Pattern of left ventricular echocardiographic changes in a group of black African footballers

Modifications echocardiographiques du ventricule gauche dans un groupe de footballeurs noirs africains

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RESUME

Introduction: *Le football de compétition nécessite un entrainement physique intense, qui s'associe à des modifications morphologiques et physiologiques du cœur souvent appelées "Cœur d'athlète". Les caractéristiques échocardiographiques de cette population particulière n'avaient pas encore été décrites au Cameroun. Le but de notre étude était de décrire les caractéristiques échocardiographiques de 23 footballeurs professionnels camerounais comparées à 23 sujets normaux.*

Méthodologie: *Une échocardiographie de repos a été réalisée chez les sujets des 2 groupes, pour évaluer et comparer la morphologie et les fonctions cardiaques. Nous avons mesuré les épaisseurs des parois, la fraction d'éjection du ventricule gauche (F.E), les diamètres du ventricule gauche et étudié le profil diastolique mitral ainsi que le flux veineux pulmonaire. La masse du ventricule gauche (MVG) et l'épaisseur pariétale relative (EPR) ont été calculées.*

Résultats: *Les moyennes non indexées et indexées du diamètre télédiastolique du ventricule gauche (56,6±2,7 mm, 28,4±1,8 mm/m^2), de l'épaisseur du septum en diastole (9,6±1,1 mm, 5,5±0,6 mm/m^2) et de la MVG (245,5±35,4 g, 123,0±17,8 g/m^2) étaient augmentées chez les footballeurs comparées aux sujets contrôlés. Nous avons retrouvé une hypertrophie ventriculaire gauche chez 11 (47,8%) footballeurs qui avaient tous une fonction diastolique et une fonction systolique normales. Quatre (17,4%) footballeurs avaient un rapport septum/paroi postérieure augmenté (≥1,3). L'EPR et la moyenne des F.E (58,7±7,2% versus 61,8±7,2%) étaient similaires dans les 2 groupes.*

Conclusion: *Chez les footballeurs camerounais sélectionnés à l'équipe nationale, des modifications morphologiques du cœur sont présentes. Cependant, la fonction systolique de leur ventricule gauche est normale comme chez les sujets du groupe contrôle.*

MOTS CLES

Cœur d'athlète, footballeur, échographie cardiaque, Cameroun.

SUMMARY

Background: *Elite football players undergo intense physical training which is associated with morphological and physiological cardiac changes often referred to as the "athlete's heart." Echocardiographic features, particular to this population, have not been described in Cameroon.*

Objective: *Our objective was to describe echocardiographic features of 23 highly trained cameroonian football players compared to 23 normal subjects.*

Methods: *In both groups, resting echocardiography was performed to assess and compare cardiac morphology and function. Wall thickness, ejection fraction (EF), and diastolic left ventricular internal diameter (LVID) were measured; and left ventricular (LV) mass calculated, as well as relative wall thickness (RWT).*

Results: *The mean non indexed and indexed LVID (56.6 +/- 2.7 mm, 28.4 +/- 1.8 mm/m^2), maximal wall thickness (9.6 +/- 1.1 mm, 5.5 +/- 0.6 mm/m^2) and LV mass (245.5 +/- 35.4 g, 123.0 +/- 17.8 g/m^2) in football players were increased as compared to control subjects. Of the players, 47.8% had evidence of LV hypertrophy, all of them asymptomatic, with normal systolic and diastolic functions. Four players had an increased septal-to-posterior-wall-thickness ratio (> or =1.3). The RWT was < 0.44 among players and control subjects. The mean resting EF was similar in both groups (57.71% (+/- 7.2% versus 61.8 +/- 7.2%).*

Conclusions: LVID, wall thickness and LV mass among football players are increased and correlate with body size. There is a low RWT, reflecting an emphasis on endurance training. The LV EF was normal and almost similar to normal subjects individuals.

KEY WORDS

Athlete's heart, exercise, ventricular ultrasonography, Cameroon.

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INTRODUCTION

Intense physical training results in significant changes in myocardial structure and function, which are referred to as the "athlete's heart"[1,2]. Pioneer reports on this topic were made in the 1800s and early 1900s by Swedish and American clinicians. Henschen, used percussion and auscultation to demonstrate increased cardiac dimensions in elite Nordic skiers [3]. Eugene Darling of Harvard University made similar findings in rowers [4], whereas his compatriot, Paul Dudley White reported marked resting sinus bradycardia in long-distance runners [5]. The advent of imaging techniques such as chest X-ray, echocardiography, MRI has enabled a better understanding of the athlete heart. These initial reports had resulted in speculative debate, as some investigators thought that the noticed changes represented beneficial adaptations to exercise [3,4], while others postulated that they were a mark of overuse pathology and could lead to premature heart failure[6]. This last line of thinking created the concept of the "athlete's heart" syndrome to designed athletic patients presenting symptoms or abnormal cardiac findings.

The physiological changes on the myocardium oppose hemodynamic stimulus due to the predominant variation either in cardiac output (volume challenge), or peripheral vascular resistance (pressure challenge). Thus, the 26th Bethesda conference segregated sports into 2 groups with defining hemodynamic differences [7]. Isotonic exercise, also referred to as endurance training, involves sustained increased in cardiac output (cycling, swimming, long-running or rowing); whereas isometric exercise also referred to as strength training, is characterized by increased peripheral vascular resistance (American football, weightlifting, field throwing events)[8,9]. A third group associates elements of both strength and endurance exercise (soccer, basketball, hockey).

As competitive and recreational sports gain in popularity, cardiovascular practitioners may face an increase in the number of people presenting the "athlete's heart". Thus it is important for them to possess knowledge on this subject.

Even though it is now well-established that cardiac response to several stimuli differs in black Africans as opposed to the other groups [10, 11, 12]; data on the "athlete heart in native Africans remain scarce. We therefore carried out this study to investigate the echocardiographic left ventricular sizes and functions in a set of intense physically trained football players of the Cameroon National team, in order to ascertain the pattern of the "athlete's heart" in native Africans.

METHODOS

Design and setting

We conducted a cross sectional study at the Yaounde General Hospital, from September 2008 to February 2009. Cases comprised 23 players of the Cameroon football national team, aged 21 to 35 years. They have been practicing this sport for a mean duration of 13 years, and for a mean weekly rhythm of training of 11 hours.

Cases were paired with age, weight and height, and included students, teachers, shop-workers and unemployed individuals. They overall had a mean weekly rhythm of physical exercise less than 2 hours.

Both cases and controls were male gender black Africans, asymptomatic without a previous known cardiovascular disease. Furthermore they were not on any drug potentially acting on the heart.

The study protocol was approved by the ethic committee of the hospital, and informed consent was obtained from each participant before enrollment.

Data collection and variables

Baseline clinical and demographic characteristics were acquired using a pre-defined questionnaire. They consisted of age, weight, height, body mass index (BMI), body surface area (BSA) and blood pressure (BP). Other information included the weekly rhythm of physical training and the overall duration of such sport practice. Standard beam balance and an anthropometric plane measured weight and height respectively. Participants were light clothed, without shoes or headgear.

The body surface area was calculated by the Dubois et Dubois formula [13], body mass index using the formula: BMI = Weight/(Height)^2. We measured blood pressure with an automatic sphygmomanometer (OMRON 907), after a resting period of 5 minutes on both arms. The mean value of the two measures was retained.

Later, cases and controls underwent echocardiography exam. Echocardiograms were performed with a GENERAL ELECTRIC CP710 LOGIQ 500 MD machine, using a 2.22 Megahertz transducer. The probe was placed on the chest, on subjects lying on left lateral decubitus position. T-Mode, Bidimensional and Doppler modes helped to obtain the requested parameters, according to the recommendations of the American Society of Echocardiography. They included end-diastolic and end-systolic left ventricular internal dimension (LVIDd, LVIDs), diastolic and systolic left ventricular volume (LVVd, LVVs), diastolic and systolic thickness of interventricular and posterior walls (IVSd, IVSs, PWd, PWs), and left atrium dimension (LAD). Relative wall thickness (RWT) was obtained by the formula: RWT = IVSd+PWd/LVIDd, the left ventricular mass (LVM) by the Devereux et Reichek method [14]. Left ventricular fractional shortening (FS) was calculated by the formula FS = 100 x LVIDd-LIVDs/LVIDd and systolic function by Teichholz's formula [14]. Doppler recording analysed mitral, aortic and pulomonary vein flows. On the mitral valve, it provided the peak Doppler velocities of early (E) and late diastolic flow (A), the deceleration time (DT), the E/A ratio, and the duration of the late diastolic flow. On the pulmonary vein, systolic (PVs), diastolic (PVd), and atrial reversal (PVa), as well as the duration of flow at atrial contraction were recorded. Indexing parameters was obtained with the body surface area.

Reproducibility of echocardiographic measurements was improved in 2 ways: by independent measurement of the same echocardiograms and by independent measurement of echocardiogram taken on the same patient at different time.

Data analysis

Analysis was done using Epi-info 3.5 software. Continuous data, presented as means and standard deviation, were compared using a t-test. A value of $P < 0.05$ was considered statistically significant.

RESULTS

Anthropometric and physiologic characteristics

Table 1 mean age and body surface area were comparable in both groups. Conversely, heart rate (58.6 +/- 8.2 versus 71.8 +/- 13.4) and diastolic blood pressure (67 +/- 5.4 versus 73.9 +/- 7.9) appeared significantly lower among the case group as compared to the control group.

Echocardiography assessments

Table 2 shows left ventricular echocardiographic characteristics of players and paired-subjects. It presented no significant differences between the 2 groups for: end-systolic left ventricular thickness (LVIDs and PWs), relative wall thickness, ejection fraction, « STRESS or wall constraint », and the PVs/PVd ratio. Conversely diastolic left ventricular thickness (IVSd : 9.6 +/- 1.1 mm versus 8.5 +/- 0.8 mm ; PWd : 8.5 +/- 1.1 mm versus 7.0 +/- 1.3 mm), end-diastolic dimension (LVIDd : 28.4 +/- 1.8 mm/m^2 versus 26.4 +/- 1.7 mm/m^2), as well as left ventricular mass index (123.0 +/- 17.8 g/m^2 versus 89.3 +/- 20.1 g/m^2) were significantly higher among players. However the values remained within the normal (upper) ranges.

Table 3 details more over the echographic characteristics in the players group. Even though 65.2% of players presented a LVIDd upper to 56 mm, the theoretical definition LV dilation, this lesion was confirmed in only 1 case when indexed to BSA (>31 mm/m^2).

DISCUSSION

Morphological changes induced by « athlete heart » include increased left ventricular cavity dimension, wall thickness, and calculated mass; while functional disturbances can present as sinusal bradycardia and/or arrythmia. Even if these findings are then physiologically adapted and benign, differentiation with a potential pathology and harbinger of cardiac disease may sometimes be capital.

Football game combines both endurance and strength conditioning, and as such, may associate changes induced by a complex set of central and peripheral mechanisms related to both training modes.

Our results are similar to those previous studies regarding the significant lowering of the resting heart rate among player group as compared to paired non players (58.6 +/- 8.2 versus 71.8 +/- 13.4)[10,15,16]. Indeed, great variety of bradyarrythmias in the context of rest or sleep is a common description on athletics. They are almost asymptomatic and purportedly due to heightened to parasympathetic activity [8].

Echocardiography changes

Even though diastolic left ventricular thickness remained within normal range in the soccer players group, it was significantly increased in comparison to control group (9.6 +/- 1.1 mm versus 8.5 +/- 0.8 mm). Bennani et al had a similar result among Moroccan soccer players (10.5 +/- 1 versus 7.5 +/- 2)[17]; whereas another cross-sectional comparison by Al Hazzaa et al faced PWd indexed to BSA, had not observed any difference (5.5 +/- 0.6 versus 5.2 +/-0.6)[18]. Such controversial data are common in literature and oppose followers of training-related effect per se to followers of other between-subject differences like body size, age or race [19, 20, 21]. However, as the same in our study, aforementioned reports had not noticed any case of wall thickness above 11 mm.

The mean (indexed and non-indexed to BSA) LVIDd and left ventricular mass were increased over control subjects (players: 56.6 +/- 2.7 mm or 28.4 +/- 1.8 mm/m^2, and 245.5 +/- 35.4 g or 123.0 +/- 17.8 g/m^2; control subjects: 51.6 +/- 3.5 mm or 26.4 +/- 1.7 mm/m^2, and 175.7 +/- 45.6 g or 89.3 +/- 20.1 g/m^2). Relative wall thickness was almost similar in the 2 groups and less than 0.4. Such an exceed in the LV dimensions and mass is a classical description in the "athlete heart", from the clinically-built hypothesis of Morganroth to the most recent studies using more accurate techniques like echocardiography or magnetic resonance imaging[8,10,19,22]. Morganroth et al explained that dynamic-training mainly leads to an eccentric form of hypertrophy, presenting as a dilation of the left ventricular, and thus LV mass. This is a consequence of prolonged volume overload. Conversely, isometric-training induces a concentric form of hypertrophy characterized by an increased wall thickness, with no change in cavity size, as a consequence of the pressure overload. Relative wall thickness aids to differentiate between the 2 types of adaptation: less than 0.44 in eccentric hypertrophy and above 0.44 in concentric hypertrophy. The RWT for the players was 0.32. Ouldzein et al and Maldeira et al had also found similar results (0.38 and 0.39 respectively)[23,24]. There were no differences with control subjects, the same like in Ouldzein et al study.

65.2% of players presented a LVIDd upper to 56 mm, and 8.7% upper than 60 mm. These measures theoretically defined dilation in the LV. However, when indexed to BSA, this change was real in only 1 case (>31 mm/m^2). This emphasized the place of BSA in the assessment of LV parameters.

LV mass exceeded $125 g/m^2$ in eleven players (47.8%) against 1 control (4.3%). This hypertrophy was eccentric, with systolic and diastolic functions were normal in the 2 groups. Ouldzein et al recorded such a result in 23.2% of its players group, with all of them of eccentric type [23]. Extreme increase in LV mass (>$134 g/m^2$) was noticed in 30.4%. Here also, systolic and diastolic functions were normal, with no lesion of the valve; but systolic blood pressure and stress were slightly exceeding the value found in the other players while remaining within normal range.

Even though 4 (17.4%) players showed an elevated IVSd/PWd ratio (>1.3), only 1 associated an increased indexed LV mass (>$134 g/m^2$), IVSd/PWd > 1.3 However, we could not retain the diagnosis of cardiomyopathy because the wall thickness was below 13 mm, and the case was asymptomatic without a relevant family history.

CONCLUSION

Our study demonstrates that players of the Cameroon football National team, sustaining intense and prolonged physical conditioning, are also developing cardiovascular adaptations as is the case with the other Africans and Caucasians. These changes consist of increased wall thickness and LVID. The RWT is low, emphasizing a predominant endurance type of their training.

Table 1

Anthropometric and physiological characteristics in players and control groups

Parameters	Soccer players		Controls		*p
	Mean	SD	Mean	SD	
Age (years)	26.9	3.7	26.9	3.7	(NS)
Weight (kg)	79.0	5.6	76.5	7.2	(NS)
Height (cm)	181.2	6.1	180.1	7.2	(NS)
Body mass index (kg/m²)	24.0	1.1	23.58	1.8	(NS)
Body surface area (m²)	1.99	0.1	1.9	0.1	(NS)
Heart rate (beats/mn)	58.56	8.2	71.8	13.4	<0.05
Systolic Blood Pressure (mmHg)	124.3	9.8	119.4	9.5	(NS)
Diastolic Blood Pressure (mmHg)	67	5.4	73.9	7.9	<0.05
Training rhythm (hours/week)	11.47	2.2	< 2		
Duration of training	13.5	3.5			

**P values mean comparison between the 2 groups. **SD Standard deviation. ***NS not significant*

Table 2

Echocardiographic parameters in players and control groups

Parameters	Soccer players		Controls		*p
	Mean	SD	Mean	SD	
Diastolic [1]IVS thickness (mm)	9.6	1.1	8.6	0.8	<0.05
Systolic SIV thickness (mm)	13.0	1.3	12.2	1.6	(NS)
End-diastolic [2]LV dimension (mm)	56.6	2.7	51.6	3.5	<0.05
End-diastolic LV dimension indexed (mm/m²)	28.4	1.8	26.4	1.7	<0.05
End-systolic LV dimension (mm)	39.4	2.6	34.0	3.8	<0.05
Diastolic Posterior wall thickness (mm)	8.5	1.1	7.0	1.3	<0.05
Systolic Posterior wall thickness (mm)	13.6	3.2	12.7	2.3	(NS)
LV mass (g)	245.5	35.4	175.7	45.6	<0.05
LV indexed mass (g/m²)	123.0	17.8	89.3	20.1	<0.05
Relative wall thickness	0.3	0.0	0.3	0.0	(NS)
Ejection fraction (%)	58.7	7.2	61.8	7.2	(NS)
STRESS 1 (dynes/cm²)	45.8	24.4	55.6	21.6	(NS)
STRESS 2 (dynes/cm²)	162.3	31.7	164.4	32.1	(NS)
Shortening fraction (%)	30.4	2.7	34.2	4.6	<0.05
Max velocity of E (m/s)	0.7	0.1	0.7	0.1	(NS)
Max velocity of E (m/s)	0.4	0.0	0.5	0.1	<0.05
E/A ratio	1.8	0.4	1.5	0.4	<0.05
Deceleration time E (m/s)	159.9	12.7	163.9	21.1	<0.05

Max velocity of S (m/s)	0.3	0.1	0.4	0.1	<0.05
Max velocity of D (m/s)	0.3	0.1	0.5	0.0	<0.05
S/D ratio	1	0.3	0.9	0.4	(NS)

**P values mean comparison between the 2 groups. **SD Standard deviation. ***NS not significant. [1]IVS interventricular septum. [2]LV left ventricular.*

Table 3

Echocardiographic parameters in the LV among players group

Parameters			Number	Frequency (%)
LVd	Non indexed	->56 mm	15	65.2
		->60 mm	2	8.7
	Indexed	>31 mm/m^2	1	0.0
LV mass	≥125 g/m^2		11	47.8
	≥134 g/m^2		7	30.4
IVSd/PWd ratio	>1.3	-Associated to a LV mass >134 g/m^2	1	17.4
		-Non associated to a LV mass >134 g/m^2	3	

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