

Association Between Hydronephrosis Severity and Renal Function in Patients with Ureteric Obstruction

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Abstract: **Background:** Nephrolithiasis is a common urological condition that predominantly affects adults during their most productive years and may lead to recurrent episodes of renal colic, reduced quality of life, and an increased risk of chronic kidney disease. The purpose of the study is to evaluate the relationship between hydronephrosis severity and renal function parameters in patients with ureteric obstruction. **Aim of the study:** The aim of the study was to evaluate the relationship between hydronephrosis severity and renal function parameters in patients with ureteric obstruction. **Methods:** This cross-sectional study at the Department of Urology, Bangladesh Medical University (BMU), Dhaka, Bangladesh, from January to December 2024, included 80 adult patients with ureteric obstruction. Hydronephrosis severity was assessed by ultrasonography, renal function by serum creatinine, eGFR, and split renal function, and symptom duration recorded. Data were analyzed using SPSS version 26 with one-way ANOVA and Pearson's correlation ($p < 0.05$). **Results:** Among 80 patients (mean age 48.2 years, 65% male), ureteric calculi caused 72.5% of obstructions. Hydronephrosis was mild in 32.5%, moderate in 35%, and severe in 32.5%. Renal function declined with severity—creatinine 1.0→2.3 mg/dL, eGFR 85.1→36.8 mL/min/1.73 m² ($p < 0.001$). Hydronephrosis grade correlated with creatinine ($r = 0.79$) and inversely with eGFR ($r = -0.82$). Longer symptom duration (> 48 h) was linked to greater severity and lower eGFR. **Conclusion:** Increasing hydronephrosis severity and longer symptom duration were strongly associated with progressive renal function decline, emphasizing the need for early detection and prompt management of ureteric obstruction.

Keywords: Hydronephrosis, Renal Function, Ureteric Obstruction.

INTRODUCTION

Nephrolithiasis represents a prevalent and increasingly encountered urological disorder globally, with its incidence and impact varying according to geographic region, sex, and underlying metabolic conditions. It predominantly affects adults during their most active and productive years [1]. Beyond causing episodes of acute renal colic, recurrent stone formation can lead to persistent reductions in health-related quality of life, manifesting as pain, sleep disturbances, and increased healthcare utilization. Furthermore, it is associated with a heightened risk of chronic kidney disease and downstream cardiovascular complications, highlighting the importance of timely diagnosis and appropriate triage [2,3]. Patients presenting with renal stones often experience sudden, severe flank pain characteristic of renal or ureteric colic, which constitutes one of the most common urological emergencies. Clinically, the majority of patients fall within the age range of 30 to 60 years, and men are approximately three times more likely than women to develop this condition [4].

Hydronephrosis refers to the dilation of the renal collecting system, which includes the renal pelvis, infundibula, and calices [5]. The Society of Fetal

Urology (SFU) grading system classifies hydronephrosis into five grades: Grade 0 indicates no dilatation; Grade 1 denotes dilatation of the renal pelvis; Grade 2 represents mild caliceal dilatation; Grade 3 indicates severe caliceal dilatation; and Grade 4 corresponds to parenchymal atrophy [6,7]. Hydronephrosis serves as a crucial imaging marker for obstructive uropathy, with the grade of dilatation reflecting the extent of renal damage [8]. Ultrasonography, in particular, is highly effective in detecting hydronephrosis resulting from ureteric obstruction caused by renal stones, providing a non-invasive and accurate method for clinical assessment.

Current literature reveals that there is limited research examining the relationship between stone size, stone location within the urinary tract, and the resulting grade of hydronephrosis. For healthcare providers, the key clinical question often extends beyond the mere presence of a stone to whether it is producing significant obstruction that requires intervention. Evidence quantifying these relationships through CT imaging in symptomatic adults could help establish standardized guidelines for clinical decision-making, enable timely decompression when necessary, and reduce unnecessary hospital admissions or procedures

[9-11] Although prior studies have investigated potential predictors of obstruction severity, including hydronephrosis grade, ureteral diameter, renal parenchymal thickness, and the presence of bilateral disease, the predictive models proposed so far remain inconsistent and inconclusive [12,13]. The purpose of the study is to evaluate the relationship between hydronephrosis severity and renal function parameters in patients with ureteric obstruction.

Objective

- To evaluate the relationship between hydronephrosis severity and renal function parameters in patients with ureteric obstruction.

METHODOLOGY & MATERIALS

This cross-sectional study was conducted at the Department of Urology, Bangladesh Medical University (BMU), Dhaka, Bangladesh, from January to December 2024. A total of 80 patients diagnosed with ureteric obstruction were included, selected based on specific inclusion and exclusion criteria. Data were collected to evaluate the relationship between hydronephrosis severity and renal function parameters.

Inclusion Criteria:

- Adult patients (age ≥ 18 years).
- Sonographically confirmed hydronephrosis with a documented ureteric cause (calculus, stricture, or external compression) on further imaging (e.g., Non-Contrast Computed Tomography – NCCT).

- Availability of renal function tests (serum creatinine) at the time of diagnosis.

Exclusion Criteria:

- Patients with bilateral ureteric obstruction.
- Patients with known chronic kidney disease or previous renal surgery.
- Patients with urinary tract malignancy or congenital urinary tract anomalies.
- Pregnant women.
- Patients with incomplete clinical or imaging data.

Socio-demographic and clinical data, including age, sex, side of obstruction, and underlying cause, were collected through structured interviews and medical record review. Hydronephrosis severity was assessed using ultrasonography and categorized as mild, moderate, or severe. Renal function was evaluated using serum creatinine, estimated glomerular filtration rate (eGFR), and split renal function of the affected kidney determined by radionuclide renal scintigraphy. Duration of symptoms from onset to presentation was also recorded and analyzed in relation to hydronephrosis severity and renal function. Statistical analysis was performed using SPSS version 26. Continuous variables were presented as mean $\pm$ standard deviation, and categorical variables as frequency and percentage. Comparisons across hydronephrosis grades were conducted using one-way ANOVA, and correlations were assessed using Pearson's correlation coefficient, with a p-value <0.05 considered statistically significant.

RESULTS

Table 1: Socio-demographic and Clinical Characteristics of the Study Population (n = 80)

Variables		Frequency (n)	Percentage (%)
Age group (years)	18–39	22	27.5
	40–59	35	43.8
	≥ 60	23	28.7
	Mean $\pm$ SD	48.2 $\pm$ 13.7	
Sex	Male	52	65.0
	Female	28	35.0
Side of obstruction	Right	42	52.5
	Left	38	47.5
Cause of obstruction	Ureteric calculus	58	72.5
	Stricture	14	17.5
	External compression	8	10.0

Table 1 shows that among the 80 patients with ureteric obstruction, the largest proportion (35 patients, 43.8%) were aged between 40–59 years, followed by 22 patients (27.5%) aged 18–39 years and 23 patients (28.7%) aged 60 years or above, with a mean age of 48.2 $\pm$ 13.7 years. There was a clear male predominance, with 52 males (65.0%) compared to 28

females (35.0%). Right-sided obstruction was slightly more common, affecting 42 patients (52.5%), while 38 patients (47.5%) had left-sided involvement. The leading cause of obstruction was ureteric calculus, observed in 58 patients (72.5%), followed by ureteric stricture in 14 patients (17.5%) and external compression in 8 patients (10.0%).

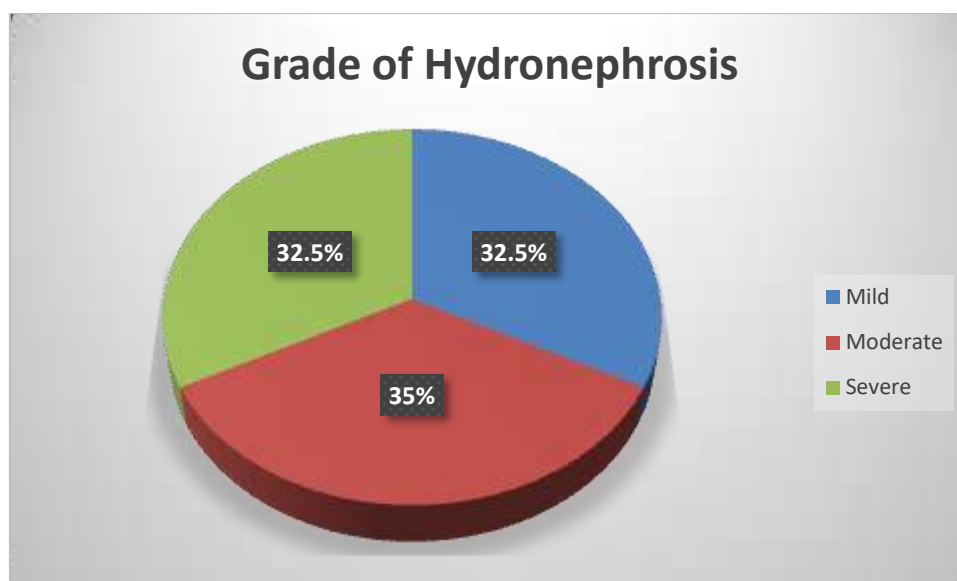


Figure 1: Distribution of Patients According to Grade of Hydronephrosis (n = 80)

Figure 1 shows that among the 80 patients, 26 patients (32.5%) had mild hydronephrosis, 28 patients (35.0%)

had moderate hydronephrosis, and 26 patients (32.5%) had severe hydronephrosis.

Table 2: Renal Function Parameters According to Grade of Hydronephrosis (n = 80)

Parameters	Mild (n=26)	Moderate (n=28)	Severe (n=26)	p-value
Serum Creatinine (mg/dL), Mean $\pm$ SD	1.0 $\pm$ 0.2	1.4 $\pm$ 0.3	2.3 $\pm$ 0.6	<0.001*
eGFR (mL/min/1.73 m ²), Mean $\pm$ SD	85.1 $\pm$ 9.5	62.3 $\pm$ 8.7	36.8 $\pm$ 11.2	<0.001*
Split Renal Function (affected kidney, %), Mean $\pm$ SD	44.8 $\pm$ 3.5	35.2 $\pm$ 4.1	20.5 $\pm$ 7.8	<0.001*

Table 2 shows that renal function declined progressively with increasing severity of hydronephrosis. Patients with mild hydronephrosis had a mean serum creatinine of 1.0 $\pm$ 0.2 mg/dL, a mean eGFR of 85.1 $\pm$ 9.5 mL/min/1.73 m², and a mean split renal function of 44.8 $\pm$ 3.5% in the affected kidney. Those with moderate hydronephrosis had higher serum creatinine (1.4 $\pm$ 0.3 mg/dL), lower eGFR (62.3 $\pm$ 8.7

mL/min/1.73 m²), and reduced split renal function (35.2 $\pm$ 4.1%). Patients with severe hydronephrosis demonstrated the greatest impairment, with a mean serum creatinine of 2.3 $\pm$ 0.6 mg/dL, eGFR of 36.8 $\pm$ 11.2 mL/min/1.73 m², and split renal function of 20.5 $\pm$ 7.8%. All comparisons were statistically significant (p < 0.001).

Table 3: Correlation Between Hydronephrosis Grade and Renal Function Parameters (n = 80)

Correlation Variable	Pearson's r	p-value
Hydronephrosis Grade vs Serum Creatinine	0.79	<0.001
Hydronephrosis Grade vs eGFR	-0.82	<0.001
Hydronephrosis Grade vs Split Renal Function	-0.85	<0.001

Table 3 demonstrates the relationship between hydronephrosis severity and renal function parameters. A strong positive correlation was observed between hydronephrosis grade and serum creatinine (r = +0.79, p

< 0.001), while strong negative correlations were found with eGFR (r = -0.82, p < 0.001) and split renal function of the affected kidney (r = -0.85, p < 0.001).

Table 4: Association of Duration of Symptoms with Hydronephrosis Severity and Renal Function (n = 80)

Duration of Symptoms	Mild (n=26)	Moderate (n=28)	Severe (n=26)	p-value
$\leq$ 48 hours, n (%)	18 (69.2%)	10 (35.7%)	4 (15.4%)	<0.001
>48 hours, n (%)	8 (30.8%)	18 (64.3%)	22 (84.6%)	
Mean eGFR (mL/min/1.73 m ²) $\pm$ SD	85.1 $\pm$ 9.5	62.3 $\pm$ 8.7	36.8 $\pm$ 11.2	<0.001

Table 4 shows that the duration of symptoms was significantly associated with the severity of

hydronephrosis and renal function. Among patients with mild hydronephrosis, 18 patients (69.2%) presented within $\leq$ 48 hours of symptom onset, whereas

only 4 patients (15.4%) with severe hydronephrosis had early presentation. Conversely, longer symptom duration (>48 hours) was more common in patients with moderate (18 patients, 64.3%) and severe hydronephrosis (22 patients, 84.6%). Mean eGFR declined progressively with increasing hydronephrosis severity, from 85.1 ± 9.5 mL/min/1.73 m² in mild cases to 36.8 ± 11.2 mL/min/1.73 m² in severe cases ($p < 0.001$).

DISCUSSION

Ureteric obstruction is a common urological condition that can lead to significant renal impairment if not promptly recognized and managed. Hydronephrosis, the dilation of the renal collecting system, serves as a key marker of the severity of obstruction and reflects the degree of renal functional compromise. The findings of this study demonstrate that increasing severity of hydronephrosis is associated with progressive deterioration of renal function, as evidenced by rising serum creatinine, declining eGFR, and reduced split renal function in the affected kidney. These results underscore the clinical importance of early detection and assessment of hydronephrosis severity in patients with ureteric obstruction to guide timely intervention and preserve renal function.

In the present study, the majority of patients with ureteric obstruction were within the 40–59-year age group (43.8%), with a mean age of 48.2 ± 13.7 years, indicating that the condition predominantly affects individuals in the middle decades of life. This finding closely aligns with the observations of Jeevaraman *et al.*[14], who reported the highest incidence between 21–49 years (~60%), and Jagannath *et al.*[15], who found a similar concentration between 31–50 years (~52%). A male predominance (65%) was noted in our study, consistent with the findings of both Jeevaraman *et al.*[14] (57.8%) and Jagannath *et al.*[15] (57.8%), reflecting the higher predisposition of males to stone formation, possibly due to dietary, metabolic, and occupational factors. The right side was slightly more affected (52.5%) than the left (47.5%), which also corresponds with the trends reported by both reference studies, where right-sided involvement was marginally higher (~50.37%). The most common cause of obstruction in our cohort was ureteric calculus (72.5%), followed by stricture (17.5%) and external compression (10%), reinforcing the established understanding that calculi remain the predominant etiology of ureteric obstruction in most adult populations.

In this study, hydronephrosis severity among patients with ureteric obstruction was distributed as 26 patients (32.5%) with mild, 28 patients (35.0%) with moderate, and 26 patients (32.5%) with severe hydronephrosis. These findings align with previous reports demonstrating that hydronephrosis commonly presents across a spectrum of severity in adults with urinary tract obstruction. Alshoabi *et al.*[16], in an ultrasonographic

assessment of 233 patients, reported that hydronephrosis occurred in varying grades, with the majority exhibiting moderate obstruction (Grade 2: 58.8%). Similarly, Mahmud *et al.*[17] observed a comparable range of hydronephrosis severity among 248 patients with urinary stones, indicating that obstruction may manifest from mild to severe forms. Collectively, these studies highlight that hydronephrosis in ureteric obstruction typically spans a wide severity spectrum, consistent with the distribution seen in our cohort.

Renal function in our study declined progressively with increasing hydronephrosis severity. Patients with mild hydronephrosis had a mean serum creatinine of 1.0 ± 0.2 mg/dL, eGFR of 85.1 ± 9.5 mL/min/1.73 m², and split renal function of $44.8 \pm 3.5\%$, whereas those with moderate and severe hydronephrosis exhibited progressively higher serum creatinine, lower eGFR, and reduced split renal function, with all differences being statistically significant ($p < 0.001$). These findings are in line with previous studies demonstrating a clear relationship between hydronephrosis severity and renal impairment. Mohammadi-Sichani *et al.*[18] reported that higher grades of hydronephrosis were significantly associated with lower GFR ($p = 0.000$), while Singla *et al.*[19] observed that adults with ureteropelvic junction obstruction exhibited lower split renal function in more severe cases. Collectively, these findings reinforce that increasing hydronephrosis severity in ureteric obstruction correlates strongly with deterioration in renal function.

A strong positive correlation was observed between hydronephrosis grade and serum creatinine ($r = 0.79$, $p < 0.001$), and strong negative correlations with eGFR ($r = -0.82$, $p < 0.001$) and split renal function ($r = -0.85$, $p < 0.001$). These results indicate that as hydronephrosis severity increases, renal function worsens proportionally. Similar trends were noted by Kumar *et al.*[20], who demonstrated a linear relationship between the severity of histological changes and preoperative split renal function in patients with ureteropelvic junction obstruction, showing that greater obstruction corresponded to lower renal function. Likewise, Wang *et al.*[21] reported that higher grades of obstructive hydronephrosis were associated with greater functional impairment, including significant reductions in GFR. Together, these findings affirm that hydronephrosis grade serves as a reliable indicator of renal function decline in ureteric obstruction.

Finally, a clear relationship was observed between the duration of symptoms, severity of hydronephrosis, and renal function. Patients presenting within ≤ 48 hours predominantly exhibited mild hydronephrosis (69.2%), whereas those with symptom duration >48 hours had a higher frequency of moderate (64.3%) and severe (84.6%) hydronephrosis. Correspondingly, the mean eGFR progressively declined with increasing

hydronephrosis grade, from 85.1 ± 9.5 mL/min/1.73 m² in mild cases to 36.8 ± 11.2 mL/min/1.73 m² in severe cases ($p < 0.001$). These findings are consistent with Li *et al.*[22], who reported significantly lower pre-treatment eGFR among patients with longer symptom duration and more advanced hydronephrosis grades, suggesting that both duration of obstruction and hydronephrosis severity are strong predictors of renal functional impairment. This emphasizes the importance of early diagnosis and prompt intervention to prevent irreversible renal damage in ureteric obstruction.

Limitations of the study

The study had a few limitations:

- The study was conducted with a relatively small sample size, which may limit the generalizability of the findings to the broader population.
- As a single-center study based in one hospital, the results may not fully represent the national population or reflect variations in other regions.

CONCLUSION

This study demonstrated that increasing severity of hydronephrosis was closely associated with progressive deterioration of renal function in patients with ureteric obstruction. Patients with more advanced hydronephrosis showed higher serum creatinine and lower eGFR and split renal function values, indicating significant impairment of renal performance. A clear correlation was also observed between longer duration of symptoms and greater hydronephrosis severity, emphasizing the impact of delayed presentation on renal outcome. These findings highlight that both the degree and duration of obstruction are critical determinants of renal function, underscoring the importance of early diagnosis and timely intervention to prevent permanent renal damage.

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