Original Article

Urological Anomalies in Early Childhood UTI: MCU Detects What Ultrasound Misses

Aishwarya Venugopal[1], Prasanth Soundararajan[2], Nikhil Kumar[3], Anjana S.R.Krishnan[4], Ramesh Bhat Y[5]

From, [1]Senior Resident in Neonatology, Department of Neonatology, Government Medical College, Thrissur, [2]MD Radiology, Consultant Radiologist, Radnest Enterprises, Bangalore, [3]DM Neonatology, MD Paediatrics, Senior Resident in Neonatology, Department of Neonatology, Government Medical College, Thrissur, [4]Paediatric Consultant, Department of Paediatrics, Parvathi Multispeciality Hospital, Chrompet, Chennai, [5]Professor, Department of Paediatrics, Kasturba Medical College, Manipal

ABSTRACT

Background: Urinary tract infection (UTI) is a common serious bacterial infection in young children and may be associated with underlying congenital anomalies of the kidney and urinary tract (CAKUT). Early identification of these anomalies is essential to prevent renal scarring and long-term renal morbidity. However, the optimal imaging strategy following UTI in young children remains debated. This study aimed to determine the prevalence and pattern of urinary tract anomalies in children and to evaluate the diagnostic yield of renal–bladder ultrasonography (RBUS) and micturating cystourethrogram (MCU). **Methods:** This prospective observational study was conducted in a tertiary care hospital over 1.5 years. Children aged 1 month to 5 years admitted with UTI were included. All participants underwent RBUS and MCU following treatment of the acute infection. Additional imaging was performed when indicated. Vesicoureteral reflux (VUR) was graded according to standard criteria. **Results:** Ninety-six children were included in the final analysis. RBUS was abnormal in 61.4% of children, most commonly showing hydronephrosis. MCU detected abnormalities in 33.3%, with vesicoureteral reflux identified in 28.1%. High-grade reflux (Grades IV–V) constituted the majority of VUR cases. Notably, 70.3% of children with VUR had a normal RBUS. Renal scarring was detected in a substantial proportion of children with VUR who underwent DMSA scanning. **Conclusions:** MCU demonstrated a superior diagnostic yield in children with UTI who have underlying urological anomalies compared to ultrasonography, supporting the inclusion of MCU in the initial evaluation of young children with culture-proven UTI, especially in settings with a high burden of congenital uropathies.

Key words: Urinary tract infection, Vesico-Ureteral reflux, Congenital urogenital anomalies, Ultrasonography

Urinary tract infection (UTI) is one of the most common serious bacterial infections in infancy and early childhood, with the highest incidence reported during the first two years of life. Young children often present with non-specific symptoms such as fever, poor feeding, or irritability, leading to delayed diagnosis and increased risk of complications. Recurrent or inadequately treated UTI may result in renal scarring, hypertension, and long-term renal impairment. Thus, early identification and appropriate evaluation are crucial in this age group. Population-based studies have demonstrated a substantial burden of UTI-related morbidity in young children, particularly in low- and middle-income settings where delayed presentation is common [1-3].

Congenital anomalies of the kidney and urinary tract (CAKUT), including vesicoureteral reflux (VUR), pelvi-ureteric junction obstruction, ureterocele, duplex collecting system, and posterior urethral valves, are important predisposing factors for pediatric UTI. These structural abnormalities impair normal urinary drainage and increase susceptibility to infection and renal damage. 20–30% of children presenting with a first febrile UTI have an underlying urological abnormality, with VUR being the most frequently identified lesion [4-6]. High-grade or bilateral VUR is associated with a greater risk of recurrent infections and renal scarring. [5-7].

The exact diagnostic aids for UTI in children are still not established. While renal–bladder ultrasonography (RBUS) is widely used as an initial screening tool because of its

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Correspondence to: Dr Aishwarya Venugopal, Department of Neonatology, Government Medical College, Thrissur.

Email: aishvenu56@gmail.com

availability and non-invasive nature, its sensitivity for detecting VUR and lower urinary tract obstruction is limited [8-10]. Micturating cystourethrogram (MCU) remains the gold standard for diagnosing VUR and identifying obstructive lesions such as posterior urethral valves, but since it is invasive, its usage is limited. The American Academy of Pediatrics and NICE guidelines recommend restricting MCU to selected high-risk cases, whereas the recent Indian Society of Pediatric Nephrology (ISPN) advocates a broader imaging approach in regions with a higher prevalence of CAKUT and delayed diagnosis [10, 11].

This study was done to evaluate the diagnostic yield of RBUS and MCU in young children with UTI to identify the optimal imaging protocols.

MATERIALS AND METHODS

This was a prospective observational study conducted in the pediatric ward of a tertiary care medical college over a period of 1.5 years. Ethical clearance was obtained from the Institutional Ethics Committee (IEC: 601) before the commencement of the study. All children aged 1 month to 5 years admitted with one or more episodes of UTI were included in the study. Written informed consent was obtained from parents or guardians. Children with catheter-associated UTIs, known immunodeficiency, or polymicrobial growth on urine culture were excluded.

Urine samples were collected using suprapubic aspiration or catheterization in non–toilet-trained children, and clean-catch midstream samples were obtained in toilet-trained children, following standard recommendations [12, 13].

The presence of pyuria with a positive urine culture showing $\geq 10^5$ CFU/mL of a single uropathogen was considered a definite UTI, and a pyuria with positive nitrite and/or leukocyte esterase testing in a culture-negative setting was taken as a probable UTI. Recurrent UTI was defined as ≥2 episodes within six months or ≥3 episodes within one year [11].

Investigations and Imaging

Baseline investigations included complete blood count, inflammatory markers, renal function tests, and blood cultures when clinically indicated. All children underwent RBUS and MCU following completion of treatment for the acute infection. VUR was graded from I to V according to the International Reflux Study classification [14, 15].

Additional imaging, including Dimercaptosuccinic acid (DMSA) scan or Diethylenetriamine pentaacetate (DTPA) scan, was performed in selected cases based on clinical indication.

Statistical Analysis

Data was entered into Microsoft Excel and analyzed using SPSS version 27. Categorical variables were summarized as frequencies and percentages, while continuous variables were expressed as mean ± standard deviation or median with interquartile range, as appropriate. Comparisons between groups were performed using the t-test or Mann–Whitney U test for continuous variables and chi-square test or Fisher's exact test for categorical variables. A p-value <0.05 was considered statistically significant.

RESULTS

Study Population

During the study period, 112 children aged 1 month to 5 years were diagnosed with UTI. After exclusions, 96 children were included in the final analysis. There was a male predominance, and more than half of the study population was below two years of age. The median age was 12 months (IQR 6.75–24 months). Most children presented with the first episode of UTI.

Table 1: Baseline characteristics of the study population

Baseline Characteristics		n (%)
Gender	Male	54 (56.2)
	Female	42 (43.8)
Age	1 month–1 year	34 (35.4)
	1–2 years	20 (20.8)
	2-3 years	20 (20.8)
	3-4 years	13 (13.5)
	4-5 years	9 (9.5)

Ultrasonographic Findings

RBUS demonstrated abnormalities in nearly two-thirds of children (Table 2). Hydronephrosis was the most frequent abnormal finding, followed by hydroureteronephrosis and features suggestive of cystitis. Other congenital or structural abnormalities were less common. More than one-third of children had a completely normal ultrasonographic examination.

Table 2. Ultrasonographic Findings in Children with UTI (n=96)

Ultrasonographic Finding	Number (%)
Hydronephrosis	30 (31.2)
Hydroureteronephrosis	10 (10.4)
Cystitis	9 (9.3)
PUJ Obstruction, hydronephrosis	2 (2.2)
Ureterocele	2 (2.2)
Duplex Kidney	2 (2.2)
Prostatic Utricle	1 (1)
Ectopic Kidney	1 (1)
Medullary Nephrocalcinosis	1 (1)
Absent Kidney	1 (1)
Normal USG	37 (38.5)

MCU Findings and VUR

MCU identified abnormalities in one-third of children (Table 3). VUR was the predominant abnormality detected, with

bilateral reflux being more common than unilateral involvement. Among children with VUR, high-grade reflux (Grades IV–V) constituted most cases (Table 4). A substantial proportion of children with VUR were below two years of age, although significant reflux was also observed in older children.

Table 3. MCU Findings in Children with UTI (n=96)

MCU Finding	n (%)
VUR	27 (28)
- Bilateral	19
- Unilateral	8
Duplex Collecting System	2 (2)
Posterior Urethral Valve	1 (1)
Bladder Diverticulum	1 (1)

Table 4. Grading of VUR (n=27)

VUR Grade	n (%)
Grade I	1 (3.7)
Grade II	3 (11.1)
Grade III	3 (11.1)
Grade IV	6 (21.4)
Grade V	14 (51.8)

Comparison of Ultrasonography and MCU

A key finding of the study was the limited concordance between ultrasonography and MCU. Many children diagnosed with VUR on MCU had a normal ultrasonographic study, indicating that reliance on ultrasonography alone would have missed most clinically significant reflux cases.

Renal Scintigraphy and Additional Investigations

Renal scintigraphy was performed in selected children (Table 5). Renal scarring was detected in a notable proportion of children with VUR who underwent DMSA scanning. Functional abnormalities were identified on DTPA scans in a smaller subset. Endoscopic and contrast-based investigations revealed lower urinary tract obstruction in a few cases.

Table 5: Other investigations done

Other investigations	n (%)
DMSA	32 (33.3)
DTPA	14 (14.6)
Cystoscopy	3 (3.1)
IVU	3 (3.1)

DISCUSSION

UTI in early childhood is frequently associated with underlying urological abnormalities, and timely identification of these conditions is essential to prevent recurrent infections and long-term renal damage. In the present study of children aged 1 month to 5 years diagnosed with UTI, one-third had abnormalities detected on micturating cystourethrogram, with VUR identified in 28.1% of cases. The major reflux detected was high grade, and more than two-thirds of children with VUR had a completely normal RBUS. These findings highlight the limited sensitivity of ultrasonography and highlight the diagnostic value of MCU in identifying clinically significant reflux and lower urinary tract abnormalities.

Many studies have also demonstrated a high prevalence of underlying urological anomalies in young children presenting with UTI. Large cohort studies and meta-analyses have reported that 20–30% of children with a first febrile UTI have an associated structural abnormality, with VUR being the most common lesion [1, 4-6]. Few Indian studies have also documented a substantial burden of high-grade reflux in children evaluated for UTI, particularly in infancy, with rates comparable to the present study findings [5,7,9]. The strong association between high-grade VUR and renal scarring observed in our study also aligns with existing evidence showing that severe reflux and recurrent infections significantly increase the risk of permanent renal damage [16].

However, there is ongoing debate regarding the optimal imaging strategy following a first UTI in children. The present study results support a broader use of MCU, as reliance on ultrasonography alone would have missed a significant proportion of children with high-grade reflux, potentially delaying appropriate intervention.

Although this study included a well-defined age group, with a systematic imaging of all enrolled children, and used renal scintigraphy to assess parenchymal damage in selected cases, its single-center design, relatively small sample size, and lack of long-term follow-up to assess outcomes such as progression of renal scarring or resolution of reflux, recommend future Randomized Controlled Trials (RCT) with larger sample size and longer follow up period. Despite these limitations, the findings provide important evidence supporting the role of MCU in the initial evaluation of young children with UTI.

CONCLUSION

A significant proportion of young children with UTI have underlying urological abnormalities, particularly high-grade VUR, which may not be detected by ultrasonography alone. MCU demonstrated superior diagnostic yield in identifying clinically important reflux and lower urinary tract anomalies, facilitating earlier diagnosis and reducing the risk of recurrent infection and renal damage.

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