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ORIGINAL ARTICLE

MRI diffusion-weighted imaging in intracranial hemorrhage (ICH)

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KEYWORDS
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Abstract *Purpose:* To assess the role of MRI DWI in detection and characterization of ICH.
Patients and methods: 61 patients with intracranial hemorrhage who underwent MRI (including DWI, ADC, and GRE) and CT were retrospectively included in this study. MRI DWIs were analyzed for age, type, (primary parenchymal hemorrhage or hemorrhagic lesion) and location of the hemorrhage. The results were compared with conventional MRI sequences, GRE, and CT to assess the diagnostic accuracy of DWI in assessment of patients with intracranial hematoma.
Results: We had 61 patients with intracranial hemorrhage, six cases were missed by DWI. MRI DWI was accurate for the detection of hyperacute, medium, large sized acute, early and late sub acute, subdural, hemorrhagic components of arterial and venous infarction, intraventricular hemorrhage. DWI showed low sensitivity in detection of subarachnoid and small intraparenchymal hemorrhage The ADC measurements in hyperacute, acute, early and late subacute hematoma were statistically equivalent and were significantly less than the late subacute hematoma as well as the contralateral white matter.

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Conclusion: MRI DWI was accurate in detection, characterization and staging hyperacute, acute, subacute hemorrhage as well as hemorrhagic components of arterial and venous infarctions and of low diagnostic accuracy in subarachnoid and small parenchymal hemorrhage.

1. Introduction

Non contrast computed tomography (CT) has been the standard imaging modality for the initial evaluation of patients presenting with acute stroke symptoms (1,2). The primary diagnostic advantage of CT in the hyperacute phase (0–6 h) is its ability to rule out the presence of hemorrhage. Accurate early detection of blood is crucial since a history of intracerebral hemorrhage is a contraindication to the use of thrombolytic agents. However, a major disadvantage of conventional CT within the first few hours of symptom onset is its limited sensitivity for identifying early evidence of cerebral ischemia. Conversely, multimodal magnetic resonance imaging (MRI), including diffusion-weighted imaging (DWI), has excellent capacity to delineate the presence, size, location, and extent of hyperacute ischemia (3) but unproven reliability in identifying early parenchymal hemorrhage. The advent of thrombolytic therapy and other interventional therapies for acute ischemic stroke has led to increasing interest in using MRI to select and stratify candidates for treatments (4). Currently, many stroke centers obtain both CT and MRI in the initial evaluation of patients with stroke. The use of both modalities is time consuming and expensive (4).

2. Purpose

To assess the role of MRI diffusion weighted imaging in detection and characterization of intracranial hemorrhage.

3. Patients

Among all consecutive patients admitted to our institution between March 2008 and Feb. 2011, we retrospectively selected those who fulfilled the following criteria: (1) Intracranial hematoma unrelated to neoplasm; (2) patients performed MRI (including DWI and GRE) and CT with time interval between the CT and MRI examinations 2–4 h.

61 patients (10 females and 51 males; mean age, 56 years; range, 19–83) fulfilled these criteria and constituted our study group.

4. Imaging techniques

MR examination was done for all patients using Magnetom symphony, syngo, 1.5 T machine. The conventional MR imaging protocol included (a) axial T1-weighted spin-echo (467/9 [repetition time (TR) msec/echo time (TE) msec]), (b) axial T2-weighted fast spin-echo (3417/102 [effective echo time]), and (c) axial FLAIR (10000/400/2200 [inversion time]). The parameters of conventional MR imaging were a 256 192 matrix, a 23-cm field of view, and a 5 mm/2 mm slice thickness/intersection gap. Singleshot, spin-echo, echo-planar DWI sequences were obtained by applying diffusion gradients in three orthogonal directions at each slice, with two diffusion weightings (b value = 0 and 900 or 1000 s/mm^2). Isotropic DWI was generated on-line by averaging three orthogonal-axis images. The DWI examination acquired 20 slices with parameters of 6500/96.8 (TR/TE), a 128 128 matrix, a 28-cm field of view, and 5-mm slice thickness with a 2-mm intersection gap. gradient-echo imaging (TR/TE = 450/20).

Computed tomographic scans were performed on Lightspeed scanner (General Electric). Images were acquired following the orbito-meatal plane with 3 mm thickness for the entire examination.

5. Imaging analysis

All the MRI and CT examination were reviewed by experienced neuroradiologist. Interpretations for each imaging

Table 1 Signal intensities of intracerebral hematoma-according to the various stages demonstrated on MR images.

Stage of hematoma	No of patients	T1 WIs	T2 WIs	DWI	GRE
Hyper acute	3	Isointense	Hyperintense	Heterogeneous hyperintense	Iso or hyperintense
Acute	11	Isointense	Hypointense	Hypo	Hypointense
Small parenchymal hemorrhage	4	–	Hypo or hyperintense	Hypo or hyperintense	Hypointense
Early subacute	7	Hyperintense	Hypointense	Hypointense	Hypointense
Late subacute	9	Hyperintense	Hyperintense	Hyperintense	Hyper or iso
Subdural					
Early	1	Hyperintense	Hypointense	Hypointense	Hypointense
Late	4	Hyperintense	Hyperintense	Hypointense	Iso or hypointense
Intraventricular	4	Hypointense	Hypointense	Hypointense	Hypointense
Hemorrhagic arterial infarction	8	Heterogeneous hypo and hyper	Heterogeneous hypo and hyper	Heterogeneous hypo and hyper	Heterogeneous hypo and hyper
Hemorrhagic venous infarction	7	Heterogeneous hypo and hyperintense	Heterogeneous hypo and hyperintense	Heterogeneous hypo and hyperintense	Heterogeneous hypo and hyperintense
Subarachnoid hemorrhage	3	Hypo or hyperintense	Hypointense	Hypointense	Hypointense