Turkish Journal of Thoracic and Cardiovascular Surgery 2021;29(3):354-359
http://dx.doi.org/doi: 10.5606/tgkdc.dergisi.2021.19960

Original Article / *Özgün Makale*

The importance of autologous blood transfusion in lung transplantation and cardiovascular surgeries

Akciğer nakli ve kalp damar ameliyatlarında otolog kan transfüzyonunun önemi

Tevfik İlker Akçam[1], Ali Özdil[1], Önder Kavurmacı[2], Pelin Öztürk[3], Deniz Can Başaran[3], İsmet Tanzer Çalkavur[3], Ufuk Çağırıcı[1], Mustafa Özbaran[3]

Institution where the research was done:
Ege University Faculty of Medicine, Izmir, Turkey

Author Affiliations:
[1]Department of Thoracic Surgery, Ege University Faculty of Medicine, Izmir, Turkey
[2]Department of Thoracic Surgery, Izmir Bozyaka Training and Research Hospital, Izmir, Turkey
[3]Department of Cardiovascular Surgery, Ege University Faculty of Medicine, Izmir, Turkey

ABSTRACT

Background: In this study, we aimed to investigate the effect of using autologous blood recovery systems on transfusion-related complications in patients undergoing lung transplantation and cardiovascular surgeries.

Methods: Between May 2016 and May 2019, a total of 104 patients (90 males, 14 females; mean age: 59.3±16.4 years; range, 12 to 89 years) in whom cell-saver and autologous blood recovery systems were used during lung transplantation or cardiovascular surgeries were retrospectively analyzed. The patients were divided into two groups as Group 1 (n=61) consisting of patients who received autologous blood transfusion and as Group 2 (n=43) consisting of patients who did not. Data including demographic and clinical characteristics of the patients, operation data, and postoperative complications were recorded.

Results: The total amount of transfused blood/blood product was found to be significantly higher in Group 1 (p=0.018). However, transfusion-related complications were found to be higher in Group 2 (p=0.0261). There was no significant difference in the length of hospital stay between the groups.

Conclusion: Autologous blood transfusion may prevent the development of transfusion-related complications by reducing the amount of allogenic transfusion in major surgical procedures. In our study, the autologous blood transfusion was used in critical patients with major bleeding and, therefore, the total amount of transfused blood/blood product was higher in these patients. Nevertheless, lower complication rates in this patient group emphasize the importance of autologous blood transfusion.

Keywords: Autotransfusion, cardiovascular surgery, hemorrhage, operation, thoracic surgery, transfusion.

ÖZ

Amaç: Bu çalışmada akciğer nakli ve kalp damar ameliyatları yapılan hastalarda otolog kan iyileştirme sistemlerinin transfüzyon ile ilişkili komplikasyonlar üzerindeki etkisi araştırıldı.

Çalışma planı: Mayıs 2016 - Mayıs 2019 tarihleri arasında akciğer nakli veya kalp damar ameliyatları sırasında hücre kurtarma ve otolog kan iyileştirme sistemlerinin kullanıldığı toplam 104 hasta (90 erkek, 14 kadın; ort. yaş: 59.3±16.4 yıl; dağılım, 12-89 yıl) retrospektif olarak incelendi. Hastalar otolog kan transfüzyonu yapılan hastalardan oluşan Grup 1 (n=61) ve yapılmayan hastalardan oluşan Grup 2 (n=43) olmak üzere iki gruba ayrıldı. Hastaların demografik ve klinik özellikleri, ameliyat verileri ve ameliyat sonrası komplikasyonları dahil olmak üzere verileri kaydedildi.

Bulgular: Transfüze edilen toplam kan/kan ürünü miktarı Grup 1'de anlamlı düzeyde yüksek olduğu saptandı (p=0.018). Ancak, transfüzyon ile ilişkili komplikasyonlar Grup 2'de daha yüksek oranda izlendi (p=0.0261). Hastanede kalış süresi açısından gruplar arasında anlamlı bir farklılık yoktu.

Sonuç: Otolog kan transfüzyonu, majör cerrahi işlemlerde allojenik transfüzyon miktarını azaltarak transfüzyon ile ilişkili komplikasyonların gelişimine engel olabilir. Çalışmamızda otolog kan transfüzyonu, majör kanama gelişen kritik hastalarda kullanıldı ve bu nedenle toplam transfüze edilen kan/kan ürünü miktarı bu hastalarda daha yüksek bulundu. Buna rağmen, bu hasta grubunda daha düşük komplikasyon oranları, otolog kan tansfüzyonunun önemini vurgulamaktadır.

Anahtar sözcükler: Ototransfüzyon, kalp damar cerrahisi, kanama, ameliyat, göğüs cerrahisi, transfüzyon.

Received: April 30, 2020 *Accepted*: July 27, 2020 *Published online*: July 26, 2021

Correspondence: Önder Kavurmacı, MD. İzmir Bozyaka Eğitim ve Araştırma Hastanesi Göğüs Cerrahisi Kliniği, 35170 Karabağlar, İzmir, Türkiye.
Tel: +90 505 - 409 48 32 e-mail: doctor_onder@hotmail.com

Cite this article as:
Akçam Tİ, Özdil A, Kavurmacı Ö, Öztürk P, Başaran DC, Çalkavur İT, et al. The importance of autologous blood transfusion in lung transplantation and cardiovascular surgeries. Turk Gogus Kalp Dama 2021;29(3):354-359

Early/late complications may occur during blood and blood product transfusions, despite all the tests carried out and the current precautions taken in this regard. In addition to these complications, there may be several issues to resolve, such as limited numbers of donors, transfusion-related infections and high costs.[1,2] Such issues may become more important in operations requiring the use of large quantities of blood/blood product, such as cardiac surgery and organ transplants.[1-4]

Autologous blood recovery systems (ABRS), which allow the reinfusion of the blood lost by the patient during surgery through dedicated systems, are an important step forward in the efforts to overcome such issues. These systems have been shown to be safe and to reduce the need for allogenic blood transfusions, particularly in cases of general surgery, orthopedics, gynecology, and cardiovascular surgery.[3-8] These systems are also helpful to overcome the transfusion-related reactions related to blood bank products replacement.[3-8] Similar systems have also shown their ability to reduce the need for allogenic transfusions during liver and heart transplantations.[2,6] Considering these studies, we hypothesized that autologous blood transfusion (ABT) systems might be also of benefit during lung transplant (LTx) operations and would reduce the blood bank products replacement and associated complications in these patients. In this study, therefore, we aimed to investigate the effect of using ABRS on transfusion-related complications in patients undergoing lung transplantation and cardiovascular surgeries requiring massive transfusion.

PATIENTS AND METHODS

This retrospective study was conducted at Ege University Faculty of Medicine, Department of Departments of Thoracic Surgery and Cardiovascular Surgery between May 2016 and May 2019. The files of a total of 104 patients (90 males, 14 females; mean age: 59.3±16.4 years; range, 12 to 89 years) in whom cell-saver and ABRS were used during LTx or cardiovascular surgeries were analyzed. The patients were divided into two groups as Group 1 (n=61) consisting of patients who received autologous blood transfusion and as Group 2 (n=43) consisting of patients who did not (except for lung and heart transplantation) during the same period in a tertiary care center. All operations were performed by a single team and, in LTx, thoracic surgeons led the surgery team. The decision to use the cell-saver was made by the surgeon who led the operation, taking into account the amount of intraoperative bleeding. A written informed consent was obtained from each patient. Ege University, Faculty of Medicine, Ethics Committee (Date: 08/08/2021-No: 21-7T/31). The study was conducted in accordance with the principles of the Declaration of Helsinki.

The examined parameters were the reduction of blood bank requirement and postoperative complications. Complications were examined as being either cardiac (e.g., arrhythmia), metabolic (e.g., renal failure), infectious (e.g., wound site infection, sepsis), respiratory (e.g., atelectasis requiring bronchoscopic aspiration, pleural effusion requiring drainage) or transfusion-related (e.g., transfusion-related fever, allergic reactions). Demographic characteristics of the patients, the types of operations performed and additional data were obtained from the medical files. The use of intraoperative blood transfusions was retrieved from the anesthesia records. An ABRS technical specialist's notes and anesthesia records were used for the amount of blood obtained by using ABRS. In addition, postoperative blood transfusions and transfusion-related complications were recorded using transfusion follow-up forms. Transfusion follow-up forms were filled by at least one nurse and one physician for each patient. Postoperative complications such as pneumonia and arrhythmia were recorded based on the consultation notes of the related branch for each complication.

Statistical analysis

Statistical analysis was performed using the IBM SPSS for Windows version 22.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were expressed in mean ± standard deviation (SD), median (min-max) or number and frequency. The independent samples t-test and Mann-Whitney U test were used to compare the two groups of numerical data. The chi-square test was used for categorical variables. A p value of <0.05 was considered statistically significant.

RESULTS

Baseline demographic characteristics of patients and operation types are summarized in Table 1. The ABRS was used combined with blood bank products, particularly in cases with severe bleeding. The total mean blood product delivered to the patients (ABT + blood bank product) was 7.8±9.4 (range, 1 to 50). A mean of 3.5±1.3 (range, 1 to 6) units of ABT was delivered to the patients, while a mean of 2.2±5.9 (range, 0 to 38) units of blood bank products (erythrocyte suspension and/or whole blood) and a mean of 2.1±4.5 (range, 1 to 20) units of fresh frozen plasma or other blood product were replaced (Table 2).

Table 1. Demographic data of patients and operation types

	Group 1			Group 2		
	n	%	Mean±SD	n	%	Mean±SD
Age (year)			60.5±17.6			57.9±13.8
Sex						
Male	55	90.2		35	81.4	
Female	6	9.8		8	18.6	
Abdominal aortic replacement	31	50.8		12	27.9	
Cardiac transplantation	7	11.4		0	0	
Left ventricular assist device	6	9.8		30	69.8	
Coronary artery bypass grafting	5	8.2		0	0	
Lung transplantation	5	8.2		0	0	
Other	7	11.5		1	2.3	

SD: Standard deviation.

Among the cases, 25 (40.9%) developed postoperative complications (Table 3). The complications were related to the transfusion in three (4.9%) cases. The mean length of stay of the discharged patients was 12.3±8.3 (range, 2 to 47) days.

Considering specifically the LTx procedures, all five patients needed ABT, being administered an average of two units. In one case, allogeneic transfusion was required combined with ABT due to the severity of bleeding. None of the patients developed complications secondary to the transfusion, and all were uneventfully discharged, except for one patient.

Group 2 consisted of patients who experienced severe bleeding during similar cardiovascular surgeries in the same period, but that were not administered ABRS. The operations in this group of patients were left ventricular assist device (LVAD) implantation in 30 (69.8%), abdominal aortic replacement in 12 (27.9%), and biventricular assist device (BIVAD) implantation in one (2.3%) patient. A mean of 4.3±2.2 (range, 1 to 11) units of blood/blood product was delivered to the patients, along with 3.2±2.2 (range, 1 to 9) units of erythrocyte suspension/whole blood and 1.1±2.4 (range, 1 to 6) units of fresh frozen plasma or other blood products. Among these cases, 22 (51.2%) developed complications, with complications related to the transfusion in eight (18.6%). The mean length of stay of the discharged patients was 13.8±7.2 (range, 5 to 40) days.

A comparison of the data revealed the total blood/blood product amount to be significantly higher in Group 1 (p=0.018). However, there was no significant difference in the amounts of erythrocyte suspension/whole blood (p=0.2891) and fresh frozen plasma (p=0.1812) delivered to the two groups. The two

Table 2. Statistical analysis results of groups

	Group 1		Group 2		
	%	Mean±SD	%	Mean±SD	*p*
Total transfusion count (Unit)		7.8±9.4		4.3±2.2	0.018
Total autologous blood transfusion (Unit)		3.5±1.3		0	-
Total FWB+PRC+SWB transfusion count		2.2±5.9		3.2±2.2	0.2891
Total FFP and other blood product transfusion count		2.1±4.9		1.1±2.4	0.1812
Percentage of total complications	40.9		51.2		0.3009
Percentage of transfusion-related complications	4.9		18.6		0.0261

SD: Standard deviation; FWB: Fresh whole blood; PRB: Packet red cells; SWB: Stored whole blood; FFP: Fresh frozen plasma.

Table 3. Postoperative complications of patients

	Group 1		Group 2	
	n	%	n	%
ECMO need	7	11.5	0	0
Reoperation due to bleeding	6	9.8	3	6.9
Renal failure	5	8.2	5	11.6
Pleural effusion	5	8.2	4	9.3
Respiratory failure	4	6.6	2	4.6
Sepsis and septic shock	4	6.6	2	4.6
Neurological complications	4	6.6	2	4.6
Liver failure	3	4.9	3	6.9
Atelectasis	3	4.9	1	2.3
Cardiac complications	3	4.9	2	4.6
Incision hematoma/infection	3	4.9	2	4.6
Other	4	6.6	3	6.9
Total transfusion related complications	3	4.9	8	18.6
Allergic reactions	2	3.3	4	9.3
Febrile non-hemolytic reactions	1	1.6	3	6.9
Transfusion-related acute lung injury	0	0	1	2.3
Number of patients occurred complications	25	40.9	22	51.2

ECMO: Extracorporeal membrane oxygenation.

groups had similar total complication rates (p=0.3009), while Group 2 had a higher rate of transfusion-related complications (p=0.0261). There was no significant difference in the length of stay between the two groups (p=0.3405).

DISCUSSION

Bleeding secondary to surgical interventions is still an important cause of mortality and morbidity, despite advances in surgical techniques, equipment, and experience. A substantial proportion of patients may require blood/blood product replacement in spite of proper fluid and volume replacement.[9-12] Such a need becomes more evident, particularly during vascular and thoracic operations and major surgical interventions.[9-12] Early/late complications related to transfusions may still occur, despite modern analyses and tests applied during transfusions. In addition to these complications, there are several issues that need to be resolved, such as the limited number of donors.[13] These problems have led researchers to carry out studies investigating ways of minimizing blood loss, and the significance of blood preservation techniques has again come to the agenda.

Blood preservation techniques and measures are mainly classified under preoperative, perioperative, and postoperative periods.[9-16] The primary preoperative precautions include careful patient assessment in terms of bleeding diathesis and anemia, etiological treatment planning in case of anemia (replacement of iron, folic acid and B12; erythropoietin therapy, when required, etc.) and planning preoperative autologous donations.[15-18] There have been also various methods described for the minimization of blood loss in the perioperative period, including prophylactic methods such as positioning the patient in such a way that venous pressure is reduced, ensuring perioperative normothermia, perioperative controlled hypotension, the efficient use of anti-hemorrhagic agents, and normovolemic hemodilution.[18,19] The ABRS is an update technique that has recently witnessed an increase in popularity and generality.

The ABRS, in short, refers to the collection, filtering, conditioning and re-infusing of extravasated blood.[7] The systems used for this purpose differ in how they carry out such processes; however, the common goal of all is to recover the lost blood. The ABRS involves the recovery of the patient's own

blood, which is of significant importance in the avoidance of allergic reactions following standard transfusion procedures. In a similar way, the patient is protected from infections that can be transmitted through transfusions, such as hepatitis and human immunodeficiency virus (HIV). Another advantage of ABT is that there is no need for donors, and the recovered blood can be used immediately without the need for blood group, Rh and cross-match tests. These important features have increasingly extended the usage area of ABT systems.[8] It has been documented that the ABRSs, which were formerly used only in cardiac and major vascular surgical procedures and heart-LTx, are currently being used effectively in several other surgical procedures. The literature contains a number of studies reporting that ABT systems reduce the need for allogenic blood transfusions during orthopedic, general, urological, gynecological, and trauma surgeries.[3-8]

The present study, conducted jointly by cardiovascular and chest surgery clinics, gave the chance to report the experiences of both clinics together. Although it was thought that fewer allogenic transfusions could be encountered in the group using ABRS before the study, the result was the opposite. A review of the data revealed that the total transfusion amount was higher in Group 1 (7.8 *vs*. 4.3, respectively; p=0.018). This is an important finding, suggesting that surgeons resort to ABRS, particularly in cases with major bleeding. The presence of lung and heart transplant cases in Group 1 also indicates the same finding. Despite the high blood loss expected in Group 1, the amount of allogenic blood product infused was not significantly different between the two groups (2.2 *vs*. 3.2, respectively; p=0.2891, for erythrocyte suspension and whole blood; 2.1 *vs*. 1.2, respectively; p=0.1812, for fresh frozen plasma and other blood products). This finding can be interpreted as that using ABRS decreases the need for allogenic transfusion.

In terms of the overall complications in the present study, major complications such as the need for extracorporeal membrane oxygenation and reoperation due to bleeding were observed in Group 1 patients at a higher rate, consistent with the severity of the operation. The total number of complicated patients being higher in Group 1 seems to be related to the severity of the operation. Some of the patients may die before late complications occur. Surprising findings were encountered, when transfusion-related complications were compared. Although the transfusion rate was higher in Group 1, it is a promising finding that Group 2 had a higher rate of transfusion-related complications. The findings may indicate that ABT does not significantly increase the risk of developing transfusion-related complications.

The main limitations of the current study include the absence of a clear identification of indications for using ABTS, the administration of blood bank products transfusion in cases considered necessary, despite the use of ABTS, and the inhomogeneity of the groups. The inhomogeneity of the patient groups is the most important issue to be discussed. Unfortunately, there is no homogenization between the groups, since the patients' conditions during the operation cannot be predicted previously. The ABRS was used for all patients who needed intraoperatively, by prioritizing the patient's benefit. In all of the LTx cases, ABRS was used due to bleeding/bleeding risks and, thus, all LTx cases were categorized in Group 1 including heart transplantation, as well. However, since the main evaluated parameter is blood loss and complications related to transfusion, we believe that the study results are not affected by the type of operation. The second issue that should be discussed in our study is the total amount of blood. Different techniques have been described for the detection of total blood loss. In addition to comparing the peri- and postoperative hematocrit values, monitoring the number of sponges used, recording the amount of fluid accumulated in the intraoperative aspirator, and collecting the amount of fluid drained from the thorax drains are estimated. Since there are many factors that may have affected these methods in our study (e.g., using different sizes of sponges, intraoperative transfusions, intraoperative lavage fluids, and reoperations), total blood loss data were excluded from the study.

Another important issue that is open to criticism in our study is recovered blood amount during heart-lung pump. As it is known, during heart-lung pump, some amount of blood can be recovered and reinfused to patients. This recovered blood has a higher concentration of heparin content and, in our cases, all of the blood was used during the pump. Therefore, the amount of blood reinfused with this method was not included in the study. Finally, many factors are related to the amount of bleeding, such as preoperative platelet counts, prothrombin time, medications, and additional hematological diseases. In our study, a preoperative standardization could not be performed due to the fact that most of the patients needed emergency surgery.

In conclusion, using ABRS is a method that reduces the need for allogenic blood transfusions. It has been

included among blood preservation methods due to the absence of allergic reactions and infective conditions following allogenic transfusions, and the immediate supply of blood. We believe that its use would increase in suitable cases, if cost is considered.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

This study was supported by the Ege University Rectorate Scientific Research Projects with the Approval No of 16-TIP-065.

REFERENCES

1. Savage WJ. Transfusion reactions. Hematol Oncol Clin North Am 2016;30:619-34.
2. Feltracco P, Brezzi M, Barbieri S, Galligioni H, Milevoj M, Carollo C, et al. Blood loss, predictors of bleeding, transfusion practice and strategies of blood cell salvaging during liver transplantation. World J Hepatol 2013;5:1-15.
3. Kumakiri J, Kikuchi I, Kitade M, Matsuoka S, Kono A, Takeda S. Retrospective analysis of the efficacy of perioperative use of the cell salvage and autologous blood recovery system during laparoscopic myomectomy. Arch Gynecol Obstet 2012;285:1073-7.
4. Schmidt A, Sues HC, Siegel E, Peetz D, Bengtsson A, Gervais HW. Is cell salvage safe in liver resection? A pilot study. J Clin Anesth 2009;21:579-84.
5. Yamamoto K, Imakiire A, Masaoka T, Shinmura K. Autologous blood transfusion in total hip arthroplasty. J Orthop Surg (Hong Kong) 2004;12:145-52.
6. Santos AA, Silva JP, Fonseca Ld, Baumgratz JF. Heart retransplantation in children without the use of blood product. Rev Bras Cir Cardiovasc 2012;27:327-30. English, Portuguese.
7. Waters JH. Intraoperative blood recovery. ASAIO J 2013;59:11-7.
8. Waters JH, Dyga RM, Waters JF, Yazer MH. The volume of returned red blood cells in a large blood salvage program: Where does it all go? Transfusion 2011;51:2126-32.
9. Vretzakis G, Kleitsaki A, Aretha D, Karanikolas M. Management of intraoperative fluid balance and blood conservation techniques in adult cardiac surgery. Heart Surg Forum 2011;14:E28-39.
10. Avgerinos DV, DeBois W, Salemi A. Blood conservation strategies in cardiac surgery: More is better. Eur J Cardiothorac Surg 2014;46:865-70.
11. Society of Thoracic Surgeons Blood Conservation Guideline Task Force, Ferraris VA, Ferraris SP, Saha SP, Hessel EA 2nd, Haan CK, Royston BD, et al. Perioperative blood transfusion and blood conservation in cardiac surgery: The Society of Thoracic Surgeons and The Society of Cardiovascular Anesthesiologists clinical practice guideline. Ann Thorac Surg 2007;83(5 Suppl):S27-86.
12. Menkis AH, Martin J, Cheng DC, Fitzgerald DC, Freedman JJ, Gao C, et al. Drug, devices, technologies, and techniques for blood management in minimally invasive and conventional cardiothoracic surgery: A consensus statement from the International Society for Minimally Invasive Cardiothoracic Surgery (ISMICS) 2011. Innovations (Phila) 2012;7:229-41.
13. Delaney M, Wendel S, Bercovitz RS, Cid J, Cohn C, Dunbar NM, et al. Transfusion reactions: Prevention, diagnosis, and treatment. Lancet 2016;388:2825-36.
14. Bardakçı H, Kervan Ü, Durak P, Vural K, Ulaş MM, Altıntaş G, et al. The use of cell saver system in surgical treatment of aortic aneurysms. Turk Gogus Kalp Dama 2008;16:150-4.
15. Shander A. Preoperative anemia and its management. Transfus Apher Sci 2014;50:13-5.
16. Muñoz M, Acheson AG, Auerbach M, Besser M, Habler O, Kehlet H, et al. International consensus statement on the peri-operative management of anaemia and iron deficiency. Anaesthesia 2017;72:233-47.
17. Kansagra AJ, Stefan MS. Preoperative anemia: Evaluation and treatment. Anesthesiol Clin 2016;34:127-41.
18. Heper Y. Hasta kanı yönetimi. İKSST Derg 2018;10:87-94.
19. Bisbe E, Moltó L. Pillar 2: Minimising bleeding and blood loss. Best Pract Res Clin Anaesthesiol 2013;27:99-110.