Atrial Vectorcardiogram in Left Atrial Rhythm

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The atrial vectorcardiograms of two cases of left atrial rhythm are described. The essential vectorcardiographic features of the usual type of this ectopic rhythm, with its variations, are discussed. The probable sites of origin of these variations are considered. It is suggested that the atrial vectorcardiogram amplified to the greatest possible magnification is the best and most direct means of demonstrating the direction of atrial activation.

The problem of left atrial rhythm has attracted increasing attention over the past 15 years. Interest, however, has been directed mainly to the electrocardiographic diagnosis of the ectopic rhythm. Vectorial analysis of the P waves of clinical electrocardiograms have been described, but direct vectorcardiographic studies of the P loop in this rhythm have not been reported. This paper describes the atrial vectorcardiogram in two cases which meet the proposed electrocardiographic criteria of left atrial rhythm and considers the possible sites of the ectopic pacemaker.

**Recording Methods**

A twelve-lead electrocardiogram was obtained with a Cambridge Versa-scribe III, direct writing electrocardiograph. Vectorcardiograms were recorded using the Frank system of electrode placement. Horizontal, right sagittal and frontal planes were photographed from the storage screen of the oscilloscope. To produce optimum amplification of the P loop, the machine was standardized so that 1 cm of deflection was equivalent to 0.05 mv. However, the recording sensitivities used varied when magnification interfered with clarity of the loop. The vectorcardiographic loops were interrupted 400 times per second, each dash representing 2.5 msec. The pointed end of the tear drop was the leading edge of the direction of inscription.

**CASE 1**

A 34-year old woman was admitted to the hospital with bilateral thrombophlebitis, chest pain and dyspnea. Routine chest film, serial serum bilirubin, serum glutamic oxaloacetic transaminase (SGOT) determinations and two lung scans were normal. Serial electrocardiograms showed inverted P waves in Leads 1-2-3-aVF and V4 to V6 without "dome and dart" P waves in V1 and a PR interval of 0.14 second (Fig 1). The patient was treated with vascular packs and anticoagulation and recovery was unevenful. The electrocardiogram reverted to sinus rhythm after the eighth hospital day. Subsequent tracings over a two-year period have shown intermittent left atrial rhythm.

**Atrial Vectorcardiogram (Fig 1)**

Horizontal Plane: The P loop is a predominantly rightward figure-of-eight loop with the initial portion CCW to the right and anterior and the terminal portion CW and directly posterior.

Right Sagittal: The P loop is an open figure-of-eight predominantly anterior and superior, with the terminal segment inferior and posterior.

Frontal Plane: The P loop is a narrow, open figure-of-eight, mainly rightward and superior with a terminal portion extending inferiorly from right to left.

**CASE 2**

A 74-year old man was admitted with an obstructing rectal carcinoma requiring an emergency colostomy. There was no past history of cardiac disease. Cardiac examination and chest x-ray were normal. Several electrocardiograms over a period of three weeks showed inverted P waves in Leads 1-2-3-aVF and V4 to V6 without "dome and dart" P waves in V1 and a PR interval of 0.14 second (Fig 2). There were no cardiac complications following sigmoid colostomy.

**Atrial Vectorcardiogram (Fig 2)**

Horizontal Plane: The entirely rightward P loop is a figure-of-eight, initially inscribed anterior and CCW and terminally posterior and CW.

Right Sagittal: The P loop is open and CW, predominantly superior and anterior with a small terminal inferior segment projecting anteroposteriorly.

Frontal Plane: The P loop is narrow, CW and directed mainly to the right and superiorly with a small terminal inferior and leftward segment.

**DISCUSSION**

An understanding of the depolarization pathway in left atrial rhythm involves a consideration of...
both anatomic and physiologic factors. The true spatial relationship of the atria is not always fully appreciated and it is worth reemphasizing that the left atrium is as much posterior as it is to the left of the right atrium. In addition, available evidence in animals indicates that atrial ectopic foci are always located in specialized fibers, rather than in myocardial muscle cells. When such fibers are present in the left atrium, they are usually found posteriorly in the atrial tissues surrounding the entry of the pulmonary veins. It is interesting that in both cases presented in this report and in 16 of 18 cases reported previously, the ectopic focus was located inferiorly, for the maximum P vector was directed superiorly. It seems probable, therefore, that left atrial ectopic foci are more likely to originate in the region of the inferior than of the superior pulmonary veins. Because of the anteroposterior relationship of the atria, as well as the more frequent site of ectopic impulse formation within the posterior left atrial wall, the depolarization pathway in left atrial rhythm usually projects initially anteriorly.

Electrophysiologically, left atrial rhythm causes a reversal of the normal order of atrial depolarization, the left atrium being depolarized before the right. This unusual sequence of activation causes either an entire or an initial rightward inscription of the P loop which we consider to be the essential vectorcardiographic feature of this rhythm. In addition the terminal portion of the P loop showed a reversal of inscription to clockwise in the horizontal plane. In our cases this criterion was satisfied, since the initial portion of the P loop projected rightward in case 1.
and the entire P loop remained rightward in case 2. Commonly, but of lesser importance, is additional superior direction of the loop. There was also initial anterior and superior orientation of the P loop in both cases. This is in contradistinction to the normal spatial loop which is leftward, inferior and slightly posterior.

From the above anatomic and electrophysiologic considerations it would be expected that most ectopic pacemaker impulses arising in the left atrium would project a P loop inscribed either entirely or initially rightward and usually initially anterior. Spatially, some variations in this pathway may occur, depending on the exact site of impulse formation within the left atrium. For example, an ectopic focus arising from the posterior, superior left atrial wall will project a P loop oriented to the right, anteriorly and inferiorly. Similarly, a more lateral impulse site would be expected to cause a greater degree of rightward deflection of the P loop and of the mean P vector, while a more medial site, near the interatrial septum, would cause only minimal rightward displacement. Thus, a more rightward mean P vector along the X axis in the vectorcardiogram and a greater degree of negativity of the P wave in lead V6 of the electrocardiogram can be correlated, in a general way, with a more lateral site of impulse formation within the left atrium.

Recognition of the variations possible in left atrial rhythm is of importance in differentiating this ectopic rhythm from nodal or coronary sinus rhythm, since retrograde activation with inverted P waves in
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leads II, III, and aVF may be present in all three rhythms. Vectorially left atrial rhythm projects the mean spatial P vector to the right, anterior and superior, while in nodal and coronary sinus rhythms it is left, posterior and superior.\textsuperscript{2,5,11} With impulse formation within the left atrium adjacent to the intra-atrial septum, the mean P vector may project either slightly to the right or left. Such directions may cause an overlapping of the vectors and ECG patterns of left atrial, nodal and coronary sinus rhythms in the frontal plane leads. However, these may be differentiated by the direction of the horizontal P vector, which in left atrial rhythm is directed initially anterior while in nodal and coronary sinus rhythm this vector is directed posteriorly. This is reflected in the precordial P wave pattern of the electrocardiogram which usually permits a ready differentiation of left atrial rhythm from nodal or coronary sinus rhythm.

At present, despite newly described techniques of study including closed chest stimulation of the left atrium by bipolar catheters with simultaneous surface, intracavitary and esophageal leads, there is neither common agreement, nor a final answer to the specific criteria necessary to establish a diagnosis of left atrial rhythm.\textsuperscript{2,5,11} Atrial vectorcardiography is a direct means of studying amplified atrial forces and is a more readily tolerated procedure than the above methods. The finding of an initially or entirely rightward P loop, in the absence of atrial inversion, would appear to be evidence for left atrial rhythm.

\textbf{REFERENCES}


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SLEEP VERSUS GENERAL ANESTHESIA

Sleep differs from anesthesia in that the sleeper still is his natural self. He turns and twists and snores and groans because he needs to do these things. But the patient under an anesthetic, the drunken man in his oblivion, the patient dangerously asphyxiated by carbon monoxide, all these have lost a part in the regulation of breathing. When a physician gives an anesthetic, he has more than apparently simple obligation of getting a patient through an operation; he must also think of every factor which will result in complete ventilation of all parts of the lungs. He must be like the man who found his lost mule just by going where he would have gone had he been the mule. A good anesthetist is a person who by knowledge or instinct is really breathing for his patient.


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