# TECHNIQUE FOR PRODUCING CARDIAC RADIONUCLIDE MOTION IMAGES

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***Sequential frames of different portions of the cardiac cycle are gated into a minicomputer by using an EKG signal recorded onto digital tape simultaneously with imaging information. Serial display of these frames on the computer oscilloscope or projection of 35-mm half frames of these images provides a cardiac motion image with information content adequate for qualitatively assessing cardiac motion.***

Motion reproduction enhances the ability to discern cardiac abnormalities on cineangiocardiography. This should be particularly true of radionuclide images suffering from a dearth of image information. The recent report that average gated radionuclide images, sorted by computer and displayed sequentially, could yield high-information cardiac motion pictures (*1*) suggested that the same results could be accomplished with a minicomputer.

## TECHNIQUE

Bolus injection of 0.21 mCi/kg $^{99m}$Tc-labeled albumin is made by flushing the dose from a venotube reservoir into a scalp vein needle cannulating an external jugular vein (*2*). The Anger camera equipped with a 20-deg slant-holed collimator (tomographic collimator) is angled an additional 20 deg to the left and approximately 10 deg toward the feet to obtain a modified left anterior oblique view (*3*). The initial passage of the bolus is recorded onto a standard digital tape system (Searle Datastore System). A 10-min image from the left anterior oblique view is then recorded along with the EKG signal that is stored in modulated form through a gating system (built by G. W. Jones, University Hospital, San Diego, Calif.) onto the sound track of the digital tape. This is followed by another 10-min image from the opposite 40-deg right anterior oblique view without angling toward the feet. The patient is dismissed and all image and gating information is retrieved from the digital tape.

On playback of the EKG, a 50-msec gate as determined by calibration with the gating instrument is placed initially on the downslope of the T wave (Frame 1 of Fig. 1) representing end systole (*4*). A portion of the 10-min sequence, usually 100–150 sec, but which varies depending on the counting rate, yielding a total of 1.2 million events, the limit of our disk storage capacity, is played into the Hewlett-Packard 2100A minicomputer in list mode along with the amplified square wave gate signal. While it is on, this signal labels the information being stored under the tag "isotope 3." Using the list framing mode, only the information labeled as "isotope 3" containing approximately 100K counts is stored in Frame 1. The tape is rewound, the gate moved on visually to the next 50-msec interval (Frame 2, Fig. 1) and the process repeated. The intervals from the QRS to the downstroke of the T are reproducible since the QT interval remains fairly stable in spite of variations in rhythm. After the T wave, timing is less certain and 50-msec intervals are skipped between gate settings to allow for variations in rhythm. Depending on the RR interval, seven or eight such frames are generated requiring 30–45 min for one oblique view. An additional 30–45 min are required for the other oblique view. Each frame represents an average of a 50-msec portion of the cardiac cycle (Fig. 1).

Utilizing a keyboard program the frames are displayed serially, each frame persisting for 50 msec, repeating the entire cycle when the last frame is reached. The operator can play the image as long as desired for diagnostic purposes. Each frame may also be photographed with a 35-mm half-frame camera making seven film frames of each computer

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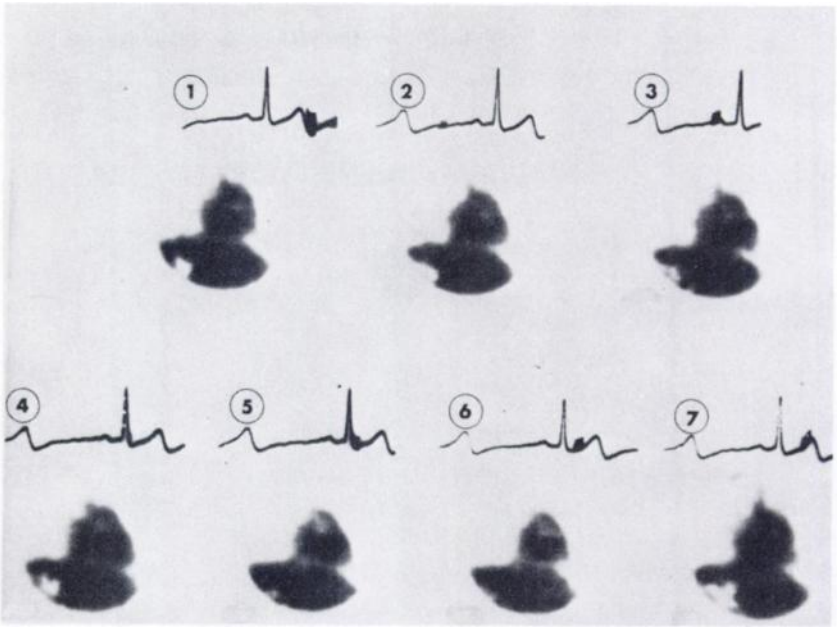


**FIG. 1.** Serial 50-msec gated frames. Images represent portion of cardiac cycle indicated by artifact on EKG tracing above. Frame 1 represents end systole; Frame 2, early diastole; Frame 3, mid-late diastole; Frame 4, end diastole; Frame 5, early systole; Frame 6, mid-systole; and Frame 7, late systole. Each frame photographed with the image displayed out of focus contains approximately 100K counts. Rapid serial display yields motion image.

frame. The 35-mm strip can then be made into a loop for projection by a standard 35-mm cine projector. Alternatively, the moving images may be videotaped from a camera viewing the display oscilloscope (*5*). Using the initial transit of the bolus, the confines of the left ventricle can be delineated as an area of interest for purposes of data analysis.

## RESULTS

Figure 1 shows a typical sequence of seven frames from the right anterior oblique projection in an individual with valvar pulmonic stenosis and normal contraction of the left ventricle. The moving display has been helpful in a variety of cases including aneurysms of the ascending aorta, rheumatic mitral valve disease, congenital pulmonary valvular stenosis, myocardiopathy, ventricular dyskinesia secondary to myocardial infarction, and pericardial effusion. Qualitative visual assessment of left heart chamber or vessel motion during the average cardiac cycle provides a means of assessing information not so readily apparent but present on single transit studies or on single-gated systolic and diastolic images.

## ACKNOWLEDGMENT

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