Echocardiographic Findings of Iranian Military Parachutists, in Comparison to Normal Population

Firoozeh Abtahi[1], Seyed Taghi Heydari[2]*, Seyed Morteza Seyed Jafari[3], Alireza Abdi Ardekani[1], Alireza Khoshdel[4], Fatemeh Jabbary Lak[3]

[1]Cardiovascular Research Center, School of Medicine, Shiraz University of Medical Sciences, Shiraz, Iran, [2]Department of Biostatistics, Jahrom University of Medical Sciences, Jahrom, Iran, [3]Health Policy Research Center, School of Medicine, Shiraz University of Medical Sciences, Shiraz, Iran, [4]Department of Epidemiology, School of Medicine, AJA University of Medical Sciences, Tehran, Iran

ABSTRACT

Background: Occupation related stress such as military parachuting has been considered to be a potentially important cardiovascular risk factor. The present study was performed to determine structural and functional changes of the left ventricle (LV), right ventricle (RV) and aorta by echocardiographic assessment of Iranian military parachutists compared to the normal population. **Materials and Methods:** This is a cross-sectional study on the echocardiographic findings of 95 military parachutists, compared to 92 healthy workers with normal range of activities and no previous history of heart and other diseases. Information regarding demographic and lifestyle were obtained from each subject. Arterial blood pressure (BP), weight, height, body mass index, waist circumference, and hip circumference were measured by standard methods. Then transthoracic echocardiography was performed for two groups. **Results:** Systolic BP, diastolic BP, LV end systolic diameter, septal wall thickness, posterior wall thickness, left ventricular mass (LVM), LVM index, ascending aorta systolic and diastolic diameter and aortic stiffness were significantly higher in parachutists whereas, pulse pressure, LV ejection fraction, RV tricuspid annular plane systolic excursion, aortic distensibility and pulmonary acceleration time were significantly lower in parachutists. **Conclusion:** War-related stressors and high intensity physical activities are associated with cardiac events and morphologic and functional alteration. Echocardiographic evaluations could clarify these differences.

Keywords: Cardiovascular disease, echocardiography, parachuting

INTRODUCTION

Now-a-days, the incidence of cardiovascular disease (CVD) is increasing rapidly.[1,2] Identification of the risk factors of cardiovascular events, which cause morbidity and mortality in the world, has always been a real concern for the medical community.[3] Recent studies show the increasing rate of all cardiovascular risk factors.[1,4] Occupation related stress has been known as an important cardiovascular risk factor.[5,6] Despite the known benefits of regular exercise training, military related stressors such as parachuting are related to acute and chronic cardiac events.[7,8] Furthermore, an enhanced risk of undesirable events such as sudden death has been reported in individuals who participate mainly in high intensity physical activities, with incidence range of 1:15,000-1:50,000.[6,9] On the other hand, it has been established that hard physical and professional exercise is accompanied by alterations in the morphology and function of the heart, which is known as "athlete's heart."[9-11]

The general aim of the present study is to measure parameters associated with alterations in the left ventricle (LV) structure and function, right ventricle (RV) structure and function, ascending aorta and dispensability by echocardiographic of military parachutists in comparison with the control subjects.

***Corresponding address:**
Dr. Seyed Taghi Heydari, Department of Biostatistics, School of Medicine, Jahrom University of Medical Sciences, Jahrom, Iran. Phone: +98-711-2309615, Fax: +98-711-2309615, E-mail: heidaryt@sums.ac.ir

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MATERIALS AND METHODS

This cross-sectional study was conducted from September 2010 to December 2011 between two groups. For the first group, a total of 95 male military parachutists with more than 5 years of parachuting experience and more than 50 successful diving were selected by random sampling after clustering the military parachutists according to their military ranks. We selected 92 aged-matched healthy males with normal range of activities and no previous history of heart and other diseases for the control group. Individuals with histories of cardiorespiratory diseases, hypertension, diabetes mellitus, neuromuscular disorders, or any other systemic diseases were excluded from the study. This survey was approved by the Committee of Research Ethics of Shiraz University of Medical Sciences. After signing an informed consent, the participants were called to the survey center for the risk factor assessment and clinical examinations. The field examinations were done by trained health-care providers for this study.

They were asked to sit in a silent room for 5 min before their arterial blood pressure (BP) were measured. BP for all participants was measured twice by zero-calibrated sphygmomanometers with appropriate size cuff in the right arm. The readings at the first and the fifth Korotkoff phase were taken as systolic and diastolic BP (systolic blood pressure [SBP] and diastolic blood pressure [DBP]), respectively. The average of the two BP measurements was recorded.[12,13] After measuring BP, anthropometric indices, including weight, height, body mass index, waist circumference, and hip circumference were measured using standard methods. Then, the standard M-mode and two-dimensional echocardiography followed by color flow imaging and Doppler study was performed in individuals in left lateral decubitus position by the same investigator, professional cardiologist. Echocardiograms were performed using a S5 vivid ultrasonic scanner (General Electrics, USA) equipped with 2.5 MHz transducer. For each parameter, three consecutive measurements were acquired, and the average was calculated. In all patients, standard echocardiography examination from multiple views, including long axis, short axis and apical 4-chamber views of the heart were used. All echocardiographic measurements were acquired according to the standards established by the American Society of Echocardiography.[14] For the LV, LV end-diastolic diameter, LV end systolic diameter, ejection fraction (EF), wall thickness (inter-ventricular septum and posterior wall) were measured. Relative wall thickness (RWT) of the LV was obtained by dividing the sum of diastolic posterior wall thickness (PWT) and inter-ventricular septum thickness by LV end-diastolic diameter.

Left ventricular mass (LVM) was calculated using the formula from Devereux *et al*.:[15] lvm (g)= 0.80 × (1.04 [(SED + left ventricular end-diastolic [LVED]+ PWED)^3 − (LVED)^3])+0.6 where SED is ventricular septum thickness in end diastole, LVED is the end-diastolic diameter of the LV, and PWED is PWT in diastole. For the RV, RV end-diastolic minor axis dimension, tricuspid annular plane systolic excursion (TAPSE) and the peak myocardial systolic velocity (Sm) by tissue Doppler imaging (TDI); for the ascending aorta, systolic and diastolic diameter, strain, distensibility, and stiffness; for pulmonary artery (PA), PA thrombosis (PAT), and PA diameter were measured.

Statistical analysis

Data were collected, analyzed, and reported as mean ± standard deviation statistical comparisons between groups were carried out using Statistical Package for Social Sciences (SPSS, version 19.0 for Windows). Independent *t*-test was applied to identify the relationship between the echocardiographic findings of military parachutists and the control group. $P \leq 0.05$ was considered as statistically significant.

RESULTS

The case and control groups aged from 20 to 50 years old with mean ages of 37.5 ± 6.2 and 37.1 ± 2.4 years old, respectively. The echocardiographic measurements for both groups are presented in Table 1, including the values for LV, aorta, PA and RV. SBP, DBP, LV end systolic diameter, septal thickness, PWT, LVM, LVM index, aortic systolic diameter, aortic diastolic diameter, aortic stiffness were significantly higher in parachutists. On the contrary, pulse pressure, left ventricular ejection fraction (LVEF), TAPSE, aortic distensibility, and PAT were significantly lower in parachutists.

DISCUSSION

Despite the association of war-related stressors and high intensity physical activities with both acute cardiac events and cardiac risk factors, the available data on military personnel is in favor of lower frequency of cardiovascular risk factors among the military personnel.[6,8,16] The regular exercise training is also could be associated with cardiac alterations[17] such as left ventricular hypertrophy (LVH) and increased stroke volume, however as a physiologic and adaptive mechanism[10] and the practicing physician should be aware of the range of cardiovascular findings in the healthy athlete in order to avoid the erroneous diagnosis for the continuation of an athlete's career.[4]

Table 1 Echocardiographic findings of both groups

Groups	Physical examination			LV									RV			Aorta					PA	
	SBP	DBP	Pulse pressure	LV end diastole	LV end systole	EF	Interventricular septum	Posterior wall	RWT	MV	LVM	LVMI	RV end diastole	TAPSE	Sm	Aorta systolic size	Aorta diastolic size	Strain	Distensibility	Stiffness	PA time	PA size
Mean±SD																						
Control	111.9± 11.5	68.8± 8.5	43.8± 7.3	5.1± 0.3	3.2± 0.2	59.0± 2.8	0.8± 0.1	0.8± 0.1	3.8± 0.3	155.7± 20.8	129.6± 17.3	71.3± 10.1	3.0± 0.2	22.1± 1.9	13.7± 1.5	2.8± 0.3	2.± 0.3	0.1± 0.001	5.8± 1.7	11.3± 2.6	134.0± 10.3	2.3± 0.1
Parachutists	117.3± 14.1	81.4± 12.4	36.0± 6.7	5.0± 0.4	3.5± 0.4	50.8± 6.9	0.9± 0.1	0.9± 0.1	3.7± 0.4	201.4± 48.8	169.8± 37.2	86.9± 19.1	3.1± 0.2	20.6± 2.8	13.9± 1.8	2.9± 0.2	2.7± 0.3	0.1± 0.002	4.9± 2.2	15.6± 6.9	125.7± 13.2	2.4± 2.2
P value	0.004	<0.001	<0.001	0.135	<0.001	<0.001	0.010	<0.001	0.584	<0.001	<0.001	<0.001	0.629	<0.001	0.263	<0.001	<0.001	0.999	0.005	<0.001	<0.001	0.512

LVMI: Left ventricular mass index, LVM: Left ventricular mass , MV: Mitral valve, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, LV: Left ventricle, EF: Ejection fraction, RWT: Relative wall thickness, RV: Right ventricle, TAPSE: tricuspid annular plane systolic excursion, Sm: Myocardial systolic velocity, PA: pulmonary artery, SD: Standard deviation

Although echocardiography remains the most commonly used modality for imaging patients with cardiac disorders due to its availability, accuracy and providing prognostic information,[7] there are limited reports on the echocardiographic findings of military parachutists.

Regular participation in competitive sports frequently causes adaptive LV hypertrophy, which is called "athlete's heart."[17] The type and the extent of "athlete's heart" depend on the forms, amount and intensity of the training.[18,19] The basic forms of exercise are dynamic exercise (long distance running), static exercise (all sports involving the throwing and lifting of heavy objects), and combined dynamic and static exercise (cycling and rowing).[17] It has been stated that intense isometric (anaerobic, strength/power) exercise training leads to a more concentric LVH, which is featured by an increase in the LVM and augmented ratio of wall thickness to the left ventricular diameter (i.e.: RWT).[20] On the flip side, extensive isotonic (aerobic and endurance) exercise training causes a more prominent enlargement of left ventricular diameter.[19]

The mean LV end systolic diameter and mean LVM were significantly higher in parachutists, in our study. In Sobhani *et al.*[10] study, the mean of LVM in wrestlers group was significantly higher than that of control subjects (219.7 ± 50.7 vs. 166.8 ± 44.2 g). In a meta-analysis of cardiac structure and function, Pluim *et al.*[17] declared that the overall mean of LVM in the control subjects was significantly less than the overall mean of LVM in the trained athletes. Morganroth *et al.*[21] showed that LVM increased in wrestlers group (330-348 g). Cohen *et al.*[22] discovered that LVM was higher in wrestlers and runners than in the control group at rest (311.8 and 325.9 g vs. 215 g).

Although there were no significant differences between the athletes and the control subjects with respect to LVEF, according to Pluim *et al.*[17] and Sobhani *et al.*,[10] EF was significantly lower in the parachutist group in our study.

According to our results, the inter-ventricular wall thickness and PWT had significant differences between two groups. Pluim *et al.*[17] in their meta-analysis stated that there was a significant difference between the athletes and control subjects with respect to the left ventricular internal diameter. They also reported that the overall mean relative left ventricular wall thickness of control subjects was significantly smaller than that of the athletes. Sobhani *et al.*[10] stated that inter-ventricular septal thickness of the wrestlers was 10.1 ± 1.5 mm but compared with control, the difference was not statistically significant.

The RV is a complex chamber structurally and functionally whose importance has been neglected previously.[23] Right ventricular function is an important parameter in cardiac disease.[24] It propels systemic venous blood returning from the right atrium through the pulmonary vascular bed and maintains hemodynamic stability.[23] In our study, TAPSE was significantly lower in the parachutist group, but RV end-diastolic diameter and TDI Sm were not significantly different between two groups.

We found that aortic distensibility was significantly lower, whereas aortic systolic and diastolic diameter and aortic stiffness had significant higher values in the parachutist group. D'Andrea *et al*.[25] showed that in strength trained athletes aortic root diameter and root stiffness were significantly increased in comparison with healthy controls.

SUGGESTION

Although having a healthy life, it is recommended to carry out routine screening for the cardiovascular risk factors among military parachutists because of susceptibility to acute and chronic cardiac events.

As a suggestion, comparison of risk factors of CVD between military parachutists and military nonparachutists could be helpful to determine the real causes of reported differences.

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