

MANAGEMENT AND THE IMPORTANCE OF DIAGNOSTIC IMAGING IN MALFORMATIONS AND URINARY TRACT INFECTIONS IN CHILDREN.

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SUMMARY

We present our expertise on a group of 251 patients on the importance and contribution of the diagnostic imaging methods in urinary malformations and vesicoureteral reflux (VUR) in children.

Reno-urinar malformations have been found in patients with urinary infection and those are: vesicoureteral reflux (VUR) in the proportion of 42%, hydronephrosis in the junction syndrome in 18%, the pyelo-ureteral duplication in proportion of 14.5% and megaureter in 10 %.

The most used method of diagnosis and classification for VUR remains mictional cystography.

Urography and ultrasound are designed to indicate the presence of malformations and urinary and vesicoureteral reflux shape and nuclear imaging to diagnose renal function and specify renal scarring.

Keywords: vesicoureteral reflux, mictional cystography, urinary infection, ultrasound, nuclear.

The study included 251 patients, aged 1-18 years, diagnosed with urinary infection. Analyzing the group of patients we found the highest incidence of urinary infection at the age of one year, representing 25% of patients.

As in the literature there is a higher incidence of urinary tract infection in boys up to age 4, after which urinary infection is more common in female. In most patients, the age at which has been issued for the first time, the diagnosis of urinary infection was the age of 1 year, highlighting the difficulties of diagnosis of urinary infection at younger ages, because of nonspecific clinical picture and their difficulties for collection of a sample of sterile urine.

The studied group showed a higher proportion of acute pyelonephritis, 59%, against acute cystitis, which was present in 41% of patients. Females were represented in higher proportions in both acute pyelonephritis, 57%, and cystitis, 61%.

Renal and urinary malformation, often responsible for establishing and maintaining urinary infection were detected in 84% of patients, equally by gender. Among patients with acute pyelonephritis, 27% have associated renal and urinary abnormalities, and among those with a diagnosis of cystitis, malformations were present in 84% of patients.

Kidney and urinary malformations which were found in patients with urinary infection are: vesicoureteral reflux in the proportion of 42%, hydronephrosis in the junction syndrome in 18%, the pyelo-ureteral duplication in proportion of 14.5% and megaureter in proportion of 10%.

Analyzing patients with vesicoureteral reflux, was found a high incidence of vesicoureteral reflux grade III

or IV, grade III vesicoureteral reflux being found in 40% and grade IV in 36% of backward flow renal units.

In addition to renal and urinary malformations in the group of patients were found other predisposing factors of urinary infection, of which, 6% of patients with phimosis, and 1% of patients with labial coalescence.

The increased incidence of phimosis stresses the need to resolve the anomalies to prevent recurrent episodes of urinary infection.

Following the completion of quantitative urine culture, which is the most important criterion for establishing the laboratory diagnosis of urinary infection, there was detected highest incidence of urinary infections caused by *Escherichia coli* (73%), followed by *Proteus* (8%) and *Enterobacter* (7 %).

Both in patients with renal-urinary malformations and those without associated malformations, urinary infection was caused most commonly by *Escherichia coli*.

RENAL AND URINARY IMAGING DEVICE.

The purpose of imaging in patients diagnosed with UTI (Urinary Tract Infection) is: discovery of a possible urinary tract malformations, identifying patients with chronic kidney damage and 'scars', those as a result of a previously undiagnosed urinary tract infections or untreated ones; in association with clinical and laboratory data, is established diagnosis of acute pyelonephritis (uncomplicated or complicated).

Urological abnormalities as VUR, the duplicate collecting system and urinary obstruction may predispose the child to achieve chronic kidney damage, so structural abnormalities urological screeneng is considered essential to prevent long term sequelae.

Diagnostic imaging is intended to indicate the presence of renal-urinary malformations and the presence of VUR, allow VUR classification by grade and state the form of primary or secondary VUR.

Positive diagnosis and staging the degree of VUR are made classic by mictional cystography; this method persists today as a top imaging one for VUR. Seeking ways less radiant, led to the use of contrast Doppler ultrasound and isotope cystography to evaluate the presence and degree of VUR, both investigations reported good results in mictional cystography comparing.

Evaluation and determining prognosis in VUR should also include assessing the degree of renal scarring by enhancing lesions. This goal was initially provided by intravenous urography. Intravenous urography is the basic investigation. Urography semiology is malformation specific.

Today, the standard diagnosis of renal scars is the DMSA scintigraphy, the investigation with the utmost accuracy in their diagnosis. The renal ultrasound is trying to define the role of this method to reveal scars.

Further shall be analyzed the value of each imaging methods in diagnosis of renal malformations and VUR.

ULTRASOUND

Ultrasound examination is a modern method of diagnosis in pediatrics, is in constant improvement and expansion of the scope. In this context, ultrasound examination has become indispensable in pediatric practice. Moreover, it became a method of screening in the detection of specific diseases child (perinatal cerebral hemorrhage, hydrocephalus, hip dysplastic, obstructive urological disease, congenital heart disease, and others).

It is a noninvasive method without irradiation, widely available, repetitive, cheap, no stress for the patient, making it the first line imaging investigation. We can say that ultrasound examination is required in pediatric clinical practice by:

- Lack of harm to the infant and the possibility of recurrence based on clinical context.
- Examination may be performed in the presence of parents, decreasing the fear and stress for the patient
- There are possibilities for comparing the dynamic documentation of changes detected;
- Plays an important role in such emergencies, abdominal trauma, thoracic trauma, acute abdomen, cardiac defects, etc.
- Early detection of clinical entities with reduced symptoms and avoidance of other unnecessary laboratory examinations.

Renal ultrasound investigation indicate the presence, location and morphology of the kidney, bladder contour. Observing the examination of the bladder ureteral jet exhaust, has led to trying to include the examination in the evaluation of VUR.

The first reports of diagnostic ultrasound VUR were published in 1976 and again in 1981. Today, ultrasound evaluation of the VUR is done with indirect and direct methods.

Indirect Techniques

It is based on urinary tract ultrasound without administration of any substances in the bladder. VUR ultrasound semiology includes the following indirect signs, highlighted in Table 1:

- Ureteric and pyelocaliceal dilation;
- Lack of cortico-medullary differentiation;
- Renal dysplasia
- Changes cortico-medullary

1. Ultrasound examination of the urinary

Ultrasound findings	Patients with VUR
Dilated renal cavity	135 (%)
Juxtavesical ureteric dilation	52 (%)
renal dysplasia	34 (%)
cortico-medullary changes	40 (%)

However, a normal ultrasound examination does not exclude the presence of VUR. Thus, 78% of the VUR kidneys have a normal ultrasound appearance, including 40% of cases of VUR grades 3-4.

Such findings appear in cases of grade 4-5 VUR. Color Doppler examination appearance led to new diagnostic tests. Thus, ureteral jet was studied and evaluated in terms of flow direction, flow angle, length, shape, frequency and amplitude and measure the distance from the midline ureteral orifice.

The observation of a non-diagnosis rates of parenchymal damage and renal scarring lesions detected in 50% of cases, comparative studies with DMSA scintigraphy, make ultrasound an inappropriate method for this purpose.

Intravenous urography (IVU)

In the past, IVU urography had a principal role in investigating children with UTI. In most pediatric centers in the world, ultrasound has replaced i.v urography, as the initial method for evaluation of patients with UTI.

If the ultrasound shows an abnormality in renal architecture or mictional uretro-cystography, demonstrate the presence VUR, there will be recommended i.v urography.

I.v. urography provides a better definition of kidney "scars" than ultrasound. In many centers in other countries, nuclidic scintigraphy (DMSA-scan) is used as the initial imaging investigation in patients with UTI, especially to those with high risk and suspect renal lesions.

Intravenous urography, is radiological highlighting the urinary tract by intravenous injection of iodine renotope (Odiston, Urografin). Well-managed,

intravenous urography allow full investigation of the urinary urethra up to nephrons, both in terms of morphological aspects, as well as the functional ones.

Minute intravenous urography is used to highlight renal ischemia. Iodine contrast media, properly dosed on body weight, is injected rapidly (4-6 sec). Radiographs are made quickly - 30 seconds 1, 2, 3, 5 minutes to 90-120 minutes.

IVU is a morphological investigation and able to provide functional information. After injection of contrast, the first cliché is carried out at 5 minutes and highlights secretion time renal parenchymal. Normally, the discharge must be synchronous bilateral and equal.

The second film at 15 minutes, evaluate the renal system of morphologically from calyces to the bladder. It is possible to evaluate dynamic evacuation pyeloureteral or renal excretion. Depending on the suspected condition may be performed intermediate or delayed clichés or reinjection(Fig.2).

Modern techniques urography that uses the injection of diuretics (furosemide) before contrast medium, brought progress in the use of this investigation to diagnose obstructive urological diseases high. Can be continued with cystography mictional excretory, but this technique requires high doses of substances urography. This one, it should contain three clichés: one in repletion, one in passing urine, with urethra evaluation and postmictional to assess bladder residue.

Figure 2. Urography aspect of developing VUR



VUR standard urography contribution is minimal, providing indirect evidence, as shown in Table 2:

- calyces swollen, with loss of contour and deleted images cup;
- Ureter filled throughout its length, most commonly the lower dilated or flattened;
- VUR can be viewed directly, by observing an upper urinary tract refills once were empty;
- Appearance at the end of the exam, of renal opacities on a non-functional kidney, on the cliché of miction, when exam continues through cystografic time.

Table 2. Urography changes in VUR

Changes urography	Paediatric Clinic Arad
Normal	3%
Hydronephrosis	18%
Labial Coalescence	1%
Megaureter	63%
Duplication	4%
Ectopic kidney	10%
Kidney hypoplasia	6%
VUR	42%
Congenital kidney	3%

Mictional Cystography

It is the most important examination in the diagnosis of VUR. Standard technique involves probing transurethral bladder with a probe adapted to patient size, with the introduction of radiological contrast agent. This investigation requires careful preparation of urethral and perineal region to prevent iatrogenic infection.

The examination is performed, fluoroscopic controlled by introducing the contrast agent with low pressure at body temperature, so the feeling of urinary urgency emerge, then extract the probe and stimulate urination. It is a dynamic exploration and requires to obtain radiological filling clichés, of micturition and postmictional. At boys is necessary to assess the development of lateral incidence urethra.

The method has specificity rates, and negative predictive accuracy of over 99%.

Is the method of classification VUR in five degrees (Fig. 3), adopted by the "International Reflux Study Committee" (IRSCA) and confirmed by the "International Reflux Study in Children", used today by authors and pediatric surgical trainers. We can say that this classification (Table 3) is the only really common in discussions and work on vesicoureteral reflux.

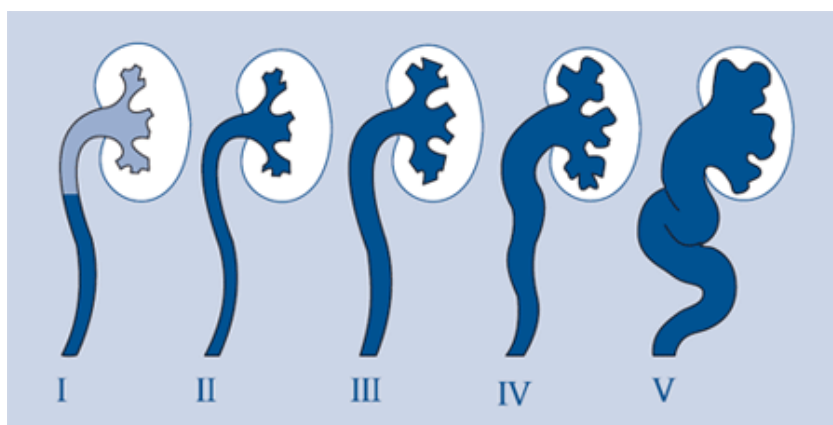


Figure 3. Classification of the degree of VUR

Thus we find:

- I) ureter with orthotopic flattening into the bladder rarely can be affected by ureterocel (orthotopic) or vesicorenal reflux.
- II) normal ureter with ectopic bladder flattening on side of the normal position, pre-dispose to vesicorenal reflux (Fig 4 a).
- III) normal ureter with antero-inferior ectopic bladder flattening to it's normal position, predispose to ectopic ureterocel (urography-snakehead dilatation in the terminal) ureter.
- IV) ureter can be flattened ectopic outside the bladder (the seminal vesicle, urethra, cervix, vagina, etc.), When orifice is stenotic causing dilatation superjacent.
- V) Renal pelvis is severely dilated, ureter is tortuous and chalices deeply modified anatomically (Fig. 4 b) In this case proceed to excision of diseased area, followed by vesicoureteral implantation with antireflux procedure.

Table 3. Cystographic Classification of VUR per grade

VUR grade	Paediatric Clinic
I	71%
II	20%
III	2%
IV	3%
V	4%

The disadvantage of this investigation is actionless gonadal irradiation and acute failure of ITU examination because of the risk of kidney infection. No examination is recommended for a period for 4-6 weeks from the acute episode, but studies suggest that the same risk exists and to seven days.

Iatrogenic infection rate is another disadvantage that reaches 16-22% without antibiotic prophylaxis and 1.7% in a study to assess the occurrence of UTI in 7 days from the maneuver (12).



Fig.4. a) VUR Cystography grade II; b) VUR grade 5

Isotopic Cystography

This investigation has a lower radiation dose and risk no iatrogenic infection. There are two techniques: direct techniques and indirect techniques.

Direct techniques

Involves transurethral catheterization or suprapubic puncture of the bladder. Tc-99m radioactive tracer is introduced, then fill the bladder with sterile saline, heated, and observe its course. It has high sensitivity and specificity and is not affected by other components of the abdomen or overlaps the air especially in infants. This investigation allows the determination of bladder volume and bladder pressure reflux, which helps the healing prognosis. (11).

Indirect techniques

Radioactive tracer is administered intravenously, Tc-99m MAG3 or DTPA, and get a nephrogram. This investigation does not require bladder polling and is therefore better tolerated, but can be applied only to children who have sphincter control. Allows determination of bladder residue and formulate a prognosis of gravity for the evolution of VUR.

It can measure the total bladder volume (TBV) expressed as a report to the average capacity for age. This correlates well with mictional disorders determined by urodynamic studies.

Thus, a low TBV corresponds to unstable bladders, and a TBV increased, corresponding to a vesical-sphincter concern(14).

The disadvantage of both techniques is the inability to play the morphological details especially regarding the male urethra. Therefore studies are preferred especially for girls, who benefit from lower gonadal irradiation.

Scintigraphy

The only imaging method that shows the true renal function. Of scintigraphic techniques have been deployed static and the dynamic method.

Dynamic scintigraphy

It is considered that higher intake of information on urinary tract. Is performed with Tc-99m DTPA radiotracer (diethylenetriamin-pentaacetic acid), with glomerular filtration, or Tg-99m MAG3 (mercaptoacetyl triglicin), benefiting from a glomerular and tubular excretion.

In scintigraphy with Tc-99m DTPA can be calculated glomerular filtration rate in vivo, using computer algorithms scan or in vitro, by making one or two blood harvesting standardized time intervals and determining tracer. It can be estimated by the method in vivo glomerular filtration rate per kidney.

Static scintigraphy

Is determined with the use of Ga or Tc-99m DMSA -67.

The technique of scintigraphy with Tc-99m DMSA (dimercaptosuccinic acid) is necessary as standard technique for the detection of renal scars. Thus, urography reveals only 70-85% of renal scars detected through this exam. Moreover, in recent years emerged as the examination of acute pyelonephritis, thus offsetting the disadvantage of cystography.

DMSA scintigraphy value is greater, because through it we have the only reliable means of demonstrating parenchymal involvement in ITU.

DMSA tracer is secreted at tubular level and is thus affected by the intrarenal blood flow and proximal tubular cell by damage.

Damage, will generate defects, focal or diffuse. Acute pyelonephritis is in fact a tubulopathy, and the affected territory is marked by vessels-constriction (2). Tracer is administered intravenously and renal scanning is done in 3-4 hours (9).

That being pathophysiological foundations for the use of DMSA scintigraphy, it highlights changes in the renal parenchyma of 80% of cases labeled as biological pyelonephritis.

This investigation allows to demonstrate the direct relationship between final renal scars location and of changes made from examination data of the acute phase, which showed the involvement of infection in the evolution of NO.

Parenchymal damage could also highlight more common for UTI associated with VUR and boys.

Cure rate of acute pyelonephritis lesions detected by DMSA in VUR (62%) is significantly lower than for non-flow backward and into renal units (86%) (4).

Cure rate of acute pyelonephritis lesions detected by DMSA in VUR (62%) is significantly lower than for non-refluent renal units (86%) (4).

These observations demonstrate the effect of sensitization for UTI, which VUR has on kidney.

“American Academy of Pediatrics Subcommittee on Urinary Tract Infections” with did not recommended DMSA scintigraphy as compulsory examination under 2 years (9).

Use of leukocytes marked with indium or gallium citrate may be useful in demonstrating renal inflammation and pyelonephritis. Their usefulness is applied to demonstrate acute lesions in patients which already have renal scarring or complex anatomical changes that would affect the DMSA scintigraphy image.

The method is less common (9).

CT

Spiral CT and Multiscan CT with contrast agent examination were used as a means of highlighting focal parenchymal lesions of pyelonephritis but no comparative

studies have found the method. This detection is more reliable and less radiant with DMSA scintigraphy (8).

Nuclear Magnetic Resonance

It has a minor role in renal exploration but may serve to specify the tumor diagnosis. Important for VUR, may reveal the existence of ectopic ureter or renal sclerosis.

CONCLUSIONS

Urinary infection in young children is a marker of urinary tract abnormalities.

Imaging should be recommended in infants and young children who have fever and is the first episode of urinary infection, to highlight the risk of renal complications.

VUR is a serious condition of the renourinary apparatus, the primary cause of over 10-20% of cases of CRF – chronic renal failure .

Association with UTI is constant, being the cause for kidney damage with renal nephropathy occurrence, renal atrophy and progression to CRF.

Any UTI must be diagnosed correctly and in case of relapse, requiring inclusion in the diagnostic protocol of the VUR.

The presence of dilated renal ultrasound must require completion of investigations.

Early diagnosis of primary VUR is the only way to reduce the number of cases with progression to renal nephropathy, because renal scars occur mainly during the first 2-3 years of age.

Mictional cystography remains the most effective investigation and is mandatory in diagnosis and staging VUR.

Urography is particularly important in specifying the form of primary or secondary VUR. It has particular value for the surgeon.

Scintigraphy is a single direct imaging of renal function and the most effective for detection of renal scars. It is mandatory to establish the correct therapeutic indications.

Other imaging methods like CT or MRI have a role in specifying only reno-vesical complex malformations.

The role of imaging is to detect those defects that require surgical correction, monitor progress and outcome after surgery and to identify children who are at risk for developing long-term renal complications.

Signs and symptoms accompanying urinary tract infection in infants and small children are usually nonspecific, making difficult recognition for first episode of infection and also for prevention of renal complications.

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