

Early Detection of BP Abnormalities by Ambulatory Monitoring in Normotensive Children With Predisposing Factors

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ABSTRACT

Background: Measurement of the blood pressure is an essential part of the health care of children, as well as adults. Early elevation of the blood pressure is usually asymptomatic. However, if undetected, it may lead to progressive damage to target organs, including the heart and the kidneys. For these reasons, it is an advantage to use a technique that allows the detection of increased blood pressure at the earliest possible time, to allow intervention before any effects of the blood pressure elevation on the target organs.

Objectives: This study was performed in order to find out if ambulatory blood pressure monitoring can detect early abnormalities in children who are considered normotensive by conventional blood pressure measurement, but who have one of the predisposing factors for the development of hypertension.

Methods: A group of 32 children (18 girls, 14 boys) (ages 8-15.5 years, mean 13) participated in the study. All participating children were normotensive by the usual method of measurement of blood pressure, and according to the normal levels for their age and gender. Twenty one of these children (9 girls, 12 boys) have a family history of hypertension (One or both parents with hypertension, currently under medication). 11 of these children (9 girls, 2 boys) have a history of one or more attacks of urinary tract infection. Mean 24-hr BP was evaluated in each of the two groups of children.

Results: Mean 24-hr BP ranged from 103 to 131 (mean = 117 mm Hg) Systolic; and from 56 to 83 (mean = 72 mm Hg) Diastolic in the group of children with a family history of hypertension. Overall, 3/21 (14.3%) children in this group had mean 24-hr blood pressure, systolic and/or diastolic, exceeding their blood pressure taken by conventional measurement.

Regarding the group of children with a history of UTI, mean 24-hr BP ranged from 110 to 136 (mean = 122 mm Hg) Systolic; and from 69 to 82 (mean = 78 mm Hg) Diastolic in this group of children. Overall, 2/11 (18.2%) children in this group had mean 24-hr blood pressure, systolic and/or diastolic, exceeding their blood pressure taken by conventional measurement. In addition, BP loads (% of readings \geq 95th percentile, S & D) were evaluated in the two groups of children. BP loads ranged from 0% to 42.5% (mean = 15.4%) Systolic; and from 0% to 33.3% (mean = 12.9%) Diastolic in the group of children with a family history of hypertension. Overall, 6/21 (28.5%) children in this group had blood pressure loads 20% or more (= 20% or more of their blood pressure readings were greater than the 95th percentile for age and sex), systolic and/or diastolic, day and/or night. Regarding the group of children with a history of UTI, BP loads ranged from 0% to 51% (mean = 22.5%) Systolic; and from 0% to 29% (mean = 18.6%) Diastolic in this group of children. Overall, 4/11 (36.4%) children in this group had blood pressure loads 20% or more (= 20% or more of their blood pressure readings were greater than the 95th percentile for age and sex), systolic and/or diastolic, day and/or night.

In the group with a family history of hypertension, mean % nocturnal decline was 8.8% Systolic and 11.9% Diastolic. Overall, 0/21 of the children in this group showed absence of a drop of blood pressure during the night as compared to the day. In the group with a history of UTI, mean % nocturnal decline was 10.4% Systolic and 13% Diastolic. Overall, 1/11 of the children in this group showed absence of a drop of blood pressure during the night as compared to the day.

Conclusions: These data demonstrate that some early abnormalities of blood pressure can be detected by the use of ambulatory blood pressure monitoring in children who have one of the predisposing factors for hypertension. These abnormalities could not be detected by the use of the conventional method of blood pressure measurement, which is done on one occasion. Such findings may help in the prediction of blood pressure problems and its early management in predisposed children.

INTRODUCTION

Measurement of the blood pressure is an essential part of the health care of children, as well as adults. Early elevation of the blood pressure is usually asymptomatic. However, if undetected, it may lead to progressive damage to target organs, including the heart and the kidneys. For these reasons, it is an advantage to use a technique that allows the detection of increased blood pressure at the earliest possible time, to allow intervention before any effects of the blood pressure elevation on the target organs.

Regular measurement of the blood pressure should be a part of the routine care of children as well as adults. Measurement of the blood pressure is usually done in the doctor's office or in the hospital on one or more occasions. It is important to take the measurements with the patient under resting conditions, physically and mentally, in order to reflect the true blood pressure of the patient, without any influence of external factors. However, this will only reflect the patient's blood pressure at the time of measurement, and may not represent the patient's blood pressure throughout the day. In recent years, it has been suggested that continuous ambulatory blood pressure monitoring may give a true picture of the pattern of blood pressure during the day (and night)^(1,2). In addition, the use of continuous ambulatory blood pressure monitoring allows better monitoring of anti-hypertensive medications⁽³⁾. It has been suggested that the sequelae of hypertension correlate better with continuous ambulatory blood pressure readings than with intermittent blood pressure measurements^(1,4). The availability

of ambulatory blood pressure monitors light enough for use in children and with appropriate size cuffs has allowed improved experience with this technique in children.

AIM OF THE WORK

The aim of this study is to find out if ambulatory blood pressure monitoring can detect early abnormalities in children who are considered normotensive by conventional blood pressure measurement, but who have one of the predisposing factors for the development of hypertension, including positive family history in one of the parents, or a history of urinary tract infection with or without detectable vesicoureteric reflux and reflux nephropathy.

SUBJECTS AND METHODS

A group of 32 normal children (18 girls, 14 boys) (ages 8-15.5 years, mean 13) participated in the study. They were recruited from the outpatient clinic of Cairo University Children's Hospital during the period from August-October, 2001. A complete history and physical examination was done. All participating children were normotensive by the usual method of measurement of blood pressure, and according to the normal levels for their age and gender. Twenty one of these children (9 girls, 12 boys) have a family history of hypertension (one or both parents with hypertension, currently under medication). Eleven of these children (9 girls, 2 boys) have a history of one or more attacks of urinary tract infection (UTI) treated with a course of antibiotics during the past year. Since it is an important part of their evaluation, nine of the 11 children with a

history of UTI were already investigated by renal ultrasound and voiding cystourethrography for the presence of obstructive uropathy or vesico-ureteric reflux. Two of these children had evidence of grade 2 vesicoureteric reflux on voiding cysto-urethrography.

Exclusion criteria: children were excluded from the study in the following cases:

1. If they had a history of blood pressure problems in the past, or if their blood pressure measurements by the conventional method exceeded the upper limits of normal for their age and gender⁽⁵⁾.
2. If they had evidence of any other renal, endocrine or cardiac disease known to affect the blood pressure.
3. If they were taking any medication which is known to affect the blood pressure.

Ideally, the blood pressure monitor is a portable oscillometric monitor. It uses disposable batteries, and it can be programmed to take timed measurements of the blood pressure at regular intervals spontaneously, throughout the day and night. However, as an alternative, we used a digital electronic blood pressure monitor which can be easily used by the parents to obtain blood pressure measurements every hour during the day and every two hours during the night. It is attached to a blood pressure cuff, which has the appropriate size. The cuff encircles the upper arm and covers 2/3 of its length, according to each child's arm length. Mean 24-hr BP, mean daytime (6 am-8 pm), and nighttime (8 pm - 6 am) BP were evaluated, and compared with blood pressure taken by the

conventional method. In addition, BP loads (% of readings \geq 95th percentile, S & D) were evaluated. The information obtained by 24-hr ambulatory blood pressure monitoring allowed evaluation of the circadian pattern of blood pressure and the presence or absence of a nocturnal decline of blood pressure in these children.

At the beginning of the study, three BP measurements were obtained using the conventional sphygmomanometer, with the child seated comfortably and rested for 5 minutes. The mean of these three measurements was calculated and referred to as conventional blood pressure. The study was explained to the parents and the children, and they were instructed to take the blood pressure every hour during the daytime (6 am to 8 pm) and every 2 hours during the night (8 pm to 6 am). The readings of blood pressure monitoring were recorded and saved on a computer, and the findings were evaluated.

RESULTS

In order to confirm that all the children participating in the study were normotensive, at the beginning of the study, three BP measurements were obtained using the conventional sphygmomanometer, with the child seated comfortably and rested for 5 minutes. The mean of these three measurements was calculated. All children who participated in the study had conventional blood pressure measurements within the normal range. This was one of the inclusion criteria for the study.

Evaluation of mean 24-hr blood pressure was performed in each of the two groups of children and was compared with

conventional blood pressure. As shown in Table 1, mean 24-hr BP ranged from 103 to 131 (mean = 117 mm Hg) systolic; and from 56 to 83 (mean = 72 mm Hg) diastolic in the group of children with a family history of hypertension. Overall, 3/21 (14.3%) children in this group had mean 24-hr blood pressure, systolic and/or diastolic, exceeding their blood pressure taken by conventional measurement. Regarding the group of children with a history of UTI, mean 24-hr BP ranged from 110 to 136 (mean = 122 mm Hg) systolic; and from 69 to 82 (mean = 78 mm Hg) diastolic in this group of children. Overall, 2/11 (18.2%) children in this group had mean 24-hr blood pressure, systolic and/or diastolic, exceeding their blood pressure taken by conventional measurement.

In order to evaluate the circadian pattern of blood pressure (presence or absence of a nocturnal decline) in these children, the degree of drop of blood pressure during the night was calculated. Mean blood pressure was evaluated for each child during the daytime (6 am - 8 pm) and during the nighttime (8 pm - 6 am). In the group with a family history of hypertension, mean % nocturnal decline was 8.8% systolic and 11.9% diastolic. Overall, 0/21

of the children in this group showed absence of a drop of blood pressure during the night as compared to the day. In the group with a history of UTI, mean % nocturnal decline was 10.4% systolic and 13% diastolic. Overall, 1/11 of the children in this group showed absence of a drop of blood pressure during the night as compared to the day.

Evaluation of blood pressure loads (defined as the percentage of readings = or > the 95th percentile for age and gender) was performed and was evaluated in each of the two groups of children. As shown in Table 1, BP loads ranged from 0% to 42.5% (mean = 15.4%) systolic; and from 0% to 33.3% (mean = 12.9%) diastolic in the group of children with a family history of hypertension. Overall, 6/21 (28.5%) children in this group had blood pressure loads 20% or more, systolic and/or diastolic, day and/or night.

Regarding the group of children with a history of UTI, blood pressure loads ranged from 0% to 51% (mean = 22.5%) systolic; and from 0% to 29% (mean = 18.6%) diastolic. Overall, 4/11 (36.4%) children in this group had blood pressure loads 20% or more, systolic and/or diastolic, day and/or night.

Table 1: Ambulatory blood pressure monitoring findings in children with predisposing factors for hypertension: FH (Family History) Group, and UTI (Urinary Tract Infection) Group. Blood pressure loads (the percentage of readings = or > the 95th percentile for age and gender), systolic (S) and diastolic (D), 24-hr Mean, S & D, and nocturnal decline [(mean day-mean night)/mean day] S & D are shown for each of the two groups.

	BP LOADS		24-hr MEAN		NOCT. DECLINE	
	S	D	S	D	S	D
FH GROUP	0-42.5%	0-33.3%	103-131	56-83	8.8%	11.9%
	(15.4%)	(12.9%)	117	72		
UTI GROUP	0-51%	0-29%	110-136	69-82	10.4%	13%
	(22.5%)	(18.6%)	122	78		

DISCUSSION

This study was performed in order to find out if ambulatory blood pressure monitoring can detect early abnormalities in children who are considered normotensive by conventional blood pressure measurement, but who have one of the predisposing factors for the development of hypertension, including positive family history in one of the parents, or a history of urinary tract infection with or without detectable vesicoureteric reflux and reflux nephropathy.

Evaluation of blood pressure loads (defined as the percentage of readings = or > the 95th percentile for age and gender) was done in each of the two groups of children. BP loads ranged from 0% to 42.5% (mean = 5.4%) systolic; and from 0% to 33.3% (mean = 12.9%) diastolic in the group of children with a family history of hypertension. Overall, 6/21 (28.5%) children in this group had blood pressure loads 20% or more (= 20% or more of their blood pressure readings were greater than the 95th percentile for age and sex), systolic

and/or diastolic, day and/or night.

Regarding the group of children with a history of UTI, BP loads ranged from 0% to 51% (mean = 22.5%) systolic; and from 0% to 29% (mean = 18.6%) diastolic in this group of children. Overall, 4/11 (36.4%) children in this group had blood pressure loads 20% or more (= 20% or more of their blood pressure readings were greater than the 95th percentile for age and sex), systolic and/or diastolic, day and/or night.

Evaluation of mean 24-hr blood pressure was performed in each of the two groups of children. In the group of children with a family history of hypertension, 3/21 (14.3%) children had mean 24-hr blood pressure, systolic and/or diastolic, exceeding their blood pressure taken by conventional measurement. Regarding the group of children with a history of UTI, 2/11 (18.2%) children had mean 24-hr blood pressure, systolic and/or diastolic, exceeding their blood pressure taken by conventional measurement.

In the group with a family history of hypertension, mean percentage nocturnal

decline was 8.8% systolic and 11.9% diastolic. Overall, 0/21 of the children in this group showed absence of a drop of blood pressure during the night as compared to the day. In the group with a history of UTI, mean % nocturnal decline was 10.4% systolic and 13% diastolic. Overall, 1/11 of the children in this group showed absence of a drop of blood pressure during the night as compared to the day.

Other studies have addressed the question of the use of ABPM in children with predisposing factors for hypertension. Seeman et al.⁽⁶⁾ investigated the BP profile in children with unilateral multicystic dysplastic kidney (MCDK) using ABPM. Their study concluded that arterial hypertension in children with multicystic dysplastic kidney is detected more by using ambulatory blood pressure monitoring than on casual blood pressure recordings.

It is believed that renal scarring due to reflux nephropathy is the main factor predisposing to hypertension in children following urinary tract infection. To evaluate blood pressure in a group of children with and without renal scarring after childhood urinary tract infection, Wennerstrom et al.⁽⁷⁾ performed a follow-up investigation 16-26 years after the first detected urinary tract infection. Mean systolic or diastolic blood pressure above +2 SD were found in 5/53 (9%) in a group with renal scarring, and 3/47 (6%) in a group without scarring. In a study of ambulatory blood pressure in children with type 1 diabetes, Cohen et al.⁽⁸⁾ observed a loss of the nocturnal fall in BP in their patients. They suggested that further studies

are needed to find out if high BP burden during the night could represent a risk for nephropathy and cardiovascular disease in diabetic patients⁽⁸⁾.

Ambulatory blood pressure (ABP) monitoring has become increasingly more available in clinical practice. The ambulatory blood pressure is more reliable than office readings, and is a better predictor of target organ damage. ABP recordings are useful in making a diagnosis of hypertension by identifying people with high office blood pressure but normal ambulatory blood pressure values. ABP monitoring can also be performed in patients already receiving antihypertensive therapy to determine the extent of any "white coat" effect (increased blood pressure due to the anxiety in the presence of the physician) that may be increasing office readings⁽⁹⁾. ABPM may help differentiate such transiently elevated readings from true persistent hypertension, to avoid unnecessary diagnostic evaluation and to identify children most likely to benefit from early intervention⁽¹⁰⁾. In addition to its use in adults, ambulatory blood pressure monitoring (ABPM) is a valuable clinical and research method in the assessment of pediatric hypertension⁽¹¹⁾. Pediatric studies using ABPM to evaluate elevated blood pressure have shown that the prevalence of white coat hypertension in children is similar to that reported in adults. ABPM has allowed detailed assessment of circadian blood pressure patterns that show early subtle abnormalities in some high-risk groups and normal patterns in other groups previously thought to be at high risk. These studies will help to improve the

management of pediatric hypertension^(12,13).

Several studies have suggested that 24-hr average blood pressure (BP) is better than office BP in relation to target organ damage. Not only 24-hr average BP values, but also specific BP patterns occurring within the 24 hours may have clinical importance. This is the case for daytime versus nighttime BP, the day/night BP difference, the morning BP rise, and BP variability⁽¹⁴⁾. Khan et al.⁽²⁾ reviewed their experience with the use of this technique in children and adolescents. There were differences between day and night readings of systolic blood pressure, diastolic BP, and heart rate. A "white coat" effect was found in children: office systolic BPs were higher than daytime systolic ABPM (no difference in diastolic). Nocturnal systolic and diastolic decline were closely correlated. Decrease in the amount of nocturnal decline was found in children with kidney disease and in those with organ transplants. The technique was useful in selected cases, such as borderline or secondary hypertension, and for therapeutic monitoring when BP control is difficult⁽²⁾. Accurate measurement

of blood pressure in children requires use of appropriate technique, particularly the use of an appropriate size cuff, and comparison with normal values based on age, sex and height. Ambulatory blood pressure monitoring may facilitate detection of early hypertension in high-risk patients. Careful clinical assessment is essential for identifying secondary causes or a predisposition to primary hypertension, and laboratory testing can be done only if a specific underlying cause is suspected⁽¹⁵⁾.

In conclusion, our findings demonstrate that some early abnormalities of blood pressure can be detected by the use of ambulatory blood pressure monitoring in children who have one of the predisposing factors for hypertension. These abnormalities could not be detected by the use of the conventional method of blood pressure measurement, which is done on one occasion. Ambulatory blood pressure monitoring has the potential to become an important tool in the evaluation and management of childhood hypertension, and it is suggested that more application of this technique can be useful in children.

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