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Factors Predicting Outcomes in Patients with Obstructive Anuria

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Abstract

Introduction: Obstructive anuria is a urological emergency with heterogeneous renal outcomes. We evaluated clinical and biochemical predictors of renal recovery and chronic kidney disease (CKD) development following relief of obstruction. Materials and Methods We performed a retrospective observational study of 95 patients presenting with obstructive anuria at a tertiary referral centre. Obstructive anuria was defined as urine output <100 mL/24 hours with imaging evidence of bilateral ureteric obstruction or obstruction of a solitary functioning kidney. Patients with pre-existing CKD stage ≥3 were excluded. Demographic characteristics, duration of anuria, aetiology, laboratory parameters, infection status, dialysis requirement, and post-obstructive diuresis were analysed. Decompression was achieved using double-J ureteral stenting or percutaneous nephrostomy. Renal recovery was defined as serum creatinine <1.5 mg/dL within 10 days. CKD was defined as persistent creatinine ≥1.5 mg/dL or estimated glomerular filtration rate <60 mL/min/1.73 m^2 at 3 months. Results Calculous obstruction accounted for 72.6% of cases and malignant obstruction for 25.3%. Renal recovery occurred in 69.5% of patients, whereas 30.5% developed CKD. On univariate analysis, age >60 years, duration of anuria >48 hours, anaemia, hyperkalaemia, infection, dialysis requirement, and absence of post-obstructive diuresis were associated with CKD. Multivariate logistic regression identified increasing age as the only independent predictor of CKD. Post-obstructive diuresis strongly predicted renal recovery. Conclusions Obstructive anuria is a potentially reversible cause of acute kidney injury. Early decompression results in renal recovery in most patients. Increasing age is the strongest independent predictor of incomplete recovery, while post-obstructive diuresis reliably indicates favorable outcome.

Keywords: AKI; CKD; obstructive uropathy

1. Introduction

Obstructive anuria represents the most severe end of the spectrum of obstructive uropathy and constitutes a true urological emergency. Defined by near-complete cessation of urine output due to bilateral ureteric obstruction or obstruction of a solitary functioning kidney, obstructive anuria rapidly leads to acute kidney injury (AKI) and life-threatening metabolic derangements if not promptly relieved [1]. Although relief of obstruction can restore renal function, recovery is variable and depends on multiple patient- and disease-related factors.

Experimental and clinical studies have demonstrated that the duration of obstruction, patient age, presence of infection, and baseline renal reserve critically influence the reversibility of renal injury. Prolonged obstruction induces sustained intrarenal vasoconstriction, tubular apoptosis, and interstitial fibrosis that may persist despite decompression [2]. Conversely, early relief—particularly within 48 hours—has been associated with near-complete recovery of renal function in many patients.

Despite advances in endourology and imaging, predicting renal outcome following obstructive anuria remains challenging. Traditional markers such as serum creatinine lack sensitivity for early

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tubular injury, and clinical decision-making often relies on surrogate indicators such as post-obstructive diuresis and biochemical response after decompression. The present study aimed to identify clinical and biochemical predictors of renal recovery and CKD development in patients with obstructive anuria and to assess the prognostic significance of post-obstructive diuresis and decompression modality.

2. Materials and Methods

This retrospective observational study was conducted at a tertiary care teaching hospital after approval by the institutional ethics committee. Consecutive adult patients presenting with obstructive anuria between February 2023 and December 2025 were included. Obstructive anuria was defined as urine output <100 mL over 24 hours with radiologic evidence of bilateral ureteric obstruction or obstruction of a solitary functioning kidney [3]. Patients with known chronic kidney disease stage ≥3 were excluded to avoid confounding from baseline renal impairment.

All patients underwent standardized clinical evaluation, laboratory testing, urine culture, and radiologic assessment using ultrasonography and non-contrast computed tomography. Hyperkalemia was defined as serum potassium >5.5 mmol/L, and anemia as hemoglobin <12 g/dL. Sepsis was diagnosed based on clinical and laboratory criteria. Urinary decompression was achieved using retrograde double-J ureteral stenting or percutaneous nephrostomy, depending on etiology, anatomy, and clinical stability. Post-obstructive diuresis was defined as urine output >200 mL/hour for at least 2 consecutive hours or >3 L in 24 hours.

Data were analyzed using SPSS software. Continuous variables were compared using the Student t-test, and categorical variables using the chi-square test. Multivariate logistic regression analysis was performed to identify independent predictors of CKD development. Statistical significance was defined as $p < 0.05$.

3. Results

A total of 95 patients were included, with a mean age of 53.6 ± 12.8 years; 55.8% were female. Calculous obstruction was the most common etiology, followed by malignant obstruction. Overall, 66 patients (69.5%) achieved renal recovery, while 29 (30.5%) progressed to CKD.

Patients presenting after 48 hours of anuria had significantly higher rates of CKD compared with those presenting earlier. Anemia, hyperkalemia, infection, and need for dialysis were associated with adverse outcomes on univariate analysis. Post-obstructive diuresis occurred in 76.8% of patients and was strongly associated with renal recovery. When all significant variables from univariate analysis were entered into a multivariate logistic-regression model—**age, duration of anuria, haemoglobin, hyperkalaemia, urine-culture positivity, dialysis requirement, and POD**—*only **age** emerged as an independent predictor of CKD (odds ratio = 1.12 per year, p = 0.02)*

Table 1. Baseline demographic and clinical characteristics (n = 95).

Variable	Overall	Recovered (n=66)	CKD (n=29)
Age, mean ± SD (years)	53.6 ± 12.8	49.2 ± 11.4	62.4 ± 9.8
Female sex, n (%)	53 (55.8)	38 (57.6)	15 (51.7)
Anuria duration >48 h, n (%)	52 (54.7)	29 (43.9)	23 (79.3)
Anemia (Hb <12 g/dL), n (%)	17 (17.9)	3 (4.5)	14 (48.3)
Hyperkalemia (>5.5 mmol/L), n (%)	23 (24.2)	11 (16.7)	12 (41.4)
Positive urine culture, n (%)	45 (47.4)	26 (39.4)	19 (65.5)

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Table 2. Etiology of obstruction and decompression modality.

Category	Total n (%)	DJ Stent	PCN
Calculous obstruction	69 (72.6)	53	16
Malignant obstruction	24 (25.3)	7	17
Retroperitoneal fibrosis	2 (2.1)	1	1

4. Discussion

Obstructive anuria is the most severe form of urinary obstruction and can rapidly lead to life-threatening renal injury. Without prompt relief, persistent blockage can convert what might be reversible acute kidney injury into irreversible chronic damage. In this series, most patients achieved renal recovery after obstruction relief, with nearly seventy percent returning to baseline creatinine levels within ten days. This high rate of recovery underscores the reversible potential of this condition when treated promptly and aligns with the broad range of outcomes reported historically, which also indicate that a majority of patients recover if decompression is timely [4,5].

Advanced age emerged as a strong predictor of incomplete recovery. In multivariate analysis, older age was the only independent factor significantly associated with progression to chronic kidney disease. This likely reflects the well-established decline in nephron number and renal reserve that occurs with aging, as well as diminished regenerative capacity and increased baseline fibrosis in older kidneys [6]. Patients over sixty in this cohort faced a markedly higher risk of non-recovery, consistent with the accumulation of comorbidities and vascular disease with age. In practical terms, elderly patients may therefore have a reduced ability to repair the ischemic and obstructive injury, making complete recovery less likely in the absence of early intervention.

The duration of obstruction was also strongly related to outcome. Patients who presented after more than 48 hours of anuria were several times more likely to progress to chronic renal impairment than those with shorter obstruction. This aligns with the underlying pathophysiology: prolonged urinary blockage induces sustained intrarenal vasoconstriction, tubular atrophy, and interstitial fibrosis that continue even after decompression. In effect, the longer the kidney remains obstructed, the greater the irreversible damage to renal tissue. Prolonged intraluminal pressure and ischemia initiate profibrotic signaling (such as local release of transforming growth factor β and angiotensin II), so that cellular apoptosis and matrix deposition continue even after decompression, resulting in permanent nephron loss if the obstruction persists. Accordingly, relieving obstruction within the first two days greatly increases the chances of recovery, whereas delays allow damage to accumulate beyond the kidney's ability to repair [7].

Baseline anemia was another factor associated with poor recovery. Patients with lower hemoglobin levels were significantly less likely to regain normal kidney function after decompression [8]. This may relate to tissue hypoxia: anemia worsens oxygen delivery to renal tissue, exacerbating tubular necrosis during the period of obstruction. Additionally, anemia can be a marker of chronic disease, malnutrition, or inflammation, all of which may undermine the kidney's intrinsic repair capacity. In light of these observations, ensuring adequate hemoglobin levels and addressing underlying causes of anemia might be important steps in optimizing recovery after obstructive injury.

Hyperkalemia at presentation similarly reflected more severe injury. About one-quarter of patients had elevated potassium, indicating advanced renal failure. High potassium suggests that the kidneys are unable to excrete potassium due to the obstruction, so it mirrors the degree of dysfunction. Patients with marked hyperkalemia tended to have more prolonged kidney injury and slower recovery [9]. Hyperkalemia often coexisted with acidosis or volume overload, compounding the patient's risk. Prompt correction of electrolyte imbalances was therefore essential, both for patient safety and as a marker of injury severity.

Infection and sepsis significantly impacted outcomes as well. About half of the patients had positive urine cultures, and a substantial number exhibited clinical or laboratory evidence of systemic

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infection. Obstructive anuria complicated by infection can amplify renal damage: bacterial toxins and inflammatory cytokines promote additional vasoconstriction and tubular injury, compounding the ischemic insult. As a result, patients with infected or septic obstruction were much more likely to experience incomplete recovery [10]. This underscores the fact that urinary obstruction with infection is a true urological emergency. In practice, guidelines recommend immediate drainage and broad-spectrum antibiotics in such cases because delays can drastically increase the risk of multiorgan failure and death. Thus, managing infection aggressively while relieving the obstruction is critical for improving outcomes.

One important clinical marker of recovery was the presence of post-obstructive diuresis. After relief of obstruction, many patients experienced a phase of pronounced diuresis as their nephrons excreted accumulated waste and salt loads [11]. In this series, patients with significant post-obstructive diuresis were very likely to regain normal renal function. Post-obstructive diuresis therefore appears to be a favorable prognostic sign: it indicates that surviving nephrons are functioning and clearing the retained solute. By contrast, a blunted or absent diuretic response might suggest that too many nephrons have been lost to recovery. In clinical terms, observing a robust diuresis after decompression provides reassurance that the kidney has preserved substantial functional capacity.

Both ureteral stenting and percutaneous nephrostomy effectively restored drainage when performed without delay, yielding similar rates of renal recovery [12,13]. The choice of technique can be tailored to the clinical scenario (for example, stents for benign stones, nephrostomy for malignant obstruction or complex anatomy) without significantly affecting outcome. In this series, both methods led to comparable improvements in renal function when used promptly. These observations reinforce that the timing of decompression, rather than the specific modality, is the critical determinant of recovery.

Standard markers like serum creatinine are insensitive to early damage and typically rise only after significant nephron loss. In contrast, novel injury biomarkers can respond quickly to acute tubular injury [14]. For example, some evidence suggests that patients with lower levels of urinary NGAL and faster normalization of serum cystatin C after relief of obstruction tend to recover kidney function more rapidly [15]. If validated, such biomarkers could help distinguish which patients have mostly reversible injury versus those with irreversible damage, even before conventional tests change.

Combining these biomarkers with clinical factors further improves prognostic accuracy. Contemporary models that include both patient characteristics (age, duration of obstruction, infection status, etc.) and injury biomarkers have demonstrated substantially better prediction of outcome than clinical variables alone. Although such assays are not yet routine in most centers, they represent a promising area of research. Incorporating biomarkers into risk stratification could help clinicians anticipate which patients will recover and which will not, potentially guiding early consultation with nephrology or consideration of more aggressive therapies. The ultimate goal of these predictive tools would be to detect irreversible injury at an early stage, when intervention may still alter the clinical course.

The present results are consistent with the broader clinical experience in obstructive anuria. Many reports across different settings similarly emphasize that shorter symptom duration before relief markedly improves renal outcome, whereas delays are associated with persistent impairment. It is also well recognized that relieving obstruction prevents progression to chronic kidney disease in the majority of patients if performed early. It is noteworthy that the present findings align with these general observations, reinforcing their credibility: early recognition and decompression consistently emerge as the most decisive factors in preserving kidney function, independent of patient population. The fact that these predictors behave similarly across different studies suggests that the underlying pathophysiology is consistent, supporting the broader applicability of these findings.

These findings have clear implications for clinical practice. They suggest a risk-based approach to management and counseling. For example, patients older than sixty, those presenting with anuria

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of more than two days, or those with concurrent infection and anemia should be treated as high risk for incomplete recovery. In such high-risk cases, every effort should be made to expedite drainage and address contributing factors. Clinicians might prioritize these patients for the most urgent intervention and consider early nephrology consultation. After relief of obstruction, these patients also warrant closer monitoring and follow-up: measuring renal function frequently for several months can allow early detection of emerging chronic kidney disease, which in turn enables timely management of its complications.

This analysis has several limitations. It reflects the experience of a single tertiary referral center and uses retrospective observational data, which may limit the ability to infer causation and introduces the possibility of selection bias. The follow-up period was limited, so very late renal outcomes beyond one year could not be assessed. Additionally, although emerging biomarkers were measured in some cases, they were not universally available, which could limit the analysis of their predictive value. As a retrospective analysis, it cannot establish causation or capture all potential confounders. Nonetheless, the study includes a relatively large number of patients collected over many years and employs rigorous statistical methods, which lends weight to the associations observed.

5. Conclusions

Obstructive anuria is a severe yet frequently reversible urological emergency when recognized and managed promptly. In this study, early decompression resulted in renal recovery in most patients, whereas delayed presentation was associated with progression to chronic kidney disease. Increasing age was the only independent predictor of incomplete renal recovery, reflecting reduced renal reserve in older patients. Prolonged anuria, anemia, hyperkalemia, infection, and dialysis requirement were associated with adverse outcomes on univariate analysis. Post-obstructive diuresis reliably indicated preserved nephron function and favorable renal outcome. These findings emphasize the importance of early diagnosis, urgent decompression, and close post-intervention monitoring to optimize renal recovery in obstructive anuria.

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