

The Added Value of Gated- SPECT Myocardial Perfusion Imaging Amongst the Elderly and Very Elderly Patients

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ABSTRACT

Background: Myocardial perfusion g-SPECT method in the diagnosis and decision making in the very elderly (>75) remains scarce in its evidence. We conducted research to evaluate the added value g-SPECT perfusion in the diagnosis, risk stratification and decision making in patients with suspected or diagnosed coronary artery disease (CAD).

Methods and Results: We retrospectively evaluated the results of 183 patients aged ≥ 65 years with clinical suspected CAD. Exclusion criteria: structural heart disease, dilated-hypertrophic cardiomyopathy, hemodynamic instability. G-SPECT: Technetium-99m sestamibi (8 mCi rest-16 mCi stress); stress test according clinical conditions (pharmacological, only stress or mixed). Imaging acquisition: SIEMENS®-Symbia-S equipment with IQ-SPECT technology, and evaluated subjectively in 17 segment analysis. Mean age was 72 ± 5.50 years old (88% 65-79 and 12% >80); 126 (70%) had ischemia: 63 (65%) mild, 51 (28%) moderate, and 12 (7%) severe; 28% with FEV1>45%. Twenty one (33%) with moderate or severe ischemia were derived to catheterization; 12 underwent stent placement, 2 surgical revascularization; and, 7 continued medical treatment.

Conclusion: G-SPECT, even conducting with stress, is a safety non-invasive test with high diagnosis accuracy in the very elderly. It adds value in the decision making and reduces the risk of referring unnecessary catheterization, represents a gatekeeper option and a turn for better prognosis.

Keywords

g-SPECT, Elderly, Very elderly, Cardiovascular disease diagnosis, Myocardial perfusion imaging, Ischemia, Coronary artery disease.

Objective

To evaluate the added value of gated myocardial perfusion single-photon computed tomography (g-SPECT) in the diagnosis, risk stratification; and, decision making in elder and very elder patients with suspected or diagnosed coronary artery disease (CAD).

Introduction

Globally, deaths from cardiovascular disease are increasing; in particular, due to the aging population [1]. Between 1990 and 2013, the number of global deaths caused by cardiovascular disease has increased by 41% [2]. As a result of aging of the population, more

elderly patients are referred for diagnostic and prognostic cardiac evaluation. Stress myocardial perfusion imaging (MPI) is useful for the evaluation of coronary artery disease (CAD) in elderly patients [3,4].

Despite of this betterment of our health status, non-communicable diseases predominate and are the leading cause of morbi-mortality; particularly, atherosclerotic cardiovascular diseases (CVD) and ischemic disease [5]. In this setting, 80% of patients with heart failure and 60% of those who had suffered a myocardial infarction are people of 60 years old and older [6].

Thus, as the population grows older worldwide, and CAD remains the leading cause of morbidity and mortality, there is an imminent need to identify effective methods of cardiovascular

risk stratification which may direct management decisions in such patients. In this setting, the diagnostic value of Single Photon Emission Computed Tomography Myocardial Perfusion Imaging (SPECT MPI) in the general population is well understood [7-9]; nevertheless, the role of this non-invasive technique in the elderly population remains scarce, particularly in octogenarians [10,11].

In this regard, since a considerable proportion of elderly patients cannot perform adequate exercise stress test, solid evidence has shown the usefulness of pharmacological stress with dipyridamole g-SPECT stress myocardial perfusion imaging for clinical diagnosis and also, prognosis in patients aged 70 years and older [12]. Still, little research has been conducted in adequate exercise stress test performance. Therefore, clinical decisions on whether pursue non-invasive versus invasive management, particularly in the presence of abnormal myocardial perfusion imaging, is crucial to address quality of life and prognosis rather than only prolongation of life amongst increasing elderly population [7].

The aim of the present study was to evaluate the added value of gated myocardial perfusion single-photon computed tomography (g-SPECT) in the diagnose, risk stratification and decision making in patients aged 60 years and older with suspected or diagnosed (CAD) performing all stress tests types, exercise and/or pharmacological, depending on patients' physical capability.

Patients and Methods

We searched patients' records aged 60 years and older that were clinically referred to undergo stress ^{99m}Tc-Sestamibi g-SPECT for the evaluation of suspected or known CAD; patients with history of coronary artery disease were assessed for risk stratification and control after a revascularization. A total of 183 patients met these criteria within a six month period. Excluded patients were those with any of the following at the time of MPI: structural heart disease, dilated or hypertrophic cardiomyopathy, cardiac failure; and, haemodynamic instability.

We evaluated clinical characteristics, history of cardiovascular events and risk factors as hypertension (defined as systolic blood pressure ≥ 130 mmHG and diastolic pressure ≥ 80 mmHG); dyslipidaemia (cholesterol levels ≥ 200 mg/dl and c-LDL ≥ 130 mg/dl triglycerides ≥ 150 MG/dl; diabetes (A1C $\geq 6.5\%$ or fasting plasma glucose ≥ 100 mg/dl); and, smoking.

This study was approved by the institutional ethics committee at the National Medical Center "20 de Noviembre", ISSSTE.

Nuclear screening and Image Acquisition

All 183 patients were non-invasively assessed through one-day protocol g-SPECT rest-stress. Rest/stress MPI was performed with ^{99m}Tc Sestamibi in a 1-day protocol following the American Society of Nuclear Cardiology protocols (ASNC) [13]; and, American Heart Association (AHA) consensus [14]. The stress testing was determined by the nuclear cardiologist based on each patient's clinical history, physical exploration, patients' functional capacity; and, general condition. Stress protocol was conducted

through physical exercise, pharmacological vasodilation with dipyridamole, or physical and pharmacological (mixed stress).

The perfusion images were acquired in synchronization with the patient's electrocardiogram (g-SPECT); this allowed us to study not only the left myocardial perfusion, but also the function (left ventricle ejection fraction), wall motion, and systolic wall thickness.

We utilized a gamma camera SIEMENS®-Symbia-S, with IQ-SPECT technology (dual head) and collimators SMATRZOOM with acquisition of 32 images (in 180° elliptical orbit from 45° right anterior oblique to 45° left anterior oblique, in step and shoot mode); allowing the use of radiotracer lower doses and the acquisition of high quality imaging in less time than older technology (4 minutes).

Image Processing and Data Analysis

All 183 g-SPECT myocardial perfusion imaging (MPI) studies were analysed by two experienced nuclear cardiologist physicians who were blinded to perfusion results (Kappa intra e inter-observer 0.92). Reconstruction and image processing were generated as ordinary: short axis, vertical long axis and horizontal long axis. For qualitative analysis, perfusion g-SPECT studies were assessed visually, using the 17-segment model rated based on the severity of perfusion defects, in a visual 5-point scale, where 0 denotes normal perfusion, 1 mild perfusion defect, 2 moderate defects, 3 severe perfusion defect and 4 denotes absence of perfusion. Necrosis was indicated at the presence of a perfusion defect in the rest images, and was defined as transmural (severe defect or absence of perfusion), and nontransmural (moderate perfusion defect).

Ischemia was indicated where the presence of a reversible defects, which refers to a perfusion defect present in stress that resolved at rest in the same segment; and, was rated as mild, moderate and severe level of ischemia.

Statistical analysis

Continuous data were expressed as mean \pm SD, and percentages were rounded. Discrete or dichotomized variables were compared using Chi-square or Fisher's exact tests and continuous variables using Student's t-tests for unpaired samples. A p value <0.05 was considered statistically significant. All statistical analyses were 2 tailed and performed using SPSS version 21 [15].

Results

One hundred eighty-three patients' records met the inclusion criteria and were examined from the Nuclear Medicine Department. Patients' average age was 72 ± 5.50 years within a range of 69-85 years old. Table 1. Baselines characteristics and cardiovascular risk factors by groups and Figure 1. Gated-SPECT myocardial perfusion study indications by groups shows variables divided into two groups defined as elderly those from 65 to 79 years old and very elderly who were those at the age of 80 or more years old.

Variable	Age groups			P
	All patients n=183 (100%)	Aged 65-79 n=162 (88%)	Aged ≥ 80 n=21 (12%)	
Age (mean ± SD)	72 ± 5.5	71.4 ± 4.2	83 ± 2.2	<.0001
Female	60 (32.8)	49 (30.2)	11 (52.4)	<.0001
Male	123 (67.2)	113 (69.8)	10 (47.6)	<.0001
Risk Factors				
Hypertension	138 (75.4)	119 (73.5)	19 (90.5)	<.0001
Dyslipidaemia	93 (50.8)	85 (52.5)	8 (38.1)	NS
Diabetes	80 (43.7)	72 (44.4)	8 (38.1)	<.0001
Ex-smoker	74 (40.4)	71 (43.8)	3 (14.3)	NS
BMI ≥30	46 (25.1)	42 (25.9)	4 (19.0)	<.0001
Renal Failure	4 (2.2)	3 (1.9)	1 (4.8)	<.0001

Table 1: Baseline characteristics and cardiovascular risk factors by groups.

NS: Nonsignificant; SD: Standard deviation.

The indications for the performance of the myocardial perfusion study with g-SPECT in both groups of patients were multiple.

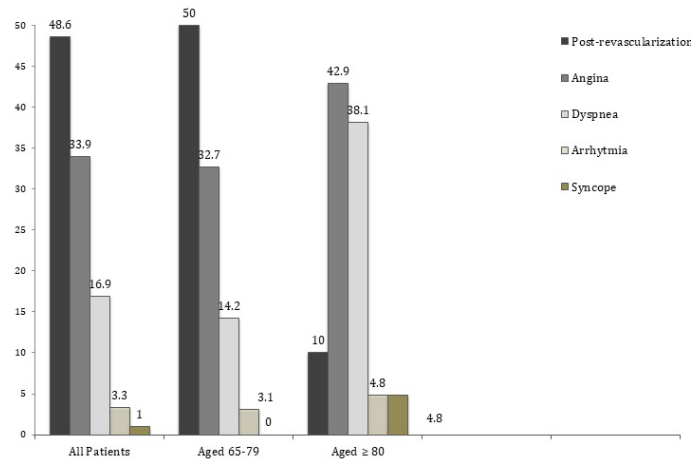


Figure 1: Gated-SPECT myocardial perfusion study indications by groups.

In general, the most frequent indication was control study as part of the clinical follow-up in patients with a history of revascularization (post-revascularization) which predominated in the group of elderly patients (50%); in the very elderly group the most frequent indication was the presence of typical angina (42.9%)

The vast majority of patients (96.2%) performed the one-day protocol including stress phase. According to their clinical conditions, 60.2% performed mixed stress (dipyridamole + physical stress); 38.6% dipyridamole; and, only 1.2% performed only exercise in treadmill. In the elderly group, 60.3% patients performed a mixed stress protocol, while most of the patients in the very elderly group underwent a pharmacological stress with dipyridamole (62%). There were no complications or related adverse events during the performance of the stress phase. The MPI was abnormal in all patients. When subjectively evaluating the degree of ischemia, the majority presented mild ischemia

(67.6%), 25% had a moderate degree and only 7.4% had severe grade ischemia; 29.5% of the group in general showed a decrease in post-exercise LVEF (Table 2).

According to the findings of myocardial perfusion, 33.5% and 23.8% of the patients belonging to the elderly and very elderly group respectively had a high-intermediate post-test risk.

		All patients n=183 (100%)	Aged 65-79 n=162 (88%)	Aged ≥ 80 n=21 (12%)
Study type	Stress/Rest	176 (96.2)	155 (95.7)	21 (100)
	Only rest	7 (3.8)	7 (4.3)	0 (0)
	Stress test	n=176 (96.2%)	n=155 (95.7%)	n= 21 (12)
	Mixed	106 (60.2)	93 (60.0)	8 (38.0)
	Dipyridamol	68 (38.6)	60 (38.7)	13 (62.0)
	Only exercise	2 (1.2)	2 (1.3)	0 (0)
Stress test results	Electrically (-)	156 (88.6)	135 (87.0)	21 (100)
	ST depression	26 (14.7)	26 (16.7)	0 (0)
	ST elevation	1 (0.5)	1 (0.6)	0 (0)
	Clinical symptoms (+)	20 (11.3)	19 (12.2)	1 (4.8)
Gated-SPECT Ischemia	Mild	119 (67.6)	103 (66.5)	16 (76.2)
	Moderate	44 (25.0)	40 (25.8)	4 (19.0)
	Severe	13 (7.4)	12 (7.7)	1 (4.8)
	FEVI post-stress < 45%	52 (29.5)	48 (31.0)	4 (19.0)
Treatment	Coronary angiography	21 (11.9)	21 (13.5)	0 (0)

Table 2: Gated-SPECT one day protocol (stress/rest) characteristics, MPI and treatment data.

According to the myocardial perfusion results, 21 (13.5%) elderly patients with moderate to severe ischemia were referred for coronary angiography; from who 12 (57.1%) underwent percutaneous coronary intervention with stent and only two (9.5%) had revascularization surgery; the other 7 (33.4%) continued with medical treatment due to coronary anatomy (Figure 2).

On the other hand, the vast majority of very elderly patients (76.2%, n=16) presented mild ischemia and five patients (23.8%) had moderate to severe ischemia. All very elderly patients were conservatively treated.

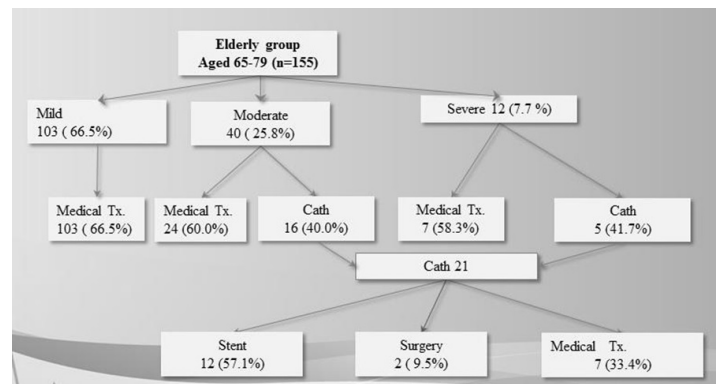


Figure 2: Decision making and treatment according myocardial perfusion imaging data.

Discussion

Worldwide, rates of cardiovascular diseases continue to increase and their impact on medical practice is huge. Important differences should be taken into account in elderly patients with CAD as compared with their younger counterparts: symptom presentation may be different, and complex coronary lesions, coexisting illness, and functional limitations are more prevalent; and, the risk of revascularization procedures is generally increased [16]. In this context, a diagnosis of only coronary anatomy is not sufficient, and the prognostic estimation in a given patient is of utmost importance in the management of older elderly patients with CAD [17]. Other prospective studies focus their primary goal of treatment in elderly and very elderly patients to be not only the prolongation of life, as in younger patients, but rather the improvement in the quality of life. Our results demonstrate that stress myocardial SPECT successfully stratified the risk for subsequent cardiac events [18] and also are consistent with literature in terms of the added value of risk stratification after g-SPECT protocol is performed.

In addition, prior studies have found that stress diagnostic and stratification tests are not conducted in the elderly and; much less, in the very elderly population due to aggregated comorbidities; and thus, complications and adverse events increment during the process [19]. The current study proves well that stress test could be thoroughly conducted in elderly and very elderly people with suspected and/or history of coronary artery disease. Another important finding is that 12% of our sample was ≥ 80 which indicates that even in this particular group stress stratification test is also possible to be safely conducted.

We conducted protocols as follows: 60.2% of stress tests were mixed, 38.6% induced with dipyridamole, and two (1.2%) patients were able to do the complete exercise treadmill test. The vast majority of patients were favoured by the vasodilator alone or in combination with slight exercise (walk) in order to conduct a thorough and valid g-SPECT results interpretation; the most important clinical finding was to prove that this option is an added value and a benefit for clinicians to properly evaluate myocardial perfusion in the very elderly and the elderly who commonly present comorbidities that limit the ability to do an effective physical stress.

As shown in the results, the vast majority of the total sample (n=156, 88.6%) had a clinical and electrical negative result, only 26 (14.7%) presented significant ST segment depression, and 20 (11.3%) develop angina equivalent symptoms during the stress test. It is important to mention that no patient presented or develop related adverse events or complications.

Myocardial perfusion was positive in all patients according to SPECT results. In the elderly group, 66.5% had mild, 25.8% had moderate, and 7.7% had severe ischemia; from the very elderly group, 76.2% had mild, 19% had moderate, and only one patient

(4.8%) had severe ischemia. A third of the elderly group of patients (n=48, 31%) and 4 (19%) of the very elderly presented a decrease of left ventricular ejection fraction (LVEF), which added evidence to correctly and safely stratify them in intermediate to high post-test risk. Therefore, treatment was indicated according to the diagnosis for each patient.

From all 183 patients, 21 (11.4%) from the elderly group with moderate to severe ischemia were referred to catheterization; 12 of them underwent stent placement and 2 patients to surgical revascularization, seven continued with medical treatment. None of the very elderly was referred to catheterization, since all were low to intermediate risk and received medical treatment.

In the aging population, CAD is a major health problem, and cardiovascular disease is still the leading cause of mortality in elderly patients. As a result, elderly patients with known or suspected CAD are frequently encountered in a nuclear cardiology practice. Stress MPI is an important non-invasive technique for the evaluation of patients with known or suspected CAD, also in the control after revascularization and after myocardial infarction. Elderly patients are frequently unable to perform an exercise test due to several comorbidities (e.g. obstructive lung disease, peripheral vascular disease, poor functional capacity or clinical conditions); however, our study shows evidence that in patients with hemodynamic stability is possible to perform stress with physical exercise, or undergoing mixed test, which relevant use is that stress phase is induced through the dipyridamol and little physical exercise. Taken together these results show that if stress test protocol is effectively chosen according to each patient history, symptoms and comorbidities, diagnostic and prognostic efficacy is achieved regardless the age. More important, treatment decision making is clearer and all available options as catheterization and further revascularization. Therefore, g-SPECT is the door for therapeutic routes and decision making regardless the age.

Conclusion

The main finding of this study is that g-SPECT proves to be an effective, accurate and safe prognostic tool for the elderly; and moreover, for the very elderly population. Given the fact that myocardial ischemia is very frequent in 60 years old and more population and based on present results, gated-SPECT seems to add value in the diagnosis and decision making process in the elders and even in the very elders.

This non-invasive cardiovascular imaging assessment is very accurate; and more important, is safe even in very elderly patients undergoing whether the mixed protocol or vasodilator alone protocol reducing the risk of referring a patient to an unnecessary catheterization. Therefore, myocardial perfusion with gated-SPECT represents to be a gatekeeper option and a turn for better prognosis risk stratification. The added value of the mixed protocol, the combination of induced dipyridamol along with low-level exercise represents a powerful alternative in the elderly and very elderly population.

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