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Recurrent Accelerated Hypertension Better Managed by Continuous Ambulatory Peritoneal Dialysis: A Case Series of Three Patients

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Abstract

Aims and Objectives: To highlight the role of continuous ambulatory peritoneal dialysis (CAPD) in controlling recurrent accelerated hypertension in end-stage renal disease (ESRD) patients who remain hypertensive despite optimal medical management and adequate volume control on maintenance haemodialysis (MHD).

Materials and Methods: A retrospective analysis of three ESRD patients with recurrent accelerated hypertension on MHD at our center was conducted. Clinical profiles, comorbidities, antihypertensive regimens, dialysis details, and outcomes following transition to CAPD were reviewed. Patients were followed up for a minimum period of six months post-CAPD initiation.

Results: Case 1: A 48-year-old male with type 2 diabetes mellitus, hypertension, and ESRD on twice-weekly MHD since April 2023 developed multiple episodes of accelerated hypertension with left ventricular failure (LVF) requiring ICU admissions despite intensified dialysis and maximal antihypertensive therapy. Following CAPD initiation in September 2023, hypertensive crises reduced to two in the first month and were absent thereafter. Pill burden decreased from five to two agents. Case 2: A 32-year-old female with long-

standing hypertension and ESRD, initiated on MHD in January 2024, experienced recurrent accelerated hypertension and LVF despite thrice-weekly HD and maximal antihypertensive therapy. After CAPD initiation in April 2024, no further episodes occurred and pill burden decreased from four to one. Case 3: An 18-year-old female with focal segmental glomerulosclerosis (FSGS) on twice-weekly MHD for two years was switched to CAPD due to vascular access failure. Hypertension, previously sub-optimally controlled, improved significantly without escalation of antihypertensive therapy.

Conclusion: CAPD provided rapid and sustained blood pressure control in ESRD patients with refractory hypertension on MHD, including those with recurrent LVF and those with vascular access issues. CAPD should be considered as a viable alternative modality in similar challenging cases. Further studies with larger cohorts are needed to establish its efficacy.

Keywords: Accelerated hypertension, ESRD, CAPD, haemodialysis, refractory hypertension, heart failure, peritoneal dialysis, focal segmental glomerulosclerosis

Introduction

Hypertension is highly prevalent among patients with end-stage renal disease (ESRD), affecting 70-90% of those undergoing dialysis.[1,2] It represents a significant cardiovascular risk factor and contributes substantially to morbidity and mortality in this population. Despite the availability of multiple antihypertensive agents and dialysis modalities, achieving adequate blood pressure (BP) control remains a formidable challenge in many ESRD patients.

Accelerated hypertension, characterized by severely elevated BP with evidence of acute target organ damage, poses particular management difficulties. In patients on maintenance haemodialysis (MHD), several factors contribute to resistant hypertension, including volume overload between dialysis sessions, activation of the renin-angiotensin-aldosterone system (RAAS), sympathetic nervous system hyperactivity, endothelial dysfunction, and arterial stiffness.[3]

Continuous ambulatory peritoneal dialysis (CAPD) offers a fundamentally different approach to renal replacement therapy. Unlike the intermittent nature of haemodialysis, CAPD provides continuous, gentle ultrafiltration and solute removal throughout the day. This continuous modality may offer advantages in volume and sodium management, potentially leading to improved BP control.[4,5] We present a case series of three ESRD patients with recurrent accelerated hypertension refractory to optimal management on MHD who demonstrated significant improvement following transition to CAPD.

Literature Review

The pathophysiology of hypertension in dialysis patients is multifactorial. Extracellular volume expansion remains the predominant mechanism, with studies demonstrating that excessive body fluids are present in the majority of hypertensive haemodialysis patients.[1,3] The intermittent nature of conventional thrice-weekly haemodialysis leads to cyclical volume fluctuations, with interdialytic weight gains contributing to BP variability and hypertensive episodes. Additionally, activation of the RAAS occurs even in ESRD patients, contributing to renin-dependent hypertension that may be refractory to fluid removal alone.

Several studies have suggested that BP control in peritoneal dialysis (PD) patients may be superior to those on haemodialysis. Data from the 1995 Peritoneal Dialysis Core Indicators Study involving 1202 patients

demonstrated an average BP of 139/80 mmHg among PD patients, compared to higher values typically observed in haemodialysis cohorts.[2] The proposed mechanisms for improved BP control in PD include removal of vasopressor substances and sodium pump inhibitors, more consistent volume control through continuous ultrafiltration, and preservation of residual renal function.

The continuous nature of CAPD allows for gradual sodium and fluid removal without the hemodynamic instability associated with rapid ultrafiltration during haemodialysis sessions.[4,5] Studies have demonstrated that CAPD provides greater ultrafiltration and sodium removal compared to automated PD cyclers, particularly with longer dwell times that allow for equilibration of sodium across the peritoneal membrane. The avoidance of interdialytic gaps eliminates the cyclical volume overload that characterizes thrice-weekly haemodialysis, potentially reducing the incidence of hypertensive emergencies.

Furthermore, PD may offer advantages in preserving residual renal function compared to haemodialysis, which contributes to better volume and BP control over time.[6] The maintenance of even minimal urine output allows for additional sodium and water excretion, reducing dependence on dialytic clearance alone for volume management.

Materials and Methods

This retrospective case series was conducted at the Department of Nephrology, Gauhati Medical College and Hospital, Guwahati, Assam. We reviewed the clinical records of three ESRD patients who presented with recurrent accelerated hypertension while on maintenance haemodialysis and were subsequently transitioned to CAPD between April 2023 and April 2024.

Data collected included demographic characteristics, etiology of ESRD, comorbidities, duration on haemodialysis, frequency and severity of hypertensive crises, antihypertensive medications, dialysis prescriptions, and clinical outcomes following CAPD initiation. Accelerated hypertension was defined as severely elevated BP (systolic BP >180 mmHg and/or diastolic BP >120 mmHg) with evidence of acute target organ damage, including acute pulmonary edema or left ventricular failure requiring hospitalization.

All patients were followed up for a minimum of six months after CAPD initiation. Outcomes assessed included frequency of hypertensive crises, number of antihypertensive medications required, and episodes of heart failure requiring hospitalization. This study was approved by the Institutional Ethics Committee, and written informed consent was obtained from all patients.

Case Presentations

Case 1

A 48-year-old male with type 2 diabetes mellitus of 15 years duration and hypertension was diagnosed with ESRD and initiated on twice-weekly maintenance haemodialysis in April 2023. Despite adequate dialysis with appropriate dry weight targeting and maximal antihypertensive therapy comprising five agents (including an angiotensin receptor blocker, calcium channel blocker, beta-blocker, alpha-blocker, and loop diuretic), the patient developed multiple episodes of accelerated hypertension complicated by left ventricular failure requiring intensive care unit (ICU) admissions.

Dialysis frequency was intensified to thrice-weekly sessions with extended duration, yet hypertensive crises persisted. In September 2023, the patient was

transitioned to CAPD with a standard prescription of four exchanges daily using glucose-based solutions. Following CAPD initiation, the patient experienced only two hypertensive episodes in the first month, with complete resolution of hypertensive crises thereafter. His antihypertensive regimen was successfully reduced from five to two agents, and no further ICU admissions for LVF occurred during the six-month follow-up period.

Case 2

A 32-year-old female with long-standing hypertension progressed to ESRD of undetermined etiology and was initiated on maintenance haemodialysis in January 2024. From the outset, BP control proved extremely challenging despite thrice-weekly haemodialysis with aggressive ultrafiltration and a regimen of four antihypertensive medications at maximal doses. She experienced recurrent episodes of accelerated hypertension with acute pulmonary edema requiring multiple hospital admissions.

After three months of failed conservative management, the patient was transitioned to CAPD in April 2024. The response was remarkable: no further episodes of accelerated hypertension or LVF occurred following CAPD initiation. Her antihypertensive regimen was progressively reduced from four agents to a single medication, with sustained BP control throughout the six-month follow-up period.

Case 3

An 18-year-old female with biopsy-proven focal segmental glomerulosclerosis (FSGS) had been on twice-weekly maintenance haemodialysis for two years.[7] Her hypertension was suboptimally controlled despite multiple antihypertensive agents. She was transitioned to CAPD primarily due to recurrent vascular access failure, which had necessitated multiple access procedures and temporary catheter placements.

Following CAPD initiation, marked improvement in BP control was observed without any escalation of her antihypertensive regimen. This unexpected benefit, in addition to resolution of her vascular access issues, significantly improved her quality of life. She maintained stable BP control throughout the follow-up period.

Table 1: Baseline Clinical Characteristics of Patients

Parameter	Case 1	Case 2	Case 3
Age/Sex	48/Male	32/Female	18/Female
Etiology of ESRD	Diabetic nephropathy	Hypertensive nephrosclerosis	FSGS
Comorbidities	T2DM, HTN	HTN	HTN
Duration on MHD	5 months	3 months	2 years
HD Frequency	Twice to thrice weekly	Thrice weekly	Twice weekly
Indication for CAPD	Refractory HTN with LVF	Refractory HTN with LVF	Vascular access failure

T2DM: Type 2 Diabetes Mellitus; HTN: Hypertension; MHD: Maintenance Hemodialysis; HD: Hemodialysis; FSGS: Focal Segmental Glomerulosclerosis; LVF: Left Ventricular Failure

Table 2: Comparison of Outcomes Before and After CAPD

Parameter	Case 1	Case 2	Case 3
Antihypertensives on MHD	5	4	Multiple
Antihypertensives on CAPD	2	1	No escalation
HTN crises on MHD	Multiple with ICU admissions	Multiple with hospitalizations	Suboptimal control
HTN crises post-CAPD	2 in first month, then none	None	Marked improvement
LVF episodes post-CAPD	None	None	N/A
Follow-up duration	6 months	6 months	6 months

MHD: Maintenance Hemodialysis; CAPD: Continuous Ambulatory Peritoneal Dialysis; HTN: Hypertension; ICU: Intensive Care Unit; LVF: Left Ventricular Failure; N/A: Not Applicable

Discussion

This case series demonstrates the potential benefit of CAPD in managing refractory accelerated hypertension in ESRD patients who fail to achieve BP control on maintenance haemodialysis. All three patients showed significant improvement in BP control following transition to CAPD, with reduction in antihypertensive medication burden and elimination of hypertensive crises requiring hospitalization.

The mechanisms underlying improved BP control with CAPD likely relate to several factors. First, the continuous nature of peritoneal dialysis eliminates the interdialytic volume fluctuations characteristic of thrice-weekly haemodialysis. The gradual, sustained ultrafiltration throughout the day avoids the hemodynamic stress of rapid fluid removal during haemodialysis sessions, which can paradoxically activate compensatory mechanisms including the RAAS and sympathetic nervous system.[1,3]

Second, CAPD provides effective sodium removal, which is crucial for volume and BP control in ESRD patients. Studies have demonstrated that CAPD achieves greater sodium removal compared to automated peritoneal dialysis, particularly with longer dwell times that allow for equilibration.[4,5] The importance of sodium balance in BP control is well-established, and the enhanced sodium removal with CAPD may contribute significantly to the observed improvements.

Third, peritoneal dialysis has been associated with better preservation of residual renal function compared to hemodialysis.[6] Even minimal residual urine output contributes to sodium and water excretion and has been associated with improved BP control and survival in dialysis patients. Additionally, the removal of vasopressor substances and uremic toxins through the peritoneal membrane may contribute to improved vascular function.

Our findings are consistent with previous observations suggesting superior BP control in PD patients compared to those on hemodialysis.[2] However, it is important to acknowledge the limitations of this case series. The small sample size and retrospective nature preclude definitive conclusions. Additionally, we did not have ambulatory BP monitoring data or detailed volume assessment by bioimpedance, which would have

provided more objective measures of BP control and volume status.

Nevertheless, these cases highlight that CAPD should be considered as a therapeutic option in ESRD patients with refractory hypertension on haemodialysis, particularly those with recurrent hypertensive emergencies and heart failure. The dramatic improvement observed in all three patients, despite their different underlying etiologies and clinical presentations, suggests that the benefits of continuous dialysis on BP control may apply broadly to patients with volume-dependent and resistant hypertension.

Conclusion

This case series demonstrates that CAPD can provide rapid and sustained BP control in ESRD patients with recurrent accelerated hypertension refractory to optimal management on maintenance haemodialysis. The transition to CAPD resulted in elimination of hypertensive crises, reduction in antihypertensive medication burden, and prevention of heart failure hospitalizations in our patients. These findings suggest that CAPD should be considered as a viable alternative dialysis modality in patients with challenging hypertension on haemodialysis, including those with vascular access difficulties. Prospective studies with larger cohorts are warranted to establish the efficacy of this approach and identify patients most likely to benefit from modality transition.

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