Results after early haemofiltration for acute renal failure after cardiac surgery

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Summary

Background: Acute renal failure (ARF) remains a significant cause of mortality after cardiac surgery.
Aim: The aim of this study was to present our data with continuous venovenous haemofiltration (CVVH) in patients with ARF.
Methods: 1136 consecutive patients (pts) who underwent adult cardiac surgical procedures performed between January 2004 and June 2005 were audited. Out of these, 32 patients required CVVH due to acute renal failure. Mean age in this group was 69±10 years. There were 27 males and 5 females with an average Euroscore of 7±3.5. Mean ejection fraction was 51±10%. All patients were in New York Heart Association (NYHA) class II. Twelve patients had preoperative renal insufficiency. Indication for surgery was coronary artery disease (CAD) in 23 patients, ascending aortic aneurysm in 4 and the remaining 5 patients had valvular heart disease requiring valve replacement.
Results: Hospital mortality in the 32 patients who developed ARF and required CVVH was 41% (13/32) with overall 1.1% mortality associated with ARF. Cause of death was multi-organ failure in ten patients, postoperative myocardial infarction in 2 patients and sepsis in one. Mean time between operation and initiation of CVVH was 1.2±0.2 days. Mean duration of CVVH was 4.32±1.8 days.
Conclusion: Early and aggressive CVVH is associated with better than expected survival in severe ARF after cardiac operations.
Key words: cardiosurgery, acute renal failure, haemofiltration, multi-organ failure.

Streszczenie

Wstęp: Ostra niewydolność nerek (ARF) wciąż pozostaje poważną przyczyną zgonów u pacjentów poddanych operacjom kardiochirurgicznym.
Cel: Celem tej pracy jest przedstawienie wyników leczenia ARF u pacjentów operowanych w Klinice Kardiochirurgii CSK MSWiA w Warszawie za pomocą ciągłej hemodiafiltracji żylno-żylnej (CVVH).
Metoda: Między styczniem 2004 a czerwcem 2005 r. w Klinice operowano 1136 pacjentów, 32 chorych wymagało CVVH z powodu ARF. Średni wiek pacjentów wyniósł 69±10 lat. Wśród pacjentów było 27 mężczyzn i 5 kobiet, średni Euroscore wyniósł 7±3,5, średni EF wyniósł 51±10%. Wszyscy byli w klasie NYHA II, 12 pacjentów miało rozpoznaną przedoperacyjnie przewlekłą niewydolność nerek. Wskazaniem do operacji była choroba wieńcowa (23 pacjentów), tętniak aorty wstępującej (4), wady zastawkowe (5).
Wyniki: Śmiertelność szpitalna wśród pacjentów z ARF, u których wykonywano CVVH, wyniosła 41% (13/32). Najczęstszą przyczyną zgonów były: niewydolność wielonarządowa (10 pacjentów), zawał okołooperacyjny (2), wstrząs septyczny (1). Średni czas po operacji do momentu włączenia CVVH wyniósł 1,2±0,2 dnia. Średni czas trwania cykli CVVH wyniósł 4,32±1,8 dnia.
Wnioski: Wczesne zastosowanie CVVH u pacjentów z ARF po operacjach kardiochirurgicznych wiąże się z lepszą przeżywalnością.
Słowa kluczowe: kardiochirurgia, ostra niewydolność nerek, hemofiltracja, niewydolność wielonarządowa.

Introduction

Acute renal failure (ARF) is still a major complication after cardiac surgery and is associated with very high mortality [1-6]. In recent years, continuous renal replacement techniques have been introduced, which circumvent the haemodynamic instability associated with intermittent haemodialysis and its limited ability to control patients' volume status [7]. One such form of continuous renal replacement therapy is continuous venovenous haemofiltration (CVVH). Its application is, however, still under debate because the procedure is very costly. Furthermore, the indication as well as the timing of CVVH still need to be defined. In addition, there is no algorithm to predict which patients will benefit most from such intensive therapy to use it rationally [8].

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Bent and co-workers reported a mortality rate of 40% in ARF patients treated with CVVH [9]. Thus, outcome prediction and choice and effect of renal replacement therapy after cardiac surgical procedures remain poorly defined and yet important issues in the postoperative management of patients undergoing heart operations.

This retrospective study was undertaken to summarize our experiences with CVVH.

Materials and methods

An audit of 1136 consecutive patients who underwent adult cardiac surgical procedures conducted between January 2004 and June 2005 was performed. Out of these, there were 32 patients requiring renal supportive intervention. Mean age in this group was 69±10 years. There were 27 males and 5 females with an average Euroscore of 7±3.5. Mean ejection fraction was 51±10%. Twelve patients had preoperative renal insufficiency. Nine patients had diabetes type II. All patients were in New York Heart Association (NYHA) class II. Patients with coronary artery disease had a mean preoperative Canadian Coronary Score (CCS) of 2.2. Indication for surgery was CAD in 23 patients, ascending aortic aneurysm in 4 and the remaining 5 patients had valvular heart disease requiring valve replacement. Patients' demographics and clinical characteristics are presented in table I. All patients received CVVH treatment when urine output was less than 100 ml within 8 hours consecutively after surgery despite furosemide and mannitol infusion. Levels of serum creatinine and potassium were not taken into account.

The technique of CVVH consists of a double lumen catheter that is used to pump blood through a module (Prisma, Gambro AS, Denmark) containing pressure alarms and an air bubble trap. The blood flow rate is kept at 200 to 250 mL/m. Ultrafiltration is pump controlled at 2 L/h. Replacement fluid is administered prefilter at a dynamically adjusted rate chosen to achieve the desired fluid therapy goals for any time period. Anticoagulation of the circuit is carried out according to clinical judgement and circuit duration. In this study, all patients received only low-dose (300-500 IU/h) heparin therapy.

Tab. I. Clinical and demographic characteristics of patients (n=32)

Age (years)	69±10
Sex (M/F)	27/5
Angina Status (CCS) CCS 3 CCS 4	 10 (31%) 2 (6.2%)
Dyspnoea Status (NYHA) NYHA III NYHA IV	 7 (21%) 0 (0%)
Preop creatinine (mmol/l)	152.8±66.0
Preop urea (mmol/l)	12.5±5.8
Type of Surgery CABG only Aortic surgery Valve replacement	 23 (72%) 4 (12.5%) 5 (15.5%)

CABG – coronary artery bypass grafting

Results

Hospital mortality in the 32 patients who developed ARF and required CVVH was 41% (13/32) with overall 1.1% mortality associated with ARF. Intra- and postoperative variables are presented in table II. Coronary artery bypass grafting (CABG) using extracorporeal circulation was performed in 15 patients and the remaining 5 pts had off-pump CABG surgery. Replacement of the ascending aorta was performed in 4 patients, of which 2 procedures were done in profound hypothermic circulatory arrest. Three patients had mechanical valve replacement of the aortic valve and 2 patients had mechanical mitral valve replacement. Cause of death was multi-organ failure in ten patients, postoperative myocardial infarction in 2 patients and sepsis in one. Five patients required a tracheostomy due to prolonged mechanical ventilation support. Mean time between operation and initiation of CVVH was 1.2±0.2 days and mean duration of CVVH was 4.32±1.8 days. Volume removal during the CVVH cycle was adjusted according to patients' weight and filling pressure. Mean duration of ICU stay was 11.5 days and mean duration of hospital stay was 20.8 days. All surviving patients recovered enough renal function to discontinue haemofiltration during their hospital stay.

Discussion

Postoperative development of acute renal failure after cardiac operations has adverse prognostic significance and itself increases the risk of death [10, 11]. Advanced age, pre-existing renal insufficiency, preoperative left ventricular dysfunction, low cardiac output in the perioperative period and duration of cardiopulmonary bypass (CPB) are just some of the factors that contribute to renal failure in the postoperative period. In fact, most patients with severe ARF requiring haemofiltration therapy continue to deteriorate and require more intensive care [12]. Many of these patients develop multi-organ failure, require mechanical ventilation,

Tab. II. Intra- and postoperative variables (n=32)

Mean CPB time (min)	54.2±12.5
Mean aortic cross-clamp time (min)	32.7±8.9
Inotropy requirement	23 (72%)
IAPB	4 (12,5%)
Tracheostoma	5 (16 %)
Mean ICU stay (days)	11.5±5.3
Mean hospital stay (days)	20.8±4.2

CPB – cardiopulmonary bypass time, IAPB – intra-aortic balloon, ICU – intensive care unit

intraaortic balloon counterpulsation, and the continuous administration of inotropic and vasopressor drugs. In this patient cohort, mortality has remained as high as 70%, despite the aggressive use of intermittent haemodyalisis.

There are several potential explanations for such high mortality. Transient endotoxemia in patients undergoing surgery involving CPB has been widely accepted to be a major stimulus for the development of systemic inflammatory response syndrome (SIRS) [13]. The endotoxemia associated with cardiac surgery is thought to be dominantly influenced by the use of CPB [14, 15]. However, the pathogenesis involved in this phenomenon is still not entirely clear. Studies have also shown the haemodynamic changes during different stages of the operation. Decrease in cardiac output might likely lead to a reduction of vital organ perfusion [16]. Whether or not multiple organ failure is the result of poor balance in proinflammatory and anti-inflammatory cytokine production in these conditions has not been proven.

Continuous renal replacement techniques offer continuous and steady fluid removal and uremic toxin clearance. Their intensity can easily be titrated to prevent or rapidly treat volume overload. CVVH is also useful in right heart failure because it reduces preload and may therefore be particularly useful in patients with valvular heart disease and in patients after heart transplantation. A series of studies revealed that haemofiltration improves heart and lung functions in patients with ARF and cardiac shock after heart surgery. This may reduce the need for inotropic support, which also contributes to patient survival [17, 18]. Furthermore, continuous removal of waste products also ensures minimization of the adverse immunologic and proinflammatory effects of uremia. Myocardial depressant factors may be removed, myocardial performance improved and nutrition optimized [8, 19, 20].

However, in-hospital mortality has remained at a high percentage despite these beneficial effects of this method. Hospital mortality rate was reported to be as high as 52% in a study by Alarabi, 80% by Baudouin and 40% by Bent [9, 21, 22]. They advocated early and aggressive CVVH after cardiac surgery, but apparently they waited for the development of full-blown renal failure findings and then aggressively performed CVVH. Recognition of renal failure after cardiac surgery may take time when classical recognition parameters are used, and new parameters for early recognition of renal failure after cardiac procedures may help in avoiding this high mortality. We performed CVVH when urine output was less than 100 ml in 8 hours. With this criterion, renal failure could easily be recognized and CVVH could be implemented as soon as possible.

In this retrospective study we demonstrated that the incidence and survival from ARF after cardiopulmonary bypass have improved with the implementation of CVVH at an early stage. Being a retrospective study, there were several limiting factors that should be taken into consideration when interpreting our results. As with most advances in critical care medicine, there seems to be a sequence of events probably influencing the survival rate rather than isolated phenomena. Furthermore the number of patients in our study was relatively small.

In conclusion, CVVH is an excellent technique in patients with acute renal failure after cardiac surgery. Most importantly, early recognition of ARF and early initiation of renal replacement therapy are of paramount importance. The sooner ARF after cardiac surgery is recognized, the greater are the chances of reducing hospital mortality.

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