Original Article

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The Importance of Osmolarity in the Prognosis Prediction of ST-elevation and Depression in aVR Derivation of Patients with Acute Coronary Syndrome

Akut Koroner Sendrom Hastalarının aVR Derivasyonunda ST-elevasyonu ve Depresyonunun Prognoz Öngörüsünde Osmolaritenin Önemi

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ABSTRACT

Objective: ST-elevation and depression in augmented voltage right (aVR) are associated with high mortality and prolonged coronary artery disease in patients with the acute coronary syndrome. It was aimed to compare the patients in terms of cardiac troponin, three-vessel disease, serum osmolarity and mortality.

Methods: The study was performed through retrospective scanning of the files of 372 (162 females, mean age 64±10 years) patients who were admitted to the emergency department due to chest pain between January 2014 and December 2016 and who were admitted to the cardiology clinic with the diagnosis of the acute coronary syndrome. Patients with ST-elevation in aVR were included in Group I and patients with ST-depression in aVR were included in Group II.

Results: Osmolarity was 295.8±16 in Group I and 291.7±8.1 in Group II. Troponin values in Group I was higher than Group II (p=0.002). The Gensini score was 40±2.7 in Group I and 28.6±2.3 in Group II (p=0.001). In Group I, unstable angina was found in 32 (18.1%) patient, ST-elevated myocardial infarction (MI) in 135 (76.3%) and non-ST-elevated MI in 10 (5.6%), whereas these numbers and percentages were 62 (31.8%), 106 (54.4%) and 27 (13.8%) in Group II, respectively (p=0.001). The three-

ÖZ

Amaç: Augmented voltage right'daki (aVR) ST-elevasyonu ve depresyonu akut koroner sendrom hastalarında yüksek mortalite ve uzamış koroner arter hastalığıyla ilişkilidir. Hastaların, kardiyak troponin, üç damar hastalığı, serum osmolarite ve mortalite açısından karşılaştırılması amaçlanmıştır.

Yöntemler: Çalışmaya Ocak 2014-Aralık 2016 tarihleri arasında acil servise göğüs ağrısı nedeniyle başvuran, akut koroner sendrom tanısıyla kardiyoloji kliniğine yatırılan, 372 (162 kadın, yaş ortalaması 64±10 yıl) hastanın dosyası retrospektif olarak taranarak dahil edildi. aVR'de ST-elevasyonu olan hastalar Grup 1 ve ST-depresyonu olan hastalar Grup 2 olarak ayrıldı. Hastaların prognozu, yaş, cinsiyet, lipid profili ve Gensini skoru, osmolarite ve mortalite açısından karşılaştırıldı.

Bulgular: Grup 1'de osmolarite 295,8±16, Grup 2'de 291,7±8,1 idi (p=0,003). Grup 1'in troponin değerleri Grup 2'den yüksekti. Gensini skoru Grup 1'de 40±2,7, Grup 2'de 28,6±2,3 idi (p=0,001). Grup 1'de unstabil angina 32 (%18,1), ST-elevasyonlu miyokard infarktüsü (MI) 135 (%76,3) ve non-ST-elevasyonlu MI 10 (%5,6) hastada görülürken; Grup 2'de sırasıyla; 62 (%31,8), 106 (%54,4) ve 27(138) hastada görüldü (p=0,001). Üç damar hastalığı Grup 1'de 56 (%31,6), Grup 2'de 29 (%14,9) hastada tespit edildi (p=0,001).

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vessel disease was found in 56 (31.6%) patients in Group I and 29 (14.9%) patients in Group II (p=0.001). The most common complication in both groups was ischemic heart failure. Mortality was observed in 36 (20.3%) patients in Group I and 14 (7.2%) in Group II. Osmolarity was lowest in unstable angina, highest in non-ST-elevation MI, and was also higher in three-vessel disease, men, and patients with mortality.

Conclusion: In patients with acute coronary syndrome, osmolarity may predict ST-elevation and depression in aVR, three-vessel disease, and mortality.

Keywords: Acute coronary syndrome, three-vessel disease, mortality, osmolarity

Her iki grupta en sık komplikasyon iskemik kalp yetmezliğiydi. Mortalite Grup 1'de 36 (%20,3) ve Grup 2'de 14 (%7,2) hastada görüldü. Osmolarite en düşük unstabil anginada, en yüksek non-ST-elevasyonlu MI'da tespit edildi ve ayrıca üç damar hastalığında, erkeklerde ve mortal seyreden hastalarda yüksek bulundu.

Sonuç: Akut koroner sendrom hastalarında osmolarite; aVR'de ST-elevasyonu ve depresyonu, üç damar hastalığı ve mortalite açısından öngörücü bir değer olabilir.

Anahtar Sözcükler: Akut koroner sendrom, üç damar hastalığı, mortalite, osmolarite

Introduction

In patients with acute coronary syndrome (ACS), early diagnosis and treatment planning are of great importance. Myocardial necrosis has been shown to develop after 30-min coronary artery occlusion in studies (1). Accordingly, mortality increases in every 30-min delay between the onset of symptoms and reperfusion therapy (2). Electrocardiography (ECG) is significant in determining the size of the myocardial area at risk and the severity of ischemia in these patients. In addition to diagnosis, ECG can provide precious information on the determination of coronary reperfusion therapy type, lesion localization, and prognosis in these patients. Despite the increasing prevalence of coronary artery disease (CAD), medical technologies, new developments in etiopathogenesis and treatment, ACS including ST-elevated and non-ST-elevated myocardial infarction (MI) has been remaining as the main cause of morbidity and mortality in the world (3).

How important is augmented voltage right (aVR) in electrocardiography? As is known, aVR provides specific information about the upper right part of the heart. If ST-segment elevation in V1 in ECG exceeds aVR, the proximal left anterior descending (LAD) occlusion is interpreted as the left main coronary artery (LMCA) occlusion, where ST-segment elevation in aVR exceeds V1 (4). It was found that 1 mm or more ST-segment elevation in aVR was associated with higher mortality in patients with acute "anterior and inferior" myocardial infarction. It was shown that ST-segment depression in lead aVR had higher mortality in patients with "anterior" MI (5). ST-segment depression in lead aVR in anterolateral acute MI has been stated to be useful in predicting larger infarct area and left ventricular dysfunction despite successful reperfusion (6). Also, except for myocardial infarctions, it has been associated with serious conditions such as ST-segment elevation in aVR, shock, cardiac tamponade in patients with Type A aortic dissection (7). Again, in ventricular tachycardia and supraventricular tachycardia studies, the long R wave at the beginning of the aVR lead confirmed the diagnosis in favor of ventricular tachycardia (8). aVR ST-segment elevation highlights atrioventricular re-entry tachycardia in differentiating the supraventricular tachycardia mechanism (9). PR depression seen in all other derivations with PR elevation in aVR suggests the diagnosis of pericarditis (10). Pulmonary embolism is associated with an increased risk of shock and death with ST elevation in aVR (11). One of the electrocardiographic changes encountered in cases of tricyclic antidepressant toxicity is the R wave >3 mm in aVR and an R/S ratio of >0.7 in aVR, all of which indicated that aVR has a high predictive value in terms of seizures and cardiac arrhythmias (12).

The specific and sensitive indicator of myocardial damage is cardiac troponins. Increasing cardiac troponin (cTn) level in ACS is important in terms of prognosis and treatment management. Therefore, the cTn level is frequently used in the differential diagnosis of ACS (13-16). In most patients with high-risk ACS, if myocardial necrosis is absent, these patients cannot be identified since serum troponins do not increase. Therefore, new cardiac biomarkers are needed to assist in providing a rapid and accurate diagnosis for ACS risk assessment in patients in whom markers showing myocardial cell damage are not elevated.

Apart from cardiac troponins, many studies may show marker properties. Serum osmolarity measurement is an easily calculated and non-invasive method. A normal value is 280-295 mOsm/kg H_2O, and this value is measured by an osmometer. Simple calculation is as follows "Osmolality (mOsm/kg H_2O)=2[Na^+]+Glucose/18+ blood urea nitrogen (BUN)/2.8" (17). The main components of osmolarity are; plasma glucose, BUN, and sodium (Na). Nutrition rich in Na, glucose, and protein forms the basis of atherosclerosis. These compounds cause metabolic activity resulting in increased heat in the body, then disrupt the coronary arteries. It is important to remove or limit the foods that increase the patient's osmolarity burden to protect the patient from CAD or to delay the development of the disease (18). Therefore, calculated osmolarity is an important indicator of CAD and mortality (19).

In the literature, we did not find studies of serum osmolarity levels with ST-elevation and depression in AVR. Therefore, we aimed to show the association of ACS subtypes with serum osmolarity level, three vascular diseases, morbidity, and mortality.

Method

Study Design and Population

The study was performed through scanning the clinical data and files of 372 (210 males, 162 females, mean age 64.25±10.81 years; range 39-87 years) patients who were admitted to the emergency department due to chest pain between January 2014 and December 2016, and who were admitted to the cardiology clinic with the diagnosis of the ACS.

Patients with normal ST segment in aVR, patients in whom blood glucose and lipid profile were not examined within the first 24 hours, patients in whom angiographies and echocardiography were not performed, patients with cerebrovascular disease, psychiatric diseases, chronic liver diseases, chronic inflammatory disease, malignancy or hematological diseases, and patients undergoing dialysis due to chronic renal failure were excluded.

The patients were divided into two groups as ST-elevation (Group I: 0.5mm and above elevation in aVR derivation) and ST-depression (Group II: 0.5mm and above depression in aVR derivation) in aVR derivation. These two groups were investigated in terms of age, gender, lipid profile, troponins, blood glucose, osmolarity, and Gensini score.

Patients with ACS were divided into three groups as high risk unstable, STEMI and NSTEMI. The acute STEMI was subdivided into inferior, posterior, anterior, lateral, diffuse anterior and high lateral myocardial infarction.

Three-vessel disease (TVD); was defined as stenosis of at least 50% and above in all of the LAD coronary artery, circumflex artery, and right coronary artery.

Complications following ACS are divided into six groups including ischemic heart failure, ventricular tachycardia, atrioventricular block, cardiac tamponade and effusion, acute pulmonary edema, and no complications.

Hemogram was measured using a Sysmex DI-60 CBC Analyzer (İstanbul, Turkey).

Biochemistry blood was analyzed with the Beckman Coulter Automated AU-680 (Beckman Coulter, Inc., Fullerton, CA, USA).

The demographic, clinical, and reference laboratory data of the patients who were admitted to the emergency department due to ACS were evaluated by reviewing the medical records of the hospital.

Cardiac biomarker analysis; cTn I values of patients were obtained using STAT Elecsys Cobas e-411 (Hitachi, Roche, USA) analyzers. Troponin levels were measured at the clinic where the patients were hospitalized at 0 hours, 6, and 12 hours at the time of admission to the emergency room. The reference range of troponin I was 0-0.05 ng/dL, and a value above this value was considered positive.

Acute coronary syndrome; patients who had chest pain and/or discomfort lasting at least 30 minutes and who were diagnosed as having STEMI with ECG according to the 2013 American College of Cardiology Foundation/American Heart Association guidelines were included in the study (20). UA/NSTEMI was defined according to the criteria of the 2014 American Heart Association/American College of Cardiology Guide for Management of NSTE-ACS Patients (20). Transthoracic echocardiography (TTE) was applied to all patients to determine whether there were motion abnormalities in the focal wall. In this study, Philips Epiq 7 Ultrasound Machine was used for TTE.

Angiographic analysis; all angiographies were evaluated by two experienced cardiologists blinded to the study. Inconsistencies were resolved in consensus.

Gensini score; is an important scale for coronary artery prevalence. The degree and severity of CAD were evaluated with the Gensini score (21).

Statistical Analysis

The study data were analyzed with SPSS v20.0 (SPSS Inc, Chicago, IL, USA) software package. Shapiro Wilk's test was used while investigating if the variables had a normal distribution. The Mann-Whitney U test and the Kruskal-Wallis H test were used to examine the differences between the groups as the variables did not have normal distribution. Friedman's Two-Way ANOVA was performed in the analysis of more than two dependent variables because they did not have normal distribution. In case of significant differences, variables that differed from each other were determined by using Multiple Comparison Tests. When analyzing the intergroup correlations of nominal variables, the chi-square analysis was performed. If the predicted values in the cells of 2X2 tables did not have enough volume, Fisher's Exact Test was used, and the Spearman's chi-square test was used with the help of Monte Carlo Simulation to analyze RxC tables. When interpreting the results, 0.05 was used as the level of significance, and P values below 0.05 were considered statistically significant.

Results

The mean Gensini score was 31.20±36.73 in all patientsand it was significantly higher in Group I (p=0.001). Triglyceride level was 140.39±91.65 mg/dL, high density lipoprotein 35.35±13.95 mg/dL, low density lipoprotein 106.52±47.01 mg/dL, low density lipoprotein 26.97±17.25 mg/dL, and blood glucose 139.27±69.01 mg/dL in all patients. No difference was found in terms of those markers between groups. However, cholesterol levels were found to be significantly higher in Group I (p=0.030). Osmolarity was measured as 293.38±13.46 mOsm/L and was higher in Group I (p=0.003). Among cardiac biomarkers of patients; cTn I level was 1.83±2.24 ng/dL, cTn II 5.15±7.21 ng/dL, and cTn III 12.24±17.78 ng/dL in all patients and their levels were statistically significantly higher in Group I. Osmolarity was higher, TVD was more, and prognosis was worse in patients with a Gensini score of more than 20 points (Table 1).

Table 1. Baseline characteristics of study patients

	All patients n=372 mean ± SD	**aVR (+) n=177** mean ± SD	**aVR(-) n=195** mean ± SD	p-value
Age, yr	64.40±10.68	64.25±10.81	64.61±10.51	0.745
Famale	162 (43.5%)	116 (51.8%)	46 (31.1%)	**0.001**
Male	210 (56.5%)	108 (48.2%)	102 (68.9%)	
TG, mg/dL	140.38±91.65	140.87±85.53	139.66±99.18	0.298
Cho, mg/dL	172.39±61.92	178.67±67.54	162.87±51.03	**0.030**
HDL, mg/dL	35.35±13.95	34.88±12.18	36.07±16.28	0.927
LDL, mg/dL	106.52±47.01	109.50±50.03	102.00±41.78	0.211
VLDL, mg/dL	26.98±17.25	8,93±0,86	8,24±1,03	**0.001**
Tn I, ng/dL	1.83±2.25	2.02±2.32	1.53±2.09	**0.002**
Tn II	5.15±7.21	5.73±7.73	4.27±6.26	0.013
Tn III	12.42±17.78	13.11±18.12	10.93±17.23	**0.016**
Osmolarity, mOsm/kg	293.38±13.46	295.85±16.01	291.67±8.10	**0.003**
LVEF, %	51.34±11.13	52.55±11.43	49.61±10.48	**0.012**
BS, mg/dL	139.27±69.01	142.07±73.28	135.02±61.98	0.350
Gensini score	31.20±36.73	40.04±2.71	28.62±2.30	**0.001**

Yr: Year, aVR: Augmented voltage right arm, +: ST elevation, -: ST depression, TG: Triglyceride, Cho: Cholesterol, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, VLDL: Very low-density lipoprotein, Tn: Cardiac troponin, LVEF: Left ventricular ejection fraction, BS: Blood sugar, SD: Standard deviation

There was a significant difference between groups in terms of diagnosis (p=0.001), TVD (p=0.001), complication (p=0.001), and mortality (p=0.002). When the distribution of the diagnoses by groups was examined, 33 (14.7%) of 224 patients in Group I had UA, 61 (27.2%) inferior MI, 4 (1.8%) posterior MI, 66 (29.5%) anterior MI, 8 (3.6%) lateral MI, 36 (16.1%) common anterior MI, 5 (2.2%) high lateral MI and, 11 (4.9%) NSTEMI. Sixty six (41.2%) of the 148 patients in group II had UA, 22 (14.9%) inferior MI, 3 (2%) posterior MI, 26 (17.6%) anterior MI, 1 (0.7%) lateral MI, 7 (4.7%) diffuse anterior MI, 2 (1.4%) high lateral MI, and 26 (17.6%) NSTEMI. Inferior MI, posterior MI, anterior MI, lateral MI, diffuse anterior MI, high lateral MI were more common in Group I; UA and NSTEMI were more common in Group II (p=0.001, Table 2).

There was a statistically significant difference in terms of osmolarity between diagnoses (p=0.001, Table 3).

When osmolarity was compared in terms of gender (p=0.001), TVD (p=0.009), and mortality (p=0.011), there were statistically significant differences. However, no difference was found in terms of complications developed (Table 4).

There was no correlations between osmolarity and complications, but there were correlations between osmolarity and other variables (Table 5).

Discussion

Sudden occlusion or severe stenosis in the coronary artery causes acute coronary syndromes. Ischemic changes in ECG and increased serum cardiac markers play an important role in the diagnosis and treatment of patients with ACS. In electrocardiographic evaluation, aVR derivation is generally ignored, whereas ECG changes in aVR derivation are important in the prognosis of patients with ACS. In literature, studies on serum osmolarity levels and aVR derivation, TVD, and mortality are rare or absent. We planned the study to identify correlations between them.

The diagnosis and treatment of ACS should be done as soon as possible. With the delay of treatment, mortality increases and 63% of deaths due to MI occur within the first hour. The patient's history, ECG, and cardiac markers are important for the diagnosis of the ACS (22). Twelve-derivation ECG which is commonly used in diagnosis is fast, cheap, and easy. In emergency departments, ECG should be done within the first 10 minutes. Many findings can be detected with ECG. With these findings, it is possible to predict myocardial ischemia and its severity, and reperfusion treatment options can be decided. Also, ECG can provide information about ST-depression, ST-elevation and secondary developing reciprocal ST-depression, ischemic T negativity, emerging left bundle branch block, left anterior and posterior hemiblock (23,24).

Male gender is considered a risk factor alone in CAD in many studies and this is present in 60% of the patients. Atherosclerotic heart diseases, which do not occur 10-20 years earlier, are 3-6 times higher in males than in females (25). In the study, 56.5% of the patients were male and 43.5% were female. The mean age in Group I was 64 years and 48.2% of Group I were women, while the mean age in Group II was 64 years and 68.9% of Groups II were women. According to the data, the male gender was found a little bit low, and we thought that the reason might be a low number of patients included in the study. In two similar studies by Aygul et al. (26) and Wong et al. (5), the mean age was 61 and 60 years, and 32% and 29% were female, respectively,

Table 2. Test results regarding the difference between variables in terms of aVR Lead

		aVR (+) n (%)	aVR (-) n (%)	p-value
Diagnosis	**Unstable angina**	32 (18.1)	62 (31.8)	**0.001**
	Inferior MI	21 (11.9)	62 (31.8)	
	Posterior MI	1 (0.6)	6 (3.1)	
	Anterior MI	65 (36.7)	27 (13.8)	
	Lateral MI	8 (4.5)	1 (0.5)	
	Common anterior MI	35 (19.8)	8 (4.1)	
	High lateral MI	5 (2.8)	2 (1)	
	NSTEMI	10 (5.6)	27 (13.8)	
	Total	177 (100)	195 (100)	
TVD	**No**	121 (68.4)	166 (85.1)	**0.001**
	Yes	56 (31.6)	29 (14.9)	
	Total	177 (100)	195 (100)	
Complication	**No**	43 (24.3)	125 (64.1)	**0.001**
	Ischemic heart failure	83 (46.9)	30 (15.4)	
	Ventricular tachycardia	19 (10.7)	12 (6.2)	
	Atrioventricular block	8 (4.5)	17 (8.7)	
	Cardiac T/E	8 (4.5)	0 (0)	
	Acute pulmonary edema	16 (9)	11 (5.6)	
	Total	177 (100)	195 (100)	
Mortality	**No**	141 (79.7)	181 (92.8)	**0.002**
	Yes	36 (20.3)	14 (7.2)	
	Total	177 (100)	195 (100)	

MI: Myocardial infarction, NSTEMI: Non-ST-elevated MI, TVD: Three-vessel disease, T/E: Cardiac tamponade/effusion

in the group with ST-elevation in aVR. In the group with ST depression, the mean age was 58 and 61 years, and 16.8% and 28% were female, respectively.

Osmolarity has an important place in many systemic diseases, especially CAD. The study by Fauci (27) was one of the important studies that revealed the relationship between osmolarity and CAD. In another study, hyperosmolarity was shown to increase by 4.3 times and the risk of cardiovascular mortality by 3.9 times even after a moderate follow-up for cardiovascular mortality risk (28). Arbel et al. (29) found a significant difference between the calculated osmolarity values of patients with CAD and healthy individuals. In their study, in which Çiçek et al. (30) investigated the effect of hyperosmolarity on prognosis in patients undergoing primary angioplasty for STEMI, they predicted that, regardless of Na, blood glucose, and blood urea nitrogen, hyperosmolarity could lead to some important cardiac complications in the long-term follow-up of patients with STEMI undergoing primary percutaneous coronary intervention.

Serum osmolarity values in Group I were higher than Group II in the study. Greater detection of osmolarity in male gender may be a cause of CAD, thus mortality and poor prognosis. Mortality was significantly higher in Group I in which osmolarity was higher. Gensini score, which indicated the prevalence of CAD,

Table 3. Test results regarding the difference between osmolarity and diagnosis

Diagnosis	n	Mean ± SD	Min-max	p-value
Unstable angina	94	280.62±14.20	184-296	**0.001**
Inferior MI	83	285.89±5.95	273-294	
Posterior MI	7	290.57±4.96	280-294	
Anterior MI	92	296.30±2.39	278-299	
Lateral MI	9	299.77±0.44	299-300	
Common anterior MI	43	303.16±1.92	300-306	
High lateral MI	7	307.00±0.0	307-307	
NSTEMI	37	315.00±6.96	308-346	
Total	372	293.38±13.46	184-346	

SD: Standard deviation, Min: Minimum, Max: Maximum

also showed a positive strong correlation with cardiac troponin, STEMI, TVD, mortality, and osmolarity. Besides, it was found that it decreased the left ventricular ejection fraction and caused ischemic heart failure after showing negative correlation with STEMI. Osmolarity which could be examined with a simple method, might be predictive for mortality and ischemic heart failure in patients with ACS who were admitted to emergency

Table 4. Test results regarding the difference between variables in terms of osmolarity

Osmolarity			
		Mean ± SD	**p-value**
Gender	**Female**	290.05±15.02	**0.001**
	Male	295.00±11.86	
TVD	**No**	291.85±14.50	**0.009**
	Yes	296.25±8.75	
Complication	**No**	291.63±13.95	0.152
	Ischemic heart failure	295.46±11.36	
	Ventricular tachycardia	295.83±14.85	
	Atrioventricular block	295.00±12.54	
	Cardiac T/E	297.00±15.93	
	Acute pulmonary edema	295.90±15.13	
Mortality	**No**	292.20±13.31	**0.011**
	Yes	297.76±14.37	

Table 5. Correlation coefficients for osmolarity

	Osmolarity	
	r	p-value
LVEF	**-0.171**	**<0.001**
Complication	0.093	>0.075
cTn I	**0.110**	**<0.034**
cTn II	**0.119**	**<0.022**
cTn III	**0.125**	**<0.008**
Diagnosis	**0.169**	**<0.001**
aVR+/-	**0.141**	**<0.006**
Gensini score	**0.124**	**<0.017**
TVD	**0.120**	**<0.021**
Mortality	**0.153**	**<0.003**

departments due to chest pain, in whom ST-elevation and depression in aVR were detected on ECG.

In the study of Gorgels et al. (31), they reported left main CAD and TVD following detection of ST-elevation in aVR and ST depression in other derivations. Kosuge et al. (32) found that more than 0.5 mm ST elevation in aVR derivation was a strong marker of the occlusion of LMCA, or the presence of TVD. Patients were followed up for 90 days; and LMCA disease, TVD, and complications were observed more frequently in those with elevated troponin, and ST-elevation in aVR at the end of follow-up. As a result, they found that ST-elevation in aVR and troponin increase were simple and inexpensive tools for early risk assessment of ACS without ST-elevation. In another study, it was associated with TVD in 32% of patients with ST depression and with left main stenosis in 13% (33).

In our study, TVD was detected in 85 (22.58%) of 372 patients. TVD was detected in 4 (4.8%) patients with UA and 7 (8.3%) patients with NSTEMI among patients with ACS without ST-elevation. TVD was found in 36 (42.9%) of 92 patients with anterior MI and 17 (20.2%) of 83 patients with inferior MI. TVD was found in 56 (65.9%) patients in group I and 29 (34.1%) patients in Group II. We thought this was due to excess number of anterior, lateral, diffuse anterior, and high lateral MIs in Group I. Also, troponin was measured when the patients were admitted. Troponin values at 0^{th}, 6^{th} and 12^{nd} hours were higher in Group I. In patients with the ACS, elevated osmolarity and troponin in those with ST-elevation and depression in aVR might have predictive importance for TVD and mortality. Therefore, the presence of ST-elevation in aVR suggests that it is a better indicator for common and severe myocardial ischemia than ST-depression in other derivations.

Information about aVR derivation in MI with ST-elevation is more limited. In a study evaluating 100 patients who had acute anterior MI, it was shown that ST-segment elevation in aVR indicated a proximal lesion in the LAD with 95% specificity and 43% sensitivity (34). Yamaji et al. (4) compared changes in aVR derivation in acute occlusions of LMCA, LAD proximal and right coronary artery, and they found 88% sensitivity of ST-elevation in aVR in demonstrating acute LMCA occlusion. There are also studies evaluating the importance of ST-elevation in aVR lead in anterior MI and ST-depression in inferior MI (35,36). There was no study in which ST-segment change in aVR was evaluated in all MIs. In the study of Nair and Glancy (37) in 30 patients with acute inferior MI, 0.1 mV or more depression was observed in aVR derivation. In this study, aVR depression was found 80% specific and 96% sensitive in determining circumflex artery occlusion. In our study, among 177 patients in Group I; UA was seen in 32 (18.1%), NSTEMI in 10 (0.6%), and STEMI in 135 (81.8%). In Group II, 62 of 195 (31.8%) patients had UA, 27 of 195 (13.8%) had NSTEMI and 106 of 195 (54.4%) had STEMI. Accordingly, MIs due to LAD occlusion and anterior group MIs due to circumflex artery occlusion were common in Group I, while more MIs due to occlusion of the right coronary artery and its branches and lessinferior group MIs due to circumflex

artery involvement were detected in Group II. Unstable angina and NSTEMIs were more common in Group II. Accordingly, the Gensini score, TVD, mortality, and development of ischemic hearth failure were higher in Group I than in Group II.

In some studies, mortality and prognosis were compared with patients with normal ST segment. Therefore, mortality was found higher in patients with ST-elevation or depression. Hebbal et al. (38) showed that ST-depression in aVR was more mortal than elevation. It was stated that this was because depression affected wider myocardial area. Again, mortality was found higher in patients with ST-depression in aVR than in those with normal ST segment in aVR. On the other hand, Wong et al. (5) found a two-times increase in 30-day mortality in patients with aVR elevation. In our study, the mortality rate was higher in the group with ST-elevation in aVR. In similar studies, Antman et al. (39) and GRACE study (40) reported that ST-elevation in aVR was highly associated with in-hospital mortality, ischemic events, and heart failure, and was more effective than ST depressions. In our study, mortality was detected in 43 of 372 patients (11.55%). Mortality was seen in 36 of 177 (20.3%) patients in the group with ST-elevation in aVR and 14 of 195 (7.2%) patients with ST depression. In the ST-elevation group, it was found that mortality was higher because TVD was frequent, Gensini score, troponin level, and osmolarity were higher, and left ventricular ejection fraction were lower. This situation might increase the need for patients to have a coronary bypass and contribute to the worsening of their prognosis. The reason for elevated osmolarity in the ST-elevation group in aVR might be due to the fact that larger myocardial area such as in anterior MIs was affected.

We found that troponin and osmolarity were higher in the group with ST-elevation in aVR than in the group with depression. Serum osmolarity was found to be higher in patients with TVD and patients with mortality. In UA, where myocardial involvement was low, serum osmolarity level was low when compared to other acute coronary syndromes. We think that osmolarity increases due to more inflammatory events that occur when myocardial necrosis is wide, such as coronary artery disease, ST-elevated MI and NSTEMI.

Study Limitations

The most important limitation was that the study was retrospective and single-centered. Also, the difficulty in accessing the drugs used by the patients, difficulty in completion of the deficiencies in the registration system, and difficulty in accessing echocardiography and angiography reports were other important limitations. Moreover, other known risk factors of patients were not evaluated, so the multivariate analysis could not be performed to define the independent factor.

Conclusion

Serum osmolarity level was higher in the group with ST elevation in aVR derivations than in the ST depression group. Also, serum osmolarity was found to be higher in males, patients with TVD and patients with mortality. We think that osmolarity, just like troponin, can predict morbidity and mortality, and its effects in patients with CAD are open to investigation.

Ethics

Ethics Committee Approval: The study was approved by the institutional review board.

Informed Consent: Written informed consent was not necessary because the study was performed retrospectively by screening patient files.

Peer-review: Externally peer reviewed.

Authorship Contributions

Surgical and Medical Practices: A.C., Ş.H.E., Concept: A.C., Ş.Ö.H., Design: Ş.Ö.H., Ş.H.E., Data Collection or Processing: A.C., Ş.Ö.H., Ş.H.E., Analysis or Interpretation: A.C., Ş.H.E., Literature Search: Ş.Ö.H., Ş.H.E., Writing: A.C.

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