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Original research article

How to avoid false positive hyperdense middle cerebral artery sign detection in ischemic stroke

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ABSTRACT

Objectives: The aim of the study was to find how to differentiate hyperdense middle cerebral artery sign (HMCAS) in stroke patients from asymmetric hyperdensity not related to stroke, by comparison of the CT density values typical for HMCAS to the values in normal or atherosclerotic middle cerebral artery (MCA).

Methods: The group analyzed consisted of 100 patients with ischemic stroke, presenting HMCAS on the admission CT. Density measurements in HU were performed in the hyperdense segment of the involved MCA, contralateral MCA, brain cortex adjacent to the hyperdense MCA. The control group consisted of 100 patients with no symptoms of cerebral stroke. Density measurements in HU were performed: in the M1 segment of right and left MCA, brain cortex adjacent to the more dense from right or left MCA.

Results: In the stroke group the median values obtained were: in the hyperdense MCA 59 HU, contralateral MCA41 HU, brain cortex 36 HU. In the control group the median values obtained were: in the more dense MCA 43 HU, contralateral MCA 40 HU, brain cortex 34 HU. The range of HMCAS/contralateral MCA density ratios in stroke only slightly overlapped the range of more dense MCA/contralateral MCA density ratios in non-stroke patients.

Conclusion: The ratio of hyperdense MCA CT density/contralateral density is a good tool to differentiate HMCAS from asymmetric hyperdensity not related to stroke. The threshold ≥1.16 provided 100% sensitivity and 97% specificity, whereas ≥1.22 provided 94% sensitivity and 100% specificity.

1. Introduction

Non-contrast computed tomography (CT) brain examination is still the most commonly used imaging modality in patients with clinical symptoms of acute ischemic brain stroke [1–3]. The procedure is chosen as it is widely available, fast and inexpensive. It is performed to rule out intracranial pathologies mimicking stroke such as tumor, to exclude intracranial hemorrhage not allowing thrombolysis and also to assess early symptoms of stroke.

In the hyperacute phase during the first 3 h after onset, typical brain tissue abnormalities possible to observe in CT are: loss of gray-white matter differentiation, especially loss of distinction among the nuclei of the basal ganglia (lenticular obscuration), blending of the densities of the cortex and underlying white matter in the insula (insular ribbon sign) and over the convexities (cortical ribbon sign), as well as cortical

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hypodensity and parenchymal swelling causing gyral effacement.

In some patients, it is also possible to see in CT a hyperdense segment of the artery, representing direct imaging of an intravascular thrombus. Sometimes it may be the earliest and only visible CT sign of ischemic stroke. This can be localized in any vessel, but it is most often observed in the middle cerebral artery (MCA) as hyperdense middle cerebral artery sign (HMCAS) (Fig. 1).

Such increased attenuation may be found in a long segment of MCA, especially the proximal portion or, usually distally, may be limited to a very short segment, as an MCA dot sign.

In histopathological studies the composition of the thrombus is defined as typical for early phase (RBC – Red Blood Cell Count dominant and RBC proportion equal to fibrin) and late phase (fibrin dominant and organized fibrin). Hyperdense artery sign on CT is usually seen in early phase thrombus composition [4,5].

HMCAS recognition is crucial for radiologists, because it may help to save the patient in the proper time window for thrombolysis (4.5 h from stroke onset to rtPA treatment [1]).

HMCAS may be a valuable predictor of the final severity of stroke. In patients with cerebral ischemic stroke involving MCA region and no early signs of brain tissue ischemia on admission CT, HMCAS is associated with significantly lower Alberta Stroke Program Early CT Score (ASPECTS) in the follow up CT. Long hyperdense MCA segment is generally associated with a large area of brain tissue damage; however, short hyperdense MCA segment does not exclude large area of brain tissue damage [6].

In patients with HMCAS shown by baseline CT, treated with intravenous thrombolysis, the size of hyperdense MCA segment correlates with the effects of treatment and the final outcome. Shobha [7] found that short-length HMCAS (<10 mm) disappeared in 85.7% of cases, medium-length HMCAS (10–20 mm) – in 37.5% and long-length HMCAS (>20 mm) did not disappear in any of the cases.

The persistence of HMCAS on the follow-up CT after intravenous thrombolysis is an early predictor of poor functional outcome [8,9].

Furthermore, the location of the thrombus in the proximal or distal part of the vessel is important for the prognosis of the patient. Man [10] found that proximal HMCAS predicts an unfavorable outcome of intraarterial thrombectomy for acute stroke. Similarly, Li [11] showed that poor neurological recovery post intravenous thrombolysis was confined to proximal HMCAS cases, contrary to distal HMCAS cases.

Zou [12] concluded that HMCAS is also associated with increased risk of hemorrhagic transformation after intravenous thrombolysis for patients with acute ischemic stroke.

HMCAS is seen in about one third to one half of cases of angiographically (DSA – digital subtraction angiography) proven thromboses [13,14], so the sensitivity is rather low.

The specificity of the sign is much higher, however, in some cases, false positive results of HMCAS are reported, because of advanced atherosclerotic disease, especially with asymmetric calcifications.

Commonly, it is easy to confirm a calcified plaque as a reason for a hyperdense vessel segment, because of high CT density values typical for calcifications.

However, in some, usually older patients, a generally increased density of the arterial wall is observed, but not reaching the threshold of calcifications. Such a hyperdense vessel on the background of adjacent brain tissue may be misinterpreted as HMCAS, particularly in asymmetric head position during scanning (Fig. 2).

Apart from atherosclerosis, there are only very rare reports of false positive HMCAS seen in herpes simplex virus (HSV) encephalitis [15].

The aim of the study was to find how to differentiate HMCAS in stroke patients from asymmetric hyperdensity unrelated to stroke, by comparison of the CT density values typical for HMCAS to the values in normal or atherosclerotic MCA.

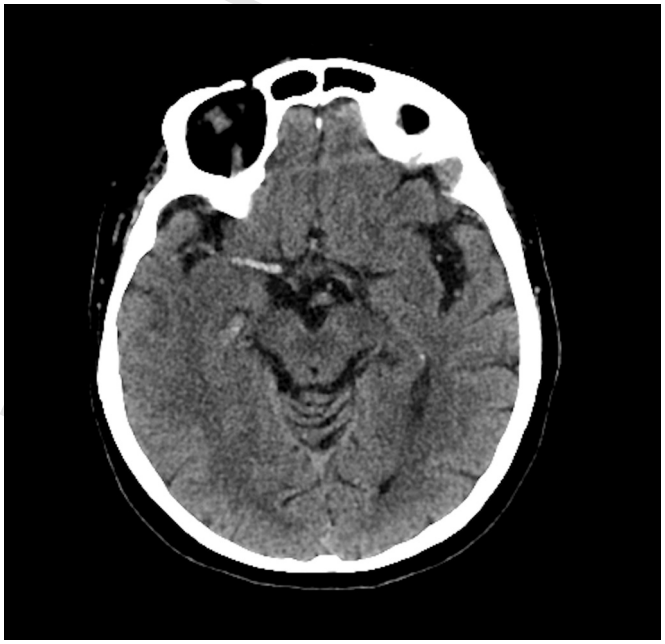

Fig. 1 – Hyperdense middle cerebral artery sign (HMCAS) in a stroke patient.

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