IOSR Journal of Applied Physics (IOSR-JAP)
e-ISSN: 2278-4861.Volume 11, Issue 4 Ser. I (Jul. – Aug. 2019), PP 70-75
www.iosrjournals.org

Assessment of Ventricular Volumes and Ejection Fraction using SPECT MPI in Cardiac Diseases

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Abstract: *heart disease is one of the cause's numbers of death in world. If the heart could not pump blood and distribute it's to all parts of the body, pain in the chest will be happened while heavy work or walk a rush. Myocardial perfusion imaging (MPI) techniques is an ideal approach to doing the assessments of myocardial perfusion. The Assessment of Ventricular Volumes and Ejection Fraction using SPECT scan in Cardiac Diseases were the correlate between the age group with the risk factor were the hypertension patient was the biggest number of up normal patients in this study with 25 patients then the diabetes mellitus with 13 patients while the normal patients were 32 one. For the age group the patients in range 40-60 years represent a half of total number of patients.*

using paired sample Test show the correlation between the end diastolic and systolic volume for rest and stress condition of heart muscle were the p.value 0.000 showed a significant difference between the end systolic and diastolic for both condition stress and rest, while the ejection fraction givers 0.012 which mean a significant difference in both rest and stress of heat muscle.

correlate between the end diastolic volume at rest and stress condition using regression equation found that the rate of change at stress was 0.9936 for each ml from rest, correlate between the end systolic volume at rest and stress condition using regression equation found that the rate of change at stress condition was 0.980 for each ml at rest, and correlate between the end ejection fraction at rest and stress condition using regression equation found that the rate of change at stress was 0.9551 for each percent from rest.

Keywords: *SPECT, End Systolic Volume, End Diastolic Volume, Ejection Fraction*

Date of Submission: 08-07-2019 Date of acceptance: 23-07-2019

I. Introduction

The American Heart Association estimates that more than 600,000 people in the United Statesdied of causes related to coronary artery disease in 2000 [1]. Imaging and estimation of leftventricular function and volumes have major diagnostic and prognostic importance in patientswith coronary artery disease [2–4]. It was shown by Sharir et al [5] that the cardiac death rateincreased exponentially as post stress cardiac ejection fraction (EF) decreased. Thus, smallerrors in estimates of cardiac EF may result in improper treatment because of this exponential relationship.

ejection fraction and ventricular volume measurements have been used to evaluate various cardiac diseases. These measurements have been considered important, particularly in ischemic heart diseases, to determine functional status and predict prognosis. In nuclear cardiology, a classicbut standard method has been the gated blood-pool (GBP) study, for which reproducibility and accuracy are well recognized [6] Recent reports on gated SPECT studies have revealed that EF with gated SPECT is accurate and reliable [7-20] Conversely, some studies have shown limits on the use of gated SPECT for quantification [21]. Although gated SPECT has become increasingly important to clinical studies, whether it can replace the GBP study has not been confirmed.

the assessment of myocardial perfusion from stress and rest myocardial perfusion single photon emission computed tomography (SPECT) (MPS) has become central to the management of patients with known or suspected coronary artery disease (CAD) [22].More recently, electrocardiography (ECG)–gated SPECT, with the ability to measure left ventricular (LV) ejection fraction (EF) and ventricular volumes, as well as to evaluate presence of regional wall motion abnormalities (RWMAs), has become a routine part of clinical protocols, expanding the clinical utility of MPS. Recent American College of Cardiology/American Heart Association/American Society of Nuclear Cardiology guidelines for the clinical use of cardiac radionuclide imaging consider ECG-gated SPECT as the "current state of the art" and indicate the following: "The ability to observe myocardial contraction in segments with apparent fixed perfusion defects permits the nuclear test reader to discern attenuation artifacts from true perfusion abnormalities. The ability of gated SPECT to provide measurement of LVEF, segmental wall motion, and absolute LV volumes also adds to the prognostic information that can be derived from a SPECT study [23]. Gated SPECT is now performed in over 90% of all MPS studies in the United States [24].This review is intended to describe the major milestones in which ventricular function assessment has emerged and added to perfusion assessment by use of gated SPECT.

Recent improvements in computer processing have made gated SPECT available to many laboratories, generating wide interest in the application of this technique to the quantitative assessment of ventricular performance characteristics [25-27]. The development of technetium-99m-labeled perfusion agents has led to greater interest in obtaining simultaneous perfusion and function information with a single diagnostic study. However, this has required specialized equipment for the evaluation of ventricular function using first-pass radionuclide angiography, which can be followed by tracer localization in the myocardium for perfusion imaging [28-33]. Determination of ejection fraction from gated perfusion tomography would therefore be useful to the many laboratories that do not routinely perform first-pass studies.

II. Material and Methods

The study was conducted at Al-Neelain Center of Khartoum in Khartoum state. A total of 145Sudanese patients with different heart diseases referred to assess myocardial perfusion on SPECT scan, were the **variables:** Gender, age (year), weight (kg), height (cm), body mass index, and risk factors such as diabetes, hypertension, smoking. Type of stress, MPI finding and SPECT finding.

Data collection: The data was collected by data collection sheets, recording the measurements of the MPI SPECT and 2D echocardiogram quantities EVD(ml), ESV(ml), SV (ml), and EF (%)**.** Data recording included the gender, age, weight, height, BMI, and finding.

Preparation of the patient and measurements:

SPECT Myocardial Perfusion Imaging: Before any stress test, all the patients were NPO for 4 to 6 hours to reduce blood flow to the bowel and liver. Calcium channel blockers and beta-blockers were discontinued for 48-72 hours, and long-acting nitrates discontinued for 12-24 hours. Caffeine was consumed for 1 day prior to the exam. Out of 145 patients myocardial stress was achieved with an exercise treadmill test in 48 patients, Pharmacologic stress (adenosine) in 90 patients and 17 asthmatic patients were stressed on dabutamine. When the patient's heart rate reaches 85% of the maximum predict, 3 mci of Tl-201 thallous chloride injected to 54 patients and 30 mci of TC^{99m} MIBI for 70kg weighted had been injected to 91 patients.The 1-day protocol is primarily used, as it is more convenient for patients and more efficient. Computer software can help provide quantitative analysis of myocardial perfusion. The programs use a 17-segment polar map of the LV to help identify specific areas of perfusion abnormality. The images are compared to a normalized control database. With the addition of gated images, LV motion and function can be analyzed. We only obtain gated images poststress, as the statistics are better due to the higher administered activity, and the patient is already physiologically at rest at the time of acquisition. Normal LV motion results in at least 20% shortening of the long axis and 40% shortening along the short axis, with the anterior wall moving the most and the apex moving the least.[18] The septum should thicken and move toward the center. Cine analysis of slices from the 3 axes of the gated images should show all walls thickening and brightening with systole. Calculated LVEF is usually provided, with 50% to 70% being normal.

Volumetric measurements: Global function of LV is assessed by measuring the difference between the end –diastolic and the end –systolic value of 2D parameter divided by its end –diastolic value. EF, is calculated from EDV and ESV estimates. using the following formula

$$EF=(EDV-ESV) \setminus EDV$$

Method of data analysis: The present study used statistical package for social science (SPSS) as a base method for analysis data, analyzed the echo characteristics (gender, age, BMI, risk factors and SPECT finding) to get the frequency, percentage, and mean for each one. And used the linear regression analysis to demonstrate the relationships. On the other hand, the same characteristics of MPI.

III. Results

heart disease is one of the cause's numbers of death in world. If the heart could not pump blood anddistribute it's to all parts of the body, pain in the chest will be happened while heavy work or walk a rush.Myocardial perfusion imaging (MPI) techniques is an ideal approach to doing the assessments of myocardialperfusion. The Assessment of Ventricular Volumes and Ejection Fraction using SPECT scan in Cardiac Diseases and the results presented as tables and figures:

Table 1. show statistical parameters for all patients examined by SPECT MPI:

Variables	*Mean*	*Std Dev*	*Variance*	*Min*	*Max*
Age	53.46	16.24	263.85	23	116
BMI	25.48	6.093	37.12	12.62	39.83
Rest EDV ml	90.42	41.13	1691.80	21	217
Rest ESV ml	46.79	24.68	608.85	2	102
Stress EDV ml	90.05	41.18	1695.93	16	216
Stress ESV ml	44.66	24.44	597.16	2	100
Rest EF %	0.587	0.174	0.030	0.00	1.00
Stress EF %	0.59	0.143	0.020	0.28	0.88

Table 2. show correlation between the age group with risk factor:

Risk Factor	*Age Group*							*Total*
	20-30	*31-40*	*41-50*	*51-60*	*61-70*	*71-80*	*< 81*	
Null	1	6	11	7	3	3	1	32
DM	0	3	3	5	0	0	2	13
HBN	2	1	4	8	5	4	1	25
Smoking	1	3	1	1	4	0	0	10
DM+ HBN	0	3	1	1	4	1	0	10
HBN+ smoking	0	2	2	1	1	0	0	6
DM+ smoking	0	0	2	0	0	0	0	2
DM + HBN + Smoking	0	0	0	2	0	0	0	2
Total	4	18	24	25	17	8	4	100

Table 3. show correlation between the rest and stress at EDV, ESV and EJ

Paired Samples Correlations		*Correlation*	*P.value*
Pair 1	Stress EDV ml & Rest EDV ml	.992	.000
Pair 2	Stress ESV ml & Rest ESV ml	.990	.000
Pair 3	Stress EF % & Rest EF %	.249	.012

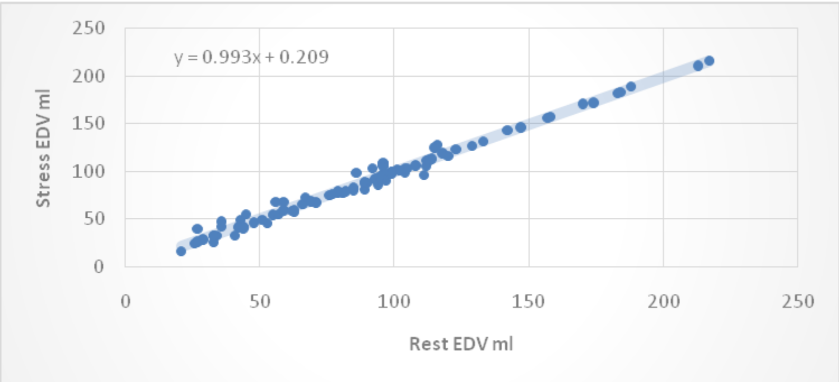

Figure 1: correlate between the stress and rest for EDV per ml

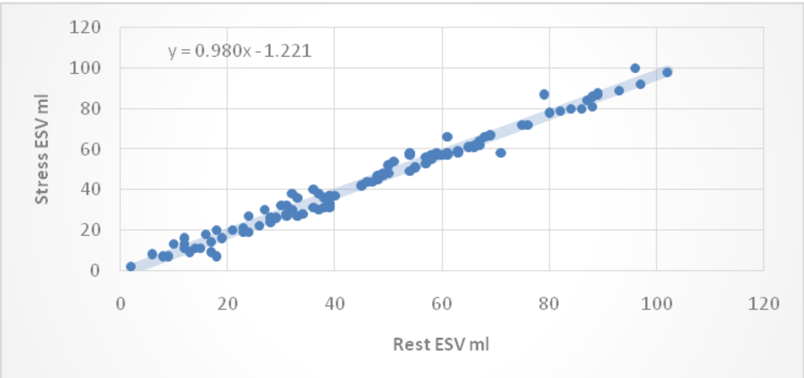

Figure 2: correlate between the stress and rest for ESV per ml

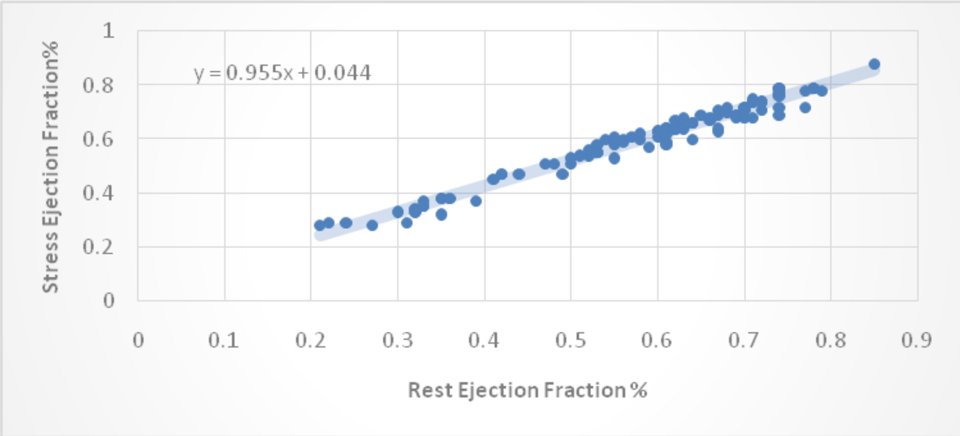

Figure 3: correlate between the Ejection fraction at stress and rest

IV. Discussions

The demographic and measurement information were presents as mean ± standard deviation, for the age and body mass index was 53.46 ± 16.24 year and 25.48 ± 6.09 kg/cm^2, and the measurement data the end diastolic volume and end systolic volume for rest mode was 90.42 ± 41.13 ml and 46.79 ± 24.68 ml,in stress mode was 90.05 ± 441.18ml and 44.66 ± 24.44 ml, the ejection fraction in rest mode and stress was 0.587 ± 0.174 % and 0.59 ± 0.143 %, as shown in table 1. Table 2. Correlate between the age group with the risk factor were the hypertension patient was the biggest number of up normal patients in this study with 25 patients then the diabetes mellitus with 13 patients while the normal patients was 32 one. For the age group the patients in range 40-60 years represent a half of total number of patients.Table 3. show paired sample Test show the correlation between the end diastolic and systolic volume for rest and stress condition of heart muscle were the p.value 0.000 showed a significant difference between the end systolic and diastolic for both condition stress and rest, while the ejection fraction givers 0.012 which mean a significant difference in both rest and stress of heat muscle.

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V. Conclusion

Assessment of Ventricular Volumes and Ejection Fraction using SPECT scan in Cardiac Diseases were the correlate between the age group with the risk factor were the hypertension patient was the biggest number of up normal patients in this study with 25 patients then the diabetes mellitus with 13 patients while the normal patients were 32 one. For the age group the patients in range 40-60 years represent a half of total number of patients.

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Stress End diastolic volume per ml = 0.9936 (EDV at rest) + 0.2095
Stress End systolic volume per ml = 0.9806 (ESV at rest) + (-1.2212)
Ejection Fraction at stress = 0.9551 (EF at rest) + 0.0447

References

[1]. American Heart Association. Heart Disease and Stroke Statistics—A 2003 Update. Dallas, X:American heart Association; 2003.

[2]. Cwajg E, Cwajg J, He Z-X, et al. Gated myocardial perfusion tomography for the assessment of leftventricular function and volumes: comparison with echocardiography. J Nucl Med 1999;40:1857–1865. [PubMed: 10565781]

[3]. White HD, Cross DB, Elliot JM, Norris RM, Yee TW. Long-term prognostic importance of patencyof the infarct-related coronary artery after thrombolytic therapy for acute myocardial infarction.Circulation 1994;89:61–67. [PubMed: 8281696]

[4]. Ritchie JL, Bateman TM, Bonow RO. Guidelines for clinical use of cardiac radionuclide imaging.Report of the American College of Cardiology/American Heart Association Task Force on theAssessment of Diagnostic and Therapeutic Cardiovascular Procedures. J Am CollCardiol1995;25:521–547. [PubMed: 7829809]

[5]. Sharir T, Germano G, Kang X, et al. Prediction of myocardial infarction versus cardiac death by gatedmyocardial perfusion SPECT: risk stratification by the amount of stress-induced ischemia and thepostress ejection fraction. J Nucl Med 2001;42:831–837. [PubMed: 11390544]

[6]. Ashburn WL, Shelbert HR, Verba JW. Left ventricular ejection fraction: a reviewof several radionuclide angiographic approaches using scintillation camera. SeminNucl Med. 1978;20:267–284.

[7]. Germano G, Kiat H, Kavanagh PB, et al. Automatic quantification of ejectionfraction from gated myocardial perfusion SPECT. J Nucl Med. 1995;36:2138 –2147.

[8]. Germano G, Erel J, Lewin H, Kavanagh PB, Berman DS. Automatic quantificationof regional myocardial wall motion and thickening from gated technetium99msestamibi myocardial perfusion single-photon emission computed tomography.J Am CollCardiol. 1997;30:1360 –1367.

[9]. Germano G, Kavanagh PB, Kavanagh JT, Wishner SH, Berman DS, KavanaghGJ. Repeatability of automatic left ventricular cavity volume measurements frommyocardial perfusion SPECT. J NuclCardiol. 1998;5:477– 483.

[10]. Yoshioka J, Hasegawa S, Yamaguchi H, et al. Left ventricular volume andejection fraction calculated from quantitative electrocardiographic-gatedTctetrofosminmyocardial SPECT. J Nucl Med. 1999;40:1693–1698.

[11]. Faber TL, Akers MS, Peshock RM, Corbett JR. Three-dimensional motion andperfusion quantification in gated single-photon emission computed tomograms.J Nucl Med. 1991;32:2311–2317.

[12]. Cook CD, Vansant JP, Krawczynska EG, Faber TL, Garcia EV. Clinical validationof three-dimensional color-modulated displays of myocardial perfusion.J NuclCardiol. 1997;4:108 –116.

[13]. Faber TL, Cooke CD, Folks RD, et al. Left ventricular function and perfusionfrom gated perfusion images: an integrated method. J Nucl Med. 1999;40:650 –659.

[14]. Kritzman JN, Ficaro EP, Corbett JR. Reproducibility of 3-D MSPECT forquantitative gated SPECT sestamibi perfusion analysis [abstract]. J Nucl Med.2000;41(suppl):166P.

[15]. Ficaro EP, Kritzman JN, Corbett JR. Development and clinical validation ofnormal Tc-99m sestamibi database: comparison of 3D-MSPECT to Cequal[abstract]. J Nucl Med. 1999;40(suppl):125P.

[16]. Nakata T, Katagiri Y, Odawara Y, et al. Two- and three-dimensional assessmentsof myocardial perfusion and function by using technetium-99m sestamibi gatedsingle-photon emission computed tomography with a combination of count- andimage-based techniques. J NuclCardiol. 2000;7:623– 632.

[17]. Everaert H, Bossuyt A, Franken PR. Left ventricular ejection fraction andvolumes from gated single-photon emission tomographic myocardial perfusionimages: comparison between two algorithms working in three-dimensional space.J NuclCardiol. 1997;4:472–476.

[18]. Nichols K, Lefkowitz D, Faber T, et al. Echographic validation of gated SPECTventricular function measurement. J Nucl Med. 2000;41:1308 –1314.

[19]. Achtert AD, King MA, Darlberg ST, et al. An investigation of the estimation ofejection fractions and cardiac volumes by a quantitative gated SPECT softwarepackage in simulated gated SPECT images. J NuclCardiol. 1998;5:144 –152.

[20]. Nakajima K, Taki J, Higuchi T, et al. Gated SPET quantification of small hearts:mathematical simulation and clinical application. Eur J Nucl Med. 2000;27:1372–1379.

[21]. Vallejo E, Dione DP, Bruni WL, et al. Reproducibility and accuracy of gatedSPECT for determination of left ventricular volume and ejection fraction: experimentalvalidation using MRI. J Nucl Med. 2000;41:874 –882.

[22]. Berman DS, Hachamovitch R, Shaw L, Hayes SW, Germano G. Nuclear cardiology. In: Fuster V, Alexander RW, O'Rourke RA, Roberts R, King SB, Prystowsky EN, et al, editors. Hurst's theheart. 11th ed. New York: McGraw-Hill; 2004.

[23]. Klocke FJ, Baird MG, Lorell BH, Bateman TM, Messer JV, Berman DS, et al. ACC/AHA/ASNC guidelines for the clinical use of cardiac radionuclide imaging—executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (ACC/AHA/ ASNC Committee to Revise the 1995 Guidelines for the Clinical Use of Cardiac Radionuclide Imaging). J Am CollCardiol2003;42:1318-33.

[24]. Williams KA. A historical perspective on measurement of ventricular function with scintigraphic techniques: part II—ventricular function with gated techniques for blood pool and perfusion imaging. J NuclCardiol2005;12:208-15.

[25]. Kouris K, Abdel-Dayem HM, Taha B, Ballani N, Hassan IM, Constantinides C. Left ventricular ejection fraction and volumes calculated from dual gated SPECT myocardial imaging with 99mTc-MIBI. Nucl Med Cornmun1992; 13:648-55.

[26]. Mochizuki T, Murase K, Fujiwara Y, Tanada S, Hamarnoto K, Tauxe WN. Assessment of systolic thickening with thallium-201 ECG-gated single-photon emission computed tomography: a parameter for local left ventric- ular function. J Nucl Med 1991;32:1496-500.

[27]. DePuey EG, Nichols K, Dobrinsky C. Left ventricular ejection fraction assessed from gated Tc-99m-Sestamibi SPECT. J Nucl Med 1993;34:1871-6.

[28]. Sporn V, Perez-Balino N, Holman BL, et al. Simultaneous measurement of ventricular function and myocardial perfusion using the technetium-99m isonitriles. ClinNucl Med 1988;13:77-81.

[29]. Baillet GY, Mena IG, Kuperus JH, Robertson JM, French WJ. Simultaneous technetium-99m MIBI angiography and myocardial perfusion imaging. J Nucl Med 1989;30:38-44.

[30]. Jones RH, Borges-Neto S, Potts JM. Simultaneous measurement of myocardial perfusion and ventricular function during exercise from a single injection of Tc-99m sestamibi in corona~ artery, disease. Am J Cardiol1990;66:68E-71E.

[31]. Larock MP, Cantineau R, Legrand V, Kulbertus H, Rigo P. 99mTc-MIBI (RP-30) to define the extent of myocardial ischemia and evaluate ventricular function. Eur J Nucl Med 1990;16:223-30.

[32]. Elliott AT, McKillop JH, Pringle SD, et al. Simultaneous measurement of left ventricular function and perfusion. Eur J Nucl Med 1990;17:310-4.

[33]. Villanueva-Meyer J, Mena 1, Narahara KA. Simultaneous assessment of left ventrieular wall motion and myocardial perfusion with technetium-99m- methoxy isobutyl isonitrile at stress and rest in patients with angina: comparison with thallium-201 SPECT. J Nucl Med 1990;31:457-63.

IOSR Journal of Applied Physics (IOSR-JAP) is UGC approved Journal with Sl. No. 5010, Journal no. 49054.

Sawsan A. A. Osman " Assessment of Ventricular Volumes and Ejection Fraction using SPECT MPI in Cardiac Diseases.” IOSR Journal of Applied Physics (IOSR-JAP) , vol. 11, no. 4, 2019, pp. 70-75.