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## USEFULNESS OF LOWER-DOSE COMPUTED TOMOGRAPHY UROGRAPHY WITH ITERATIVE RECONSTRUCTION TECHNIQUE IN DIAGNOSIS OF CONGENITAL ANOMALIES IN URINARY TRACT IN CHILDREN

### PRZYDATNOŚĆ UROGRAFII TOMOGRAFII KOMPUTEROWEJ Z ZASTOSOWANIEM ITERACYJNYCH TECHNIK REKONSTRUKCJI OBRAZU W DIAGNOSTYCE WAD WRODZONYCH UKŁADU MOCZOWEGO U DZIECI

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#### Abstract

*Introduction of iterative reconstruction technique in modern computed tomography allowed to reduce the radiation dose and to extend indications for computed tomography urography in children. We describe the case of boy with congenital anomalies in urinary tract including bilateral double collecting system, dilatation of double collecting system in the right kidney and dilatation of lower pelvis in left kidney and bilateral dilatation of ureters. Anomalies were detected in prenatal and then confirmed in postnatal ultrasonography. Voiding cystourethrography, which was performed on the 4th day of life revealed grade IV vesicoureteral reflux to the lower part of double collecting system in the right kidney and grade V vesicoureteral reflux to the left kidney. In cystoscopy posterior urethral valves were excluded and presence of double ureters was confirmed. Dynamic scintigraphy (99mTc-EC) detected impaired parenchymal secretory function in the lower pole of left kidney. The patient was qualified for surgical treatment including left lower heminephroureterectomy. Before surgery procedure computed tomography urography was performed and revealed congenital anomalies in urinary tract: bilateral double collecting system, bilateral hydronephrosis of the lower part of kidneys, dilatation of ureters associated with high grade of vesicoureteral refluxes, narrow cortex of left kidney. Computed tomography urography with iterative reconstruction techniques enables precise visualization of urinary tracts with reduced radiation dose. It replaces conventional X-ray urography because of much better visualization of urinary tracts with comparable or even lower radiation dose.*

**Key words:** computed tomography urography, CAKUT, vesicoureteral reflux, nephrectomy, children

#### Streszczenie

*Wprowadzenie iteracyjnych technik rekonstrukcji obrazu w nowoczesnych tomografach komputerowych umożliwiło obniżenie dawki promieniowania oraz poszerzyło zakres wskazań do urografii tomografii komputerowej. Przedstawiono przypadek chłopca z rozpoznaną w prenatalnym i potwierdzoną w postnatalnym badaniu ultrasonograficznym wadą układu moczowego w postaci zdwojenia nerek, poszerzenia obu układów kielichowo-miedniczkowych nerki prawej i dolnego nerki lewej oraz obustronnego poszerzenia moczowodów. Cystourethrografia mikcyjna wykonana w 4. dobie życia wykazała odpływ pęcherzowo-moczowodowy IV stopnia do dolnego układu nerki prawej, V stopnia do nerki lewej.*

*W cystoskopii wykluczono zastawki cewki tylnej, potwierdzono całkowite zdwojenie obu moczowodów. W badaniu izotopowym (99mTc-EC) stwierdzono śladowy udział w oczyszczaniu dolnego bieguna nerki lewej. Chłopiec został zakwalifikowany do heminefroureterektomii dolnej lewej. W celu dokładnej oceny anatomii dróg moczowych przed planowanym zabiegiem operacyjnym wykonano urografię tomografii komputerowej, która potwierdziła rozpoznanie obustronnego całkowitego zdwojenia nerek, wykazała wodonerczowe poszerzenie obu dolnych układów i moczowodów związane z wysokimi odpływami pęcherzowo-moczowodowymi i zwężenie warstwy mięższowej dolnego układu nerki lewej.*

**Słowa kluczowe:** urografia tomografii komputerowej, wady wrodzone układu moczowego, odpływ pęcherzowo-moczowodowy, dzieci

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## INTRODUCTION

Congenital abnormalities of urinary tract occur with the incidence 7,6:1000-17,7:1000 live births (1, 2). These diseases are responsible of 34-43% of cases of end-stage renal disease in children all over the world (3). Ultrasonography, scintigraphy and voiding cystourethrography belong to the basic imaging techniques in these cases. These methods have been for a long time „the gold standard” in pediatric nephrology and urology (4). Main disadvantages of conventional X-ray urography are low quality nondiagnostic images resulting from gases and stool masses present within the intestines. Computed tomography urography performed with standard reconstruction techniques enables better visualization of urinary tracts, but is also connected with ca. 1,5-time higher radiation dose than in conventional X-ray urography (5). Iterative reconstruction techniques, implemented in modern computed tomography scanners within last few years, enable to reduce the radiation dose for 45% or even more, with image quality comparable to standard algorithms (6, 7, 8, 9). For computed tomography urography it is connected with dose reduction comparable to conventional X-ray urography or even lower. It allows to extend the range of indications for computed tomography urography, and replaces conventional X-ray urography (11). Advantage of computed tomography urography is more precise visualization of the urinary tracts, especially in multiplanar and volume rendering reconstructions.

## CASE REPORT

A 2-month-old boy was admitted to the Pediatric Nephrology Department because of congenital abnormalities of the urinary tract. The child was born at term, after the second pregnancy, second delivery. His birth weight was 3862g. Congenital abnormalities in the urinary tract were diagnosed during the pregnancy using antenatal ultrasonography. Postnatal ultrasonography revealed bilateral duplication of kidney pyelocalyceal system, bilateral dilatation of collecting system and ureters (left to 10 mm, right to 7 mm). The left kidney was 70 mm in diameter, right kidney 56 mm. In left kidney we found hydronephrosis (kidney pelvis diameter was 35mm). Voiding cystourethrography revealed vesicoureteral

reflux grade IV to the lower pyelocalyceal system of the right kidney, and grade V to the left kidney (Fig. 1). In cystoscopy posterior urethral valves were excluded, and four ureters were reported. Dynamic scintigraphy (99mTc-EC) revealed normal function of right kidney (55%), the left double kidney had function of 83% in its upper pole and 17% in the lower pole (Fig. 2). In urodynamic test a detrusor-sphincter dyssynergia was

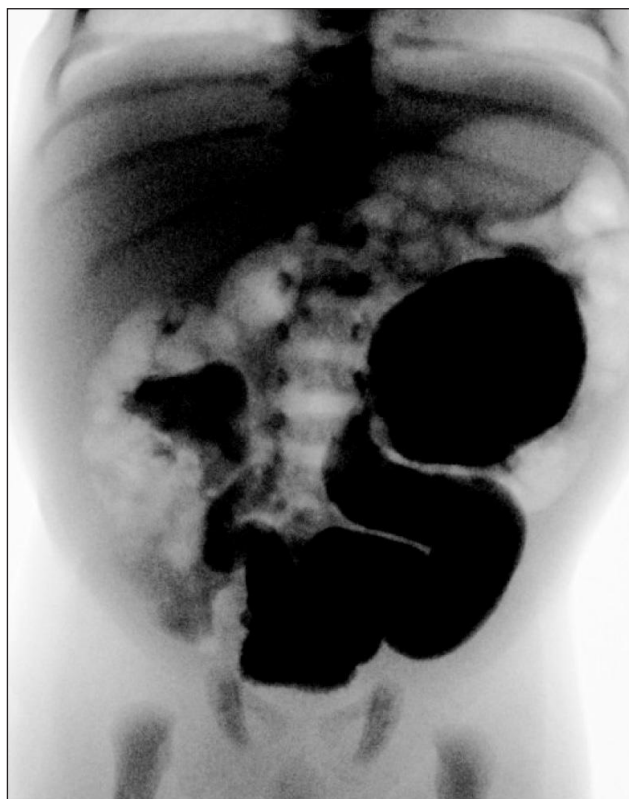


Fig. 1. Voiding cystourethrography. Vesicoureteral reflux grade IV to the lower pyelocalyceal system of the right kidney, and grade V to the left kidney.

Ryc. 1. Cystourethrografia mikcyjna. Odpływ pęcherzowo-moczowodowy IV stopnia do dolnego układu kielichowo-miedniczkowego nerki prawej, odpływ pęcherzowo-moczowodowy V stopnia do nerki lewej.

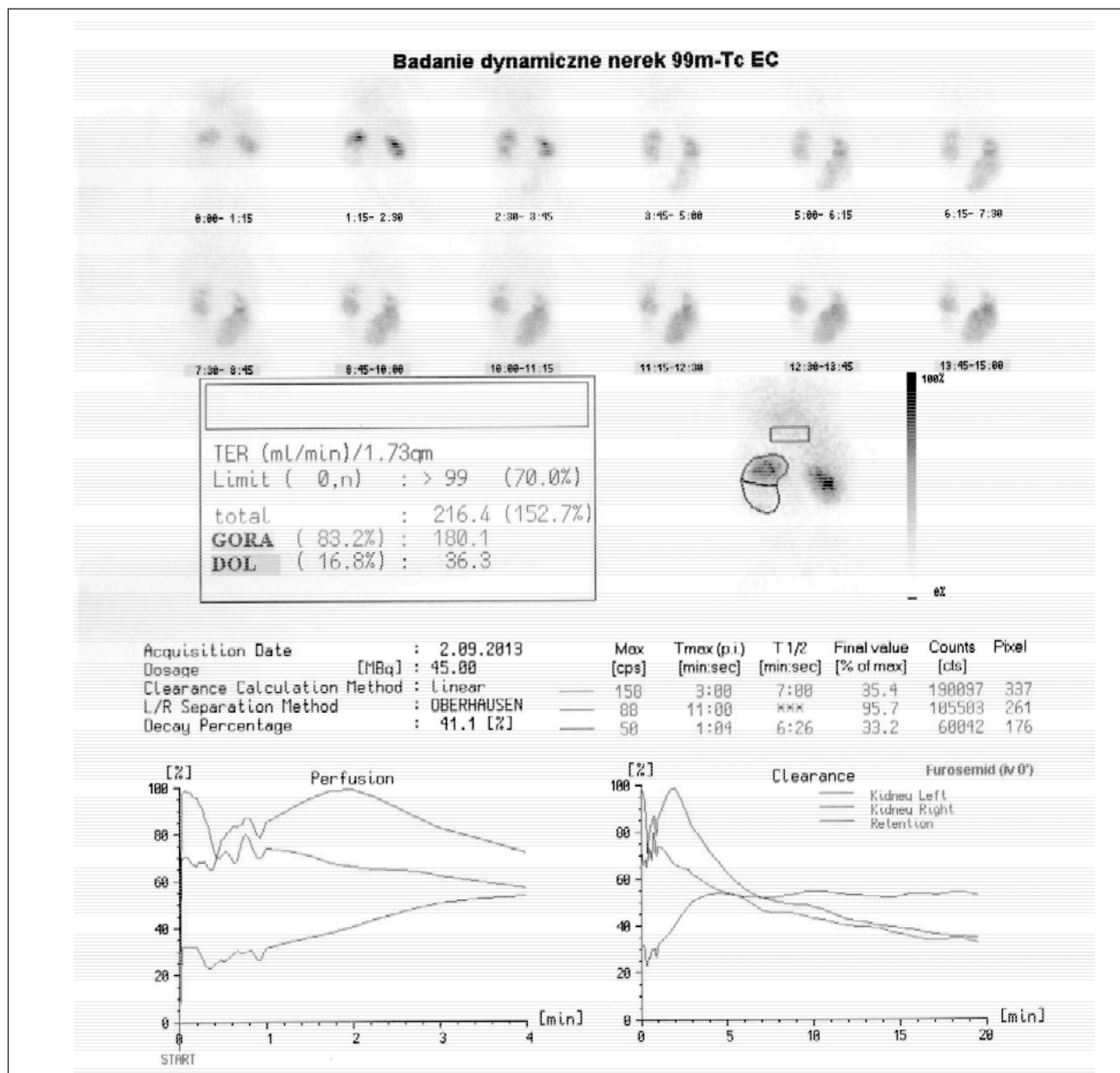


Fig. 2. Dynamic scintigraphy (99mTc-EC) revealed normal function of the right kidney (55%), left double kidney had function of 83% in its upper pole and 17% in its lower pole.

Ryc. 2. Scyntygrafia dynamiczna nerek (99mTc-EC). Prawidłowa funkcja wydzielnicza prawej nerki (55%), zdwojenie układu kielichowo-miedniczkowego lewej nerki z udziałem górnego bieguna w oczyszczaniu – 83%, dolnego bieguna – 17%.

diagnosed. Patient received an alpha-blocker. At the age of 3 months patient was qualified for surgical intervention including left lower heminephroureterectomy. However, before final decision of surgery, computed tomography urography was performed to visualize precisely the anatomy of kidneys and urinary tracts. This imaging test revealed double kidneys, with the left kidney, which was 66 mm in diameter, and the right kidney 58 mm. In the right kidney, the dilatation of right ureter up to 6mm and dilatation of the lower part of collecting system (kidney pelvis dilated to 16 mm) were seen. In the left kidney with the cortex thickness of 2-3 mm, dilatation

of left ureter to 16mm and dilatation of the lower part of collecting system (pelvis 25 mm) were diagnosed (Fig. 3). At the age of 10 months blood pressure and kidney function tests were normal. Right kidney and upper part of the left kidney remain normal on follow-up ultrasonography.

## DISCUSSION

Introduction of prenatal ultrasonography at the end of the twentieth century allowed early diagnosis of congenital abnormalities of kidney and urinary tract (CAKUT)



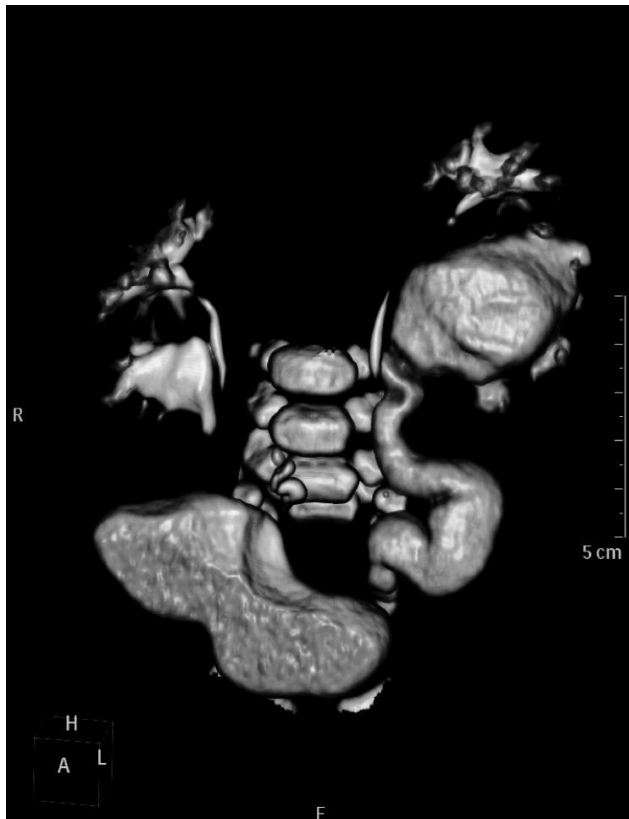


Fig. 3. Lower dose computed tomography urography. Double kidneys, bilateral hydronephrosis of the lower part of the collecting systems associated with high grade of vesicoureteral refluxes, narrow cortex of the left kidney.

Ryc. 3. Urografia tomografii komputerowej z obniżoną dawką promieniowania. Obustronne zdwojenie układów kielichowo-miedniczkowych, obustronne wodonercze dolnych układów związane z wysokimi odpływami pęcherzowo-moczowodowymi, zwężona kora lewej nerki.

(2). In children with normal prenatal ultrasonography, anomalies in the urinary tract are usually detected after urinary tract infection or by chance during routine ultrasonography. Dilatation of collecting system is one of the indications for voiding cystourethrography. If posterior urethral valves are suspected in a patient, then cystoscopy should be performed. Renal scintigraphy allows to check dysplastic changes in kidneys and help to decide which further diagnostic procedures are needed for a patient (10).

In our patient, complex abnormalities of the urinary tract were diagnosed first with prenatal and then with postnatal ultrasonography, voiding cystourethrography and scintigraphy. Voiding cystourethrography revealed bilateral, high grade vesicoureteral refluxes to the kidneys. There were difficulties in assessing reflux to the left kidney. Ultrasonography and renal scintigraphy suggested reflux to the left lower pyelocalyceal system, but the result of cystourethrography was inconclusive. Lower-dose computed tomography urography with iterative reconstruction

technique allowed to visualize abnormalities in the urinary tract: bilateral duplication of the kidney pyelocalyceal system, bilateral hydronephrosis of the lower pelvis, dilatation of ureters associated with high grade (IV/V) of vesicoureteral refluxes, and narrow cortex of the left kidney. Because of changes in dynamic scintigraphy the patient was qualified for surgical treatment left lower heminephroureterectomy.

According to the recommendation of the European Society of Pediatric Radiology, in children with congenital abnormalities in urinary tract, ultrasonography and MRI should be performed. These imaging techniques allow to limit imaging tests involving X-rays in children. However, MRI requires sedation and usually lasts significantly longer than CT. Lower-dose computed tomography urography with iterative reconstruction technique can be an alternative method in diagnosing abnormalities of the urinary tract. This new reconstruction algorithms, implemented in modern computed tomography scanners within last few years, allow 45% or even more dose reduction in comparison to standard algorithms (6, 7, 8, 9). Thus, radiation doses received in computed tomography urography are comparable or even lower than in conventional X-ray urography, with much better visualization of urinary tracts (11).

In our hospital, indications for computed tomography urography are as followed:

- 1) diagnosis of complex abnormalities of kidneys and urinary tract in case in which, it is not possible to assess the abnormalities with ultrasonography, voiding cystourethrography and scintigraphy, for example in a case of ectopic ureter,
- 2) after surgical intervention on the urinary tract,
- 3) in children after trauma to kidneys and/or urinary tract.

In fact, since 2011 at our centre, lower-dose computed tomography urography with iterative reconstruction technique has been one of the basic method of visualization of urinary tract in the Pediatric Radiology Department and replaced conventional X-ray urography (11).

## CONCLUSIONS

Computed tomography urography with iterative reconstruction techniques enables precise visualization of urinary tracts with reduced radiation dose. It replaces conventional X-ray urography because of much better visualization of urinary tracts with comparable or even lower radiation dose.

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