

Left Ventricular Function Parameters in a Hispanic Population: Comparison of Planar & Tomographic Radionuclide Ventriculography (MUGA)

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Objective: Left ventricular (LV) function parameters have major diagnostic and prognostic importance in heart disease. Measurement of ventricular function with tomographic (SPECT) radionuclide ventriculography (MUGA) decreases camera time, improves contrast resolution, accuracy of interpretation and the overall reliability of the study as compared to planar MUGA. The relationship between these techniques is well established particularly with LV ejection fraction (LVEF), while there is limited data comparing the diastolic function parameters. Our goal was to validate the LV function parameters in our Hispanic population.

Methods: Studies from 44 patients, available from 2009-2010, were retrospectively evaluated.

Results: LVEF showed a good correlation between the techniques ($r = 0.94$) with an average difference of 3.8%. In terms of categorizing the results as normal or abnormal, this remained unchanged in 95% of the cases ($p = 0.035$). For the peak filling rate, there was a moderate correlation between the techniques ($r = 0.71$), whereas the diagnosis remained unchanged in 89% of cases ($p = 0.0004$). Time to peak filling values only demonstrated a weak correlation ($r = 0.22$). Nevertheless, the diagnosis remained the same in 68% of the cases ($p = 0.089$).

Conclusion: Systolic function results in our study were well below the 7-10% difference reported in the literature. Only a weak to moderate correlation was observed with the diastolic function parameters. Comparison with echocardiogram (not available) may be of benefit to evaluate which of these techniques results in more accurate diastolic function parameters. [*PR Health Sci J* 2015;34:155-158]

Key words: Cardiac function, Left ventricular function, Radionuclide ventriculography

Planar radionuclide ventriculography (RVG) also commonly known as multigated acquisition (MUGA) cardiac blood pool scintigraphy has long been a simple and noninvasive method to assess ventricular function and, in particular, left ventricular ejection fraction (LVEF). All planar projection imaging studies have the disadvantage of overlapping anatomic structures. On the other hand, tomographic images are able to isolate anatomic structures without overlap to improve the assessment of each individual organ. Specifically, single photon emission computed tomography (SPECT) MUGA has the benefit of isolating the left and right ventricles. SPECT MUGA would hence improve the assessment of individual ventricular function. Several studies have established the relationship between planar and SPECT MUGA. The calculated left ventricular ejection fraction (LVEF) tends to be overestimated (7-10%) in SPECT as compared to planar acquisition (1, 2). Limited data is available comparing the diastolic function parameters between the two acquisition methods. The goal of the study was to evaluate these LV function parameters in our Hispanic veteran population.

The application of SPECT in MUGA has the benefit of increased spatial resolution and contrast, beneficially isolating

the ventricles without overlap of the other cardiac chambers (3). These factors allow for improved assessment of regional wall motion and volumetric computation of LVEF. SPECT MUGA images can also be acquired in less time (approximately 15min) than is needed for a complete 3-view planar RVG, allowing improved laboratory efficiency (3). Two-dimensional echocardiography and MUGA are widely used techniques to assess ventricular function (4). Evaluation of LVEF is the main reason for patient echocardiogram referrals. Systolic and diastolic function can be evaluated by using real-time echocardiography, in addition to measurements of dimensions and volume calculation. Nevertheless, the technique is limited by its inability to define endocardium and poor visualization of the apex (5, 6). The technique is also operator dependent,

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which affects the reproducibility of the study when compared to MUGA. For these reasons, planar MUGA has been the traditional “gold standard” for the measurement of LVEF.

MUGA cardiac blood pool imaging was first described by Strauss and coworkers in 1971 (7). In 1975, Green et al. were the first investigators who were able to produce high temporal resolution electrocardiogram-gated cine angiocardiology (8). The technique became rapidly disseminated and the preferred method for assessment of global and regional left ventricular function throughout the later part of the 1970s and 1980s (4).

In conventional planar MUGA, three planar views are routinely obtained for evaluation of ventricular wall motion. These views are necessary since there is an overlap of anatomical structures, as with any planar study. The left anterior oblique (LAO) view, which best isolates the LV for LVEF calculations, may have superimposition of activity from the left atrium. As such, the LVEF tends to be slightly underestimated particularly due to the presence of the filled left atrium at end systole (3, 9).

Methods

A retrospective record review of SPECT and Planar 99mTc-RBC MUGA was performed. Data from all subjects who underwent a MUGA between February 1, 2009 and February 28, 2010 at the Nuclear Medicine Service of the San Juan Veterans Affairs Caribbean Healthcare System was reviewed. Inclusion criteria were subjects who had both planar and SPECT MUGA acquisitions performed on the same day on either a GE Infinia or GE Varicam Gamma Camera. Data from subjects who had the MUGA performed at any other gamma camera or who did not have both planar and tomographic acquisitions performed were excluded from analysis. Left ventricular ejection fraction

(LVEF), peak filling rate (PFR) and time to peak filling (TPF) values were obtained for comparison from the workstation database archives. The average values of LVEF, PFR and TPF were compared for both the planar and SPECT MUGA using linear regression analysis and a Pearson’s r correlation coefficient was computed for these comparisons. Individual results of the LVEF, PFR and TPF were categorized as normal or abnormal for both the Planar and SPECT MUGA acquisition techniques (1). Differences in category (normal or abnormal) for each subject were performed an analysis of variance (ANOVA). The study was approved by the Human Studies Subcommittee of the San Juan VA Caribbean Healthcare System.

Results

The average results for the planar and SPECT MUGA were computed (Table 1). LVEF showed a good correlation between the planar and SPECT MUGA acquisition techniques (Figure 2). Using a lower limit of normal for LVEF of 50% results were categorized as normal and abnormal (1) for both Planar and SPECT techniques. In 95% of the subjects no change in LVEF category (normal vs. abnormal) occurred between the two techniques ($p < 0.05$). For the PFR, there was a moderate correlation between the planar and SPECT MUGA acquisition techniques (Figure 3). Using a lower limit of normal for PFR of 2.50 EDC/sec results were categorized as normal and abnormal (1) for both Planar and SPECT techniques. In 89% of the subjects no change in PFR category (normal vs. abnormal) occurred between the two techniques ($p < 0.05$). Evaluation of the TPF values did not correlate adequately ($r = 0.22$) between the Planar and SPECT techniques and the change in category (normal vs. abnormal) was also not statistically significant ($p > 0.05$) for TPF.

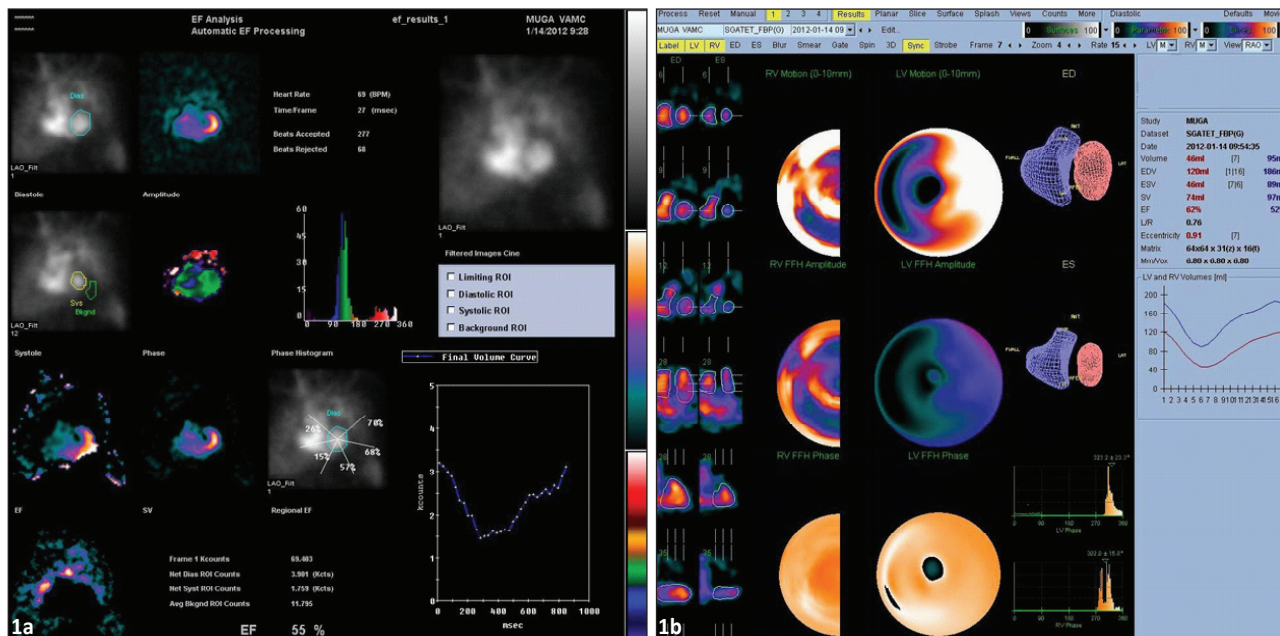
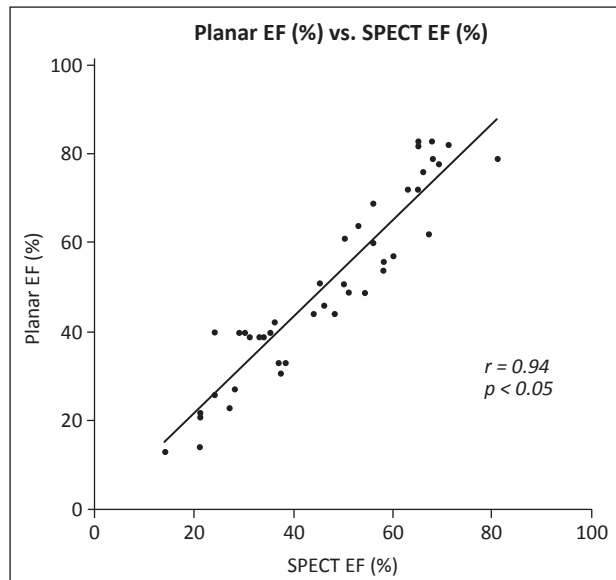
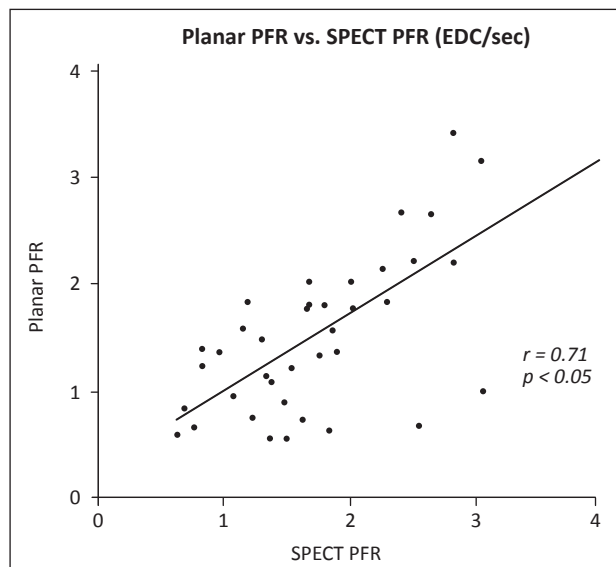


Figure 1. (1a) Traditional planar MUGA analysis. (1b) SPECT MUGA analysis of the acquisition in the same patient.

Table 1. Average values for MUGA modalities

	Planar	SPECT	Pearson's <i>r</i>	Significance
LVEF (%)	47 ± 3	51 ± 3	<i>r</i> = 0.94	<i>p</i> = 0.035
PFR(EDC/sec)	1.81 ± 0.11	1.60 ± 0.12	<i>r</i> = 0.71	<i>p</i> = 0.0004
TPF(msec)	174 ± 15	172 ± 7	<i>r</i> = 0.22	<i>p</i> = 0.089

LVEF - Left Ventricular Ejection Fraction, PFR - Peak Filling Rate, TPF - Time to Peak Filling

**Figure 2.** Ejection fraction determined by Planar (ordinate) vs. SPECT (abscissa) MUGA. Line of linear regression is shown.**Figure 3.** Peak Filling Rate determined by Planar (ordinate) vs. SPECT (abscissa) MUGA. Line of linear regression is shown.

Discussion

Left ventricular function, which is commonly assessed with two-dimensional echocardiography and MUGA, has major

diagnostic and prognostic importance in patients with coronary artery disease (4, 10). Planar MUGA has been the traditional “gold standard” for the measurement of LVEF.

With the availability of SPECT acquisition in MUGA there is the potential gain of spatial resolution and contrast. SPECT facilitates the isolation of the ventricles without overlap of the other cardiac chambers, also eliminating the need to find the best septal view for the planar LAO acquisition (3). These factors allow for improved assessment of regional wall motion and volumetric computation of LVEF. In addition, right ventricular ejection fraction (RVEF) can also be calculated using this technique, without the need for a first pass study. SPECT images can also be acquired in less time (approximately 10 min) than is needed for a complete 3-view planar MUGA Scan (20-25min) or echocardiogram (~15min for EF only; 40 min for valvular disease), allowing improved laboratory efficiency (3). It is also important to emphasize that the approximate cost for SPECT radionuclide ventriculography is significantly lower than other alternatives such as cardiac MR and comparable to echocardiography.

The results of our study demonstrate that the LVEF measurements obtained with SPECT MUGA are comparable to values calculated with the traditional planar acquisition methods (Table 1). These results are well within the 7-10% difference reported in the literature (1). Increased contrast resolution in SPECT imaging most likely accounts for the slight differences in the calculated LVEF. It is our understanding that the negligible 3.8% difference between the acquisition methods, may justify the application SPECT in our Hispanic population for the evaluation of LVEF, particularly in high volume Nuclear Cardiology Centers.

Recently it has been reported that Cardiac MRI and SPECT MUGA produce comparable results in terms of LVEF (11). This study raises the question of which of these techniques is the true “gold standard” for the measurement of LVEF and whether planar nuclear medicine imaging may be in fact resulting in underestimated values. We believe that a large clinical trial comparing the radionuclide techniques with echocardiography and cardiac MRI may be warranted to require to further clarify these issues.

For the PFR, there was a moderate correlation between the techniques (*r* = 0.71), whereas the diagnosis (normal vs. abnormal) remained unchanged in 89% of cases. The results were also statistically significant (*p* = 0.0004). Evaluation of diastolic function using PFR may be an adjunct in evaluating patients with symptoms of congestive heart failure that have normal LVEF. Evaluation of the TPF values only demonstrated a weak correlation (*r* = 0.22) between the acquisition methods. Although the diagnosis (normal vs. abnormal) remained the same in 68% of the cases (180msec cut off value), the results were not statistically significant (*p* = 0.089). There is limited data comparing the diastolic function parameters in the radionuclide ventriculography techniques. Direct comparison of echocardiography and cardiac MRI may also be beneficial

in determining which of the MUGA imaging methods is more accurate. Unfortunately, echocardiography results were not available for our study population.

Conclusion

Planar and Tomographic Radionuclide Ventriculography (MUGA) techniques were compared in a Hispanic population. Unfortunately, in terms of diastolic function parameters, we are unable to draw clear conclusions for SPECT MUGA at this time. Comparison of the radionuclide techniques with echocardiogram is required to evaluate which of these techniques (planar or SPECT) results is most reliable measurement of diastolic filling parameters.

LVEF correlated well results in our study and the results were well below the 7-10% difference reported in the literature. SPECT MUGA adds further benefits by improving contrast resolution, decreasing camera time, improving accuracy of interpretation and the overall reliability of the study as compared to planar acquisition. Measurement of left ventricular systolic function with tomographic MUGA is a cost effective, time saving alternative for evaluation of LVEF in the Hispanic population such as ours. We can therefore recommend the application SPECT MUGA in our Hispanic population for the evaluation of LVEF, particularly in high volume nuclear medicine centers.

Resumen

Objetivos: La función del ventrículo izquierdo (VI) tiene gran importancia diagnóstica y pronóstica en la enfermedad coronaria. La ventriculografía nuclear (MUGA) tomográfica (SPECT) disminuye el tiempo de cámara, mejora la resolución, la precisión de la interpretación y la confiabilidad del estudio comparado con el MUGA planar. La relación entre las técnicas, particularmente con la fracción de expulsión del VI (FEVI), está bien establecida; los datos comparando los parámetros de función diastólica son limitados. Nuestro objetivo fue validar los parámetros de la función del VI en la población hispana. **Métodos:** Evaluación retrospectiva de 44 estudios entre 2009-2010 con ambas técnicas realizadas el mismo día. **Resultados:** FEVI demostró buena correlación entre las técnicas ($r = 0.94$) con una diferencia promedio de 3.8%. Se sostuvo la categorización de los resultados como normal o anormal en 95% de los casos ($p = 0.035$). Para la velocidad de llenado, la correlación fue moderada ($r = 0,71$), mientras que el diagnóstico no cambió en 89% de los casos ($p = 0.0004$). El tiempo de llenado máximo demostró una correlación débil

($r = 0,22$) aunque el diagnóstico se sostuvo en 68% de los casos ($p = 0.089$). **Conclusiones:** Los resultados de función sistólica en nuestro estudio estaban por debajo de la diferencia de 7-10% reportada en la literatura. Se observó una correlación leve a moderada con los parámetros de función diastólica. La comparación con la ecocardiografía (indisponible) pudiera ser beneficiosa para evaluar cuál de las técnicas es más certera en los parámetros de función diastólica.

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