INFLUENCE OF RIGHT VENTRICULAR ISCHEMIA ON PRECORDIAL ST DEPRESSION DURING RIGHT CORONARY ARTERY OCCLUSION

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To determine the cause of precordial ST depression in acute inferior myocardial infarction, we evaluated the relationship between precordial ST deviation and ventricular involvement. Forty-nine patients who were admitted to the hospital with an acute inferior myocardial infarction, and 60 patients who were treated with elective angioplasty to the right coronary artery, were analyzed. All patients had single vessel disease and were divided into 2 groups (A and B) according to the site of the lesion. Patients in group A had a lesion proximal to the largest right ventricular branch, while in group B the lesion was distal to that branch. There were no differences in inferior ST elevation between the 2 groups, but precordial ST segments were more depressed in group B than in group A. A significant correlation was observed between inferior and precordial ST deviation in group B, but not in group A. These results were similar in patients with myocardial infarction and in those treated by angioplasty. These results suggest that precordial ST depression in an evolving inferior infarction is due to reciprocal ST deviation which reflects inferoposterior involvement. In addition, when inferior infarction is accompanied by right ventricular involvement the precordial ST depression is lessened. (*Jpn Circ J* 1993; **57**: 803–808)

PRECORDIAL ST depression is frequently observed in evolving inferior wall myocardial infarction. Several hypotheses have been proposed to explain the ST depression, but an acceptable etiology has not been defined. Although several investigators have reported a relationship between precordial ST depression and scintigraphic findings, findings at left ventriculography or hemodynamic findings,^{1–3} the relationship between precordial ST depression and the site of the lesion has not been examined. We evaluated this relationship in patients with single-vessel right coronary artery disease.

Key words:

Acute inferior infarction
Precordial ST depression
Right ventricular infarction
Reciprocal ST depression

PATIENTS AND METHODS

Patients

The subjects consisted of 109 patients with single-vessel right coronary artery disease. All of the patients were divided into groups A and B according to the site of lesion. Group A consisted of patients with a lesion proximal to the largest right ventricular branch, while group B consisted of patients with a lesion distal to that branch.

Forty-nine patients, 24 patients in group A and 25 in group B, were admitted within 6 h of the onset of a first inferior acute myocardial infarction (inf-AMI). These patients received intra-coronary thrombolytic therapy and/or coronary angioplasty (PTCA) immediately following their admission. All of

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TABLE I PATIENT CHARACTERISTICS

	Patients with inf-AMI		Patients undergoing PTCA	
	A (n=24)	B (n=25)	A (n=39)	B (n=21)
Sex (Male/Female)	17/7	22/3	26/13	12/9
Age (mean $\pm$ SD, (years))	69.6 $\pm$ 10.7	68.2 $\pm$ 9.6	66.0 $\pm$ 10.5	63.0 $\pm$ 6.6
Site of lesion				
Seg. 1	22	4	26	0
Seg. 2	2	8	12	6
Seg. 3	0	8	1	8
Seg. 4	0	5	0	7
Previous MI				
None			21	13
Non-Q MI			8	4
MI with abnormal Q			10	4

inf-AMI=inferior acute myocardial infarction; PTCA=percutaneous transluminal coronary angioplasty; A=Patients with lesions proximal to the right ventricular branch; B=Patients with lesions distal to the right ventricular branch; Seg=segment (based on AHA report²²); MI=myocardial infarction.

TABLE II MEAN ST DEVIATION IN EACH GROUP

	Patients with inf-AMI		Patients undergoing PTCA	
	Inferior ST	Precordial ST	Inferior ST	Precordial ST
A (mV, mean $\pm$ SD)	0.37 $\pm$ 0.26 (n=24)	0.05 $\pm$ 0.32 (n=24)	0.21 $\pm$ 0.12 (n=39)	-0.08 $\pm$ 0.10 (n=39)
B (mV, mean $\pm$ SD)	0.31 $\pm$ 0.20 (n=25)	-0.18 $\pm$ 0.17 (n=25)	0.20 $\pm$ 0.08 (n=21)	-0.18 $\pm$ 0.10 (n=21)
p	NS	<0.005	NS	<0.001

inf-AMI=inferior acute myocardial infarction; PTCA=percutaneous transluminal coronary angioplasty; A=Patients with lesions proximal to the right ventricular branch; B=Patients with lesions distal to the right ventricular branch; NS=Not significant; SD=standard deviation.

the 49 patients showed a total or subtotal obstruction on the initial right coronary angiogram.

Sixty patients, 39 patients in group A and 21 in group B, underwent elective PTCA on the right coronary artery and showed ST elevations of 0.1 mV or more in at least 2 inferior leads (II, III and aVF) during balloon inflation.

Patients with complete atrioventricular block either upon admission or during PTCA were excluded, as were patients whose right coronary arterial system could not be evaluated because of a total obstruction which was not improved with reperfusion therapy. Patients in shock or those with marked congestive heart failure were also excluded. In-

formed consent was obtained from all patients.

Electrocardiographic analyses

Precordial (V1, V2 and V3) and inferior (II, III and aVF) leads were recorded simultaneously. We measured ST deviation in precordial and inferior leads at 80 msec from the J point and calculated the mean ST deviation millivolts (mV). ST elevation and depression were represented as plus and minus millivolts, respectively.

In patients with inf-AMI, the electrocardiograms obtained immediately before reperfusion therapy were analyzed. In patients who underwent PTCA, changes in mean inferior and precordial ST deviation were

Fig.1. Relationship between inferior (II, III, aVF) ST elevation and precordial ST (V1–V3) deviation in patients with acute inferior wall infarction.

A: Patients with lesions proximal to the right ventricular branch.

B: Patients with lesions distal to the right ventricular branch.

N.S.: Not significant.

Fig.2. Relationship between inferior (II, III, aVF) ST elevation and precordial ST (V1–V3) deviation in patients treated by elective coronary angioplasty.

A: Patients with lesions proximal to the right ventricular branch.

B: Patients with lesions distal to the right ventricular branch.

N.S.: Not significant.

calculated by measuring ST deviation before, and 1 min after, beginning balloon inflation.

Statistical analyses

The Student's t-test was used to analyze the differences between mean values and the significance of correlation coefficients. The chi-square test was used to analyze percentages. A p value of less than 0.05 was considered statistically significant.

RESULTS

Patient characteristics

The clinical characteristics of the subjects are shown in Table I. There were no significant differences in age and sex between group A and B. The incidence and severity of previous inferior wall myocardial infarction in patients treated by PTCA did not differ between groups A and B.

ST deviation

Although the mean inferior ST elevation in group A did not differ from that in group B, the mean precordial ST depression in group B was significantly greater than that in group A (Table II). These results were similar in patients with inf-AMI and in those treated by PTCA.

In patients with inf-AMI, 12 patients in group A (12/24, 50.0%) had precordial ST elevation, whereas only 2 patients in group B (2/25, 8.0%) had precordial ST elevation. In patients undergoing PTCA, 7 patients in group A (7/39, 17.9%) had precordial ST elevation during balloon inflation, while no patients in group B (0/21, 0.0%) had precordial ST elevation. These differences were statistically significant ($p < 0.01$).

Relationship between inferior and precordial ST deviation

The relationship between inferior and precordial ST deviation in patients with inf-AMI is shown in Fig. 1. A significant correlation was found between the 2 ST shifts in group B, but not in group A. As shown in Fig. 2, the same results were also observed in patients treated by PTCA.

DISCUSSION

Despite numerous studies, the mechanisms responsible for precordial ST depression in inf-AMI have not been clarified. Some researchers have proposed that anterior wall ischemia due to a lesion in the left anterior descending artery⁴ is responsible for ST depression in inf-AMI. Some investigators have suggested that this condition may be due to ischemia in the inferoposterior,⁵ posterolateral⁶ or inferoseptal wall^{6,7} while others have characterized it as a benign reciprocal electrical phenomenon⁸. Other studies have evaluated patients with multi-vessel disease, or have failed to perform electrocardiography and coronary angiography simultaneously in all patients. In an evolving myocardial infarction, the electrocardiogram is affected by the interval between the onset and the time of recording, the severity of the infarct-related lesion, and the presence of significant stenosis in other coronary arteries. One explanation for the lack of an acceptable cause of precordial ST

depression may be due to the fact that previous studies did not examine a homogeneous population of patients. Therefore, we selected patients who showed either total or subtotal stenosis of only the right coronary artery, and examined the electrocardiograms obtained during angiographic study. By doing so, we were able to exclude other factors which may affect precordial ST deviation and studied just the relationship between precordial ST deviation and the site of the lesion. We were particularly interested in the presence or absence of right ventricular involvement.

In patients who had a lesion distal to the largest right ventricular branch (group B) without right ventricular involvement, there was a significant correlation between inferior ST elevation and precordial ST depression. This observation supports the theory^{2,6} that precordial ST depression in inf-AMI is caused by reciprocal ST depression due to ischemia of the posterior wall. Since the horizontal plane leads (V1–3) are perpendicular to the frontal plane leads (II, III, aVF)⁹, precordial ST depression in inf-AMI represents reciprocal ST deviation of posterior, rather than inferior, leads.

Only 1 report has described the relationship between precordial ST deviation and right ventricular involvement in inf-AMI. Lew et al¹⁰ found a significant correlation between the ST elevation in aVF and the ST depression in V2 in patients without right ventricular involvement. However, they did not describe the severity of the coronary artery lesions and obtained electrocardiograms and coronary angiograms simultaneously in only about 50% of the patients. In contrast, none of our patients had multi-vessel disease, the electrocardiographic and angiographic studies were conducted simultaneously, and the right coronary artery showed either total or subtotal occlusion in all patients.

Patients in group B showed greater precordial ST depression than those in group A, although the degrees of inferior ST elevation in the 2 groups were similar. Some researchers have reported that the ST segment is elevated in the right precordial leads of patients with an acute right ventricular infarction^{11,12}; and in some cases, the precordial ST level is also elevated in V1, V2 or

V3^{13,14} Since the right ventricle is near the anterior middle chest wall, it is reasonable that precordial ST segments are elevated in leads V1, V2 and V3 in right ventricular infarction. Furthermore, Geft et al¹⁵ and Mittal et al¹⁶ have reported that the electrocardiographic manifestations of left ventricular inferoposterior injury can be suppressed due to the electrical forces of a right ventricular infarction. In this study, we demonstrated that more patients showed precordial ST elevation in group A than in group B. These findings suggest that right ventricular involvement markedly affects the direction and magnitude of the precordial ST deviation in inf-AMI. The earlier findings and our present results suggest that precordial ST depression in inf-AMI may be caused by reciprocal ST changes in posterior wall involvement. In contrast, when inf-AMI is accompanied by right ventricular involvement, precordial ST segments are initially elevated, but eventually return to baseline.

In our previous study, no significant correlation was found between precordial ST depression and the size or length of the right coronary artery¹⁷ However, the size of the right ventricular branch can influence the extent of right ventricular involvement in inf-AMI, and the size of the atrio-ventricular branch can determine posterior wall involvement in inf-AMI. Therefore, differences in the sizes of the right ventricular branch and/or atrio-ventricular branch may affect ST deviation and explain the imperfect correlations between precordial and inferior ST segment deviations in group B (Fig. 1 and 2).

Some reports have addressed the clinical importance of precordial ST depression in inf-AMI.¹⁸⁻²⁰ In most studies, patients with precordial ST depression had worse left ventricular function, a higher incidence of complications and a higher mortality rate than those without precordial ST depression. Some of the patients who were analyzed in the above reports had multi-vessel disease, so that diminished left ventricular function due to multi-vessel lesions may have predisposed them to a higher risk of complications or death. Roubin et al²¹ have reported that patients with multi-vessel disease frequently exhibit precordial ST depression during inf-AMI.

Our results indicate that precordial ST segments are depressed in almost all patients with inf-AMI, and that the ST depression is masked when accompanied by right ventricular involvement. Five patients in group A with inf-AMI showed hemodynamic evidence of right ventricular infarction before reperfusion therapy, while none of the patients in group B showed similar evidence. Many group A patients had ST elevation in right precordial leads during PTCA balloon inflation. Patients with inf-AMI and accompanying right ventricular infarction may have more serious disease than those without right ventricular infarction. Therefore, we speculate that inf-AMI patients without precordial ST depression are likely to have more complications than those with precordial ST depression. An earlier report suggested that precordial ST depression does not necessarily require a poor prognosis.³ We think that patients with single right coronary artery lesion should be studied to clarify the relationship between precordial ST depression and disease prognosis.

In this study, we examined patients with inf-AMI and those treated with PTCA. Because the results in the 2 groups were similar, electrocardiograms during PTCA may reflect electrocardiographic changes in acute myocardial infarction.

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