An overview of hydronephrosis in adults

Abstract

Hydronephrosis is diagnosed more often with the increased availability of computed tomography and ultrasound scanning. Hydronephrosis is an important consideration in patients with abdominal or pelvic pathology as progressive dilation of the upper urinary tract can lead to acute kidney injury and, if not corrected, permanent nephron loss. This article explores how to approach an adult patient with hydronephrosis, encompassing aetiology, clinical presentation, diagnosis and management.

Key words: Urology; Surgery; Upper tract infection; Hydronephrosis; Benign prostatic hyperplasia; Pelviureteric junction obstruction; Malignancy; Ureter

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Kishan Patel[1]

Deepak Batura[1]

Author details can be found at the end of this article

Correspondence to: Kishan Patel; kishan.patel7@nhs.net

Introduction

Hydronephrosis is unilateral or bilateral urine-filled aseptic dilation of the renal pelvis and calyces. When combined with dilation of the ureters, it is known as hydroureteronephrosis. Imaging modalities for the detection of hydronephrosis include computed tomography, intravenous urography and ultrasound. Hydronephrosis may be identified incidentally through imaging requested to investigate a non-related intra-abdominal symptom or in a symptomatic patient with loin pain and a rising creatinine level.

Dilation of the renal pelvis and collecting system is a response to obstruction or urinary reflux; it reflects smooth muscle hypertrophy and accumulation of urine above the level of the obstruction. The pressure is transmitted to the delicate tubular system and leads to tubulointerstitial nephritis because of deposition of excessive amounts of extracellular matrix (Doig and Huether, 2014). The result is decreased glomerular filtration rate, decreased renal blood flow and nephron loss.

Aetiology and clinical presentation

The classification of hydronephrosis is outlined in Table 1. Common causes of unilateral hydronephrosis (Table 2) are obstructive ureteric calculi or idiopathic pelviureteric junction obstruction. Primary pelviureteric junction obstruction (Figure 1) may be the result of uminal narrowing caused by a defective recanalisation process in utero at the cephalad end

Table 1. Classification of hydronephrosis

Cause	Congenital, eg posterior urethral valves
	Acquired, eg calculus obstruction
Level	Upper tract: ureter or above
	Lower tract: bladder or below
Unilateral or bilateral	Both kidneys are usually involved in lower tract obstruction
	An individual kidney can be affected by upper tract obstruction
Complete or partial	Complete obstruction is the most common cause of anuria
	Partial: can be challenging to diagnose, urine output may vary
Intrinsic or extrinsic	Intrinsic: arising within the urinary tract, eg ureteric stone
	Extrinsic: arising externally, eg tumours

From Steddon et al (2014)

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of the developing ureter. Acquired stenosis of the pelviureteric junction can result from upper tract infections, stones, trauma or ischaemia, which can all cause reactive fibrosis and an annular stricture. Patients with pelviureteric junction obstruction may present with gradual worsening pain and dragging heaviness in the loin worsened by increased fluid intake. Intermittent hydronephrosis that occurs suddenly (Dietl's crisis) causes acute renal pain because of obstruction at the pelviureteric junction.

Classically patients with ureteric colic present with flank pain radiating to the groin and gross or microscopic haematuria. The character of this pain will vary depending on whether the obstruction is acute or chronic and partial or complete.

Bilateral hydronephrosis

Bilateral hydronephrosis can be a problem in men secondary to benign prostatic hyperplasia. A combined analysis of 25 studies showed that 7% of patients with clinical symptoms of benign prostatic hyperplasia will have hydronephrosis and up to 33% of them will have associated renal insufficiency (McConnell et al, 1994).

Bilateral hydronephrosis can develop in chronic high-pressure retention defined by Reynard et al (2013) as maintenance of voiding with a bladder volume of higher than 800 ml and an intravesical pressure above 30 cmH_2O. A man with chronic high-pressure

Table 2. Causes of unilateral hydronephrosis

Obstructing ureteric stone	
Pelviureteric junction obstruction	
Obstructing ureteric clot	
Obstructing ureteric transitional cell carcinoma	
Vascular compression: aberrant lower polar vessel or retrocaval ureter	
Extramural ureteric compression	Tumour
	Granuloma
	Cyst
	Lymph node

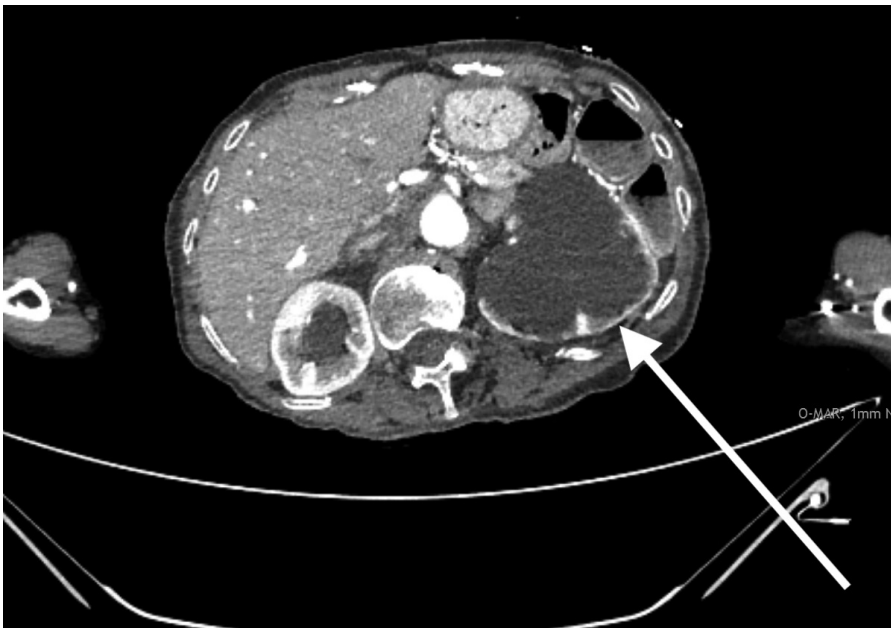

Figure 1. Computed tomography of the chest, abdomen and pelvis with contrast showing a severely dilated left pelvicalyceal system (arrow) as a result of primary pelviureteric junction obstruction.

retention may void spontaneously and will often have no sensation of incomplete bladder emptying because of gross distention of the bladder. These patients may have urinary dribbling and a palpable bladder; over time, this can lead to renal failure. Table 3 shows other causes of bilateral hydronephrosis.

Pregnancy is a physiological cause of hydronephrosis. The mechanism is related to high levels of circulating progesterone during pregnancy. During pregnancy, about 90% of women will have some degree of dilation of the calyces, renal pelvis and proximal ureters (Ferguson and Bechtel, 1991).

Iatrogenically a ureter may be ligated, especially during gynaecological or colorectal surgery, because of the proximity of the uterine artery and bowel to the ureter. Postoperatively patients may present with fever, flank pain and peritonitis.

Diagnosis

Hydronephrosis should be approached initially with a thorough abdominal examination and a focused history. Look for surgical scars, organomegaly and masses. Palpate the kidneys bilaterally looking for tenderness or nephromegaly, also percuss and palpate for an enlarged urinary bladder. Measure blood pressure and examine for signs of fluid overload. In men perform a digital rectal examination and examine the external genitals. In women genital examination is rarely required and is best carried out by a specialist. Check serum creatinine level, and urea and electrolytes. It is important to note that the serum creatinine level may be normal in a patient with unilateral hydronephrosis because of compensation

Table 3. Causes of bilateral hydronephrosis

Bladder outlet obstruction	Benign prostatic hyperplasia
	Prostate cancer
	Urethral stricture
	Detrusor sphincter dyssynergia
	Posterior urethral valves
Ureteric obstruction at their entry to the bladder	Cervical cancer
	Prostate cancer
	Rectal cancer
	Neuropathic bladder (spinal cord injury, spina bifida, diabetes, multiple sclerosis, parkinsonism)
	Post-pelvic radiotherapy
Peri-ureteric inflammation	Inflammatory bowel disease
	Pancreatitis
	Diverticulitis
	Appendicitis
Retroperitoneal fibrosis	Idiopathic
	Periarteritis
	Post-radiation
	Drugs – methysergide, hydralazine, haloperidol, methyldopa, beta-blockers, phenacetin, amphetamine
	IgG4 related disease
	Infection – tuberculosis, syphilis, gonorrhoea
	Sarcoidosis
Hydronephrosis of pregnancy	
Bilateral pelviureteric junction obstruction	
Bilateral ureteric calculi	

from the contralateral kidney. However, the patient may have severe ipsilateral flank pain because of distention of the renal calyces and pelvis – this needs prompt treatment to prevent permanent damage to the kidney.

Urine dipstick and mid-stream urine may give evidence to suggest a upper tract infection. Hydronephrosis may lead to pyonephrosis caused by stasis of urine in the presence of a upper tract infection; pus may collect in the upper collecting system and disseminate into the renal parenchyma causing acute pyelonephritis. In this case urgent treatment of the underlying causes is necessary as the patient may be systemically unwell with progression to sepsis indicated by fever, rigours, hypotension, tachycardia, and a rising white cell count and C-reactive protein level.

Renal ultrasound (Figure 2) is usually the imaging modality of choice unless nephrolithiasis is suspected. This will evaluate the kidneys and collecting system. Hydronephrosis is seen as an anechoic fluid-filled interconnected space with enhancement within the renal sinus, and usually the dilated pelvis can be differentiated from the dilated calyces.

Computed tomography urography provides excellent delineation of the urinary tract. Cowan (2012) defined it as computed tomography examination of the kidneys, ureters and bladder with at least one series of images acquired during the excretory phase after intravenous contrast administration. The upper tracts can be clearly assessed with enhancement initially of the parenchyma (parenchymal phase) and then excretion of contrast through the collection system (excretory phase). Non-contrast computed tomography of the kidneys, ureters and bladder is useful in patient with suspected ureteric colic to detect renal tract calculi or calcification.

A mercaptoacetyltriglycine renogram (Figure 3) may be used to identify obstruction of the ureters, for example in pelviureteric junction obstruction. After intravenous injection of contrast media, the radioisotope is excreted through the renal collecting system. It is a dynamic test that tracks renal uptake, transit and excretion of an isotope. The test then generates a time–activity curve.

How well can renal ultrasound detect hydronephrosis compared to computed tomography?

Watkins et al (2007) studied 63 patients with suspected ureteric colic where an emergency physician or registrar performed a focused ultrasound scan, followed by a computed tomography scan within 24 hours of the ultrasound. A total of 57 patients completed the ultrasound and computed tomography imaging, of which 49 had confirmed nephrolithiasis

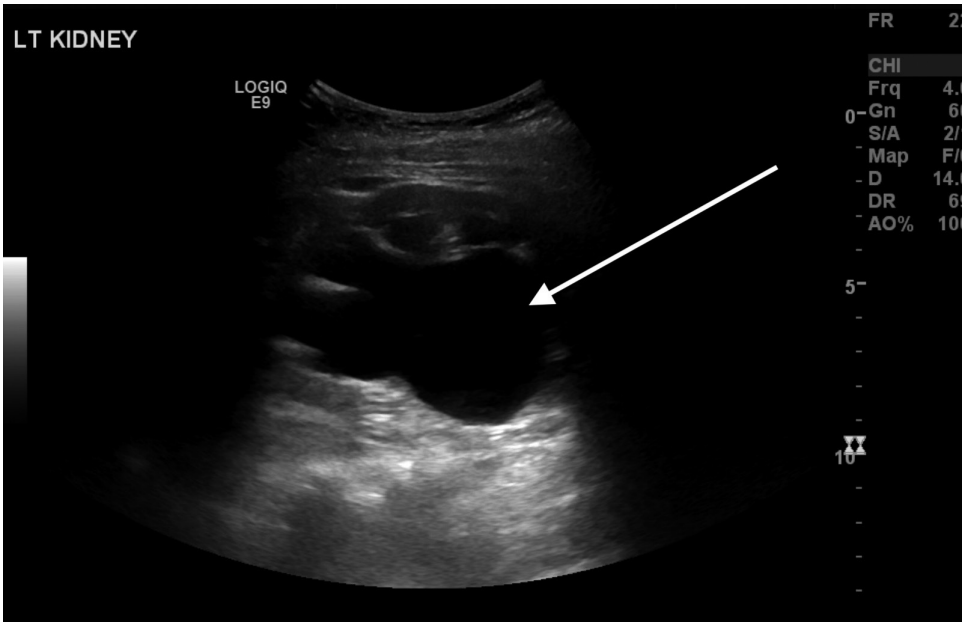

Figure 2. Ultrasound of the left kidney showing severe hydronephrosis (arrow) with thinning of the renal cortex secondary to chronic pelviureteric junction obstruction.

on computed tomography with 39 having evidence of hydronephrosis. The overall prevalence of hydronephrosis was 68% (95% confidence interval 56–79%). Compared with computed tomography, ultrasound done by the emergency physician and registrar had a sensitivity of 80% (95% confidence interval 65–89%), specificity of 83% (95% confidence interval 61–94%), positive predictive value of 91% (95% confidence interval 75–98%) and negative predictive value of 65% (95% confidence interval 43–83%). The overall accuracy was 81% (95% confidence interval 69–89%).

This study shows that ultrasound is a valuable tool for detecting hydronephrosis. It is non-invasive, uses non-ionising ultrasound waves and requires little preparation. However, image quality is operator dependent and further training in ultrasound may improve the accuracy of detection of hydronephrosis. Ultrasound rarely has contraindications and is relatively inexpensive compared to computed tomography or magnetic resonance imaging. On the other hand, computed tomography provides better image resolution, shorter scan times and the addition of contrast allows excellent visualisation of the urinary tract. Although ultrasound can accurately identify hydronephrosis, computed tomography is required when there is poor visualisation, or detailed interrogation of the urinary tract is required, for example, when staging a locally advanced renal cell carcinoma.

Management

The duration and site of obstruction should guide management. It is essential to treat any co-existing sepsis and metabolic disturbances.

In acute lower tract obstruction, urethral catheterisation will relieve pressure from a distended bladder causing high pressure chronic retention because of a lower urinary tract obstruction (Figure 4). If this is not possible because of a urethral stricture, flexible

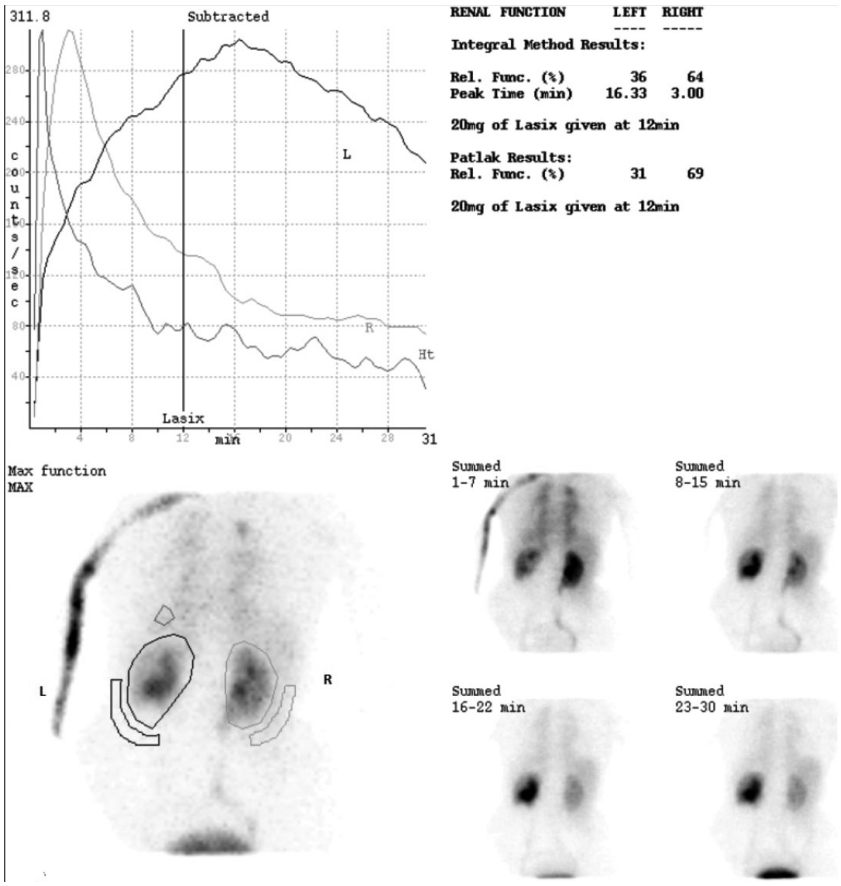

Figure 3. Mercaptoacetyltriglycine renogram in a patient with pelviureteric junction obstruction. On the left side, dynamic changes show slow uptake, distribution and extraction of tracer to the urinary bladder with temporary retention on the dilated renal pelvis.

cystoscopy-guided catheter insertion can be performed at the bedside. If this fails, suprapubic catheterisation can be considered.

If the upper tracts are obstructed, prompt treatment of the underlying cause is necessary, whether for example this is medical expulsive therapy and analgesia in a patient with a ureteric calculus or bilateral nephrostomies in a patient with retroperitoneal fibrosis. In people with acute stone episodes, the presence of complications such as fever and acute kidney injury or where medical therapy fails, a JJ stent may be cystoscopically inserted to allow the kidney to drain and relieve hydronephrosis.

Decompression of the upper urinary tracts can be performed with a nephrostomy inserted under radiological guidance. Nephrostomies are used in patients unable to tolerate general anaesthesia or where a JJ stent insertion has failed. Also, when there is a large staghorn calculus causing hydronephrosis, a nephrostomy decompresses the upper urinary tract initially and then provides access for percutaneous nephrolithotomy to allow definite fragmentation of the stone.

Pelviureteric junction obstruction may be treated with pyeloplasty either by a laparoscopic or open approach. According to the National Institute for Health and Care Excellence (2002), both procedures have very high rates of operative success, with obstructions typically removed in more than 90% of patients.

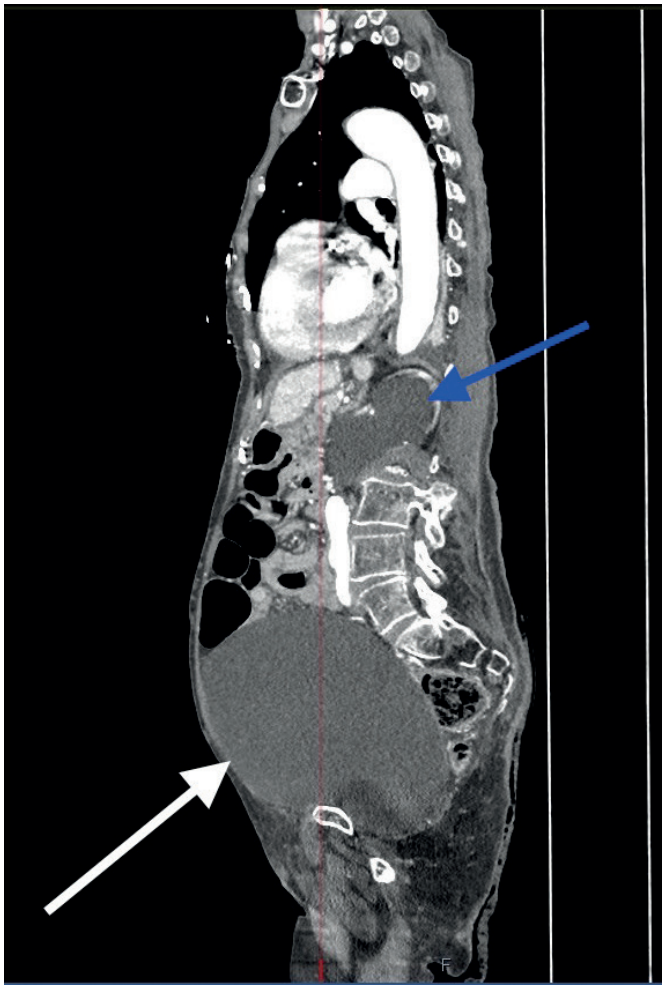

Figure 4. Sagittal view of a computed tomography scan of the chest, abdomen and pelvis with contrast showing a distended urinary bladder (white arrow) resulting from bladder outlet obstruction and left-sided hydronephrosis (blue arrow).

Conclusions

Beyond catheterising, it is also essential to look for hydronephrosis in any patient with suspected urinary tract obstruction. Compelling indications for urgent treatment of hydronephrosis would be in the case of severe ipsilateral flank pain, acute kidney injury and signs of sepsis. Further investigations with suitable imaging are often required before an appropriate management plan can be defined.

Author details
[1]Department of Urology, London North West University Healthcare NHS Trust, Harrow, UK

Conflicts of interest
The authors declare no conflicts of interest.

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Key points

- Benign prostatic hyperplasia and ureteric stones are common causes of bilateral and unilateral hydronephrosis respectively.
- Pelviureteric junction obstruction can present as loin pain, exacerbated by fluid load.
- Hydronephrosis of pregnancy is a physiological cause of hydronephrosis driven by high levels of circulating progesterone.
- Renal ultrasound is a safe imaging modality that does not use ionising radiation.
- Treatment of hydronephrosis is directed at the cause. Nephrostomies and JJ stents can be used to drain the urinary tract.

Top tips

- If urinary retention is suspected, examine the abdomen for a palpable bladder.
- If you suspect urinary retention, promptly insert a urethral catheter. Record residual volume at 10–15 minutes and describe the appearance of urine.
- Consider pelviureteric junction obstruction and malignancy in the differential for all patients who present with flank pain.

Curriculum checklist

This article addresses the following requirements from the general internal medicine training curriculum:

- Managing an acute unselected take
- Managing patients in an outpatient clinic, ambulatory or community setting, including management of long-term conditions
- Managing medical problems in patients in other specialties and special cases.

References

Cowan NC. CT urography for hematuria. Nat Rev Urol. 2012;9(4):218–226. https://doi.org/10.1038/nrurol.2012.32

Doig A, Huether S. Alterations of renal and urinary tract function. In: McCance L, Huether S, eds. Pathophysiology: the biologic basis for disease in adults and children. St. Louis (MO): Elsevier;2014.

Ferguson T, Bechtel W. Hydronephrosis of pregnancy. Am Fam Physician. 1991;43(6):2135–2137.

McConnell JD, Barry MJ, Bruskewitz RC et al. Benign prostatic hyperplasia: diagnosis and treatment. Clinical practice guidelines No 8. AHCPR Publication No 94-0582. Rockville (MD): Agency for Health Care Policy and Research, Public Health Service, US Department of Health and Human Services; 1994.

National Institute for Health and Care Excellence. Interventional procedures overview of laparoscopic pyeloplasty. 2002. https://www.nice.org.uk/guidance/ipg46/evidence/overview-pdf-255589309 (accessed 6 December 2019)

Reynard J, Brewster S, Biers S. Oxford handbook of urology. 3rd edn. Oxford: Oxford University Press: 118–120; 2013.

Steddon S, Ashman N, Chesser A, Cunnigham J. Oxford handbook of nephrology and hypertension. 2nd edn. Oxford: Oxford University Press; 2014.

Watkins S, Bowra J, Sharma P et al. Validation of emergency physician ultrasound in diagnosing hydronephrosis in ureteric colic. Emerg Med Australas. 2007;19(3):188–195. https://doi.org/10.1111/j.1742-6723.2007.00925.x