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Clinical significance of mild inferolateral wall ischemia of the left ventricle on 99mTc-MIBI myocardial perfusion single photon emission computed tomography (SPECT)

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Abstract. – INTRODUCTION: Mild ischemia in the inferolateral wall on myocardial perfusion imaging is seen frequently in practice. The aim of this study is to assess the importance of the above issue on myocardial perfusion SPECT with coronary angiography.

PATIENTS AND METHODS: All patients enrolled in this study exhibited mild ischemia of the inferolateral wall on myocardial single photon emission computed tomography (SPECT) with 99mTc-MIBI, using the 20 left ventricular segments model. Each patient completed a questionnaire, including type of chest pain, risk factors, and previous examinations, and all cases were followed up for one year. Luminal stenosis of >50% was classified as significant stenosis on coronary angiography. A *p* value < 0.05 was considered statistically significant.

RESULTS: During investigation, 105 cases had mild ischemia on myocardial perfusion imaging (MPI) of which 36 subjects (22 male and 14 female) underwent coronary angiography. The mean age was 56.62±10.23 years old (age range: 36-73 years). The inferolateral wall was compared to the left circumflex (LCX) territory. Nineteen out of 36 (52.7%) cases had stenosis in the LCX. Twenty-three of 105 (21.90%) underwent revascularization during the one year follow up. In multiple logistic regressions, with LCX stenosis on angiography as the dependent variable, only abnormal MPI was independently associated significantly.

CONCLUSIONS: The findings of the study may indicate that even a mild perfusion defect in the inferolateral wall should be carefully managed, especially in high-risk subjects for coronary artery disease.

Key Words:
Myocardial perfusion imaging (MPI), Inferolateral wall, SPECT.

Introduction

Cardiovascular disease is the main cause of death in humans and it is characterized by significant societal morbidity and huge health care cost[1,2]. Myocardial perfusion imaging (MPI) is an extremely important procedure in the accurate management of patients with cardiovascular disease because it provides unique information for diagnosing cardiovascular disease, making prognoses, evaluating therapies , and assessing viability[3,4]. Nonetheless, it also exposes a number of potential artifacts that can limit its use[4,5]. Artifacts and pitfalls may be related to the equipment, the patient, or the technologist[4,5]. Furthermore, mild ischemia in the inferolateral wall on myocardial perfusion imaging is seen frequently in practice. This can be due to real perfusion defects, artifacts, or some anomalies[6,7].

This study was designed to determine the clinical significance of mild inferolateral wall ischemia on MPI in patients suspected of having or known to have coronary artery disease (CAD), with coronary angiography serving as the reference standard. Also, the study included a one-year follow up.

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Patients and Methods

Participants and Study Design

One hundred and thirty patients with known or suspected CAD, who were referred to the Researchers' Center for myocardial perfusion imaging from January 2007 to September 2009, were invited to participate in the study. Inclusion in the investigation was restricted to patients who had mild ischemia of the inferolateral wall on the myocardial perfusion single photon emission computed tomography (SPECT) with 99mTc-MIBI, using the 20 left ventricular segments model. None of the participants had valvular heart disease (VHD), congestive heart failure (CHF), congenital heart disease (CHD), or cardiomyopathy. Patients who were not eager to take part in the study or did not meet the requisite eligibility for the study were excluded. The remaining 105 subjects who gave informed consent were enrolled in the study.

Body weight, height, and blood pressure were determined during the initial investigation. Risk factors encountered during the study included: (1) hypertension (self-reported history of hypertension and/or use of antihypertensive medication, or a blood pressure > 140/90 mm Hg); (2) smoking; (3) dyslipidemia (high-density lipoprotein cholesterol < 40 mg/dl, low-density lipoprotein cholesterol > 100 mg/dl, or antihypercholesterolemic treatment); and (4) family history of coronary heart disease (in men, a first-degree relative < 55 years of age; in women, a first-degree relative < 65 years of age). The pretest likelihood of CAD was anticipated by consideration of age, the ratio of cholesterol to HDL, gender, and smoking[8].

All cases were followed for one year.

The study complies with the Declaration of Helsinki and it was confirmed by the institutional Ethics Committee of Bushehr University of Medical Sciences.

Study Protocol

All subjects underwent a 2 day SPECT protocol. Technetium-99m sestamibi was intravenously injected at rest and during exercise or pharmacologic stress.

Dipyridamole Technetium 99m-Sestamibi SPECT Protocol

All cardiovascular drugs were stopped for at least 2 days and participants fasted overnight before the study. An intravenous line of normal saline solution was inserted into an antecubital vein using a 20-gauge cannula. Dipyridamole (0.56 mg/kg) was administered over 4 min A12-lead ECG was recorded and patient symptoms were continuously monitored and noted. A dose of 740 MBq of Tc-99m sestamibi as a compact bolus was administered 4 min after the beginning of the infusion. Twenty minutes later, the patients were requested to eat a fatty meal to hasten hepatobiliary clearance of Tc-99m sestamibi, and imaging occurred 90 minutes after the initial infusion of dipyridamole. The rest phase took place the next day.

Exercise Stress Protocol

All cardiovascular drugs were stopped for at least 2 days and participants fasted overnight before the study. All cases were asked to exercise on a treadmill under a standard Bruce protocol. 740 MBq (20 mCi) Tc-99m MIBI as a compact bolus was administered when the peak heart rate was achieved (more than 85% of the age-predicted maximum heart rate), at the appearance of typical angina, and/or at positive exercise ECG findings. The exercise test was recorded to confirm if there was a horizontal or down-sloping ST segment depression more than 1 mm for 80 microseconds after the J point. Imaging was performed 15-30 minutes after exercise. On the next day, 20 minutes after the administration of 740 MBq Tc-99m MIBI, the patients were requested to eat a fatty meal to accelerate hepatobiliary clearance of Tc-99m MIBI. The resting SPECT was carried out 90 minutes after Tc-99m MIBI administration.

Acquisition and Processing Protocols

A double-head SPECT scintillation camera (ADAC Genesys, Malpitas CA, USA) was utilized to obtain 32 views over 180º using a step-and-shoot method, progressing from 45º right anterior oblique to 45º left posterior oblique projections. A symmetric 20% energy window over the 140 keV Tc-99m photopeak and a low energy all-purpose (LEAP) collimator were used, and the data were stored in 64 * 64 matrices. Acquisition time was 25 seconds per projection during rest and stress studies. An expert nuclear medicine specialist used the cine display of the rotating planar projections to evaluate sub-diaphragmatic activities, attenuations, and patient motion to optimize the quality of the images. Processing was performed using a two-dimensional Butterworth prefilter and a ramp filter for back projec-

tion of transaxial tomographic images. The transaxial images were reoriented along the vertical long axis, the horizontal axis, and the short axis of the left ventricle. Acquisition parameters were similar for the rest and stress studies. For each patient, each of the three stress images was interpreted individually in comparison to the same rest image.

Visual SPECT Analysis

For assessment, scans were divided into 20 segments, corresponding to the location of the territories of the various coronary arteries (Figure 1). For evaluation of the segments, a five-grade scale was used: normal perfusion, mild, moderate, and severe ischemia, and fixed segments. Ischemia was defined as the existence of a region with decreased or absent myocardial activity on exercise scans but that improved on the rest stage images. A fixed segment was defined as a region of decreased or absent myocardial activity both on exercise and rest sets. The location of each segment was corresponded to each vessel territory based on the 20-segment model of MPI size. In this way, the inferolateral wall was congruent with the LCX territory (Figure 1).

Image interpretation was performed visually, supported by standard autoquant software (AutoQUANT; ADAC Laboratories, Milpitas, CA, USA), by two observers without knowledge of the patient's data.

Coronary Arteriography

Thirty-six of the 105 patients underwent coronary angiography to confirm myocardial ischemia. Coronary arteriography was done with a monoplane imaging system and recorded on DVD. Angiographic images were visually assessed by two readers who were blind to the MPI data. Luminal stenosis of > 50% was considered significant stenosis.

Statistical Analysis

A 2-tailed *t*-test compared the mean values between groups. Continuous variables are expressed as the mean ± SD, and categorical variables as the absolute values and percentages. The chi-square test was used for categorical variables. Multiple logistic regression analysis was used to ascertain the association of angiographic results as dependent variables and the remaining items were considered covariates. The statistical analysis was done using the Statistical Package for the Social Science (SPSS) version 18, (SPSS Inc., Chicago, IL, U.S.A). A p value < 0.05 was considered statistically significant.

Results

During the investigation of 105 cases with mild ischemia on MPI, 36 subjects (22 males and 14 females) underwent coronary angiography. The mean

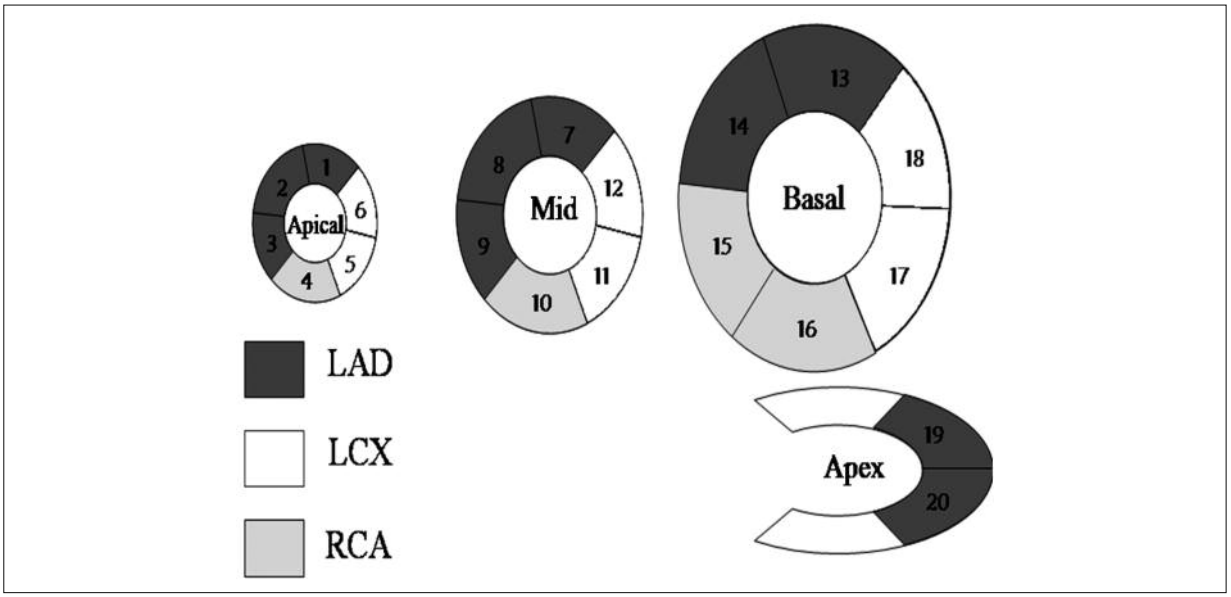

Figure 1. The 20-segment model, obtained by three individual short-axis slices as well as one mid-cavity vertical long-axis slice. A depiction of the coronary artery distribution is also noted. (LAD: left anterior descending coronary artery; LCX: left circumflex coronary artery; RCA: right coronary artery).

age was 56.62±10.23 years old (age range: 36-73 years). In 25 (69.4%) patients, stress was created by dipyridamole and in 11 (30.6%) cases by treadmill exercise. In total, 16 (44.4%) cases had hypertension, 18 (50%) had hyperlipidemia, 9 (25%) had diabetes mellitus, 2 (5%) were obese, 20 (55.55%) smoked, and 7 (19.44%) cases had a family history of CAD. In addition, 7 (19.44%) cases had typical chest pain and the remaining 29 (80.56%) cases had atypical chest pain.

In total, 25 cases had stenosis in at least one vessel on angiography. Nineteen out of 36 (52.7%) cases had stenosis in LCX.

According to the pretest likelihood of CAD assessment, 13 (36.11%) cases had low risk of CAD (Group1), 17 (47.22%) had intermediate risk of CAD (Group 2) and 6 (16.66%) had high risk of CAD (Group 3). Seven out of 13 cases in Group 1, 9 out of 17 cases in Group 2, and 3 out of 6 cases in Group 3 had obvious stenosis in the LCX artery on angiography.

In multiple logistic regressions with angiographic results as dependent variables, only the MPI results were independently associated significantly (p value < 0.05). None of the other variables – family history of CAD, age, obesity, ejection fraction (EF), electrocardiographic (ECG) results, type of chest pain, and pretest likelihood of CAD – showed such a correlation (p value > 0.05).

In addition, 23 of the 105 cases (21.90%) underwent revascularization during the one-year follow up.

Discussion

The main finding of this study was the good correlation of detection of CAD between MPI and angiography in the LCX territory. More than 1/2 of the patients with mild inferolateral ischemia, as evaluated by MPI SPECT, had a significant stenosis in the LCX artery. In addition, when patients with more severe ischemia (i.e. moderate, severe, and fixed perfusion defects) were included, this correlation was higher than the current value.

Inferolateral wall ischemia, mainly mild in severity, am seen frequently in practice and the current study was designed to ascertain the importance of this finding. The inferolateral wall perfusion defect is also observed in some anomalies[6,7,9]. MPI in the patients with an anomalous left coronary artery arising from the pulmonary artery [Bland-Garland White syndrome (BGWS)] depicted a perfusion defect in the posterolateral wall[6,9]. In anomalous origins of the entire coronary system by three separate ostia within the right coronary sinus, a perfusion defect in the inferolateral region was seen[6,7]. Because possible anomalies can create perfusion defect images, Researchers checked all cases for anomalies during angiography and found.

Artifacts related to the patients, equipment, or technologist may establish the same defect; these may be ruled out by careful attention during each stage of MPI implementation, before the interpretation of each image[4].

In the literature, a number of investigations assess the accuracy of MPI in determining CAD in LCX territory[3,10]. In our previous study, sensitivity and specificity of MPI in LCX territory were 80% and 81%, respectively[11]. In that study, we enrolled all perfusion defects, regardless of degrees of severity.

Bae et al[10] compared tc-99m-MIBI myocardial SPECT results with the findings of coronary angiographies in 98 male and 37 female patients who underwent dipyridamole Tc-99m-MIBI myocardial imaging within one month of cardiac catheterization. They showed that sensitivity in men and women was 52.2% and 46.7%, respectively, for LCX (p = ns); the specificity was 88.9% and 86.4%, respectively, for LCX (p =ns)[10]. They concluded that Tc-99m-MIBI myocardial SPECT was a safe, noninvasive test for the evaluation of CAD and that there was no gender difference in detecting CAD.

The current investigation demonstrated that although the possibility of CAD is higher in patients with more risk factors, only MPI perfusion defects had good correlations with documented angiographic CADs. It also showed that MPI is an accurate method to depict significant coronary stenosis in LCX territory in patients suspected of having or known to have CAD.

Finally, it depicted that even mild inferolateral perfusion defects in patients should be carefully managed because more than 1/5 cases underwent revascularization during the one-year follow up; however these data must be vigilantly interpreted because of the small sample size in this study.

In addition to the small sample size, this research had several limitations. Assessments of global and regional ventricular function with gated MPS were not carried out in this study, as gated MPS assessments were not routinely done at the center. Angiography was limited to abnormal

MPI cases, for ethical reasons. However, the probability of abnormal angiography in subjects with normal MPI is low and Researchers followed the patients for one year. Finally, a longer follow-up study to evaluate the progression of myocardial abnormalities did not occur.

Conclusions

The findings of the study may indicate that even a mild perfusion defect in the inferolateral wall should be carefully managed, especially in high-risk subjects for coronary artery disease.

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Conflict of Interest

The Authors declare that they have no conflict of interests.

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