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Research Article

Use of filtered vs. Nonfiltered Residual circuit volume, a comparative study

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Abstract
Cardiac surgery causes large amount of blood loss in form of CPB circuit residual volume. Re infusion of the circuit volume reduces homologous blood requirements and there by eleminats the adverse effects of homologous blood. But unprocessed residual blood retransfusion itself can have tremendous hazards which may lead to increased post op bleeding, Increased homologous blood requirement, SIRS which may ultimately lead to organ dysfunction[1]. These unwanted effects of unprocessed residual CPB circuit volume can be eliminated by processing it[2] as processing by various methods and devices reduce amount of active inflammatory mediators[3,4]. Due to low cost effectiveness of cell salvage technique we used haemofiltration as a technique to decrease load of activated inflammatory factors[5]. Our study includes two groups Group A (n=25) who were transfused with unprocessed residual circuit volume and Group B (n=25) who were transfused with residual blood transfused after processing it through haemofiltration. In Group B we observed lower blood and blood product requirement, less bleeding in ist 24 hour post operatively and reduced ventilatorry stay than Group A.

Keywords: *Circuit residual volume, haemofiltration, blood loss, Inflammation, autologous blood transfusion.*

Introduction

One of the major complications in cardiac surgery with cardiopulmonary bypass is excessive intraoperative and postoperative blood loss. Blood loss usually is compensated by infusion of homologous blood products which may cause number of adverse reactions like febrile haemolytic and nonhaemolytic transfusion reaction, TRALI, septicaemia, endotoxemia etc[6,7]. With increasing number of open heart surgery day by day, it is putting tremendous load on blood banks also. For these reasons, it is important to reduce the need for transfusion of allogenic blood.

After any operation with CPB extensive form of blood loss occurs in form of the blood volume which remains in total circuit which is called residual circuit volume. The amount of volume includes circuit's priming volume and volume gained from cardiotomy suctions after venous decannulation. To minimize loss of blood this residual volume is often given. It is a type of autologous blood transfusin.

Now CPB involves extensive contact between blood and nonphysiologic artificial surface of circuit which cause activation of complement cascade, fibrinolysis, loss of coagulation factors,

induction of systemic inflammatory response[8]. So transfusion of unprocessed residual blood volume of CPB can cause more post operative blood loss and may increase SIRS. In particular the products generated after cleavage of C3 namely C3a & C3b stimulates release of histamine and other inflammatory mediators from mast cell and basophiles. This results in smooth muscle constriction and an increase in vascular permeability. Cleavage of C5 results in production of C5a &C5b. C5a is a potent chemotactic factor for neutrophil and promotes aggregation, adhesion and activation of neutrophils. C3b & C5b interact on cell membrane with components C6-C9 to form membrane attack complex which activates platelets and damages cell membrane. Other mediators for SIRS are cytokines, TNF alfa, interleukins etc.

To decrease the adverse reaction caused by the infusion of unprocessed residual volume, filtration is an alternative method. Filtration and washing reduces load of activated complement factors very significantly which causes less inflammatory response and post operative bleeding.

Processing of residual blood with cell saver machine can also be an alternative but in comparison to salvaged blood which is only washed RBC, filtered blood contains RBCs as well as other components like fresh plasma, platelets etc and is also cost effective.

Material & Methods

50 patients undergoing elective cardiac surgery (e.g ASD, VSD, MVR, AVR, DVR, CABG on pump) were prospectively enrolled in this study. Patient aged less than 18 years were excluded from this study. All the patients were divided into two groups- Group A (n=25) and Group B (n=25). In group A (n=25) after completion of operation non filtered residual circuit volume was transfused and in Group B (n=25) washed and filtered residual volume was transfused.

All surgeries of both groups were performed using a standard general anaesthesia protocol, median strenotomy approach, employing cardiopulmonary bypass with mild to moderate hypothermia (28°C - 35°C) and cardioplegic arrest (antegrade). Topical hypothermia was performed by cold ice saline intermittently.

CPB circuit consisted membrane oxygenator, with heat exchanger, a custom made uncoated PVC tubing pack with siliconized roller pump head tubing, arterial line filter (and haemofilter in group B patients). Circuit was primed with 1200-1400 ml RL/RI, 20ml NaHCO3 8.4%, 5.4IU heparin/ml priming volume.

Before cannulation, the patients were heparinised with 300IU heparin/kg body weight to achieve ACT>480 sec and throughout CPB ACT is maintained above 480 sec.

Throughout CPB mean arterial pressure was maintained 50-60mmHg.

In all patients after CPB heparin was neutralized with protamine sulphate and sternum was closed after thorough checking of haemostat by senior surgeon.

In Group A patients residual volume, after detachment of venous line from patient and collecting the blood volume of venous line in reservoir, was given through arterial line without filtration at slow rate before administration of protamine and circuit volume replaced by Ringer Lactate solution. After that protamine was given.

In Group B patients residual volume after detachment of venous line from patient and collecting the blood volume from venous line into reservoir, first the arterial line was clamped. Then the blood was circulated through haemofilter @ 400-500ml/min maintaining line pressure less than 100mmHg till a certain amount of filtrate (in average 400ml) filtrate was filtered out. The arterial line then was unclamped, filter was clamped and pump flow was reduced to 200ml/min and residual volume was given and replaced by Ringer Lactate solution (Ringers Chase technique)[9]. Then protamine was started.

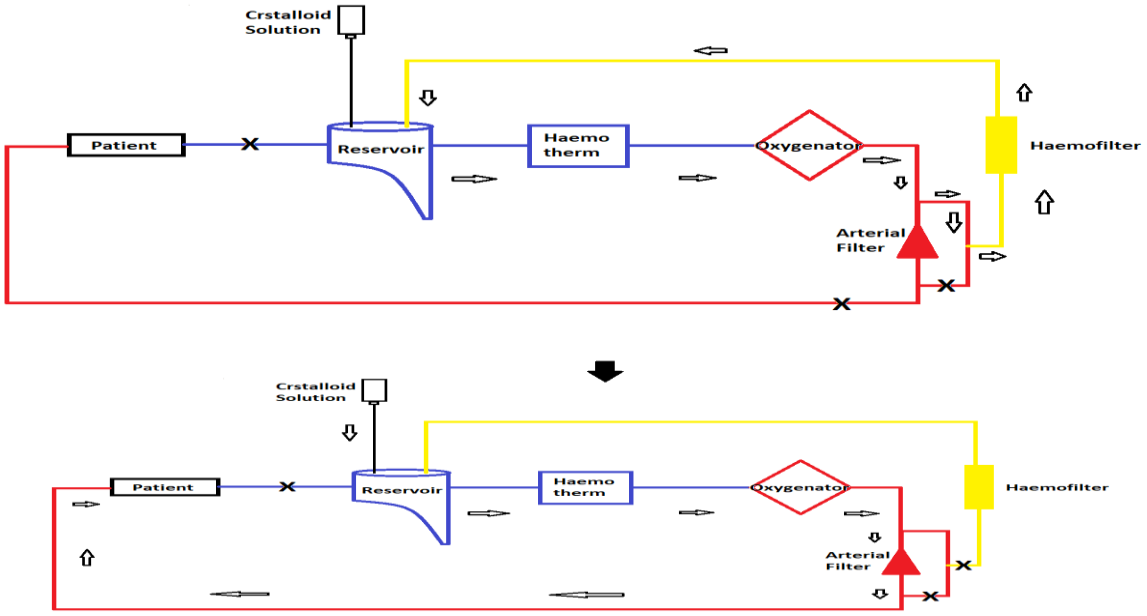


Fig: Circuit diagram of technique of haemofiltration of residual blood volume before transfusion

Then the post operative data of both group of patient of ventilator stay, drainage within 24 hours, homologous blood requirement were recorded and were analysed by statistical software "SPSS" version

Result

Out of 50 patients 16 patients (32%) were female and 34(68%) were male. All of them were aged between 25 to 60 years.

In group A (n=25) 21 patients (84%) required total blood and blood products more than 5 units and for 18(72%) patients bleeding were more than 500 ml during the first 24 hour after operation. In Group A patients inotropic requirement was also high as well as ventilator stay was also longer.

In group B (n=25) only 9 patients (36%) required total blood and blood products more than 5 units and only 7 patients (28%) bleed more than 500 ml in first 24 hour after surgery. Inotropic requirement and ventilator stay were also reduced. No death occurred during this study.

Table 1: Data of group A patients

SL no.	Age/Sex	Procedure	Residual volume transfused(ml)	Blood and Blood Product requirement	Drainage (ml) in ist 24 hour	Ventilator stay(hr)
1	35/m	MVR	1000	2PRBC, 3FFP, 3Platelet	600	33
2	29/M	OS-ASD closure	1000	1PRBC, 4FFP, 3Platelet	570	18
3	31/F	AVR	1200	2PRBC, 3FFP, 3Platelet	650	28
4	60/M	CABG-On pump	1000	3PRBC, 3FFP, 2Platelet	750	34
5	25/M	SV ASD with PAPVC	1100	1PRBC, 2FFP, 1Platelet	430	24
6	36/F	MVR	1400	2PRBC, 3FFP, 4Platelet	850	41
7	45/M	AVR	1000	1PRBC, 4FFP, 3Platelet	575	21
8	31/M	OS-ASD closure	1200	1PRBC, 4FFP, 4Platelet	450	17
9	33/M	MVR	1500	3PRBC, 5FFP, 4Platelet	790	40
10	26/M	OS-ASD closure	1000	0PRBC, 3FFP, 1Platelet	300	12
11	56/M	CABG-On pump	1250	2PRBC, 3FFP, 3Platelet	650	26
12	28/M	OS-ASD closure	1000	0PRBC, 4FFP, 3Platelet	320	13
13	37/F	MVR	1400	4PRBC, 6FFP, 4Platelet	940	53
14	39/F	MVR	1250	1PRBC, 4FFP, 3Platelet	400	29
15	59/M	CABG-On pump	1000	3PRBC, 4FFP, 4Platelet	780	31
16	36/M	MVR	1000	0PRBC, 2FFP, 2Platelet	300	18
17	27/F	OS-ASD closure	1000	1PRBC, 2FFP, 0Platelet	290	18
18	43/M	AVR	1250	2PRBC, 3FFP, 4Platelet	630	18
19	41/M	MVR	1500	2PRBC, 2FFP, 2Platelet	590	27
20	25/M	OS-ASD closure	1000	1PRBC, 3FFP, 3Platelet	340	14
21	32/M	MVR	1500	3PRBC, 5FFP, 5Platelet	700	38
22	38/M	DVR	1500	4PRBC, 5FFP, 4Platelet	880	49
23	29/M	OS-ASD closure	1000	1PRBC, 3FFP, 2Platelet	370	18
24	31/M	MVR	1000	2PRBC, 4FFP, 4Platelet	790	36
25	43/F	DVR	1250	1PRBC, 5FFP, 3Platelet	540	29

Table 2 : Data of group B patients

Sl. No.	Age/Sex	Procedure	Residual volume transfused(ml)	Filtered volume(ml)	Blood & Blood Product requirement	Drainage in ist 24 hour(ml)	ventilator stay(hr)
1	26/F	AVR	1000	400	0PRBC, 3FFP, 3PLATELET	300	20
2	46/M	CABG on pump	1100	400	0PRBC,4FFP,0PLATELET	250	20
3	36/F	MVR	1150	550	1PRBC, 3FFP, 0PLATELET	250	20
4	44/F	DVR	1000	450	1PRBC,3FFP,3PLATELET	350	18
5	48/F	MVR	1000	380	NIL	NIL	17
6	60/M	CABG on pump	1350	400	2PRBC,4FFP,2PLATELET	800	48
7	45/M	CABG on pump	1500	550	1PRBC, 3FFP,3PLATELET	200	18
8	28/F	OS-ASD closure	1100	400	0PRBC,2FFP, 0PLATELET	50	15
9	40/F	OS-ASD closure	1000	350	0PRBC, 3FFP, 0PLATEELET	NIL	14
10	54/F	AVR	1000	300	2PRBC, 3FFP, 3PLATELET	675	34
11	39/F	OS-ASD closure	900	200	0PRBC, 2FFP ,1PLATELET	175	20
12	56/M	CABG on pump	1000	350	1PRBC, 3FFP, 3PLATELET	400	20
13	32/M	AVR	1200	450	3PRBC, 4FFP, 4PLATELET	1000	49
14	26/M	OS-ASDclosure	950	350	0PRBC, 3FFP, 0PLATEELET	200	24
15	43/M	MVR	1250	400	0PRBC, 3FFP, 1PLATELET	250	20
16	25/M	OS-ASD closure	1000	200	0PRBC, 3FFP, 2PLATELET	250	20
17	35/M	MVR	1250	400	1PRBC, 3FFP, 0PLATELET	NIL	20
18	39/M	DVR	1500	450	2PRBC, 3FFP, 3PLATELET	325	24
19	28/F	OS-ASD closure	1000	250	0PRBC, 2FFP, 0PLATELET	NIL	17
20	56/M	CABG on pump	1200	375	0PRBC, 3FFP, 2PLATELET	50	20
21	33/F	OS-ASD closure	900	250	NIL	125	19
22	37/M	MVR	1000	250	NIL	75	20
23	26/M	OS-ASD closure	650	200	0PRBC, 2FFP, 0PLATELET	250	20
24	30/M	MVR	1000	350	3PRBC, 5FFP, 4PLATELET	850	34
25	51/M	DVR	970	200	1PRBC, 3FFP, 0PLATELET	575	20

We also did organ dysfunction evaluation using Sequential Organ Failure Assessment (SOFA)[10] scoring system.

Table 3 : Average SOFA score of group A and group B patients

	Group A	Group B
Average SOFA score after 24 hour of surgery	4.64	3.88

Discussion

Cardiopulmonary bypass offers various challenging situation one of which is decreasing the need for homologous blood after cardiac surgeries. The most extensive form of blood loss during cardiac surgery occurres in form of CPB circuit residual volume. A common technique of autologous transfusion is reinfusion of circuit's residual volume.

Now, several studies show that unprocessed residual blood has many deleterious effects such as increased post op bleeding, development of SIRS.

In our study we also observed these deleterious effects in group A patients in whom unprocessed residual blood was transfused. There was increased bleeding and increased requirement of autologous blood.

So, we sought an alternative to process the residual blood volume through haemofilter before transfusion.

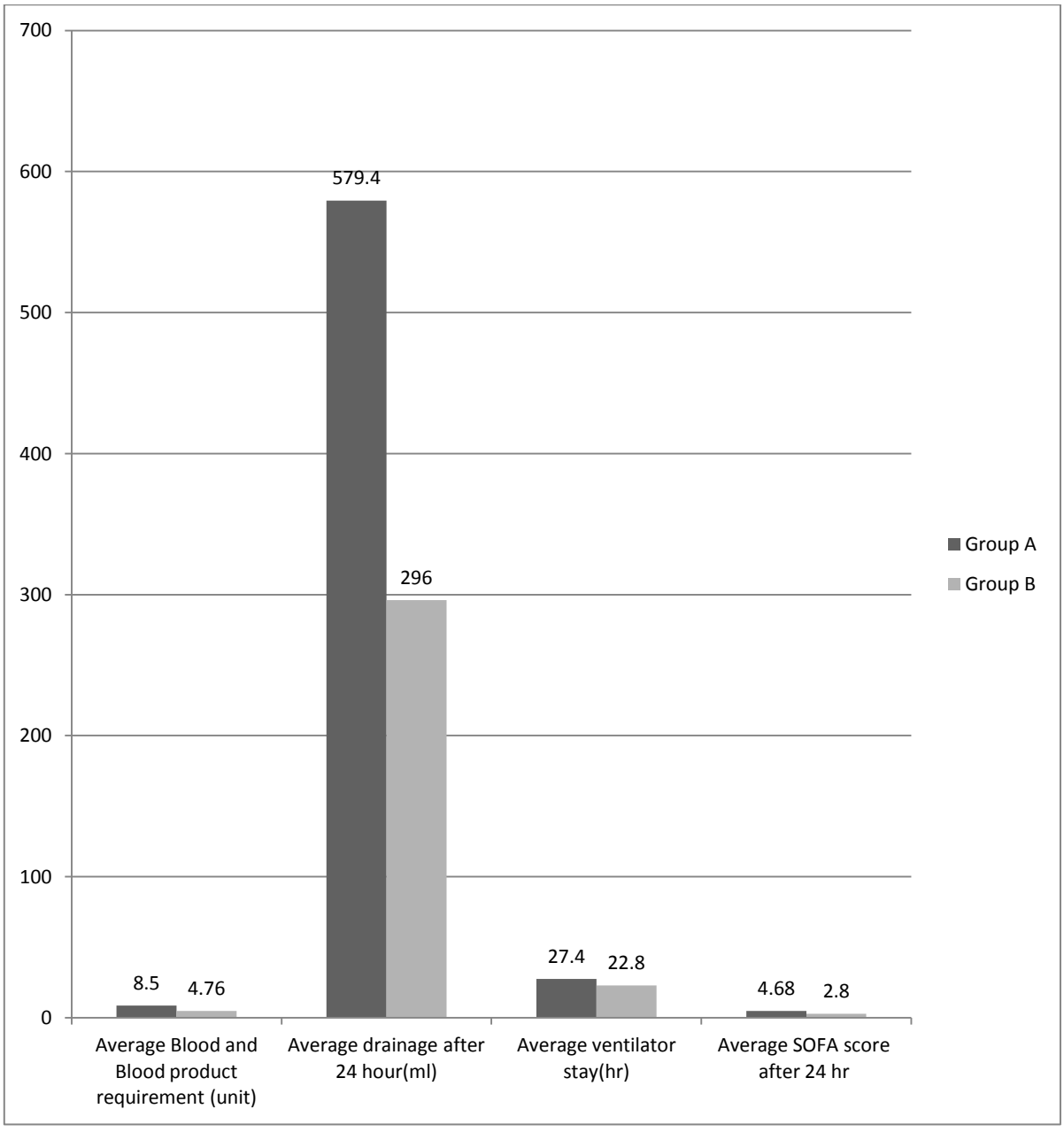
In group B we first filtered the residual blood and then transfused it to the patient and got satisfactory result. There was decreased bleeding.

Many other studies also suggest that haemofiltration reduces the inflammatory mediator[11]. In our study this fact can be partially proved by reduced ventilator stay as observed in patients of Group B than Group A patients. And also in Group B patients SOFA score after 24 hours of surgery were also relatively lower than Group A patients.

Result Analysis

Significant decrease in blood and blood product requirements in group B (n=25) patients than in group A (n=25) patients. Average blood and blood product requirement in group A patients is 8.5 unit

while in group B patients average requirement is 4.76 unit. P value = 0.008 i.e, significant.
Drainage within ist 24 hour was also less in group B(average296 ml) where as in group A average was 579.4 ml. P value is =0.001 i.e significant.
In group B average ventilator stay(average 22.8 hour) was also low than group A (average27.4 hour) as well as average SOFA score measured after 24 hour of surgery.



Conclusion

After cardiac surgery in CPB, transfusion of the filtered circuit residual volume is useful in an attempt to reduce post operative autologous blood requirement along with reduction in post operative bleeding and also inflammatory reaction due to transfusion of unfiltered residual volume may be avoided. No morbidity and mortality occurred due to this procedure. So to decrease post operative homologous blood product transfusion this technique can be successfully performed with good outcome.

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Conflicts of interest: Not declared

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