Clinical Evaluation for the Indirect Measurement of Arterial Stiffness Index

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1. Introduction

The oscillometric method is used as a basic principle for determining the relationship between pressure applied to an artery and arterial extensibility. While using the oscillometric method in our research to measure the value of arterial pressure, we developed a quantification method, the Arterial Stiffness Index (ASI), which provides a value for the factors associated with the stiffness of the arteries. We had already provided notice at our academic conference concerning the principles of measurement using the above method, but as Figure 1 indicates, pattern analysis of the pulse amplitude obtained during blood pressure measurement reveals that this method obtains a numerical value in correlation with the arterial tunica media level's elastic modulus. Since the ASI increases in proportion to arterial hardness, it is an effective method for diagnosing arterial hardening and other pathological changes.

2. Principles of Measurement and Data Evaluation

With the intention of evaluating the clinical significance of the measurement values, we considered the consistency between theoretical inquiry and measurement results. Using the ASI and other indexes associated with blood pressure, we measured: (1) normal subjects in a resting state and under a cold (laboratory) environment; and (2) under a resting state, subjects who have come to a hospital (for a physical or diagnosis). From the analysis of the measurement results for over 500 subjects, we were able to confirm from a physiological point of view that under stress and cold environmental conditions the ASI increases in proportion to the arterial elastic modulus, and furthermore, that the ASI is related to arterial stiffness. Figure 2 summarizes the relationship between blood pressure and ASI. In clinical ASI measurements and blood pressure standard indexes, ASI possesses a high correlation with the systolic blood pressure and pulse pressure, but it is clear that there is almost no connection with mean blood pressure and diastolic blood pressure. According to this finding, which matches current knowledge of increases in pulse pressure and increases in systolic blood pressure as a result of arterial hardening, the ASI is independent of blood pressure. At the same time, we were able to confirm the ASI's normal boundaries and limitations as well as the fact that ASI, in comparison with other known methods of measuring blood pressure, pulse pressure, and pulse wave velocity, has a greater sensitivity and covers a broader scale. In these studies, we have evaluated ASI's degree of reliance as well as its consistency in reproducing the same measurements in the same measurement sessions (reproducibility) and have confirmed that it is this system is both of practical and reliable use.

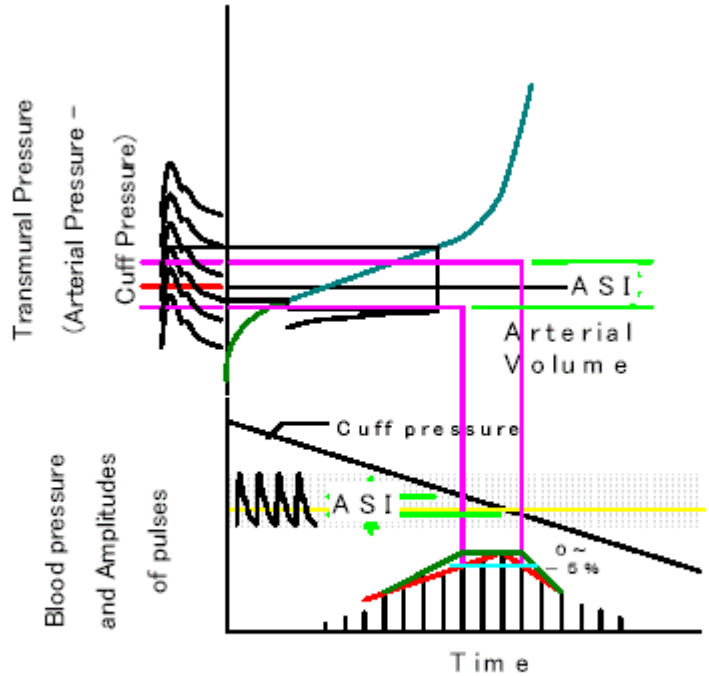

Fig. 1 Schematic diagram illustrating the principle for the determination of arterial stiffness index.

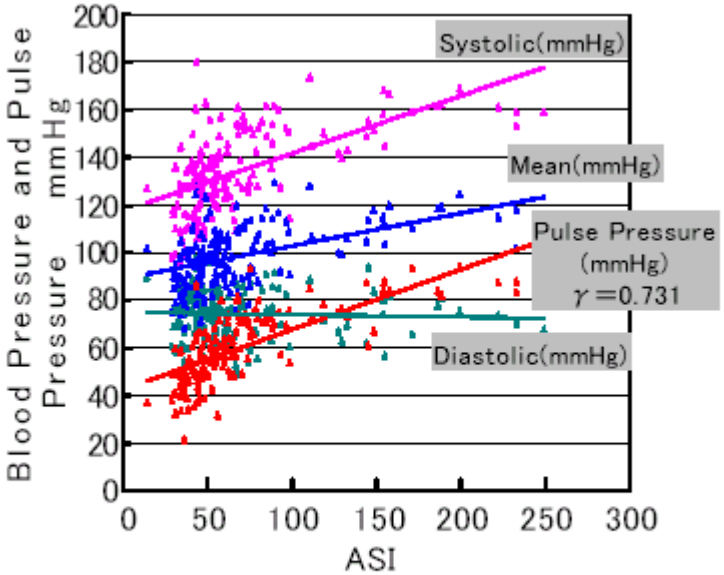

Fig.2 Correlation between blood pressure and ASI measured from patients.