dP/dt and Isovolumic Pressure Decline

I read with great interest the thoughtful article by Paulus et al.\(^1\) I take issue, however, with their use of dP/dt (20/60) as an index of nonexponentiality of isovolumic pressure decline, as suggested by Kumada et al.\(^2\) For a pure monoeponential pressure decline,\(^3\)

\[
P = P_0 e^{-t/T} + P_B
\]

\[
dP/dt = -1/T [P_0 e^{-t/T}]
\]

Thus

\[
dP/dt (20/60) = e^{-(20/60)} T\]

\[
e^{-(20/60)} T \approx 0.837 T
\]

dP/dt (20/60) is greater for smaller values of T. Thus, it is affected by T itself independent of nonexponentiality of pressure decline.

Inspection of the data of Paulus et al.\(^4\) shows that this inverse relation holds true for all T and dP/dt (20/60). The group mean values of their four measurements of T were 47, 53, 42, and 73 msec. For exponential pressure decline, the corresponding values for dP/dt (20/60) predicted by the last equation above are 2.4, 2.1, 2.6, and 1.7, respectively. The actual values of dP/dt (20/60) reported by the authors are 2.8, 2.8, 2.7, and 1.7. Because the fall in dP/dt (20/60) to 1.7 on nitroprusside after balloon aortic valvuloplasty could be predicted from the associated increase in T to 73 msec itself, the conclusion that it demonstrates nonexponentiality of isovolumic pressure decline is not justified.

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References


Reply

Inversion of the negative dP/dt upstroke pattern from convex upward to convex downward was first reported by Kumada et al\(^1\) during the initial stages of brief coronary occlusion. Such inversion implies a deviation of isovolumic left ventricular (LV) pressure decline from a monoeponential decay.\(^1\) The same investigators subsequently reported this phenomenon in patients with coronary artery disease and proposed the dP/dt (20/60) ratio as an index for the morphology of the negative dP/dt upstroke pattern.\(^2\) In their study, a deviation from a monoeponential decay was accompanied by a lower dP/dt (20/60) ratio.

Dr. Fifer points out nicely that for a monoeponential decay, the dP/dt (20/60) ratio is also affected by a prolongation of T and therefore provides no unique measure of the morphology of the negative dP/dt upstroke pattern. Assessment of the morphology of the negative dP/dt upstroke pattern should consist of a comparison between the measured value of the dP/dt (20/60) ratio and the value predicted by the corresponding T assuming a monoeponential pressure decline (=e\(^{-t/T}\)). When the measured value is significantly different from the predicted one, the conclusion of deviation from a monoeponential pressure decline seems justified.

After sequential balloon aortic valvuloplasty with arterial vasodilation,\(^3\) a significant prolongation of T was observed for the entire study group, but a bimodal negative dP/dt waveform and a convex downward negative dP/dt upstroke pattern was observed in only 10 of the 14 patients. As shown by Dr. Fifer, the mean dP/dt (20/60) ratio for the entire study group was equal to the predicted one (1.7), but 11 of the 14 individual dP/dt (20/60) ratios were lower than their predicted counterparts. For these patients, in whom a convex downward negative dP/dt upstroke pattern was observed after sequential balloon aortic valvuloplasty-arterial vasodilation, the mean measured dP/dt (20/60) ratio (1.5±0.4) was significantly lower than the mean predicted dP/dt (20/60) ratio (1.7±0.2; p<0.05). Hence, comparison of measured dP/dt (20/60) ratio to predicted dP/dt (20/60) ratio failed to show a significant deviation from monoeponential LV pressure decay for the entire study group but revealed a significant change in the patient subgroup, in whom an actual inversion of the negative dP/dt upstroke pattern had occurred after sequential balloon aortic valvuloplasty-arterial vasodilation.

We agree with Dr. Fifer that the dP/dt (20/60) ratio is affected not only by the morphology of the negative dP/dt upstroke pattern but also by T itself. This dependence on T should be accounted for in future studies by comparing actually measured dP/dt (20/60) ratios to dP/dt (20/60) ratios predicted from corresponding T values and the e\(^{-t/T}\) formula. Moreover, deviation from a monoeponential LV pressure decay should be deduced not only from a dP/dt (20/60) ratio but also from a phase-plane plot\(^4\) of LV pressure decay (dP/dt versus P plot; Figure 4 in Reference 3). Such phase-plane plots offer the advantage of comparing isovolumic relaxation rates at similar isovolumic relaxation pressures irrespective of the presence or absence of a monoeponential LV pressure decay.

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*Circulation*. 1990;82:1077
doi: 10.1161/01.CIR.82.3.1077

*Circulation* is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 1990 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/82/3/1077.citation

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