ATHLETE’S HEART SYNDROME AND ECHOCARDIOGRAPHIC CHANGES

AMIR KRESO¹*, AMILA ARSLANAGIĆ²

¹ Public Institution Center for Sports Medicine, Sarajevo Canton, Patriotske lige 36, 71000 Sarajevo, Bosnia and Herzegovina

² Clinic for Heart Diseases and Rheumatism, University of Sarajevo Clinics Centre, Bolnička 25, 71000 Sarajevo, Bosnia and Herzegovina

* Corresponding author

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/m² vs. 83.98g/m²) 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 (m²)

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 (m²) = ( [height (cm) x mass (kg)] / 3600 )³

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 mass was calculated according to the formula:

LVM(g) = 1.04 × [(LVIDd + IVSd + PWTd)² - LVIDd²] – 13.6

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

LVMI (g/m²) = LVM (g)/BSA (m²)

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 20,5±8,51(SD) years, while average values of body mass, body surface area

<table>
<thead>
<tr>
<th>MIN</th>
<th>MAX</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>14</td>
<td>65</td>
</tr>
<tr>
<td>Body mass (kg)</td>
<td>60</td>
<td>121</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>158</td>
<td>194</td>
</tr>
<tr>
<td>BMI</td>
<td>19.59</td>
<td>34.49</td>
</tr>
<tr>
<td>BSA (m²)</td>
<td>1.38</td>
<td>3.16</td>
</tr>
<tr>
<td>Blood pressure (mmHg)</td>
<td>110/75</td>
<td>145/90</td>
</tr>
</tbody>
</table>

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 115.25/82.75 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 125.20/85.15 (SD) mmHg respectively (Table 2).

**Ultrasound findings**

Average left ventricle mass index (LVMI in g/m²) (± SD) is 401.23 ± 100.55 grams in athletes and 143.42 ± 12.86 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).

**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 non-athletes. Ultrasound findings showed that athletes have a significantly larger left ventricle mass index compared to non-athletes. 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).
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 echocardiogra-
phy. 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 electro-
cardiography (15 18). Our group did not include ath-
letes 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 echocardiographically assessed myocard morphol-
ogy 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 mi-
nor changes in 60% subjects. Abnormal ECG was as-
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 main-
tained 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 ath-
letes, 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 ven-
tricle internal diameter along with normal systolic and dia-
static function, which is concordant with the cited study.
Considering that “athlete’s heart syndrome” only par-
tially 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 im-
lications in athlete’s heart should be better addressed
in the future. Modern non-invasive techniques facili-
tate 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 ven-
tricular arrhythmia and be associated with sudden
death. Also, possible role of ergogenous aids (dop-
ing) 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/m²) 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/m²) 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.
References


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