Review Article

A practical guide to urinary tract ultrasound in a child: Pearls and pitfalls

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Abstract

The aim of this review article is to equip the sonographer with the necessary knowledge to perform a detailed and clinically relevant assessment of the urinary tract in a child. Many of the techniques and principles used in the imaging of the urinary tract in adults can be applied to children. There are, however, notable differences with which the sonographer should be familiar. There is often a certain amount of trepidation when asked to image a child, but there are a number of simple steps that can make the process easier and more fulfilling. This article begins with advice on how to maintain cooperation in a child and the differences in the technical aspects of imaging of children. This is followed by a detailed review of the different pathologies that may be encountered, as well as highlighting information that is particularly relevant to the clinician looking after the child.

Keywords: Urinary tract imaging, renal tract imaging, paediatric, child, ultrasound

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Introduction

Ultrasound is the mainstay of paediatric imaging, allowing detailed evaluation without the use of ionising radiation. Children are particularly rewarding patients to ultrasound as tissue composition and body habitus allows exquisite detail to be obtained. However, children can also be one of the most challenging groups of patients to image and an efficient and sensitive approach is often necessary.

Preparation

Preparation is the key to a successful examination and there are a number of ways the sonographer can help to ensure it runs smoothly. Investing time at the beginning of the consultation helps to contribute towards a stress free examination. The time the child spends in the ultrasound room should be kept to a minimum as children can become anxious as soon as they enter an unfamiliar environment. Therefore, before they enter the ultrasound room, the sonographer should:

- Familiarise themselves with the clinical information available so that the examination can be tailored to the clinical question.
- Review any previous imaging so that a meaningful comparison can be made for the clinician.

General tips

Once the child has been brought into the room, the sonographer should:

- Try to gain the child's trust. Often a few kind words, a question about friends, family, hobbies or school may put the child at ease. Before starting the examination, the sonographer should explain the procedure using age appropriate language. This can help to alleviate any apprehension the child might have. Placing a probe with jelly applied gently on the back of the child's hand may help to demonstrate to the child that the examination will not be painful. If available, a collection of age appropriate toys or a television to watch can also be used as very effective distractions. The offer of a sticker or certificate to be given at the end of the examination can also help to encourage the child to cooperate.
- Use the appropriate probes and the appropriate machine pre-sets. This is vital and will vary depending on local equipment, any software manipulation that has been performed and what structures are to be assessed. Optimisation of the paediatric pre-sets in a general ultrasound department can sometimes be overlooked but can make an enormous difference to the image quality. In our institutions, we use a linear,

Figure 1 'Bear hug' embrace

high frequency (9 MHz or higher) probe for neonates. In older children, a 6 MHz curvilinear probe will be used for initial assessment, reserving the linear probe for more focused review. Be prepared to change probes during an examination. For instance, if the entire length of the kidney cannot be visualised with a linear probe, it may be helpful to obtain a detailed assessment of the renal architecture using the higher frequency probe and then change to a curvilinear probe for an accurate measurement of overall length.

- Have a routine in mind of the order in which the examination will be performed, but be prepared to improvise. Sometimes, despite everyone's best attempts to allay any fears, the child may remain anxious and as a consequence uncooperative. In these circumstances, it will be necessary to obtain the images opportunistically. The child may be happier lying on top of their guardian on the examination couch. Another useful way of obtaining prone images in a very distressed child is to embrace the child as demonstrated in Figure 1.

Remember, the attention span of even the most cooperative child may not be very long and it is therefore important to perform an efficient examination.

Suggested routine for paediatric urinary tract ultrasound (See tables 1–3)

Bladder

This should be examined first in the paediatric urinary tract assessment. A child who is not potty trained may micturate soon after placement of the probe on the abdomen and vital information can be lost if these initial bladder views are not obtained.

Table 1 Hints and tips for scanning the bladder

Supine bladder	
Suggested routine	a. Transverse and longitudinal bladder views b. Pre- and post-micturition bladder volumes c. Bladder wall d. Bladder contents e. Ureters f. Assess surrounding structures
Tips for scanning	1. A very full bladder can give a false impression of a dilated collecting system 2. Use colour Doppler to avoid the common pitfall of mistaking either the iliac vessels or ovaries for the ureters 3. Check behind the bladder

Table 2 Hints and tips for supine scanning of the kidneys

Supine kidneys	
Suggested routine	a. Compare the echogenicity of kidneys relative to liver and spleen b. Assess the adrenals
Tips for scanning	1. Supine measurements of kidney length can exaggerate the length, therefore prone measurements are used 2. The adrenals are most easily visualised in a neonate and are best assessed in the supine position

Table 3 Hints and tips for prone scanning of the kidneys

Prone kidneys	
Suggested routine	a. Maximal length b. Outline c. Corticomedullary differentiation d. Assess for mass or cyst e. Pelvicalyceal system f. Doppler assessment of the renal vessels
Tips for scanning	1. 10% difference in size allowed between contra-lateral kidneys 2. Is the outline smooth, irregular or is there global thinning? 3. Do not mistake the medullary pyramids for hydronephrosis 4. Note if dilatation is pelvic/calyceal or both 5. A pelvic diameter of 7 mm is the upper limit of normal for neonates and in older children it is 10 mm (measured transversely)[1,2] 6. Urothelial thickening can be seen in urinary tract infection or reflux 7. If a renal tumour is suspected, this should include the IVC to assess for tumour thrombus

Assess the bladder volume

Normal bladder volume for age can be calculated using the formula:

Age of child (yr) × 30 + 30 = bladder capacity in ml.

The interpretation of any subsequent findings should take into account how well filled the bladder is. A post-micturition bladder volume should also be obtained in a potty-trained child. Yang and Chang found that bladder over-distension, age of the child and extra hydration prior to assessment can significantly affect the post-micturition volume.[3] As a general guide, a residual volume of 20 ml or less is within normal limits.[4]

Assess the bladder wall

Is the wall smooth or irregular in contour? An irregular contour may indicate a trabeculated bladder. Assessing the child in different positions will avoid mistaking dependent debris for a focal wall abnormality. Debris can be seen secondary to dehydration or can indicate urinary tract infection.

Is the wall thickness within normal limits? A thickened bladder wall can indicate underlying abnormality such as a neurogenic bladder or distal obstruction. The wall thickness can only be accurately assessed when the bladder is full. If the bladder is not full, the sonographer should exercise caution when commenting on wall thickness. This should be measured away from the trigone, as musculature increases the wall thickness in this region. Jequier and Rousseau found a linear relationship between bladder wall thickness and distension. They suggested the bladder wall thickness should be <3 mm in a well filled bladder and <5 mm in an under-filled bladder.[5]

Examine bladder contents

The urine should ideally be anechoic but can contain internal echoes, particularly in a dehydrated child, which are not pathological. Another common cause of internal echoes is a urinary tract infection, however, haemorrhage or frank pus should be considered. Bladder stones, although uncommon, can be seen in children. Look for a ureterocoele, which can be classified as simple or ectopic and is normally seen as a thin walled intra-vesicular rounded cystic structure. The ureterocoele wall is composed of bladder and ureteral epithelium and the ureteric orifice may be stenosed or obstructed. A simple ureterocoele refers to a ureterocoele associated with a normally positioned vesico-ureteric junction (VUJ) (at the lateral aspect of the trigone). These are more commonly associated with infection and are more common in adults. An ectopic ureterocoele, which refers to a ureterocoele associated with an abnormally positioned VUJ, is one of the most common findings associated with a duplex kidney and will be discussed later (Figure 2).

Assess the ureters

The distal ureters are best evaluated in the supine position. Non-dilated ureters are occasionally visualised, however, dilated ureters should not be missed and should be examined in transverse and longitudinal planes. If the ureter is dilated, a measurement of the transverse diameter should be taken and this should be documented along with the level to which dilatation is seen. This is useful for comparison in serial scanning and also gives the clinician an overall impression of the degree of dilatation. A diagnosis that, although rare, should be considered in girls with daytime wetting is ectopic insertion of the ureter. The ureter can insert more inferiorly than expected, below the level of the sphincter, into the bladder neck, urethra or vagina. Ectopic ureters associated with a duplex kidney are discussed later.

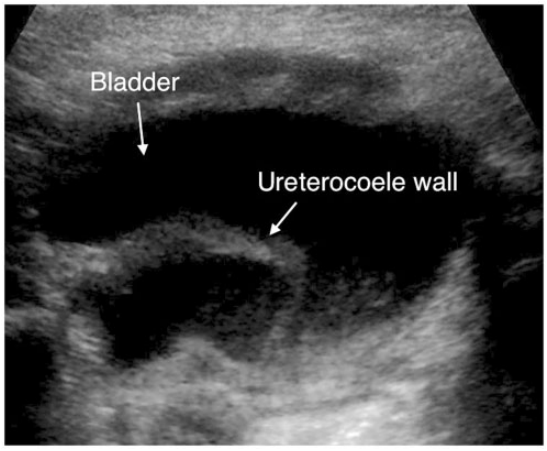

Figure 2 Ultrasound appearance of a ureterocoele

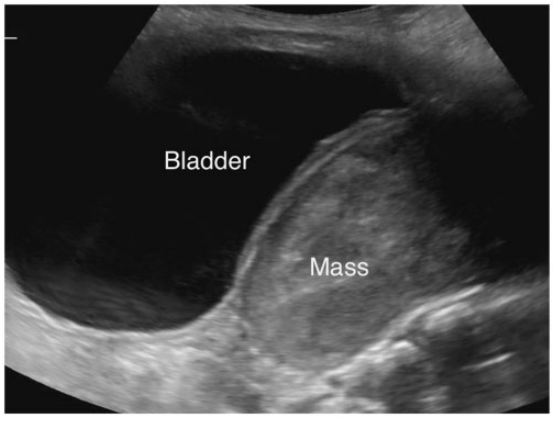

Figure 3 Longitudinal view of mass behind the bladder

Review surrounding structures

Once the examination of the bladder is complete, the surrounding structures should be evaluated. The sonographer should be aware that masses and collections can rarely be found behind the bladder and interrogation of this region will help to avoid missing an unexpected abnormality (Figure 3).

Neonatal renal ultrasound scanning

There are number of differences that can be seen between the infant and adult kidney (Figure 4):

1. Foetal lobulation of the kidney can persist into adulthood but can be very prominent in infancy.

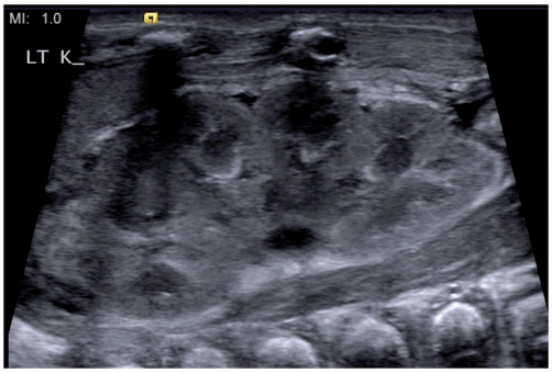

Figure 4 Normal appearance of a neonatal kidney

The kidneys are formed in utero from distinct lobules that eventually fuse. This can result in smooth indentations of the renal outline that lie in between the medullary pyramids. This should not be confused with renal scarring where more irregular indentations are seen, usually overlying the renal pyramid.

2. The cortex is thinner than seen in older children.
3. The echogenicity of the cortex is increased due to the increased density of glomeruli in the infant renal cortex, creating a greater number of ultrasound interfaces. Normal infant kidneys are therefore often of equal or increased echogenicity when compared to the liver. The kidneys become hypoechoic to the liver by approximately 4 months but this process can take up to 6 months.[6,7]
4. The medullary pyramids can look markedly hypoechoic. This, in conjunction with the increased cortical echogenicity, exaggerates the corticomedullary differentiation. This appearance should not be mistaken for hydronephrosis. A hyperechoic focus at the tip of the papillae is physiological in a neonate (if identified in an older child it can suggest hypernatraemic dehydration). This focus can help differentiate the medullary pyramids from a dilated calyceal system, if there is any doubt.
5. There is a general paucity of renal sinus fat. The echogenic renal sinus becomes more prominent with age and as the ratio of body fat increases.
6. Be aware that dehydration in the first 1–2 days of life can mask abnormalities.

Congenital anomalies

These can be divided into anomalies of number, rotation or position and are seen in 2–4% of children, although most will have no clinical manifestations.[8,9] Anomalies may be due to failure of the metanephric blastema to migrate appropriately in the expected cranial direction or of failure of separation of the primitive nephrogenic cell masses. Anomalies may be detected antenatally. Postnatal ultrasound is then used to confirm the abnormality and obtain a more detailed assessment. Kidneys may be located anywhere along their normal path of in utero ascent and it is therefore important to assess from the renal angles to the level of the bladder, including behind the bladder. The psoas muscles are useful landmarks for this purpose.

Ultrasound is also very useful to look for associated complications which include:

- Increased rates of infection;
- Stone formation;
- Reno-vascular hypertension;
- Traumatic injury to which anomalous kidneys may be more prone (traumatic injury is currently best assessed by computed tomography (CT)).[10]

Horseshoe kidney

This is the most common renal anomaly with an overall incidence of 1:600.[11] The inferior mesenteric artery prevents the connecting isthmus between the two kidneys from normal in utero ascent. The connecting isthmus can vary from functioning renal tissue to a thin fibrous band, which may not be well seen on ultrasound. Always check the lower poles of both kidneys. The lower poles of a horseshoe kidney will have a more medial orientation than expected and may be difficult to clearly delineate. Horseshoe kidneys are usually best visualised scanning anteriorly, with the isthmus often well visualised following graded compression of the central abdomen. Due to the orientation, it can be difficult to see 'the horseshoe' in one plane and scanning postero-laterally with the probe in a coronal orientation is an alternative. The most common complication is calculi (Weizer et al. found an incidence of 39%)[11] and this should be assessed for when examining a patient with a horseshoe kidney. The kidney may be drained by a variable number of ureters and associated anomalies are found in one-third of patients.[12] There is an association with Turners Syndrome and Trisomy 18.[13]

Ectopic kidneys

The incidence of renal ectopia is 0.2%.[14] The ureteral bladder insertion may be on the same or opposite side to the ectopic kidney. When there is fusion of the two kidneys with the ureteral bladder insertion on the opposite side to the ectopic kidney, it is referred to as 'crossed fused ectopia.' Most ectopic kidneys demonstrate a degree of malrotation. The incidence of associated anomalies is, in contrast to a horseshoe kidney, low. The most frequently associated abnormality is vesico-ureteric reflux.[15]

Unilateral renal agenesis

Unilateral renal agenesis has an incidence of 1:1000 births[16] and can be sporadic or inherited as an autosomal dominant trait. The left kidney is more commonly absent. This is associated with a high incidence of anomalies of the reproductive system in both sexes. When scanning a child with renal agenesis one would expect to see compensatory hypertrophy of the contralateral side.

'Duplex kidney' or uretero-pelvic duplication

These terms cover a wide range of duplication variations ranging from incomplete to complete. This is often an incidental finding in adults – in one series, the presence of a duplex kidney was thought to be an incidental finding in 73% of cases.[17] A duplex kidney is only clinically significant if associated with complications such as vesico-ureteric reflux (the most common associated abnormality)[17,18] or obstruction. The classic complete duplex kidney follows the 'Weigert-Meyer' rule:

''The upper moiety ureter inserts more inferiorly and medially than the lower moiety ureter.''

This ureter may insert into the bladder, bladder neck or urethra. The ureter is often associated with a ureterocoele which can lead to bladder outflow obstruction and resultant dilated moiety. Although this is a far more common complication associated with the upper moiety ureter, either ureter can be involved (Figure 5).

The lower moiety ureter inserts into the expected position in the bladder but has a shorter, more vertical course and is therefore more prone to vesico-ureteric reflux. It is also more prone to uretero-pelvic junction obstruction.

If uncomplicated, the only clues to the presence of a duplex kidney may be:

1. A slightly larger kidney than expected when compared to the other side.
2. Interruption of the normal continuous central sinus fat by a band of less echogenic tissue, similar in echogenicity to the renal cortex.

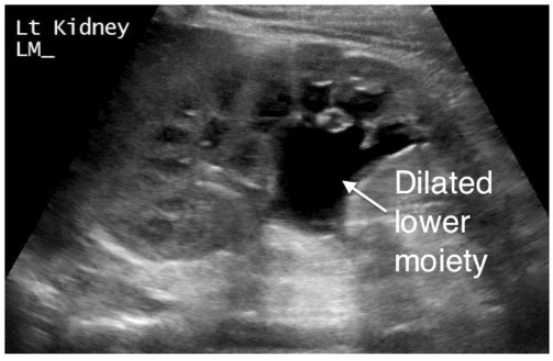

Figure 5 Duplex kidney with dilated lower moiety

Urachal remnants

The urachus is the embryological remnant of the allantois and extends from the umbilicus to the bladder dome. This normally closes before birth forming the median umbilical ligament.

The abnormalities that result for incomplete closure are listed in Table 4.

Posterior urethral valves

This is the most common urethral abnormality in boys and is due to an obstructing membrane that acts as a ball-valve causing partial obstruction to the passage of urine. The diagnosis is often suggested on prenatal imaging but postnatal ultrasound and micturating cystourethrogram are the main diagnostic modalities. If an immediate postnatal ultrasound (within 1–2 days after birth) is normal, this should be repeated after adequate hydration as hydronephrosis can be masked by dehydration.

The consequences of the obstructive valves and the associated reflux can be assessed on ultrasound:

- Trabeculated bladder wall due to muscle hypertrophy and increased connective tissue secondary to chronic obstruction (Figure 6).
- Dilated ureters (this is most commonly bilateral but can be unilateral).
- Pelvicalyceal dilatation (this is more commonly bilateral but can be unilateral).

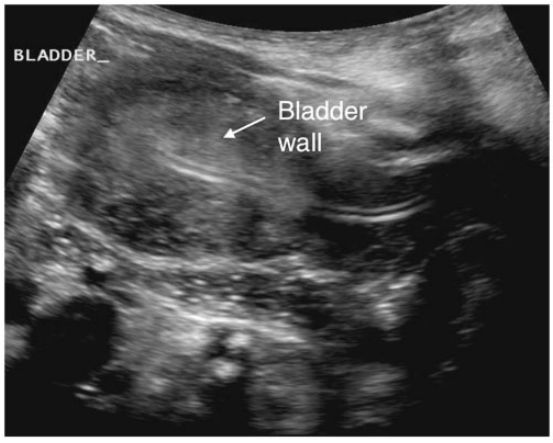

Figure 6 Thickened bladder wall (catheter in situ) in a child with chronic obstruction secondary to posterior urethral valves

Table 4 Urachal remnants[19]

Type	Frequency	Presentation
Patent urachus	16%	Open tract from bladder to umbilicus resulting in urine leak from the umbilicus. For this reason, a patent urachus is normally diagnosed in the neonatal period.
Urachal cyst	45%	Umbilical and bladder ends close leaving a fluid filled midline structure, anterior to the bladder, that may enlarge and present because of secondary infection.
Urachal sinus	37%	The umbilical end of the urachus remains patent but is no longer connected to the bladder.
Urachal diverticulum	1%	The bladder end of the urachus remains patent but is no longer connected to the umbilicus. This diagnosis should be considered if a diverticulum of the antero-superior aspect of the bladder is visualised.

- Echogenic dysplastic kidneys.
- Rarely, the dilated posterior urethra may be visible on ultrasound as a tubular cystic structure inferior to the bladder.

Renal cystic disease

Although incidental simple cysts can be uncommonly seen in children, this is a diagnosis of exclusion in the paediatric population and should prompt further investigation. If a diagnosis of an incidental simple cyst is made, the child will require long-term follow-up to monitor any development of further cysts which may suggest an underlying condition, for example, autosomal dominant polycystic kidney disease (ADPKD).[20] The cause of the cyst(s) may not be immediately evident on ultrasound. However, there are important features that should be documented, which can help the clinician to identify any underlying condition:

- What are the characteristics of the cysts? Specifically, size, number and location (cortex and/or medulla).
- Are the kidneys large or small?
- Is the intervening renal parenchyma normal?
- Are both kidneys affected?
- Are there any extra-renal abnormalities, e.g. extra-renal cysts?

First, the sonographer should carefully evaluate the 'cyst' to ensure the appearance is not due to hydronephrosis or a duplex kidney. Once the presence of cysts has been confirmed, consideration should be given to the possible causes. These can be broadly categorised into:

1. Cystic kidney disease:
   - Multi-cystic dysplastic kidneys;
   - Autosomal recessive polycystic kidney disease (ARPCKD);
   - ADPKD;
   - Cystic dysplasia (often *small* kidneys associated with cysts).
2. Syndromes associated with cysts:
   - Tuberous sclerosis;
   - Von Hippel Lindau syndrome;
3. Tumours with cystic elements:
   - Multilocular cystic nephroma (boys <4 yrs);
   - Wilms tumour (rare cystic variant).
4. Other causes of renal cysts:
   - Calyceal diverticulum;
   - Adrenal lesion;
   - Gastro-intestinal duplication cyst.

Multi-cystic dysplastic kidneys

This sporadic condition is thought to be caused by atresia of the ureter or uretero–pelvic junction during the metanephric stage of intra-uterine development. It is characterised by:

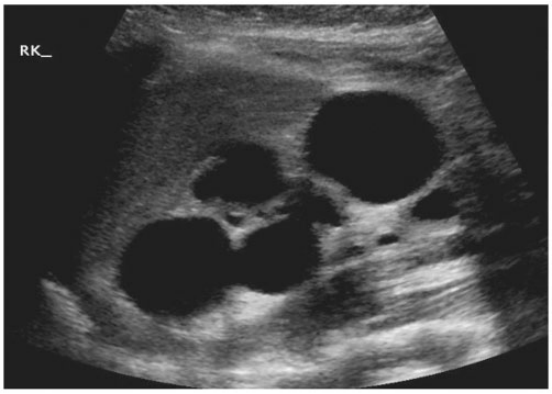

Figure 7 Multi-cystic dysplastic kidney

- Multiple cysts of varying sizes from 1 cm to 15 cm that do not interconnect with each other or the renal collecting system, said to resemble a bunch of grapes (Figure 7).
- One side predominantly affected.
- A framework of echogenic dysplastic renal tissue within which the cysts are anchored.
- Atretic renal vessels.

Nuclear scintigraphy demonstrates lack of functioning renal tissue. If renal function is demonstrated in the affected kidney, the alternative diagnosis of hydronephrosis should be considered. The contra-lateral kidney is abnormal in one-third of cases, the most common abnormality being vesico-ureteric reflux.[21]

Serial ultrasounds are performed to:

1. Assess growth in the contra-lateral kidney.
2. Document the gradual involution of the affected kidney. If growth is seen in the affected kidney, a developing Wilms tumour should be excluded (this is a rare association).

Genetic renal disease

Genetic disease usually results in a bilateral renal abnormality. ARPCKD covers a spectrum of severity in which renal disease, secondary to abnormality of the collecting tubules, is concurrent with diffuse hepatic fibrosis. Severe renal disease predominates in the infantile form. Children who present later in childhood are more likely to encounter health problems relating to hepatic fibrosis with resultant portal hypertension and concurrent mild renal involvement. The typical ultrasound appearance of ARPCKD is shown in Figure 8 and is characterised by:

- Kidneys above the 95th centile in size for age.
- Multiple tiny (1–2 mm) cysts throughout the renal parenchyma. The cysts are not normally seen as discrete entities on ultrasound due to their size. Larger cysts can be infrequently seen, but tend to be <1 cm in size.
- Echogenic parenchyma.

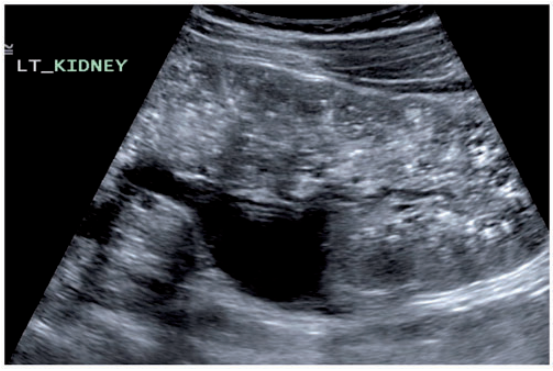

Figure 8 Autosomal recessive polycystic kidney disease

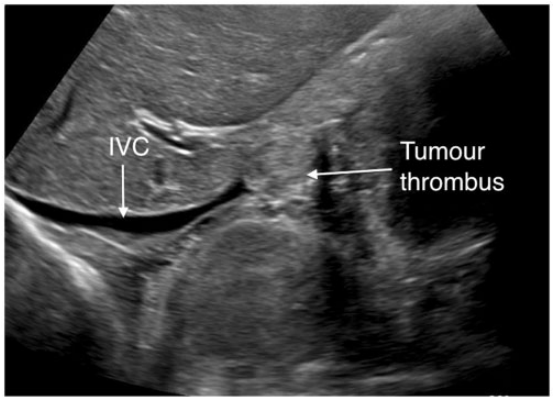

Figure 9 Tumour thrombus in IVC

Follow-up ultrasound examination should include:

1. Documentation of size of the kidneys for comparison and the development of any visible cysts.
2. Detailed assessment of the hepatic parenchyma with a high frequency linear probe.
3. Splenic size and documentation of the presence of any splenic varices.
4. Doppler studies of the portal vessels.

Conversely, ADPKD in the paediatric population is characterised by:

- Kidneys that can be within the normal size range for age (although kidney enlargement as a result of cyst expansion is the hallmark of ADPKD).
- Macroscopic cysts – typically >1 cm in size.
- Normal ultrasound appearances of the intervening parenchyma.

The disease is usually clinically silent in childhood although the pathological process begins in utero.[22] Diagnostic criteria include two or more unilateral or bilateral cysts in a patient <30 years of age with a positive family history.[23] Cysts are also found elsewhere in the body such as liver, pancreas and spleen.

Solid renal masses

Wilms tumour is the most common renal tumour of childhood with 80% of children younger than 5 years old at presentation. It is the third most common paediatric malignancy after leukaemia and central nervous system (CNS) tumours and is associated with a deletion on chromosome 11.[24] Wilms tumour is thought to originate from persistent rests of metanephric blastema that normally fully differentiate into mature renal tissue by 34 weeks gestation. Persistence of these nephrogenic rests is called nephroblastomatosis (which can be identified on ultrasound), and is considered a precursor to Wilms tumour.[25]

Children with Wilms tumour usually present with a palpable abdominal mass.

Features are:

- Large heterogenous, predominantly solid mass (1% predominantly cystic).
- A mass that causes displacement of vessels and abdominal contents.
- Extension of tumour thrombus into the renal vein and inferior vena cava (Figure 9). Doppler assessment of these vessels is therefore vital.
- Cystic areas from tumour necrosis or haemorrhage if large.
- Wilms Tumour can be bilateral in 5–10% of cases.
- Most commonly metastasises to the lung, but can also metastasise to the liver which should be carefully assessed.

If a renal mass is identified, a comment in the report on amenability to percutaneous biopsy is helpful to the clinician. There is currently a screening program for high risk patients which includes children with sporadic anirridia, hemihypertrophy syndromes including Beckwith-Weidemann, DRASH and WAGR syndromes. These children will have regular screening (normally every 3–4 months) for Wilms tumour, predominantly by ultrasound.[26]

Other solid renal tumours are rarely encountered and include renal cell carcinoma, lymphoma, rhabdoid tumour and clear cell sarcoma. Mesoblastic nephromas are benign rare tumours of infancy.

Postnatal evaluation of antenatally diagnosed renal pelvic dilatation

Antenatal detection of hydronephrosis is found in 1–5% of all pregnancies.[27] Postnatal investigation should be performed when a renal pelvis diameter of >5 mm is seen after 34 weeks.[28] The presence of calyceal dilatation is associated with a greater complication rate. The report should include an accurate transverse pelvic diameter and the presence or absence of calyceal and ureteric dilatation. Supporting information such as bladder wall thickening will help differentiate between the various causes, which include:

- Vesico-ureteric reflux;
- Duplex kidneys;
- Posterior urethral valves;
- Dysplastic kidneys.

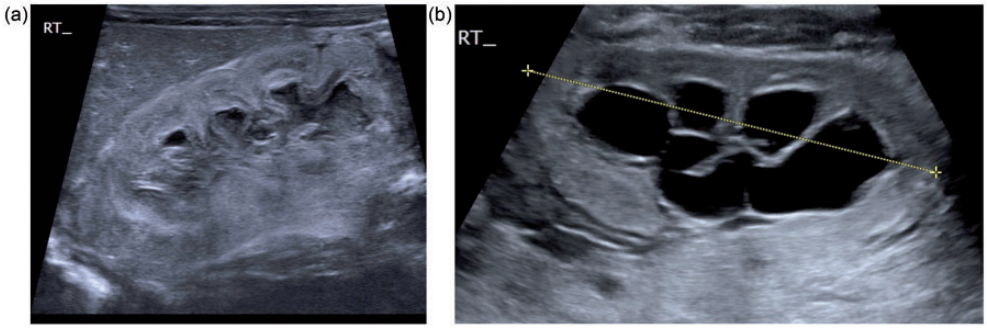

Figure 10 Appearance of a hydronephrotic kidney immediately following birth (a) and after adequate hydration (b)

The timing of the ultrasound is crucial. In most circumstances, it is possible to delay the initial ultrasound to 2–3 days after birth when any relative dehydration has been corrected. Under some circumstances however, for example antenatally diagnosed posterior urethral valves, it may be clinically indicated to perform an ultrasound soon after birth. In either circumstance, if the first postnatal ultrasound is normal, a second follow-up ultrasound should be performed (Figure 10). The timing of this will depend on the severity of the abnormality in question, but in most circumstances a repeat ultrasound after 6 weeks is considered reasonable.[29] Children with continuing abnormality on postnatal ultrasound may go on to have functional nuclear medicine studies and/or micturating cystourethrograms, depending on the diagnoses under consideration.

Renal tract calcification

Renal ultrasound is a standard radiological investigation for imaging urinary tract calcification in children. Plain film and CT kidney, ureter and bladder are useful adjuncts but are only utilised on an individual basis, to minimise exposure to ionising radiation.

Renal stones

Urolithiasis (intraluminal stones either in the kidneys, ureter, bladder or urethra) and nephrocalcinosis although often found in the same patient, are not always linked. In children with urolithiasis, an underlying abnormality is found in 75%.[30] Metabolic causes such as hypercalciuria or tubular pathology such as distal renal tubular acidosis are high in the differential.

The rationale for ultrasound imaging in the context of stones is similar to that in adults. Ultrasound is used to provide detail on the following:

- Location and size of the stone(s). Ureteric stones can be difficult to visualise (Figure 11). The level of obstruction can be inferred from the level of hydroureter.
- Any structural or metabolic abnormality that may lead to a predisposition to stone formation.
- Evidence of secondary urinary tract infection.
- Follow up of children with stones.

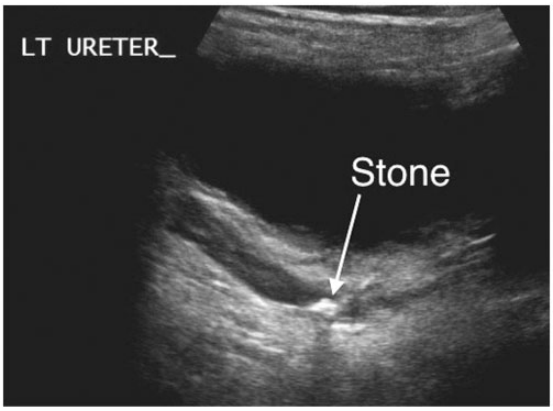

Figure 11 Obstructing stone in lower ureter

Nephrocalcinosis

Nephrocalcinosis may be isolated to the cortex (cortical nephrocalcinosis) or medullary pyramids (medullary nephrocalcinosis (Figure 12)) or generalised. It is important to state the location of the nephrocalcinosis as this information can help to narrow the differential diagnosis, although there is overlap between pathologies.

Early medullary nephrocalcinosis is characterised by echogenic outlining of the medullary pyramids. If left untreated this can lead to markedly hyperechoic medullary pyramids from calcium deposition and reversal of the normal pattern of corticomedullary differentiation.

Early detection of nephrocalcinosis will allow prompt medical intervention in order to preserve remaining kidney function.

The role of ultrasound urinary tract imaging

The NICE guidance for Urinary Tract Infection in Children published in August 2007[31] has standardised the imaging protocols used. Ultrasound, as one would expect, is the mainstay of imaging to look for an underlying cause or sequelae of infection and should be performed in the following circumstances:

1. Every child under the age of 6 months with a proven urinary tract infection.
2. Every child over 6 months with recurrent or atypical urinary tract infection.

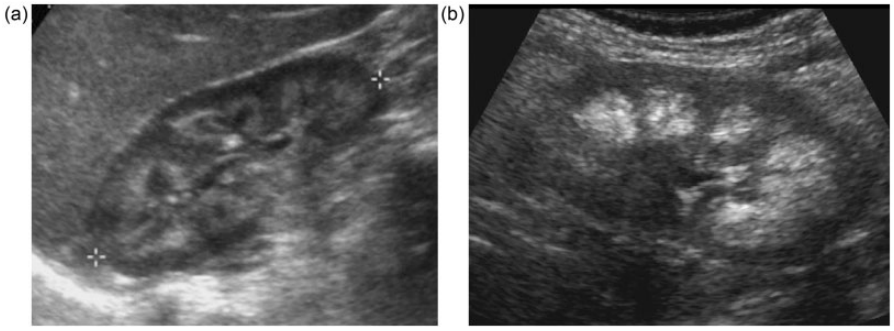

Figure 12 Early (a) and late (b) appearances of nephrocalcinosis

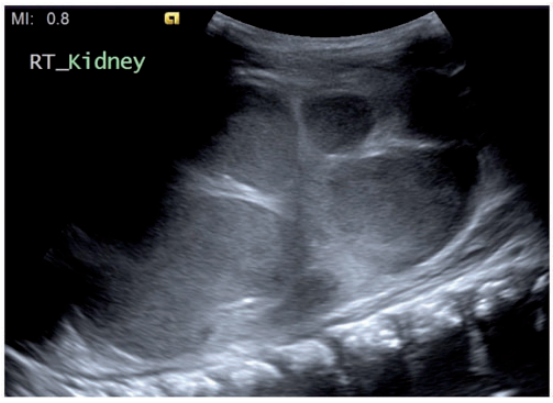

Figure 13 Pyonephrosis

Echogenicity within dilated calyces, particularly in the context of pyrexia, can indicate pyonephrosis (Figure 13). If this is suspected by the sonographer, the information should be communicated urgently to the referring clinician who may wish to consider urgent drainage.

The report

Every report should specifically mention:

1. The size of both the kidneys, the mean size and size range for the age of the child, which is available from reference charts, should be included.[32]
2. The degree of corticomedullary differentiation.
3. The presence/absence of mass.
4. The presence/absence of renal/ureteric calcification.
5. The presence/absence of dilatation of the collecting system and ureters.
6. Appearance of the bladder and adequacy of bladder filling and emptying.
7. Any follow-up that is necessary as a result of the findings.

Any limitations of the examination should be stated in the report as well as a mention of any structures that were inadequately visualised. The sonographer should refer back to the request card. If a specific question has been asked, this should be clearly answered in the report.

If an unexpected abnormality has been found, it is best practice to speak directly with a member of the relevant clinical team or fax a copy of the report to the referring consultant. The appropriate route of communication will be governed by the urgency with which action is necessary.

Conclusion

Experience and exposure to as many paediatric examinations as possible will allow the sonographer to gain confidence in paediatric imaging. As confidence increases, the sonographer will be able to build upon the basic principles and continue to improve their technique and expand their knowledge. The sonographer should now have a sound understanding of the similarities and differences between adult and paediatric urinary tract ultrasound examination. Knowledge of the different pathologies that may be encountered will enable the sonographer to perform a structured examination that can then be used by the clinician for initial diagnosis and to guide ongoing treatment. Above all, a systematic, sensitive approach is required and the sonographer should always remember the differing needs of each individual child.

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