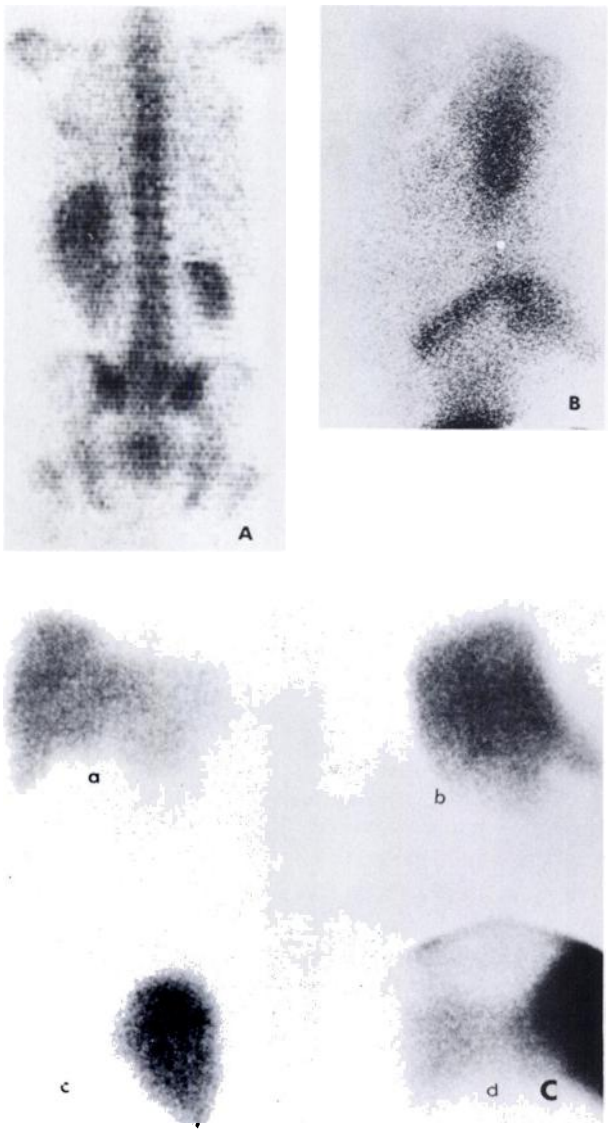

FIG. 1. (A) Bone scan (posterior view) with Tc-99m diphosphonate, showing increased splenic accumulation. (B) Left lateral view of bone scan confirmed presence of activity within spleen. (C) Technetium-99m sulphur colloid liver and spleen scan showing no activity in spleen. Normal liver. (a) anterior, (b) right lateral, (c) posterior (centered toward right), and (d) posterior (midline).

(a) sluggish intrasplenic circulation secondary to the increased viscosity of the blood containing sickled cells, and (b) blockage of the reticuloendothelial system by oversaturation of these phagocytic cells (*8*). Possibly the severe hemosiderosis secondary to multiple transfusions bears some relation to the decreased splenic uptake of sulphur colloid.

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A Modified FORTRAN Program for the Calculation of Modulation Transfer Function

In a recent Concise Communication, Benedetto and Nusynowitz (*1*) presented a FORTRAN program for calculation of the modulation transfer function (MTF) from line spread function data. Several assumptions were made concerning the symmetry of the line spread function (LSF): specifically, that the peak value of the LSF occurs at the origin and that the LSF is symmetric about this peak value. Yet in their example the LSF is clearly not symmetric about the peak value. The true peak of the LSF curve does not occur at the observed maximum, and hence the origin should not be taken to be this value. Further, the program requires an odd number of LSF values. If the LSF data are symmetric, but the true peak is straddled by two equal data points, the program requires the loss of an important data point in order to provide an odd number of LSF values.

We have been using a modified program that is independent of symmetry about the origin and accepts an odd or even number of LSF values. Our program also computes the integral of the MTF,

$$\int_{\nu=0}^{\nu=\gamma} \mathrm{MTF}(\nu) \cdot d\nu,$$

from frequency 0 to the first spatial frequency where MTF(γ) reaches 0. This integral provides a convenient basis for the comparison of modulation transfer functions.

Calculations. Let N = number of LSF values, and let each be represented by $f(X_i)$, where X_i is the displacement along the abscissa. If N is odd, let $m = (N - 1)/2$; if N is even, let $m = N/2$.

Then, for a given spatial frequency ν, define

$$SC = \sum_{i=-m}^{N-(m+1)} f(X_i) \cos 2\pi\nu X_i,$$

$$SS = \sum_{i=-m}^{N-(m+1)} f(X_i) \sin 2\pi\nu X_i.$$

Let $\beta = \tan^{-1}(-SC/SS)$. If $\beta < 0$, let $\beta = \beta + \pi$. Then

$$\mathrm{MTF}(\nu) = \left[\frac{SC \cdot \sin(\beta) - SS \cdot \cos(\beta)}{\sum_{i=-m}^{N-(m+1)} f(X_i)}\right]$$

While this is not the most general form of the MTF, it is the most general form that can easily be used in nuclear medicine. The sine term [SS · cos(β)] in this form corrects LSF for asymmetrical values. This form reduces directly to the form given in (*1*) if true symmetry is assumed. However, this is rarely the case in actual LSF data.

The integral is estimated using the trapezoidal rule, i.e., for N frequency increments to zero MTF we have

$$\int_0^{\nu} \mathrm{MTF}(\upsilon)\,d\upsilon$$

$$\sum_{i=1}^{N} [[\mathrm{MTFS}\ (i-1) + \mathrm{MTFS}\ (i)]/2]*\mathrm{FREQ},$$

where i is the ith frequency increment, MTFS(i) = MTF (FREQ*i).

Program description. We have modified the program published by Benedetto et al. to include the sine correction and MTF integral as shown in Appendix 1. The increase in computational time is unnoticeable on a mini-computer system. In Appendix 2, MTF values of the unmodified and modified programs are compared using the LSF data from the sample run given in (*1*). Further, the MTF values are compared when the LSF data have been entered in reverse order. Note that for the odd number of LSF values, both versions compute MTF values independent of the order of entry, whereas for an even number of LSF values the MTFs are identical with the modified program. Note also that the difference in MTF as computed by the two methods is significant when compared with the differences in MTF one might obtain from different systems or collimators.

Thus this program is run the same as that shown in (*1*), but it admits a wider range of line spread functions. The program also incorporates the integral of the MTF, which is useful for comparing more than a few MTFs.

APPENDIX 1

Modifications for computer program. The program given in (*1*) can be modified in the following manner, starting after statement 2.

```
      .
      .
      .
      XNUM = 0.0
      XNUM1 = 0.0
      XNUM2 = 0.0
      SUMTF = 0.0
      TEMP = 1.0
      DO 12 I = 1,N
      XNUM1 = XNUM1 + Y(1) * COS
        (TWOPI*XFREQ* X(I))
 12   XNUM2 = XNUM1+Y*SIN(TWOPI*XFREQ*
        X(I))
      IF (XNUM2) 15,16,15
 15   DFREQ = ATAN(-XNUM1/XNUM2)
      IF (DFREQ) 13,14,14
 16   DFREQ = TWOPI/4.0
      GOTO 14
 13   DFREQ = DFREQ + 3.1415
 14   THET = SIN(DFREQ)
      PHI = COS(DFREQ)
      XNUM = XNUM1*THET - XNUM2*PHI
      XMTF = XNUM/SUMY
      IF (XMTF) 98,22,22
 22   IF (1.0-XMTF) 98,24,23
 23   SUMTF = SUMTF + (XMTF+TEMP)*FREQ/2.0
 24   TEMP = XMTF
      WRITE (1,302) XFREQ, XMTF
      .
      .
      .
 98   CONTINUE
      WRITE (1,308) XFREQ, SUMTF
308   FORMAT (1X, "THE INTEGRAL FROM 0 TO ",
      F5.3, " IS", F6.3)
      .
      .
      .
```

APPENDIX 2

MTF output comparing modified with unmodified program, with both an even and an odd number of LSF values, based on sample run in (*1*). Enter number of LSF values to be read; 19

	GIVEN ORDER		REVERSE ORDER	
FREQ	UNMODI-FIED	MODI-FIED	UNMODI-FIED	MODI-FIED
0.000	1.000	1.000	1.000	1.000
0.025	0.984	0.985	0.984	0.985
0.050	0.939	0.939	0.939	0.939
0.075	0.868	0.869	0.868	0.869
0.100	0.777	0.778	0.777	0.778
0.125	0.673	0.675	0.673	0.675
0.150	0.565	0.567	0.565	0.567
0.175	0.458	0.462	0.458	0.462
0.200	0.360	0.364	0.360	0.364
0.225	0.274	0.279	0.274	0.279
0.250	0.202	0.208	0.202	0.208
0.275	0.145	0.151	0.145	0.151
0.300	0.102	0.108	0.102	0.108
0.325	0.070	0.076	0.070	0.076
0.350	0.047	0.054	0.047	0.054
0.375	0.031	0.038	0.031	0.038
0.400	0.019	0.027	0.019	0.027
0.425	0.010	0.018	0.010	0.018
0.450	0.004	0.012	0.004	0.012
SUM=	0.17570	0.17764	0.17570	0.17764

Enter No. of LSF values to be read; 18

	GIVEN ORDER		REVERSE ORDER	
FREQ	UNMODI-FIED	MODI-FIED	UNMODI-FIED	MODI-FIED
0.000	1.000	1.000	1.000	1.000
0.025	0.985	0.985	0.984	0.985
0.050	0.940	0.941	0.937	0.941
0.075	0.870	0.871	0.864	0.871
0.100	0.780	0.781	0.771	0.781
0.125	0.677	0.679	0.665	0.679
0.150	0.569	0.572	0.555	0.572
0.175	0.462	0.465	0.448	0.465
0.200	0.363	0.366	0.349	0.366
0.225	0.275	0.279	0.264	0.279
0.250	0.202	0.207	0.194	0.207
0.275	0.144	0.149	0.140	0.149
0.300	0.099	0.106	0.100	0.106
0.325	0.067	0.075	0.072	0.075
0.350	0.045	0.054	0.053	0.054
0.375	0.030	0.039	0.039	0.039
0.400	0.020	0.029	0.029	0.029
0.425	0.012	0.021	0.021	0.021
0.450	0.006	0.014	0.014	0.014
SUM=	0.17612	0.17816	0.17484	0.17816

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Gated Radionuclide Biventriculography

In contrast to conventional radiographic ventriculography —where a high-volume pressure injection of hyperosmolar contrast agent is required to visualize and evaluate the volume of one side of the heart at a time (*1,2*)—the radionuclide angiocardiogram (*3,4*) is a physiologic, safe, noninvasive procedure that is easy to perform and to repeat without undesirable side effects or discomfort to the patient.

Following the i.v. injection of an intravascular tracer such as Tc-99m-labeled human serum albumin, the passage of radioactivity through the heart is monitored by a scintillation camera and images are sequentially recorded to be assessed qualitatively and/or quantitatively.

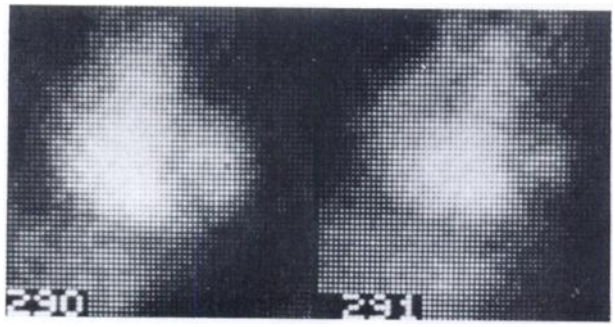

FIG. 1. Gated radionuclide biventriculogram in LAO projection in diastole (left) and systole (right) to demonstrate the hugely enlarged right ventricle.

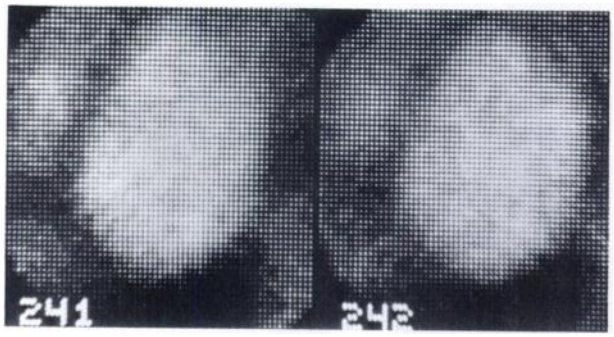

FIG. 2. Gated radionuclide biventriculogram in LAO projection in diastole (left) and systole (right) to illustrate the markedly enlarged left ventricle.

On a qualitative basis, the obtained scintiphotos are used to estimate the sizes of cardiac chambers and great vessels and to detect congenital or acquired anatomic abnormalities.

For quantitative analysis, the output of the scintillation camera is interfaced to a computer system. By introducing a physiologic gating signal (e.g., electrocardiographic), the data are obtained only during selected portions of the cardiac cycle. By summation of the obtained information over several cardiac cycles, mean cardiac scintiphotos are obtained for selected portions of each heart beat. When this procedure is applied to end-systole and end-diastole, information is obtained regarding regional wall motion (*5*), ventricular volume, and ejection fraction.

This gated radionuclide technique has a major advantage that has not received enough recognition: it permits simultaneous evaluation of both right and left ventricles regarding their size (Figs. 1 and 2) and calculation of the ejection fraction of each ventricle (*6,7*). Accordingly, this technique fully deserves to be called Gated Radionuclide Biventriculography instead of the less descriptive terms currently used.

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Segmental Analysis of Tl-201 Stress Myocardial Scintigraphy: The Problem of Using Uniform Normal Values of Tl-201 Myocardial Uptake

The method of quantitation of regional Tl-201 myocardial uptake, described by Lenaers et al. (*1*) is very similar to the Tl-201 scintimetry (*2*) which was designed to relate the regional Tl-201 minimum uptake to the myocardial maximum uptake (= 100%). This method has proved to be valid for comparing Tl-201 regional uptake with (a) the grade of coronary artery stenosis, and (b) the regional left-ventricular motion pattern (*2*). As we have shown, with the subject at rest, each anatomically defined region of the left ventricular myocardium has its own normal Tl-201