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Left Atrial Mechanical Functions in Professional Soccer Players: A Pilot Study

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Abstract

Long-term regular exercise is associated with physiologic and morphologic alterations in the heart chambers. The aim of this study to evaluate left atrium (LA) phasic functions in professional football players and compare with control subjects. Left atrial volume was calculated at end-systole (Vmax), end-diastole and pre-atrial contraction by echocardiography in 20 professional male football players (mean age, 20.15±2.11 years) and 20 male control subjects (mean age, 22.3±1.49 years). Echocardiographic assessments were performed were performed using the criteria of the American Society of Echocardiography. The following LAVs were measured: maximal volume (Vmax), minimal volume (Vmin) and LAV before atrial contraction (VpreA) at the onset of the P wave of the simultaneously recorded ECG. Left atrial ejection fraction (LAEF), expansion index (LAEI), active emptying volume index (LAAEVI) and fraction(LAAEFr), passive emptying volume index (LAPEVI) and fraction (LAPEFr) were calculated. Baseline characteristics, demographics, two dimensional and tissue Doppler echocardiographic parameters were not statistically significant between the groups (Table 1). Both groups were similar in terms of Vmax index but Vmin index and VpreA index were significantly higher in football players. LAEF, LAEI, LAAEVI and LAAEFr were lesser in football player but they were not statistically significant. Also LAPEVI and LAPEFr were similar in both groups (Table 2). Professional football playing can be associated with morphologic alteration in left atrium mechanical functions. Further prospective, randomized, controlled trials with long term follow-up are necessary to make more robust interpretations of this issue.

Keywords: left atrial, soccer, mechanical functions

1. Introduction

Top-level training is usually associated with morphological changes in the heart, including increases in left ventricular (LV) cavity size and wall thickness that have been known as 'athletes heart'. This term includes physiologic alterations like increased stroke volume and decreased heart rate (Maron, 1986; Tümüklü, 2008). The adaptation of the cardiovascular system to training different with respect to the type of sports. For example endurance sports like long-distance running, soccer have a high dynamic component or strength training, wrestling has a high static or isometric component. Sports with high static demands lead to concentric, sports with high dynamic and low static demands lead to eccentric hypertrophy (Fagard, 1996; Hoogsten et al., 2004).

Alterations in LV diameter and functions can cause left atrium (LA) dysfunction that have been known as 'atrial myopathy. LA myopathy is associated with the increase in LV filling pressure for a long period. Because the LA immediately response to changes in LV end-diastolic pressure, LA remodeling is common. As a result, remodeling in the LA causes the alteration in LA mechanical functions (Anwar et al., 2008; Tülüce 2014).

Left atrial mechanical mechanical functions provide information about the atrial remodeling in various cardiovascular disease and athletes heart (Suga, 1974; Abharayatna et al., 2008). However, LA mechanical functions have not been investigated according to professional soccer players. The aim of this study to evaluate the effect of regular exercise on the left atrial (LA) mechanical functions in professional soccer players and compare with control subjects.

2. **Material and Method**

2.1 Study Population

After approval of the local ethics committee, 20 professional male soccer players (mean age, 20.15±2.11 years) and 20 male control subjects (mean age, 22.3±1.49 years) were enrolled into this study. The soccer players were the player staff of Turkish Third Division football clubs. Controls were recruited from healthy members of students and were matched for age, height, weight, body surface area and were not taking regular physical exercise. Healthy volunteers and soccer players were enrolled after their informed consent was obtained.

2.2 Echocardiography

Echocardiographic examinations were performed using the iE33 cardiac ultrasound system (Phillips Healthcare) with 2.5-5 MHz probes. Evaluation was performed according to standard guidelines and left ventricular ejection fraction (LVEF) was calculated by modified Simpson method. Simultaneous electrocardiogram (ECG) recordings were done for all patients during the examination.

2.3 Evaluation of Left Atrium

Left atrial volumes (LAVs) were calculated in four- and two-chamber views by Simpson's rule. The endocardial border of the LA was manually traced to measure its area. LAVs were measured: the maximal volume (Vmax) during left ventricular end-systole just before mitral valve opening, the minimal volume (Vmin) just before mitral valve closure, and the LA volume before atrial contraction (VpreA) at the onset of the P wave on the simultaneously recorded ECG (10,11). In all subjects, LA volumes were indexed to body surface area (BSA) and LA volume index (LAVI) was calculated by indexing Vmax to BSA. LAVs were obtained as the mean of three consecutive beats. By using three LAVs, the LA mechanical functions were evaluated and the following parameters were obtained, similar to previous studies (Blume et al., 2011; Appleton et al., 1997)

1. LA ejection fraction (LAEF) defined as (Vmax-Vmin)/Vmax×100%)
2. LA expansion index (LAEI) defined as (Vmax-Vmin)/Vmin×100%)
3. LA active emptying volume (LAAEV) defined as (VpreA-Vmin)
4. LA active emptying fraction (LAAEFr) defined as (LAAEV/VpreA×100%)
5. LA passive emptying volume (LAPEV) defined as (Vmax-VpreA)
6. LA passive emptying fraction (LAPEFr) defined as (LAPEV/Vmax×100%)

Left atrial ejection fraction and expansion index were used for the assessment of the LA reservoir function, LAPEFr for the conduit function and LAAEFr for the booster pump function.

2.4 Doppler and Tissue Doppler Measurements

The peak LV outflow velocity was evaluated by continous wave (CW) Doppler in the apical five-chamber view using the modified Bernoulli equation. Mitral inflow velocities were studied using pulsed-wave (PW) Doppler after placing the sample volume at the leaflets' tips. The peak early (E-wave) and late (A-wave) velocities were measured. Both septal and lateral mitral annular velocities were obtained by tissue Doppler imaging (TDI). The E′ velocity (E′) was obtained from the septal and lateral annular E′ velocities and the ratio of the mitral inflow E velocity to average tissue Doppler velocity (E/E′av) was calculated for the prediction of LV filling pressure.

2.5 Statistical Analysis

All results were analyzed by using Statistical Package for Social Sciences (SPSS) for Windows (version 18.0; SPSS Inc., Chicago, IL, USA). Continuous data was reported as mean and standard deviation or median if not normally distributed, and compared using the Student's t-test or the Mann-Whitney U test between groups. Categorical variables were summarized as percentages and compared with the Chi-square test. A two tailed p value <0.05 was considered significant.

3. Findings

Baseline characteristics and demographics were similar between the groups (Table 1).

LA diameter (32.35±3.34 vs 31.05±2.91 mm, p= 0.198), LVESD (31.90±4.91 vs 30.65±3.77 mm, p=0.373), LVEDD (49.00±6.34 vs 47.60±5.26 mm, p=0.452) and other two dimensional and tissue Doppler echocardiographic parameters were not statistically significant between the groups (Table 2).

Both groups were similar in terms of Vmax index (27.55±6.68 vs 23.97±5.66 ml/m2, p=0.076), but Vmin index (13.12±3.69 vs 10.15±2.99 ml/m2, p=0.008) and VpreA index (17.84±4.95 vs 14.84±4.13 ml/m2, p=0.045) were significantly higher in soccer players. LAEF, LAEI, LAAEVI and LAAEFr were lesser in football player but they were not statistically significant. Also LAPEVI and LAPEFr were similar in both groups (Table 3).

Table 1. Baseline characteristics and demographics

Variables	Soccer players (n=20)	Control group (n=20)	p-value
Age (years)	21. 2 ±23.9	21 ± 23.2	0.102
BMI (kg/m2)	23.66±1.96	24.74±3.59	0.247
BSA (m2)	1.94±0.15	1.96±0.22	0.771
Heart rate (beats/min)	75.05±6.80	66.80±14.30	0.280
Systolic BP (mmHg)	115.50±6.26	117.50±13.12	0.544
Diastolic BP (mmHg)	77.00±4.97	75.75±5.68	0.464

BMI: body mass index, BSA: body surface area

Table 2. Two dimensional and tissue Doppler echocardiographic parameters

Variables	Soccer players (n=20)	Control group (n=20)	p-value
Left atrium (mm)	32.35±3.34	31.05±2.91	0.198
LVSED (mm)	31.90±4.91	30.65±3.77	0.373
LVEDD (mm)	49.00±6.34	47.60±5.26	0.452
Septum thickness (mm)	9.50±1.27	9.85±1.22	0.382
Posterior wall thickness (mm)	9.45±1.05	9.55±1.46	0.806
Right ventricle (mm)	28.05±5.00	26.25±3.78	0.207
LVEF	65.65±3.96	65.45±5.09	0.891
RVEF	65.00±0.00	64.85±0.67	0.324
LV mass (g)	193.02±34.12	188.38±56.20	0.756
E (m/sn)	0.82±0.15	0.80±0.21	0.707
A (m/sn)	0.54±0.08	0.55±0.13	0.874
E/E' septal	5.84±1.29	5.41±1.58	0.357
E/E' lateral	4.34±1.09	4.13±1.21	0.561

LVESD: left ventricular end-systolic diameter, LVEDD: left ventricular end-diastolic diameter, LVEF: left ventricular ejection fraction RVEF: left ventricular ejection fraction

Table 3. Measurements of left atrial mechanical functions

Variables	Soccer players (n=20)	Control group (n=20)	p-value
Vmax index (ml/m2)	27.55±6.68	23.97±5.66	0.076
Vmin index (ml/m2)	13.12±3.69	10.15±2.99	**0.008**
VpreA index (ml/m2)	17.84±4.95	14.84±4.13	**0.045**
LA ejection fraction (%)	51.15±10.85	56.65±9.73	0.100
LA emptyig index (ml/m2)	117.10±50.15	145.15±42.13	0.063
LA active emptying volume index (ml/m2)	4.66±2.54	4.69±2.81	0.973
LA active emptying fraction (%)	25.45±11.17	30.00±13.16	0.246
LA passive emptying volume index (ml/m2)	9.71±5.40	9.12±3.20	0.678
LA active emptying fraction (%)	33.55±14.80	38.50±11.09	0.225

LA: left atrium, Vmax: left atrium maximum volume, Vmin: left atrium minimum volume, VpreA: left atrium volume before p wave

4. Discussion and Conclusion

The present study focused more on the assessment of the relation between regular exercise and LA mechanical functions in soccer players. We demonstrated that regular exercise can affect LA mechanical functions. Top-level soccer players had larger indexed LAVs at the time of passive emptying and atrial systole but similar volumes at the time of maximal atrial filling. The increased LA Vprea index is likely to reflect chronic cavity remodeling in soccer players. La volume during the active pumping phase is increased in soccer players. This data confirms that with LA remodeling its pump function is decreased. When two-dimensional echocardiographical findings are evaluated it is observed that the diameter of the LV and LA, and the LV mass started to increase, although not statistically significant.

The left atrial enlargement is known as a component of the heart of an athlete. Most of the previous studies focused on the LA enlargement in athelets. Meta-analysis of 54 studies carried out in the recent time until today, in which the data of 7189 athletes and 1044 control were included. Nine of the 54 studies (including 992 athletes and 426 controls) presented LA volume corrected for BSA. This meta-analysis showed that the adjusted weighted mean LA diameter was greater in athletes overall compared with sedentary controls, and LA volume index was greater in athletes than controls. Furthermore, it was observed that the atrial sizes varied depending on the type of the exercise (İskandar et al., 2015).

The left atrium has been regarded as only a carrier that conduit the blood from the lung to LV for long years. However nowadays, it is known that it has active and passive filling pressure, reservoir functions and it secretes neurohormones. In other words, the LA also has mechanical functions that are called phasic functions. Because the left atrium (LA) immediately responds to changes in the LV end-diastolic pressure, LA enlargement is common in certain conditions. LV wall thickness and elevated LV filling pressure have been suggested as potential contributors to LA enlargement (7). LA volumetric remodeling affects mechanical functions. Assessment of LA mechanical functions has revealed that a mild to moderate increase in LA volume causes an increase in LA contractility; however, a further increase in LA preload does not enhance the LA pump function, but rather leads to functional failure of the LA (Bauer et al., 2004).

In athletes, the data about the mechanical functions of the LA, rather than the dilation, are very limited. In the MAGYAR-Sport study, Nemes et al. compared 20 elite basketball and handball players with 23 control groups. This study showed that systolic maximum and diastolic pre-atrial contraction and minimum LA volumes were significantly higher in elite basketball and handball players. Total and passive LA stroke volumes were increased, while total and active LA emptying fractions proved to be decreased in athletes as compared to controls (Nemes et al., 2016).

D'Ascenzi et al. also analysed 26 top-level athletes and 23 control subjects to investigate the adaptive changes of LA reservoir, conduit, and active volumes and their response to different training loads. Athletes had larger maximum, pre-P and minimum LA indexed volumes, compared with controls. Total and passive emptying volume indices were also larger in athletes compared with controls. Our findings are similar with MAGYAR-Sport Study and D'Ascenzi et al (2015). We found that Vmin index and VpreA were significantly higher in soccer players. In our study LAEF, LAEI, LAAEVI and LAAEFr were lesser in football player but they were not statistically significant. Also LAPEVI and LAPEFr were similar in both groups. These findings can be explained that our soccer players were younger and total exercise time was not long. Morphological changes in the LA mechanical functions may be observed in professional soccer players depending on the exercises performed for long years. Further prospective trials with long-term follow-up are necessary to show the effect of regular exercise to LA mechanical functions in soccer players specificaly.

5. Conflict of Interest

None

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