European Geriatric Medicine 7 (2016) 86–89

Available online at ScienceDirect www.sciencedirect.com

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Study of cardiac structure and function assessed by echocardiography in patients older than 100 years

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ARTICLE INFO

Article history:
Received 2 September 2015
Accepted 30 October 2015
Available online 18 November 2015

Keywords:
Echocardiography
Aged 80 and over
Geriatric assessment
Cardiovascular disease

ABSTRACT

Objective: To describe the echocardiographic characteristics of nonhospitalized centenarians in the area of Lugo (Spain).
Method: Within a prospective follow-up observational study of 99-year-old and older patients in the area of Lugo (Spain), an echocardiogram was offered to all patients able to move to the clinic. Complete bidimensional and Doppler transthoracic echocardiography were recorded with standard views and procedures.
Results: Sixteen patients aged 101 ± 1.3 agreed to perform an echocardiogram. Hypertension was registered in 50% of those subjects and 93% had at least one cardiovascular risk factor, without differences by gender except for smoking (71, 4% male vs. 0% female, $P = 0.005$). Polypharmacy was common (3.5 ± 1.7 drugs). Charlson index was above 2 points in 37, 5% and mean Barthel index was 59.4 ± 36.1. At the time of the home visit 3 patients had atrial fibrillation. None of the patients included in the study had a normal echocardiogram. Left ventricular hypertrophy was recorded in 43%, systolic dysfunction (left ventricular ejection fraction < 55%) in 31% (no case of severe degree) and left ventricular diastolic dysfunction in 56, 3%. The left atrium diameter was > 40 mm in 8 patients (50%). Mild or moderate valvular lesions were common (93%), mainly mitral or aortic regurgitation. There were no differences by gender.
Conclusion: Our centenarians had an abnormal echocardiogram, possibly in relation to physiological changes associated with age and the presence of chronic cardiovascular disease. However, they showed no major structural alterations.

Advances in living standards and public health systems have achieved greatly extended life expectancy in recent decades; thus, older population has increased exponentially, leading to a progressive increase in the number of centenarians [1]. In spite of the fact that data on this population are still limited, most of studies are focused on the assessment of their functional and cognitive status.

A number of changes have been described in the heart of the elderly, such as the loss of myocytes with subsequent hypertrophy of the remaining cells, calcification involving the conduction and valvular apparatus, and the loss of the arterial compliance. This contributes to systolic hypertension and left ventricular hypertrophy, although it has been recognized that a sedentary lifestyle can be responsible for a large fraction of this so-called 'age-related' changes [2].

Clinical studies on centenarians are scarce and usually evaluate basic aspects of health [3,4]. Regarding cardiovascular system there are some data on their cardiovascular risk profile [5] and on the electrocardiographic abnormalities [6]. The presence of structural heart disease in centenarians has been seldom studied.

Cardiac anatomy of centenarians has been described in short necropsy series [7–9] and echocardiogram findings have been reported in retrospective inpatient case series [10], nursing home residents [11] and patients limited to ventricular function in the ambulatory setting [12].

The aim of this study is to describe the structural and functional echocardiographic features of a cohort of centenarians in our health setting [13].

1. Method

Within a prospective follow-up observational study in the area of Lugo (Galicia, northwest of Spain), the information of all 99-year-old and older patients of this area was obtained from the

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http://dx.doi.org/10.1016/j.eurger.2015.10.012
1878-7649/

Table 1
Clinical characteristics of the 16 centenarians studied.

	Male $n=7$ (43.8%)	Female $n=9$ (56.3%)	Total $n=16$	P
Age (years)[a]	101 ± 1.3	101 ± 1.4	101 ± 1.3	ns
Past medical history				
Smoking	5 (71.4%)	0	5 (31.3%)	0.005
Hypertension	2 (28.6%)	6 (66.7%)	8 (50%)	ns
Diabetes	1 (14.3%)	3 (33.3%)	4 (25%)	ns
Dyslipidemia	1 (14.3%)	1 (11.1%)	2 (12.5%)	ns
Heart disease	2 (28.6%)	3 (33.3%)	5 (31.3%)	ns
Stroke	1 (14.3%)	0	1 (6.3%)	ns
At least one of the above	7 (100%)	8 (88.9%)	15 (93.8%)	ns
Body mass index (kg/m^2)	25.2 ± 3.1	24.3 ± 3.5	24.6 ± 3.1	ns
Systolic blood pressure (mmHg)	158.2 ± 33	128.9 ± 20.3	140 ± 29	ns
Diastolic blood pressure (mmHg)	83.5 ± 8.3	63.9 ± 14.5	71 ± 15	0.006
Heart rate	81 ± 13	76 ± 12.1	78 ± 12	ns
Glomerular filtration rate < 60 (mL/min/1.73 m^2)	3 (42.9%)	8 (88.9%)	11 (68%)	0.04
Charlson index > 2	2 (28.6%)	4 (44.4%)	6 (37.5%)	ns
Barthel index[a]	66.4 ± 27	53.9 ± 42.6	59.4 ± 36.1	ns

[a] Mean (DS).

National Health System register. After contacting the patients and/or their main caregiver, they were informed about the aims of the study and their consent to participate was requested. We conducted a domiciliary visit by a doctor and a nurse, who completed the study protocol, which included a sampling blood, demographic data, medical history and physical examination [13]. Age, gender, smoking record, drug use, Barthel and Charlson comorbidity index were all registered.

The following definitions were established: hypertension (systolic blood pressure > 140 mmHg or diastolic > 90 mmHg), hyperglycemia (fasting glucose > 126 mg/dL), dyslipidemia (total cholesterol > 220 mg/d), renal failure (estimated glomerular filtration rate (MDDR-4) < 60 mL/min/1.73 m^2), heart disease (clearly documented history of ischemic heart disease, valvular disease or heart failure), cardiovascular disease (high blood pressure, heart disease, stroke or peripheral arterial disease), comorbidity (Charlson index > 2) and polypharmacy (chronic use of 4 or more drugs).

Subsequently, the possibility of performing an echocardiogram was offered to all the patients able to move to the hospital. Complete bidimensional and Doppler transthoracic echocardiography were recorded with standard views and procedures, using various models of Philips echocardiographic equipment. Left ventricular systolic function was assessed by Teichholz method and Simpsons' biplane method of discs with manual planimetry of the endocardial border in end-diastolic and end-systolic frames. Diastolic function was estimated by combining mitral valve blood flow Doppler with lateral mitral annulus tissue Doppler. Doppler derived right ventricular systolic pressure was calculated from the peak tricuspid regurgitant jet velocity using the modified Bernoulli equation and an estimation of the right atrial pressure depending on the degree of vascular filling and respiratory motion of the inferior vena cava. Considering that no patients had right ventricular outflow tract obstruction, pulmonary artery systolic pressure was considered equivalent to right ventricular systolic pressure [14].

Statistical analysis: a descriptive study of the variables included in the study was performed. Quantitative variables were expressed as mean and standard deviation (SD). Qualitative variables were expressed as absolute value and percentage. In the univariate analysis, we performed the comparison of numerical parameters between test groups using the Student-t test or Mann-Whitney test, as appropriate, after verification of normality using the Kolmogorov-Smirnov test. For the comparison of qualitative variables, the Chi^2 test was performed, Fisher's exact test was used when the cells contained expected values less than five. Statistical significance was set at $P < .05$. Statistical analysis was performed using SPSS 17.0 for Windows.

The study was approved by the Galician clinical research Ethics Committee.

2. Results

Of the 80 interviewed 16 (66, 2% female) were functionally independent, which allowed the transfer to the hospital, and they agreed to perform an echocardiogram. Table 1 shows their main clinical features.

Only one patient did not have a prior diagnosis of cardiovascular disease. Polypharmacy was common (3.5 ± 1.7 drugs per patient). Most of the drugs recorded were usually used in the treatment and prevention of cardiovascular diseases. At the time of registration, 50% of patients had hypertension and 3 (18.8%) atrial fibrillation, only one of them with tachycardia (heart rate 104).

Left ventricular echocardiographic characteristics are shown in Table 2. None of the patients included in the study had a normal echocardiogram. Forty-three percent (3 males and 4 females) presented left ventricular hypertrophy. Systolic dysfunction (ejection fraction < 55%) was present in 31.3% of subjects (3 mild, 2 moderate, none severe), and diastolic dysfunction in 56.3% (5 men and 3 women). The left atrium was dilated (diameter > 40 mm) in 8 patients (50%). Dilatation of the right atrium and right ventricle was registered in 25% and 18.8%, respectively.

The prevalence of valvular heart disease was 93%. The most common lesions were mild or moderate mitral or aortic regurgitation, related to degenerative changes.

3. Discussion

This study is one of the largest reports assessing the cardiac structural and functional features of centenarians. Within a prospective study in outpatient centenarians, the echocardiogram showed mild or moderate structural changes of clinical interest, despite a high prevalence of vascular risk factors.

Age linearity increases left ventricular mass and wall thickness, leading to a decline of end-systolic stress and a decrease of ventricular afterload (Laplace law) [15]. This could account for the values of ejection fraction above the normality range (ejection