

Effect of thrombolysis on the evolution of late potentials within 10 days of infarction

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Abstract

Patients with late potentials in the signal averaged electrocardiogram are more at risk of lethal arrhythmias in the period after acute myocardial infarction. To test the effects of thrombolysis on the incidence and evolution of late potentials, 158 consecutive patients were prospectively studied during the first 10 days after acute myocardial infarction. The study population consisted of two groups: 93 control patients treated conservatively and 65 patients treated with intravenous thrombolysis. Recordings of signal averaged electrocardiogram were obtained within two days and 7-10 days after infarction. The incidence of late potentials in the first two days after infarction was not significantly different in the thrombolytic and control groups (14% v 11.8%). By 7-10 days the incidence of late potentials among patients who underwent thrombolysis remained unchanged (14%); however, it increased significantly in the control group (11.8% to 22.5%).

Thus thrombolysis seems to reduce the evolution of late potentials within 10 days of infarction. Because the risk of fatal arrhythmias is higher in patients with late potentials this study may partly explain the reduced mortality after thrombolysis.

Ventricular late potentials consist of low amplitude high frequency electrical signals that occur at the end of the QRS complex or during the ST segment. These signals probably arise from areas of slow conduction in diseased myocardial regions and may thus be markers of arrhythmogenic features.¹ Late potentials present within 1-4 weeks after acute myocardial infarction predicted a higher risk of sudden cardiac death and ventricular tachycardia in the next 6-24 months.² Recently, thrombolytic treatment within a few hours of acute myocardial infarction has been established as an effective means of improving survival^{3,4} and preserving myocardial function^{5,6} in the acute and chronic phases of infarction. However, there are few data on the incidence, course, and the effects of thrombolysis on late potentials in the early post-infarction period. We have evaluated the effects of thrombolytic treatment on the incidence and evolution of late potentials during the first 10 days after acute myocardial infarction.

Patients and methods

Our prospective study included 158 consecutive patients with first acute myocardial infarction who underwent two signal averaged electrocardiogram recordings, the first within two days and the second within 7-10 days of the acute myocardial infarction. We excluded patients with a QRS complex lasting ≥ 110 ms or atrial fibrillation on an admission surface electrocardiogram. There were 138 men and 20 women (mean (SD) age 60 (8) years). Anterior acute myocardial infarction was diagnosed in 60 and inferior acute myocardial infarction in 98 patients. The diagnosis of acute myocardial infarction was based on prolonged (> 30 minutes) chest pain, ST elevation of ≥ 1 mV in at least two leads on the admission electrocardiogram, and a raised serum concentration of creatine kinase of myocardial origin.

Intravenous thrombolytic agents were given to 65 patients within four hours of the acute myocardial infarction: 24 were treated with streptokinase (1.5 million units) and 41 with tissue plasminogen activator (120 mg) (thrombolysis group). In 49 patients reperfusion was successful and in 16 it was not. Successful reperfusion was defined as an abrupt decrease in chest pain and a decrease of ST segment elevation by at least 50% within 30 minutes of administration of the thrombolytic agent associated with early peaking of creatine kinase MB (within 9-12 hours). Ninety three patients did not receive thrombolytic agents (control group) either because they arrived too late at the hospital (chest pain for more than four hours) or because of conventional contraindications to thrombolytic treatment. The mean (SD) left ventricular ejection fraction determined 2-10 days after infarction by the multiple gated acquisition technique was significantly higher in successful reperfusion than unsuccessful reperfusion and control patients (57.4 (10.1)% v 42.3 (14.7)% and 42.3 (15)%, respectively, $p < 0.05$). No other clinical variables were significantly different among the groups (table 1).

Signal averaging was obtained by the Hypec analyser (Aerotel, Israel), which allows separate averaging of the 12 electrocardiographic leads. The system uses a non-recursive (finite impulse response) digital filter provided by fast Fourier transformation algorithm which allows for a zero phase delay and prevention of the ringing phenomenon without the use of bidirectional signal processing.⁷ Normal values for signal averaged electrocardiogram were measured in 25 normal subjects, 22

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Table 1 Clinical variables of the study groups

Variable	Thrombolysis		Control
	Successful	Unsuccessful	
Patients	49	16	93
Age (mean (SD))	58.6 (10)	61 (6.25)	61 (9)
Men	42	15	81
Women	7	1	12
Anterior MI	21	8	31
Inferior MI	28	8	62
LVEF % (mean (SD))	57.4 (10.1)	42.3 (14.7)	42.3 (15.0)

LVEF, left ventricular ejection fraction; MI, myocardial infarction.

patients after infarction, and 14 patients with ventricular tachycardia or fibrillation after infarction. Accordingly, late potentials were defined as filtered (60–200 Hz) QRS complexes lasting ≥ 110 ms with a root mean square voltage in the last 40 ms of the QRS complex (RMS_{40}) of $\leq 10 \mu V$ in at least two adjacent electrocardiographic leads.

We used the McNemar test for significance of changes⁸ for statistical analysis of the difference between the occurrence of late potentials on the first and subsequent signal averaged electrocardiograms. The Mann-Whitney U test was used to compare the distribution of QRS duration and RMS_{40} in both groups.

Results

Table 2 shows the frequency of late potentials. Figures 1 and 2 show signal averaged electrocardiograms with and without late potentials.

The mean (SD) duration of the QRS complex was significantly shorter after successful reperfusion than in the control group in seven out of 12 leads recorded within two days (for example in lead II 96 (8) v 101 (13) ms, $p < 0.05$) and in 10 of 12 leads within 7–10 days (for example in lead II 99 (8) v 106 (19) ms, $p < 0.05$). There were no significant differences in

Table 2 Frequency of late potentials in thrombolysis and control groups

Treatment	2 days n (%)	7–10 days n (%)
Thrombolysis:		
Total	9/64 (14)	9/64 (14)
Successful	5/49 (10.4)	5/49 (10.4)
Unsuccessful	4/16 (25)	4/16 (25)
Control:		
Total	11/93 (11.8)	21/93 (22.5)

RMS_{40} between the groups. For example, in lead II RMS_{40} was 19 (10) v 21 (14) μV within two days and 20 (10) v 19 (13) μV within 7–10 days in the successful reperfusion and control groups respectively. No significant differences in QRS duration and RMS_{40} were found between patients in whom thrombolysis was unsuccessful and the controls.

In the first signal averaged electrocardiogram (recorded within two days of infarction) the frequency of late potentials was similar in the thrombolysis and control groups (14.0% and 11.8% respectively). In the second signal averaged electrocardiogram (recorded within 7–10 days) there was a significant increase in the frequency of late potentials among control patients (from 11.8% to 22.5%, $p < 0.01$), whereas the frequency of late potentials in the thrombolysis group remained at 14%. In patients showing successful reperfusion late potentials disappeared in two patients in the second signal averaged electrocardiogram while in two other patients late potentials were detected for the first time in the second (7–10 days) signal averaged electrocardiogram recording. In patients in whom reperfusion was unsuccessful and in control patients late potentials recorded within two days were still present in the signal averaged electrocardiogram performed 7–10 days after the acute myocardial infarction. The difference in the frequency of

Figure 1 Signal averaged electrocardiogram of six precordial leads recorded from a patient with successful reperfusion. Late potentials were not present and QRS duration and RMS_{40} were normal in all leads.

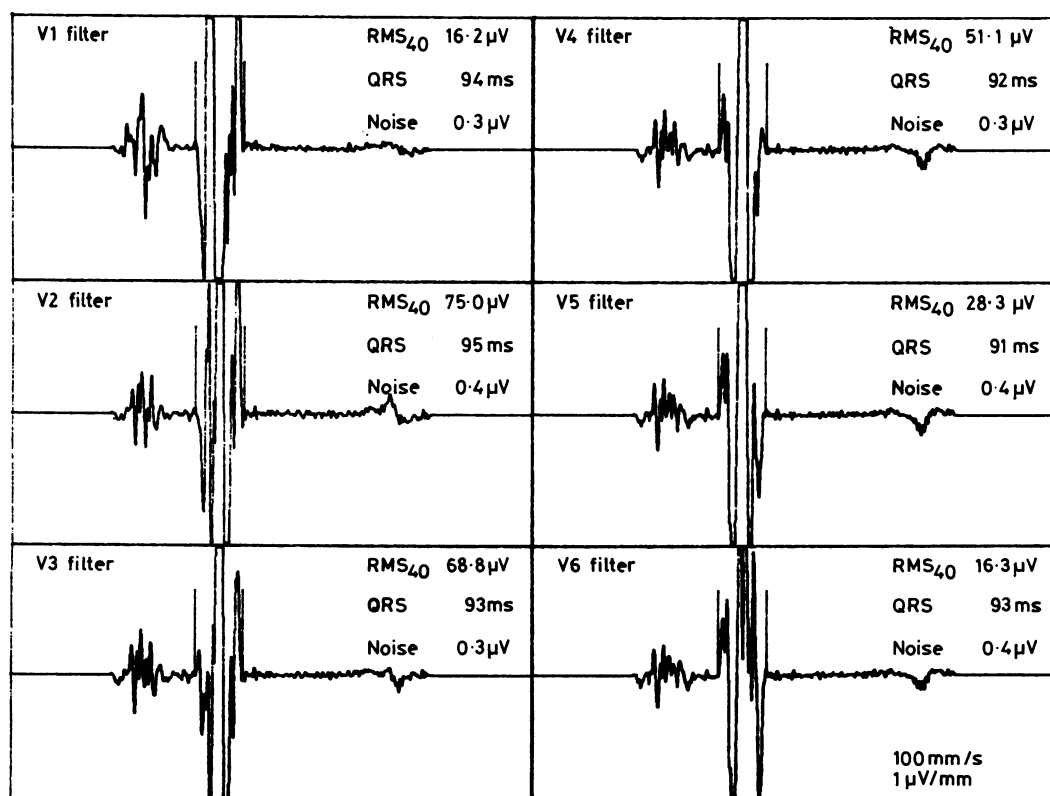
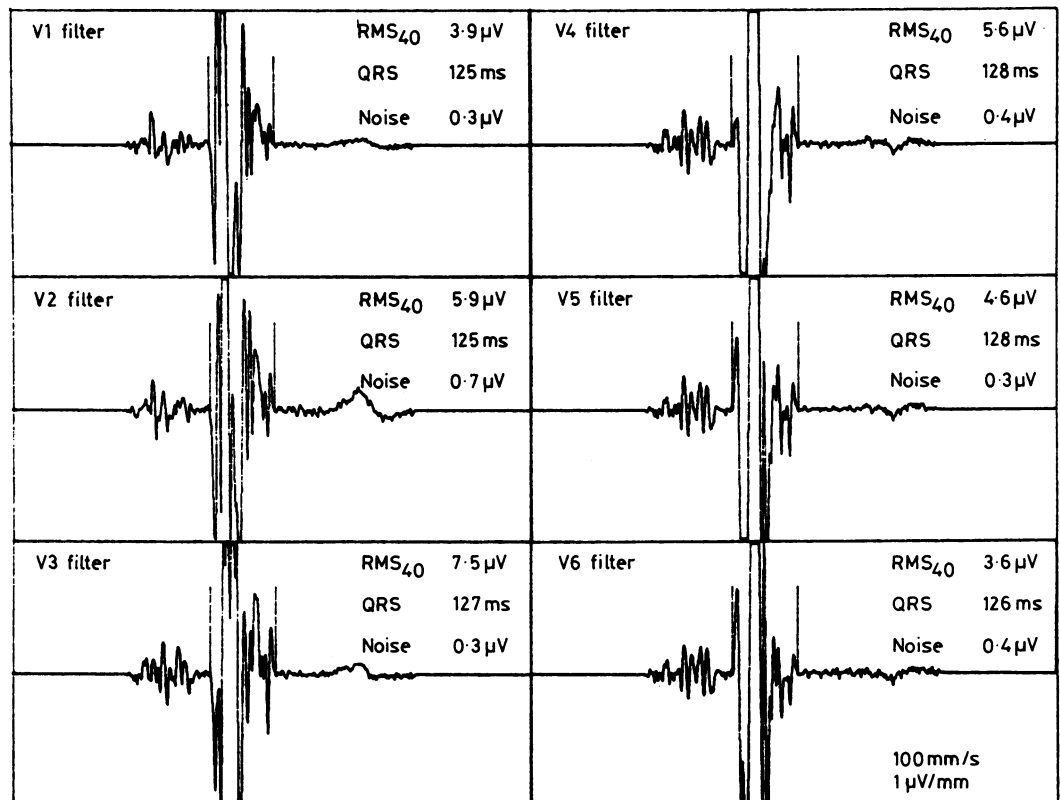


Figure 2 Signal averaged electrocardiogram of six precordial leads in a patient who was not treated with thrombolytic agents. Late potentials are clearly detected at the end of the filtered QRS complexes. The abnormally long QRS duration and low RMS_{40} values are given for each lead.



late potentials between patients in whom reperfusion was successful or unsuccessful (10.4% v 25.0%) was not statistically significant ($p = 0.11$).

Discussion

This study indicates that patients treated with thrombolytic agents within four hours of an acute myocardial infarction are "protected" from the increase in the frequency of late potentials that occurs in patients not treated by thrombolysis. Irwin *et al* and Volosin *et al* reported that late potentials that presented within a few hours of acute myocardial infarction regressed within seven days of successful reperfusion.^{9,10} The difference with our observations may reflect differences in methods. Both groups^{9,10} performed the first signal averaged electrocardiogram earlier than we did, at a time when dynamic changes in the border zone of the acute myocardial infarction are likely. In addition, Irwin *et al* used $RMS_{40} \leq 25 \mu V$ as the sole criterion for late potentials,⁹ while criteria for late potentials were not reported by Volosin *et al*.¹⁰ Like us, Gang *et al* found a reduced incidence of late potentials among successfully reperfused patients.¹¹

To detect late potentials we averaged 12 electrocardiogram leads filtered at a cut off of 60 Hz by a non-recursive digital filter. This method differs from Simson's technique, which is based on the orthogonal (XYZ) lead system, with a bidirectional filter at a cut off of 40 Hz. Our own (unpublished) data and those of others^{12,13} show a comparable or higher detection of late potentials with a multilead rather than a composite XYZ vector. A 60 Hz cut off is within the accepted range of filters used for the detection of late potentials.¹⁴ We

sought an abnormal RMS_{40} and QRS duration in two adjacent leads because we had never found these two features in two or more adjacent leads in healthy individuals.

Our study indicates that thrombolytic treatment may enhance electrical stability, as reflected by the decreased frequency of late potentials. The present study does not establish whether this is an independent effect on the ventricular electrical characteristics or a result of enhanced myocardial salvage (shown by the higher left ventricular ejection fraction after successful reperfusion). This would require a long term study. Several studies showed fewer spontaneous severe arrhythmias and less inducibility of ventricular tachycardia by programmed ventricular stimulation in patients who had undergone thrombolytic treatment.¹⁵⁻¹⁷ Our data accord with these observations of increased electrical stability, which may be partly responsible for the enhanced survival of patients who undergo thrombolytic treatment for acute myocardial infarction.

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