Dynamic geometry of the left ventricle in hypertrophy studied by quantitative angiocardiography

Quantitative angioskadiographische Studien über die dynamische Geometrie des hypertrophierten linken Ventrikels

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With 3 figures and 1 table

Summary

An automated videoangiographic system has been developed and used for the study of dynamic internal left ventricular geometry, in 53 patients (12 normals, 20 patients with different degrees of left ventricular [LV] pressure, and 8 with LV volume overload; 9 patients had different types of cardiomyopathy and 4 atypical or failing LV). From the measurements of ejection phase parameters of contraction, the degree of endsystolic and enddiastolic eccentricity of the LV, the ejection fraction, and the circumferential fiber shortening or shortening velocities it has been shown that there are no signs of impaired left ventricular function in mild and moderate left ventricular hypertrophy due to pressure or volume overload.

The contraction and relaxation phases of the beating left ventricle can be studied in vivo by angiographic techniques. Automated video-metric systems facilitate the otherwise time-consuming work required for dimensional analysis of the heart. Nevertheless, comparably simple diameter measurements may also detect specific patterns of contraction and relaxation under varying conditions.

The main questions to be dealt with in this article were:

1. Are there detectable, objective differences with respect to the dynamic internal geometry of the left ventricle in different types of left ventricular overload, and in particular
2. are there characteristic changes in left ventricular shape from systole to diastole if some eccentricity parameters such as the relation of the longitudinal to the transverse diameters, circumferences or the respective extents of shortening or shortening velocities are considered?

Methods

Hardware-Software System (3-6, 8, 9):

Biplane videoangiographic diagrams are taken at a rate of 50 frames per second and stored side by side on one magnetic tape or disc recorder. During stop action replay the contrast-filled ventricles are outlined manually by an experi-
enced investigator sitting in front of a television screen. The contours drawn are automatically superimposed onto the original angiocardiogram for control and correction. Additional points, marking the LV wall thickness or other anatomical landmarks, as well as physiological reference tracings (ecg, pressure etc.) can be read into a digital computer together with the corresponding heart border coordinates in real time (3, 4). From the ventricular contours, chamber volumes can be calculated according to the multiple slices or area-length method (1), respectively.

The two ventricular silhouettes can be handled separately or in combination for various kinds of dimensional measurements (5, 6, 8). For dimensional analysis of the left ventricle elliptical cross sections are assumed, combining the biplane (ap. and lateral) videoline information. The computer generates three-dimensional models of the left ventricle, which can be sliced in any desired number and direction of parallel planes, cutting the original model into a series of non-elliptical circumferences (5, 6). For standardization purposes (between patients), the slices are normally chosen perpendicular to the long axis of the LV or to a line connecting the center of gravity of the LV with the center of the valvular planes or the apex.

The discrimination of normal from abnormal dynamic geometry of the left ventricular inner surface - with respect to a chosen reference system - is possible by different approaches:

Fig. 1. Right: Three-dimensional representation of the left ventricle derived from biplane angiograms together with the a.p. and lateral projections in the endsystolic (above) and enddiastolic (below) phases. Computer-generated cross sections perpendicular to the long axis can be seen on the surface of the models. Left: Circumferential fiber shortening velocities of eight circumferences of such ventricular slices are depicted as velocity-time plots with the spatial coordinates from apex to base given in the third dimension. In this case of hypertrophic cardiomyopathy, the extreme transversal shortening compared with the longitudinal shortening is obvious from the endsystolic and enddiastolic left ventricles demonstrated on the right.