Study on ultrasound evaluation of carotid atherosclerosis and its predicting value for coronary heart disease

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ABSTRACT

Objective: To study the ultrasound features of carotid atherosclerosis and its predicting value for coronary heart disease. Methods: A total of 55 cases of patients with coronary heart disease were selected as coronary heart disease group, 55 cases of healthy subjects were selected as control group, carotid artery ultrasound was used to detect intima-media thickness and judge the degree of coronary artery lesion, and plasma was collected to detect blood lipid metabolism indicators (FFA, LDL-C and HDL-C) and inflammation indicators (CCL21, CCR7, sCD40L, MFG-E8 and IL-10). Results: Carotid artery IMT of CHD group was significantly higher than that of control group, and the more the number of coronary artery lesions, the higher the IMT; plasma FFA, LDL-C, CCL21, CCR7 and sCD40L content of CHD group were higher than those of control group, and HDL-C, MFG-E8 and IL-10 content as well as HDL-C/LDL-C ratio were lower than those of control group; blood lipid metabolism indicators and inflammation indicators of coronary heart disease patients with different IMT were different, and the thicker the IMT, the higher the plasma FFA, LDL-C, CCL21, CCR7 and sCD40L content, the lower the HDL-C, MFG-E8 and IL-10 content as well as HDL-C/LDL-C ratio. Conclusion: Carotid artery IMT of patients with coronary heart disease significantly thickens and can assess the number of coronary artery lesions, blood lipid metabolism and degree of inflammation.

1. Introduction

Coronary heart disease is a common disease of cardiovascular system with high incidence and big harm, about half of patients with coronary heart disease are first manifested as acute myocardial infarction or sudden cardiac death, treatment is difficult and prognosis is poor. Early detection and diagnosis of coronary heart disease and implementation of intervention is an effective means to improve the prognosis of patients. Coronary atherosclerosis is the pathological basis of coronary heart disease, coronary angiography can accurately assess the condition, but the inspection is invasive and requires the use of contrast agents, so it is not suitable for the screening of the disease. Peripheral atherosclerosis and coronary atherosclerosis are consistent in pathological basis, risk factors and disease progression, and evaluating the degree of peripheral atherosclerosis can provide reference and basis for the diagnosis of coronary atherosclerosis[1-2]. Carotid artery is peripheral artery with relatively superficial position, and color Doppler ultrasound can accurately and clearly identify the carotid artery and assess the extent of atherosclerosis, thus providing reference for evaluation of coronary atherosclerosis[3]. In the following research, ultrasound evaluation of carotid atherosclerosis and its predicting value for coronary heart disease were analyzed.

2. Subjects and methods

2.1 Research subjects

A total of 55 cases of patients who were diagnosed with coronary
atherosclerotic heart disease in our hospital from April 2012 to October 2015 were selected as coronary heart disease group, all patients were clearly diagnosed through coronary arteriography, and they included 20 cases with single-vessel lesion, 22 cases with two-vessel lesion and 13 cases with three-vessel lesion. 55 cases of healthy volunteers who received physical examination in our hospital during the same period and whose general information matched that of coronary heart disease patients were selected as control group. Coronary heart disease group included 31 male cases and 24 female cases who were (58.6±7.2) years old; control group included 31 male cases and 24 female cases who were (59.2±6.9) years old. Informed consent was obtained from both groups.

2.2 Carotid artery ultrasonography

Color Doppler ultrasonic diagnostic instrument produced by Philips Company was used for carotid artery ultrasonography, probe frequency was 12-12 MHz, the probe was used to horizontally check the initial segment of carotid artery from the internal extremity of clavicle, then it moved along the carotid artery to the head to obtain images of common carotid artery, internal carotid artery and the carotid sinus, the position that was 10 mm from common carotid artery bifurcation to proximal end was chosen to measure arterial wall intima-media thickness (IMT), and the following standards were referred to judge the degree of carotid artery lesion: IMT<1.0 cm meant normal, IMT 1.0-1.5 mm meant thickening and IMT≥1.5 mm or more than 50% of the peripheral artery IMT meant plaque.

2.3 Serum index detection

10 mL peripheral venous blood was collected from patients with coronary heart disease before the diagnosis, 10ml peripheral venous blood was collected from control group during physical examination, and the blood was centrifuged to get plasma. Plasma samples were collected and automatic biochemical analyzer was used to determine free fatty acid (FFA), low density lipoprotein cholesterol (LDL-C) and high density lipoprotein cholesterol (HDL-C) content; enzyme-linked immunosorbent assay was used to determine CCL21, sCD40L, MFG-E8 and IL-10, and flow cytometry was used to determine the CCR7 proportion.

2.4 Statistical methods

SPSS 20.0 software was used to input and analyze data, measurement data analysis was by t test or variance analysis, and differences were considered to be statistically significant at a level of P<0.05.

3. Results

3.1 Carotid artery IMT of two groups

Carotid artery IMT of CHD group was (1.15±0.20) mm and significantly higher than carotid artery IMT (0.79±0.09) mm of control group; and the more the number of coronary artery lesions, the higher the IMT; carotid artery IMT of CHD group with single-vessel lesion, two-vessel lesion and three-vessel lesion were (0.93±0.11) mm, (1.12±0.15) mm and (1.46±0.24) mm respectively, pair wise comparison showed differences and they were all higher than that of control group.

3.2 Blood lipid metabolism indicators of CHD group and control group

Plasma FFA content (1.03±0.14) vs. (0.39±0.05) mmol/L and LDL-C content (3.55±0.51) vs. (2.97±0.36) mmol/L of CHD group were significantly higher than those of control group, and HDL-C (1.03±0.14) vs. (1.29±0.18) mmol/L content and HDL-C/LDL-C (0.291±0.036) vs. (0.434±0.062) were significantly lower than those of control group.

3.3 Inflammation indicators of CHD group and control group

Plasma CCL21 content (784.5±94.9) vs. (142.8±20.5) pg/mL, CCR7 content (49.6±6.5) vs. (32.4±4.9%) and sCD40L content (7.91±0.94) vs. (3.65±0.58) ng/mL of CHD group were significantly higher than those of control group, and MFG-E8 content (165.5±23.7) vs. (656.6±89.87) ng/mL and IL-10 content (78.5±11.3) vs. (165.7±23.7) mg/mL were significantly lower than those of control group.

3.4 Blood lipid metabolism indicators of CHD patients with different degree of carotid artery lesions

Plasma FFA, LDL-C and HDL-C content as well as HDL-C/ LDL-C ratio were different in IMT normal, thickening and plaque patients; the thicker the carotid artery IMT, the higher the plasma FFA content (0.48±0.06) vs. (0.89±0.10) vs. (1.32±0.18) mmol/L and LDL-C content (3.19±0.40) vs. (3.49±0.50) vs. (4.11±0.62) mmol/L, the lower the HDL-C content (1.22±0.16) vs. (1.07±0.13) vs. (0.89±0.10) mmol/L and HDL-C/LDL-C ratio (0.382±0.045) vs. (0.307±0.033) vs. (0.217±0.028).

3.5 Inflammation indicators of CHD patients with different degree of carotid artery lesions

Plasma CCL21, CCR7, sCD40L, MFG-E8 and IL-10 content were different in IMT normal, thickening and plaque patients; the thicker the carotid artery IMT, the higher the plasma CCL21 content (323.5±44.1) vs. (654.4±78.7) vs. (1123.6±133.2) pg/ml, CCR7 content (38.4±5.9) vs. (47.1±6.2) vs. (65.1±8.9%) and sCD40L content (4.88±0.62) vs. (10.14±1.42) ng/ml, the lower the MFG-E8 content (495.6±71.3) vs. (236.9±36.6) vs. (103.2±14.5) ng/ml and IL-10 content (123.4±15.9) vs. (85.8±10.3) vs. (61.3±7.9).
4. Discussion

Coronary angiography is the gold standard in the clinical diagnosis of coronary heart disease, but the inspection is invasive and requires the use of contrast agents, also with relatively high price, and not suitable for screening and early diagnosis of the disease. Atherosclerosis is a systemic disease, and when coronary atherosclerosis occurs, atherosclerosis has also taken place in various arteries of the body. Carotid artery, thoracic aorta and coronary arteries all belong to medium artery, have similar characteristics in anatomical structure, and also share the same risk factors and pathologic basis in the occurrence of atherosclerosis [4,5]. Study has shown that carotid artery atherosclerosis and thoracic aortic atherosclerosis are synchronized and earlier than coronary artery, and measuring the degree of carotid artery atherosclerosis can not only screen for coronary heart disease, but could also evaluate to the illness severity. The common pathologic basis of carotid artery and coronary atherosclerosis includes abnormal lipid metabolism and inflammatory reaction activation. Abnormal lipid metabolism is characterized by higher free fatty acid (FFA) content in serum and cholesterol metabolism disorder. Increased free fatty acid content in circulating blood can increase the production of reactive oxygen species and cause endothelial cell damage, thus promoting lipid ingredients such as ox-LDL penetration under the endometrium and accelerating the formation of atheromatous plaque [11]. High density lipoprotein cholesterol (HDL-C) and low density lipoprotein cholesterol (LDL-C) are two kinds of important cholesterol involved in plaque formation, and HDL-C can retrograde transport and clear cholesterol, inhibit the formation of ox-LDL and protect endothelial

Table 1
Comparison of blood lipid metabolism indicators between CHD group and control group

<table>
<thead>
<tr>
<th>Group</th>
<th>FFA (mmol/L)</th>
<th>LDL-C (mmol/L)</th>
<th>HDL-C (mmol/L)</th>
<th>HDL-C/LDL-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHD</td>
<td>1.03±0.14</td>
<td>3.55±0.51</td>
<td>1.03±0.14</td>
<td>0.29±0.036</td>
</tr>
<tr>
<td>Control</td>
<td>0.39±0.05</td>
<td>2.97±0.36</td>
<td>1.29±0.18</td>
<td>0.43±0.062</td>
</tr>
<tr>
<td>T</td>
<td>16.585</td>
<td>6.371</td>
<td>5.586</td>
<td>7.218</td>
</tr>
<tr>
<td>P</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
</tr>
</tbody>
</table>

Table 2
Comparison of inflammation indicators between CHD group and control group

<table>
<thead>
<tr>
<th>Group</th>
<th>CCL21 (pg/mL)</th>
<th>CCR7 (%)</th>
<th>sCD40L (ng/mL)</th>
<th>MFG-E8 (ng/mL)</th>
<th>IL-10 (mg/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHD</td>
<td>784.5±94.9</td>
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<td>7.91±0.94</td>
<td>165.5±23.7</td>
<td>78.5±11.3</td>
</tr>
<tr>
<td>Control</td>
<td>142.8±20.5</td>
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</tr>
<tr>
<td>T</td>
<td>29.494</td>
<td>11.338</td>
<td>12.447</td>
<td>24.823</td>
<td>10.492</td>
</tr>
<tr>
<td>P</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
</tr>
</tbody>
</table>

Table 3
Blood lipid metabolism indicators of CHD patients with different degree of carotid artery lesions

<table>
<thead>
<tr>
<th>Group</th>
<th>FFA (mmol/L)</th>
<th>LDL-C (mmol/L)</th>
<th>HDL-C (mmol/L)</th>
<th>HDL-C/LDL-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMT normal</td>
<td>0.48±0.06</td>
<td>3.19±0.40</td>
<td>1.22±0.16</td>
<td>0.38±0.045</td>
</tr>
<tr>
<td>IMT thickening</td>
<td>0.89±0.10</td>
<td>3.49±0.50</td>
<td>1.07±0.13</td>
<td>0.30±0.033</td>
</tr>
<tr>
<td>IMT plaque</td>
<td>1.32±0.18</td>
<td>4.11±0.62</td>
<td>0.89±0.10</td>
<td>0.21±0.028</td>
</tr>
<tr>
<td>P</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
</tr>
</tbody>
</table>

Table 4
Comparison of inflammation indicators among CHD patients with different degree of carotid artery lesions

<table>
<thead>
<tr>
<th>Group</th>
<th>CCL21 (pg/mL)</th>
<th>CCR7 (%)</th>
<th>sCD40L (ng/mL)</th>
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<td>85.8±10.3</td>
</tr>
<tr>
<td>IMT plaque</td>
<td>1123.6±133.2</td>
<td>65.1±8.9</td>
<td>10.14±1.42</td>
<td>103.2±14.5</td>
<td>61.3±7.9</td>
</tr>
<tr>
<td>P</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
</tr>
</tbody>
</table>
cells[12]. Analysis of lipid metabolism indicators in the research showed that plasma FFA and LDL-C content of CHD group were higher than those of control group while HDL-C content and HDL-C/LDL-C ratio were lower than those of control group. It indicated that there was abnormal lipid metabolism in patients with coronary heart disease.

Abnormal activation of inflammatory reaction is an important change throughout all pathological stages of coronary atherosclerosis, and a variety of pro-inflammatory factors, anti-inflammatory factors and chemotactic factors are involved in the process of inflammation[13]. Chemokine CC family is important cytokines involved in cardiovascular diseases and atherosclerosis, CCR7 and its receptor CCL21 can activate T lymphocytes and dendritic cells and promote the immune cell homing to the process, CCR7 and its receptor CCL21 can activate T lymphocytes and amplify inflammatory response and cytokines involved in cardiovascular diseases and atherosclerosis [13]. Chemokine CC family is important cytokines involved in cardiovascular diseases and atherosclerosis process, CCR7 and its receptor CCL21 can activate T lymphocytes and dendritic cells and promote the immune cell homing to the lymph nodes, and they have activation and amplification effects on the inflammation within the artery plaque[14]; Soluble CD40L (sCD40L) can be combined with CD40, promote the generation of a variety of inflammatory factors in plaque, form a network, start and amplify inflammatory response[5]. Milk fat globule epidermal growth factor 8 (MFG-E8) and interleukin-10 (IL-10) are the cytokines that play a protective role in the process of atherosclerosis, MFG-E8 can antagonize the role of pro-inflammatory factors and inhibit cell apoptosis, and IL-10 can suppress the activation of Th1 and the secretion of a variety of inflammatory factors[16]. Analysis of plasma inflammatory markers in the research showed that plasma CCL21, CCR7 and sCD40L content of CHD group were significantly higher than those of control group while MFG-E8 and IL-10 content were significantly lower than those of control group. It indicated that there was significant inflammatory reaction activation in patients with coronary heart disease.

In order to further clarify the predictive value of carotid artery ultrasound for coronary heart disease, the standard of carotid artery intima-media thickness and atheromatous plaque was referred to judge the degree of carotid artery lesions, and serum illness-related molecule levels were determined and compared. It was known from the analysis of the results that plasma lipid metabolism indicators and inflammation indicators were different in IMT normal, thickening and plaque patients; the thicker the IMT, the higher plasma FFA, LDL-C, CCL21, CCR7 and sCD40L content, the lower the HDL-C, MFG-E8 and IL-10 content as well as HDL-C/LDL-C ratio. It meant that the thickness of IMT was closely related to lipid metabolism and the inflammatory reaction degree in patients with coronary heart disease, and carotid ultrasound measurement of IMT could assess the lipid metabolism and inflammation degree in patients with coronary heart disease, and then make accurate judgment and prediction about the illness.

To sum up, carotid artery IMT of patients with coronary heart disease significantly thickens and can assess the number of coronary artery lesions, blood lipid metabolism and the degree of inflammation.

References