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Causes and Incidence of Early Repolarization and its Alteration in Electrocardiogram in Patients with Chest Pain

Iftikhar Ahmad[1], Shakoor Ahmad Malik[2], Munir Ahmad[3], Zia Ul Mustafa[4], Muhammad Aleem Uddin[5], Muhammad Adil[6*]

[1]Consultant Cardiologist, Cardiology Department, Timergara Teaching Hospital, Timergara Dir Lower, Pakistan

[2]Department of Gastroenterology Medical college: Jinnah Sindh Medical University (Sindh Medical College), Pakistan

[3]Associate Professor Department of Cardiology Faisalabad Institute of Cardiology, Faisalabad, Pakistan

[4]Associate Professor, Medicine Department, Sahara Medical College, Narowal, Pakistan

[5]Assistant Professor, Medicine Department, Sahara Medical College, Narowal, Pakistan

[6*]Associate Professor, Cardiology Department, Lady Reading Hospital, Peshawar, Pakistan

Corresponding Author:

Muhammad Adil

Associate Professor, Cardiology Department, Lady Reading Hospital, Peshawar, Pakistan

Email ID: dradil2003@gmail.com

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ABSTRACT

Background: The “early repolarization (ER)” pattern, previously regarded as benign, has recently shown associations with adverse outcomes, including all-cause, arrhythmic and cardiac mortality.

Objective: This study set out to determine how often chest pain is at a tertiary cardiac center and what variables are associated with electrocardiogram (ECG) abnormalities in the emergency room.

Methods:A total of 160 individuals ranging in age from 20 to 78 years old who reported chest pain were included in this descriptive cross-sectional research. Detailed demographic information was obtained after obtaining informed written consent. In order to evaluate the ER pattern, baseline 12-lead electrocardiograms were utilized. All data was analyzed using SPSS 22.0.

Results: The patients mean age was 58.7±11.65 years. There were majority 96 (60%) males and 64 (40%) females among all cases.Early repolarization pattern (ER) was present in 59 (36.9%). Hypertension, diabetes mellitus, obesity, family history of CAD and smoking were the comorbidities among all cases. Frequency of STEMI was found in 32 (20%) cases.Specific characteristics, such as a low body mass index ($p<0.002$), reduced T-wave length ($p=0.002$), and lower heart rate ($p=0.003$), were shown to be substantially linked with the ER patterns.

Conclusion: Based on our findings, one-third of individuals experiencing chest discomfort have an ECG rhythm known as early repolarization. It is less common in individuals with STEMI and non-STEMI, and associated characteristics include a low body mass index (BMI), shorter T-wave length, and lower heart rate.

Keywords: *ECG, Chest pain, Early repolarization, BMI, STEMI*

1. INTRODUCTION

Millions of patients enter emergency rooms every year with the major complaint of chest discomfort. It is a sign that can develop from a wide variety of diseases and disorders, from very harmless ones to potentially fatal heart attacks.1Since "acute myocardial infarction (AMI)", also known as a heart attack, is a top cause of death and disability worldwide, it is critical to identify the causes of heart problems as soon as possible so that the right treatment may be administered.in [1-3]When assessing patients who arrive with chest pain, electrocardiography (ECG) is a lifesaver because it helps distinguish between benign chest pain and serious cardiac events.[1-3]

One to two percent of the general population has ERP. Men and younger people, particularly those with a genetic predisposition to vagotonia, are at increased risk for developing the disorder. Athletes, cocaine addicts, and those with hypertrophic obstructive cardiomyopathy are also common places to see ERP [4]. High endurance athletes, in particular, have an ERP incidence of up to 10% [5].

The possible involvement of ERP in potentially fatal arrhythmias and unexpected unexplained fatalities has been more clear during the past decade [6]. Several studies have linked ERP in the inferior or mid-to lateral precordial pathways to these arrhythmias. Multiple recent case-control studies have linked ERP to an increased risk of ventricular fibrillation [7]. The parallels between ERP and Brugada syndrome (BS) have reignited clinical interest in ERP [1].

It can be more difficult to tell the difference between an emergency room visit and a potentially fatal subtle ST-segment elevation myocardial infarction (STEMI), which can lead to invasive procedures or the use of thrombolytic agents; according to Sharkey et al. [8], 11% of patients who did not actually have a STEMI ended up with thrombolytic medication. When cardiovascular risk markers suggest moderate to high risk, such as in the acute situation of chest discomfort, it can be difficult—even for experienced eyes—to distinguish modest STEMI from emergency room visits.

The predictive value of this ECG pattern in structural heart disease patients is little understood. Ventricular tachyarrhythmias are more common in individuals with chronic coronary artery disease (CAD) who have an ER pattern on electrocardiogram (ECG) [9]. The leading cause of sudden cardiac mortality in adults is acute ST segment elevation myocardial infarction (STEMI), which is characterised by a high prevalence of ventricular arrhythmias. Nevertheless, there are just a few of case-control studies that have examined the predictive significance of ER in acute myocardial infarction, and these studies have used small patient numbers and had very brief follow-up periods [10–12].

Age, gender, preexisting heart conditions, and other clinical risk factors are among the variables that could impact the onset of repolarisation alterations in the electrocardiogram (ECG).[12,13]

Furthermore, there is continuing interest in studying the involvement of genetic and hereditary variables in the development of earlyrepolarisationpatterns.[10-13]By adding to what is already known about early repolarisation patterns in chest pain patients, this study hopes to aid in the development of more accurate diagnostic algorithms and the enhancement of emergency department and beyond patient care for these individuals. Even more concerning is the paucity of local data and clinical proof on this crucial ECG rhythm. Risk classification of cardiac emergency department patients can benefit from our local context understanding and evaluation. Consequently, the purpose of this research was to identify the prevalence and risk factors of early repolarization alterations in electrocardiograms (ECGs) in patients coming to tertiary care cardiac centers complaining of chest pain.

2. MATERIALS AND METHODS

The study was conducted in Timergara Teaching Hospital, Timergara Dir Lower from May 2022 to January 2024. A total of 160 individuals ranging in age from 20 to 78 years old who reported chest pain were included in this descriptive cross-sectional research.The study included male and female patients (ranging in age from 20 to 78) who received medical attention in the emergency room due to chest discomfort. Non-probability sequential sampling was used to guarantee a representative sample. People who had previous heart-related procedures or interventions or who refused to give their permission were not included in the research.

The number of patients needed to conduct this research was decided by looking at a previous study by Chen Q et al.16. In that study, 12.5% of consecutive patients with acute anterior STEMI showed signs of early repolarisation. Utilising a 95% confidence interval (CI) and a 4% margin of error, the necessary sample size of 160 was determined.

In addition to the early repolarisation pattern, other ECG findings such as QTc intervals, QRS duration, R-R interval, P-R interval, T-wave duration, heart rate, and the presence of left ventricular hypertrophy were recorded using a 12-lead electrocardiogram (ECG). In accordance with a predetermined standard, we recorded the patient's gender and age (in years) when they arrived at the hospital and computed their body mass index (BMI) in kilogrammes per square metre. Hypertension, diabetes mellitus, smoking habits, obesity, and family medical history were among the additional topics included in the patient's medical history. The hospital's protocol and standards for clinical practice were followed by all patients.

The ER pattern is a "an elevation of the QRS-ST junction (J point) by ≥0.1 mV above the baseline, and/or either notching or slurring morphology of the terminal portion of QRS at ≥2 inferior (II, III, and aVF) and/or lateral (I, aVL, and V4-V6) leads" .16Patients were diagnosed as "ST-segment elevation myocardial infarction (STEMI)," "non-ST elevation myocardial infarction (NSTEMI)," unstable angina, or non-cardiac chest pain based on baseline 12-lead ECG abnormalities, chest pain duration, and low-sensitivity troponin.
The “Shapiro-Wilk test” examined variables for normality. Descriptive statistics, such mean ± SD or median (IQR), were calculated from variable distribution. Gender, age, final diagnosis, hypertension, diabetes, family history, obesity, smoking, left ventricular hypertrophy, and early repolarisation were listed with frequencies and percentages. All data was examined with SPSS 22.0.

3. RESULTS

The patients mean age was 58.7±11.65 years and had mean BMI 26.12±8.44 kg/m^2. There were majority 96 (60%) males and 64 (40%) females among all cases. Early repolarization pattern (ER) was present in 59 (36.9%). Hypertension, diabetes mellitus, obesity, family history of CAD and smoking were the comorbidities among all cases. Frequency of STEMI was found in 32 (20%) cases.(table 1)

Table-1: Demographics of the presented cases with chest pain

Variables	**No/ Percentage (160)**
Mean age (years)	58.7±11.65
Mean BMI (kg/m^2)	26.12±8.44
Sex	
Male	96 (60%)
Female	64 (40%)
Early repolarization pattern	
Yes	59 (36.9%)
No	101 (63.1%)
Comorbidities	
HTN	55 (34.4%)
DM	42 (26.3%)
Family history of CAD	38 (23.4%)
Smoking	13 (8.1%)
obesity	12 (7.5%)
Diagnosis	
STEMI	32 (20%)
Non-STEMI	98 (61.3%)
Non-Cardiac	20 (12.5%)
Unstable Angina	10 (6.3%)

Specific characteristics, such as a low body mass index ($p<0.002$), reduced T-wave length ($p=0.002$), and lower heart rate ($p=0.003$), were shown to be substantially linked with the ER patterns, and the final diagnosis of conditions other than STEMI ($p=0.035$). (table 2)

Table-2: Results from electrocardiograms, differential diagnosis between those with and without an early repolarization pattern

Variables	**ER Absent (101)**	**ER Present (59)**	**P Value**
BMI (kg/m^2)	27.17±11.38	25.14±7.29	<0.002
ECG Parameters			
QTc intervals (ms)	310 [280-370]	310 [275-350]	0.121
QRS duration (ms)	75 [65-105]	75 [65-100]	0.269
R–R interval (sec)	0.70 [0.50-0.7]	0.79 [0.58-0.7]	0.081

P–R interval (ms)	140 [110-150]	135 [110-150]	0.079
T-wave duration (ms)	100 [90-150]	80 [70-110]	0.002
Heart rate (bpm)	80.5± 9.8	76.7±5.10	0.003
Left ventricular hypertrophy	7 (6.9%)	3 (5.1%)	0.878
Final diagnosis			
STEMI	25 (24.8%)	7 (11.9%)	0.035
Non-STEMI	52 (51.5%)	30 (50.8%)	0.038
Non-Cardiac	12 (11.9%)	8 (13.6%)	0.114
Unstable Angina	7 (6.9%)	3 (5.1%)	0.874

4. DISCUSSION

In order to identify the frequency with which electrocardiogram (ECG) changes occur in persons who present with chest pain, as well as the factors that are associated with these changes, our objective was to investigate. The early repolarisation pattern was observed in around 36.9% of the patients, which is approximately one-third of the total number of patients. As a result of the fact that recent research have shed light on the potential clinical implications of ER changes, this frequency is notable and should be investigated further. [14]

Our analysis reveals a significantly higher incidence of ER patterns as compared to the research that was done in the past. One hundred and thirty-three (12.5%) of the 1,460 consecutive patients who were diagnosed with acute anterior STEMI had an ER pattern that was documented in a previous analysis [15]. A study of the propensity-matched population revealed that the presence of ER was associated with an increased risk of prolonged VT/VF. The hazard ratio for this association was 2.915 (95% confidence interval: 1.520-5.588, P=0.001) among the population.

Researchers Oka E. and colleagues [16] examined the findings of cardiac MRI in patients who were diagnosed with acute myocarditis. Their goal was to identify the frequency of the ER-ECG pattern, the significance of the pattern, and the processes that are responsible for its occurrence. In thirty percent of the instances, the ER-ECG pattern was found to be present, according to their investigation. A voltage gradient across the ventricular wall was hypothesised to be the result of acute myocarditis-induced inflammation and swelling of the "left ventricular (LV)" epicardium, which they believed was the cause of this phenomenon. A further point of interest is that the ER-ECG pattern in individuals with acute myocarditis was not shown to be related with the development of potentially catastrophic "ventricular tachyarrhythmias (VT)" [16].

According to the findings of Sucuet al.[17], coronary slow flow phenomenon was shown to be related with the J-wave and slurring early repolarisation pattern in persons who had positive reactions to treadmill tests or who experienced chest pain that suggested "stable angina" pectoris. People who have vasospastic angina (VSA) are more likely to develop ventricular fibrillation (VF) recurrence if they have early repolarisation patterns, particularly if they display daily changes, according to the findings of another study. Therefore, the installation of a "implantable cardioverter defibrillator (ICD)" is a realistic alternative for patients who are at a high risk of developing ventricular tachycardia (VSA) to employ as a secondary VF preventive treatment.

According to the data that we obtained, an ER pattern is substantially related with having a body mass index that is low. It was shown that patients with lower body mass index (BMI) quartiles had a greater likelihood of exhibiting emergency room patterns. In light of these findings, there is more evidence to support the hypothesis that a lower body mass index is linked to an increased risk of ER changes. It is necessary to do further study in order to find out the mechanism behind this link. The likelihood of ER patterns was higher in individuals whose T-wave durations were shorter. This was the case in the overall population. It is possible that this discovery may provide insight on the electrophysiological basis of these patterns, and it also underscores the relevance of T-wave features in connection to ER modifications. One further significant finding that emerged from our research was that a slower heart rate was associated with a higher likelihood of experiencing adverse respiratory patterns. It is necessary for us to get further knowledge on the treatment implications of this heart rate–ER pattern link for the purpose of risk classification. Movahed MR et al. conducted a study on the African-American race, and their findings indicated that there is a correlation between a slower heart rate and a higher incidence of emergency room visit [18]. On the other hand, they found that those with a high body mass index were more likely to experience episode of respiratory distress (ER).

Additionally, it is essential to take into consideration the connection that exists between the patterns of endocrinology and the final diagnosis. The chance of patients with non-cardiac symptoms having an emergency room pattern was much lower

than the likelihood of patients diagnosed with STEMI or NSTEMI having an ER pattern. Based on the findings of the study, it is essential to have a thorough understanding of and recognition of emergency room patterns, particularly when chest pain is present, in order to differentiate these patterns from actual MI findings. Previously, it was believed that ER patterns were not harmful anomalies on an electrocardiogram. Due to the fact that the treatment and clinical effects of these two disorders are distinct from one another, it is vital to properly differentiate between the two. When electrocardiograms are performed, the presence of ER is often a surprise discovery. ER can be discovered on occasion.[19] It should be noted that in one study, over twenty percent of the 542 persons who were diagnosed with ER did not dependably display ER patterns on subsequent electrocardiograms.[20] An electrocardiogram (ECG) that was performed on patients who were hospitalised for cardiac arrest did not display the ER pattern in as many as 58% of the cases. This is the case even when ER syndrome is regarded to be a probable diagnosis.[21] For the present being, there are no tests that have been proved to be reliable for detecting concealed ER. Although there are some characteristics of an electrocardiogram that have been associated with an elevated risk of malignant ER, there are presently no approaches that can properly detect this risk in a physiological setting.

It is recommended that persons with asymptomatic ER who do not have a family history of malignant ER have their electrocardiogram (ECG) alterations deemed normal until a more accurate and precise stratification marker or tool is discovered.[22] It is of the utmost importance to manage modifiable cardiac risk factors regardless of whether or not the emergency room is exhibiting symptoms.

5. CONCLUSION

Based on our findings, one-third of individuals experiencing chest discomfort have an ECG rhythm known as early repolarization. It is less common in individuals with STEMI and non-STEMI, and associated characteristics include a low body mass index (BMI), shorter T-wave length, and lower heart rate.

REFERENCES

[1] Bautz B, Schneider JI. High-risk chief complaints I: chest pain—the big three (an update). Emerg Med Clin North Am. 2020;38(2):453-98

[2] Ko DT, Dattani ND, Austin PC, Schull MJ, Ross JS, WijeysunderaHC, et al. Emergency department volume and outcomes for patients after chest pain assessment. CircCardiovascQualOutcomes. 2018;11(11):e004683

[3] Mir MU, Bachani AM, Khawaja H, Afridi SQ, Ali S, Khan MM, et al.The Pakistan national emergency department surveillance study (Pak-NEDS): introducing a pilot surveillance. BMC Emerg Med. 2015;15 Suppl 2(Suppl 2):S1.

[4] Gussak I., George S., Bojovic B. ECG phenomena of the early ventricular repolarization in the 21 century. Indian Pacing Electrophysiol J. 2008;8:149–157.

[5] Bianco M., Bria S., Gianfelici A. Does early repolarization in the athlete have analogies with the Brugada syndrome? Eur Heart J. 2001;22:504–510. doi: 10.1053/euhj.2000.2247.

[6] Miyazaki S., Shah A.J., Haïssaguerre M. Early repolarization syndrome—a new electrical disorder associated with sudden cardiac death. Circ J. 2010;74:2039–2044. doi: 10.1253/circj.cj-10-0753.

[7] Nam G.B., Kim Y.H., Antzelevitch C. Augmentation of J waves and electrical storms in patients with early repolarization. N Engl J Med. 2008;358:2078–2079. doi: 10.1056/NEJMc0708182.

[8] Antzelevitch C. Genetic, molecular and cellular mechanisms underlying the J wave syndromes. Circ J. 2012;76:1054–1065. doi: 10.1253/circj.cj-12-0284.

[9] R.B. Patel, J. Ng, V. Reddy, M. Chokshi, K. Parikh, H. Subacius, A.A. Alsheikh-Ali, T. Nguyen, M.S. Link, J.J. Goldberger, L. Ilkhanoff, A.H. Kadish. Early repolarization associated with ventricular arrhythmias in patients with chronic coronary artery disease.CircArrhythmElectrophysiol, 3 (2010), pp. 489-495

[10] Y. Naruse, H. Tada, Y. Harimura, M. Hayashi, Y. Noguchi, A. Sato, K. Yoshida, Y. Sekiguchi, K. Aonuma. Early repolarization is an independent predictor of occurrences of ventricular fibrillation in the very early phase of acute myocardial infarction.CircArrhythmElectrophysiol, 5 (2012), pp. 506-513

[11] B. Rudic, C. Veltmann, E. Kuntz, M. Behnes, E. Elmas, T. Konrad, J. Kuschyk, C. Weiss, M. Borggrefe, R. Schi mpf.Early repolarization pattern is associated with ventricular fibrillation in patients with acute myocardial infarction.Heart Rhythm, 9 (2012), pp. 1295-1300

[12] Gussak I, Antzelevitch C. Early repolarization syndrome: clinical characteristics and possible cellular and ionic mechanisms. J Electrocardiol. 2000;33(4):299-309

[13] Impact of the electrocardiogram on the delivery of thrombolytic therapy for acute myocardial infarction. Sharkey SW, Berger CR, Brunette DD, et al. Am J Cardiol. 1994;73:550–553. doi: 10.1016/0002-9149(94)90331-x

[14] Patton KK, Ellinor PT, Ezekowitz M, Kowey P, Lubitz SA, Perez M, et al. Electrocardiographic early repolarization: a scientific statement from the American Heart Association. Circulation. 2016;133(15):1520-9

[15] Neupane G, Seedat ZO, Zahra T. Electrocardiographic Early Repolarization in an Emergency Setting: The Subtleties of Electrocardiography. Cureus. 2023 Sep 30;15(9):e46253. doi: 10.7759/cureus.46253.

[16] Oka E, Iwasaki YK, Maru Y, Fujimoto Y, Hagiwara K, Hayashi H, et al. Prevalence and significance of an early repolarization electrocardiographic pattern and its mechanistic insight based on cardiac magnetic resonance imaging in patients with acute myocarditis. CircArrhythmElectrophysiol. 2019;12(3):e006969

[17] Sucu M, Ucaman B, Altunbas G. Early repolarization pattern in the coronary slow flow phenomenon. ScandCardiovasc J. 2018;52(3):108-12

[18] Movahed MR, Ramaraj R, Bates S. Early repolarization is independently associated with African–American race, younger age, higher BMI and lower heart rate. Future Cardiol. 2022;18(10):771-5.

[19] Radiographic and clinical brain infarcts in cardiac and diagnostic procedures: a systematic review and meta-analysis. Cho SM, Deshpande A, Pasupuleti V, Hernandez AV, Uchino K. Stroke. 2017;48:2753–2759. doi: 10.1161/STROKEAHA.117.017541.

[20] Anoshi A, Zada S, Khan KA, Rajpoot S, Bai P, Nazir P, Sorath S, Kumari P. Frequency and Factors Associated with Early Repolarization Changes in ECG in Patients Presenting With Chest Pain. Pak Heart J.2023;56(04):261-267. DOI: https://doi.org/10.47144/phj.v56i4.2668

[21] G.Z. Sun, N. Ye, Y.T. Chen, *et al.*Early repolarization pattern in the general population: Prevalence and associated factors. Int J Cardiol, 1 (2017), pp. 614-618

[22] M.S. Cho, C.H. Kwon, G.B. Nam, *et al.*Characteristics of early repolarization parameters and prognostic implications in the general ambulatory Korean population. Int J Cardiol, 15 (2017), pp. 571-576