RESEARCH ARTICLE

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The Relationship of Early Repolarization Morphology with Prognosis and Mortality Accompanied by Angiography Results

ABSTRACT

Objective: Early repolarization (ER) is a common finding in cases. It can be benign or malignant. We aimed to evaluate the effects of early repolarization morphology and electrocardiogram (ECG) findings on the clinic, prognosis, and mortality with angiography findings.

Methods: This retrospective study included 442 patients who were admitted to the emergency department between January 2010 and December 2015 and had ER in their ECG. The patients were divided into two groups according to the horizontal and ascending ER morphology. According to the derivation, four groups were formed as inferior, inferolateral, anterior, and common. During the five-year follow-up period, patients who had an indication for angiography due to chest pain and underwent the procedure were divided into four groups (left anterior descending (LAD), circumflex (Cx), right coronary artery (RCA), and normal) according to the vessel in which the lesion was detected in angiography.

Results: The average age of the patients in the study was 52.16±9.07 years and 260(58.8%) were male. Horizontal morphology was observed in 123(28%) of the patients and ascending morphology in 319(72%). Mortality was detected in 9(7.3%) of the horizontal group and 6(1.9%) of the ascending group (p=0.008). In the angiography results of the mortality group, 8(53.3%) patients had Cx, 4(26.7%) patients had RCA, and 3(20%) patients had LAD occlusion. Angiography results of 318(74.5%) surviving patients were normal (p=0.001). Mortality; It had a strong positive correlation with family history, Brugada Syndrome, aVR ST-segment formation and the presence of syncope, and moderate positive correlation with gender, notch presence, QRS morphology in V1-2, and angiography results.

Conclusions: Early repolarization morphology may be a helpful finding for prognosis, mortality, and interventional angiography decisions.

Keywords: Emergency Department, Early Repolarization, Mortality, Angiography.

Erken Repolarizasyon Morfolojisinin Anjiyografi Sonuçları Eşliğinde Prognoz ve Mortalite ile İlişkisi

ÖZET

Amaç: Erken repolarizasyon (ER) sık görülen bir bulgudur. Benign ya da malign karakterde olabilir. Erken repolarizasyon morfolojisi ve elektrokardiyogram (EKG) bulgularının anjiyografi bulguları ile klinik, prognoz ve mortalite üzerine etkilerini değerlendirmeyi amaçladık.

Gereç ve Yöntem: Bu retrospektif çalışmaya Ocak 2010 ile Aralık 2015 arasında acil servise başvuran ve EKG'sinde ER olan 442 hasta dahil edildi. Hastalar ER morfolojisinin yatay ve dikey olmasına göre iki gruba ayrıldı. Derivasyona göre ise inferior, inferolateral, anterior ve yaygın olmak üzere dört grup oluşturuldu. Ayrıca anjiyografi bulgularına göre sol ön inen (LAD), sirkumfleks (Cx), sağ koroner arter (RCA) ve normal olmak üzere dört grup belirlendi.

Bulgular: Çalışmaya alınan hastaların yaş ortalaması 52.16±9.07 yıl ve 260'ı (%58.8) erkekti. Hastaların 123'ünde(%28) yatay, 319'unda(%72) dikey morfoloji izlendi. Yatayl grupta 9(%7.3) ve dikey grupta 6(%1.9) olguda mortalite saptandı (p=0.008). Mortalite grubunun anjiyografi sonuçlarında 8 (%53,3) hastada Cx, 4 (%26,7) hastada RCA ve 3 (%20) hastada LAD oklüzyonu vardı. Yaşayan 318 (%74,5) hastanın anjiyografi sonuçları normaldi (p=0,001). Mortalitenin; aile öyküsü, brugada sendromu, aVR ST-segment varlığı ve senkop ile güçlü, cinsiyet, notch varlığı, V1-2'de QRS morfolojisi ve anjiyografi sonuçları ile orta düzeyde pozitif korelasyonu tespit edildi.

Sonuç: Erken repolarizasyon morfolojisi, prognoz, mortalite ve girişimsel anjiyografi kararları için yardımcı bir bulgu olabilir.

Anahtar Kelimeler: Acil Servis, Erken Repolarizasyon, Mortalite, Anjiyografi.

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INTRODUCTION

Early repolarization (ER) is defined as the positive J wave that starts with notching at the end of the R wave in the 12-lead electrocardiogram (ECG) recording, and the ST-segment elevation of 0.1 mV or more in at least two consecutive leads following the J wave. It is a finding seen in society with a rate of 12% and frequently encountered in the clinic. The frequency of early repolarization decreases with advancing age and is observed more frequently in healthy, young, male, and athletic individuals. Its prevalence in African and African Americans is higher than in other societies (1,2). This ECG finding is often seen in the inferior and precordial leads. While early repolarization has been considered as an innocent ECG finding for many years, recent studies have shown that this change has some potential arrhythmogenic effects (3,4).

The majority of patients are asymptomatic and have a low risk of arrhythmia. It is very important to identify the small patient group with high arrhythmic risk. To date, most of the research on this topic has evaluated variants of the ER model that increase the risk of sudden death. In studies conducted, the presence of J waves and ST-segment elevation on the ECG, which is called early repolarization pattern, has been accepted as a benign finding without clinical significance (5,6). It is very important to distinguish benign ER, which is very common, from the rare malignant form. Recently, two ER morphologies, ascending and horizontal, have been emphasized in determining the severity of early repolarization (7,8). An image describing ascending and horizontal ER morphologies is given in Figure 1 (9). While these criteria are valuable in predicting fatal arrhythmias in elderly patients, they are insufficient in predicting ventricular arrhythmia and sudden cardiac death in young patients. Genetic predisposition is important in ER patients with idiopathic sudden cardiac death. Studies have found that patients with ER in the inferior and lateral leads have a higher genetic predisposition. In cases where ER is detected in patients with fatal arrhythmia symptoms or a family history of sudden cardiac death, it is very important to evaluate and perform further examination (10-12).

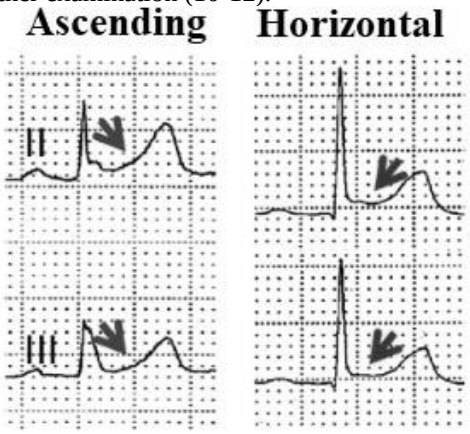

Figure 1. Ascending and horizontal ER morphologies (9)

In the differential diagnosis, it is important to distinguish ER from ST-segment elevation conditions such as asthenic habitus, acute pericarditis, ST-elevation myocardial infarction, Brugada Syndrome, congenital short QT syndrome, and idiopathic ventricular fibrillation. Congenital long QT syndrome without ST-segment elevation but causing syncope and sudden cardiac death and catecholaminergic polymorphic ventricular tachycardia (VT) should also be included in the differential diagnosis. It is necessary to distinguish between these pathologies and ER.

It is very important to determine the ECG features that distinguish the benign ER model from the malignant ER. In our study, we aimed to contribute to the literature on distinguishing benign and malignant ER by associating the demographic characteristics, ECG findings, laboratory values, mortality rates, and especially the results of coronary angiography, which has not been evaluated until now, with the ER pattern.

MATERIAL AND METHODS

Study Design and Population: In this retrospective study, 442 patients (182 females, 260 males; average age 52.2 ± 9.1 years; range 23-72 years, 41.2% females) over 18 years old who presented to the emergency department between January 2010 and December 2015 and had early repolarization in their ECG were included.

Patients with severe heart valve diseases, rhythm disturbances, history of by-pass operation, cerebrovascular disease, ECG changes due to subarachnoidal hemorrhage, chronic liver disease, chronic renal failure, malignancy, aortic dissection, pneumothorax, pulmonary pathologies causing ECG changes, myocardial infarction, and related aneurismatic appearance, and electrolyte imbalance were excluded from the study. Patients diagnosed with early repolarization were angiographed during the follow-up period and evaluated by two experienced cardiologists who were blinded to the study. Inconsistencies were resolved by consensus, and these patients were included in the study.

For all ER patients, four groups were created as inferior (DII, DIII, aVF), inferolateral (DII, DIII, aVF, V3-6), anterior (V1-6), and common (DII, DIII, aVF, aVL, V1-6) (13). In addition, ER cases were divided into two groups according to their morphology as horizontal and ascending. Patients were also divided into two groups according to their mortality status. Patients who had an indication for angiography due to chest pain and underwent the procedure were divided into four groups (left anterior descending (LAD), circumflex (Cx), right coronary artery (RCA), and normal) according to the vessel in which the lesion was detected in angiography

Demographic, clinical, and laboratory data, along with diagnoses, admission dates, contact

information, are available in the registry system of our hospital. In our study, while the follow-up of the patients was done through the hospital registry system, those who did not re-enter the hospital were reached via the call system. Finally, after the first diagnosis of ER, patients were followed up for an average of 60 months and their results were recorded.

Electrocardiography; When the patient was admitted to the emergency department, a 12-lead ECG was obtained at the bedside with Cardiofax ECG-9132K (Nihon Kohden, Tokyo, Japan).

The study was conducted in accordance with the Helsinki Declaration on Human Research after obtaining Institutional Local Ethics approval. After all patients were informed, their consent for inclusion was obtained.

Statistical Analysis: The data obtained from the study were analyzed with the SPSS 20 (SPSS Inc., Chicago, IL, USA) package program. Kolmogorov-Smirnov test was used while investigating the normal distribution of variables. Descriptive statistics were presented as mean ± standard deviation or median (minimum-maximum) for continuous variables and as the number of cases and percentage (%) for nominal variables. While examining the differences between groups, Mann-Whitney U and Kruskal-Wallis H tests were used because the variables were not normally distributed. Chi-square analysis was used when examining the relationships between groups of nominal variables. Spearman's rho analysis was used for the correlation of early repolarization with variables. When interpreting the results, values below the significance level of 0.05 were considered statistically significant.

RESULTS

The mean age of the 442 patients in the study was 52.16 ± 9.07 years and 182 (41.2%) of them were women. In the ER classification; 242 (54.7%) were in the inferior group, 83 (18.8%) in the inferolateral, 100 (22.6%) in the anterior, and 17 (3.8%) in the common group. Of the inferior group patients, 138 (31.2%) were male and 104 (23.4%) were female. There was no significant relationship between these groups with gender and laboratory parameters (Table 1).

Table 1. Basal and laboratory findings according to the early repolarization types of the patients

		Early Repolarization				
	All patients n:442(%) mean±SD	**Inferior n:242(%) mean±SD**	**Inferolateral n:83(%) mean±SD**	**Anterior n:100(%) mean±SD**	**Common n:17(%) mean±SD**	***p-value***
Baseline characteristics						
Mean age (year)	52.16±9.07	51.70±9.05	52.36±8.96	53.21±8.98	51.47±10.64	0.565
Famale	182(41.2)	104(23.4)	35(7.9)	37(8.4)	6(1.4)	0.724
Male	260(58.8)	138(31.2)	48(10.9)	63(14.3)	11(2.5)	
Laboratory Findings						
BS (mg/dl)	141.00±63.52	139.75±61.74	150.01±69.93	137.71±65.47	134.23±40.74	0.259
AST (U/L)	35.31±20.44	35.21±20.11	35.67±20.36	34.92±21.51	34.44±21.70	0.384
ALT (U/L)	33.48±23.82	33.72±22.71	34.01±22.38	33.78±23.39	34.51±22.67	0.412
Cho (mg/dl)	172.57±51.39	170.25±51.92	174.69±59.36	175.81±45.50	176.18±33.79	0.567
TG (mg/dl)	148.18±89.63	144.85±84.02	163.12±103.41	137.07±82.09	188.06±121.65	0.257
HDL (mg/dl)	35.38±7.81	35.32±7.43	35.89±9.67	35.14±7.12	35.12±7.17	0.990
LDL (mg/dl)	105.11±36.95	103.08±36.88	106.95±35.74	109.27±36.47	100.70±46.44	0.419
VLDL(mg/dl)	33.03±27.15	32.88±27.28	32.64±21.75	32.81±31.61	38.23±2.75	0.376
RDW (%)	15.09±3.70	15.16±4.26	14.96±1.88	14.86±3.21	16.05±4.62	0.167
MPV(fL)	8.51±0.89	8.48±0.90	8.59±0.88	8.53±0.87	8.60±.91	0.815
MCHC(g/dL)	33.78±6.64	33.25±4.05	34.95±10.35	34.13±8.10	33.56±1.11	0.126
MCV (fL)	85.87±9.22	86.44±7.83	86.70±5.22	83.74±12.78	84.69±15.09	0.687

SD; Stanndard Deviation, BS: Blood Suger, AST:Asptartate aminotransferase; ALT: Alanine aminotransferase, Cho: Cholesterol, TG: Triglyceride, HDL: High Density Lipoprotein, LDL: Low High Density Lipoprotein, VLDL:Very Low Density Lipoprotein, RDW: Red cell distrubition width, MPV:Mean Platelate Volum; MCHC: Mean Corpuscular Hemoglobin Concentration; MCV; Mean Corpuscular Volume; **P<0.05**

The ST-segment in aVR was normal in 272 (85.5%) of all patients, whereas 17 (38.6%) of the Cx group had elevation (p = 0.001). QRS complex was found to be positive in V1-2 in 21 (47.7%) patients in the Cx group. 181 (56.9%) of the patients with normal angiography results were in the inferior group. However, ER was detected in the anterior in 18 (51.4%) of the LAD group, inferolateral in 18 (40.9%) of the Cx group, and inferior in 41 (91.1%) of the RCA group (p = 0.001). Syncope was present in 11 (24.4%) of the patients in the RCA group. Ascending morphology was detected in 262 (82.4%) of the patients with normal angiography results. Horizontal morphology was observed in 15 (42.9%) of the patients in the LAD group, 26 (59.1%) of the Cx group, and 26 (57.8%) of the RCA group (p = 0.001).

Mortality was most common in 8 (18.2%) patients in the Cx group, 4 (8.9%) in the RCA group, and 3 (8.6%) in the LAD group. Mortality could not be detected in patients with normal angiography results (p = 0.001, Table 2).

Table 2. Table of variables according to angiography result

Variables		Angiography Normal n(%) 318(71.9)	LAD n(%) 35(7.9)	Cx n(%) 44(10)	RCA n(%) 45(10.2)	P Value
Gender	Female	140(44)	13(37.1)	11(25)	18(40)	0.108
	Male	178(56)	22(62.9)	33(75)	27(60)	
aVR	Normal	272(85.5)	23(65.7)	22(50)	27(60)	**0.001**
	ST Elevation	35(11)	5(14.3)	17(38.6)	12(26.7)	
	ST Depression	11(3.5)	7(20)	5(11.4)	6(13.3)	
V1-V2	Normal	211(66.4)	17(48.6)	14(31.8)	20(44.4)	**0.001**
	QRS (-)	41(12.9)	8(22.9)	9(20.5)	12(26.7)	
	QRS (+)	66(20.8)	10(28.6)	21(47.7)	13(28.9)	
ER	Inferior	181(56.9)	8(22.9)	12(27.3)	41(91.1)	**0.001**
	Inferolateral	59(18.6)	2(5.7)	18(40.9)	4(8.9)	
	Anterior	68(21.4)	18(51.4)	14(31.8)	0(0)	
	Common	10(3.1)	7(20)	0(0)	0(0)	
Syncope	No	313(98.4)	28(80)	35(79.5)	34(75.6)	**0,001**
	Yes	5(1.6)	7(20)	9(20.5)	11(24.4)	
Morfology	Horizontal	56(17.6)	15(42.9)	26(59.1)	26(57.8)	**0.001**
	Ascending	262(82.4)	20(57.1)	18(40.9)	19(42.2)	
Family History	No	306(96.2)	24(68.6)	24(54.5)	29(64.4.)	**0.001**
	Yes	12(3.8)	11(31.4)	20(45.5)	16(35.6)	
Notch	No	281(88.4)	18(51.4)	32(72.7)	21(46.7)	**0.001**
	Yes	37(11.6)	17(48.6)	12(27.3)	24(53.3)	
Brugada Syndrome	No	302(95)	27(77.1)	34(77.3)	35(77.8)	**0.001**
	Yes	16(5)	8(22.9)	10(22.7)	10(22.2)	
Mortality	No	318(100)	32(91.4)	36(81.8)	41(91.1)	**0.001**
	Yes	0(0)	3(8.6)	8(18.2)	4(8.9)	

LAD: Left anterior descending artery, Cx: Circumflex artery, RCA: Right coronary artery, aVR: Augmented Voltage Right, V1-V2: Leads V1 and V2 in electrocardiography ER: Early Repolarization ST: The distance between S and T on electrocardiography QRS (-): The area under the isoelectric line of the distance between Q, R and S in electrocardiography, QRS (+): The area above the isoelectric line of the distance between Q, R and S in electrocardiography, P<0.05

The relationship between early repolarization groups and syncope, family history, presence of a notch, Brugada Syndrome, mortality was significant. Syncope was most frequently observed in 16 (6.6%) of the inferior group, however, although the number of cases was low, it was found with a higher rate in 5 (29.4%) patients of the common group (p = 0.001). Horizontal morphology was seen most frequently in 6 (35.3%) of the common group and at least in 17 (17%) patients of the anterior group (p = 0.004). In the Common group, 8 (47.1%) patients had notch and 4 (23.5%) had Brugada syndrome. Mortality was observed most frequently in 8 (9.6%) patients in the inferolateral group (Table 3).

Table 3. Chi-square analysis of early repolarization according to variables

Variables		Early repolarization Inferior n(%)	Inferolateral n(%)	Anterior n(%)	Common n(%)	*p-value*
aVR	Normal	190(478.5)	57(68.7)	84(84)	13(76.5)	0.378
	ST Elevation	37(15.3)	18(21.7)	11(11)	3(17.6)	
	ST Depression	15(6.2)	8(9.6)	5(5)	1(5.9)	
V1-V2	Normal	139(57.4)	48(57.8)	60(60)	15(88.2)	0.345
	QRS (-)	41(16.9)	12(14.5)	16(16)	1(5.9)	
	QRS (+)	62(25.6)	23(27.7)	24(24)	1(5.9)	
Syncope	No	226(93.4)	75(90.4)	97(97)	12(70.6)	**0.001**
	Yes	16(6.6)	8(9.6)	3(3)	5(29.4)	
Morphology	Horizontal	66(27.3)	34(41)	17(17)	6(35.3)	**0.004**
	Ascending	176(72.7)	49(59)	83(83)	11(64.7)	
Family History	No	215(88.8)	71(85.5)	86(86)	11(64.7)	**0.042**
	Yes	27(11.2)	12(14.5)	14(14)	6(35.3)	
Notch	No	200(82.6)	70(84.3)	73(73)	9(52.9)	**0.005**
	Yes	42(17.4)	13(15.7)	27(27)	8(47.1)	
Brugada Syndrome	No	229(94.6)	67(80.7)	89(89)	13(76.5)	**0.001**
	Yes	13(5.4)	16(19.3)	11(11)	4(23.5)	
Mortality	No	237(97.9)	75(90.4)	99(99)	16(94.1)	**0.013**
	Yes	5(2.1)	8(9.6)	1(1)	1(5.9)	

aVR: Augmented Voltage Right, ST: The distance between S and T on electrocardiography, V1V2: Leads V1 and V2 in electrocardiography, QRS (-): The area under the isoelectric line of the distance between Q, R and S in electrocardiography, QRS (+): The area above the isoelectric line of the distance between Q, R and S in electrocardiography, P<0.05

When early repolarization morphology groups were evaluated, horizontal morphology was observed in 123 (28%) of the patients and ascending morphology in 319 (72%). ST-elevation in aVR was present in 27 (8.3%) patients in the ascending group and in 42 (34.1%) patients in the horizontal group (p = 0.001). While the QRS complex in V1-2 was evaluated as normal in 235 (73.7%) of the ascending group, it was most frequently detected in the horizontal group in the positive direction and in 57(46.3%) patients (p=0.001). Of the horizontal group patients, 26 (21.1%) had syncope, 52(42.3%) had a family history, 42 (34.1%) had notch, and 35 (28.5%) had Brugada syndrome. In the ascending group, 6 (1.9%) had syncope, 7 (2.2%) had a family history, 48 (15%) had a notch, and 9 (2.8%) had Brugada syndrome. While mortality was observed in 9 (7.3%) of the horizontal group, it was observed in 6 (1.9%) of the ascending group (p = 0.008, Table 4).

Table 4. Chi-square analysis of early repolarization morphological structure according to variables

Variables		Early Repolarization Morphology		
		Horizontal n:123(%)	**Ascending n:319(%)**	***p-value***
aVR	Normal	59(48)	285(89.3)	**0.001**
	ST Elevation	42(34.1)	27(8.3)	
	ST Depression	22(17.9)	7(2.2)	
V1V2	Normal	27(22)	235(73.7)	**0.001**
	QRS (-)	39(31.7)	31(9.7)	
	QRS (+)	57(46.3)	53(16.6)	
Syncope	No	97(78.9)	313(98.1)	**0.001**
	Yes	26(21.1)	6(1.9)	
Family History	No	71(57.7)	312(97.8)	**0.001**
	Yes	52(42.3)	7(2.2)	
Notch	No	81(65.9)	271(85)	**0.001**
	Yes	42(34.1)	48(15)	
Brugada Syndrome	No	88(71.5)	310(97.2)	**0.001**
	Yes	35(28.5)	9(2.8)	
Mortality	No	114(92.7)	313(98.1)	**0.008**
	Yes	9(7.3)	6(1.9)	

aVR: Augmented Voltage Right, ST: The distance between S and T on electrocardiography, V1V2: Leads V1 and V2 in electrocardiography, QRS (-): The area under the isoelectric line of the distance between Q, R and S in electrocardiography, QRS (+): The area above the isoelectric line of the distance between Q, R and S in electrocardiography, P<0.05

In the mortality group, 9 patients (60%) had ST-elevation in the lead aVR, 10 (66.7%) had QRS positivity in V1-2, 11 (73.3%) had syncope, 12 (80%) had a family history, 9(60%) had Notch and 9 (60%) had Brugada syndrome (p = 0.001 Table 5).

Table 5. Chi-square analysis of mortality according to variables

Variables		Mortality		
		No n:427(%)	**Yes n:15(%)**	***p-value***
aVR	Normal	343(80.3)	1(6.7)	**0.001**
	ST Elevation	60(14.1)	9(60)	
	ST Depression	24(5.6)	5(33.3)	
V1-V2	Normal	261(61.1)	1(6.7)	**0.001**
	QRS (-)	66(15.5)	4(26.7)	
	QRS (+)	100(23.4)	10(66.7)	
Syncope	No	406(95.1)	4(26.7)	**0.001**
	Yes	21(4.9)	11(73.3)	
Family History	No	380(89)	3(20)	**0.001**
	Yes	47(11)	12(80)	
Notch	No	346(81)	6(40)	**0.001**
	Yes	81(19)	9(60)	
Brugada Syndrome	No	392(91.8)	6(40)	**0.001**
	Yes	35(8.2)	9(60)	

aVR: Augmented Voltage Right, ST: The distance between S and T on electrocardiography, V1-V2: Leads V1 and V2 in electrocardiography, QRS (-): The area under the isoelectric line of the distance between Q, R and S in electrocardiography, QRS (+): The area above the isoelectric line of the distance between Q, R and S in electrocardiography, P<0.05

DISCUSSION

There are many studies in the literature on early repolarization. However, we did not find a study in which variables and risk factors were so high, and the effect of the horizontal and ascending structure of the ER on mortality was evaluated with angiography findings. In our study, we showed that correct recognition and interpretation of ER types can independently predict the prevention of unnecessary invasive angiography in patients. Although it is always thought optimistically about ER, it has recently been reported that it may be malignant and even be associated with sudden cardiac death (14). The pathophysiological mechanisms explaining the relationship of early repolarization with ventricular arrhythmias have not been fully elucidated. Experimental studies indicate that increased transmural heterogeneity increases ventricular repolarization and this contributes to elevation at the J point (15). It may also affect ER-related ventricular arrhythmias in the autonomic system because it has been reported that a significant number of events occur more frequently during increased vagal tone or after eating too much (16,17). However, situations in which adrenergic stimulation is triggered, such as exercise, can suppress ER and associated arrhythmias (18).

Morphology of the ST segment provides important diagnostic and prognostic information in early repolarization (1,19,20). Therefore, differentiating the common benign ER from the malignant form, which is rare but can be fatal, is very important in terms of clinical prognosis and mortality (21). James et al. (22) stated in the study that ER was observed more frequently in adolescents and men and this difference may be due to gonadal steroids. Antzelevitch et al. (23) made a classification based on ECG leads kept with arrhythmia risk. Type 1 was considered benign among healthy male athletes in the lateral precordial leads (V5, V6). In Type 2, it occurs in the inferior (II, III, aVF) or inferolateral leads and is associated with moderate risk. Type 3 was considered to have the highest relative risk and was associated with an early repolarization pattern commonly localized in the inferior, lateral, and right-sided leads. Hünük et al. (24), in their study evaluating 504 male patients, found 34 ER findings ECG and showed that 19 of them were in the lateral derivation. In our study, the majority of the patients were male, but the ER was more frequently observed in the inferior lead.

The morphology of early repolarization is when there is a 0.1 mV rise in the ST segment within 100 ms after the J point, and when the ST segment gradually joins the T wave, it is considered an ascending pattern and is considered a benign form. In malignant morphology, 0.1 mV ST-segment elevation occurs within 100 ms after the J point and continues straight until the beginning of the T wave and is known as the horizontal pattern (7,8). Wasserburger et al. (25) defined ER as an ST-segment elevation accompanied by descending concavity of the ST segment at the junction of the QRS complex and suggested that this is a normal variant. Tikkanen et al. (1) showed that ER with a horizontal / descending ST-segment is associated with an increased risk of sudden cardiac death in the general population compared to the ascending segment. Uberoi et al. (26) stated in their study that the ascending ST segment was not associated with mortality in ER. Rosso et al. (8) showed that ER with horizontal ST segments was associated with sudden cardiac death in their study. Similar to the studies performed, ST-segment elevation and mortality were more frequent in aVR in our horizontal group patients.

Sinner et al. (27) demonstrated in their study that there was a strong relationship between ER and cardiac mortality, and this relationship was greater especially in inferior leads. In the same study, they found that ER has a strong relationship with mortality due to cardiac and noncardiac causes. Syncope and family history were higher in the group in which mortality was observed in our study. We attribute this to the genetic effects of cardiac mortal pathologies and the fact that syncope is a symptomatic stimulus in patients. We can also consider the presence of ST elevation in aVR and positive QRS in V1-2 as a stimulus for mortality. In addition, although the risk factors mentioned in the studies were evaluated, we did not find any association according to the angiography results of the patients. Occlusion was detected in more than half of the angiography results in the horizontal ER formation showing a malignant pattern. On the other hand, angiography findings were mostly normal in ascending form. LAD, Cx, and RCA involvements were close to each other, but angiography findings were significantly positive in the horizontal form. We think this is because the prognosis of the horizontal form is worse and more malignant. In the study, the absence of normal angiography results in any of the patients with mortality may be evidence of the relationship between angiography findings and mortality. In addition, more Cx occlusion in patients as a result of angiography may be parallel with high inferior and inferolateral mortality. We think that the relationships of our angiography findings with the ER derivation originate from the vascular distribution localizations of the heart.

CONCLUSION

In the horizontal morphology of early repolarization, positive angiography findings and higher mortality should be a warning situation for the clinician. Besides, it can be said that the presence and shape of the ER in the ECG is a guide for the prognosis, mortality and angiography of the patients. More prospective studies are needed on early repolarization.

The most important limitations of the study are that it is single-centered, retrospective, difficult

to follow-up for 5 years, and we do not have data on diabetes, hypertension and smoking histories of the patients.

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We confirm that the authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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