Short Pelvic Floor Electromyographic Lag Time: A Novel Noninvasive Approach to Document Detrusor Overactivity in Children with Lower Urinary Tract Symptoms

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Abbreviations and Acronyms

DO = detrusor overactivity
DV = dysfunctional voiding
EBC = expected bladder capacity
EMG = electromyography
IDOD = idiopathic detrusor overactivity disorder
LUT = lower urinary tract
LUTS = lower urinary tract symptoms
OAB = overactive bladder
PBND = primary bladder neck dysfunction
UDS = urodynamic study

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Purpose: Noninvasive uroflow with simultaneous electromyography can measure electromyographic lag time, ie the interval between the start of pelvic floor relaxation and the start of urine flow (normally 2 to 6 seconds). Intuitively one would expect that in patients experiencing urgency secondary to detrusor overactivity the lag time would be short or even a negative value. We studied whether short electromyographic lag time on uroflow with electromyography actually correlates with documented detrusor overactivity on urodynamics.

Materials and Methods: We reviewed 2 separate and distinct cohorts of 50 neurologically and anatomically normal children with persistent lower urinary tract symptoms who were evaluated by uroflow with simultaneous electromyography and videourodynamics. Group 1 consisted of 30 boys and 20 girls (mean age 7.8 years, range 4 to 19) selected based on electromyographic lag time of 0 seconds or less on screening uroflow with electromyography who subsequently underwent videourodynamics. Group 2 consisted of 14 boys and 36 girls (median age 8.4 years, range 5 to 18) selected based on the presence of detrusor overactivity on videourodynamics whose screening uroflow with electromyography was then reviewed. Correlations between short electromyographic lag time and videourodynamically proved detrusor overactivity were analyzed.

Results: For group 1 urodynamics confirmed the presence of detrusor overactivity in all patients with an electromyographic lag time of 0 seconds or less. For group 2 mean ± SD electromyographic lag time was 0.1 ± 1.7 seconds, and 35 patients (70%) with urodynamically proved detrusor overactivity had a lag time of 0 seconds or less.

Conclusions: In patients with lower urinary tract symptoms an electromyographic lag time of 0 seconds or less is 100% predictive of detrusor overactivity. This short electromyographic lag time has 100% specificity and 70% sensitivity for diagnosing detrusor overactivity (88% if less than 2 seconds). Thus, diagnosing the presence or absence of detrusor overactivity in most children with lower urinary tract symptoms and a quiet pelvic floor during voiding can be done reliably via uroflow with simultaneous electromyography.

Key Words: electromyography; lower urinary tract symptoms; urinary bladder, overactive; urination disorders; urodynamics

DIAGNOSIS of a nonneurogenic lower urinary tract condition based solely on symptomatology is often misleading and can result in less efficacious or even inappropriate therapy.[1,2] Noninvasive testing that provides useful objective information can be invaluable in making a more accurate diagnosis, selecting patients who would benefit from more invasive testing, enhancing ther-

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apy selection and more accurately assessing treatment response.

We previously reported the concept of pelvic floor EMG lag time obtained by noninvasive uroflow/EMG and its usefulness in diagnosing and managing PBND.[3–5] Pelvic floor EMG lag time is the interval between the start of pelvic floor relaxation and the start of urine flow during volitional voiding. Normal pelvic floor EMG lag time ranges from 2 to 6 seconds, and the concept is based on the physiological principle that as the first stage in normal voiding, pelvic floor relaxation normally precedes by a few seconds the start of a volitional detrusor contraction and the beginning of urine flow (fig. 1, *a*).[3] In patients with PBND this lag time is markedly prolonged and mirrors opening time, defined as the elapsed time from the start of a volitional detrusor contraction to the start of urine flow.[3] We have also reported on the usefulness of EMG lag time in the followup of these patients by monitoring response to therapy.[4,5]

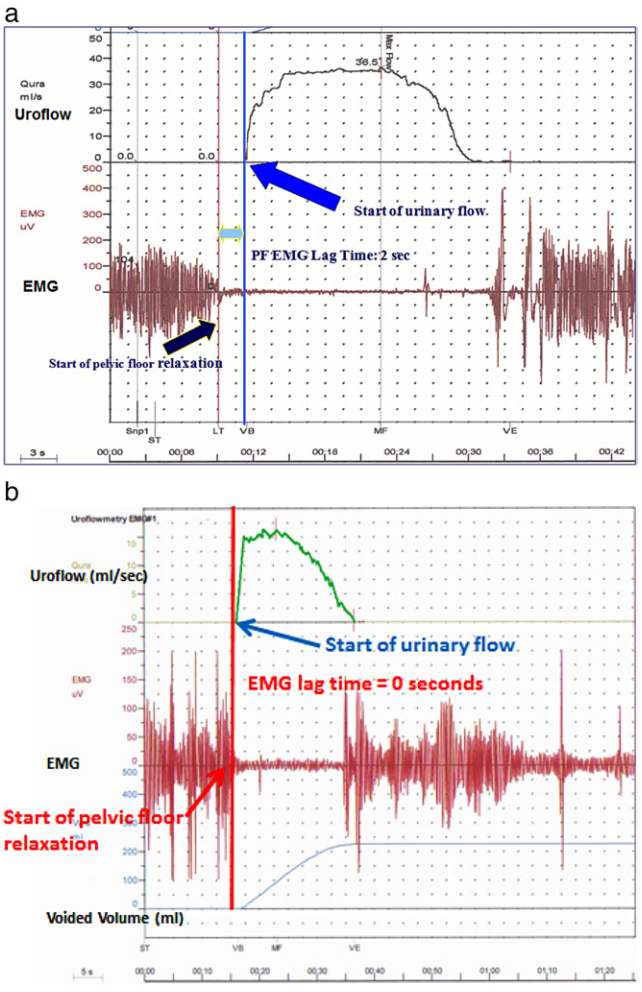

Figure 1. *a*, representative normal uroflow/EMG in 14-year-old girl voiding with strong desire to urinate and volume of 100% EBC. Pelvic floor relaxation (start of EMG quieting, black arrow) occurs 2 seconds before start of urinary flow (blue arrow) and remains relaxed throughout voiding. *b*, representative uroflow/EMG in 14-year-old girl with history of urgency and enuresis but no daytime wetting voiding at volume of 220 ml (63% EBC). Urine flow (blue arrow) begins simultaneously with pelvic floor EMG relaxation (red arrow) for EMG lag time of 0 seconds, and pelvic floor EMG remains quiet throughout voiding.

It gradually became evident that EMG lag time might also be useful in diagnosing DO. Patients who experienced urgency often had an EMG lag time that was essentially zero or even negative when uroflow/EMG was obtained (fig. 1, *b*). It seems intuitive that DO would be present in patients experiencing urgency and flow beginning before or simultaneously with pelvic floor relaxation.

Our practice has been to focus more on identification of the underlying force that drives LUTS in each specific condition than on the symptoms themselves. As such, we were interested in knowing if this short EMG lag time was indeed associated with DO. It is believed that DO can only be documented on UDS. However, the feasibility of using uroflow/EMG to also document the presence of DO was intriguing. We investigated the usefulness of short EMG lag time on uroflow/EMG in predicting the presence of DO on urodynamic evaluation.

METHODS

With institutional review board approval we analyzed the records of 2 separate and distinct cohorts of anatomically and neurologically normal children with persistent irritative LUTS who underwent screening uroflow/EMG and UDS as part of the evaluation. Group 1 consisted of 50 consecutive patients (30 males and 20 females) who were selected based on an EMG lag time of 0 seconds or less and a quiet pelvic floor during the remainder of voiding on screening uroflow/EMG. For these children the subsequently performed UDS was evaluated for the presence of DO. Group 2 consisted of 50 consecutive children (13 males and 37 females) who were selected based on the presence of DO documented during UDS. For these children the screening uroflow/EMG studies were reviewed for the presence of a short EMG lag time. Seven patients in group 1 and 5 in group 2 were previously treated with anticholinergics. All patients were off anticholinergic therapy for at least 3 months before either study.

All uroflow/EMG and urodynamic studies were performed using the Duet™ External Drainage and Monitoring System or the Aquarius™ TT Urodynamics System by a single experienced clinician. To be included in the study, the EMG was required to stay quiet once initial pelvic floor relaxation occurred and to remain quiet throughout voiding.

Pelvic floor EMG recording was performed using integrated Biosensors International™ patch EMG electrodes that were placed at the 3 and 9 o'clock positions at the margin of the external anal sphincter. Simultaneous audio monitoring was also included to confirm the absence of motor activity during voiding. EMG lag time, voided volumes, post-void residual and bladder capacity were measured for all patients. Actual bladder capacity was calcu-