초청 강연 II

Measurement device of arterial stiffness : algorithm and development

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Measurement Device for Arterial Stiffness: algorithm and development

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Hardening of the arteries, and its relation to age, is far from a new phenomenon, and is an important independent risk factor for cardiovascular disease. The fact that arteries stiffen with increasing age, and that such changes are associated with an increased incidence of major cardiovascular events is now established beyond doubt. Early researchers used pulse contour analysis of peripheral pressure waveforms to obtain information about arterial stiffness, but their results were mainly qualitative, and pulse contour analysis was largely abandoned by practicing clinicians, in favor of conventional sphygmomanometry. PWA (pulse wave analysis) is one technique that is simple, reproducible, non-invasive, and provides more information on ventricular vascular interaction than measurements of systolic and diastolic pressure using conventional syphgmomanometry. The forward-going pressure wave is reflected back from sites of impedance mismatch and normally returns to the aorta during diastole, where it serves to maintain coronary artery blood flow. With age and conditions associated with premature vascular aging, such as diabetes and hypercholesterolaemia, arteries stiffen, increasing both the PWV and the amplitude of the reflected wave.

The rate at which pressure waves travel along the arterial tree (PWV, pulse wave velocity) is in part determined by the stiffness of the arterial wall. PWV is determined by dividing the distance between two presssure transducers by the time to travel between characteristic points of two pulse waves. Improved computerized algorithm for determining upstroke points (foot of pulse wave) were developed using intersecting tangent algorithm. Optimum ranges of sampling frequency, frequency bandwidth, and output from the pressure transducer were investigated, and implemented on the regional PWV (large artery, upper limb, and lower limb) diagnosis system, PP-1000, Hanbyul Meditech Co., Ltd, Korea. Standard values for each regional PWV values were acquired from the Saint Mary's Hospital, Catholic University.

Augmentation index (AIx) is a composite of PWV and wave reflection and as such is a good surrogate marker of systemic arterial stiffness. Indeed, recent studies have shown

good agreement between peripheral and central AIx. In clinical practice the AIx has been shown to predict both cardiovascular risk and outcome. Furthermore, recent studies have also shown that AIx coupled with pharmacological stimuli can be adapted for the assessment of endothelial function simply non−invasively in large patient cohorts making the technique suitable for large scale intervention and outcome studies. Measurement of AIx provides a potentially clinically more useful method of assessing the effects of antihypertensive and other cardiovascular drugs than measurement of peripheral blood pressure alone. For the development of an PWA device, clinical study was performed at the Cardiovascular Center, Yonsei University). Central aortic pressure waves using Millar catheter and radial arterial pulse waves using tonometry pressure sensor were acquired simultaneously. Transfer function for estimating central aortic pressure waves from radial arterial pulse was established, and an algorithm for extracting accurate points from pulse contour was established. Developed transfer function and algorithm for pulse contour analysis was proved to provide more accurate results than the ones developed by previous studies for the deviation from −11∓14.34 points to −3.75∓1.26 points. The results were implemented on the PWA device (GAON 21A, Hanbyul Meditech Co., Ltd, Korea).

Measurements of regional PWVs (large artery, upper limb, and lower limb) at the same time would provide more powerful results, and once the pulse waves from various sites are obtained AIx could be derived, and provides a potentially useful method of assessing the effects of structural components within the arterial wall. There is no doubt that the assessment of arterial stiffness together with PWV and AIx will make a major contribution to the improved management of cardiovascular disease in the clinical area and should be included in all future large intervention studies.