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Patients with suspected myocardial infarction who present with ST depression

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Summary

Patients with suspected myocardial infarction who present with ST depression have a high mortality which is not reduced by thrombolytic therapy. Despite this, there are few data on these patients. We studied the electrocardiographic and clinical characteristics of these patients, the diagnostic and prognostic value of the presenting electrocardiogram (ECG), and the reasons for the high mortality and apparent lack of thrombolytic efficacy.

We studied all patients with suspected infarction admitted during 1990 with ST depression. Of the 136 patients (84 men, mean [SD] age 68 [11] years), 74 (54%) had confirmed infarction and 73 (54%) had previous infarction. 1-year mortality was 26% for all patients, 31% for those with confirmed infarcts, and 19% for those in whom infarction was subsequently excluded. Patients with infarction had more severe ST depression (mean 2·5 mm [SD 1 5]) and more ECG leads with ST depression (mean 4·7 leads [1 8]) compared with patients without infarction (1·4 mm [0·8], $p < 0$ 001; 3·6 leads [1·7], $p < 0·001$). Sensitivity and specificity for the subsequent diagnosis of infarction with ST depression were 20% and 97%, respectively, for at least 4 mm; and 21% and 95%, respectively, for at least 7 leads. 1-year mortality was low in patients with 1 mm ST depression (14%) or no more than 2 leads (11%), but high in patients with at least 2 mm ST depression (39%, $p < 0·001$) and at least 3 leads (30%, $p = 0$ 08).

Patients with suspected infarction and ST depression had a high mean age, high incidence of previous infarction, and poor prognosis. The presenting ECG is helpful in predicting prognosis, and ST depression of at least 4 mm or involving at least 7 leads is highly specific for diagnosis of infarction.

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Introduction

Although many data characterise patients with non-Q wave infarction[1-5] and patients with infarction and reciprocal ST depression,[6-8] few data exist on suspected myocardial infarction patients whose presenting electrocardiogram (ECG) shows ST depression as the predominant feature. The results of the GISSI[9] and ISIS-2 trials[10] show that subgroups of patients with ST depression have a high mortality of 16–19% which is not reduced by thrombolytic therapy. It is therefore important to obtain further information on these patients in order to understand the reasons for the high mortality and the apparent lack of efficacy of thrombolytic therapy. The value of the presenting ECG in the diagnosis and risk stratification of these patients is also important to know. We studied the case notes of all patients with suspected acute myocardial infarction who presented to Aberdeen Royal Infirmary with ST depression during 1990.

Patients and methods

Patients

All patients with suspected myocardial infarction admitted to Aberdeen Royal Infirmary during 1990 with ST depression but without reciprocal ST elevation (except in lead aVR) in their presenting ECG were included. Casenotes were reviewed to confirm the ECG findings and cardiac enzyme data. Mortality data were obtained from the local death registry.

Methods

All ECGs were recorded in 12-lead format at a paper speed of 25 mm/s. ST depression was judged to be present if the J point was depressed by 1 mm or more and was followed by a horizontal or downward sloping ST segment for at least 0·08 s in 1 or more of the 12 leads. The depth of ST depression was measured at 0·08 s after the J point. ST elevation in lead aVR was judged to be present if it was 1 mm or more.

For the diagnosis of acute myocardial infarction, both of the following criteria had to be fulfilled: a characteristic chest pain of more than 30 minutes duration, and a rise of serum aspartate aminotransferase to at least twice the upper limit of normal in our laboratory (normal less than 31 U/L) with a characteristic rise and fall of the enzyme.

The decision to administer thrombolytic therapy was left to the individual clinician. In general, patients were given thrombolytic therapy if myocardial infarction was thought likely from the history and the admission ECG. The standard relative contraindications to thrombolysis such as previous bleeding peptic ulceration, previous cerebrovascular accident, and severe hypertension were known to the clinicians.

Data analysis

The unpaired *t* test was used to compare the difference between group means. The chi-square test with Yates' correction was used to calculate the mortality difference between the two groups of patients.

Results

Myocardial infarction

136 patients presented with ST depression. 84 were men and 52 were women. The mean age of the men was 66 years (SD 11, range 35–87) compared with the mean for women of 72 (SD 10, range 47–88). 74 patients (54%) had confirmed infarction; 48 of these were men. The figure shows the characteristics of the patients.

Previous myocardial infarction had occurred in 73 patients (54%); 48 were men and 25 were women. The mean age of these patients was 68 years (SD 12). In the 74 patients with confirmed infarction during this admission, 43 (58%) had a previous history of myocardial infarction (mean age 67 years, SD 11, 29 men, 14 women). 17 patients died during this admission; 11 (65%) had a previous history of myocardial infarction.

Thrombolytic therapy

Of the 74 patients with confirmed infarction on this admission, 49 did not receive thrombolysis and 17 of these (35%) died within 1 year. 25 patients had thrombolytic therapy; 6 (24%) of these died. The difference in mortality between the two groups of patients did not reach significance ($\chi^2 = 0{\cdot}46$, $p = 0{\cdot}33$).

9 of the non-infarct patients were given thrombolytic therapy.

Prognosis (1-year mortality)

1-year mortality was 26% for all patients and 31% for those with confirmed infarction. It is noteworthy that those patients who presented with ST depression in whom myocardial infarction was subsequently excluded during this admission had a relatively high 1-year mortality of 19% (48% had a previous history of myocardial infarction).

72 patients presented with ST depression of 1 mm (26 of these had confirmed infarction). Only 10 (14%) of these patients died within 1 year of presentation. In contrast, 25 (39%) of the 64 patients who presented with ST depression of at least 2 mm died within 1 year; their mortality was significantly higher than those patients with 1 mm ST depression ($\chi^2 = 9{\cdot}96$, $p < 0{\cdot}001$).

The 1-year mortality for patients whose presenting ECG showed ST depression in 2 or fewer leads was only 11% (3 deaths in 28 patients). This was much lower than the 32 deaths (30%) in the 108 patients with at least 3 leads with ST depression ($\chi^2 = 3{\cdot}23$, $p = 0{\cdot}08$).

The 1-year mortality of patients with previous myocardial infarction was 29% (21 deaths in 73 patients).

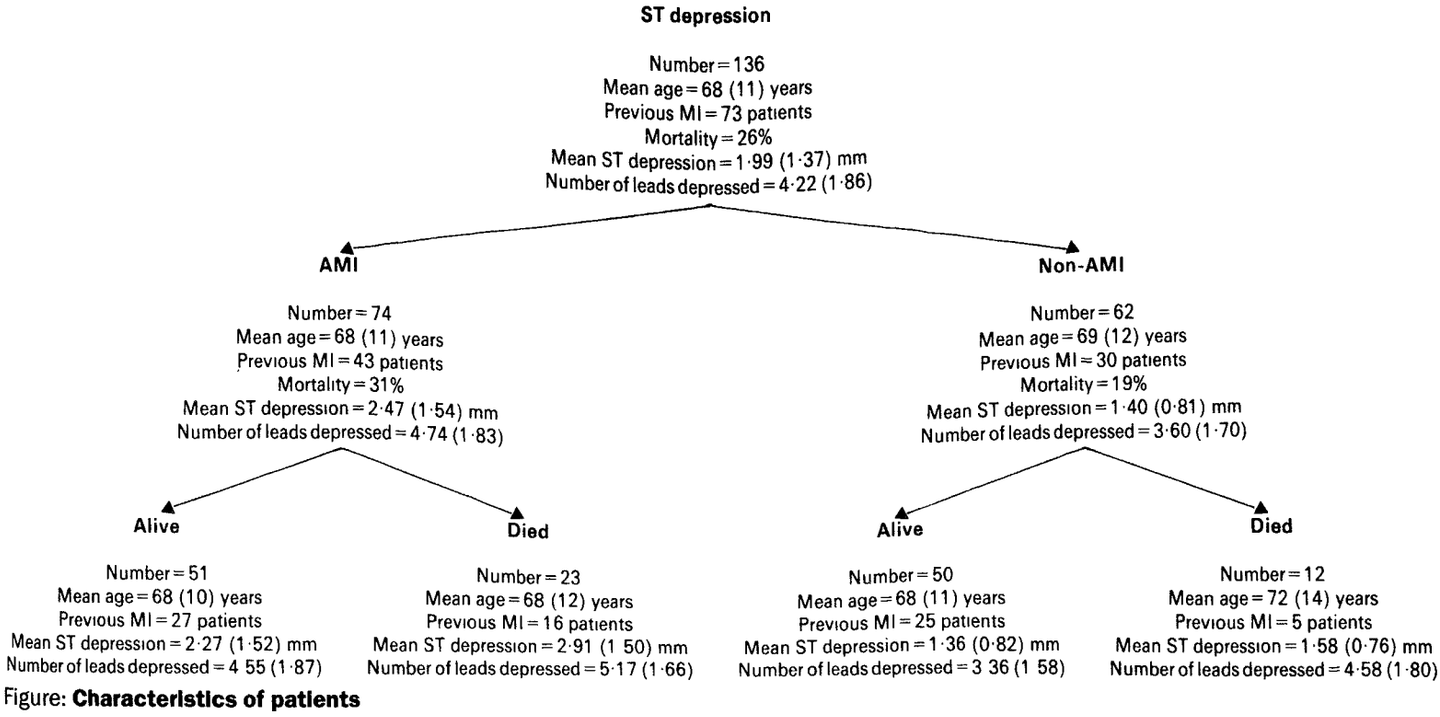

Figure: **Characteristics of patients**

MI = myocardial infarction, AMI = acute myocardial infarction, and standard deviations are shown in parentheses.

	Sensitivity	Specificity
ST depression (mm)		
⩾3	41	90
⩾4	20	97
⩾5	12	98
⩾6	5	100
Leads with ST depression		
⩾4	74	52
⩾6	35	84
⩾7	21	95
⩾8	7	100

Table 1: **Sensitivity and specificity (%) of ST depression and number of leads with ST depression for diagnosis of acute myocardial infarction**

Although this figure was higher than for those without a history of previous infarction (14 deaths in 63 patients [22%]), it did not reach statistical significance ($\chi^2 = 0{\cdot}45$, $p = 0{\cdot}38$). For confirmed infarction during this admission, mortality was 37% (16 deaths in 43 patients) in those with previous myocardial infarction compared with 23% (7 deaths in 31 patients) in those without previous infarction ($\chi^2 = 1{\cdot}18$, $p = 0{\cdot}16$).

Prognosis (in-hospital mortality: comparison with all patients with infarction)

In 1990, 663 patients were admitted to the Aberdeen Royal Infirmary with confirmed myocardial infarction. 17 in-hospital deaths (23%) occurred in the 74 patients who presented with ST depression. This was higher than the 94 deaths (16%) in the other 589 patients with confirmed infarction ($\chi^2 = 1{\cdot}84$, $p = 0{\cdot}17$).

ECG changes and diagnosis of infarction

The ECGs of those with acute infarction had more severe ST depression (mean 2·5 mm, SD 1·5) than those with infarction later excluded (mean 1·4 mm, SD 0·8; $p < 0{\cdot}001$). The patients with infarction also showed ST depression in more ECG leads (mean 4·7 leads, SD 1·8) than those without infarction (mean 3·6 leads, SD 1·7; $p < 0{\cdot}001$).

ST depression of at least 4 mm was 20% sensitive and 97% specific for the subsequent diagnosis of acute myocardial infarction. For ST depression in at least 7 ECG leads the sensitivity was 21% and specificity 95% (table 1). Combining the severity of ST depression and the number of leads with ST depression was no more helpful than severity or number alone for the subsequent diagnosis of myocardial infarction (table 2).

	Sensitivity	Specificity
ST depression ⩾3 mm		
⩾4 leads	76	52
⩾5 leads	55	68
⩾6 leads	47	82
⩾7 leads	42	89
ST depression ⩾4 mm		
⩾4 leads	76	52
⩾5 leads	52	88
⩾6 leads	41	84
⩾7 leads	31	93
ST depression ⩾5 mm		
⩾4 leads	74	52
⩾5 leads	49	68
⩾6 leads	36	84
⩾7 leads	26	95

Table 2: **Sensitivity and specificity of combined data on the severity of ST depression and the number of leads with ST depression for the diagnosis of acute myocardial infarction**

None of the patients showed ST elevation in the ECG recorded after admission.

ST elevation of at least 1 mm in lead aVR was present in 49 patients. 31 (63%) of these patients had myocardial infarction subsequently confirmed. Thus 18 (37%) patients with 1 mm ST elevation in lead aVR did not have myocardial infarction. There were only 2 patients with ST elevation of 2 mm (none with more than 2 mm ST elevation); myocardial infarction was confirmed in both patients.

Discussion

We studied patients with suspected myocardial infarction who had ST depression as the predominant feature in their admission ECG. We found that these ECGs were helpful in the diagnosis of myocardial infarction and in determining prognosis. We included patients with ST depression whose presenting ECG also showed ST elevation in lead aVR because, from experience, ST elevation only in this lead does not appear to have much discriminating power in the diagnosis of acute myocardial infarction and is largely ignored by clinicians. Our data confirmed this suspicion: myocardial infarction was subsequently excluded in a large number of patients (37%) with ST elevation in lead aVR. All patients with ST elevation in any other lead were excluded from this study.

Willich et al[11] looked at a subgroup of patients with non-Q wave infarction who presented with ST depression without ST elevation. These patients had a high incidence (39%) of previous myocardial infarction. Raunio et al[12] reported a series of postmortem results in patients with transmural and subendocardial infarction. 7 of these patients had ST depression but not ST elevation in their presenting ECG. 5 of these 7 patients had postmortem evidence of previous infarction. Our data support these findings with 54% of all patients having a previous history of myocardial infarction. These results suggest that previous myocardial damage is an important reason for the high mortality in these patients.

For patients with confirmed myocardial infarction, an explanation for the absence of ST elevation is the "cancelling out" of electrical events because of infarction in opposite myocardial planes.[13-15] Thus, a new anterolateral myocardial infarction could normalise the ECG changes of a previous healed inferior myocardial infarction by subtracting anterior and lateral dipole contributions from the QRS complex resulting in ST segment and/or T wave changes only. The large number of patients with previous infarction in our study supports the presence of this effect in at least some patients. ST depression can also be the only ECG finding in transmural myocardial infarction—Raunio et al[12] documented the occurrence of ST depression without ST elevation in 17% of patients whose postmortem findings confirmed the presence of transmural myocardial infarction. Another explanation for the lack of ST elevation in patients with infarction may be a subtotal coronary occlusion leading to subendocardial myocardial infarction.

The mortality of the subgroup of patients with ST depression in the GISSI and ISIS-2 trials was not reduced by thrombolytic therapy.[9,10] Three reasons may account for this finding. First, the number of patients with ST depression was relatively small in both trials (224 patients in GISSI and 571 in ISIS-2 who received thrombolytic therapy). The confidence intervals for mortality reduction would therefore be expected to be wide in these patients. Indeed, this was the case in the ISIS-2 trial with an odds

ratio for mortality reduction of 1·01 (95% confidence interval 0·75–1·36). Second, in patients with ST depression, the criteria for the administration of thrombolytic therapy were based on clinical suspicion and not ECG changes. This would almost certainly mean that a large number of patients who received thrombolytic therapy in these trials did not have an infarction. Third, since many of these patients may have a previous myocardial infarction, a further infarction could have destroyed a critical volume of myocardium. Such patients might benefit from earlier thrombolysis to limit the size of the infarction. Recently, many groups have substantially reduced the time from symptom onset to thrombolysis by advocating the administration of thrombolytic therapy in the community,[16] or by improving the "door to needle time" by fast-tracking suitable candidates for thrombolytic therapy.[17] These strategies may especially benefit the patient with ST depression.

Traditionally, convex ST elevation is considered to be highly specific for the diagnosis of acute myocardial infarction whereas ST depression indicates ischaemia. Although this is true for minor ST depression, our study shows that more severe ST depression is highly specific for the subsequent diagnosis of acute myocardial infarction. ST depression of at least 4 mm in the presenting ECG is 97% specific (20% sensitive) for the subsequent diagnosis of myocardial infarction. The number of leads with ST depression is also helpful in the subsequent diagnosis of myocardial infarction (at least 7 leads with ST depression has a specificity of 95% and sensitivity of 21%). These variables may be helpful in identifying those patients who might benefit from thrombolytic therapy. Thrombolytic therapy could then be targeted only to those patients who are likely to be having an infarct.

The severity of ST depression and the number of ECG leads showing ST depression are also good prognostic indicators and should help to identify those patients who may benefit from more intensive investigation and management. For example, clinicians may have a lower threshold for investigating patients with at least 2 mm ST depression (1-year mortality 39·1%) compared with those having 1 mm ST depression (mortality 13·9%).

It is important to note that some patients who present with severe ST depression may have unstable angina. The role of thrombolysis is still unclear in these patients.[18,19] Studies are needed to determine if it is possible to distinguish very quickly those patients with unstable angina who present with ST depression from those who are actually having an infarct. It is possible that most patients with severe ST depression are having an infarct; ST depression of at least 4 mm may well be an indication for thrombolysis. Myoglobin enzymes are known to be raised very soon after myocardial infarction[20] and rapid myoglobin analysers can now yield quantitative results within 6 minutes of blood collection.[21,22] This technique has promise and its use may answer some of the above questions and, more importantly, may further refine the management of this important group of patients.

Our study provides further insight into patients with suspected myocardial infarction who present with ST depression. We show that these patients have a high mean age, a high incidence of previous myocardial infarction, and a poor prognosis. The admission ECG is helpful in stratifying the prognosis of these patients, and ST depression of at least 4 mm or in at least 7 leads has a high specificity for subsequent diagnosis of acute myocardial infarction.

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