ATHLETE'S HEART SYNDROME AND ECHOCARDIOGRAPHIC CHANGES

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Abstract

The study was designed with the main intent to assess and explain the differences between athlete's heart syndrome and the heart of healthy non-athletes, and to distinguish between physiological and pathological heart condition. Prolonged athletic training causes changes in heart that are termed "athlete's heart syndrome". Athlete's heart diagnosis and related issues are a great challenge due to complementary morphological, functional and electro-physiological changes that may indicate both physiological and pathological condition. The study included 150 subjects, of those 100 were active athletes and 50 were in control group. The study protocol included one clinical examination, one electrocardiogram and one echocardiograph for each subject. Average age was 20,51±8,51 in the athletes and 21,48±2,53 in control group. Significantly higher average left ventricle (LV) mass (401,23g vs. 143,23g) and LV mass index (196,05g/m^2 vs. 83,98g/m^2) was found in the athletes (p<0,05). The study showed increased mass and wall thickness with usual inner dimensions of athlete's heart. Systolic and diastolic function of athlete's heart is normal. Athlete's heart with these features is a healthy heart.

KEY WORDS: athlete's heart, left ventricle hypertrophy, ultrasound.

Introduction

"Athlete's heart syndrome" is a well known condition that includes structural, electrophysiological and functional adaptation of myocard to an increased physical activity (training), which depends on the intensity, duration and type of the Activity (1,2,3,4). Left ventricle hypertrophy in athletes frequently resembles pathological conditions (hypertension or hypertrophic cardiomyopathy) and differential diagnosis is particularly important in active athletes (5,6,7). Different data on the nature (physiological vs. pathological) of left ventricle hypertrophy (LVH) in athletes and veterans were collected in the past (8,9,10). Pathological left ventricle hypertrophy is a risk factor for disease and death in mature age (11,12). Early detection of pathological LVH may reduce cardiac complications in athletes during training. Echocardiography is capable of analyzing structural and functional changes in myocard in athlete's heart and distinguish between physiological and pathological hypertrophy (13,14,15). The study was designed with the objective of demonstrating echocardiographic features in athletes in comparison to those in healthy non-athletes.

Subjects and Methods

The study is designed as a monocentric, open, prospective, comparative analysis within groups of active athletes classified according to the type of athletic activity and within the group of healthy individuals engaged in no recreational athletic activity. Subjects were examined and analyzed in Public Institution Center for sports medicine and Public Institution Center for students' healthcare. The study included 150 subjects, of those 100 were athletes with at least two years of active training and 50 were control group subjects with no athletic activity whatsoever.

Analyzed echocardiographic parameters:

- Ao - aorta width
- LA - left atrium
- RVD - right ventricle
- IVSd - intraventricular septum diastolic thickness
- LVIDd – left ventricle diastolic internal diameter
- LVPWd – posterior wall diastolic thickness
- IVSs – intraventricular septum systolic thickness
- LVIDs - left ventricle systolic internal diameter
- LVPWs – left ventricle posterior wall systolic thickness
- EF-systolic function of left ventricle
- E/A- diastolic function of left ventricle

Other parameters significant in heart ultrasound and function assessment:

- Blood pressure (mmHg)
- Pulse (beats per min)
- Body mass (kg)
- Body mass index
- Body height (cm)
- Body Surface Area - BSA (m^2)

The subjects were classified in groups according to the estimation of their athletic activity or lack thereof. Basic analyzed parameters were compared among groups. The results were analyzed by the mode of descriptive statistic. In analyzing the significance of the differences between means the threshold was set at $p<0,05$. We also analyzed left ventricle mass index. Left ventricle mass and body surface area were used to calculate left ventricle mass index. Body surface area (BSA) was calculated according to Mosteller's formula:

$BSA (m^2) = ([height (cm) \times mass (kg)] / 3600)^{½}$

Left ventricle mass is calculated from the measured parameters: LVID - left ventricle diastolic internal diameter, LVPWd posterior wall diastolic thickness and IVSd - intraventricular septum diastolic thickness. Left ventricle mess was calculated according to the formula:

$LVM(g)= 1,04 * [(LVIDd + IVSd + PWTd)^3 - LVIDd^3] – 13,6$

Left ventricle mass index was calculated according to Penn's formula:

$LVMI (g/m^2) = LVM (g)/BSA (m^2)$

Deveroux criteria indicate hypertrophy when LVMI> 134 g/m² in men and LVMI>110 g/m² in women.

Finally, we calculated average thickness of left ventricle wall according to the formula:

(IVST + PWT)/ LVID.

Results

Average age of the athletes was 20,51±8,51(SD) years, while average values of body mass, body surface area

	MIN	MAX	Mean ± SD
Age (years)	14	65	20,51 ± 8,51
Body mass (kg)	60	121	81,12 ± 2,53
Height (cm)	158	194	181,26 ± 7,76
BMI	19,59	34,49	24,68 ± 3,38
BSA (m^2)	1,38	3,16	2,05 ± 0,37
Blood pressure (mmHg)	110/75	145/90	115(25,5)/82(13,75)

Legend: MIN-minimal value, MAX- maximal value, SD – standard deviation, BMI – body mass index, BSA – body surface area

TABLE 1. Basic characteristics of the athletes (n=100)

(BSA) and blood pressure were 81,12 ±12,53 (SD) kg, 2,05±0,37(SD)m² and 115(25,5)/82(13,75) mmHg respectively (Table 1).

Average age of the non-athletes was 21,48 ±2,53 (SD) years, while body mass, body surface area (BSA) and blood pressure were 69,46±12,25 (SD) kg, 1,69±0,37(SD) m2 and 125(20,5)/85(15,75) mmHg respectively (Table 2).

	MIN	MAX	Mean ±SD
Age (years)	18	33	21,48 ± 2,53
Body mass (kg)	49	102	69,46 ±12,25
Height (cm)	160	200	174 ± 0,09
BMI	29,74	17,36	22,92 ± 3,01
BSA (m2)	2,83	1,10	1,69 ± 0,37
Blood pressure (mmHg)	115/77	155/92	125(20,5)/85(15,75)

Legend: MIN-minimal value, MAX- maximal value, SD – standard deviation, BMI – body mass index, BSA – body surface area

TABLE 2. Basic characteristics of the non-athletes (n=50)

Ultrasound findings

Average left ventricle mass index (LVMI in g/m²) (± SD) is 196,05±35,42 grams in athletes and 83,98±19,48 grams in non-athletes. The difference between groups is statistically significant (p<0,05). Average posterior wall diastolic thickness (LVPWd in cm) (± SD) is 1,51±0,17 cm in athletes and 0,78±0,09 cm in non-athletes. The difference between groups is statistically significant (p<0,05) (Table 3).

All subjects	Athletes	Non-athletes
LVM (left ventricle mass in g)	401,23±100,55	143,42±12,86
LVMI (LV mass index in g/m²)	196,05±35,42	83,98±19,48
LVPWd (LV posterior wall diastolic thickness in cm)	1,51±0,17	0,78±0,09
IVSd (IV septum diastolic thickness in cm)	1,55±0,21	0,83±0,09
LVIDd (LV diastolic internal diameter in cm)	4,93±0,40	4,97±0,29
Average LV wall thickness (IVSd +LVPWd / LVIDd)(cm)	0,621±0,09	0,324±0,06

TABLE 3. Ultrasound heart parameters in all subjects

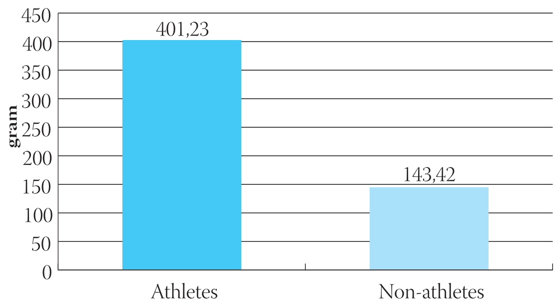
The values are given as mean ± standard deviation (SD)

	LV mass in athletes	LV mass in non-athletes
Min	212,57	116,52
Max	749,00	160,18
Med	390,57	144,31
AV	**401,23**	**143,43**
SD	100,55	12,86

Legend: AV – mean, SD – standard deviation, MAX – maximal value, MIN – minimal value, MED – median, LVM – left ventricle mass

TABLE 4. Average left ventricle mass (g)

Average left ventricle mass (± SD) is 401,23±100,55 gram in athletes and 143,42±12,86 gram in non-athletes. The difference between groups is statistically significant (p<0,05) (Table 4, Graph 1).



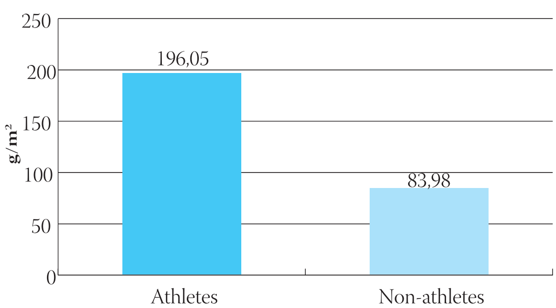
GRAPH 1. Left ventricle mass (LVM) (g) in all subjects

Average values of left ventricle mass index in all subjects is illustrated in Graph 2. Average LV mass index (±SD) is 196,05±35,42 g/m2 in athletes and 83,98±19,48 g/m2 in non-athletes. The difference between groups is statistically significant (p<0,05) (Table 5).

	Athletes	Non-athletes
Min	119,61	46,71
Max	289,62	135,02
Med	193,83	85,81
AV	**196,05**	**83,98**
SD	35,42	19,48
		(P = <0,001) , S

Legend: AV – mean, SD – standard deviation, MAX – maximal value, MIN – minimal value, MED – median

TABLE 5. Average left ventricle mass index in g/m²



GRAPH 2. Left ventricle mass index-LVMI-(g/m²) in all subjects

Discussion

The paper presents the results of our study on similarities and differences in heart size using echocardiography as a basic tool. The set of parameters was compared between the groups of active athletes and the control group of healthy subjects that pursue no athletic activity, even for recreational purposes. Their study yielded significant data on clinical examination of changes in electrocardiographs and echocardiography. The results obtained in our study are comparable. Athletes pursuing endurance sports (bicycling, rowing/canoe and "cross country skiing") exhibit significantly larger left ventricle (16,17). This group also exhibits significant changes in echocardiography and electrocardiography (15 18). Our group did not include athletes of this profile so we were unable to obtain the data. On the other hand, athletes pursuing technical sports (alpine skiing, judo etc.) most frequently show no changes in electrocardiograph. Furthermore, their electrocardiographs are normal or close to normal. In order to establish clinical importance of abnormal ECG in athletes, Pelliccia et al. compared ECG changes with echocardiographicaly assessed myocard morphology using different criteria, in 1360 athletes engaged in 38 different sports. ECG was distinctly changed in 14%, mildly changed in 26% and normal or with minor changes in 60% subjects. Abnormal ECG was associated with male sex, young age, strength sports and large heart dimensions. Structural cardiovascular disorder was rarely responsible for ECG changes in trained athletes. It suggests that the bizarre ECG changes may be a part of "athlete's heart syndrome". Pelliccia et al. (19) published their study of 947 athletes competing in Olympic sports. Athletes participating in this study suffered from no cardiovascular disorders and maintained blood pressure < 140/90 mmHg almost constantly. Average age was 22 years (range 13-49) and 78% of them were male. Our study group included only male subjects and their blood pressure was also maintained below 140/90 mmHg. Echocardiography showed left ventricle posterior wall thickness above 12 mm in 16 athletes. In our study, this record was found in 36 athletes, with values ranging between 11,5 mm and 21 mm. These values were recorded in athletes pursuing strength sports such as weightlifting. We found normal left ventricle internal diameter along with normal systolic and diastolic function, which is concordant with the cited study. Considering that "athlete's heart syndrome" only partially develops due to the training itself, two studies demonstrated significant heritability of left ventricle posterior wall thickening, thus myocardial changes in athletes may be genetic in part (20). Possible genetic implications in athlete's heart should be better addressed in the future. Modern non-invasive techniques facilitate examination of myocard metabolism in athletes. Finally, although studies confirm athlete's heart as a physiological change, there are beliefs that intensive training may cause development of malignant ventricular arrhythmia and be associated with sudden death. Also, possible role of ergogenous aids (doping) cannot be completely excluded. In addition, the fact that heart remains enlarged in numerous athletes after cessation of training is increasingly addressed.

Conclusion

Demographic differences and heart size between athletes and non-athletes were compared using echocardiography. Significant differences ($p<0{,}05$) were found in athletes in: IVSd (1,55 cm), LVPWd (1,51 cm), LVM (401,23 g), LVMI (196,05 g/m^2) and average LV thickness (0,621 cm) in comparison with non-athletes: IVSd (0,83 cm), LVPWd (0,78 cm), LVM (143,42 g), LVMI (83,98 g/m^2) and average LV thickness (0,324 cm).

The final conclusion stated that athlete's heart has thicker walls, increased mass with unchanged internal dimensions. Systolic and diastolic function in athlete's heart is normal. Athlete's heart with those characteristics is a healthy organ.

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