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Evaluation of cases with early repolarization on electrocardiogram and normal population in terms of laboratory and clinical results

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ABSTRACT

Aim: Early repolarization (ER) is a frequent indication, and it is important to correctly evaluate the effects of its benign and malignant forms in terms of prognosis. It was aimed to compare ER cases with the normal population in terms of multi-vessel disease, bypass and mortality.

Material and Method: This study comprised 776 patients aged 18 and older who admitted the emergency department between January 2015 and December 2020. 377 of these patients had ER in the electrocardiogram (ECG), 409 patients had normal ECGs and were added to the study as the control group. Age, gender, multi-vessel disease, by-pass and mortality relations of the patients were evaluated with angiographic findings.

Results: The mean age of 786 patients was 50.49±6.82 years, 372 (47.3%) were female, and the age range was 23-66 years (p<0.001). Of the cases, 110 (14%) were in the horizontal ER, 267 (34%) were in the ascending ER, and 409 (52%) were in the normal group. Multi-vessel disease was observed in 58 (7.4%) of all cases (p<0.001), while 19 (2.4%) had a by-pass attempt because angiography could not be cured (p=0.001). Of the cases with early repolarization, 176 (22.4%) were inferior, 112 (14.2%) were inferolateral, 77 (9.8%) were anterior, and a small number of them were 12 (1.5%) common ER types (p<0.001). Angiography was normal in 575 (73.2%) cases, left anterior descending artery was occluded in 65 (8.3%), circumflex artery was occluded in 73 (9.3%) and right coronary artery was occluded in 73 (9.3%) cases (p<0.001). Eighteen (2.3%) patients resulted in mortality in the 60-month follow-up of all cases. Of these, 9 (8.2%) were horizontal, 2 (0.7%) were asending, and 7 (1.7%) were in the normal population (p<0.001).

Conclusion: Electrocardiography can be a helpful method to evaluate interventional angiography, prognosis and mortality in both early repolarization cases and normal cases.

Keywords: Emergency department, early repolarization, angiography, multiple vessel disease, mortality

INTRODUCTION

In electrocardiography (ECG), early repolarization (ER) is characterized by a positive J wave that begins with a notch at the end of the R wave and is followed by an ST-segment elevation of at least 0.1 mV in at least two consecutive derivations. Early repolarization is common, with a prevalence between 1% and 24%. Although it is more prevalent in young, healthy, athletic individuals as they mature, its prevalence decreases with age (1,2). Early repolarization is a common ECG finding in the inferior, inferolateral, and precordial leads. While ER has been regarded a harmless ECG finding for many years, recent research indicates that it may have arrhythmogenic effects (3,4).

The massive amount of early repolarization patients are asymptomatic and, they have a lower risk of arrhythmia. Few patients are at high risk for arrhythmia; therefore, identifying these patients is a significant challenge. In reality, the majority of research have investigated ER model variants that enhance the risk of sudden death. ER pattern, which is regarded benign, and the presence of ST segment elevation and J waves on the electrocardiogram are considered clinically inconsequential (5,6). In both the general population and patients with idiopathic ventricular fibrillation, the horizontal/descending ST segment of early repolarization poses a greater risk. This horizontal/descending group is believed to be aggressive. Therefore, it is crucial to differentiate between the common benign ER and the rare malignant type (7,8).

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Although the current criteria for early repolarization are inadequate for assessing the likelihood of ventricular arrhythmias and sudden cardiac death in younger individuals, they may be effective in the elderly. In these patients, the genetic susceptibility to idiopathic sudden cardiac death is essential for considering ER. It was revealed that cases with ER in the lateral and inferior leads were more genetically predisposed. Differentiate early repolarization from asthenic structure, acute pericarditis, brugada syndrome, ST-elevation myocardial infarction, idiopathic ventricular fibrillation, and congenital short QT syndrome. Moreover, sudden cardiac death and syncope are induced by catecholaminergic polymorphic ventricular tachycardia and long QT syndrome, both of which should be evaluated in the differential diagnosis (9-11).

In electrocardiography, it is also important to compare early repolarization with the normal population, apart from the benign and malignant distinction. Thus, it is possible to determine which of the normal population and early repolarization cases has a higher rate of multi-vessel disease, morbidity, and mortality. In the study, we aimed to determine the demographic characteristics of the cases, electrocardiographic findings, laboratory values, coronary angiography results, multi-vessel disease, by-pass, morbidity and mortality relationships by considering these groups.

MATERIAL AND METHOD

The study was carried out with the permission of Sivas Cumhuriyet University Non-Invasive Clinical Research Ethics Committee (Date: 11.12.2019, Decision No: 2019-12/06). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Study Design and Population

This observational retrospective analysis comprised 776 individuals older than 18 who attended to the emergency department from January 2015 to December 2020. While 377 of these individuals revealed early repolarization on the ECG, 409 patients with normal ECGs participated as the study's control group. Data, age, gender, hemogram and biochemistry laboratory values were created from ECG findings taken in the emergency department. Patients diagnosed with ER in the emergency department were included in the follow-up program. Concurrently, a patient with a normal ECG close to the age of the patient diagnosed with ER was added. When selecting patients from the normal population group, patients with no cardiac history, or those with stable angina and low risk in stable clinic for the first admission were included. These patients were followed up until angiography during their follow-up. The average follow-up period for all patients was 52 months. The absence of these and ER findings was valid at the first admission of the cases. However, the patients who underwent angiography for any reason (chest pain, shortness of breath, ECG finding suggestive of non-ER ischemic pathology or elective because of high risk) were selected as the normal group during this entire follow-up period. Absence of no cardiac history is valid for the first admission, absence of ER is valid for all applications. The selection criteria for these were the absence of ER and the absence of cardiac pathology in the application, which was considered as the first admission. The study was conducted in a hospital with a tertiary education and research program's emergency department.

Inclusion criteria: The cases were split into two groups. Newly diagnosed patients or individuals previously diagnosed with ER were included in the ER group. Included in the study were individuals having a normal ECG at the time of admission who comprised the typical population for the control group. During the follow-up of the patients, the cases who admitted to the emergency or cardiology outpatient clinic for causes such as chest pain and arrhythmia, were hospitalized in the service and subsequently had angiography were included in the study. Two certified doctors who were blind to the research assessed the early repolarization diagnosis findings. After resolving inconsistencies by consensus, these patients were added to the research.

Exlusion criteria: Patients who did not satisfy the diagnostic criteria for the ER, patients under the age of 18, patients whose laboratory results were not evaluated in the emergency department, patients who did not undergo angiography within the first 60 months of the follow-up period, and cases with a history of heart valve disease, rhythm disorder, or bypass procedure were excluded. Patients with cerebrovascular illness and subarachnoidal hemorrhage, chronic liver disease, chronic kidney failure, myocardial infarction, cancer, and concurrent aneurysm appearance, and electrolyte disorder were also excluded. High-risk individuals with a history of cardiac pathology and those who were clinically unstable were excluded from the trial for the normal population group.

Early repolarization classification: Four classes were created; 1- anterior (V1-V6), 2- inferior (DII,DIII,aVF), 3- inferolateral (DII,DIII,aVF,V3-6), and 4- common (DII,DIII,aVF,aVL,V1-6) (12). In addition, ER cases were divided into two groups as horizontal and ascending.

Tikkanen's study was taken as reference in the sample of patients with horizontal or ascending ER (1). When the ST segment rises by more than 0.1 mV within 100 ms following the J point, or when the ST segment remains raised by more than 0.1 mV throughout the ST segment, we call this a concave/rapidly ascending ST segment. Within 100 ms of the J point, a ST segment elevation of 0.1 mV was considered to be of the horizontal/descending type.

Coronary angiography: It is the gold standard imaging approach for diagnosing coronary artery stenosis. Cardiologists performed coronary angiography in the research for chronic chest pain and arrhythmias, to exclude or confirm a diagnosis of coronary artery disease, to assess prognosis, and to choose the best medication or interventional therapy. According to the angiography data of the cases, four groups were formed as normal, Circumflex Artery (Cx), Right Coronary Artery (RCA), and Left Anterior Descending (LAD). According to the results of coronary angiography, multi-vessel disease was defined as >50% stenosis in more than one coronary artery and >75% stenosis in the LAD or >50% stenosis of the right coronary, circumflex, and left main coronary arteries (13). In addition, the gensini score was used to show the extent of coronary artery involvement (14). A gensini score between 1 to 20 indicated mild coronary atherosclerosis, whereas a score more than 20 indicated severe. By-pass indications in our study were defined as failure to relieve angina with medical or invasive treatment, obstruction of the left main coronary artery (>50%) and unresponsiveness to invasive treatment.

Electrocardiography: Using the Cardiofax ECG-9132K at the patient's bedside, a 12-lead ECG was recorded (Nihon Kohden, Tokyo, Japan).

Our hospital's registry system contains diagnoses, admission times, contact details, as well as demographic, clinical, and laboratory data. In our study, the follow-up of the patients was done through the hospital registry system and the call system for those who did not have access to the hospital afterwards. The patients were followed up for 60 months after the first diagnosis of ER and the results were recorded.

Statistical Analysis

The data were analyzed using the SPSS 20 (SPSS Inc., Chicago, IL, USA) software package. When studying the normal distributions of the variables, the Kolmogorov-Smirnov test was used. Descriptive statistics for continuous variables were supplied as meanstandard deviation or median (minimum-maximum), whereas descriptive statistics for nominal variables were reported as the number of cases and percentage (%). The Kruskal-Wallis H test was performed to compare the groups because the data did not have a normal distribution. Chi-square analysis was used to look at the relationships between groups of nominal variables. To associate early repolarization morphology and type with factors, Spearman's rho analysis was used. When analyzing the data, values less than 0.05 were considered statistically significant.

RESULTS

The mean age of the 786 cases was 50.49±6.62 years, with 372 (47.3%) being female and a range of 23-66 years (p<0.001). When the patients were evaluated based on ER morphology and the normal population, the total cholesterol value was 145.73±36.16 mg/dL (p<0.001), high density lipoprotein (HDL) 33.44±6.98 mg/dL (p=0.007), mean corpuscular volume (MCV) 87.60±4.98 fL (p<0.001), mean platelate volume (MPV) 8.36±0.89 fL (p<0.001), gensini score was 18. The patients' mean follow-up length till angiography was 52.06±5.36 months (p=0.007). The horizontal group had 110 cases (14%), the ascending group had 267 cases (34%), and the normal group had 409 cases (52%) (**Table 1**).

Table 1. Comparison of the early repolarization group and the normal population in terms of age and laboratory data

	Early Repolarization Morphology		Normal Population	All Patients	p-value
	Horizontal	Ascending			
	n (%) 110 (14) mean±SD	n (%) 267 (34) mean±SD	n (%) 409 (52) mean±SD	n (%) 786 (100) mean±SD	
Age (year)	51.78±10.13	48.31±6.24	51.58±5.66	50.49±6.82	**<0.001**
CHO (mg/dl)	149.63±36.89	139.03±35.98	149.05±35.54	145.73±36.16	**<0.001**
TG (mg/dl)	116.15±36.41	109.98±31.24	120.17±48.50	116.14±41.94	0.183
HDL (mg/dl)	32.33±3.96	34.35±5.38	33.14±8.35	33.44±6.98	**0.007**
LDL (mg/dl)	97.20±28.64	93.49±25.95	95.03±30.14	94.81±28.56	0.443
VLDL(mg/dl)	25.31±9.23	24.86±8.12	26.25±12.85	25.65±10.97	0.976
MCV (fL)	86.75±5.32	86.94±4.77	88.27±4.94	87.60±4.98	**<0.001**
MCHC(g/dL)	33.01±0.99	33.09±1.09	32.87±0.77	32.97±0.93	0.266
RDW (%)	14.72±1.58	14.43±1.32	14.24±0.83	14.37±1.15	0.069
MPV(fL)	8.46±0.90	8.56±0.88	8.20±0.86	8.36±0.89	**<0.001**
GS	40.16±36.13	13.45±20.85	15.36±24.85	18.18±27.00	**<0.001**
GLU (mg/dl)	134.37±46.50	117.59±28.11	150.10±63.88	136.86±53.92	**<0.001**
TTA (minute)	51.05±5.61	52.81±5.32	51.84±5.27	52.06±5.36	**0.007**

SD; Stanndard Deviation, CHO: Cholesterol, TG: Triglyceride, HDL: High Density Lipoprotein, LDL: Low High Density Lipoprotein, VLDL: Very Low Density Lipoprotein, MCV; Mean Corpuscular Volume, MCHC: Mean Corpuscular Hemoglobin Concentration, RDW: Red cell distrubition width, MPV:Mean Platelate Volum, GS: Gensini Score, GLU: Glucose, TTA: Time to Angiography , p<0.05 significance level

While the total cholesterol value was 156.17±37.13 mg/dL in the common group, it was lower in the anterior (p=0.027). The mean MCV value was 87.60±4.98 fL (p=0.001). Red cell distribution width (RDW) was highest in the common group with a value of 15.30±1.32 %, similar results were observed with the other groups (p=0.033). MPV was found to be higher in the common group with 8.77±0.94 fL (p<0.001). Gensini score of 40.68±35.15% was highest in the inferolateral and lowest in the inferior group (p<0.001). Blood glucose was found to be high in the normal population with a value of 150.10±63.88 mg/dL (p<0.001). The follow-up time of both groups until angiography was not statistically significant (**Table 2**).

Of the 786 patients, 372 (47.3%) were female and 414 (52.7%) were male. Of these, 40 (36.4%) were horizontal, 113 (42.3%) ascending, and 219 (53.5%) were females in the normal population (p=0.001). Multi-vessel disease was present in 58 (7.4%) of all cases (p<0.001), and by-pass was performed in 19 (2.4%) cases, since there was no response to invasive treatment at the end of angiography (p=0.001). Of the cases with early repolarization, 176 (22.4%) were inferior, 112 (14.2%) were inferolateral, 77 (9.8%) were anterior, and 12 (1.5%) were common types (p<0.001). Angiography findings were normal in 575 (73.2%) cases, left anterior descending artery was occluded in 65 (8.3%), circumflex artery in 73 (9.3%) and right coronary artery in 73 (9.3%) cases (p<0.001). Mortality was observed in 18 (2.3%) patients in the 60-month follow-up of all cases. Of these, 9 (8.2%) were horizontal, 2 (0.7%) ascending, and 7 (1.7%) were in the normal population (p<0.001, **Table 3**).

Table 2. Comparison of occlusion localization with age and laboratory data

	Occlusion Localization					p value
	Inferior n (%) 176 (22.4) mean±SD	Inferolateral n (%) 112 (14.2) mean±SD	Anterior n (%) 77 (9.8) mean±SD	Common n (%) 12 (1.5) mean±SD	Normal n (%) 409 (52) mean±SD	
Age (year)	48.44±7.62	51.42±7.89	48.75±7.11	46.50±8.71	51.58±5.66	**<0.001**
CHO (mg/dl)	141.64±34.92	142.78±39.05	140.09±36.44	156.17±37.13	149.05±35.54	**0.027**
TG (mg/dl)	108.78±32.82	116.03±33.66	110.39±30.99	125.08±35.54	120.17±48.50	0.187
HDL (mg/dl)	34.23±4.82	32.87±5.39	34.34±4.91	31.50±5.90	33.14±8.35	0.054
LDL (mg/dl)	94.24±28.13	94.94±25.48	96.05±25.62	86.67±27.45	95.03±30.14	0.896
VLDL(mg/dl)	24.92±8.95	25.31±8.68	24.22±6.75	28.17±8.66	26.25±12.85	0.770
MCV (fL)	86.87±4.81	87.13±5.16	86.71±4.77	85.92±5.98	88.27±4.94	**0.001**
MCHC(g/dL)	33.06±1.08	33.07±1.06	32.99±1.01	33.72±1.24	32.87±0.77	0.114
RDW (%)	14.43±1.36	14.57±1.51	14.52±1.35	15.30±1.32	14.24±0.83	**0.033**
MPV(fL)	8.45±0.92	8.63±0.84	8.53±0.86	8.77±0.94	8.20±0.86	**<0.001**
GS	12.20±19.12	40.68±35.15	13.96±21.84	19.25±37.40	15.36±24.85	**<0.001**
GLU (mg/dl)	116.28±25.64	132.23±40.23	121.86±42.88	126.58±37.98	150.10±63.88	**<0.001**
TTA (minute)	52.16±5.50	52.39±5.61	52.69±5.12	51.00±5.95	51.84±5.27	0.562

SD; Stanndard Deviation, CHO: Cholesterol, TG: Triglyceride, HDL: High Density Lipoprotein, LDL: Low High Density Lipoprotein, VLDL:Very Low Density Lipoprotein, MCV; Mean Corpuscular Volume, MCHC: Mean Corpuscular Hemoglobin Concentration, RDW: Red cell distrubition width, MPV:Mean Platelate Volum, GS: Gensini Score, GLU: Glucose, TTA: Time to Angiography, p<0.05 significance level

Table 3. Evaluation of variables in normal population and early repolarization groups

Variables	Early Repolarization Morphology		Normal Population	All Patients	p value
	Horizontal n (%) 110 (14)	Ascending n (%) 267 (34)	n (%) 409 (52)	n (%) 786 (100)	
Gender					**0.001**
Female	40 (36.4)	113 (42.3)	219 (53.5)	372 (47.3)	
Male	70 (63.6)	154 (57.7)	190 (46.5)	414 (52.7)	
MVD					**<0.001**
No	84 (76.4)	258 (96.6)	386 (94.4)	728 (92.6)	
Yes	26 (23.6)	9 (3.4)	23 (5.6)	58 (7.4)	
Bypass					**0.001**
No	102 (92.7)	265 (99.3)	400 (97.8)	767 (97.6)	
Yes	8 (7.3)	2 (0.7)	9 (2.2)	19 (2.4)	
Localization					**<0.001**
Inferior	47 (42.7)	129 (48.3)	0 (0)	176 (22.4)	
Inferolateral	46 (41.8)	66 (24.7)	0 (0)	112 (14.2)	
Anterior	13 (11.8)	64 (24)	0 (0)	77 (9.8)	
Common	4 (3.6)	8 (3)	0 (0)	12 (1.5)	
Normal	0 (0)	0 (0)	409 (100)	409 (52)	
Angiography					**<0.001**
Normal	51 (46.4)	223 (83.5)	301 (73.6)	575 (73.2)	
LAD	13 (11.8)	19 (7.1)	33 (8.1)	65 (8.3)	
Cx	23 (20.9)	13 (4.9)	37 (9.0)	73 (9.3)	
RCA	23 (20.9)	12 (4.5)	38 (9.3)	73 (9.3)	
Mortality					**<0.001**
No	101 (91.8)	265 (99.3)	402 (98.3)	768 (97.7)	
Yes	9 (8.2)	2 (0.7)	7 (1.7)	18 (2.3)	

MVD: Multi-vessel disease LAD: Left anterior descending Cx: Circumflex RCA: Right coronary artery, p<0.05 significance level

In the analysis of early repolarization cases according to localization; multi-vessel disease was observed in 26 (23.2%) patients in the inferolateral cases and 23 (5.6%) in the normal population (p<0.001). Again, 7 (6.3%) of the patients who underwent by-pass were in the inferolateral group and 9 (2.2%) were in the normal population (p=0.018). Ascending type was the highest in all groups (p<0.001). The most common right coronary artery was in 25 (14.2%) patients in the inferior group, and the circumflex artery was most common in 19 (17%) patients in the inferolateral group. In the anterior and common groups, the most common left anterior descending was in 16 (20.8%) and 5 (41.7%) cases, respectively (p<0.001). Of the total 18 mortality patients, 8 (7.1%) were in the inferolateral, and 7 (1.7%) were in the normal population group (p=0.002, **Table 4**).

When the relationship between multi-vessel disease, by-pass and mortality was examined, 58 (7.4%) of all cases had multi-vessel disease (p=0.274). 19 (32.8%) of these cases required by-pass procedure (p<0.001). Multi-vessel disease was present in 26 (44.8%) cases in the horizontal group, 9 cases (15.5%) in the ascending group, and 23 (39.7%) cases in the normal population group (p<0.001). In addition, this vascular disease was seen most frequently in the inferolateral, least in the inferior and common groups (p<0.001). Mortality was highest in multi-vessel disease with 14 (24.1%) cases (p<0.001). Multi-vessel disease was most commonly seen in occlusion of the circumflex artery. No relationship with gender was found in 19 patients who underwent by-pass procedure. Mortality was detected in 11 (57.9%) of the bypass patients (p<0.001, **Table 5**).

Correlation results of early repolarization with morphologies and localizations with variables was performed. Total cholesterol, MCV, RDW, MPV, gensini score, multi-vessel disease, age, gender, mortality, blood glucose, and angiography results were weakly correlated, either negative or positive, according to the variables (**Table 6**).

Table 6. Correlation of early repolarization morphology and localization with variables

Variables	Correlation			
	Morphology		Localization	
	r	p	r	p
Morphology	-	-	**0.903**	**<0.001**
Localization	**0.903**	**<0.001**	-	-
CHO	**0.075**	**0.035**	**0.103**	**0.004**
TG	0.038	0.285	0.065	0.068
HDL	-0.025	0.480	-0.065	0.070
LDL	-0.020	0.569	-0.005	0.894
VLDL	-0.008	0.828	-0.001	0.974
MCV	**0.145**	**<0.001**	**0.139**	**0.001**
MCHC	-0.051	0.153	-0.047	0.186
RDW	**-0.076**	**0.033**	-0.043	0.227
MPV	**-0.176**	**0.001**	**-0.164**	**<0.001**
GS	**-0.105**	**0.003**	0.006	0.876
MVD	**-0.138**	**<0.001**	-0.020	0.584
Bypass	-0.053	0.139	-0.002	0.945
Age	**0.079**	**0.028**	**0.146**	**<0.001**
Gender	**0.135**	**<0.001**	**-0.121**	**0.001**
Anjiography	**-0.088**	**0.014**	0.009	0.810
Mortality	**-0.084**	**0.019**	-0.025	0.493
GLU	**0.159**	**<0.001**	**0.212**	**<0.001**
TTA	-0.018	0.622	-0.042	0.239

CHO: Cholesterol, TG: Triglyceride, HDL: High Density Lipoprotein, LDL: Low High Density Lipoprotein, VLDL:Very Low Density Lipoprotein, MCV; Mean Corpuscular Volume, MCHC: Mean Corpuscular Hemoglobin Concentration, RDW: Red cell distrubition width, MPV:Mean Platelate Volum, GS: Gensini Score, GLU: Glucose, TTA: Time to Angiography, MVD: Multi-vessel disease, p<0.05 significance level

Table 4. Evaluation of the relationship of variables between occlusion localization groups

Variables	Localization					p value
	Inferior n (%) 176 (22.4)	Inferolateral n (%) 112 (14.2)	Anterior n (%) 77 (9.8)	Common n (%) 12 (1.5)	Normal n (%) 409 (52)	
Gender						**0.010**
Female	72 (40.9)	45 (40.2)	31 (40.3)	5 (41.7)	219 (53.5)	
Male	104 (59.1)	67 (59.8)	46 (59.7)	7 (58.3)	190 (46.5)	
MVD						**<0.001**
No	174 (98.9)	86 (76.8)	72 (93.5)	10 (83.3)	386 (94.4)	
Yes	2 (1.1)	26 (23.2)	5 (6.5)	2 (16.7)	23 (5.6)	
Bypass						**0.018**
No	174 (98.9)	105 (93.8)	77 (100)	11 (91.7)	400 (97.8)	
Yes	2 (1.1)	7 (6.3)	0 (0)	1 (8.3)	9 (2.2)	
Morphology						**<0.001**
Horizontal	47 (26.7)	46 (41.1)	13 (16.9)	4 (33.3)	0 (0)	
Ascending	129 (73.3)	66 (58.9)	64 (83.1)	8 (66.7)	0 (0)	
Normal	0 (0)	0 (0)	0 (0)	0 (0)	409 (100)	
Angiography						**<0.001**
Normal	138 (78.4)	78 (69.6)	51 (66.2)	7 (58.3)	301 (73.6)	
LAD	6 (3.4)	5 (4.5)	16 (20.8)	5 (41.7)	65 (8.3)	
Cx	7 (4)	19 (17)	10 (13)	0 (0)	73 (9.3)	
RCA	25 (14.2)	10 (8.9)	0 (0)	0 (0)	73 (9.3)	
Mortality						**0.002**
No	174 (98.9)	104 (92.9)	77 (100)	11 (91.7)	402 (98.3)	
Yes	2 (1.1)	8 (7.1)	0 (0)	1 (8.3)	7 (1.7)	

MVD: Multi-vessel disease LAD: Left anterior descending Cx: Circumflex RCA: Right coronary artery, p<0.05 significance level

Table 5. Evaluation of three vessel disease, bypass and mortality with variables

Variables	MVD		p value	Bypass		p value	Mortality		p value
	No n (%) 728 (92.6)	Yes n (%) 58 (7.4)		No n (%) 767 (97.6)	Yes n (%) 19 (2.4)		No n (%) 768 (97.7)	Yes n (%) 18 (2.3)	
Gender			0.274			0.589			0.168
Female	349 (47.9)	23 (39.7)		363 (47.3)	9 (47.4)		366 (47.7)	6 (33.3)	
Male	379 (52.1)	35 (60.3)		404 (52.7)	10 (52.6)		402 (52.3)	12 (66.7)	
Bypass			**<0.001**			-			**<0.001**
No	728 (100)	39 (67.2)		-	-		760 (99)	7 (38.9)	
Yes	0 (0)	19 (32.8)		-	-		8 (1)	11 (61.1)	
MVD			-			**<0.001**			**<0.001**
No	-	-		728 (94.9)	0 (0)		724 (94.3)	4 (22.2)	
Yes	-	-		39 (5.1)	19 (100)		44 (5.7)	14 (77.8)	
Morphology			**<0.001**			**0.001**			**<0.001**
Horizontal	84 (11.5)	26 (44.8)		102 (13.3)	8 (42.1)		101 (13.2)	9 (50)	
Ascending	258 (35.4)	9 (15.5)		265 (34.6)	2 (10.5)		265 (34.5)	2 (11.1)	
Normal	386 (53)	23 (39.7)		400 (52.2)	9 (47.4		402 (52.3)	7 (38.9)	
Angiography			0.092			0.412			0.114
Normal	539 (74)	36 (62.1)		564 (73.5)	11 (57.9)		565 (73.6)	10 (55.6)	
LAD	58 (8)	7 (12.1)		62 (8.1)	3 (15.8)		62 (8.1)	3 (16.7)	
Cx	63 (8.7)	10 (17.2)		70 (9.1)	3 (15.8)		69 (9)	4 (22.2)	
RCA	68 (9.3)	5 (8.6)		71 (9.3)	2 (10.5)		72 (9.4)	1 (5.6)	
Localization			**<0.001**			**0.018**			**0.002**
Inferior	174 (23.9)	2 (3.4)		174 (22.7)	2 (10.5)		174 (22.7)	2 (11.1)	
Inferolateral	86 (11.8)	26 (44.8)		105 (13.7)	7 (36.8)		104 (13.5)	8 (44.4)	
Anterior	72 (9.9)	5 (8.6)		77 (10)	0 (0)		77 (10)	0 (0)	
Common	10 (1.4)	2 (3.4)		11 (1.4)	1 (5.3)		11 (1.4)	1 (5.6)	
Normal	386 (53)	23 (39.7)		400 (52.2)	9 (47.4)		402 (52.3)	7 (38.9)	
Mortality			**<0.001**			**<0.001**			-
No	724 (99.5)	44 (75.9)		760 (99.1)	8 (42.1)		-	-	
Yes	4 (0.5)	14 (24.1)		7 (0.9)	11 (57.9)		-	-	
Total	728 (100)	58 (100)		767 (100)	19 (100)		768 (100)	18 (100)	

MVD: Multi-vessel disease LAD: Left anterior descending Cx: Circumflex RCA: Right coronary artery, p<0.05 significance level

DISCUSSION

Even though there are a lot of studies on early repolarization and few studies on angiography results, we could not find a study that distinguishes horizontal and ascending, multi-vessel disease, by-pass, morbidity and mortality relationship with angiography findings compared to the normal population. In our research, we demonstrated that proper identification and interpretation of ER morphologies can predict the prognosis of patients independently. Recent reports indicate that early repolarization may have a malignant nature and be connected with abrupt cardiac mortality, despite the fact that it was previously seen as a positive sign (15). Since the pathophysiology of early repolarization has not been completely elucidated, its link with malignant arrhythmias remains obscure. As demonstrated by a number of experimental experiments, ventricular repolarization rises due to an increase in transmural heterogeneity, which contributes to an elevation at the J point (16). Additionally, it is hypothesized that the autonomous system can trigger ER-related ventricular arrhythmias. Due to reports that it occurs more commonly during elevated vagal tone or after overeating (17,18). Moreover, conditions involving adrenergic stimulation can inhibit ER and associated arrhythmias (19).

In early repolarization, the shape of the ST segment in electrocardiography provides crucial diagnostic and prognostic information (1,20,21). In terms of determining prognosis and death, it may be crucial to distinguish between the common benign ER type and the rare malignant ER form (22). According to James et al. (23) 's study, ER is more prevalent in young persons and men, and this disparity may be caused by gonadal hormones. Antzelevitch et al. (24) established a categorization based on arrhythmia risk and ECG leads. Bening lateral precordial leads (V5, V6), which are commonly observed in athletic males and athletes, are considered as type 1, but moderate-risk inferior (II, III, aVF) or inferolateral leads are accepted as type 2. In type 3, it was acknowledged that the inferior, lateral, and right side leads posed a high relative danger. In their investigation of 504 male patients, Hünük et al. (25) discovered 34 ECGs with ER abnormalities, 19 of which were in the lateral lead.

The majority of patients in our study were male. Early repolarization occurred more commonly in the inferior lead, but the inferolateral leads displayed multi-vessel disease, bypass, and mortality. Multiple-vessel disease was identified at a rate of 4.1%, bypass surgery at a rate of 2.9%, and mortality at a rate of 4.7%.

The ascending pattern is distinguished by a benign form of early repolarization morphology, a 0.1 mV increase in the ST segment 100 ms after the J point, and increasing convergence of the ST segment with the T wave. In the malignant variant, ST segment elevation of 0.1 mV occurs within 100 ms of the J point and remains horizontal until the T wave begins (7,8). Wasserburger et al. (26) postulated that ER is a normal variety by defining it as an elevation of the ST segment accompanied by a downward concavity of the ST segment at the junction of the QRS complex. Tikkanen et al. (1) discovered that in the general population, an ER with a horizontal/descending ST segment is associated with a higher risk of sudden cardiac death than an ER with an ascending ST segment. According to Uberoi et al. (27)'s research, the ascending ST segment was not linked with ER mortality. In their research, Rosso et al. (8) discovered that ER with a horizontal ST segment is related with sudden cardiac death. In our study, bypass surgery, multi-vessel disease, and death in the horizontal pattern were shown to be significantly higher in the asending and normal populations. Furthermore, for all multi-vessels, the gensini score and occlusion were higher in the horizontal pattern. This demonstrates that the horizontal pattern is associated with a higher prevalence of coronary artery disease.

In their investigation, Moritz et al. (28) demonstrated a correlation between ER and cardiac mortality, which is more prevalent in the inferior leads. In the same study, ER was found to be strongly linked with death due to both cardiac and noncardiac causes. Similarly, our study revealed that the ER group had a greater mortality rate than the general population. Moreover, despite the fact that diverse variables were utilized in numerous research, we did not uncover a correlation between the variables and the angiography data of the patients. In more 50% of the horizontal ER formations with a malignant pattern, blockage was observed by angiography. However, the majority of the ascending form's angiographic findings were normal. In the normal population, the incidence of coronary artery blockage was comparable to that of ascending form. We believe this is because the horizontal form has a worse and more malignant prognosis than other kinds. There were no normal angiography results found in any of the study's subjects who died. This may indicate a relation between angiographic findings and mortality. As a result of angiography, circumflex artery stenosis was also more prevalent in patients. This could be attributed to the high rate of death in the inferior and inferolateral regions. The relation between angiographic results and early repolarization in cardiac leads may be attributable to the vascular feeding areas of the heart.

Obviously, there were limitations. The fact that it is a retrospective, single-center study stands out the most among these limitations. Also, due to the wide time interval, the difficulties in accessing the data, the drugs used by the patients, the absence of such information other than the registered additional diseases were other important limitations.

CONCLUSION

The fact that there was no significant difference between the ascending form of early repolarization and the normal population, and the high rate of obstruction and mortality on angiography in horizontal morphology may be a admonitory for the clinician. In addition, the morphology and location of early repolarization in the ECG serve as an indicator of the patients' prognosis, mortality, and angiographic abnormalities. We believe that more prospective investigations on the interaction between early repolarization, multi-vessel disease, and bypass are required..

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Sivas Cumhuriyet University Non-Invasive Clinical Researches Ethics Committee (Date: 11.12.2019, Decision No: 2019-12/06).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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