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Echocardiographic analysis of the left ventricular function in elderly runners

Análise ecocardiográfica da função ventricular esquerda em corredores idosos

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Abstract

Introduction: During the aging process, cardiovascular function suffers intense changes. **Objective:** To perform an echocardiographic evaluation of left ventricular function in elderly male athletes and non-athletes. **Methods:** Eleven elderly males were separated into two groups: group A, with six non-athletes (61.66 ± 3.20y) and group B, with eight athletes (62.75 ± 3.24y). Two-dimensional and M mode color Doppler echocardiography were used to assess heart rate (HR), stroke volume (SV), diastolic dimension (DD), systolic dimension (SD), end diastolic volume (EDV), end systolic volume (ESV), mass of the left ventricle (M), isovolumetric relaxation time (IRT), and deceleration time (DT). **Results:** HR was significantly higher in Group A. The mean values of EDV, ESV, and DT were significantly higher in athletes (Group B). IRT and SV values were higher in Group A; and DD, DS and M trended to be higher in Group B, but without any statistical significance. **Conclusions:** The regular practice of running improved both hemodynamic and structural variables in elderly subjects.

Key words: Echocardiography; Elderly; Stroke volume; Running.

Resumo

Introdução: Ao longo do processo de envelhecimento a função cardiovascular sofre intensas modificações. **Objetivos:** Realizar avaliação ecocardiográfica da função ventricular esquerda em idosos atletas e não atletas. **Métodos:** Quatorze homens idosos foram separados em dois grupos: grupo A, seis não atletas (61.66 ± 3.20 anos), e grupo B, oito atletas (62.75 ± 3.24 anos). Para avaliar a frequência cardíaca (FC), a fração de ejeção (FE), as dimensões sistólica e diastólica (DS e DD), os volumes sistólico e diastólico finais (VES e VED), a espessura ventricular esquerda (M), o tempo isovolumétrico de relaxamento (TIR) e o tempo de desaceleração (TD), usou-se o ecocardiógrafo Doppler colorido, bidimensional, em modo M. **Resultados:** A FC foi maior no grupo A em relação ao B, resultado estatisticamente significante (p<0,05). Os valores médios de VED, VES e TD foram significativamente maiores nos atletas (grupo B) em relação aos não atletas. Valores de TIR e FE foram maiores no grupo A; DD, DS e M tenderam a ser maiores no B, resultado que, porém, não apresentou significância estatística. **Conclusões:** A prática regular de caminhada melhorou as variáveis hemodinâmicas e estruturais de idosos.

Descritores: Corrida; Ecocardiografia; Fração de ejeção ventricular; Idoso.

Introduction

Cardiovascular aging is associated with gradual changes in endothelia and blood vessels, as well as in heart structure and function. Progressive hypertrophy of smooth muscle cells from blood vessels' walls, thickening of the intima-media arterial wall due to collagen deposition, degeneration of elastic fibers, and calcium deposition constitute a plethora of factors that decrease arterial compliance and increase arterial stiffness[1,2]. Beyond the vascular changes, aging is also associated with direct changes in the heart which explain why cardiovascular diseases, especially hypertension, coronary artery disease, and congestive heart failure are so common among the elderly[2-4]. In fact, some forms of heart failure are linked to arterial stiffness and systemic hypertension, leading to poor prognosis and increased risk of mortality.

Echocardiography is the type of examination currently used in assessing cardiac function because of its simple, quick, and non-invasive methodology, capable of identifying the regional and global normality of the left ventricle function. It is considered a non-invasive method of greater applicability within the gamut of image techniques[5]. Using two-dimensional and M mode color Doppler echocardiography, it is possible to evaluate the morphological, functional, and hemodynamic aspects of the cardiovascular system. This is an indispensable diagnostic method of heart function in health and disease[6].

Physical exercise is an important non-pharmacological therapy for prevention of cardiovascular disease in healthy individuals at any age and its prescription should be based on established criteria[6,7]. Elderly exercise practitioners had better left ventricular function than the sedentary group[7]. Data is scant regarding elderly athletes, although they may show better left ventricular function than the elderly non-athletes[7].

In fact, moderate-to-intense physical exercise induces greater reduction of the alert response in hemodynamic variables, culminating with a potent exercise-related hypotensive effect[7,8].

The main objective of this article was to analyze the left ventricular function variables in elderly practitioners of regular physical exercise.

Material and methods

We studied 14 elderly volunteers divided into two groups, as follows:

- Group A: six elderly males (61.66 ± 3.20 years old), enrolled in the Physical and Recreational Activities for Seniors Project at the College of Physical Education, Federal University of Uberlândia (FUU), and living in the city of Uberlândia, Brazil.
- Group B: eight elderly male athletes (62.75 ± 3.24 years old), practitioners of high resistance aerobic sports (running) for more than five years; living in Uberlândia; and not enrolled in the Physical and Recreational Activities for Seniors Project at FUU.

We excluded volunteers with diabetes or high blood pressure (stage 2 or 3), smokers, and anyone whose ergometric tests revealed arrhythmias and/ or ischemias. All the volunteers were submitted to two-dimensional and mode M, color and Doppler echocardiograms, applied at the Clinical Hospital of UFU, and were examined by the same doctor.

All volunteers were examined, with special focus on systolic and diastolic function of the left ventricle. Structural and functional variables were analyzed: heart rate (HR), left ventricular mass (M), diastolic diameter (DD), systolic diameter (SD), ejection fraction (EF), end-diastolic volume (EDV), end-systolic volume (ESV), deceleration time (DT) and isovolumetric relaxation time (IRT). The continuous variables were described by mean and standard deviation, and Student's t-test statistical analysis was adopted to evaluate the heart of the elderly athletes and non-athletes.

All volunteer signed a consent term approved by the Research Ethics Committee of UFU (protocol nº 126/05) where the study was conducted.

Results

The results are presented in Table 1.

Variables related to diastolic left ventricular function

The diastolic diameter (DD) in group B (49.12 ± 3.64) was higher than in group A (46.66 ± 2.50), which can lead to a higher cardiac output in the elderly athletes. This tendency was not reach significant.

The end diastolic volume (EDV) was also high in group B (114.12 ± 25.23) compared with group A (95.16 ± 12.48), with statistically significant difference ($p<0.05$). In both groups, the values reported are within the normal range.

Isovolumetric relaxation time (IRT) tended to be low in elderly athletes (146.25 ± 21.99) compared to the elderly non-athletes (154.16 ± 54.07) without reaching statistical significance.

Variables related to systolic left ventricular function

The mean value of systolic diameter (SD) in group B (31.50 ± 2.67) was higher than in group A (28.83 ± 2.31), but no significant difference was found.

End systolic volume (ESV) was also high in group B (41.37 ± 11.19) compared with the group A (30.33 ± 4.08), showing a significant difference ($p <0.05$). In both groups the values are within the parameters of normality.

The mean values of ejection fraction (EF) in group B (72.75 ± 3.19) tended to be lower than in group A (74.66 ± 2.06), but did not reach statistical significance.

Compared to group B (392.50 ± 72.80), the deceleration time (DT) of group A (142.25 ± 272.50) was low and statistically significant ($p<0.05$). Those variables are shown in Figure 1.

Other variables

Group B had higher left ventricle mass (M) than group A (145.25 ± 44.69 x 119.16 ± 28.79), but this trend was not statistically significant. The mean values of heart rate (HR) were high in group A (67.66 ± 14.12) compared to group B (56.50 ± 4.50) with $p <0.05$ (Figure 1).

Discussion

The results of this study show that elderly runners have better performance, as measured by different cardiac function variables, than elderly non-athletes. The echocardiogram mode used in this study is a useful and practical method in the differential diagnosis between constrictive pericarditis and restrictive cardiomyopathy, in monitoring of heart transplantation, in assessing ventricular function targets, and in the diagnostic of

Table 1: Heart echocardiographic parameters of elderly athletes and non-athletes

	AGE	M (g/m²)	HR (bpm)	DD (mm)	SD (mm)
Non-athletes	61.66 ± 3.20	119.16 ± 28.79	67.66 ±14.12[a]	46.66 ± 2.50	28.83 ± 2.31
Athletes	62.75 ± 3.24	145.25 ± 44.69	56.50 ± 4.50	49.12 ± 3.64	31.50 ± 2.67
	EF (%)	EDV (mL)	ESV (mL)	DT (ms)	IRT (ms)
Non-athletes	74.66 ± 2.06	95,16 ± 12.48	30.33 ± 4.08	142.25 ± 272.50	154.16 ± 54.07
Athletes	72.75 ± 3.19	114,12 ± 25.23[b]	41.37 ±11.19[b]	392.50 ± 72.80[b]	146.25 ± 21.99

[a]= A > B ($p<0.05$); [b]= B > A ($p<0.05$). M= mass, HR= heart rate, DD= diastolic diameter, SD= systolic diameter, EF= ejection fraction, EDV= end diastolic volume, ESV= end systolic volume, DT= deceleration time, and IRT= isovolumetric relaxation time

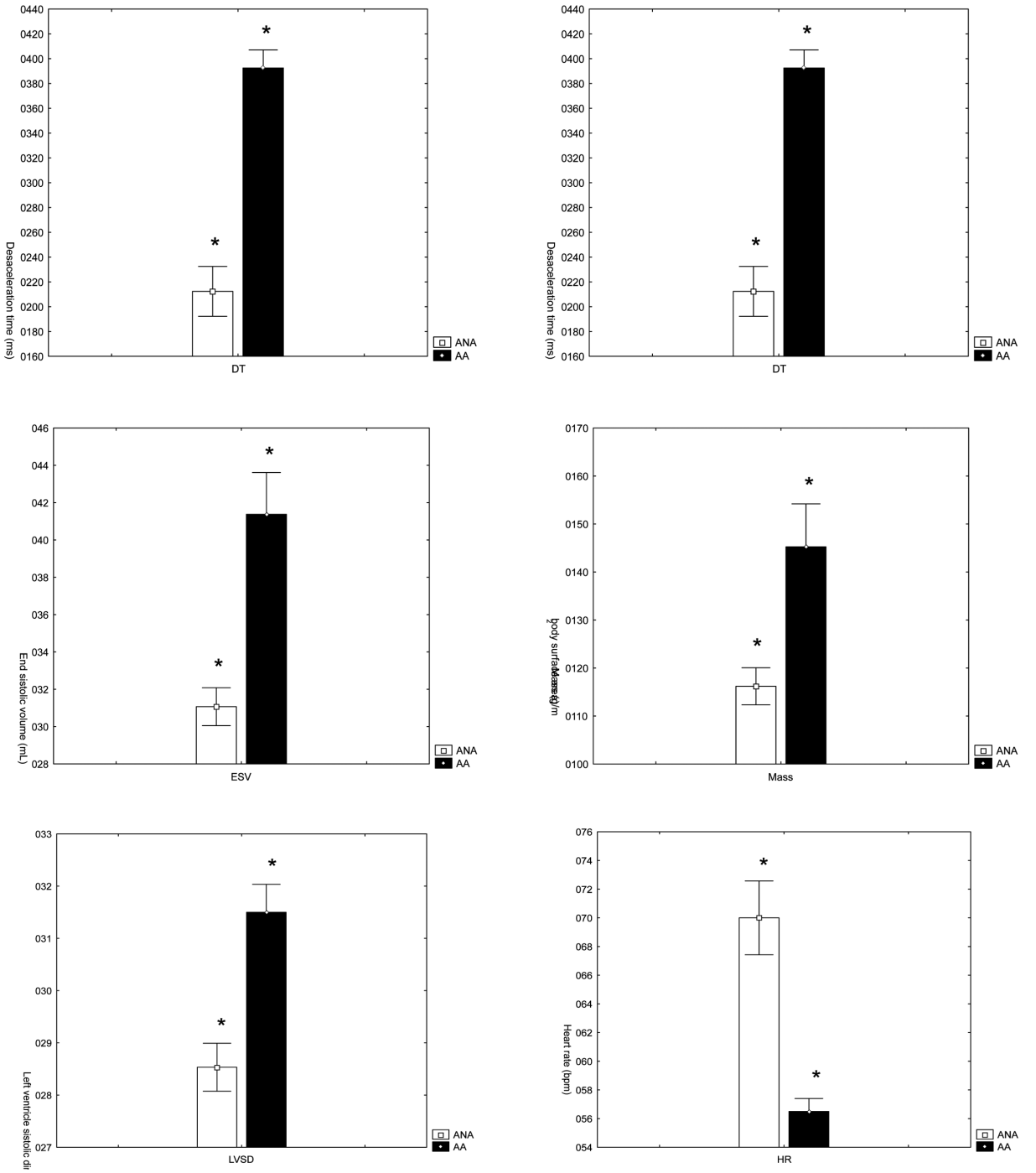

Figure 1: Echocardiographic variables in elderly athletes and non-athletes

physiological as well as pathological ventricular hypertrophy[1,2]. This method has also been employed in assessing the role of systolic and diastolic left and right ventricles[5,6].

The systolic and diastolic diameters are higher in elderly athletes, but not significantly different from those of the elderly non-athletes. During aging there is a clear gradual reduction of myocardial relaxation and elastic recoil, resulting in a slow decline of the left ventricular pressure and slow ventricular diastolic filling[3,6]. This study suggests that exercise prevented this

physiological decay. The end diastolic volume and end systolic volume are significantly higher in elderly athletes but parameters were found to be within the range of normality (135 mL and 65 mL, respectively). It is well known that elderly trained subjects have diverse cardiovascular adaptations and improved cardiac performance[5-8]. These adjustments include both anatomical and functional changes that in some circumstances surpass the normal ranges[6,7], which was not the case in this study.

The cardiovascular effects of vigorous physical training performed over long periods are different and have been observed experimentally in competitive, trained elderly athletes[8,9]. Physical training also potentiates the mechanical efficiency of skeletal muscles with increased capillary growth, changes in myocyte enzyme activity, improved functional capacity, and better ventilation/perfusion rates.

These cardiovascular changes result from complex interactions of central and peripheral mechanisms operating at structural, electrophysiological, biochemical, metabolic, and neurogenic levels[2,3]. These factors are dependent on the intensity and duration of training, the type of athletic activity, and intrinsic genetic factors. Exercise training in the elderly improves ionotropic reserve of the heart by restoring β-adrenergic receptor signaling; preserves and restores cardiac preconditioning and angiogenesis that protects muscle tissue against ischemic injuries; and helps to decrease massive release of oxygen and nitrogen free radicals, lowering tissue-damaging reactions[10]. Improvement of the ionotropic reserve partially explains the positive effects of running on echocardiographic parameters found in this study.

Isovolumetric relaxation time tended to be higher in elderly athletes compared to non-athletes, which means that the heartbeat of elderly athletes is more efficient. Deceleration time was significantly lower in the elderly non-athletes, which means a faster ventricular systole in the heart of the non-athletes. The ejection fraction was lower in elderly athletes, showing a differentiation on the time of the mitral valve closing in the hearts of elderly athlete versus non-athletes. Lower ejection fraction means lower peak oxygen in the lungs during exercise and decreased quality of life.

The assessment of various echocardiographic indices of both left diastolic ventricular function, such as speed of the E waves and the mitral flow, E/A relationship, time of E wave slowing, and isovolumetric relaxation time; and of left systolic ventricular function, such as ejection fraction and deceleration time, taken of elderly athletes in this study showed values within normal ranges in baseline conditions.

The heart of elderly athletes have increased systolic and diastolic left ventricular cavity diameter, changes in the thickness of parietal and left ventricular mass, improved diastolic filling, and reduction of heart rate. For this reason, the median heart mass of the elderly athletes was significantly lower than that of elderly non-athletes, and the heart frequency could be lower. In fact, regular exercise during at least 5 days per week was associated with lower thickness and stiffness of the left ventricule[11].

Left ventricle mass was higher in elderly athletes that in non-athletes, but this difference was not significant. The increase of left ventricle mass could be a ventricular hypertrophy, which is an adaptive compensatory mechanism to hemodynamic stimuli (pressure and/or volume). The best explanatory theory of the hypertrophy patterns states that the ventricular response takes place to keep the stress on parietal ventricles relatively constant, and to maintain the end systolic and diastolic volume at appropriate values[1,2,5]. Thus, research data have shown that changes in left ventricular mass and in size of the ventricular cavity in adaptation to training and physical conditioning occur in parallel with changes in VO_{2max}[10], strongly suggesting an association between ventricular hypertrophy and better cardiac function[1,6].

Studying veteran football players it was found that regular sports training was associated with better left ventricular outcomes,

improved microvascular function, and better physical fitness and body composition[11-19].

Left ventricular dysfunction has also been linked to increased risk of stroke[20].

Conclusions

Systolic and diastolic function variables of the left heart ventricles that were examined indicate a better performance in the elderly athletes than in the non-athletes. Moreover, the heart of elderly athletes had better preserved structural variables. Collectively the data showed that regular practice of moderate-to-intense physical exercise provides both hemodynamic and structural heart benefits and may also decrease the risk of cerebrovascular disease.

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