ELASTIC INDEXES OF THE ASCENDING AORTA BY ECHOCARDIOGRAPHY IN SPORTSPERSON WITH DIFFERENT TYPES OF EXERCISE

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Abstract

Background: Epidemiological studies have found that physically active person have lower prevalence of cardiovascular disease compared to sedentary. It has been reported that age-related increases in central arterial stiffness are absent or attenuated in endurance-trained adults. Echocardiography is a noninvasive test, simply, to help evaluate the elastic properties of ascending aorta through the indices such as aortic strain, aortic stiffness, aortic distensibility. **Aim:** Was to estimate the indexes of aortic elasticity in the sportsperson with different types of exercise. **Patients and Methods:** 33 endurance-trained athletes (runners, swimmers, aerobic) (group A), 48 strength-trained athletes (karatedo) (group B), were identified. Uniform between the groups (age, duration of exercise). 60 untrained volunteers as control participants. They are all under echocardiography to measure systolic aortic diameter and diastolic aortic diameter. Then, assess the indexes such as: aortic strain, aortic stiffness, aortic distensibility. Blood pressures simultaneously measured by sphygmomanometry to calculate the pulse pressure. **Results:** Aortic stiffness is significantly lower and aortic strain and aortic distensibility are significantly higher in group A than the control group ($p < 0.05$). Aortic stiffness is significantly higher and aortic strain and aortic distensibility are significantly lower in group B than the control group ($p < 0.05$). Between two groups, Aortic stiffness is significantly lower and aortic strain and aortic distensibility are significantly higher in group A than group B ($p < 0.01$). **Conclusion**: Changes in arterial stiffness may be related with different training programs.

Key words: *Aortic elasticity, echocardiography*

1. INTRODUCTION

A decrease in arterial compliance or an increase in arterial stiffness is common with advancing age and it is a predictor of cardiovascular risk factors. Additionally, increased arterial stiffness has been implicated in the development and progression of hypertension, left ventricular hypertrophy, myocardial infarction, and congestive heart failure [10]. Several epidemiologic studies have demonstrated that physically active person have lower prevalence of cardiovascular disease compared to sedentary [6], [8].

Physically active improve arterial stiffness and may reduce the risk of developing adverse complications. However, the effects of exercise training on the arterial stiffness also depend on different training programs [1], [3]. Therefore, we carried out this study to evaluate the indexes of escending aortic elasticity in the sportsperson with different types of exercise. Comparison with the control group.

2. PATIENTS AND METHODS

2.1. Subjects

- Studied groups: We divided subjects into groups based on the type of sport played (strength or endurance). 50 endurance-trained athletes (runners, swimmer, aerobic) (group A), 30 strength-trained athletes (karatedo) (group B), were identified. Age under 45. The mean duration of sport participation was over 2 years.
- Control group: 60 untrained volunteers as control participants who has the same age and gender.
- Exclusion criteria: History of smoking, currently taking any medications. Alcohol consumption > 50gr/day. Signs, symptoms, and history of any overt chronic diseases. Heart disease.

For all subjects: Before all measurements, subjects refrained from alcohol consumption and intense physical activity (exercise) for 24 hours and caffeine consumption for 4 hours to avoid acute effects.

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2.2. Procedures

- Measures of weight and height to calculate the surface area and body mass index.

- Measures of blood pressures with mercury sphygmomanometry according to the recommendations of the Vietnam Heart Association 2010: in each subject, brachial artery BP was measured in at least three separate days after 15 min of comfortably sitting and the average of the measurements was recorded.

- Conventional echocardiographic examination: Aortic strain, distensibility index and stiffness index were calculated from aortic diameters measured by echocardiography and blood pressures simultaneously measured by sphygmomanometry: measurements of diastolic and systolic diameter of the ascending aorta and aortic root were recorded at a level 3 cm above the aortic valve and at the aortic orifice, respectively, guided by M-mode tracking using cross sectional echocardiography in the parasternal long axis view.

Systolic and diastolic aortic diameters were measured at maximum anterior motion of the aorta and at the peak of the QRS complex, respectively [4], [11].

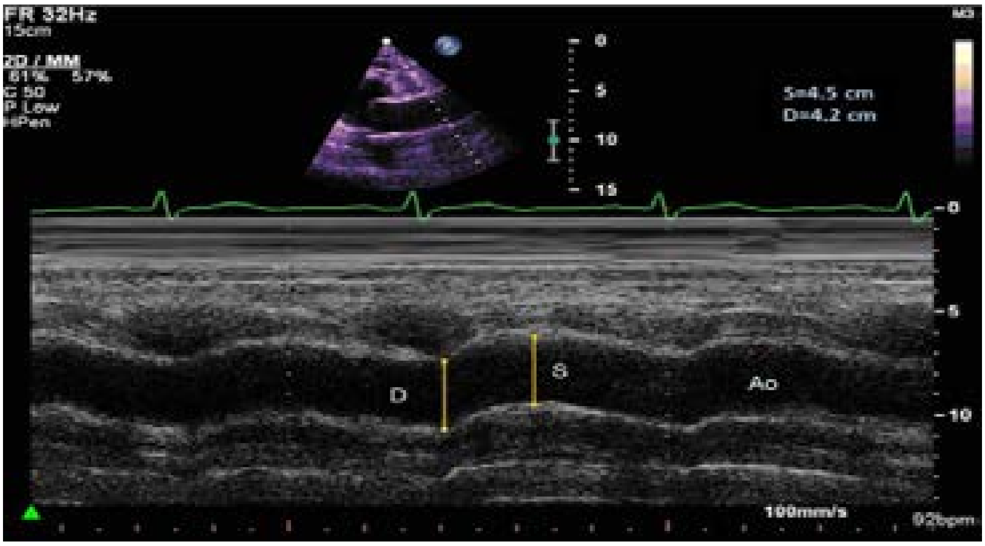

Figure 1. Measurements of aortic diameters shown on the M-mode tracing [4]

Measurements of aortic diameters shown on the M-mode tracing obtained at a level 3 cm above the aortic cusps. Ao = aorta; D = diastolic aortic diameter; S = systolic aortic diameter.

2.3. Parameters studied

- Aortic elastic properties was calculated from the three indexes, using the following formula described by Stephanadis [11]:

+ Aortic strain (%) = (AODs-AODd) × 100 / AODs

+ Stiffness index = ln (SBP-DBP)/[(AODs-AODd)/AODd]

+ Distensibility index ($cm^2.dyn^{-1}.10^{-6}$) = 2 x aortic strain x (SBP - DBP)

Decreased aortic elastic properties: increased aortic stiffness, reduced aortic strain and aortic distensibility.

Statistical Analyses: Statistical analyses were performed using Medcalc and Microsoft Office Excel 2003 software.

3. RESULTS

3.1. Physical characteristics of the study groups

Table 1. Physical characteristics of the subjects

Characteristics		Studied groups (n=80)	Control group (n=80)	p
Age (years)		32.06±7.74	31.05±7.9	> 0.05
Gender	Male	51(63.75%)	46 (57.5%)	> 0.05
	Female	29(36.25%)	34 (42.5%)	> 0.05

BSA (m^2)	1.63±0.19	1.6±0.16	> 0.05
HR (b/min)	65.25±5.67	69.5±5.42	<0.01
Systolic BP (SBP) (mmHg)	108.5±7.77	108.3±7.91	> 0.05
Diastolic BP (DBP) (mmHg)	66.63±6.35	68.63±5.95	< 0.05
Pulse Pressure (mmHg) PP	41.88±5.24	39.69±5.47	<0.05

No differences in demographic variables and other characteristics (age, gende, BSA, SBP) were observed between the groups (p<0.05). DBP was lower and PP was significantly higher in studied groups than the control group (p < 0.05).

The index of aortic elasticity by type of exercise

Table 2. Distribution by type of sport played

Type of sport played	Endurance-trained subjects (group A)			Strength-trained athletes (Karatedo) (group B)
	Runners	Swimmers	Aerobics	
n%	25 (31.25%)	12 (15%)	13 (16.25%)	30 (37.5%)
Total	62.5%			37.5%
p (A-B)	<0.05			

Table 3. Indexes of escending aortic elasticity in two types of sport played

Parameters	Endurance-trained subjects (1)	Strength-trained athletes (Karatedo) (2)	Control group (3)	p (1) - (3)	p (2) – (3)	p (1) – (2)
AoDs (cm)	27.3±3.61	27.18±3.5	26.38±3.96	>0.05	>0.05	>0.05
AoDd (cm)	24.48±3.23	24.36±3.43	23.96±3.33	>0.05	>0.05	>0.05
Aortic strain (%)	12.55±2.11	9.47±0.92	10.64±2.35	<0.05	<0.05	<0.01
Stiffness index	3.83±0.62	5.54±0.85	4.48±1.11	<0.05	<0.01	<0.01
Distensibility index ($cm^2.dyn^{-1}.10^{-6}$)	6.82±1.36	4.33±0.62	5.42±1.33	<0.05	<0.01	<0.01

Aortic diameter did not significantly differ between the study groups (p>0.05).

Stiffness index in the group A and control group were significantly lower than the group B (p<0.05; p<0.01). Aortic strain, aortic distensibility of the group A was significantly higher than that of the group B and control group (p < 0.05; p < 0.01).

4. DISCUSSION

Physical characteristics of the study groups

We conducted on the 2 groups based on the type of sport played. Age, gender, BSA were homologous in the groups and the control group. This means duration of sport participation was over 2 years. So, they have been changes in the cardiovascular system, favorable when compared to the control group.

According to Fox et Mathews (1984), after 8 weeks of training, sports players will begin with changes in the muscle, but significant changes in the cardiovascular system often appears after 2 years with bradycardia, cardiac structural changes, increased arterial distensibility, especially in endurance-trained subjects [5].

The average age of the studied groups was 32.06 ± 7.74 and 31.05±7.9 in control group, p> 0.05. Rönnback.M (2007) showed that, the stiffness of the "central" arteries (eg, aortic, carotid) increases with age, as indicated by an increase in pulse wave velocity or earlier pressure wave reflections (ie, increased "augmentation index"). These increases in arterial stiffness are thought to contribute to age-related increases in the incidence of cardiovascular disease [10]. Influence of age on arterial functions was recorded after 55 years [10]. So, we chose this age to avoid the influence of age on the structure and function of the aorta.

The index of aortic elasticity by type of exercise

Many studies previously reported that the indexes of escending aortic elasticity related to the different types of exercise [1], [2], [8]. That was, regular endurance exercise decreases and regular strength exercise increases arterial stiffness, aortic pulse pressure and decrease elasticity [8], [10]. Thus, we classified the various types of exercise to evaluate different elastic artery changes, if any, depending on the type of exercise.

Our research recognized, aortic diameter did not differ between the study groups (p>0.05). Aline Iskandar (2013), performed a systematic literature review and meta-analysis to examine whether athletes demonstrate increased aortic root dimensions compared with nonathlete controls. The authors noted elite athletic training is associated with a small but significantly larger aortic root diameter, especially at the sinuses of Valsalva. The magnitude of this increase is clinically nonsignificant, and marked increases in aortic root measurements in athletes should not be attributed to athlete's heart. This further emphasizes that the effects of exercise training on aortic diameters are small and that marked enlargement suggests a pathological process [6].

We identified that arterial stiffness index in endurance-trained young adults is lower than that of sedentary healthy subjets. On the contrary, the aortic strain, aortic distensibility of the endurance-trained young adults was significantly higher than that of the strength-trained athletes and control group (p< 0.05; p < 0.01). The present data demonstrate that arterial stiffness in endurance-trained young adults is lower than that of their sedentary peers, and changes in arterial stiffness is associated with training begun at school age. Taken together, these data suggest that endurance training in school-age youths decreases arterial stiffness, and continued endurance training should maintain this decrease and/or exert additive effects [2], [8].

Kacilcioglu E. (2005) studied thirty male runners and thirty age-matched healthy male controls. All subjects underwent echocardiographic examination and cardiopulmonary exercise testing. The aortic distensibility index was found to be higher in athletes compared with controls (5.37 +/- 1.50 vs. 3.37 +/- 1.48 $cm^2.dyn^{-1}.10^{-6}$, p < 0.001). While the aortic stiffness index in athletes was significantly lower than in controls (2.77 +/- 0.28 vs. 3.43 +/- 0.41, p < 0.001). The auteurs concluded that, increased aortic distensibility in endurance-trained athletes may cause better diastolic function as a physiological cardiovascular adaptation factor [7]. Thus, regular endurance exercise is effective in preventing and reversing arterial stiffness in healthy adults.

The results of our study also noted that: aortic stiffness index in strength-trained athletes were significantly higher than endurance-trained subjects and control group (p< 0.05; p < 0.01). Aortic strain, aortic distensibility of the strength-trained athletes was significantly lower than that of the group A and control group (p< 0.05; p < 0.01).

D'Andrea A (2012) studied on four hundred ten elite athletes (220 endurance-trained athletes and 190 strength-trained athletes; 290 men; mean age, 28.3 ± 13.6 years; age range, 18-40 years) and 240 healthy controls underwent standardized comprehensive transthoracic echocardiography, including Doppler studies. The auteurs showed that aortic root diameters and stiffness were significantly greater in strength-trained athletes, while aortic distensibility was higher in endurance athletes compared with age- and sex-matched healthy controls [2].

Although it is possible that the increased arterial stiffness is one of the physiological adaptations to the intense blood pressure increase during strength-based sports, the increases in arterial stiffness can be unfavorite adaptation for heart and vessels at resting condition. However, the type of strength training may also affect arterial stiffness; one study suggests that arterial stiffness may increase less in individuals performing eccentric strength training compared to concentric strength training. Takeshi Otsuki (2007) showed that changes in arterial stiffness are associated with endurance or strength training begun in adolescence, and such adaptations continue through young adulthood [8].

The mechanism underlying the differences in arterial stiffness between endurance and strength-trained player remains unclear. Vascular endothelial cells play an important role in the regulation of vascular activity by producing vasoactive substances, such as endothelin-1 (ET-1) and nitric oxide (NO). Endurance training decreases the plasma concentration of ET-1, a potent vasoconstrictor peptide and it is also associated with increased plasma level of NO, an endothelium-derived relaxing factor, and NO bioavailability. Therefore, it is possible that changes in ET-1 and NO production caused by exercise training could promote differential changes in arterial stiffness. Alternatively, strength training could cause increased in plasma norepinephrine concentrations leading to chronically elevated sympathetic adrenergic vasoconstrictor tone and associated arterial stiffness [9].

5. CONCLUSIONS

Regular physical activity is associated with reduced risk of cardiovascular disease and changes in arterial stiffness associated with different training programs. Many observations suggest that habitual aerobic exercise may delay or prevent age-associated increases in central arterial stiffness, although further studies are needed to adequately address the role of strength training in such programs. As well from the above studies, we can see the endurance sports (walking, swimming, running long ...) are good for artery function in young and older adults who want to participate in sports to improve health and prolong their life.

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