

Original Article

The predictive value of HRMRI and MRI in the diagnosis of atherosclerotic plaques in middle cerebral artery of patients

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Abstract: Objective: To study the predictive value of high resolution magnetic resonance imaging (HRMRI) and magnetic resonance imaging (MRI) in the diagnosis of atherosclerotic plaques in middle cerebral artery (MCA) of patients. Methods: A total of 62 patients admitted to our hospital from December 2017 to May 2019 who were diagnosed with atherosclerosis and located in the brain artery were selected, among whom 32 patients were in group A with HRMRI, and the other 30 patients were in group B with MRI. The detection rate, misdiagnosis rate and missed diagnosis rate, postoperative neurological function and limb recovery SSS (Scandinavian stroke scale) score, Fugl-Meyer assessment (FMA) score, postoperative quality of life (QL-index), expression levels of hs-cTnT, hs-CRP and HCY, and total effective rate of the two groups were detected and compared. The postoperative predictors of patients were analyzed. Results: Compared with group B, group A had higher detection rate, lower misdiagnosis rate and missed diagnosis rate, lower SSS and FMA scores, higher QL-INDEX score, lower expression levels of hs-cTnT, hs-CRP and HCY, and higher total effective rate. Detection rate and expression levels of hs-cTnT, hs-CRP and HCY were the postoperative predictors of patients. Conclusion: HRMRI is more accurate than MRI in predicting the diagnosis of atherosclerotic plaques in MCA of patients, and the accurate diagnostic effect is more helpful to the postoperative curative effect and recovery of patients. Detection rate and expression levels of hs-cTnT, hs-CRP and HCY can be used as prognostic factors.

Keywords: High resolution magnetic resonance imaging, magnetic resonance imaging, atherosclerosis, Scandinavian stroke scale, Fugl-Meyer assessment

Introduction

The middle cerebral artery (MCA) is the larger terminal branch of the internal carotid artery (ICA) [1]. Compared with anterior cerebral artery (ACA) and posterior cerebral artery (PCA), its distribution range is larger [2]. Intracerebral atherosclerosis is the main cause of ischemic stroke, and its patients have a high risk of stroke [3]. MCA is one of the most common sites where atherosclerosis occurs. Atherosclerosis will lead to vascular stenosis, which further increases the stroke risk of symptomatic patients [4, 5]. Mechanisms related to this disease include arterial-arterial embolism, hypoperfusion, branch occlusive diseases, and combinations of the foregoing [6, 7]. The treat-

ment of atherosclerosis is important, and the detection of atherosclerotic plaques is the top priority.

The accumulation of lipids and inflammatory cells in large arteries, from pathological intimal thickening to fibrous atherosclerosis, and to thin fibrous atherosclerosis, eventually, the plaque ruptures, causing coronary artery obstruction, making the disease change unpredictable [8-11]. Therefore, plaque should be diagnosed and treated before it causes harm. Color Doppler imaging and contrast-enhanced ultrasound are all great methods for diagnosing atherosclerotic plaques [12, 13]. In this study, we will study the diagnosis of atherosclerotic plaques by high resolution magnetic resonance

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imaging (HRMRI) and magnetic resonance imaging (MRI). Among many studies on atherosclerotic plaques, MRI has become an ideal imaging method for studying and analyzing the morphological and compositional characteristics of atherosclerotic plaques. With the development of HRMRI technology, it can well display the characteristics of intracranial arterial plaque, especially can reflect the inflammatory response of plaque through the degree of plaque enhancement. Therefore, in the detection and treatment of many cardiovascular and cerebrovascular diseases at home and abroad, such technologies are often used, which improves the detection rate of atherosclerosis in patients [14-16]. However, there are few studies on the prognostic factors. The purpose of this study was to investigate the predictive value of HRMRI and MRI in the diagnosis of atherosclerotic plaques in the brain.

Materials and methods

General data

A total of 62 patients admitted to our hospital from December 2017 to May 2019 who were diagnosed with atherosclerosis and located in the brain artery were selected, among whom 32 patients were in group A with HRMRI, and the other 30 patients were in group B with MRI. Patients and their families were informed of the study and signed a consent form. The ethics committee of our hospital approved the study.

Inclusion and exclusion criteria

Inclusion criteria: patients had moderate-to-severe stenosis (stenosis $\geq 50\%$) of the proximal middle cerebral artery confirmed by CTA or MRA and were offending vessels, patients had no contraindications related to MRI, patients were mentally normal, patients had no major impairment in communication and were able to express physical discomfort relatively accurately, patients had a first episode, patients' symptoms were stable within the last month and no new strokes had occurred. Exclusion criteria: patients with neurological disorders such as cerebral hemorrhage, trauma, and intracranial space-occupying lesion, non-atherosclerotic cerebrovascular diseases such as moyamoya disease and arteritis, patients were unable to care for themselves, patients with MRI-related contraindications, patients with respiratory failure, patients with relatively severe

mental illnesses such as anxiety, depression, and suicidal tendencies.

Methods and detection indicators

HRMRI was used to diagnose the plaques of patients in group A. Blood lipid, blood glucose, blood pressure and other indicators should be tested before the test. HRMRI nuclear magnetic resonance scanner provided by our hospital was used to perform the examination to locate the patient's stenotic vessels, collect the patient's vascular state, and measure the diameter of the patient's lumen. GE Discovery 750W 3.0T superconducting magnetic resonance machine was used to scan all patients. 16-channel head and neck coil was used for HRMRI scanning of plaque. The sequence and parameters were as follows: firstly, T1-weighted three-dimensional isotropic fast spin echo sequence (T1W-CUBE) at transverse position was used: TR 800 ms, TE 20 ms, FOV 230 mm \times 230 mm, NEX for once, with the layer thickness of 0.6 mm. Followed by the T2-weighted black blood sequence at the transverse position: TR 2500 ms, TE 326 ms, FOV 230 mm \times 230 mm, NEX for 2 times, with the layer thickness of 0.6 mm. Finally, the sagittal view of T1W-CUBE: TR 800 ms, TE 20 ms, FOV 230 mm \times 230 mm, NEX for once, with layer thickness of 0.6 mm. It was performed at the transverse position T1W-CUBE sequence, the dose was 0.2 ml/kg body weight, and enhanced scanning was performed after intravenous injection of Gd-diethylenetriamine pentaacetic acid (Gd-DTPA). The patient's image was analyzed. All 30 patients in group B were diagnosed with MRI. In this study, GE Discovery 750W 3.0T superconducting nuclear magnetic resonance imaging system was applied, and neck coil and head coil were prepared. Medical staff used CE-MRA technology to acquire images by injecting contrast agent Gd-DTPA, and set fl3d -cor sequence scanning parameters as TR 3.78 ms, TE 1.37 ms, flip angle 30, visual field 300 mm \times 300 mm, layer thickness 0.7 mm, and total acquisition time TA23s for a single sequence to analyze the images of patients. After that, interventional therapy was carried out in a unified way: routine local anesthesia and disinfection were conducted, followed by femoral artery puncture. During the treatment process, saline and urokinase were pumped into the patient along the catheter at a speed of 1 mL/min with a micro guide wire and a path diagram, and then the stent was inserted into

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the site of arterial stenosis or embolism. All patients received thrombolytic drugs for a period of 6 months.

Observation indicators: (1) Detection rate: the number of negative and positive columns in the two groups was counted to calculate the detection rate (detection rate = number of positive columns/total cases). (2) misdiagnosis rate and missed diagnosis rate: the misdiagnosis rate and missed diagnosis rate of intracranial atherosclerosis patients in the two groups were detected. (3) Postoperative neurological function and limb recovery: Scandinavian stroke scale (SSS) [17] was used to evaluate the neurological function recovery of the two groups. The better the patient's neurological function recovered, the lower the score was. The Fugl-Meyer assessment (FMA) score [18] was used to evaluate the limb recovery of patients. The higher the score was, the better the recovery of limb effect. (4) Quality of life after treatment: quality of life index QL-index [19] was used for assessment. The questionnaire included 6 items, including activities, daily life, health, overall index, recent support and overall mental. The higher the total score was, the better the quality of life of the patient was. (5) Detection of HS-CTNT, hs-CRP and HCY: the fasting venous blood of the two groups was drawn in the morning after diagnosis. The serum was immediately separated and placed in a refrigerator at -20 for examination. Serum high-sensitivity troponin T (hs-cTnT), high-sensitivity C-reactive protein (hs-CRP) and homocysteine (HCY) were measured within one week. Hs-cTnT was determined by electrochemical luminescence immunoassay instrument of Roche. Hs-CRP was detected by immune fluorescence method, and the instrument was an i-CHROMA immunofluorescence analyzer made in Korea. HCY test was conducted by ELISA, and the kit was provided by Kanu Shanghai Biological Technology Co., Ltd. All the tests were operated by the same inspector, and the steps were carried out in strict accordance with the operating instructions for quality control. (6) Total effective rate: therapeutic effect criteria were as follows: markedly effective: the improvement rate of neurological function was over 46%, and the ability of daily life was basically restored. Effective: the improvement rate of nerve function was 18%-45%, and the ability of daily life restored to some extent. Ineffective: the improvement rate of neurological function was

less than 18%, and the ability of daily life did not restore. Total effective rate = markedly effective rate + effective rate.

Statistical methods

SPSS 19.0 (Asia Analytics Formerly SPSS China) was used for statistical analysis of comprehensive data. χ^2 test was used for counting data. Measurement data were represented by ($\bar{X}\pm S$), and t test was adopted. When $P<0.05$, the difference was obvious and statistically significant.

Results

General data

There was no remarkable difference between the two groups in terms of general data of gender, age, BMI, smoking history, drinking history, and obesity ($P>0.05$), as shown in **Table 1**.

Detection rate

Group A had 4 negative cases and 28 positive cases, with a detection rate of 87.50%. Group B had 18 negative cases and 32 effective cases, with a detection rate of 60.00%. The detection rate of patients in group A was significantly higher than that in group B ($P<0.05$). More details were shown in **Table 2**.

Misdiagnosis rate and missed diagnosis rate

In group A, 4 cases were misdiagnosed (misdiagnosis rate: 3.13%) and 1 case was missed (missed diagnosis rate: 3.13%). In group B, there were 6 cases of misdiagnosis (20.00%) and 7 cases of missed diagnosis (23.33%). The misdiagnosis rate and missed diagnosis rate of group A were evidently lower than that of group B ($P<0.05$). More details were shown in **Table 3**.

Postoperative neurological function and limb recovery

SSS score of group A was (24.11 ± 2.76) before nursing and (12.51 ± 0.97) one month after nursing, and the score of group B was (24.45 ± 2.94) before nursing and (19.34 ± 0.86) one month after nursing. SSS score decreased in both groups one month after nursing, and the score of group A one month after nursing was notably lower than that of group B ($P<0.05$).

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Table 1. General data of the two groups

Classification	Group A (n=32)	Group B (n=30)	t/X ²	P
Gender			0.30	0.585
Male	17 (53.13)	18 (60.00)		
Female	15 (46.87)	12 (40.00)		
Age (years)	64.21±5.44	63.82±5.79	0.27	0.785
BMI (kg/m ²)	24.23±0.87	23.93±1.08	1.21	0.232
Smoking			0.39	0.533
Yes	20 (62.50)	21 (51.25)		
No	12 (37.50)	9 (48.75)		
Drinking			0.20	0.652
Yes	22 (68.75)	19 (63.33)		
No	10 (31.25)	11 (36.67)		
Hyperlipidemia			2.39	0.122
With	24 (77.50)	27 (78.75)		
Without	8 (22.50)	3 (21.25)		
Hypertension			0.59	0.443
With	27 (84.38)	23 (76.67)		
Without	5 (15.62)	7 (23.33)		
Diabetes			0.06	0.858
With	15 (62.50)	15 (50.00)		
Without	17 (37.50)	15 (50.00)		

Table 2. Total detection rate of the two groups

Classification	Group A (n=32)	Group B (n=30)	X ²	P
Negative	4 (12.50)	12 (40.00)	-	-
Positive	28 (87.50)	18 (60.00)	-	-
Detection rate (%)	28 (87.50)	18 (60.00)	6.12	0.013

Table 3. Misdiagnosis rate and missed diagnosis rate of the two groups

Classification	Group A (n=32)	Group B (n=30)	X ²	P
Misdiagnosis	1 (3.13)	6 (20.00)	4.40	0.036
Missed diagnosis	1 (3.13)	7 (23.33)	5.63	0.018

FMA score of group A was (48.65±6.22) before treatment and (89.31±6.15) one month after treatment, and the same score of group B was (49.12±6.05) before treatment and (80.34±5.78) one month after treatment. The FMA score improved in both groups one month after treatment, and the score was remarkably higher in group A than that of group B one month after treatment (P<0.05). As shown in **Figure 1**.

Quality of life after treatment

The QL-index score of postoperative quality of life between the two groups was compared. Gr-

oup A had significantly higher activity, daily life, health, recent support, overall mental and even overall index than group B (P<0.05). As shown in **Figure 2**.

Detection of expression levels of hs-cTnT, hs-CRP and HCY

There was no remarkable difference in the expression levels of hs-cTnT, hs-CRP and HCY between the two groups before operation. The relative expression levels of hs-cTnT, hs-CRP and HCY in group A were notably lower than those in group B (P<0.05). As shown in **Figure 3**.

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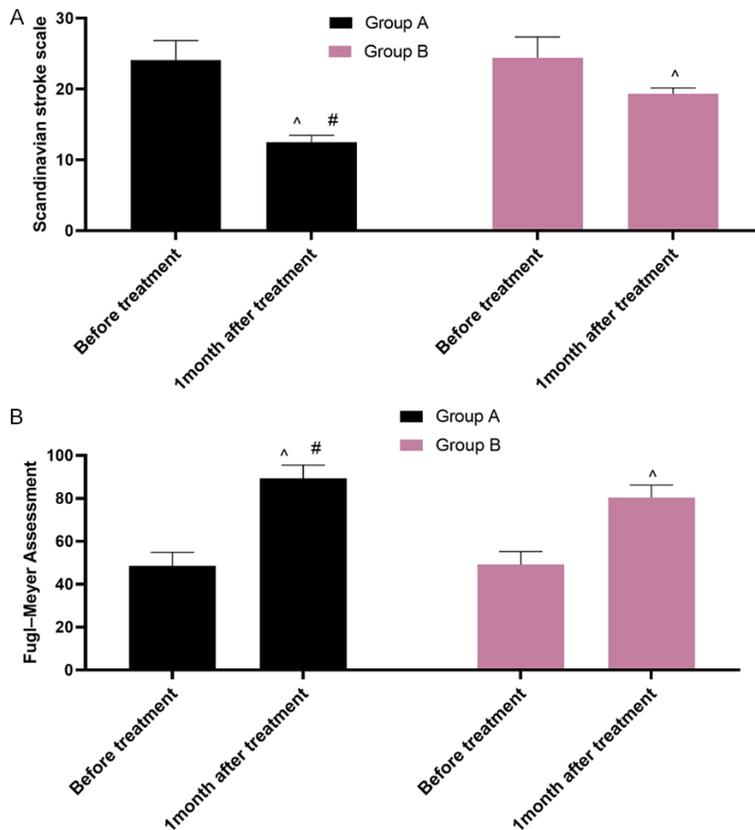


Figure 1. Postoperative neurological function and limb recovery of the two groups. A. SSS score: SSS score decreased in both groups one month after nursing, and SSS score of group A was remarkably lower than that of group B one month after nursing ($P < 0.05$). B. FMA score: FMA score improved in both groups one month after treatment, and the FMA score of group A was remarkably higher than that of group B one month after treatment ($P < 0.05$). Notes: ^ means comparison with before treatment, $P < 0.05$. # means comparison with group B, $P < 0.05$.

Total effective rate

There were 60 markedly effective cases, 54 effective cases and 6 ineffective cases in group A, with a total effective rate of 95.00%. There were 29 markedly effective cases, 32 effective cases and 19 ineffective cases in group B, with a total effective rate of 76.25%. The total effective rate of group A was considerably higher than that of the group B ($P < 0.05$). More details were shown in **Table 4**.

Risk factors

Multivariate logistic regression analysis showed that the detection rate and the expression levels of hs-cTnT, hs-CRP and HCY could be used as risk prognostic factors for MCA atherosclerosis.

More details were shown in **Tables 5 and 6**.

Discussion

Although HRMRI and MRI are widely used in the diagnosis of multiple atherosclerotic plaques, there are few studies on their clinical and predictive values, and these are the objectives of this study.

Vulnerability of intracranial arterial plaque and cerebral hypoperfusion at distal stenosis sites are highly correlated with stroke events and recurrence [20, 21]. The structure of blood vessels and the effect of plaques on blood vessels can be explored using HRMRI and MRI, two common imaging methods [22, 23]. MRI has the advantages of no exposure to ionizing radiation, better tissue contrast, and no need to force the use of contrast agent. If administered, the volume of contrast agent is much smaller, and cell-specific contrast agent of the scanned site can be used [24]. HRMRI has a higher resolution and evaluation rate than MRI, and is

more promising. It can better distinguish various pathological features that may be the cause of intracranial arterial stenosis, such as atherosclerosis, and can also analyze the composition of plaque [25]. For this reason, the detection rate of HRMRI is significantly higher than MRI. The results of this study showed that the detection rate of group A using HRMRI was notably higher than that of group B using MRI, which just proves the point above. Since HRMRI can better distinguish the location of plaque than MRI, it not only improves the detection rate, but also reduces the probability of misdiagnosis and missed diagnosis. This may also be the reason why the probability of misdiagnosis and missed diagnosis was also lower than that of group B. Therefore, the detection rate can also be used as an important prognos-

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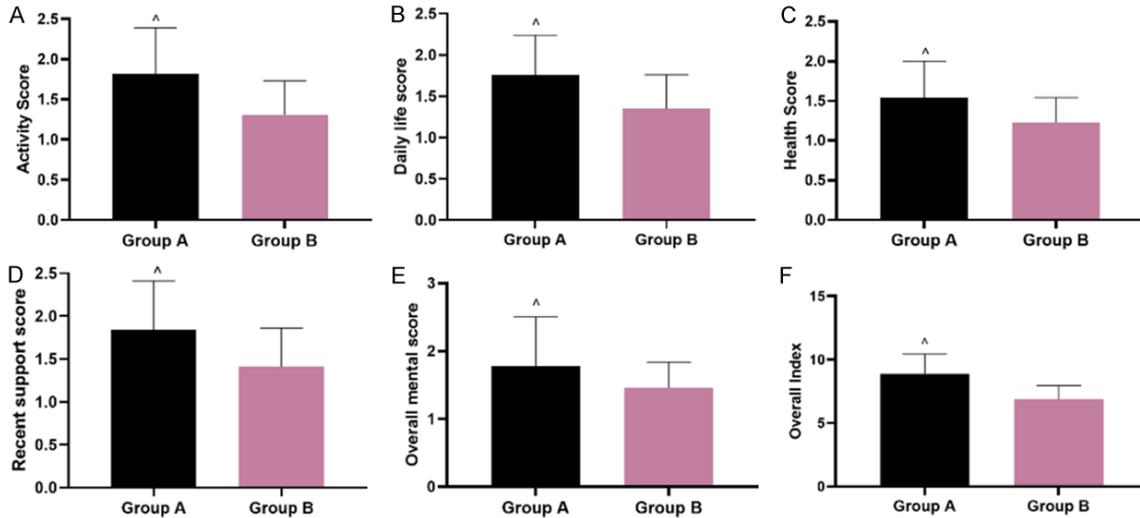


Figure 2. QL-index score of the two groups. A. Activity: group A scored significantly higher than group B ($P < 0.05$). B. Daily life: group A scored significantly higher than group B ($P < 0.05$). C. Health: group A scored significantly higher than group B ($P < 0.05$). D. Recent support: group A scored significantly higher than group B ($P < 0.05$). E. Overall mental: group A scored significantly higher than group B ($P < 0.05$). F. Overall index: group A scored significantly higher than group B ($P < 0.05$). Note: ^ means comparison with before treatment, $P < 0.05$.

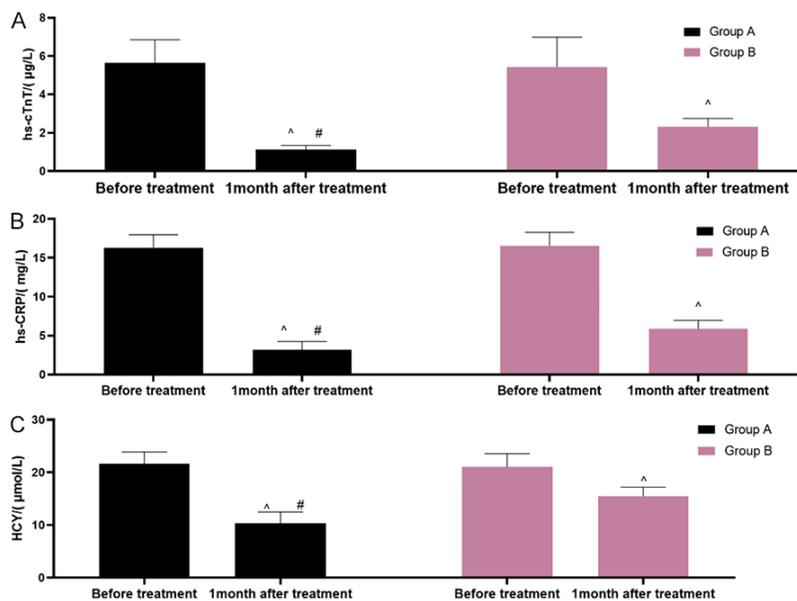


Figure 3. Expression levels of hs-cTnT, hs-CRP and HCY in the two groups. A. Expression level of hs-cTnT: the expression level of hs-cTnT decreased in both groups, and its relative expression level in group A was remarkably lower than that in group B after operation ($P < 0.05$). B. Expression level of hs-CRP: the expression level of hs-CRP decreased in both groups, and its relative expression level in group A was remarkably lower than that in group B after operation ($P < 0.05$). C. Expression level of HCY: the expression level of HCY decreased in both groups, and its relative expression level in group A was remarkably lower than that in group B ($P < 0.05$). Notes: ^ means comparison with before treatment, $P < 0.05$. # means comparison with group B, $P < 0.05$.

imaging is more detailed to explore the atherosclerotic plaques, which is more helpful to patients [26]. Meanwhile, the research of Shu et al. on carotid atherosclerosis also demonstrated that HRMRI carotid atherosclerosis can detect more plates in details [27]. All these above are similar to this article.

Our research not only studied the diagnosis of HRMRI, but also studied the role of HRMRI diagnosis in the treatment of atherosclerotic plaques in MCA. Among some other brain diseases, HRMRI is beneficial in clinical treatment, which can provide structural information of brain. For example, in resection of a brain tumor, it can locate the area of the brain tumor, so that the brain tumor can be

removed well [28]. However, there is little research on whether the diagnostic value of

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Table 4. Total effective rate of the two groups (n=50)

Classification	Group A (n=32)	Group B (n=30)	X ²	P
Markedly effective	18 (56.25)	13 (43.33)	-	-
Effective	12 (37.50)	9 (30.00)	-	-
Ineffective	2 (6.25)	8 (26.67)	-	-
Total effective rate %	30 (93.75)	22 (73.33)	4.77	0.029

Table 5. Logistic regression analysis assignment

Factors	Variable	Assignment
Gender	X1	Male = 1, female = 0
Detection rate	X2	II, III = 1, IV = 0
hs-cTnT	X3	Continuous variable
hs-CRP	X4	Continuous variable
HCY	X5	Continuous variable

Table 6. Risk prognostic factors affecting middle cerebral atherosclerosis

Risk factors	β value	SE value	Wald value	p	OR	95% CI
Gender	-2.213	0.071	12.358	0.231	0.007	0.013-0.025
Detection rate	1.571	0.201	25.334	0.004	2.665	2.221-3.047
hs-cTnT	1.875	0.624	2.671	0.023	1.451	1.007-2.256
hs-CRP	1.239	0.439	5.392	0.044	1.154	0.623-3.145
HCY	3.477	2.454	1.782	0.019	2.318	1.572-3.575

HRMRI will affect the clinical therapeutic effect of patients with cerebral atherosclerosis. According to the results of this experiment, the total effective rate of group A using HRMRI was higher indicating efficient treatment of this group of patients. At the same time, from the perspectives of postoperative neurological function, limb function and quality of life recovery, patients in group A had great recovery effects. Interventional therapy was used in this experiment, and some other studies indicate that interventional therapy needs to be guided by imaging scans of patients [29, 30]. Because of the guidance, after using HRMRI, the patient could have better treatment efficacy and faster recovery. In addition, we found that the relative expression levels of hs-cTnT, hs-CRP and HCY in group A were lower after operation. Hs-cTnT, hs-CRP and HCY are important markers in cardiovascular diseases and are positively correlated with the severeness of disease. The decrease of hs-cTnT, hs-CRP and HCY in group A indicated that HRMRI has a better effect on the therapeutic effect of patients, which also proves that hs-cTnT, hs-CRP and HCY can be used as a predictor and a good prognostic factor in cere-

bral atherosclerosis. Taken together, our results demonstrate that HRMRI has a better diagnostic effect than MRI, and thus has a better effect on the treatment of atherosclerosis in patients. In future studies, patients can be divided into three groups to compare the advantages and disadvantages of HRMRI, MRI and other men able to investigate the satisfaction degree of patients after operation. In the future research, we will improve the deficiencies of this study and make patients more satisfied while continuously improving the clinical treatment plan.

In conclusion, HRMRI is more accurate than MRI in predicting the diagnosis of atherosclerotic plaques in MCA of patients,

and the accurate diagnostic effect is more helpful to the postoperative curative effect and recovery of patients. The detection rate and the expression levels of hs-cTnT, hs-CRP and HCY can be used as prognostic factors.

Disclosure of conflict of interest

None.

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