

Functional evaluation of the congenital hydronephrosis using DCE-MR urography: A Comparison with technetium-99m-MAG3

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Introduction: Hydronephrosis is the most common indication for MR urography in infants and children. Recently, the incidence of fetal hydronephrosis has been significantly increased as a result of fetal ultrasound screening. Therefore, there is controversy concerning the postnatal investigation and management of these children. Differential renal function (DRF) is an important tool to determine the need for surgical intervention. The dynamic renal scintigraphy (99mTc-DTPA or MAG3) helps to diagnose renal function or to rule out obstructive uropathy. MAG3 provides superior diagnostic images for small children, because the renal uptake of tracer is better than DTPA. MR urography can define the anatomy more clearly without using ionizing radiation (Fig.1). Furthermore, DRF is calculated on the basis of enhancing renal volume (vDRF) and the Patlak number (pDRF). In the past reports, vDRF is shown to be similar to values obtained with DMSA. And pDRF is closer to the DRF measured with DTPA. There are few recent reports comparing MR urography and MAG3 results.

Purpose: To evaluate the usefulness of DRF dynamic contrast-enhanced MR urography (DCE-MRU) in comparison to MAG3.

Materials and Methods: From December 2011 to October 2012, 7 children (5 boys and 2 girls, a mean age of 8 years) with hydronephrosis underwent DCE-MRU. DCE-MRU was obtained using a 1.5T scanner (Magnetom Aera, Siemens, Erlangen, Germany). The MRI scan protocol included T2-weighted morphological imaging as well as a dynamic contrast enhanced measurement. For DCE-MRU a 3D-FLASH sequence in the coronal plane was used. The dynamic data was acquired for 20 minutes after intravenous injection of Gd-DTPA. The dose of Gd-DTPA of 0.2mmol/kg and the injection of Gd-DTPA took 20 seconds followed by saline solution (approximately 20cc) with same rate. Furosemide (1mg/kg to a maximum dose of 20mg) was given 20 minutes prior to administration of the contrast medium. After DCE-MRU, the excretory phase of MRU was acquired. Both vDRF and pDRF were analyzed using the demonstrator software of Patlak-Rutland plot technique released by Siemens (Fig. 3). Numbers of patients underwent MAG3 and DMSA were 7 and 5 respectively. And we reviewed the DRF by comparing vDRF to DRF of DMSA and pDRF and the split renal function of MAG3.

Results: Of 7 children, 6 had hydronephrosis with pelvoureteric junction stenosis and 1 had mild calyceal dilatation of the left kidney. As the result of DCE-MRU, vDRF was similar to the DRF of DMSA in all 5 children. In 5 of 7 children, pDRF was similar to the split renal function of MAG3. There was a discrepancy of the remaining 2 children (Table 1). **Discussion:** The biodistribution of Gd-DTPA is determined by DTPA macromolecule. The dynamics of DTPA is mostly dependent on glomerular filtration. There is little tubular absorption or excretion. On the other hand, MAG3 is rapidly cleared by tubular secretion. In the present study, pDRF was similar to the split renal function of MAG3 except for 2 cases. While the cause of the discrepancy is unknown, it may be considered that: 1) The contrast excretion into the collecting system was not visualized during the dynamic study, because of the severe hydronephrosis in the affected kidney. 2) The technical errors of the contrast study resulted in poor enhancement of renal cortex. However, pDRF is well correlated with MAG3 as well as DTPA. In the present study, vDRF was correlated to DRF of DMSA. Our result is in agreement with previous reports.

Conclusion: DCE-MRU is a powerful diagnostic tool that provides both anatomic and functional assessment without ionizing radiation. Moreover, the DRF of DCE-MRU provided similar results as DMSA and MAG3. Therefore, it is considered that DCE-MRU is the best examination in the evaluation of renal tract disorders in children.

References:

- 1] Grattan-Smith JD, et al., *Pediatr Radiol* 2006 (36): 1119-1132
- 2] Grattan-Smith JD, et al., *Pediatr Radiol* 2008 (38): S49-S69
- 3] Jones RA, et al., *Pediatr Radiol* 2008 (38): S18-S27
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Table 1. Summary of renal scintigraphy and DCE-MRU in children with hydronephrosis

Case no.		1	2	3	4	5	6	7
Sex		Boy	Girl	Girl	Boy	Boy	Boy	Boy
Age		3 months	11 years	14 years	13 years	2 years	11 years	8 years
Affected side		Lt	Lt	Lt	Lt	Lt	Bilateral	Lt
Degree of SFU		3	4	2	0	4	Lt 3 Rt 4	3
DRF(%)	DMSA Lt/Rt	57/43	27/73	49/51	41/59	58/42	Not obtained	Not obtained
	MAG3 Lt/Rt	50/50	27/73	49/51	42/58	56/44	65/35	50/50
Renogram		Obst.	Obst.	Non-obst.	Normal	Obst.	Rt. obst. Lt. normal	Obst.
DCE-MRU	vDRF Lt/Rt	57/43	27/73	49/51	47/53	65/35	47/53	48/52
	pDRF Lt/Rt	65/36	25/75	43/57	42/58	64/37	69/31	15/85
	CTT(min) Lt/Rt	0.45/0.45	1.06/0.63	0.28/0.42	0.2/0.2	0.41/0.41	0.41/0.61	0.59/0.59

LT, left side, Rt, right side, SFU: The Society of Fetal Urology grading system Obst, obstructive

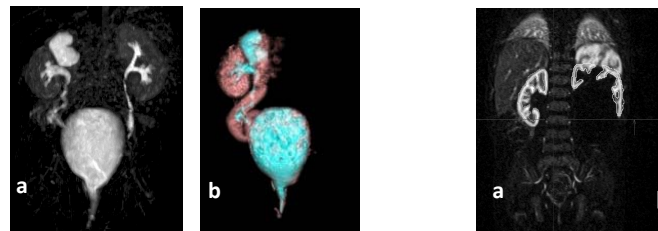


Fig.1. Right double collecting system Contrast MRU (a) and 3D image combined SPACE and contrast MRU (b)

Fig. 2a. Left hydronephrosis Renal cortical enhancement of DCE-MRU.

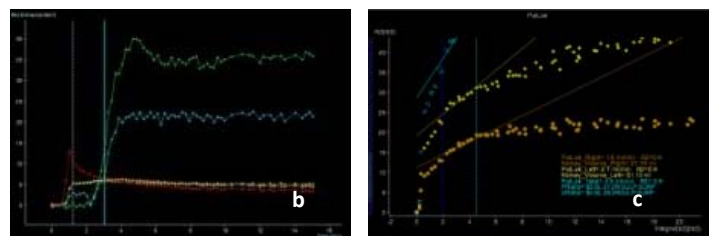


Fig. 2b. Time intensity curves of excretion, 2c. Patlak curves