Specificity and sensitivity of SPECT myocardial perfusion studies at the Nuclear Medicine Department of the Limassol General Hospital in Cyprus

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Abstract. The aim is to determine the sensitivity and specificity of Myocardial Perfusion Imaging (MPI) performed at the Nuclear Medicine Department of the Limassol General Hospital in Cyprus. Through a retrospective analysis, patient results obtained by MPI were compared to results obtained by Invasive Angiography. We analyzed data from 96 patients that underwent both MPI and Angiography during the years 2009-2010, with a maximum time interval of ±9 months between the two types of medical exams. For 51 patients, the indication was the detection of CAD. For 45 patients, the indication was to assess viability and/or ischemia after MI, PCI or CABG. Out of 84 patients with CAD confirmed by angiography, 80 patients resulted in abnormal MPI (sensitivity of 95% and positive predictive value of 98%). Out of 12 patients with normal coronaries, 10 patients resulted in normal MPI (specificity of 83% and negative predictive value of 71%). In conclusion, for the patients with abnormal MPI and confirmed CAD, MPI was a useful aid for further therapy management.

1. Introduction
Myocardial Perfusion Imaging (MPI) has proven its value as a noninvasive examination, which determines whether or not a patient suffers from CAD [1-3]. When a patient is complaining of chest pain or other equivocal symptoms and when a stenosis is found with angiography, it is important to determine the clinical significance of the stenosis, to allow the cardiologist to proceed to further therapeutic intervention. The best way to estimate the efficiency of blood flow to a certain area and simultaneously to observe and calculate the function of the Left Ventricle is Gated SPECT MPI. This study aims at determining the sensitivity and specificity of MPI at the Nuclear Medicine Department of the Limassol General Hospital in Cyprus.

2. Methods
This is a retrospective analysis of the data obtained in 2009-2010 by MPI and Angiography in Limassol General Hospital Nuclear Medicine and Angiography Departments. 96 patients have been selected (78 male, 18 female) that fulfilled a requirement for a maximum of nine month interval between the two medical tests. The MPI was performed using one-day protocol with Tc-99m – Tetrofosmin. The type of stress was either dynamic or pharmaceutical [4].

The indications for MPI were separated into two categories. The first category referred to the detection of CAD (51 patients) whereas the second category referred to the assessment of viability and/or ischemia after MI, PCI or CABG (45 patients).
The gender of the patients was also considered in the analysis, as it affects the imaging results depending on soft tissue attenuation due to the diaphragm in men and due to breasts in women. Furthermore, we anatomically matched the defects detected with MPI against the findings of angiography. The stenosis type was categorized according to the stenosis of the vessel diameter: moderate stenosis (40-70%), significant stenosis (71-90%), tight stenosis (91-99%), occluded (100%).

3. Results
Among the 84 patients with CAD confirmed by angiography, 80 presented abnormal MPI test (sensitivity 95%, table 1 and 2), and 4 of them presented a normal MPI test (table 3). 12 patients did not present CAD confirmed by angiography, 10 of which had a normal MPI result (specificity 83%) (table 1 and 2).

| Vessel condition | MPI | Angiography |
|------------------|-----|-------------|
| CAD              | 80  | 84          |
| No active CAD a  | 10  | 12          |

a Coronaries with good previous PCI result and no intrastent stenosis were considered as normal.

| Statistical Parameter       | Value a (%) | 95% Confidence Interval (%) |
|-----------------------------|-------------|----------------------------|
| Sensitivity                 | 95          | 88-98                      |
| Specificity                 | 83          | 51-97                      |
| Positive Predictive Value   | 98          | 91-100                     |
| Negative Predictive Value   | 71          | 42-90                      |

a Approximate integer number.

| Patient | Condition |
|---------|-----------|
| 1       | LAD (patient PCI), D1 significant stenosis, LCx moderate stenosis, OM tight stenosis, RCA moderate stenosis |
| 2       | LMS 50% and LAD tight stenosis |
| 3       | LMS 90% and OM tight stenosis |
| 4       | Moderate RCA stenosis and distal LAD occlusion |

For the 4 patients with false negative result, 1 of them presented three vessel disease, 2 presented LMS disease and 1 presented moderate RCA stenosis and distal LAD occlusion. Further analysis with anatomical matching of areas of defect with vessel territories, indicated that out of the 80 patients with true positive result, 8 (10%) were underestimated by MPI and 3 (4%) were not matched [5]. From the 8 patients that were underestimated (table 4), 3 presented three-vessel disease, 3 presented three-vessel disease and LMS disease, 1 presented four-vessel disease and 1 presented one-vessel disease and LMS disease.

As for the gender consideration, false negative (FN) results have been recorded for 4 male patients, whereas false positive (FP) results have been observed for 1 male and 1 female patient. True positive results that were underestimated by MPI, have been recorded for 7 male patients and 1 female patient. Results that did not match have been observed for 3 male patients. The FP results have indicated a female patient with anterior wall defects and a male patient with inferior and anterior wall defects.

The obtained sensitivity and specificity (see table 2) of MPI for the detection and assessment of ischemia, in correlation within evasive angiography, are satisfactory when compared to published results (pooled sensitivity of 87% and specificity of 73% with exercise stress for 33 published studies, and pooled sensitivity of 89% and specificity of 75% with pharmacological stress for 17 published studies) [6-7].
Table 4. Condition of vessels that were underestimated with detected MPI defects.

| Patient | Vessel Disease                                      | Segments with defect |
|---------|-----------------------------------------------------|----------------------|
| 1       | Three-vessel disease                                | 4, 5, 11, 2, 3, 8, 9, 14 |
| 2       | Three-vessel disease                                | 4, 1, 7, 13          |
| 3       | One-vessel disease and moderate LMS stenosis        | 4, 10, 15            |
| 4       | Three-vessel disease and moderate LMS stenosis      | 5, 11, 17            |
| 5       | Three-vessel disease and significant LMS stenosis   | 16                   |
| 6       | Three-vessel disease and significant LMS stenosis   | 4, 10, 15            |
| 7       | Three-vessel disease                                | 11, 5, 4             |
| 8       | Four-vessel disease                                 | 8, 14, 10, 15        |

4. Discussion

These results should be seen under the perspective that the majority of the patients had a high pretest probability for CAD [8]. It is widely understood that when MPI presents a False Negative (FN) result the patient will not undergo angiography, and that not all FN will be detected. On the contrary, when a FP result is presented the patient will most probably undergo angiography, so the majority of FP results are identified. With this way, the sensitivity and specificity percentages are affected [9-10]. In this study the number of FN or FP results was not sufficient to enable further statistical analysis. The FN detected results indicated LMS disease and three vessel disease in the majority of patients. This finding brings forward the necessity of Gated SPECT MPI so that in the absence of perfusion defects, a poor LV function, wall motion abnormality or other extra cardiac findings such as lung uptake to enable identification of multi-vessel CAD [11,12].

Because of the well known imaging problems with breasts and diaphragm attenuation in female and male patients, respectively, even after application of attenuation correction with gadolinium sources, we decided to utilize the 2-day protocol in obese patients so that to minimize the stress-rest photon overlapping in the 1-day protocol, which is mistakenly interpreted as reversible ischemia. The gender analysis showed a tendency for false/underestimating results in male patients. However, the total number of samples was insufficient for safer assumptions.

5. Conclusion

MPI was a threshold point for further therapeutic management for the patients that were correctly diagnosed with CAD or for the follow up of the patients after MI, PCI or CABG. In addition, MPI is useful for risk stratification when perfusion defects, function abnormalities and lung uptake are co-estimated [13-14]. It is though necessary to undertake a new prospective study with a sufficient normal group of patients in order to estimate sensitivity and specificity without referral bias.

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