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Original article

Density heterogeneity and fluid–blood levels in patients aged over 55 with lobar hematoma

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INFO ARTICLE

Article history:
Received 7 March 2016
Accepted 25 May 2016
Available online 20 June 2016

Keywords:
Density heterogeneity
Fluid–blood level
Lobar hematoma
Intracranial hemorrhage
Cerebral amyloid angiopathy

ABSTRACT

Background. – Density heterogeneity and fluid–blood levels (FBLs) are frequently seen on acute CT scans of deep brain hemorrhage. Our aim was to analyze the density heterogeneity and FBLs seen on acute/subacute CT in patients aged > 55 with lobar haemorrhage (LH), and to study the relationship of these brain abnormalities with other parameters, including cerebral amyloid angiopathy (CAA)-related abnormalities.

Methods. – This was an observational study and retrospective analysis of early CT scans (< 7 days) in patients aged > 55 years with acute lobar hemorrhage who, between 2012 and 2015, were entered into our stroke database. A total of 37 LH episodes (without trauma, abnormal coagulation/platelet counts, vascular malformation, tumor or vasculitis) in 35 patients were analyzed. Other studied parameters were gender, age, history of hypertension, blood pressure on admission, prior antiplatelet treatment, aPTT, PTT, platelet count, hematocrit, timing of first CT, LH volume, involved lobe, cortical superficial siderosis, microbleeds, chronic LH and CAA (classic and modified Boston) criteria. CAA-related abnormalities seen on MRI were also scored.

Results. – Overall, in 26 LH episodes (70%), CT was performed within 24 h. Density heterogeneity and FBLs were seen in 19 (51%) and 9 (24%) LH episodes, respectively. Also, according to classic and modified Boston criteria, 18 (51%) and 24 (69%) patients, respectively, fulfilled criteria for probable/definite CAA. As for the presence of FBLs, a statistically significant association was found with both the presence of probable/definite CAA according to modified Boston criteria ($P = 0.033$) and the presence of superficial siderosis ($P = 0.019$).

Conclusion. – Density heterogeneity and, to a lesser degree, FBLs are frequently seen in patients aged > 55 with LH. FBLs may also be associated with CAA-related hemorrhage.

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http://dx.doi.org/10.1016/j.neurol.2016.05.003

1. Introduction

Density heterogeneity (hyperdensities of different densities) is frequently seen in acute intracerebral hemorrhage, which is mostly studied in patients aged > 18 years with deep brain hemorrhage (most often seen in a context of hypertension-related small-vessel pathology) on computed tomography (CT) performed within 3–6 h of the event [1,2]. Blood density on CT scans in cases of brain hemorrhage is related to the age of the blood, the number of foci of hemorrhage and the hematocrit. Thus, density heterogeneity might reflect active hemorrhage, a more variable hemorrhagic time course (including rebleeds) and multifocality. A particular form of heterogeneous CT density is when a fluid–blood level (FBL; a hypodense layer lying above a hyperdense one with a horizontal interface in between) is present within the hemorrhage. FBLs are most often seen in patients with coagulopathy or taking anti-coagulant medications, but they can also be observed in hemorrhages related to tumors, arteriovenous malformations (AVMs) and cerebral amyloid angiopathy (CAA) [3,4].

To the best of our knowledge, density heterogeneity and FBLs on CT have never been studied in patients with lobar hemorrhage (LH). In patients aged > 55 years, and in the absence of trauma, anticoagulation treatment and underlying vascular or tumoral lesions, CAA is a frequent cause of LH. Thus, the aim of the present preliminary study was to analyze:

- the frequency of density heterogeneity and FBLs on CT scans performed during the acute or subacute phase in patients aged > 55 with LH;
- the relationship of these radiological abnormalities with other parameters [including CAA-related abnormalities seen on magnetic resonance imaging (MRI)].

2. Methods

The present observational study retrospectively analyzed the brain imaging results of consecutive patients, aged > 55 with symptomatic acute LH, who fulfilled inclusion/exclusion criteria and were entered between January 2012 and February 2015 into our stroke database.

Inclusion criteria were:

- age > 55 years;
- initial imaging (CT or MRI) within 3 days of symptom onset revealing LH;
- absence of radiological basal ganglia involvement;
- CT scan performed within 7 days (when various CT scans were available, only the earliest one was analyzed) of symptom onset (to look for signal heterogeneity and FBLs);
- MRI [including gradient-echo (GRE) weighted sequences] performed within 3 months of symptom onset.

Exclusion criteria were:

- recent trauma;
- anticoagulation treatment;
- pathological blood coagulation tests [activated partial thromboplastin time (aPTT) ratio = patient's aPTT/normal control aPTT > 1.2, or partial thromboplastin time [PTT] < 75%] or platelet count (< 100×10^9/L);
- radiological imaging suggestive of AVM, brain tumor, vasculitis or cavernoma.

In our stroke unit, 243 patients with intracranial hemorrhage were admitted between January 2012 and February 2015. After excluding patients with basal ganglia involvement, 110 patients with pure LH remained. Of these, 27 were excluded because of pathological coagulation tests (mainly due to ongoing anticoagulation treatment), leaving 83 patients and, of these, 24 were excluded because of radiological imaging suggestive of AVM/brain tumor/vasculitis/cavernoma, 16 for failing to meet the CT/MRI time window required, and six because of movement artifacts on CT or MRI scanning, leaving 37 LH episodes eligible for analysis.

The presence of density heterogeneity (hyperdensities of different densities) and FBLs (a hypodense layer lying above a hyperdensity with a horizontal interface in between) were looked for within the brain hemorrhage on early (< 7 days after symptom onset), unenhanced brain CT scans. Images were evaluated visually (without the use of Hounsfield units or other semi-quantitative measurements) and independently by two staff neurologists (D.R. and A.W.), who were blind to the patients' clinical and other radiological data. If disagreement arose between the evaluators, a decision was made by consensus. Density heterogeneity and FBLs were considered to be either present or absent. When present, a clear and evident signal heterogeneity or FBL had to be visible on the image as well as on those taken above and below the most apparent image to avoid partial volume effects. When only an FBL was seen with no density heterogeneity within the lower hyperdense layer, this was not counted as density heterogeneity.

In the everyday practice of our center (CHU Nîmes, Hôpital Caremeau), most patients undergo CT as the initial brain imaging on admission (especially when > 4.5 h from symptom onset), followed by MRI a few days (or rarely, weeks or months) later. Some patients (because of potential thrombolysis treatment due to admission < 4.5 h from symptom onset) have an initial MRI in the hyperacute phase, with follow-up CT a few days later. Contrast enhancement is used for at least one of the two imaging modalities (CT and MRI).

Other analyzed parameters were: gender; age; history of hypertension; systolic blood pressure (SBP) on admission; use of chronic antiplatelet treatment prior to LH; aPTT ratio, PTT, platelet count and hematocrit on admission; initial imaging modality (CT or MRI); timing of initial imaging after symptom onset, timing of first CT scan and timing of MRI; LH volume (using the ABC/2 formula) and the predominantly involved brain lobe (both evaluated on initial imaging); presence of cortical superficial siderosis (CSS; called 'focal' when < 4 sulci and 'diffuse' when > 3 sulci are involved); number of microbleeds (called 'innumerable' when > 25); ancient LH (rather than recently symptomatic); and the presence of criteria for possible, probable or definite CAA, according to both classic and modified Boston criteria (all evaluated by MRI) [5,6].

For MRI, a 1.5- or 3-Tesla (T) scan was used in all cases except for two patients, who underwent 0.3-T MRI using slightly different repetition time (TR) and echo time (TE) parameters. Slice thicknesses were 5 mm for MRI and 3 mm