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Usefulness of echocardiography in athletes: experience of a Portuguese center

Utilidad de la ecocardiografía en deportistas: experiencia de un centro portugués

Geraldo Dias,* Pedro Von Hafe,‡ Filipa Cardoso,* Tamara Pereira,* Mariana Tinoco,* João Português,* António Lourenço‡

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Palabras clave:
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ABSTRACT

Introduction: Pre-participation screening aimed at the detection of disorders associated with sudden cardiac death is universally supported by major medical societies. However, the best method for screening remains controversial. The aim of this study was to evaluate the prevalence of structural cardiac lesions identified by echocardiography in apparently healthy athletes referred for pre-participation screening. **Material and methods:** We conducted an observational retrospective study (January 2017-December 2019) performed in a single center. We evaluated echocardiograms of athletes under 35 years of age, performed in the first evaluation for pre-participation screening. **Results:** A total of 1,981 different athletes' echocardiograms were included; 36 exams (1.8%) reported structural cardiac lesions. The most common cardiac lesions found were mitral valve prolapse (n = 5), atrial septal aneurysm (n = 5) and atrial septal defect (n = 4). The bicuspid aortic valve and left ventricular hypertrophy were each present in 3 athletes (n = 3); ventricular septal defects, left ventricular noncompaction, aortic dilatation and dilated cardiomyopathy were each found in 2 athletes (n = 2). Less frequent lesions were present in only one athlete, such as hypertrophic cardiomyopathy, surgically-corrected transposition of the great arteries, and pulmonary valve stenosis. Notably, among 36 patients with structural abnormalities in echocardiography, only 6 (16.7%) had positive standard pre-participation screening (combining personal and family history, physical examination and electrocardiogram). **Conclusions:** Echocardiography plays an important role in detecting cardiac structural abnormalities that would otherwise escape standard screening protocols and could be left unnoticed. This study suggests a potential benefit of including echocardiography in the first evaluation for pre-participation screening of competitive athletes.

RESUMEN

Introducción: *Las principales sociedades médicas respaldan universalmente el cribado previo a la participación destinado a la detección de trastornos asociados con la muerte súbita cardiaca. Sin embargo, el mejor método para la detección sigue siendo controvertido. El objetivo de este estudio fue evaluar la prevalencia de lesiones cardiacas estructurales identificadas por ecocardiografía en atletas aparentemente sanos, referidos para tamizaje pre-participación.* ***Material y métodos:*** *Realizamos un estudio observacional retrospectivo (enero 2017-diciembre 2019) de un único centro. Se evaluaron ecocardiogramas de atletas menores de 35 años, realizados en la primera evaluación para tamizaje pre-participación.* ***Resultados:*** *Se incluyeron en total 1,981 ecocardiogramas de atletas diferentes; 36 exámenes (1.8%) reportaron lesiones cardiacas estructurales. Las lesiones cardiacas más frecuentes encontradas fueron prolapso de la válvula mitral (n = 5), aneurisma del tabique interauricular (n = 5) y comunicación interauricular (n = 4). La válvula aórtica bicúspide y la hipertrofia ventricular izquierda estuvieron presentes cada una en tres atletas (n = 3); defectos del tabique ventricular, miocardiopatía por ventrículo izquierdo no compacto, dilatación aórtica y miocardiopatía dilatada se encontraron cada uno en dos atletas (n = 2). Las lesiones menos frecuentes se presentaron en un solo atleta, e incluyeron miocardiopatía hipertrófica, transposición de grandes arterias corregida quirúrgicamente, estenosis de válvula pulmonar, entre otras. En particular, entre 36 pacientes con anomalías estructurales en la ecocardiografía, sólo 6 (16.7%) tuvieron un examen estándar previo a la participación positivo (combinando antecedentes personales y familiares, examen físico y electrocardiograma).* ***Conclusiones:*** *La ecocardiografía transtorácica juega un papel importante en la detección de anomalías estructurales cardiacas que de otro modo escaparían a los protocolos de detección estándar y podrían pasar desapercibidas. Este estudio sugiere un beneficio potencial de incluir la ecocardiografía en la primera evaluación para la detección previa a la participación de atletas competitivos.*

* Medical doctor in the Department of Cardiology.
‡ Medical doctor in the Department of Cardiology and Sports Medicine Center of Guimaraes, Guimaraes, Portugal.

Senhora da Oliveira Hospital, Guimarães, Portugal.

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INTRODUCTION

Regular physical activity and exercise are widely recommended by the scientific community since it is associated with a decrease in cardiovascular and all cause-mortality.[1,2] On the other hand, in susceptible individuals, the practice of intense exercise may paradoxically increase the risk of cardiac events and sudden cardiac death (SCD).[1,3]

Estimates on the incidence of SCD in competitive athletes are widely inconsistent, varying from 1 in a million to 1 in 5,000 athletes per year, mainly due to heterogeneous populations and unstandardized study designs.[1,4] In most cases, the mechanism of SCD is a sudden ventricular arrhythmia that occurs as a consequence of a previously silent culprit disease.[3,5] As a result, screening subjects for cardiovascular (CV) diseases potentially associated with SCD as part of a pre-participation screening (PPS) is widely supported by major medical societies.[1,6] However, the best method for CV screening remains controversial and is still under debate.[1,7] Along with medical history and physical examination, different countries apply different regulations regarding complementary exams to be used in PPS in competitive athletes.[3,7] These exams may include electrocardiogram (ECG), exercise testing or compulsory echocardiography.[3] Although echocardiography may be able to identify additional structural disorders, there is still insufficient evidence to recommend routine echocardiographic screening.[8,9]

In Portugal, in recent years, there has been a growing trend in the registration of competitive athletes in sports federations. In 2020 there were around 587,812 registered athletes, about 57 per 1,000 inhabitants.[10] These are significant numbers that make it important to establish a cost-effective PPS methodology prior to the initiation of exercise that is capable of detecting potentially life-threatening CV disease and preventing sudden death events.

The aim of this study was to evaluate the prevalence of structural cardiac lesions identified by echocardiography in apparently healthy athletes referred for pre-participation screening.

MATERIAL AND METHODS

In the Sports Medicine Center of Guimarães (SMCG), all athletes undergo a CV evaluation consisting of family and personal medical history, physical examination and ECG. In the first evaluation, by local protocol, every athlete undergoes an echocardiogram regardless of age, sex, degree of activity or sport's modality. The European Society of Echocardiography recommends complete two-dimensional and color Doppler echocardiogram with standard transthoracic echocardiographic views performed by experienced cardiologists and pediatric cardiologists.[11]

In this study, we retrospectively evaluated consecutive echocardiograms of athletes under 35 years of age that were performed in the first evaluation for PPS between the years 2017 and 2019.

RESULTS

A total of 1,981 different athletes were included. Structural cardiac lesions were found in 36 (1.8%) individuals. In this subgroup, the median age was 18.5 (IQR = 16) years, the vast majority of athletes were male (91.7%; n = 33), of the white race (94.4%; n = 34), and the most represented sport was football (66.7%; n = 24). Demographic characteristics discriminated by sports modality are described in *Table 1*.

Cardiac lesions found in athletes' echocardiograms are described in *Table 2*. The most frequent lesions were mitral valve prolapse (MVP, n = 5) and atrial septal aneurysm (ASA, n = 5). Four athletes presented with *ostium secundum* atrial septal defect (ASD); bicuspid aortic valve (BAV) and left ventricular hypertrophy (LVH) were each present in 3 athletes. Ventricular septal defects (VSD), left ventricular noncompaction (LVNC), aortic dilatation and dilated cardiomyopathy (DCM) were each present in 2 patients.

Less frequent lesions were present in only one athlete, such as subaortic membrane, patent ductus arteriosus, hypertrophic cardiomyopathy (HCM), surgically corrected transposition of the great arteries (TGA), persistent left superior vena cava with coronary sinus dilatation, dysplastic pulmonary valve

Table 1: Demographic characteristics discriminated by type of sport.

Type of sport	N (%)	Median age	Male sex, N (%)	White race, N (%)
Football	24 (66.7)	15.5	23 (95.8)	22 (91.7)
Referees	3 (8.3)	25.0	3 (100.0)	3 (100.0)
Combat sports	2 (5.6)	32.5	1 (50.0)	2 (100.0)
Rugby	2 (5.6)	22.5	2 (100.0)	2 (100.0)
Basketball	1 (2.8)	14.0	1 (100.0)	1 (100.0)
Boxing	1 (2.8)	23.0	0 (0.0)	1 (100.0)
Cycling	1 (2.8)	20.0	1 (100.0)	1 (100.0)
Handball	1 (2.8)	10.0	1 (100.0)	1 (100.0)
Volleyball	1 (2.8)	30.0	1 (100.0)	1 (100.0)
Total	36 (100.0)	18.5 (IQR = 16)	33 (91.7)	34 (94.4)

stenosis, right ventricle dilatation and coronary fistula between the left coronary artery and pulmonary trunk. Among the two black athletes with documented cardiac lesions on echocardiograms, one presented with HCM and the other with DCM. Among female athletes, two had ASA and one ASD.

Only three of the athletes with echocardiographic lesions had an abnormal ECG tracing (8.3%), namely an athlete with ventricular pre-excitation (MVP), another with negative T waves from V4 to V6 leads (VSD) and a black athlete with Q waves and negative T waves in the inferior leads and deep, negative/biphasic T waves in V2-V6 leads (HCM). Only one athlete (DCM) reported a family history of sudden cardiac death, and the other (corrected TGA) reported previous cardiac surgery. Two athletes presented with systolic murmurs in physical examination (one with corrected TGA and the other with dysplastic pulmonary valve stenosis). Overall, only 6 of the 36 athletes (16.7%) with cardiac lesions on echocardiogram presented positive findings when combining personal and family background, physical examination and ECG *(Table 2)*.

DISCUSSION

This study reports a cardiac lesion incidence of 1.8%, overlapping what is described in the literature.[7,8] Football is the most common sport practiced in this region, explaining the greatest number of abnormalities associated with this modality. Highly dynamic sports, like football, are known to pose a higher risk for SCD.[4]

Most European institutions (including Portugal) follow a specific workup based on European Society of Cardiology recommendations. The first-line evaluation protocol consists of personal and family history and physical examination, with the inclusion of a 12 lead ECG.[12] Additional investigation is required only if the first evaluation returned any positive findings.[12] On the other hand, in the United States of America (US), the latest guidelines from the US Preventive Services Task Force recommends against screening with resting or exercise ECG in asymptomatic adults with low risk of CV events.[13]

Institutions that use echocardiography as a first line in PPS are rare since the evidence supporting the use of echocardiography in routine screening is still scarce.[1,8]

However, some cardiac structural abnormalities that can easily be recognized with echocardiography can be missed on physical examination and ECG.[14]

In our study, only 16.7% of patients with documented cardiac lesions had a positive non-echocardiographic PPS, which would leave the remaining 83.3% unnoticed and unaddressed prior to sports participation. Not all cardiac lesions pose an increased risk of SCD, but many are associated with an increased risk of non-lethal CV events and thus require intervention or surveillance.[8]

In concordance with some studies, our findings suggest that the use of echocardiography in at least the first PPS of competitive athletes may improve the effectiveness of programs in detecting cardiac lesions and, possibly, help prevent SCD in athletes.[8,14]

Studies analyzing the cost-effectiveness of adding routine echocardiography to PPS protocols report increased sensitivity in detecting cardiac lesions otherwise not detected by standard screening, but with an estimated 20 to 30% increase in cost.[8,15]

Study limitations. Echocardiograms were performed in different laboratories and reported by different cardiologists without a standardized revision process.

We did not study clinical outcomes nor evaluate the costs of echocardiography inclusion in PPS. Therefore, we cannot objectively infer the prognostic significance or the cost-effectiveness of these findings.

The single-center nature further limits the generalizability of our findings.

CONCLUSIONS

To our knowledge, this report is the first published with a Portuguese sample that studies the impact of the inclusion of echocardiography in PPS for competitive athletes. Echocardiography plays a unique role in detecting cardiac structural abnormalities that would otherwise escape standard screening protocols based on medical history, physical examination and ECG alone.

In this study, we report that 83.3% of the cardiac lesions that were found by echocardiography in this population would not be detected by the standard screening protocol. This finding emphasizes the importance of echocardiography in structural heart disease detection and suggests a potential benefit of echocardiography in the first evaluation for PPS of competitive athletes. Nevertheless, larger studies with cost-effective analysis will be necessary to objectively support a recommendation

Table 2: Cardiac lesions prevalence in echocardiogram and abnormalities detection by standard non-echocardiographic pre-participation screening.

Type of lesion	Prevalence N (% within lesions; % overall)	Abnormal standard PPS N (% within type of lesion)
Atrial septal aneurysm	5 (13.9; 0.25)	0 (0)
Mitral valve prolapse	5 (13.9; 0.25)	1 (20)
Atrial septal defect	4 (11.1; 0.20)	0 (0)
Bicuspid aortic valve	3 (8.4; 0.15)	0 (0)
Left ventricular hypertrophy	3 (8.4; 0.15)	0 (0)
Ascending aortic dilation	2 (5.6; 0.10)	0 (0)
Dilated cardiomyopathy	2 (5.6; 0.10)	1 (50)
Left ventricle noncompaction	2 (5.6; 0.10)	0 (0)
Ventricular septal defect	2 (5.6; 0.10)	1 (50)
Coronary fistula (LCA-PT)	1 (2.8; 0.05)	0 (0)
Corrected great arteries transposition	1 (2.8; 0.05)	1 (100)
Dysplastic pulmonary valve stenosis	1 (2.8; 0.05)	1 (100)
Hypertrophic cardiomyopathy	1 (2.8; 0.05)	1 (100)
Patent ductus arteriosus	1 (2.8; 0.05)	0 (0)
Persistent left superior vena cava	1 (2.8; 0.05)	0 (0)
Right ventricle dilatation	1 (2.8; 0.05)	0 (0)
Sub-aortic membrane	1 (2.8; 0.05)	0 (0)

LCA = left coronary artery; PPS = preparticipation screening; PT = pulmonary trunk.

on the inclusion of echocardiograms in PPS protocols.

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Correspondence:
Geraldo Faia Carvalho Dias
E-mail: geraldofaia@gmail.com