Mitral Valve Prolapse
Evolution and Refinement of Diagnostic Techniques

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Because the term "mitral valve prolapse" connotes an abnormality of the mitral apparatus, echocardiographic diagnostic criteria should strive to be specific. The work of Levine et al in this issue of Circulation represents a significant step forward in providing additional specificity. The authors' work is the most recent important contribution in the evolution and refinement of diagnostic techniques that began when Barlow's angiographic observations provided the first rational basis for the origin of apical late systolic murmurs. Intracardiac phonocardiography subsequently recorded the clicks and late systolic murmur within the left atrium, a site appropriate for auscultatory events originating in the mitral apparatus. The advent of echocardiography catalyzed an explosion of interest, and a veritable epidemic of mitral valve prolapse ensued. M-mode records supplied a noninvasive method for detecting systolic mitral leaflet movement toward the left atrium, and two-dimensionally targeted M-mode echocardiography is still advocated. When twodimensional real-time imaging appeared upon the scene, the technique was heralded as ideally equipped to record the range of motion of the mitral leaflets relative to the annulus, and Doppler color flow interrogation soon furnished a sensitive means for detecting the presence and degree of mitral regurgitation. It rapidly became an article of faith that the diagnosis of mitral valve prolapse was established if the leaflets ascended above the plane of the annulus on two-dimensional imaging. This assumption has been called into question on at least two counts, first, by the disturbingly high frequency of the diagnosis of mitral prolapse in otherwise normal general populations, and second, by the observation that mitral leaflets could appear to be above the annulus in one projection (implying mitral valve prolapse) but below the annulus in another projection (implying normality).

If "prolapse" is defined as displacement of an organ or part of an organ from its normal position through an opening or into a cavity, then "mitral prolapse" so designated is an abnormality. The first necessity was to recognize a long suspected matter of fact—that superior systolic movement of the mitral leaflets is not necessarily abnormal. As Levine et al reemphasize, the mitral annular circumference decreases in systole, whereas the leaflet lengths remain unchanged. Accommodation of a constant leaflet length and area within a smaller annular circumference sets the stage for normal superior systolic movement of the leaflets.

All of the above echocardiographic criteria for the diagnosis of mitral valve prolapse have one thing in common—use of the mitral annulus as the spatial reference against which superior systolic displacement of the mitral leaflets is judged. Accordingly, the configuration of the annulus becomes pivotal. Levine et al initially argued that if the mitral annulus were planar, its relation to the leaflets would be equivalent in different two-dimensional cross sections. These studies relied upon an in vitro model that supported the notion of a nonplanar annulus—a hyperbolic paraboloid or "saddle-shaped" configuration—that may allow a mitral leaflet that is actually on the left ventricular side of the annulus to appear in a two-dimensional image to be within the left atrium. The present study of Levine et al tests this hypothesis in vivo with a technique of three-dimensional reconstruction of the complex geometry of the mitral apparatus and with simultaneous and continuous real-time acquisition of echocardiographic images and their locations in space. The technique is believed to be capable of reconstructing three-dimensional structures with a precision in the millimeter range. The authors argue convincingly that their three-dimensional reconstructions provide the most accurate available means of displaying the spatial relations between the mitral leaflets and the annulus. Assuming the validity of these claims, the range of normal leaflet-annular relations with this method remains to be determined. "Whether and at what point leaflet displacement uniquely describes a patho-

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logic process should not be accepted without first defining on real-time echocardiography the pattern of normal mitral leaflet motion. Gradations from normal to abnormal must be established, not assumed.'"14 This same caveat, originally applied to two-dimensional echocardiography, now applies to the three-dimensional technique. Levine et al. assert, "This three-dimensional technique should enhance our ability to ask appropriate clinical questions and develop new criteria that better associate mitral valve shape with clinical and pathologic consequences." In so stating, the authors recognize that their technique involves time-consuming computations, but they voice the hope that methodologic refinements will make the method more readily accessible to clinical laboratories. Whether or not this hope is realized, the innovative investigative methodology developed by Levine et al. promises to play an important role in refining two-dimensional echocardiographic criteria for distinguishing mitral valve prolapse as an abnormality of the mitral apparatus from normal superior systolic displacement of mitral leaflets.

References
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