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Evaluation of Right-Ventricular Function by Gated Blood-Pool Scintigraphy

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The purpose of this paper is to review several modalities that can be helpful in evaluating right-ventricular (RV) function. We have investigated the role of functional imaging in analysis of regional RV function and in selection of RV region of interest (ROI). From this we have derived a method to determine the RV ejection fraction using a single RV ROI. The analysis is performed in a modified LAO projection; Fourier phase and amplitude functional images are used to help trace the ROI and study wall-motion abnormalities. This method is compared with the double-ROI technique of Maddahi. Values of RV ejection fraction obtained with one ROI correlate well with those obtained using two ROIs ($r = 0.95$). The regression equation is used to correct for the single-ROI underestimation. The inter- and intra-observer variability is better for the single- than for the double-ROI technique. RV function studies are performed in normal volunteers and in patients with a variety of cardiac disorders. Changes in RV ejection fraction caused either by direct alteration of RV function or by altered loading conditions are documented. Analysis of regional RV function demonstrates RV free wall as well as septal perturbations, further characterizing the extent of dysfunction and providing some etiologic information. We conclude that: 1. RV ejection fraction can be measured by the use of an adequate single diastolic ROI; and 2. A simple equilibrium gated technique can provide detailed information about global and regional RV function that should be systematically added to the analysis of the parameters for left-ventricular function.

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The use of multigated blood-pool imaging to study left-ventricular function is well established (1–3). The complex geometry of the right ventricle, however, has delayed the development of quantitative equilibrium methods to study right-ventricular (RV) function, despite early recognition of its potentials (4–7).

Recently methods have been proposed to measure the RV ejection fraction using multigated blood-pool imaging in the left anterior oblique projection and assuming counts to be proportional to volume (8). Problems remain, however, in defining the right-ventricular background and in handling right-atrial overlap, and the proposed methods differ widely in the approach of these problems (8–9).

In this study, we have analyzed the role of multigated blood-pool imaging to assess RV function. To determine the suitability of a technique using a single region of interest combined with automatic thresholding, we have compared it with the method of Maddahi et al. (8) and have tested its accuracy and reproducibility. We have determined the range of RV ejection fraction in various groups of controls and in patients with coronary heart disease, RV volume or pressure overload, and cardiomyopathy. We have also studied the role of functional images to evaluate regional RV wall motion.

MATERIAL AND METHODS

Patients. Studies were performed in 94 patients categorized into six clinical groups.

Group A. Ten healthy volunteers, seven male and three female, aged 23 to 54 yr (mean 31 yr) without clinical or hemodynamic evidence of cardiopulmonary

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disease by physical examination, ECG, and chest radiography. None was receiving cardiopulmonary medication, and all had a normal exercise capacity for age.

Group B. Fifteen patients with congestive cardiomyopathy (eight ischemic, three thalassemic, and four idiopathic) were studied. All were receiving digitalis and diuretics at the time of the study.

Group C. Fourteen patients with RV volume or pressure overload secondary to atrial septal defect (four cases), tricuspid regurgitation (one case), primary pulmonary hypertension (one case), pulmonary-valve stenosis (one case), severe mitral regurgitation (two cases), or mitral stenosis (two cases). One patient with ventricular septal defect and two with ductus arteriosus are also included in this group. None of these patients had ischemic heart disease.

Group D. Twenty-three patients with recent (<15 days) anterior myocardial infarction.

Group E. Fourteen patients with recent inferior myocardial infarction without RV involvement (on the basis of technetium pyrophosphate scintigraphy).

Group F. Eighteen patients with recent inferior myocardial infarction, with RV involvement demonstrated by Tc-99m pyrophosphate scintigraphy.

Patients in Groups D, E, and F had no previous myocardial infarction or cardiac failure. The mean age of the patients (groups B to F) was 53 yr, range 10–73 yr. There were 24 females and 60 males. All were in stable condition at the time of the study.

Radionuclide technique. *A. Data acquisition.* Multi-gated blood-pool imaging was performed 5–10 min after injection of 25 mCi of Tc-99m albumin into an antecubital vein. Patients were studied supine; the detector was first oriented for a right anterior oblique projection (25° with 10° of caudocranial obliquity), next in a modified left anterior oblique projection (30–50° LAO with 5–10° of craniocaudal tilt). The degree of obliquity used was the one that provided the best separation between both ventricles and atria.

Sixteen frames per cycle were acquired in cine mode using a standard scintillation camera fitted with an all-purpose, parallel-hole collimator and a nuclear medicine computer. Individual frames contained more than 250,000 counts; they were recorded in a 64 × 64 matrix.

B. Data analysis. The data were analyzed using a semiautomatic program. First each frame is normalized for constant acquisition time; this corrects for the frequent drop in counts in the last images resulting from variations of RR interval. Smoothing is performed next using a 3 points time, then space (X and Y) smooth (1-2-1 filters) for the entire 64 × 64 × 16 series. Background subtraction was performed using the automatic thresholding technique of Goris et al. (10), which assumes that background activity, as opposed to that in the

cardiac structures, remains stable throughout the cardiac cycle. Using this background policy, we obtain good correlation between angiographic and scintigraphic determinations of left-ventricular ejection fraction ($y = 0.87x + 5.56$, $r = 0.85$, $s.e.e. = 4.76$, $n = 24$).

Fourier phase and amplitude images are then calculated using the program of Bossuyt et al. (11). Areas of interest are traced manually on four images simultaneously: the diastolic frame, the systolic frame, and the Fourier amplitude and phase images. The amplitude and phase images provide best separation along the atrio-ventricular and ventriculo-arterial junctions, but the best definition of the septal plane requires the four images. Regions of interest thus determined closely resemble conventional diastolic areas but exclude better the atrial counts and include part of the RV outflow tract that the latter frequently omit (Fig. 1). Other functional images (regional stroke-volume image, regional ejection-fraction image, paradox image) are obtained after determination of the systolic point of a time-activity curve constructed using the left-ventricular ROI.

For calculation of the RV ejection fraction, a second systolic ROI is traced on the systolic image, as suggested by Maddahi (8). This systolic ROI differs from the diastolic ROI mainly by exclusion of the right atrial contribution, which is partially pulled into the diastolic ROI during systole (Fig. 1). The right-ventricular ejection fraction (RVEF) is then calculated in duplicate, using either the single- or the double-ROI method after background subtraction. Regional motions of the RV wall and septum are estimated subjectively using the full set of functional images.

Variability of the radionuclide method. Twenty-two

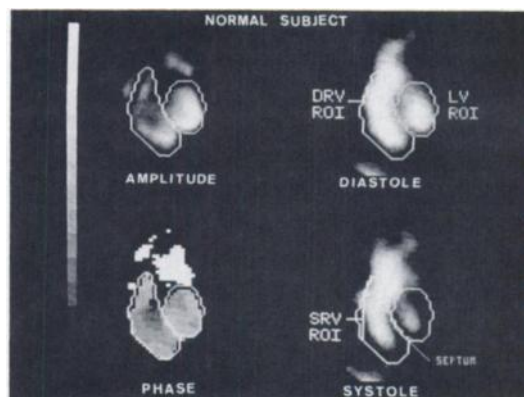


FIG. 1. Gated blood-pool images obtained from normal subject: diastolic and systolic images in left anterior oblique view (LV = left ventricle, RV = right ventricle), together with functional images obtained by Fourier amplitude and phase analysis. Simultaneous visualization of four images permits determination of both diastolic right- and left-ventricular regions of interest (DRV ROI and LV ROI) by exclusion of atria and clear definition of septum. For right ventricle, a second, systolic, RV region of interest (SRV ROI) is traced on systolic image (see text). Scale at left represents amplitude and phase of variation from minimum to maximum and from 0° to 360°.

LEGRAND, CHEVIGNE, FOULON, AND RIGO

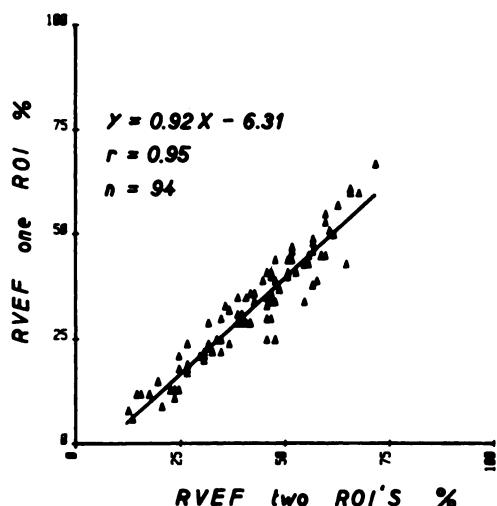


FIG. 2. Comparison of right-ventricular ejection fractions (RVEF) using either one (diastolic) or two (diastolic and systolic) regions of interest (ROI) among 94 patients at rest.

patients were re-evaluated by the same and by another observer to analyze inter- and intra-observer variability for calculations of the RV ejection fraction.

Statistical methods. Comparison of RVEF using one or two regions of interest was analyzed by linear regression. Student's t-tests were performed to compare the RVEF in different groups of patients. Paired t-tests were used when appropriate. A p value <0.05 is considered statistically significant.

RESULTS

Comparison between right-ventricular ejection fraction calculated with one or two regions of interest. The results of RVEF determinations using one or two regions of interest are compared in Fig. 2. The linear regression equation shows a high degree of correlation between

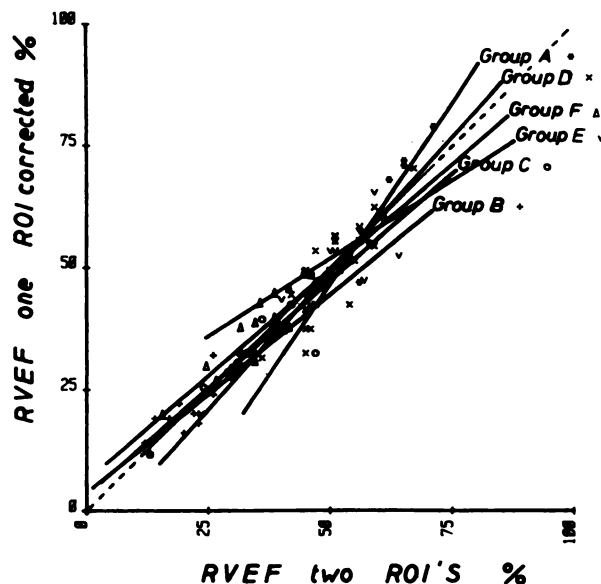


FIG. 3. For each group of patients, RVEF values, using one diastolic ROI and corrected by regression equation, are plotted against those using two (diastolic and systolic) ROIs. For whole population, relation follows identity line (- -).

these two methods. With RVEF as percentages: RVEF (one ROI) = 0.92 RVEF (two ROIs) - 6.31 (r = 0.95, s.e.e. = 4.25, n = 94). Thus it is possible to measure the RVEF with a single diastolic ROI and to obtain values similar to those reported with two ROIs by correcting the single-ROI data through the calculated regression equation: RVEF (corrected) = 1.09 RVEF (one ROI) + 6.86.

Table 1 gives the values of the RVEF calculated with these methods. The values obtained are quite similar, and the differences between each group of patients and normals subjects are at the same statistical level.

To assess the accuracy of the technique, the corrected

TABLE 1. VALUES OF RVEF AND LVEF IN EACH GROUP OF PATIENTS

	N	RVEF 2 ROIs	RVEF 1 ROI	RVEF 1 ROI corrected	LVEF
A. Normal Subjects (at rest)	10	58.6 ± 7.8	48.4 ± 11.2	59 ± 12.3	70.2 ± 10.7
B. Congestive cardiomyopathy	15	22.7 ± 7.7 [‡]	14.0 ± 6.6 [‡]	22 ± 7.1 [‡]	18.6 ± 13 [‡]
C. Right ventricular overload	14	33.3 ± 8.8 [‡]	23.6 ± 8.3 [‡]	32.6 ± 8.7 [‡]	54.9 ± 13 [†]
D. Anterior MI	23	49.3 ± 7.6 [†]	38.2 ± 9.2 [†]	48.3 ± 10.3 [†]	35.4 ± 14.1 [‡]
E. Inferior MI without RVMI	14	52.6 ± 5.9 [*]	42.6 ± 5.6 [*]	53.3 ± 6.1	52.4 ± 10.1 [†]
F. Inferior MI with RVMI	18	35.1 ± 8 [‡]	27.3 ± 7.2 [‡]	36.6 ± 7.7 [‡]	48.3 ± 10.5 [‡]

* p < 0.05.

† p < 0.01.

‡ p < 0.001, all compared with normal subjects at rest.

RVEF = right-ventricular ejection fraction; LVEF = left-ventricular ejection fraction.

ROI = region of interest; corrected means corrected by regression equation.

MI = myocardial infarction.

RVMI = right-ventricular myocardial infarction.

TABLE 2. ACCURACY OF THE CORRECTED RVEF MEASUREMENT AS COMPARED TO THE STANDARD (2 ROIs) RVEF

	N	Paired t-test	p value	Regression equation	r value	s.e.e.
Whole population	94	-0.13	NS	$y = x$	0.95	4.62
Group A	10	-0.51	NS	$y = 1.5x - 27$	0.94	4.28
Group B	15	+0.68	NS	$y = 0.82x + 3.4$	0.90	3.27
Group C	14	+0.64	NS	$y = 0.88x + 3.4$	0.89	4.22
Group D	23	+0.82	NS	$y = 1.1x - 7$	0.85	5.32
Group E	14	-0.50	NS	$y = 0.64x + 19.9$	0.61	5.08
Group F	18	-1.78	NS	$y = 0.87x + 6$	0.90	3.52

y = corrected RVEF (one ROI); x = RVEF (two ROIs); NS = not significant; s.e.e. = standard error of estimate.

single-ROI values, calculated with the use of one diastolic ROI and the regression equation, were compared with the double-ROI values. The paired t-test showed no significant differences between the values obtained, whether considering the whole population or within each group of patients alone. The correlation between the two measurements was RVEF (corrected) = RVEF (two ROIs), $r = 0.95$, s.e.e. = 4.62 for the whole population. In no group of patients did the linear correlation differ significantly from unity (Table 2, Fig. 3).

Right-ventricular ejection fraction in different groups of patients. The values for RVEF and left-ventricular ejection fraction (LVEF) in normal subjects and in patients with different heart diseases are listed in Table 2.

Group A. Our results from normals closely resemble those reported by others using similar methods (5–8).

Group B. All patients with cardiomyopathy show a marked decrease of both RVEF and LVEF ($p < 0.001$).

Group C. Patients with RV pressure or volume overload also show a significant decrease of RVEF ($p < 0.001$).

Group D. Patients with anterior myocardial infarction show marked alteration of LV function. In contrast, there is only a mild decrease in the mean RVEF: only four patients fall more than 2 s.d. below the mean normal value. This drop in RVEF is probably due to an elevated pulmonary wedge and pulmonary pressure.

Groups E,F Patients with inferior myocardial infarction can be divided in two groups according to the presence or absence of RV wall involvement. Patients without such involvement (E) have only a slight decrease in RVEF ($p < 0.05$). On the other hand, patients with RV infarction (F) show a marked decrease in RVEF ($p < 0.001$). The LVEF is significantly reduced in both groups, but this change is less important than in patients with anterior myocardial infarction.

Variability of RVEF measurements. The files of 22 patients were reviewed 3 mo to 4 mo after the first study.

When the RVEF was calculated with one ROI, (RVEF corrected), the intra-observer correlation was: $y = 0.98x - 0.67$, $r = 0.96$, s.e.e. = 4.01 and the interobserver correlation was: $y = 0.95x + 1.31$, $r = 0.95$, s.e.e. = 4.27. Using two ROIs, the correlations were, respectively, $y = 0.97x - 0.53$, $r = 0.87$, s.e.e. = 7.01, and $y = 0.86x + 4.96$, $r = 0.87$, s.e.e. = 6.29 for the intra-observer and the interobserver measurements. Although variability was smaller with the single-ROI method than with two ROIs, the r values cannot be demonstrated to be different statistically. When comparing the two methods, however, we found that both intra-observer variability (respectively, 8.7% for one ROI and 24.5% for two) and the interobserver variability (respectively 8.2% for one ROI and 20.6% for two) were significantly lower ($p < 0.05$) with the single-ROI technique.

Reliability of stroke-counts measurements. The analysis of LV compared with RV stroke counts was performed among the ten normal subjects (Group A). The ratio between LV stroke counts and RV stroke counts (diastolic counts \times RVEF one-ROI) is 1.12 ± 0.18 (range 0.81 to 1.32). The ratio between LV stroke counts and RV stroke counts calculated using one diastolic and one systolic ROI (stroke counts = diastolic counts – systolic counts) is 0.91 ± 0.18 (range 0.65 to 1.25). The ratio between LV stroke counts and RV stroke counts calculated using one diastolic ROI and the corrected RVEF (diastolic counts \times RVEF corrected) is 0.91 ± 0.15 (range 0.66 to 1.13). There are no significant differences between the last two measurements ($t = 0.51$, $p = \text{NS}$). In Group B patients (congestive cardiomyopathy), the ratio LV compared with RV (one diastolic ROI) counts exceeded the upper limit of normal (mean + 2 s.d. = 1.48) in eight cases (53%) suggesting left-ventricular regurgitation. It was lower than normal (mean – 2 s.d. = 0.76) in three cases (20%) suggesting right-ventricular regurgitation. All Group C patients had ratios higher or lower than normal values except for one patient with mitral stenosis and another with pulmonary stenosis. In Group D patients (anterior myocardial in-

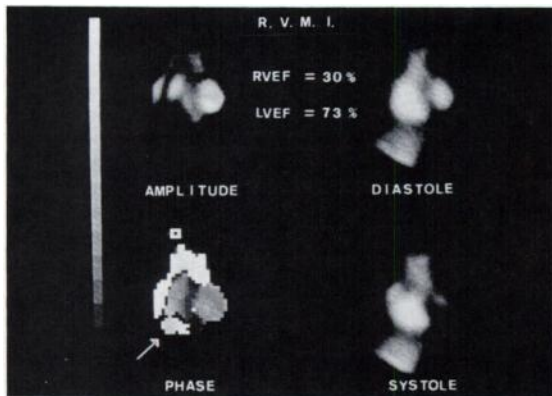


FIG. 4. Right-ventricular myocardial infarction (RV MI): diastolic image reveals important RV enlargement. Fourier amplitude and phase images reflect severe contraction abnormalities, with dyskinesia of inferolateral wall of RV (arrow). RVEF is diminished, although LVEF remains normal.

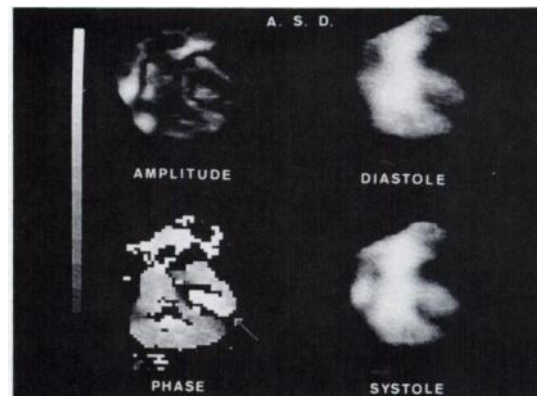


FIG. 5. Atrial septal defect (ASD): RV overload produces RV enlargement associated with paradoxical septal motion. This is shown on phase image by phase shift over left paraseptal region (arrow).

farction), seven patients (30%) had ratios higher than 1.48 and one (4%) was lower than 0.76. The mean value of LV/RV (one-ROI) stroke-counts ratio for the remaining 15 patients was 1.17 ± 0.20 . The LV/RV (two-ROI) stroke-counts ratio was 0.87 ± 0.18 , and the LV/RV stroke counts calculated with the corrected RVEF was 0.91 ± 0.16 . In Group D patients (inferior myocardial infarction without RV infarction), four subjects (29%) had LV/RV (one-ROI) stroke-counts ratios higher than 1.48. For the remaining ten patients, the LV/RV (one-ROI) stroke-counts ratios were 1.23 ± 0.20 ; the LV/RV (two-ROI) ratios were 0.98 ± 0.15 , and the LV-RV ratios calculated with the corrected RVEF were 0.98 ± 0.16 . In Group E patients (inferior myocardial infarction and RV infarction), seven (39%) had LV/RV (one-ROI) ratios higher than 1.48 and three (17%) had ratios lower than 0.76. For the remaining eight patients, the LV/RV (one-ROI) stroke-counts ratios were 1.36 ± 1.10 ; the LV/RV (two-ROI) ratios were 1.04 ± 0.12 , and the LV/RV ratios calculated with the corrected RVEF were 0.99 ± 0.13 .

Clinical illustrations of right-ventricular regional wall motion. *A. Normal motion.* A normal subject with normal ventricular wall motion as demonstrated by the phase and amplitude images is illustrated in Fig. 1. The RV contraction is in phase with the LV wall motion. The RV free wall can be divided into infero-apical, infero-lateral, and infundibular segments. They are separated by the region of the tricuspid valve plane where right atrial overlap prohibits analysis of RV wall motion. Usually, the motion of the inferior segments is somewhat larger, but all these segments can move with similar amplitude. Since the septum normally moves toward the left ventricle during systole, the variation of counts is marked mainly on its left-ventricular border and is lower on its right-ventricular side. Overall, the range of count variations is usually lower over the RV than over the LV.

B. Right-ventricular myocardial infarction (Fig. 4). Right-ventricular infarction produces an asynergy of one or several segments of the RV wall clearly depicted on the amplitude image in 13 of the 18 patients with RV infarction. It is associated with RV dilatation in eight patients. Various patterns of phase alteration are produced within or beyond the area of diminished amplitude. We have also observed that, in seven patients of Group E (39%), stroke counts calculated from the diastolic and systolic frames appeared to underestimate the systemic stroke counts in the absence of recognized valvular regurgitation or shunts. This may reflect, in RV myocardial infarction, the occurrence of diastolic blood flow through the right ventricle suggested by other techniques (12), or may be related to marked atrial dilatation and overlap.

C. Abnormal septal motion. Patients with RV volume overload (e.g., in atrial septal defect) may have an important RV dilatation associated with perturbation in the phase and amplitude images reflecting paradoxical septal motion (Fig. 5).

During diastole, the septum is convex toward the LV because of the RV volume overload, but during systole the septum is displaced to the right and becomes convex toward the right ventricle (13). This septal motion appears on the phase and amplitude images as a systolic increase in counts in the LV paraseptal area and is therefore associated with a phase shift at this level.

Another type of abnormal septal motion can be observed among patients with aortic or mitral regurgitation. The patient in Fig. 6 shows a phase delay over the RV area in the right paraseptal region. The increase of counts in this region during systole is probably due to a vigorous septal contraction with posterior and leftward displacement of the septum during systole.

By comparison, the abnormal septal motion observed among patients with septal aneurysm shows as an increase in count variability associated with a phase delay

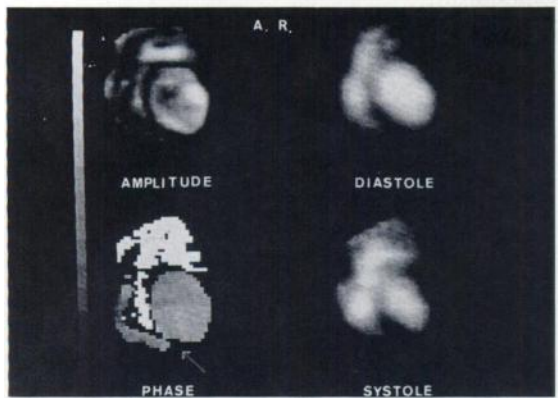


FIG. 6. Severe aortic regurgitation (AR): vigorous LV contraction produces displacement of septum to left, demonstrated by increase of systolic counts over RV paraseptal area in Fourier image (arrow).

over the paraseptal and septal areas corresponding to a systolic displacement of the septum to the right (Fig. 7).

DISCUSSION

The desirability and potentials of the left anterior oblique equilibrium blood-pool technique for simultaneous measurement of left and right ventricular functions have long been apparent. Difficulties in defining an adequate method to correct for background and for the right atrial and aortic overlap have, however, delayed its routine application.

Reliability of RVEF determination. The methods proposed thus far are critically dependent on the relative surfaces of the diastolic and systolic areas (8) or on the relative sampling of noncardiac, atrial, and pulmonary structures (9). They therefore require a high degree of operator expertise and are more difficult to standardize. Our method, on the other hand, can easily be applied by an untrained operator, since the background calculation does not require the determination of an area of interest (10) and the phase and amplitude images clearly identify the functional borders of the right ventricle, especially at the ventriculo-arterial and atrio-ventricular junctions. The images also serve as an internal check on positioning.

Comparison of the LV and RV stroke counts using single LV and RV ROIs has shown systematic underestimation of RV stroke counts ($\pm 12\%$ in normal subjects). This is probably related to the more complex geometry of the right ventricle, leading to superimposition with adjacent structures. For similar reasons it is also possible that the RV diastolic counts are overestimated. In any event, it seems certain that the RVEF estimated with one ROI is underestimated.

This RVEF underestimation can be corrected through the use of diastolic and systolic ROIs, as demonstrated

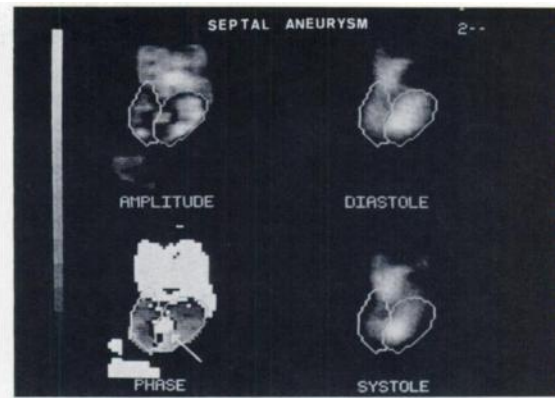


FIG. 7. Septal aneurysm: increase of systolic counts shown in Fourier image over inferior part of septum (arrow) reveals dyskinesia at this level. Patient has anteroseptal myocardial infarction.

by Maddahi (8). RVEF values thus calculated correlate well with first-pass data (5–9). This latter technique has been compared with catheterization data (5). In our hands, application of the dual-ROI technique leads to a slight overestimation of the RV stroke counts ($\pm 9\%$ in normal subjects). However, the calculated RVEF is similar to that reported in other studies (5–9).

Our method demonstrates a high linear correlation ($r = 0.95$) between RVEF measurements using one or two ROIs. Thus the RVEF can also be corrected by the simple use of the calculated regression equation. Indeed, values for all clinical groups are highly similar whether calculated using the dual-ROI method or the corrected single-ROI method. Moreover, the inter- and intra-observer variability is higher using the dual-ROI method than with the corrected single ROI. This reflects the greater difficulty of tracing the end-systolic ROI in the absence of functional image correlate.

The RVEF calculated with one ROI differs from that obtained with two ROIs by a constant (-6.31) and by a nonunity slope (0.92). As diastolic counts are similar in both methods, the differences between the two values are related to differences in calculated RV stroke counts. Thus, the regression equation implies that the difference in RV stroke counts (stroke counts with two ROIs—those with one ROI) is not constant but varies; it increases with the RVEF.

The use of a systolic ROI permits the exclusion of atrial counts (8), leading to a lower systolic count rate and a higher stroke-count rate and ejection fraction. However, the exclusion of the atrial counts is not always easy and an overlap may persist, particularly when the right atrium is enlarged. Although no data concerning the right atrial volume are available, it can be hypothesized that right-atrial overlap increases with right-ventricular and concomitant right-atrial dilatation.

Significance of RVEF determination. In normal subjects, RVEF measurements thus performed are consistent with the known higher diastolic volume and

lower ejection fraction of the RV relative to the LV (14).

Right-ventricular functional alterations can easily be detected in many patients. A drop in the overall RVEF is observed in many, but not all, patients with RV myocardial infarction (as suggested by pyrophosphate scan) or cardiomyopathy, reflecting a direct alteration of the RV function. In many patients with RV volume or pressure overload, as well as in some patients with myocardial infarction without RV wall involvement, a decreased RVEF more likely results from the altered loading conditions of the RV. Alteration in the global RV function should not be analyzed as due to a specific cause, in view of the sensitivity of the right ventricle to alteration in its loading conditions and of its dependence on LV functional changes. Concomitant determination of stroke index ratio (LV/RV stroke counts) may indicate shunt or regurgitation (15-16). However, we have observed in several patients with a large RV infarct an underestimation of RV stroke counts compared with the systemic stroke counts, without evidence of shunt or regurgitation. This alteration in stroke index ratio may reflect diastolic blood flow (12) or be related to a marked atrial overlap. This should be considered in interpreting the results in patients with RV infarction.

Interest of RV regional wall-motion analysis. In normal subjects, the pattern of RV wall motion shows homogeneous contraction amplitude of the infero-apical, inferolateral, and infundibular segments. Overlap with the right atrium, however, can cause an interruption in the functional image. During systole, the interventricular septum thickens and moves slightly toward the left ventricle. This results in limited amplitude changes along the RV septal borders.

Regional alterations in the RV contraction pattern permit a more detailed analysis of the causes and nature of these changes. Myocardial ischemia—and especially infarction—induces regional asynergy characterized by reduced amplitude and frequently by a phase delay on the Fourier images.

Right-ventricular volume frequently results in an increased count variability, and a paradoxical septal motion may be apparent as an increased RV paraseptal amplitude with a phase shift in the LV paraseptal region. On the other hand, RV pressure overload frequently results in a generalized decrease in count variability over the RV. Phase delay in the RV paraseptal region has been observed with hyperactive septal motion (for example with mitral or aortic regurgitation), whereas true paradoxical septal motion, as in anteroseptal aneurysm, appears as a systolic increase of counts over the septal area. The detail and accuracy of these changes are not surprising, since it has been shown that the phase images can give information on the contraction patterns associated with conduction delays or pre-excitation (17).

In summary, analysis of multigated blood-pool images

is incomplete without assessment of the data on RV function. This can be performed quite simply with the help of the functional Fourier phase and amplitude images and with a single RV region of interest. Concomitant determination of the stroke index ratio and absolute volume determination open the way for a comprehensive program of cardiac function analysis with multigated blood-pool imaging (15,16).

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**Southwestern Chapter
Society of Nuclear Medicine
29th Annual Meeting**

March 22-25, 1984

Astrovillage Hotel

Houston, Texas

Announcement and Call for Abstracts

The Scientific Program Committee of the Southwestern Chapter of the Society of Nuclear Medicine invites submitted abstracts of original work in nuclear medicine from members and nonmembers of the Society of Nuclear Medicine to be considered for the 29th Annual Meeting to be held March 22-25, 1984 at the Astrovillage Hotel, Houston, Texas.

The program will include submitted scientific papers, invited speakers, and teaching sessions covering areas of current interest in nuclear medicine. The program will be approved for credit toward the AMA Physicians Recognition Award under Continuing Medical Education Category 1 through the Society of Nuclear Medicine.

Scientific exhibits also are solicited for this meeting. Use the abstract submission guidelines listed below. Descriptions of exhibits, including size, shape, and necessary lighting and support requirements should be listed on a separate sheet. Exhibits will be judged on scientific content in the technologist and professional level categories.

The Southwestern Chapter 6th Annual Nuclear Medicine refresher course will be held March 22-23, 1984. The course will include reviews of basic science, instrumentation, radiopharmaceuticals, and in vitro and diagnostic imaging techniques. Nuclear Medicine Scientists, Technologists, and Physicians interested in a state of the art review are invited to attend.

Abstract forms may be obtained from:

Southwestern Chapter
1209 Lair Avenue
Metairie, LA 70003
Tel: (504)733-0063

Abstracts must be received in Chapter Office by Dec. 1, 1983 (Postmark).

Additional information may be acquired from:

Jerry L. Prather, MD
Radiology Associates
Doctor's Building, Suite 101
Little Rock, AR 72205
Tel: (501)664-3914