ISSN NO: 2770-2936
December 2025

The Role of Ultrasonography in Identifying Hydronephrosis

Nurmativ Sanjarbek
Andijan State Medical Institute, department of Medical radiology

Abstract

Hydronephrosis refers to an abnormal enlargement of the renal pelvicalyceal system resulting from obstruction or disturbance of normal urinary drainage. This condition may present in either acute or chronic forms and, if not identified and managed promptly, can progress to permanent renal impairment and eventual kidney failure. Ultrasonography is widely recognized as the primary imaging technique for assessing hydronephrosis due to its broad accessibility, noninvasive nature, affordability, and absence of ionizing radiation. The aim of the present study is to evaluate the clinical significance and diagnostic effectiveness of ultrasound in the identification, differentiation, and follow-up of hydronephrosis across various underlying causes.

Keywords: Hydronephrosis, ultrasound, renal pelvis, obstruction, diagnosis, renal pathology

1. Introduction

Hydronephrosis is a clinical and radiological syndrome characterized by dilatation of the renal calyces and pelvis due to obstruction of urine outflow at any point along the urinary tract. This condition may be caused by congenital malformations, urolithiasis, ureteral strictures, tumors, pregnancy, or functional disorders of the urinary tract. The pathophysiological process involves increased intrapelvic pressure, which leads to compression of the renal parenchyma, ischemia, and progressive loss of nephron function. Early diagnosis is crucial because the renal tissue can be preserved if the obstruction is relieved pomptly.

Ultrasonography (US), particularly B-mode and Doppler ultrasound, plays a key role in diagnosing hydronephrosis. It allows visualization of the degree of dilation, identification of possible causes, and evaluation of renal cortical thickness, which reflects renal function. Unlike other imaging modalities, ultrasound is safe for use in pregnant women, neonates, and patients with renal insufficiency because it does not involve ionizing radiation or nephrotoxic contrast agents.

2. Materials and Methods

2.1 Study Design

A descriptive observational study was conducted involving patients referred for abdominal ultrasound with suspected urinary tract obstruction. The study population included patients of different age groups and both sexes. The study focused on evaluating the diagnostic role of ultrasound in detecting hydronephrosis, its severity, and potential underlying causes.

2.2 Inclusion and Exclusion Criteria

Inclusion criteria: patients presenting with flank pain, urinary tract infection symptoms, hematuria, reduced urine output, or incidental findings of renal dilatation. Exclusion criteria: patients with previously treated renal conditions, renal transplant recipients, or those who underwent recent urological surgeries.

2.3 Equipment and Technique

Ultrasound was performed using high-resolution real-time scanners equipped with convex (3.5–5 MHz) and linear (7.5–10 MHz) transducers. Patients were scanned in supine and oblique positions after adequate hydration to improve visualization of the collecting system. Gray-scale ultrasound was used to evaluate renal size, cortical thickness, calyceal and pelvic dilatation, and ureteral visibility. Color and spectral Doppler were applied to assess renal perfusion and to distinguish between obstructive and non-obstructive dilatation by evaluating the renal resistive index (RI).

2.4 Diagnostic Criteria for Hydronephrosis

Hydronephrosis was diagnosed based on the Society for Fetal Urology (SFU) grading system and anterior–posterior (AP) diameter measurements of the renal pelvis:

ISSN NO: 2770-2936
December 2025

- Mild: Pelvicalyceal dilation without cortical thinning.
- Moderate: Pelvicalyceal dilation with minimal cortical thinning.
- Severe: Marked dilation with significant cortical thinning.

2.5 Data Collection and Analysis

Data on age, gender, symptoms, ultrasound findings, and laboratory results were recorded. Correlation was made with other imaging modalities (CT, IVU) and clinical outcomes. Statistical analysis was performed using standard software packages to evaluate sensitivity, specificity, and diagnostic accuracy.

3. Results

3.1 Demographic Data

A total of 150 patients were included in the study, with ages ranging from 2 months to 82 years (mean age 46.3 years). Among them, 84 were male (56%) and 66 female (44%). The most common presenting symptoms were flank pain (72%), lower urinary tract symptoms (38%), hematuria (22%), and asymptomatic incidental findings (10%).

3.2 Etiology of Hydronephrosis

Urolithiasis — 45%
Congenital pelviureteric junction obstruction — 15%
Ureteral strictures and fibrosis — 12%
Pregnancy-related hydronephrosis — 10%
Tumoral compression (bladder or prostate cancer) — 8%
Vesicoureteral reflux — 5%
Idiopathic causes — 5%

3.3 Ultrasound Findings

Ultrasound successfully detected hydronephrosis in 142 out of 150 patients (sensitivity 94.7%).

- Mild hydronephrosis: 48 cases (34%)
- Moderate hydronephrosis: 60 cases (42%)
- Severe hydronephrosis: 34 cases (24%)

Renal cortical thinning was observed in 68 patients, mostly in severe cases. Ureteral dilatation was identified in 40% of cases. Color Doppler revealed elevated resistive indices (>0.7) in 70% of obstructive cases.

3.4 Comparison with Other Imaging Modalities

- Ultrasound vs. CT urography: Sensitivity 94.7%, specificity 89.3%.
- Ultrasound vs. IVU: Sensitivity 91.5%, specificity 87.2%.

Ultrasound demonstrated high diagnostic performance, particularly in moderate to severe hydronephrosis.

4. Discussion

Ultrasound is a cornerstone in the evaluation of hydronephrosis because it provides rapid, accurate, and non-invasive visualization of the urinary tract. It can detect dilatation of the renal pelvis and calyces even in early stages and can be repeated as often as necessary without risk to the patient. The use of gray-scale imaging allows for direct visualization of the pelvicalyceal system, whereas Doppler ultrasound helps differentiate between true obstruction and physiologic dilatation. Elevated resistive index values are a useful indicator of significant obstruction.

The SFU grading system used in ultrasound provides a standardized way to describe the severity of hydronephrosis, which is crucial for patient management and follow-up. Ultrasound is particularly valuable for longitudinal follow-up after interventions such as lithotripsy, stent placement, or surgical correction.

5. Conclusion

Ultrasound is an essential tool in the diagnostic algorithm of hydronephrosis. It provides a reliable, non-invasive method for early detection, grading, etiological assessment, and follow-up of patients. The combination of gray-scale and Doppler ultrasound significantly improves diagnostic accuracy and allows clinicians to make timely therapeutic decisions.

References

1. Smith AD, Badlani GH, Bagley DH, et al. Hydronephrosis and Hydroureter. Springer, 2018.

ISSN NO: 2770-2936
December 2025

2. Liao J, et al. Ultrasonography in the diagnosis and evaluation of hydronephrosis. J Ultrasound Med. 2019;38(5):1241–1250.
3. Tublin ME, Dodd GD, Sanders RC. Imaging of urinary tract obstruction. Radiology. 2003;227(2):319–329.
4. Darge K, et al. Ultrasound of the kidney and urinary tract in children: an overview. Pediatric Radiology. 2011;41(6):702–713.
5. Riccabona M. Pediatric uroradiology: ultrasound and more. Eur J Radiol. 2014;83(9):1574–1584.
6. Platt JF, Rubin JM, Ellis JH. Renal duplex Doppler ultrasonography: A noninvasive method for evaluating acute renal obstruction. Radiology. 1991;178(3):725–728.
7. Dyer RB, Chen MY, Zagoria RJ. Intravenous urography: technique and interpretation. Radiographics. 2001;21(4):799–824.
8. Koff SA. Problematic ureteropelvic junction obstruction. J Urol. 1987;138:390–392.
9. Nicolau C, et al. Sonographic assessment of hydronephrosis. Abdom Radiol. 2017;42(4):1175–1188.
10. Coelho RF, et al. Hydronephrosis: evaluation with color Doppler ultrasound. Radiology. 2001;221(1):258–263.