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Original Research Article

Factors Predicting Outcome in Patients with Obstructive Anuria: A Retrospective Analysis

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Abstract: ***Objective***: To evaluate the clinical and biochemical factors predicting outcomes in patients with obstructive anuria. ***Methods***: A retrospective observational study was conducted at the Department of Urology, Goa Medical College, India. Ninety-five patients presenting with obstructive anuria (urine output <100 mL/24 h with imaging evidence of bilateral ureteric obstruction or obstruction of a solitary functioning kidney) were analysed. Variables including age, duration of anuria, comorbidities, haemoglobin level, serum creatinine, white blood cell count, urine culture, hyperkalaemia, metabolic acidosis, sepsis, dialysis requirement, and post-obstructive diuresis were evaluated. Renal recovery was defined as serum creatinine <1.5 mg/dL within 10 days, and chronic kidney disease (CKD) as persistent creatinine ≥1.5 mg/dL or eGFR <60 mL/min/1.73 m² at 3 months. ***Results***: The most common aetiology was ureteric or pelvi-ureteric junction calculi (72.6%), followed by pelvic malignancies (25.3%). CKD developed in 29 of 95 patients (30.5%). On univariate analysis, age >60 years, anuria duration >48 hours, anaemia (Hb ≤12 g/dL), hyperkalaemia, positive urine culture, sepsis, and dialysis requirement were significantly associated with CKD development. Post-obstructive diuresis correlated strongly with renal recovery (p <0.0001), with an 86.3% likelihood of recovery in patients demonstrating diuresis. Multivariate logistic regression identified age as the only independent predictor of CKD (odds ratio 1.12 per year, p = 0.02). ***Conclusion***: Timely decompression, correction of metabolic derangements, and infection control are crucial for renal recovery in obstructive anuria. Age remains the most significant independent predictor of chronic kidney disease development following relief of obstruction. Post-obstructive diuresis serves as a reliable prognostic indicator of renal recovery.

Keywords: Obstructive anuria; Acute kidney injury; Predictive factors; Double-J stenting; Percutaneous nephrostomy; Renal outcome; post-obstructive diuresis.

INTRODUCTION

Obstructive anuria is defined as complete cessation of urine output (less than 100 mL over 24 hours) resulting from mechanical obstruction at one or both ureters or at the pelvi-ureteric junction of a solitary functioning kidney [1,2]. It represents a urological emergency that can rapidly progress to life-threatening complications, including severe uraemia, hyperkalaemia, metabolic acidosis, and sepsis, if not promptly identified and managed [3].

The pathophysiology of obstructive renal injury involves elevated intrapelvic and intratubular pressure causing reduction in glomerular filtration rate and backflow of urine into the renal venous and lymphatic systems [4]. This triggers a cascade of inflammatory responses, including activation of the renin-angiotensin-aldosterone system and upregulation of cytokines such as transforming growth factor-β1 (TGF-β1), tumour necrosis factor-α (TNF-α), and interleukin-6 (IL-6), resulting in oxidative stress, tubular ischaemia, apoptosis, and eventual fibrosis [5,6]. If the obstruction is not relieved early, irreversible nephron loss and chronic kidney disease (CKD) may follow [7].

In clinical practice, obstructive anuria arises from a wide spectrum of causes. Ureteric and pelvi-ureteric junction calculi account for approximately 60–75% of presentations in contemporary series, while malignant pelvic and retroperitoneal tumours, including carcinoma of the cervix, bladder, prostate, and colorectum, represent another major group, particularly among elderly and female patients [8,9]. Less common aetiologies include iatrogenic ureteric injury, blood clots, congenital anomalies, and retroperitoneal fibrosis [10].

Management of obstructive anuria requires urgent decompression of the collecting system, correction of biochemical derangements, and treatment of sepsis [11]. Two primary drainage modalities—retrograde double-J (DJ) ureteric stenting and percutaneous nephrostomy (PCN)—are widely employed [12]. Both procedures aim to re-establish urine flow, reduce intrapelvic pressure, and allow renal healing. Comparative analyses demonstrate similar long-term renal outcomes provided drainage is performed early; however, the choice between the two depends on aetiology, anatomical accessibility, and haemodynamic stability [13,14].

Predicting renal recovery following relief of obstruction remains challenging. Several factors have been associated with poor prognosis, including older age, delayed presentation, anaemia, hyperkalaemia, metabolic acidosis, and positive urine culture [15–17]. Emerging evidence also suggests that tubular injury biomarkers such as neutrophil gelatinase-associated lipocalin (NGAL), kidney injury molecule-1 (KIM-1), and cystatin C may identify reversible injury earlier than serum creatinine [18,19]. However, in most clinical settings, risk prediction still relies on classical parameters and response after decompression.

The present study was designed to evaluate the factors predicting outcome in patients with obstructive anuria treated at a tertiary care centre. The objectives were to identify independent clinical and biochemical predictors of renal recovery, highlight the prognostic role of post-obstructive diuresis, and compare outcomes between DJ stenting and PCN in benign and malignant obstructions.

MATERIALS AND METHODS

Study Design and Setting

This was a retrospective observational study conducted in the Department of Urology, Goa Medical College, India, over a 2.6-year period from February 2023 to December 2025. The study was approved by the Institutional Ethics Committee (Ref No. GMC/Uro/2025/154), and written informed consent was obtained from all participants. The study was conducted in accordance with the Declaration of Helsinki.

Patient Selection

All patients presenting with features of obstructive anuria—defined as urine output less than 100 mL/24 hours with imaging evidence of bilateral ureteric obstruction or obstruction of a solitary functioning kidney—were evaluated for inclusion. Patients with known chronic kidney disease (CKD stage ≥3) at baseline were excluded to eliminate pre-existing renal impairment as a confounding factor.

Clinical and Laboratory Evaluation

Each participant underwent detailed clinical evaluation, including medical history (onset and duration of anuria, comorbid conditions, previous calculus disease, and urological interventions) and complete physical examination. Baseline investigations comprised complete blood count, haemoglobin concentration, serum creatinine, blood urea nitrogen, serum electrolytes, and arterial blood gas analysis.

Anaemia was defined as haemoglobin less than 12 g/dL according to World Health Organization criteria. Hyperkalaemia was defined as serum potassium greater than 5.5 mmol/L, and metabolic acidosis as arterial pH less than 7.35 with bicarbonate less than 22 mmol/L. Urinalysis and urine culture were performed using standard microbiological techniques, with a colony count of $\geq 10^5$ CFU/mL interpreted as significant bacteriuria. Sepsis was documented based on clinical features (fever >38°C, tachycardia, hypotension) and laboratory evidence of leucocytosis (>12,000 cells/µL) or positive blood cultures.

Radiological Evaluation

Ultrasonography of the kidneys, ureters, and bladder was performed as the initial imaging modality in all patients. Non-contrast computed tomography (NCCT) was performed to confirm the level and cause of obstruction. When malignancy was suspected, contrast-enhanced CT or MRI was used to delineate the extent of disease.

Intervention

After initial optimisation, urinary drainage was achieved either by retrograde DJ stenting or percutaneous nephrostomy, depending on anatomical feasibility and patient stability. The choice of procedure was determined by the operating urologist: DJ stenting was preferred in calculous obstruction, whereas PCN was selected for cases with gross infection, distorted pelvic anatomy, or failed retrograde access. Both interventions were performed under fluoroscopic or ultrasound guidance using standard aseptic technique. In patients with severe uraemia or metabolic derangements, haemodialysis was performed prior to decompression.

Definitions and Outcome Measures

Patients were categorised according to duration of anuria (≤48 hours and >48 hours) and by aetiology (calculous obstruction, malignant obstruction, or other causes). Post-obstructive diuresis (POD) was defined as urine output greater than 200 mL/hour for at least 2 hours or greater than 3 L in 24 hours after relief of obstruction.

The primary outcome measures were: (1) return of serum creatinine to less than 1.5 mg/dL within 10 days post-intervention, indicating renal recovery; and (2) development of CKD, defined by persistent creatinine ≥1.5 mg/dL or eGFR less than 60 mL/min/1.73 m² at 3 months.

Statistical Analysis

Data were compiled using Microsoft Excel and analysed with SPSS version 25.0 (IBM Corp, USA). Continuous variables were expressed as mean ± standard deviation and compared using the Student t-test; categorical variables were compared using the chi-square test. Multivariate logistic regression was performed to identify independent predictors of CKD after relief of obstruction. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Patient Demographics

A total of 95 patients with obstructive anuria were included in the study. The age range was 20–82 years (mean 53.6 ± 12.8 years), and 53 patients (55.8%) were female. The majority of patients (45%) were aged between 41 and 60 years, indicating that middle-aged adults formed the most vulnerable group.

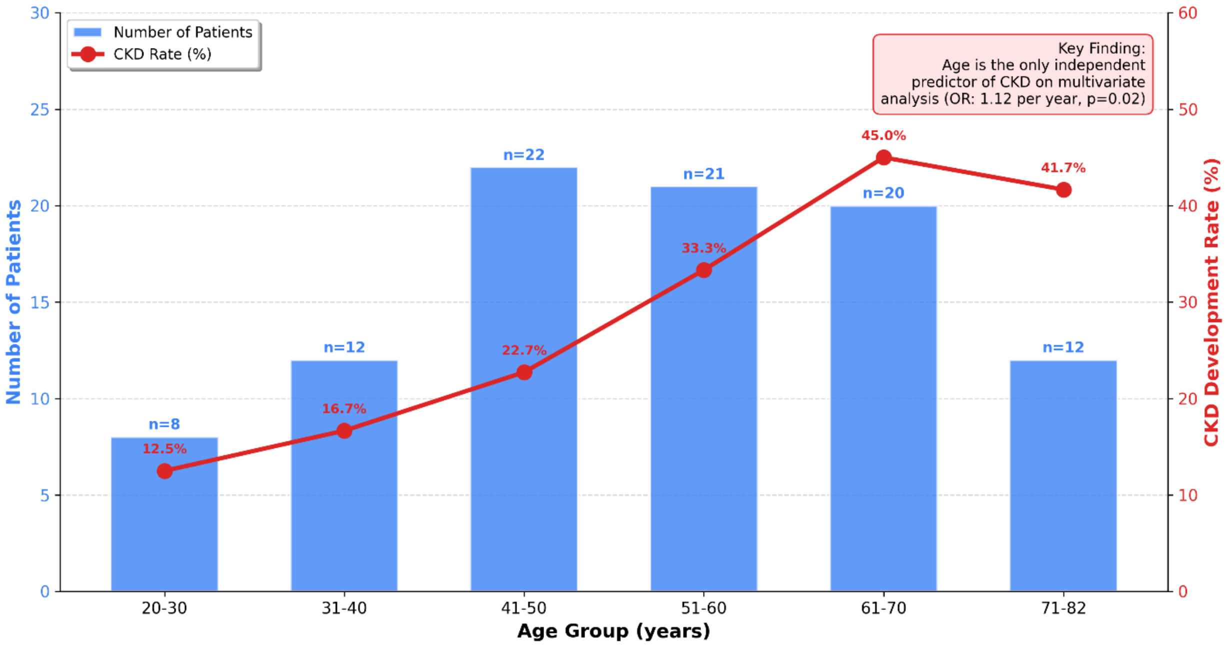

Figure 1: Age Distribution and CKD Rate

Aetiology of Obstruction

Calculous obstruction accounted for 69 patients (72.6%), malignant causes for 24 patients (25.3%), and retroperitoneal fibrosis for 2 patients (2.1%). Within the calculous group, bilateral ureteric calculi were seen in 37 patients, bilateral pelvi-ureteric junction calculi in 13, combined pelvi-ureteric junction and ureteric calculi in 11, and solitary kidney obstruction by a ureteric calculus in 8. Among malignancies, carcinoma of the cervix was the most frequent cause (14 patients), followed by carcinoma of the rectum (7 patients) and endometrial carcinoma (3 patients).

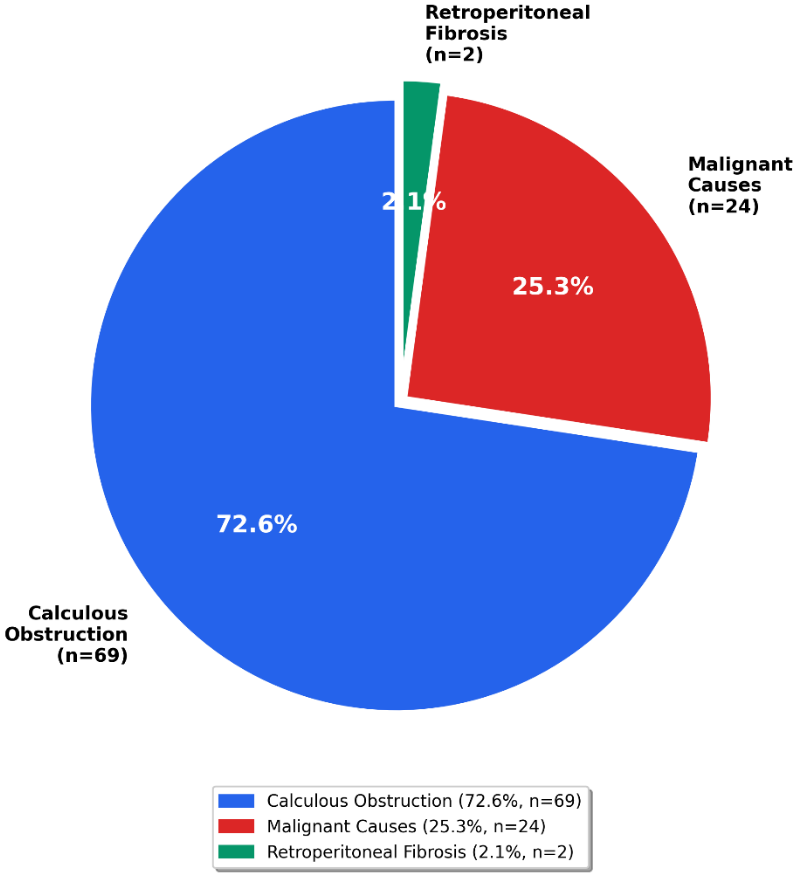

Figure 2: Aetiology of Obstructive Anuria (Pie Chart)

Duration of Anuria and Outcome

Forty-three patients (45.3%) presented within 48 hours of onset, while 52 patients (54.7%) presented later. The mean duration of anuria among those developing CKD was significantly longer (4.8 ± 2.2 days) than in those who recovered (2.1 ± 1.3 days, $p < 0.001$). Overall, 29 patients (30.5%) progressed to CKD despite intervention, while 66 patients (69.5%) achieved renal recovery. Table 1 summarises the relationship between duration of anuria and CKD development.

Table 1. Association between duration of anuria and CKD development

Duration of Anuria	n	CKD Developed, n (%)	p-value
≤48 hours	43	6 (14.0%)	<0.001
>48 hours	52	23 (44.2%)	

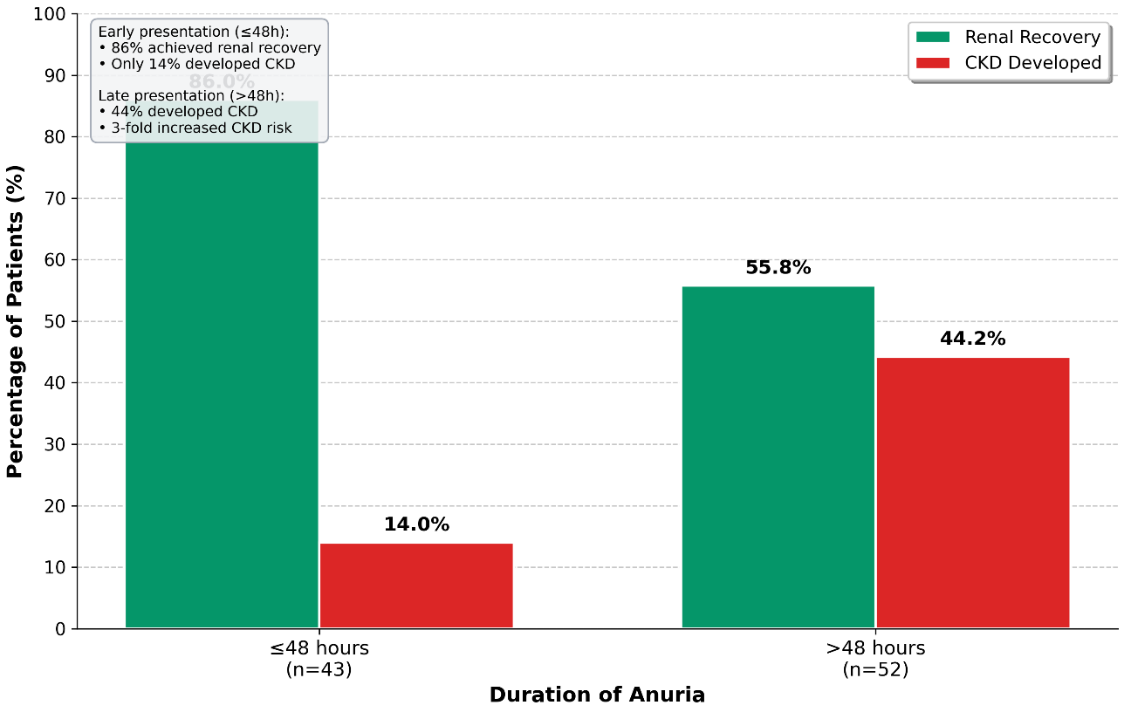

Figure 3: Duration of Anuria vs CKD Development

Procedures Performed

DJ stenting was performed in 135 renal units, and PCN in 47 renal units. Bilateral stenting was achieved in 37 cases; unilateral stenting with contralateral PCN was required in 8 patients because of infected hydronephrosis. Among malignant obstructions, PCN was the primary modality in 70% of cases due to distorted pelvic anatomy and failed retrograde access.

Univariate Analysis of Prognostic Factors

Table 2 presents the univariate analysis of factors associated with CKD development.

Table 2. Univariate analysis of factors associated with CKD development

Variable	CKD Developed	Recovered	p-value
Anaemia (Hb ≤12 g/dL)	14/17 (82.4%)	15/78 (19.2%)	<0.001
Hyperkalaemia (K^+ >5.5 mmol/L)	12/23 (52.2%)	17/72 (23.6%)	0.0096
Positive urine culture	21/45 (46.7%)	8/50 (16.0%)	0.001
Sepsis at presentation	22/50 (44.0%)	7/45 (15.6%)	<0.001
Pre-intervention dialysis	23/52 (44.2%)	6/43 (14.0%)	0.0014
Post-obstructive diuresis	10/73 (13.7%)	19/22 (86.4%)	<0.0001

Seventeen patients (17.9%) were anaemic (Hb ≤12 g/dL); of these, 14 (82.4%) developed CKD compared with 15 of 78 non-anaemic patients (19.2%, $p < 0.001$). Hyperkalaemia (>5.5 mmol/L) was detected in 23 patients (24.2%), of whom 12 (52.2%) developed CKD compared with 17 of 72 normokalaemic patients (23.6%, $p = 0.0096$). Metabolic acidosis was observed in 55 patients (57.9%), but its association with CKD was not statistically significant ($p = 0.42$). Leucocytosis (>12,000 cells/µL) was present in 51 patients (53.7%). Of these, 19 (37.3%) developed CKD compared with 10 (22.7%) among those with normal counts; however, statistical significance was not reached ($p = 0.09$). Positive urine cultures were obtained in 45 patients (47.4%), predominantly Escherichia coli and Klebsiella pneumoniae, and were significantly correlated with CKD ($p = 0.001$). Sepsis at presentation (50 patients, 52.6%) was also significantly associated with adverse outcome ($p < 0.001$).

Pre-intervention dialysis was required in 52 patients (54.7%) due to severe azotaemia or hyperkalaemia. Among these, 23 (44.2%) developed CKD compared with 6 of 43 (14.0%) who did not require dialysis ($p = 0.0014$). Serum creatinine at admission averaged 7.2 ± 2.8 mg/dL and decreased to 2.1 ± 1.1 mg/dL by day 10 post-procedure among those who recovered.

Post-Obstructive Diuresis

Post-obstructive diuresis occurred in 73 patients (76.8%), lasting 24–48 hours in most cases. Of those with POD, only 10 (13.7%) developed CKD, whereas 19 of 22 patients without POD (86.4%) developed CKD ($p < 0.0001$). Thus, the presence of diuresis predicted favourable outcome with a negative predictive value of 86.3%.

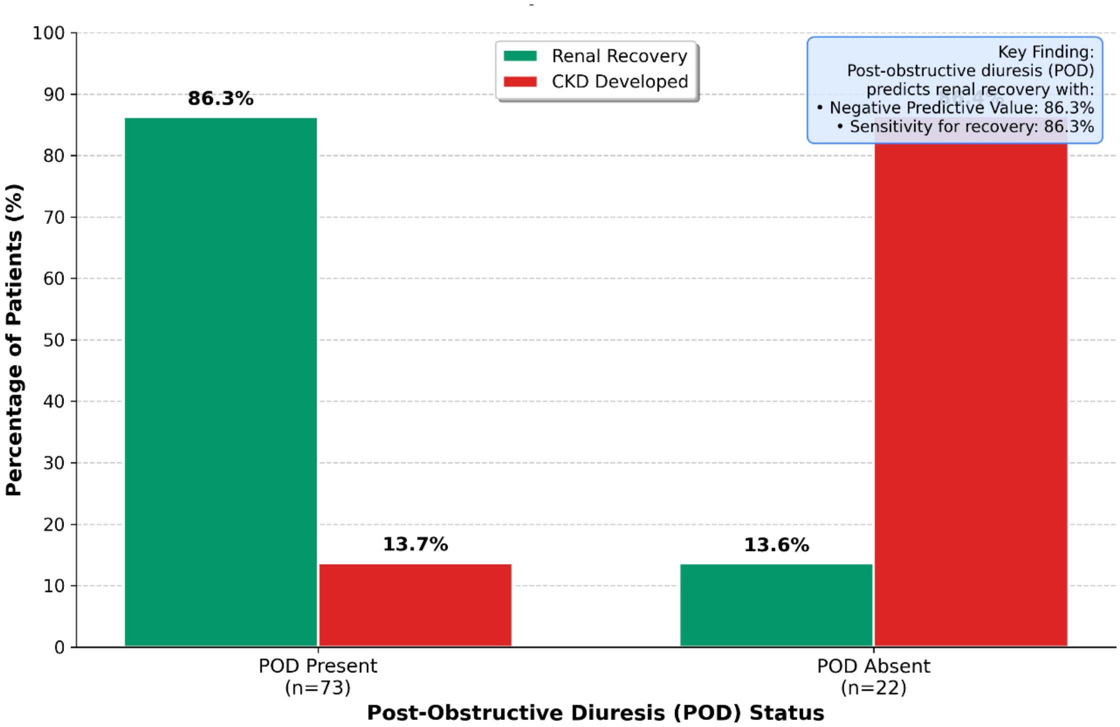

Figure 4: Post-Obstructive Diuresis and Renal Outcome

Multivariate Analysis

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 post-obstructive diuresis—only age emerged as an independent predictor of CKD (odds ratio 1.12 per year, 95% confidence interval 1.02–1.23, $p = 0.02$). This finding confirms the reduced nephron resilience and regenerative capacity in elderly patients.

DISCUSSION

Obstructive anuria remains one of the most urgent conditions in urology because persistent obstruction can transform a reversible acute kidney injury into irreversible chronic kidney disease if relief is delayed [20]. In the present study, prompt decompression restored renal function in the majority of patients, with 69.5% regaining normal creatinine within 10 days. This recovery rate is consistent with previously reported series, where recovery ranged from 60–80% depending on duration of anuria and associated comorbidities [15,21].

Age was found to be the only independent prognostic factor on multivariate analysis, reflecting the decline in nephron reserve and regenerative capacity in older patients. Similar observations were reported by Harraz et al. [16], who demonstrated slower renal recovery in patients aged greater than 60 years after relief of benign obstruction. The diminished capacity for tubular regeneration and increased susceptibility to ischaemic injury in the elderly kidney likely contribute to this finding [22].

Duration of obstruction correlated strongly with outcome in our study; presentation beyond 48 hours increased the risk of CKD threefold. Animal experiments and human studies alike confirm that prolonged obstruction results in sustained vasoconstriction, tubular atrophy, and interstitial fibrosis that persist despite decompression [5,23]. Relief within 24–48 hours allows almost complete functional recovery, whereas delays beyond one to two weeks significantly decrease the likelihood of renal restitution [7,24].

Anaemia was a significant predictor of poor renal recovery in our cohort, consistent with the role of tissue hypoxia and reduced oxygen delivery in aggravating tubular necrosis [25]. A low haemoglobin may also indicate chronic illness or nutritional deficiency that impairs renal repair mechanisms. This finding aligns with observations from Khan and Vohra [17], who reported that anaemia was associated with prolonged renal dysfunction in acute renal failure.

Hyperkalaemia at presentation, observed in 24.2% of our cohort, was another adverse factor and often paralleled the degree of renal failure. This association reflects the severity of metabolic derangement accompanying advanced obstruction and highlights the importance of early recognition and correction [26]. Nearly half of our patients had positive urine cultures, and sepsis was significantly associated with unfavourable outcomes. Infected obstruction exacerbates inflammatory injury via endotoxin-mediated vasoconstriction and cytokine release, compounding ischaemic damage [27]. Prompt decompression and appropriate antibiotics remain essential to reduce mortality, as demonstrated by Ibrahim et al. [28], who observed a threefold mortality increase when drainage was delayed beyond 48 hours in septic obstruction.

Post-obstructive diuresis was seen in 76.8% of cases and had a strong positive association with renal recovery ($p < 0.0001$). POD reflects tubular recovery and the ability of surviving nephrons to excrete solute load after decompression [29]. Patients developing POD had an 86.3% likelihood of regaining baseline creatinine, a finding consistent with earlier studies showing diuresis as a surrogate marker for preserved tubular function [30,31]. The absence of POD should alert clinicians to the possibility of severe tubular injury and the need for closer monitoring and nephrology referral.

Both DJ stenting and PCN proved effective in our study, with no difference in renal recovery when performed promptly. PCN was preferred in malignant obstruction or when retrograde access was not possible, achieving a higher technical success rate (97% vs 91%) [13]. These findings reinforce current clinical consensus that the timing of decompression is more critical than the method used [14,32]. The choice between modalities should be guided by aetiology, anatomical considerations, and patient stability.

The findings of our study parallel those of Rajadoss et al. [15], who found that symptom duration less than 6 days increased the likelihood of renal recovery 22-fold after relief of bilateral calculous obstruction. Similarly, Amanullah et al. [33] reported that timely decompression in calculus anuria prevented progression to CKD in nearly 80% of patients. These parallels strengthen the external validity of our results and highlight the universality of early intervention as a decisive factor.

While conventional biochemical parameters are useful for diagnosis, they are insensitive to early injury. Recent literature identifies NGAL, KIM-1, cystatin C, and TGF-β1 as promising biomarkers for early prediction of renal recovery [18,19,34]. Sharma et al. [19] demonstrated that patients with urinary NGAL less than 250 ng/mL and normalising cystatin C within 72 hours had rapid creatinine decline after obstruction relief. Integration of these biomarkers with clinical variables such as age and duration of obstruction has improved prognostic accuracy from AUC 0.68 to 0.82 in contemporary models [35]. Although biomarker assays are not yet routine in many centres, they represent a promising adjunct for risk stratification and early nephrology referral.

Study Limitations

The main limitations of this study are its single-centre design and retrospective nature, which may limit generalisability. Long-term renal outcomes beyond three months were not assessed, and advanced biomarkers were not measured in all patients due to cost constraints. Nonetheless, the robust statistical analysis and consistency with published literature lend reliability to the findings.

Clinical Implications

The prognostic model derived from this study may assist clinicians in counselling patients regarding expected outcomes and prioritising urgent decompression in high-risk cases. Patients over 60 years, presenting after 48 hours of anuria, or with infection and anaemia should be considered at high risk for incomplete recovery. Close monitoring and follow-up for at least six months are advised to identify subclinical CKD progression.

CONCLUSION

Obstructive anuria remains a critical reversible cause of acute kidney injury, and timely intervention determines prognosis. In this retrospective series, early decompression within 48 hours of onset led to recovery of renal function in nearly 70% of patients. Age, duration of anuria, anaemia, hyperkalaemia, and infection were significant predictors of poor renal outcome on univariate analysis, with age identified as the only independent predictor on multivariate analysis. Post-obstructive diuresis proved to be a reliable indicator of renal recovery, signifying preserved tubular function. Both DJ stenting and PCN were effective decompression modalities with comparable recovery rates when performed promptly; however, PCN offered higher technical success in malignant and septic obstruction, whereas DJ stenting was preferable for benign calculous disease. Early recognition, prompt decompression, and optimisation of anaemia and infection remain the cornerstones of management in obstructive anuria.

DECLARATIONS

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Conflict of Interest: The authors declare no conflicts of interest.

Data Availability: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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