Acute small subcortical infarctions on diffusion weighted MRI: clinical presentation and aetiology

T Seifert, C Enzinger, M K Storch, G Pichler, K Niederkorn, F Fazekas


Objective: To determine the clinical presentation and aetiology of small subcortical infarctions as found on diffusion weighted magnetic resonance imaging (DWI). DWI is both sensitive and specific in the early detection of acute ischaemic brain lesions irrespective of pre-existing vascular damage.

Methods: Ninety three patients were identified showing subcortical or brainstem DWI lesions <1.5 cm in diameter within a maximum of 7 days from the onset of stroke symptoms. The patients’ clinical status on admission was reviewed according to the Oxfordshire Community Stroke Project (OCSP). The results of procedures searching for cerebrovascular risk factors, large artery disease, and potential sources of cardiac embolism were included to determine stroke aetiology. Magnetic resonance imaging scans were also reviewed for concomitant changes that could support the aetiologic classification.

Results: Only 41 (44.1%) patients presented clinically with a lacunar syndrome according to OCSP criteria. The nine (9.7%) patients who showed two or more DWI lesions in different vascular territories were also significantly more likely to have potential sources of cardiac embolism (5/9, 55.6% v 20/84, 23.8%). Hypertension was significantly more prevalent in the group of patients who showed a microangiopathy related imaging pattern, but this pattern did not exclude the presence of large artery disease or a possible cardioembolic source of stroke.

Conclusion: Identification of small subcortical infarctions as the cause of stroke appears quite uncertain based on clinical characteristics only. DWI adds significant aetiological information but does not obviate the search for other potentially causative mechanisms.

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Small subcortical infarctions are currently assumed to have several aspects in common as proposed by the concept of “lacunar stroke”.1 First, histopathologic studies found that ischaemic subcortical lesions <1.5 cm in diameter result predominantly from occlusion of small penetrating arteries, which is presumed to be due to microatheroma or lipohyalinosis in the penetrating vessel or due to an atheroma lining the parent vessel.2–4 Early reports also suggested that the occlusion of a penetrating artery may be due to embolism,2 but subsequent investigations could not confirm a significant contribution of cardiac embolism to lacunar infarction.5–6 Second, small subcortical infarctions have been linked to distinct clinical syndromes: pure motor syndrome; TACS, total anterior circulation syndrome; MRI, magnetic resonance imaging; OCSP, Oxfordshire Community Stroke Project; PACS, partial anterior circulation syndrome; TEE, transoesophageal echocardiography; TOAST, Trial of Org 10172 in Acute Stroke Treatment; TTE, transthoracic echocardiography; WMH, white matter hyperintensities

Abbreviations: DWI, diffusion weighted magnetic resonance imaging; ECG, electrocardiogram; ICA, internal carotid artery; LACS, lacunar syndrome; MRI, magnetic resonance imaging; OCSP, Oxfordshire Community Stroke Project; PACS, partial anterior circulation syndrome; PCOS, posterior circulation syndrome; TACS, total anterior circulation syndrome; TEE, transoesophageal echocardiography; TOAST, Trial of Org 10172 in Acute Stroke Treatment; TTE, transthoracic echocardiography; WMH, white matter hyperintensities
undergo examination, when there were no contraindications to MRI (for example, a cardiac pacemaker), and the patient agreed to scanning. The respective case records were screened for patients who fulfilled the following criteria: neurologic deficit present on admission and persisting for at least 24 h, MRI performed between 0 and 7 days after the onset of clinical symptoms, and subcortical or brainstem DWI lesions <1.5 cm in diameter. Patients with additional cortical involvement on DWI were not included. Based on these criteria, we identified a total of 93 patients. The clinical examination of patients on admission was documented in a standardised scheme according to predefined in-house guidelines. A primary diagnosis of vascular territory involved, that is, anterior, median, posterior cerebral artery, or basilar artery, was made based on the clinical examination. For our retrospective study, an investigator (CE) who was involved, that is, anterior, median, posterior cerebral artery, guidelines. A primary diagnosis of vascular territory examination of patients on admission was documented in a criteria, we identified a total of 93 patients. The clinical risk factor) within the past 5 years was recorded. Duplex Doppler sonography, and electrocardiograms (ECG) were performed to compare differences in age between different patient groups. A p value of less than 0.05 was considered to indicate statistically significant differences.

RESULTS

We identified 93 patients with subcortical or brainstem DWI lesions <1.5 cm in diameter (63 men, 30 women; mean age 65.7 years, range 28–89). The lesions were located in the vertebrobasilar circulation in 57 (61.3%) patients, thereby affecting areas supplied by pontine perforators in 22 patients and by thalamic, lateral medullary, and midbrain perforators in 18, 10, and 7 patients, respectively. Thirty four (36.6%) patients had lesions in the ICA territory; 23 of these had lesions in the basal ganglia and internal capsule and 11 had lesions in the centrum semiovale. Two (2.1%) of the 93 patients showed lesions in regions of both the anterior and posterior circulation.

A lacunar syndrome (LACS) was found clinically in 41 (44.1%) patients, a posterior circulation syndrome (POCS) in 37 (39.8%), a partial anterior circulation syndrome (PACS) in 14 (15.0%), and a total anterior circulation syndrome (TACS) in one (1.1%) patient. When patients with small subcortical infarcts located only in areas supplied by the anterior circulation (n = 34) were considered, we found a LACS in 52.9% of patients. Patients with small infarcts in the posterior circulation (n = 57) showed a LACS in 40.4% of cases.

The major cerebrovascular risk factors associated with small vessel disease, that is, hypertension, hypercholesterolaemia, diabetes mellitus, and smoking, were found in 72.0%, 55.9%, 32.3%, and 38.7% of all patients, respectively. No coagulopathy or atrial fibrillation was found. Transthoracic echocardiography (TTE) was normal.
angiography in one of these patients with normal results. Screening for serologic parameters indicating vasculitis or coagulopathy was carried out in four and five of the patients, respectively, with normal results. The characteristics of these patients in comparison to all other patients are given in table 1. No statistically significant differences were found between these patient groups concerning gender, clinical syndrome, or vascular risk factors. Potential sources of cardiac embolism were detected significantly more often in the group of patients with multiple DWI lesions in different vascular territories.

We found 36 (38.7%) patients with a microangiopathy-related imaging pattern. These patients were significantly older, the ratio of both genders was shifted significantly towards women, and hypertension was significantly more prevalent in this group. The prevalence of other vascular risk factors, large artery disease, or potential sources of cardiac embolism was not statistically different between the groups of different imaging patterns (table 1).

DISCUSSION
Clinical examination of stroke patients is not sufficient to differentiate lacunar infarcts from other stroke subtypes. In our study, only 44.1% of patients in whom a small subcortical infarction was found on DWI presented clinically with a LACS. This is in line with earlier studies which pointed out the limitations of stroke classification by clinical criteria only. In a previous observation using DWI and perfusion weighted imaging, lacunes could also not be reliably diagnosed on the basis of clinical findings only. Other studies have shown that only 75% of patients are correctly classified clinically by the OCSP classification, and that a significant proportion of patients presenting with a LACS show cortical lesions on cerebral imaging. In our analysis, overlap of a LACS with other stroke syndromes persisted even when we considered only supratentorial small subcortical infarcts. As clinical classifications are frequently used for patient description and for selection for stroke trials, it is important to recognise this limitation in the accuracy of clinical classification of stroke subtypes. Apparently, patient selection for examination of therapeutic interventions targeted at specific stroke subtypes should be based on DWI.

Clearly, the retrospective design of our study imposes some limitations and the investigated cohort is not representative of the overall stroke population. Referral of patients to MRI was based solely on the discretion of the treating neurologist and may therefore have been prone to selection bias regarding age, stroke severity, or results from other examinations. However, it is the policy of our department to routinely obtain MRI in all stroke patients, and there were no specified guidelines to exclude patients from routine MRI other than those given in the Methods section. All ischaemic stroke patients who underwent MRI also had DWI sequences. The retrospective classification of patients according to the OCSP may have been influenced by the quality of the documentation of the patients’ symptoms and signs, but a systematic bias towards a specific clinical syndrome seems unlikely.

For a targeted diagnostic procedure and specific secondary prevention, a clear association between infarct patterns and aetiology is desirable. In this context, small vessel disease and related risk factors, such as hypertension, have been implicated as the major causes of lacunar stroke. Hypertension is a predominant risk factor in our cohort of patients. Reported frequency rates of hypertension in patients with lacunar stroke vary from 24% to 97%, with a mean of approximately 70%, which is similar to our results. Not unexpectedly, we found hypertension to be especially prevalent in the subgroup of patients with an overall imaging pattern suggestive of microangiopathy.
DWI offers the advantage of differentiating acute from chronic small subcortical and brainstem ischaemic lesions with unprecedented accuracy. Therefore, DWI has been claimed to have the potential to improve early diagnosis of stroke aetiology according to the TOAST criteria, especially by identifying multiple acute lesions in different vascular territories. However, the assumption that such lesions are strongly suggestive of an embolic aetiology has been questioned recently by a report of 10 patients with multiple DWI lesions in whom a cardioembolic source could only be identified in one patient. In contrast to this observation, we found a possible cardioembolic source in five out of nine individuals (55.6%) with multiple small acute DWI lesions in truly different vascular territories. This may be explained in part by the fact that our study included data from TEE and/or TTE in all our patients with multiple DWI lesions, whereas Chowdhury et al obtained TTE in only three of their patients. In conclusion, MRI with the addition of DWI provides important information regarding stroke subtype and aetiology. Concomitant morphological features as proposed in our study may help to further differentiate true small vessel disease from other stroke subtypes. In this regard, the impact of age related cerebral white matter changes on vascular events is currently under investigation in a prospective multicentre trial. Large artery disease and potential sources of cardiac embolism may be not only coincidental but also causally related to small subcortical infarctions, thus underscoring the need for complete diagnostic evaluation in all stroke patients irrespective of their clinical presentation.

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REFERENCES


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