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Magnetic resonance urography for diagnosis of pediatric ureteral stricture

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Abstract *Purpose:* Ureteral stricture is a rare cause of hydronephrosis in children and is often misdiagnosed on ultrasound (US) and diuretic renal scintigraphy (DRS), requiring intraoperative diagnosis. We evaluated ureteral strictures diagnosed by magnetic resonance urography (MRU) at our institution.
Materials and methods: Children with ureteral stricture who underwent MRU were identified. Patient demographics, prior imaging, MRU findings, and management were assessed. The efficacy of MRU in diagnosis of stricture was compared with US and DRS. Patients with ureteropelvic or ureterovesical junction obstruction were excluded.
Results: Twenty-eight ureteral strictures diagnosed by MRU between 2003 and 2013 were identified; 22% of strictures were diagnosed by DRS ± US. The mean age at MRU diagnosis was 2.4 years (range 4 weeks—15 years). Hydronephrosis was the most common presentation, accounting for 20 (71%) cases. Other etiologies included pain (3), incontinence (2), and urinary tract infection, cystic kidney, and absent kidney, present in one case each. A mean of 2.7 imaging studies was obtained prior to MRU diagnosis. Twenty-one (75%) ureteral strictures required surgical intervention, with the approach dependent upon location.
Conclusions: MRU provides excellent anatomic and functional detail of the collecting system, leading to accurate diagnosis and management of ureteral stricture in children.

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Introduction

Urinary tract abnormalities are a frequent finding on prenatal ultrasonography, with hydronephrosis reported in approximately 1–5% of all pregnancies [1–3]. A minority of prenatally detected hydronephrosis cases result in clinically significant obstruction, and an individualized postnatal imaging approach is recommended based on severity of hydronephrosis, laterality and associated anomalies [4]. While upper urinary tract obstruction occurs most often at the ureteropelvic (UPJ) or ureterovesical junction (UVJ), true ureteral stricture is a rare cause of hydronephrosis in children, found in just 4% of pediatric autopsy studies [5–9].

Renal bladder ultrasound (RBUS). Ultrasound (US) is defined in the abstract, so from this point on either abbreviation (US or RBUS) should be able to be used. Ultrasound (US) is the most common imaging modality for monitoring hydronephrosis in the pediatric population. US provides anatomic detail in the absence of radiation, but is a poor independent predictor of which children will require surgical intervention [10]. A voiding cystourethrogram (VCUG) is performed to evaluate the lower urinary tract and determine the presence of vesicoureteral reflux, while renal scintigraphy is an adjunct test that estimates differential renal function and the severity of obstruction. Ureteral strictures are often misdiagnosed as UPJ or UVJ obstruction with these modalities [11]. Magnetic resonance urography (MRU) has the unique advantage of providing both functional and anatomic details of the urinary tract, and is utilized at our institution when the degree or location of ureteral obstruction is in question [12,13]. We report a series of pediatric ureteral strictures detected via MRU with the objective of determining whether MRU is superior to US and renal scintigraphy in the diagnosis of ureteral strictures.

Materials and methods

Upon receiving institutional review board approval, we reviewed the medical charts of all pediatric patients who had been diagnosed with ureteral stricture on MRU over a 10-year period between January 1, 2003, and April 30, 2013. Patients with UPJ or UVJ obstruction were excluded from study. Strictures located between these two anatomic locations have been traditionally classified as "mid-ureteric strictures" in the literature. The precise location of such strictures was determined by MRU in our series. MRU was performed under sedation in accordance with previously published protocols [13,14]. Standard anatomic and functional parameters were assessed using both T2 weighted and delayed post-contrast images [14]. Patient demographics, prior imaging, MRU findings, and management of stricture, including surgical approach, were abstracted. Anatomical, functional, and drainage data derived from MRU were compared with scintigraphy and US findings. Statistical analysis was performed using SAS 9.2, with $p < 0.05$ representing statistical significance.

Results

Demographics

Twenty-six children, 15 boys and 11 girls, with 28 ureteral strictures diagnosed on MRU between 2003 and 2013 were identified. Of the 28 strictures diagnosed, MRU identified 16 strictures (62%) on the right, eight (31%) on the left, and two patients (7%) had bilateral ureteral strictures. The mean age at the time of diagnosis by MRU was 2.4 years (range 4 weeks–15 years). Sixty-eight percent of strictures were diagnosed within the first year of life. Hydronephrosis was the most common presentation, accounting for 20 (71%) cases. Ninety-five percent (19/20) of hydronephrosis cases were detected on US antenatally. Other presentations included pain in three, incontinence in two, urinary tract infection, cystic kidney, and absent kidney each in one case. Children with hydronephrosis were diagnosed with stricture at a significantly younger age (0.78 ± 1.18 years) than those with other presentations (5.64 ± 5.57 years, t test $p < 0.05$).

Radiographic imaging

Patients underwent a mean of 2.7 imaging studies prior to receiving a definitive diagnosis of ureteral stricture by MRU. All children required anesthesia for MRU; no immediate complications were reported. All but one patient (96%), who presented with pain, underwent ultrasonography. Eighty-one percent (21/26) underwent a VCUG and 35% (9/26) underwent renal scintigraphy. Hydroureteronephrosis was diagnosed on all MRUs. Hydronephrosis was accurately detected in 97% of patients with US ± renal scan; however, less than half of all patients (42%) had a diagnosis of hydroureter after US ± renal scan compared with all patients on MRU (χ^2 test, $p < 0.0001$). Obstruction was detected on 56% of renal scans, compared with 73% of MRUs which did not represent a statistically significant difference. Ureteral stricture was diagnosed on only 22% (2 of 9) of DRS, compared with 100% of MRUs (χ^2 test, $p < 0.0001$). Anatomic and functional data obtained from various imaging studies are presented in Table 1. On DRS, $t_{1/2}$ was

Table 1 Anatomical, functional and drainage data from imaging studies.

	MRU	DRS	RBUS	RBUS + DRS
Number of studies	30	14	34	48
Hydronephrosis (percentage diagnosed)	100	79	97	97
Hydroureter (percentage diagnosed)	100	36	32	42
Renal transit time (min), mean (range)	9.7 (3.5–15)			
$t_{1/2\ (min)}$, mean (range)		19.9 (5–30)		
Differential renal function, mean (range)	49 (0–100)	57 (24–100)		
Obstruction	73	56		56
Ureteral stricture	100	22	0	22

Note. DRS = diuretic renal scintigraphy; MRU = magnetic resonance urography; RBUS.