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Original Research Article

ULTRASONOGRAPHIC ABNORMALITIES ASSOCIATED WITH PEDIATRIC URINARY TRACT INFECTIONS: DIAGNOSTIC IMPLICATIONS

Suman Uppin[1], D Pooja Reddy[1], Raghuveer S Anantapur[2], Nagaraj[1]

[1]*Assistant Professor, Department of Paediatrics, YIMS Yadgiri, India.*
[2]*Senior Resident, Department of Paediatrics, YIMS Yadgiri, India.*

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Corresponding Author:
Dr. Nagaraj,
Assistant Professor, Department of Paediatrics, YIMS Yadgiri, India.
Email: naghk414@gmail.com

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ABSTRACT

Background: Urinary tract infection (UTI) is one of the most common bacterial infections in children and may be associated with underlying urinary tract abnormalities that increase the risk of recurrent infection and renal damage. Ultrasonography is widely used as the initial imaging modality for evaluating pediatric UTI because it is non-invasive, radiation-free, and readily available. The aim is to assess ultrasonographic abnormalities associated with pediatric urinary tract infections and evaluate their diagnostic implications.

Materials and Methods: A hospital-based prospective observational study was conducted among 102 children aged 1 month to 14 years diagnosed with urinary tract infection. Clinical, laboratory, microbiological, and ultrasonographic findings were recorded. Associations between ultrasonographic abnormalities and clinical characteristics were analyzed using appropriate statistical tests. Diagnostic performance of ultrasonography for identifying complicated UTI was assessed using sensitivity, specificity, predictive values, and receiver operating characteristic (ROC) analysis.

Results: The mean age of participants was 4.3 ± 3.1 years, with the majority belonging to the 1–5 years age group (55.9%). Males constituted 61.8% of cases. Fever (59.8%), dysuria (52.9%), and vomiting (42.1%) were the most common presenting symptoms. Ultrasonography was normal in 52.0% of children, while 32.4% demonstrated abnormal findings. Among abnormal studies, cystitis (51.5%) was the most frequent finding, followed by hydroureteronephrosis (33.3%) and prominent renal pelvis without hydronephrosis (15.2%). Fever, dysuria, vomiting, and upper UTI showed significant associations with abnormal ultrasonographic findings ($p<0.05$). Abnormal USG was significantly associated with complicated UTI (OR=8.66, $p<0.001$), hydroureteronephrosis, vesicoureteral reflux, and prolonged hospital stay. Diagnostic evaluation demonstrated a sensitivity of 62.9%, specificity of 83.6%, positive predictive value of 66.7%, negative predictive value of 81.1%, and overall accuracy of 76.5%. The ROC analysis showed an AUC of 0.73 (95% CI: 0.63–0.82; $p<0.001$).

Conclusion: Ultrasonography is a valuable first-line imaging tool in pediatric urinary tract infections. Abnormal ultrasonographic findings are significantly associated with complicated UTI and important urinary tract pathology. Early ultrasonographic evaluation facilitates risk stratification, guides further investigations, and may help prevent long-term renal complications in affected children.

Keywords: Pediatric Urinary Tract Infection. Ultrasonography. Vesicoureteral Reflux (VUR).

INTRODUCTION

Urinary tract infection (UTI) is one of the most common bacterial infections encountered in the pediatric population and represents a significant cause of morbidity worldwide. It accounts for a considerable proportion of outpatient visits and hospital admissions among children. Early diagnosis and appropriate management are essential because recurrent or inadequately treated UTIs may result in renal scarring, hypertension, proteinuria, and chronic kidney disease later in life. The clinical presentation of UTI varies according to age. Infants often present with nonspecific symptoms such as fever, irritability, poor feeding, vomiting, and failure to thrive, whereas older children commonly exhibit dysuria, urgency, frequency, abdominal pain, and flank pain. Due to these variable presentations, diagnostic evaluation frequently requires laboratory and radiological investigations.[1]

Imaging studies play a crucial role in the evaluation of children with UTI because underlying structural abnormalities of the urinary tract may predispose children to infection and recurrent disease. Ultrasonography (USG) is the preferred initial imaging modality owing to its non-invasive nature, absence of ionizing radiation, widespread availability, and ability to evaluate both renal and bladder anatomy. Renal and bladder ultrasonography can identify abnormalities such as hydronephrosis, hydroureteronephrosis, cystitis, renal pelvic dilatation, congenital anomalies, bladder wall thickening, and obstructive uropathies. Detection of these abnormalities helps clinicians identify children at risk for recurrent infections and renal damage.[2]

Recent pediatric guidelines recommend renal ultrasonography following a febrile UTI, particularly in infants and young children, to assess for anatomical abnormalities. Although most children with a first UTI have a structurally normal urinary tract, a significant proportion may harbor clinically important abnormalities requiring further evaluation with micturating cystourethrogram (MCUG) or dimercaptosuccinic acid (DMSA) scanning. Ultrasonography also assists in identifying complications such as renal abscess, pyonephrosis, and obstructive lesions in children who fail to respond to antibiotic therapy.[3]

The prevalence and spectrum of ultrasonographic abnormalities vary across different populations and age groups. Previous studies have reported hydronephrosis, vesicoureteral reflux-associated changes, bladder wall thickening, cystitis, and congenital anomalies as common findings among children with UTI. Identification of such abnormalities has important diagnostic and prognostic implications because they may influence treatment decisions, follow-up strategies, and preventive interventions. Furthermore, recognition of urinary tract abnormalities can facilitate early referral to pediatric nephrology or pediatric surgery services when necessary.[4]

Aim: To assess ultrasonographic abnormalities associated with pediatric urinary tract infections and evaluate their diagnostic implications.

Objectives

1. To determine the frequency and pattern of ultrasonographic abnormalities among children diagnosed with urinary tract infection.
2. To evaluate the association between ultrasonographic findings and clinical characteristics of pediatric urinary tract infections.
3. To assess the diagnostic significance of ultrasonographic abnormalities in identifying complicated urinary tract infections and underlying urinary tract pathology.

MATERIALS AND METHODS

Source of Data: The data were collected from pediatric patients diagnosed with urinary tract infection attending the Outpatient Department (OPD) and those admitted to the Department of Pediatrics of a tertiary care teaching hospital. Children fulfilling the eligibility criteria during the study period were enrolled consecutively after obtaining informed consent from parents or legal guardians.

Study Design: Hospital-based Prospective Observational Study.

Study Location: Department of Pediatrics in collaboration with the Department of Radiodiagnosis of a tertiary care teaching hospital.

Study Duration: The study was conducted over a period of 18 months from January 2024 to June 2025.

Sample Size: A total of 102 children diagnosed with urinary tract infection were included in the study.

Inclusion Criteria

1. Children aged 1 month to 14 years.
2. Children with clinically suspected urinary tract infection and laboratory confirmation by urine culture.
3. Children who underwent ultrasonographic examination of the urinary tract.
4. Parents/guardians willing to provide written informed consent.

Exclusion Criteria

1. Children with previously diagnosed chronic kidney disease.
2. Children with known congenital urinary tract anomalies already under treatment.
3. Children who had undergone previous urological surgery.
4. Children with incomplete clinical, laboratory, or ultrasonographic data.
5. Parents or guardians unwilling to provide consent.

Procedure and Methodology: After obtaining Institutional Ethics Committee approval, eligible children presenting with symptoms suggestive of urinary tract infection were screened. Detailed

demographic information including age, sex, presenting complaints, past history of UTI, and associated risk factors was recorded using a predesigned proforma.

Clinical examination was performed in all participants. Urine samples were collected using age-appropriate sterile techniques including clean-catch midstream urine collection, catheterization, or suprapubic aspiration whenever indicated. Urinalysis and urine culture were performed for confirmation of UTI.

Following confirmation of UTI, all enrolled children underwent ultrasonographic evaluation of the kidneys, ureters, and urinary bladder using a high-resolution ultrasound machine by an experienced radiologist. Ultrasonographic parameters assessed included:

- Renal size and morphology
- Hydronephrosis
- Hydroureteronephrosis
- Renal pelvic dilatation
- Bladder wall thickening
- Cystitis changes
- Ureteric abnormalities
- Congenital urinary tract anomalies
- Residual urine volume
- Any other structural abnormality

Patients with significant abnormalities suggestive of vesicoureteral reflux or obstructive uropathy were advised further imaging investigations such as MCUG according to institutional protocols.

All findings were documented and correlated with clinical presentation and laboratory parameters.

Sample Processing: Urine specimens were transported immediately to the microbiology laboratory. Routine urine examination included assessment of pyuria, bacteriuria, leukocyte esterase, and nitrite positivity. Urine cultures were performed using standard microbiological techniques. Significant bacteriuria was defined according to accepted pediatric criteria based on the method of urine collection.

Ultrasonographic examinations were performed using standardized protocols. Reports were reviewed and categorized into normal and abnormal findings. Abnormalities were further classified into cystitis, hydronephrosis, hydroureteronephrosis, prominent renal pelvis, bladder abnormalities, and other structural lesions.

Statistical Methods: Data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) version 26.0.

- Categorical variables were expressed as frequency and percentage.
- Continuous variables were expressed as mean ± standard deviation (SD).
- Chi-square test or Fisher's exact test was used to assess associations between categorical variables.
- Independent t-test was used for comparison of quantitative variables between groups.
- Odds ratios (OR) with 95% confidence intervals (CI) were calculated where appropriate.
- A p-value <0.05 was considered statistically significant.

Data Collection

Data were collected using a structured and prevalidated case record form. Information recorded included:

- Demographic details (age, gender)
- Clinical presentation
- Duration of symptoms
- Risk factors for UTI
- Urinalysis findings
- Urine culture results
- Ultrasonographic findings
- Presence of complicated or uncomplicated UTI
- Additional imaging findings where available

The collected data were verified for completeness and accuracy before statistical analysis.

RESULTS

[Table 1] presents the baseline demographic and clinical characteristics of 102 children diagnosed with urinary tract infection who underwent ultrasonographic evaluation. The majority of participants belonged to the 1–5 years age group, accounting for 57 (55.9%) children, followed by those older than 5 years (22.5%) and infants younger than 1 year (21.6%). The age distribution was statistically significant (χ^2=24.29, p<0.001), indicating that UTIs were predominantly observed among preschool-aged children. The mean age of the study population was 4.3 ± 3.1 years (95% CI: 3.7–4.9 years), which was also statistically significant (t=13.98, p<0.001). Male children constituted a significantly higher proportion of cases than females, with 63 (61.8%) males and 39 (38.2%) females (χ^2=5.65, p=0.017). Regarding clinical presentation, fever was the most common symptom and was observed in 61 (59.8%) children, showing statistical significance (χ^2=3.92, p=0.048). Dysuria was reported in 54 (52.9%) cases, while vomiting was present in 43 (42.1%) children; however, neither dysuria (p=0.553) nor vomiting (p=0.139) demonstrated statistically significant predominance.

Table 1: Baseline Characteristics of Children with UTI Undergoing Ultrasonographic Evaluation (N=102)

Variable	n (%) / Mean±SD	95% CI	Test value	P value
Age <1 year	22 (21.6)	14.7–30.5	χ^2=24.29	<0.001
Age 1–5 years	57 (55.9)	46.2–65.1		
Age >5 years	23 (22.5)	15.5–31.6		
Male	63 (61.8)	52.1–70.6	χ^2=5.65	0.017
Female	39 (38.2)	29.4–47.9		

Age (years)	4.3 ± 3.1	3.7–4.9	t=13.98	<0.001
Fever	61 (59.8)	50.1–69.0	χ^2=3.92	0.048
Dysuria	54 (52.9)	43.2–62.3	χ^2=0.35	0.553
Vomiting	43 (42.1)	32.9–51.9	χ^2=2.19	0.139

Table 2: Frequency and Pattern of Ultrasonographic Abnormalities Among Children with UTI (N=102)

Ultrasonographic Finding	n (%)	95% CI	Test value	P value
Normal USG	53 (52.0)	42.4–61.4	χ^2=8.48	0.004
Abnormal USG	33 (32.4)	24.0–42.1		
Non-specific/minor findings	16 (15.6)	9.7–24.0		
Cystitis	17 (51.5)*	34.8–68.0	χ^2=7.82	0.005
Hydroureteronephrosis	11 (33.3)*	19.2–50.2	χ^2=1.36	0.243
Prominent renal pelvis without hydronephrosis	5 (15.2)*	6.7–30.1	χ^2=5.48	0.019
MCUG performed	5 (4.9)	2.1–10.9	—	—
Low-grade VUR	3 (60.0)#	23.1–88.2	—	—
High-grade VUR	2 (40.0)#	11.8–76.9	—	—

*Percentage calculated among abnormal USG cases (n=33); #Percentage calculated among MCUG cases (n=5)

[Table 2] summarizes the ultrasonographic findings among children with urinary tract infections. More than half of the study population, 53 (52.0%), demonstrated normal ultrasonographic findings, and this predominance was statistically significant (χ^2=8.48, p=0.004). Abnormal ultrasonographic findings were identified in 33 (32.4%) children, whereas 16 (15.6%) showed non-specific or minor abnormalities. Among the abnormal USG cases (n=33), cystitis was the most frequent finding, observed in 17 (51.5%) children, and this association was statistically significant (χ^2=7.82, p=0.005). Hydroureteronephrosis was detected in 11 (33.3%) cases but did not reach statistical significance (χ^2=1.36, p=0.243). Prominent renal pelvis without hydronephrosis was observed in 5 (15.2%) children and showed statistical significance (χ^2=5.48, p=0.019). Further evaluation using micturating cystourethrogram (MCUG) was performed in only 5 (4.9%) children with suspected structural abnormalities. Among these, low-grade vesicoureteral reflux (VUR) was identified in 3 (60.0%) cases and high-grade VUR in 2 (40.0%) cases.

Table 3: Association Between Ultrasonographic Findings and Clinical Characteristics of Pediatric UTI

Clinical Variable	Abnormal USG (n=33)	Normal USG (n=53)	χ^2/t value	P value	OR (95% CI)
Fever	26 (78.8)	26 (49.1)	χ^2=7.58	0.006	3.84 (1.43–10.31)
Dysuria	23 (69.7)	24 (45.3)	χ^2=4.78	0.029	2.78 (1.13–6.83)
Vomiting	18 (54.5)	16 (30.2)	χ^2=5.13	0.024	2.77 (1.12–6.84)
Upper UTI	20 (60.6)	10 (18.9)	χ^2=15.87	<0.001	6.60 (2.43–17.90)
Lower UTI	13 (39.4)	43 (81.1)	χ^2=15.87	<0.001	0.15 (0.06–0.41)
Age (years)	3.9 ± 2.8	4.4 ± 3.2	t=0.73	0.468	—
Male gender	24 (72.7)	30 (56.6)	χ^2=2.23	0.135	2.04 (0.80–5.20)

[Table 3] evaluates the relationship between ultrasonographic abnormalities and clinical characteristics of pediatric urinary tract infections. Children with abnormal USG findings had significantly higher frequencies of fever compared with those having normal USG findings (78.8% vs. 49.1%; χ^2=7.58, p=0.006). The odds of having abnormal USG findings were approximately 3.8 times higher among children presenting with fever (OR=3.84; 95% CI: 1.43–10.31). Similarly, dysuria was significantly more common among children with abnormal USG findings (69.7% vs. 45.3%; p=0.029), increasing the likelihood of abnormal imaging by nearly three-fold (OR=2.78; 95% CI: 1.13–6.83). Vomiting also showed a significant association with abnormal USG findings (54.5% vs. 30.2%; p=0.024), with an odds ratio of 2.77 (95% CI: 1.12–6.84). A particularly strong association was observed between upper urinary tract infection and abnormal ultrasonographic findings, with 60.6% of abnormal USG cases having upper UTI compared to only 18.9% among normal USG cases (χ^2=15.87, p<0.001). Children with upper UTI were approximately 6.6 times more likely to exhibit abnormal ultrasonography (OR=6.60; 95% CI: 2.43–17.90). Conversely, lower UTI was significantly associated with normal USG findings (OR=0.15; 95% CI: 0.06–0.41). No significant differences were observed regarding age (p=0.468) or male gender (p=0.135).

Table 4: Diagnostic Significance of Ultrasonographic Abnormalities in Identifying Complicated UTI and Underlying Urinary Tract Pathology

Variable	Complicated UTI (n=35)	Uncomplicated UTI (n=67)	χ^2 value	P value	OR (95% CI)
Abnormal USG	22 (62.9)	11 (16.4)	21.64	<0.001	8.66 (3.37–22.27)
Normal USG	10 (28.6)	43 (64.2)	11.88	0.001	0.22 (0.09–0.54)
Upper UTI	23 (65.7)	15 (22.4)	17.92	<0.001	6.64 (2.68–16.44)
Hydroureteronephrosis	9 (25.7)	2 (3.0)	11.31	0.001	11.23 (2.21–57.02)
VUR detected	5 (14.3)	0 (0.0)	Fisher Exact	0.003	—
Hospital stay (days)	6.8 ± 2.4	4.2 ± 1.6	t=6.21	<0.001	—

Diagnostic Accuracy of Abnormal USG for Complicated UTI

Parameter	Value (95% CI)
Sensitivity	62.9% (45.1–77.8)
Specificity	83.6% (72.8–90.9)
Positive Predictive Value	66.7% (49.0–80.4)
Negative Predictive Value	81.1% (70.2–88.7)
Accuracy	76.5% (67.2–84.0)
Diagnostic Odds Ratio	8.66 (3.37–22.27)
AUC (ROC)	0.73 (0.63–0.82), p<0.001

[Table 4] demonstrates the diagnostic value of ultrasonographic abnormalities in identifying complicated urinary tract infections and associated urinary tract pathology. Abnormal USG findings were significantly more frequent among children with complicated UTI compared to those with uncomplicated UTI (62.9% vs. 16.4%; χ^2=21.64, p<0.001). Children with abnormal ultrasonography had nearly nine times higher odds of having complicated UTI (OR=8.66; 95% CI: 3.37–22.27). In contrast, normal USG findings were significantly associated with uncomplicated UTI (64.2% vs. 28.6%; OR=0.22; 95% CI: 0.09–0.54). Upper urinary tract infection was also strongly associated with complicated UTI, occurring in 65.7% of complicated cases compared with 22.4% of uncomplicated cases (OR=6.64; 95% CI: 2.68–16.44; p<0.001). Hydroureteronephrosis emerged as an important pathological finding, being significantly more common in complicated UTI (25.7% vs. 3.0%; OR=11.23; 95% CI: 2.21–57.02; p=0.001). Vesicoureteral reflux was detected exclusively among complicated UTI cases (14.3%), yielding a significant association (Fisher exact p=0.003). Furthermore, children with complicated UTI experienced significantly longer hospital stays than those with uncomplicated infections (6.8 ± 2.4 days vs. 4.2 ± 1.6 days; t=6.21, p<0.001). Diagnostic accuracy analysis demonstrated that abnormal ultrasonography had a sensitivity of 62.9%, specificity of 83.6%, positive predictive value of 66.7%, negative predictive value of 81.1%, and overall accuracy of 76.5% for identifying complicated UTI. The diagnostic odds ratio was 8.66, and the area under the ROC curve was 0.73 (95% CI: 0.63–0.82; p<0.001), indicating good discriminatory ability.

DISCUSSION

In the present study, most children with UTI belonged to the 1–5 years age group (55.9%), with a mean age of 4.3±3.1 years. This age predominance is comparable with Shaikh et al,[1] (2008) and Kaufman et al,[2] (2019) who reported that pediatric UTI commonly clusters in infancy and early childhood because of immature host defense, toilet-training related urinary stasis, and higher frequency of febrile illnesses. Male predominance was observed in the present study (61.8%), which differs from many older pediatric UTI studies where female predominance was reported after infancy; however, Hoberman et al,[3] (2003) and Shaikh et al,[4] (2010) noted that males, especially younger boys and those with possible congenital urinary tract abnormalities, may show higher UTI risk in early life. Fever was the most common symptom (59.8%) and showed statistical significance (p=0.048), similar to Coulthard et al,[5] (2014) and Subcommittee on Urinary Tract Infection, AAP (2011),[6] who emphasized fever as the most important clinical clue for UTI in younger children.

Ultrasonography showed normal findings in 52.0% of children, while 32.4% had abnormal findings. This supports the observation by NICE (2022),[7] and Barola et al,[8] (2024) that although many children with first UTI have normal renal-bladder ultrasonography, USG remains useful for detecting structural abnormalities, obstruction, hydronephrosis, and bladder changes. Cystitis was the most common abnormal finding (51.5% among abnormal USG cases), followed by hydroureteronephrosis (33.3%) and prominent renal pelvis without hydronephrosis (15.2%). Similar abnormalities were described by Mahant et al. (2002),[9] and Ismaili et al (2011),[10] who found that renal-bladder ultrasound could identify dilatation, hydronephrosis, bladder wall changes, and other urinary tract abnormalities in children with febrile UTI. MCUG was performed in 4.9% of cases, among which low-grade VUR was seen in 60.0% and high-grade VUR in 40.0%. This selective use of MCUG is consistent with current recommendations that VCUG/MCUG should be reserved for abnormal ultrasound, recurrent UTI, atypical UTI, or suspected reflux rather than used routinely in all children.

The association analysis showed that fever, dysuria, vomiting, and upper UTI were significantly associated with abnormal USG findings. Upper UTI had the strongest association, with children having upper UTI being 6.6 times more likely to show abnormal USG findings. This finding agrees with Montini et al,[11] (2011) and Preda et al,[12] (2007) who reported that febrile or upper tract infections are more likely to be associated with renal parenchymal involvement, urinary tract dilatation, or underlying reflux. Lower UTI was negatively associated with abnormal USG findings, suggesting that isolated cystitis without systemic involvement is less likely to reveal major structural abnormality. Age and male gender were not statistically significant predictors in the present analysis, which is consistent with the view that clinical severity and infection site may be more useful than demographic variables alone for deciding imaging priority.

In the present study, abnormal USG was significantly more frequent in complicated UTI than uncomplicated UTI (62.9% vs 16.4%, p<0.001), with an odds ratio of 8.66. Hydroureteronephrosis showed a strong association with complicated UTI (OR=11.23), while VUR was detected only among complicated cases. These findings are comparable with studies by Massanyi et al. (2013),[13] Ristola et al,[14] (2017) and Swerkersson et al,[15] (2007) where abnormal ultrasound findings, hydronephrosis, ureteric dilatation, and reflux were linked with complicated or recurrent infections. Diagnostic accuracy analysis showed moderate sensitivity (62.9%) but good specificity (83.6%) and negative predictive value (81.1%) for abnormal USG in identifying complicated UTI. Similar observations were made by Nelson et al,[16] (2014) who noted that renal-bladder ultrasound is better as a screening and risk-stratification tool than as a definitive test for VUR. The AUC of 0.73 in the present study indicates acceptable discriminatory performance, supporting the role of ultrasound as a practical, non-invasive, first-line imaging modality in pediatric UTI.

CONCLUSION

The present study evaluated ultrasonographic abnormalities among children diagnosed with urinary tract infections and assessed their diagnostic implications. The majority of affected children belonged to the 1–5 years age group, with a significant male predominance. Fever was the most common presenting symptom, followed by dysuria and vomiting.

Ultrasonographic evaluation revealed that while over half of the children had normal imaging findings, a substantial proportion demonstrated significant abnormalities. Cystitis emerged as the most frequent ultrasonographic abnormality, followed by hydroureteronephrosis and prominent renal pelvis without hydronephrosis. Selective MCUG evaluation identified vesicoureteral reflux in a subset of children with abnormal imaging findings, highlighting the importance of targeted radiological assessment.

The study further demonstrated that fever, dysuria, vomiting, and upper urinary tract infection were significantly associated with abnormal ultrasonographic findings. Children with upper UTI were considerably more likely to exhibit structural or inflammatory abnormalities on imaging. Moreover, abnormal ultrasonographic findings showed a strong association with complicated UTI, hydroureteronephrosis, vesicoureteral reflux, prolonged hospitalization, and increased disease severity.

Diagnostic performance analysis indicated that ultrasonography possesses good specificity, negative predictive value, and overall diagnostic accuracy for identifying complicated urinary tract infections and underlying urinary tract pathology. Although ultrasonography alone may not detect all abnormalities, it serves as an effective, non-invasive, readily available first-line imaging modality for risk stratification and early identification of children requiring further evaluation.

In conclusion, ultrasonography plays a pivotal role in the diagnostic workup of pediatric urinary tract infections by facilitating the detection of clinically significant urinary tract abnormalities and helping identify children at increased risk for complicated disease. Early imaging assessment can contribute to timely intervention, prevention of recurrent infections, and reduction of long-term renal complications.

Limitations of study

1. The study was conducted at a single tertiary care center, limiting the generalizability of findings to the wider pediatric population.
2. The sample size was relatively modest, which may have reduced the precision of estimates for less common ultrasonographic abnormalities.
3. The cross-sectional observational design precluded assessment of long-term outcomes and causal relationships.
4. Follow-up imaging studies were not performed routinely in all participants.
5. MCUG was conducted only in selected patients, which may have led to underestimation of vesicoureteral reflux prevalence.
6. DMSA renal scintigraphy was not performed systematically, preventing assessment of renal scarring and parenchymal damage.
7. Interobserver variability among radiologists performing ultrasonography was not evaluated.
8. Some ultrasonographic abnormalities may have been transient and related to acute infection rather than underlying structural pathology.
9. The study did not evaluate the impact of prior antibiotic therapy on imaging findings.
10. Severity grading of ultrasonographic abnormalities was not analyzed separately.
11. Recurrent and first-episode UTIs were not evaluated independently for imaging differences.
12. Potential confounding factors such as socioeconomic status, nutritional status, and circumcision status were not assessed.
13. Advanced imaging modalities such as MRI urography were not utilized.
14. The study did not evaluate cost-effectiveness of routine ultrasonographic screening.
15. Long-term renal function and recurrence rates could not be assessed due to lack of longitudinal follow-up.

REFERENCES

1. Shaikh N, Morone NE, Bost JE, Farrell MH. Prevalence of urinary tract infection in childhood: a meta-analysis. Pediatr Infect Dis J. 2008;27(4):302-308.
2. Kaufman J, Temple-Smith M, Sanci L. Urinary tract infections in children: an overview of diagnosis and management. BMJ Paediatr Open. 2019;3(1):e000487.

3. Hoberman A, Charron M, Hickey RW, Baskin M, Kearney DH, Wald ER. Imaging studies after a first febrile urinary tract infection in young children. N Engl J Med. 2003;348(3):195-202.
4. Shaikh N, Ewing AL, Bhatnagar S, Hoberman A. Risk of renal scarring in children with a first urinary tract infection: a systematic review. Pediatrics. 2010;126(6):1084-1091.
5. Coulthard MG, Vernon SJ, Lambert HJ, Matthews JNS. A nurse led education and direct access service for the management of urinary tract infections in children. BMJ. 2003;327(7416):656-659.
6. Subcommittee on Urinary Tract Infection, Steering Committee on Quality Improvement and Management. Urinary tract infection: clinical practice guideline for diagnosis and management of initial UTI in febrile infants and children 2 to 24 months. Pediatrics. 2011;128(3):595-610.
7. National Institute for Health and Care Excellence. Urinary tract infection in under 16s: diagnosis and management. NICE guideline NG224. London: NICE; 2022.
8. Barola S, Koyfman A, Long B. Urinary tract infections in children. StatPearls. Treasure Island: StatPearls Publishing; 2024.
9. Mahant S, Friedman J, MacArthur C. Renal ultrasound findings and vesicoureteral reflux in children hospitalised with urinary tract infection. Arch Dis Child. 2002;86(6):419-420.
10. Ismaili K, Avni FE, Wissing KM, Hall M. Long-term clinical outcome of infants with mild and moderate fetal pyelectasis. J Pediatr. 2004;144(6):759-765.
11. Montini G, Tullus K, Hewitt I. Febrile urinary tract infections in children. N Engl J Med. 2011;365(3):239-250.
12. Preda I, Jodal U, Sixt R, Stokland E, Hansson S. Normal dimercaptosuccinic acid scintigraphy makes voiding cystourethrography unnecessary after urinary tract infection. J Pediatr. 2007;151(6):581-584.
13. Massanyi EZ, Preece J, Gupta A, Lin SM, Wang MH. Utility of screening ultrasound after first febrile urinary tract infection among patients with clinically significant vesicoureteral reflux. Urology. 2013;82(4):905-909.
14. Ristola MT, Hurme T, Lanning P, Uhari M. Ultrasonography in recurrent urinary tract infections in children. Acta Paediatr. 2017;106(4):653-657.
15. Swerkersson S, Jodal U, Sixt R, Stokland E, Hansson S. Relationship among vesicoureteral reflux, urinary tract infection and renal damage in children. J Urol. 2007;178(2):647-651.
16. Nelson CP, Johnson EK, Logvinenko T, Chow JS. Ultrasound as a screening test for genitourinary anomalies in children with UTI. Pediatrics. 2014;133(3):e394-e403.