Comparison of the Diagnostic Value of Magnetic Susceptibility-Weighted Imaging and Routine Magnetic Resonance Imaging in Cerebral Amyloid Angiopathy Hemorrhage

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To investigate the diagnostic value of the magnetic susceptibility-weighted imaging and routine magnetic resonance imaging in cerebral amyloid angiopathy hemorrhage. A total of 64 patients with suspected cerebral amyloid angiopathy hemorrhage diagnosed in our hospital from January 2018 to January 2019 were included in the study. All patients were diagnosed by routine magnetic resonance imaging and magnetic susceptibility-weighted imaging before the operation. The consistency of the two detection methods in the diagnosis of cerebral amyloid angiopathy hemorrhage and the difference in image quality were analyzed. Multivariate Logistic regression analysis was used to analyze the preoperative imaging features of routine magnetic resonance imaging and magnetic susceptibility-weighted imaging and the risk of focal hemorrhage. The qualified rate of lesions scanned by magnetic susceptibility-weighted imaging was 93.75 %, which was higher than that of routine magnetic resonance imaging (85.94 %), the difference was statistically significant ($p<0.05$). Based on the postoperative pathological results, the sensitivity of routine magnetic resonance imaging and magnetic susceptibility-weighted imaging was 67.50 % and 90.25 %, respectively. The specificity was 25.00 % and 75.00 %, and the coincidence rate was 85.94 % and 93.75 %. The Kappa index is 0.279, and the consistency between them is poor. The results of the regression analysis showed that the independent predictive signals of the focal hemorrhage in patients with cerebral amyloid angiopathy hemorrhage were patchy signal and multiple clear edge low signal (OR=4.356, p=0.017; OR=3.763, p=0.021). Magnetic susceptibility-weighted imaging has obvious advantages in detecting the micro cerebral hemorrhage, and it can show the characteristics of the cerebral amyloid angiopathy multiple hemorrhages, and its diagnostic value was better than that of routine routine magnetic resonance imaging.

Key words: Cerebral amyloid angiopathy hemorrhage; Magnetic resonance imaging (MRI); Magnetic susceptibility-weighted imaging (SWI)

Cerebral amyloid angiopathy (CAA) was a group of diseases characterized by the deposition of the insoluble fibrin (glycoprotein) in brain tissue. Because the disease has no specific clinical manifestations, it was easy to cause misdiagnosis and missed diagnosis in the early stage. CAA was an important cause of the spontaneous subcortical intracerebral hemorrhages (ICH) in the elderly with normal blood pressure[1]. CAA was a cerebrovascular disease characterized by the deposition of β-amyloid protein in the media and adventitia of small and medium-sized vessels in the cerebral cortex, cortex, and pia mater. The disease was clinically characterized by multiple and complex intracerebral hemorrhages, so it was also known as cerebral amyloid angiopathy hemorrhage (CAAH)[2,3]. As the onset of CAAH was located in the brain, the amount and location of hemorrhage was uncertain, the diameter of the focus was small, and there was no edema and other inflammation around the disease, the routine MRI was difficult to detect and diagnose effectively. Therefore, there was an urgent need for the detection methods which can detect the CAAH accurately in the clinic. In recent y, with the development of science and technology, magnetic susceptibility-weighted imaging (SWI) with higher sensitivity was used in the diagnosis

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of the minute lesions of central nervous system diseases[4,5]. Not only this, Susceptibility-weighted imaging (SWI) which is a new neuroimaging technique, uses tissue magnetic susceptibility differences to generate a unique contrast where a conventional MRI doesn't. However, there were few clinical reports on the value of SWI in the diagnosis of CAAH. In this study, SWI technology was applied to patients with CAAH treated in our hospital, and the value and application prospect of SWI technology in the early diagnosis of CAAH were analyzed. From January 2018 to January 2019, 64 patients who were initially diagnosed as CAAH were enrolled in the study. The patients and their families all signed the informed consent forms. Inclusion criteria: The symptoms of CAAH patients meet the 2011 Boston Diagnostic criteria[6] and the patients were over 50 y old. It was confirmed by pathological examination that there were more amyloid deposits in the cerebral vessels of the patients. Confirmed by brain CT, MRI, SWI, and other medical imaging techniques, the patient had multiple satellite hemorrhagic lesions. Exclusion criteria: The patient has severe immune metabolic diseases, heart disease, family medical history, and mental illness. The patient has metastatic malignant tumors. Patients with coagulation dysfunction and multiple organ damage. In this study, the Achieva 3.0T Nuclear Magnetic Resonance (NMR) spectrometer with superconducting magnet (Philips Company) was used. All patients underwent the routine MRI examination before the operation. The patients took a supine position, fixed the head, and used an 8-channel phased-array coil. The check mode mainly includes T1 weighted image (T1WI) and T2 weighted image (T2WI), fast spin. After the routine MRI check, the SWI check was carried out. The main parameters were as follows, depth: 1.5 mm, matrix: 468×364, TR: 49.0 ms, TE: 40.0 ms, FOV: 24 cm×24 cm. The collected image data were converted and processed by Siemens syngo software to get the SWI image. In this study, the images were independently observed and judged by two medical imaging chief physicians with 10 years' working experience, and the consistent interpretation results were taken as the final diagnosis results. If the two results were inconsistent, it will be interpreted and determined by the director of the department, and the final result will be the result of the diagnosis. The evaluation indicators of this study mainly include the following points. Evaluate the image quality of MRI and SWI. The evaluation mainly included the number, shape, and clarity of hemorrhagic lesions. The Likert scale[7] was commonly used to evaluate the image quality. The quality score was divided into 5 levels, level 1 (5 scores) means the image can show the microlesions around 1 mm, level 2 (4 scores) means the image can show the microlesions around 1-5 mm, level 3 (3 scores) means the image can show the focus can be interpreted from the image, level 4 (2 scores) means the quality of the image was general, and it was difficult to distinguish the focus, level 5 (1 score) means the quality of the image was poor, and the useful information cannot be obtained. Therefore, only those images with level 3 or above were qualified. The results of the pathological examination were used as the gold standard to evaluate the consistency of MRI and SWI. Detection of image features of CAAH by MRI and SWI. All the data were analyzed by SPSS20.0; the measurement data were expressed by mean±standard deviation, and analyzed by t-test. The counting data were expressed by the number of cases and percentages, and analyzed by χ^2 test. Multivariate regression analysis was used to analyze the relationship between the preoperative imaging features and the risk of hemorrhages. Kappa consistency test was used to analyze the consistency of the two groups of methods for CAAH detection. $p<0.05$ indicates that the difference was statistically significant. The results of the routine MRI showed that T1WI images showed low signal intensity, while T2WI showed different proportions of high and low mixed signals, and the lesions were in various shapes, mostly flaky and layered. The results of SWI showed that the shape of the hematoma was punctate, annular and lobulated, and the boundary of the focus was clear. The minute lesions were mainly shown as punctate or small round low signal areas on SWI, and the images were more regular. The comparison of the two methods was shown in TABLE 1, which shows that the resolution of the CAAH lesions and signal images of SWI was better than that of MRI. The qualified rate of lesions scanned by SWI was 93.75 %, which was higher than that of MRI (85.94 %). The difference was statistically significant ($p<0.05$) (TABLE 2). Based on the results of the postoperative pathological examination, the coincidence, specificity, and sensitivity of MRI and SWI were compared and analyzed. The results showed that the sensitivity of MRI and SWI was 67.50 % and 90.25 % respectively. The specificity was 25.00 % and 75.00 %, and the coincidence rate was 85.94 % and 93.75 %. The final Kappa index was 0.279, indicating that for the newly diagnosed CAAH patients in this study, the consistency between SWI and MRI was poor (TABLE 3). The image features of CAAH patients were

obtained by MRI and SWI. In this study, the patchy signal, punctate signal, small round signal, and multiple edge signal area in the image were used as independent variables to establish a regression model to analyze the risk degree of the patient's disease. The results showed that the patchy signal and multiple edge clear low signals were the independent predictors of focal hemorrhage in patients with CAAH (OR=4.356, p=0.017; OR=3.763, p=0.021, TABLE 4). CAAH has the characteristics of strong crypticity, and high mortality, and it often occurs in the elderly, which was the most serious cerebrovascular disease[1-3]. CAAH has a variety of common clinical symptoms, such as dizziness and headache, vomiting, and it was accompanied by the intracranial pressure increase caused by the hematoma compression before massive hemorrhage[5,8]. Because CAAH was located in a specific part of the brain and has a high risk of massive hemorrhage, surgical treatment was not recommended unless the patient has an excessive hematoma or a cerebral hernia[8,10]. Therefore, it is of great significance to study the diagnosis and treatment of CAAH in the early stage, which is helpful to improve the quality of life of patients with CAAH. With the development of science and technology, SWI technology has been widely used in the diagnosis and treatment of tumor, cardio-cerebrovascular, and orthopaedics, and achieved good results. SWI was a new type of MRI contrast enhancement technique. Its detection principle was to analyze the difference of electromagnetic sensitivity fed back by different tissues, the signal difference between the diseased tissue and normal tissue were revealed based on the principle of electromagnetic imaging, thus to identify the size, shape, and position of the pathological tissue[11,12]. Because SWI was highly sensitive to the changes of venous blood flow in brain tissue and Fe^{2+} in red blood cells, hemorrhagic lesions show the obvious signal loss in SWI images. Therefore, SWI was superior to MRI in the diagnosis of some small lesions[13,14]. Some studies have found that SWI has a higher recognition of CAAH, and its image quality was better than that of MRI[15]. From the research results of this paper, it can be seen that SWI can identify the lobulated, punctate, circular, and elliptical signal regions, while MRI can only distinguish the flake and layered signal regions, and its high and low signals were mixed. At the same time, the results of this paper show that the qualified rate of SWI image was 93.75 %, significantly higher than that of MRI, which was consistent with other research results[16,17]. This study also analyzed the consistency of SWI and MRI in the diagnosis of CAAH. The results showed that the sensitivity, specificity, and consistency of SWI to CAAH were significantly higher than those of MRI,

TABLE 1: DETECTION OF THE IMAGE FEATURES OF CAAH BY MRI AND SWI

Methods	Lesion types	Acute stage		Subacute stage		Chronic stage	
		T1WI	T2WI	T1WI	T2WI	T1WI	T2WI
MRI	Flaky, layered	Low signal intensity	Low signal intensity	Low signal intensity	High and low mixed signals	High and low mixed signals	High signal intensity
SWI	Punctate, annular, smallround, and lobulated	Low signal intensity		Low signal intensity		Mainly low signal, a few high signal	

TABLE 2: COMPARISON OF IMAGE QUALITY BETWEEN MRI AND SWI

Methods	5 scores	4 scores	3 scores	Qualified	Qualified rate
MRI	9	31	15	55	85.94 %
SWI	18	38	4	60	93.75 %
x^2					2.787
P					0.073

TABLE 3: CONSISTENCY EVALUATIONS OF SWI AND MRI

Methods	Sensitivity	Specificity	Coincidence rate	Kappa index
MRI	67.50 %	25.00 %	85.94 %	0.279
SWI	90.25 %	75.00 %	93.75 %	

TABLE 4: RETROSPECTIVE ANALYSIS OF MRI AND SWI IMAGE FEATURES

Type of signal	Regression coefficient	Wald value	Standard deviation	OR	P
Patchy signal	1.378	11.532	0.0670	4.356	0.017
Round signal	0.609	7.351	0.0560	1.897	0.103
Multiple edge signal	1.273	9.887	0.0731	3.763	0.021
Ring signal	0.475	7.658	0.102	1.764	0.089

indicating that SWI was more suitable for medical imaging diagnosis of CAAH. This may be because SWI can perform 3D sampling, adopt flow compensation, gradient echo of thin-layer reconstruction, reduce the interference of noise error, carry out phase-weighted and minimum signal intensity projection 3D reconstruction, and can display micro-hemorrhage, microvascular malformations and other small vascular lesions with high resolution. At the same time, SWI was specific to the changes of hemosiderin deposition and the difference of the local magnetic field, which can enhance the sensitivity and diagnostic accuracy of SWI in hemorrhagic lesions. Some studies have found that compared with MRI, SWI can more accurately identify the location of haemorrhage and the shape of hemorrhagic lesions in patients with CAAH. Through the establishment of multivariate regression models for different hemorrhagic lesions and patients' disease risk, it was found that the patchy signals and multiple edge clearance signals were independent predictors of hemorrhagic events in CAAH. This may be because when the patchy signal and multiple edge clear low signal areas were shown in SWI and MRI images, hemorrhagic edema has existed in a large area of the patient's skull, which was the most dangerous time for the occurrence of CAAH. However, it is worth noting that the punctate low echo signal in SWI was caused by the local plasma extravasation, which contains the paramagnetic substances such as heme and deoxyhemoglobin and makes the local magnetic field uneven. The routine MRI was insensitive to this inhomogeneity and often has no obvious signal characteristics. Therefore, these results show that SWI can diagnose CAAH in the early stage, which has important clinical value for the diagnosis of CAAH. In a word, SWI has obvious advantages in detecting cerebral microhemorrhage. It can show the characteristics of CAAH, and its diagnostic value was higher than that of the routine MRI.

Conflict of interests:

The authors declared no conflict of interest.

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