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Original Article

Surgery Section

Diagnostic Validity of Urinalysis in Comparison with Urine Culture Prior to Micturating Cystourethrogram in Children: A Retrospective Observational Study at a Tertiary Care Centre in Kerala, India

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ABSTRACT

Introduction: Micturating Cystourethrogram (MCUG)-triggered Urinary Tract Infections (UTIs) are well-known, but the risk factors that trigger infections are not well studied. Even though MCUG being invasive, there is no general consensus regarding the use of peri-procedural antibiotic coverage and screening for sub-clinical UTIs just before MCUG.

Aim: To determine the diagnostic validity of Urinalysis (UA) when compared with the gold standard, Urine Culture and Sensitivity (UCS), to exclude pre-procedure infections.

Materials and Methods: This retrospective observational study involved paediatric patients who underwent MCUG from January 2021 to December 2022, at Kozhikode Government Medical College (Kerala) to exclude urological anomalies. All children were tested with UA and UCS before MCUG, which was done under antibiotic coverage. A positive UCS was defined as a significant growth of a single organism (>100,000 for mid-stream urine or >50,000 for catheterised sample), while a positive UA was defined as pus cells >5/high power field on microscopy. After exclusions, the authors analysed 300 patients. The diagnostic validity of UA was assessed using the Pearson Chi-square test, by Statistical Package for Social Sciences (SPSS) version 16.0. and a p-value less than 0.05 was considered significant.

Results: The median age was nine months (IQR 13 months) with 68% being male. The most common indication for MCUG was evaluation for recurrent/febrile UTIs (n=171, 56.6%). Both Pre-MCUG, UA and UCS were documented as positive in eight patients (2.6%), and pre-MCUG, UCS alone was positive in two patients. The diagnostic validity of UA when compared with UCS showed high specificity and positive predictive values at 100% (p<0.05).

Conclusion: A simple UA, when compared with UCS (the gold standard investigation for UTIs), has high specificity and positive predictive value in excluding sub-clinical UTIs prior to MCUGs. It may be preferable as it yields quick and reliable results.

Keywords: Anomalies, Infection, Investigation, Predictors, Reflux, Urosepsis

INTRODUCTION

The MCUG is a fluoroscopic investigation performed to investigate the anatomy and function of the lower urinary tract system in paediatric patients for evaluating a range of urological conditions with structural and neurogenic etiology [1]. It is widely believed by clinicians, patients, and parents of patients that MCUG may increase the risk of UTI and/or urosepsis; therefore, it is essential to exclude any infection before MCUG [2]. Even though various articles have been published regarding the incidence of UTI after MCUG and the need for peri-procedural antibiotic cover, there are few published articles addressing the risk factors triggering UTI after MCUG [1-4].

It is important to exclude UTIs before MCUG by performing UA and/or UCS. If found positive, then the invasive procedure is not performed [4]. While UA costs less and yields quick results, UCS is relatively expensive, time-consuming, and occasionally has difficulties with interpretation [3,4]. Nevertheless, UCS is the gold standard diagnostic test for establishing UTIs [4]. The exclusion of pre-procedure sub-clinical UTIs and the utility of UA in this regard have not been discussed in the literature. Therefore, the aim of this study was to determine the diagnostic validity of UA when compared with UCS to exclude infections prior to MCUG.

MATERIALS AND METHODS

A retrospective observational study of paediatric patients (up to 13 years old) who underwent MCUG at our institution, Government Medical College, Kozhikode, Kerala, between January 2021 and December 2022, was performed and the data was compiled in October 2023. Patients were referred to our center for various urological problems, and MCUG was performed as part of the evaluation. All patients had a pre-MCUG Ultrasound Scan of the Kidney/Urethra/Bladder (USG KUB). This study was cleared by the Institutional Review Board of the institution with the number IRC/2023/Protocol/192.

Inclusion criteria: All children included in the study had UA and UCS conducted, at least within 14 days (as per our routine department protocol) before the scheduled MCUG.

Exclusion criteria: Patients with ureterostomy, vesicostomy, colostomy, epispadias, proximal hypospadias, patients clinically suspicious for UTI or receiving treatment for UTI, repeat/redo MCUGs, patients already on prophylactic antibiotics, or antibiotics for other reasons were excluded.

Procedure

Patient demographics, indication for MCUG, and results of pre-MCUG UA and UCS were recorded.

Positive UCS was defined as a significant growth of a single organism after 48 hours (>100,000 for mid-stream urine or >50,000 for catheterised samples), whereas pyuria was defined as urinary pus cells >5/high power field on microscopy [4,5]. Mixed growth, meaning a culture showing more than one organism, would be

repeated only if there was pyuria along with symptoms suggestive of UTI. The sub-clinical infections are situations where clinical symptoms are absent, but UA and/or UCS may be positive. Urine collection was done either by clean catch mid-stream or by catheterising the bladder. Patients with clinical evidence of concurrent UTI or with either positive UA or UCS did not proceed with the MCUG.

STATISTICAL ANALYSIS

Data were analysed using SPSS version 16.0. (IBM, Armonk, New York, NY, USA). Descriptive statistics were expressed as median and IQR or mean and SD. Categorical variables were expressed as the number of patients and the percentage of patients and compared across the groups. Diagnostic validity was assessed using the Pearson Chi-square test with a degree of freedom of one. Any p-value less than 0.05 was considered significant. The standard formulas for sensitivity, specificity, and predictive values were used.

RESULTS

Out of the total of 326 patients who underwent MCU, 26 were excluded as they did not meet the inclusion criteria. A total of 300 patients were then considered for analysis. Of these, 204 were males (68%) and 96 were females (32%). The ages ranged from six months to seven years (IQR 13 months) with a median age of nine months. The patient characteristics are shown in [Table/Fig-1]. The most common age group in which MCUG was performed was the 1-5 years age group (n=169, 56.3%). MCUGs were ordered for a variety of reasons such as abnormal USG KUB and/or recurrent/febrile UTIs. Patients were routinely administered antibiotic cover at a therapeutic dosage during the procedure. The most common indication for MCUG evaluation was recurrent/febrile UTIs (n=160, 53.3%).

Patient characteristic	Value, n (%) (Total N=300)
Age in months at time of MCUG	
0-6 months	23 (7.6)
7-12 months	88 (29.3)
1-5 years	169 (56.3)
Above 5 years	20 (6.6)
Gender	
Male	204 (68)
Female	96 (32)
Indication for MCUG	
Post-urinary tract infection evaluation	171 (56.6)
Hydronephrosis	86 (28.6)
Duplex system	6 (2)
Ectopic kidney	6 (2)
Multi-cystic dysplastic kidney	3 (1)
Posterior urethral valve	20 (6.7)
Voiding dysfunction	18 (6)
Vesico-ureteric junction obstruction	5 (1.7)

[Table/Fig-1]: Patient characteristics. (Total N=300 patients).

Some patients had multiple indications for undergoing MCUG. Both Pre-MCUG UA and UCS were documented as positive in six patients (2%), and pre-MCUG UCS alone was positive in two patients (0.7%). All eight cultures that were positive showed pure growth of a single organism (*Escherichia coli*). MCUG was deferred in all these eight patients. The diagnostic validity of UA when compared with UCS is summarised in [Table/Fig-2]. Both the specificity and positive predictive values are 100% (p<0.05).

	Urine culture positive	Urine culture negative	Total
Urinalysis (UA) positive	6 (2%)	0 (0%)	6 (2%)
Urinalysis (UA) negative	2 (0.7%)	292 (97.3%)	294 (98%)
Total	8 (2.7%)	292 (97.3%)	300 (100%)

Validity measure	Value (%)	p-value
Sensitivity	75	<0.001
Specificity	100	
Positive predictive value	100	
Negative predictive value	99.3	

[Table/Fig-2]: Diagnostic validity of UA when compared with UCS.
Pearson Chi-square test at degree of freedom of 1, p<0.05 statistically significant

DISCUSSION

The MCUG is one of the most common fluoroscopic investigations performed in paediatric radiology and remains the gold standard for demonstrating the grade of reflux as well as urethral anatomy.

Among its complications, MCUG-acquired UTI remains an important concern with reports of urosepsis and even death. Current institutional guidelines for considering MCUG following UTI in children vary considerably. Despite the frequent use of MCUG in paediatric practice, there is a lack of general consensus over the use of antibiotics or pre-procedure screening for sub-clinical UTIs or asymptomatic bacteriuria [4,5]. The incidence of developing UTI is often considered high after MCUG as it is an invasive procedure. Performing MCUG with antibiotic cover seems to be a logical approach as there is a theoretical chance of introducing peri-urethral bacteria into the bladder and, in the presence of Vesicuo-Ureteric Reflux (VUR), even into the kidney. However, the lack of robust clinical evidence has resulted in this practice being questioned and the adoption of variable other practices. While the National Institute for Health and Care Excellence (NICE) UK guideline advocates antibiotics for MCUG, others have questioned this approach [6,7].

Despite MCUG being a commonly performed investigation, reports are scant and variable on the incidence of MCUG-acquired UTI. A retrospective review by Ngweso S et al., shows that following an MCUG, the incidence of culture-positive UTI is 5.6%, and the risk of developing febrile, culture-positive UTI is 1.4% [2]. According to the previous study, there were 39.9% abnormal MCUGs (36.9% children with VUR, 2.97% bladder diverticulum), and 57.73% refluxing renal units (25.59% high-grade VUR units) [8]. In contrast, in a large cohort of 1108 by Johnson EK et al., the post-procedure UTI was found to be only 1% [9]. In the latter study, the presence of a pre-existing urologic diagnosis such as VUR or hydronephrosis was strongly associated with UTI. Furthermore, they suggest that children should not be started on antibiotic prophylaxis solely for the purpose of post-procedure UTI prevention; instead, decisions about antibiotic prophylaxis should be made based on other clinical indications such as VUR or hydroureter.

In recent literature, most studies have quoted the incidence of MCUG-acquired UTI ranging from 0% to 8%, with some reported incidences varying up to 30% [10,11]. Moreover, there is no uniformity regarding definitions and diagnostic criteria of UTI, and whether they were symptomatic or asymptomatic. Considering these variable results, higher risks of UTIs in the presence of anomalies, and the inconsistencies with ultrasound findings (such as the presence of hydroureter), here the clinicians routinely administer antibiotic cover during MCUG, albeit the practice remains controversial.

Even though the need for antibiotics and post-procedure UTIs are well discussed in the literature, the need to screen the urine for infection prior to the procedure to exclude sub-clinical infections is not clearly documented.

Some authors recommend that, after an episode of UTI, MCUG can be done following a negative urine culture as soon as possible [12]. Similarly, there are others who contend that the traditional recommendation of performing VCUG 3-6 weeks after the diagnosis of UTI should be re-evaluated [13]. This may be relevant to situations where a documented UTI has actually occurred. However, if the MCUG is being done for the evaluation of anomalies after an

abnormal USG KUB (where infection may not have occurred) or for complete urological evaluation after a significant interval following the last infection, the need to screen urine for infections just prior to MCUG is logical, but there is no consensus among authors and institutions.

Often, the MCUG is done electively in many institutions after an interval of days/weeks once the last infection is cleared. In such situations, it appears reasonable to exclude infections that may have happened in the interim. Since MCUG is an invasive procedure and post-procedure UTI remains a significant concern, especially with serious yet undetected underlying anomalies, the authors have developed the protocol to screen the urine to exclude sub-clinical UTIs and/or asymptomatic bacteriuria through both UA and UCS prior to every MCUG done at our institution. UA costs less and yields quick results compared to UCS (which is the gold standard), though the latter is relatively expensive, time-consuming, and may have difficulties with interpretation. In the present study, these two modalities are compared in an objective manner.

In the present study, pre-MCUG UA and UCS were documented as positive in 6 out of 300 (2%) and 8 out of 300 (2.7%) cases, respectively. Two of them were only UCS positive with normal UA. This contrasts with the general population, where the prevalence of asymptomatic bacteriuria was 0.37% in boys and 0.47% in girls. The corresponding values for asymptomatic bacteriuria without pyuria were 0.18% and 0.38%, respectively [14]. The diagnostic validity of UA compared to UCS was then evaluated. While the sensitivity was only 75%, it is highly specific at 100%. The positive predictive value is 100%, and the negative predictive value is 99.3%. This demonstrates that UA is reliable in excluding UTIs and is comparable to UCS. If UA is positive, the MCUG may be deferred until the infection is cleared, potentially avoiding serious UTIs. Hence, screening the urine prior to MCUGs seems justified. Screening for sub-clinical UTI before MCUG in children with underlying urological anomalies, with a comparison between pre-procedure UA and UCS, has not been discussed in the literature previously.

Limitation(s)

First, it was a retrospective study, and clinical details about some of the children were limited. Not all children met the strict diagnostic criteria established at the study initiation, whether they were symptomatic or not. There are also practical difficulties in obtaining samples in very young children. Additionally, the interpretation of UA is not based on pus cells alone. Given that the study was undertaken in a tertiary care center, the data may be biased towards more complex patients. Furthermore, the findings of this study may not be applicable to other complex anomalies and special situations that have been excluded (as per the exclusion criteria above), where a UCS would otherwise be preferable. The idea here is to use UA as a screening test alone.

Some would also argue that in the absence of clinical symptoms, a screening test would be redundant. Lastly, being a single-center study, the results may not be applicable to a different population in a different set-up. A double-blind, placebo-controlled trial would be ideal.

CONCLUSION(S)

Exclusion of sub-clinical infections prior to MCUG is crucial, as this cohort may have potentially serious underlying anomalies. A simple screening UA, when compared with UCS (gold standard investigation for UTIs), is highly specific and has a high predictive value in detecting such infections before MCUG and may be preferred as it yields reliable and quick results.

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