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Normal Versus Abnormal Central Hemodynamics in the Korean Population

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Chung et al.[1] released an interesting set of data on the reference values for augmentation index (AI) and pulse pressure (PP) in central and peripheral arteries in apparently healthy Korean subjects. Publishing the reference value demarcating normal and abnormal Korean subjects is timely to address the following questions: 1) the change in peripheral and central hemodynamics with age in healthy subjects without cardiovascular (CV) risk factors; 2) differences in hemodynamic changes between men and women, and between older and younger subjects; 3) the effects of CV risk factors, such as hypertension, isolated systolic hypertension, dyslipidemia, diabetes, smoking, increased alcohol intake, obesity, physical inactivity on these hemodynamic changes; 4) the reference value of accelerated vascular aging in Koreans and the differences compared to Caucasian subjects; 5) how these hemodynamic changes occur in patients with established cardiovascular disease (CVD), which will further the understanding of CVD pathogenesis. For the aforementioned reasons, this publication represents a timely start in the collection of data on blood pressure (BP) behaviors in apparently healthy Korean subjects, such as central hemodynamics. It is because the treatment paradigm is changing as the understanding of central hemodynamics is improved over established standards, in the assessment and management of hypertension. I am of the opinion that central BP measurement will soon be adopted in clinical practice.

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Central (aorta and carotid artery) versus brachial hemodynamics

BP measurement using cuff around the brachial artery is fundamental to managing patients with hypertension. The landmark SHEP study demonstrated the importance of systolic BP, particularly in the elderly. New techniques to measure pressure waveforms either at the upper limb (radial artery) or close to the heart (carotid artery), have made it possible to measure central BP and arterial stiffness such as pulse wave velocity (PWV) and AI. Arterial pressure wave is a composite of forward outgoing wave modified by backward reflected waves. Wave reflection is mainly created by impedance mismatch at the branch point of the arterial system and low resistance arterioles.[2] The occurrence of reflected waves leads to progressive boost in wave amplitude, and this amplification causes concurrent changes in the shape, along with variability, in the elasticity along the arterial tree. A key characteristic of the amplification phenomenon is its occurrence in different extents in the peripheral and central arteries. Therefore, brachial PP is not a good surrogate for aortic PP. Thus far, several techniques have been developed for non-invasive analysis of pulse waveforms. The most widely used in clinical studies is applanation tonometry, which uses the principle of flattening the arterial wall that results in normalization of tangential pressure, which is subsequently recorded by a sensor on the flattened surface. Aortic systolic pressure is derived from the radial artery using a generalized transfer function, which characterizes the properties of arteries in the upper limbs. It was initially developed for the measurement of intraocular pressure, and this technique was applied to the measurement of arterial pressure in the 1960s. There is consistency between these two methods when compared directly or when used independently to study drug effects. Hemodynamically,

aortic pressure and stiffening have different impacts: 1) systolic aortic pressure has a direct impact on the left ventricle; 2) diastolic aortic pressure determines coronary perfusion; 3) progressive aortic stiffening with early wave reflection results in a widening of PP. Physiologically, aortic BP is more relevant than brachial BP.[3] Furthermore, histological changes that alter arterial structure, function, and mechanics in particular, increased stiffness, over time appear to be less relevant to the brachial artery. Hemodynamic indices derived from waveforms including PP, PWV and AI are indications of wave reflections.

Over the past 25 years, the combination of cuff with pulse waveform measurements have improved with many epidemiological studies, clinical trials, risk stratification and recently, management of patients with hypertension and high CV risks.[4]

Central pulse pressure ≥50 mmHg is a better predictor of cardiovascular events than brachial pulse pressure

Aortic and carotid PP and AI have been shown to be independently related to target organ damage, the incidence of CVD, and CV events in a number of observational studies. More recently, aortic PP has been shown to be a better predictor of CV events in American Indians and in an un-selected elderly population.[5] However, if aortic PP is to be utilized clinically, a specific threshold for high aortic PP will need to be defined. Preliminary data have recently been reported by the Strong Heart Study investigators.[5] Chung et al.[1] proposed a peripheral PP of 70 mmHg, central PP of 50 mmHg, peripheral AI of 100% and central AI of 40% to be considered the preliminary values in adult subjects. This value is confirmed in a recent prospective outcome study, which showed that central PP was more predictive of the outcome than brachial PP.[6] The hazards ratio (HR) of the fourth quartile compared to the first quartile brachial PP was 1.37 {95% confidence interval (CI) 0.967-1.942}, and that of aortic PP was 1.69 (95% CI 1.20-2.39, $p<0.005$). The event rate in the fourth compared to the first quartile was significantly different only in aortic PP (not for brachial PP). Therefore, a central PP of ≥50 mmHg was significantly related to CV events regardless of sex, age and diabetes.[6] It was mandatory to follow-up these patients in Korea and compare with patients of other ethnicity. For this reason, comparison of central hemodynamic progression according to age between Koreans and Caucasian subjects should be conducted thereafter, because genetic and environmental differences should be considered.

Another interesting finding in this publication surrounds the association of central PP with dyslipidemia. Usually central AI are increased in female, elderly subjects and subjects with hypertension. In this publication, central AI and PP in subjects with dyslipidemia were significantly increased compared to that in subjects without dyslipidemia ($p<0.001$), which is different from previous data. In addition, Williams et al.[8] found that statin therapy that significantly reduce CV events in treated hypertensive patients in ASCOT did not influence central aortic BP, or hemodynamics in a large representative cohort of ASCOT patients in Conduit Artery Function Evaluation-Lipid-Lowering Arm. Therefore more studies are needed to clarify this finding in the Korean population.

In conclusion, it is an important start to collect Korean Data on central and peripheral hemodynamics, and assess changes according to age, sex and in subjects with and without hyperlipidemia, which will guide better management in patients with hypertension.

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