

Hypertension in Children: An Overview

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Abstract: Hypertension in children is an increasing concern for health care professionals. Updated guidelines for the treatment of hypertension in children and adolescents were published in 2004. This report reviews the epidemiology and management of pediatric hypertension and suggests an oral health protocol to apply to hypertensive children in the dental setting. A web search was performed using Medline, PubMed, ISI Citation Index, and Cochrane evidence-based databases for articles regarding hypertension in children published in English between 1998 and 2004. Relevant articles describing the epidemiology, classification, pathophysiology, and management of pediatric hypertension are discussed, and recommendations for dental treatment of pediatric patients are suggested. The incidence of pediatric hypertension can reach 5 percent. Data on the prevalence of pediatric hypertension in the dental setting is scarce. However, using the prevalence in the general population, at least fifty young patients will be hypertensive in a busy general or pediatric practice. Dental students and residents should have the opportunity to screen for hypertension during their training and familiarize themselves with the appropriate techniques in children. Oral health professionals should become aware of the implications of hypertension in children.

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Hypertension is defined as a blood pressure reading that exceeds a threshold that separates individuals at risk for adverse outcomes from those with no increased risk.^{1,2} A sustained elevation in blood pressure increases the risk of an adverse outcome, such as stroke and myocardial events.³⁻⁵ Many efforts have focused on the primary prevention and control of hypertension in adults.³ Nevertheless, the increasing incidence of hypertension in younger age groups has drawn attention to the severity and complications of the disease in children and adolescents.³⁻⁶ Public health implications of hypertension in children are overwhelming because many of these individuals will eventually face medical sequelae into adulthood.^{3,9} Management and screening of pediatric patients with elevated blood pressure should form part of the dental school curriculum because the incidence of the disease is climbing. This article provides an overview of pediatric hypertension and offers suggestions for oral health management of hypertensive pediatric patients.

Epidemiology and Classification

The National Health and Examination Survey (NHANES III) reported an average rise of 1.4 mmHg

in systolic and 3.3 mmHg in diastolic measurement in children between the years of 1988 to 1994 and 1999 to 2000.¹⁰⁻¹⁴ This seemingly innocent variation in systolic blood pressure will affect the epidemiology of systemic disease in young adults within a decade.¹¹⁻¹³ Evidence of ethnic disparities in the prevalence of hypertension in children follows the proven disparity in the presence of cardiovascular disease among ethnic groups.¹³⁻¹⁷ Although the prevalence of pediatric hypertension in the United States has been calculated to be between 1 and 5 percent,^{3,6} this number is expected to increase due to the close association between hypertension and obesity.^{3,18} Obesity has become an epidemic in children, reaching almost 16 percent in recent years.^{17,18} A direct relationship between weight status and systolic blood pressure has also been reported.¹⁸ Slight elevations in pressure (1 to 2 mm Hg) in childhood will elevate the risk of developing hypertension as an adult by 10 percent.^{6,17}

The updated classification of hypertension in children was published in August 2004 by the National Blood Pressure Education Program, Working Group on Children and Adolescents.⁶ Hypertension in children is defined as systolic and/or diastolic based on repeated measurements (more than three occasions) above the 95th percentile for age, sex, and height (Table 1). Staging of hypertension in pediatrics follows the percentile classification.¹⁴ Measure-

ments below the 90th percentile are considered normal, while measurements between the 90th and the 95th percentile are considered prehypertensive and an indication for lifestyle modification.^{6,10} Stage 1 hypertension includes measurements between 95 percent and 99 percent, and Stage 2 hypertension includes measurements above 99 percent. The updated guidelines also incorporate accurate numbers corresponding to the 50th, 90th, 95th, and 99th blood pressure percentiles corresponding to age. Primary or essential hypertension is characterized by an elevated reading with no obvious etiology. Most cases of hypertension in children over the age of six fall into this category. Secondary hypertension is more prevalent in children than in adults.^{3,6}

Etiology and Pathophysiology

The onset of clinical hypertension in the pediatric group is the result of the interaction among multiple etiologic factors. Hypertension in the infant or young child often has a secondary cause such as congenital renal or cardiovascular disease.¹⁵ (See Table 2.) Older children might present with reflex ne-

phropathy or nephritis. Acute and chronic parenchymal kidney diseases are the most common comorbidities in adolescents. Congenital renal disease, such as polycystic disease, has also been linked to hypertension in children.^{19,20}

Common medications that cause elevations in blood pressure include cold medications such as decongestants and antihistamines, tricyclic antidepressants, and nonsteroidal anti-inflammatory agents. Among the conditions responsible for the development of secondary hypertension, pheochromocytoma (a catecholamine secreting adrenal tumor) poses a challenging diagnosis in children due to the absence of flushing, tachycardia, and sweating, which are evident in adults with this disorder.^{3,6,14} Other systemic etiologies include Cushing syndrome, primary hyperaldosteronism, and hyperthyroidism. Ulbak reported a significant decrease in blood pressure readings in Danish children with increased protein intake in early life, suggesting a nutritional role in the etiology of hypertension.^{3,21} The validity of nutrition as an etiologic agent for the development of hypertension in children is still under investigation. The following paragraphs briefly review the pathophysiology underlying primary or essential hypertension.

Table 1. Systolic blood pressure levels for boys based on age and height percentiles

Age (years)	BP systolic	Height Percentile						
		5 th	10 th	25 th	50 th	75 th	90 th	95 th
1	50 th	80	81	83	85	87	88	89
	90 th	94	95	97	99	100	102	103
	95 th	98	99	101	103	104	106	106
	99 th	105	106	108	110	112	113	114
2	50 th	84	85	87	88	90	92	92
	90 th	94	95	97	99	100	102	103
	95 th	98	99	101	103	104	106	106
	99 th	109	110	111	113	115	117	117
3	50 th	86	87	89	91	93	94	95
	90 th	100	101	103	105	107	108	109
	95 th	104	105	107	109	110	112	112
	99 th	111	112	114	116	118	119	120
4	50 th	88	89	91	93	95	96	97
	90 th	102	103	105	107	109	110	111
	95 th	106	107	109	111	112	114	115
	99 th	113	114	116	118	120	121	122

Ages 1 through 4. Readings in blue represent prehypertension; readings in yellow represent stage 1 (95 percent) and 2 (99 percent) hypertension. Readings above 99 percent require medical intervention.

Table 2. Conditions that may cause hypertension in children

- Renal parenchymal disease (60-80 percent of hypertension in children)
 - Coarctation of the aorta: the most common nonrenal etiology (5-15 percent of cases)
 - Renal artery stenosis (5-25 percent of cases)
 - Endocrine: excess mineralocorticoids (congenital adrenal hyperplasia) or catecholamine (pheochromocytoma, neuroblastoma)
 - Obesity
 - Solid organ transplants
 - Medications
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The kidneys play an important role in the development of primary hypertension. Elevation of blood pressure occurs when the kidney fails to maintain an adequate volume of extracellular fluid. Increased peripheral resistance (atherosclerosis being one of its causes) is highly indicative of essential hypertension.³ Genetics also plays an increasing role in the development of primary hypertension.^{22,23}

Atherosclerosis is an etiologic agent linked to primary hypertension.^{24,25} The Bogalusa Heart Study examined 204 children postmortem who died accidentally from trauma.²⁴ Antemortem blood pressure readings, obesity, and abnormal lipid profiles were significantly associated with the number of postmortem atherosclerotic lesions. Subjects with no risk factors for cardiovascular disease were found to have 1.3 percent of their intimal blood vessel surfaces covered by plaques, while subjects with four risk factors had an 11 percent of intimal surfaces involved, suggesting a high association between blood pressure and atherosclerosis.⁵

The natural history of atherosclerosis starts with the accumulation of low density lipoprotein (LDL) beneath the endothelial arterial layer. The central core of LDL goes through glycation, a process by which glucose molecules are incorporated into the LDL plaque, attracting monocytes and T lymphocytes.

Clinical Presentation

Elevated blood pressure in children is usually detected during a well child visit. Children with mild to moderate elevation of blood pressure are asymptomatic. Only severe hypertension is symptomatic, causing headache, vision changes, epistaxis, or nausea. Retinal changes observed in adults affected by hypertension are seen in less than 50 percent of pediatric patients.²⁶ Emergent complications of hypertension include encephalopathy, seizures, stroke, acute heart failure, pulmonary edema, dissecting aortic aneurysm, acute renal failure, and eclampsia.^{3,23}

In overt hypertension, the normal nocturnal decrease in blood pressure is lost, implying a loss of homeostasis. Signs and symptoms of organ damage are present only in the late stages of the disease.^{27,28}

Left ventricular hypertrophy (LVH) is the most common target organ abnormality found in childhood.³ LVH is present in 34 to 38 percent of children with mild, untreated hypertension.²⁷⁻²⁹ Pediatric patients with established hypertension should receive echocardiographic evaluation at the time of diagnosis and have periodic follow-up. The presence of LVH is an indicator to initiate or intensify antihypertensive therapy. Sleep histories should be taken from children who have concurrent obesity and hypertension.³ Approximately 15 percent of hypertensive children snore, and between 1 and 3 percent have sleeping disorders. Evaluation for secondary hypertension should be pursued in children with stage 2 hypertension and in the presence of signs suggesting systemic involvement. Symptoms warranting further evaluation include gross hematuria, edema, fatigue, chest pain, exertional dyspnea, palpitations, polyphagia, polyuria, tremors, and joint pain.

Medical Management

Few studies support the efficacy of non-pharmacologic interventions in children and adolescents. Nevertheless, past experience with lifestyle modification and blood pressure in adults is used to justify this approach. In addition, the potential for blood pressure control in children based on weight reduction is supported by longitudinal tracking through adolescence and young adulthood.^{20,22} Weight loss reduces sensitivity to salt and decreases other cardiovascular risk factors. Dietary counseling is recommended for obese children, including increasing consumption of fiber, vegetables, and fruit.²⁵ Regular physical activity and limitation of sedentary practices will complement a weight management approach.

Pharmacologic therapy for hypertension in children has been controversial.³⁰⁻³² In 1999, less than 25 percent of approved antihypertensive medications had been studied in children.^{14,32} Although some progress has been made in this respect, the long-term consequences of antihypertensive therapy in children are unknown. In addition, the late effects of antihypertensive medications on growth and development are also unknown.^{19,30,31} Indications for pharmacologic therapy in children include symptomatic hypertension, secondary hypertension, established target-organ damage, and failure of nonpharmacologic methods. Therapy should be started with a single agent. Approved medications for use in the pediatric population include angiotensin converting enzyme (ACE) inhibitors, angiotensin receptor blockers, calcium channel blockers, and diuretics.^{32,34} The objective of therapy is the reduction of blood pressure below the 95th percentile. If comorbid conditions are present, the goal of therapy is a reduction below the 90th percentile.^{27,29}

Oral Health Considerations

Data on the prevalence of hypertension in the dental setting is scarce.^{35,36} The oral health provider, as part of a primary health care team, is responsible for the physical well-being of his pediatric patients. Office personnel should be trained in blood pressure measurement techniques. Reproducibility of blood pressure in children can be challenging, especially in younger individuals, and the practitioner should be alert for shallow reading ranges in young children. At-risk patients (obese, renal, or cardiovascular disease) should have blood pressure monitoring across visits to account for white coat hypertension induced by the anxiety produced by the dental visit. Even healthy young patients exposed to excessive doses of local anesthetic with vasoconstrictor are susceptible to blood pressure crisis. In the presence of an existent predisposition, the outcome could be fatal.

Protocol for Screening Pediatric Patients in Dental Settings

Table 3 provides a suggested protocol for screening of pediatric patients in the dental setting, highlighting actions before, during, and after treat-

ment. Evaluating children in the dental care setting before treatment includes close follow-up of suspected elevations in blood pressure by taking measurements during consecutive visits and physician consultation. Children with renal disease or a family history of cardiovascular disease should have their blood pressure measured periodically. The guidelines for measurement of blood pressure in children suggest that children above the age of three who are seen in a health care setting should have their blood pressure taken.³⁷ The gold standard for pressure monitoring is the mercury manometer. The preferred method of measurement is auscultation over the use of analog or electronic devices. This oscillometric device, however, must be validated semiannually, and measurements may differ from the ones seen using the auscultatory method.³⁸ The right arm is the extremity of choice for older children. The cuff width should cover approximately 40 percent of mid-arm circumference, at the midpoint between the olecranon and acromion, the anatomic extension of the arm,¹⁴ and its length should cover between 80 and 100 percent of the arm circumference.

Systolic blood pressure is identified by the onset of the first audible pulsation. The diastolic blood pressure is identified by the disappearance of the sounds. In the pediatric age, these pulsations (Korotkoff sounds) may be heard until the gauge reaches the zero mark. In such cases, the measurement should be repeated, reducing the amount of pressure placed on the head of the stethoscope.³⁹ The practitioner should be familiar with the percentile tables that classify hypertension, and these should be readily accessible to any member of the dental team. Objective assessment of the patient's weight is important to establish a relationship with blood pressure.

There is a dearth of literature concerning other oral complications observed in the pediatric hypertensive population, although gingival overgrowth has been reported as a side effect of calcium channel blocking medications in children.³⁵ A detailed periodontal examination is necessary in children who have been treated pharmacologically for an extended period of time. Xerostomia has been associated with hypertensive therapy in adults. Xerostomia has similar clinical manifestations in children with autoimmune and connective tissue disease. Consequently, medication-induced xerostomia in children undergoing treatment for hypertension may lead to caries, periodontal disease, oral ulcerations, and dysgeusia.³⁶

The potential for drug interactions exists in this age group, although, to our knowledge, no prospec-

Table 3. Suggested protocol for screening of pediatric patients in the dental setting

Before treatment

- Assess medical and family history of hypertension and medications.
- Decrease any possible stressors that could induce elevations in blood pressure.
- Elective dental treatment should be deferred in Stage 2 patients.
- Assess control (number of medications, diet, target organ damage: left ventricular hypertrophy and renal dysfunction).
- If uncontrolled, confirm reading at following visit and refer to pediatrician.
- Acquire baseline blood pressure.

During treatment

- No modifications for normotensive patients.
- Stage 1 hypertension and prehypertension:
 - Monitor blood pressure perioperatively.
 - Local anesthetics with vasoconstrictors should be avoided in stage 1 hypertension.
 - Pain control is essential to maintain stability of BP.
 - Assess presence of xerostomia, especially with diuretics.
 - If xerostomia is present, consider the use of fluoride supplements or artificial saliva on a daily basis.
 - Assess the presence of gingival overgrowth with calcium channel blockers.

After treatment

- No modifications in normotensive patients.
 - Stage 1 hypertension and prehypertension:
 - Monitor vital signs post procedure.
 - Do not prescribe more than a ten-day course of NSAIDs due to pharmacologic interactions with BP medications.
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tive studies have been performed in children. The practitioner is cautioned to be aware of the interaction between nonsteroidal anti-inflammatory medications (NSAIDs) and ACE inhibitors, beta adrenergic blocker, and diuretics.⁴⁰ Prescription of NSAIDs in pediatric patients should be limited to a brief period of time (no more than ten days) to avoid decreasing the antihypertensive effect of these medications. Children with poorly controlled hypertension should avoid the use of local anesthetics with vasoconstrictor.

Conclusion

The latest recommendations by the National Blood Pressure Education Program aim to clarify diverse concepts ranging from the ideal blood pressure measurement technique in children to the establishment of threshold values for 50th, 95th, and 99th percentiles associated with gender, age, and height. Due to the escalating incidence of hypertension in children, the responsibility of the dental practitioner is to function as a screener for hypertension

in this age range and to reinforce diet counseling for young patients with weight issues. Dental students and residents should be familiar with the complications and techniques used in the assessment of blood pressure in children. Blood pressure measurement in children can be challenging due to the number of false positive readings, white coat hypertension, and behavior management in very young individuals. Safe provision of dental care to hypertensive children requires knowledge about the etiology of the elevation in blood pressure, oral manifestations, target organ damage, and possible drug interactions. The recommendations presented in this article have been formulated using the available data regarding hypertension in children. Due to the lack of controlled studies on the epidemiology of pediatric hypertension in the dental setting, some of these guidelines have been extrapolated from preliminary data found in the literature. However, the potential for anesthetic complications and the oral sequelae of xerostomia-inducing medications has been well documented. Children with elevated blood pressure and no previous history of cardiovascular disease should be referred to a pediatrician for further workup and diagnosis.

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