Upsala J Med Sci 83: 41–42, 1978

Comparison between Videodensitometric and Angiocardiographic Determination of Left Ventricular Ejection Fraction in Patients with Cardiac Disease

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ABSTRACT

Angiocardiograms have been widely used to calculate volumes of cardiac chambers. By determining the left ventricular volume in end-diastole and end-systole the ejection fraction can be calculated. The ejection fraction is considered a clinically useful index of left ventricular function and is widely used in the preoperative evaluation of patients with cardiac disease.

INTRODUCTION

Various methods have been used for calculating the left ventricular volume from angiocardiograms. (For a review see Sandler (1).) All formulas used to calculate the volume are based on the assumption that the left ventricle is a regularly shaped ellipsoid. This is obviously not so, particularly in end-systole and in ventricles with abnormalities of the wall. Furthermore the calculations are based on manual tracing of the left ventricular contour. This is time-consuming and contains a subjective element. These disadvantages of the angiocardiographic method have led to a search for other methods of determining the volume of cardiac chambers. Videodensitometry (2) eliminates the need for assuming that the left ventricles has a regular geometric shape and also the need for manual tracing of the contour of the left ventricle. The present study was undertaken to compare determinations of the left ventricular ejection fraction by the angiocardiographic videodensitometric methods in an unselected group of cardiac patients.

MATERIAL

The study was made on 25 patients—16 men and 9 women—with a mean age of 52 years (range 30 to 67). Thirteen of the patients had coronary artery disease, eight had aortic valvular disease and four had mitral valvular disease.

As part of a routine preoperative evaluation, all patients underwent cardiac catheterization and angiocardiography of the left ventricle and usually also coronary arteriography.

METHODS

In all patients right anterior oblique and left anterior oblique cineangiocardiograms of the left ventricle were obtained simultaneously, at an exposure rate of 100 frames per second. The blood pressure, left ventricular pressure and electrocardiogram were continuously monitored before, during and after the injection of the contrast agent. Approximately 0.4 ml of Urografin 76% per kg body weight was used. In 17 patients the contrast agent was injected into the left ventricle, in six into the left atrium, and in two patients with severe aortic insufficiency into the root of the ascending aorta. The rate of injection was 15 ml/s. The cineangiocardiograms from the two projections were projected on to a digitising board, the contours of the ventricle were manually traced and the coordinates for the contours were fed to a computer via magnetic tape. Using iterated Simpson's rule calculations, the volumes of the ventricle in end-diastole and in end-systole for two consecutive normal beats were calculated. The ejection fraction was then calculated from the mean of these two volumes.

Fifteen minutes later, when the heart rate and pressure had returned to their original levels, an injection of contrast agent was made for videodensitometric determination of the left ventricular volume, with the patient and the

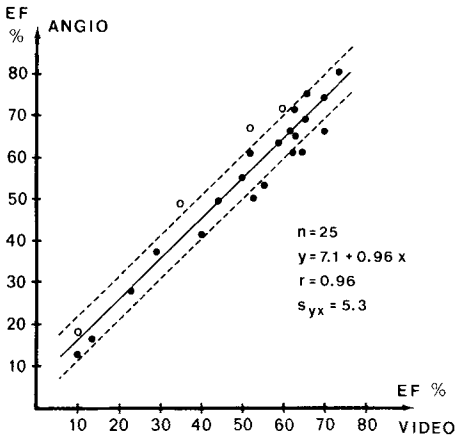

Fig. 1. Comparison between the ejection fraction of the left ventricle obtained by the videodensitometric and angiocardiographic methods in 25 patients. The largest discrepancy between the methods is seen in four patients with irregular shaped ventricles (open circles).

catheter remaining in the same position. Approximately 0.2 ml of 76% Urografin per kg body weight was injected. The right anterior oblique projection of the left ventricle was utlized and recorded on videotape. Using the densitometer the ejection fraction was calculated (3).

RESULTS

The ejection fractions obtained by the angiocardiographic and the videodensitometric methods are plotted in Fig. 1. There is good agreement between the two determinations. The angiographic method tended to give somewhat higher values than videodensitometry. The discrepancy between the values obtained by the two methods was greatest in four ventricles with an irregular shape.

DISCUSSION

A problem when comparing two methods for calculating the ventricular ejection fraction is that there is no way of determining the "true" ejection fraction. The major errors of the angiocardiographic method have been extensively discussed (Sandler (1) and others). Some of these (effects of contrast agents and catheters) are also inherent in the videodensitometric method, whereas other sources of error (assumptions regarding geometric shape, distortion in imaging system, difficulties in tracing borders of the left ventricle) are eliminated when videodensitometry is used. Sources of error in the videodensitometric determination have been discussed previously (2). Adequate mixing of contrast agent and blood is of course essential. Comparative biplane examinations with injections both into the left atrium and into the left ventricle seem to indicate that with the injection technique used adequate mixing does occur almost invariably. If, for some reason, adequate mixing does not occur, this is usually apparent on visual inspection of the videotape recording of the injection, and the videodensitometric curve will also have a clearly abnormal pattern. The interval of 15 min between the two determinations was chosen to allow any effect of the contrast agent on the heart or the circulation to wear off. The return of the heart rate and pressures to their original levels indicates that this did in fact occur and that the circulatory status of the patients was the same for the two determinations. The videodensitometric method for determining the left ventricular ejection fraction was well correlated to the angiocardiographic technique. On theoretical grounds the values obtained by the densitometric method should be closer to the "true" ejection fraction than those obtained angiocardiographically. The former appears to be a rapid, simple and clinically useful method for determining the left ventricular ejection fraction, offering certain advantages over the routinely applied angiocardiographic method.

ACKNOWLEDGEMENT

This work was supported in part by USPHS grants GM 18674 and HL 11668.

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Received June 12, 1977

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