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The prevalence of hypertension in children with spina bifida

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ABSTRACT

Aim: To determine whether children with spina bifida (SB) have a higher prevalence of hypertension (HTN) than population-based controls.

Methods: Charts of all patients (n = 123) seen in the Spina Bifida Clinic at Shriners Hospital in Houston, Texas, were reviewed for age, gender, ethnicity, type and level of neural tube defect, height, weight and blood pressure (BP). HTN was defined as a systolic blood pressure or diastolic blood pressure ≥95th percentile for age, gender and height on ≥3 occasions. Data from the National Health and Nutrition Examination Survey and from a Houston-based study were used for comparison.

Results: Fifty-one (41.5%) patients were hypertensive. This was significantly higher than the 3% prevalence in the national controls, $p < 0.001$ and the 4.5% prevalence in the Houston controls, $p < 0.001$. Maximum body mass index increased the risk for HTN [odds ratio, 1.018; 95% confidence interval (1.005, 1.031); and $p = 0.005$].

Conclusion: Children with SB have a significantly higher prevalence of HTN than children in the general population. Age-, gender-, and height-based norms are important for the early identification and treatment of HTN in children.

INTRODUCTION

Hypertension (HTN) in the general paediatric population is steadily increasing (1,2). Patients with spina bifida (SB) have or may develop additional risk factors such as renal or urinary tract dysfunction that further increase their lifetime risk of HTN. However, little is known about the actual prevalence of HTN in this population.

There is some evidence that adults with SB have an increased prevalence of HTN (3,4). One report from the United Kingdom showed that 15% were on anti-hypertensive medications (3). Two studies from the Netherlands that included young teens and adults with SB raised similar concerns. One defined HTN as a mean systolic blood pressure (SBP) >160 mmHg and/or a mean diastolic blood pressure (DBP) >95 mmHg and found that 3% were hypertensive (5). The other defined HTN as a SBP >140 mmHg and/or a DBP >90 mmHg and showed that 20% were hypertensive (6). However, neither study included a control group or adjusted the measurements for age, gender or height. Because so little is known about the prevalence of HTN in children with SB, the purpose of our study was to determine whether these children have a higher prevalence of HTN than age-matched population-based controls.

PATIENTS AND METHODS

We retrospectively analysed the outpatient charts of all children seen in the SB Clinic at Shriners Hospitals for Children in Houston, Texas. For every visit between January 2004 and December 2008, data on age, gender, ethnicity, type of neural tube defect, level of defect (thoracic, lumbar or sacral) as determined by the neurosurgeon's and physical therapist's evaluation, height or arm span, weight and blood pressure (BP) were collected. When more than one BP was recorded during a clinic visit, the lowest measurement was recorded.

During the time of the study, an automated NDE – Escort 2 (Arleta, CA, USA) monitor was used for BP measurements. The monitor underwent testing and calibration every 3 months. Because the American Academy of Pediatrics recommends BP measurements in children <3 years under special circumstances, i.e. renal and urological problems, all of our patients had BP measurements at every clinic visit.

Abbreviations
BP, blood pressure; DBP, diastolic blood pressure; HTN, hypertension; NHANES, National Health and Nutrition Examination Survey; SB, spina bifida; SBP, systolic blood pressure; WCH, white coat hypertension.

Key notes
- When measuring a child's BP and BMI it is important to determine gender, age and height percentile specific values.

Measurements were obtained by one medical assistant who had been trained in accordance with the working group on HTN recommendations for technique and cuff sizes. After a 15- to 30-min wait in the waiting room, with the patient in the seated position, the assistant measured and recorded the patient's vital signs. Normal BP values for the patient's age, gender and height were not posted during the time of the study.

The Center for Disease Control growth charts were used to determine each patient's height and weight percentile for each visit (7). Arm span length was converted to height using the formula 100/106× arm span (8). The National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents definitions of HTN were used; a SBP and/or DBP ≥95th percentile for age, gender and height on ≥3 occasions. For measurements >95th percentile, stage 1 was defined as a measurement between the 95th and 99th percentile plus 5 mmHg and Stage 2 was defined as >99th percentile plus 5 mmHg. Pre HTN included values between the 90th and 95th percentile or a measurement of ≥120/80 mmHg in an adolescent (9). Measurements <90th percentile and patients with less than three BP measurements were classified as normotensive.

Because the Shriners Hospital for Children in Houston is an orthopaedic hospital, recruitment of a normal control group from a group of general paediatric patients was not possible. Therefore, the National Health and Nutrition Examination Survey (NHANES) data on the prevalence of HTN in children ages 8 through 17 years was used for comparison (1). We also compared our results to those from a school-based Houston study that included children between the ages of 10 and 19 years (10). The study was approved by Shriners Hospital for Children and the Committee for the Protection of Human Subjects at the University of Texas Health Sciences Center at Houston.

Statistical analysis

Data management and statistical analyses were carried out using Microsoft Excel (version 2003; Microsoft Corporation, Redmond, WA, USA) and SPSS (version 15.0; SPSS Inc, Chicago, IL, USA). Frequencies and descriptive statistics for demographic and medical variables were tabulated. Body mass index (BMI) was calculated as weight (kg) divided by height (m) squared. BP categories for normal, pre-HTN and HTN were tabulated, both overall and by type of neural tube defect, meningomyelocele (thoracic, lumbar, or sacral), lipomeningocele and sacral agenesis. Difference in HTN status between types of defect was assessed by the chi-square statistic. To determine the risk factors for HTN and pre-HTN, univariate logistic regression was used to assess the potential risk factors of gender, ethnicity and maximum BMI level.

RESULTS

Charts of 123 children were reviewed. See Table 1 for demographic and clinical variables. No charts had missing BP data, and none of the patients had been previously diagnosed with HTN or renal failure. Seventy-three (60%) patients had height measurements; the remainder had arm span measurements. Patients had an average of 4.9 BP measurements (SD 2.7; range 1–15 measurements). Twenty-five (20%) patients had less than three BP measurements and were considered normotensive.

Table 1 Demographic and clinical variables

Age	3–18 years
	N (%)
Gender	
Male	60 (48)
Female	63 (52)
Ethnicity	
Hispanic	66 (54)
White	35 (32)
African-American	16 (14)
Asian	4 (2)
Other	2 (1)
Myelomeningocele	
Thoracic	29 (23.6)
Lumbar	53 (43.1)
Sacral	3 (2.4)
Lipomeningocele	29 (23.6)
Sacral agenesis	9 (7.3)

Fifty-one patients (41.5%) met the definition of HTN. Twenty-seven patients had only systolic HTN, three had diastolic HTN; the remaining patients had both systolic and diastolic HTN. Of the 51 patients, 2 (4%) had Stage I HTN and 3 (6%) had Stage 2 HTN. The total was significantly higher than the 3% prevalence in the NHANES controls, $p < 0.001$ (1) and the 4.5% prevalence from the Houston study, $p < 0.001$ (10). Although there were more Hispanic children in our study and more African-American children in the Houston study, the difference in proportions of children with HTN between racial/ethnic groups was not statistically different, $p = 0.828$.

For pre-HTN, an additional 23 (18.7%) patients had measurements between the 90th and 95th percentiles or, if they were adolescents, had values >120/80 mmHg. The differences in HTN/pre-HTN between patients with myelomeningocele, lipomeningocele and sacral agenesis was not statistically significant, $p = 0.073$. HTN status by diagnosis is shown in Table 2. There was no association between

Table 2 Hypertension (HTN) status by type of diagnostic classification

		HTN	Prehypertension	Normal*
	N	≥95%	>120/80 or 90–95th %	<95%
Meningomyelocele	85	35	17	33
Lipomeningocele	29	11	5	13
Sacral agenesis	9	5	1	3
Total	123	51	23	49

*Or <3 measurements.

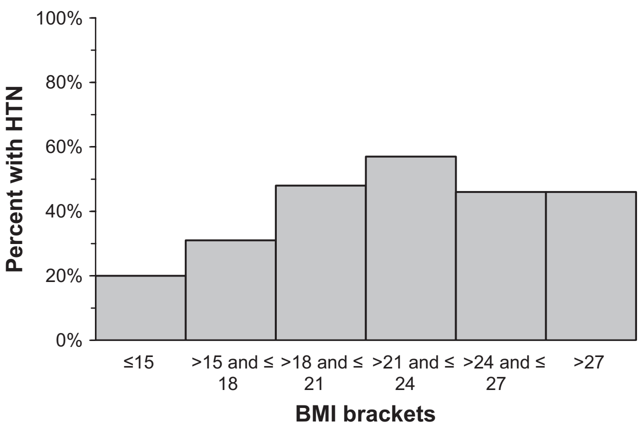

Figure 1 Prevalence of hypertension by body mass index category.

HTN and gender, ethnicity or level of SB. Of note, during subsequent follow-up clinic visits, five patients had DBPs greater than 100 mmHg and were started on anti-hypertensive medications. Two of the five patients were symptomatic and required admission to the hospital.

For BMI, 36 (29.3%) patients had a maximum BMI greater than the 95th percentile and were classified as 'overweight'. This was significantly higher, $p < 0.0005$, than the 17.1% prevalence in the NHANES control group. The mean maximum BMI was 22.29 (SD 6.9) with a minimum of 10.7 and a maximum of 51.5. There was no significant difference in BMI between patients with meningomyelocele and patients with a lipomyelomeningocele or sacral agenesis. BMI percentile was the only significant risk factor for HTN [odds ratio, 1.018; 95% CI (1.005–1.031); and $p = 0.005$]. Figure 1 shows the distribution of HTN by BMI category.

DISCUSSION

Our study showed that the prevalence of HTN was higher in children with SB when compared to children from two large population-based surveys. It is well known that children with SB have an increased prevalence of obesity and there is strong epidemiological evidence that BMI is directly correlated with HTN (1). One study addressed HTN as a component of the metabolic syndrome in adolescents with SB (11). The authors included 34 patients between the ages of 11 and 20 years. Results showed that 24 (70.5%) patients were obese and that 29.2% of these patients had HTN. However, because the study group was a convenience sample, the actual prevalences of HTN and obesity were unable to be determined. Although both our study and the Nelson study revealed an association between obesity and HTN, not all HTN is related to obesity; the majority of our patients, 87 (70.7%), had a maximum BMI less than the 95th percentile.

The high prevalence of HTN in our population may be attributed to other factors such as white-coat hypertension (WCH) or to other limitations of our study design. Patients with WCH have a BP >95th percentile in a physician's office or clinic but are normotensive outside a clinical setting. In a summary of paediatric studies on WCH, the prevalence varied from 1% to 50% (12). Therefore, even if we reduced the prevalence of HTN in our study by 50%, the findings are still significantly different from the control groups. Studies have also shown that WCH is more common in children and adolescents with mild elevation of office BP than in those with more severe HTN and that WCH does not vary significantly by age, gender, race or BMI (13). Other studies suggest that WCH may represent a prehypertensive stage that can still be associated with target organ damage (14,15).

The increased prevalence may also be related to technical limitations. First, the use of an automated oscillometric device, rather than an auscultatory mercury manometer, for BP measurements may have overestimated measurements by 4–5 mmHg (16). However, as hospitals and clinics continue to transition away from mercury-containing to oscillometric devices and as fewer providers are trained in the manual measurement of BP, these monitors may soon become the standard. Future efforts may require the development of oscillometric normative data. Also, because of the retrospective nature of our study, the size of the BP cuff could not be determined and elevated BPs were not consistently repeated or confirmed.

Although the possible overestimation of the prevalence of HTN is concerning, other factors may have contributed to an underestimation of the prevalence. Despite a good correlation coefficient between arm span and height in normal individuals (17), patients with SB may have arm span measurements greater than anticipated for their length and there is more variability in children who are wheelchair ambulators (18). Consequently, any overestimation of height would underestimate the prevalence of HTN. Additionally, the classification of 25 (20%) children with less than three BP measurements as normotensive could have underestimated the prevalence.

The difference in prevalence of HTN between the NHANES and Houston studies, 3% and 4.5% respectively, may be attributed to the slightly younger children in the NHANES group, 8–17 years compared to 10–19 years in the Houston study or to the populations studied. In our study, unlike the school-based Houston study (10) where repeat measurements were obtained on only those students whose BPs were ≥95th percentile on the first visit, all of our patients had BP measurements taken at each clinic visit.

In conclusion, because children with HTN usually become adults with HTN (19), it is important not only to obtain BP and BMI measurements at every clinic visit but to determine gender, age and height-percentile-specific values as well. Although poor renal function did not play a role in the development of HTN in our patient population, it is still an important risk factor for clinicians to consider over a patient's lifetime. HTN compromises the long-term health in children with SB and contributes to the development of renal complications. Additionally, because obesity is a common problem in children with SB and because it increases their risk for the development HTN, the prevention of obesity plays an important role in the prevention of HTN. Future prospective studies are needed to investigate the role of ambulatory BP monitoring in differentiating WCH from true HTN and the significance of BP load in obese children (20). Additionally, investigation into the prevalence of end-organ damage in children with SB and elevated BPs is important.

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