Blood pressure (BP) elevation is a well-established risk factor for cardiovascular morbidity and mortality in adults. More recently, it has been established through autopsy studies and studies using noninvasive imaging techniques that BP elevation is also a risk factor for the development of atherosclerosis in childhood and adolescence. Hypertension is a powerful risk factor for left ventricular hypertrophy and for congestive heart failure in adults. It is now clear that BP elevation is also associated with left ventricular hypertrophy in children and adolescents. If cardiovascular disease morbidity and mortality are to be prevented, then children with elevated BP must be identified and appropriately treated. Am J Hypertens 2002; 15:61S–63S © 2002 American Journal of Hypertension, Ltd.

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Blood pressure (BP) elevation is a well-established risk factor for cardiovascular disease (CVD) morbidity and mortality in adult populations. Hypertension is a public health concern because it is common in many populations. It is associated with important adverse outcomes and preventing or treating it is a possibility. It has become clear that BP elevation can begin in childhood and could contribute to the early development of atherosclerosis and other cardiovascular disease.

In adults, hypertension has been associated with cerebrovascular disease, myocardial infarction, renal disease, and other cardiovascular end points.1 For example, in the Seven Countries study, there was a moderate correlation (r = 0.64) between median systolic BP and the 10-year age standardized rates of coronary death.2 In the Framingham study, BP status (normal, borderline, elevated) after 18 years of follow-up was associated with the average annual incidence of coronary heart disease, ischemic stroke, congestive heart failure, and intermittent claudication.3 Every 10 mm Hg increment of systolic BP is associated with an increase in age-adjusted risk of cardiovascular events: 20% at age 35 to 64 years and 13% at age 65 to 94 years. The increase in cardiovascular risk associated with a 10 mm Hg increase in diastolic BP is 13% for individuals aged 35 to 64 years and 19% for those aged 65 to 94 years.4 The risk for stroke and congestive heart failure is highest compared to other adverse outcomes. However, the impact of hypertension on the development of coronary heart disease is important because it is such a common end point. In addition, hypertension is second only to diabetes mellitus as a cause of end-stage renal disease.5

The role of hypertension in the process of atherosclerosis is not completely known. Blood pressure elevation may be involved in both the initiation and acceleration of the atherosclerotic process. The increased shear stress associated with higher BP is probably one mechanism through which the endothelium may be injured. The combination of alteration of the plasma membranes due to elevated LDL cholesterol leading to increased rigidity of the endothelial cells and high pressure with turbulent blood flow could cause retraction of the endothelial cells and produce a denuded endothelium.

Treatment of hypertension has been definitively shown to improve risk of cardiovascular disease in adults. The Veterans Administration Cooperative Study Group reported in 1967 that there was a significant beneficial effect of treating individuals with diastolic BP between 115 and 129 mm Hg.6 More recently, the benefit of treating mild-to-moderate hypertension has also been demonstrated. For example, the Treatment of Mild Hypertension Study (TOMHS) demonstrated a 33% reduction in cardiovascular events after 4 years in subjects who received antihypertensive drug therapy in addition to lifestyle modification compared to control subjects who received lifestyle modification and placebo.7

Unfortunately, despite the knowledge that treatment of high BP prevents subsequent cardiovascular disease, this is often not translated into action for individual patients.
Blood pressure may not be measured. Elevated BP may not be recognized or appropriately treated. Despite improvement in available pharmacologic agents for hypertension control, rates of hospitalization for congestive heart failure are increasing in the United States. In addition, there has been a concern that the trend toward decreasing rates of mortality from stroke may have slowed or even begun to increase, particularly for African Americans. Hypertension in adults has also been associated with increased left ventricular mass. Left ventricular hypertrophy may in part be an end-organ effect of high BP. However, other risk factors may contribute to increased left ventricular mass, such as obesity. Left ventricular hypertrophy appears to be an independent risk factor for the development of CVD. The combination of BP elevation and left ventricular hypertrophy appears to be especially problematic. For example, deSimone et al9 showed that there was a fourfold increase in risk of cardiovascular end points in patients with hypertension who also had left ventricular mass index greater than 51 g/m2.7 The presence of left ventricular hypertrophy in patients with hypertension increases the myocardial oxygen requirement increasing the likelihood of ischemia. Cardiac hypertrophy may also be important in the ultimate development of congestive heart failure.

The phenomenon of tracking confirms that persistent BP elevation in childhood may be related to hypertension in adulthood. This has led to the concern that BP elevation may be important in the early stages of the development of atherosclerosis and other cardiovascular disease. Studies from the Korean War and the war in Vietnam first established that the process of atherosclerosis is well underway in some individuals by the late teenage years or early twenties.10,11 However, it was not possible in such studies to evaluate the association of known risk factors for coronary heart disease with the early stages of development of atherosclerosis. In addition, few, if any, data directly connect a level of BP in childhood with morbidity or mortality from cardiovascular disease in adulthood.

Results from the Bogalusa study have provided a better view of the association between traditional risk factors and development of atherosclerosis.12,13 The Bogalusa Heart Study group performed autopsies on 204 young people, aged 2 to 39 years, who had died from a variety of causes, principally trauma. Of those subjects, 93 also had data on antemortem risk factor status from previous epidemiologic studies of cardiovascular disease risk factors in childhood. Among the cardiovascular risk factors, body mass index, systolic and diastolic BP, and serum lipid and lipoprotein concentrations were strongly associated with the extent of fatty streaks and fibrous plaques in the aorta and coronary arteries seen at autopsy. In addition, the presence of multiple risk factors was associated with an increase in the extent of atherosclerosis on pathologic evaluation. Subjects with 0, 1, 2 and 3 or 4 risk factors had respectively 1.3%, 2.5%, 7.9%, and 11.0% of the coronary artery surface covered with fatty streaks. For fibrous plaques, the corresponding figures were 0.6%, 0.7%, 2.4%, and 7.2%. Statistical analysis showed a significant trend relationship.13

In addition, the Pathobiological Determinants of Atherosclerosis in Young (PDAY) research group recently published results of an analysis of the effects of nonlipid risk factors on atherosclerosis in youth.14 This multicenter study evaluated 629 men and 227 women who had died of external noncardiovascular causes and who had a favorable lipid profile. In this study, three pathologists independently examined the extent to which the intimal surface area of the abdominal aorta and the right coronary artery was involved with fatty streaks and raised lesions. To evaluate the presence of hypertension an algorithm was used to estimate mean arterial pressure from intimal thickness. Among individuals with normal lipids and lipoproteins, hypertensive African American subjects had more raised lesions in the aorta and coronary artery than normotensive African Americans. Of interest, hypertension was not associated with the presence of fatty streaks in either whites or African Americans.15

Although autopsy studies can be useful in providing a direct evaluation of vascular changes, autopsies have severe limitations. They can only evaluate individuals at a single point in time (death) and often must infer risk factor status indirectly. Recently other noninvasive methods of assessment of vascular changes related to atherosclerosis such as assessment of coronary artery calcification by computed tomographic imaging and assessment of carotid artery intimal medial thickness have become available. Mahoney et al16 evaluated the prevalence of coronary artery calcification in young adults who had had risk factor measurements in childhood and again in adulthood as part of the Muscatine study. The prevalence of coronary artery calcification was 31% in young adult men and 10% in women. The risk factors that were associated with coronary artery calcium deposition were obesity, increased BP, and decreased HDL cholesterol. The odds ratio for coronary artery calcification using measurement of BP at age 33 years and the highest decile of systolic BP was 6.4 for both men and women. In a subsequent study, Davis et al17 evaluated the relationship between carotid intimal medial thickness (IMT) and coronary artery calcification. They also studied the relationship between cardiovascular risk factors and carotid IMT in young adults and found that carotid IMT was significantly associated with coronary artery calcification. After adjustment for age, the significant risk factors for carotid IMT were LDL cholesterol and cigarette smoking for men and LDL cholesterol and systolic BP in women. They speculated that because carotid IMT is less thick in women than men, the lesions in women may be at an earlier stage of development, suggesting that BP elevation may be more active in the early stages. Further longitudinal studies will be necessary to address this question.

Left ventricular hypertrophy has also been found to be...
prevalent in children and adolescents with essential hypertension. Daniels et al. studied 130 young patients with persistent BP elevation. They found that 55% of hypertensive patients had left ventricular mass index above the 90th percentile, 14% had left ventricular mass index above the 99th percentile, and 8% had left ventricular mass index above a cutpoint of 51 g/m².², which has been associated with a fourfold increase in risk of cardiovascular end points in adults with hypertension.

It is clear that BP elevation in children and adolescents is not innocuous. It is associated with adverse effects on the heart and the vascular system. These effects may be worse when hypertension is combined with other risk factors, such as obesity, lipid and lipoprotein abnormalities, and cigarette smoking. If cardiovascular disease morbidity and mortality are to be prevented, then children with elevated BP must be identified and appropriately treated.

References


