Original Article

Hippocampal infarction: Identification of three new types

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ABSTRACT

Background and purpose. – Hippocampal infarction (HI) is common but yet still not comprehensively studied. In the present study, we aimed to identify novel HI patterns and to describe additional ischemic lesions outside the hippocampus to draw conclusions regarding the underlying vessel occlusion.

Methods. – In 222 patients (mean age 69.9 ($\pm$ 13.6) years; 129 (58.1%) male, 93 (41.9%) female) with HI, diffusion-weighted images were analyzed with emphasis on HI patterns and associated ischemic lesions outside the hippocampus. HI were classified as type 1 (complete), 2 (lateral), 3 (dorsal), and 4 (circum-scribed). Further possible HI patterns were defined and classified as type 5 (ventral), 6 (ventrolateral), and 7 (dorsolateral).

Results. – Unilateral HI was found in 218 (98.2%) patients. In these, type 5 and 6 were identified in 5 (2.3%) patients, and type 7 in 8 (3.7%) patients respectively. Type 1 was found in 62 (28.4%), 2 in 53 (24.3%), 3 in 57 (26.1%), and 4 in 28 (12.8%) patients. Further ischemic lesions were found in the territory of the anterior cerebral artery (4.1%), middle cerebral artery (15.3%), anterior choroidal artery (AChA) (7.7%), posterior cerebral artery (89.2%), and in the brainstem (6.3%) and cerebellum (20.3%). Type 5 and 6 were significantly associated with acute ischemic lesions in the AChA territory (6/10 (60%) vs. 11/200 (5.5%), $P < 0.001$).

Conclusions. – We identified three novel HI types. Probably, type 5 and 6 can be attributed to occlusion of the AChA. Overall, these HI types are rare, possibly due to a better collateralization in the case of AChA occlusion.

Introduction

Although present in up to three-fourths of acute ischemic strokes due to posterior cerebral artery (PCA) occlusion, [1] the medical literature concerning hippocampal infarction (HI) is still scarce [2–5]. In 2009, the first comprehensive study focusing on HI in PCA territory infarction was published and described four distinct infarction patterns: complete, lateral, dorsal and small punctuate. In this study, further ischemic lesions outside the hippocampus were found in all cases [4].

Anatomical studies demonstrated that the arterial blood supply of the hippocampus arises not exclusively from branches of the PCA but also to a lesser extent from the anterior choroidal artery (AChA) and is very variable in general [6–8]. For a schematic illustration, see Fig. 1. Besides the hippocampus, the vascular territory supplied by the AChA includes the uncus, the amygdala, the lateral part of the lateral geniculate body, the posterior part of the internal capsule, the medial globus pallidus, and the tail of the caudate nucleus [9]. The vascular territory supplied by the PCA includes the mesen-cephalon, the thalamus, the splenium of the corpus callosum, the occipital lobe, as well as parts of the temporal and parietal lobes [9,10].

In the present study, we aimed:

- to identify novel, less common HI patterns;
- to evaluate the frequency of these novel HI patterns;
- to describe the distribution of further acute ischemic lesions outside the hippocampus in order to draw conclusions regarding the probable affected arterial vessel.

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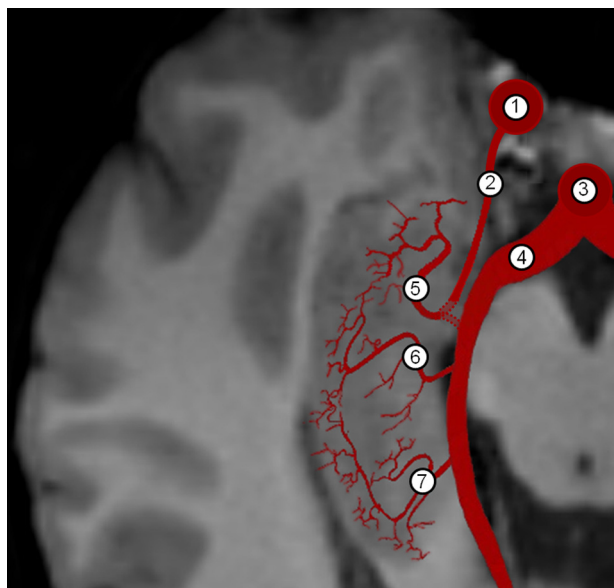[1] A.F. and M.A. contributed equally to this study.

Fig. 1. Schematic illustration of the vascularisation of the hippocampus. 1. Internal carotid artery. 2. Anterior choroidal artery. 3. Basilar artery. 4. Posterior cerebral artery. 5. Anterior hippocampal artery. 6. Middle hippocampal artery. 7. Posterior hippocampal artery.

Materials and methods

Patients

From a prospectively maintained MRI report database (SDM) with more than 60.000 neuroradiological MRI reports (2002–2015), we identified all patients with acute HI by searching for HI, as well as for infarctions in the AChA or PCA territory and reviewing of diffusion-weighted imaging (DWI) in these cases. The demographic details and clinical symptoms were abstracted from the case records. This study has been approved by the local institutional review board and has therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. Patient consent was waived for this analysis by the local institutional review board due to its retrospective nature.

MRI studies

Magnetic resonance imaging (MRI) was performed on a 1.5-T or a 3-T MR system (Magnetom Sonata/Avanto/Trio, Siemens Medical Systems, Erlangen, Germany). A standardized protocol was used in all patients including DWI (field of view 230×230 mm, matrix $128 \times 128/192 \times 192/192 \times 192$ mm, TR 4200/4000/4000 ms, TE 101/96/91 ms, b values 0 and 1000 s/mm^2, 24 slices, slice thickness 5 mm for Magnetom Sonata/Avanto/Trio), T1- and T2-weighted as well as FLAIR images, and a 3D time-of-flight MR angiography.

MRI analysis

All MRI scans were analyzed by two raters (A.F. and M.A., both with more than eight years of experience in neuroimaging). Cases with discrepancies were re-reviewed by both readers and discussed until a consensus was reached. HI patterns were evaluated on axial DWI as well as DWI parallel to the hippocampal body reconstructed by use of OsiriX (Pixmeo SARL, Bernex, Switzerland), a multidimensional image navigation and display software [11], and classified as described previously: type 1 (complete), type 2 (lateral), type 3 (dorsal), and type 4 (circumscribed) [4]. For a schematic illustration, see Fig. 2. In addition to the above-mentioned previously recognized HI types, further possible infarction patterns that had been identified during clinical practice were defined and categorized: type 5 (ventral), type 6 (ventrolateral), and type 7 (dorsolateral). For a schematic illustration, see Fig. 3. Further acute ischemic lesions outside the hippocampus were also noted on DWI by use of OsiriX, the topography determined according to the maps by Tatu et al. [9,10] and categorized in territory of the (1) anterior cerebral artery (ACA), (2) middle cerebral artery (MCA), (3) AChA, (4) PCA, as well as (5) in the brainstem, and (6) the cerebellum.

Statistical analysis

Statistical analysis was carried out using SPSS 17.0. Descriptive data was analyzed by use of Chi-square tests. All statistics was performed with a 0.05 level of significance.

Results

Demographics and clinical presentation

Overall, we identified 222 patients with HI. The mean age of patients was 69.9 (± 13.6) years; 129 (58.1%) patients were male, 93 (41.9%) female. Comorbidities and cerebrovascular risk factors included arterial hypertension (81.1%), atrial fibrillation (31.1%), diabetes mellitus (27.5%), hyperlipidemia (26.1%), coronary heart disease (18.5%), smoking habit (10.4%), and transient ischemic attack/stroke (9.5%). Most common clinical symptoms
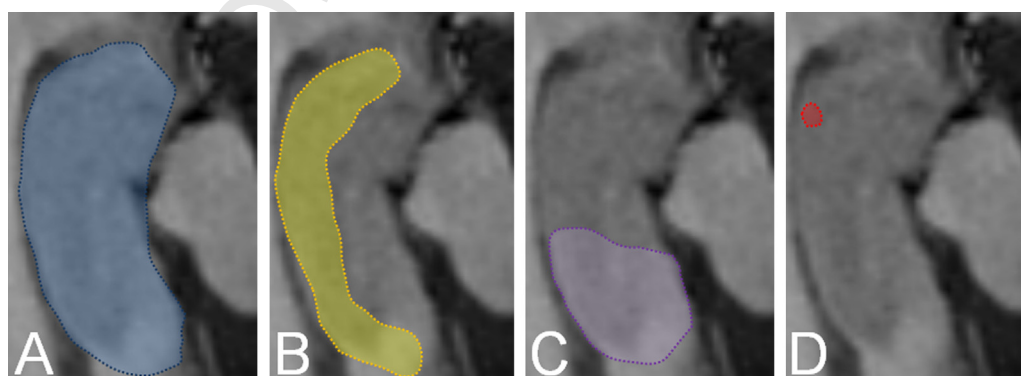

Fig. 2. Schematic illustration of the previously recognized HI types. A. Type 1: complete (dark blue). B. Type 2: lateral (yellow). C. Type 3: dorsal (violet). D. Type 4: circumscribed (red).