

COLLECTION AND CHARACTERIZATION OF A DATABASE FORMED BY MYOCARDIAL SCINTIGRAPHIC IMAGES

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Abstract: The myocardial perfusion and function study, performed through the myocardial scintigraphy exam, still is one of the most non-invasive methods used in the clinical realm for coronary arterial disease diagnosis. Myocardial scintigraphic images can be obtained using a gamma camera employing the SPECT technique. In this work, normal myocardial scintigraphic images were collected, creating a database. We selected 103 patients with normal exams from a group of 537 patients clinically indicated to perform myocardial perfusion scintigraphy. This database is available at the URL: <http://lad.dsc.ufcg.edu.br/spect>, serving as well as reference for subsequent studies of myocardial perfusion and function evaluation.

Introduction

The present work refers to the collection and characterization of a database formed by myocardial scintigraphic images whose perfusion and functions were considered normal by the physicians in the myocardial scintigraphic exam. Myocardial scintigraphic images can be obtained through a gamma camera employing the SPECT (Single photon emission computed tomography) [1, 2, 3, 4, 5] technique, used in nuclear medicine. The SPECT technique is used to produce tomographic images of the radiotracer distribution inside the human body, in a non-invasive way. We selected 103 patients from a group of 537 patients clinically indicated to perform myocardial perfusion scintigraphy exam. In this database it is available images of the rest and stress phases of each patient, as well as some global and regional parameters of left ventricular function, measured from gated perfusion SPECT images as, for instance, end-diastolic volume (EDV), end-systolic volume (ESV) and the left ventricular ejection fraction (LVEF) [6, 7, 8, 9]. The LVEF value is given by the following ratio:

$$LVEF = \left(\frac{EDV - ESV}{EDV} \right) \times 100\% \quad (1)$$

Thus the user will be able to interact with the database, visualizing the referred exams phases of each patient, verifying the calculated parameters from the images, and also he will have the option to download archives of interest.

Our objective was to create a database originated from patients with normal results of myocardial perfusion scintigraphy ECG stress testing. Myocardial scintigraphic images, as well as the parameters cited above, can thus be used by other researchers, as a reference, for further studies of myocardial perfusion and function evaluation.

Materials and Methods

This work started collecting images acquired by a tomographic gamma camera, installed in a specialized nuclear medicine service. These images are obtained in two phases, resting and stress phase. The material used was: ^{99m}Tc labeled myocardial perfusion tracer, ^{99m}Tc-sestamibi (CardioliteTM, Du Pont Pharmaceuticals, North Billerica, MA), and the data was acquired using a 20 seconds per projection rate, performing a total of 64 projections during a 180° rotation. The doses used in the studies were 555 Mega Becquerel (MBq) and 1110 MBq, for the resting and stress phases, respectively. The electrocardiography data was obtained during the exercise stress testing, or pharmacological stress testing for those patients whose exercise test was not indicated. The heart images are obtained after a post-injection interval of one hour for the resting and pharmacological stress phases, and thirty minutes for the exercise phase.

Our database was formed by a selection of 103 patients (39 males and 64 females; range, 30 – 94 years; mean age 61 years) using the following criteria:

- The use of images for the database was approved by the patient;
- Patients with clinical indication to perform the myocardial scintigraphy exam;
- Patients with normal results for stress testing;
- The patients was clinically stable throughout the protocol;
- Gated SPECT imaging was performed during sinus rhythm without sinus tachycardia, frequent extra-

systoles, atrial fibrillation, or other tachyarrhythmias;

- Patients with normal results for left ventricular perfusion and function.

Using the described technique we collected 103 normal scintigraphic studies creating a database. The database is composed by the following data:

- Perfusion and function pages (JPEG files);
- Movie files (stress.mpg and rest.mpg);
- Acquisition files (stress and rest, proprietary format);
- ZIP file with all files above (spect.zip).

Results

This work used data collected from 537 patients clinically indicated to perform myocardial perfusion scintigraphy with the use of gated SPECT technique. From this group we selected 103 patients that presented normal results for the following procedures: exercising or pharmacological stress test, myocardial perfusion scintigraphy. The patients also present normal results for the global and regional parameters of left ventricular function. The parameters derived from this study can be used as a reference for subsequent studies of myocardial perfusion and function evaluation. The parameters measured were:

- Stress test result;
- EDV;
- ESV;
- LVEF;
- Wall's motility;
- Polar map.

The table 1 shows some parameters derived from the gated SPECT study.

Table 1: Parameters derived from the myocardial images.

| Mean±SD Range | Total | Men | Women |
|------------------|-------------------------|-------------------------|-------------------------|
| EDV (ml) | 76.92±22.82 30 - 177 | 87.15±20.12 55 - 147 | 70.43±22.18 30 - 177 |
| ESV (ml) | 26.29±11.44 9 - 75 | 31.90±10.99 16 - 62 | 22.73±10.29 13 - 46 |
| LVEF (%) | 66 ±7 51 - 80 | 64±7 51 - 74 | 68±7 54 - 80 |

Since our main objective was the database creation and characterization using data from patients with normal results in myocardial perfusion, we used, initially, the results obtained with the use of the SIEMENS' image processing software (ICON version 7.1), which had been evaluated by a physician specialist in nuclear medicine. Images in figures 1 and 2, show some results obtained with the use of the ICON software. These figures show images of a male, age 73, which was submitted to myocardial scintigraphy exam, to evaluate a probable coronary artery disease. Figure 1 shows myocardial function images which demonstrate certain homogeneity in the radiotracer distribution, in the regions irrigated by the following arteries: left anterior descendant (LAD), right coronary artery (RCA) and left circumflex (LCX). The left ventricle EDV and ESV were respectively 64 milliliters and 23 milliliters. The LVEF was of 64%. Figure 2 shows myocardial perfusion images in the short, horizontal long and vertical long axes. Images demonstrate uniform radiotracer uptake in all left ventricle walls, in the two exam phases (stress and rest).

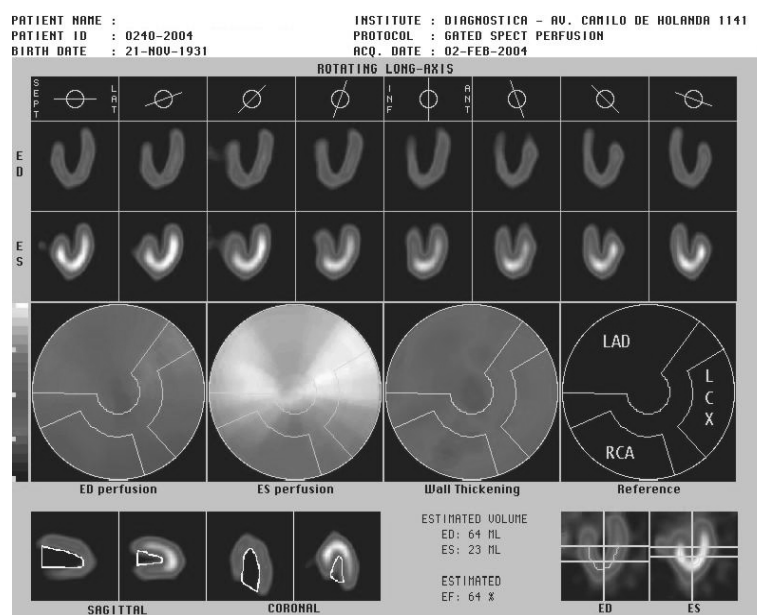


Figure 1: Images and parameters derived from the gated SPECT perfusion.

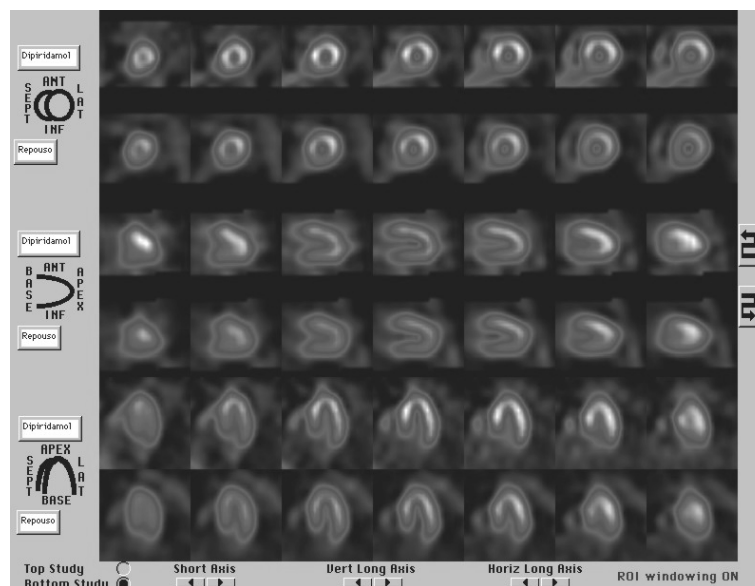


Figure 2: Myocardial perfusion images in the short, horizontal long and vertical long axes.

Clinical data for this patient were:

- Patient clinically indicated to perform myocardial scintigraphy exam because presented stress testing alterations that suggested coronary insufficiency.
- Risk' factors: arterial hypertension, diabetes and dislipidemy.

The conclusions for the stress test and myocardial perfusion scintigraphy were:

- Pharmacological stress with dipyridamole. Absence of clinical and electrocardiographic alterations suggestive of myocardial ischemia;
- The stress images were compared to rest images and it was not observed any scintigraphic element consistent with regional myocardial ischemia;
- Gated SPECT images show normal left ventricular wall-thickness and a preserved regional motility.
- The tomographic slices on short axis, vertical long and horizontal long show low probability of coronary artery disease.

Discussion

We carried out a study with an expressive number of normal patients (103), extracting useful parameters for the characterization of a normal myocardial perfusion scintigraphic exam. The analyzed parameters were: walls motility, ejection fraction, end-diastolic volume, end-systolic volume, visual analysis of the myocardial perfusion and stress testing results. The results obtained in our work are comparable to results obtained in the work of Carmona et al [10]. The clinical diagnosis was

made by the analysis of the results obtained with the use of the SIEMENS' image processing software (ICON version 7.1), evaluated by a nuclear medicine physician.

We intend in a posterior stage, use the database to implement a new method to make a quantitative assessment of SPECT perfusion abnormalities. The first step will be the determination of the normal perfusion distribution of the radioisotope, defined as the mean and variance of the homologous pixel count values from the polar maps of the 103 patients that had a low likelihood of coronary artery disease studied with that radioisotope. Then, the criteria for detection of perfusion abnormalities will be developed in a pilot population that will be at least 100 normal and abnormal patients, with perfusion defects of different location, size and severity. The ideal would be to determine, for each pixel, the fractional number of standard deviations below normal at which perfusion in that pixel could be classified as abnormal. Finally, the normal limits and criteria for normality will be validated in a prospective population of similar characteristics to the pilot one, with coronary angiography as the gold standard for normality.

It is our intention to develop a new technique, based on neural networks, which could establish correlations between several exams used for the diagnosis of CAD, such as clinical data, myocardial perfusion scintigraphy, and cardiac catheterism and ECG stress test.

The neural networks should work with image data and those obtained in the exams mentioned above, but they should also rely on other parameters such as patient risk factors (family coronariopathy, diabetes, tobacco). So, we intend to obtain as the result of a patient examination a report containing detailed information about the physiologic conditions of the main arteries

that perfuse the heart (left anterior descending, right coronary artery and left circumflex). The report should inform about the presence of CAD and myocardial pathology (hibernating myocardium, ventricular hypertrophy, etc) and in the presence of these anomalies, the probability of these to cause heart ischemia or myocardial infarction.

With this new methodology it will be possible to determine in an automatic way the obstruction degree of the coronary arteries, as well as the perfusion contribution provided by collateral arteries. We hope to establish quantitative parameters that could make it easier to indicate or discard surgical intervention.

Conclusions

The database created and made available in the WEB with an expressive number of patients with normal results in the myocardial perfusion scintigraphy exam represents an excellent source of information that can easily be used by other researchers for the characterization of a normal myocardial scintigraphy exam. The parameters obtained in our study were comparable with those found in the specialized literature.

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