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Research Article

Comparison of the Values of MRI in the Differential Diagnosis of Symptomatic Carotid Stenosis and Atherosclerotic Plaque

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Abstract: ***Objective:*** To evaluate the values of Carotid Magnetic Resonance Imaging (MRI) in the differential diagnosis of symptomatic carotid stenosis and atherosclerotic plaque. ***Methods:*** 56 patients with ischemic cerebrovascular disease admitted in our hospital from October 2018 to October 2019 were selected and treated with Carotid MRI and digital subtraction angiography (DSA) examinations. According to the two examination results recorded and the "gold standard" of DSA examination, values of Carotid MRI in the differential diagnosis of symptomatic carotid stenosis were evaluated. ***Results:*** According to the "gold standard" of DSA examination, the sensitivity and specificity of MRI examination for carotid stenosis were: Mild: 92.54% and 97.78%; Moderate: 85.71% and 88.78%; Severe: 100.00% and 97.8%; and complete occlusion: 100.00% and 100.00%; The proportions of intraplaque haemorrhage and ruptured fibrous cap in different degrees of carotid artery stenosis were: Mild: 30.16% and 22.22%; Moderate: 43.48% and 39.13%; And severe: 57.89% and 52.63%. ***Conclusion:*** MRI examination can evaluate the degree of symptomatic carotid artery stenosis, and show the characteristics of atherosclerotic plaque at the same time to provide a reference for early clinical differential diagnosis and treatment.

Keywords: Symptomatic carotid stenosis; Atherosclerotic plaque; MRI

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To master the morbidity characteristics of carotid atherosclerosis, an important cause of ischemic stroke and transient ischemic attack, is conducive to the prevention and treatment of these diseases. Carotid atherosclerosis can cause lumen stenosis or complete occlusion, generally confirmed by non-invasive imaging examination or invasive digital subtraction angiography (DSA)[1]. Carotid magnetic resonance imaging (MRI) examination can determine disease characteristics through multiple sequence imaging, and display some characteristics of atherosclerotic plaques. However, there are still few reports about the functions of MRI to display specific degrees of stenosis and plaque lesions[2]. Based on this, this study aims at analysing the values of MRI in the differential diagnosis of symptomatic carotid stenosis and atherosclerotic plaque. The instructions are shown as follows.

1 Data & Methods

1.1 General Data

56 patients with ischemic cerebrovascular disease admitted in our hospital from October 2018 to October 2019 were selected. There were 35 males and 21 females, aged 45 to 80 years old, averagely (64.78 ± 2.01) years old; Among them, there were 23 cases with the history of hypertension, 18 cases with the history of diabetes, 8 case with the history of coronary heart disease, as well as 16 cases with the history of hyperlipidaemia, and 56 cases with dizziness, 46 cases with sensory disturbances, and 39 cases with vision loss.

1.2 Inclusion criteria

1.2.1 Inclusion criteria

(1) Those who meet the diagnostic criteria for cerebral infarction or transient cerebral ischemia[3]; (2) Those have the symptoms of the atherosclerotic plaque and thickened film using the ultrasound examination; (3) Those who does not receive medication before the examination.

1.2.2 Exclusion criteria

(1) Those with intracranial haemorrhage and malignant tumour; (2) Those with hypertension and coronary heart disease.

1.3 Methods

All patients received the arterial MRI and DSA examinations: (1) Carotid MRI: The instrument was US GE 1.5T Signa HDxt Echospeed medical MRI equipment and carotid coil. The carotid artery was treated with multi-directional scans, including T1 weighted imaging (T1WI), T2 weighted imaging (T2WI), PD weighted imaging (PDWI), time of flight (TOF), MP-RAG and CE-T1WI. Among them, the matrix was set to 256*256, and the FOV, TR, TE, layer thickness and interval were 14cm, 800 ms, 10 ms, 2 mm, and 0 respectively. For the contrast agent Gadopentetate Dimeglumine (Bayer Schering Pharma, SFDA Approval Number J20080063), the dose was 0.1 mmol/kg, the speed was 0.7 ml/s, and the scan delay was 5 min. PDWI and T2WI are fast spin echo sequences with TR of 4800 ms; TE of PDW and T2WI was 9ms and 50ms respectively; The TR and TE of TOF and MP-RAGE using FFE sequence were 20ms,5ms and 9.1ms, 5.1ms respectively. (2) DSA inspection: With the instrument of a Siemens DSA machine, the patient in the supine position was punctured through the femoral artery with Seldinger technology, and inserted a 4-5F arterial sheath to send the catheter into the carotid artery[4]. The top of the catheter was inserted to the 4-5 cervical vertebral plane. In addition, a small amount of contrast agent was injected into it, and after confirmation, a contrast examination was performed. The symptomatic carotid artery stenosis can be calculated as (the normal diameter-the lowest remaining diameter)/ the normal diameter×100%, and was divided into four: mild stenosis(0%-49%), moderate stenosis (50%-69%), severe stenosis(70%-99%) and complete occlusion(100%). Characteristics of plaque components in MR image signals were shown as follows: For fresh intraplaque hemorrhage, T1WI and TOF were high signals while T2WI and PDWI were equal signals; For sub-acute hemorrhage, T1WI, TOF, T2WI and PDWI were all high signals and the plaque surface, like ruptured fibrous cap was evaluated.

1.4 Evaluation indicators

According to the recorded two examination results and the "gold standard" of DSA examination, values of Carotid MRI in the differential diagnosis of symptomatic carotid stenosis were evaluated.

1.5 Statistical methods

SPSS 23.0 software was used for data processing; and the count data were expressed as a percentage. Then, χ^2 was used to test, $P<0.05$, indicating there was a statistical significance.

2 Results

2.1 Results of the examination of carotid artery stenosis with two methods

There were complete examination data of 56 patients, 112 blood vessels in total. In DSA examination, there were 67 cases with mild stenosis, 21 cases with moderate stenosis, 19 cases with severe stenosis and 5 cases with complete occlusion[5]; While in MRI examination, there were 63 cases with mild stenosis, 23 cases with moderate stenosis, 21 cases with severe stenosis and 5 cases with complete occlusion. The sensitivity and specificity of mild carotid stenosis by MRI were 92.54% and 97.78%; that of moderate stenosis was 85.71% and 88.78%; that of severe stenosis was 100.00% and 97.8%; that of complete occlusion was 100.00%. See Table 1 and 2.

Table 1. Results of the examination of carotid artery stenosis with two methods (*n*)

MRI examination	DSA examination				Total
	Mild stenosis	Moderate stenosis	Severe stenosis	Complete occlusion	
Mild stenosis	62	1	-	-	63
Moderate stenosis	5	18	-	-	23
Severe stenosis	-	2	19	-	21
Complete occlusion	-	-	-	5	5
Total	67	21	19	5	112

Table 2. Values of MRI in examination of carotid artery stenosis

Project	Sensitivity	Specificity
Mild stenosis	92.54(62/67)	97.78(44/45)
Moderate stenosis	85.71(18/21)	88.78(87/98)
Severe stenosis	100.00(19/19)	97.8(91/93)
Complete occlusion	100.00(5/5)	100.00(5/5)

2.2 Atherosclerotic plaques of different degrees of carotid artery stenosis

The proportions of intraplaque haemorrhage and ruptured fibrous cap in different degrees of carotid artery stenosis were: Mild: 30.16% and 22.22%; Moderate: 43.48% and 39.13%; And severe: 57.89% and 52.63%. See Table 3.

Table 3. Atherosclerotic plaques of different degrees of carotid artery stenosis *n* (%)

Project	Intraplaque Haemorrhage	Ruptured Fibrous Cap
Mild stenosis	30.16(19/63)	22.22(14/63)
Moderate stenosis	43.48(10/23)	39.13(9/23)
Severe stenosis	57.89(11/19)	52.63(10/19)

3 Discussion

Carotid artery stenosis is closely related to stroke, and about 30% of ischemic strokes are caused by carotid artery disease. Therefore, the evaluation of carotid artery stenosis degree is beneficial to the diagnosis and treatment of the disease[6]. Due to the characteristics of the carotid artery structure, its shunting function, blood flow stagnation function, as well as rapid expansion of the diameter of the tube, etc., can increase the retention time of fat, which can easily lead to fat deposition and damage to the blood vessel wall, thereby causing plaque and appendix thrombosis. In addition, it can further worsen atherosclerosis damage. Therefore, the evaluation of the carotid stenosis degree is conducive to the treatment of the disease[7]. Nowadays, there are many approaches to diagnose carotid artery stenosis, such as CT, MRI, DSA, etc. in which, DSA is generally the "gold standard". However, due to its high sensitivity and specificity, long diagnosis process and need to puncture, DSA has some limitations in early clinical diagnosis.

As a non-invasive approach with a high resolution of soft tissues, MRI is conducive to various imaging techniques to more comprehensively view the size, scope, location and stenosis of plaques[8]. Meanwhile, based on the qualitative analysis of plaque components, it can assist in clinical selection of treatment programs. In this study, with DSA examination as the "gold standard", the sensitivity, accuracy and so on found are around 90%, indicating that carotid stenosis degree of sensitivity is good in MRI examination, which is better than DSA examination for moderate and severe stenosis judgement, indicating that the good evaluation of carotid artery stenosis degree in MRI examination may be related to image acquisition time and other factors like the blood flow[9]. Therefore, clinical diagnosis can be combined with other methods. The inhibition of vascular smooth muscle cell protein synthesis aggravated by the severe carotid artery stenosis can easily lead to plaque damage and cause symptoms like intraplaque haemorrhage.

To sum up, MRI examination can evaluate the degree of symptomatic carotid artery stenosis, and show the characteristics of atherosclerotic plaque at the same time to provide a reference for early clinical differential diagnosis and treatment.

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