Echocardiographic left ventricular hypertrophy in Chinese endurance athletes

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Most echocardiographic data on the athletic heart syndrome originate from the United States and Western Europe. There are no published data on echocardiographically documented left ventricular hypertrophy in Asian athletes. We investigated the echocardiographic changes which take place with endurance training by studying eight Hong Kong national cyclists. This study confirms that left ventricular hypertrophy and increased left ventricular end-diastolic dimensions are common findings in Chinese endurance athletes as in their Caucasian counterparts. Calculated left ventricular muscle mass exceeded the 95th percentile in seven of eight subjects.

Keywords: Echocardiography, left ventricular hypertrophy, athlete's heart

Introduction

Prolonged and consistent physical training in endurance athletes tends to result in an altered cardiac physiology. Such altered cardiac physiology is commonly referred to as the 'athletic heart syndrome', and presents itself in any of the following forms: cardiac murmurs, marked bradycardia, abnormal electrocardiogram, enlarged silhouette on chest X-ray, and left ventricular hypertrophy on echocardiography[1]. Most echocardiographic data on the athletic heart syndrome originate from the United States and Western Europe. To the best of the authors' knowledge, there has not been any published data on echocardiographically documented left ventricular hypertrophy in Asian athletes. We investigated the echocardiographic changes which take place with endurance training by studying the Hong Kong national cyclists.

Methods

Eight Hong Kong national cyclists of ethnic Chinese origin participated in the study before election to the Seoul Olympics in 1988. All subjects were asymptomatic, healthy individuals without any prior history of heart disease who engaged in year-round intensive endurance training on a regular, almost daily basis. Each training session consisted of 2–3 hours of road-cycling, at an intensity between 70 and 85% VO_{2max}.

Physiologic and physical evaluations

Anthropometric measurements included body weight, height, vital capacity and body fat content. Percentage body fat was estimated from measurements of skinfold-thickness with a Harpenden Skinfold Caliper at three different sites of the body surface[2]. The subjects were also submitted to a direct, continuous, multistage, maximal oxygen uptake determination (VO_{2max}) performed on an electromagnetically braked bicycle ergometer equipped with toe clips (Lannooy, Lode's Instrument, Gronigen, Holland). Initial load was set at 150 W and work rate was increased by 25 W every minute, following a 3 minute 100 W warm up period, until exhaustion. Heart rate was calculated from the continuously monitored electrocardiogram. Oxygen uptake and CO_2 output were measured by the open circuit method using a Gould 2900 Energy Expenditure Unit. The leveling-off criterion for heart rate and oxygen consumption was used to extablish VO_{2max} values.

Echocardiographic evaluation

Resting echocardiographic examination was performed using a Hewlett-Packard 77020 echocardiograph. All subjects were examined in the left lateral decubitus position and the usual parasternal and apical windows were used. Both M-mode and 2-D imaging were employed for measurements. Measurements of the left ventricular posterior free wall, septum, left ventricular end-diastolic dimension, left ventricular end-systolic dimension were in accordance with the recommendations of the American Society of Echocardiography[3]. Left ventricular mass was estimated using the Penn Convention[4]. The American Society of Echocardiography standards for the normal population were used for comparison, and dimensions above the 95th percentile, adjusted for body surface area, were considered increased.

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Colour-Doppler flow-imaging was performed to exclude any significant valvular regurgitation or septal defects. Pulsed Doppler was performed in cases of left ventricular hypertrophy to determine if an outflow tract gradient was present.

Results

Physiologic and physical characteristics

Anthropometric and physiologic data for the subjects appear in *Table 1A* and *Table 1B*. The mean value of 5.1 ± 1.9% body fat of the Hong Kong national cyclists is similar to that for international elite cyclists[5]. The Hong Kong cyclists have the metabolic characteristics of high-calibre endurance-trained athletes. The mean value of VO_{2max} was 72 ml.kg^{-1} min^{-1} which is comparable to that of international elite cyclists reported in other studies[6–8]. Cyclist 5 from the present study who had the highest VO_{2max} value of 77.4 ml.kg^{-1} min^{-1}, finished 12th overall and first in Asia in the road race of the Seoul Olympics in 1988.

Echocardiographic characteristics

The results of echocardiographic measurements are listed in *Table 1A* and *1B*. There was no evidence for valvular pathology or atrial/ventricular septal defects in all subjects studied. Ventricular systolic function was normal in all subjects. No cases of left ventricular hypertrophy were associated with systolic anterior motion of the mitral valve, presence of an intraventricular gradient and/or turbulence of intraventricular blood flow. The mean septum to left ventricular posterior free wall ratio was 1.1 with a range from 1 to 1.33; two of eight subjects had ratios > 1.3.

Discussion

Several echocardiographic studies have confirmed that endurance athletes usually possess cardiac dimensions which are larger than sedentary individuals[9,10]. Such hypertrophy is a normal physiological response and should not be regarded as a pathological condition. Indeed, radiographic cardiomegaly is not uncommon in athletes and a cardiothoracic ratio often approaches or exceeds 0.5[1]. As in their Caucasian counterparts, this study confirms that left ventricular hypertrophy and increased left ventricular end-diastolic dimensions are also common findings in Chinese endurance athletes. Calculated left ventricular muscle mass exceeded the 95th percentile of standards used in seven of eight subjects.

This study also demonstrated a tendency for the septum to be relatively more hypertrophied than the left ventricular posterior free wall. In the available literature, the septum to left ventricular posterior free wall ratio is greater than 1.3 (asymmetric septal hypertrophy) in 40% of athletes studied[1]. A logical question to ask is whether some of the athletes with asymmetric septal hypertrophy may in fact have hypertrophic cardiomyopathy. However, other than septal hypertrophy, there was no evidence to

Table 1A. Physical and echocardiographic characteristics of individual cyclist

Subject	*Age (yr)*	*Height (cm)*	*Weight (kg)*	*BSA (M^2)*	*VO_{2max} (ml/kg/min)*	*FVC (litre)*	*LVEDD (cm)*	*LVESD (cm)*	*SEP (cm)*	*LVPFW (cm)*	*LVM (gm)*
1	30	178	61	1.63	75.5	4.74	5.5	3.4	1.2	0.9	269
2	29	165	62	1.55	71.0	4.28	5.4	3.5	1.1	1.0	261
3	23	176	64	1.65	70.6	4.45	5.4	3.3	1.0	1.0	244
4	20	179	68	1.71	69.2	4.94	5.9	3.6	1.1	1.1	325
5	24	176	67	1.67	77.4	4.28	5.4	3.2	0.9	0.9	210
6	19	176	63	1.64	71.4	5.48	5.2	3.2	1.2	0.9	244
7	24	168	59	1.54	68.9	4.24	5.0	3.3	1.2	1.2	277
8	20	172	63	1.60	73.0	4.98	5.4	3.0	1.1	1.0	261

Table 1B. Group statistics

Subject	*Age (yr)*	*Height (cm)*	*Weight (kg)*	*Body Fat (%)*	*VO_{2max} (ml/kg/min)*	*FVC (litre)*	*LVEDD (cm/M^2)*	*LVESD (cm/M^2)*	*SEP (cm/M^2)*	*LVPFW (cm/M^2)*	*LVM (gm/M^2)*
mean	24 ± 4	174 ± 4	63 ± 3	5.1	72 ± 3	4.7 ± 0.4	3.4 ± 0.1	2.1 ± 0.1	0.67 ± 0.08	0.62 ± 0.07	161 ± 20
Range	19–30	165–179	59–68	3.8–9.8	69–77	4.2–5.5	3.2–3.5	1.9–2.3	0.54–0.78	0.54–0.78	126–190
95th							7/8	1/8	6/8	2/8	7/8

95th percentile = number of patients over the 95th percentile
FVC = forced vital capacity
LVEDD = left ventricular end-diastolic dimension
LVESD = left ventricular end-systolic dimension
LVM = left ventricular mass estimated using the Penn Convention: $LVM = 1.04\ [(SEP + LVEDD + LVPFW)^3 - 13.6\,g - LVEDD^3]$
LVPFW = left ventricular posterior free wall
SEP = septum

corroborate the diagnosis of hypertrophic cardiomyopathy.

With the increasing awareness of the importance of and necessity for regular exercise in many Asian countries in the last decade, it is important that physicians be aware that ventricular hypertrophy is part and parcel of the athletic heart syndrome, and that otherwise healthy endurance-trained athletes should not be inappropriately labelled as having cardiac pathology.

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