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ECHOCARDIOGRAPHY AND SUDDEN CARDIAC DEATH IN ATHLETES

EHOKARDIOGRAFIJA I IZNENADNA SRČANA SMRT SPORTISTA

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Ključne reči
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Abstract

Although there is no doubt that physical exercise and competitive sport are healthy, improving quality of life and life expectancy, a number of tragic sudden deaths involving young competitive athletes were reported in the press in recent years. Underlying cardiac disorders are the most common cause of sudden death during sports activities. Left ventricular remodeling is associated with a long-term athletic training. Echocardiography is an easy, non-invasive and efficient way to the precise distinction between these exercise-induced changes, called "physiological" hypertrophy, that revert after detraining, and those of cardiac disorders or "pathological" hypertrophy. The identification of a cardiac disease in an athlete usually leads to his disqualification in an attempt to reduce the risk. On the other hand, a false diagnosis of a cardiac disease in an athlete may also lead to disqualification, thus depriving him of the various benefits from sports participation. Pronounced left ventricular dilatation and hypertrophy should always be suspected for underlying cardiac disease. Physiological left ventricular remodeling is associated with normal systolic and diastolic left ventricle function. Both global and regional left ventricle diastolic function should be evaluated. New echocardiographic techniques (tissue Doppler imaging, strain rate) have revealed "super – diastolic" left ventricle function in athletes, adding the new quality in differential diagnosis od athletežs heart syndrome.

INTRODUCTION

Although there is no doubt that physical exercise and competitive sport are healthy, improving quality of life and life expectancy, a number of tragic sudden deaths involving young competitive athletes were reported in the press in recent years [1]. Sudden death among athletes is very rare (1:50,000–1:100,000 annually) but it is still 2–4 times more frequent than in the age-matched control population and attracts significant media attention. [2, 3]. The risk-benefit ratio varies according to the athlete's age, physical capacity, and state of health [4]; nevertheless, underlying cardiac disorders are the most common cause of sudden death during sports activities [5,6].

Although athletes are considered to be the healthiest part of the population, it has been found that adolescent and young athletes have a 2.8-fold greater risk of sudden cardiovascular death (SCD) than their sedentary counterparts [7,8]. The incidence of sudden cardiac death in young people (age <35 years) is estimated to be 2.1 cases per 100,000 athletes per year from cardiovascular causes and 2.3 per 100,000 from all causes in Europe [7] , while in the USA the corresponding rate is 0.96 per 100,000 athletes per year [9] .

Preparticipation screening – current recommendations

Regular pre-participation cardiovascular screening is the best way to the identification of athletes affected by cardiovascular diseases [10,11]. The American Heart Association as well as the European Society of Cardiology have published guidelines for the cardiovascular screening of athletes, aiming to detect the high-risk athletes and to prevent undesirable events [11,12]. However, according to these recommenda-

tions, echocardiographic examination is not in the first line of diagnostic and it should be recommended in selected athletes, after standard medical examination [13]. The results of several studies based on the cost-effectiveness ratio of the proposed guidelines for pre-participation cardiovascular screening raised some doubts about the additional use of echocardiography [14,15]. Around 30% of sudden death cases cannot be precluded by current proposed medical screening of athletes, even when an ECG examination is included [16]. Transthoracic echocardiography significantly improves the diagnostic power of screening in the detection of both mild and serious cardiac conditions in the athletic population. In the recently published study Rizzo et al. have shown that additional echocardiographic examination in apparently healthy boys referred for pre-participation screening revealed in almost 1.8 % of the athletes a structural cardiac lesion with potential future complication [17].

Left ventricle remodeling

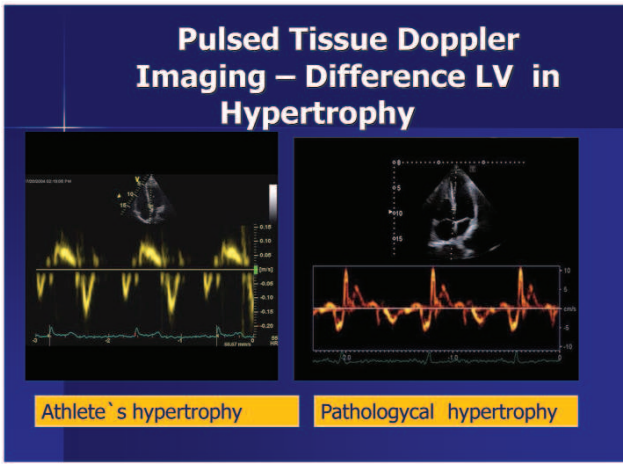
A long-term athletic training in adult athletes is associated with changes in cardiac morphology, including increased left ventricular (LV) cavity dimension, wall thickness and mass. These changes have been extensively studied and are commonly described as "athlete's heart", a positive adaptation to exercise suiting an athlete very well [18-20].

The "athlete's heart" syndrome was described by Henschen in 1899, using only a basic physical examination with a careful percussion for the recognition of the enlargement of the heart caused by the athletic activity in cross-country skiers [21]. Henschen [21] concluded that both dilatation and hypertrophy were present, involving both the left and right sides of the heart, and that these changes were normal and favourable.

The extent of changes in cardiac morphology varies between sports and previous training duration and may complicate the differentiation between normal physiologic changes and hypertrophic and dilatative cardiomyopathy, recognised as causes of a sudden death in young athletic population [22, 23]. Long-term cardiovascular adaptation leads to the left ventricle remodeling. It has been noted that adult elite professional footballers, undertaking both isotonic and isometric forms of exercise, have increased wall thickness, chamber dimensions, aortic root size, and left ventricular mass compared with healthy non-athletes [23-25]. This is the consequence of the physiological action caused by two physiological laws: the law of Frank-Starling (left ventricle dilatation) and the Laplacežs law (left ventricle hypertrophy). Increase in left ventricle mass is the final product of this action.

However, the responses of individual athletes to systematic conditioning are heterogeneous. The pattern and magnitude of physiologically increased LV mass may vary with respect to the nature of sports training, but also to the athletežs age [23, 26]. There are numerous studies suggesting that specific morphological adaptations and changes in LV mass are induced by systematic training in different sports disciplines [27-31]. The most extreme increases in LV wall thickness have been observed in those elite athletes training in rowing, and cycling, whereas limited data available in those athletes participating in ultra-endurance sports (such as triathlon) paradoxically show more modest alterations in cardiac dimensions [32]. Some misunderstanding persisted considering whether strength training (eg. wresting, weight lifting) alone results in LV hypertrophy. These sports are associated with only mild increase in wall thicknesses (although often disproportionate to cavity size), whereas absolute values uncorrected for body surface area usually remain well within the accepted normal range. These differences in left ventricle remodeling, known as the "Morganroth hypothesis", initially proposed some 30 years ago, initiated substantial and important research in the field of cardiac adaptation to physical exercise in athletes [33]. However, there are some scientific debates about insufficient evidences to endorse the "Morganroth hypothesis" of differential adaptation to aerobic and resistance training [34].

Normalization of cardiac dimensions according to body size is of the highest importance in comparisons between athletes and non-athletes, as it is known that cardiac dimensions vary with body size and composition and in everyday practice is hard to use BSA-matched population [26,35-37]. Cardiac dimensional alterations associated with athletic training have been defined over the past 30 years in a number of cross-sectional echocardiographic studies. However, pronounced left ventricular dilatation and hypertrophy should always be suspected for underlying cardiac disease. Physiological left ventricular remodeling is associated with normal systolic and diastolic left ventricle function [26, 38]. Both global and regional left ventricle diastolic function should be evaluated [38,39]. New echocardiographic techniques (tissue Doppler imaging) have revealed "super – diastolic" left ventricle function in athletes, adding the new quality in differential diagnosis of athletežs heart syndrome [39,40]. The difference in pathologic and physiologic Doppler tissue imaging patterns are shown at the Picture No 1.



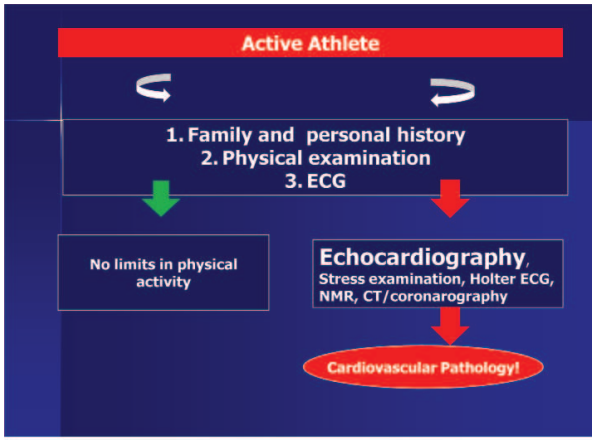
Picture No 1: The difference in pathologic and physiologic Doppler tissue imaging patterns

On the other hand, 3-dimensional echocardiographic morphologic and functional assessment of the left ventricle in Olympic athletes demonstrated a balanced adaptation of LV volume and mass, with preserved, not improved, systolic function, regardless of specific disciplines participated. Caselli [41, 42] in recently published studies have shown some improvement in athletežs left ventricle function, that can be detected by significant shortening of the systolic time in association with a significant increase in LV emptying

velocity. These patterns of left ventricle systolic and diastolic function characterize the physiological LV adaptation of the athletes and may potentially be useful in differential diagnosis of the 'athlete heart'.

Left ventricular remodeling is also linked to the left atrial remodeling, as well as the remodeling of the aortic root [26, 43-45]. A few new studies revealed that right ventricular dimensions are also affected by left ventricular remodeling, claiming the anatomical and functional unity of the two heart chambers [46-48].

The current recommendations for preparticipation athlete`s screening and the role of echocardiography are displayed at the Graph No 1.



Graph No 1: The current recommendations for preparticipation athlete`s screening and the role of echocardiography

Final remarks

Left ventricular remodeling is associated with a long-term athletic training. Echocardiography is an easy, non-invasive and efficient way to the precise distinction between these exercise-induced changes, called "physiological" hypertrophy, that revert after detraining, and those of cardiac disorders or "pathological" hypertrophy. The identification of a cardiac disease in an athlete usually leads to his disqualification in an attempt to reduce the risk. On the other hand, a false diagnosis of a cardiac disease in an athlete may also lead to disqualification, thus depriving him of the various benefits from sports participation. The correct echocardiographic quantification of the left ventricle function is of the highest importance for the athletežs health and career.

Apstrakt

Iznenadna srčana smrt je, nažalost, relativno česta kod aktivnih sportista. Veliki broj oboljenja koja su uzrok iznenadne srčane smrti mogu lako biti dijagnostikovana predtakmičarskim ehokardiografskim pregledom. Za sada i po evropskim i po američkim preporukama za predtakmičarsko praćenje sportista ehokardiografski pregled nije obavezan, već je indikovan u strogo selektivnim slučajevima. Ostaje pitanje adekvatne diferencijalne dijagnostike ehokardiografskih promena nastalih u sklopu fiziološkog remodelovanja srčanih struktura i početnih ehokardiografskih manefestacija patoloških stanja, potencijalnosmrtonosnih. Fiziološko remodelovanje leve komore kod sportista je uvek povezano sa očuvanom sistolnom I dijastolnom funkcijom leve komore, što nije slučaj kod patoloških stanja. Najčešći uzrok iznenadne srčane smrti kod sportista mladjih od 35 godina u Italiji je aritmogena displazija leve komore, a u Americi, s druge strane, hipertrofična kardiomiopatija. Oba oboljenja se vrlo lako i brzo mogu dijagnostikovati ehokardiografskim pregledom. Nove ehokardiografske tehnike (pulsni tkivni dopler, strain metoda) su pokazale da kod sportista postoji " super-dijastolna funkcija" leve komore, što je vrlo koristan parameter u diferencijalnoj dijagnozi fizioloških manifestacija "sportskog srca" i oboljenja srčanog mišića sa druge strane.

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