Paediatrica Indonesiana
Paediatr Indones 2001;41:1-5

Special article

Cystosonography with echocontrast: *A new imaging technic for detecting vesicoureteral reflux in children*

EKB Ifran,[1] B Lombay,[2] E Nyari,[2] L Szabo[3]

[1]*Department of Child Health, Medical School, University of Indonesia, Cipto Mangunkusumo Hospital, Jakarta, Indonesia,* [2]*Department of Pediatric Radiology, Borsod County Teaching Hospital, Miskolc, Hungary,* [3]*Department of Pediatric Nephrology, Borsod County Teaching Hospital, Miskolc, Hungary*

ABSRACT Vesicoureteral reflux (VUR) is a common pediatric problem. Its late consequences may cause hypertension and renal failure, so that early diagnosis is important. Micturition cystourography (MCU) or radionuclide cystography (RNC) is the imaging of choice but these technics expose the children to radiation. Cystosonography with echocontrast is a new imaging technic for detecting VUR without exposing the children to radiation. The aim of this article is to review this technic and to show our early experiences with this new method in the Pediatric Radiology Department of Borsod County Teaching Hospital, Miskolc, Hungary. **[Paediatr Indones 2001;41:1-5]**

Keywords: *vesicoureteral reflux, imaging technic, cystosonography, echocontrast sonography*

VESICOURETERIC REFLUX (VUR) IS A COMMON PEDIATRIC problem and is frequently found in young children who are evaluated for urinary tract infection (UTI) or congenital anomaly. It provides a pathway for ascending bacteria from the bladder into the kidney and may cause renal scarring. In some cases hypertension and renal failure can occur as late consequences. The prevalence of VUR in asymptomatic children is less than 0.5% but it accounts for 29-50% in children with UTI;[1] the prognosis correlates with severity of VUR. Renal parenchymal scarring may occur in 8% of female patients with UTI and grade I VUR; in female patients with grade IV VUR, renalparenchymal scarring may develop in as high as 100% of cases.[2]

Correspondence: Evita K.B. Ifran, MD, Department of Child Health, Medical School, University of Indonesia, Jakarta, Jalan Salemba 6, Jakarta 10430, Indonesia. Tel 62-21-3907742, Fax 3907743.

The imaging modality of choice for demonstrating and grading VUR is fluoroscopic micturition cystourography (MCU) or radionuclide cystography (RNC). Recently a new technic, i.e., echocontrast sonography has been developed. This article reviews this technic and shows our early experiences with the new method in the Pediatric Radiology Department of Borsod County Hospital, Miskolc, Hungary.

Micturition cystourography (MCU)

The role of VUR in the pathogenesis of renal scarring has been reported in many instances. Due to its prognosis correlates with the severity of the reflux,[2] it is important to decide its grade correctly. One of the technics to detect of VUR is MCU. Some systems of VUR grading have been developed using this technic and may cause difficulties and confusions for reporting and discussing its management.

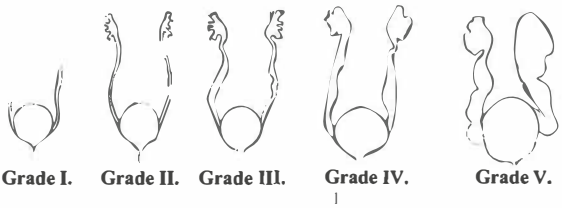

Figure 1. IRSC grading of VUR (see text).

In order to avoid these problems and to make the same opinion about VUR grading, the International Reflux Study in Children (IRSC) has made the grading system that is based on radiographic appearance on MCU. The definition of the International Grades of VUR[3] is seen on Figure 1.

Grade I : Reflux to the ureter only
Grade II : Ureter, pelvis and calyces; no dilatation, normal calyceal fornices
Grade III : Mild or moderate dilatation and/or tortuosity of the ureter and mild or moderate dilatation of the renal pelvis. No or slight blunting of the fornices.
Grade IV: Moderate dilatation and/or tortuosity of the ureter and moderate dilatation of the renal pelvis and calyces. Complete obliteration of the sharp angle of the fornices but maintenance of the papillary impression in the majority of calyces
Grade V : Gross dilatation and tortuously of the ureter. Gross dilatation of the renal pelvis and calyces. The papillary impression are no longer visible in the majority of the calyces

In this technic with fluoroscopic guidance the radiation gonad doses is high. The whole urinary tract should be visualized in frontal projection and the films are exposed at partial filling of bladder, when the bladder is full, at the time of reflux occurs, at the high of voiding or increasing of reflux, and immediately after voiding. The examiner sometimes need to perform again this procedure in lateral or oblique view in order to find out the reflux which means increasing of radiation exposure.

Cystosonography with echocontrast

Since ultrasonography has been introduced, it has been used word-wide to screen patients, especially in children. This technic has become a routine procedure in patients with neurogenic and dysfunction bladder which have a high incidence of urinary tract infection, bladder stones, and reflux.[4] Recently, the sonicated albumin enhanced ultrasonography has been developed and later, galactose suspension has been used as an echogenic contrast medium to evaluate the usefulness of ultrasonography in detecting and grading VUR.[5] The echocontrast that is diluted with normal saline produced a strongly hyperechoic, homogenous contrast in the bladder.

Since October 1998 in Borsod county teaching hospital, Miskolc, echocontrast sonography (ECS) (Levovist and Echovist) has been used to evaluate VUR in children. As comparison, MSU has also been performed in the same time using the international system of radiographic for grading the VUR. Infants and young children with history of pyelectasis, pyelonephritis, recurrent UTI, or dilatation of distal ureter which suspected of VUR were examined.

Procedure of cystosonography:

1. The ultrasonography examination was performed by pediatric radiologist.
2. Preparation the tool:
   - 5 MHz curvilinear transducer
   - Non-ballooning catheter

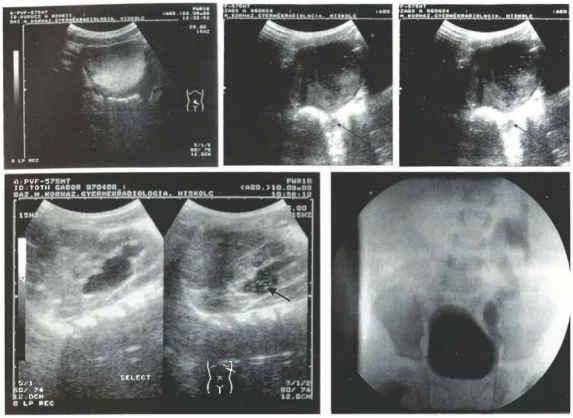

Figure 2. Ultrasonography of the bladder during administration of contrast showed strong echogenic microbubbles in the bladder

Figure 3. Case 1: A 3-year-old girl with history of pyelectasis and distal ureter dilatation. Pyelectasis was found by chanced at 2 month-old when she was examined by ultrasound due to prolonged jaundice. ECS: showed echogenic microbubbles in the dilated distal ureter (arrow)

Figure 4. Case 2: A 9-year-old girl with history of recurrent of UTI. On ECS: before contrast (a), after contrast (b), showed increased echogenicity in pelvis region, and also noted a transient increased of renal parenchym echogenicity when the contrast distended the pelvis (intrarenal reflux)

Figure 5. Case 3: A 3-year-old boy with history of pyelonephritis, recurence of UTI. Grade IV reflux. Ultrasonography before contrast: showed pelvic dilatation (a) after contrast administration: showed the pelvis with microbubbles (arrow) (b). In the same time MCU showed the same finding (c)

- Pre-warmed (37°C) normal saline that was connected to the carheter
- Contrast media (Levovist, Echovist - Schering product)

3. Preparation of the child: The child was on supine position during the whole procedure.
4. Procedure: The first ultrasonic scan of the urinary tract was performed with particular attention to the pelvio-calyces region, proximal and distal ureter. Any dilatation found was measured and documented in transversal and longitudinal views.
   - This first scanning was the basic data for comparing with the imaging after administration of contrast media.
   - The catheter was inserted into the bladder and urine was discarded.
   - Catheter was connected to intravenous tube with the bag containing pre-warmed normal saline solution and filled into the bladder.
   - The contrast media (1 ml/kgBW and saline: bladder volume - contrast volume) was injected into the bladder slowly under sonographic monitoring and videotape recording. On sonography, the contrast was seen as a strong echogenic microbubbles (Figure 2). When echocontrast gradually filled the bladder, particular attention should be paid to the distal ureter for appearance of microbubbles which meant reflux (Figure 3).

Then both kidneys were examined also with particular attention to the pelvic region, and compared with the previous imaging to decide grading of reflux (Figures 4 and 5). The grading of reflux by echocontrast sonography also according to the IRSC classification.

- Scanning of the kidneys was continued during micturition looking for increase of the reflux and residual urine was checked.
- MCU was performed for comparing the result of cystosonography (Figure 5).

Discussion

VUR is defined as abnormal, retrograde passage of urine from the bladder into the upper urinary tract. Previously, VUR was considered due to obstruction at or distal to the bladder neck. Later, urinary tract infection has been considered as a cause of VUR. Now, most investigators believe that VUR is a primary phenomenon due incompetence of the ureterovesical junction and is not secondary to either obstruction or infection. The increased incidence of reflux in siblings, as well as 20 fold greater in white versus black children, support the concept that reflux is a primary phenomenon.[1]

The valve mechanism of the uretero-vesical junction is due to an oblique entry of the ureter into the bladder and an adequate length of the intramural ureter, especially its submucosal segment. It is primarily passive mechanism, although there is an active mechanism by ureterotrigonal longitudinal muscles and ureteral peristalsis. Deficiency or immaturity of the longitudinal muscle of the sub-mucosal ureter may cause incompetence of its anti-reflux and is thought as a cause of VUR.[1] The VUR was very rare showed evidence of obstruction and there were no significant difference in incidence of reflux and non reflux in children with sterile urine and infected urine. Early detection of VUR in children is important. Thirty to sixty percent of children with VUR has renal scarring. The renal scarring as a result of VUR requires the present of UTI,[2] although it has been suggested that sterile VUR may cause renal scarring too by chemical or hydrodynamic effects.

The dilatation of renal pelvic and distal ureter which is frequent finding in young children is considered due to VUR. They usually undergo MCU or RNC to confirm or exclude VUR. Sometimes if VUR is not seen during MCU examination, one usually takes more expose with some other positions in order to find the reflux. It means more exposing the children to ionizing radiation. It is considered to be responsible for about one quarter of the genetically significant radiation exposure in children.[6] Although with RNC it is liable to limitations related to low resolution, it is possible failure to depict grade I reflux, as well as failure to discriminate the four grades of reflux in the pelviocalyceal system.[7,8]

Since ultrasound has been introduced, it has become a popular imaging tool for screening children with urinary tract disorders. It also can be used to follow-up the renal growth or renal scarring. Ultrasonography using echocontrast is a new approach for detecting VUR.

The authors used microbubbles of iodinated, sonicated albumin, galactose suspension with or without palmitic acid as an echogenic contrast medium to evaluate the usefulness of ultrasonography in detecting and grading of VUR.[5,9,10,11] The duration of echocontrast persists in urinary tract depends on the type of contrast. Echocontrast contains of palmitic acid and galactose persists more longer than echocontrast contains galactose only.[5] Excessive diluted of echocontrast will reduce the signal. During and after administration of echocontrast one should scan urinary tract carefully and systematically from the bladder, distal ureters to the kidneys. Every reflux should be documented immediately.

The comparisons of sensitivity and specificity of echocontrast sonography with MCU in excluding or detecting VUR are 100% and 86% respectively,[5] particularly of high grade, when the two exams were performed on the same day. Ultrasound may display corticomedullary differentiation, parenchymal echogenicity, renal size, or anatomic variants. This technic can be repeated for follow-up as well. Echoenhance sonography seems to be reliable in detection VUR, in the hand of expericnced examiner. Until now there is no classification of VUR by ultrasound. Is the IRSC grading of VUR can be totally applied for echocontrast VUR reflux or is necessary to make special grading for sonography appearance? However, it is a promising imaging technic in detecting of VUR. It has opened the opportunity to evaluate children with sus-

pected of VUR using non-ionizing imaging and diminish radiation hazard in children. Until now there is no information of any side effect, and the only contraindication is galactosemia.

References

1. **Bisset III GS, Strife JL, Kirks DR.** Genitourinary tract: vesicoureteral reflux. In: Kirks DR, editor. 2nd ed. Practical pediatric imaging. Diagnosis radiology of infants and children. Boston: Little Brown, 1991. p. 984-90.
2. **Bisset III GS, Strife JL.** The duplex collecting system in girls with urinary infection. Prevalence and significance. AJR 1987; 148: 479.
3. **Lebowitz RL, Olbing H, Parkkulainen KV, Smellie JM, Tamminen-Mobius TE.** International system of radiographycgradingof vesicoureteric reflux. Pediatr Radiol 1985; 15:105-9.
4. **Sherman NH, Rosenberg NK.** The pediatric pelvis: lower urinary tract. In: Rumack CW, Wilson SR, Charboneau JW, editors. Diagnostic ultrasound. St. Louis: 1991. p. 1222.
5. **Bosio M.** Cystosonography with echocontrast: a new imaging modality to detect vesicoureteric reflux in children. Pediatr Radiol 1998; 28:250-6.
6. **Seppanen U, Tornianen P, Kiviniity K.** Radiation gonad doses received by children in intravenous urography and micturitioncystourethrography. Pediatr Radiol 1979; 8: 169-72.
7. **Fretzayas A, Karpathios T, Dimitriou P,** et al. Grading of vesicoureteral reflux by radionuclide cystography. Pediatr Radiol 1984; 14:148-58.
8. **Kleinman PK, Diamond DA, Karellas A,** et al. Tailored low dose fluoroscopic voiding cystourethrography for the reevaluation of vesicourereral reflux in girls. AJR 1994; 162:1151-4.
9. **Atala A, Wible JH, Share JC,** et al. Sonography with sonicated albumin in the detection of vesicoureteral reflux. J Urol 1993; 150: 756-8
10. **Kesslee R, Altman D.** Real time sonographic detection of vesicoureteral reflux in children.
11. **Hanbury D, Coulden R, Farman P, Sherwood T.** Ultrasound cystography in the diagnosis of vesicoureteral reflux. Br J Urol 1990; 65: 250-3.