Original Article

Urinary tract abnormalities in children with first urinary tract infection

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ABSTRACT

Background: Pediatric urinary tract infections (UTIs) are a major health-care issue. UTI may be a harbinger of variety of underlying urinary tract abnormalities. The long-term complications of recurrent UTI are kidney scarring, hypertension, and chronic kidney disease. **Aim:** The present study aims to determine the prevalence of urinary tract abnormalities in children with first episode of UTI. **Materials and Methods:** This study was a hospital-based prospective observational study carried out in the department of pediatrics over a period of 15 months from January 2015 to March 2016. A total of 100 children with culture-positive first UTI who fulfilled the inclusion criteria were enrolled in the study. Ultrasonography (USG) abdomen, micturating cystourethrography (MCU), and dimercaptosuccinic acid (DMSA) kidney scan were done. **Results:** Among 100 children with culture-proven UTI, USG was abnormal in 16% with the majority (31.7%) having hydroureteronephrosis. MCU was abnormal in 14% and DMSA in 13%. About 9% had kidney scarring. Overall prevalence of urinary tract abnormalities was 14%. About 42.8% of urinary tract abnormalities were detected in children between 1 and 5 years and 35.7% below 1 year. Vesicoureteral reflux was the most common abnormality (8.0%). **Conclusion:** UTI in young children serves as marker for abnormalities of the urinary tract. Early diagnosis is of considerable significance to preserve kidney function and prevent complications.

Key words: First urinary tract infection, Kidney scarring, Urinary tract abnormality, Vesicoureteral reflux

Urinary tract infections (UTIs) are the most common source of bacterial infections in young children. Overall 3–5% of young febrile children have UTIs, including 5–7% of those "without a source of fever" [1,2]. The male-to-female ratio is 2.8:5.4 in infants, whereas it is 1:10, beyond 1–2 years [3]. *Escherichia coli* is the most common infecting pathogen in children, accounting for up to 54–67% of UTIs [3]. Other pathogens include *Staphylococcus* and *Streptococcus* species, a variety of enterobacteria (*Klebsiella* and *Proteus*), and occasionally *Candida albicans*. The virulence of the invading bacteria and the susceptibility of the host are of primary importance in the development of UTI [4].

In neonates, the usual route of infection is hematogenous [5]. Later in life, infection is usually caused by ascent of bacteria into the urinary tract [6]. Any condition leading to urinary stasis (renal calculi, obstructive uropathies, vesicoureteral reflux [VUR], and voiding disorders) may be predisposing to the development of UTI in children [6]. UTI recurs easily if it is accompanied with anatomical anomalies of the urinary system. Parenchymal infection and scarring are well-established complications of infections of the upper urinary tract in children leading to reduced glomerular filtration rate, hypertension, and kidney failure. Parenchymal scarring develops in 10–15% of children with UTI. Children less than 1 year of age are at much greater risk of kidney scarring than older children [7]. This study was conducted to identify the prevalence of urinary tract abnormality in children following the first episode of UTI. The early diagnosis may help to prevent complications.

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MATERIALS AND METHODS

This was a hospital-based prospective observational study conducted in children with culture-proven first episode of UTI attending the outpatient department or admitted in the tertiary hospital of South India over a period of 15 months from January 2015 to March 2016. During the study period of 15 months, 100 children were diagnosed as culture proved first UTI. The inclusion criteria were children less than 18 years with culture proved first UTI. Children with known congenital genitourinary anomalies, previously evaluated and treated for UTI, or neonates were excluded from the study.

A total of 100 children with culture-proven first episode of UTI who fulfilled inclusion criteria were enrolled in the study after taking written consent from parents and institutional ethical clearance. Detailed data on history and examination were recorded

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on a hard copy of the data form. Children were investigated as per the Indian Society of Pediatric Nephrology guidelines [8].

More than 5 pus cells/high-power field in a centrifuged urine sample was taken as significant pyuria. On culture of urine, a colony count of $>10^5$ colony-forming unit (CFU)/mL microorganisms of a single species in midstream clean catch specimen, $>50\times10^3$ CFU/mL microorganisms of a single specimen in catheterized sample, and any number of pathogens in suprapubic aspirated sample was considered significant. Samples showing insignificant growth, mixed growth of two or more pathogens, or growth of non-pathogens were not considered as culture positive. Ultrasonography (USG) abdomen and pelvis were done in all children with culture-positive UTI.

Dimercaptosuccinic acid (DMSA) evaluation was done at 2 months following UTI in all children with culture-positive UTI <5 years of age and in children above 5 years of age if USG was abnormal. Technetium-99 m-labeled DMSA scan was considered normal if homogeneous uptake of the radioisotope was evident throughout the kidneys and the renal contour was preserved. Acute pyelonephritis was defined by the presence of focal or diffuse areas of decreased uptake of labeled DMSA without evidence of cortical loss or by the presence of diffusely decreased uptake in an enlarged kidney. Kidney scarring was defined by the presence of decreased uptake of labeled DMSA associated with loss of the contours of the kidney or by the presence of cortical thinning with decreased volume. The degree of scarring was assessed quantitatively by outlining the scarred area and calculating its ratio to the total area of the kidney.

Micturating cystourethrogram (MCU) was performed in all children with UTI under 1 year, in children between 1 and 5 years if DMSA or USG was abnormal and in children >5 years of age if USG was abnormal. MCU was performed with strict aseptic precautions, after the urine was sterile after 3–4 weeks following therapy. The contrast was introduced into the bladder through a catheter under strict aseptic precautions. Films were taken when the child was voiding. Information on bladder dynamics, reflux, and amount of residual urine was noted.

Mean and standard deviation for age was calculated. The prevalence of urinary tract anomalies was calculated and data were entered into Microsoft Excel sheet. The statistical analysis was made using SPSS software. $p<0.05$ was considered statistically significant.

RESULTS

Majority were in the age group of >5 years (44%) (Table 1). Majority (86%) presented with fever. Urinary symptoms were present in 14% of the cases. Out of 100 children with culture proved UTI, only 46% had significant pyuria in centrifuged urine sample. The most common pathogen isolated in urine culture was *E. coli* (64%).

About 16% had abnormal finding in USG abdomen. Structural abnormality was seen in 14%. Among them, majority (31.71%) had hydroureteronephrosis. DMSA scan was done in 58 children which showed abnormalities in 13. MCU was done in 43 children, which showed abnormalities in 14. The most common anomaly detected was VUR. Among eight children with VUR, majority 37.5% had Grade I VUR. MCU was abnormal in two children who had normal USG findings. The results are compiled in Table 2. Overall prevalence of urinary tract anomalies in children with UTI was 14%. Among them, majority were under the age of 5 years (78.57%).

DISCUSSION

UTI is one of the most common bacterial infections among infants and children. It may unmask underlying structural or functional anomalies of the urinary tract. Early detection and management are pivotal to reduce significant morbidity, with kidney scarring, being the most worrisome long-term sequelae.

A total of 100 children with culture-proven first episode UTI were enrolled to determine associated urinary tract abnormalities. Majority were in the age group of above 5 years (44%) followed by 1–5 years (38%). Male predominance was noted with a male-to-female ratio of 3.5:1 in <1 year. Similar results were seen in a study conducted by Nair *et al*. [9].

In our study, fever was the most common presenting symptom (86%) which was similar to the studies done by Ahmadzadeh *et al*. [10] (83%) and Ponvelil *et al*. (74.2%) [11]. Urinary symptoms were seen in only 14%. In the present study, 46% had significant pyuria in centrifuged urine sample, which was similar

Table 1: Age and sex distribution of the study group

Age (years)	Sex		Total n=100
	Males (n=58)	Females (n=42)	
<1	14	4	18
1–5	24	14	38
>5	20	24	44

Table 2: USG, MCU, and DMSA findings

Findings	USG (n=100)	DMSA (n=58)	MCU (n=43)
Normal	84	45	29
Cystitis	4	-	-
Bilateral hydroureteronephrosis (HUN)	4	-	4
Vesicoureteral reflux (VUR)	2	-	4
Distended bladder with residual urine suggestive of posterior urethral valve	1	-	1
Obstructive uropathy suggestive of posterior urethral valve	1	-	1
Pelviureteric junction obstruction	1	-	1
Right hydronephrosis	1	-	1 (PUJ obstruction)
Pyelonephritis	-	2	-
Left ureterocele	1	1	1
Right megaureter	1	1	1
Kidney scarring	-	9	-

USG: Ultrasonography, MCU: Micturating cystourethrography, DMSA: Dimercaptosuccinic acid

Table 3: Prevalence of urinary tract abnormalities as detected by USG, MCU, and DMSA

Study	Abnormalities			
	USG (%)	MCU (%)	DMSA (%)	Most common anomaly
Present study	16	14	13	VUR
Zamir *et al*. (2004) [12]	14.1	18.4	-	VUR
Hoberman *et al*. (2003) [15]	12	39	61	VUR
Nair *et al*. (2018) [9]	26.67	14.67	2	VUR
Ahmadzadeh *et al*. (2007) [10]	-	39.6	62	VUR

USG: Ultrasonography, MCU: Micturating cystourethrography, DMSA: Dimercaptosuccinic acid, VUR: Vesicoureteral reflux

to a study done Hoberman *et al*. [1] (54%). It was seen in only 7% in a study conducted by Nair *et al*. [9]. Hence, UTI may be missed if urine culture is not done.

We found that *E. coli* was the most common organism isolated (64%), followed by *Klebsiella* (16%), which was similar to the studies done by Zamir *et al*. [12], Ahmadzadeh *et al*. [10], Ponvelil *et al*. [11], Saadeh *et al*. [13], and Nair *et al*. [11]. In contrast, a study done by Nowell *et al*. [14] reported higher isolation rates of coagulase-negative *Staphylococcus aureus* (28%) over *E. coli* (17%). This could probably be due to the study group belonging to age below 2 months in neonatal intensive care unit.

In the present study, 16% had abnormal finding in USG abdomen. Structural abnormality was seen in 14% which was similar to the studies by Hoberman *et al*. [15]. Of the 14 children with abnormalities in MCU, majority (78.5%; n=14) were under 5 years of age which was similar to the studies done by Zamir *et al*. [12]. In contrast, studies done by Ahmadzadeh *et al*. [10] and Sinha *et al*. [16] showed a higher incidence rate as their study group consisted only of children under 5 years of age. About 13% of children in our study had abnormalities in DMSA. In contrast, Hoberman [15] reported a higher incidence (70.8%), probably because their study group consisted of only children aged less than 2 years.

Kidney scarring was seen in 9% of children with UTI which was similar to the study done by Andrich *et al*. (10–15%) [7]. Of the 9 children with kidney scarring, 77.7% (n=7) had underlying urinary tract abnormalities and 22.2% (n=2) were without underlying urinary tract abnormalities who were under 2 years. In the current study, the overall prevalence of urinary tract abnormalities was 14%, which was similar to the study done by Zamir *et al*. [12]. In contrast, Ahmadzadeh *et al*. [10] reported a higher incidence of abnormalities (60.6%), as majority (77%) of their study group were children aged less than 5 years. The most common abnormality detected in our study was VUR, which was similar to other studies [9-12,16], of which 37.5% (3/8) had bilateral VUR. similar results obtained by other studies are compiled in Table 3.

The study had a few limitations. The study was done in a single center. Since it was a time-bound study, only 100 children were enrolled.

CONCLUSION

UTI is a common pediatric problem with the potential to produce long-term morbidity. In children below 5 years, symptoms and signs are non-specific and routine urine examination may not yield persistent findings. Hence, high index of suspicion is necessary.

The present study reinforces the importance of evaluation for genitourinary anomalies following the first UTI. Early identification and intervention of these abnormalities will prevent recurrent UTI and damage to growing kidney.

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