

International system of radiographic grading of vesicoureteric reflux

International Reflux Study in Children. Writing committee: R. L. Lebowitz, H. Olbing, K. V. Parkkulainen, J. M. Smellie and T. E. Tamminen-Möbius

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Abstract. The classification of grading of vesicoureteric reflux (VUR) agreed to by the participants in the International Reflux Study in Children is described. It combines two earlier classifications and is based upon the extent of filling and dilatation by VUR of the ureter, the renal pelvis and the calyces. A standardised technique of voiding cystography is also described to ensure comparability of results.

The importance of vesicoureteric reflux (VUR) as a factor in the pathogenesis of renal scarring is widely recognised and both surgical and medical approaches to the management of children with VUR have been explored. Because the severity of VUR varies widely and correlates with prognosis, numerous systems of VUR-grading have been devised,

based upon radiographic appearances [3]. This diversity of grading has made the comparison of published results difficult and also has caused confusion in discussions about VUR. Some uniformity of reflux grading is essential if any comparison of different therapeutic methods is to be made [2, 4].

The International Reflux Study in Children (IRSC) is a multicenter collaborative study (Table 1) comparing surgical and nonsurgical management of VUR. Before embarking upon this a standard method of grading was clearly necessary both for the selection of children for enrolment and for the assessment of results of different management regimes. This in turn had to be based upon a standard method of cystography since variations in technique may affect the radiographic appearances [5].

A grading system depending mainly on the degree of filling and dilatation of the ureter and upper urinary tract during cystography performed by a

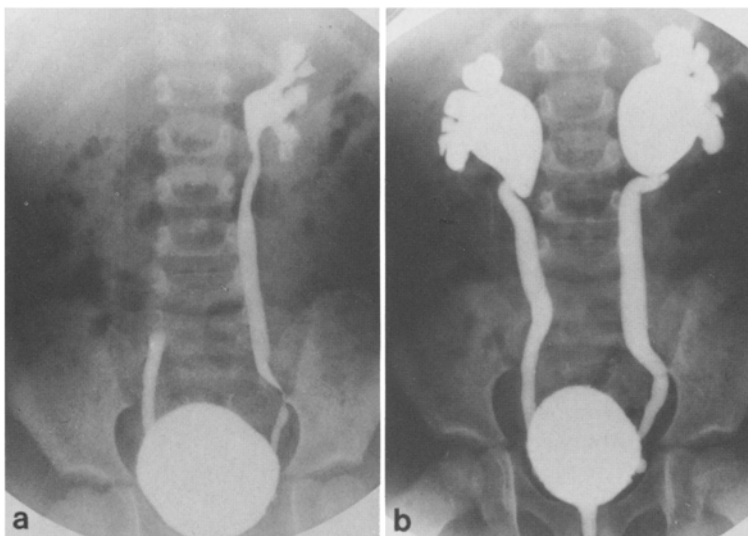


Fig. 1 a and b. VUR in a 4-year-old girl, **a** at completion of bladder filling and **b** at the height of voiding showing a marked increase of VUR, now indicating bilateral VUR grade IV

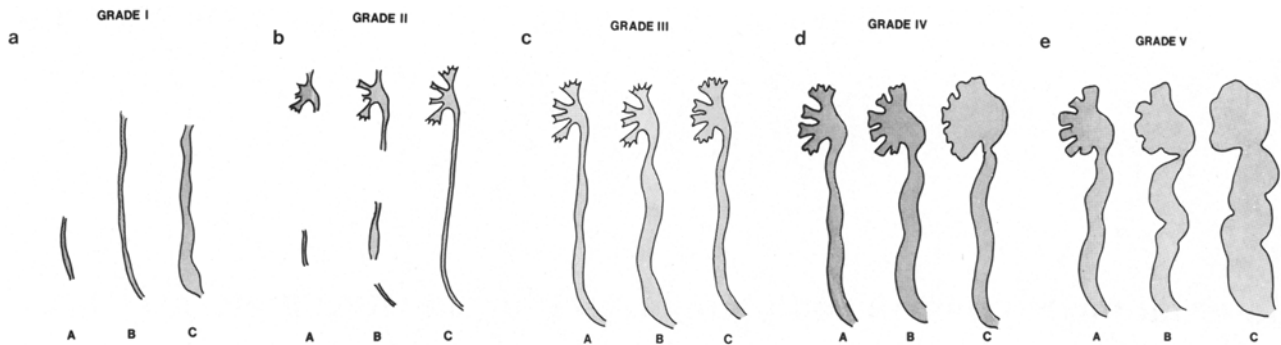


Fig. 2a–e. Diagrams illustrating variations within grades I to V VUR. **a Grade I:** VUR does not reach the renal pelvis, with A, B, C: different degrees of ureteral dilatation. **b Grade II:** VUR extending up to the renal pelvis without dilatation, with A and B: Filling of the ureter and calyces incomplete C. Filling of the ureter and calyces complete. **c Grade III:** VUR extending up to the kidney, with A: Mild dilatation of the ureter, renal pelvis and calyces, no blunting of the calyceal fornices. B: Moderate dilatation of the ureter and renal pelvis and mild ureteral tortuosity, no blunting of the calyceal fornices. C: Mild dilatation of the ureter, moderate dilatation of the renal pelvis, slight blunting of the calyceal fornices. **d Grade IV:** Moderate dilatation of the ureter with complete obliteration of the sharp angles of the calyceal fornices, but the papillary impressions visible, with A: Moderate dilatation of the renal pelvis and calyces, complete obliteration of the sharp angles in majority of fornices. B: Moderate tortuosity of the ureter and moderate dilatation of the renal pelvis. Complete obliteration of the sharp angles of all fornices. C: Moderate tortuosity of the ureter, extensive dilatation of the renal pelvis, though papillary impressions are visible in the majority of calyces. **e Grade V** with A: moderate dilatation of the tortuous ureter, moderate dilatation of the renal pelvis, a papillary impression visible in only one of the calyces. B: Gross dilatation of a tortuous ureter, renal pelvis and calyces; no papillary impressions visible. C: Extreme dilatation of the whole upper urinary tract

standardised method was worked out by the participants in IRSC [8, 9]. This grading system and method are presented here in detail so that they may be widely used as a standard grading system and to allow comparison between the results of IRSC and others.

Standardised method of voiding cystourethrography (VCU)

The child should empty the bladder if possible and then, after measurement of any residual urine, the bladder should be filled with contrast medium at body temperature, usually in 15–20% concentration and not more than 30% to avoid chemical irritation. This is introduced through a catheter by drip infusion, using an infant feeding tube (6–8 Charr.), with the bottle at a maximum height of 70 cm above the bladder, until dripping of the contrast agent ceases while the child is quiet and/or until wishes to void. The volume at this point (indicating the bladder capacity together with contrast material refluxed) is recorded and compared with mean bladder volume of respective age [1, 7, 11]. In successive examinations, the aim should be to introduce at least the previous volume unless gross VUR has disappeared spontaneously or has been corrected surgically. Also, soon after surgery there may be a temporary reduction in the volume of the bladder.

The whole upper urinary tract should be visualised in the frontal projection, and the films including kidneys exposed as follows: (a) at partial filling, (b) when the bladder is full; (c) at the height of voiding; (d) immediately after voiding.

If possible the examination should be made with fluoroscopic guidance and the films exposed when reflux is maximal. In the first examination, the lower urinary tract should be visualised during voiding, including a lateral view in boys.

It is preferable to avoid sedation. If a general anaesthetic has to be used, the radiographic appearance of any reflux seen will not be strictly comparable, for grading purposes, with that in an awake child who is voiding physiologically.

International grading of VUR

The definitions of the International Grades of VUR are as follows.

Grade I: 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 impressions in the majority of calyces.

Grade V: Gross dilatation and tortuosity of the ureter. Gross dilatation of the renal pelvis and calyces. The papillary impressions are no longer visible in the majority of the calyces.

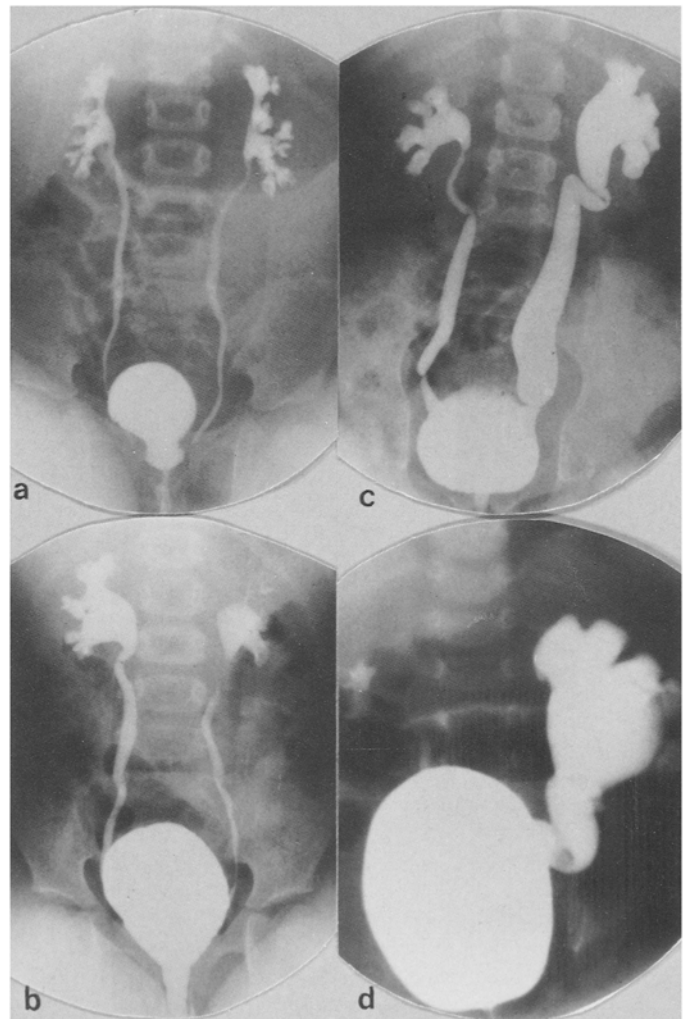
The grade is determined by the most severe VUR which usually coincides with the peak of voiding (Fig. 1). The bladder volume at which VUR is first seen as well as any intrarenal reflux should be noted although these are not relevant to the International Grading System.

In Figure 2 the characteristics of the different grades in the International System are shown diagrammatically. Figures 3 a–d present X-ray examples of grades II to V.

Comparison with the grading of Heikel and Parkkulainen [6] and Dwoskin and Perlmutter [4] are shown in Table 2. The two mildest grades and the

Table 1. Hospitals in the participating International reflux study in children

<i>Europe</i>		
Belgium	Brussels	Cliniques Universitaires Libre Brugmann, Erasme, Saint-Pierre
Finland	Helsinki	Yliopistollinen Keskussairaala Lastentautien Klinikka
Finland	Oulu	Yliopistollinen Keskussairaala Lastentautien Klinikka
Sweden	Göteborg	Universitet, Östra Sjukhuset, Barnklinikerna
Sweden	Stockholm	Karolinska Institutet St. Görans Sjukhus Barnklinikerna, Sachsska Barnsjukhuset
FRG	Bonn	Universitätskinderklinik
FRG	Essen	Universitätsklinikum der GHS, Kinderklinik, (Coordinating Center)
FRG	Hamburg	Universitätskrankenhaus Eppendorf Kinderklinik Urologische Klinik
<i>USA</i>		
Alabama	Birmingham	University of Alabama
California	Los Angeles	University of California School of Medicine
California	San Diego	University of California
Florida	Gainesville	University of Florida
Illinois	Chicago	Children's Hospital
Kentucky	Lexington	University of Kentucky
Maryland	Baltimore	Johns Hopkins School of Medicine
Massachusetts	Boston	Childrens Hospital
Michigan	Detroit	Childrens Hospital
Minnesota	Rochester	Mayo Clinic
Missouri	St. Louis	Childrens Hospital
New York	Bronx	Albert Einstein College Hospital (Coordinating Center)
New York	Brooklyn	Downstate Medical Center
New York	New York	Babies Hospital Columbia University
N. Carolina	Durham	Duke University Medical Center
Pennsylvania	Philadelphia	Childrens Hospital
Texas	Houston	Texas Childrens Hospital
D. C.	Washington	Childrens Hospital National Medical Center

**Fig. 3.** a–d. VCU's VUR grades II to V. **a** VUR grade II right; VUR lower limit grade III left. **b** VUR upper limit grade III right; VUR lower limit grade III left. **c** VUR grade III right; VUR upper limit grade IV left. **d** VUR grade II right; VUR grade V left

most severe ones are similar in all three systems but the intermediate grades differ.

Permanent calyceal changes which can be seen not only on the VCU but also on the intravenous urogram should not be misinterpreted as blunting. If such changes exist, the degree of dilatation in renal pelvis and ureter determine the grade of VUR. Figure 4 shows an example in a child with established renal scarring.

Discussion

The International Grading System is a hybrid, made from the classifications of Heikel and Parkkulainen [6] and of Dwoskin and Perlmutter [4]. In the former

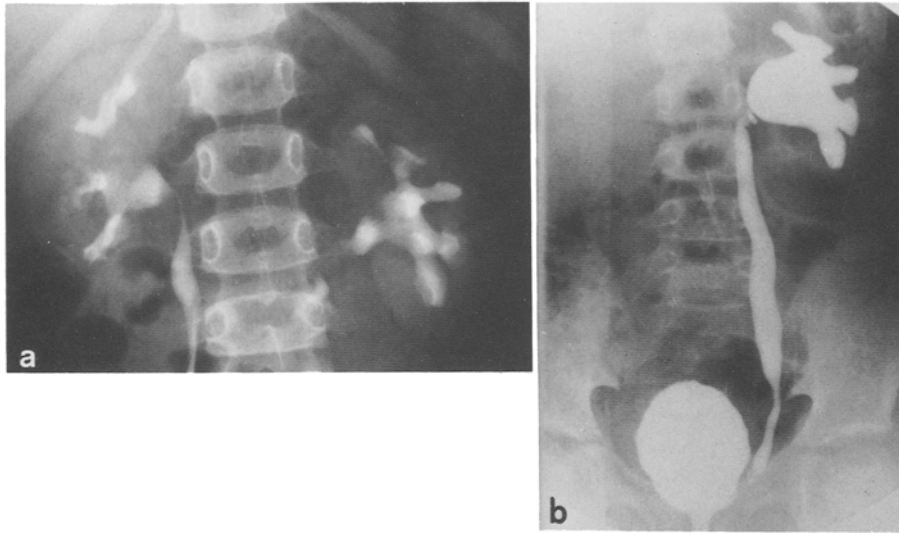


Fig. 4. **a** Intravenous urogram showing bilateral renal scarring with calyceal clubbing of most of the calyces. **b** Voiding cystourethrogram showing left VUR grade IV. No papillary impressions are visible because of the permanent structural changes (clubbing of all calyces) as seen in Figure 4a

Table 2. Comparison between three radiographic grading systems of VUR

International grading	Heikel and Parkkulainen [6]	Dwoskin and Perlmutter [8]
<i>Grade I</i> – ureter only	<i>Grade I</i> shows slight reflux confined to the lower part of the ureter, which is of normal width	<i>Grade I</i> – lower ureteral filling
<i>Grade II</i> – ureter, pelvis and calyces. No dilatation, normal calyceal fornices.	<i>Grade II</i> shows reflux up into the renal pelvis, but the ureter and pelvis are of normal size	<i>Grade IIA</i> – ureteral and pelvicalyceal filling without other changes
<i>Grade III</i> – mild or moderate dilatation and/or tortuosity of ureter, and mild or moderate dilatation of renal pelvis but no or slight blunting of the fornices.	<i>Grade III</i> shows reflux into a slightly dilated ureter and pelvis	<i>Grade IIB</i> – ureteral and pelvicalyceal filling with mild calyceal blunting but without clubbing and without dilatation of the pelvis or tortuosity of the ureter
<i>Grade IV</i> – moderate dilatation and/or tortuosity of ureter and moderate dilatation of renal pelvis and calyces. Complete obliteration of sharp angles of fornices but maintenance of papillary impressions in majority of calyces.	<i>Grade IV</i> shows reflux into a moderately dilated ureter and pelvis	<i>Grade III</i> – ureteral and pelvicalyceal filling, calyceal clubbing and minor to moderate pelvic dilatation with slight tortuosity of the ureter
<i>Grade V</i> – gross dilatation and tortuosity of ureter. Gross dilatation of renal pelvis and calyces. Papillary impressions are no longer visible in majority of calyces.	<i>Grade V</i> shows massive reflux into a grossly dilated ureter and pelvis	<i>Grade IV</i> – massive hydronephrosis and hydroureter

[6] the grades depend on the extent of ureteral and pelvic dilatation during cystography. In the latter [4] calyceal changes during the VCU such as blunting and clubbing were stressed.

It is important to know of any renal damage or anomaly when the calyceal fornices are assessed because some of the calyceal changes seen on the VCU may be due to preexisting deformities (see Fig. 4) and only dilatation being produced by the VUR during cystography can be used to grade VUR.

VUR is not an “all or none” phenomenon but has a spectrum of severity. This may change during the course of VCU usually being most marked during

voiding after complete bladder filling. A difference in severity of VUR has also been noted when cystography is repeated. This may be due to:

1. an actual decrease in the degree of VUR because of maturation of the VU junction;
2. the technique of VCU (the use of a syringe, for example, may affect both the bladder filling and voiding);
3. the rate of urine flow;
4. the extent of bladder filling.

No satisfactory measurements of ureteric calibre are available so that the degree of dilatation cannot be defined exactly. Figures 2 and 3 give an indication

of slight, moderate and severe dilatation but there will be some overlap between them.

Additional information about the vesico-ureteric junction and VUR which may be useful in further characterising or defining the patient may be obtained on cystoscopy [10] or on isotope cystography [12] but the International Grading System is based solely on radiography.

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