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ORIGINAL ARTICLE

A Technique for Reducing Coronary Bypass Morbidity in Patients with Compensated Renal Failure; Perioperative Ultrafiltration

Kompanse Böbrek Yetmezlikli Hastalarda Koroner Bypass Morbiditesini Azaltan bir Teknik; Peroperatif Ultrafiltrasyon

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ABSTRACT

Introduction: Preoperative renal dysfunction is one of the most important risk factors affecting postoperative morbidity and mortality in patients undergoing cardiac surgery. While patients with end-stage renal disease and dialysis-dependent constitute 1-3% of the renal failure spectrum, it should not be forgotten that coronary revascularization surgery is performed at a rate of 2-5% in the remaining asymptomatic majority. However, an optimal perioperative strategy has not been developed for this group of patients who have not yet undergone hemodialysis. In our study, the conventional ultrafiltration (UF) technique was modified to a heart-lung machine and applied preoperatively, and in this way, we have aimed reducing mortality and morbidity.
Material-Method: 6303 patients who underwent coronary bypass surgery with the cardiopulmonary bypass technique between 2004 and 2011 at Başkent University Adana Hospitals were examined, and 99 patients with a preoperative serum creatinine level higher than 1.5 mg/dl were included in this retrospective study. 99 patients were divided into two groups as UF performed (n=35) and not performed (n=64); They were evaluated in terms of drainage amounts, length of hospital stay, early/late mortality and morbidity, and newly developing dialysis needs.
Results: There was no significant difference between the groups in terms of post-operative hemodialysis need, length of hospital stay and major complications. However; perioperative ultrafiltration in obese, diabetic patients and patients with recent myocardial infarction, chronic obstructive pulmonary disease (COPD) and congestive heart failure needed postoperatively less inotrope (P=0.0001), less diuretic requirement (P=0.0001), less colloidal fluid replacement (p=0.009), and relatively discharged with fewer minor complications.
Conclusion: We recommend ultrafiltration to be applied during cardiopulmonary bypass in order to create a more balanced intravascular volume in patients with compensated renal failure, to reduce the need for volume expander fluid used for this purpose, to remove inflammation mediators that occur during cardiopulmonary bypass, and therefore to protect renal functions without the need for additional medication, especially in COPD, diabetic and obese patient group.

Key Words: Ultrafiltration, COPD, Renal failure

ÖZ

Giriş: Ameliyat öncesi böbrek fonksiyonlarındaki bozukluk, kalp cerrahisi uygulanan hastalarda, ameliyat sonrası morbidite ve mortaliteyi etkileyen en önemli risk faktörlerinden birisidir. Son dönem böbrek yetmezliği olan ve diyaliz bağımlı hastalar, böbrek yetmezliği spektrumunda %1-3'lük dilimi oluştururken, geri kalan asemptomatik büyük çoğunlukta her yıl % 2-5 oranında koroner revaskülarizasyon cerrahisine gidildiği unutulmamalıdır. Ancak henüz hemodiyalize girmemiş bu hasta grubu için optimal bir peroperatif strateji geliştirilememiştir. Çalışmamızda konvansiyonel ultrafiltrasyon (UF) tekniği, kalp akciğer makinesine modifiye edilerek peroperatif olarak uygulanmış ve bu sayede mortalite ve morbidite de azalma amaçlanmıştır.
Materyal-Method: Başkent Üniversitesi Adana Hastanelerinde 2004-2011 yılları arasında kardiyopulmoner bypass tekniği ile koroner bypass ameliyatına alınan 6303 hasta incelenmiş, preoperatif serum kreatinin seviyesi 1,5mg/dl'den yüksek olan 99 hasta bu retrospektif çalışmaya dahil edilmiştir. 99 hasta UF yapılan (n=34) ve yapılmayan (n=65) olarak iki gruba ayrılmış; drenaj miktarları, hastane kalış süreleri, erken/geç dönem mortalite ve morbiditeleri ve yeni gelişen diyaliz ihtiyaçları yönünden değerlendirilmişlerdir.
Bulgular: Ameliyat sonrası hemodiyaliz ihtiyacı, hastanede kalış süresi ve major komplikasyonlar açısından gruplar arasında anlamlı fark saptanmadı. Ancak; obez, diyabetik, yeni enfarktüs geçiren, kronik obstrüktif akciğer hastalığı olan (KOAH) ve konjestif kalp yetmezliği bulunan olgularda peroperatif uygulanan ultrafiltrasyon; postoperatif daha az inotrop (P=0,0001), daha az diüretik (P=0,0001) ihtiyacı, daha az kolloidal mayi replasmanı (p=0,009) ve görece daha düşük minör komplikasyon ile seyretmiştir.
Tartışma ve Sonuç: Kompanse böbrek yetmezlikli hastalarda daha dengeli intravasküler volüm oluşturabilmek, bu amaçla kullanılan volüm genişletici mayi gereksinimi azaltabilmek, kardiyopulmoner bypass esnasında ortaya çıkan inflamasyon mediatörlerini ortamdan uzaklaştırabilmek, dolayısı ile renal fonksiyonları ek medikasyona ihtiyaç duymadan koruyabilmek amacıyla kardiyopulmoner bypass esnasında uygulanacak ultrafiltrasyonu özellikle KOAH'lı, diyabetik ve obez hasta grubunda önermekteyiz.

Anahtar Kelimeler: Ultrafiltrasyon, KOAH, böbrek yetmezliği

Introduction

One of the most important risk factors affecting postoperative morbidity and mortality in patients undergoing cardiac surgery is preoperative renal dysfunction. Given the aging population and the prevalence of diseases such as diabetes and hypertension, which increase the risk of both cardiovascular problems and kidney failure, it is clear that asymptomatic patients with impaired renal

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function, in particular, are of particular importance for cardiac surgery (1,2). While patients with end-stage renal disease and dialysis-dependence represent the tip of the iceberg with a 1-3% slice of the renal failure spectrum, the remaining asymptomatic majority undergo open heart surgery at a rate of 2-5% every year due to coronary revascularization, and it should be noted that this rate gradually increases each year. The European System for Cardiac Operative Risk Evaluation (EuroSCORE) assigns two risk points to patients with renal failure who are not dialysis dependent, emphasizing how carefully and consciously these patients' preoperative periods, while still in the compensated phase, should be managed (3,4). In addition to this volume load, surgical mortality and morbidity rates in patients with renal failure are high due to electrolyte imbalance, coagulation disorders, susceptibility to infections, and prolonged extubation time due to delayed anesthetic drug excretion (5). Furthermore, these patients are more likely to develop postoperative bleeding, pulmonary edema, arrhythmia, pneumonia, and mediastinitis. Many studies in the literature have reported that removing inflammatory mediators by ultrafiltration (UF) significantly reduces postoperative mortality and morbidity rates, increases myocardial contractions, requires fewer inotropic agents, and shortens extubation time in patients with normal renal function (6).

In this study, our aim is to demonstrate the benefit of perioperative ultrafiltration in the patient group whose renal function was impaired before coronary revascularization but did not require renal replacement therapy yet.

Material and Method

With the approval of Başkent University Hospital Clinical Research and Ethics Committees (KA11/184), the total number of patients who underwent coronary bypass surgery with cardiopulmonary bypass technique between January 1, 2004 and August 11, 2011 in our two clinics (Seyhan and Yuregir) affiliated to Başkent University Adana Application and Research Center. Ninety-nine patients with preoperatively measured serum creatinine level higher than 1.5mg/dl out of 6303 patients or diagnosed with compensated renal failure by the Nephrology department for any previous indication were included in the retrospective study. With patients undergoing hemodialysis for any reason, including preoperative ARF, even for once; additional procedures to coronary bypass (all types of heart valve replacements and interventions for the ascending aorta, all cases requiring total circulatory arrest), which are thought to cause incorrect results by changing the postoperative hospital stay, pump and cross-clamp times, may lead to a significant change in the pump and clamp times for its repair. Patients with heart valve failure that changed the fluid balance and dynamics of the body, were excluded from the study, even if they met the necessary conditions in terms of renal functions.

Ninety-nine patients who were envisaged to be examined were divided into two groups as UF performed (n=35) and not performed (n=64). It was decided to evaluate them in terms of early/late mortality, morbidity and surgical complications, dialysis needs, and renal function changes that occurred during the follow-up period. The Canadian Cardiovascular Society Classification of Angina (CCS) was used to classify the severity of angina in patients.

Surgical Technique

There was no difference between the coronary revascularization techniques in both groups. After the release of LIMA, standard cannulation (two-stage atrial and aorta) followed by retrograde cardioplegia cannula was placed in multiple coronary bypass cases and CPB was started. Moderate hypothermia was achieved using external (water blanket) and internal (CPB) cooling, a membrane oxygenator (Cobe® Optima® XPTM) was used during CPB, and the perfusion rate was 50-75 ml/kg/min, and the mean arterial pressure was 55 mmHg and is set to the top. During cardiopulmonary bypass, the alpha-stat pH strategy was applied, and myocardial protection was provided by intermittent blood cardioplegia and topical cooling, following the clamping of the aorta when appropriate conditions were met. Vasodilator infusion was continued so that the mean blood pressure remained stable during the cross-clamp. In patients with low blood pressure, 5-10 mg bolus ephedrine was administered, and urine output was controlled during cardiopulmonary bypass. Urine output was induced by administration of 0.1-0.3 mg/kg furosemide in patients with urine output below the expected amount (1 ml/kg/hour). In the group without ultrafiltration, proximal anastomoses were performed with a side-clamp after the cross-clamp was removed, and in the other group, the procedure was completed under a cross-clamp. Because of aortic pathology and low ejection fraction, 11 patients underwent coronary artery bypass surgery in beating heart. Conventional ultrafiltration technique was chosen as a standard for ultrafiltration, but modified ultrafiltration was also applied in 4 cases. Ultrafiltration is essentially a hemodialysis filter that does not use dialysate. It is done with a dialyzer placed between the arterial and venous lines of the bypass circumcircuit. A vacuum is used instead of a separate dialysate pump to increase the transmembrane pressure. Ultrafiltration is used to remove inflammatory mediators from the system, to prevent excessive hemodilution in patients with normal renal function, to prevent excessive hemodilution in patients with renal dysfunction, to reduce the fluid load due to chronic insufficiency in the preoperative period in cardiac surgery and to reduce pulmonary edema and preload in the preparation of the patient for surgery in the intraoperative and postoperative period. It can be used to remove excess water, to increase the plasma levels of the agents involved in hemostasis, to provide hemostasis and therefore to reduce the need for blood and blood product transfusion. COBE Hemoconcentrator before 2006 and ALLMED POLYPURE 13 dialyzer (Allmed Medical GmBH Germany) was added to the cardiopulmonary bypass circuit after 2006. The surface area of the dialyzer used is 1.3 square meters and is resistant to a maximum pressure of 500mmHg. After the bleeding control was completed in accordance with the surgical grip, straight tubes were placed in the mediastinum and thorax, and the sternum was closed.

Door technique was preferred in patients with left ventricular aneurysm, in patients requiring concomitant carotid endarterectomy, first the carotid lesion was intervened under general anesthesia, the anesthesia doses were completed after the patient was partially awakened and neurological examination was performed and then sternotomy was performed.

Patient Monitoring

During the intensive care follow-up, urine output was monitored hourly, and intermittent blood gases, potassium and bicarbonate values were measured. In case of oliguria, fresh frozen plasma transfusion was given first and then furosemide was administered according to weight. In cases where there was no adequate response, mannitol was added to the treatment and given as a diuretic infusion. In case of hyperkalemia, firstly, 20% glucose solution-insulin infusion was tried, and renal replacement therapy was started in resistant cases. The criteria for renal replacement therapy were accepted as wet-lung accompanied by anuria, hyperkalemia and resistant uremia, and treatment was started after the patient was evaluated by the nephrology department. In the intensive care unit, hemodynamic stabilization, rhythm problems, chest tube drainage amount (1st, 2nd, 3rd day), urine output (1st, 2nd, 3rd day), oxygenation profile, consciousness status and pain control are monitored. After spending at least, the first 48 hours in the intensive care unit, the patients who were stable were taken to the service.

Statistical analysis

SPSS 10.0 (statistical package for the social sciences SPSS Inc, Chicago, IL) was used to enter the data collected from the files and follow-up forms of the patients, and statistical analyzes were performed with the NCSS (Number Cruncher Statistical System) 2007 Statistical Software (Utah, USA) package program. In addition to descriptive statistical methods (mean, standard deviation) in the evaluation of data, paired one-way analysis of variance in repeated measurements of multiple groups, Newman Keulas multiple comparison test in subgroup comparisons, paired t-test in pairwise repeated measures of groups, independent t-test in comparison of paired groups, in comparisons of qualitative data chi-square test was used. The results were evaluated at the significance level of $p<0.05$.

Results

In terms of demographic data, the mean age of the patients in the UF (+) group was 63.54±8,97 years and 64.52±8,82 years in the UF (-) group. In terms of gender distribution, there was no difference between the groups. In terms of obesity, it is worth noting that the ultrafiltered group included statistically obese individuals. In terms of mean ejection fractions and CSS scores, there was no difference between groups (Table 1).

Table 1: Demographic data

	UF (-)	UF (+)	t	p
BMI	28,86±4,58	31,06±4,46	-2,30	**0,023**
EF	44,05±10,42	46,34±9,35	-1,09	0,280
CCS	2±0,71	2,26±0,56	-1,84	0,068

UF: Ultrafiltration BMI: body mass index EF: Ejection Fraction CCS: Canadian Cardiovascular Society Classification of Angina

Periprocedural data:

The patients were examined for comorbidities that were known to have a direct effect on mortality and morbidity; diabetes was more common in the ultrafiltration group, and the familial predisposition to vascular events was higher. No statistically significant difference was observed between UF (-) and UF (+) groups' means of target vessel, pump time, cross clamp time, distal anastomosis, pump temperature, mean arterial pressure during pumping. The mean blood and blood products in the UF (+) group were statistically significantly higher than the UF (-) group (p=0.044), however, while these blood products were in favor of fresh frozen plasma in the ultrafiltration group, the use of red blood cell suspension was more remarkable in the other group. The mean urine output of the UF (+) group during the pump was statistically significantly lower than that of the UF (-) group (p=0.0001). There was no statistically significant difference in Mannitol amount made in the pump between the UF (-) and UF (+) groups (p=0.143). The UF (+) group's mean amount of Lasix required during pumping was statistically significantly lower than that of the UF (-) group (p=0.029). The UF (+) group required less Mannitol and Lasix throughout the entire operation process, including the CPB period than the UF (-) group (Table 2).

Table 2: Surgical Statistics

	UF (-)	UF (+)	t	p
Target Vessel Count	2,88±0,58	2,91±0,56	-0,33	0,745
CPB Time	83,55±31,14	76,51±15,93	1,25	0,215
Cross Clamp Time	55,39±18,11	60,79±13,42	1,24	0,158
Distal Anastomosis	3,66±1,29	4±0,8	-1,43	0,155
Operating Temperature	32,19±1,26	32,27±1,69	-0,28	0,781
MAP	63,36±6,12	64,06±5,99	-0,55	0,586
Perop Blood	578,91±394,18	731,43±272	-2,04	**0,044**
Urinary output (CPB)	417,73±433,92	104,29±71,61	4,23	**0,0001**
Mannitol (CPB)	182,03±36,04	171,43±30,4	1,48	0,143
Lasix (CPB)	8,13±16,61	1,71±5,68	2,21	**0,029**
Mannitol (Perop)	223,44±80,16	171,43±30,4	3,69	**0,0001**
Lasix (Perop)	13,28±24,17	4±8,12	2,20	**0,03**

UF: Ultrafiltration CPB: Cardiopulmonary Bypass MAP: Mean Arterial Pressure

The UF (+) group's inotrope requirement was statistically significantly lower (p=0.0001). There was no statistically significant difference between the Intra-aortic balloon requirement (IABP) and Hemodialysis Need distributions of the UF (-) and UF (+) groups. (Table 3)

Table 3: Postoperative data

		UF (-)		UF (+)		
Inotrope	**(+)**	35	54,70%	6	17,10%	χ^2:13,15
	(-)	29	45,30%	29	82,90%	**p=0,0001**
IABP	**(+)**	2	3,10%	0	0,00%	χ^2:1,12
	(-)	62	96,90%	35	100,00%	p=0,291
Hemodialysis	**(+)**	6	9,40%	4	11,40%	χ^2:0,11
	(-)	58	90,60%	31	88,60%	p=0,746

IABP: Intraaortic Balloon Pump

Two patients in the UF (-) group required revision due to bleeding, one died due to uncontrolled bleeding, and two died early due to low cardiac output. Hemodialysis became necessary in both patients with low cardiac output. There was no early revision or mortality in the UF (+) group.

Postoperative data:

Three patients in the UF (-) group had SVO, (4%), two patients with COPD experienced delayed extubation, two patients had saphenous harvested leg wound infection, one patient had pleural effusion, and one patient had sternal dehiscence. however, it did not need revision and was followed with a corset. In the UF (+) group, wound site infection developed in the saphenous region in three patients and on the sternum in one patient, and wound site revision was performed in four patients.

When considering the causes of late mortality, one patient in the UF (-) group died before he could reach our center due to rupture of abdominal aortic aneurysm, and one patient died due to malignancy. Late mortality in the UF (+) group was also due to malignancy (Table 4).

Table 4 : Postoperative follow-up

		UF (-)		UF (+)		
Revision due to						
Bleeding or Infection	**(+)**	2	3,10%	0	0,00%	χ^2:1,12
	(-)	62	96,90%	35	100,00%	p=0,291
Permanent Hemodialysis	**(+)**	5	7,90%	2	5,70%	χ^2:0,17
	(-)	58	92,10%	33	94,30%	p=0,682
Postoperative	**(+)**	9	14,10%	4	11,40%	χ^2:0,14
Complication	**(-)**	55	85,90%	31	88,60%	p=0,711
Postoperative	**(+)**	18	28,10%	5	14,30%	χ^2:2,43
Arythmia	**(-)**	46	71,90%	30	85,70%	p=0,119
Early Mortality	**(+)**	3	4,70%	0	0,00%	χ^2:1,69
	(-)	61	95,30%	35	100,00%	p=0,193
Late Mortality	**(+)**	2	3,10%	1	2,90%	χ^2:0,01
	(-)	62	96,90%	34	97,10%	p=0,941
POARF	**(+)**	10	15,60%	4	11,40%	χ^2:0,33
	(-)	54	84,40%	31	88,60%	p=0,567

POARF: Postoperative Acute Renal Failure

Discussion

Advances in surgical techniques and postoperative care have made it possible to obtain better and satisfactory surgical results in patients with risk factors such as advanced age, organ dysfunction, and recurrent surgery (7). Renal dysfunction is one of these risk factors that affects surgical morbidity and mortality. and coronary artery disease, it originates from many etiological factors, but also plays a role in the pathogenesis of CAD on its own (8,9). It has been shown that the decrease in glomerular filtration rate (GFR) is associated with both CAD risk factors and CAD clinic directly. In fact, the indicative effect of this reduction on mortality has been proven to be greater than that of LVEF (10). The HOPE study, Cardiovascular Health Study (CHS), Hypertension Optimal Treatment (HOT) study, Framingham and Framingham Offspring studies, and Atherosclerosis Risk In Communities (ARIC) studies have shown that blood pressure and total cholesterol are higher in individuals with low GFR, and left ventricular hypertrophy, diabetes, heart failure seem to be higher than in the normal population as in our study. As a result of a study conducted in 16.429 patients, it emerges as a risk factor on its own that causes significant deterioration in renal functions after cardiac surgery (10-13).

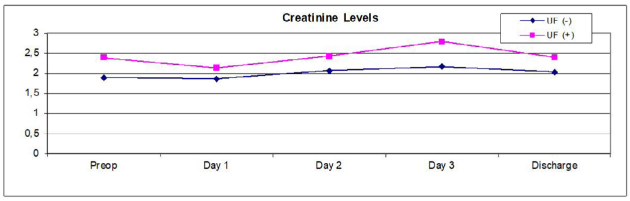
The incidence of acute renal failure (ARF) requiring dialysis after open heart surgery is relatively low in the normal population (1-5%), but mortality is high, ranging from 60 to 90% (14). The etiology of acute renal failure is multifactorial, and the decrease in renal perfusion after CPB is due to advanced age, pre-existing renal failure, left ventricular failure, long-term use of diuretic drugs. It consists of factors such as inability to compensate, prolonged cross-clamp time, and lower mean perfusion pressure during cardiopulmonary bypass (CPB) compared to preoperative value (15). CPB duration was not a significant risk factor for ARF development; it was thought to have an effect, but only after surgery. The use of vasoconstrictor and inotropic agents is a significant ARF factor (16).

Numerous treatment studies have been conducted on the effect of ARF on surgical success once it has occurred, but controversial results of treatment strategies have resulted in many studies focusing on the pathogenic basis of postoperative renal dysfunction and efforts to prevent it before it occurs. First time in 1968 after the valve replacement was performed by de Lansig et al. in a patient with CRF, patients with end-stage renal disease (ESRD) with high mortality and morbidity and intensive care costs were the common point of the studies for a long time, however, the incidence in the community is now many times higher than the ESRD group. Being able to perform open heart surgery without complications in the patient group with renal failure has become one of the conditions of being a qualified surgery center.

Creatinine was generally used as an indicator in the calculation of presurgical risk, and it was reported that even an increase in serum level in the range of 1.2-

1.9 mg/dl is an independent indicator. An increase of 50% or 0.5 mg/dl in creatinine was accepted as an indicator of kidney damage (17). Although we were able to form similar groups, the UF (+) group achieved similar postoperative results with the UF (-) group, but the UF (+) group differed in terms of risk factors such as obesity, diabetes, family history (p<0.05) and preoperative creatinine levels. That can be considered that this ultrafiltration was beneficial in this group of patients. It is interesting that renal functions were similarly preserved, especially considering a possible underlying diabetic nephropathy. When the creatinine curves were examined, it was determined that relatively higher creatinine levels were achieved in the UF (+) group, a peak was experienced on the 2nd postoperative day, but it returned to preoperative values during discharge. On the other hand, although it was not statistically significant in the UF (-) group, a slight upward trend in creatinine would be noticed. (Table 5)

Table 5 : Creatinine Levels



Following the definition and widespread acceptance of all of these risk factors, the primary goal has been to eliminate these risk factors while effectively managing those that cannot be eliminated. Several strategies have been proposed to protect postoperative renal functions in patients with compensated renal failure, slow disease progression, and provide surgical outcomes comparable to the normal population. With the benefits of a beating heart (BH), surgery appeared to be a good choice at first. Antonino Roscitano et al. reported that adding venovenous hemofiltration to a surgery performed in BH preserves postoperative renal functions (18). Although hemofiltration has been used for a long time to conserve blood and reduce the need for transfusion after it was first used in routine use in 1985, it has always been interesting because of its effect on plasma mediators. Satish Das and Joel Dunning reviewed 273 studies on hemofiltration and compiled 9 of them and said that hemofiltration reduces the need for post-operative transfusion and many inflammation mediators, increases cardiac index and blood pressure, but does not cause significant changes in mortality and morbidity (19). In order to suppress the immune response that occurs during CPB, an experimental study was also conducted by Ziegeler et al. (20).

In the light of this information, we investigated in this study; the indirect and direct effects of conventional ultrafiltration used during CPB on mortality and morbidity, particularly on renal functions, in a patient group that has received little attention until today. Despite the fact that we were able to form similar groups, the UF (+) group had similar postoperative results as the UF (-) group, but UF (+) group differed in terms of risk factors such as obesity, diabetes, family history (p<0.05), and preoperative creatinine elevation. It is interesting that renal functions were preserved similarly, especially given the possibility of underlying diabetic nephropathy. When the creatinine curves were examined, the UF (+) group had relatively higher creatinine levels; a peak was observed on the second postoperative day, but it returned to preoperative levels upon discharge. In the UF (-) group, however, a slight upward trend in creatinine was observed, but it was not statistically significant.

When the perioperative fluid dynamics were compared, the UF (-) group received less transfusion as a blood product, but more erythrocyte suspension was required, whereas the UF (+) group was mostly supplemented with fresh frozen plasma. Although the operation was performed with higher hematocrit values, the UF (-) group had lower postoperative hematocrit values despite receiving more erythrocyte suspension (p<0.05), confirming the effect of ultrafiltration on hematocrit. Although the UF (+) group seems to be behind in terms of perioperative fluid intake and output, when the values are carefully examined, it will be seen that the urine output never falls below the oliguria limit during CPB. Accordingly, in the UF (-) group, it is necessary to give more fluids and use more diuretics both during the operation and in the postoperative care in order to ensure urine output, and even in the UF (+) group, a peak diuretic use is observed on the 2nd postoperative day compared to the constantly decreasing diuretic amount. It will be understood that it is far from being beneficial for the patient when it is remembered that furosemide provides an increase in urine output, but does not reduce the incidence of kidney damage and kidney dysfunction after cardiac surgery. (21-24) It should not be forgotten that a well-balanced fluid regimen and diuresis are more beneficial to renal functions. There was no significant difference between the groups or between operations performed with and without cross-clamping in 11 operations performed without cross-clamping but with CPB support.

The amount of drainage was low in the UF (+) group (p<0.05), and there were no patients who underwent revision due to bleeding. When the diuretic regimens of the patients were examined, the amount of diuretic used in the UF (+) group decreased day by day, but urine output reached the required level. Again, when the nephrotoxic effects of inotropic and vasoconstrictor agents are remembered, it should be noted that the need for inotropic support is clearly reduced by ultrafiltration (p<0.05). The need for more inotropic agents is consistent with the knowledge that ultrafiltration improves cardiac performance. It should not be overlooked that postoperative complications (late extubation, pleural effusion) that are remarkable in COPD patients who already have an increased mortality and morbidity are experienced significantly more in the UF (-) group. The cleansing effect of ultrafiltration on immune-active mediators appears in a lung-protective way with the fluid balance it provides here. The fact that all 3 cerebrovascular events occurred in the absence of carotid surgery in the UF (-) group is another interesting outcome, and it was thought to have been caused by the technical difference between the side clamp and the single cross clamp, rather than ultrafiltration. Although there was no significant difference between the two techniques in terms of the development of postoperative anuria, it was observed that a higher percentage of patients had acute renal failure in the UF (-) group.

Conclusion

In patients like our study group who are obese, diabetic, have COPD and a family history of vascular disease, have high blood creatinine and urea values, have a recent myocardial infarction and congestive heart failure, lower ejection fraction, and the accompanying additional procedures; a simple ultrafiltration applied with CPB provides a more comfortable postoperative follow-up with easier perioperative fluid management. It is clear that by this method less inotropic and diuretic agent use, and relatively lower complication rates can be achieved without putting any additional burden on the patient and the surgical team. Considering all these benefits of ultrafiltration; it is a simple application that will benefit every patient in the risk group without increasing the cost of surgery.

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