Continuous renal replacement therapy in a post-bentall procedure patient complicated by sepsis and acute kidney injury: A case report

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SUMMARY

Background: Acute kidney injury (AKI) frequently complicates major cardiac surgery and is associated with significant morbidity and mortality. In complex aortic procedures such as the Bentall operation, the risk is further amplified by prolonged cardiopulmonary bypass, systemic inflammation, and postoperative hemodynamic fluctuations. When septic shock develops early after surgery and renal disfunction may progress rapidly, the likelihood of Kidney Disease: Improving Global Outcomes (KDIGO) stage 3 AKI requiring renal replacement therapy increases substantially. Continuous renal replacement therapy (CRRT) provides gradual solute removal and hemodynamic stability, making it preferable in unstable postoperative patients. Case Presentation: A 58-year-old female underwent a Bentall procedure for an ascending aortic aneurysm with severe aortic regurgitation. On postoperative day three, she developed early septic shock complicated by rapidly progressive acute kidney injury requiring continuous renal replacement therapy. Due to hemodynamic instability and metabolic derangement, CRRT was initiated, resulting in stabilization of the patient's metabolic status, improvement in hemodynamics, and gradual recovery of renal function. The patient ultimately regained kidney function and was discharged without the need for ongoing renal replacement therapy. Conclusions: This case demonstrates the successful early use of CRRT in septic shock–associated AKI following a Bentall procedure. Key novel aspects include the complexity of postoperative hemodynamics, feasibility of CRRT soon after major aortic surgery, and rapid renal recovery despite severe AKI. Individualized CRRT prescription and careful hemodynamic guidance were crucial for ensuring safety and metabolic control.

INTRODUCTION

Cardiac surgery–associated acute kidney injury (CSA-AKI) remains a major postoperative complication and significantly contributes to morbidity, mortality, and prolonged hospital stay.[1,2]

The incidence of CSA-AKI varies depending on the type and complexity of surgery, patient comorbidities, and perioperative factors, but it frequently affects a substantial proportion of patients undergoing major cardiac procedures.[1,2] Complex aortic root surgeries, including the Bentall operation, are particularly associated with higher risk due to prolonged cardiopulmonary bypass duration, ischemia-reperfusion injury, and heightened inflammatory response.[1,2]

The superimposition of sepsis further amplifies the risk and severity of AKI by introducing additional inflammatory and hemodynamic insults.[3,4] Sepsis-associated vasodilation, endothelial dysfunction, and microcirculatory disturbances compromise renal perfusion and exacerbate tubular injury.[3,4] In advanced stages of AKI, especially when accompanied by hemodynamic instability or refractory metabolic derangement, renal replacement therapy becomes a critical component of supportive management.[2,4]

Continuous renal replacement therapy has emerged as the modality of choice in critically ill patients with unstable hemodynamics.[3,4] Unlike intermittent hemodialysis, CRRT facilitates slow and continuous solute clearance and fluid removal, reducing the risk of abrupt shifts in intravascular volume and osmolarity.[3,4] Furthermore, the use of regional citrate anticoagulation has gained prominence because of its favorable bleeding profile and ability to prolong filter lifespan, which is particularly advantageous in the postoperative cardiac surgery setting.[4,5]

This report presents a rare and complex case characterized by the development of early fulminant septic shock and KDIGO stage 3 AKI within the first three postoperative days following a Bentall procedure, necessitating early initiation of continuous renal replacement therapy, highlighting unique hemodynamic challenges, individualized prescription strategies, and comparison with existing CRRT literature.

CASE PRESENTATION

A 58-year-old female with a history of hypertension and bicuspid aortic valve disease was admitted for elective surgical correction of an ascending aortic aneurysm with severe aortic regurgitation. Preoperative evaluation showed stable renal function with a serum creatinine level of 0.97 mg/dL and estimated glomerular filtration rate of 82 mL/min/1.73 m². There was no prior history of chronic kidney disease.

The patient underwent a Bentall procedure with composite graft replacement using a mechanical valved conduit. Cardiopulmonary bypass lasted 185 minutes, and aortic

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Table I: Hemodynamic and Renal Parameter Trends From POD-1 to POD-11

POD	MAP (mmHg)	NE (µg/kg/min)	UO (mL/h)	K^+ (mmol/L)	Creatinine (mg/dL)
1–2	65–70	0.00	50–60	3.8	0.97
3–4	70–75	0.05	20–30	6.1	4.2
5–6	72–80	0.03	150	4.5	3.9
7–8	68–70	0.02	50–80	3.3	2.8
9	70–75	0.01	30–50	3.1	3.8
10	75–80	0.00	80–100	4.1	2.5
11	70–75	0.00	70–80	4.0	2.9

MAP = mean arterial pressure; NE = norepinephrine; UO = urine output; K^+ = potassium.

Table II: Renal and Hemodynamic Response After CRRT

Parameter	Pre-CRRT	24 h	72 h
MAP (mmHg)	65	72	75
UO (mL/h)	20	50	80
K^+ (mmol/L)	6.1	4.5	3.9
Creatinine (mg/dL)	4.2	3.6	2.8
CRP (mg/L)	50.49	27.5	18.5
PCT (ng/mL)	5.2	3.9	2.4

CRP = C-reactive protein; PCT = procalcitonin.

Table III: CRRT Prescription

Variable	Value
Mode	CVVHDF
Blood flow rate	100–120 mL/min
Dialysate flow	800 mL/h
Replacement fluid	500 mL/h pre-filter + 200 mL/h post-filter
Net ultrafiltration	50 mL/h
Effluent dose	25–30 mL/kg/h
Anticoagulation	Regional citrate anticoagulation
Filter lifespan	>48 h

Table IV: Antimicrobal therapy timeline

Day	Antibiotic	Dose	Rationale
POD 3	Meropenem	Standard	Empirical therapy for septic shock
POD 3	Levofloxacin	Standard	Empirical dual coverage
POD 4	Meropenem discontinued	—	Culture result
POD 4	Levofloxacin discontinued	—	Culture result
POD 4 → onward	Amikacin	1 g/day	Susceptibility-guided targeted therapy

cross-clamp time was 140 minutes. The intraoperative period was uneventful, and transfusion requirements were minimal. Postoperatively, she was transferred to the intensive care unit and initially maintained stable hemodynamics on low-dose norepinephrine, which was successfully weaned within 24 hours.

On postoperative day three, the patient developed high-grade fever, tachycardia, and hypotension despite fluid resuscitation and requiring norepinephrine. Urine output progressively declined to less than 0.3 mL/kg/h, and biochemical analysis revealed leukocytosis, elevated lactate, hyperkalemia, metabolic acidosis, and a significant rise in serum creatinine to 4.2 mg/dL. Chest imaging demonstrated a new right basal infiltrate, and blood cultures grew Klebsiella pneumoniae. A diagnosis of septic shock complicated by KDIGO stage 3 AKI was established.

Given the hemodynamic instability and progressive metabolic derangements, CRRT was initiated using Continuous Veno-Venous Hemodiafiltration (CVVHDF) mode, QB: 100–120 mL/min, dialysate: 800 mL/h, replacement: 500 mL/h pre-filter + 200 mL/h post-filter, net UF: 50 mL/h, effluent dose: 25–30 mL/kg/h, filter life: >48 hours, no clotting. Vascular access was achieved via a right femoral double-lumen catheter. Regional citrate anticoagulation was employed with continuous monitoring of systemic and post-filter ionized calcium levels.

Fluid balance was initially maintained at a neutral to slightly positive level to ensure adequate perfusion, then gradually transitioned to a negative balance as cardiovascular stability improved. No episodes of intradialytic hypotension occurred, and filter lifespan averaged 52 hours.

After seven days of CRRT, vasopressor support was discontinued, metabolic parameters stabilized, and urine

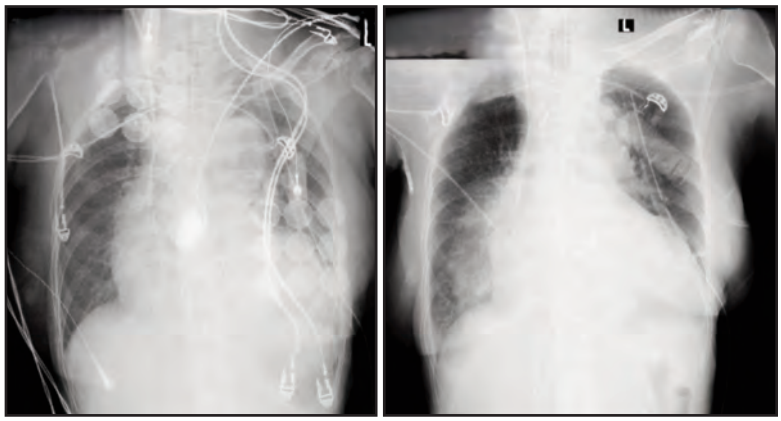

Fig. 1: Chest X-ray on postoperative day (POD) 1 (left) and POD 3 (right) demonstrating progressive radiographic features consistent with pneumonia

output progressively improved. The patient was transitioned to sustained low-efficiency dialysis for two sessions before complete discontinuation. Renal function showed steady recoverywith stable hemodynamics and satisfactory urine output.

DISCUSSION

This case illustrates the convergence of CSA-AKI and septic shock early after a Bentall procedure-an uncommon but devastating clinical scenario driven by prolonged bypass time, systemic inflammation, vasopressor use, and sepsis-related microcirculatory impairment. The Bentall procedure, originally described by Bentall and De Bono, is a complex aortic root replacement technique, and despite improved early survival, postoperative morbidity remains substantial, particularly in patients who develop AKI and septic shock.[6]

CSA-AKI and Sepsis Interaction

AKI after cardiac surgery is associated with worse short- and long-term outcomes, including increased mortality and prolonged hospitalization.[1,2] Sepsis acts as an independent contributor to renal dysfunction by intensifying systemic inflammation, causing microcirculatory failure, and promoting renal hypoperfusion.[3,4] This dual insult significantly increases the severity of kidney injury and the likelihood of requiring RRT. In our case, inflammatory markers were available, and both CRP and procalcitonin (PCT) demonstrated a decline following CRRT initiation, indicating attenuation of systemic inflammation during treatment. This trend aligns with findings from Wu et al., who reported that CRRT significantly reduced inflammatory mediators in sepsis-associated AKI. Specifically, CRP levels decreased in two treatment groups after CRRT.[7]

Choice of RRT Modality

In this patient, CRRT was favored due to vasopressor-dependent shock and the need for gradual solute and fluid management.[3,4] Although studies demonstrate comparable mortality between intermittent and continuous modalities, CRRT offers superior hemodynamic tolerance and more controlled metabolic correction, which is critical in unstable postoperative patients.[3,4]

Anticoagulation Strategy

Regional citrate anticoagulation provided several advantages. By chelating calcium within the extracorporeal circuit, RCA prevented clot formation while minimizing systemic anticoagulation effects.[4,5] This approach significantly reduced bleeding risk and prolonged filter lifespan, which is especially relevant in patients shortly after major cardiac surgery where surgical sites remain vulnerable to hemorrhage.[4,5]

The observed filter lifespan of 52 hours in our case aligns with previously reported benefits of RCA in critically ill populations, supporting its use as a first-line anticoagulation strategy during CRRT.

Dose and Fluid Strategy

An effluent dose of 20–25 mL/kg/h has been widely accepted as adequate for achieving metabolic control without increasing adverse effects.[3,4] In this patient, the chosen dose effectively corrected hyperkalemia and metabolic acidosis while maintaining cardiovascular stability. The fluid strategy was tailored to evolving hemodynamics, ensuring optimal tissue perfusion without precipitating volume overload or hypoperfusion. The randomized controlled trial by Park et al. demonstrated that although BIA(bioimpedance analysis)-guided ultrafiltration achieved higher nominal fluid removal than conventional strategies, it did not improve target volume reduction or clinical outcomes.8 These findings suggest that, in sepsis-associated AKI, hemodynamic stability and infection control may be more critical determinants of outcome than the degree of fluid removal alone.

Timing CRRT

In our case, early CRRT was initiated during significant metabolic and hemodynamic instability, resulting in prompt correction of acidosis, hyperkalemia, and improved perfusion. This favorable response supports the concept that timely CRRT may attenuate ongoing renal injury driven by inflammation and fluid imbalance, indicating potential value in earlier initiation among high-risk septic patients. The CRTSAKI Study, highlighted the persistent uncertainty regarding optimal CRRT timing in sepsis-associated AKI, noting that early renal injury may still be reversible and that intervention prior to advanced tubular damage could offer clinical benefit.[9]

Clinical Implications

This case reinforces several practical lessons:

- CRRT is particularly beneficial in hemodynamically unstable postoperative cardiac surgery patients with septic shock and severe AKI and Early fulminant septic shock and KDIGO stage 3 AKI occurring shortly after a Bentall procedure, a scenario rarely reported.
- Regional citrate anticoagulation reduces bleeding risk and prolongs filter life, enhancing safety and efficiency.
- An effluent dose of 20–25 mL/kg/h provides effective metabolic control without unnecessary complications.
- Individualized fluid balance management is essential for optimizing renal recovery and hemodynamic stability.
- Rapid renal recovery despite severe sepsis-associated AKI.

CONCLUSIONS

CRRT was safe and effective in this Bentall patient with SA-AKI and hemodynamic instability. Individualized prescription, careful monitoring, and early initiation allowed metabolic stabilization and renal recovery. This case provides unique clinical insights for managing complex postoperative patients not represented in major CRRT trials.

INFORMED CONSENT

Written informed consent was obtained from the patient for publication of this case report and any accompanying data.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

REFERENCES

1. Wang X, Bao R, Lan Y, Zhao Z, Yang X, Wang Y, Quan Z, Wang J, Bian J. The incidence, risk factors, and prognosis of acute kidney injury in patients after cardiac surgery. Front Cardiovasc Med. 2024; 11: 1396889.
2. Duplechin MO, Folds GT, Duplechin DP, Ahmadzadeh S, Myers SH, Shekoohi S, et al. Prevention and management of perioperative acute kidney injury: a narrative review. Diseases. 2025; 13(9): 295.
3. Evans L, Rhodes A, Alhazzani W, Antonelli M, Coopersmith CM, French C, et al. Surviving sepsis campaign: international guidelines for management of sepsis and septic shock 2021. Intensive Care Med. 2021; 47(11): 1181-247.
4. Kidney Disease: Improving Global Outcomes (KDIGO) Acute Kidney Injury Work Group. KDIGO clinical practice guideline for acute kidney injury. Kidney Int. (2012).
5. Jacobs R, Verbrugghe W, Dams K, Roelant E, Couttenye MM, Devroey D, et al. Regional citrate anticoagulation in continuous renal replacement therapy: is metabolic fear the enemy of logic? A systematic review and meta-analysis of randomised controlled trials. Life (Basel). 2023; 13(5): 1198.
6. Al-Mudhaffar SS, Alwan A, Ouj R, et al. Bentall procedure as a lifesaving surgery: a single center experience. Med Int (Lond). 2023; 3(1): 8.
7. Wu S, Xu T, Wu C, Lei X, Tian X. Continuous renal replacement therapy in sepsis-associated acute kidney injury: Effects on inflammatory mediators and coagulation function. Asian J Surg. 2021; 44(10): 1254-9.
8. Park CH, Koh HB, Lee JH, Jung HY, Ha J, Kim HW, Park JT, Han SH, Kang SW, Yoo TH. Volume control strategy and patient survival in sepsis-associated acute kidney injury receiving continuous renal replacement therapy: a randomized controlled trial with secondary analysis. Sci Rep. 2024; 14(1): 14284.
9. Chen WY, Cai LH, Zhang ZH, Tao LL, Wen YC, Li ZB, Li L, Ling Y, Li JW, Xing R, Liu XY, Lin ZD, Deng ZT, Wang SH, Lin QH, Zhou DR, He ZJ, Xiong XM. The timing of continuous renal replacement therapy initiation in sepsis-associated acute kidney injury in the intensive care unit: the CRTSAKI Study (Continuous RRT Timing in Sepsis-associated AKI in ICU): study protocol for a multicentre, randomised controlled trial. BMJ Open. 2021; 11(2): e040718.