

Electrocardiography

A 12-Lead EKG as a Routine Procedure

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A 12-Lead EKG as a Routine Procedure

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IN MOST OF THE current literature on electrocardiography, 12-lead electrocardiograms are presented routinely as part of the clinical investigation of patients suffering from cardiac disease. An exception to this generalization is in the instance of certain cases of arrhythmias in which this many leads is superfluous. However, in spite of this common practice in the larger centers¹ it is to be noted that the obsolete 4-lead electrocardiogram apparently is still in use as a routine study in some hospitals. It is the purpose of this paper to emphasize the need for routinely taking twelve leads in most clinical situations.

DEFINITION

By twelve leads is meant the bipolar extremity leads I, II and III, the unipolar extremity leads AVR, AVL and AVF, and the unipolar precordial electrode positions V, 1-6. By routine four leads is meant the bipolar leads I, II, III and IV (Cf4).

BACKGROUND

Pruitt¹ in his analysis of the value of the electrocardiogram in clinical problems came to certain conclusions which are worth quoting verbatim: "It is the concept of a precordial lead as a means of exploring the anterior surface of the heart which is of importance. Whether this exploration is accomplished by V leads or by CR, CL or CF leads is of far less significance than that the exploration be adequate. Conceptions of adequacy vary, but minimal requirements would appear to include leads from three points on the precordium, one of which should be to the right and one to the left of the transition zone. The unipolar extremity leads find their major usefulness in the development of concepts basic in an understanding of electrocardiography."

Levine and Phillips² in correlating the 12-lead electrocardiogram with autopsy findings in 150 consecutive cases observed the following:

1. When the electrocardiogram pointed to the diagnosis of acute myocardial infarction, the interpretation was invariably correct. However, 25 per cent of all infarcts at autopsy had been missed on the electrocardiogram.

2. However, no case of acute or old myocardial infarction showed a normal series of electrocardiograms.

3. The electrocardiographic diagnosis of left ventricular hypertrophy was invariably substantiated at autopsy.

4. The electrocardiographic diagnosis of right ventricular hypertrophy was substantiated in all eight cases.

5. The diagnosis of acute cor pulmonale was confirmed in seven of eight patients in whom it was made by electrocardiogram.

The authors warn, however, that, since the electrocardiogram represents the composite effect of a number of factors operating simultaneously, the effect of certain changes may be obscured in the resulting tracing and thus escape detection. "Accordingly, restraint, caution, humility and sound judgment are still vital in its evaluation."

Rosenbaum³ also cautions the clinician to be wary of overreading any electrocardiogram, regardless of the number of leads. He states, "The electrocardiogram is in its proper place in cardiac diagnosis when it is correlated with all of the other clinical and laboratory information which can be obtained in that particular patient."

Dawber et al.,⁴ in a study of 2,000 patients, found that the 12-lead electrocardiogram correctly classified 89.3 per cent of the clinically normal persons as normal, but correctly classified as normal 64.1 per cent of the persons judged by clinical examinations to have possible heart disease. This is understandable, nevertheless, in view of the fact that this series included cases of hypertensive cardiovascular disease and rheumatic heart disease. It is well known that many of these cases and also many patients with coronary atherosclerosis will have normal electrocardiograms.

An especially important reason for using the 12-lead electrocardiogram in clinical problems is that without this many leads, or at least most of them, the analysis and interpretation of the recording is not possible by spatial vector methods.^{5, 6, 7} There are many instances in which the interpretation becomes obvious after the QRS and T vectors have been plotted and the angle between the two determined, whereas the "pattern" method of diagnosis previously emphasized by Goldberger^{8, 9} has often led electrocardiographers astray. This is true simply because few physicians are expert enough to memorize all of the possible patterns which may be produced by all of the possible spatial relationships between the vectors. The 12-lead electrocardiogram also eliminates in most instances the uncertainty that usually arises as to whether a given bundle branch block is right or left.

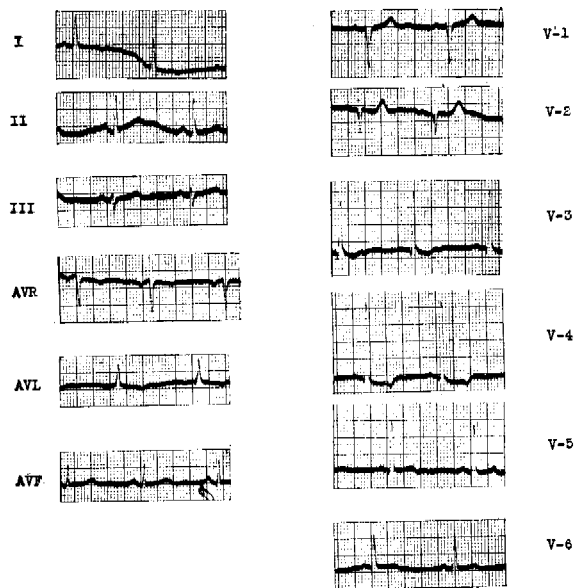
The following cases are described in some detail to illustrate the thesis of this paper, that a routine 12-lead electrocardiogram is of value in many clinical problems.

CASE REPORTS

Case 1. E. T., a 46 year old carpenter, while climb-

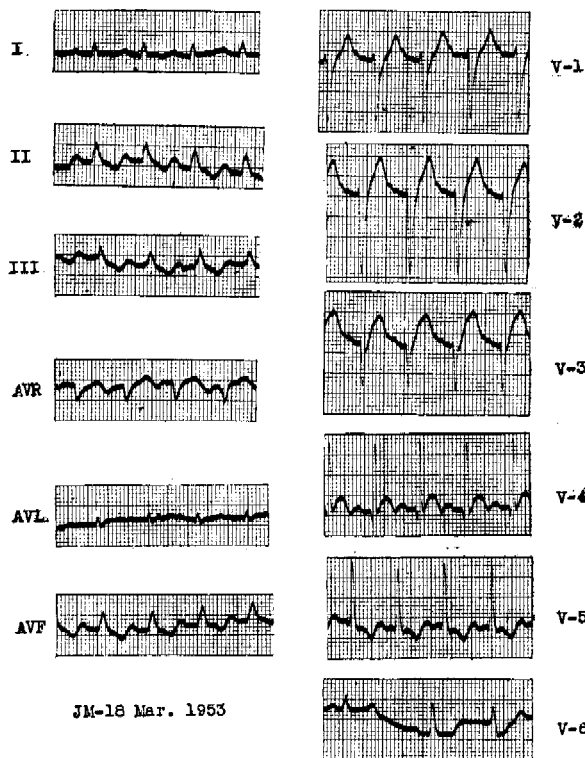
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ing a ladder, developed crushing precordial pain radiating down the left arm, associated with dyspnea and weakness. The pain disappeared after one hour.



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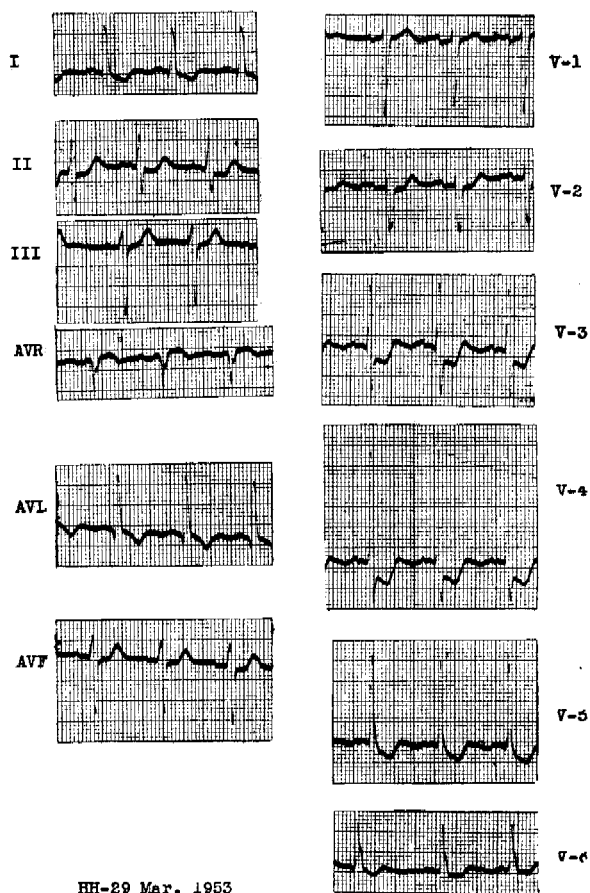
Fig. 1. (Case 1, E. T.) QRS-T angle is about 75 degrees in the frontal plane. (Abnormal.) Note biphasic T in lead I and leads V-3, 4, 5, 6. R wave is absent in V-2 and Q wave is notched. Presumptive evidence is present indicating a small anterior myocardial infarction.



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Fig. 2. (Case 2, J. M.) Diminutive R waves in V-2, absent R wave in V-3, and elevated S-T segments in V-2, and V-3 indicate acute anterior infarction. Note leads I, II, III, and V-4. Abnormal tracings are present in these four leads but diagnosis of infarction cannot be made.

He continued his activities but had several recurrences of precordial pain. When seen the next morning, because of a recurrence of chest pain upon arising from bed, the patient appeared anxious but, otherwise, physical findings were not remarkable. The pulse was 78 and regular and the blood pressure was 130/80. An electrocardiogram taken in the home (fig. 1) revealed evidence of an anterior infarct and the patient accordingly was hospitalized. He was treated with anticoagulants and bed rest and the usual supportive measures. During the first two weeks



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Fig. 3. (Case 3, H. H.) Depressed S-T segments in leads I, V-3, V-4 and V-5. Note that there are no diagnostic signs of infarction.

of treatment, he developed frequent ventricular premature systoles and occasional runs of ventricular tachycardia. This complication was managed successfully by administration of Pronestyl. Two months after his initial attack, the patient was working and asymptomatic.

Comment: This case is presented to demonstrate the fact that a patient can have a typical clinical episode of myocardial infarction which produces presumptive changes in only one precordial lead. In this instance, a widened QRS-T angle is present, suggesting coronary artery disease, and the absent R wave in V-2 with notching of the Q wave suggests a small dead zone. Without lead V-2, even the presumptive diagnosis of infarction cannot be made.

Case 2. J. M., a 70 year old farmer, had three

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episodes of precordial pain during the two weeks prior to his initial examination. When first seen, he had been experiencing severe precordial pain for the previous twelve hours, associated with pallor, sweating, nausea and vomiting. Examination revealed a seriously ill, aged man in shock. An electrocardiogram (fig. 2) revealed an acute anterior infarction. He was hospitalized and treated diligently with nor-epinephrine infusions, oxygen and other supportive measures. Serial electrocardiograms revealed the development of severe conduction disturbances. The patient died fifteen hours after admission. Autopsy revealed both an anterior and a posterior infarction. An adherent thrombus was found in the anterior

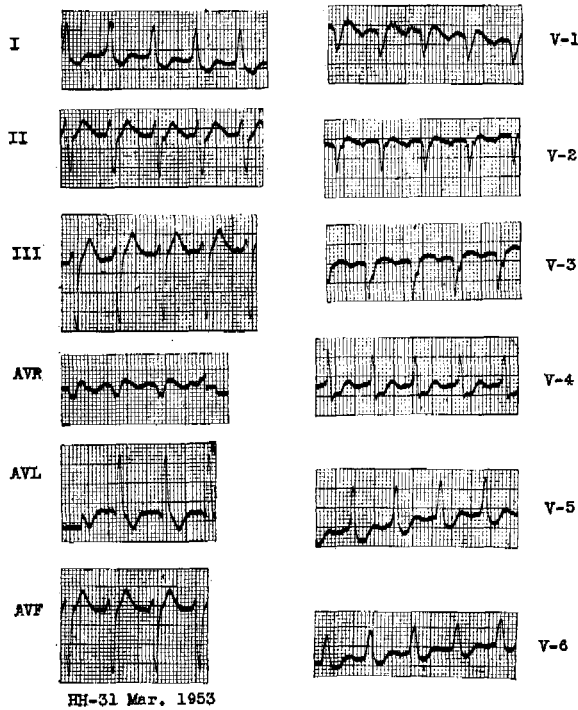


Fig. 4. (Case 3, H. H.) The repeat electrocardiogram the next day in this case was essentially the same as the first one except that the R wave in leads V-2 and V-3 are now absent, indicating infarction. Autopsy demonstrated an anterior myocardial infarct.

descending branch of the left coronary artery, and a more recent thrombus was demonstrated in the right coronary artery.

Comment: This case is described to demonstrate a proven anterior infarction which could not have been diagnosed by using only the leads I, II, III and V-4. It will be noted that the characteristic changes of infarction are found only in leads V-2 and V-3. In retrospect, it was decided that the posterior coronary occlusion occurred after hospitalization, causing the conduction disturbances (not shown). Thus, at the time the first electrocardiogram was taken (fig. 2), only an anterior infarct was present.

Case 3. H. H., an 85 year old farmer, was stricken with excruciating precordial pain while walking in his yard. When seen thirty minutes later, he was found to be in acute distress and writhing in pain. An electrocardiogram taken after the patient had become quieted with Demerol (fig. 3) revealed marked depression of the S-T segment in leads V-3, V-4 and

V-5, but no diagnostic signs of infarction. A repeat electrocardiogram the following day (fig. 4) revealed complexed in V-2 and V-3 diagnostic of an acute anterior infarction. The patient went into shock and despite diligent efforts and administration of the usual medications, including nor-epinephrine, he died on the

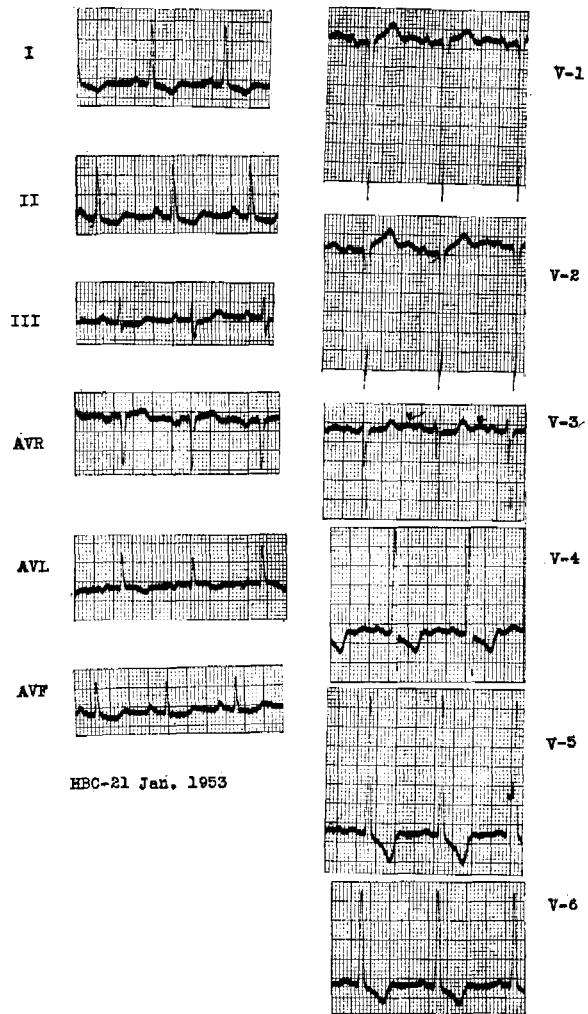


Fig. 5. (Case 4, H. B. C.) Left ventricular hypertrophy and strain. Abnormal QRS complex in V-3 suggestive of old infarct.

fourth day. Autopsy revealed an extensive anterior myocardial infarction. No occlusion of the coronary arteries could be demonstrated, however.

Comment: This case demonstrates clearly two points:

1. Early in the course of infarction, diagnostic changes may not be present. The S-T depressions in this case could have been due to: (a) acute coronary insufficiency, (b) acute posterior infarction, (c) sub-endocardial infarction, or (d) as it turned out, the initial stages of a transmural anterior infarction.

2. The thesis of this paper is also demonstrated in that the electrocardiographic changes diagnostic of infarction could not have been found on the 4-lead electrocardiogram.

Case 4. H. B. C., a 65 year old retired railroad engi-

neer, had suffered a "heart attack" three years previously and since that time had been under medical care for cardiac decompensation. Under a regimen of digitalis, mercurial diuretics and other supportive measures, he had been doing well except for exertional dyspnea. The blood pressure was 125/74 and the heart was enlarged. There was a grade 4, harsh systolic murmur at the aortic area. The second aortic sound was absent. The diagnosis of calcific aortic

iting. The pain lasted four hours. The patient was hospitalized the following day. A repeat electrocardiogram (fig. 7) done three days later revealed one further change: the R wave in V-3 was now completely absent and was replaced by a "W" type Q wave. After three weeks of bed rest, anticoagulants and other measures, the patient was made ambulatory. He has had an uneventful convalescence and, now, ten months following his attack, is active about his farm.

Comment: This case demonstrates clearly how serial changes in an electrocardiogram indicating an acute anterior myocardial infarction may be present in only one lead.

Case 5. H. R., a 74 year old retired businessman, was first seen in January 1953, complaining of right sided chest pain initiated by effort. He gave a history of having had a "heart attack" with severe precordial pain three years previously at which time he had been restricted to bed for two weeks. A 12-lead electrocardiogram (fig. 8) showed normal findings in all

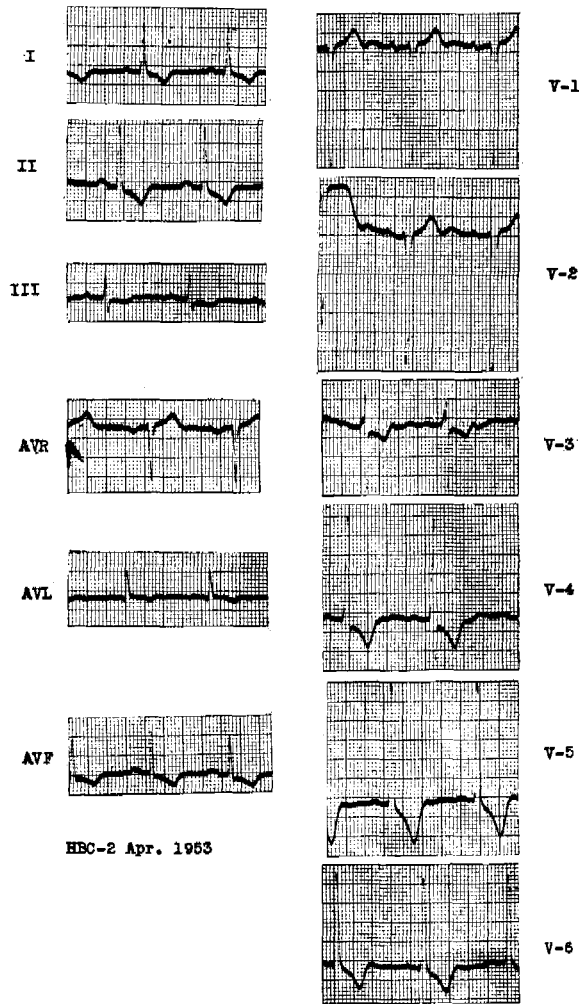


Fig. 6. Electrocardiograph taken after episode of chest pain. Slight depression of S-T segment in V-3 is the only significant change from previous graph.

stenosis had been made by several observers. An electrocardiogram taken in January 1953 revealed (fig. 5) characteristic signs of left ventricular hypertrophy and strain. The small R wave and notched S wave in V-3 were interpreted as suggestive of an old infarction. A second electrocardiogram (fig. 6) four months later taken twenty-four hours after an episode of precordial pain with radiation down the left arm, lasting one hour, showed only one significant change: the S-T segment in V-3 was depressed 1.5 mm., whereas previously it was depressed 0.5 mm. Two hours after this electrocardiogram was taken, the patient experienced severe precordial pain radiating down both arms, associated with pallor, sweating and vom-

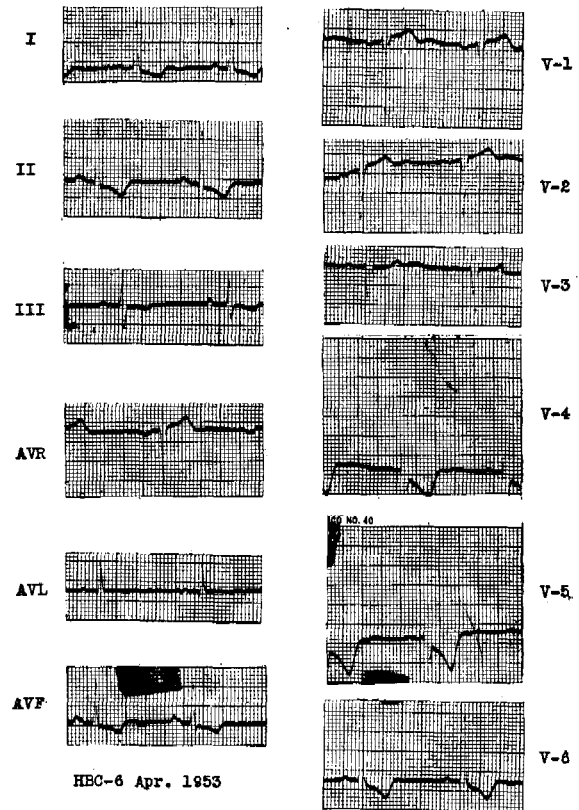
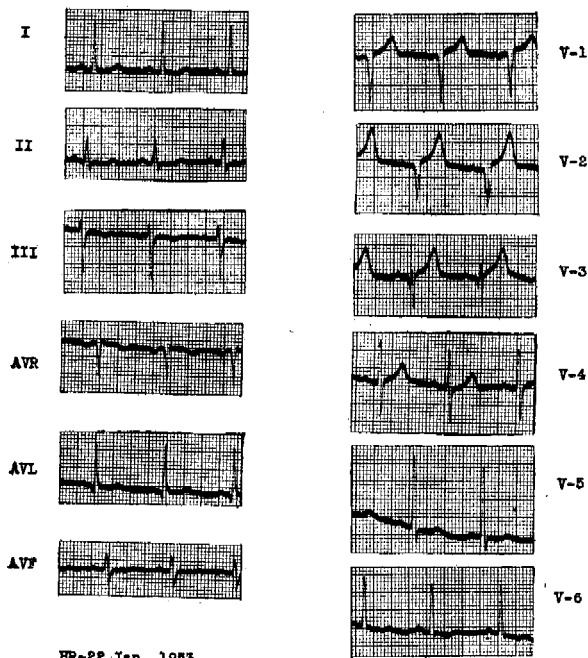


Fig. 7. (Case 4, H. B. C.) Three days after obvious clinical episode of acute coronary occlusion. Only change is absent R wave in lead V-3.

leads except V-2 and V-3. In these leads, the absent R waves and notched QRS complexes are presumptive signs of an old, healed anterior myocardial infarction. The patient is practically free of anginal attacks seven months after this electrocardiogram was taken.

Comment: This case demonstrates how an old healed myocardial infarct can be evident on an electrocardiogram only if adequate electrode exploration is undertaken. Diagnostic signs are present only in leads

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HR-22 Jan. 1953

Fig. 8. (Case 5, H. R.) This would be classified as a normal electrocardiogram were it not for leads V-2 and V-3. Absent R waves and notching of the Q indicate an old healed anterior myocardial infarction.

V-2 and V-3. Had only four leads been recorded, the tracing could have been recorded only as normal.

SUMMARY

1. The thesis is presented that a 12-lead electrocardiogram is necessary as a routine study in clinical cardiac problems.
2. Five cases of myocardial infarction are presented to demonstrate the value of the 12-lead electrocardiogram.

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