Blood Preservation in Open Heart Surgery (*)

Mehmet Balkanay, M.D.
Turan Berki, M.D.
Tuncer Koçak, M.D.
Ömer Bayezid, M.D.
Ömer Işık, M.D.
Cevat Yakut, M.D.

The efficiacy of blood preservation was studied in 120 patients consisting of two groups. The first group consisted of 60 patients which received autotransfusion and the second group of 60 patients which recieved homologous bank blood transfusion. Hemodilution before CPB, intraoperative cell washing and processing, and reinfusion of postoperative shed mediastinal blood were applied to the autotransfusion group.

Although the average shed mediastinal blood of Group I was significantly more than Group II ($p < 0.95$), Group I received 330 ml of homologous blood while Group II received 930 ml per patient ($p < 0.95$). No complications were detected because of reinfusing unwashed shed mediastinal blood.

From: Koşuyolu Heart and Research Hospital.

Address for reprints:
M. Balkanay, M.D.
Koşuyolu Heart and Research Hospital.

Blood preservation in cardiac surgery has reduced homologous bank blood usage significantly in the last decade. Due to application of blood preservation programs, an average of 8 units of homologous bank blood used per patient was reduced to 1-3 units per patient[1,2,5].

As far as we know, the first autotranfusion was performed by Duncan a century ago[3]. Currently blood preservation programs are applied in many centers in a widespread fashion. Tranfusion of autologous blood, cristalloid and/or colloid priming of the extracorporeal circulation, intraoperative and postoperative autotransfusion systems have reduced the incidence of transfusion complications significantly.

Material and Methods

120 open heart surgery patients were subjected to this prospective study. In the first group of patients blood preservation was applied pre,intra, and postoperatively. The second group of patients received homologous transfusion. Each group consisted of 60 patients, and were selected at random. Cardiopulmonary bypass was established in standard techniques.

(*) Presented at the 31st Annual Meeting of International College of Angiology, Rome. Italy 1989

TABLE I: Distribution of the operations in Group I and II.

	Group I	Group II
LIMA-AD bypass grafting+SVG	16	21
LIMA-AD bypass grafting+SVG+ANEURYSMECTOMY	3	1
LIMA-AD bypass grafting	4	3
SVG	8	7
SVG+ANEURYSMECTOMY	6	7
MVR	16	14
AVR	2	1
MVR+AVR+TV	3	3
ASD	2	1
VSD	-	1
Ebstein's Anomaly	-	1
	60	60

LIMA-Left internal mammary artery, AD-anterior descending coronary artery, SVG-saphenous vein grafting, MVR-mitral valve replacement, AVR-aortic valve replacement, TV-tricuspid valvotomy, ASD-atrial septal defect, VSD-ventricular septal defect.

In the first group blood preservation was established in three stages. Intraoperative hemodilution was applied before cardiopulmonary bypass (CPB) started. A total of 300 ml of blood was withdrawn from the patient and retransfused when CPB was terminated. Intraoperative shed blood was collected with a Dideco 795/V cell saver autotransfusion system. The collected blood was washed, processed and retransfused to the patient.

Postoperative shed mediastinal blood was collected with a Sorenson drainage system and the autologous blood was retransfused without washing it within four hours. Twenty micron microporous filters were used while retransfusion was applied.

The second group received homologous bank blood for all requirements, only hemodilution was applied to these patients before CPB started.

TABLE II: Total perfusion and cross-clamp times of the patients ($p \geq 0.95$) in Group I and II.

	Total Perfusion Time(min)			Aortic Cross-clamp time (min)		
	Shortest	Longest	Mean	Shortest	Longest	Mean
AUTOLOGOUS TRANSFUSION	36	198	105	16	120	77
HOMOLOGOUS TRANSFUSION	32	172	101	19	132	71

TABLE III: Amounts of blood collected intraoperatively from 60 patients in Group I with the cell saver autotransfusion system.

Minimal	Maximal	Mean	Total
300 ml	1100 ml	630 ml	37800 ml

Table I presents the distribution of cardiac operations. Various cardiac procedures were performed in both groups. The smallest patient in Group I was 13 and the oldest was 74 years old with an average of 46.9 years. In Group II the youngest patient was 9 and the oldest 72 years old with an average of 42.7 years old. In the first group 28.3% of the patients were female and 71.7% were male. In the second group 35% of the patients were female, and 65% were male.

Table II presents total perfusion and aortic cross-clamp times of the autotransfusion and homologous transfusion groups. The amounts of intraoperatively collected blood by cell saver device in Group I is presented in Table III. A total amount of 37800 ml of autologous blood was washed, processed and reinfused to the patients in Group I.

Table IV presents the amounts of shed mediastinal blood in both groups. An average of 965 ml and 780 ml of shed mediastinal blood was measured in Group I and II ($p< 0.95$). The average amounts of homologous bank blood transfused to Group I and Group II was 330 ml and 930 ml respectively (Table IV and V).

Results

In this study, 55800 ml intraoperative (hemodilution and collection of shed blood), 42900 ml of shed postoperative autologous blood was preserved. This is equivalent to 3.1 units of autologous blood per patient. The mean total perfusion and aortic cross-clamp periods of both groups were not significant ($p>0.95$).

The postoperative shed mediastinal blood of Group I and II was statistically significant, which is an expected phenomenon ($p<0.95$),[2,11]. Although the first group has bled significantly more than the second group, the amount of reexplorations because of hemorrhage are the same in the two study groups (Table VI).

TABLE IV: The comparison of postoperative 24 hour shed mediastinal blood in Group I and Group II ($p< 0.95$) (ml)

	Minimal	Maximal	Mean
Autologous group	250	2560	965
Homologous group	175	1900	780

TABLE V: The amount of homologous bank blood transfused to the study groups (P<0.95)

	Group I			Group II		
	Min.	Max.	Mean	Min.	Max.	Mean
Amount of homologous bank blood transfused (ml)	0	1500	330	0	2050	930

When mortality and morbidity of the two groups are compared (Table VI) febrile reactions, postoperative hepatitis-B, ARDS syndrome has been encountered more frequently in the homologous transfusion group. There has not been any significant difference in postoperative reexplorations because of bleeding and operative mortality.

Although the average shed mediastinal blood of Group I was significantly more than Group II (p<0.95), Group I received 330 ml of homologous bank blood, while Group II received 930 ml per patient (p< 0.95).

Discussion

Blood conservation techniques include predeposition, hemodilution, reinfusion of residuel extracorporeal pump volume, intraoperative and postoperative shed mediastinal blood autotransfusion. As a result of these preservation techniques, the average transfusion requirements for patients undergoing cardiac operations has dropped significantly over the last decade[4,5,6] from 8 units of homologous bank blood per patient to 1-3 units per patient[7,8,5,9].

The specific risks of homologous transfusion vary depending on the donor source and the component transfused. Risks with homologous red cell transfusion increase additively with the number of units received[10]. Transfusion of fresh frozen plasma has an even higher risk of transmission of serum viral diseases. Non-A, Non-B hepatitis occurs in 6-10% of individuals receiving a single unit blood cell transfusion and consists of 95% of patients with hepatitis after transfusion. The incidence of chronic hepatitis is high and results in 0.9 per 1000 transfusion recipients having highly morbid or fatal complications from transfusion related non-A non-B hepatitis[11].

It has been reported that cardiac surgical patients account for 27% of all adult patients with transfusion associated AIDS[12]. Most serious transfusion reactions involve major (ABO) incompatibility with an approximate mortality of 10% in 6000 transfusions. Minor (Rh) incompatibility, interdonor incompatibility, delayed transfusion reactions remain a present risk but are not generally associated with severe adverse effects. Allergic reactions have a 1-3%, and febrile reactions have a 1% incidence[11]. Other risks of homologous blood transfusion include transfusion associated cytomegalovirus and Ebstein-Barr virus infections, posttransfusion hepatitis.

TABLE VI: Mortality and morbidity seen in the autologous and homologous transfusion group.

	Autologous transfusion	%	Homologous transfusion	%
Febrile reaction	6	10	11	18.3
Wound infection	4	6.6	5	8.3
Mediastinitis	2	3.3	3	5
ARDS syndrome	-	-	2	3.3
Low Cardiac output	6	10	3	5
Postoperative hepatitis B (HbsAg (+))	-	-	2	3.3
Hemoglobinuria	1	1.6	7	11.6
Septicemia	1	1.6	-	-
Reexploration (postoperative bleeding)	12	3.3	2	3.3
IABP assistance	8	13.3	4	6.6
Mortality	1	1.6	2	3.3

The autologous transfusion group has received a mean of 330 ml of homologous bank blood per patient, while the second group received 930 ml per patient. The autotransfusion group had a mean postoperative mediastinal drainage of 965 ml per patient while the homologous transfusion group bled 780 ml per patient within postoperative 24 hours. The postoperative drainage of the first group of patients seems to be statistically significant ($p<0.95$) although there is not of any surgical importance (Table VI).

Although mediastinal drainage of the autotransfusion group is significantly more than the second group, the patients received significantly lesser amounts of homologous bank blood ($p<0.95$). The mediastinal drainage of the autotransfusion group may seem as a disadvantage. It has been stated in the literature that unless the retransfused drainage blood amount does not reach 3000 ml, a significant coagulopathy does not happen[2,13,14,15,16]. The autotransfusion group was retransfused with a maximum amount of 2560 ml (Table IV).

The postoperative mediastinal blood drainage system is a very practical and cheap method of autotransfusion. It has been stated that reinfusion of

the shed mediastinal blood could be associated with laboratory evidence of disseminated intravascular coagulation. Although a clinical problem of bleeding could not be demonstrated, the fibrin degradation products of 17 patients out of 20 converted from negative to positive who received unwashed shed mediastinal blood. Nevertheless the same authors claim that the success or failure of postoperative blood salvage should be judged largely on its influence on the use of homologous bank blood[17]. The autotransfusion group was reinfused with unwashed shed mediastinal blood. In these patients a tendency towards bleeding was not detected.

The incidence of febrile reactions was 18.3% in the homologous transfusion group, where it was 10% in the autotransfusion group. Postoperative hepatitis was seen 3.3% times more in the homologous transfusion group. Hemoglobinureia was encountered more frequently in the homologous transfusion group. There was no difference between mortality and reexploration rates in both study groups (Table VI).

Conclusion

The application of blood conservation techniques have significantly reduced homologous blood transfusion requirements in patients undergoing cardiac surgery. When a unique blood preservation program is established, complications due to autotransfusion are minimal. The effects of reinfusion of postoperative shed mediastinal blood are still open to further investigation. Currently there is no clinical evidence that reinfusion of postoperative shed mediastinal blood has undesired effects on the patient.

References

1- Utley JR, Moores WY, Stephens DB: Blood Conservation Techniques. Ann Thorac Surg 1981;31: 481.

2- Thurer RL, Hauer JM: Autotransfusion and blood conservation. Curr Probl Surg 1982;19: 121.

3- Silvergleid AJ: Autologous transfusion: Experience in community blood center. J.A.M.A. 1979;241: 2724.

4- Roche JK, Stenhgle JM: Open-heart surgery and the demand for blood. JAMA 1973;225: 1516.

5- Johnson RG, Rosenkrantz KR, Preston RA, et al: The efficacy of postoperative autotransfusion in patients undergoing cardiac operations. Ann Thorac Surg 1983;36: 173.

6- Alter HJ, Purcell RH, Feinstone SM et al: Non-A Non-B hepatitis: Its relationship to cytomegalovirus, to chronic hepatitis and to direct and indirect test methods. In Szmuness W, Alter HJ, Maynard J.E. (eds): Viral Hepatitis: 1981 International Symposium. Philadelphia, Franklin Institute Press, 1981;p: 279.

7- Yeh TJr, Shelton L, Yeh TJ: Blood loss and bank blood requirement in coronary bypass surgery. Ann Thorac Surg 1978;26:11.

8- Tector AJ, Gabriel RP, Mateicka WE, et al: Reduction of blood usage in open heart surgery. Chest 1976;70: 454.

9- Cosgrove DM, Thurer RL, Lytle BW, et al: Blood conservation during myocardial revascularization. Ann Thorac Surg 1979;28: 184.

10- Alter MJ, Gerety RJ, Smallwood LA, et al: Sporadic non-A, non-B hepatitis: Frequency and epidemiology in an urban U.S. population. J Infect Dis 1982;145: 886.

11- Love TR, Hendren WG, Daggett WM: Transfusion of predonated autologous blood, Ann Thorac Surg 1987;43: 508.

12- Peterman TA, Jaffe HW, Feorino PM, et al: Transfusion associated acquired immunodeficiency syndrome in the United States, JAMA 1985;254: 2913.
13- Cuello L, Vasques E, Rios, et al: Autologous blood transfusion in thoracic and cardiovascular surgery. Surgery 1967;62: 814.
14- Keeling MM, Gray LA, Brink MA, et al: Intraoperative autotransfusion: experience in 725 consecutive cases. Ann Surg 1983;197: 536.
15- Ordell AR, Lavender SW: An appraisal of blood salvage techniques in vascular and cardiac operations. Ann Thorac Surg 1981;31: 421.
16- Council on Scientific Affairs: Autologous blood transfusion; JAMA 1981;256:17.
17- Griffith LD, Fillman GF, Daily PO: Appearent coagulopathy caused by infusion of shed mediastinal blood and its prevention by washing of the infusate. Ann Thorac Surg 1989;47: 400.