Right-Ventricular Function as Assessed by Two Radionuclide Techniques: Concise Communication

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The gated semiautomated first pass and nongated manual first pass methods of right ventricular ejection fraction calculation were compared. It was found that the gated first pass study was the simplest and fastest to process and was overall judged to give at least as much information as the other technique.

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Recently several radionuclide techniques have been used for the evaluation of right-ventricular (RV) function (*1–5*). The first is the equilibrium gated technique (EG). This works well for the left ventricle (LV) (*6*), correlating closely with contrast angiography. However, cardiac chamber overlap is a potential problem with RV evaluation. The second technique that might be used is the list-mode first-pass study (LMFP). This has been used with both the Anger and the multicrystal cameras for LV function, and it also correlates very well with contrast angiography. The LMFP has also been used to evaluate RV function, mainly with the multicrystal camera. When used with the Anger camera, however, it requires considerable disk space and extensive reformatting and processing time. A frame-mode first-pass study has been used with the injection of pertechnetate (Tc-99m) through a catheter in the superior vena cava (*5*). We considered the first-pass approach to be the most accurate method commonly used for the study of right-ventricular function. In this study, we evaluated a variation of a new technique, the gated first-pass method (GPF) for determining RV function. The purpose was to determine whether this less complex technique could perform as accurately as the nongated manual first-pass technique (MFP) in calculating the RV ejection fraction (EF).

MATERIALS AND METHODS

We have studied 21 unselected patients who were referred to the nuclear medicine laboratory for evaluation of LV function. Five patients had prior myocardial infarctions. Two had myocardiopathies, one alcoholic and one viral. One had aortic stenosis and one aortic insufficiency. One had cor pulmonale and another had chronic obstructive lung disease. All the others had ischemic heart disease or a question of congestive heart failure.

A portable scintillation camera was placed in the 30° right anterior oblique projection. Two minicomputers, each with 32 K of core, were interfaced in parallel to the same camera. Thus two data sets were recorded simultaneously for each patient. The patients were first given stannous pyrophosphate, and 20 min later were given a bolus injection of 20 mCi of pertechnetate (Tc-99m) by the basilic vein. The volume of the pertechnetate was between 0.1 and 0.4 ml, which was flushed in with 30 cc saline. When the persistence oscilloscope showed activity in the inferior portion of the superior vena cava or in the right atrium, the acquisition was begun in byte mode with a 64×64 format.

The manual first-pass data were acquired at 25 frames/sec for a total of 15 sec, using the FAST pro-

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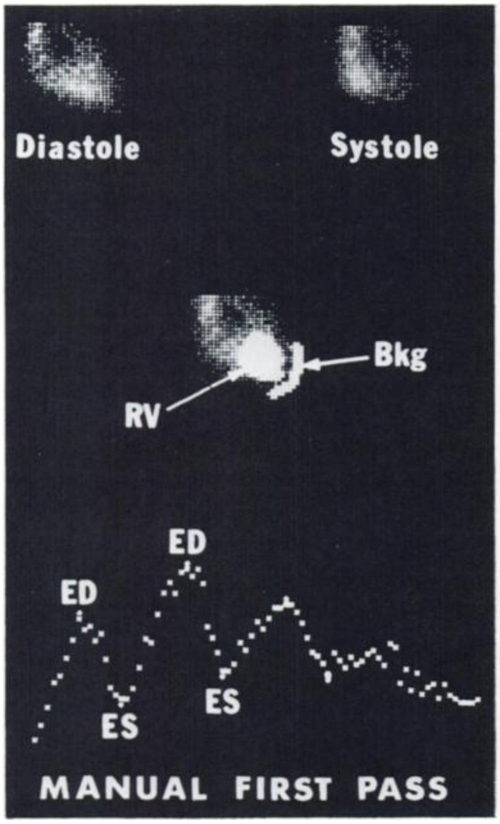

FIG. 1. Manual first-pass method. Top: frames from diastole and systole. Middle: background region outside single RV region of interest at diastole. Bottom: background-subtracted RV time-activity curve.

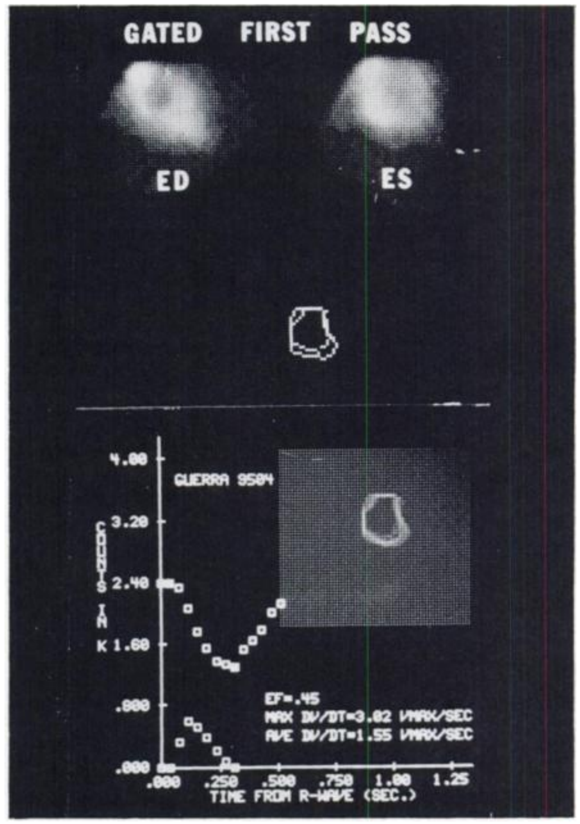

FIG. 2. Gated first-pass method. Top: frames from diastole and systole. Middle: variable RV regions of interest selected by edge-detection algorithm. Botton: RVEF calculated.

gram.† The GFP had a 6-sec acquisition at 40 msec/frame, using commercially available software (MUGX†). Fourteen frames per cardiac cycle were obtained. MUGX does not provide software zooming, so all zooming was obtained by hardware. Zooming can provide a better display.

The processing for the manual first-pass was done as follows. Four RV frames were added together at a time to allow for adequate valve-plane delineation. Four frames near end-diastole were used for the final delineation of the valve planes. The single RV region of interest (ROI) and the background ROI in diastole were manually selected. The latter was a semi-horseshoe shape drawn with a light pen near the tip of the RV (Fig. 1), and was normalized to the RV area. The RV time-activity curve was generated after background subtraction. Utilizing the best two to three cardiac cycles, the RVEF was calculated.

The processing for the gated first pass was done as follows. The tricuspid and pulmonary-valve planes were delineated on the end-diastolic and/or end-systolic image after viewing the wall-motion study. Commercially available software (MUGE-MUGCV†) was used for edge detection, selection of the background ROI, and EF calculation (Fig. 2). This program uses a variable region of interest for the right ventricle. After equilibrium, the camera was shifted to the left anterior oblique projection for the gated blood-pool study of the left ventricle.

RESULTS

The RVEFs ranged from 0.27 to 0.66. Values obtained by the MFP and GFP techniques correlated well ($r = 0.97$, $y = 0.93 \times +0.03$, $p < 0.001$). The count densities were comparable for the two methods.

Of the nine patients with a LVEF less than 0.50, six had an RVEF below 0.45. Of the 12 patients with a normal LVEF, seven had a normal RVEF. The patients with clinical diagnoses of cor pulmonale and chronic obstructive lung disease had RVEFs of 0.52 and 0.35, respectively.

DISCUSSION

The LVEF has been found to be a sensitive and reproducible index of left-ventricular function. Its measurement has been found highly useful in a variety of clinical situations. The RVEF has been less extensively studied. The fact that the shape of the RV is not an ellipsoid of revolution has made even its angiographic measurement difficult. Data on RV function have po-

TABLE 1. MEASUREMENTS OF RV EJECTION FRACTION BY TWO METHODS, WITH THE LVEF FOR COMPARISON

Patient	Gated first-pass RVEF	Manual first-pass RVEF	Left ventricular EF
1	0.42	0.43	0.46
2	0.30	0.31	0.60
3	0.33	0.35	0.62
4	0.50	0.54	0.57
5	0.41	0.40	0.61
6	0.50	0.50	0.62
7	0.44	0.41	0.75
8	0.64	0.63	0.22
9	0.37	0.40	0.23
10	0.57	0.52	0.64
11	0.30	0.27	0.33
12	0.45	0.45	0.77
13	0.45	0.45	0.47
14	0.69	0.66	0.74
15	0.44	0.40	0.36
16	0.46	0.51	0.27
17	0.38	0.38	0.60
18	0.57	0.58	0.73
19	0.63	0.58	0.72
20	0.29	0.28	0.36
21	0.43	0.43	0.48

tential clinical utility in the evaluation and follow-up of patients with chronic obstructive pulmonary disease, primary pulmonary hypertension, inferior myocardial infarction with right-ventricular involvement, functional effects of right coronary artery lesions, valvular heart disease, and intracardiac shunts (*1,3,7*).

One deficiency in the present study is that contrast angiographic calculation of RVEF was not done in these patients.

However, the MFP method bears certain similarities to that described by Steele et al. (*5*), and they found good correlation with RV contrast angiography. The GFP in our study required the least processing time and provided superior delineation of the tricuspid and pulmonic valve planes. The GFP technique allows the evaluation of RVEF as accurately as the more complex MFP procedure and provides more easily available information regarding RV wall motion.

FOOTNOTE

† MDS

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NOTICE

Due to errors in printing, Stephen E. Derenzo's article entitled "Method for Optimizing Side Shielding in Positron-Emission Tomographs and for Comparing Detector Materials" (*J Nucl Med* 21:971–977, 1980) will be reprinted in its entirety, with all corrections, in the March 1981 issue.