

Clinical significance of minor ST/T depression in resting electrocardiogram

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Horizontal or downward-sloping ST depression of 0.25 to 0.5 mm, or a T wave less than one-tenth the height of the preceding R wave in leads I, II, aVF, or V3 to V6, was not seen in the resting cardiogram of any of the 200 apparently healthy men or women under the age of 30 years who were studied.

An analysis of 225 patients, seen in consulting outpatient or domiciliary practice, who showed these changes, indicated that at least 92 per cent of them had heart disease. Coronary disease and left ventricular hypertrophy between them accounted for over 80 per cent of the total; and acute carditis, alcoholism, cardiac trauma, and paroxysmal tachycardia (usually associated with praecordial pain) for over 10 per cent. In 16 patients (7%), the cause of the abnormality was unexplained; but three-quarters of these either presented with chest pain or discomfort, or else had a family history of coronary heart disease.

Thus slight ST/T depression, as defined above, in a resting cardiogram recorded under standard conditions is abnormal. It may be due to a number of factors, but the commonest in clinical practice are coronary heart disease and left ventricular hypertrophy.

Horizontal or downward-sloping depression of the ST segment of between 0.25 and 0.5 mm and a T wave less than one-tenth the height of the preceding R wave (Fig. 1) in one or more leads are frequently encountered as the sole 'abnormality' in the resting electrocardiogram of patients with suspected coronary disease. For example, in a series of 1000 consecutive tracings recorded in the course of an Electrocardiogram Reporting Service, over a quarter showed one or both of these features (Short, 1969a). Opinions differ with regard to the significance of these patterns. On the one hand they were regarded by Blackburn *et al.* (1960) as too slight and insignificant to merit inclusion in the Minnesota Code, and are dismissed by Friedberg (1966) with the statement 'ST depression of less than 0.5 mm and T wave inversion of less than 1 mm are not significant, or at least not due to myocardial ischaemia'. On the other hand, Evans (Evans and McRae, 1952; Evans, 1965) has repeatedly emphasized the importance of these patterns as evidence of coronary heart disease, and Short (1970) has shown that they are frequently found in the early stages of myocardial infarction.

Here, then, is a common electrocardiogra-

phic pattern, about which authorities hold divergent views. Some say the patterns are evidence of serious disease. Others say they should be ignored. How can the matter be resolved? There is good evidence that similar patterns may be produced in normal subjects by a variety of influences - ranging from drinking iced water to driving through rush-hour traffic, and from pregnancy to drugs - as well as by a faulty electrocardiograph machine, or incorrect recording technique (Short, 1969b), but this does not exclude the possibility that they may be significant when present in a resting cardiogram, recorded under standard conditions.

There are, in reality, two questions to be answered. The first is, are these patterns found in healthy young men and women under standard resting conditions? The second is, what is the clinical condition of individuals who do show such patterns under standard conditions?

Material and methods

In the first place, cardiograms were recorded on 200 apparently healthy university students, and other adults of both sexes under the age of 30 years. All recordings were made on Cambridge Transrite direct-writing instruments, which were carefully maintained and repeatedly checked,

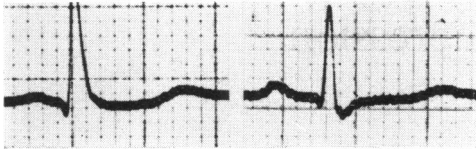


FIG. 1 Left. *Minor ST segment depression. The degree of depression is between 0.25 and 0.5 mm. Right. Low T wave. The height of the T is less than one-tenth that of the R wave.*

either by the author, or by the senior cardiographic technician to the hospital.

In addition, for the past 7 years I made a note of every patient I examined, either as an out-patient or in his own home, whose resting cardiogram, recorded under standard conditions showed the patterns under consideration, without any other abnormality, in one or more of the following leads: I, II, aVF, V₃ to V₆. All these patients were questioned and examined personally by me, particular note being made of any drugs the patient was taking. Those in whom a definite diagnosis was not made on the first occasion were followed up and investigated as intensively as possible. Cardiograms showing upward-sloping (J type) ST depression were excluded, and so were those with a heart rate of over 100 a minute, or atrial fibrillation or flutter.

During the period of this survey, I examined approximately 2,500 patients outside hospital wards. In half, the presenting symptom was chest pain. Among these patients, there were 225 who had one or more cardiograms satisfying the above criteria, of whom 70 per cent presented with chest pain. Of these, 11 per cent were less than 40 years of age, 16 per cent were between 40 and 49, 27 per cent between 50 and 59, 31 per cent between 60 and 69, and 15 per cent were aged 70 or over. Fifty-six per cent were men. Most of these patients were examined on several occasions; 85 per cent had at least two cardiograms and 22 per cent more than five.

Minor ST/T depression was found most commonly (182 patients) in the lateral leads (I and/or V₆) either alone or with other leads, and the combination of minor ST depression and T flattening was almost twice as frequent as T flattening alone. In 25 patients, the patterns were confined to the anterior leads, without V₆; in 6 patients to the inferior leads; in 7 to both anterior and inferior leads; and in 5 to lead II alone.

Results

Healthy subjects None of the 200 apparently healthy subjects examined showed the cardiographic patterns under consideration.

Patients showing minor ST/T depression

The 225 patients who showed one or both of the specified minor abnormalities fell into

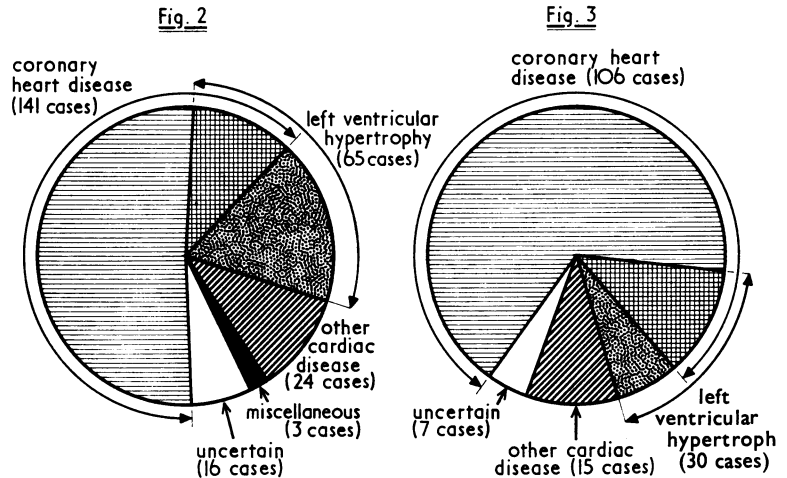


FIG. 2 *Diagnosis in 225 patients with minor ST/T abnormalities.*

FIG. 3 *Diagnosis in 158 patients presenting with chest pain.*

five groups (Fig. 2). The largest was coronary heart disease with 141 cases – 63 per cent of the total. (Twenty-four had associated left ventricular hypertrophy.) The second largest group was left ventricular hypertrophy with 65 cases – 29 per cent of the total (including the group with associated coronary disease). There were also 24 patients (11%) with other varieties of cardiac disease. Thus, cardiac disease accounted for 92 per cent of all the cases showing these patterns. Of the remainder, 3 were due to miscellaneous identifiable causes, and in 16 (7%) the cause of the cardiographic abnormality was uncertain. If only the 158 patients who presented with chest pain are considered, the proportion with coronary disease (with or without left ventricular hypertrophy) rises to 79 per cent, and with heart disease of all types to 96 per cent (Fig. 3).

Coronary heart disease

One hundred and forty-one patients exhibited, at one time or another, during the period of observation, one or more of the following criteria of coronary heart disease.

- 1) One of the criteria laid down by the World Health Organization Expert Committee on Cardiovascular Disease and Hypertension (1959); in particular, abnormal Q waves or ST elevation with characteristic evolution (Fig. 4).
- 2) A clinical history of myocardial infarction associated with serial ST and/or T wave ab-

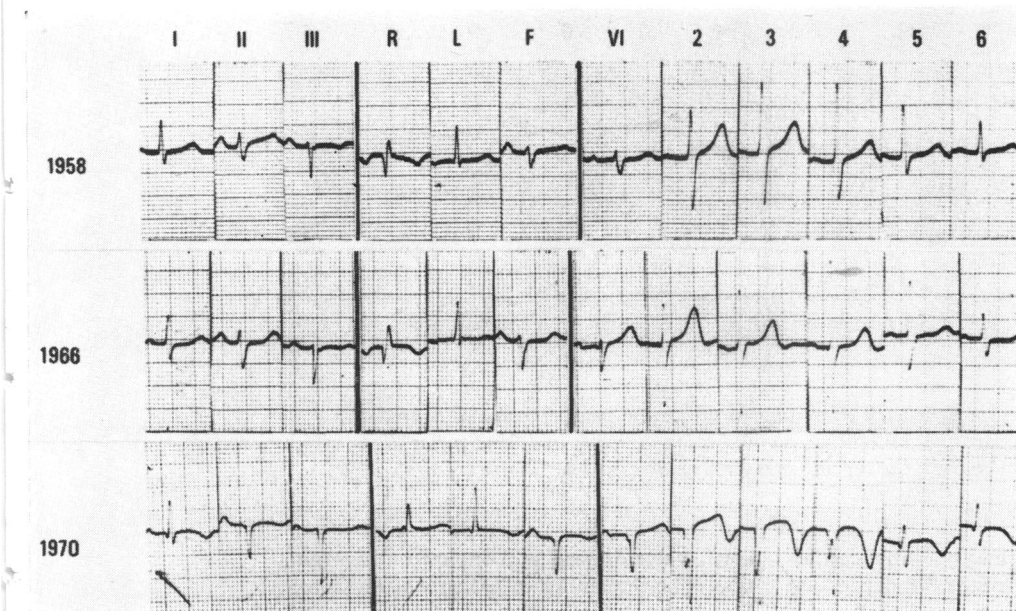


FIG. 4 Minor ST depression in a patient with atypical chest pain. (1958) ST segment and T wave within normal limits. (1966) Minor ST depression in I and V6. (1970) Evidence of transmural anterior infarction. This series of cardiograms also shows the progressive development of left anterior hemiblock.

normalities of coronary type, or a consistent serum enzyme pattern (Fig. 5).

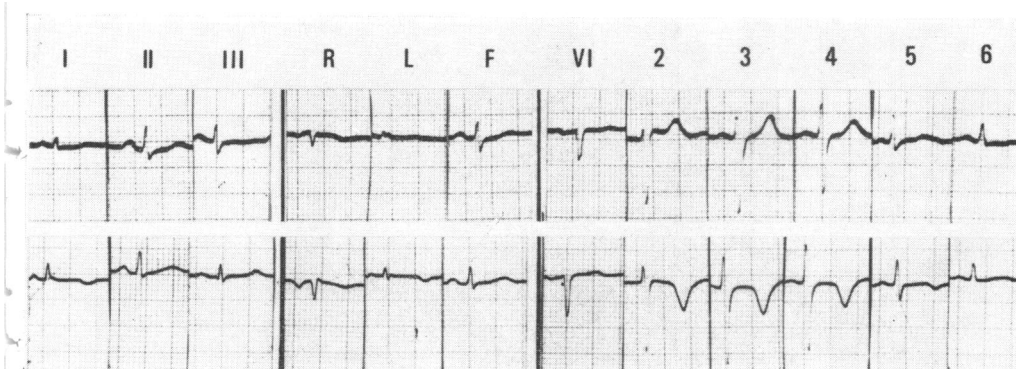
- 3) A classical history of effort angina (Fig. 6).
- 4) Necropsy evidence of old or recent myocardial infarction.

In about half these patients (69) the cardiogram showing these minor abnormalities indicated the early stage of acute infarction.

Sometimes the finding of a minor abnormality led to a strong suspicion of coronary heart disease when the history was atypical or even completely negative, as in the following instance.

A man, aged 52, applied for an air pilot's licence. This necessitated a medical examination, including a cardiogram. The applicant denied any symptoms, and clinical examina-

FIG. 5 Minor ST/T depression in a symptomless applicant for a pilot's licence. The first cardiogram (above) shows minor ST depression in I and a low T wave in V6. A second tracing four weeks later was similar. After a further two weeks, the patient developed clinical infarction (see text).



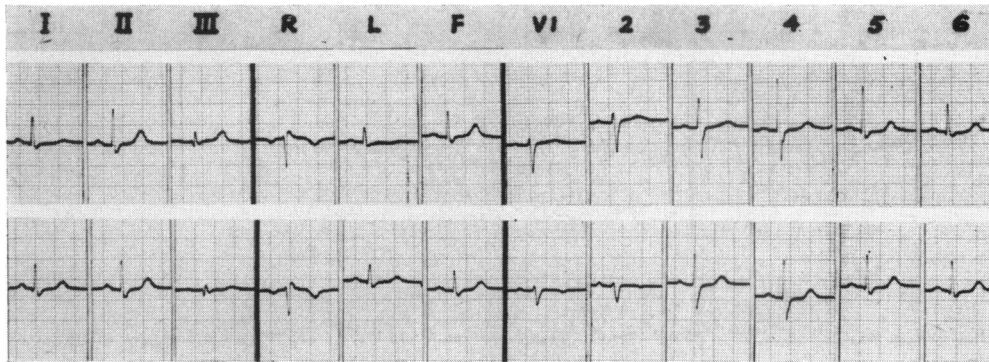


FIG. 6 Low T wave in a patient with effort angina of abrupt onset. Two months after the onset of effort angina, the cardiogram (above) showed a low T wave in I (and a flat T in aVL). Four months later (below), the tracing was as normal as it had been six years earlier.

tion revealed no abnormality. The cardiogram, however, showed minor ST depression and T flattening in the posterolateral leads (Fig. 5). A repeat cardiogram four weeks later was similar. Two weeks later the patient had an attack of chest pain accompanied by inversion of the T waves in the anterior leads and a rise of serum aspartate aminotransferase (SGOT) to 38 IU (76 RF units).

Left ventricular hypertrophy

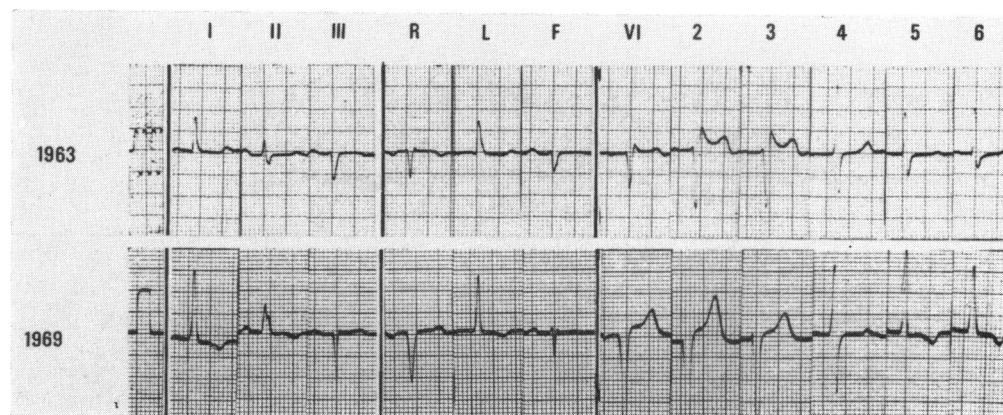
Sixty-five patients had minor ST depression or T wave flattening, or both, in one or more left ventricular leads without unequivocal RS voltage criteria of left ventricular hypertrophy (Fig. 7). (Twenty-four of these patients had associated coronary heart disease.) Eight had

aortic valve disease, and one mitral regurgitation. The remaining 56 patients had a systolic blood pressure of over 200 mmHg, or a diastolic blood pressure of over 100 mmHg (33 had both) with the exception of 4 who were on antihypertensive therapy, or in heart failure. Most of these patients also had clinical or radiological evidence of left ventricular hypertrophy.

Other myocardial disease

Twenty-four patients had evidence of cardiac disease other than coronary disease or left ventricular hypertrophy. Thirteen presented with a clinical picture of *acute carditis*. Two of these showed laboratory evidence of active brucellosis, and one of recent Coxsackie B3

FIG. 7 Minor ST/T depression in a patient with severe aortic stenosis. In 1963 there was a minor degree of ST depression in lead I and low T wave in V₅ and V₆, without any definite voltage criteria of left ventricular hypertrophy. Six years later, there was an unequivocal left ventricular hypertrophy pattern.



infection; in the remainder, the cause of the disease was not established. Two were *chronic alcoholics*, and 2 others had sustained recent injury to the chest in road accidents. The remaining 7 patients in this group suffered from *paroxysmal atrial tachycardia or fibrillation*. Five of these gave a history of pain, tightness, or discomfort in the chest during attacks, and 2 had a family history of coronary disease. None had been treated with a cardiac glycoside.

Miscellaneous

Three patients had minor ST or T wave abnormalities which could be attributed to a noncardiac cause. Two were taking *digoxin* regularly, and one was in the middle of *pregnancy*.

Uncertain

Sixteen patients showed minor ST or T wave abnormalities for which there was no obvious explanation (Table). Seven gave a history of chest pain or discomfort which might have been cardiac in origin. Ten gave a history of coronary disease in a close relative under 70 years of age, and in 4 of these, 2 relatives were known to be affected. Two gave a history of severe pneumonia or pleurisy with effusion. In the remaining 2 patients, no indication of the cause could be obtained.

Discussion

Horizontal or downward-sloping ST depression of 0.25 to 0.5 mm, or a T wave less than one-tenth the height of the preceding R wave in leads I, II, aVF, or V₃ to V₆ was not seen in the resting cardiogram of any of the 200 apparently healthy men or women under the age of 30 years who were studied. It is reasonable to conclude, therefore, that these patterns, when seen in a resting cardiogram recorded under standard conditions, are abnormal.

An analysis of 225 patients, seen in consulting outpatient or domiciliary practice, who showed these changes, indicated that at least 92 per cent of them had heart disease; most commonly coronary disease or left ventricular hypertrophy; less frequently acute carditis, alcoholism, trauma, or paroxysmal tachycardia (usually associated with praecordial pain).

The relative incidence of the different pathological factors naturally depends on the population studied. Thus, if the survey is limited to patients presenting with chest pain, the proportion with coronary disease is higher. In a hospital study, the variety of diseases is greater. Thus, Friedberg and Zager (1961)

TABLE Patients with ST/T depression of uncertain cause

Case No.	Age (yr)	Sex	Chest pain or discomfort	Family history of coronary disease*	Other data
1	32	F	+	++	
2	44	F	+	++	
3	41	F	+	+	
4	46	M	+	+	
5	48	M	+	+	
6	44	M	+	—	
7	55	F	+	—	Recurrent attacks of left basal pneumonia and pleurisy
8	53	M	—	++	Arcus senilis, serum cholesterol 310 mg/100ml.
9	60	M	—	++	
10	24	M	—	+	Obesity
11	36	F	—	+	
12	39	F	—	+	
13	25	M	—	—	Pleural effusion with residual thickening
14	37	F	—	—	On oral contraceptive pill
15	38	M	—	—	Obesity
16	63	F	—	—	

* + One parent suffered from angina or myocardial infarction, or died from coronary thrombosis, or suddenly under the age of 70 years; ++ both parents or one parent and one sib so affected.

found the following diseases associated with 'non-specific ST and T wave changes', in addition to those already mentioned: radiation injury, electrolyte disturbance (especially hypokalaemia), metabolic disease (e.g. hypothyroidism, cortisol deficiency), anaemia, intracranial disease, and acute pancreatitis.

There are many physiological and pharmacological factors capable of affecting the ST/T portion of the cardiogram, but most of these are not relevant to the conditions of clinical practice, and the majority can be excluded by a careful history and examination. The commonest noncardiac factors of practical importance at the present time are the glycosides and the tricyclic antidepressant drugs.

The nature and prognosis of any heart disease present cannot, as a rule, be determined from the cardiogram alone; but only by careful consideration of all the evidence. The same pattern which in one patient is the earliest evidence of acute infarction, in another may represent merely the scar of an old infarct or a patch of healed myocarditis.

If unwarranted cardiac invalidism is to be avoided, two considerations are of paramount importance. First, abnormalities should not be seen where they are not present; and secondly a diagnosis should never be made without careful consideration of all the clinical evidence. Thus, those reading cardiograms

should be aware of the artefacts which may be produced by an unsatisfactory machine; and if there is any doubt on this score the tracing should be repeated on another machine. No deduction should be drawn from technically imperfect tracings, or those in which the baseline is not strictly horizontal. It is also essential to recognize the unimportant upward-sloping (J type) ST depression, and ignore slight changes associated with tachycardia. Caution should also be exercised in the interpretation of slight ST/T depression confined to the inferior leads (Evans and Lloyd-Thomas, 1957).

A recognition of the significance of minor ST/T depression is of great importance in the early diagnosis of coronary heart disease. At the time when symptoms first appear, clinical examination is usually unhelpful and major cardiographic abnormalities are found in less than half the patients; but approximately one-third show ST/T depression (D. Short and M. Stowers, 1972, in preparation). One of the most difficult diagnostic problems in cardiology is presented by the patient with brief attacks of central chest pain unrelated to effort or excitement. In such patients, the finding of minor ST/T depression may be a vital clue to the diagnosis.

What attitude should be adopted towards symptomless individuals whose cardiograms show these abnormalities? If other causes can be excluded, the probable diagnosis must be coronary heart disease; for silent infarcts are undoubtedly common (Master and Geller, 1969). In such cases, the cardiogram should always be repeated after an interval. If the pattern has changed, it suggests an acute lesion. If it is unchanged, it probably indicates a myocardial scar; either from a small, healed infarct, or possibly from old myocarditis or pericarditis. In these circumstances,

it is usually unnecessary and unwise to mention the possibility of coronary disease; but the opportunity should be taken of correcting any adverse factors which may be present, such as smoking, excess weight, or lack of exercise. If the suspicion of coronary disease is strong, the patient should probably be prevented from taking sole charge of a public transport vehicle.

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