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Children with nocturnal enuresis have posture and balance disorders

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Summary

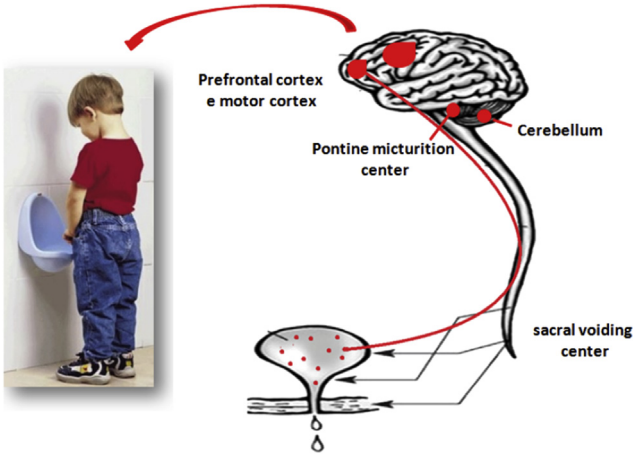
Introduction
Integration of the neuromuscular system is required for maintaining balance and adequate voiding function. Children with enuresis have delayed maturation of the motor cortex, with changes in the sensory and motor systems. Along with various alterations, including the genetic, hormonal, behavioral, and sleep disturbances, and neuromotor and sensory deficits associated with nocturnal enuresis (NE) in children and adults, a consistent alteration in the posture of children with NE has been observed in the current practice. Because posture and the balance control system are strongly connected, this study aimed to investigate posture and balance in children and teenagers with NE.

Material and methods
A total of 111 children with enuresis were recruited to the enuretic group (EG) and 60 asymptomatic children made up the control group (CG). The participants were divided into two age subgroups: (A) 7–11 years old, $N = 77$ for EG/A, $N = 38$ for CG/A; and (B) 12–16 years old, $N = 34$ for EG/B, $N = 22$ for CG/B. Balance was assessed using an electronic force plate (100 Hz) to calculate the area of the center of pressure (COP) displacement. The COP is the point that results from the action of vertical forces projected onto the force plate. Sensory integration was analyzed using a 60-s trial with the subject standing under four conditions: (1) eyes open, stable surface; (2) eyes closed, stable surface; (3) eyes open, unstable surface; (4) eyes closed, unstable surface.

Posture was assessed by placing reflective anatomical landmarks on the anterior superior iliac spine, the posterior superior iliac spine, the greater trochanter, and lateral malleolus. A photograph was taken while the subject stood quietly. The angles were obtained from landmark connections using software to assess the following posture variables: pelvic ante/retroversion and pelvic ante/retropulsion.

Results
The EG showed a greater area of COP displacement compared with the CG under all four sensory conditions and both subgroups, except for EG/B in condition 3. Regarding posture, EG showed higher pelvic anteversion angles than CG.

Conclusions
Enuretic children showed forward inclination of the pelvis and had worse balance compared with control children.



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Introduction

Nocturnal enuresis (NE), also called bedwetting, is defined as involuntary voiding while sleeping in people aged >5 years. It is related to developmental disturbances and frequently causes psychological and social suffering for the affected children and their families. Monosymptomatic nocturnal enuresis can be defined as the presence of urine incontinence during sleep, and non-monosymptomatic when associated with other symptoms of the lower urinary tract, including: nocturnal and diurnal losses, bladder changes, post residual urine, UTI, constipation and/or encopresis. This set of associated symptoms can cause deterioration of bladder function, upper urinary tract and, in extreme cases, even kidney failure [1].

The two subtypes of enuresis are important for understanding the pathophysiology of the current study. At present, NE does not seem to be an isolated phenomenon because various alterations, including genetic [2], hormonal [3], behavioral disturbances [4,5], sleep disturbances [6,7], and neuromotor and sensory deficits [8—12] have been reported in children and adolescents with NE. Therefore, NE may be a manifestation of multifactorial disorders of development during childhood.

Recent publications have indicated that the picture of NE and its associated alterations remains unclear. Are these alterations causes or consequences of NE? Do they occur independently or along with NE? Are there any other manifestations of the development delay related to NE?

In the current clinical practice, consistent alterations of posture and balance have been noticed in children and adolescents with NE during their physiotherapy evaluations. These alterations may be an important part of the developmental disturbances in children with NE. Therefore, it was hypothesized that children and adolescents with NE could present with postural and balance alterations. This study aimed to investigate posture and balance in children and adolescents with NE.

Methods

The current study had an observational cross-sectional design. It comprised two groups: the enuretic group (EG), with a total of 111 children diagnosed with NE (aged 10.27 ± 2.61 years), and the control group (CG), with 60 healthy children (aged 10.88 ± 2.40 years). The EG children were initially screened, categorized into monosymptomatic or non-monosymptomatic NE, and referred to the study by two physicians from the Pediatric Nephrology Unit, Instituto da Criança do Hospital das Clínicas, University of Sao Paulo, Medical School (HC-FMUSP). The CG children were recruited from relatives of students and workers at the hospital. For both groups, their legal guardians signed a consent form approved by the Ethics Committee of this hospital (CAPpesq No 0609/11).

The EG comprised 65 children with monosymptomatic nocturnal enuresis, and 46 with non-monosymptomatic nocturnal enuresis, according to the ICCS criteria [1]. The EG and CG were subdivided into two age subgroups: (A) 7—11 years old, EG/A $N_{Monosymptomatic} = 47$, $N_{Non\text{-}monosymptomatic} = 30$; CG/A $N = 38$; and (B) 12—16 years old, EG/B $N_{Monosymptomatic} = 18$, $N_{Non\text{-}monosymptomatic} = 16$; CG/B $N = 22$. The age subgroups were adopted due to variability in the area of COP displacement throughout the age range [13—16]. Children with anatomical changes in the urinary tract, genetic syndromes, neurological conditions or diseases that could affect balance, cognitive impairments, trauma or previous orthopedic surgeries were not included in the study.

Posture assessment

Posture refers to body alignment to maintain the proper conditions to perform movements [13]. It was assessed using a photogrammetry technique, which is considered as a reliable alternative to the quantitative evaluation of posture with measurement of linear and angular variables [17]. Reflective anatomical landmarks were placed on the lateral malleolus (LM), greater trochanter (GT), anterior superior iliac spine (ASIS), and posterior superior iliac spine (PSIS). A photograph was taken from the child's right side while the child stood quietly against a dark, matte back wall. The room was prepared to reduce noise as much as possible. Total abolishment of noise was not guaranteed, however, the main distractors that could interfere with balance were controlled. A photographic digital camera was used (SONY Cyber-shot, 16.1 mega pixels, 5× optical zoom, DSC-W570, São Paulo, SP, Brazil) that was fixed on a tripod placed in a controlled position.

The angles obtained from the landmark connections were analyzed using software of postural assessment (SAPO, Brazil, http://sapo.incubadora.fapesp.br). The following angles were used: pelvic ante/retroversion (ASIS-PSIS-horizontal) and pelvic ante/retropulsion (GT-LM-vertical) (Fig. 1A). The pelvic ante/retroversion position indicated, respectively, the forward/backward rotation around the transversal axis of the pelvis. The pelvic ante/retropulsion position indicated, respectively, the anterior/posterior position of the pelvis related to the ankle [18].

Balance assessment

Balance is the ability to maintain body stability [13]. Data were acquired using a system that was made up of a force plate (EMG System do Brasil Ltda®, São José dos Campos, SP, Brazil.) and an analog digital convertor (OR6 12-bits) connected to a computer at a frequency of 100 Hz. A computerized program transformed the primary center of pressure (COP) signal into numeric data throughout the acquisition duration (Fig. 1B). The COP is the point that results from the action of vertical forces projected onto the force plate. Center of pressure displacement reflects the body's movements in the attempt to keep the center of mass within the boundaries of the weight-supporting base (both feet) and maintain balance [19].

The children were asked to stand barefoot, with their arms at their sides, on a force plate embedded in the laboratory floor, and to remain motionless. Because the integration of visual, somatosensory and vestibular information is essential for balance, data from 60-s trials were collected under four different sensory conditions: (1) eyes open, standing on a stable surface; (2) eyes closed, standing on a stable surface; (3) eyes open, standing on an unstable surface; and (4) eyes closed, standing on an unstable