Original Article

# Application value between dynamic electrocardiogram and MSCT myocardial perfusion imaging in the diagnosis of myocardial ischemia in coronary heart disease

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**Background:** Dynamic electrocardiogram and multi-spiral computed tomography (MSCT) myocardial perfusion imaging are commonly used in clinical examination methods, which can provide important reference for the diagnosis of myocardial ischemia in coronary heart disease. To analyze and compare the application value of dynamic electrocardiogram and MSCT myocardial perfusion imaging in the diagnosis of myocardial ischemia in coronary heart disease.

**Methods:** The clinical data of 79 patients diagnosed with coronary heart disease admitted in our hospital from October 2017 to October 2019 were retrospectively collected. Exercise load/rest myocardial perfusion imaging (MPI) confirmed the presence of myocardial ischemia, and the patients were all examined by dynamic electrocardiogram and MSCT. The diagnosis of exercise load/resting MPI was used as a benchmark to compare the sensitivity, specificity, and accuracy of the different tests in the diagnosis of myocardial ischemia in coronary heart disease.

**Results:** As confirmed by the exercise load/rest MPI, the 79 included patients had myocardial ischemia. Fifty-five cases of myocardial ischemia were detected by dynamic electrocardiogram, of which 33 cases showed horizontal depression of the ST segment. Also, 15 cases exhibited downward oblique depression, and seven cases showed upward oblique depression. MSCT examination showed that 78 patients had myocardial ischemia, of which 74 showed abnormal myocardial perfusion when contracted. Of these patients, 47 showed reversible perfusion filling, 20 exhibited partially reversible perfusion filling, and seven showed fixed perfusion defects. The sensitivity, specificity, and accuracy of dynamic electrocardiogram in the diagnosis of myocardial ischemia in coronary heart disease were 60.76%, 72.15%, 69.62%, respectively, while those of MSCT were 91.14%, 75.94%, and 86.07%, respectively. The sensitivity and accuracy of MSCT examination were significantly higher than those of dynamic electrocardiogram examination ($P<0.05$), and the specificity was slightly higher than that of dynamic electrocardiogram examination, but this difference was not statistically significant ($P>0.05$).

**Conclusions:** Compared to dynamic electrocardiogram examination, MSCT myocardial perfusion imaging has superior sensitivity and accuracy in the diagnosis of myocardial ischemia in coronary heart disease, and can provide a reference for clinical diagnosis and treatment.

**Keywords:** Dynamic electrocardiogram; multi-spiral computed tomography myocardial perfusion imaging (MSCT myocardial perfusion imaging); coronary heart disease; myocardial ischemia

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## Introduction

Coronary heart disease is caused by atherosclerosis of coronary arteries, which involves narrowing or blockage of the vascular lumen, resulting in myocardial ischemia, hypoxia, and eventually heart disease, which is also known as ischemic heart disease (1). With the improvement of people's living standards, the incidence of coronary heart disease in China is gradually increasing, and the age of onset is steadily decreasing. Studies have shown that paying attention to whether coronary heart disease stenosis will cause myocardial ischemia is crucial for the clinical diagnosis and treatment of patients (2).

With the continuous development of medical technology, the advancement of imaging technology has shifted from only showing the pathological anatomy of the patient's lesions to the integration of functions. It has important use value in the diagnosis of various diseases, disease evaluation, and prognosis monitoring (3). Dynamic electrocardiogram (also Holter) and multi-spiral computed tomography (MSCT) myocardial perfusion imaging are commonly used clinical examination methods, which can provide important reference materials for the diagnosis of coronary heart disease and myocardial ischemia (4). Dynamic electrocardiogram and MSCT myocardial perfusion imaging are commonly used in clinical examination. Electrocardiogram can feedback the continuous heart condition of patients, and has high value in the diagnosis of early asymptomatic myocardial ischemia. MSCT myocardial perfusion imaging can reflect the micro-circulation disease of the heart of patients and provide important reference for the diagnosis of myocardial ischemia in coronary heart disease (5). At the beginning of this century, some scholars proposed that dynamic electrocardiogram and computed tomography (CT) myocardial perfusion imaging had certain application value in the diagnosis of myocardial ischemia, but the research process was affected by equipment, and there were certain limitations, and the persuasiveness needed to be improved. With the continuous updating of medical technology and equipment, and the continuous progress of CT technology, the application value of MSCT myocardial perfusion imaging in the diagnosis of myocardial ischemia in coronary heart disease was studied based on the perfusion imaging technology of Siemens 64-slice MSCT in this study. The purpose was to further verify the relevant speculation. The report is as follows. We present the following article in accordance with the STROBE reporting checklist (available at https://dx.doi.org/10.21037/apm-21-2481).

## Methods

### *General information*

The clinical data of 79 patients diagnosed with coronary heart disease who were admitted to our hospital from October 2017 to October 2019 were retrospectively collected. Among these patients, 55 were males and 34 were females, aged 40–75 years old, with an average age of (51.32±10.23) years old. Also, 45 patients had a history of hypertension, 39 patients had hyperlipidemia, and 22 patients had a history of diabetes. All of the patients were confirmed to have myocardial ischemia by exercise load/resting myocardial perfusion imaging (MPI). All procedures performed in this study involving human participants were in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by ethics committee of Sichuan Provincial People's Hospital (No. 20170916) and informed consent was taken from all the patients.

### Inclusion and exclusion criteria

Inclusion criteria: (I) the clinical data of the patients were complete; (II) all patients signed the relevant informed consent; and (III) All patients underwent Holter and MSCT examination within 2 weeks.

Exclusion criteria: (I) patients with relevant check-in contraindications; (II) those with incomplete clinical data; (III) patients with congenital heart disease; (IV) those with severe arrhythmia or other diseases affecting the study; and (V) patients who were treated for severe heart disease prior to admission.

 

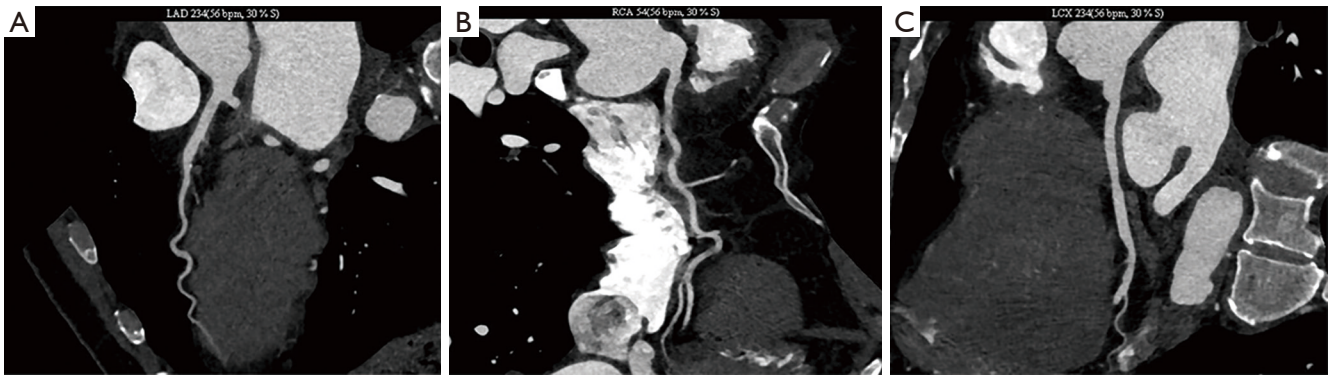


**Figure 1** CT scan image of myocardium. (A) Moderate stenosis in the middle of the left anterior descending branch; (B) moderate stenosis of right coronary artery; (C) mild stenosis of the left circumflex branch.

### *Study methods*

#### Holter examination method

The use of β-R blockers, digitalis, and other drugs that affect the results of the examination were prohibited within 48 hours before the examination. BI9800 Holter (Boying Medical Instrument Technology Co., Ltd., Shenzhen, China) was used to record the patients' 24 h electrocardiogram (ECG), and BioxWin software (Boying Medical Instrument Technology Co., Ltd., Shenzhen, China) was used to analyze the patient's images. The positive standard for myocardial ischemia was as follows: 80 ms after the J point, in the ST-segment horizontal type or descending oblique type with a decrease of ≥1 mm. When the baseline ST segment had decreased and increased, it was necessary to subtract the original decrease/increase. Obvious displacement of ST needed to be maintained for 1 min. The interval between an adjacent episodes of myocardial ischemia needed to be more than 1 min.

#### MSCT examination

All patients underwent MSCT examination, and a Siemens 64-slice spiral CT (Siemens, GER) instrument was used for scanning. Before the scan, all metal objects on the patient were removed, and the patient's heart rate was controlled below 80 beats per minute. At the same time, the patient was trained to perform breathing exercises to avoid frequent breathing.

##### *Patient position selection*

The patient was instructed to lay flat on the scanning table, and the supine position was selected. The scanning range was from 1–2 cm below the tracheal bifurcation to the apex of the heart. The scanning parameters were as follows: tube voltage, 110 kV; tube current, 200 mA; scanning layer thickness and spacing, both 5mm. After the completion of plain scan, according to the ECG-gated cardiac scanning mode, positioning phase and ECG to determine and scan the location of ischemia. An 18 G trocar was inserted into the median vein of the right elbow, and the contrast medium was counted. Following the injection, an additional injection of normal saline (30 mL) was performed at the same rate to trigger the myocardial perfusion scan during systole.

After the scan was completed, the CT processing workstation was used to process the patient's image and reconstruct the obtained original data. The diagnostician then read and analyzed the scanned images, CT scan image of myocardium see *Figure 1*. Myocardial ischemia was defined as follows: when the systolic myocardial enhancement density (CT value) was significantly lower than the surrounding normal myocardial enhancement density and there was no significant difference between the diastolic myocardial enhancement density and the surrounding normal myocardial enhancement density.

### *Observation indicators*

The patients' images were analyzed, and the exercise load/resting MPI diagnosis was used as the benchmark to compare the sensitivity, specificity, and accuracy of the different examinations in the diagnosis of coronary heart disease and myocardial ischemia.

### *Statistical methods*

The data in this study were statistically analyzed using SPSS18.0 software (SPSS, Illinois, USA). Count data were

 

**Table 1** Sensitivity, specificity, and accuracy of the different examinations in the diagnosis of myocardial ischemia in coronary heart disease [n (%)]

| Check method | Number of cases | Sensitivity | Specificity | Accuracy |
|---|---|---|---|---|
| Holter | 79 | 48 (60.76) | 57 (72.15) | 55 (69.62) |
| MSCT examination | 79 | 72 (91.14) | 60 (75.94) | 68 (86.07) |
| $\chi^2$ | – | 19.958 | 0.296 | 6.203 |
| P | – | 0.000 | 0.568 | 0.013 |

MSCT, multi-spiral computed tomography.

expressed by the pass rate or composition ratio, and the $\chi^2$ test is used. The difference was considered statistically significant when P<0.05.

## Results

### *Holter and MSCT examination results*

The exercise load/rest MPI confirmed that the 79 included patients had myocardial ischemia. Holter showed 55 cases of myocardial ischemia, of which 33 cases (60.00%) were horizontally depressed in the ST segment. The ST segment was depressed downwardly in 15 cases (27.27%), and was depressed upwardly in seven cases (12.73%). MSCT imaging examination showed that 78 patients had myocardial ischemia. Of these, 74 contractions showed abnormal myocardial perfusion, 47 of which were reversible perfusion filling, 20 were partially reversible perfusion filling, and seven exhibited fixed perfusion defects.

### *Sensitivity, specificity, and accuracy of the different examinations in the diagnosis of coronary heart disease and myocardial ischemia*

The sensitivity, specificity, and accuracy of Holter electrocardiogram for the diagnosis of coronary heart disease and myocardial ischemia were 60.76%, 72.15%, and 69.62%, respectively, while those of MSCT examination were 91.14%, 75.94%, and 86.07%, respectively. MSCT examination exhibited significantly higher sensitivity and accuracy than Holter examination (P<0.05), and the difference in specificity between the two methods was not statistically significant (P>0.05), see *Table 1*.

## Discussion

Cardiovascular diseases the leading causes of human mortality, and seriously threaten the life and health of people. Previous studies have shown that the degree of coronary artery stenosis is not significantly correlated with the incidence of coronary heart disease; meanwhile myocardial ischemia is positively correlated with the incidence of coronary heart disease, and is also one of the important risk factors for acute cardiovascular disease (5).

In current clinical examinations, the exercise load/rest MPI is an important clinical method for diagnosing the presence of myocardial ischemia in patients with coronary heart disease; it is clinically recognized and often used as the "gold standard". However, due to the high cost of examination and the substantial radiation exposure to patients during the examination, its widespread use in clinical practice is difficult (6,7). Holter examination is different from conventional ECG examination. It can monitor the patient's heart condition continuously over a long period of time, and provide feedback about the patient's heart condition in daily life and work. ST segment changes can be recorded completely and accurately, so that the clinic can fully understand the onset duration, and frequency of myocardial ischemia in patients, and effectively improve the detection rate of myocardial ischemia. Moreover, Holter examination is easily accepted by patients for clinical examination as it is a simple operation, non-invasive, and non-radiation, and it has obvious advantages for early asymptomatic myocardial ischemia examination (8,9).

Myocardial perfusion refers to the blood flow through the coronary vascular network in the myocardial tissue; that is, the blood that flows in from the small arteries and then flows out from the capillaries to the veins (10). The whole process can effectively reflect the microcirculation of the patient's heart; by combining the patient's other morphological examinations as well as the overall and local cardiac function analysis, it can reflect the state of the structure and function of the heart. Myocardial perfusion has a high clinical value and exceptional sensitivity in the

 

diagnosis of myocardial ischemia. Furthermore, it is also valuable in coronary stent and bypass grafting (11). In recent years, with the development of MSCT, its spatial resolution has been greatly improved, and it has an important use value in the diagnosis of coronary heart disease (12). It can provide clinical anatomical information about the patient's heart and coronary arteries, and can also locate the patient's coronary artery stenosis, and evaluate the degree and scope of the stenosis.

Previous studies have reported that the contraction movement affects the coronary blood flow and myocardial perfusion during systole (13). During myocardial ischemia, the patient's myocardial microvascular resistance changes, and has a greater impact on the subintimal myocardium during systole and the myocardium during diastole. During systole, the capillary resistance under the intima will increase according to the degree of stenosis of the coronary arteries, and the blood volume of the capillaries will decrease, eventually leading to myocardial ischemia. This rule of change is used in the myocardial perfusion of MSCT, and the raw data obtained by coronary computed tomography angiography (CCTA) is used to evaluate the myocardial perfusion in the patient's systole to evaluate whether the patient has myocardial ischemia (14). There is no need for additional examinations for the patient, and the practice of CCTA diagnosis can simultaneously reflect the patient's hemodynamics and coronary artery stenosis, achieving a "one-stop" diagnosis (15).

In this study, the sensitivity, specificity, and accuracy of Holter electrocardiogram for the diagnosis of coronary heart disease and myocardial ischemia were 60.76%, 72.15%, and 69.62%, respectively, while those of MSCT examination were 91.14%, 75.94%, and 86.07%, respectively. MSCT examination exhibited significantly higher sensitivity and accuracy than Holter examination, and there was no difference in specificity between the two methods, suggesting that MSCT myocardial perfusion imaging can effectively improve the sensitivity and accuracy of diagnosis, and has a higher application prospect. Compared with MSCT examination, dynamic electrocardiogram examination has the advantages of simple, economic and applicable in the diagnosis of cardiovascular diseases. Patients have high acceptance. In clinical use, dynamic electrocardiogram examination can be used as a routine screening method, and MSCT examination can be further performed for patients with highly suspected myocardial ischemia. The combination of the two can provide more comprehensive reference information.

In summary, compared to Holter examination, MSCT myocardial perfusion imaging has superior sensitivity and accuracy in the diagnosis of myocardial ischemia in coronary heart disease, and can provide a reference for clinical diagnosis and treatment.

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## Footnote

*Reporting Checklist:* The authors have completed the STROBE reporting checklist. Available at https://dx.doi.org/10.21037/apm-21-2481

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*Conflicts of Interest:* All authors have completed the ICMJE uniform disclosure form (available at https://dx.doi.org/10.21037/apm-21-2481). The authors have no conflicts of interest to declare.

*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study involving human participants were in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the medical ethics committee of Sichuan Provincial People's Hospital (No. 20170916) and written informed consent was obtained from all patients.



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