Atrial Rhythm in Ventricular Tachycardia 
Occurring During Cardiac Catheterization

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SUMMARY
The atrial rhythm was studied in 38 patients during runs of tachycardia of five or more beats in sequence which occurred during cardiac catheterization and whose ventricular site of origin could be established with considerable confidence. Simultaneous esophageal and other leads were recorded. The most frequent mechanism was retrograde conduction to the atria with varying degrees of V-A (ventriculo-atrial) block which occurred in 26 of the 38 patients. Runs of ventricular tachycardia with one-to-one V-A conduction occurred in 13 patients. Runs with an independent atrial rhythm (A-V dissociation) occurred in nine patients. Varying atrial mechanisms during different runs of tachycardia occurred in 11 patients. The minimum QRS-to-retrograde P intervals in 24 of 35 patients with V-A conduction were within 0.03 sec of P-R interval. The briefest QRS-to-retrograde P interval observed was 0.09 sec. Reciprocal beats occurred in eight of 35 patients with V-A conduction.

AN independent atrial rhythm (A-V dissociation) is often considered characteristic or diagnostic during ventricular tachycardia.\textsuperscript{1-4} Evidence, however, has been presented that retrograde conduction to the atria occurs frequently.\textsuperscript{5} Since an unequivocal diagnosis of ventricular tachycardia is difficult, if not impossible, in the usual clinical situation,\textsuperscript{6,7} the problem was studied further during diagnostic cardiac catheterization under conditions which establish the ventricular origin of spontaneous, catheter-induced tachycardia with reasonable assurance. The observations confirm the frequent occurrence of retrograde conduction to the atria.

Methods
Runs of ventricular tachycardia (five or more beats in sequence) occurring during catheterization of the right and left ventricles were studied. The position of the catheter tip during the tachycardia was verified in every run by the pressure recorded through the catheter and often by fluoroscopic observation. The configuration of the ectopic beats conformed with that expected from premature ventricular beats originating within the ventricle under observation. A large, wide S or QS in lead V\textsubscript{1} or a Z vector lead was observed with ectopic beats originating from the right ventricle (figs. 1 and 2) and a large, wide, usually notched R or an RSR' or QR in V\textsubscript{1} was observed with left ventricular ectopic beats (fig. 3). In two cases, ectopic beats which did not conform with this pattern occurred when the catheter was in the left ventricle and were excluded from the study.

Bipolar esophageal leads\textsuperscript{5} were recorded simultaneously with Frank vector leads\textsuperscript{8} or with leads II and V\textsubscript{1}. The electrodes of the bipolar lead were German silver rings, 3 mm wide, mounted 2 cm apart on a soft rubber tube, 5 mm in diameter. Multiple peripheral leads were recorded simultaneously with one or more esophageal leads in an attempt to reduce the error of measurement of the QRS-to-retrograde P interval; the onset of activation may be recorded better in some leads than in others.\textsuperscript{9} Some of the records were obtained with an Electronics for Medicine DR-8 photographic recorder. Others

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Work supported in part by Grants HE-07578-03 and HE-07578-04 from the U. S. Public Health Service.
Figure 1
Simultaneous vector leads and a bipolar esophageal lead, 42 cm from the nares. Ventricular tachycardia produced by a catheter in the right ventricle. Retrograde conduction to the atria (P') with some V-A block; 13 of the 19 ventricular beats are followed by V-A conduction. At the end of the run there is a ventricular reciprocal beat (R). The retrograde P wave preceding this beat is visible not only in the esophageal lead but also as a small inverted deflection in the Y lead.

Figure 2
Simultaneous leads II, V1, and a bipolar esophageal lead. Ventricular tachycardia produced by a catheter in the right ventricle. During the first beat of the run there is interference with the sinus beat (P). After that every ventricular beat is followed by retrograde conduction to the atria (P'). The average rate of the tachycardia is about 165 per minute.
Simultaneous leads II, V₁, and a bipolar esophageal lead. Ventricular tachycardia produced by a catheter in the left ventricle. Retrograde conduction to the atria (P') with some V-A block; 5 of the 7 ventricular beats are followed by V-A conduction.

Observations

Ventricular tachycardia was studied during cardiac catheterization in 38 patients, 36 with normal A-V conduction and two with P-R intervals of 0.22 sec. In 18 of the patients cardiac catheterization was done for evaluation of pulmonary hypertension in pulmonary disease (Beckley group); these patients had little or no clinical evidence of heart disease. In 20 of the patients, the cardiac catheterization was for evaluation of significant heart disease (D. C. General Hospital group). Right ventricular tachycardia alone occurred in 28 patients, left ventricular tachycardia alone in five, and both right and left ventricular tachycardia in five. The most frequent mechanism was retrograde conduction to the atria with varying degrees of ventriculo-atrial (V-A) block (figs. 1 and 3) which occurred in 26 patients. In 13 patients there were runs of 5 to 23 beats, every one of which was followed by V-A conduction (fig. 2). In nine patients there were runs during which none of the ventricular impulses were conducted retrograde, and persistent A-V dissociation prevailed during ventricular tachycardia. In 11 patients atrial mechanisms varied during different runs.
of ventricular tachycardia. The incidences of the various atrial mechanisms were about the same with both right ventricular and left ventricular tachycardia, but the value of this observation is limited by the small number of cases of left ventricular tachycardia.

Whether or not retrograde conduction occurred seemed to depend sometimes on a fortuitous timing relation of the tachycardia to the sinus rhythm and sometimes on the rate of the tachycardia. It seemed clear in some runs where some beats were followed by V-A conduction and some were not, that the latter occurred at shorter intervals after preceding beats and presumably encountered refractoriness of the conducting tissues (fig. 4). In 27 patients it was possible to measure the intervals (R-R) between two successive beats both of which were followed by V-A conduction. Intervals of 0.40 sec or less were observed in all but two of the patients, of 0.30 sec or less in 12 patients, of 0.22 sec in one, and of 0.18 sec in one. Examples of runs of ventricular tachycardia at the fastest rates with one-to-one V-A conduction are: 5 beats at an average rate of 204 per minute; 10 beats, 189; 19 beats, 186; 12 beats, 180; 5 beats, 169; 11 beats, 165; 22 beats, 162; and 11 beats, 162.

In 35 patients with V-A conduction the QRS-to-retrograde P intervals were measured from the earliest deflection of QRS in any of the simultaneous leads to the earliest deflection of the retrograde P wave and compared with P-R (fig. 5). The minimum QRS-to-retrograde P interval in 24 of the 35 patients was within 0.03 sec of the P-R. Some long QRS-to-retrograde P intervals were observed as would be expected after ectopic beats occurring early in the cycle and during partial refractoriness of the conducting tissues. The briefest QRS-to-retrograde P interval observed was 0.09 sec. Beats consistent with the interpretation of reciprocal rhythm11 (fig. 1) in association with V-A conduction were observed in eight of the 35 patients.

Figure 4
Simultaneous vector leads and a bipolar esophageal lead, 39 cm from the nares. During the first 5 beats of ventricular tachycardia at a rapid rate there is retrograde conduction to the atria (P) three times. After that at a slower rate every ventricular beat is followed by retrograde conduction. The ninth and fourteenth beats of the tachycardia occur relatively early after the preceding beats, and the following V-A conduction times are prolonged.
Relation of the minimum QRS-to-retrograde P interval (R-P') of ventricular ectopic beats to P-R in each case. In 24 of the 35 cases R-P' is within 0.03 sec of P-R (enclosed by the diagonal lines).

References


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Circulation. 1967;35:10-14
doi: 10.1161/01.CIR.35.1.10
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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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:
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