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Research Article

Micturating Cystourethrogram Findings in Children with Urinary Tract Infections: A Five Year Review

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Abbreviations MCUG: Micturating Cystourethrogram; UTI: Urinary Tract Infection; VUR: Vesico-Ureteric Reflux; PUV: Posterior Urethral Valves; CRF: Chronic Renal Failure; ESRD: End Stage Renal Disease; CAKUT: Congenital Abnormalities of the Kidneys and Urinary Tract; CKD: Chronic Kidney Disease; AAP: American Academy of Pediatrics; NICE: National Institute for Health and Clinical Excellence; KUB Ultrasound: Kidney, Ureter and Bladder Ultrasound; PUJ: Pelvi-Ureteric Junction

Abstract

Although the micturating cystourethrogram is included in the radiological evaluation of Jamaican children with urinary tract infections, there has never been a formal local study evaluating abnormal findings from this investigation. The aim of this paper is to document in a cohort of Jamaican children < age 12 years with urinary tract infections, the pattern of urological pathology identified by the micturating cystourethrogram. Radiological reports of micturating cystourethrogram findings in children with urinary tract infection investigated at the Bustamante Hospital for Children between October 2008 and January 2012 were identified and information on age, sex, and urological pathology recorded. Of the 523 children undergoing micturating cystourethrography, 458 fulfilled inclusion criterion. Males outnumbered females both in number (male: female 2.5:1) and in the frequency of abnormalities (13% of males and 7% of females). MCUG were abnormal in 54 children (11.8%). The commonest pathologies were vesicoureteric reflux (29%) followed by bladder /urethral abnormalities (28%). Posterior urethral valves were identified in 4 patients (1.2% of all males). In this study of a predominantly black population of children, the frequency of abnormal MCUG was less than in international studies, primarily due to the low frequency of VUR. However, the incidence of posterior urethral valves and bladder abnormalities is similar. As posterior urethral valves remain a major cause of chronic renal failure in Jamaican children, the micturating cystourethrogram is an important investigation. Financial constraints mandate local clinical research to establish more selective criteria for micturating cystourethrography.

Introduction

Urinary tract infections are one of the most common infections in childhood, with international prevalence documented to be between 2.9-11.6% in infants less than 24 months [1-3] and between 6.4-9% in children less than 19 years [4,5]. The investigation of UTI involves the use of KUB ultrasound, MCUG and renal scan.

The main reason for investigation of UTI is to ensure early identification of urological pathology, which, if left untreated, may lead to ESRD [6-9]. Internationally in developed countries, CAKUT and hereditary nephropathies account up to 66% of all cases of CKD [6]. The situation is similar in Jamaica where CAKUT accounts for 41-44% of cases of CRF [7,8]. Posterior urethral valves are the most common cause of obstructive uropathy in Jamaica, accounting for 27% of all cases of CRF [8]. Children with VUR are significantly more likely to develop pyelonephritis and renal scarring compared with children with no VUR and those with VUR grades III or higher are more likely to develop scarring than children with lower grades of reflux [9].

In recent years, there have been changes in the investigation of urinary tract infection worldwide, with a trend towards less aggressive investigation internationally [10,11]. Local guidelines recommend that all first UTIs be investigated, with the choice of investigation depending on age. For children <5years, a renal ultrasound and an MCUG are performed, with renal scan if UTI is febrile i.e. suspected pyelonephritis, recurrent or abnormalities are noted on screening studies. In children >5years old, a KUB ultrasound is done with MCUG investigation in all male children and in females with an abnormal ultrasound or examination or history suspicious of a voiding disorder. The indications for renal scan are as for the younger child [12]. In Jamaica, antenatal ultrasounds are not performed routinely and in some cases locally, infants with normal fetal ultrasounds have been shown to have abnormalities on investigation for UTI post delivery.

The American Academy of Pediatrics 2011 guidelines recommend that KUB ultrasonography be performed on all children between the ages of 2-24 months with first UTI, and MCUG reserved for those in whom the KUB ultrasound is abnormal or UTI recurs [10]. The National Institute for Health and Clinical Excellence (NICE) British guidelines recommend the MCUG in infants <age 6 months, in cases of atypical or recurrent UTI or if KUB ultrasound is abnormal. However in children over the age of 6 months, the MCUG is restricted to those with abnormal ultrasound, non *E coli* UTI, poor stream or familial VUR [11].

On the other hand, there are numerous studies which challenge this worldwide conservative trend and document that the omission of this study will result in significant missed diagnoses [13-15].

Analysis of CRF data in Jamaican children reveals that since the first application of the local UTI investigative guidelines in 1985, all cases of obstructive uropathy in the years 2001-2006 were diagnosed before age 5 years [8] as opposed to 43% in the years 1984-2000 [7]. Additionally CRF secondary to PUJ obstruction is no longer seen and posterior urethral valves are virtually now the only obstructive urological pathology causing CRF [8]. It is against this background that the local protocol [12] including the use of MCUG has been maintained.

The incidence of VUR in Caucasian populations with UTI ranges from 22% in Italy [16] to 41% in USA [14]. In USA it is reported that VUR is less common in black than Caucasian populations [17]. West, et al. documented VUR in 10% of Jamaican children in whom MCUG was performed for various reasons including UTI [18].

There is however, no literature on urological abnormalities in Jamaican children specifically investigated for only UTI. This study documents the frequency and types of urological pathology found on MCUG evaluation of a cohort of Jamaican children investigated for UTI. The information so obtained will add to the body of knowledge on local uropathology, and contribute objective data which may be useful in determining future local investigative protocols for childhood UTI.

Methods

This was a retrospective study documenting the yield of MCUG following investigation for UTI. Patients were identified from the electronic radiological records of the Bustamante Hospital for Children-the only stand-alone children's hospital in the English speaking Caribbean. This hospital serves the Kingston and St Andrew areas of Jamaica, and receives referrals from other parishes' island wide. It was selected as the setting because it was the only public hospital that offered MCUG services to children at minimal or no cost during the study period, thus providing a large cohort of patients for investigation. Bustamante Hospital for Children is a solely paediatric hospital with no antenatal unit so antenatal ultrasonography is not performed here.

All MCUG's reported between October 2008 and January 2012 were evaluated. Only those in which the indication for study was UTI were included. The UTI diagnosis was based solely on the electronic radiology records and not by bacteriological conformation from a medical records search. Information recorded included: date of study, date of birth, age, sex and urological pathology. The pathology was divided into the following major categories: VUR, PUV, anterior urethral valves, bladder abnormalities, urethral abnormalities, and other findings. VUR was further subdivided into Grades 1-5 according to the International Classification [19]. Bladder abnormalities were sub-grouped into: diverticulum, trabeculation, ureterocoele, spinning top bladder, elongated bladder and dilated bladder base. Urethral abnormalities were sub-classified as: diverticulum dilated proximal urethra and filling defects. If VUR was bilateral, the highest grade was used and recorded as a solitary entity / patient). Only primary VUR was evaluated. A single radiologist reported on all MCUG. Pathology was analyzed independently as a function of age in two-year categories up to age <12 years.

As this was a purely radiological study there was no verification by chart review that the MCUG analyzed was in fact the MCUG for the first UTI, however it is likely that this would have been the case since only the first MCUG on record was evaluated and MCUG performed for previously documented abnormalities excluded.

The inclusion criteria were the first recorded MCUG in patients of the Bustamante Hospital for Children who were under the age of 12 years at the time of investigation, had no co morbidities, and in whom the MCUG was performed only for UTI investigation and not for evaluation of known structural urological abnormalities or recurrent UTI. Patients whose age and sex were unrecorded on the radiological request were excluded. If any child had more than one MCUG report, only the first was evaluated.

SPSS version 20 was used for statistical analysis. Ethical approval was obtained from the University Hospital of the West Indies / University of the West Indies Ethics Committee and the Ethics Committee of the South East Regional Health Authority.

Results

523 MCUG reports were identified between October 2008 and January 2012. After the exclusion criteria were applied, (Figure 1) the remaining 458 reports were recorded and analyzed.

Age and Sex Distribution of Total Cohort (Figure 2)

Of 458 who had MCUG for investigation of UTI 326 (71%) were males and 132 (29%) were female. Sixty-four percent (294) of the patients were less than 2 years old. Of this group 121 (40%) were age <6 months. There was a male predominance in most age groups. The median age was 16.4 months and the interquartile range was 9.3-34.6 months (Figure 2).

Age and Sex Distribution of Children with Abnormal MCUG (Figure 3)

Pathology was identified in 54 children (11.8% of the total). The majority (81.5%) were males. Some patients had more than one abnormality. Children < age 2 years were the largest group (64%)

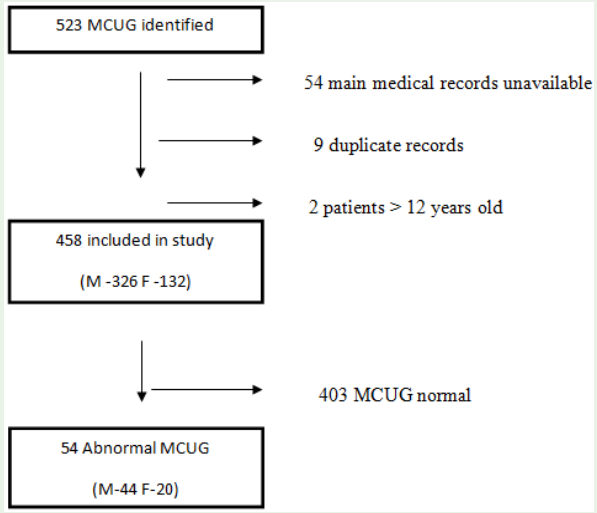

Figure 1: Patient selection process.

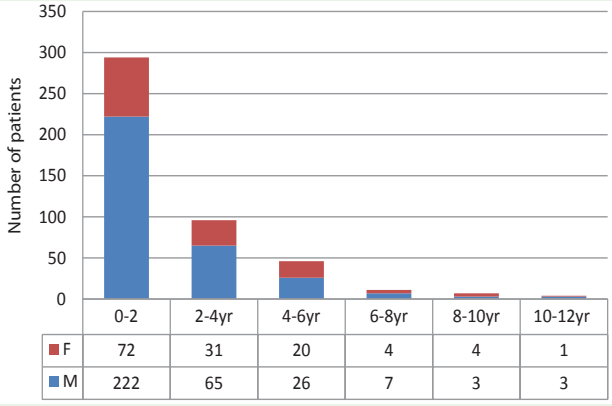

Figure 2: Age and sex distribution of 458 children undergoing MCUG for UTI.

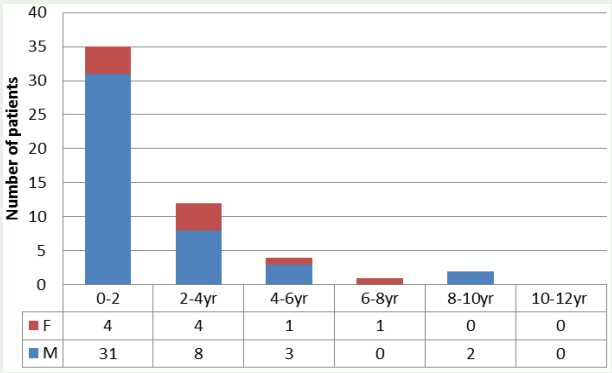

Figure 3: Age and sex distribution of children with abnormal MCUG.

Table 1: Age related urological abnormalities.

	Number (%)	Age (years)						Total
		0-2	2-4	4-6	6-8	8-10	10-12	
VUR (highest) grade	19(27%)							
Grade 1		2	4	2	1	0	0	**9**
Grade 2		9	1	0	0	0	0	**10**
PUV	4(5%)	4	0	0	0	0	0	**4**
Bladder abnormalities	20(29%)							
Diverticulum		3	2	0	0	0	0	**5**
Trabeculation		2	3	1	0	0	0	**6**
Bladder elongated		4	1	0	0	0	0	**5**
Bladder base dilated		2	0	0	0	0	0	**2**
Spinning top		1	0	0	0	0	0	**1**
Other bladder abnormality		1	0	0	0	0	0	1
Urethral abnormalities	20(29%)							
Dilated proximal urethra		6	2	2	0	1	0	**11**
Filling defect		3	2	1	0	0	0	**6**
Other urethral abnormality		1	1	0	0	1	0	**3**
Other MCUG abnormalities	5(7%)	4	1	0	0	0	0	**5**
Total		42	17	6	1	2	0	**68**

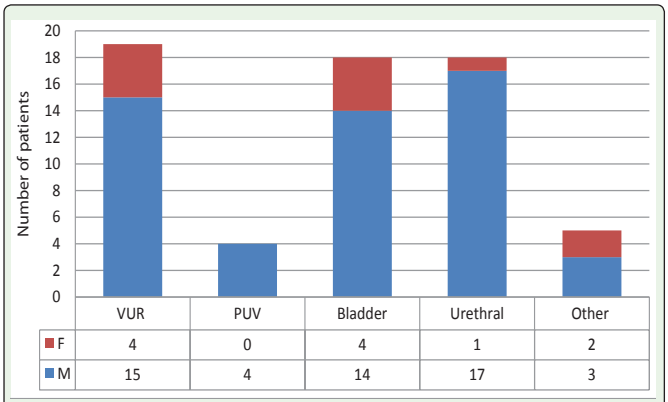

Figure 4: Gender distribution of urological abnormalities on MCUG.

and of these, 47% were infants 6-12 months old. Males were twice more likely to have an abnormal MCUG (44/326-13%) than females (10/132 or 7%).

Urological Abnormalities (Figure 4), (Table 1)

Of the abnormal MCUG, VUR and PUV were the only two definitive diagnoses stated on the radiology report. In all other cases, the abnormality was described and clinical correlation recommended. VUR was the most common abnormality seen overall (35%). PUV accounted for 7% (4/53) of all abnormal MCUG in males and 1.2% (4/326) of males undergoing MCUG for UTI. Most children with PUV were < 2years old. Most children who were diagnosed with VUR were under the age of 3 years and VUR was bilateral in 6 patients. Vesicoureteric reflux was more frequent in younger children and was < Grade 2 in all. Of the bladder abnormalities trabeculation (35%) was the most common. Urethral Abnormalities were reported in 18 patients half of whom had proximal urethral dilatation. Of the 4 males with a firm diagnosis of PUV, 3 were less than 6 months of age and one was 19 months old. There was no overlap between PUV and any other descriptive diagnoses e.g. dilated proximal urethra, because once PUV was reported it was recorded as a single diagnosis and no other associated pathology was described.

Discussion

Our study is limited by the fact that it was purely a radiological one. As the diagnosis of UTI was made from the radiology records and not verified with microbiological data, we cannot guarantee that all the children sent for MCUG had a truly bacteriological confirmed UTI. Additionally, the frequency of VUR was documented as an occurrence per patient not in terms of renal units so by other classifications this may have understated the frequency of VUR. Although by our selection process, the UTI investigation is likely to have been the first, this was not validated by a medical records search.

Within our cohort of 458 patients there was a predominance of male children (71%) and children < age 2 years (65%). This was to be expected as studies have shown that UTI is 2-3 times more common in males than females < 3 months old [20,21] and also more frequent in children under age 2 years [4,20]. As the local guidelines for females > 5 years recommend routine MCUG with first UTI only in those with an abnormal KUB ultrasound or suspicious clinical findings, [12] it is not unexpected to find few children between the ages of 6-12 years represented in this cohort.

In the present study the yield of pathology from MCUG following UTI was 11%. This is less than the international experience in which rates of detection vary from 60% in Iran [22], to 38-41% in the USA [14,23], 34% in England [24], 27% in Finland [25] and 22% in Italy [16].

The difference in yield is due mainly to frequency of VUR within given populations. Internationally VUR is responsible for 65-100% of abnormal MCUG and is reported in 22-41% of patients investigated for UTI [14,22]. The incidence of VUR is lower in Italy 22% [16] and Finland 27% [25] but higher in USA 41% [14] and Iran 39% [22]. This is in stark contrast to our local study in which VUR, although being the commonest pathology, accounted for only 36% of abnormal MCUG's and 4% of patients investigated for UTI. VUR is reportedly infrequent in black races [18,26]. Within black populations there is also variation in the frequency of VUR from a high of 13% in black populations in the USA [17] to a low of 0% in Nigerian children [26]. Although Jamaica is multiracial, the population in general [27] and the children attending the study hospital (the Bustamante Hospital for Children) in particular, are predominantly black so a lower incidence of VUR was expected. However, there are racial minorities that contribute to the Jamaican population as a whole, and data regarding VUR and other urological abnormalities may be different in Caucasian mixed race children who are more likely to have had their MCUG done privately.

Although a firm diagnosis of PUV was made only in four boys, (0.7% of all males studied) the potential exists that more cases may have been subsequently diagnosed following clinical correlation of suspicious urethral findings on MCUG. The relative infrequency of PUV detection appears to be international: 0.2% in Finland [25] and USA [14] and 3% in England [24].

The frequency of non VUR urological pathology (most commonly dilated proximal urethra and bladder trabeculation) in our series (7%) falls in between that of USA (2.2%) [14] and Iran 39% [22]. The second comparable pathological group was a subcategory classified by Hannula, et al. as "bladder abnormalities" [25] which include bladder wall trabeculation, diverticulum, marked residual urine and widened posterior urethra. The frequency with which these bladder abnormalities were detected was similar locally (4%) to Finland (5%) [25], but was greater than in USA (2%) [14]. Bladder abnormalities accounted for 36% of the total abnormalities in the present study but only 12 % and 4% in the Finnish [25] and American (14) studies respectively.

Local guidelines (12) include the MCUG in the investigation of first UTI in all children < 5 years old, all males, and children > 5 years with abnormal renal ultrasound, renal scan, recurrent UTI or symptoms suggestive of voiding disorders. Since the 1985 introduction of this protocol congenital abnormalities have been diagnosed earlier and obstructive urological disease causing CRF is virtually limited to posterior urethral valves [8]. Overall, PUV remains an important cause of CRF in Jamaican children (26-28%) [7,8] and MCUG is the gold standard of diagnosing this pathology. Antenatal ultrasonography is not routine in Jamaica, and is not always accurate in diagnosing lower tract anomalies in our population.

Current guidelines by the AAP [10] and Britain (NICE guidelines) [11] recommend that the MCUG be excluded from investigation of first UTI because of the perceived ineffectiveness of antibiotic prophylaxis in the management of VUR – the primary reason for performing the MCUG in those countries. The RIVUR trial [28] found prophylaxis to significantly reduce the risk of febrile UTI in children with VUR and recommended re-evaluation of the AAP guidelines. In Jamaica the problem is not VUR but PUV which can only be conclusively diagnosed with the MCUG, making a case for the continued use of the MCUG.

Conclusion

In this predominantly black cohort of children, VUR occurs infrequently. However, the use of MCUG in the detection of lower tract abnormalities is undeniably important as the percentage of PUV and other urethral abnormalities found following UTI is similar to that seen internationally. In a resource poor country such as ours the low overall yield of MCUG documented in this study mandates further local research to identify clinical and laboratory features which select children at greater risk of having underlying urological pathology and make our local guidelines for MCUG use more cost effective.

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