

Comparison of Renal Ultrasound and Voiding Cystourethrography in the Detection of Vesicoureteral Reflux

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Abstract

Background: This study evaluates the accuracy of renal ultrasonography (US) in the detection of vesicoureteral reflux (VUR) compared to voiding cystourethrography (VCUG). **Materials and Methods:** We retrospectively reviewed the medical records of 131 children with urinary tract infection. Ultrasound findings were considered to be suggestive of VUR if a “pelvocalyceal dilatation”, “retrovesical ureteral dilatation” and/or an “increase in one or both kidneys’ size” were reported. **Results:** Ultrasound findings were positive for VUR in 5 of 24 patients with confirmed VUR on VCUG, and were negative in all of 107 patients without VUR on VCUG. Altogether, of the 131 children, 24 had reflux on VCUG, 19 (79%) of who had no sonographic findings suggestive for reflux. The sensitivity and specificity of ultrasound in Suggesting VUR were 20% and 100%, respectively. **Conclusion:** The results of this study showed that ultrasonography cannot accurately detect or predict vesicoureteral reflux. This outcome should be mentioned by clinicians in evaluation of patients with complaints which are suggestive for VUR. [GMJ.2013;2(2):54-59]

Keywords: Vesicoureteral reflux; Ultrasonography; Voiding cystourethrography (VCUG)

Introduction

Vesicoureteral reflux (VUR) is a common urinary tract disorder in children. In normal kidney-bladder function, urine flows only from the kidneys to the bladder. VUR is an abnormal backward flow of urine from the bladder toward the ureters. The term “reflux nephropathy” is described as sustained injury of kidneys with concomitant gross pathologic changes as a consequence of VUR and urinary tract infection (UTI) [1].

Some individuals with untreated VUR are at

an increased risk for urinary tract infections, hypertension, and progressive kidney damage. The association between VUR, UTI, and renal scarring has produced a strong argument in favor of diagnosing reflux [2]; albeit, there is a little dispute regarding the need for some forms of imaging studies. Thus, in medical practice, the early recognition and careful monitoring of VUR are considered to be very important. The standard evaluation of an infant or young child after the first documented febrile urinary tract infection (UTI) includes renal ultrasonography (US) and voiding cyst-

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ourethrography (VCUG). The latter is used mostly as the method of choice to confirm the diagnosis of VUR. A Dimercaptosuccinic acid (DMSA) renal scan is also used to assess any renal abnormalities. In clinical practice, these recommendations and methods of diagnosis are often extended to older children [2].

Based on what mentioned above, primarily, the diagnosis and follow-up of VUR is based on VCUG despite having the main disadvantages of significant gonadal radiation exposure and catheterization complications [3]. Additionally, all of these interventions might be stressful to the child and the family. Thus, over the past two decades, in an attempt to provide comfort for child and the family and also to eliminate the radiation exposure caused by these methods, many efforts have been made to use ultrasonography for the non-invasive diagnosis of VUR which avoids the need for urethral catheterization, and which avoids the anxiety of parents and patients that leads many families to refuse such evaluation [1,4]. Ultrasound (US) is an appealing imaging test for the urinary tract in children due to its accessibility, noninvasiveness, and lack of radiation. Several studies have looked at its value in the detection of VUR demonstrating low accuracy compared to VCUG as the gold standard [5]. However, there is still a challenge among clinicians regarding the accuracy of diagnosis with US in VUR in children. The goal of this study was to compare the diagnostic accuracy of sonography with that of VCUG in VUR diagnosis in children with UTI.

Materials and Methods

This study was carried out to evaluate the reliability and usefulness of renal sonography in the diagnosis of VUR in children. We retrospectively reviewed the charts of 131 children under 14 years old with UTI who underwent renal US examinations and were followed by VCUG within two weeks apart. Renal collecting system and ureter of each kidney was regarded separately and defined as a renal unit (RU). Subjects with history of urinary tract surgery and kidney anomalies were excluded. In this study, by means of US, VUR was con-

sidered if a “pelvocalyceal dilatation”, “retro-vesical ureteral dilatation” and/or an “increase in one or both kidneys’ size” could be detected. Normal and abnormal sonographic findings were compared with detection of reflux by VCUG. VUR grade was classified according to the International Reflux Study guidelines in Children [6].

Since the differentiation of Grades 4 and 5 of reflux has no clinical significance, these groups were combined and described as grade 4–5 in this report. Accuracy of diagnostic test were calculated with confidence intervals of about 95% for each test.

The efficiency of US was assessed by the ability to detect VUR. The statistical indices used for evaluation of this diagnostic method, were sensitivity, specificity, and predictive values (positive and negative). Considering VCUG results as the gold standard test, sensitivity was described as the proportion of patients with the disorder (VUR) in who the renal ultrasound was affirmative; Specificity was explained as the proportion of those without the disorder in who the test was negative. The positive predictive value in this study was the probability that confirmed VUR in children with dilatation noted on the US. The negative predictive value was the probability that the subject does not have VUR in children with any dilatation noted in US.

The collected data were analyzed after encoding by using statistical computing SPSS software (version 16.0).

Results

A total of 131 charts of patients (age 1 month to 14years) with a final diagnosis of UTI, were investigated for VUR using US before VCUG. Of the subjects, 96 (73%) were females and 35 (27%) were males. The patients were divided into 3 age groups; the age of the 73 subjects (56 %) was “1 month to two years”, while the age group of “2 to 5 years” included 31 children (24%) and subjects aged 5 years and older were 27 children (21%). In this study, VUR were found in thirty three RU through VCUG, of which 9 cases (7%) were bilateral, 9 cases (7%) were only in left side and 6 cases (5%) were only in the right side

and 107 cases (82%) were normal. Among 24 patients with abnormal findings 22 cases (91%) were females. Table-1 shows the distribution of the patients with VUR on VCUG by grade and table-2 shows comparative results of US and VCUG considering examinations of RUs.

Descriptively, patients' US examinations were reported as follows: 113 normal, 13 cases of bladder inflammation (cystitis), 1 person showed ureteral dilatation, 1 with right ureteral dilatation with cystitis, one patient with increased size of right kidney, one patient with bilateral hydronephrosis, and one showed unilateral hydronephrosis with ipsilateral ureteral dilatation.

Out of 113 subjects whom reported US were completely normal, VCUG showed the presence of VUR in 11 RUs in the right and 13 RUs in the left (grade 1 to 3). VCUG results suggested the presence of VUR in 3 RUs of the 13 patients who were sonographically indicated only with cystitis; of them one was in right side (grade 2) and two on the left (grade 3). In one patient who had left ureteral dilatation on US, VCUG reported reflux grade 3 in the same side. In one patient with dilatation of the right ureter and cystitis in US, VCUG reported grade 1 reflux in the same side. One patient with increase in size of right kidney on US showed right sided grade 4 of reflux in VCUG. The patients who had

bilateral hydronephrosis on US, in VCUG were reported as bilateral reflux grade 3, And a patient with dilatation of calyceal system and hydronephrosis in the left side, showed grade 5 of reflux on the same side in VCUG. Considering the total of 131 patients, VUR was documented in 24 patients (18.3%) on VCUG (33RUs). US results suggested the presence of VUR in only 5 (3.8%) patients. In none of 107 subjects with normal VCUG, US criteria for VUR, were found.

Results of calculations performed for detection of VUR by means of US are as follows: sensitivity with confidence interval about 95 percent: 20.83%; specificity with confidence interval about 95 percent: 100%; positive predictive value: 100%; negative predictive value: 84.93%; percentage of false negative: 79.2%; percentage of false positive: 0.0; test Diagnostic accuracy: 32.7%. US was not sufficiently sensitive for detecting VUR since there was 25% missed diagnosis of refluxing kidneys or the grade of reflux.

Discussion

UTI is a common pediatric problem. Most cases of VUR are diagnosed after UTI occurs. The reported frequency of VUR ranges from 20% to 40% in children who presented with UTI [1].

Boys and girls are equally considered to be at

Table-1. Distribution of the patients with vesicoureteral reflux (VUR) on voiding-cystourethrography (VCUG) by grade, regarding reno-ureteral (RU) units.

VCUG	Normal Cases	Reflux Grade 1	Reflux Grade 2	Reflux Grade 3	Reflux Grade 4 or 5	Reflux Total
Right Side	116 (88.5%)	3	9(7%)	2	1	15 (11.5%)
Left Side	113(86 %)	5	6(5%)	6	1	18(14%)

Table-2. Comparative results of Ultrasonography (US) and voiding-cystourethrography (VCUG) in reno-ureteral units (RU) in 131 patients.

VCUG	Ultrasonography		
	Normal results(RUs)	Abnormal results(RUs)	Total(RUs)
Normal results	229(RUs)	0(RUs)	229(RUs)
Abnormal results	28(RUs)	5(RUs)	33(RUs)
Total(RUs)	257 (RUs)	5(RUs)	262(RUs)

risk of acquiring VUR after a UTI [1].

Girls are more commonly detected with VUR presumably since they are more likely to get UTI [7].

The principal complications of VUR and renal scarring are end-stage renal disease and hypertension [8]. Pediatric clinical practice guidelines introduce screening the children for VUR after UTI [9]. Thus, selecting the appropriate techniques to diagnose VUR will permit a better understanding of this disorder. VCUG is the standard choice modality in the diagnostic approach to VUR [9,10]. However, according to its aforementioned disadvantages, researchers are still tending to find better and safer diagnostic methods. The present study showed that VUR is more common in girls (91% here). This can be associated with higher prevalence of UTI in girls that leads to greater screening and, therefore, diagnosis of VUR in females. The findings indicated that children aging two years old were more susceptible to VUR as well. Overall, correlation between the reflux on US and VCUG was seemed to be poor and a normal US did not rule out VUR.

Our findings were similar to results of a study by Elder et al, which showed that females (80%) and young children (70%) were more prone to VUR [11]. Our review of literatures indicated similar studies investigated the reliability of US in contrast with VCUG in identification of VUR in children. The accuracy of US compared to VCUG in the diagnosis of VUR was reported low, with sensitivities ranging from 26% to 53% and specificities up to 80% [12,13,14]. In a study done by Lee et al in 2009, they stated a low sensitivity and specificity of US versus VCUG [15]. Several recent studies have shown similar findings regarding the role of US as an initial screening modality for VUR. Mahant and colleagues [16] studied retrospectively 162 children under the age of 5 years who had US and VCUG after their first episode of UTI. The sensitivity, specificity, and positive and negative predictive values of US for VUR were 40%, 76%, 32%, and 82%, respectively. Similar to our findings, they stated a high specificity but a low sensitivity value to diagnose the VUR [16]. In another study by Nafisi-Moghadam et

al in 2010 it was shown that US has a high specificity but a low sensitivity to diagnose the VUR [17].

Alon et al [18] evaluated four methods of investigation in 58 children following UTI. Thirty six patients (62%) were found to have VUR by VCUG, but only eight (13%) had abnormal US outcome, giving a sensitivity, specificity, and false negative rate of 42%, 91%, and 78%, of US for predicting VUR. They concluded that US is unreliable in detecting VUR, renal scarring, or inflammatory changes, and solely, is inadequate for managing UTI in children. A retrospective investigation on 493 infants and children was performed by Blane et al to assess the reliability of renal US for detecting VUR. 272 (34%) of the evaluated kidneys were found to have reflux; of them 201 (74%) were reported normal on US. This gives a sensitivity of only 26%, pointed out that the correct diagnosis of reflux is not reliable by US [19]. In a study by Muensterer et al the accuracy of renal US in the diagnosis of VUR compared to VCUG was evaluated. A total of 407 RUs were studied. The results of this study showed that when the sonographic diagnosis of reflux was based on morphological changes and degree of dilatation alone, correlation with VCUG results was poor [5]. Taking both age-adjusted kidney length as well as sonographic morphology into account, dilative VUR was detected by US with a sensitivity of 92% (95% CI) and a sensitivity of 67% (95% CI, $P < 0.001$).

On the other hand, results of some of studies have been different from our outcome. A study conducted by Balbay et al (1998) showed that overall sensitivity and specificity of US for detection of reflux in their patient group were 66.7% and 93.48%, respectively; conclusively, a VUR patient can be efficiently followed up by US, after initial diagnosis with VCUG [20]. Schneider et al (1984) investigated one hundred and ten children, aged 6 days to 14 years for VUR using US before VCUG. They concluded that US is a sensitive and specific tool for screening and follow-up of VUR [21].

Conclusion

Regarding the fact that US method depends

on the skill and experience of the technician as well as a number of different types of devices that are used in various studies, the sensitivity and specificity can be justified. The results of our study showed that the renal US has a little value in following up of children with VUR suffering from UTI.

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Conflicts of Interest

None declared

References

- Greenbaum LA, Mesrobian HG, Vesicoureteral reflux. *Pediatr Clin North Am.* 2006;53(3):413-27.
- Smith EA. Pyelonephritis, renal scarring, and reflux nephropathy: A pediatric urologist's perspective. *Pediatr Radiol.* 2008;38(Suppl 1):76-S82.
- Unver T, Alpay H, Biyikli NK, Ones T. Comparison of direct radionuclide cystography and voiding cystourethrography in detecting vesicoureteral reflux. *Pediatr Int.* 2006;48(3):287-91.
- Darge K. Diagnosis of vesicoureteral reflux with ultrasonography *Pediatr Nephrol.* 2002;17(1):52-60.
- Muensterer OJ. Comprehensive ultrasound versus voiding cysturethrography in the diagnosis of vesicoureteral reflux. *Eur J Pediatr.* 2002;161(8):435-7.
- Lebowitz RL, Olbing H, Parkkulainen KV, Smellie JM, Tamminen-Möbius TE. International system of radiographic grading of vesicoureteric reflux. International Reflux Study in Children. *Pediatr Radiol.* 1985;15(2):105-9.
- Hansson S, Martinell J, Stokland E, Jodal U. The natural history of bacteriuria in childhood. *Infect Dis Clin North Am.* 1997;11(3):499-512.
- Ardissino G, Daccò V, Testa S, Bonaudo R, Claris-Appiani A, Taioli E, et al. Epidemiology of chronic renal failure in children: data from the ItalKid project. *Pediatrics.* 2003;111(4):382-7.
- Committee on Quality Improvement, Subcommittee on Urinary Tract Infection, American Academy of Pediatrics. Practice parameter: the diagnosis, treatment, and evaluation of the initial urinary tract infection in febrile infants and young children. 1999;103(4):843-52.
- Piscitelli A, Galiano R, Serrao F, Concolino D, Vitale R, D'Ambrosio G, et al. Which cystography in the diagnosis and grading of vesicoureteral. *Pediatr Nephrol.* 2008; 23(1):107-10.
- Elder, Jack S. "disorder of kidney and urinary tract" in Nelson textbook of pediatrics. 19th ed. Philadelphia : Saunders company ; 2011: 1834-38.
- Blane CE, DiPietro MA, Zerlin JM, Sedman AB, Bloom DA. Renal sonography is not a reliable screening examination for vesicoureteral reflux. *J Urol.* 1993;150(2):752-5.
- Stokland E, Hellström M, Hansson S, Jodal U, Odén A, Jacobsson B. Reliability of ultrasonography in identification of reflux nephropathy in children. *BMJ.* 1994;309(6949):235-9.
- Tibballs JM, De Bruyn R. Primary vesicoureteric reflux--how useful is postnatal ultrasound? *Arch Dis Child.* 1996;75(5):444-7.
- Lee MD, Lin CC, Huang FY, Tsai TC, Huang CT, Tsai JD. Screening young children with a first febrile

- urinary tract infection for high-grade vesicoureteral reflux with renal ultrasound scanning and technetium-99m-labeled dimercaptosuccinic acid scanning. *J Pediatr*. 2009;154(6):797-802
16. Mahant S, Friedman J, MacArthur C. Renal ultrasound findings and vesicoureteral reflux in children hospitalized with urinary tract infection. *Arch Dis Child*. 2002;86(6):419-20.
17. Nafisi-Moghadam , Malek M, Najafi F, Shishehsaz B. The Value of Ultrasound in Diagnosing Vesicoureteral Reflux in Young Children with Urinary Tract Infection. *Acta Medica Iranica*. 2011; 49(9): 588-591.
18. Smellie JM, Rigden SPA, Prescod NP. Urinary tract infection: a comparison of four methods of investigation. *Arch Dis Child*. 1995;72:247-50.
19. Blane CE, DiPietro MA, Zerlin JM, Sedman AB, Bloom DA. Renal sonography is not a reliable screening examination for vesicoureteral reflux. *J Urology*. 1993;150:752-755.
20. Balbay MD, Ozsan O, Ozbek E, Ozkan S, Gunes A. Comparison of screening of vesicoureteral reflux with renal ultrasound and voiding cystourethrography. *International Urology and Nephrology*. 1998; 30(3):263-6.
21. Schneider K., Jablonski C., Wiessner M., Kohn M., Fendel. H. Screening for vesicoureteral reflux in children using real-time sonography. *Pediatr Radiol*. 1984;14(6):400-3

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