Value of conventional MRI and susceptibility weighted imaging in diagnosis of cerebral microbleeds.

Dongmei Zhang[1#], Liping Xu[2#], Aidong Ma[1], Zhenbin Cao[2*]

[1]Department of Radiology, Jining No.1 People's Hospital, PR China

[2]Department of Radiology, Ruikang Hospital Affiliated to Guangxi University of Chinese medicine, PR China

[#]These authors contributed equally to this work

Abstract

Objective: To investigate the value of conventional MRI and susceptibility weighted imaging sequences in the diagnosis of cerebral microbleeds.

Methods: A total of 160 patients with cerebral microbleeds treated in our hospital from July 2015 to July 2017 were selected as the objects. They were divided into study group (n=80) and control group (n=80) according to randomized picking method in which the control group received routine MRI detection and the study group were examined with susceptibility weighted imaging followed by comparison of examination results in between.

Results: Detection rate was 96.3% in the study group and 81.3% in the control group with significant difference in between, P<0.05. SWI examination showed the foci form of cerebral microbleeds round, round-like, patches strip, ring and punctiform shape.

Conclusion: The examination of susceptibility weighted imaging can significantly enhance the detection rate in patients with cerebral microbleeds and enables to analyse the lesions in detail, thus worthy of clinical reference and popularization.

Introduction

The diameter of hemorrhagic foci of cerebral microbleeds is usually no more than 5 mm and more frequently seen in deep layers of white matter and gray matter. The symptoms in patients with the disease are generally mild with no typical manifestation, thus extremely easy to be ignored, and it is much prone to missed diagnosis in MR routine examination and CT scan, thereby making the condition develop progressively and then causing serious complications or even death, which poses a huge threat to life safety of patients [1]. Cerebral microbleeds are a new concept currently proposed in the world of medicine. It refers to cerebral microvascular lesions and hypertension is considered as one of its risk factor in modern medicine. That is because hypertension can cause hyalinized change of cerebral arterioles and degenerative changes in the media of arteries, which will weaken vascular smooth muscle layer and elastic fiber layer with loss of toughness. In essence, the pathological change of cerebral microbleeds is that tiny vessels in brain are diseased and it is mainly characterized by minor bleeding without specific symptoms. It is a subclinical lesion with the predilection sites of basal ganglia, thalamus, subcortex and cortex. SWI is mainly to take advantage of bulk magnetic susceptibility effect

[2], that is to say, different tissues vary from one another in magnetic susceptibility and it then will cause phase difference. Conventional sequence fails to detect out micro veins because there is certain difference between deoxygenated hemoglobin and peripheral tissues in the vein. The difference, although very small, leads to certain changes in local magnetic field, then gives rise to phase difference between veins and peripheral blood vessels and finally reveals above changes through imaging. Therefore, the small lesions having the diameter of less than 5 mm and failing to be detected by conventional sequence can be detected out by SWI, thus making its detection rate significantly increased. In this study we selected from our hospital 85 patients with cerebral microbleeds to assess diagnostic value of routine MRI and susceptibility weighted imaging in this regard with the details reported as follows.

Data and Methods

Baseline data

A total of 160 patients pathologically diagnosed with cerebral microbleeds and treated in our hospital from July 2015 to July 2017 were selected as the objects with ethics committee

approval. They were divided into study group (n=80) and control group (n=80) according to randomized picking method. In the study group there were 46 males 34 females aged 36-70 with an average age of (53.06 ± 6.62 y) and the onset time of 1-13 h, (7.06 ± 6.14 h) on the average. In the control group, there were 47 males 33 females aged 39-71 with an average age of (55.06 ± 15.96 y) and the onset time of 2-12 h, (7.09 ± 5.67 h) on the average. All family members signed informed consent form before the study. There was no significant difference between groups in baseline data, P>0.05, as shown in Table 1.

Table 1. Baseline data in two groups.

Group	Male (n)	Female (n)	Average age (Y)	Average course (Y)
Study group (n=80)	46	34	53.06 ± 16.62	7.06 ± 6.14
Control group (n=80)	47	33	55.06 ± 15.96	7.09 ± 5.67
χ^2	0.0725	0.7763	0.0321	
P	0.7877	0.4387	0.9744	

Methods

The patients were examined by Holland PHILPS 3.0T multisource MRI scanner (model: Achiera-3.0T-TX; producer: Holland). Control group: the patients were given conventional scanning including scanning of DWI, FIAIR, T2W1 and T1W1 by using SENSE with factor 2, the layer thickness was set as 6mm and layer space 0.6 mm, the length and width of image reconstruction were both 0.9 mm, the number of excitation was 2 and the size of matrix was: 512 × 256 [3,4]. Study group: the patients were given SWI detection: SWI images were achieved by filtering echo sequence of Ven-Bold-HR 3D ladder, obtained phase image and matrix image and generating a new phase mask picture combined with magnetic image [5,6].

Evaluation index

The images obtained were required to be evaluated by 2 experienced chief physicians and the lesion shape was analysed under SWI and MRI examinations.

Statistical methods

SPSS23.0 statistical software was used for analysis, the detection rate, representing enumeration data, was assessed by test, P<0.05 suggested there was obvious difference of statistical significance.

Results

Comparison of detection rate

In the study group 77 cases were detected and 3 cases failed to be detected with the detection rate as 96.3% (77/80); while in the control group 65 cases were detected and 15 cases failed to be detected with the detection rate as 81.3% (65/80), there was significant difference between the two groups, P<0.05, and undetected patients in both groups were followed up and given pathological examination as shown in Table 2.

Table 2. Comparison of detection rate.

Group	Detected (n)	Undetected (n)	Detection rate (%)
Study group (n=80)	77	3	96.3
Control group (n=80)	65	15	81.3
χ^2	-	-	9.0141
P	-	-	0.0026

Morphological features of cerebral microbleeds lesion under SWI examination

A total of 80 patients were examined with SWI and among them 31 were hypertension, 17 hemorrhagic cerebral infarction, 15 cavernous hemangioma, 12 diffuse shaft damage and 5 cerebral keratoma. A total of 77 cases of lesions were found in the shape of round, round-like, patches, strip, and ring in which the cerebral keratoma, mainly in the form of strip, round and round-like, accounted for 50% with clear-cut margin, hypointensity; the diffuse shaft damage, mainly in the form of round and round-like, accounted for 55.6% and was mainly seen in cortico medullary zone and basal ganglia region with clear-cut margin, hypointensity; cavernous hemangioma, mainly punctiform-shaped, accounted for 77.8%, hypointensity; hemorrhagic cerebral infarction, mainly punctiform-shaped, accounted for 60%, hypointensity; hypertension, mainly in the form of round and round-like, accounted for 47.8% and is more commonly seen in regions of cortex, brainstem, thalamus and basal ganglia with smooth edge and no edema as shown in Table 3.

Table 3. Analysis on morphological features of cerebral microbleeds lesion under SWI (n/%).

Lesion type	Ring	Punctiform	Patchy strip	Round and round-like	Sum
Cerebral keratoma	0 (0.0)	0 (0.0)	2 (50)	2 (50.0)	4
Diffuse shaft damage	2 (22.2)	0 (0.0)	2 (22.2)	5 (55.6)	9
Cavernous hemangioma	0 (0.0)	7 (77.8)	3 (23.1)	3 (23.1)	13
Hemorrhagic cerebral infarction	0 (0.0)	12 (60.0)	5 (25.0)	3 (15.0)	20
Hypertension	1 (3.2)	6 (19.4)	1 (3.2)	23 (74.2)	31
Sum	3 (3.9)	25 (32.5)	13 (16.9)	36 (47.8)	77

Discussion

Cerebral microbleeds are closely related to hyaline fiber degeneration, cerebral vascular amyloidosis, hyperglycemia, hypertension, stroke, parenchymal hemorrhage and cognitive impairment [7-9]. In this study, there were 11 cases of hemorrhagic cerebral infarction, showing that the occurrence of cerebral microbleeds is closely associated with cerebral infarction. It is usually accompanied with leukoaraiosis as well as lacunar infarction and its incidence rate is proportional to severity of the two lesions generally without obvious clinical features in patients. It is mainly pathologically characterized by hemosiderin deposition, meanwhile accompanied by incomplete necrosis around and surrounding glial hyperplasia [10,11]. Cerebral microbleeds can exert certain effects on the patients' cognitive function, such as affective disorder after stroke, attention, computational power, executive function and cognitive function and it may cause disturbance of side looking despite being cured. What's worse, it will give rise to the risk of anticoagulation as well as thrombolysis and affect the aggregation of platelets [12,13].

The result of this study showed that detection rate was 96.3% in the study group and 81.3% in the control group with significant difference in between, P<0.05, suggesting that SWI is of unique value in diagnosis of cerebral microbleeds. SWI, mainly taking advantage of the differences in magnetic field sensitivity among varying tissues, enables the vein to remain a tissue of low signal with differences from others, and then it requires to compare the images obtained with moderately high resolution and signal-to-noise ratio, thus able to well respond to pathological changes of cerebral microbleeds [14-16]. In this study, the acceleration factor-2 of SWI greatly shortened examination time with good effect. SWI, based on GRET2WI [17,18], has significant diagnosis effect on abnormal or normal small veins, enables to reveal bleeding site easier than conventional sequence and detects out lesion morphology early, which provides a more scientific reference for clinical diagnosis and treatment, betters the prognosis in patients, prevents and reduces the incidence of cerebral microbleeds to a certain extent and finally improves the patients' living condition [19].

To sum up, in patients with cerebral microbleeds, the examination of magnetic susceptibility weighted imaging can significantly improve diagnosis accuracy and discovery rate and determine the form of lesions with moderately high application value and huge advantages, worthy of trust and recommendation from majority of patients; but due to high expense of magnetic resonance diagnosis, most of patients suffer from heavy financial burden. So it requires clinicians to constantly improve their professional knowledge so as to provide the most accurate and most suitable diagnosis method for patients.

References

1. Matano F, Murai Y, Mizunari T, Adachi K, Kobayashi S, Morita A. Intracerebral hemorrhage caused by cerebral hyperperfusion after superficial temporal artery to middle cerebral artery bypass for atherosclerotic occlusive cerebrovascular disease. NMC Case Rep J 2017; 41.

2. Razmjooy N, Mehdi R, Noradin G. Imperialist competitive algorithm-based optimization of neuro-fuzzy system parameters for automatic red-eye removal. Int J Fuzzy Sys 2017.

3. Sophia FS, Sepideh AH, Hassan M, Victor AA, Fady TC, Ali A. Relationship of pulsatility and resistance indices to cerebral arteriovenous malformation angioarchitectural features and hemorrhage. J Clin Neurosci 2016.

4. Mingjun Y, Zheng RC, Jianan Z, Yongchen S, Praveen L. Advances in nuclear magnetic resonance (NMR) techniques for the investigation of clathrate hydrates. Renew Sustain Energy Rev 2016.

5. Michael CDT, Tobias FS, Alexander P, Dmitry B. Nuclear magnetic resonance at millitesla fields using a zero-field spectrometer. J Magn Reson 2016.

6. Ebrahimian H, Ojaroudi M, Ojaroudi N, Ghadimi N. Distributed diode single-balanced mixer using defected and protruded structures for Doppler radar applications. Appl Comp Electromagn Soc J 2015.

7. Matsuoka G, Kubota Y, Okada Y. Delayed cerebral ischemia associated with reversible cerebral vasoconstriction in a patient with Moyamoya disease with intraventricular hemorrhage: case report. Neuroradiol J 2015; 283.

8. Ou K, Lin C, Chen C, Wu B, Zhu D, Zhong W, Wang X, Xie X, Chen Q. Association of probiotics and bone mineral density in Chinese patients with type 2 diabetes. Biomed Res 2017.

9. Akoudad S, Portegies ML, Koudstaal PJ, Hofman A, van der Lugt A. Cerebral microbleeds are associated with an increased risk of stroke: the Rotterdam study. Circulation 2015; 132: 509-516.

10. Tyler JG, Joseph AP. Ruptured berry aneurysm with minimal subarachnoid hemorrhage. J Forens Leg Med 2017.

11. Josephson CB, White PM, Krishan A, Al-Shahi Salman R. Computed tomography angiography or magnetic resonance angiography for detection of intracranial vascular malformations in patients with intracerebral haemorrhage. Cochrane Database Syst Rev 2014; 009372.

12. Wu G, Ghimire P, Zhu L, Baral A, Su J. Magnetic resonance imaging characteristics of primary intraspinal peripheral primitive neuroectodermal tumour. Canadian Assoc Radiol J 2013; 643.

13. Dammann P, Jabbarli R, Wittek P, Oppong MD, Kneist A. Solitary sporadic cerebral cavernous malformations: risk factors of first or recurrent symptomatic hemorrhage and associated functional impairment. World Neurosurg 2016; 91: 73-80.

14. Lazzeretti P. Electronic current densities induced by magnetic fields and nuclear magnetic dipoles. Sci Technol Atom Mol Condens Matt Biol Sys 2013; 3.

15. Shunji S. The rules of computerized cardiotocography and middle cerebral artery for diagnosis of fetomaternal hemorrhage. Taiwanese J Obstetr Gynecol 2017.

16. Parsian A, Mehdi R, Noradin G. A hybrid neural network-gray wolf optimization algorithm for melanoma detection. Biomed Res 2017.

17. Ghadimi N, Mohammad O. A novel design of low power Rectenna for wireless sensor and RFID applications. Wireless Personal Commun 2014.

18. Liu C, Li W, Tong KA, Yeom KW, Kuzminski S. Susceptibility-weighted imaging and quantitative susceptibility mapping in the brain. J Magn Reson Imaging 2015.

19. Zhang H, Song S, Ouyang Z. Intraventricular hemorrhage caused by intracranial venous sinus thrombosis: case report. Med 2016; 9528.

*Correspondence to

Zhenbin Cao

Department of Radiology

Ruikang Hospital Affiliated to Guangxi University of Chinese medicine,

PR China