group II. No mortal cases within the first month were included in the study.

Conclusion: The incidence of AF was significantly lower in coronary bypass operations without the usage of blood and blood products during and after the operation. We conclude that limiting the usage of blood and blood products will result in a significant reduction in the incidence of AF.

Key words: Open heart surgery, blood and blood products, trial fibrillation

1. INTRODUCTION

AF is defined by the absence of P waves and irregular R-R distance ranges on electrocardiography (ECG). In patients with AF, atrial contractions are 300-600 / minute but most of the electrical activity does not reach the ventricle. There are two types of AF; AF with slow ventricule response and AF with rapid ventricule response.AF is the most common rhythm disturbance after coronary bypass surgery. Some studies pointed that this ratio varies between 20-40%.[1] Irregular contractions of the atria, which have a 30% effect on the ejection fraction, are of great importance in peri-operative period of post cardiopulmonary bypass (CPB) phase. Although the progress of myocardial protection methods, shorter duration of operations due to surgical experience, preoperative and postoperative close follow-up and initiation of antiarrhythmic treatments, the incidence of AF still remains as a problem. Patients with AF have a longer hospital stay, increased risk for stroke; they require antiarrhythmic drugs and the use of pacemakers, all which results in cost increases. Although the aetiology of AF after open heart operations is not fully known, many factors are thought to be responsible for it. There are several factors that contribute to atrial fibrillation (AF) development after coronary bypass surgery. Many

factors such as age, cardioplegia solutions, hypothermic arrest, damage to the atrium site due to local cold applications, over-manipulation of cardiac tissue, electrolyte imbalance, prolonged aortic cross clamping can play a role in AF. Despite the advancements in surgical techniques, post-operative AF rate is still high.

In this study, we investigated whether blood products used during and after isolated coronary bypass operations in our clinic played a role in the development of AF which causes haemodynamic instability in postoperative period, the risk of embolism, long term stay in intensive care unit and cost increases. We aimed to explain the relationship between blood and blood-products that are used during surgery and AF.

2. MATERIAL AND METHODS

A total of 260 patients who underwent elective isolated coronary artery bypass grafting (CABG) performed between January 2014 and March 2016 by the same surgery team in our clinic were included retrospectively in this study. Patients with additional valve pathologies, patients who underwent additional surgical procedure (i.e. ascending aortic valve replacement, valve repair and replacement, congenital ventilation), patients who already had arrhythmia preoperatively, patients underwent emergency surgical procedures due to acute myocardial infarction, patients with postoperative complications (i.e. patients with increased need of blood products due to revision surgery for postoperative reactionary hemorrhage, patients with low cardiac output syndrome, patients with intra-aortic balloon pump) and patients with hemodialysis-dependent chronic renal failure who were prone to bleeding were excluded from the study. Mortality and stroke occurring in Group 1 and Group 2 patients were excluded from our study. Patients were divided into two groups: those whom we used blood and blood products on (Group I) and those whom we did not use blood or any blood products on (Group II). There were 140 patients (54 female, 86 male) in Group I and 120 patients (45 female, 75 male) in Group II. Patients' preoperative demographic data and other risk factors such as hypertension (HT), diabetes mellitus (DM), chronic obstructive pulmonary disease (COPD), smoking, hypercholesterolemia, aortic cross clamp time and postoperative electrolyte imbalances, were compared in detail. For all patients EUROSCORE was used for risk scoring before operation. All patients underwent surgery with median sternotomy under general anesthesia. Premedication with 3 mg Dormicum and ½ Atropine was taken to the operating room before the operation. General anesthesia was administrated to the patient with 1 mg/kg Propofol, 7 mg/kg Fentanyl, 0.7 mg/kg Rocuronium and 2 mg Dormicum. Intravenous 2 mg/kg/h Proferol and 8 mcg/kg/h Fentanyl infusion were initiated. The esophageal temperature probe was placed before heparinization to control the temperature of the patients. All patients were catheterized via the right jugular vein for central catheterization. All patients were treated by the same anesthesia team.Left internal mammary artery (LMA) was used for replacement ofthe left anterior descending artery (LAD) in all patients in both groups.After heparinization, limit for activated clotting time (ACT) had been set for 250 for beating heart, 460 for cardiopulmonary by-pass with medication. Octopus and Starfish (Medtronic, Inc., Minneapolis, Minn., USA) coronary stabilizers were used for coronary stabilization. For CPB patients, aortic cannula was used first, then two-stage venous cannula was used, and aortic root needle was used for antegrade cardioplegia. Blood cardioplegia was used every 20 minutes for cardioplegia. During the operation, variables such as total number of grafts, inotropic agent usage, CPB time (minutes), cross clamp time (minutes) were recorded and evaluated.

2.1. Statistics

For descriptive statistics, mean ± standard deviation (mean ± SD), percentage values were used for both groups of data. T-test, wilcoxon tests were used in comparison of both groups. Statistical analysis was performed using the Statistical Package for the Social Sciences 17.0 (SPSS 17.0, SPSS Inc, Chicago, IL) software. In the comparison, $p < 0.05$ was considered statistically significant.

4. RESULTS

Patients were divided into two groups: those whom we used blood and blood products during their operation (Group I) and those whom we did not use blood and blood products during their operation (Group II). There were 140 patients (54 female, 86 male) in Group I and 120 patients (45 female, 75 male) in Group II. The mean age was 63.2 ± 9.2 in Group I and 60.5 ± 8.3 in Group II. Of the patients in group I, 43 were underwent off-pump surgery, on the other hand 97 were underwent on-pump surgery. 41 of the group II patients were underwent off-pump surgery, 79 were on-pump surgery. There was no significant difference in favor of on-pump or off-pump bypass techniques among the groups. Preoperative demographic data of the patients are given in Table 1.There was no statistically significant difference between the two groups in terms of DM, COPD, hypertension, hypercholesterolemia and smoking habits ($p < 0,05$). Perioperative and postoperative findings are presented in Table 2. One bag of blood was given to 75 patients (53.5%), 2 bags to 38 patients (27.1%) and 3 bags to 27 patients (19.2%).Mean hemoglobin level during operation was Group I off-pump 10,48 ± 1,45, on-pump 9,62 ± 1,23, Group II off-pump 10,18 ± 1,20, on-pump 8,53 ± 1 , respectively. AF was developed in 64 (45%) patients in Group I patients and 31 (25%) patients in Group II (Table 3). These values are found to be statistically significant (p

<0.05). Anastomosis numbers were not significantly different between the two groups. In on-pump operations, the duration of ACC was 65.2 ± 33.1 in Group I and 59.7 ± 25.4 minutes in Group II. The mean duration of hospitalization was 8.21 ± 1.3 days in Group I and 7.4 ± 1.8 days in Group 2 and this was found to be statistically significant (p>0.05). Intensive care unit stay was found to be longer in Group I. In both groups of patients, medical treatment agents (Amiodarone ampoule 900 mg loading and maintenance treatment, amiodarone 200 mg tablets and Metoprolol 50 mg tablets for follow up treatment) were started in the same protocol for AF treatment. During the discharge of the patients and at the follow-up of the first month, it was seen that the patient had normal sinus rhythm on ECG.

Table 1 Preoperative Demographic Characteristics

Parameters	Group 1 (n=140)	Group 2 (n=120)	pvalue
Mean Age ± SD	63.2 ± 9.2	60.5 ± 8.3	p >0.05
Female / Male (n)	54 K / 86 E	45 K / 75 E	p >0.05
Hypertension, n(%)	65 (%46)	55(%45)	p >0.05
Smoking, n(%)	K 20 (%37) E 70 (%81)	K 18 (%40) E 60 (%80)	p >0.05
Hyperlipidemia, n (%)	80 (%57)	55 (%45)	p >0.05
Preoprative statin usage (%)	63 (%45)	43 (%35)	p >0.05
EF	%45 ± 8.9	%48 ± 7.3	p >0.05
COPD, n (%)	20 (%14.2)	25 (%20.8)	p >0.05
DM, n (%)	46 (%32)	38 (%31)	p >0.05
Hemoglobin level(mg/dl)	12.35 ± 2.15	11.75 ± 3.51	p >0.05
Leukocyte count	9216.6 ± 2438.8	8294.6 ± 1949.8	p >0.05
Platelet count	353.9 ± 65.7	284.9 ± 70.2	p >0.05
INR	1.1 ± 0.3	1.3 ± 0.15	p >0.05
BMI, kg/m2	22 ± 2.34	24.7 ± 1.54	p >0.05
EUROSCORE	3.1 ± 2.2	3.2 ± 2.3	p >0.05

BMI: Body Mass Index, EF: Ejection Fraction

Table 2 Perioperative and Postoperative Findings

Parameters	Group 1 (n=140)		Group 2 (n=120)		pvalue
	Off-pump n (43)	On-pump n (97)	Off-pump n (41)	On-pump n (79)	
Number of Anastomoses	1.2 ± 0.66	2.39 ± 0.71	1.1 ± 0.53	2.92 ± 0.88	p >0.05
Inotropic agent usage n(%)	15 (%34)	38 (%39)	22 (%53)	32 (%40)	p >0.05
Aortic Cross Clamp Duration	-	65.2 ± 33.1	-	59.7 ± 25.4	p >0.05
Cardiopulmonary Bypass Duration	-	85.4 ± 22.6	-	81.5 ± 19,6	p >0.05
Mean hemoglobin level during					

operation (mg/dl)	10,48 ± 1,45	9,62 ± 1,23	10,18 ± 1,20	8,53 ± 1,18	p >0.05
Intubation duration (hours)	3,2 ± 1,3	5,4 ± 2,3	3,1 ± 1,2	4,4 ± 2,1	p >0.05
Intensive care stay (days)	3.2 ± 1.6		2.1 ± 1.1		p<0,05
Total drainage volume (ml)	632 ± 263	857 ± 262	542 ± 138	721 ± 243	p >0.05
Hospitalization Duration (days)	8,21 ± 1,3		7,4 ± 1,8		p<0,05
Postoperative hemoglobin level(mg/dl)	10,3 ± 1,2		9,1 ± 1,4		p >0.05

Table 3 Groups / Atrial fibrillation development rates

Parameters	**Group 1 (n=140)**		**Group 2 (n=120)**		**pvalue**
	Off-pump n (43)	On-pump n (97)	Off-pump n (41)	On-pump n (79)	p >0.05
Atrial fibrillation development	19 (%44)	45 (%46)	10 (%24)	21 (%26)	P<0.05
Atrial fibrillation development time (days)	1,04 ± 0,4	2,03 ± 0,5	1,8 ± 0,8	2,4 ± 0,6	p >0.05

5. DISCUSSION

Blood transfusion was first made in 1818 by a gynecologist named James Blundell to a patient with postpartum hemorrhage. A total of 10 patients underwent allogeneic blood transfusions within 12 years of follow-up by the same gynecologist, but 5 patients were reported to have died due to anaphylactic shock. After blood groups were described by Karl Landsteiner[2] in 1901, a new era in the use of allogenic blood began.

Blood and blood products transfusion due to low hematocrit may be required during and after open heart surgery due to hemodilution, postoperative hemorrhage, bleeding after platelet dysfunction. Blood and blood products transfusion due to low hematocrit may be required during and after open heart surgery due to hemodilution, postoperative hemorrhage, bleeding after platelet dysfunction. In a study conducted by Koch et al.[3] Only on coronary bypass patients, it was shown that infusion, acute tubular necrosis-induced renal failure, neurological complications, prolonged ventilatory support, and increased risk of hospital morbidity and mortality were associated with increased risk factors, especially in postoperative cardiac complications due to the number of units of erythrocyte suspension. The rate of blood transfusion in patients undergoing coronary bypass surgery has been reported to be between 30% and 70%.

In a study conducted by Güven and colleagues[4] on 407 patients, blood and blood product transfusion has been shown to increase postoperative complications and mortality in relation to the number of units in patients underwent coronary bypass surgery. They have stated that blood and blood products should not be used unless compelled to do so.

The most common rhythm disturbance after heart surgery is AF.[5] Especially in patients with mitral valve disease, it occurs after growth in the atrium. Also AF often occurs after isolated coronary bypass operations. In recent years, a variety of reasons have been stated to cause for postoperative AF.[6] Advanced age, excessive manipulation of the right atrium during operation, cardioplegia solutions, cardiopulmonary bypass, hypoxia, local cold applications, electrolyte imbalances during and after surgery, hypertension and COPD are all believed to cause AF.[7] In the up-to-date literature, it has been reported that the AF rate is lower after beating heart coronary bypass surgery.[8] In a study conducted by Yüksel and his colleagues[9] on 449 patients, it was found that after off-pump cardiac revascularization, atrial fibrillation was statistically significantly lower than on-pump bypass surgery. However, in a study conducted by Lewicki et al.[10] 1836 patients were examined and it is stated that there was no significant difference in the development rates of atrial fibrillation between off-pump and on-pump coronary bypass. In our study, after off-pump bypass, atrial fibrillation was found to be statistically significantly lower than on-pump bypass surgery.

In a retrospective study performed by Yousef et al.[11] On 1116 patients, the prevalence of postoperative AF was lower in patients using preoperative statin therapy. In a different meta-analysis study conducted by Putzu et al.[12] son 5102 patients, stated that preoperative statin use did not reduce the risk of AF development after surgery. In our study, statin use was 45% in patients who developed AF after surgery and 35% in patients without AF development after surgery.

Complications such as postoperative mediastinitis, pneumonia, and sepsis after the transfusion have been reported to be seen more commonly; especially in patients whom we used more than 4 bags of blood and blood products on.[13] In our study, no postoperative infectious disease developed in any patient. However, it was seen that the patients who had blood transfusion had a longer duration of stay in the ICU and hospitalization than those who did not.

In clinical practice, giving fresh frozen plasma in the intensive care unit became a routine after the operation over the years. Studies have shown that fresh frozen plasma and thrombocyte suspensions, especially after coronary bypass surgery, have emerged as an independent risk factor for postoperative mortality.[14] None of our patients were given fresh frozen plasma as long as there was no bleeding or the activated clotting time did not prolong or shorten.

Blood transfusion is the most common type of transplant in the world. Each unit of blood should be treated as a tissue transplant. Despite cross-matching, morbidities such as elevated levels of liver enzymes, elevated renal creatinine, hemolytic anemia, generalized edema, and even mortality due to tissue rejection may be seen due to subgroup incompatibility.[15]

Postoperative AF development increases the length of stay in intensive care unit and cause cost increases. In a study by Elizabeth et al.[16], 10550 patients were studied. Especially in elderly patients with COPD, valve surgery, combined valve and coronary bypass surgery, AF was observed at high rates and prophylactic amiodarone treatment was shown to increase costs. AF after open heart surgery usually occurs on day 2 or 3. In a study conducted by Afzar et al.[17], 358 patients were examined and it was shown that the AF development times were 2 days postoperatively. Although many factors are blamed, the cortisol increase, especially in the morning, and low partial pressure of oxygen in patients are particularly remarkable. In our patients, AF development usually occurred on the 2nd day after surgery.

6. CONCLUSION

The incidence of AF was significantly lower in coronary by-pass operations performed without blood transfusion during and after coronary bypass operations. We conclude that a significant reduction in the incidence of AF will be seen after limiting the use of blood transfusion. Blood transfusion should be avoided unless compulsory on patients who underwent open heart surgery.

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