FUNDAMENTAL STUDY ON PERIPHERAL VASCULAR SYSTEM INPUT-OUTPUT WAVEFORM MEASUREMENT AND ITS ANALYSIS FOR NON-INVASIVE VASCULAR CONDITION ASSESSMENT.

No. 2281207 Yuki Ando
(Supervised by Prof. Masaki Kyoso)

ABBSTRACT

It has been suggested that when the function of blood vessels is impaired due to lifestyle and obesity, tissues are not supplied with sufficient oxygen and nutrients, leading to the development and progression of a wide range of diseases such as atherosclerosis and hypertension. As tests of vascular function, arterial stiffness in the aorta is measured by pulse wave velocity, while peripheral circulation is measured by reactive hyperemia. In this study, we developed a novel diagnostic method for microvascular lesions using time constant(τ) obtained from the peripheral Wind-Kessel model (WK model). The τ of the WK model was proposed to be used as an indicator for vascular evaluation, as it reflects changes in resistance and vascular elasticity due to a decrease in vascular inner diameter, an increase in the surface roughness of the intima and an increase in blood viscosity. In order to measure τ non-invasively and simply, it is necessary to calculate it from the frequency components of the input signal, the arterial pressure pulse wave (AP), and the output signal, the peripheral volume pulse wave (PV), and the respective pulse wave measurement methods, measurement conditions and analysis methods were studied. Since the PV is considered in the literature to be reflected by the fingertip photoplethysmograph, (1) transmission (IR) and (2) reflection (IR) photoplethysmographs were used. The AP measured using conventionally used (3)air-conduction, (4)reflective (IR) and (5) reflective (Green) photoelectric methods. In this report, the optimal input-output pulse combination method for the proposed τ estimation method was investigated. Three methods, (1) and (3), (1) and (4), and (1) and (5), with aligned fingertip photoelectric pulse wave measurement methods, and two methods, (2) and (4) and (2) and (5), with aligned input-output signal measurement methods were used. The probability of obtaining τ and the fluctuation rate were compared across the five methods. As a result, the method combining (1) and (3) was the best. The air-conduction method was considered to have obtained a waveform proportional to the arterial pressure pulse wave. Ideally, the arterial pressure pulse wave obtained by the photoelectric method should capture only the blood volume changes caused by blood pressure changes, but it is thought that not only the target artery but also the volume changes of the surrounding tissue were captured and a waveform proportional to the arterial blood pressure pulse wave was not obtained. Therefore, it was concluded that the most suitable pulse wave measurement method for measuring peripheral τ is the air conduction method for the AP and the transmission (IR) photoelectric method for the PV.