EVOLUTION OF INDIVIDUAL RENAL FUNCTION IN CHILDREN WITH UNILATERAL COMPLEX RENAL DUPLICATION

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Objective To assess the evolution of individual renal function during the maturation process in terms of single kidney glomerular filtration rate (SKGFR) and split function in children with unilateral complex renal duplication.

Study design We retrospectively reviewed the records of 44 children with unilateral complex duplex kidney. All affected kidneys had a poor or nonfunctioning dysplastic moiety, 28 in the upper pole and 16 in the lower pole. At least 2 radioisotopic examinations, including a 99mTc-mercaptoacetyltriglycine (99mTc-MAG3) renogram and a plasma clearance of 51Cr-ethylenediaminetetraacetic acid (Cr-51 EDTA), were performed in all children, the first one performed at a median age of 3 months (range 2 to 15 months) and the last one at 24 months (range 12 to 120 months). They allowed a precise estimation of split renal function, overall glomerular filtration rate (GFR), and SKGFR.

Results Mean overall kidney GFR increased significantly between the two measurements from 63 ± 12.7 mL/minute/1.73m^2 to 95 ± 21 mL/minute/1.73m^2 (P <.0001). SKGFR of the duplex side similarly increased from 26 ± 7.7 mL/minute/1.73m^2 to 38 ± 12.6 mL/minute/1.73m^2 (P <.0001). In terms of split function, the affected kidney had a remarkable stable function between the two measurements, 40% ± 8.6 and 39% ± 8.3 (P = .94), respectively. However, cases with the lowest initial split function (<30%) had the lowest initial SKGFR and the worst further evolution.

Conclusion In children with unilateral complex renal duplication, we found on the affected side a significant increase of SKGFR because of renal maturation, whereas mean split function remained stable during follow-up. *(J Pediatr 2005;147:208-12)*

Prenatal ultrasonongraphy (US) has resulted in increased detection of duplex systems.[1] We have shown, in a large and unselected population, that dilatations of the fetal urinary tract are associated with complex renal duplication in 4.7% of cases.[2] Actually, with the improving resolution of US equipment, it is possible to differentiate between the two collecting systems, particularly if one is dilated. It is even possible to differentiate between ectopic ureter and ureterocele.[3,4] This may lead to the discovery of more cases of fetal renal duplications amenable to neonatal management. The present article deals with the estimation of the renal function of this pathological duplex kidney. Split function evaluation is classically obtained from a radionuclide renogram and constitutes a robust and well-standardized measure. However, this only describes the *relative* function, the behavior of one kidney compared with the contralateral one. Symmetrical increase of renal function related to renal maturation is undetectable using this technique. Similarly, a drop of split function may be a result of either deterioration of unilateral function or contralateral compensation. The combined use of split renal function obtained by means of the renogram and the overall glomerular filtration rate (GFR), obtained by means of the 51Cr-ethylenediaminetetraacetic acid (Cr-51 EDTA) clearance, allows an accurate estimation of the unilateral absolute function in terms of single kidney GFR (SKGFR). In an attempt to clarify the functional behavior of the pathological duplex

Cr-51 EDTA	51Cr-ethylenediaminetetraacetic acid	US	Ultrasonography
99mTc-DTPA	99mTc-diethylene triamine pentaacetic acid	UTI	Urinary tract infection
GFR	Glomerular filtration rate	VCUG	Voiding cystourethrography
99mTc-MAG3	99mTc-mercaptoacetyltriglycine	VUR	Vesicoureteral reflux
SKGFR	Single kidney GFR		

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Table. Functional characteristics of the 44 children presenting unilateral complex duplex kidney during follow-up

	First measurement (median age 3 months)	Second measurement (median age 24 months)	*P* values
Mean overall GFR mL/min/1.73m^2	63 ± 12.7	95 ± 21	<.0001
Mean single GFR mL/min/1.73m^2 on the side of the duplex kidney	26 ± 7.7	38 ± 12.6	<.0001
Mean split function on the side of the duplex kidney	40% ± 8.6	39% ± 8.3	.94

kidney during the maturation process, we present our experience using this combined approach.

METHODS

Since 1990 we have maintained a registry of antenatally diagnosed urinary tract abnormalities, including renal duplications, in collaboration with colleagues in obstetrics, radiology, and urology. During the last 10 years, 44 consecutive newborns (30 girls) with unilateral severe complex duplex kidney were systematically followed in our department of pediatric uro-nephrology, using the same imaging protocol. Only infants with a poor or nonfunctioning dysplastic moiety were considered for this study.

All babies had serial postnatal US examinations of the urinary tract during follow-up. They also were screened with a voiding cystourethrography (VCUG). Vesicoureteral reflux (VUR) was graded by means of the International Reflux Study Committee classification.[5]

Radionuclide Studies

All children had at least two radioisotopic examinations during follow-up, the first one performed at a median age of 3 months (range 2 to 15 months) and the last one at a median age of 24 months (range 12 to 120 months). The median interval time between the two studies was 12 months (range 8 to 114 months). Between these two examinations, none of these complex duplex kidneys underwent any surgical procedure, apart from endoscopic incision in cases of ureterocele.

For the renograms, the patient was in supine position and placed above the gamma camera. 99mTc-mercaptoacetyltriglycine (99mTc-MAG3) was administered intravenously at a maximal dose of 100 MBq, scaled on a body surface basis.[6] A 20-minute renogram acquisition was obtained, using 20-second frames. The renal curves were corrected for background using a perirenal area. Split renal function was determined on the basis of the 1- to 2-minute cumulative corrected renal activity, the sum of left and right split function being equal to 100%. The usual range of normality for split function is considered to be between 45% and 55%.[7] We considered a 5% change in split function as significant.[7] For the evaluation of overall kidney GFR, Cr-51 EDTA was injected, together with 99mTc-MAG3, at a maximal dose of 3.7 MBq adapted to the body surface.[6] GFR was determined using a blood sample taken 120 minutes after tracer injection.[8] Values, expressed in milliliters per minute, were corrected for body surface. Normal values in function of age have been published previously.[9] A 10 mL/minute/1.73 m^2 change in GFR was considered as significant.[9] SKGFR was obtained by combining the split function obtained from the MAG3 renogram and the overall Cr-EDTA clearance, and was expressed in mL/minute/1.73 m^2. Although the cutoff is probably slightly exaggerated, a similar 10mL/minute/1.73 m^2 change in SKGFR was considered as significant.

Statistics

Differences between paired samples were determined using Wilcoxon's signed rank test. A two-sided *P* value of <.05 was considered statistically significant. The difference between the first and the last measurement was calculated for each duplex kidney. For example, if the kidney uptakes were 48% and 45%, respectively, for first and last measurements, then the difference was noted as 3%. The mean and the standard deviation of these individual differences estimate the systematic bias between the two measurements, whereas the standard deviation of these differences represented the variability between the two successive tests.[10]

RESULTS

Anomalies Detected

On US scans, all dysplastic moieties showed severe thinning and/or high-grade hydronephrosis. On 99mTc-MAG3 sequential images, poor or absent uptake in the dysplastic moiety was seen on the early 1- to 2-minute image in 16 lower poles and in 28 upper poles.

Clinical Evolution and Treatment

High-grade VUR associated with nonfunctioning lower-pole segment. Sixteen infants (37%) had high-grade (IV-V) reflux into a lower pole on routine neonatal VCUG. These infants were initially managed by medical surveillance and antibiotic prophylaxis. At 2 years of age, reflux ceased spontaneously or decreased in severity in five patients. Three patients underwent lower-pole heminephrectomy for repeated episodes of urosepsis. The other 13 children are still managed non-operatively, and none of them developed symptoms during follow-up.

Ureterocele associated with a nonfunctioning upper-pole segment. In 16 infants (37%), poor function and