The Association between Level of Brachial-ankle Pulse Wave Velocity and Onset of ADL Impairment in Community-dwelling Older Individuals

Yumi Kuroiwa 1), Ichiro Miyano 1), Masanori Nishinaga 2), Jun Takata 3), Yuji Shimizu 4), Kiyohito Okumiya 5), Kozo Matsubayashi 6), Toshio Ozawa 7), Hiroaki Kitaoka 4), Yoshinori Doi 4), Nobufumi Yasuda 1)

1) Department of Public Health, Kochi Medical School, Nankoku, Japan
2) Department of Internal Medicine, Saitama Memorial Hospital, Saitama, Japan
3) The Center to Promote Creativity in Medical Education, Kochi Medical School, Nankoku, Japan
4) Department of Medicine and Geriatrics, Kochi Medical School, Nankoku, Japan
5) Research Institute for Humanity and Nature, Kyoto, Japan
6) The Center for Southeast Asian Studies, Kyoto University, Kyoto, Japan

Funding sources: a grant-in-aid from the Japanese Atherosclerosis Prevention Fund and the research funding for Longevity Sciences from the National Center for Geriatrics and Gerontology, Japan.

Key words: arterial stiffness, brachial-ankle pulse wave velocity, ADL impairment, fall, mortality
INTRODUCTION

Arterial stiffness, which increases with advancing age, is known to lead to cardiovascular disease. Pulse wave velocity (PWV), known as an indicator of arterial stiffness, is frequently assessed by determining carotid-femoral PWV (cfPWV) or brachial-ankle PWV (baPWV). Increased cfPWV and baPWV has been reported to be associated with increased risks of total or cardiovascular mortality in individuals with chronic conditions, as well as in community-dwelling individuals. In older individuals, it is important to predict not only mortality but also impairment in activities of daily living (ADL). In Japan, the major causes of impairment in ADL include cerebrovascular diseases, dementia, falls, fracture, and disuse syndrome. Arterial stiffness, as determined by cfPWV, has been reported to be associated with the incidence of stroke, prevalence of cognitive dysfunction and reduced thigh muscle mass. However, there are no reports regarding an association between baPWV and the onset of ADL impairment. The purpose of this study was therefore to evaluate the relationship between baPWV level and onset of ADL impairment during three years among community-dwelling older individuals.

METHODS

Study Population
The participants were elderly people who aged 65 years and over living in Kahoku, and 577 individuals who did first time consultation of the medical examination in 2000 to 2003. Of the 577 individuals, 127 were excluded from the present analysis for the following reasons: 18 had baPWV unmeasurable state, 80 had self-reported impairment in ADL items in the baseline questionnaire, 15 had atrial fibrillation, 5 had medical history of arteriosclerosis obliterans (ASO), and 9 had an abnormal ankle/brachial pressure index (ABI) of less than 0.9. Therefore, the effective sample of this study included 450 participants (181 men and 269 women; mean ± SD of age at entry, 76.6 ± 5.7 years).

Brachial-Ankle Pulse Wave Velocity Measurements
Measurements of baPWV and ABI were conducted automatically by a form PWV/ABI instrument (Colin Co., Ltd., Komaki, Japan). Each subject lay in a spine position for at least five minutes before having baPWV / ABI measurements. The measurements were performed twice consecutively and the mean of the two measurements was used. The participants were dichotomized according to a median value of baPWV and that of ABI.
Follow-up Survey for Mortality and Onset of ADL impairment

For participants who died during the follow-up, the date of death was obtained from the death certificate submitted to the municipality. For all participants, the performance of seven ADL items (walking, ascending stairs, eating, dressing, toilet, bathing, and grooming) was evaluated through the annual self-administered questionnaires at study entry and 12, 24, and 36 months. The seven ADL items were rated from 3 to 0 (3, needs no help - 0, totally dependent), and total score ranging from 0 to 21. A total of 450 participants with an ADL score ≥ 20 at study entry were included as the eligible subjects of this study. The participants who scored ≤19 at 12-, 24- or 36-month follow-up were defined as those who experienced the onset of ADL impairment. After excluding 28 participants who died and 13 participants who had unknown ADL status during the follow-up, 409 participants (160 men and 249 women: mean ± SD of age at entry, 76.4 ± 5.7 years) were used in the analyses regarding the association between baPWV levels and onset of ADL impairment. The incidence of medical conditions including cardiovascular disease(CVD) and fall/fracture were evaluated through the annual questionnaires. Participants who reported the onset of ADL impairment in a specific year were grouped according to whether self-reported occurrences of CVD and/or fall/fractures preceded or accompanied the onset of ADL impairment.

Statistical Analysis

A multiple logistic regression model was used to describe the association of baPWV levels dichotomized at the median value with mortality and onset of ADL impairment, while adjusting for age, sex, and blood pressure levels. The association between baPWV and onset of ADL impairment following/accompanying the occurrence of CVD and/or fall/fracture was analyzed. The odds ratio for the onset of ADL impairment following/accompanying respective conditions for comparing high vs. low baPWV was computed with excluding participants who experienced the onset of ADL impairment following/accompanying other conditions. 2-sided P values less than 0.05 were considered statistically significant. All analyses were performed using SPSS 18.0J for Windows (SPSS Japan Inc., Tokyo).
RESULTS
The median of baPWV was 18.61 m/sec for all participants. The participants with baPWV < 18.61 m/sec (n=225) were grouped as the low baPWV, and the subjects with ≥ 18.61 m/sec (n=225) as the high baPWV. During three years of follow-up, 60 had an onset of ADL impairment. The high baPWV group had a higher proportion of participants who died (the high baPWV group vs. the low baPWV group, 9.3% vs. 3.1%) and a higher proportion of those who had an onset of ADL impairment (the high baPWV group vs. the low baPWV group, 20.7% vs. 9.3%). Multiple logistic regression models showed that a high baPWV level was significantly associated with an increased risk of mortality (adjusted odds ratio (OR) = 3.22, 95% confidence interval (CI) = 1.26–8.22), and with an increased risk for onset of ADL impairment (adjusted OR = 1.94, 95% CI = 1.03–3.63) after adjustment for age, sex, and systolic blood pressure (SBP). A high baPWV group had an increased risk for the onset of ADL impairment following/accompanying fall/fracture only (adjusted OR = 5.40, 95% CI = 1.11–26.38).

DISCUSSION
In this study, the high baPWV group had a higher proportion of participants with the onset of ADL impairment following/accompanying fall/fracture as compared to the low baPWV group. It is therefore suggested that high baPWV levels reflect clinical conditions that present risks for falls/fractures. In older individuals, clinical conditions, such as sarcopenia and cognitive impairment, are risk factors for falls/fractures. The association between high baPWV and onset of ADL impairment is mediated by sarcopenia which is known to be related to weakened lower extremity performance and to be a risk factor for falls/fractures and functional disability. Previous studies have suggested that the mechanisms of sarcopenia are related to atherosclerosis. Cytokines, insulin-like growth factor (IGF)-I and androgens were reported to be involved in arterial stiffness. These may be pathophysiologic changes that underlie both of sarcopenia and arterial stiffness. Another possibility is that individuals with elevated baPWV are more likely to have silent cerebral small vessel diseases. The association between baPWV and ADL impairment is mediated by cerebral small vessel disease which elevates the prevalence of cognitive impairment and gait disturbances.

In conclusion, the present study indicates that the assessment of arterial stiffness by baPWV contributes to identifying functionally independent community-dwelling older individuals at risk for ADL impairment, in particular ADL impairment associated with fall/fracture, as well as for mortality.