

## The Value of Ultrasound in Diagnosing Vesicoureteral Reflux in Young Children with Urinary Tract Infection

Reza Nafisi-Moghadam<sup>1</sup>, Mahrooz Malek<sup>2</sup>, Farzaneh Najafi<sup>3</sup>, and Behzad Shishehsaz<sup>1</sup>

<sup>1</sup> Department of Radiology, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

<sup>2</sup> Department of Radiology, Tehran University of Medical Sciences, Tehran, Iran

<sup>3</sup> Department of Nephrology, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

Received: 23 Oct. 2010; Received in revised form: 12 Feb. 2011; Accepted: 5 Mar. 2011

**Abstract-** Urinary tract infection is a common pediatric problem and vesicoureteral reflux is its most common complication. Detection of this reflux has classically been achieved by voiding cystourethrography (VCUG). Ultrasonography for evaluation of vesicoureteral reflux is shown to be feasible but is not widely accepted. Our aim was to assess the value of routine sonography in detecting vesicoureteral reflux in young children with urinary tract infection. This study was carried out in 105 patients suffering from urinary tract infection admitted to Shahid Sadoughi Hospital in Yazd, Iran. These patients were evaluated by two methods (sonography and VCUG). Overall sensitivity and specificity value of sonography in suggesting vesicoureteral reflux were 63% and 95% respectively. The most accurate results were obtained with high grades reflux (75% and 95%). The results reconfirmed that sonography is reliable in the exclusion or verification of high grade reflux and it has a low sensitivity in low grade vesicoureteral reflux.

© 2011 Tehran University of Medical Sciences. All rights reserved.

*Acta Medica Iranica*, 2011; 49(9): 588-591.

**Keywords:** Urinary tract infection; Ultrasonography; Vesicoureteral reflux; Children

### Introduction

Voiding cystourethrography (VCUG) is the commonest fluoroscopic examination in infants and young children. The most frequent indication is urinary tract infection (UTI), as it can result in parenchymal scarring in some patients which can be a predisposing factor to results in secondary hypertension, renal insufficiency or failure if it is bilateral (1).

The prevalence for vesicoureteral reflux (VUR) in young children (< 4 years) is 25% which is higher than its prevalence (12%) in 4-12 years children (2,3). The gold standard procedure for diagnosis of VUR is the VCUG (4). Disadvantages of this procedure are traumatic examination for the child and the parents as well as exposure of the child's gonads to a high radiation dose. An awareness of radiation protection is important. Children are relatively more vulnerable to the deleterious effect of ionizing radiation as they are still growing and have a longer age than adults. Examinations involving ionizing radiation need to be justified and optimized if they are to be performed. However, the accurate diagnosis of this procedure

depends upon the presence of the reflux because the VUR is seen alternatively (5). The accurate diagnosis of VCUG for diagnosing the reflux is very high and for the reflux with a high grade (grade III and IV) is high as nearly as 100% (6).

Every attempt should be made to answer the clinical question using techniques that do not employ ionizing radiation such as ultrasonography (US). US is an easy to reach and easy to perform technique (7,8). But some studies stated that US is not as accurate as VCUG in diagnosing VUR (9,10). The question still exists that which patient can be diagnosed by ultrasonography and which method is suitable to diagnose the VUR. The aim of this survey is to study the sensitivity of ultrasonography in VUR diagnosis.

### Materials and Methods

This study was carried out from year 2006 to 2010 in patients admitted to Shahid Sadoughi Hospital (Yazd, Iran) who suffered from UTI with a proven positive urine culture. The total number of patients was 105. Their age was under 10 and they had recurrent UTI. The

**Corresponding Author:** Reza Nafisi-Moghadam

Department of Radiology, Shahid Sadoughi University of Medical Sciences, Yazd, Iran  
Tel: +98 351 8224000, Fax: +98 351 8224001, E-mail: nafisi@ssu.ac.ir

US was performed in all patients and was followed by VCUG. The procedure was explained to their parents who gave consent. No tranquilizer medication was used in this procedure. The US was carried out in a quiet and comfortable place. During the sonography their parents stand besides. The US was performed using a Siemens G-40 machine and a transducer with a 3.5-5 MHz frequency. The total volume of the bladder was estimated by the following formula:

$$V=30 (2+A)$$

Where: V= estimated bladder volume in ml and A=age of patient in year.

The bladder was catheterized aseptically with a small catheter (6-8f) and a sample sent for culture. The first normal saline was dripped into the bladder from the bottle. We performed US in a full bladder and during micturition. The increase diameter of the ureter and/or renal pelvis was observed as a sign of a reflux. The VCUG was done by another radiologist. We used Omnipaque 240 mg/ml in 50 ml vial, which produced by Schering company. We diluted the contrast medium with normal saline in a concentration of 1 to 5 and the estimated volume calculated by the above formula. Then the bladder was catheterized and diluted water soluble contrast medium was dripped into the bladder while the child was positioned supine on the screening table. The early filling image of the bladder was obtained in the AP position. The catheter was then removed and AP, right and left oblique views were taken during micturition. In this procedure we used Varian fluoroscopy machine (800mA). The results of US and VCUG were separately reported by two radiologists at different time without notifying each others for the results.

The sensitivity and specificity of US for diagnosis of VUR were calculated with a confidence interval (CI) of approximately of 95%.

## Results

The study was performed in patients with proven urine culture and UTI in Shahid Sadoghi Hospital from 2006 to 2010. A total of 105 patients were selected with the above criteria. Of those, 20 patients were male and 85 were female.

In this study 210 cases of kidney-ureter unit (105 patients) were examined. 30 cases of VUR were observed. Of these, 8 patients had bylateral reflux (16 kidney-ureter-units) and 14 patients had unilateral VUR.

**Table 1.** Comparative results of US and VCUG in 210 kidney-ureter units in 105 patients

	VCUG	VUR(+)	VUR(-)	Total
US				
VUR+		22	9	31
VUR_		8	171	179
total		30	180	210

In contrast, VCUG showed reflux in 31 cases. Of these, 22 cases were positive in sonography. In 8 cases who were shown reflux in the US, the VCUG was reported normal (table 1). The sensitivity of the sonography versus VCUG in diagnosing the VUR is 63% (CI= 95%) and the specificity of sonography versus VCUG is 91% (CI=95%). The sensitivity and the specificity of sonography versus VCUG in diagnosing the VUR for grades III and IV (high grade) were 75% and 95%, respectively. The positive and negative predictive values were 64% and 95%, respectively.

## Discussion

VUR is a common disorder in children that leads to ascending infection, renal growth impairment and parenchymal scarring. VUR might occur in an otherwise normally functioning bladder or might be secondary to poor bladder emptying because of bladder outlet obstruction or neurogenic bladder. Primary VUR is the most common congenital anomaly. It is seen in 0.5-1.5% of children. The VUR is the result of one third of patients who presented with UTI. The reflux nephropathy is responsible for 30-50% of renal failure in children (1). Therefore, selecting the best procedure to diagnose VUR is very important. VCUG is the choice modality in the diagnosis of VUR (4). Previous studies have assessed the value of sonography in diagnosis of VUR and outcome of these investigation have been different (9,12,13). The main advantage of this procedure in contrast to VCUG is that it does not employ ionizing radiation. It is also possible to repeat the sonography in patients (7,14). When the bladder is full, cyclical filling of the bladder may increase the sensitivity for detection of VUR at the expense of increased radiation dose. For this reason the US can be used as an alternative procedure to diagnose the VUR (2). During VCUG, to reduce the radiation time and consequently the radiation dose the fluoroscopy is used non-constantly. In US we do not have any limitation in time and these is no radiation and it can be used over and over again when the reflux might be seen

alternatively (2,5). We assumed the dilatation of renal pelvis and/or ureter as a sign to diagnose the VUR. Kopac *et al.* and Keney *et al.* stated that the dilatation of ureter or renal pelvis can be considered as a criterion to diagnose the VUR (15,16).

The results of this study showed that the sensitivity and specificity of sonography to diagnose the VUR were 63% and 91%, respectively. These figures for high grades reflux are even higher (75% and 95%). Several studies have reviewed the US in contrast to VCUG. Their results have been different from our study, but most of these studied have stressed that sonography is a safe and reasonable procedure for VUR diagnosis (3,7,13,17,18). Zamir *et al.* showed that the specificity value of US in diagnosing the reflux is high and their results are similar to our study (19). In another study done by Lee *et al.* in 2009, they stated a low sensitivity and specificity of sonography versus VCUG (20). A similar study by Mahant *et al.* also showed similar results. They stated a high specificity but a low sensitivity value to diagnose the reflux (21). In our study it was shown that sonography has a high specificity but a low sensitivity values to diagnose the reflux in two third of cases.

In our study the patients with proven UTI who were referred to the specialized center might increase the number of the selected patient incorrectly and misdiagnosed as VUR. The reflux rates were almost the same as the other studies and this figure shows that the actual rate is probably is lower in our society.

We recommend another study to be done with a reasonable number of patients to evaluate the value of ultrasonography in contrast to VCUG and radioisotope scan DMSA for VUR diagnosis. Although nuclear scintigraphy is more sensitive for VUR but it provides poor anatomic details. Sonography is a reasonable and almost cheap technique without any ionizing radiation which can be performed in all children especially in those who are not toilet-trained. Our results showed that sonography is reliable in the exclusion or verification of high grade vesicoureteral reflux and it has a low sensitivity in low grade vesicoureteral reflux.

## References

- Moorthy I, Easty M, McHugh K, Ridout D, Biassoni L, Gordon I. The presence of vesicoureteric reflux does not identify a population at risk for renal scarring following a first urinary tract infection. *Arch Dis Child* 2005;90(7):733-6.
- Berrocal T, Gayá F, Arjonilla A. Vesicoureteral reflux: can the urethra be adequately assessed by using contrast-enhanced voiding US of the bladder? *Radiology* 2005;234(1):235-41.
- Giordano M, Marzolla R, Puteo F, Scianaro L, Caringella DA, Depalo T. Voiding urosonography as first step in the diagnosis of vesicoureteral reflux in children: a clinical experience. *Pediatr Radiol* 2007;37(7):674-7.
- Piscitelli A, Galiano R, Serrao F, Concolino D, Vitale R, D'Ambrosio G, Pascale V, Strisciunglio P. Which cystography in the diagnosis and grading of vesicoureteral reflux? *Pediatr Nephrol* 2008;23(1):107-10.
- Suliman A, Theodorou K, Vlychou M, Topaltzikis T, Kanavou D, Fezoulidis I, Kappas C. Radiation dose measurement and risk estimation for paediatric patients undergoing micturating cystourethrography. *Br J Radiol* 2007;80(957):731-7.
- Darge K, Trusen A, Troeger J. Diagnostic imaging of vesicoureteral reflux. *Rays* 2002;27(2):99-106.
- Xhepa R, Bosio M, Manzoni G. Voiding cystourethrosonography for the diagnosis of vesicoureteral reflux in a developing country. *Pediatr Nephrol* 2004;19(6):638-43.
- Escape I, Martinez J, Bastart F, Solduga C, Sala P. Usefulness of echocystography in the study of vesicoureteral reflux. *J Ultrasound Med* 2001;20(2):145-9.
- Alshamsam L, Al Harbi A, Fakeeh K, Al Banyan E. The value of renal ultrasound in children with a first episode of urinary tract infection. *Ann Saudi Med* 2009;29(1):46-9.
- Tsai YC, Hsu CY, Lin GJ, Wang CJ, Cheng CH, Huang YH, Yen MH, Hsia SH, Yan DC. Vesicoureteral reflux in hospitalized children with urinary tract infection: the clinical value of pelvic ectasia on renal ultrasound, inflammatory responses and demographic data. *Chang Gung Med J* 2004;27(6):436-42.
- Sjöström S, Jodal U, Sixt R, Bachelard M, Sillén U. Longitudinal development of renal damage and renal function in infants with high grade vesicoureteral reflux. *J Urol* 2009;181(5):2277-83.
- Uhl M, Kromeier J, Zimmerhackl LB, Darge K. Simultaneous voiding cystourethrography and voiding urosonography. *Acta Radiol* 2003;44(3):265-8.
- Duran C, Valera A, Alguersuari A, Ballesteros E, Riera L, Martin C, Puig J. Voiding urosonography: the study of the urethra is no longer a limitation of the technique. *Pediatr Radiol* 2009;39(2):124-31.
- Novljan G, Kenig A, Rus R, Kenda RB. Cyclic voiding urosonography in detecting vesicoureteral reflux in children. *Pediatr Nephrol* 2003;18(10):992-5.

15. Kopac M, Kenig A, Kljucevsek D, Kenda RB. Indirect voiding urosonography for detecting vesicoureteral reflux in children. *Pediatr Nephrol* 2005;20(9):1285-7.
16. Kenney IJ, Negus AS, Miller FN. Is sonographically demonstrated mild distal ureteric dilatation predictive of vesicoureteric reflux as seen on micturating cystourethrography? *Pediatr Radiol* 2002;32(3):175-8.
17. Müller L, Preda I, Jacobsson B, Sixt R, Jodal U, Hansson S, Hellström M. Ultrasonography as predictor of permanent renal damage in infants with urinary tract infection. *Acta Paediatr* 2009;98(7):1156-61.
18. Piaggio G, Degl' Innocenti ML, Tomà P, Calevo MG, Perfumo F. Cystosonography and voiding cystourethrography in the diagnosis of vesicoureteral reflux. *Pediatr Nephrol* 2003;18(1):18-22.
19. Zamir G, Sakran W, Horowitz Y, Koren A, Miron D. Urinary tract infection: is there a need for routine renal ultrasonography? *Arch Dis Child* 2004;89(5):466-8.
20. 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.
21. 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):419-20.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.