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Diagnostic Value of Spectral CT Reconstruction Mode for Carotid Atherosclerotic Plaque Lesions

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Abstract: ***Objective:*** To investigate the diagnostic value of spectral CT reconstruction mode for carotid atherosclerotic plaque lesions. ***Methods:*** From January 2017 to January 2019, 70 patients with carotid atherosclerotic plaque lesions in our hospital were selected as the research object. All patients were diagnosed with cervical vascular color Doppler ultrasound and spectral CT scan under spectral CT reconstruction mode. Taking the results of coronary angiography as the "gold standard", the clinical value of the two examination methods in the diagnosis of carotid atherosclerotic plaque lesions was compared and analyzed. ***Results:*** Coronary angiography diagnosis confirmed that 33 of 70 patients with suspected carotid atherosclerotic plaque lesions had vulnerable plaques and 37 had stable plaques. The accuracy of Spectral CT examination of carotid artery plaque was 87.14% (61/70), sensitivity was 90.91% (30/33), specificity was 83.78% (31/37), and the positive predictive value was 83.33% (30 /36), the negative predictive value is 91.76% (31/34), which is higher than that of cervical vascular ultrasonography (61.43%, 60.61%, 56.76%, 57.89%, 65.63%), the difference is statistically significant (P<0.05). ***Conclusion:*** The application of Spectral CT in the clinical diagnosis and treatment of carotid atherosclerotic plaque lesions with higher accuracy, sensitivity and specificity, is more significant and can provide a more reliable and effective imaging basis.

Keywords: Carotid atherosclerosis; Plaque lesions; Spectral CT reconstruction mode;
Cervical vascular color Doppler ultrasound; Diagnostic value

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Carotid atherosclerosis is a common clinical cardiovascular and cerebrovascular disease, the main lesions are characterized by subintimal lipid deposition at the bifurcation of common carotid artery and the initial segment of common carotid artery, accompanied by the proliferation of smooth muscle cells and fibrous matrix components, gradually developing to form atherosclerotic plaques[1]. Carotid atherosclerotic plaque lesions are a high-risk factor leading to ischemic stroke events.

It can not only cause vascular stenosis and occlusion, so that intracranial blood perfusion is insufficient, but also lead to distal intracranial vascular embolism due to plaque rupture and embolus detachment. To assess the severity of carotid atherosclerotic plaque lesions, imaging methods such as cervical vascular color Doppler ultrasound are often used to determine the degree of stenosis in clinical practice[2,3].At present, spectral CT examination is more and more widely used in the clinical diagnosis and treatment of cardiovascular and cerebrovascular diseases, and has achieved certain results. Based on this, this study investigated the diagnostic value of spectral CT reconstruction mode for carotid atherosclerotic plaque lesions. The illustrations are as follows.

1 Data & Methods

1.1 General Data

From January 2017 to January 2019, 70 patients with carotid atherosclerotic plaque lesions in our hospital were selected as the research object, and this study was reviewed and approved by the Medical

Ethics Committee of our hospital. Among the 70 patients, there were 34 males and 36 females, aged 36-84, averagely 57.31 ± 4.33; Disease course of 2-9 months, with mean one of (5.46 ± 1.37) months.

1.2 Inclusion criteria

Inclusion criteria: Patients are informed of and consent to this study. Exclusion criteria: those with other malignant tumors; those with mental illness; those with immune dysfunction; those with infectious diseases.

1.3 Methods

Cervical vascular color Doppler ultrasonography was performed in suspected patients using a color Doppler ultrasound diagnostic apparatus (manufactured by Aloka Company, Japan) with a setting frequency of 5 – 11 MHz. During the examination, keep the patient in the supine position at all times, fully expose the neck, observe the intima-media thickness of the patient and the occurrence of plaque; if any, record the location and status of plaque. Spectral CT was then performed. CT (Revolution CT) produced by GE Company, USA was used for enhanced scanning from ascending aortic arch to skull base. The tube voltage was set at high and low energy 140 kVp and 80 kVp, which could be quickly switched within 0.5 s. The tube current was 550 mA, pitch was 0.985, the detector width was 0.625 mm × 64, 80-100 ml of iohexol contrast agent was injected through cubital vein at the rate of 3.0-3.5 ml/s, dynamic phase scanning was performed for 12s, and portal phase scanning was started 30s after the end. Vascular reconstruction methods include spectral mode reconstruction and non-spectral mode reconstruction (64-slice CT reconstruction). The degree of stenosis at the carotid bifurcation and the lesion characteristics of the plaque was observed, including the condition of the fibrous cap, intraplaque hemorrhage, and lipid. GSIViewer software was used to observe and process the images and perform energy spectrum analysis.

1.4 Evaluation indicators

The results of cervical color Doppler ultrasound and spectral CT examination of carotid atherosclerotic plaque lesions were statistically analyzed, and coronary angiography was used as the "gold standard" to compare the value of the two examination methods in the diagnosis of carotid atherosclerotic plaque lesions.

1.5 Statistical methods

SPSS 20.0 statistical software was used. Quantitative data were displayed as percentage and number of cases. Comparison between groups was performed by χ^2 test. $P<0.05$ was considered statistically significant.

2 Results

2.1 The results of coronary angiography

Diagnosed by coronary angiography, a total of 33 vulnerable plaques and 37 stable plaques were detected in 70 patients with carotid atherosclerotic plaque lesions.

2.2 Results of cervical color Doppler ultrasound and spectral CT scan

The accuracy, sensitivity, specificity, positive predictive value, and negative predictive value of carotid atherosclerotic plaque lesions by spectral CT scan were higher than those by cervical vascular color Doppler ultrasound, and the differences were statistically significant ($P<0.05$). See Table 1-3.

Table 1. Comparison between the Spectral CT scan and coronary angiography in lesion plaques (*n*)

Spectral CT scan	Coronary angiography		Total
	Vulnerable plaque	Stable plaque	
Vulnerable plaque	30	6	36
Stable plaque	3	31	34
Total	33	37	70

Table 2. Comparison between the Cervical vascular color Doppler ultrasound and coronary angiography in lesion plaques (*n*)

Cervical vascular color Doppler ultrasound	Coronary angiography		Total
	Vulnerable plaque	Stable plaque	
	22	16	38
	11	21	32
	33	37	70

Table 3. Comparison of the value of cervical vascular color Doppler ultrasound and spectral CT scan of lesion plaques %(*n*)

Examination method	Accuracy	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
Spectral CT scan	87.14(61/70)	90.91(30/33)	83.78(31/37)	83.33(30/36)	91.76(31/34)
Cervical vascular color Doppler ultrasound	61.43(43/70)	60.61(22/33)	56.76(21/37)	57.89(22/38)	65.63(21/32)
χ^2	12.115	5.802	6.469	5.726	6.440
P	0.001	0.016	0.011	0.017	0.011

3 Discussion

With the rapid change of people's lifestyle, cardiovascular and cerebrovascular diseases caused by atherosclerosis are not only the "number one killer" in Western countries, but also the first cause of death in Chinese nationals. Carotid atherosclerosis is a lifestyle disease. Exercise deficiency, high-salt and high-sugar eating habits, smoking, etc., long-term accumulation, accumulate for a long time, and eventually lead to the formation of carotid atherosclerotic plaques. In recent years, the incidence of atherosclerosis remains high in the population over 60 years old in China, and gradually increases with age. Therefore, early diagnosis and treatment is particularly important to improve its prognosis[4]. The unobstructed carotid artery is the premise to ensure the normal blood supply of the brain. The blood flow in the body will produce a pulse stimulation effect on its vascular endothelium. Under long-term stimulation, the damage to the vascular endothelial system is more serious, which causes low-density lipoprotein wear in the blood. Through the damaged vascular endothelium, it invades into the blood vessel wall and becomes a foreign body. After it is engulfed by phagocytes, it will produce corresponding foam cells. Layers of foam cells accumulate to a certain extent to form atherosclerotic plaques and plaques. The accumulation of more and more blocks causes the lumen to narrow. Therefore, in order to prevent cardiovascular and cerebrovascular diseases, we must attach great importance to the examination and intervention of atherosclerotic plaque lesions[5]. Cervical vascular color Doppler ultrasound is a commonly used examination method in clinical practice. According to the acoustic characteristics of plaques, plaques can be divided into hypoechoic, isoechoic, hyperechoic and mixed echoic plaques. However, color Doppler ultrasound is greatly affected by the angle and the experience of examining physicians, and the incidence of missed diagnosis and misdiagnosis in clinical detection is relatively high[6-7]. Gemstone spectral CT imaging has the advantages of high speed, high spatial and temporal resolution, multi-directional reconstruction, non-invasive and easy to repeat.Through monoenergetic imaging technology, using the differences in Compton effect and photoelectric effect of X-ray photon penetrating substances with different energies as well as the differences in K boundaries of different atoms, the obtained lipid images, energy spectrum curves and calcium-based images are used to analyze the levels of various components (such as fibrous tissue, fat, calcification) in carotid plaques, so as to distinguish stable plaques from vulnerable plaques[8-9]. Moreover, spectral CT reconstruction mode effectively solves the problem that the partial volumetric effect caused by contrast medium concentration, plaque size and layer thickness will affect the accuracy of plaque density measurement[10]. At the same time, spectral CT can effectively reduce the radiation dose and reduce the damage to the subject's body with high safety.

The results of this study showed that spectral CT has high accuracy, sensitivity and specificity in the diagnosis of different types of lesion plaques in the early stage, providing a reliable and objective imaging basis for the clinical selection of different treatment methods and the acquisition of effective therapeutic effects. However, it should be noted that the number of samples selected in this study is relatively small, and there are few reports in the literature on the clinical study of spectral CT reconstruction mode for the plaque detection of carotid atherosclerotic lesions at home and abroad. Consequently, a large number of clinical detection studies are still needed.

In summary, spectral CT is of high value in the detection of carotid atherosclerotic lesions plaques with high diagnostic accuracy, sensitivity, and specificity, which can obtain better clinical diagnostic results.

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