Incidental White Matter Lesions Identified on Magnetic Resonance Images of Normal Japanese Individuals

—Correlation with Age and Hypertension—

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Abstract

Incidental white matter high-intensity lesions are frequently seen on T₂-weighted magnetic resonance (MR) images of the brain in older people. The incidence increases with advancing age or hypertension. Brain MR images of 59 normal individuals were examined to analyze this phenomenon. The total number of white matter high-intensity lesions correlated significantly with age ($p = 0.004$) or systolic blood pressure ($p = 0.03$). The 60- to 69-year-old group demonstrated a very close correlation of white matter lesions with systolic ($p = 0.02$) and diastolic blood pressure ($p = 0.01$), in contrast to the 50- to 59-year-old group. Hypertensive subjects in their 60s are thought to develop more white matter lesions than subjects in their 50s.

Key words: white matter lesion, magnetic resonance imaging, age, hypertension

Introduction

Brain examinations are now based on magnetic resonance (MR) imaging or MR angiography, especially for brain tumors, aneurysms, or stenoses of cerebral arteries. A frequent incidental finding is white matter high-intensity lesions on T₂-weighted MR images in older people.

Incidental white matter lesions are correlated with many factors such as prior brain ischemia,²⁾ cardiac disease,⁷⁾ diabetes mellitus, hypercholesterolemia,^{10,11,14)} advancing age, and hypertension.^{2,5,9-11,14)} This study analyzed the correlation with age and hypertension in normal individuals with no other risk factors.

Subjects and Methods

Fifty-nine normal individuals admitted to our clinic for routine brain examination with no risk factors were included in this study. There were 38 males and 21 females.

Axial T₂-weighted MR images (7.5 mm thick) were

obtained with the spin echo technique (repetition time [TR] 2500 msec, echo time [TE] 100 msec) using a 1.5 T superconducting magnet (Signa; General Electric Medical Systems, Milwaukee, Wis., U.S.A.). All high-intensity lesions in all slices were classified into six groups of 0-2.7, 2.8-5.4, 5.5-8.1, 8.2-10.8, 10.9-13.5, and 13.6-16.2 mm according to the greatest diameter (Fig. 1). The blood pressure and blood chemistry were examined in 55 subjects.

Correlations of the number of high-intensity lesions with age and systolic or diastolic blood pressure were analyzed with the Spearman's rank correlation coefficient method. P values of <0.05 were considered statistically significant.

Results

Figure 2 shows the distribution of age, systolic and diastolic blood pressure, and number of lesions among the subjects. The number of white matter high-intensity lesions was significantly correlated with age (correlation coefficient 0.38, $p = 0.004$) and systolic blood pressure (correlation coefficient 0.3, $p = 0.03$) (Fig. 3). Although the diastolic blood pressure was also correlated (correlation coefficient 0.22), it was not significant ($p = 0.11$).

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Fig. 1 Representative T₂-weighted MR image (TR 2500 msec/TE 100 msec), showing incidental high-intensity lesions of various sizes in the white matter.

The correlation of white matter lesions with blood pressure was assessed for the 50- to 59-year-old (21 subjects) and 60- to 69-year-old groups (24 subjects). In the 60- to 69-year-old group, a very close correlation with systolic (correlation coefficient 0.49, $p = 0.02$) or diastolic blood pressure (correlation coefficient 0.52, $p = 0.01$) was found, in contrast to the 50- to 59-year-old group (Fig. 4). 0- to 2.7-mm-sized lesions occurred most frequently in the 50- to 59-year-old group (mean number 37.7) and the 60- to 69-year-old group (mean 38.9) (Fig. 5).

Systolic blood pressure increased significantly with diastolic blood pressure (correlation coefficient 0.56, $p = 0.0001$) and tended to increase with age (correlation coefficient 0.21, $p = 0.12$) (data not shown). The occurrence of white matter lesions did not correlate with total cholesterol, high-density lipoprotein, triglyceride, or β -lipoprotein levels in the blood (data not shown).

Fig. 2 Histograms of age (A), systolic blood pressure (B), diastolic blood pressure (C), and number of white matter lesions (D) in the subjects.

Fig. 3 Distribution charts, showing that the number of white matter lesions correlates significantly with age (A: correlation coefficient 0.38, $p = 0.004$) and systolic blood pressure (B: correlation coefficient 0.3, $p = 0.03$), and a slight correlation with diastolic blood pressure (C: correlation coefficient 0.22, $p = 0.11$).

Discussion

The incidence of incidental white matter MR imaging lesions increases with age and correlates with both high systolic blood pressure (> 160 mmHg) and high diastolic blood pressure (> 100 mmHg).^{2,11} Our data confirmed these correlations. We also found that hypertensive subjects in their 60s tended to demonstrate more white matter lesions than subjects in their 50s. The brain vessels of older subjects may already have deteriorated due to the aging process and might be more susceptible to hypertension. As the systolic blood pressure is weakly correlated with age, it is difficult to discuss the influence of age and hypertension separately.

The pathological process causing incidental white matter lesions is generally thought to be degeneration of myelinated axons and gliosis. The lesions represent incomplete ischemia without infarction because of the absence of cavitation and resolving

necrosis.^{6,15} As dilated perivascular spaces with vascular ectasia can also appear as high-intensity lesions on T₂-weighted MR images,¹⁾ discrimination between degeneration and vascular ectasia is very difficult based only on MR images. Probably our subjects demonstrated both types of lesion. However, both types of lesion are caused by arteriosclerosis or hyaline arteriolosclerosis, which is one of the most common degenerative changes in brain vessels, and increases with advancing age and hypertension.^{1,3,8,13,15,17,20)}

Cerebral blood flow (CBF) is known to decrease gradually and progressively with increasing age^{4,12,16,18,19,21)} and is accelerated by risk factors such as hypertension, heart disease, diabetes mellitus, and hyperlipidemia.^{18,19)} This study did not measure CBF, so further examination is necessary to investigate the relationship between the occurrence of incidental white matter high-intensity lesions on T₂-weighted MR images and decreased CBF.

Fig. 4 Distribution charts of the 50- to 59-year-old group, showing that the number of white matter lesions does not correlate with systolic blood pressure (A: correlation coefficient 0.0003, $p = 0.99$) or diastolic blood pressure (B: correlation coefficient -0.23 , $p = 0.31$). Distribution charts of the 60- to 69-year-old group, showing that the number of white matter lesions correlates significantly with both systolic (C: correlation coefficient 0.49, $p = 0.02$) and diastolic blood pressure (D: correlation coefficient 0.52, $p = 0.01$).

Fig. 5 The number of white matter lesions of each size in the 50- to 59-year-old (solid columns, $n = 22$) and 60- to 69-year-old groups (shaded columns, $n = 27$). The columns show the mean number of white matter lesions and the bar shows the SD.

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