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Uroflowmetry with pelvic floor electromyography: inter-rater agreement on diagnosis of pediatric non-neurogenic voiding disorders

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Summary

Introduction
Uroflowmetry with electromyography (uroflow-EMG) is commonly used for evaluation of lower urinary tract (LUT) function in children. Diagnostic criteria based largely on uroflow-EMG findings have previously been proposed for several conditions collectively termed non-neurogenic voiding disorders (NNVDs). These include dysfunctional voiding (DV), idiopathic detrusor overactivity disorder (IDOD), detrusor underutilization disorder (DUD), and primary bladder neck dysfunction (PBND). It is unknown whether practitioners with varying levels of training and experience can apply the diagnostic criteria for these conditions with a high level of consistency.

Objective
To assess inter-rater agreement on diagnosis of NNVDs using uroflow-EMG studies.

Study design
Six raters performed post hoc evaluation of 84 uroflow-EMG studies and associated clinical data from children with symptoms of LUT dysfunction and no evidence of neurologic or anatomic abnormalities. Each rater was asked to categorize the uroflow-EMG studies as being consistent with DV, IDOD, DUD, PBND, or normal/unclassifiable. A consensus diagnosis was noted for studies on which at least four raters agreed. Inter-rater agreement was assessed via calculation of unweighted Fleiss' kappa statistics.

Results
Overall inter-rater agreement on NNVD diagnoses was moderate (kappa 0.46, 95% CI 0.38–0.54). Agreement between individual raters ranged from 0.33 (fair) to 0.74 (substantial) (Figure). There was no consensus on diagnosis for 20 patients (24%).

Discussion
Several factors may contribute to inter-rater disagreement on diagnosis of NNVDs. These include instances where patients satisfy one criterion for a particular diagnosis while missing others — or have findings consistent with more than one diagnosis. Strategies to address this may involve simplifying the diagnostic criteria, developing a clear algorithm that prioritizes certain criteria, and/or allowing assignment of multiple diagnoses. Practitioners could also benefit from standardized education regarding the diagnostic criteria for NNVDs.

Potential limitations of this analysis included the use of just one uroflow-EMG study per patient in almost all cases. Also, the raters had variable levels of previous experience using the diagnostic criteria for NNVDs, and it is possible that they were not always applied as originally intended. If this were the case, it would support development of a standardized education tool to facilitate practitioner understanding and application of the criteria.

Conclusions
Uroflow-EMG has shown promise for improving clinical management of NNVDs associated with pediatric LUT dysfunction. However, inter-rater agreement on NNVD diagnoses using current criteria is suboptimal. Various mechanisms should be explored to improve consistency in practitioners' diagnosis of NNVDs.

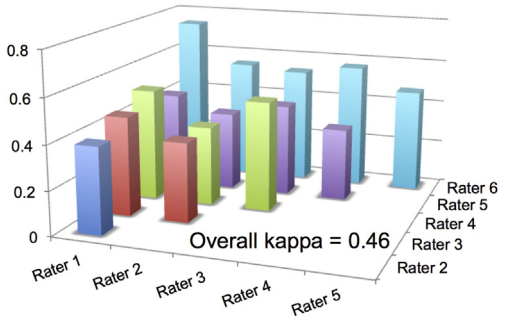

Figure Kappa statistics for inter-rater agreement on diagnosis of non-neurogenic voiding disorders. Each bar represents the kappa statistic for agreement between a pair of raters. On a scale from 0.0 to 1.0, a kappa of 0.0 denotes the amount of agreement that would be expected to occur by chance, while 1.0 indicates perfect agreement.

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Introduction

Uroflowmetry with electromyography (uroflow-EMG) is a noninvasive method of evaluating lower urinary tract (LUT) function. It simultaneously records urinary flow rate and pelvic floor electrical activity — the latter as an indicator of external urethral sphincter contraction. Based largely on uroflow-EMG findings, Van Batavia et al. defined diagnostic criteria for five conditions termed non-neurogenic voiding disorders (NNVDs) that are associated with LUT dysfunction in anatomically and neurologically normal children (Table 1) [1]:

- dysfunctional voiding (DV): irritative LUT symptoms, active pelvic floor during voiding, with or without a staccato flow pattern
- idiopathic detrusor overactivity disorder (IDOD)-Type A: urgency, shortened EMG lag time (<2 s), quiet pelvic floor during voiding
- IDOD-Type B: same as IDOD-A but with a normal EMG lag time (2—6 s)
- detrusor underutilization disorder (DUD): chronic or episodic willful deferred voiding, quiet pelvic floor, normal flow pattern, voided volume consistently in excess of estimated bladder capacity (EBC)
- primary bladder neck dysfunction (PBND): hesitancy, prolonged EMG lag time (>6 s), quiet pelvic floor during voiding, depressed uroflow curve that is often right shifted.

The clinical symptoms associated with NNVDs have been shown to be non-specific, and the use of uroflow-EMG may optimize diagnostic accuracy and selection of appropriate treatment [1,2]. However, one concern regarding the proposed criteria for DV, IDOD, DUD, and PBND is that Van Batavia et al. based their analysis of uroflow-EMG studies on assessments by a single clinician. The reliability of others' application of their diagnostic criteria is unknown.

In the present study, the aim was to determine the inter-rater agreement of several practitioners with varying levels of training and experience in the interpretation of uroflow-EMG studies for diagnosis of NNVDs. Given that the diagnostic criteria incorporate relatively objective parameters such as pelvic floor (EMG) activity during voiding and EMG lag time (i.e. the interval between pelvic floor relaxation and initiation of voiding), it was hypothesized that agreement would be high.

Materials and methods

Consecutive uroflow-EMG studies performed for children with LUT dysfunction and no evidence of neurologic or anatomic abnormalities were collected from February to May 2013. All studies were conducted by experienced nurse practitioners and initiated only after patients expressed an urge to void on their own accord. For all analyzed studies, a Mediwatch Duet urodynamics system (Williston, VT) and surface patch EMG electrodes were used, and the post-void residual (PVR) was assessed by a Mediwatch Portascan+ with real-time ultrasound imaging. Estimated bladder capacity (EBC) was calculated for patients up to the age of 12 as (age + 1) x 30 ml and assumed to be 390 ml for patients 12 years or older [3]. Pre-void bladder volume (BV) was calculated by the sum of the voided volume (VV) and PVR. Studies were excluded if a urodynamics system other than the Mediwatch Duet was used, clinical data were incomplete, later diagnosis of neurogenic bladder was made, the pre-void BV was <30% of EBC, or notations of urine spillage or poor EMG lead contact occurred during the study.

Six raters (two attending pediatric urologists, two pediatric urology fellows, a pediatric nephrologist who specializes in LUT dysfunction, and a pediatric urology nurse practitioner) each received a verbatim reproduction of Van Batavia et al.'s criteria for diagnosis of NNVDs from the Introduction to their 2011 manuscript [1]. Clinical experience with interpretation of uroflow-EMG studies ranged from minimal for two raters (<15/year) to high for three raters (>150/year). Self-reported pre-existing familiarity with Van Batavia et al.'s diagnostic criteria was none for two raters, some for one rater, and moderate-to-high for three raters.

The raters were provided with a summary of each patient's clinical history (presenting complaint, voiding symptoms, etc.), VV, PVR, pre-void BV, and EBC. They were then asked to categorize the previously performed uroflow-EMG studies as being consistent with DV, IDOD-Type A, IDOD-Type B, DUD, PBND, or normal/unclassifiable. Both

Table 1 Diagnostic criteria proposed by Van Batavia et al. [1] for non-neurogenic voiding disorders (NNVDs).

	Dysfunctional voiding (DV)	Idiopathic detrusor overactivity disorder (IDOD)		Detrusor underutilization disorder (DUD)	Primary bladder neck dysfunction (PBND)
		Type A	Type B		
Symptoms	Irritative	Urgency	Urgency	Willful voiding deferral	Hesitancy
Electromyography (EMG) lag time[a]		Short (<2 s)	Normal (2—6 s)		Long (>6 s)
Pelvic floor (EMG) during voiding	Active	Quiet	Quiet	Quiet	Quiet
Flow pattern	± Staccato			Normal	Depressed, often right shifted
Voided volume				Consistently exceeds estimated bladder capacity	

[a] EMG lag time is the interval between pelvic floor relaxation (cessation of EMG activity) and the start of urine flow.