LETTERS TO THE EDITOR

Comments on "The Ventricular Pressure-Volume Diagram Revisited"

Dr. Sagawa's review in the November issue has promoted and deepened our understanding of pressure-volume diagrams. The value of $E_{max}$ as the index for the contractile state has been almost established. Usually $E_{max}$ is taken for end-systolic pressure-volume ratio. Now it seems to me increasingly necessary to clarify more accurately how and where (both in time and dimension domains) the pressure-volume loops touch the active pressure-volume lines. In the textbooks, both of physiology and cardiology, end of systole is defined as the closure of semilunar valves, that is, end of ejection period. The term "end-systolic pressure-volume ratio" might cause misunderstandings, especially in clinical studies. It is rather easy and precise to determine the point of the smallest volume, and the error in the result would be small because of minimal distance between end-ejection and true touching point in dimension domain. But this way of thinking might make researchers concentrate on the point of end-ejection rather than try to identify the active pressure-volume lines. Thus they pay less attention to $V_e$ intercept on the volume axis. Furthermore, they feel confused in the case of mitral insufficiency, in which the smallest ventricular volume occurs in the relaxation phase. By the extrapolation from isovolumic contraction studies it is rather reasonable to suppose that the loops touch the active pressure-volume lines at the point of the shortest contractile element, or where shortening velocity of contractile element ($V_s$) is zero, not the point of the shortest muscular fiber. If this supposition is right, the index becomes based on muscle mechanics. If we introduce the term "end-contraction," $E_{max}$ could be defined as pressure-volume ratio at end-contraction. Though this term may sound peculiar and might make clinical workers hesitate in application, this is far more correct and free of misunderstandings. Conversely, the identification of active pressure-volume line could be utilized for the determination of end of contraction, which might contribute to the further progress of studies about ventricular contraction and relaxation.

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References


Reply to the Preceding Letter

This is the second letter that Dr. Iizuka has written with respect to the absence of an appropriate term for the instant of time at which the active contractile process of the ventricle comes to the peak (or end). The first letter (Iizuka, 1978) was written in reference to a paper by Dr. Grossman et al. (1977). The moment of maximally developed ventricular contraction does not necessarily agree with the end of its ejection phase because the latter depends greatly on the afterload. Since both instants of time are referred to as end-systole, Dr. Iizuka is concerned about the confusion which will result if the pressure-volume relation measured at the end-ejection time in abnormal hearts is identified as the end-systolic pressure-volume relationship that I have just reviewed. This concern is quite reasonable and valid even for the normal right ventricular ejection which can go on frequently beyond the end of active contractile process (Maughan et al., 1979). In an attempt to clarify the distinction, Dr. Suga (1979) recently wrote a letter to the editor in which a figure clearly illustrates the difference between the end-ejection and the end-systole in our terminology. Also in a recent paper (Suga et al., 1979) we explained exactly what we mean by end-systole.

It is indeed surprising that no appropriate term has ever been coined which represents the peak of active contractile process in the ventricle [and in muscle for that matter (Remington, 1962)] independently of the mode of contraction. As such, Dr. Iizuka proposes to use "end-contraction". I hesitate to follow the suggestion because the term contraction primarily means shrinking in size or shortening just as systole does. By convention, contraction has been used to cover isometric or isovolumic contraction. But so does the term systole because text books of physiology define systole as inclusive of isovolumic contraction phase. For the moment, I would stick to the use of end-systole to represent the moment of maximal ventricular contraction. At the same time, I would ask the muscle and cardiac physiologist to think of a new generic term to replace end-systole.

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