Received: 9 September 2019 | Accepted: 17 September 2019

DOI: 10.1002/joa3.12247

EDITORIAL

Journal of Arrhythmia Open Access WILEY

Early repolarization in athletes

The athletes' heart is associated with physiological, structural, and electrical remodeling by repetitive physical training that continuously increases the cardiac output. The remodeled heart, sports heart, is often associated with ECG changes. This condition is generally benign but ECG abnormalities may reflect an underlying heart disease that could lead to sudden death during exercise in rare cases. It is essential to recognize the benign and malignant ECG changes resulting from physical training. In our country, annual health examinations are widely performed and include ECG screening generally performed during the first grade of elementary school, and junior and senior high school. Some patients then visit hospitals for abnormal ECG findings during the periodic and lifetime screening. The presence of T-wave inversion as well as an early repolarization (ER) pattern are the main reasons for consultation with a cardiologist. In general, common abnormal ECG findings in athletes include sinus bradycardia, first degree AV block, incomplete right bundle branch block, ER, and an isolated QRS voltage criteria for left ventricular hypertrophy.[1] T-wave inversion and a Brugada-like ER are less common ECG findings in athletes.

1 | EARLY REPOLARIZATION

ER is defined as a slur or notch on the terminal part of the QRS complex with or without ST-segment elevation and is frequently observed in apparently healthy subjects and athletes.[1] The prognosis of subjects with ER has been considered to be benign. Previous population studies have reported that the prevalence of ER in the general population is 5%-18%. ER is more common in the younger generation, athletes, and African Americans. The prevalence of ER in athletes is reported to be 9%-89% depending on the investigators, and is much higher than that of the general population. The mechanism of the higher prevalence of ER in athletes has been explained to be due to vagal tone.

On the other hand, ER may be observed as only an ECG abnormality in association with idiopathic ventricular fibrillation (IVF).[2] Rosso et al reported that the frequency of ER among young athletes was higher than that among healthy adults but less than that observed in IVF patients.[3] ER among young athletes is observed in leads V4-6 with an ascending pattern of the ST segment. Our serial studies have shown that the amplitude of ER pattern in patients without IVF decreases during the tachycardia but it also decreases in IVF patients.[4] Thus, a response pattern of the ER amplitude (J waves) to a changing heart rate can discriminate benign from malignant ER. Benign ER in athletes would require no further clinical evaluation.

An elevation of the ST segment with T-wave changes and ER pattern in the right precordial leads should be discriminated from Brugada syndrome and ARVC/D. From the history taking for syncope or sudden death among the family history, echocardiography, cardiac MRI, provocation tests with sodium channel-blocking agents, and/or an electrophysiological study may be needed in some cases.

2 | T-WAVE INVERSION

T-wave inversion is seen in all precordial leads at birth and becomes positive over the time course. T waves in V5-6 are positive during all ages. Inverted T waves in V1-3 in adults are called a persistent juvenile pattern. T-wave inversion, except for a persistent juvenile pattern, may represent myocardial ischemia, cardiomyopathy including Brugada syndrome, and arrhythmogenic right ventricular cardiomyopathy. If inverted T waves are observed in leads V3-6 in junior high school students (or in leads V4-6 during elementary school), a detailed examination is recommended. Athletes with T-wave inversion in the inferior and/or lateral (I, aVL, V5-6) leads, however, should be examined for underlying structural heart disease.

In the issue from the *Journal of Arrhythmia*, Sahashi et al reported a case of an ER pattern and T-wave inversion in an African-Japanese athlete. His past history was noncontributory. The ECG exhibited a pattern with a dome-shaped ST elevation and T-wave inversion or biphasic T waves observed in leads V1 to V3. This ECG pattern is called a Black/African athlete repolarization variant, which is seen in up to 13% of Black/African athletes. This ECG pattern is not frequently observed in the younger Japanese population and is unfamiliar to the majority of Japanese cardiologists who may order echocardiography and/or a cardiac MRI to exclude ischemic or nonischemic cardiomyopathy. However, this ECG pattern is considered to be a normal variant in asymptomatic athletes as described in a standard textbook published in the US,[5] and the patients will need no further examination unless there is a positive family history of sudden cardiac death or an abnormal physical examination.

In 2020, the Tokyo 2020 Olympic and Paralympic Games will be held in Japan. Thousands of top athletes from all over the world will come to Japan. As the authors stated in this issue, we must refocus

on the significance of the ECG findings in trained athletes and their Ethic differences on this historic occasion.

CONFLICT OF INTEREST

Authors declare no conflict of interests for this article.

Yoshiyasu Aizawa MD, PhD
Akio Kawamura MD, PhD

Department of Cardiovascular Medicine, International University of Health and Welfare, Narita, Japan
Email: yoshiyaaizawa-circ@umin.ac.jp

ORCID

Yoshiyasu Aizawa https://orcid.org/0000-0002-8323-4229

REFERENCES

1. Sharma S, Drezner JA, Baggish A, Papadakis M, Wilson MG, Prutkin JM, et al. International recommendations for electrocardiographic interpretation in athletes. J Am Coll Cardiol. 2017;69(8):1057–75.
2. Haïssaguerre M, Derval N, Sacher F, Jesel L, Deisenhofer I, de Roy L, et al. Sudden cardiac arrest associated with early repolarization. N Engl J Med. 2008;358:2016.
3. Rosso R, Kogan E, Belhassen B, Rozovski U, Scheinman MM, Zeltser D, et al. J-point elevation in survivors of primary ventricular fibrillation and matched control subjects: incidence and clinical significance. J Am Coll Cardiol. 2008;52(15):1231–8.
4. Aizawa Y, Takatsuki S, Nishiyama T, Kimura T, Kohsaka S, Kaneko Y, et al. Tachycardia-induced J-wave changes in patients with and without idiopathic ventricular fibrillation. Circ Arrhythm Electrophysiol. 2017;10(7):https://doi.org/10.1161/CIRCEP.117.005214
5. Zipes D, Douglas P, Libby P, Peter L. Braunwald's heart disease: a textbook of cardiovascular medicine, 11th edition, 2018; 126. Philadelphia, PA: Elsevier