SIGNIFICANCE OF ST ELEVATION IN LEAD V_1 IN ACUTE ANTERIOR MYOCARDIAL INFARCTION: A PULSED WAVE TISSUE DOPPLER ECHOCARDIOGRAPHY STUDY

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Summary

Recent studies have focused upon the significance of ST segment elevation (STE) in lead V_1 in acute anterior myocardial infarctions (AAMI). Our study investigated whether STE in V1 is associated with alterations in regional and global left ventricular functions determined by tissue Doppler (TD) imaging mitral annulus corners. Standard echocardiography and TD imaging of four sites of mitral annulus were performed to 47 consecutive patients with AAMI within 36 hours of hospital admission. Correlations between the maximum STE amplitude in V_1 and TD velocities were analyzed.

The amplitude of STE in V_1 significantly correlates with early diastolic TD velocities of septal (r= -0.49), anterior (r= -0.47) and inferior mitral annulus (r= -0.51), early to late diastolic TD velocity ratio of inferior mitral annulus (r= -0.48), and mean early diastolic TD velocity (r= -0.52). A subgroup analysis revealed that patients with STE of 2 mm in V1 (32%) had significantly lower peak systolic and late diastolic TD velocity at septal annulus (5.9 ±1.8 cm/s vs. 6.8 ±1.3 cm/s; p=0.03 and 9.1 ±2.5 cm/s vs. 10.6 ±1.8 cm/s; p=0.02, respectively), early diastolic velocity at lateral mitral annulus (6.1 ±1.7 cm/s vs. 8.1 ±2.6 cm/s; p=0.02), and mean systolic TD velocity (6.2 ±1.2 cm/s vs. 6.8 ±0.9 cm/s; p=0.04).

In patients with AAMI, a pronounced STE in V_1 is associated with high degree of functional impairment involving both infarct-related and apparently best functioning portions of the left ventricle as determined by TD analysis of different mitral annulus corners. ***(Arch Turk Soc Cardiol 2003;31:432-9)***

Key words: *Acute myocardial infarction, electrocardiography, tissue Doppler echocardiography*

Özet

Akut Anteriyor Miyokard İnfarktüsünde V_1 Derivasyonundaki ST Elevasyonunun Önemi: Bir Pulsed Wave Doku Doppler Ekokardiyografi Çalışması

Yakın zamanda yapılan çalışmalar akut anteriyor miyokard infarktüsünde (AAMi) V_1 derivasyonundaki ST segment elevasyonunun (STE) önemi üzerinde odaklanmıştır. Bizim çalışmamızda V_1'deki STE ile mitral anulus köşesinden doku Doppler (DD) yöntemi ile belirlenen sol ventrikül bölgesel ve global fonksiyonlarındaki değişimin ilişkisi araştırıldı.

Kırk yedi ardışık AAMi'lü hastaya hastaneye kabulünden sonraki ilk 36 saat içinde standart ekokardiyografi ve

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mitral anulusun dört köşesinde DD görüntüleme uygulandı. V_1derivasyonundaki maksimum STE amplütüdü ile DD hızları arasındaki korelasyon incelendi.

V_1'deki STE amplütüdünün septal (r=-0.49), anteriyor (r=-0.47) ve inferiyor (r=-0.51) mitral anulusun erken diyastolik DD hızları, inferiyor mitral anulusun (r=-0.48) erken diyastolik DD hızının geç diyastolik DD hızına oranı ve ortalama erken diyastolik DD hızı (r=-0.52) ile anlamlı olarak korelesyonu gösterildi. Alt grup analizinde V_1'de 2 mm ST elevasyonu olan hastalarda (32%) septal anulusdaki zirve sistolik ve geç diyastolik DD hızları (sırasıyla 5.9 ±1.8 cm/s'ye karşın 6.8 ±1.3 cm/s; p=0.03 and 9.1 ±2.5 cm/s'ye karşın 10.6 ±1.8 cm/s; p=0.02), lateral mitral anulustaki erken diyastolik hız (6.1 ±1.7 cm/s'ye karşın 8.1 ±2.6 cm/s; p=0.02) ve ortalama sistolik DD hızı (6.2 ±1.2 cm/s'ye karşın 6.8 ±0.9 cm/s; p=0.04) anlamlı olarak düşük bulundu. Sonuç: Akut anteriyor miyokard infarktüslü hastalarda V_1 derivasyonundaki belirgin STE, farklı mitral anulus köşelerinin DD analizi ile belirlenen ve sol ventrikülün infarktla ilişkili bölgesi ile birlikte en iyi fonksiyon gören bölgesini tutan yüksek derece fonksiyonel bozulma ile ilişkilidir. ***(Türk Kardiyol Dern Arş 2003;31:432-9)***

Anahtar Kelimeler: *Akut miyokard infarktüsü, doku Doppler ekokardiyografi, elektrokardiyografi*

In patients with acute anterior myocardial infarction, ST segment elevation is infrequently observed in lead V_1 when compared to other electrocardiographic (ECG) derivations[1]. The absence of ST elevation in lead V_1 in many patients has been explained by the double circulation of septum, which is mainly supplied by the septal branches of left anterior descending artery, and additionally receives blood from a conal branch of right coronary artery in a proportion of human beings[2,3]. Furthermore, ST elevation in V_1-4 was reported to occur as a result of right coronary artery occlusion in a small fraction of patients[4]. Tissue Doppler echocardiography extends the echocardiographic interrogation to quantitatively measure the velocities of a selected region of interest. Because the apex is almost fixed throughout the cardiac cycle, analyzing the tissue Doppler profiles of different sites of left atrioventricular annuli enables a quantitative assessment of ventricular long axis function[5-7]. In the present study, the tissue Doppler spectra of septal, lateral, anterior and inferior mitral annulus were analyzed to investigate whether the presence of ST segment elevation in lead V_1 is associated with an additional impairment in left ventricular functions, and whether the amplitude of ST elevation in V_1 correlates with the degree of left ventricular functional impairment.

METHODS

Between March to November 2001, 47 consecutive patients with a first acute anterior myocardial infarction who admitted to our coronary care unit were enrolled into the study group. Exclusion criteria were: 1) previous myocardial infarction, 2) concomitant inferior infarction, 3) any complete bundle branch block or AV block, 4) atrial fibrillation 5) mortality or hemodynamic instability within 2 days of admission. The diagnosis of acute anterior myocardial infarction was based on a clinical episode of prolonged chest pain, diagnostic serial changes in creatine kinase MB isoenzyme, and ST segment elevation > 1mm at least in two anterior ECG derivations. Intravenous thrombolytic therapy with either streptokinase (n=18) or t-PA (n=17) was performed to 35 patients. Other 12 patients received conventional treatment without any reperfusion therapy.

ECG analysis

Electrocardiograms were assessed by two observes (M.Y, Ç,G) that were unaware of the echocardiographic data. Between the multiple ECG recordings within the first 24 hours of MI, the maximum amplitude of ST segment deviation in leads was recorded. ST segment deviation relative to the TP segment was measured at 60 ms from the J point. ST elevation of > 1 mm for precordial derivations and > 0.5 mm for limb leads and V5-6 were considered significant. ST segment elevation in V1 of >1mm was observed in 24 (51%) of 47 patients. Pathological Q waves developed in all cases.

Standard echocardiography

The patients underwent the examination within 36 hours of admission. All examinations were performed at left lateral decubitus position by using a commercially available diagnostic system equipped with 2,5 - 3,5 MHz transducers and a pulsed wave tissue Doppler program. The images that were obtained during quite breathing were stored on half-inch super VHS magnetic tape for later analysis by an independent observer who was masked to the ECG findings. The measurements represent the mean of at least three consecutive cardiac cycles.

M-mode measurements of left ventricular and left atrial diameters were made on parasternal long axis view according to the criteria of the American Society of Echocardiography[8]. Transmitral early and late diastolic velocities, and deceleration time of early diastolic filling were obtained by previously described methods [9]. The apical four-chamber view was preferred to determine the left ventricular diastolic and systolic volumes. Ejection fraction was calculated by the modified Simpson rule. In order to calculate the wall motion score index, the left ventricle was divided into 16 segments. Segmental wall motion was graded from normal (score=1) to dyskinetic (score=4). The wall motion score index was calculated by summation of individual segment scores divided by the number of interpreted segments.

Doppler tissue imaging of mitral annulus

Spectral pulsed wave tissue Doppler samplings were obtained by placing four sample volumes on the endocardial portions of septal – lateral corners of mitral annulus in apical four –, and anterior – inferior corners of mitral annulus in apical two-chamber views. A 3.5 MHz transducer was used, and the lowest possible Nyquist limits were selected. The velocity patterns were recorded at a sweep speed of 100mm/s with simultaneous ECG tracings. The first systolic velocity reflecting isovolumic contraction was ignored, and the positive systolic velocity and negative early – and late diastolic velocities obtained during three consecutive cardiac cycles were recorded. The mean of four systolic and early diastolic velocities at mitral annuli were also calculated and analyzed.

Statistical analysis

SPSS 8.0 software was used for the statistical analyzes. Pearson correlation coefficient was used to test the relations between the ST elevation amplitudes and echocardiographic parameters. Standard echocardiography and tissue Doppler parameters of subgroups were compared by using the Mann Whitney U test. Significance was set at a p value < 0.05. To test the the intra – and interobserver variability's, the measurements of peak annular Doppler velocities of randomly selected 20 samplings by two observers and the same observer at different times were determined with the linear regression analysis and percent SEE. The correlation coefficients and percent SEE of two sets of peak TDE velocity measurements were $r = 0.99$, 5.2% for intraobserver –, and $r = 0.96$, 8.6% for interobserver determinations.

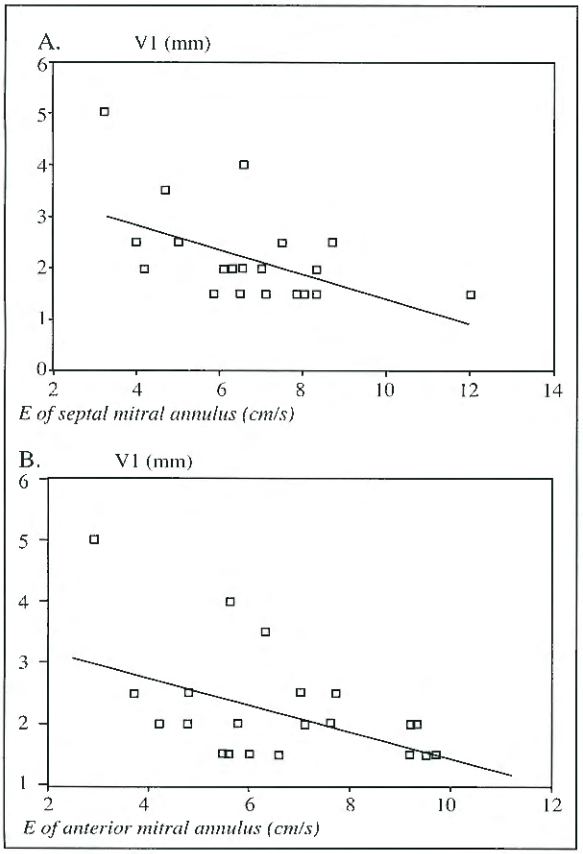
RESULTS

Clinical characteristics, prevalence's of ST elevations, and conventional echocardiographic indexes of 47 patients are summarized in Table 1. The patients were asymptomatic during the echocardiographic study; no patient had moderate to severe valvular regurgitation. All patients included had left ventricular echocardiographic wall motion abnormalities confirming the diagnosis of an anterior wall myocardial infarction. In 24 patients with ST segment elevation of > 1 mm in V_1, there was no correlation between the standard echocardiography indexes of left ventricular functions and the amplitude of V_1-ST elevation. However the amplitude of V_1-ST elevation showed significant linear associations with early diastolic tissue Doppler velocities of septal ($r = 0.49$, $p = 0.01$), anterior ($r = -0.47$, $p = 0.02$) and inferior mitral annulus ($r = -0.51$, $p = 0.01$), with the ratio of early – to late diastolic tissue Doppler velocity at inferior mitral annulus ($r = 0.48$, $p = 0.02$), and with the mean early diastolic tissue Doppler velocity of four sites ($r = 0.52$, $p = 0.01$) (Figure 1).

Table 1. *Clinical variables, standard echocardiography indexes and prevalence's of ST elevations in 47 patients with acute anterior myocardial infarction*

Variable	Variable		
Age (yrs)	56 ±11	Lead D1	15/47 (32%)
Men	45/47 (96%)	Lead aVL	19/47 (40%)
Hypertension	12/47 (26%)	Lead aVR	12/47 (26%)
Diabetes mellitus	8/47 (17%)	Lead V1	24/47 (51%)
Current smoker	40/47 (85%)	Lead V2	44/47 (94%)
Thrombolysis	35/47 (74%)	Lead V3	46/47 (98%)
LVDV-I (ml/m2)	69 ±15	Lead V4	35/47 (74%)
LVSV-I (ml/m2)	42 ±14	Lead V5	29/47(62%)
EF (%)	41 ±11	Lead V6	18/47 (38%)
WMSI	1,9 ±0.4		
E/A	0.99 ±0.3		
E-DT (ms)	157 ±42		

LVDV-I: *left ventricular end-diastolic volume index,* ***LVSV-I:*** *left ventricular end-systolic volume index,* ***EF:*** *ejection fraction,* ***WMSI:*** *wall motion score index,* ***E/A:*** *the ratio of early to late diastolic transmitral flow,* ***E-DT:*** *deceleration time of early diastolic transmitral velocity*



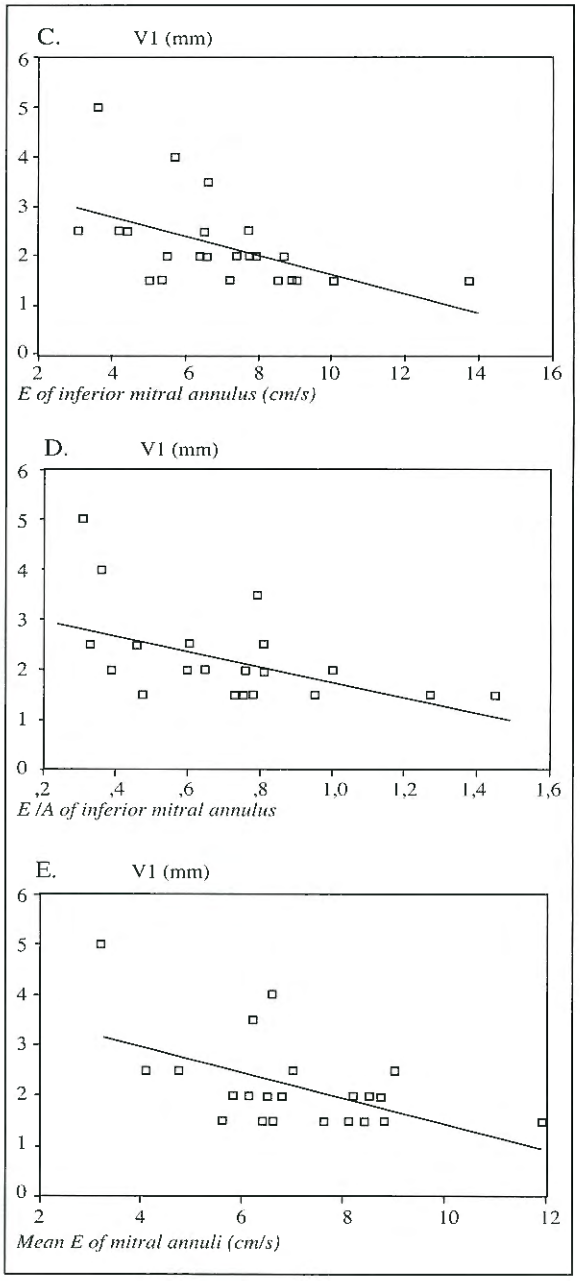


Figure 1: *Negative linear associations observed in 24 patients with V_1-ST elevation of > 1 mm between the amplitude of ST elevation and A. early diastolic tissue Doppler velocity (E) of septal mitral annulus (r= -0.49, p = 0.01), B. E of anterior mitral annulus (r= -0.47, p = 0.02), C. E of inferior mitral annulus (r= -0.51, p = 0.01), D. the ratio of early – to late diastolic tissue Doppler velocity (E/A) at inferior mitral annulus (r= -0.48, p=0.02),*
E. the mean E velocity of septal, lateral, anterior and inferior mitral annuli (r= -0.52, p = 0.01)

Table 2: *Comparison of standard echocardiography indexes and ST elevation amplitudes of other ECG derivations between patients with and without ST segment elevation of ≥2mm in lead V1*

Variable	V1 (+) (n=15)	V1 (-) (n=32)	p	Variable	V1 (+) (n=15)	V1 (-) (n=32)	p
LVDV-I (ml/m^2)	68 ±18	70 ±15	NS	D1 (mm)	1.3 ±0.4	1.4 ±0.4	NS
LVSV-I (ml/m^2)	44 ±18	41 ±12	NS	a VL (mm)	1.6 ±0.7	1.9 ±1.2	NS
LA-I (mm/m^2)	18.7 ±2.3	19.5 ±2.1	NS	aVR (mm)	1.9 ±0.8	1.5 ±0.7	NS
EF (%)	37 ±13	42 ±10	NS	V2 (mm)	4.4 ±1.8	3.5 ±2.2	0.03
WMSI	2.0 ±0.4	1.8 ±0.4	NS	V3 (mm)	5.3 ±2.8	3.8 ±2.4	0.01
E/A	1.0 ±0.4	1.0 ±0.3	NS	V4 (mm)	4.5 ±2.2	3.8 ±1.9	NS
DT (ms)	151 ±42	160 ±43	NS	V5 (mm)	3.1 ±2.3	3.3 ±2.8	NS
				V6 (mm)	2.4 ±1.6	1.9 ±1.0	NS

LVDV-1: left ventricular end-diastolic volume index, LVSV-1: left ventricular end-systolic volume index, LA-1: left atrial end-systolic dimension index; EF: ejection fraction, WMSI: wall motion score index, E/A: the ratio of early to late diastolic Doppler velocity, DT: deceleration time of early diastolic Doppler velocity

Table 3: *Comparison of tissue Doppler velocities of four sites of mitral annulus between patients with and without ST segment elevation of ≥2mm in lead V1*

Variable	V1 (+) (n=15)	V1 (-) (n=32)	Variable	V1 (+) (n=15)	V1 (-) (n=32)
Sep S (cm/s)	5.9 ±1.8*	6.8 ±1.3	Ant E (cm/s)	6.1 ±1.9	7.2 ±2.1
Sep E (cm/s)	6.1 ±1.6	7.2 ±1.8	Ant A (cm/s)	8.5 ±1.7	9.4 ±2.1
Sep A (cm/s)	9.1 ±2.5*	10.6 ±1.8	Ant E/A	0.7 ±0.3	0.8 ±0.3
Sep E/A	0.7 ±0.3	0.7 ±0.2	Inf S (cm/s)	6.9 ±1.2	7.6 ±1.2
Lat S (cm/s)	7.1 ±1.7	7.3 ±1.4	Inf E (cm/s)	6.1 ±1.7*	8.1 ±2.6
Lat E (cm/s)	7.4 ±2.6	8.5 ±2.1	Inf A (cm/s)	10.5 ±2.4	11.2 ±2.3
Lat A (cm/s)	11.1 ±3.0	10.9 ±2.1	Inf E/A	0.6 ±0.2	0.8 ±0.3
Lat E/A	0.7 ±0.3	0.8 ±0.3	S mean (cm/s)	6.2 ±1.2*	6.8 ±0.9
Ant S (cm/s)	4.9 ±0.8	5.5 ±1.2	E mean (cm/s)	6.5 ±1.7	7.8 ±1.9

*Sep: septal site of mitral annulus; Lat: lateral site of mitral annulus: Ant: anterior site of mitral annulus; Inf: inferior site of mitral annulus; S: peak systolic velocity; E: early diastolic velocity; A: late diastolic velocity; *significant at p<0.05 level*

When patients were subdivided based on the presence of ST segment elevation 2 mm in lead V_1, 15 (32%) patients with ST elevation of 2 mm in V_1 had significantly lower peak systolic – and late diastolic tissue Doppler velocity at septal annulus (5.9 ±1.8 cm/s vs. 6.8 ±1.3 cm/s; p=0.03 and 9.1 ±2.5 cm/s vs. 10.6 ±1.8 cm/s; p=0.02, respectively), early diastolic velocity at lateral mitral annulus (6.1 ±1.7 cm/s vs. 8.1±2.6 cm/s; p=0.02), and mean systolic velocity of four mitral annular corners (6.2 ±1.2 cm/s vs. 6.8 ±0.9 cm/s; p=0.04) (Table 3). These patients had lower ejection fraction, larger end-systolic left ventricular volume index, and shorter deceleration time of early diastolic filling; however these differences did not reach a statistical significance (Table 2).

Other anteroseptal ECG derivations

ST segment elevation of > 1mm in V2, V3 and V4 was observed in 44 (94%), 46 (98%) and 35 (74%) patients, respectively. Statistically significant but weak correlations were found

between both V2, V3 and late diastolic tissue Doppler velocity of lateral mitral annulus (r = + 0.37, p = 0.01 for both) V3 and early – to late diastolic velocity ratio of lateral mitral annulus (r = -0.32, p = 0.02), and between V4 and peak systolic velocity of lateral mitral annulus (r = -0.38, p = 0.02). Neither standard echocardiography indexes of ventricular functions nor any tissue Doppler velocity of septal, anterior, inferior mitral annulus were found to be correlated with the amplitude of ST elevations in these ECG leads.

DISCUSSION

The present study demonstrated that the amplitude of ST elevation in V_1 significantly correlates with regional and global impairment of left ventricular longitudinal relaxation as demonstrated by alterations in early diastolic tissue Doppler velocities of anterior, septal, surprisingly inferior mitral annular corners, and the mean early diastolic velocity of four sites of mitral annulus in patients suffering an acute myocardial infarction. Patients with ST elevation of 2 mm in V_1 had significantly lower septal annular and mean annular systolic –, inferior annular early diastolic –, and septal annular late diastolic Doppler tissue velocities when compared to patients without ST elevation or with that of < 2mm in lead V_1.

The development of tissue Doppler echocardiography modalities has allowed researchers to explore the important role of systolic shortening and diastolic lengthening of left ventricle in assessing its global and regional function in healthy subjects and various clinical states[5,6,10,11,12]. Because the apex is effectively fixed without any longitudinal motion, measuring Doppler tissue velocities of mitral annulus throughout the cardiac cycle enables quantitative assessment of contraction and relaxation of longitudinally aligned myocardial fibers[13]. Henein et al[14] suggested that left ventricular long axis motion might be more sensitive to ischemia than the short axis function. The effect of an acute myocardial infarction on mitral annular velocity profile has been reported by some recent studies, which demonstrated that patients with myocardial infarction have reduced systolic and early diastolic velocities and early to late diastolic velocity ratios in mitral annular corners when compared to healthy subjects[15,16]

The significance of ST elevation in V_1 and the traditional term "anteroseptal myocardial infarction" have been interrogated in some recent studies. Shalev et al[17] demonstrated that the ECG pattern of anteroseptal infarct is closely related to anteroapical involvement, and the true anteroseptal infarct is associated with more diffuse ECG changes. In a study by Palmes et al[18], 5 of 9 patients with septal infarct had reduced systolic TDE velocity at apparently normal lateral walls. Engelen et al[19] suggested that only V_1 out of four anteroseptal derivations discriminates between proximal and distal left anterior descending artery occlusions in the individual patient. Porter et al reported that patients with ST segment elevation in V_1 had more frequent echocardiographic wall motion abnormalities in basal anterior and septal segments within 48 hours of hospital admission. The observations of Ben-Gal et al[2,3] emphasized a link between the absence of ST elevation in V_1 and presence of a double circulation protecting interventricular septum by a large conal branch of right coronary artery. Earlier observations of Geft et al[4] showed that a right coronary occlusion might occasionally result in ST elevation in lead V_1. The results of our study are consistent with the data mentioned above in demonstrating that a pronounced ST elevation in V_1 is associated with an extensive left ventricular impairment, which does not only involve the septum and anterior wall, but also results in an impairment of longitudinal relaxation activity in the apparently best functioning inferior left ventricular portion. Mean systolic velocity of mitral annular corners, a parameter previously reported to reflect the left ventricular global systolic function[15,16], was significantly lower in patients with ST elevation of 2 mm. The lack of any correlation between mean – or septal annular peak systolic velocity

emphasized that the "presence" rather than the amplitude of ST elevation is accompanied by a decreased systolic performance. On the other hand, mean early diastolic velocity decreases as the ST elevation in V_1 increases, suggesting that a pronounced ST elevation in V_1 might be attributed to a global diastolic dysfunction. Other anteroseptal leads, which only had some weak correlations with tissue Doppler parameters of lateral mitral annulus, are far from reflecting a specific anterior-septal impairment. Considering all these findings and other recent data[2,3,19], an anterior myocardial infarction might be termed an "extensive" one when ST elevation in V_1 is prominent, and traditional electrocardiographic terms subdividing anterior myocardial infarctions based on earlier postmortem studies should be reevaluated.

Study limitations

The study group was small and the data provides no prognostic information. Tissue Doppler echocardiography parameters analyzed in this study does not reflect short axis contraction or relaxation of left ventricle; however longitudinally aligned myocardial fibers are prominent in ventricular myocardium, with the exception of septum that contracts circumferentially[13]. The variable degree of involvement in apical regions might result in smaller alterations in mitral annular dynamics when compared to the basal – and mid left ventricular segments. Intravenous thrombolysis, which might have favorably affected on ventricular functions, was performed to the majority of patients. Because the coronary angiography is not a routine application of our institution after acute infarctions, we could not evaluate the anatomical correlates of our findings.

Conclusion

In acute anterior myocardial infarctions, the relatively infrequent presence of ST segment elevation in lead V_1 is associated with an extensive functional impairment of the left ventricle as the present study demonstrated with significantly decreased mean systolic tissue Doppler velocity of four mitral annular corners and correlations between the amplitude of ST elevation in V_1 and tissue Doppler diastolic parameters of anterior, septal and inferior sites of mitral annulus, and the mean early diastolic velocity of four sites.

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