ORIGINAL ARTICLE

ROLE OF MODIFIED ULTRFILTRATION IN ADULT CARDIAC SURGERY: A PROSPECTIVE RANDOMIZED CONTROL TRIAL

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Background: Cardiopulmonary bypass (CPB) is associated with morbidity and mortality. To reduce its adverse effect modified ultrafiltration is being increasingly employed. This study is planned to evaluate the benefits of modified ultrafiltration (MUF) in adult cardiac surgery. **Methods:** Eighty consecutive patients presenting to adult cardiac surgery as elective case were enrolled. These patients were randomly divided in to two groups. MUF group which received modified ultrafiltration after separation from CPB and control group which did not receive modified ultrafiltration. Postoperative mediastinal and chest drainage in 24 hrs, blood products requirement, reopening, ICU stay, and mortality in 30 days were recorded. These variables were compared between MUF group and control group. **Results:** Forty patients were randomized to control group and 40 in MUF group. Mean age was 51.15±8.90 in control group as compared to 46.95±13.24 MUF group (*p*=0.1). Out of 40 patients in control group 7 (17.5%) were female while 11 (27.5%) out of total 40 were female in MUF group. (*p*=.284). Mean CBP time was 120.62±20.97 in control group versus 117.37±38.78 in MUF group (*p*=0.64). Post-operative drain output ranged from 330 ml to 1300 ml in control group and 300 ml to 780 ml in MUF group. Mean postoperative drain output 554.25±192.57 in control group versus 439.22±89.59 in MUF group (*p*=.001). Three (7.5%) out of 40 patients required re-exploration in control group versus 1 (2.5%) in MUF group. (*p*=.305). Mean ICU stay was 52.80±22.37 hours in control group versus 45.30±21.82 hours in MUF group (*p*=0.133). Three (7.5%) out of 40 patients died in control group versus 1 (2.5%) in MUF group. (*p*=0.305). **Conclusion:** Use of modified ultrafiltration is associated with low postoperative bleeding less requirements of blood and blood products.
Keywords: Modified ultrafiltration, Cardiac surgery, transfusion, morbidity

INTRODUCTION

Cardiopulmonary bypass (CPB) is associated with haemodilution, non-pulsatile flow, and systemic hepranization. Moreover hypothermia, ischemia, reperfusion and contact of blood components to synthetic surfaces activate inflammatory mediators. This inflammatory response is responsible for morbidity associated with cardiac surgery.[1] The clinical inflammatory response manifests by means of increase in vascular permeability, interstitial oedema and decline in the respiratory and cardiovascular function. Coagulation system, Kidneys, central nervous system and gastrointestinal system may also be affected.[2]

Due to this effect on coagulation system and dilutional anaemia cardiac surgery remains greatest consumer of blood and blood products. Studies shows that cardiac procedures consume more than 80% of blood products transfused at operation.[3] That is why, in near future, the demand for blood products is expected to outstrip the supply by 20% in near future in developed countries.[4]

To counteract these detrimental effects of cardiopulmonary bypass various therapeutic manoeuvres have been adapted such as minimally invasive surgeries, anti-inflammatory drugs, anti-fibrinolytic drugs and hemofiltration during surgery.[5] Modified ultrafiltration (MUF) is one of techniques which removes water and lower molecular weight substances under hydrostatic pressure gradient. This results in increased hematocrit, reduction in circulating inflammatory mediators, improved cardiovascular performance and improved neurological outcome.[6,7]

MUF is cost effective and complication free. It has become standard of care among paediatric population.[8] In adults, however benefits are less well documented.

The current study was undertaken to evaluate the effect of MUF on postoperative mediastinal and chest drainage, blood products requirement, re-exploration rate, Intensive care unit (ICU) stay, and mortality in adult patients undergoing cardiac surgery.

MATERIAL AND METHODS

This randomized control trial was undertaken in department of cardiovascular surgery Postgraduate Medical Institute Government Lady reading Hospital Peshawar from September to November 2014. Eighty consecutive patients above the age of fifteen years presenting to adult cardiac surgery as elective case were included in the study after taking informed consent. Emergency cases and high risk cases (American Society of anaesthetist (ASA) Class IV) were excluded. The patients fulfilling the inclusion criteria were randomly divided in to two groups. MUF group which received modified ultrafiltration after separation from CPB and control group which did not receive modified ultrafiltration, Randomization was performed by computer generated random numbers.

In MUF group after successful separation from cardiopulmonary bypass patient remained heparinised. Blood was withdrawn from aortic line and outlet line of haemofilter was connected to right atrial canula. Blood taken from aortic line. Ultrafiltration was done at a rate of 100–120 ml/min for 10 to 15 min and concentrated blood returned through venous line. Protamine was given only if Activated clotting time (ACT) was high.

In control group there was no ultrafiltration after separation of bypass. Heparin was neutralized with protamine sulphate at the dose of 4 mg/kg.

In all the patients two mediastinal drain one anterior and one posterior were placed. Plural drains were place in selected cases when plural cavity was entered.

Data was analysed using SPSS-20. Postoperative mediastinal and chest drainage in 24 hrs, blood products requirement, reopening rate, ICU stay, and mortality in 30 days were recorded. These variables were compared between MUF group and control group. Continuous variable were compared by student's t test while discrete variable were compared with Pearson's chi square test. A p value of less than 0.05 was taken as significant.

RESULTS

Eight patients were included in study. Forty patients were randomized to control group and 40 in MUF group. Age of the patient range from 26–63 years in control group while in MUF group it ranged from 19 to 67 years. Mean age was 51.15±8.90 years in control group as compared to 46.95±13.24 years MUF group (*p*=0.1). Out of 40 patients in control group 7 (17.5%) were female, while 11 (27.5%) out of total 40 were female in MUF group. (*p*=0.284)

Nine (22.5%) had history of hypertension in control group while 14 (35%) were hypertensive in MUF group (*p*=0.217) Eleven (27.5%) were diabetic

in control group as compared to 7 (17.5%) in MUF group *p*=(0.284) (Table-1) Type of procedures performed in two groups are given in table-2.

Cardiopulmonary bypass (CBP) time ranged from 60 to 150 minutes in control group and 50 to 200 minutes in MUF group. Mean CBP time was 120.62+20.97 minutes in control group versus 117.37+38.78 minutes in MUF group (*p*=0.64)

Post-operative drain output ranged from 330 ml to 1300 ml in control group and 300 ml to 780 ml in MUF group. Mean postoperative drain output in first twenty four hours was 554.25±192.57 ml in control group versus 439.22±89.59ml in MUF group (*p*=.001)

Three (7.5%) out of 40 patients required re-exploration in control group versus 1 (2.5%) in MUF group. (*p*=0.305).

Mean ICU stay was 52.80±22.37 hours in control group versus 45.30±21.82 hours in MUF group (*p*=0.133)

Three (7.5%) out of 40 patients died in control group versus 1 (2.5%) in MUF group. (*p*=0.305).

Table-1: Demographic profile

	Control group	MUF group	*p*-value
Patients	40	40	
Age	51.15±8.90	46.95±13.24	0.1
Female	7 (17.5%)	11 (27.5%)	0.284
Diabetic	11 (27.5%)	7 (17.5%)	0.284
Hypertensive	9 (22.5%)	14 (35%)	0.217

Table-2: Type of procedures performed in two groups

Procedure	Control group	MUF group
Coronary artery bypass graft (CABG)	24	16
Mitral valve replacement (MVR)	5	9
Aortic valve replacement (AVR)	5	8
Double valve replacement (DVR)	3	1
CABG + AVR	0	2
CABG + MVR	1	0
Left Atrial myexoma	0	1
Aortic Root replacement	1	0
Atrial septal defect (ASD)	0	2
Ventricular septal defect (VSD)	0	1
Tetrology of fallot (TOF)	1	0

DISCUSSION

Transfusion of blood and blood products in surgery not only have economic burden but is also associated with transmission of viral infections like Acquired Immunodeficiency syndrome (AIDS) and hepatitis.[9] Moreover it has also been documented to increase the mortality.[10] Hemodilution is one of the contributory factors responsible for coagulopathy and bleeding, resulting in increased transfusion requirement. Priming and infusion of cardioplegia solution are two main contributory factors for hemodilution in cardiac surgery. And this hemodilution is more marked in low

body weight patients. That is why low body weight has been shown a risk factor for increased postoperative blood transfusion and low body weight patients get greater benefits from modified ultrafiltration.[11]

Comparison of patient parameters in current study shows that two groups are comparable with each other's. MUF group contains more female, hypertensive and high risk patients as compared to control group but these differences are not statistically significant. On the other hand control group has more diabetic patients but the difference does not reach the significance level. The cardiopulmonary bypass time is also comparable.

Notable and significant decrease in average post-operative drain output has been observed in MUF group as compared to control group. This has been documented in many studies on adult patients[6–8] including studies addressing high risk patients only[6].

In a randomized control trail from Brazil it was concluded that MUF groups had reduced chest tube drain as compared to control group after 48 hours. Haematocrit level were higher and transfusion requirement was less in MUF group. This study included Coronary artery bypass grafting (CABG) patient only.[12] Papadopoulos et al.[6] conducted trail on high risk patients and observed the same facts with statistically significant decrease in average chest drain output. Same results have been documented from local studies as well.[13,14] Contrary to this observation some studies have concluded that MUF has no impact on post-operative bleeding. Boga et al[15] from turkey in a small prospective non-blinded study reported that although there was significant difference in blood transfusion requirement favouring MUF but there was no difference in post-operative drainage. This trail was also performed in CABG patient only. Same fact has been reported elsewhere.[16] Another large randomized control trail on all patients undergoing cardiac surgery including high risk, redo and emergency surgeries concluded lower average bleeding and lower incidence of re-exploration for postoperative haemorrhage in patients undergoing ultrafiltration, but the results failed to reach the significance.[7] The possible explanation for low drain output after modified ultra-filtration is that there is less degree of hemodilutional coagulopathy. Same is the reason for the repeated observation that MUF have greater impact in paediatric population on post-operative bleeding as crystalloid fluid overload and hemodilution is more marked in paediatric patients.[8] This relatively increased hemodilution is the possible explanation for the observation that low body weight is a predictor for postoperative blood transfusions.[17]

Although there was significant reduction in average post-operative chest drain output and blood transfusion requirement the rate of reopening for bleeding was not statistically significant. It was 2.5% in MUF group versus 7.5% in control group (p=.308). Same fact is observed in many other studies.[7,12,13]

Post-operative ICU stay was less in MUF group as compared to control group. But this difference was not statistically different. Luciani et al concluded the same results in a study. He observed that although the duration of assisted ventilation, stay in the intensive care unit and stay in the regular ward were shorter in the patients undergoing modified ultra-filtration but the difference was not significant.[7]

Impact of MUF has also been compared under normo-thermic and hypothermic cardiopulmonary bypass and it has been observed that beneficial effect of MUF is more marked in hypothermic cardiopulmonary bypass. It has minimum impact under normo-thermic conditions.[18]

This study is limited by its sample size as the current sample size is not sufficient enough to predict significant difference between the two groups based on their prevailing frequency

CONCLUSION

Use of modified ultrafiltration is associated with low postoperative bleeding less requirements of blood and blood products.

AUTHOR'S CONTRIBUTION

DN: Planned, conducted the study and drafted the manuscript. RAK: Supervised the study. AM: Did statistical analysis. ZAS, I and AH: Did literature search, data collection and proof reading.

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