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Review Article

The two faces of hypertension: role of aortic stiffness

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Abstract

Adult hypertension can be divided into two relatively distinct forms—systolic/diastolic hypertension in midlife and systolic hypertension of the aged. The two types differ in prevalence, pathophysiology, and therapy. The prevalence of systolic hypertension in the elderly is twice that of midlife hypertension. The systolic pressure is elevated in both forms, but the high diastolic pressure in midlife is due to a raised total peripheral resistance, whereas the normal or low diastolic pressure in the elderly is due to aortic stiffening. Aortic stiffness, as measured by the carotid/femoral pulse wave velocity, has been found to be a cardiovascular risk marker independent of traditional risk factors for atherosclerosis. Instead, it is related to microcirculatory disease of the brain and kidney and to disorders of inflammation. Loss of aortic distensibility is an inevitable consequence of aging, but a review of its causes suggests that it may be amenable to future pharmacologic therapy. J Am Soc Hypertens 2016;10(2):175–183.

Keywords: Aging; Arteriosclerosis; Atherosclerosis; Pulse wave velocity.

Introduction

From a hemodynamic standpoint, essential hypertension has been conventionally divided into three groups—diastolic hypertension, systolic/diastolic hypertension, and systolic hypertension. It is the purpose of this article to offer an alternative separation into two main groups—the systolic/diastolic hypertension of midlife (40 to 59 years) and the systolic hypertension of the aged (>60 years). Although this new classification appears little changed from the original, it is alternatively based on an understanding of the age group differences in prevalence, pathophysiology, cardiovascular (CV) complications, and therapy rather than on the blood pressures (BPs) alone. Clearly, the two new groups overlap as the midlife population ages, but the multiple differences that develop with aging are sufficient to consider these two forms of hypertension as relatively distinct—a distinction that allows for better understanding of the entire disease across the entire population. Underscoring the differences between these two forms of hypertension, in addition, requires a review of the role played by increased aortic and arterial stiffness and the growing appreciation of aortic stiffness as an independent CV risk factor.

Population Studies

Hypertension becomes more and more prevalent as the American population ages, and the BP values themselves vary at different ages. In 1995, the National Health and Nutrition Examination Survey (NHANES) published a cross-sectional analysis of 9900 individuals representative of the US population that related their BP to their age.[1] This article showed the now well-known steady rise in systolic blood pressure (SBP) with aging. Perhaps, less well known was that after age 55, the diastolic blood pressures (DBPs) progressively fell. The rise in SBP and fall in DBP after midlife were confirmed in a now classic article from the Framingham study published in 1997.[2] This longitudinal study looked at the effect of aging in more than 2000 subjects with different entry BPs and showed in all BP groups after age 55, a steady rise in SBP and a fall in DBP. The rise in SBP and fall in DBP resulted in a marked increase in pulse pressure (PP) as that population aged.

Conflict of interest: None of the authors have any conflicts of interest to disclose.

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Although the SBP and PP rose and the DBP fell with advancing age, the mean blood pressure (MBP) rose slightly in midlife and then stabilized.

The MBP is often an enigma because it is seldom measured clinically having found limited use as a risk predictor, but it is important in understanding the differences between the two types of hypertension. The MBP is the time-weighted average of the arterial pressure pulse or the pressure that divides the area of the pressure pulse into equal upper and lower halves. Physiologically, it is the pressure that drives the blood steadily through the peripheral resistance where there is no arterial pulsation. Calculation of the brachial MBP from the SBP and DBP requires a bit of arithmetic (PP/3 + DBP) but is now displayed in the digital output of some automatic oscillometric BP devices. The importance of the MBP will become apparent below under pathophysiology.

Epidemiology

In the most recent NHANES, the overall prevalence of hypertension in the United States was 29.1% with an equal distribution between men and women[3] (Figure 1). The prevalence at midlife (ages 40–59 years) for both sexes was 32.4%, whereas that over the age of 60 years was doubled at 65%, a striking difference. Previous NHANES studies have shown the prevalence of hypertension to be 78% more than the age of 75 years[4] and in the 1995 study[1] as high as 80% in black Americans. It is concerning to realize that nearly 4 of 5 of individuals of advanced age are hypertensive and that the already large number of Americans with hypertension will increase as the number of our elderly progressively rises.

Hypertension in the elderly is of a different types than that of midlife. Between ages 50 and 59 years, there is an elevated DBP in approximately half of the cases. By contrast, more than the age of 70, only 10% of the patients have a DBP elevation and the vast majority (90%) has systolic hypertension only.[5] In a related aside, 50% of treatment failures in midlife were due to inadequately controlled DBP elevations, but in the aged, 90% of failures were due to uncontrolled SBP elevations.[5,6] By comparison, diastolic midlife hypertension is relatively easy to treat, whereas the systolic elevation of the aged is difficult.

Pathophysiology

Figure 2 depicts the differences among the arterial pulses in normotensive subjects (pulse A), patients with midlife hypertension (pulse B), and those with systolic hypertension (pulse C). In midlife hypertension, the SBP and DBP are both elevated, both drawn up by the high MBP. The MBP is somewhat higher than normal in systolic hypertension but far lower than that of the MBP in midlife

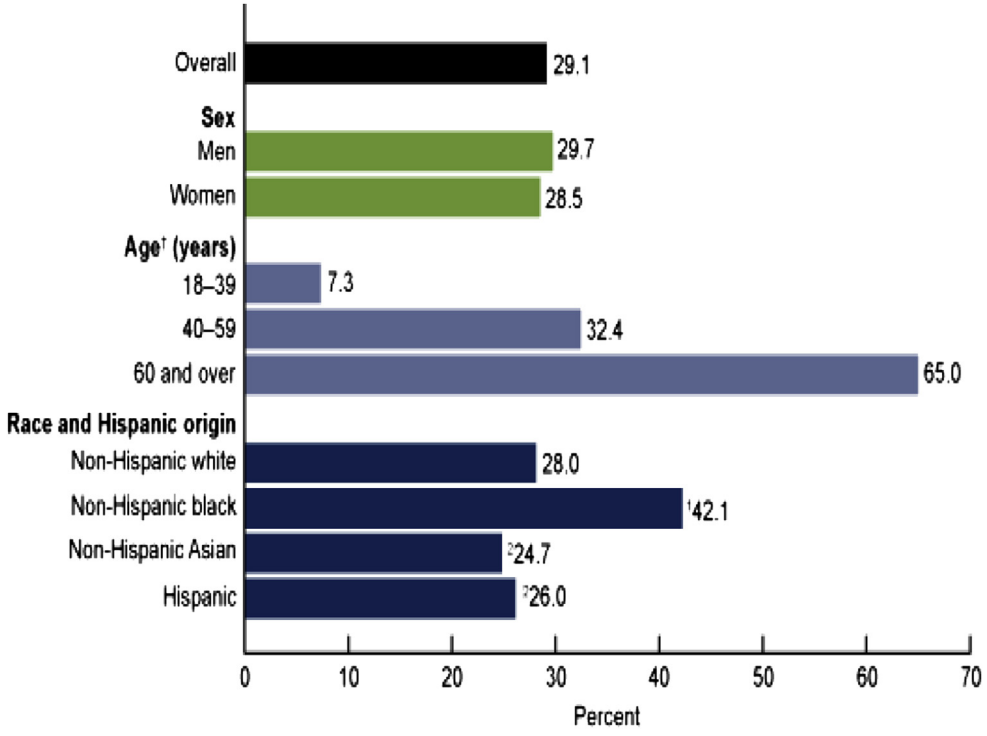

Figure 1. Age-specific and age-adjusted prevalence of hypertension among adults aged 18 years and older. †Significant linear trend; [1]Significantly different from non-Hispanic white; [2]Significantly different from non-Hispanic black. NCHS Data Brief No 133, October 2013.[3]