Pediatrics and Neonatology (2016) 57, 113—119

Available online at www.sciencedirect.com

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journal homepage: http://www.pediatr-neonatol.com

ORIGINAL ARTICLE

Role of Renal Ultrasonography in Predicting Vesicoureteral Reflux and Renal Scarring in Children Hospitalized with a First Febrile Urinary Tract Infection

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Received Jan 13, 2015; received in revised form May 21, 2015; accepted Jun 5, 2015
Available online 14 June 2015

Key Words
children;
renal scarring;
renal ultrasonography;
urinary tract infection;
vesicoureteral reflux

Background: This study was designed to examine the capability of renal ultrasonography (US) for predicting vesicoureteral reflux (VUR) and renal scarring (RS), and to assess, using initial US, the significant urologic abnormalities that impact on management of children hospitalized with a first febrile urinary tract infection (UTI).
Methods: Hospitalized children aged ≤ 2 years with a first febrile UTI were prospectively evaluated using imaging studies, including ^{99m}Tc dimercaptosuccinic acid (DMSA) scan, US, and voiding cystourethrography.
Results: Of the 310 children analyzed (195 boys and 115 girls), 105 (33.9%) had abnormal US. Acute DMSA scans were abnormal in 194 children (62.6%), including 89 (45.9%) with concomitant abnormal US. There was VUR in 107 children (34.5%), including 79 (25.5%) with Grades III—V VUR. The sensitivity and negative predictive values of US were 52.3% and 75.1%, respectively, for Grades I—V VUR and 68.4% and 87.8%, respectively, for Grades III—V VUR. Eighty-five children (27.4%) had RS, including 55 (64.7%) with abnormal US. Of the 105 children with abnormal US, 33 (31.4%) needed subsequent management (surgical intervention, parental counseling, or follow up of renal function). Nephromegaly on initial US and Grades III—V VUR were risk factors of RS.
Conclusion: Abnormal US may carry a higher probability of Grades III—V VUR and RS, and can affect subsequent management in a significant number of children. Nephromegaly on initial US and Grades III—V VUR are strongly associated with an increased risk for RS. Thus, US should be

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http://dx.doi.org/10.1016/j.pedneo.2015.06.001

performed on children after a first febrile UTI and children with normal US may not require voiding cystourethrography.

1. Introduction

Urinary tract infection (UTI) is one of the leading causes of bacterial infections in febrile children aged ≤ 2 years.[1] The association between UTI and congenital abnormalities like vesicoureteral reflux (VUR) may put children at high risk of acute pyelonephritis (APN) and subsequent renal scarring (RS).[1,2] Although the long term medical problems of VUR and infection-related renal damage are being questioned,[3,4] it is believed that postpyelonephritic RS with recurrences, especially in the presence of high grade VUR, may cause future medical problems like hypertension and/or impaired kidney function.[5–8] This is the major driving force for further investigations and treatment of the first UTI.

The goal of imaging in children after a first UTI is the early detection of congenital abnormalities of the urinary tract like obstructive uropathy and VUR that may predispose the child to additional persistent or recurrent infections and renal damage. Although the noninvasive nature, lack of radiation, and relatively lower cost of ultrasonography (US) have made it an ideal initial screening tool in children after a first UTI, its accuracy is highly dependent on the experience of the operator. The value of US in evaluating children at the time of first UTI remains contentious. The widespread use of maternal–fetal US that frequently identifies children with congenital obstructive uropathy prenatally has been suggested to lessen the need for US later in childhood.[9,10]

Moreover, recent studies have shown the limited value of US for children after a first UTI because of its poor ability in detecting VUR and RS, as well as its lack of impact on subsequent management or care.[9–15] By contrast, other authors claim that US can accurately detect obstructive uropathy, kidney size, renal abscess, and ureterocele in hospitalized children, thereby directly influencing subsequent management based primarily on US examination and suggesting that US should be carried out routinely in children with a first UTI.[16–20]

Children hospitalized with a febrile UTI are a distinct subgroup that is more clinically ill and at higher risk of renal damage. The aim of this study was to examine the ability of US for predicting VUR and RS, as well as to evaluate significant urologic abnormalities that impact on subsequent management with a change of therapy or investigations based on initial US in children hospitalized with a first febrile UTI.

2. Methods

2.1. Patients and study design

This prospective cohort study evaluated children aged ≤ 2 years who were admitted to an urban tertiary referral center and academic teaching hospital for first febrile UTI. The hospital's Institutional Review Board approved the study protocol and the parents of all participants provided informed consent.

The diagnosis of a first febrile UTI was based on the presence of fever with a body temperature ≥38°C, pyuria (≥5 white blood cells per high-power field) and/or positive nitrite or leukocyte esterase tests, and presence of positive urine culture, defined as any growth of a single bacterium in urine from a suprapubic bladder aspiration, or growth of a single microorganism from $\geq 10^5$ colony-forming units/mL collected from the midstream clean-void urine specimen of toilet-trained young children, or $\geq 5 \times 10^4$ colony-forming units/mL collected from a transurethral catheterized specimen.[1] Children with a history of antenatal hydronephrosis, known urogenital or anorectal malformations, neurogenic disease, or previous UTI episodes were excluded.

All of the children were treated empirically with combined intravenous cefazolin (100 mg/kg/d) and gentamicin (7.5 mg/kg/d) for at least 3 days after admission according to the hospital's antibiotic policy. This regimen was later adjusted according to results of the antimicrobial susceptibility tests for overall treatment duration of 7–21 days.

2.2. Renal and bladder US examinations

All of the children underwent US to detect urinary tract abnormalities within the first 2 days of admission using an SSD-4000SV (ALOKA Co., Ltd., Tokyo, Japan) with a sector or linear 5.0 MHz probe. All abnormal US findings were recorded, including ≥7-mm anteroposterior diameter of the renal pelvis, and/or any grade of dilatation of the calyces or ureters irrespective of anteroposterior diameter; pelvic or ureteral wall thickening; absence of corticomedullary differentiation; irregular renal outline and signs of renal hypoplasia (i.e., small kidney and thinned or hyperechoic cortex); duplicated renal collecting system, abnormal kidney size, renal cysts, dysplastic kidney, stenosis of the ureteropelvic junction, or ureterovesical junction and ureterocele.[21]

Renal hypoplasia was defined as a longitudinal length of kidney less than −2 standard deviations for age, and nephromegaly as a renal length greater than +2 standard deviations for age.[22] Examination of the bladder was also performed to detect dilatation of the distal ureters, bladder wall hypertrophy, and presence of ureterocele. Significant urologic abnormalities were defined as those that impacted on subsequent management with a change of therapy, investigations, or follow up (e.g., surgical intervention, parental counseling, and need for follow up of renal function) based on initial US findings. Parental