European Journal of Radiology 83 (2014) 1538–1548

Contents lists available at ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

Ultrasound of the paediatric urogenital tract

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ARTICLE INFO

Article history:
Received 25 March 2014
Accepted 7 April 2014

Keywords:
Ultrasound
Urogenital tract
Kidneys
Bladder
Children
Female genitalia

ABSTRACT

Pathology in the urinary tract is one of the most frequent queries when children are referred for an ultrasound examination. Comprehensive ultrasound examinations can answer most clinical questions of the urogenital tract with minimal patient preparation and without the use of ionising radiation. Therefore, optimised imaging protocols should be available in all radiology departments where children are examined. This review suggests a preferred imaging protocol for urogenital imaging in children and gives an overview of the different structures of the urogenital tract, the normal age-related sonographic anatomy, and gives examples of the most commonly encountered diseases of the urogenital system in children.

1. Introduction

Ultrasound (US) is the most widely used modality in urogenital imaging in children and images of great detail of the urogenital system can be produced. Ultrasound can provide both anatomical and functional information. Paediatric urogenital US is different to adult US in all respects. The normal anatomy changes with age and the pathology encountered in the paediatric urogenital tract are most often unique to children. Therefore US scans of the urogenital system in children should ideally be performed by an investigator experienced in paediatric radiology or be supervised by a paediatric radiologist or a specialist in paediatric US.

2. Imaging protocol

The child should be well hydrated before the examination for maximum distention of the collecting system and for proper assessment of the bladder, ideally with a standardised oral hydration Scheme [1,2]. Pre- and post void images should be obtained with measurement of residual urine and renal pelvis width. One should start the examination with assessment of the bladder to ensure proper pre-micturition images. This is particularly important in children who are still in their nappies. The bladder shape, wall and neck should be assessed. Try to identify the ureter ostium and the distal ureters. It is important to adjust the gain behind the bladder otherwise it is easy to miss dilated ureters. Proceed with the retrovesical space where the internal genitalia can be visualised behind the full bladder. If possible, examine the kidneys both before and after micturition in order to detect potential changes in the collecting system after voiding.

The kidneys must be assessed using both curved array and linear transducers. Scanning the child in supine position allows comparison of the parenchymal echogenicity with adjacent organs and assessment of the whole course of the ureter. The renal parenchyma is best seen from the back and scanning the patient in prone or decubitus position will give the most detailed images of the kidneys. If there is dilatation of the collecting system, measurements of maximal anterior–posterior (AP) width of the renal pelvis and the maximal extrarenal diameter in the axial plane, the maximal calyx diameter and the narrowest parenchymal width should be provided. Measurement of the kidneys in three planes to calculate the renal volume ($L \times W \times H \times 0.53$) gives the most accurate assessment due to the more spherical shape particularly in neonates and infants and is more sensitive to changes in renal size. For serial measurements, e.g. in growth assessment, consistency is crucial and measurement should ideally be performed with the patient lying the in the same position every time (i.e. prone, decubitus or supine), using the same type of transducer (i.e. either linear or curved array transducer). Colour Doppler sonography (CDS) and duplex-Doppler are not mandatory techniques in every routine scan but are *optional* to assess the renal vasculature, kidney perfusion, to differentiate prominent hilar vessels from the renal pelvis and to depict urine jet from the ureter ostium [2].

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http://dx.doi.org/10.1016/j.ejrad.2014.04.001
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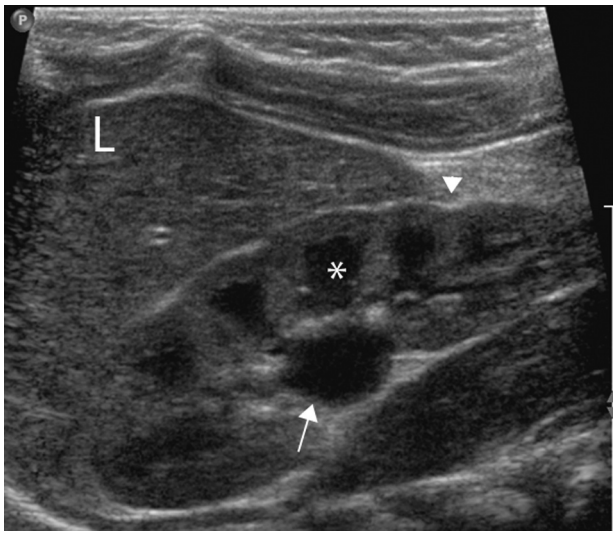

Fig. 1. Normal appearances of a neonatal kidney include renal cortex which is iso- or slightly hyperechoic to the liver (L) or spleen. The cortex contrasts the hypoechoic papillae (asterisk), which should not be misinterpreted as dilated calyces. The renal pelvis is often visualised (arrow) and an AP-diameter of the renal pelvis of up to 10 mm is usually not pathological. Foetal lobulation (arrowhead) is normally seen and this may persist up to adulthood.

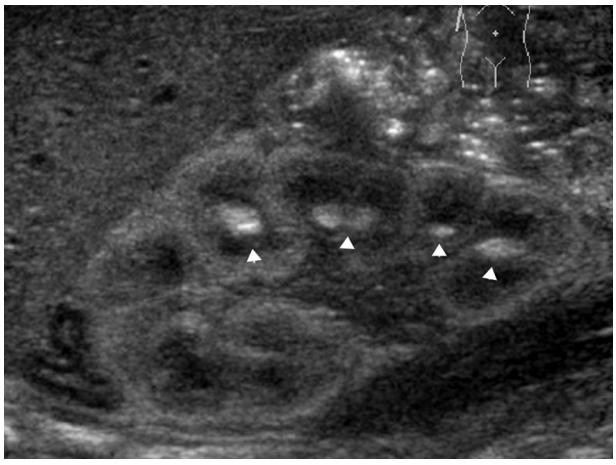

Fig. 2. Hyperechoic papillae can be seen in healthy newborn babies and is caused by transient deposition of protein. It is only located at the tip of the papilla and normally disappear within a week.

3. Renal parenchyma

The normal sonographic appearance of the renal parenchyma varies with age hence knowledge of the normal age-specific appearances of the kidneys is therefore important not to miss or overcall pathology. The renal cortex in the neonate is iso-or hyperechoic to the liver and spleen. In the neonate the glomeruli occupy twice as much of the cortical volume compared to adults and medullary volume is larger in children. This is reflected in the hyperechoic renal cortex, which contrasts the prominent, hypoechoic medullary pyramids. The difference in echogenicity between the cortex and the medulla in neonates is striking and inexperienced radiologists could potentially misinterpret the hypoechoic pyramids as dilated calyces (Fig. 1). The echogenicity of the renal cortex reduces gradually in the first year of life and usually becomes hypoechoic to liver when the child is 12–15 months. In the neonate protein deposits may give transient increased echogenicity at the tip or in of the medullary pyramids (Fig. 2). In babies with normal urine output this is a self limiting finding which disappears in a few days or weeks and does not need further work up [3]. In infants and young children the renal sinus contains little fat hence the hyperechoic renal hilus seen in adults is not as apparent in younger children. Persistent fetal lobulation is a common finding in infants and may in some individuals persist through adulthood. Fetal lobulation can be differentiated from renal scarring by the lack of parenchymal thinning. Moreover renal scars are most often located over the calyces whereas in fetal lobulation the lobulation lie between the pyramids (Fig. 1).

3.1. Parenchymal nephropathies

In children detailed, high-resolution images of the renal parenchyma can be obtained using a high frequency linear transducer. Still the ability to distinguish the causes of parenchymal nephropaties remains low. Diffuse focal or general alterations in renal size and echogenicity, particularly hyperechoic renal parenchyma and reduced corticomedullary differentiation are non-specific signs of renal parenchymal disease and can be caused by various conditions including obstruction, cystic kidney disease, metabolic diseases, toxic injuries, inflammatory and infectious disorders [4,5]. Ultrasound guided renal biopsy is the method of choice if a histopathologically correct diagnosis is required in suspected renal parenchymal disease. Ultrasound guided renal biopsies in children should be performed after a thorough clinical evaluation following a standardised procedure [6].

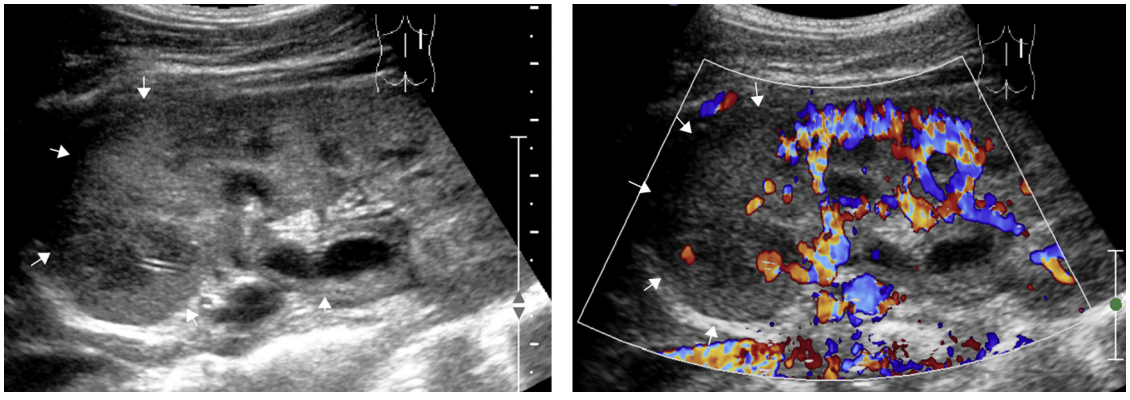

Fig. 3. Focal swelling, loss of corticomedullary differentiation and hypoperfusion of the right kidney in a 5- year old boy with pyelonephritis (arrows). There was also thickening of the uroepitelium at the renal pelvis caused by the inflammation.