Middle cerebral artery stroke lesion pattern classification after thrombolysis based on diffusion-weighted imaging and MR-angiography

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Introduction: Traditionally, the following descriptive acute ischemic stroke (AIS) lesion patterns are used: territorial, lacunar, borderzone, and embolic stroke. Although typical examples of these lesion patterns may be observed in daily practice, there is a large variety of combinations and consequently, it is more likely to find overlaps of these patterns. Especially in AIS patients treated with recombinant tissue plasminogen activator (rtPA), these overlaps might indicate individual differences in treatment response. Despite very interesting approaches to classify AIS lesion patterns in concurrent intracranial and extracranial large vessel disease [1] or in AIS patients treated with rtPA and tirofiban [2], until today a comprehensive stroke lesion pattern classification has not been established. Therefore, we aimed to develop a practical instrument to classify AIS lesion patterns and therefore analyzed stroke morphology on magnetic resonance imaging (MRI) in a series of patients with AIS in the middle cerebral artery territory (MCAT) who received i.v. thrombolysis.

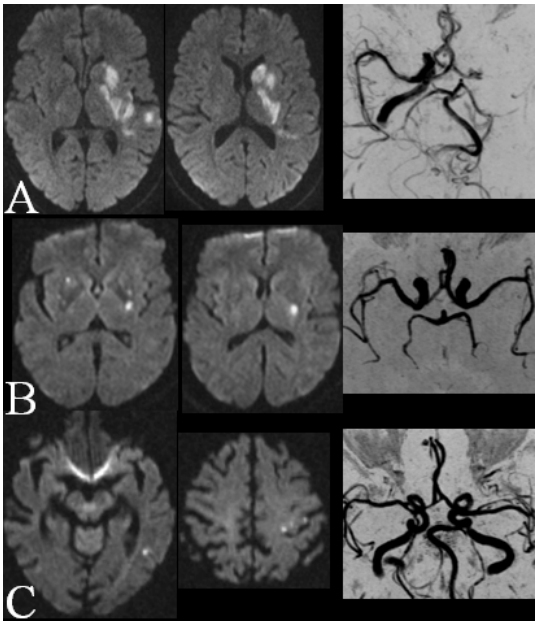
Methods: From a prospectively collected MRI database (2004-2009), we identified 350 patients with AIS in the MCAT treated with rtPA within 4.5 hours. Magnetic resonance imaging was performed on a 1.5-T or a 3-T MR system. A standardized protocol was used in all patients including T2- and T1-weighted images, diffusion-weighted imaging (DWI), FLAIR images, and MR angiography (MRA). Based on an earlier established classification [3], stroke lesion patterns were classified in detail by identifying index lesions in the MCAT and concomitant lesions in the MCAT, other vascular territories (VT) or adjacent borderzones (BZ) on DWI as well as persistent middle cerebral artery (MCA) pathology on MRA (see Table 1 and Figure 1), and compared these with regard to baseline characteristics, etiology, and clinical outcome.

Results: All predefined DWI and MRA patterns occurred in the population (see Table 1 for frequencies). Patients with pattern D4 (lacunar) were more frequently men (p=0.001) and smokers (p=0.008). Apart from a more frequent diagnosis of small vessel disease in pattern D4, there were no significant differences with regard to stroke etiology. A typical pattern associated with successful recanalisation was D6M1 and D6M2 with small embolic lesions and a normal/strong MCA signal, whereas pattern D1 (territorial) was significantly associated with MRA pattern M5a (proximal MCA occlusion). Correspondingly, baseline NIHSS/mRS scores were significantly higher in pattern D1 and D3 (p<0.001). After two hours and at discharge, a higher NIHSS/mRS score was present in pattern D1 only (p<0.001). Improvement (NIHSS of 0 or decrease ≥5 at discharge) was observed more often in pattern D2, D3, and D6 (p<0.001). This remained significant when limiting the analysis to patients with an initially severe clinical deficit (NIHSS≥10).

Table 1. Definitions and frequencies of index lesions, concomitant lesions, and MRA patterns.

Index lesions	Concomitant lesions	MRA
D1 Large territorial: > 1/3 of the MCAT (23.4%)	**a without** (29.7%)	**M1 Normal** (43.1%)
D2 Territorial: > 1.5 cm, < 1/3 of the MCAT (35.4%)	**b** in the **MCAT** (37.1%)	**M2 Prominent** (12.3%)
D3 Subcortical: larger subcortical lesion (6.0%)	**c** in **other** VT (8.3%)	**M3 Weak** (10.6%)
D4 Lacunar (12.3%)	**d** in **BZ** (6.9%)	**M4 Stenosis** (3.7%)
D5 Territorial + lacunar (0.9%)	**e** in the **MCAT** + **other** VT (4.0%)	**M5a Proximal occlusion** (18.6%)
D6 Small embolic: ≤ 1.5 cm (22.0%)*	**f** in the **MCAT** + **BZ** (7.7%)	**M5b Distal occlusion** (6.0%)
*only subtypes b, c, d, and h	**g** in **other** VT **+ BZ** (0.3%)	**MX Not evaluable** (5.7%)
	h in the **MCAT**, **other** VT + **BZ** (6.0%)	

Figure 1. Examples of acute ischemic stroke pattern according to the new classification: A. pattern D3bM5a, B. D4eM1, C. D6dM2.



Conclusion: Outcome after thrombolysis in AIS can be characterizsed with an individual DWI and MRA stroke pattern. The new classification is a simple tool based on routinely used MRI sequences, identifies embolic stroke as a common post-thrombolysis lesion pattern, and may be of use for a more precise stroke pattern description in AIS patients in general. Furthermore, it may be a useful approach for evaluating the response to thrombolysis or other new therapies in future clinical trials.

References:

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