Echocardiographic Characteristics in Patients ≥100 Years of Age

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The centenarian population is increasing, and patients ≥100 years old are encountered more frequently in clinical practice. Cardiovascular disease is the most common cause of death in this subset of patients. We report the echocardiographic characteristics of 63 hospitalized centenarians. Patients ranged in age from 100 to 112 years and were admitted to the hospital for a variety of diagnoses. The mean left ventricular end-diastolic dimension was 3.9 ± 0.7 cm (2.8 to 5.8), the mean left ventricular end-systolic dimension was 1.8 ± 0.7 cm (0.8 to 3.5), the mean ventricular septal thickness was 1.2 ± 0.25 cm (0.8 to 1.9), the mean left ventricular posterior wall thickness was 1.1 ± 0.14 cm (0.8 to 1.6), the mean left ventricular ejection fraction was 84% ± 11% (49% to 97%), the mean aortic root diameter at the level of the sinuses was 3.3 ± 0.4 cm (2.1 to 4.1), the mean left atrial dimension was 4.5 ± 0.7 cm (3.1 to 7), the mean right ventricular end-diastolic dimension was 3.4 ± 0.6 cm (2.0 to 4.8), and the mean pulmonary artery systolic pressure was 37 ± 14 mm Hg. Moderate or severe valvular lesions were common, including aortic stenosis (27%), aortic regurgitation (17%), mitral regurgitation (22%), and tricuspid regurgitation (28%). In conclusion, centenarian hearts have important differences from younger hearts, including more hypertrophied left ventricle, higher ejection fraction, higher pulmonary artery systolic pressure, and more prevalent significant valvular heart disease. **(Am J Cardiol 2007;100:1792–1794)**

Centenarians are believed to be the fastest growing age group in the United States. In 1990, centenarians numbered 37,306 persons (1 of every 6,667). In 2000, there were 50,454 centenarians (1 of every 5,578).[1,2] Therefore, this subgroup of persons is increasingly being encountered in clinical practice. Cardiovascular disease is the most common cause of death in centenarians.[3,4] Echocardiographic characteristics of centenarians have never been studied; we report our findings in a group of 63 centenarians.

Methods and Results

Echocardiographic records at a tertiary care referral hospital were screened for centenarians. The medical records of these patients were retrieved and reviewed. Original echocardiographic videotapes were retrieved from archives. The echocardiograms were reviewed by a single experienced echocardiographer. The following measurements were recorded: left ventricular (LV) end-diastolic dimension, LV end-systolic dimension, ventricular septal thickness, LV posterior wall thickness, aortic root diameter, left atrial dimension, and right ventricular end-diastolic dimension. Doppler measurements included assessment of pulmonary artery systolic pressure and severity of valve stenosis and regurgitation. LV end-diastolic dimension, LV end-systolic dimension, ventricular septal thickness, LV posterior wall thickness, and aortic root diameter were measured from the parasternal long-axis 2-dimensional guided M-mode examination. In examinations for which M-mode was not properly aligned, measurements were taken directly from 2-dimensional imaging. LV ejection fraction was calculated from LV dimensions using the Teichholz method.[5] Left atrial end-systolic transverse dimension and mid-right ventricular transverse end-diastolic dimension were measured in the apical 4-chamber view. Pulmonary artery systolic pressure was determined from the highest tricuspid regurgitation velocity recorded from multiple views using the modified Bernoulli equation. Severity of valvular regurgitation was assessed by standard color Doppler criteria. Aortic valve area was calculated by the continuity equation. Aortic stenosis was considered severe when valve area was <1 cm,^{2} moderate when 1 to 1.5 cm,^{2} and mild when >1.5 cm.^{2}

Between 1999 and 2006, a total of 63 centenarians were identified in our echocardiographic database. Patients ranged in age from 100 to 112 years. Of the 63 patients, 38 (60%) were women. Hypertension was present in 28 patients (44%), coronary artery disease was present in 12 patients (19%), and diabetes was present in 1 patient. At the time of echocardiography, the mean systolic blood pressure was 130 ± 25 mm Hg (range 65 to 187), the mean diastolic blood pressure was 63 ± 14 mm Hg (range 38 to 117), and the mean heart rate was 80 ± 16 beats/min (range 56 to 130). Table 1 lists the admitting diagnoses; cardiovascular disorders accounted for 35%. The most common cardiovascular admitting diagnosis was heart failure (16% of all diagnoses). Table 2 lists the use of cardiac medication in the study population. The most common prescribed cardiac medications were diuretics (57% of patients) followed by β blockers (43% of patients). Indications for echocardiogra-

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Table 1
Admitting diagnosis of the study population

Cardiovascular	22 (35%)
Heart failure	10
Acute coronary syndrome	5
Cerebrovascular accident	4
Other cardiovascular	3
Infectious	17 (27%)
Pneumonia	7
Urinary tract infection	6
Other infections	4
Dehydration	6 (10%)
Pulmonary disorder	5 (8%)
Fracture	4 (6%)
Other	9 (14%)

Table 2
Use of cardiac medications in the study population

Angiotension-converting enzyme inhibitor	19 (30%)
β blocker	27 (43%)
Statin	9 (14%)
Diuretic	36 (57%)
Digoxin	11 (17%)
Antiplatelet agent	9 (14%)

phy included valvular heart disease (n = 28, 44%), heart failure (n = 10, 16%), coronary artery disease (n = 5, 8%), preoperative evaluation (n = 4, 6%), arrhythmia (n = 3), syncope (n = 2), infective endocarditis (n = 2), pulmonary embolism (n = 2), hypotension (n = 2), and pericardial effusion (n = 2).

The mean LV end-diastolic dimension was 3.9 ± 0.7 cm (range 2.8 to 5.8, median 3.9, reference range 3.9 to 5.3), the mean LV end-systolic dimension was 1.8 ± 0.7 cm (range 0.8 to 3.5, median 1.6), the mean ventricular septal thickness was 1.2 ± 0.25 cm (range 0.8 to 1.9, median 1.2, reference range 0.6 to 0.9), the mean LV posterior wall thickness was 1.1 ± 0.14 cm (range 0.8 to 1.6, median 1.0, reference range 0.6 to 0.9), the mean aortic root diameter was 3.3 ± 0.4 cm (range 2.1 to 4.1, median 3.2), the mean left atrial dimension was 4.5 ± 0.7 cm (range 3.1 to 7, median 4.5, reference range 2.7 to 3.8), and the mean right ventricular end-diastolic dimension was 3.4 ± 0.6 cm (range 2.0 to 4.8, median 3.2, reference range 2.7 to 3.3). (The reference ranges are based on the recommendations of the American Society of Echocardiography for younger subjects.[6]) Mean LV ejection fraction was 84 ± 11% (range 48% to 97%, median 86%). In patients without significant LV regional wall motion abnormalities (n = 55, 87%), mean ejection fraction was 86% (calculated by Teichholz method). In patients with significant LV regional wall motion abnormalities (n = 8, 13%), the mean LV ejection fraction was 62% (estimated by visual inspection). Moderate or severe aortic stenosis was seen in 17 patients (27%). Aortic valve area <1 cm was seen in 7 patients (11%).[2] Other moderate or severe valvular lesions were common, including aortic regurgitation in 11 patients (17%), mitral regurgitation in 14 patients (22%), and tricuspid regurgitation in 18 patients (28%). The prevalence of aortic stenosis (36% vs 21%), aortic insufficiency (20% vs 16%) and mitral insufficiency (28% vs 18%) were higher in men than women. The mean pulmonary artery systolic pressure was 37 ± 14 mm Hg. Pulmonary artery systolic pressure >35 mm Hg was seen in 51% of patients. Small pericardial effusion was seen in 14 patients (22%).

Discussion

Our analysis represents the largest study to date to examine the morphologic characteristics of centenarian hearts by echocardiography. We noticed differences compared with younger hearts. Centenarian hearts had smaller LV dimensions, especially the end-systolic measurements, with resultant ejection fraction in the supernormal range. In our study, excluding the patients with segmental wall motion abnormalities, mean ejection fraction was 86%. This "supernormal" ejection fraction may be because of lower wall stress, indicated by smaller ventricular cavity dimensions and thicker walls (Laplace's law). Of note, in our echocardiography laboratory, normal LV ejection fraction is reported in the range of 55% to 75%.

The prevalence of moderate or severe valvular lesions was higher in this group of patients than reported in population studies of younger patients. The prevalence of critical aortic stenosis in patients >75 years old was reported as 2.9%.[7] In our population, severe aortic stenosis was present in 11% of the patients. The prevalence of more than moderate regurgitant valvular lesions in patients aged 70 to 83 years in the Framingham population[8] was reported as aortic insufficiency in 2.2% of men and 2.3% in women versus our population, whereas prevalence was 20% and 16%, respectively. Mitral regurgitation was 11.2% in men and 0.0% in women compared with our group (28% and 18%, respectively). Tricuspid regurgitation was 1.5% in men and 5.6% in women, whereas our set of patients had 28% prevalence. Pulmonary hypertension was seen in 51% of patients. In a study of echocardiographic data on 3,790 normal subjects, pulmonary artery systolic pressure >40 mm Hg was found in 6% of those >50 years old.[9] Another unexplained finding was the high occurrence of small pericardial effusion seen in 22% of patients.

Our study has several limitations. It represents a select group of hospitalized centenarians, and it is possible that these results may not apply to nonhospitalized healthy centenarians. Secondly, LV ejection fraction was not calculated by the recommended Simpson's biplane method. Because the echocardiographic studies were not digital and involved retrieval and analysis of videotapes, the Simpson's method could not be applied. Teichholz method, although not accurate in the presence of segmental abnormalities, has good correlation with angiographic ventricular volumes in the absence of regional wall motion abnormalities.[5]

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