Association of Postural Instability With Asymptomatic Cerebrovascular Damage and Cognitive Decline
The Japan Shimanami Health Promoting Program Study

Yasuharu Tabara, PhD; Yoko Okada, MD, PhD; Maya Ohara, MD; Eri Uetani, MD, PhD; Tomoko Kido, MD, PhD; Namiko Ochi, MD, PhD; Tokihisa Nagai, MD, PhD; Michiya Igase, MD, PhD; Tetsuro Miki, MD, PhD; Fumihiko Matsuda, PhD; Katsuhiko Kohara, MD, PhD

Background and Purpose—Asymptomatic cerebral small-vessel disease (cSVD) in elderly individuals are potent risk factors for stroke. In addition to common clinical risk factors, postural instability has been postulated to be associated with cSVD in older frail patients. Here, we conducted a cross-sectional study to understand the possible link between postural instability and asymptomatic cSVD further, namely periventricular hyperintensity, lacunar infarction, and microbleeds, as well as cognitive function, in a middle-aged to elderly general population (n=1387).

Methods—Postural instability was assessed based on one-leg standing time (OLST) and posturography findings. cSVD was evaluated by brain MRI. Mild cognitive impairment was assessed using a computer-based questionnaire, and carotid intima-media thickness as an index of atherosclerosis was measured via ultrasonography.

Results—Frequency of short OLST, in particular <20 s, increased linearly with severity of cSVD (lacunar infarction lesion: none, 9.7%; 1, 16.0%; ≥2, 34.5%; microbleeds lesion: none, 10.1%; 1, 15.3%; ≥2, 30.0%; periventricular hyperintensity grade: 0, 5.7%; 1, 11.5%; ≥2, 23.7%). The association of short OLST with lacunar infarction and microbleeds but not periventricular hyperintensity remained significant even after adjustment for possible covariates (lacunar infarction, P=0.009; microbleeds, P=0.003; periventricular hyperintensity, P=0.601). In contrast, no significant association was found between posturographic parameters and cSVD, whereas these parameters were linearly associated with OLST. Short OLST was also significantly associated with reduced cognitive function independent of covariates, including cSVD (P=0.002).

Conclusions—Postural instability was found to be associated with early pathological changes in the brain and functional decline, even in apparently healthy subjects. (Stroke. 2015;46:00-00. DOI: 10.1161/STROKEAHA.114.006704.)

Key Word: stroke, lacunar.
postural instability was an initially planned study theme. Here, we conducted a cross-sectional study to understand the possible link between postural instability and asymptomatic cSVDs further—namely, PVH, lacunar infarction, and microbleeds—in a middle-aged to elderly general population. As we previously showed that individuals with mild cognitive impairment, particularly those with Alzheimer disease, were prone to instability while standing on 1 leg, we attempted to gather more evidence in the present study.

Methods

Study Subjects

The study subjects were 1387 apparently healthy middle-aged to elderly individuals who were consecutive participants in the medical checkup program at Ehime University Hospital Anti-aging Center from February 2006 to June 2013. This medical checkup is provided to general residents of Ehime Prefecture, Japan, and is specifically designed to evaluate aging-related disorders, including atherosclerosis, cardiovascular disease, physical function, and mild cognitive impairment. A full list of clinical parameters measured in the medical checkup program is presented in Table I in the online-only Data Supplement. Evaluation of diagnostic and prognostic significance of postural instability was an initially planned study theme.

Recruitment was performed via mass communications, such as internet homepages, periodical newspapers in the local community, and commercial newspapers, and a total of 1816 individuals gave written informed consent to this study. Of the 1691 middle-aged to elderly individuals aged ≥25 years at enrollment, those who were free from symptomatic stroke (n=1619), underwent brain MRI (n=1417), were not taking drugs for dementia or dizziness (n=1398), were not taking insulin therapy (n=1393), and completed all clinical measurements (n=1387) were ultimately included in this analysis.

Assessment of Postural Instability

One-leg standing time (OLST) with eyes open was used as an index of postural stability, with the leg selected by the subject. Time interval until the raised leg was put down was measured twice, with a maximum time of 60 s allowed. The better of the 2× was used for statistical analysis.

Postural instability was also measured using a posturograph (Gravicorder G-5500; Anima Inc, Tokyo, Japan) consisting of an equilateral triangular footplate with 3 built-in vertical force transducers to determine instantaneous fluctuations in the center of pressure. Signals were processed by a DC amplifier and low-pass filters (cutoff frequency 10 Hz) and stored in a computer after analog-digital conversion at a sampling rate of 20 Hz. Subjects were instructed to maintain a static upright posture on the footplate with their feet together while watching a circular achromatic target placed 200 cm ahead of their eye point. Data were acquired for 1 minute, beginning after the subject’s posture had stabilized. The subject then rested for 1 minute while seated, after which the measurement was repeated with the eyes closed to assess the effects of visual feedback on postural stability. All measurements were performed barefoot with both arms held at the side of the body. Path length and circumferential area of the center of pressure movement were considered parameters for movement of center of gravity and used as indices of postural stability.

MRI and Assessment of Silent Cerebral Damage

The presence of cSVDs, including lacunar infarctions, PVH, and microbleeds, was evaluated based on findings on brain MRI with a 3-tesla scanner (Signa Excite 3.0T; GE Healthcare, Milwaukee, WI). MRI was performed within 1 month before the clinical measurements (mean, 19±10 days). The following images parallel to the orbitomeatal line were obtained: T1-weighted axial images (repetition time, 2000.0 ms; echo time, 16.0 ms; thickness, 6.0 mm; gap, 1.0 mm; matrix, 288×224), T2-weighted axial images (repetition time, 4800.0 ms; echo time, 92.0 ms; thickness, 6.0 mm; gap, 1.0 mm; matrix, 512×256), fluid-attenuated inversion recovery images (repetition time, 11000.0 ms; echo time, 140.0 ms; thickness, 6.0 mm; gap, 1.0 mm; matrix, 288×224), and gradient-echo (T2*-weighted) images (repetition time, 600.0 ms; echo time, 7.2 ms; thickness, 6.0 mm; gap, 1.0 mm; matrix, 320×192). Lacunar infarction was defined as areas of low signal intensity (3- to 15-mm diameter) on T1-weighted images and of high intensity on T2-weighted and fluid-attenuated inversion recovery images. Microbleeds were defined as small (2- to 5-mm diameter) hypointense lesions on T2*-weighted images. Such lesions within the subarachnoid space and areas of symmetrical hypointensity in the globus pallidus on T2*-weighted images were considered likely to represent adjacent pial blood vessels and calcifications, respectively, and were therefore ignored. PVH were defined as white matter hyperintensities depicted on T2-weighted and fluid-attenuated inversion recovery images in contact with the ventricular wall. PVH was further classified into 5 grades according to a scale developed by Shinohara et al and later modified and published as a guideline by the Japan Brain Dock Society, as follows: grade 0, absent or only a rim; grade 1, limited lesion-like caps; grade 2, irregular halo; grade 3, irregular margins and extension into the deep white matter; and grade 4, extension into the deep white matter and subcortical portion. PVH grade ≥2 was considered a pathological condition according to the guideline, as well as based on our previous findings indicating a greater frequency of left ventricular hypertrophy and microbleeds in subjects showing PVH grade ≥2 than in those with lower scores. Imaging analysis was performed by neurologists without clinical information on the subject.

Assessment of Mild Cognitive Impairment

Mild cognitive impairment was assessed using a Touch Panel-type Dementia Assessment Scale (TDAS), which was specifically designed to rate cognitive dysfunction quickly and without the need for a special rater. This test battery consists of the following 4 tasks, which were performed in a fixed order: a 3-word memory test for assessing immediate memory, temporal orientation test, 3-dimensional visual-spatial perception test, and delayed recall test for assessing short-term memory. The TDAS provides for a maximum score of 15 points, and a score of 13 was suggested as a cutoff point in discriminating cognitive impairment in a previous study. Details of this rating system have been described elsewhere.

Arterial Parameters

We measured carotid intima-media thickness (IMT) as an index of arteriosclerosis. To measure IMT, ultrasonography of the common carotid artery was performed using an SSD-3500SV or c10 ultrasonograph (Aloka Co, Ltd, Tokyo, Japan) with a 7.5-MHz probe. After 5-minute resting in the supine position, optical visualization of the bilateral carotid arteries was obtained with the subject’s head tilted slightly upward in the midline position. IMT of the far wall was measured from B-mode images using onboard software, which simultaneously measured IMT at 3 points at 1-cm intervals. Nine IMTs of the far wall were measured at 1-cm intervals proximal to the bulb from the anterior, lateral, and posterior approaches. Mean
IMT calculated from the 9 readings was used in the analysis. No measurements were taken at the discrete plaque level.

**Basic Clinical Parameters**

Basic clinical parameters used in this study were measured through the medical checkup program. Brachial blood pressure was measured after 5-minute resting in the sitting position (HEM-9000AI; Omron Healthcare, Kyoto, Japan). Hypertension was defined as either or both systolic blood pressure ≥140 mm Hg or diastolic BP ≥90 mm Hg, or taking antihypertensive drugs. Type 2 diabetes mellitus was defined as any or all of the following: plasma glucose ≥126 mg/dL, glycohemoglobin A1c ≥6.5%, or taking antihyperglycemic drugs.

**Statistical Analysis**

Differences in numeric variables were assessed by ANOVA, whereas frequency difference was assessed by a χ² test. Covariate adjusted analysis was performed by linear regression analysis. Factors independently associated with number or grade of cSVDs were assessed by a Poisson regression analysis, whereas a Tobit model with Weibull distribution was used in the multivariate analysis for OLST. Statistical analyses were conducted using commercially available statistical software (JMP version 9.0.2; SAS Institute Inc, Cary, NC) or the free R software (R version 3.0.2, http://www.r-project.org), with P<0.05 considered statistically significant.

**Results**

Clinical characteristics of the study subjects are shown in Table 1. Differences in the clinical parameters by the presence of cSVD are summarized in Table 2. Subjects with any cSVD tended to be older, more frequently hypertensive, and had higher carotid IMT than those without.

Frequency of short OLST, particularly OLST<20 s, increased linearly with number of lacunar infarctions (P=0.001), number of microbleeds (P=0.023), and PVH grade (P=0.001; Figure 1). Therefore, we used OLST 20 s as a cutoff point. Although several clinical parameters differ based on the presence of cSVD (Table 2), the associations of short OLST with lacunar infarction and microbleeds but not PVH remain significant even after adjustment for the covariates (Table 3). These associations were also found in a subanalysis with elderly subjects (≥65 years; lacunar infarction, P=0.007; microbleeds, P=0.021; PVH, P=0.653). However, conversely, evidence of cSVD was not identified as an independent determinant for OLST (lacunar infarction, P=0.717; microbleeds, P=0.737; PVH, P=0.347) on Tobit regression analysis adjusted for age, sex, body mass index, current smoking, neuropsychiatric medication, hypertension, type 2 diabetes mellitus, and carotid IMT. Age and body mass index were identified as major determinants for OLST (P=0.001).

A significant linear correlation was noted between OLST and posturographic parameters for center of gravity movement (Table 4). However, although the posturographic parameters differed significantly based on the presence of cSVD in crude analysis, these associations disappeared in the covariates-adjusted analysis (Table 4).

Association between OLST and cognitive function is illustrated in Figure 2. Short OLST was significantly associated with lower TDAS score (Figure 2) and vice versa (ie, individuals with TDAS score <13 points had significantly shorter mean OLST than subjects with higher scores; 44.9±20.9 versus 52.4±15.9 s; P<0.001 [Tobit regression analysis]). Although subjects with cSVD had significantly lower TDAS scores overall (lacunar infarction, 14.0±1.5 versus 14.2±1.0; P=0.007; microbleeds, 14.0±1.4 versus 14.2±1.1; P=0.038; and PVH, 13.9±1.4 versus 14.3±1.0; P<0.001), the association of short OLST with TDAS score was independent of possible covariates, including cSVD (Figure 2). We included lacunar infarction, microbleeds, and PVH in a same regression model. However, no severe collinearity was detected among these factors (variation inflation factor: lacunar infarction; 1.16; microbleeds, 1.14; and PVH, 1.30).
In the present study, we showed that short OLST (<20 s) but not posturographic parameters for center of gravity movement was significantly associated with cSVDs in an apparently healthy general population of middle-aged to elderly individuals. To our knowledge, this is the first study reporting the independent association of OLST with lacunar infarction and microbleeds, with the previously reported possible association of OLST with PVH not observed in our data set. Short OLST was also independently associated with impaired cognitive function.

The relationship between postural instability and PVH has been investigated in several studies,10–16 with results consistently supporting the positive relationship between the 2 parameters; however, few studies have been concluded on lacunar infarction, and even fewer on microbleeds. One strength of our present study was, therefore, the concomitant evaluation of cSVDs and findings of a positive association of postural instability with lacunar infarction and microbleeds. We also evaluated cognitive function and found a cSVD-independent association of postural instability with cognitive decline. Elucidation of postural instability as a factor for not only brain histological change but also functional decline was another strength of our study.

No significant association was found between postural instability and PVH, even in the subanalysis in elderly subjects although several previous studies have reported greater severity of PVH in subjects with short OLST or low physical function.11–14 Although reasons for the discrepancy are unclear, our results suggest that postural instability might not always be associated with PVH. Subtypes of first-ever stroke observed in both hospital-based or community-based longitudinal studies

### Table 2. Differences in Clinical Parameters Based on the Presence of cSVD

<table>
<thead>
<tr>
<th></th>
<th>Lacunar Infarction</th>
<th>Microbleeds</th>
<th>PVH</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>cSVD</strong></td>
<td>Mean±SD</td>
<td>P Value</td>
<td>Mean±SD</td>
</tr>
<tr>
<td>Age, y</td>
<td>70±7</td>
<td>&lt;0.001*</td>
<td>70±7</td>
</tr>
<tr>
<td>Sex (male %)</td>
<td>46.3 0.097</td>
<td></td>
<td>44.6</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>23.6±3.2 0.179</td>
<td></td>
<td>23.3±3.1</td>
</tr>
<tr>
<td>Neuropsychiatric drugs, %</td>
<td>15.5 0.204</td>
<td></td>
<td>13.0</td>
</tr>
<tr>
<td>Hypertension, %</td>
<td>74.8 &lt;0.001*</td>
<td></td>
<td>79.4</td>
</tr>
<tr>
<td>Type 2 diabetes mellitus, %</td>
<td>18.7 0.115</td>
<td></td>
<td>21.7</td>
</tr>
<tr>
<td>Carotid IMT, mm</td>
<td>0.84±0.13 &lt;0.001*</td>
<td></td>
<td>0.84±0.14</td>
</tr>
</tbody>
</table>

Values are mean±SD or frequency. Differences in numeric variables were assessed by ANOVA, whereas frequency difference was assessed by a χ² test. cSVD was defined as presence of lacunar infarction, microbleeds, and PVH grade ≥2. BMI indicates body mass index; cSVD, cerebral small-vessel disease; IMT, intima-media thickness; and PVH, periventricular hyperintensity.

*Statistical significance.

### Discussion

In the present study, we showed that short OLST (<20 s) but not posturographic parameters for center of gravity movement was significantly associated with cSVDs in an apparently healthy general population of middle-aged to elderly individuals. To our knowledge, this is the first study reporting the independent association of OLST with lacunar infarction and microbleeds, with the previously reported possible association of OLST with PVH not observed in our data set. Short OLST was also independently associated with impaired cognitive function.

The relationship between postural instability and PVH has been investigated in several studies,10–16 with results consistently supporting the positive relationship between the 2 parameters; however, few studies have been concluded on lacunar infarction, and even fewer on microbleeds. One strength of our present study was, therefore, the concomitant evaluation of cSVDs and findings of a positive association of postural instability with lacunar infarction and microbleeds. We also evaluated cognitive function and found a cSVD-independent association of postural instability with cognitive decline. Elucidation of postural instability as a factor for not only brain histological change but also functional decline was another strength of our study.

No significant association was found between postural instability and PVH, even in the subanalysis in elderly subjects although several previous studies have reported greater severity of PVH in subjects with short OLST or low physical function.11–14 Although reasons for the discrepancy are unclear, our results suggest that postural instability might not always be associated with PVH. Subtypes of first-ever stroke observed in both hospital-based or community-based longitudinal studies

![Figure 1. A–C. Association between cerebral small-vessel diseases and one-leg standing time (OLST). Number of each subgroup is shown in parentheses.](http://stroke.ahajournals.org/)

Downloaded from http://stroke.ahajournals.org/ by guest on July 14, 2017
are known to differ significantly between Japanese population and whites in Western countries, with the Japanese proving more prone to hemorrhage stroke. Furthermore, the proportion of lacunar stroke to total ischemic stroke in Japan was higher than that reported in Western countries. Given these previous epidemiological data, some ethnic differences might be involved in the differences in relationships of physiological instability and PVH between our study population and whites.

**Table 3. Poisson Regression Analysis for Cerebral Small-Vessel Disease**

<table>
<thead>
<tr>
<th></th>
<th>No. of Lacunar Infarction</th>
<th>No. of Microbleeds</th>
<th>PVH Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>P Value</td>
<td>Coefficient</td>
</tr>
<tr>
<td>Age, y</td>
<td>0.036</td>
<td>0.041*</td>
<td>0.027</td>
</tr>
<tr>
<td>Sex (male)</td>
<td>0.013</td>
<td>0.876</td>
<td>0.014</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>-0.011</td>
<td>0.675</td>
<td>-0.024</td>
</tr>
<tr>
<td>Current smoking</td>
<td>0.443</td>
<td>0.001*</td>
<td>0.203</td>
</tr>
<tr>
<td>Neuropsychiatric medication</td>
<td>-0.004</td>
<td>0.969</td>
<td>-0.248</td>
</tr>
<tr>
<td>Hypertension</td>
<td>0.321</td>
<td>&lt;0.001*</td>
<td>0.716</td>
</tr>
<tr>
<td>Type 2 diabetes mellitus</td>
<td>0.019</td>
<td>0.858</td>
<td>0.021</td>
</tr>
<tr>
<td>Carotid IMT, mm</td>
<td>0.686</td>
<td>0.224</td>
<td>0.763</td>
</tr>
<tr>
<td>OLST (&lt;20 s)</td>
<td>0.260</td>
<td>0.015*</td>
<td>0.334</td>
</tr>
</tbody>
</table>

BMI indicates body mass index; IMT, intima-media thickness; OLST, one-leg standing time; and PVH, periventricular hyperintensity.

**Table 4. Associations Between cSVD and Posturographic Parameters**

<table>
<thead>
<tr>
<th></th>
<th>Path Length, cm</th>
<th>Circumference Area, cm²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>P Value</td>
</tr>
<tr>
<td></td>
<td>Mean±SD</td>
<td>Crude Adjusted</td>
</tr>
<tr>
<td>Eyes open</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OLST, s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>83±25</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>&lt;60</td>
<td>101±30</td>
<td></td>
</tr>
<tr>
<td>&lt;40</td>
<td>102±35</td>
<td></td>
</tr>
<tr>
<td>&lt;20</td>
<td>115±46</td>
<td></td>
</tr>
<tr>
<td>Lacunar infarction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>99±33</td>
<td>0.001*</td>
</tr>
<tr>
<td>−</td>
<td>89±31</td>
<td></td>
</tr>
<tr>
<td>Microbleeds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>96±33</td>
<td>0.070</td>
</tr>
<tr>
<td>−</td>
<td>89±31</td>
<td></td>
</tr>
<tr>
<td>PVH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>100±33</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>−</td>
<td>88±31</td>
<td></td>
</tr>
<tr>
<td>Eyes closed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OLST, s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>131±56</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>&lt;60</td>
<td>174±82</td>
<td></td>
</tr>
<tr>
<td>&lt;40</td>
<td>172±108</td>
<td></td>
</tr>
<tr>
<td>&lt;20</td>
<td>186±100</td>
<td></td>
</tr>
<tr>
<td>Lacunar infarction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>161±87</td>
<td>0.004*</td>
</tr>
<tr>
<td>−</td>
<td>142±71</td>
<td></td>
</tr>
<tr>
<td>Microbleeds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>153±75</td>
<td>0.178</td>
</tr>
<tr>
<td>−</td>
<td>143±72</td>
<td></td>
</tr>
<tr>
<td>PVH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>164±84</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>−</td>
<td>141±70</td>
<td></td>
</tr>
</tbody>
</table>

Values are mean±SD. Adjusted factors were age, sex, body mass index, current smoking, neuropsychiatric medication, hypertension, type 2 diabetes mellitus, and carotid intima-media thickness. Small-vessel disease was defined as presence of lacunar infarction, microbleeds, and PVH grade ≥2. cSVD indicates cerebral small-vessel disease; OLST, one-leg standing time; and PVH, periventricular hyperintensity.

*Statistical significance.
the relevance of gait dysfunction to brain abnormalities further supports the importance of balance-function as a physical factor for cSVD.

Several limitations to the present study warrant mention. First, we measured postural instability using a posturograph for 60 s. Previous studies have suggested that 3 trials of 120-s measurements are needed to obtain reliable results; as such, our findings for OLST may lead to underestimation. Second, we measure neither physical functions, such as gait speed or gait abnormality, nor history or incident of falls. These data would help further clarify the relationship between physical function and brain abnormalities, including impaired cognitive function. Third, the present study is a cross-sectional design. Additional longitudinal studies are, therefore, required to clarify the prognostic significance of postural instability.

Summary
Our data from community-dwelling residents identifies postural instability as a factor in early pathological changes in the brain and functional decline, even in apparently healthy subjects. In older individuals, comprehensive geriatric assessment of frailty has been reported useful in increasing hospitalized patient’s survival duration. Furthermore, complex intervention was reported to be useful in helping community-dwelling elderly people to live independently. Comprehensive geriatric assessment is usually defined as a multidimensional diagnostic process focused on determining medical, psychological, and functional capability of a frail older patient. Our findings incorporate postural instability as an important measure of comprehensive geriatric assessment, and individuals showing postural instability should subsequently receive increased attention because this instability may signal potential brain abnormalities and cognitive decline.

Acknowledgments
We thank Yoko Ochi and Hideka Fuyuki for their help in collecting clinical data.

Sources of Funding
This study was supported by Grants-in-Aid for Scientific Research from The Ministry of Education, Culture, Sports, Science and Technology of Japan; The Ministry of Health, Labour and Welfare of Japan; The Japan Arteriosclerosis Prevention Fund; and a Research Promotion Award from Ehime University.

Disclosures
None.

References


Association of Postural Instability With Asymptomatic Cerebrovascular Damage and Cognitive Decline: The Japan Shimanami Health Promoting Program Study

Yasuharu Tabara, Yoko Okada, Maya Ohara, Eri Uetani, Tomoko Kido, Namiko Ochi, Tokihisa Nagai, Michiya Igase, Tetsuro Miki, Fumihiko Matsuda and Katsuhiko Kohara

*Stroke.* published online December 18, 2014;
*Stroke* is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2014 American Heart Association, Inc. All rights reserved.
Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://stroke.ahajournals.org/content/early/2014/12/18/STROKEAHA.114.006704

Data Supplement (unedited) at:
http://stroke.ahajournals.org/content/suppl/2016/04/06/STROKEAHA.114.006704.DC1
http://stroke.ahajournals.org/content/suppl/2016/04/07/STROKEAHA.114.006704.DC2

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in *Stroke* can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to *Stroke* is online at:
http://stroke.ahajournals.org//subscriptions/
背景および目的：高齢者における無症候性脳血管病（cSVD）は脳卒中の中の強力な危険因子である。一般的な臨床的危険因子に加え、虚弱な高齢患者では姿勢保持障害もcSVDと関連していると考えられている。我々は、脳室周囲高信号域、ラクナ梗塞、および脳微小出血などの無症候性cSVD、および認知機能低下が姿勢保持障害と関連する可能性についてさらに理解を深めるため、中高年の一般集団（n = 1,387）を対象として横断的試験を行った。

方法：姿勢保持障害は片脚立ち時間（OLST）と姿勢動揺検査所見に基づいて評価した。cSVDは脳MRIで評価した。軽度認知機能障害のコンピュータを使ったアンケートを用いて評価し、アテローム硬化的指標である頸動脈内膜中膜肥厚は超音波検査で測定した。

結果：短いOLSTの頻度、特に< 20秒の頻度はcSVDの重症度（ラクナ梗塞症候：な subtotal 9.7%、1個は16.0%、≥ 2個は34.5%、脳微小出血：なしは10.1%、1個は15.3%、≥ 2個は30.0%、脳室周囲高信号域のグレード：0は5.7%、1は11.5%、≥ 2は23.7%）と共に直線的に増加した。可能な共変量で調整後も短いOLSTとラクナ梗塞および脳微小出血の関連は有意であったが、脳室周囲高信号域との関連は有意ではなかった（ラクナ梗塞p = 0.009、脳微小出血p = 0.003；脳室周囲高信号域p = 0.601）。これとは対照的に、姿勢動揺検査のパラメーターとcSVDには有意な関連は認められず、これらのパラメーターはOLSTと直線的に関連していた。短いOLSTもcSVDなどの共変量とは関連せず、認知機能低下と有意に関連していた（p = 0.002）。

結論：健康を見える中高年者においても、姿勢保持障害は脳の早期の病理学的変化と機能低下に関連していることが明らかになった。

Stroke. 2015;46: 16-22. DOI: 10.1161/STROKEAHA.114.006704.
체위불안정과 무증상 뇌혈관 손상 및 인지 기능 저하 사이의 관련성

일본 시마다미 건강 증진 계획 연구

Association of Postural Instability With Asymptomatic Cerebrovascular Damage and Cognitive Decline

The Japan Shimanami Health Promoting Program Study

Yasuharu Tahara, PhD; Yoko Okada, MD, PhD; Maya Ohara, MD; Eri Uetani, MD, PhD; Tomoko Kido, MD, PhD; Namiko Ochi, MD, PhD;
Tokihiisa Nagai, MD, PhD; Michiya Igase, MD, PhD; Tetsuro Miki, MD, PhD; Fumihiko Matsuda, PhD; Katsuhiro Kohara, MD, PhD

(Stroke. 2015;46:16-22.)

Key Word: stroke, lacunar

배경과 목적

노인에서 발견되는 무증상 뇌 소혈관 질환(cerebral small-vessel disease, cSVD)은 뇌졸중의 강력한 위험 인자이다. 일반적으로 알려진 임상적 위험 인자와 함께, 체위불안정은 고령의 최악의 노인에서 cSVD와 관련되어 있을 것이라는 가설이 제안된 바 있다. 본 연구에서 저자는 중년 및 노년 연령층의 일반인(n=1387)을 대상으로 하여, 체위불안정과 무증상 cSVD(뇌실주위 고신호 강도, 열공성 뇌경색 및 미세 출혈) 및 인지 기능 사이의 잠재적인 연결 과리의 파해치기 위한 단면 연구를 수행하였다.

방법

체위불안정은 일측 적립 시간(one-leg standing time, OLST) 및 체위구리목(posturography) 결과로 측정하였다. cSVD는 뇌 자기공명영상으로 평가하였다. 정도 인지장애는 치유기억 기반한 설문지로 측정하였으며, 경동맥 내막중막두께(intima-media thickness)는 초음파활성으로 측정하였으며 측정성분증의 지표로 간주하였다.

결과

특히 20초 미만의 짧은 OLST 변인은 cSVD 중증도와 독립적인 상관 관계를 보였다(열공성 뇌경색 손상: 없음, 9.7%; 1, 16.0%; 2개 이상, 34.5%; 미세 출혈: 없음, 10.1%; 1, 15.3%; 2개 이상, 30.0%; 뇌실주위 고신호 강도: 0, 5.7%; 1, 11.5%; 2 이상, 23.7%). 잠재적인 공반변동을 보정한 후, 짧은 OLST는 열공성 중 및 미세 출혈과 연관되어 있었지만 뇌실주위 고신호 강도는 그렇지 않았다(열공성중층, P=0.009; 미세 출혈, P=0.003; 뇌실 주위 고신호 강도, P=0.601). 자세 측정기 결과와 cSVD는 유의한 연관성이 없었으나, 자세 측정기 결과는 OLST와 직접 관계가 있었다. 짧은 OLST는 cSVD를 포함한 공반변동에 독립적으로 인지 기능 저하의 관련성이 있었다(P<0.002).

결론

체위불안정은 건강한 사람에서도 뇌의 초기 병리학적 변화 및 기능적 감퇴와 연관성을 보인다.

Abstract 1

Figure 1. A–C. Association between cerebral small-vessel diseases and one-leg standing time (OLST). Number of each subgroup is shown in parentheses.

Figure 2. Association of short one-leg standing time (OLST) and cognitive function. Multiple linear regression analysis for Touch Panel-type Dementia Assessment Scale (TDAS) score was performed with adjustment for age, sex, body mass index, hypertension, type 2 diabetes mellitus, neuropsychiatric medication, carotid intima-media thickness, number of lacunar infarctions, periventricular hyperintensity grade, and number of microbleeds.