Early repolarization in the athlete: just a benign finding?

A repolarização precoce no atleta: apenas um achado benigno?

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INTRODUCTION

Electrocardiographically defined as J-point elevation, ST-segment elevation, J waves or terminal QRS *slurring* in the lower (IBD, DIII and aVF) and/or lateral (DI, aVL, V4-V6) leads1, Early Repolarization is traditionally considered a benign electrocardiographic variant, present in about 5% of the world population2.

At one end of the spectrum of Early Repolarization, this is considered a benign finding, predominantly found in young people and athletes3, with an estimated prevalence of 20 to 90% of this population4, strongly associated with intense physical exercise. However, a limited number of studies have associated this finding with the occurrence of idiopathic ventricular fibrillation or sudden cardiac death1,2,5, and several genetic variants have been pointed out as the underlying electrophysiological pathology2. This other end of the spectrum of Early Repolarization refers to a "syndrome" that presents with sudden cardiac death, often in the context of a structurally normal heart2.

This "syndrome", called Early Repolarization Syndrome, is diagnosed when an Early Repolarization pattern is observed (elevation of the J point > 1mm in two or more contiguous lateral and/or inferior electrocardiographic leads) in an individual resuscitated after an event of polymorphic ventricular tachycardia or ventricular fibrillation without any known heart disease6.

GOAL

To evaluate the association of Early Repolarization with sports training time, as well as weekly training hours, type of sport practiced, personal medical history and family clinical history of sudden cardiac death.

METHODOLOGY

Data collection took place between October 2022 and February 2023. This study has a quantitative and prospective typology, and the collection of samples was carried out randomly.

A questionnaire with questions related to sports training, personal clinical history and family clinical history was applied and an electrocardiogram was performed on a sample of 66 athletes.

The variables studied were the following: age; gender; time of sports practice; hours of sports training per week; type of sport practiced; personal clinical history of symptoms during practice; family clinical history of death/heart disease; presence of findings compatible with Early Repolarization on the electrocardiogram. The electrocardiogram was considered positive for Early Repolarization if an elevation of the J point > 1mm was observed in two or more contiguous leads in the lower territory (DII, DIII and aVF), lateral (DI, aVL, V4-V6) or in both[6].

In order to test the distribution of the sample, the *Kolmogorov-Smirnov* normality test was applied, from which only non-parametric variables were obtained. The associations between the numerical non-parametric variables were performed using the *Mann-Whitney U test and the* ordinal and binominal non-parametric variables with the Chi-square test, both for a significance level of $\rho \leq 0.05$ and a confidence interval of 95%. The variables obtained through the application of data collection were coded using the IBM® SPSS Statistics version 27.0 program.

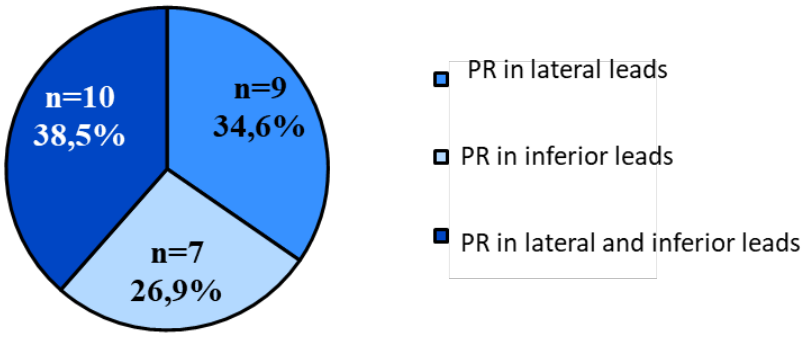
The design and respective protocol of the present study was evaluated and received a positive opinion from the Ethics Committee of the Polytechnic Institute of Castelo Branco (permission number 68/CE-IPCB/2022). All athletes included in this study were fully informed about the collection and treatment of clinical data and signed the Informed Consent form, in accordance with the Institute's policy and the best ethical standards.

DEVELOPMENT

The total sample of this study consists of 66 athletes, with a mean age of approximately 34.62 ± 14.57 years. More than one third of the individuals (n=26, 39.4%) presented electrocardiographic findings compatible with Early Repolarization.

Of the 26 electrocardiograms with the presence of Early Repolarization, 9 (34.6%) presented this finding in the lateral leads, 7 (26.9%) in the lower leads and 10 (38.5%) in the lateral and inferior leads.

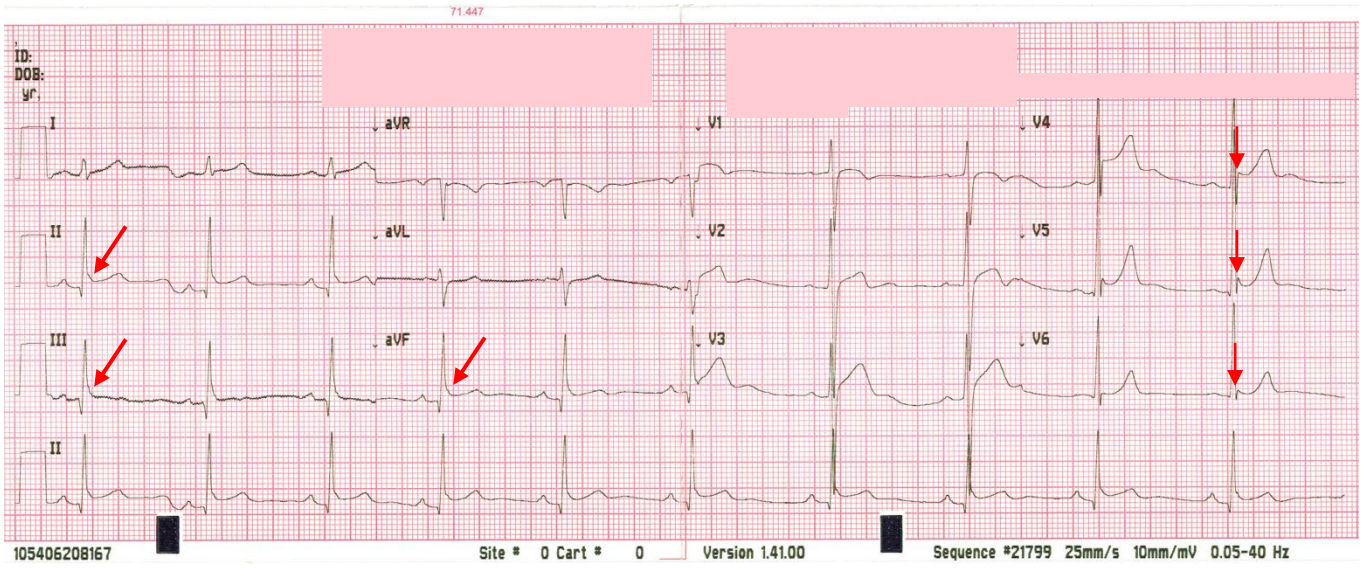
Figure 1. Distribution of the Early Repolarization pattern in the electrocardiogram of athletes



Legend: PR, early repolarization; %, percentage; n, number of samples

Figure 1 shows an example electrocardiogram of the electrocardiographic marks of Early Repolarization, collected from one of the individuals who participated in the study.

Figure 1. Electrocardiogram exemplificative of Early Repolarization



Description: Electrocardiogram of a 22-year-old male athlete, Caucasian, triathlon practitioner. It demonstrates the classic findings of early repolarization (J-point elevation with terminal QRS slurring) in IBD, DIII, aVF and V4-V6 (lower and lateral leads) (arrows).

Table 1 details the age and gender of the athletes with and without early repolarization findings. In this evaluation, no relevant significance was observed.

Table 1. Age and Sex among Athletes with and without Early Repolarization findings

GENERAL DATA	n Athletes without PR on ECG (%)	n Athletes with PR on ECG (%)	n total number of athletes (%)	*R-value* (No PR + With RP)
Age (mean value + standard deviation)	35.03 ± 14.87 years	34.00 ± 14.37 years	34.62 ± 14.57 years	p=0.932*

Sex	Male	29 (72,5%)	18 (69,2%)	47 (71,2%)	p=0.788**
	Female	11 (27,5%)	8 (30,8%)	19 (28,8%)	

Legend: ECG, electrocardiogram; PR, early repolarization; %, percentage; n, number of samples; * Mann-Whitney U test; ** Chi-square test

Table 2 details data related to sports practice among athletes with and without early repolarization findings. In this evaluation, significance was verified between the presence of Early Repolarization and the time of sports practice (ρ=0.038).

Table 2. Time of sports practice, weekly training hours and type of sport practiced among athletes with and without Early Repolarization findings

DATA RELATED TO THE PRACTICE OF SPORTS		**n Athletes without PR on ECG (%)**	**n Athletes with PR on ECG (%)**	**n total number of athletes (%)**	***R-value* (No PR + With RP)**
Time of sports practice	Less than 10 years	18 (45,0%)	5 (19,2%)	23 (34,8%)	**p=0.038***
	More than 10 years	22 (55,0%)	21 (80,8%)	43 (65,2%)	
Hours of sports practice per week	Less than 8h	24 (60,0%)	17 (65,4%)	41 (62,1%)	p=0.878*
	But from 8 a.m.	15 (37,5%)	9 (34,6%)	24 (36,4%)	
	Didn't answer	1 (2,5%)	0 (0,0%)	1 (1,5%)	
Type of sport played	Individual Sport	21 (52,5%)	16 (61,5%)	37 (56,1%)	p=0.613*
	Team Sport	19 (47,5%)	10 (38,5%)	29 (43,9%)	

Legend: ECG, electrocardiogram; PR, early repolarization; %, percentage; n, number of samples; * Chi-square test

Table 3 details the variables studied in the evaluation of personal and family clinical history among athletes with and without Early Repolarization findings. In this evaluation, no relevant significance was observed.

Table 3. Personal and family history among athletes with and without early repolarization findings

PERSONAL AND FAMILY HISTORY		**n Athletes without PR on ECG (%)**	**n Athletes with PR on ECG (%)**	**n total number of athletes (%)**	***R-value* (No PR + With RP)**
Syncope or presyncope during or after exercise	Yes	7 (17,5%)	1 (3,8%)	8 (12,1%)	p=0.134*
	No	33 (82,5%)	25 (96,2%)	58 (87,9%)	
Rapid and irregular heartbeat during exercise	Yes	2 (5,0%)	2 (7,7%)	4 (6,1%)	NS*

	No	38 (95,0%)	24 (92,3%)	62 (93,9%)	
Family history of CSM	Yes	7 (17,5%)	4 (15,4%)	11 (16,7%)	NS*
	No	33 (82,5%)	22 (84,6%)	55 (83,3%)	

Legend: ECG, electrocardiogram; CSM, sudden cardiac death; NS, not significant (ρ=1.000); PR, early repolarization; %, percentage; n, number of samples; * Chi-square test

One of the main objectives of studies that focus on Early Repolarization in the population, especially in the athletic population, is to understand if the two extremes of the spectrum of this condition have variable manifestations of electrophysiological pathology in common or if these manifestations are not related to each other.

Early Repolarization was associated with an increased risk of cardiac death, especially in the presence of J-point elevation in leads lower ≥ 0.2 mV, a finding associated with a higher arrhythmic risk (although this finding is very rare in the population, with an incidence of about 0.3%)[7]. This finding was not verified in any of the 26 athletes in whom an Early Repolarization pattern was observed on the electrocardiogram.

Although the presence of Early Repolarization increases the relative risk of arrhythmic events, the absolute risk of ventricular fibrillation caused by primary arrhythmogenic pathology remains very low, which is why the detection of Early Repolarization should not be interpreted as a high-risk marker but rather as a normal electrocardiographic variant (in asymptomatic individuals with no family clinical history)[7].

The concept of Early Repolarization in the athletic population is usually consensual among sports cardiology professionals: it is thought that the electrocardiographic patterns of Early Repolarization are the result of an increase in vagal tone, being considered benign and related to sports training[8]. Going against this concept, the literature is quite clear, stating that the risk of sudden cardiac death in the vast majority of asymptomatic athletes who present Early Repolarization on the electrocardiogram is low8, indicating an increase in the probability of arrhythmic death in this population from 2 per million to approximately 3.5 per million9. In this study there was a significant increase in the prevalence of Early Repolarization in relation to the time of sports practice, and this physical exercise seems to be the cause of the development of Early Repolarization.

Clinical decisions are applied depending on the presence and severity of symptoms and comorbidities7. In situations where there is symptomatology and/or family clinical history, Early Repolarization should be included in the risk stratification of individuals. According to the guidelines for the management of patients with ventricular arrhythmias and for the prevention of sudden cardiac death of 2022 *of the European Society of Cardiology*, the implantation of an implantable event recorder in individuals with Early Repolarization who have suffered unexplained syncope is recommended6. Although the implantation of an implantable cardiodefibrillator is not recommended in asymptomatic individuals with

Early Repolarization who have a good prognosis, in the case of an individual having high-risk Early Repolarization and a strong family history of sudden juvenile death, the implantation of this device, or treatment with quinidine, is recommended6.

FINAL CONSIDERATIONS

The non-existence of significance between the presence of Early Repolarization and personal/family clinical history seems to corroborate that Early Repolarization is a common characteristic of the athlete that does not indicate electrical and/or structural cardiac abnormalities, being a condition that does not require additional evaluation after medical-sports examination or other routine examination. However, in case there is a history of unexplained syncope and/or family clinical history of sudden cardiac death (as was the case of 5 athletes in this study who presented Early Repolarization on the electrocardiogram – 4 reported a family clinical history of sudden cardiac death and 1 reported syncope or pre-syncope during or after exercise), Early Repolarization should be included in the risk stratification of individuals.

REFERENCES

1. Drezner JA, Sharma S, Baggish A, et al. international criteria for electrocardiographic interpretation in athletes: Consensus statement. Br J Sports Med. 2017;51(9):704-731. doi:10.1136/bjsports-2016-097331

2. Noseworthy PA, Tikkanen JT, Porthan K, et al. The early repolarization pattern in the general population: clinical correlates and heritability. J Am Coll Cardiol. 2011;57(22):2284-2289. doi:10.1016/j.jacc.2011.04.003

3. Claessen FMAP, Peeters HAP, Sorgdrager BJ, van Veldhoven PLJ. Early repolarisation among athletes. BMJ Open Sport Exerc Med. 2020;6(1):e000694. Published 2020 Mar 18. doi:10.1136/bmjsem-2019-000694

4. Noseworthy PA, Weiner R, Kim J, et al. Early repolarization pattern in competitive athletes: clinical correlates and the effects of exercise training. Circ Arrhythm Electrophysiol. 2011;4(4):432-440. doi:10.1161/CIRCEP.111.962852;

5. Haïssaguerre M, Derval N, Sacher F, et al. Sudden cardiac arrest associated with early repolarization. N Engl J Med. 2008;358(19):2016-2023. doi:10.1056/NEJMoa071968

6. Zeppenfeld K, Tfelt-Hansen J, de Riva M, et al. 2022 ESC Guidelines for the management of patients with ventricular arrhythmias and the prevention of sudden cardiac death. Eur Heart J. 2022;43(40):3997-4126. doi:10.1093/eurheartj/ehac262

7. Obeyesekere MN, Klein GJ, Nattel S, et al. A clinical approach to early repolarization. Circulation. 2013;127(15):1620-1629. doi:10.1161/CIRCULATIONAHA.112.143149

8. Aagaard P, Baranowski B, Aziz P, Phelan D. Early Repolarization in Athletes: A Review. Circ Arrhythm Electrophysiol. 2016;9(3):e003577. doi:10.1161/CIRCEP.115.003577

9. Cappato R, Furlanello F, Giovinazzo V, et al. J wave, QRS slurring, and ST elevation in athletes with cardiac arrest in the absence of heart disease: marker of risk or innocent bystander?. Circ Arrhythm Electrophysiol. 2010;3(4):305-311. doi:10.1161/CIRCEP.110.945824