

MR Voiding Cystourethrography (MRVC) for Vesicoureteric Reflux in unседated infants

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Introduction

Vesico-ureteric reflux (VUR) is a congenital disorder of the paediatric renal tract, which allows the retrograde passage of urine up to the renal pelvis, predisposing to renal infection and consequential scarring, hypertension and renal failure. The current gold standard for diagnosis is the Micturating Cystourethrogram (MCUG), allowing snap-shot imaging of the urethra, bladder and ureters during micturition using X-ray fluoroscopy. This is widely used despite the small induced malignancy risk of ionizing radiation exposure. Several recent studies have tried to establish an MRI equivalent of the MCUG, but the techniques employed thus far have required intravenous (IV) or oral sedation, IV fluids, IV diuretics or gadolinium, or a custom built magnet and coils [1-4]. The aim of this study was to evaluate the feasibility of performing MRVC using only intravesical dilute gadolinium in un-sedated infants with rapid interactive image acquisition on a conventional closed bore magnet.

Methods

Full ethical committee approval and parental consent were obtained. *X-ray protocol:* X-ray fluoroscopy examinations were performed on a multipurpose C-arm fluoroscopic imaging system using a CCD-based image intensifier (Precision™ MPI; GE Healthcare, Waukesha, WI). Imaging parameters were: kV 75 / 85, tube current 100 / 160 mA. Contrast medium was Urografin 150 (Bayer) given via a urethral catheter. *MRI protocol:* All patients were examined freely breathing in the supine position on a 1.5T whole-body MR system (Signa HDx; GE Healthcare) and a quadrature head or knee coil. Initial axial and coronal T2w FIESTA and SSFSE imaging was used to look for dilatation of the renal tract or any congenital anomaly. MR fluoroscopy was performed using an in-house developed real-time sequence that allowed real-time switching between interactive gradient echo (GRE/SPGR/FIESTA) and single shot fast spin echo (SSFSE) based pulse sequences within a proprietary real-time imaging interface (i/Drive Pro Plus) [5]. The sequence supports real-time interactive control over slice prescription, field-of-view, slice thickness, flip angle, repetition time (TR), fat saturation and phase encode reordering for proton density and T2 weighting (for thick slab projection SSFSE). Contrast medium was 0.5% dilute gadolinium (Gadovist, Bayer) given via a urethral catheter. An in-room communication system was used to co-ordinate the examination (Silent Scan 3000 Series Audio System, MagMedix, Inc., Fitchburg, MA). Using a combination of interactive GRE and SSFSE imaging the bladder and urethra were observed during both filling and voiding. Sagittal interactive SPGR at approximately 1 Hz was used for observing the urethra and a combination of planes and sequences were used for evaluating VUR. Conventional T1w axial and coronal images of the renal tract were also obtained pre- and post-intravesical gadolinium. The whole examination was evaluated for posterior urethral valves and evidence of VUR, graded according to the International Classification System (Figure 2) [6].

Results

6 children (mean age 1.5 months, range 0 - 4 months; 5 males) with urinary tract abnormalities diagnosed on early postnatal ultrasound underwent conventional MCUG, followed by MRVC within 3 hours. Both X-ray and MR procedures were successfully performed in all subjects, with no complications. Clinical symptoms and results are summarised in table 1. No cases of posterior urethral valves were detected and there was complete agreement between the two methods for urethral (Figure 1) and bladder assessment (table 1). Every case of reflux identified with MCUG was identified on MRI (100% sensitivity; example given in figure 3). Over 12 renal units, there was 83% concordance (10/12) according to the severity of reflux between the two methods (table 1). One patient had bilateral grade 2 reflux identified following the second of two dilatations of the bladder using gadolinium, which was not detected by single bladder infusion at MCUG. In two cases, MR appearances gave additional information above that of the MCUG: in both cases, MRI suggested a duplex system which was later confirmed on USS.

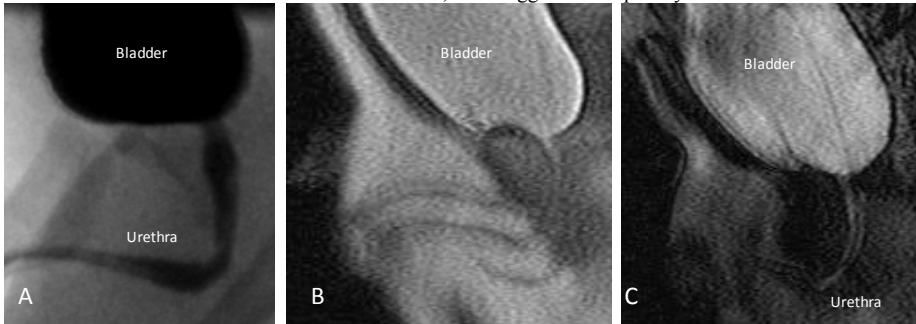


Figure 1: (A) Sagittal imaging of the urethra on voiding on MCUG, (B) using T2 weighted SSFSE, and (C) T1 weighted SPGR sequences

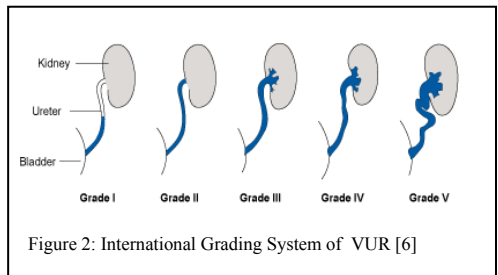


Figure 2: International Grading System of VUR [6]

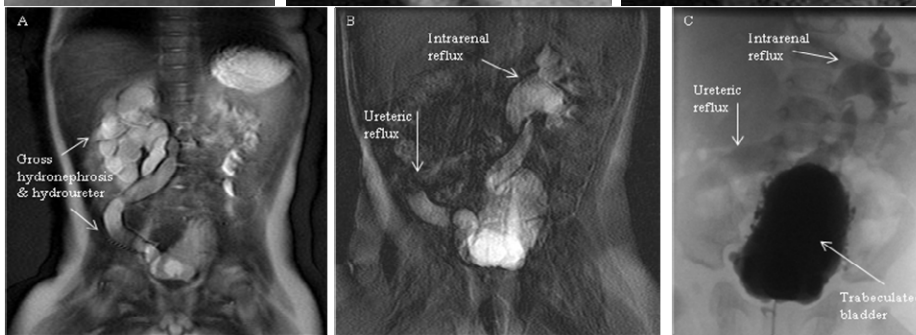


Figure 3: (A) Coronal imaging of the renal tracts post-micturition using T2w iSSFSE, (B) T1w SPGR and (C) MCUG, showing bilateral high grade vesico-ureteric reflux in dilated ureters (case 6).

Conclusion

This study demonstrated the feasibility of MRVC in un-sedated infants: MR fluoroscopic assessment of the complete renal tract for VUR appears possible using dilute intravesical gadolinium. Further comprehensive assessment is underway to evaluate the technical and diagnostic performance of this approach.

References

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Case	Referral	MCUG		MRI		MR	MR
		L / R	L / R	Bladder	Bladder		
1	UTI	0 / 0	0 / 0	Normal	Normal	-	-
2	UTI	0 / 0	0 / 0	Normal	Normal	-	-
3	Hydronephrosis	0 / 0	2 / 2	Normal	Normal	-	-
4	Hydronephrosis	4 / 3	4 / 4	Thick	Thick	-	-
5	Hydronephrosis	0 / 0	0 / 0	Ureterocele	Ureterocele	-	Unilateral duplex
6	Hydronephrosis Unilateral duplex	5 / 4	5 / 5	Thick	Thick	-	Bilateral duplex

Table 1: Results of 6 cases. UTI = Urinary Tract Infection. Thick =Thick walled bladder.