International Journal of Advances in Medicine
Alsmadi DD et al. Int J Adv Med. 2024 Mar;11(2):66-70
http://www.ijmedicine.com
pISSN 2349-3925 | eISSN 2349-3933
DOI: https://dx.doi.org/10.18203/2349-3933.ijam20240015

Original Research Article

The use of cell salvage in adult cardiac surgery at Queen Alia Heart Institute

Dya D. Alsmadi, Abdallah Alhadidi, Ahmad Alawamleh, Suhaib Alghawanmeh, Wael Alshobaki, Ashraf F. Moh'd*

Department of Cardiac Anaesthesia, QAHI, Amman, Jordan

Received: 05 December 2023
Accepted: 09 January 2024

***Correspondence:**
Dr. Ashraf F. Moh'd,
E-mail: ashraffadel1975@yahoo.com

ABSTRACT

Background: Objective of the study was to determine the incidence of use cell salvage, indications, efficacy in blood conservation and benefits on recovery after adult cardiac surgery.
Methods: This is an observational analysis of adult cardiac surgical patients presenting for cardiac surgery at Queen Alia Heart Institute in the period between September 2023 and December 2023. Patients' demographics, type of surgery (cardiac pathology), comorbidities, preoperative and postoperative laboratory results, blood transfusion requirements, extubation and intensive care unit (ICU) length of stay were recorded and statistically analysed to determine the effectiveness of cell salvage. Patients were divided into two groups: The cell saver group and the no cell saver group for comparison.
Results: Data from 141 adult cardiac surgeries is included in this analysis. Indications for cell saver use were recent anticoagulation (41.4%), more complex surgery (20.7%), high risk of bleeding (13.8%), preoperative anaemia (6.9%), intraoperative major bleeding (6.9%), coagulopathy (6.9%) and rare patient blood type (3.45%). Patients from the cell saver group required blood transfusion 2.1% more than the no cell saver group. There was no significant difference in the length of hospitalization between those who had and those who had not cell saver used during surgery (11.9 and 12 days, respectively).
Conclusions: Cell saver was used in one fifth of adult cardiac surgeries. Most common indications for cell saver use during cardiac surgery were recent anticoagulation and more complicated cardiac surgery. The use of cell saver had no impact on postoperative haematocrit or overall time of hospitalization.

Keywords: Anaesthesia, Cardiac surgery, Cell saver, Haematocrit, Hospitalisation, Transfusion

INTRODUCTION

The Queen Alia Heart Institute, known for its commitment to excellence in cardiac care, has embraced innovative practices to enhance patient outcomes. Among these practices, the use of cell salvage in cardiac surgery has gained prominence. Extensive literature has been published evaluating the use of cell salvage in cardiac surgery. However, the most recently published blood management guidelines do not give unequivocal direction on the use of cell salvage in cardiac surgical procedures.[1] Cell salvage, an autologous blood transfusion method, holds promise for reducing allogeneic blood transfusion dependence which increases morbidity, mortality and causes inflammatory reactions, and potentially improving patient recovery removing debris from shedded blood, a challenge that have a lot of potential complications including but not limited to increasing the risk of stroke or neurocognitive dysfunction.[2]

Cardiac surgeries are associated with high use of allogeneic blood products and, because of the known risks of these products; there is ongoing interest in reducing this use.[3,4]

Various ways of reducing the use of allogeneic blood have been tried, individually or within overall strategies for blood conservation. These include iron supplementation, pre-treatment with erythropoietin, acute normovolaemic haemodilution, retrograde autologous priming, pharmacological interventions (e.g., with tranexamic acid, aprotinin, and other agents), improved surgical haemostasis, strict adherence to transfusions protocols, and cell salvage. The first recorded use of cell salvage and autologous transfusion was in 1818 when a gynaecologist named Blundell treated patients with post-partum haemorrhage.[5] Blood-soaked swabs were washed in saline and then the mixture was re-infused. This was unsurprisingly associated with a high mortality. Arnold Griswald developed the first cell salvage auto-transfusion device. Suctioned blood was collected in a bottle and then strained through a cheese cloth before being re-infused. This formed the basic principles on which modern cell salvage devices are designed today. In the 1960s, a number of commercial devices became available.[6]

There are three phases involved in cell salvage collection, washing, and re-infusion. Collection of red blood cells (RBCs) from the operative field requires the use of a dedicated double-lumen suction device. One lumen suctions blood from the operative field and the other lumen adds a predetermined volume of heparinized saline to the salvaged blood. The anticoagulated blood is then passed through a filter and collected in a reservoir. Separation of the components is achieved by centrifugation. The RBCs are then washed and filtered across a semi-permeable membrane, which removes free haemoglobin, plasma, platelets, white blood cells, and heparin. The salvaged RBCs are then re-suspended in normal saline with a resultant haematocrit of 50–80%.[7,8] Traditionally, the cardiotomy suction as an extension of the intracardiac vent allows blood shed into the pericardial and pleural cavities to be returned to the cardiopulmonary bypass (CPB) circuit.[9] Studies comparing cell salvaged with allogeneic blood have demonstrated increased mean erythrocyte viability and increased 2, 3-disphosphoglycerate (2, 3-DPG) and adenosine triphosphate (ATP) levels in salvaged blood.[10] In this research we investigate the use of cell saver in parallel to the cardiotomy suction of the CPB machine. This research aims to investigate the specific indications, efficacy, and postoperative benefits of cell salvage, offering insights into how this technique may enhance cardiac surgery outcomes and patient recovery.

METHODS

This is a prospective observational analysis of adult cardiac surgical patients presenting for cardiac surgery at Queen Alia Heart Institute in the period between September 2023 and December 2023. Patients' demographics, type of surgery (cardiac pathology), comorbidities, preoperative and postoperative laboratory results, blood transfusion requirements, extubation and ICU length of stay were recorded and statistically analysed to determine the effectiveness of cell salvage (cell saver). Patients were divided into two groups: the cell saver group and the no cell saver group. Statistical analysis was performed using Microsoft excel.

The cell saver devices used are manufactured by Sorin group™. Ethical committee approval obtained.

RESULTS

Data from 141 adult cardiac surgeries is included in this analysis. They constituted 115 males and 26 females. Average age of patients was 56.7 years and ranged from 19 to 78 years. Patients' demographic and clinical characteristics are presented in Table 1.

Table 1: Patients' demographic and clinical characteristics.

Characteristics	N (%)
Total number of patients	141
Male	115 (81.6)
Female	26 (18.4)
Average age (years)	56.7
Hypertensive	105 (74.5)
Diabetic	75 (53.2)
Smoking	98 (69.5)
Ischaemic heart disease	118 (83.7)
Heart valve disease	17 (12.1)
Disease of the ascending aorta	4 (2.8)
Elective surgery	132 (93.6)
Urgent surgery	7 (5)
Emergency surgery	2 (1.4)
On-pump cardiac surgery	139 (98.6)
Off-pump coronary bypass grafting	2 (1.4)
Average CPB duration (minutes)	105.7 (ranged from 30 to 270)
CABG	120 (85.1)
Valve repair or/ replacement	17 (12.1)
Bental procedure	3 (2.2)
Combined surgery (CABG+valve)	8 (5.7)
Myxoma excision	1 (0.7)
Preoperative haematocrit	38.9
Postoperative haematocrit	30.4
Cell saver use	29 (20.6)
Intra-aortic balloon pump	14 (9.9)
Postoperative extracorporeal membrane oxygenator	2 (1.4)
Average time to tracheal extubation (hours)	22.9
Average length of ICU stays (days)	4.7
Average length of hospital stays (days)	11.99
Mortality	15 (10.6)

Cell saver was used in 29 patients (Figure 1). Indications for cell saver use were recent anticoagulation (41.4%), more complex surgery (20.7%), high risk of bleeding (13.8%), preoperative anaemia (6.9%), intraoperative major bleeding (6.9%), coagulopathy (6.9%) and rare patient blood type (3.45%) (Figure 2). Patients from the cell saver group required blood transfusion 2.1% more than the no cell saver group (Figure 3).

Table 2: Comparison between cell saver group and no cell saver group.

Characteristics	Cell saver group, n (%)	No cell saver group, n (%)
Number of patients	29 (20.6)	112 (79.4)
Blood transfusion	12 (41.4)	44 (39.3)
Average number of red blood cell units transfused per patient	1.1	0.7
Preoperative haematocrit	38.8	38.9
Postoperative haematocrit	31.3	30.2
Number of patients who needed reopening of sternum	6 (20.7)	13 (11.6)
Average CPB duration (minutes)	142.2	97.5
Elective surgery	25 (86.2)	107 (95.5)
Urgent surgery	3 (10.3)	4 (3.6)
Emergency surgery	1 (3.5)	1 (0.8)
Average time from arrival to ICU to tracheal extubation (hours)	32.1	21
Average length of ICU stays (days)	4.8	4.6
Average length of hospital stays (days)	11.9	12
Mortality	8 (27.6)	7 (6.25)

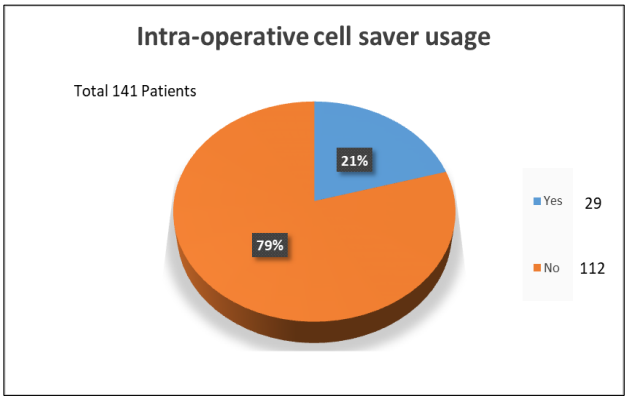

Figure 1: Intraoperative cell saver usage.

Incidence of postoperative reopening of sternum was higher in the cell saver group (20.7%) than the no cell saver group (11.6%). There was no significant difference in the length of hospitalization between those who had and those who had not cell saver used during surgery (11.9 and 12 days, respectively). Postoperative haematocrit of both groups showed no significant difference (Figure 4).

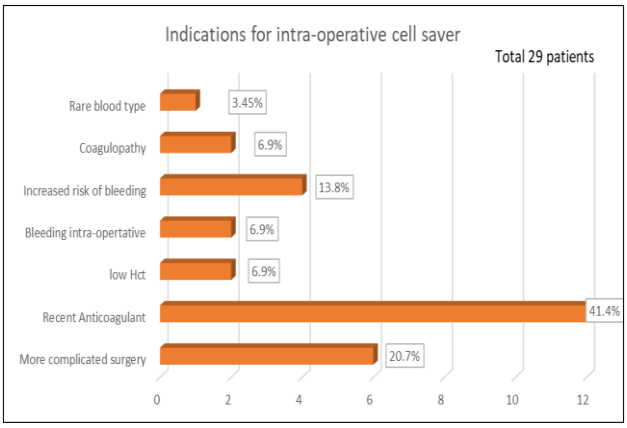

Figure 2: Indications for cell saver usage.

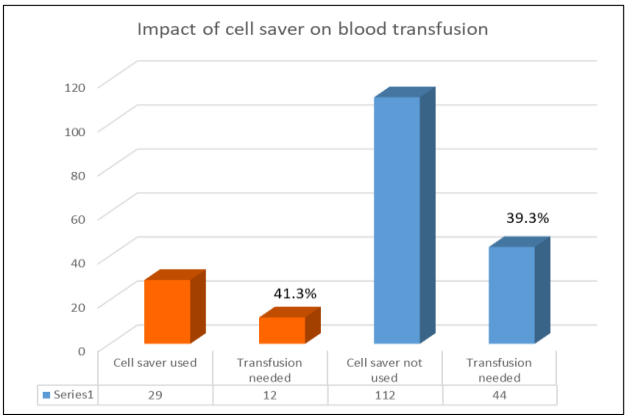

Figure 3: Impact of cell saver on blood transfusion.

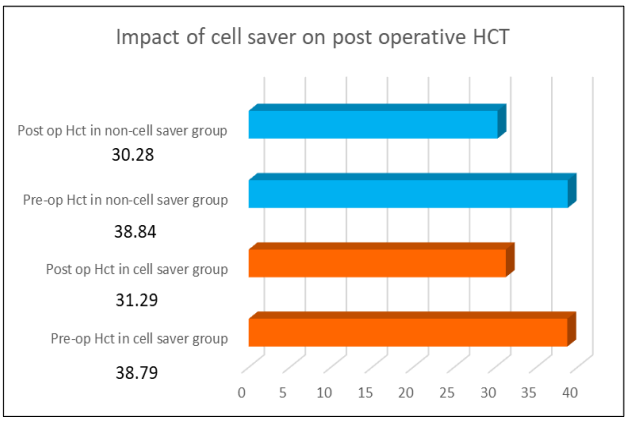

Figure 4: Impact of cell saver on postoperative haematocrit.

DISCUSSION

Cardiotomy suction of the cardiopulmonary bypass (CPB) machine is normally used to retrieve blood during cardiac

surgery. However, its use is limited to the time of heparinization; which means it cannot be used before achieving an acceptably high activated clotting time (ACT) neither after reversal of heparin with protamine sulphate.[11] On the other hand, the cell saver suction can be used in all phases of cardiac surgery and regardless of utilizing CPB or not.[12] Two patients in this study had off-pump coronary artery bypass surgery (1.4%) and both had cell saver used effectively. One of the basic benefits of using cell saver in parallel to cardiotomy suction during cardiac surgery is that the surgeons can use two suction devices and accomplish a bloodless operative field without considerable blood loss. Another benefit is the avoidance of allogenic blood transfusion and its complications.[13] Recent literature shows that cell saver use as an alternative to cardiotomy suction may lead to less lipid microemboli and therefore reduce cognitive impairment after cardiopulmonary bypass.[14] Despite the benefits mentioned above; cell saver use is only spared for selected indications in our institution due to availability and cost. Conflicting opinions regarding the cost effectiveness of cell salvage in cardiac surgery exist. Studies from Attaran et al and Klien et al found that the use of cell salvage in routine cardiac surgery is ineffective and not cost-effective and should be reserved for selected cases; in contrast Cote et al and Murphy et al and other authors found that cell saver is cost effective in cardiac surgery and supported its use.[15-18]

Indications for cell saver use in our survey were (in descending order of frequency): recent anticoagulation or antiplatelet therapy (41.4%) as in emergency or urgent surgery, recent cardiac catheterization mandating use of unfractionated heparin and clopidogrel antiplatelet therapy, atrial fibrillation or previous mechanical heart valve implantation. The second in frequency indication was more complicated heart surgery (20.7%) such as combined surgery (combination of coronary arteries bypass grafting with valve replacement or aortic surgery). The third in frequency indication was increased risk of bleeding (13.8%) as in redo heart surgery due to mediastinal adhesions. Less frequent indications were known preoperative coagulation disorder (6.9%) which can be inherited such as von Willebrand disease (vWD) or acquired due to herbal anticoagulants. Other indications for cell saver use were preoperative anaemia (6.9%) and unanticipated intraoperative iatrogenic vascular injury (6.9%). Least encountered indication was rare patient blood group (3.45%) (Figure 1). It was also noticed that cell saver use was more common in surgeries demanding longer CPB, as the average CPB duration was 142.2 minutes in the cell saver group in contrast to 97.5 minutes in the no cell saver group.

Literature is separated regarding the haematological benefits of using cell saver in cardiac surgery. A systematic review and meta-analysis by Al Khabori et al concluded that the use of cell saver during cardiac surgery does not have an impact on the rates of RBC, platelet and FFP transfusion.[19] On the contrary, Neef et al found that cell salvage was significantly associated with a reduced number of allogeneic RBC transfusions.[20] Only 40% of patients included in our analysis required blood or blood product transfusion (Figure 2). There was no significant difference in blood transfusion requirements between the cell saver group and the no cell saver group. Postoperative haematocrit was slightly higher in the cell saver group (31.3%) than in the no cell saver group (30.2%) (Table 2).

Postoperatively, both the cell saver group and the no cell saver group had almost the same ICU length of stay (4.8 and 4.6 days), respectively. The overall hospitalisation time was only slightly less in the cell saver group. Although the benefits of using cell saver techniques such as higher haematocrit and shorter hospitalisation period are mild and non-significant, one should bear in mind that the cell saver was used in the more complicated and higher risk cardiac surgeries.

Limitations

Limitations of this study are the observational nature of the study and that it is a single centre study.

CONCLUSION

Cell saver was utilised in one fifth of adult cardiac surgeries. Most common indications for cell saver use during cardiac surgery were recent anticoagulation and more complicated cardiac surgery. The use of cell saver had no significant benefits on postoperative haematocrit and the overall hospital stay.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Wang G, Bainbridge D, Martin J, Cheng D. The efficacy of an intraoperative cell saver during cardiac surgery: a meta-analysis of randomized trials. Anesth Analg. 2009;109(2):320-30.
2. Nathan M, Tishler B, Gauvreau K, Matte GS, Howe RJ, Durham L, et al. A red cell preservation strategy reduces postoperative transfusions in pediatric heart surgery patients. Paediatr Anaesth. 2018;28(5):450-7.
3. Spiess BD. Blood transfusion: the silent epidemic. Ann Thorac Surg. 2001;72(5):S1832-7.
4. Engoren MC, Habib RH, Zacharias A, Schwann TA, Riordan CJ, Durham SJ. Effect of blood transfusion on long-term survival after cardiac operation. Ann Thorac Surg. 2002;74(4):1180-6.
5. Blundell J. Experiments on the Transfusion of Blood by the Syringe. Med Chir Trans. 1818;9(Pt 1):56-92.
6. Konig G, Waters JH. Washing and filtering of cell-salvaged blood - does it make autotransfusion safer? Transfus Altern Transfus Med. 2012;12(3-4):78-87.

7. Allam J, Cox M, Yentis SM. Cell salvage in obstetrics. Int J Obstet Anesth. 2008;17(1):37-45.
8. Amand T, Pincemail J, Blaffart F, Larbuisson R, Limet R, Defraigne JO. Levels of inflammatory markers in the blood processed by autotransfusion devices during cardiac surgery associated with cardiopulmonary bypass circuit. Perfusion. 2002;17(2):117-23.
9. Lau K, Shah H, Kelleher A, Moat N. Coronary artery surgery: cardiotomy suction or cell salvage? J Cardiothorac Surg. 2007;2:46.
10. Ashworth A, Klein AA. Cell salvage as part of a blood conservation strategy in anaesthesia. Br J Anaesth. 2010;105(4):401-16.
11. O'Carroll-Kuehn BU, Meeran H. Management of coagulation during cardiopulmonary bypass. Continuing Education in Anaesthesia Critical Care & Pain. 2007;7(6):195-8.
12. Tan NL, Corbineau H, Phu BD, Verhoye JP. Is a cell saver necessary in off-pump coronary artery bypass surgery? Asian Cardiovasc Thorac Ann. 2012;20(5):539-43.
13. Ackfeld T, Schmutz T, Guechi Y, Le Terrier C. Blood Transfusion Reactions-A Comprehensive Review of the Literature including a Swiss Perspective. J Clin Med. 2022;11(10):2859.
14. Jewell AE, Akowuah EF, Suvarna SK, Braidley P, Hopkinson D, Cooper G. A prospective randomised comparison of cardiotomy suction and cell saver for recycling shed blood during cardiac surgery. Eur J Cardiothorac Surg. 2003;23(4):633-6.
15. Attaran S, McIlroy D, Fabri BM, Pullan MD. The use of cell salvage in routine cardiac surgery is ineffective and not cost-effective and should be reserved for selected cases. Interact Cardiovasc Thorac Surg. 2011;12(5):824-6.
16. Klein AA, Nashef SA, Sharples L, Bottrill F, Dyer M, Armstrong J, Vuylsteke A. A randomized controlled trial of cell salvage in routine cardiac surgery. Anesth Analg. 2008;107(5):1487-95.
17. Côté CL, Yip AM, MacLeod JB, O'Reilly B, Murray J, Ouzounian M, et al. Efficacy of intraoperative cell salvage in decreasing perioperative blood transfusion rates in first-time cardiac surgery patients: a retrospective study. Can J Surg. 2016;59(5):330-6.
18. Murphy GJ, Rogers CS, Lansdowne WB, Channon I, Alwair H, Cohen A, et al. Safety, efficacy, and cost of intraoperative cell salvage and autotransfusion after off-pump coronary artery bypass surgery: a randomized trial. J Thorac Cardiovasc Surg. 2005;130(1):20-8.
19. Al Khabori M, Al Riyami A, Siddiqi MS, Sarfaraz ZK, Ziadinov E, Al Sabti H. Impact of cell saver during cardiac surgery on blood transfusion requirements: a systematic review and meta-analysis. Vox Sang. 2019;114(6):553-65.
20. Neef V, Vo L, Herrmann E, Triphaus C, Judd L, Winter A, et al. The association between intraoperative cell salvage and red blood cell transfusion in cardiac surgery - an observational study in a patient blood management centre. Anaesthesiol Intensive Ther. 2021;53(1):1-9.

Cite this article as: Alsmadi DD, Alhadidi A, Alawamleh A, Alghawanmeh S, Alshobaki W, Moh'd AF. The use of cell salvage in adult cardiac surgery at Queen Alia Heart Institute. Int J Adv Med 2024;11:66-70.