

ORIGINAL ARTICLE

A clinical and angiographic correlation of myocardial perfusion scintigraphy in the assessment of isolated apical/peri-apical reversible perfusion defects

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Abstract

Aims A retrospective study was conducted to correlate the results of myocardial perfusion G-SPECT with clinical evaluation and coronary angiography in the assessment of isolated apical and/or peri-apical reversible perfusion defects.

Methods Coronary angiography was performed in 14 patients (eight males, six females) with isolated apical and/or peri-apical reversible perfusion defects documented on stress myocardial perfusion scintigraphy.

Results Of the eight male patients, seven had >70% LAD stenosis and one patient had 30% LAD stenosis seen on coronary angiography. Only two of the six female patients (33.3%) had a positive angiogram. In all of the positive angiograms, including those with single, double or triple-vessel disease, the most significant lesion was seen in the LAD artery. Where in addition to the apex, the inferoapical or apicolateral segments were also affected, the culprit stenosis was seen to involve the LAD artery with either normal angiographic appearance or associated less severe stenosis of the right coronary or left circumflex arteries. There was a good correlation between the angiographic and G-SPECT determination of the left ventricular systolic function.

Conclusions Caution should be exercised in the interpretation of isolated apical and/or peri-apical mild reversible perfusion defects in women without stress-induced symptoms and ECG changes, as there is a higher incidence of false-positive MPS studies in this group of patients. In patients with reversible perfusion defects affecting the apex and/or the peri-apical segments, the most significant stenosis revealed on coronary angiography was found in the LAD artery, independent of the number of diseased coronary arteries.

***Keywords**: apical reversible perfusion defects, false-positive myocardial perfusion study*

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Introduction

SPECT myocardial perfusion imaging has an approximate 90% sensitivity and 80% specificity for the detection of coronary artery disease [1]. Referring physicians should therefore, be aware of the fact that some of the patients with a positive myocardial perfusion scan (MPS) result may have a completely normal angiogram. When interpreting a SPECT myocardial perfusion study, the nuclear medicine specialist must correctly identify all the factors that may

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Table 1 Clinical details and stress data for the patients

Patient	Sex	Age	Clinical data	Stress	Symptoms	ECG
A	M	73	Chest pains. Hypertension, family history of CAD	Bicycle	No	Borderline +
B	M	83	Chest pains. Known CAD and stent in LAD	Dipyridamole	No	Negative
C	M	85	Known CAD. Diabetes	Dipyridamole	No	Negative
D	M	61	Known CAD, previous stents to RCA and Cx. Diabetes, hypertension,hypercholesterol-aemia and family history of CAD	Dipyridamole + Bicycle	No	Positive
E	M	62	Bigeminy and AF	Dipyridamole	No	Negative
F	F	70	Chest pains. Hypertension and hypercholesterolaemia	Dipyridamole	No	Negative
G	F	73	Old MI. Chest pains. Hypertension, hypercholesterolaemia and family history of CAD	Dipyridamole	Mild chest heaviness	Positive
H	M	64	Chest pains. Asthma. Smoker. Hyperlipidaemia	Bicycle	Dyspnoea	Borderline positive
I	F	47	Atypical chest pains. Hypercholesterolaemia and family history of premature CAD	Bicycle	No	Negative
J	M	52	Left arm pain on exertionPrevious stent to mid LAD	Bicycle	Left arm pain	Negative
K	F	85	Atypical chest pains. Hypertension	Dipyridamole	Moderate chest pain	Positive
L	F	63	Chest pains. No significant risk factors	Dipyridamole	No	Negative
M	F	48	Atypical chest pains. Heavy smoker	Dipyridamole	No	Positive
N	M	61	Chest pains. Known CAD	Dipyridamole	Moderate central chest pain	Negative

Table 2 G-SPECT and coronary angiogram findings

A	Small infero-apical defect mild reversibility	Distal 30% left main stenosis. Difussely diseased LAD; 30% stenosis proximal vessel, 50% stenosis mid LAD, total oclussion distally. 70% mid Cx lesion, RCA occluded proximally
B	Moderate sized apical defect moderate reversibility	30% stenosis distal left main, diffuse LAD disease with a very critical area of stenosis in the proximal part of the stent with 98% stenosis
C	Moderate apical defect mild to moderate reversibility	LAD with one segment with 50-60% occlusion and a second one with 95% occlusion; RCA completely blocked
D	Moderate apical and infero-apical defect severe reversibility	Diffuse proximal disease in the small OM branch (CX) with 60-70% stenosis; diffuse disease in the mid to distal LAD artery with areas of stenosis 80%
E	Small apical defect mild reversibility	Mild mid LAD disease with < 30% stenosis, diffuse mild RCA disease
F	Small apical defect mild reversibility	Normal
G	Moderate apical and antero-apical defect moderate reversibility	LAD completely blocked distal to a small diagonal branch; 50% proximal Cx lesion, 40% stenosis in the RCA
H	Small apical defect mild reversibility	Distal at the apex 80% area of stenosis, all other arteries normal
I	Small antero-apical defect mild reversibility	Normal
J	Moderate to large defect involving the apex, the antero-apical, apico-septal and infero-apical segments, moderate to severe reversibility	LAD moderate sized vessel, subtotally blocked distally to a moderate sized diagonal branch
K	Moderate apical defect moderate reversibility	Chronic total occlusion proximal LAD + diffuse mild to moderate disease in the distal LAD
L	Moderate apico-septal and antero-apical defect mild reversibility	Normal
M	Small apical defect mild reversibility	Normal
N	Large apical and peri-apical defect severe reversibility	Severe proximal LAD (70-80%) disease, mid LAD subtotally blocked; 40% stenosis proximal Cx; 30-40% stenosis proximal RCA

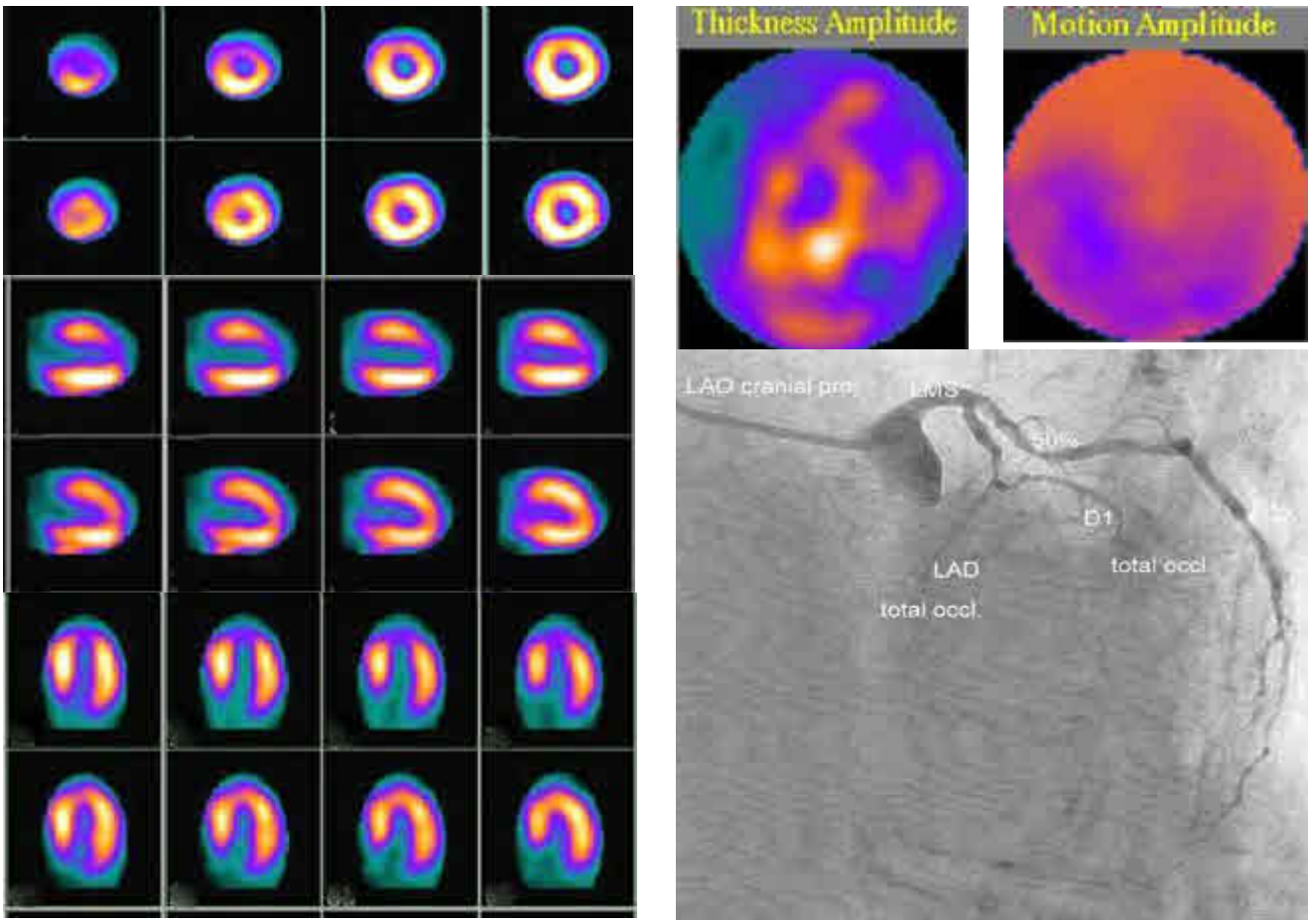

Figure 1 *A true-positive representative case: 73-year-old female with hypertension, hypercholesterolaemia and positive family history of CAD. The patient experienced mild chest heaviness during the pharmacological stress test with the ECG at peak stress showing 1.4 mm downsloping ST segment depression in the inferior and lateral leads. (Left) The MPS shows moderate reversible myocardial ischaemia in a moderate sized area at the apex and the antero-apical wall. (Top Right) Gated images show normal contractility and wall-thickening. (Bottom Right) Coronary angiogram showing 100% proximal LAD stenosis, 50% proximal circumflex lesion. There was 40% stenosis proximal to mid section of the RCA (not shown)*

contribute to a false-positive result. False-positive perfusion defects can be located anywhere in the left ventricle. An isolated fixed perfusion defect at the apex of the left ventricle is commonly attributed to myocardial infarction, apical thinning or breast/soft-tissue attenuation; however, an isolated reversible perfusion defect at the apex is usually considered to represent true reversible myocardial ischaemia.

A retrospective study was conducted to correlate the results of myocardial perfusion SPECT with clinical evaluation and coronary angiography in isolated apical and/or peri-apical reversible perfusion defects, to assess the incidence of false-positive results and to identify their potential causes.

Materials and Methods

Coronary angiography was performed in patients with isolated apical and/or peri-apical reversible perfusion defects documented on stress myocardial perfusion scintigraphy.

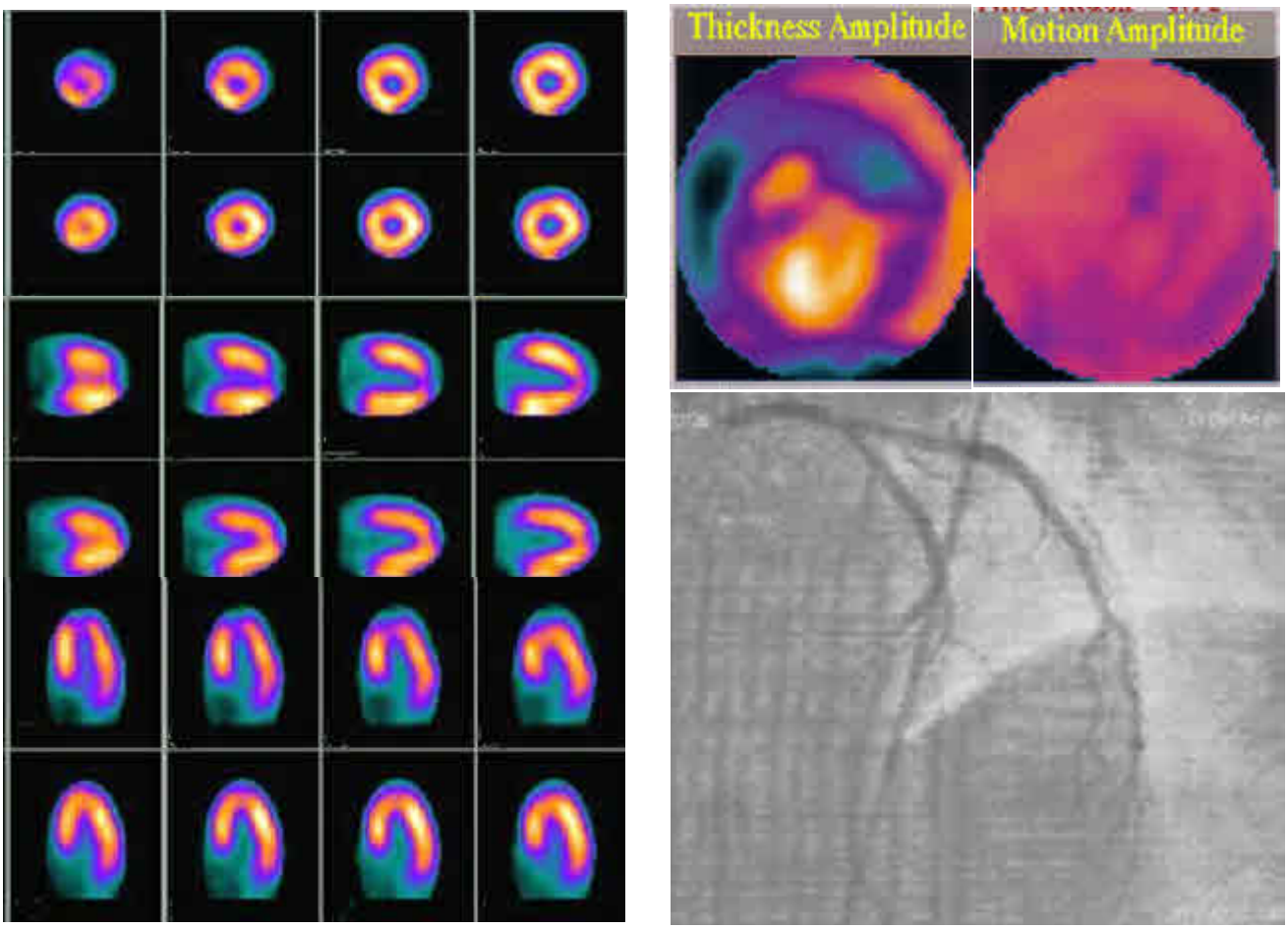

Figure 2 *A false-positive representative case*: *70-year-old female (patient F) with hypertension and hypercholesterolaemia. The patient did not experience any chest pain during the pharmacological stress test and the ECG showed no significant ischaemic changes at stress. (Left) The MPS shows mild reversible myocardial ischaemia in a small area at the apex, (Top Right) G-SPECT images show normal contractility and wall-thickening and (Bottom Right) the coronary angiogram is normal*

The study population consisted of 14 patients,including eight males (aged 52 to 85 years; mean age 67.62 years) and six females (aged 47 to 85 years; mean age 64.33 years). None of the patients had a LBBB and only one patient had a history of myocardial infarction.

The stress protocols used was either bicycle exercise or a four-minute Dipyridamole (0.56 mg/kg) infusion in all but one patient who underwent a combined pharmacological and exercise stress test. The clinical details and the stress data for the patients in this study is tabulated in Table 1. The radiopharmaceutical used in all patients was ^{99m}Tc-Sestamibi. Gated SPECT (G-SPECT) images were acquired with a dual-head IS2 gamma-camera equipped with a low-energy high-resolution collimator. All images were non-attenuation corrected.

The G-SPECT scan images were evaluated both visually and semi-quantitatively using a 17 segment polar map analysis.

Tracer uptake in each segment was scored as 0 = normal, 1 = equivocal, 2 = abnormal, 3 = severely abnormal and 4 = absent. Coronary stenosis on angiography was expressed as percent luminal diameter stenosis.

For comparison with the scintigrams, lesions in the diagonal branches were included in the left anterior descending (LAD) territory; lesions in the marginal branches included in the left circumflex territory; and lesions in the posterior lateral and posterior descending arteries in the right coronary artery territory.

Results

Coronary angiogram was positive in seven of the eight male patients (87.5%) with a >70% stenosis of the LAD; five of the seven male patients had stress-induced chest symptoms or ECG changes and the two patients without stress-related chest symptoms or ECG changes showed a reversible apical perfusion defect on the myocardial SPECT scan, which was moderate in size and severity. A small-sized mildly reversible apical perfusion defect was seen in one of the eight male patients on MPS. The patient had no stress-induced chest symptoms or ECG changes, and his coronary angiogram showed only 30% stenosis of the LAD. Table 2 shows the results of G-SPECT and coronary angiography results in all patients. Patient "E" was the only male patient who didn't have a critical stenosis on angiogram.

Only two of the six female patients (33.3%) had a positive angiogram, including one patient with a previous myocardial infarction. Both of the female patients had stress-induced symptoms and ECG changes during the myocardial perfusion study. The images from one of these true-positive representative cases (Patient G, Tables 1 & 2) are shown in Figure 1.

None of the four female patients with normal angiography experienced stress-induced chest symptoms nor showed significant ECG changes during stress. All these four patients had a mild reversible apical and/or peri-apical perfusion defect, which was small in three patients and moderate in size in one patient. None of them had significant regional wall-motion abnormalities on G-SPECT images. Figure 2 shows the images of one of the four false-positive MPS cases (Patient F in Tables 1 & 2).

The positive angiograms showed single, double or triple-vessel disease, with the most significant lesion in the LAD artery. When the infero-apical or apico-lateral segments were affected in addition to the apex, the most significant stenosis was in the LAD artery with normal angiographic appearance or non-significant stenosis of the right coronary or left circumflex arteries.

There was a good correlation between the angiographic and G-SPECT assessment of the left ventricular systolic function. No significant wall-motion abnormalities were documented in 13 of 14 patients, with a discrete apical aneurysm seen in one patient. The LVEF was normal in all patients, ranging from 51% to 67%, with an average LVEF of 60%.

Discussion

Radionuclide gated perfusion tomography is of considerable value in distinguishing between true perfusion defects and artefacts. All the four patients with false-positive isolated apical and/or peri-apical defects in our study population were females. In general, the false-positive perfusion defects were small in size. Presumably, soft-tissue attenuation was the underlying cause of the false-positive scan results. All the positive angiograms in patients with isolated apical and/or peri-apical reversible perfusion defects showed the culprit lesion to be the LAD artery, independent of the number of diseased coronary arteries. The apical and peri-apical region of the left ventricular myocardium is supplied by the LAD or its tributaries and coronary artery disease involving the LAD vasculature is the obvious underlying factor in ischaemic changes in this region.

Several factors can contribute to the apparent perfusion defects at the apex. First, the apex has a reduced myocardial thickness compared to the rest of the left ventricular myocardium, resulting in a greater partial volume effect in this area [2-4]. Second, soft-tissue attenuation induced by breast or adipose tissue can generate perfusion defects [5]. These are usually in the anterior wall, but occasionally false perfusion defects can be encountered elsewhere, depending on the size and the position of the breast during the image acquisition [1, 6]. Third, patient motion as well as an incorrect selection of the long axis of the left ventricle can create false-positive apical perfusion defects [1]. And fourth, a reversible perfusion defect found on myocardial perfusion scanning in a patient with normal angiography might be the expression of a sub-critical (less than 50%) coronary stenosis [7].

More commonly, soft-tissue artefacts appear as fixed perfusion defects mimicking myocardial infarction. Occasionally, a change in the position of the soft-tissue attenuate between the stress and rest acquisitions can lead to reversible defects, which can be mistaken for stress-induced ischaemia or reverse-redistribution defects, thus mimicking subendocardial infarction in the territory of a vessel which has restored patency [4, 8].

Conclusion

Caution should be exercised in the interpretation of isolated mild reversible apical and/or peri-apical perfusion defects with no significant regional wall motion abnormalities on G-SPECT images, without stress-induced symptoms and ECG changes, particularly in women, as there is a higher incidence of false-positive myocardial perfusion studies in this group of patients.

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