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Autonomic dysreflexia during urodynamics in children and adolescents with spinal cord injury or severe neurologic disease

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Summary

Introduction
Autonomic dysreflexia (AD) is a well-established association of high spinal cord injury (SCI), particularly in those occurring above T6. When a noxious stimulus is encountered, the body responds by stimulating an increase in blood pressure, which is then countered by vasodilation. In patients with autonomic dysreflexia, the patient is unable to vasodilate below the level of spinal injury due to interruption of the autonomic innervation below the injury. This then leads to persistently elevated blood pressure causing uncoordinated autonomic responses such as headache, flushing, sweating, and even hypertensive crisis. The noxious stimulus most commonly reported is bladder or bowel distention [1]. This potential trigger is especially important since many patients with SCI require catheterization and repeated urodynamic testing, both of which predispose them to bladder distention.

In response to an incident during which a patient developed severe hypertension during UDS, institutional concern was raised about the potential risk of AD in other patients with SCI $\geq$ T8 and other severe neurological disease undergoing urodynamic testing, and a protocol was initiated in 2007 for monitoring for AD during UDS. Although no long-term complication was encountered in this incident, the need for improvement in our understanding of the detection and treatment of AD during urodynamic testing was highlighted. However, due to the potential of UDS to trigger AD and possible subsequent severe cardiovascular crisis, a protocol was established at our institution. Because of reports documenting episodes of AD for patients with severe, non-SCI neurologic disease and the unknown risk, these patients also were historically monitored at our institution as well.

Objective
Autonomic dysreflexia (AD) is an uncoordinated autonomic response seen in patients with spinal cord injury (SCI). AD is often triggered by bladder distention, which may occur during urodynamic studies (UDS), and has potentially life-threatening consequences. Our purpose is to determine the prevalence and associated factors of AD in children undergoing UDS with either SCI or other neurological disease.

Methods
We identified 13 pediatric patients with SCI at the eighth thoracic vertebrae or above (SCI $\geq$ T8) or other severe neurological disorder with urodynamic evaluations between 2007 and 2011 at our institution. We retrospectively reviewed these patients for age, gender, bladder volume, bladder compliance, detrusor instability, symptoms of AD, blood pressure, and urinary infection.

Results
There were a total of 13 patients with SCI $\geq$ T8 (9), transverse myelitis (2), and encephalomyelitis (2). There were a total of 41 urodynamic studies with an average of 3.2 studies per patient. One adolescent with C1/2 injury and a prepubertal child with T2/3 injury developed AD. AD was not observed in non-SCI patients. The patients who developed AD had multiple subsequent episodes with follow up UDS. No statistical associations were found for the variables evaluated. No major complications occurred, and AD was successfully managed conservatively.

Conclusions
With appropriate monitoring and education, AD is easily recognized and managed conservatively. We found an increased risk of patients developing subsequent AD episodes after an initial episode. Patients who did not have autonomic dysreflexia during initial UDS did not experience autonomic dysreflexia on subsequent UDS. We did not observe autonomic dysreflexia occurring in children with transverse myelitis or encephalomyelitis.

Results	
# of patients	13
# of studies	41
Average studies per patient	3.2
Average age at study	12.4
Number of episodes of AD	1 patient with Thoracic SCI: 7 episodes of AD of 8 UDS 1 patient with Cervical SCI: 2 episodes of AD of 7 UDS

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Introduction

Autonomic dysreflexia (AD) is a well-established association of high spinal cord injury (SCI), particularly in those occurring above T6. When a noxious stimulus is encountered, the body responds by stimulating an increase in blood pressure, which is then countered by vasodilation. In patients with autonomic dysreflexia, the patient is unable to vasodilate below the level of spinal injury due to interruption of the autonomic innervation below the injury. This then leads to persistently elevated blood pressure causing uncoordinated autonomic responses such as headache, flushing, sweating, and even hypertensive crisis. The noxious stimulus most commonly reported is bladder or bowel distention [1]. This potential trigger is especially important as many patients with SCI require catheterization and repeated urodynamic testing, both of which predispose them to bladder distention.

In response to an incident during which a patient developed severe hypertension during UDS, institutional concern was raised about the potential risk of AD in other patients with SCI $\geq$ T8 and other severe neurological disease undergoing urodynamic testing, and a protocol was initiated in 2007 for monitoring for AD during UDS. Although no long-term complication was encountered in this incident, the need for improvement in our understanding of the detection and treatment of AD during urodynamic testing was highlighted. We also are aware that many hospitals do not actively monitor blood pressure during UDS evaluation. However, due to the potential of UDS to trigger AD and possible subsequent severe cardiovascular crisis, a protocol was established at our institution. Because of reports documenting episodes of AD for patients with severe, non-SCI neurologic disease and the unknown risk, these patients also were historically monitored at our institution as well.

The purpose of this study is to retrospectively analyze the prevalence, associations, complications, and treatment of AD in both high SCI injury patients and those with severe non-SCI neurological disease during UDS in our institution's pediatric population.

Methods

Patient selection

After Institutional Review Board approval was granted for this study, we identified 13 patients between the ages of 0 and 17 years with either SCI $\geq$ T8 or other severe neurological disorder who had undergone UDS evaluation between 2007 and 2011 at Arkansas Children's Hospital. Blood pressure monitoring and clinical assessment were performed throughout UDS following the AD protocol.

We retrospectively reviewed multiple variables for this cohort including age, sex, blood pressure during UDS, and the presence of bacteria at the time of UDS. All patients with non-SCI, severe neurological disease were included in this retrospective review.

Urodynamic study

The patient is supine with two clinic staff available, and a catheter is placed for normal saline infusion into the bladder. Electromyography electrode pads are placed to the right and left lateral aspect of the perianal with grounding pad on bony prominence, usually the hip or knee. Rectal manometry, with the balloon instilled with 0.5—2 mL of sterile water, is inserted to measure abdominal pressure. Normal saline is kept at $<$43 °C prior to being used for infusion. The infusion rate is dependent on patient age and/or bladder capacity and may vary during the course of a single study. The infusion rate varies from 5 to 17 mL/min and is infused via pump. The infusion rate is derived from roughly 10% of bladder volume per minute.

Autonomic dysreflexia assessment

Patients were assessed for episodes of AD by specific criteria (Fig. 1). An episode of AD was defined as an elevation of systolic blood pressure of 15—20 mmHg above baseline or the presence of symptoms commonly associated with AD [2].

Results

We reviewed 13 patients, five males and eight females, with an average age of 12.4 years. The neurologic disease of patients studied included the following: eight patients had SCI above T6 (6 of these were cervical), one patient with T8 SCI, two patients with transverse myelitis, and two patients with encephalomyelitis. In all, 41 UDS were performed, with an average of 3.2 studies per patient. One adolescent (C1/2 level injury) and one prepubertal child (T2/3 level injury) both experienced AD. Both patients experienced AD initially and on subsequent UDS, with one having a total of seven episodes of AD. In addition to blood pressure elevation, facial flushing was observed in one of the two patients during the UDS evaluation with recurrent symptoms on repeated studies. Flushing was noted with moderate filling of the bladder during the study. Symptoms of AD and hypertension were resolved in both of these patients with bladder drainage alone, without any need for pharmacological intervention. No major complications were observed. There did not appear to be noticeable correlations of AD with gender, actual-to-estimated bladder ratio, presence of uninhibited detrusor contractions, bladder compliance, or presence of bacteria during UDS. The association between demographic and clinical features with AD was examined using repeated measures analysis. Patients with transverse myelitis or encephalomyelitis were not observed to have AD.

Discussion

AD is an uncoordinated response to noxious stimuli with the potential to cause life-threatening reactions in patients with SCI or other form of neurologic dysfunction. It has