

# ELECTROCARDIOGRAPHIC STUDIES. II

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## Case 2. Complete Heart Block Showing the Chronotropic Effect of Ventricular Systole on Auricular Rhythm

This patient, a European male aged 75 years, became breathless on exertion 7 years before his hospital admission. At about the same time he had also started with pain in his chest which had all the characteristics of angina pectoris. These complaints had become progressively worse and for the past 10 months he was orthopnoeic and subject to attacks which had the nature of paroxysmal nocturnal dyspnoea. He had also developed congestive cardiac failure, for which he had been treated.

His present visit to this hospital was in connection with episodes of syncope which he had been experiencing over the past 5 months. These appeared suddenly, without warning, and occurred frequently. He lost consciousness for a very short period of time and on recovery was aware of a warm feeling and a red discoloration of his face. He had had no convulsions and there had been no injury or incontinence during any of these episodes. The remainder of his complaints were of a relatively minor nature.

### On Examination

The patient was much over-weight (weight 210 lb.) He was breathless on very mild exertion and orthopnoeic. There was evidence of congestive cardiac failure with raised jugular venous pressure, an enlarged liver and mild oedema of the ankles. Crepitations were heard at both lung bases.

The pulses were palpable in both upper and lower extremities. The rate was 34 per minute and the pulse was collapsing in nature. The blood pressure was 160/80 mm. Hg.

The heart itself appeared to be clinically enlarged and the enlargement had a left ventricular quality. No valvular lesions were discoverable and there were no other findings of importance.

On biochemical and microscopical examination the urine appeared normal. A full blood count was within normal limits. ESR 5 mm. in the first hour (Westergren).

X-ray of the chest showed generalized enlargement of the heart,

with unfolding of the aorta and mild pulmonary congestion with emphysema.

### ELECTROCARDIOGRAM

In the 12-lead ECG (Fig. 1) a right bundle-branch block pattern is evident. The cardiac rhythm as shown in a long strip from lead  $V_1$  (Fig. 2) is seen to be a complete heart block with an auricular rate of 60 beats per minute and an idioventricular rate of 34 beats per minute. The appearance of ventricular ectopic beats can also be observed.

The idioventricular rhythm is completely regular, with the exception of the ectopic beats. The auricular rate is seen to vary and the noteworthy feature is that the P-P interval which includes a QRS complex is shorter than the P-P interval which does not include a QRS complex; the shorter P-P intervals measure 0.92 seconds and the longer P-P intervals 1.02 seconds. The appearance in general gives the impression that the P waves tend to group themselves around the QRS complex, and results in a superficial resemblance to a 2 : 1 heart block.

### DISCUSSION

This patient is thought to have a degenerative heart condition with congestive cardiac failure and with complete auriculo-ventricular block and Stokes-Adams seizures.

The electrocardiogram confirms the presence of complete auriculo-ventricular block with a right bundle-branch block pattern. The main interest centres around the superficial resemblance to a 2 : 1 heart block on account of the grouping of P waves around QRS complexes, which results in a shorter P-P interval when this interval contains a QRS complex.

This tendency for auricular rhythm to be influenced by a ventricular systole is well known and the mechanism of its production has been extensively reviewed by Rosenbaum and

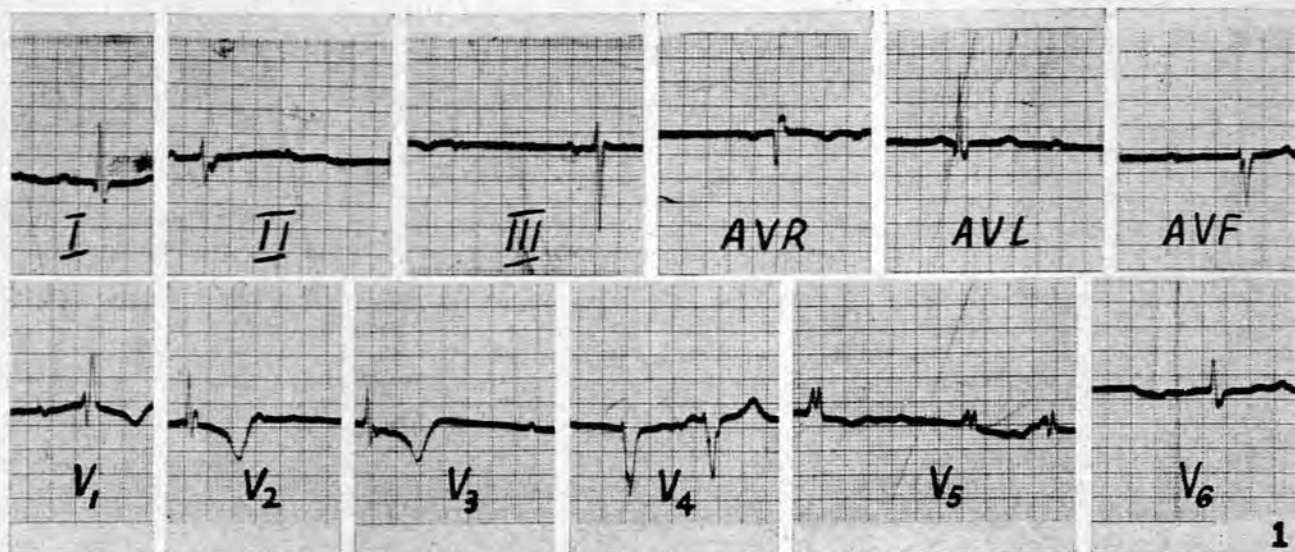


Fig. 1

Lepeschkin.<sup>1</sup> Each ventricular systole might have one of two distinct effects on the stimulus formation in the auricles. The first might be a positive chronotropic effect, which would tend to accelerate the stimulus formation and has a maximum influence on P waves appearing 0.3 - 0.4 of a second after the beginning of a ventricular QRS complex. This is thought to be due to one of a few possible mechanisms:

(a) The mechanical effect of ventricular systole, directly on the pacemaker of the sinus node, or through the effect on the sinus node of auricular pressure changes caused by ventricular systole.

(b) The direct effect of the electrical activity of the ventricles on the sinus node. Here the well-known electrical principle that two oscillating systems would tend to synchronize their rhythm is invoked to explain the tendency of idio-ventricular rhythm and the auricular rhythm to group themselves together.<sup>2</sup>

(c) Increased blood flow in the arteries of the sinus node during ventricular systole, resulting in a phasic blood supply to the pacemaker.

(d) Reflex changes have also been postulated.

The other possible effect of ventricular systole on the auricular rhythm is that of a late negative chronotropic effect which appears 0.6 - 1.0 second after the beginning of QRS and which would tend to delay the stimulus formation. This is very likely due to a reflex vagal stimulation caused by the arrival of a pulse wave at the arterial baro-receptor

areas, and may possibly be further influenced by an inhibition of the Bainbridge reflex by a decrease of the atrial pressure consequent on ventricular contraction.

In A-V block, P-P intervals containing a QRS complex are terminated by P waves which are usually affected by the positive chronotropic effect of the preceding ventricular systole, and are accordingly shorter than P-P intervals that do not contain QRS and are terminated by P waves appearing under the influence of negative chronotropic effects. This interaction tends to delay P waves which appear during the second half of diastole and to accelerate P-waves which appear during the first half of diastole. Consequently most P waves in complete auriculo-ventricular block, with pronounced chronotropic effects of ventricular systole, come either shortly before the QRS complex or soon after the T wave.

The chronotropic effect of ventricular systole on auricular rhythm in auriculo-ventricular block is present in less than half the reported instances of complete heart block. In 3.5% of the cases so reported a paradoxical effect is seen and P-P intervals containing QRS complexes may be longer than those not containing these complexes.

#### OPSOMMING

Die elektrokardiografiese beeld van volledige atrioventrikulêre blok en regter bondeltak-blok by 'n bejaarde pasiënt met ischemiese hartsiekte, word beskryf.

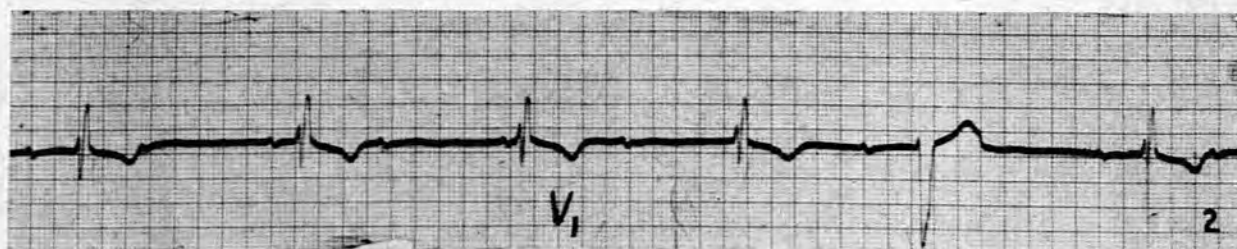


Fig. 2

Die invloed van ventrikulêre sistolië op die stimulusvorming van die sino-atriële node word gedemonstreer sodat 'n groepering van P-uitwykings om die QRS-uitwykings plaasvind. In die geheel is daar 'n oppervlakkige voorkoms van 'n 2 : 1 hartblok. Daar word ook kortliks verwys na die

meganismes waardeur ventrikulêre sistolië so 'n chronotropiese invloed op die atriële ritme uitoefen.

## REFERENCES

1. Rosenbaum, M. B. and Lipeschkin, E. (1955): *Circulation*, **11**, 240.
2. Grant, R. P., (1957): *Clinical Electrocardiography. The Spatial Vector Approach*. New York: McGraw-Hill.