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The sonographically thickened wall of the upper urinary tract system: correlation with other imaging methods

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Abstract *Background.* Sonographically detected, upper urinary tract wall thickening (UUTWT) was reported to occur in urinary tract infection, urinary tract stone disease, rejection after renal transplantation and vesico-ureteral reflux (VUR). A possible association with obstruction can be hypothesized.
Objective. The assessment of a potential relationship of UUTWT with VUR or obstruction in patients without one of the above-mentioned conditions.
Materials and methods. We analyzed 38 patients (74 upper urinary tracts) with at least unilateral UUTWT and concomitant imaging studies such as voiding cystourethrography (VCU), intravenous urography (IVU) and diuretic renography (DR).
Results. At sonography 49 urinary tracts showed UUTWT. In 33, ipsilateral VUR could be demonstrated at VCU, 11 revealed obstruction at IVU and/or DR, and 4 showed non-obstructive pelvicalyceal dilatation at IVU and DR. In one patient, all imaging studies were normal. The positive predictive value of UUTWT for the presence of VUR was 67.4% and for obstruction it was 22.5%. Altogether, UUTWT indicated pathology in 98% of urinary tracts.
Conclusion. After exclusion of urinary tract infection, urinary stone disease and prior renal transplantation, the most common associated findings in UUTWT are VUR and obstruction. Therefore, VCU seems to be justified in all cases of UUTWT. Nonrefluxing systems should be further evaluated with DR and/or IVU for exclusion of obstruction.

Introduction

Modern ultrasound equipment allows visualization of patho-anatomic details and findings, which could not be demonstrated until recently. One of these sonographic findings is upper urinary tract wall thickening (UUTWT), which is reported to occur in various diseases including urinary tract infection, urinary tract stone disease, and rejection after renal transplantation [1–3]. UUTWT could also reflect muscular hypertrophy due to volume overload in patients suffering from vesico-ureteral reflux (VUR) [4, 5]. In our experience UUTWT is also associated with obstruction. To the best of our knowledge, there are no systematically collected data published on the relationship of UUTWT with VUR or obstruction. Moreover, there is no agreement regarding diagnostic and therapeutic implications in patients with incidentally detected UUTWT.

The purpose of this report was to assess a potential relationship of UUTWT with VUR or obstruction on a retrospective basis by comparing the sonographic results with findings of voiding cystourethrography (VCU), intravenous urography (IVU) and diuretic renography (DR).

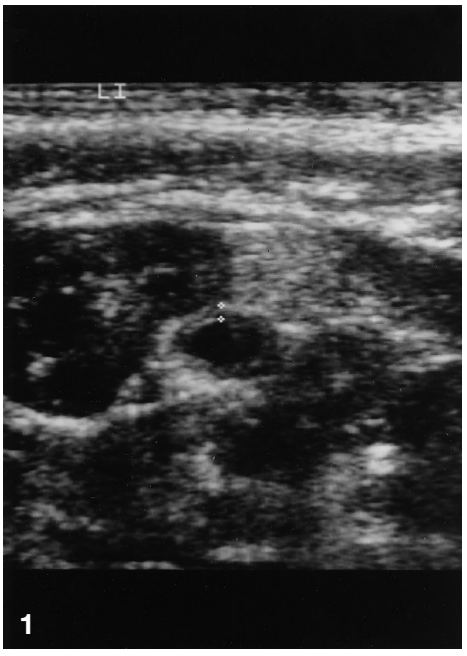
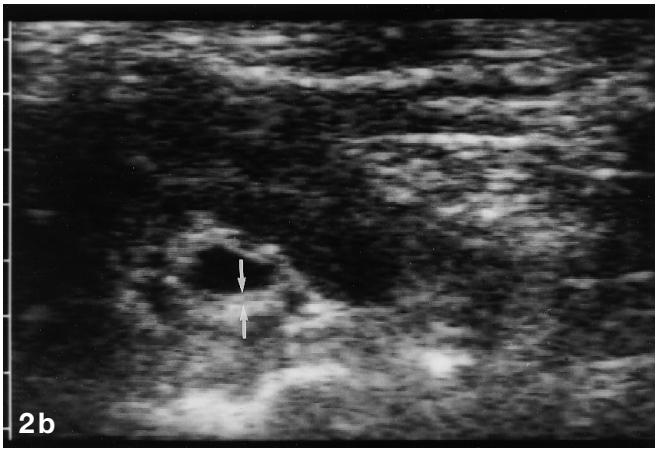


Fig. 1 Ultrasound with patient in prone position: left kidney, transverse plane. UUTWT of renal pelvis wall (wall thickness marked by *asterisks*). VCU revealed VUR grade V on the left side

Fig. 2 a, b Patient with bilateral UUTWT and bilateral VUR. **a** VCU demonstrating VUR grade III on both sides and reflux nephropathy of the right kidney. **b** Ultrasound with patient in prone position: left kidney, transverse scan. Thickened wall of the renal pelvis *(arrows)*



Materials and methods

Inclusion criteria for the study group were presence of UUTWT unilaterally or bilaterally. Only patients with concomitant imaging studies of VCU, IVU and/or DR were analyzed. The time interval between imaging studies was no more than 2 weeks. Exclusion criteria were acute urinary tract infection, urinary tract stone disease and prior renal transplantation.

The study group included 49 urinary systems with UUTWT (27 unilateral, 11 bilateral) in 38 children (21 boys, 17 girls), between ages 4 days to 12.8 years (mean 3.13 years). In patients with unilateral UUTWT, contralateral systems were used as a control group. Altogether, 74 upper urinary tracts were available for analysis, since in two children unilateral nephrectomy had been performed because of nonfunctioning kidneys due to reflux nephropathy.

All ultrasound studies were performed with the same equipment (Acuson 128XP10, Mountain View, Calif.) using 3.5–7 MHz sector and linear transducers. At sonography, the finding of a hypoechoic rim within the wall of the renal pelvis or ureter together with an increased mucosal echogenicity indicated UUTWT [2]. No measurements of the actual thickness were performed, since sonographic estimation of a distance within the submillimeter range cannot be done reliably.

VCU was performed using a technique modified from the literature [6]. Classification of VUR followed the international reflux classification system [7]. If a contrast medium – urine level within a refluxing ureter could be demonstrated in an upright position, this system was regarded as nongradable VUR. The indications for VCU were recurrent urinary tract infection or follow-up studies of known VUR.

IVU was performed in a standardized manner [8]. Indications for IVU were assessment of morphology, function and drainage of kidney, ureter and urinary bladder. Delayed opacification of the pelvicalyceal system, crescent-like opacification at the edge of dilated calyces on early films, a persistent dense nephrogram and/or the persistence of a contrast material column in a dilated urinary tract system indicated obstruction [9]. Dilated calyceal systems with spontaneous emptying, unimpaired ipsilateral renal function and no contralateral compensatory hypertrophy were considered unobstructed [10]. The diagnosis of primary obstructive megaureters was made by IVU with indwelling bladder catheter or postmicturation films.

DR technique and interpretation followed published guidelines [11–13]. The indications for DR were the assessment of kidney function, renal scars and upper urinary tract drainage. All children were hydrated adequately before DR with 99_mTc-mercapto-acetyl-triglycine (MAG3; Mallinckrodt Medical, Petten, Holland).

All 38 patients underwent VCU, but only 16 were studied with IVU and DR. In 14 patients, only IVU was done and in 8 only DR was performed. Statistical analysis was calculated using the computer program Statistical Analysis System (SAS Institute, Cary, N.C.).

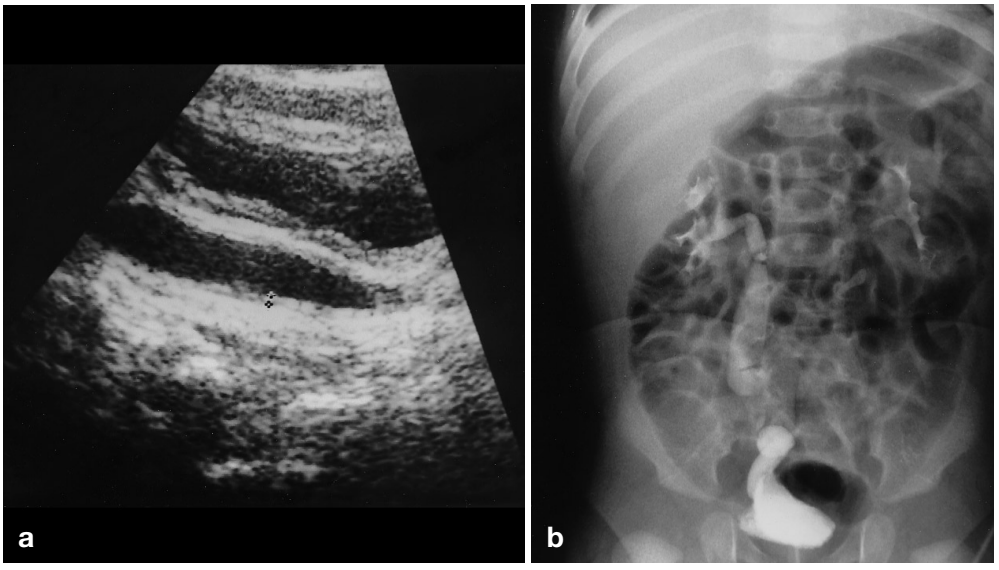


Fig. 3 **a** Ultrasound: right parasagittal plane of the pelvis. Severe thickened pelvic ureter (wall thickness marked by asterisks). **b** IVU revealed primary obstructive megaureter **b** without progress of obstruction at follow-up

Table 1 Systems with upper urinary tract wall thickening ($n = 49$)

Diagnosis	*n*
VUR	33
Uretero-pelvic junction obstruction	4
Primary obstructive megaureter	4
Primary obstructive megaureter without progress at follow-up	3
Nonobstructive hydronephrosis	4
All other studies normal	1
Total	49

Table 2 Systems without upper urinary tract wall thickening ($n = 25$)

Diagnosis	*n*
VUR	9
All studies normal	16
Total	25

Results

UUTWT (Figs. 1–3) was detected in 49 systems – unilateral in 27 cases and bilateral in 11. In 33 of the 49 systems with UUTWT, an ipsilateral VUR (1 grade I, 13 grade III, 6 grade IV, 10 grade V, 3 nongradable) could be demonstrated at VCU. The remaining 16 systems with UUTWT revealed no VUR at VCU. In eight of them, the diagnosis of obstruction could be made at IVU and/or DR. Three showed primary obstructive megaureters without progress at follow-up; four showed nonobstructive pelvicalyceal dilatations at IVU and DR; and only one system revealed normal findings at all other imaging studies (Table 1).

The control group included 25 contralateral upper urinary tracts without UUTWT. In 16 of those 25 urinary tracts, all concomitant studies were normal; 9 demonstrated VUR (two grade I, three grade II, four grade III) at VCU (Table 2). No urinary system showed the combination of VUR and obstruction.

The positive predictive value of UUTWT for the presence of VUR was 67.4%; sensitivity was 62%. For obstruction, the positive predictive value was 22.5% and sensitivity was 20.8%. Altogether, the presence of UUTWT indicated pathology in 48/49 (98%) of the urinary tracts. In 16 of 42 (38%) of the refluxing systems in this study group, UUTWT was the only finding suspicious for VUR. The remaining refluxing systems showed complications of VUR such as scars and clubbing.

Discussion

UUTWT has been regarded as a nonspecific sign associated with a variety of diseases [1–3]. One reason is that previous reports have focused on patients suffering from different diseases. The main objective of this report was the assessment of a potential relationship between UUTWT and VUR or obstruction and to determine whether this sonographic finding could be a normal variant. For that purpose, patients with acute urinary tract infection, urinary tract stone disease and prior renal transplantation were excluded.

Since it was mentioned that volume overload in VUR could lead to UUTWT, the potential relationship of UUTWT to VUR was of particular interest [4, 5]. UUTWT in that instance could be the sonographic equivalent of striated ureters seen at IVU in patients

with high-grade VUR [14]. In fact, VUR could be detected in 67.4% of systems with UUTWT. Therefore, in a patient with UUTWT, VCU seems be the next logical diagnostic step.

In more than one-third of refluxing systems, UUTWT was the only indicator of VUR. This compares favorably with figures published by Zerin et al. [15], who found normal kidneys on sonography in 25% of patients with VUR. Therefore, in cases of UUTWT as a single, incidental finding, VCU can be performed with an increased level of suspicion of the presence of VUR. The identification of VUR in an asymptomatic child with normal kidneys offers the chance to protect those kidneys from reflux nephropathy [11], which is one of the five leading causes of renal transplantation in children [16]. Initiation of antibiotic prophylaxis is recommended [17, 18].

Although kidney ultrasound is very sensitive for the detection of calyceal dilatation, distinction between obstructive and nonobstructive states cannot be made by gray scale ultrasound findings alone [19–22]. Of the 16 nonrefluxing systems with UUTWT, 11 demonstrated obstruction or impaired drainage at IVU and/or DR. One explanation for UUTWT in this condition could be hyperperistalsis, which occurs at certain stages of obstructive uropathy. Four cases of pelvicalyceal dilatation with UUTWT could be proved as nonobstructive by DR and IVU. Therefore after exclusion of VUR, UUTWT has to be further evaluated for obstruction by DR and IVU.

The case of UUTWT with normal findings after all other imaging studies occurred in a 6-month-old baby boy. In this case, and the four former cases of nonobstructive dilatation, the finding of UUTWT could be explained as a consequence of spontaneous resolution of VUR and obstruction respectively [15, 23, 24]. Our results seem to indicate that UUTWT is not a normal variant.

In conclusion, UUTWT is a polyetiological ultrasound finding. After exclusion of urinary tract infection, urinary stone disease and prior renal transplantation, UUTWT indicates VUR in 67.4% of upper urinary tracts and obstruction in 22.5%. Altogether in 98% of upper urinary tracts, pathology can be demonstrated at concomitant imaging studies. Therefore, VCU seems to be justified in all those cases. Nonrefluxing systems should be further evaluated with DR and/or IVU for exclusion of obstruction.

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