Predictive Value of Admission Electrocardiogram For Multivessel Disease in Acute Anterior and Anterior-Inferior Myocardial Infarction

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Background: Our aim was to investigate the correlation between admission ECG and coronary angiography findings in terms of predicting the culprit vessel responsible for the infarct or multivessel disease in acute anterior or anterior-inferior myocardial infarction (AMI).

Methods: We investigated 101 patients with a diagnosis of anterior AMI with or without ST-segment elevation or ST-segment depression in at least two leads in DII, III, aVF. The patients were classified as those with vessel involvement in the left anterior descending (LAD) coronary artery and patients with multivessel disease. Vessel involvement in LAD + circumflex artery (Cx) or LAD + right coronary artery (RCA) or LAD + Cx + RCA were considered as multivessel disease. Thus, (a) anterior AMI patients with reciprocal changes in inferior leads, (b) anterior AMI patients with inferior elevations, (c) all anterior AMI patients according to the ST-segment changes in the inferior region were analyzed according to the presence of LAD or multivessel involvement.

Results: Presence of ST-segment depression in aVL and V6 was significantly correlated with the presence of multivessel disease in anterior AMI patients with reciprocal changes in the inferior leads ($P = 0.005$ and $P = 0.003$, respectively). No statistically significant difference between the leads were detected in terms of ST-segment elevation in predicting vessel involvement in the two groups of anterior AMI patients with inferior elevations. When all the patients with anterior AMI were analyzed, the presence of ST-segment depression in leads aVL, V4, V5 and V6 were significantly associated with the presence of multivessel disease ($P = 0.035$, $P = 0.010$, $P = 0.011$, $P = 0.001$, respectively).

Conclusions: The presence of ST-segment depression in anterolateral leads in the admission ECG of anterior AMI patients with reciprocal changes in inferior leads was associated with multivessel disease.

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acute anterior myocardial infarction; acute inferior myocardial infarction; electrocardiography;
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In admission ECG's of patients with anterior wall acute myocardial infarction (AMI), ST-segment elevations may be seen in the chest leads, and ST-segment depression or ST-segment elevation is sometimes observed simultaneously in the inferior leads. ST-segment depression in inferior leads associated with anterior wall AMI is usually suggested to be a reciprocal change of ST-segment

elevation in the chest leads, whereas inferior ST-segment elevation occurring during anterior AMI are linked to the size of anterior wall AMI.^{1,2} There are few studies on vessel involvement which are responsible for reciprocal changes and those cases with co-existing inferior AMI. We assessed patients with anterior AMI according to ST-segment changes in inferior leads and intended to correlate

Table 1. Comparison of Cases of Anterior Wall AMI With Reciprocal Changes in the Inferior Leads With Single or Multivessel Involvement, According to the Presence of ST Segment Depression in Each of the Leads

	ST Segment Depression										
	DI	DII	DIII	aVL	aVF	V1	V2	V3	V4	V5	V6
LAD (n:44)	0	26	32	2	30	0	0	0	0	1	3
MVD (n:28)	3	16	18	9	17	0	0	0	2	2	10
P value	NS	NS	NS	0.005	NS	NS	NS	NS	NS	NS	0.003

AMI = acute myocardial infarction; LAD = left anterior descending; MVD = multivessel disease; NS = not significant.

findings in the initial ECG with infarct-related artery or multivessel disease.

METHODS

One hundred one patients with a diagnosis of anterior AMI admitted at our hospital between December 1996 and May 2001. Criteria for AMI diagnosis were: chest pain continuing more than 30 minutes and not responding to nitrates, serum creatine kinase (CPK-MB) MB isoenzyme level over 1.5 times the upper limit of normal, and ≥ 1 mm ST-segment elevation in at least two adjacent chest leads. Admission ECGs were evaluated in patients admitted in the first 3 hours after the chest pain started. The patients were classified in two separate groups, according to the presence of ≥ 1 mm ST-segment elevation or depression in at least two adjacent leads among II, III, and aVF. ST-segment deflections were measured at 0.08 seconds after J point.

Coronary angiograms with cardiac catheterization were performed on these 101 patients in order to demonstrate the infarct-related artery (IRA) or other vessels involved in the first 30 days. The average timing for catheterization is 14 ± 4 days (ranges between 6 and 30 days). IRA was determined in all cases.

Coronary angiographies were done by using "Sones" or "Judkins" techniques. Left ventriculographies were performed according to standard techniques. Stenosis $\geq 50\%$ in coronary vessels was considered significant. IRA was detected according to the presence of intraluminal thrombus, residual stenosis, and/or regional wall motion abnormalities. All coronary angiographies were evaluated by two cardiology specialists blinded to patient characteristics. Left anterior descending artery (LAD), circumflex artery (Cx), and right coronary artery (RCA) were evaluated. The patients

were classified as those with LAD lesions only and those with multivessel disease. Multivessel disease was defined as involvement of LAD + Cx or LAD + RCA or LAD + Cx + RCA. Thus, (a) anterior AMI patients with reciprocal changes in inferior leads, (b) anterior AMI patients with inferior elevations, © all anterior AMI patients according to the ST-segment changes in the inferior region were analyzed according to the presence of LAD or multivessel involvement.

Statistical Analysis

The results were analyzed with Fisher's exact test. $P < 0.05$ was considered as significant for all analyses.

RESULTS

Coronary angiography was performed on 101 patients. There were no differences between the groups in terms of mean age, duration of coronary angiography, and thrombolytic therapy applications.

(1) There were 72 inferior lead ST-segment depression associated with anterior AMI (Table 1). When the patients were evaluated angiographically for LAD or multivessel involvement, there were 44 cases with single vessel (LAD) involvement in angiograms and 28 with multivessel disease. The presence of ST-segment depression in leads aVL and V6 were significantly correlated with the presence of multivessel disease ($P = 0.005$ and $P = 0.003$, respectively).

(2) The total number of anterior AMI patients with inferior elevations were 29 (Table 2). there were 12 with single vessel (LAD) involvement, and 17 cases with multivessel involvement. No statistical difference were found between the two groups

Table 2. Comparison of Cases of Anterior Wall AMI With Reciprocal Changes in the Inferior Leads With Single or Multivessel Involvement, According to the Presence of ST Segment Elevation in Each of the Leads

	ST Segment Elevation										
	DI	DII	DIII	aVL	aVF	V1	V2	V3	V4	V5	V6
LAD (n:12)	7	7	9	8	8	11	11	11	11	9	10
MVD (n:17)	8	10	13	10	13	15	15	16	16	12	13
P value	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

AMI = acute myocardial infarction; LAD = left anterior descending; MVD = multivessel disease; NS = not significant.

in terms of prediction of vessel involvement by ST-segment elevation in all leads.

(3) When all patients with anterior AMI were evaluated, the total number of patients were 101. Fifty-five patients had LAD involvement and 46 had multivessel disease. When analyzed for ST depression, the presence of ST-segment depression in aVL, V4, V5, and V6 was found to be statistically significantly associated with multivessel disease ($p = 0.035$, $P = 0.010$, 0.011 , and 0.001 , respectively) (Table 3). The presence of ST-segment depression in lateral leads in the admission ECG predictive of the presence of multivessel disease was highly specific. When evaluated in terms of ST-segment elevation, no significant difference was found between single vessel (LAD) and multivessel involvement (Table 4).

CONCLUSIONS

Various investigators agree that ST-segment depression seen in inferior leads of the admission electrocardiograms of patients with anterior AMI reflects a reciprocal electrical phenomenon, and not ischemia in that particular region.^{3,4} Reciprocal ST-segment depressions are not considered to reflect the severity of coronary artery disease, as it is correlated with the ST-segment elevation in the precordial leads.

Crawford et al.³ have suggested that the electrical vector moves away from the inferior region in their study with 13 baboons, in which they clamped the distal one-third portion of the LAD, and observed ST-segment depression in the inferior region and ST-segment elevation in lead I. In another study by the same authors, in which an epicardial electrode was placed in the inferoposterior region in baboons, they could not detect evidences of ischemia in the inferoposterior region. They concluded that the reciprocal changes in AMI do not show the presence of ischemia in remote regions. Lew, et al.⁴ investigated the correlation between coronary angiograms and initial ECGs of 60 patients with anterior AMI. In 34 patients in whom the anterior wall of the left ventricle and the apex receives blood from the LAD, there was ST-segment depression in the inferior leads, and in 16 patients in whom the posterior and inferior wall of the left ventricle receives blood from the LAD and 10 patients with old MIs in whom RCA or Cx is totally occluded and blood is received by collateral circulation from the left system, there was ST-segment elevation in the inferior region. These investigators have concluded that ST-segment depression is an electrical phenomenon.

ST-segment depression in the inferior wall is frequent in proximal LAD⁵ and 1. diagonal branch

Table 3. Comparison of Cases of Anterior AMI With Reciprocal Changes or Elevations in the Inferior Leads With Single or Multivessel Involvement, According to the Presence of ST Segment Depression in Each of the Leads

	ST Segment Depression										
	DI	DII	DIII	aVL	aVF	V1	V2	V3	V4	V5	V6
LAD (n:55)	27	33	29	3	4	0	0	0	1	2	2
MVD (n:46)	16	21	11	9	9	0	2	2	8	10	13
P value	NS	NS	NS	0.035	NS	NS	NS	NS	0.010	0.011	0.001

AMI = acute myocardial infarction; LAD = left anterior descending; MVD = multivessel disease; NS = not significant.

Table 4. Comparison of All Cases of Anterior AMI With Reciprocal Changes or Elevations in the Inferior Leads With Single or Multivessel Involvement, According to the Presence of ST Segment Elevation in Each of the Leads

	ST Segment Elevation										
	DI	DII	DIII	aVL	aVF	V1	V2	V3	V4	V5	V6
LAD (n:55)	11	10	12	40	41	54	54	54	54	47	32
MVD (n:46)	11	12	15	27	30	36	40	41	38	41	29
P Value	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

AMI = acute myocardial infarction; LAD = left anterior descending; MVD = multivessel disease; NS = not significant.

occlusion in anterior AMI.⁶ These investigators had suggested that ST-segment depression >1 mm in the inferior region with ST-segment elevation in leads I and aVL occurs in LAD lesions proximal to the 1. diagonal branch.⁶ These findings reflect reciprocal changes in anterior AMI.

Bairey, et al.⁷ found the Cx to be the IRA with 80% sensitivity and 93% specificity when there is ST-segment elevation in at least one lateral lead and two inferior leads. Lead aVL reflects the basal portion of the free wall of the left ventricle. This region receives blood from both the 1. diagonal and 1. obtuse marginal branches.⁸ Theoretically, ST-segment elevation in aVL suggests occlusion in one of these branches or in LAD or the proximal portion of Cx, from which these branches originate.

Investigators have put forward various hypothesis to detect involvement of LAD, Cx, or RCA as IRA in AMI.^{9,10} Birnbaum, et al.¹¹ suggested that ST-segment elevation in aVL in AMI reflects occlusion in either proximal LAD, or first diagonal or first obtuse marginal (OM) branch. It was suggested that ST-segment elevation in aVL and V2-5 reflects occlusion of LAD before the first diagonal branch, isoelectric ST-segment, or ST elevation in leads V3-5 reflects occlusion of the first diagonal branch; ST-segment elevation in aVL with ST-segment depression in V2 reflects occlusion of the first OM. Midgett, et al.⁹ have developed a scoring system to predict the IRA according to ST-segment and T wave changes in the initial electrocardiograms. These investigators have suggested that the sum of the ST-segment elevation between V1-4 and the sum of T wave inversion in leads I, aVL and V5 may show which vessel among LAD, Cx, or RCA is the IRA. When the sum of the ST-segment elevations in the anterior region increases and the sum of T wave inversions in the lateral region decreases, the probability of IRA to be LAD increases; on the other hand, when the sum of the

ST-segment elevations in the anterior region decreases, as the sum of the T wave inversions in the lateral region increases, the probability of RCA to be the IRA also increases. When both the sum of the ST-segment elevations in the anterior region and the sum of the T wave inversions in the lateral region decrease together, Cx was reported to be the most probable candidate as IRA.

IRA was attempted to be detected by using 12-lead ECG findings in various studies. But in these studies, the IRA in anterior AMI was a single vessel and LAD, and IRA in inferior AMI was only RCA or Cx. Involvement of both LAD and Cx, or LAD and RCA, or LAD, Cx, and RCA as critical stenoses are commonly seen in the coronary angiograms of patients with anterior AMI. As we found in the present study, 39% of the patients with reciprocal changes in the inferior region have multivessel disease. Also, 58% of the patients with inferoanterior AMI have multivessel disease. When the important effect of proximal LAD lesions on prognosis is considered, it is obvious that the ability to predict LAD occlusion with the initial ECG is crucial, as well as the presence of multivessel disease along with LAD lesions. As we have shown in the present study, in patients with anterior AMI, LAD involvement is present either as single or multivessel disease. When findings of other studies are also considered, in 88% of the patients with only LAD involvement and 74% of the patients with multivessel disease have ST-segment elevation in lead aVL and this finding does not predict multivessel involvement. Reciprocal changes in the inferior region may be seen in both LAD involvement or multivessel disease. This finding shows that the predictive value of ST-segment elevation in aVL in multivessel disease or presence of reciprocal changes in the inferior region is insufficient. On the other hand, the presence of ST-segment depression in the lateral leads in patients with anterior or antero-inferior

AMI can predict multivessel disease as opposed to LAD only.

We conclude that the presence of ST-segment depressions in the anterolateral leads of the initial electrocardiograms of the patients with anterior AMI is useful for prediction of multivessel disease.

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