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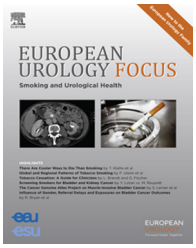

Review – Pediatric Urology

Imaging for Vesicoureteral Reflux and Ureteropelvic Junction Obstruction

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Abstract

Context: Although the imaging techniques used for diagnosing vesicoureteral reflux (VUR) and ureteropelvic junction obstruction (UPJO) are well determined, there is a need to decrease the numbers of unnecessary imaging and radiation exposure as most of the target population is children. Newer imaging techniques are promising and could be eventually used for follow up in the near future.
Objective: To review the contemporary literature regarding the imaging techniques used for VUR and UPJO.
Evidence acquisition: We conducted a nonsystematic review of the literature. A comprehensive search was performed through PubMed database between 1980 (where maternal ultrasound [US] was first popularized) and 2015 focusing on the last decade.
Evidence synthesis: Conventional US cannot replace voiding cystourethrography in the detection of VUR. Contrast enhanced voiding sonography and direct radionuclide cystography suggest acceptable detection rates of VUR with sensitivity of 71–100% and specificity of 67–100%. Renal US and diuretic radioisotope renography with choice of technetium99m mercaptocetyltriglycine are invaluable imaging modalities for the detection of UPJO.
Conclusions: Despite the concerns about the invasiveness and radiation exposure of conventional voiding cystourethrography, it is still the gold standard technique in the detection of VUR and is superior to the other options in depiction of anatomical details. US and mercaptocetyltriglycine scintigraphy are also the gold standards and will continue to be so in the diagnosis of UPJO.
Patient summary: New imaging modalities such as contrast enhanced voiding sonography and direct radionuclide cystography are promising in the detection of vesicoureteral reflux. Major effort in literature is given to decrease the radiation dose of the available imaging techniques.

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1. Introduction

Vesicoureteral reflux (VUR) is present in about 1–3% of children in Europe and in northern America [1]. Children with VUR are at high risk for febrile urinary tract infections (UTIs). According to the current European Society for Pediatric Urology/European Association of Urology (ESPU/EAU) guidelines, further diagnostic efforts aiming at VUR are indicated after the first febrile UTI and whenever there is a justified clinical suspicion of VUR, especially in children aged 0–2 yr. Concerning imaging, not only direct visualization of VUR, depicting its anatomical characteristics is also critical in decision making. Additionally, concomitant pathologic alterations of the urogenital tract such as lower urinary tract dysfunction, neurogenic bladder, posterior urethral valves (PUV) in boys, and renal duplex systems are crucial for risk stratification and planning of further management. Ultrasound (US) scan, voiding cystourethrography (VCUG), and possibly dimercaptosuccinicacid scan (DMSA) are the most commonly used imaging techniques in the diagnosis and follow-up of children with VUR [2]. However, there are numerous studies showing that contrast enhanced voiding sonography (CEVS) and direct radionuclid cystography (DRC) can also be used in the diagnosis and follow-up of VUR.

Ureteropelvic junction obstruction (UPJO) is another common condition seen in children with an incidence around 1:1500 live births [2]. Although the vast majority of cases are suspected based on detection of hydronephrosis (HN) during prenatal US, it can also be diagnosed later in life. Currently, US and isotope renography are the most common imaging techniques used in the diagnosis of UPJO.

Beyond the imaging techniques, radiation exposure is an important concern for children and it should be limited whenever possible by using state of the art technical equipment or by choosing radiation-free imaging modalities [3]. In this review, we aimed to provide contemporary literature regarding the imaging techniques used for VUR and UPJO.

2. Evidence acquisition

2.1. Study selection

A comprehensive search was performed through PubMed database between 1980 (where maternal US was first popularized) and 2015 focusing on the last decade.

2.2. Inclusion criteria

In this nonsystematic review, we included original and review articles written in English that dealt with the imaging techniques of VUR and UPJO. The Guidelines on Pediatric Urology (EAU/ESPU) were also used as a source for this review.

For each imaging technique a separate search (“imaging technique” and “vesicoureteral/vesicoureteric reflux” and “ureteropelvic/pelviureteric junction obstruction”) was performed. Priority was given to contemporary literature (last decade) and articles published in higher impact journals if similar methods were described.

3. Evidence sythesis

3.1. Diagnostic tools for VUR

3.1.1. Conventional sonography/power Doppler sonography/four-dimensional sonography

Although by conventional US, VUR cannot be depicted directly; various indirect criteria suggesting the presence of VUR have been described. In a recent study, Lee et al [4] evaluated the significance of specific ultrasound findings additionally to a HN as to their predictive value for VUR. They were able to show that 63% of the initially indicated VCUGs could have been avoided by only examining children with megaureters, duplex systems, or renal dysmorphia as diagnosed on US. In addition to renal pelvic wall thickening associated with the presence of VUR, ureteral dilatation has also recently been proven to be a good marker in the presence of accompanying UTIs [5]. Especially in direct timely relation to febrile UTIs, there is abundant data on the predictive capabilities of conventional US for VUR as well as renal scarring [6,7].

Conversely, in a recent report, the reliability of US screening in children after febrile UTIs has been discussed [7]. It was shown that 66% of children with reduced renal function and/or renal cortical defects found using DMSA scans had a normal US. Also in the RIVUR trial cohort, only a small proportion of children showed US abnormalities (4.3–6.3%); however, this refers only to HN and duplex systems [8].

Another important application of US imaging is the detection of parenchymal defects. This is especially important regarding the substantial radiation burden involved in DMSA scans. The sensitivity of conventional US in detection of small renal parenchymal defects is relatively low and it has been shown that normal US findings do not preclude pathologic DMSA findings. In a recent publication by Bush et al [9] 66% of children showing DMSA alterations after febrile UTIs had a normal US. However, up to 71.6% of *significant* renal parenchymal defects can be detected only in B-mode [10]. Power Doppler sonography was even more determinative, with a sensitivity of 73.8% and a specificity of 85.7% compared with DMSA. The best sensitivity was attained during the 1st 48 h after onset of an acute febrile UTI [11].

Taken altogether, the studies investigating the predictive value of US on detecting VUR are largely variable and the majority of them reveal that US, DMSA scans, and VCUG can give different information and cannot be replaced to each other (Table 1). Therefore, US can be used for the assessment of children during and after febrile UTIs.

3.1.2. Fluoroscopic/radiologic VCUG

Demonstration of VUR by fluoroscopy remains the gold standard method of VUR detection in children, especially in