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Observational Study for the Effect of Modified Ultra filtration in Adult Cardiac Surgery

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Abstract: *Introduction:Ultrafiltration can ameliorate the effects of cardiac surgeries by removing free water and inflammatory mediators. Present study was planned impact of modified ultrafiltration on early morbidity along with on hemodynamic, pulmonary functions after adult cardiac operations.*
Methodology: Observational Descriptive (prospective study) was conducted. Total 60 patients were included in the study and thirty from each group. Modified ultrafiltration technique was compared with conventional technique. Haematological and Physiological parameters were compared in both groups.
Result: It was observed thatt CPB (min) and cross-clamp times (min) were almost similar in both groups. It was observed that there was no statistical difference. We also observed that the ultrafiltrate volume (ml) was comparatively smaller in modified ultrafiltration. There was significant difference in both groups.
Conclusion: MUF is a safe procedure for intraoperative fluid management that is able to reduce postoperativebleeding and the need for RBC transfusion.

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I. Introduction

Cardiac surgery is associated with the increase of vascular permeability, liquid retention causing interstitial oedema and decline in the respiratory and cardiovascular function. It leads to an increase in postoperative mortality and morbidity. Several strategies have been described in the attempt of minimizing the inflammatory response, such as minimally invasive surgeries, anti-inflammatory drugs and hemofiltration during surgery. The latter modality, more specifically, the modified ultrafiltration, was described by Elliot et al. and initially used in paediatric patients.[1–4]

Ultrafiltration can ameliorate the effects of cardiac surgeries by removing free water and inflammatory mediators (low molecular weight preferably). This technique uses a semi-permeable membrane with a positive trans membrane hydrostatic pressure gradient. It has been demonstrated that it can decrease the deleterious effects of cardiopulmonary bypass and is routinely used worldwide. There are two different methods of ultrafiltration. Conventional ultrafiltration (CUF) is the first one and is performed during CPB. One positive aspect of this technique is its ease of use and that cardiopulmonary bypass need not be prolonged. On the other hand, sometimes it can only achieve moderate haemoconcentration because the amount of eliminated fluid is limited by the level contained in the venous reservoir. The second procedure is called modified ultrafiltration (MUF). This is performed after cardiopulmonary bypass is finished and is independent of the volume contained in the circuit. This difference enables MUF to provide more effective haemoconcentration, removing more free water and a higher potential to reduce inflammatory mediators. The downside of this method is that it extends the duration of patient exposure to non-endothelial surfaces because of the prolonged time of the technique (after the ends of CPB, usually 15 minutes are needed before removal of cannula). So, this study was planned impact of modified ultrafiltration on early morbidity along with onhemodynamic, pulmonary functions after adult cardiac operations. [3–5]

II. Materials and Methods

Observational Descriptive (prospective study) was conducted in the Department of Cardiovascular thoracic surgery; Super speciality Hospital Nagpur . Adult Patient (> 18 years) undergoing elective cardiac surgery were study population. All consecutive patients older than 18 years undergoing elective surgery; having ejection fraction higher than 40%, and consented to participate in the study were included in the study. Total 60 patients were included in the study and thirty from each group.Modified ultrafiltration technique were compared with conventional technique. Patients having Pregnancy; renal failure with creatinine >2 mg/ dl and heart transplants and patients where the prolonged CPB required with MUF was judged by the operating surgeon to be unsafe (e.g. excessive intraoperative blood loss, long CBP time, emergency were excluded from the study.

Ethical clearance from college Institutional Ethics Committee was obtained. Informed consent was taken from each study participant before commencing study. In our centre, ultrafiltration had been undertaken routinely when cardiac surgery was performed, over the last few years. The usual technique had been conventional ultrafiltration (CUF). In some recent cases, MUF was also done, with agreement between the anaesthesiologist and surgeon.

Details of technique [3,4]

Modified ultrafiltration was performed after coming off CPB and before the reversal of heparin, usually through the haemofilter and with negative suction applied to the ultrafiltrate. Flow of MUF was maintained around 10-15 ml/kg/min, with a mean duration of 15 min. With the aortic cannula in place, cardioplegia was flushed using the haemofilter and M line, while the C line was clamped. After filling the patient with a correct preload for haemodynamic stability, MUF was started, using the aortic cannula as inflow onto the oxygenator and the haemofilter, whilst the arterial filter was clamped. Blood then reached the cardioplegia system, where the heat exchanger maintained it around 37 degrees. From here, it was returned to the patient through the retrograde cannula towards the right atrium. Simultaneously, all the volume contained in the CPB circuit was haemoconcentrated and the patient was transfused.After achieving haemostasis and chest closure, patients was transferred to intensive care unit. In the intensive care unit, patients were monitored according to ICU protocol. Discharge criteria from the intensive care unit included a complete wean from all vasoactive and inotropic infusion, extubating without pulmonary support and no evidence of major organ failure. Discharge criteria from hospital included stable rhythm, no supplemental oxygen requirement, ambulation and tolerance of oral intake.
Measurement of hemodynamicswasincluding heart rate, mean arterial pressure and central venous pressure. Pulmonary function consisted of oxygen index, arterial to alveolar oxygen tension (a/A ratio) and alveolar arterial oxygen gradient (A-aDO2), calculated according to alveolar gas equation based on arterial blood gas analysis. All patients after anaesthetic induction was monitored by Swan-Ganz continuous debit catheter invasive blood pressure in the left radial artery and the orotracheal tube was connected to Respiratory and hemodynamic data will be collected during: anaesthetic induction, 15 minutes after discontinuing ECC and immediately preceding MUF, immediately following MUF, 24 hours of postoperative and 48 hours of postoperative. The oxygen drainage (DO2), oxygen consumption (VO2), oxygen extraction (EO2), pulmonary shunt (Qs/Qt), alveolus-arterial difference (Aa-difference) and oxygenation index was calculated. The airways resistance and pulmonary compliance was acquired by the data provided by the device Co2smo Plus DX 8100, which was performed in a continuous manner by the equipment. The haematocrit, serum lactate dosage, platelet counting, white blood cell counting, creatinine dosage, activated partial thromboplastin time (R) and international normalized ratio of prothrombin time (INR) was acquired from the results of the main laboratory of our institution. The data relating to bleeding, amount of fresh frozen plasma and concentration of erythrocytes transfused per patient was filed from the intensive care unit report. Physiological parameters were compared in both groups. The continuous variables were expressed as mean and standard deviation, and the categorical variables were expressed as proportions. Discrete variables were evaluated by chi-square test and continuous variables by unpaired Student t-test. All statistical tests were based on two-tailed probability and a p-value <0.05 was considered statistically significant.[6]

III. Result

There were total 60 patients were studied retrospectively. There were no differences among the groups in terms of baseline demographic parameter, previous history, and preoperative functional status.

Table 1: Demographic data, previous history in both groups

Variable	Conventional Ultrafiltration(n:30)	Modified Ultrafiltration(n:30)	Significance
Age (years)	61.2 ± 12.2	63.3 ± 11.8	> o.o5
Male : Female	21:9	19:11	> o.o5
NYHA score (III/IV)	23	21	> o.o5
Ejection Fraction (%)	62 ± 11	64 ± 14	> o.o5
Pathology			
Valvular	18	14	**> o.o5**
CABG	7	10	
Mixed	5	6	
Previous history			
Hypertension	19	17	**> o.o5**
Diabetes	4	6	
Smoker	5	3	

It was observed thatt CPB (min) and cross-clamp times (min) were almost similar in both groups. It was observed that there was no statistical difference. We also observed that theultrafiltrate volume (ml) was comparatively smaller in modified ultrafiltration. There was significant difference in both groups.

Table 3: Outcome variables and complications in both groups

Variable	**Conventional Ultrafiltration**	**Modified Ultrafiltration**	**Significance**
CPB time (min)	145.8 ± 42.8	118.8 ± 35.2	< 0.05 Sign
Cross-clamp time (min)	92.1 ± 34.4	94.2 ± 35.1	> 0.5 NS
Ultra filtrate volume (ml)	1568.2 ± 468	1134.3 ± 347	< 0.05 Sign
Fluid balance (after procedure) (ml)	785 ± 123.2	654.8 ± 112.6	< 0.05 Sign
Total amount of drainage (ml)	678.8 ± 84.3	584.6 ± 76.6	< 0.05 Sign
Packed red cell unit transferred (ICU) (ml)	98 ± 124	115 ± 142	> 0.5 NS
Extubation time (hours)	8.4 ± 7.8	10.2 ± 4.5	> 0.5 NS
ICU stay (hours)	46.8 ± 24	56.4 ± 21.2	> 0.5 NS
Ventricular shock	6	8	> 0.5 NS
Renal failure	1	1	> 0.5 NS
Acute lung injury	1	2	> 0.5 NS

The total amount of drainage from endothoracic chest drains was almost similar in both groups. Amount of packed red cell units used for transfusionpurposes were also similar both groups. Clinical outcomes, with similar duration of mechanical ventilation between the groups with extubation time of 8.4 hours in MUF, 10.2 hours in CUF. Ventricular shock; acute lung injury (ALI); adult distress respiratory syndrome (ADRS) and renal failure were complications seen in both groups. There were no statistical differences between groups.

IV. Discussion

Cardiac surgery can facilitate the development of a systemic inflammatory response syndrome (SIRS), and can promote capillary leakage and interstitial water retention. These physiopathological changes could lead to organ dysfunction, including multiorgan failure syndrome. This lead to an increase in probability of postoperative morbidity.[7,8] In order to avoid these potential non-desired effects, some pharmacological interventions have been designed and used, such as steroids, aprotinin or antioxidants. Moreover, some modifications have been done to the surgery process. Ultrafiltration technique allows convective transport of liquid and low-medium molecular weight molecules due to a pressure gradient through a semi-permeable membrane. Because of this, fluid overload is avoided and it is possible to reduce interstitial fluid, achieve haemoconcentration (decrease haemodilution) and wash out inflammatory mediators, but not proteins. In the cardiac surgery background, ultrafiltration has been proven to be clinically useful. [9,10]

In the present study we studied the effects of MUF in adult patients undergoing cardiac surgery. Use of MUF resulted in decreased postoperative blood loss, as indicated by decreased chest tube blood drainage and fewer RBC units transfused. Luciani and coworkers were observed that ultrafiltration has been proven to be clinically useful, either when it is performed during CPB (CUF) or just after it (MUF). They carried out prospective and randomized clinical trial of 573 patients, comparing the clinical outcomes of patients who received MUF with patients without ultrafiltration. They demonstrated that the technique is safe and also that the ultrafiltration group needs less transfusion and develops less gastrointestinal, neurological and respiratory morbidity. Mortality, although lower in the ultrafiltration group, was not significantly different compared to the control group.[11]

Leyh and colleagues studied patients scheduled for elective myocardial revascularization who were randomized to groups undergoing conventional ultrafiltration, MUF, or no ultrafiltration. They observed that reduced blood loss at 24 hours after surgery in the MUF group compared with the conventional ultrafiltration and no ultrafiltration groups. Leyh and colleagues could not elucidate the mechanism(s) for reduced blood loss. Babka et al studied 60 patients undergoing CBP. They observed that there was no difference in blood loss, blood transfused, length of stay or cost of patient.[12]

Our study was limited by the sample size, although we were able to show a t decrease in postoperative bleeding after MUF. The lack of randomization and a non-blind medical and nursing staff to treatments might have affected the results. In future, it would be desirable to develop a multicentre, randomized study, with an elevated number of recruited patients, to clearly elucidate the differences in clinical outcomes associated with the application of different techniques and amounts of removal fluid. The study was not designed to evaluate mortality.

In conclusion, MUF is a safe procedure for intraoperative fluid management that is able to reduce postoperative bleeding and the need for RBC transfusion.

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