

The Fate of Acute Lacunar Lesions in Terms of Shape and Size

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Background: The description of lacunar infarcts on imaging is widely variable. In particular, there are fewer agreements on lacunar lesion size and the presence of cavitation. In this regard, we investigated the changes in size and shape of acute ischemic lesion that is possibly considered as small vessel occlusion on long-term follow-up. **Methods:** Patients with acute single subcortical ischemic lesion on penetrating arterial territories and without definite cause of cardioembolism and large vessel disease were included. Magnetic resonance imaging (MRI) was performed during an acute stroke period and approximately 1 year after the stroke. Maximal diameters on diffusion-weighted image and on follow-up (T2 or fluid attenuation inversion recovery) were measured. The change in lesion diameter over time was analyzed. Regarding the change in shape, lacunar lesions on follow-up were classified as either “disappeared,” “cavitated,” or “white matter lesion.” **Results:** A total of 64 patients were included. The mean age was 64.94 ± 11.29 years and 32 patients were male. The mean time interval between initial and follow-up MR scan was 23.39 ± 14.88 months. The mean diameter of acute lacunar lesion was 14.11 ± 5.77 mm. On follow-up, the mean diameter reduced to 7.76 ± 5.19 mm. The mean percentage of final diameter over initial diameter was $53.57 \pm 26.45\%$. All of the lesions were less than 15 mm on follow-up. Regarding the shape of the lesion on follow-up, the lesions of 33 (51.6%) patients remained cavitated, the lesions of 14 (21.9%) patients remained as white matter lesions, and the lesions of 17 (26.6%) patients disappeared. There were no differences on clinical characteristics between patients with cavitation and those without. **Conclusions:** The diameter of acute lacunar lesions on initial diffusion-weighted MRI was markedly reduced on follow-up. In 52% of the patients, acute lacunar lesions were cavitated. **Key Words:** Lacunar infarcts—MRI—size criteria—shape.

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Introduction

The description of lacunar infarcts on imaging is widely variable.¹ In particular, there are fewer agreements on lacunar lesion size and the presence of cavitation.¹ The conventional criteria for the size of lacunar infarct are known to be less than 15 mm.^{2,3} However, lesion size on diffusion-weighted magnetic resonance imaging (DWI MRI) looks larger than the conventional lesion size because it includes not only the ischemic core but also the ischemic penumbra.^{4,5} In a recent review of small vessel disease, they extended the diameter criteria to 20 mm on axial plane.^{6,7}

According to the conventional criteria for lacuna size, lacunar lesions that are slightly larger than 15 mm would be classified as cryptogenic according to the strict diameter

criteria, particularly when they are measured during an acute stroke period.

Regarding the shape of the lacunar lesion, there is also heterogeneity in description of cavitation when we define lacunar in chronic period. A previous study showed that cavitation occurred in one fifth of symptomatic lacunar ischemic strokes, whereas most continued to resemble focal white matter lesions.⁸ The proportion of cavitation was different according to follow-up imaging time.⁹

Therefore, it would be helpful to know the temporal change of lesion size and shape over time through long-term, serial follow-up of brain MRI for better diagnosis of lacunar infarction. In this regard, we investigated the changes in size and shape of acute ischemic lesion that is possibly considered as small vessel occlusion (SVO) with long-term follow-up study.

Methods

Patients who showed acute single subcortical ischemic lesion on penetrating arterial territories from middle cerebral artery, posterior cerebral artery, and basilar artery were consecutively enrolled. Patients with stroke subtypes of SVO and cryptogenic causes were included. SVO was defined by a single subcortical lesion on penetrating arterial territory, which is less than 20 mm in maximal diameter without other causes (15 mm in case of brainstem).

The common MRI parameters for DWI, fluid attenuation inversion recovery (FLAIR), and T2-weighted images were a slice thickness of 4~5 mm, an inter-slice gap of 2 mm, and 22 axial slices. The DWI parameters included a field of view of 240 mm, a repetition time (TR) of 7000 milliseconds, an echo time (TE) of 85.3 milliseconds, a matrix number of 128 × 128, and two *b* values of 0 and 1000 s/mm². FLAIR imaging was obtained using a fast-spin echo sequence with TR/TE = 9902/125.8 milliseconds, inversion time = 2400 milliseconds, a field-of-view of 220 mm, and a 320 × 256 matrix. The TR/TE of T2-weighted image was 4000/100.3 milliseconds.

MRI was performed during the acute stroke period (DWI) and approximately 1 year after the stroke onset (T2-weighted image or FLAIR image). The maximal lesion diameters on DWI and on follow-up MRI were measured. The change in lesion diameter over time was analyzed. The percentage of final diameter over initial size was calculated. Regarding change in shape, lacunar lesions on follow-up MRI were classified either as "disappeared," "cavitated," or "white matter lesion." Descriptive analysis was performed. Nonparametric comparison of the mean was used to analyze the factors related to lacunar shape change according to time interval. This study was approved by the institutional review board of our hospital. Informed consent was obtained from all the participants.

Results

Between 2009 and 2013, a total of 64 patients were included. The mean age was 64.94 ± 11.29 and 32 patients were male. Acute ischemic stroke lesions were located in the pons in 21 (32.8%) patients, in the corona radiata or basal ganglia in 26 (40.6%) patients, in the internal capsule in 7 (10.9%) patients, in the thalamus in 9 (14.1%) patients, and in midbrain in 1 patient. The stroke subtypes were SVO in 59 (92.2%) patients and cryptogenic in 5 (7.8%) patients. The mean time interval between the initial and follow-up MR scan is 23.39 ± 14.88 months. As a follow-up MR scan, T2-weighted MRI was performed in 25 patients and FLAIR in 39 patients.

The mean diameter of acute ischemic lesion on DWI was 14.11 ± 5.77 mm (5.9 to 32.33 mm). In 21 patients, the lesion diameters were more than 15 mm. On follow-up MRI, the mean diameter reduced to 7.76 ± 5.19 (0 to 23.9 mm). The mean percentage of final diameter over initial diameter was 53.57% ± 26.45%. Most of the lesion diameters were reduced markedly on follow-up. All of the lesions were measured as less than 15 mm on follow-up, which meets the conventional size criteria for lacunar infarction.

Regarding the shape of the lesion on follow-up, the lesions of 33 (51.6%) patients remained cavitated whereas those of 14 (21.9%) patients remained focal white matter lesions. In 17 (26.6%) patients, the acute lacunar lesion disappeared or could not be found on conventional MRI (Fig 1). The long time interval was not related to cavitation of lacunar lesions. In contrast, patients whose lesions remained as focal white matter lesions had longer time interval than those whose lesions remained cavitated (mean: 36.71 versus 19.48 months, *P* = .015). The follow-up diameter was smaller in patients without cavitation (5.99 ± 5.38 versus 9.43 ± 4.47, *P* = .007). The clinical characteristics were not different between patients with cavitation and those without (Table 1).

Between the patients with T2-weighted MRI as a follow-up imaging and those with FLAIR MRI, the percentage of final diameter over initial lesion (60.8% versus 48.9%, *P* = .11) and the cavitation rate (10 out of 25 versus 23 out of 39, *P* = .20) was not different.

Discussion

The lacunar lesion diameter on DWI during the acute stroke period was markedly reduced on follow-up MRI during the chronic stroke period. The lacunar lesions that were initially diagnosed as cryptogenic just because of a longer diameter according to the conventional criteria could be reclassified after follow-up imaging. Thus, the diameter criteria for lacunar infarct should not be so strict, particularly during the acute ischemic stroke period when they are mostly diagnosed using DWI. In a previous study, the clinical characteristics were not different between a

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