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What is a representative voiding pattern in children with lower urinary tract symptoms? Lack of consistent findings in ambulatory and conventional urodynamic tests

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Summary

Background
Conventional urodynamics (CU) is a highly standardized evaluation of lower urinary tract function. However, in pediatric patients there is concern that the reliability of measurements could be influenced by development effects and measurement variability, as well as by the unfamiliar clinical environment. Ambulatory urodynamics (AU) provides an alternative to this — it uses natural filling, is measured over a prolonged period, and is conducted in a child-friendly environment.

Objective
The aim of this study was to conduct a comparative analysis of AU and CU to evaluate the consistency in voiding patterns obtained with these two methods of urodynamic testing.

Study design
Urodynamic parameters obtained by AU and CU methods in 50 pediatric patients aged >5 years were retrospectively analyzed. Voiding patterns were categorized into six types: coordinated contraction, detrusor after-contraction, fluctuated contraction, pre-void contraction, relief voiding, and weak or absent contraction. Voiding patterns were used to determine the repeatability within urodynamic tests and to identify consistency between AU and CU tests. Five urodynamic parameters were quantified and compared between AU and CU: voided volume, flow rate, maximum detrusor pressure, and detrusor pressure at peak flow rate. For inter-observer variation analysis, 100 voiding curves were randomly selected and categorized by two independent observers; inter-observer agreement was evaluated using the kappa statistic.

Results
A single pattern of voiding was identified in five patients using AU and 37 using CU. Consistency of a single pattern between AU and CU was identified in three patients, and consistency between a predominant pattern with AU, defined by one type of voiding occurring >50% of one's voids, and a single pattern with CU was identified in 10 patients (summary table). Flow rates were similar between methods; however, higher maximum detrusor pressure and detrusor pressure at peak flow and lower voided volume were recorded with AU.

Discussion
AU resulted in more diverse voiding patterns. Along with the differences in measured urodynamic parameters challenges the application of findings from one method to form a clinical diagnosis. Furthermore, CU may not be as sensitive as AU to the variability in lower urinary tract pathophysiology.

Conclusions
More diverse voiding patterns were identified in AU compared with CU, with a lack of consistency in identified voiding pattern in both methods. Therefore, the urodynamic findings in children may have to be analyzed in more detail, taking the variations into account.

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Summary table Voiding patterns identified by ambulatory and conventional urodynamic methods, and consistency between the two methods.

	Number of voids		Repeatability of voiding pattern (number of patients)			Consistency between AU and CU (number of patients)	
	CU	AU	SP in CU	SP in AU	PP in AU	SP in CU—SP in AU	SP in CU—PP in AU
Type 1	1	21	0	0	1	0	0
Type 2	18	73	8	2	6	1	1
Type 3	55	170	19	2	16	1	7
Type 4	0	4	0	0	0	0	0
Type 5	25	54	8	1	2	1	2
Type 6	4	23	2	0	1	0	0
N	103	345	37	5	26	3	10

AU, ambulatory urodynamics; CU, conventional urodynamics; PP, predominant pattern; SP, single pattern; Type 1, coordinated voiding; Type 2, voiding with detrusor after-contraction; Type 3, voiding with fluctuating detrusor pressure and urine flow; Type 4, pre-void contraction; Type 5, terminal detrusor over-activity leading to relief voiding; Type 6, absence of detrusor contraction during voiding.

Introduction

Conventional urodynamics (CU) is intended to be a highly standardized evaluation of lower urinary tract (LUT) function. By filling the bladder with either normal saline or contrast media, the parameters of LUT function, in both filling and voiding phases, can be evaluated. Schäfer et al. [1] recommended that one CU test is sufficient when the urodynamic findings correlate with the patient's symptoms, with repeated testing when urodynamic findings lead to invasive treatment. However, CU testing has poor test-retest reliability, with up to 15% variability [2], which constrains interpretation and categorization of CU findings. This problem becomes a significant issue in pediatrics, due to the naturally high variability related to development, which makes it difficult to differentiate impaired LUT function from the effects of normal development. Therefore, the findings from one CU study may not correlate well with the patients' complaints, and at least two CU tests are recommended in pediatrics [3]. However, short-term CU tests completed within 20—40 min may have poor sensitivity or even yield incorrect results, as they may not be representative of typical daily conditions.

Ambulatory urodynamics (AU), using natural filling and recording of multiple cycles, may reveal more patient-relevant findings [4—6]. The time required for AU and the related expense of prolonged monitoring are factors that are against its clinical use. It is currently unknown whether consistent results can be obtained from AU to form a urodynamic diagnosis. Furthermore, whether a consistent result from two or more cycles of CU is representative of LUT function also needs clarification. Therefore, the aim of the present study was to conduct a comparative analysis of AU and CU to evaluate the consistency in voiding patterns obtained with these two methods.

Materials and methods

Participants

Children with voiding problems, including urgency, incontinence, wetting and difficulty in voiding, underwent the standard treatment protocol, including treatment of fecal disorders, urotherapy, and anticholinergic medication. Complete urodynamic evaluation, both AU and CU testing, was performed in children who did not satisfactorily respond to treatment. The database of Aarhus University Hospital (Skejby) was searched to identify patients who had undergone urodynamic evaluation between January 2006 and April 2015. A total of 749 conventional and 332 ambulatory urodynamic records were identified, with unique patient identification codes used to identify 108 patients with both CU and AU records. Patients were excluded if any of the following criteria were met: aged <5 years, a neurogenic bladder, no voids during CU, and less than two voids recorded by the AU method. Fifty patients met the study criteria: 32 males and 18 females. The examination dates were scattered, with 2 before 2011, 2 in 2011, 11 in 2012, 15 in 2013, 16 in 2014 and 4 in 2015. For analysis of puberty effect, patients were divided into two age groups: $\leq$11 years and $>$11 years [7].

Urodynamic testing

A suprapubic catheter (6-F pigtail, double lumen) was used for both urodynamic tests. The catheter was sited during a 10-min general anesthesia (2 mg/kg of propofol in combination with 0.01 mg/kg of alfentanil or 0.5 mg/kg of remifentanil) 24 h before testing. Bupivacaine (0.25%, maximum dosage $<$1 mg/kg) was used as the local anesthesia. Abdominal pressure was measured using a rectal balloon catheter (8-F) placed inside the rectum; the catheter was removed during defecation and replaced by the guardian. The AU testing was performed using the Luna System (Medical Measurement System Company, The Netherlands; sampling rate 8 Hz), with a Bluetooth-embedded uroflowmeter to record urine flow. Patients used a sitting position for the CU testing, while a self-selected position was used for the AU. During AU testing, the patients and guardians were accommodated in the patient hotel for easy access. Patients were instructed to ingest fluid according to their usual habits and to record their LUT events (voiding, urge feelings and leakage) by pressing the appropriate event keys on the recording device. Recording was performed continuously from morning