ECHOCARDIOGRAPHY IN THE ELDERLY

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Abstract. Heart structure changes with age. Due to increased life expectancy, a growing percentage of the population presents such changes. Old age is also linked to a high prevalence of comorbidities, including cardiac comorbidities. It is therefore imperative to know the physiological changes that occur in the elderly people in order to be able to differentiate the normal of pathological. In addition to the clinical examination and ECG, echocardiography provides important information about heart changes taking place in elderly people. Echocardiography assess structural changes (left ventricular hypertrophy, changes in heart geometry, fibrosis and valvular calcifications) and functional changes (systolic and diastolic dysfunction of the left ventricle with decrease of the left ventricle compliance, increase of myocardial stiffness, lusitrope function alteration, decrease of early diastolic filling and increase of atrial contraction, leading to atrial dilatation and left atrium remodeling. In elderly, the left ventricle ejection fraction is preserved, but the peak cardiac output in effort is lower compared to young people. In addition, the elderly have specific pathologies, such as senile cardiac amyloidosis.
Key words: echocardiography, elderly, valvular calcifications

Rezumat. Odată cu înaintarea în vârstă au loc modificări structurale la nivelul cordului. Datorită creşterii speranţei de viaţă, un procent tot mai mare din populaţie prezintă astfel de modificări. Înaintarea în vârstă este legată totodată de o prevalenţă mare a comorbidităţilor, inclusiv cardiace. Devine astfel imperios necesară cunoaşterea modificărilor fiziologice care au loc la vârstnici pentru a putea diferenţia normalul de patologic. Alături de examenul obiectiv şi ECG, ecocardiografia aduce informaţii importante referitoare la modificările cardiace care au loc la vârstnici. Ecocardiografia evaluează modificările structurale (hipertrofia de ventricul stâng, modificări în geometria cardiacă, fibroze şi calcificări valvulare) şi funcţionale ale cordului (disfuncţie sistolică şi diastolică de ventricul stâng cu scăderea complianţei ventriculului stâng, creşterea rigidităţii miocardice, scăderea umplerii diastolice precoce şi creşterea contracţiei atriale care duce la dilatare atrială, remodelare de atriu stâng, alterarea funcţiei lusitrope). La vârstnici, fracţia de ejecţie a ventriculului stâng este prezervată, dar debitul cardiac maximal la efort este mai mic decât la tineri. În plus, vârstnicii au patologii specifice, precum amiloidoza cardiaca senila.
Cuvinte cheie: ecocardiografie, vârstnici, calcificări valvulare

INTRODUCTION

According to Michael Rose, aging is defined as "a decline or loss of adaptation with increasing age, caused by a time-progressive decline of natural selection. Biologists define aging as "a decline or loss of adaptation with increasing age, caused by a time-progressive decline of Hamilton's forces of natural selection."[1].

Adaptation decrease in time is due to cardiac physiological, structural, and functional changes. The population distribution by age shows an increased number of old people, so the prevalence of physiological echocardiographic changes in elderly increases.

The recognition of these physiological changes is important for the differential diagnosis between a normal, but old heart, and a pathologically modified heart, so it helps to establish the diagnosis of diseases in elderly. Often there is no difference between the changes due to physiological aging and those due to the disease. The differences are more difficult and important to establish as the prevalence of cardiovascular disease increases with age.

There is a higher probability that an elderly will have cardiovascular disease compared to a young person (chronic coronary syndrome expressed as kinetic abnormality in ultrasound, arterial hypertension expressed as left ventricular hypertrophy in ultrasound, atrial fibrillation expressed in ultrasound as atrial dilation).

On the other hand, cardiac changes associated with aging increase the risk of cardiovascular disease. This creates a

vicious circle. These changes decrease the cardiac functional reserve and increase the risk of left ventricular hypertrophy (LVH), heart failure and atrial fibrillation which in turn are interdependent. LVH leads to decreased left ventricle (LV) compliance and diastolic LV dysfunction. Dilation and remodelling of left atrium (LA) and pulmonary veins in the presence of diastolic dysfunction increase the risk of arrhythmogenesis with the appearance of atrial fibrillation (AFib). AFib in turn aggravates diastolic dysfunction. The cardiac changes in the elderly decrease the manifestation threshold of some pathological disorders and decrease the heart capacity of adapting to physiological conditions (decrease the functional reserve). An ischemic episode asymptomatic in young people, in the elderly may be associated with a severe symptomatology.

The main structural changes that occur with advanced age are LVH, ventricular systolic and diastolic dimensions discrete decreasing (especially in women), left atrium and aortic root dilation (in both genres), valves thickening and fibrosis with physiological regurgitations worsening, increase in the amount of epicardial fat both anterior and posterior (especially in women), pericardium thickening and stiffening. Foramen oval is less prevalent in the elderly but when present, it is wider [2]. Sometimes, normal aging changes is similar to some heart disease: sigmoid-shaped ventricular septum may mimic hypertrophic cardiomyopathy, mitral leaflet "buckling" may mimic floppy mitral valve [3].

Regarding cardiac functional changes, significant alterations occur in left ventricular diastolic filling time, with decreased early filling and increased atrial filling velocity and mildly prolonged early deceleration and isovolumic relaxation time. These changes in diastolic function are relatively uniform and independent of other age-related changes.

Histological Changes

In the aging heart produces cardiomyocyte hypertrophy, transition from fibroblasts to myofibroblasts, extracellular matrix protein accumulation in the interstitium, interstitial fibrosis, fibrotic remodelling, subepicardial fat accumulation, myocardium brown atrophy, focal amyloid deposits increase and calcific deposition in the mitral annulus aortic valve, and epicardial coronary arteries. Collagen accumulates in the heart due to its reduced degradation [4]. These histological changes lead to visible echocardiographic changes.

Structural Echocardiographic Changes

1. Left ventricular remodeling

Since 1983 it has been found that left ventricular mass increases with age (Framingham study). According to these data, blood pressure and body weight are the most important risk factors associated with increased left ventricular mass. The question arose whether aging inevitably leads to LVH or if left ventricular mass remains stable in the absence of risk factors [5].

Subsequent studies have shown that left ventricular wall thickness and left ventricular mass are correlated with age, in both sexes, but also with systolic blood pressure, body mass index and mitral regurgitation [6].

Cheng MRI study included patients enrolled in MESA (Multi-Ethnic Study of Atherosclerosis) aged 45 to 84 years in the 4 ethnic groups (non-Hispanic white, black, Hispanic and Chinese), without cardio - vascular disease at the time of enrollment (ischemic coronary disease, peripheral arthritis, cerebrovascular disease or heart failure). This study shows a discrete decrease in the absolute value of left ventricle mass in the elderly, but a significant increase in the mass / volume ratio with aging [7].

Also by MRI studies, in 2013, a subset of patients (without cardiovascular disease and without hypertension) enrolled in the

Framingham study, showed LV volume but not the LV mass decrease. Advanced age increased the LV concentricity and ejection fraction. It has not been established, however, whether the increased concentricity was due to physiological aging or subclinical disease [8].

In 1990, a group of patients over 55 years old showed an increased prevalence of LVH, despite the controlled values of blood pressure in 2 years preceding the study. Moreover, the LVH presence did not correlate with the hypertension control level, neither with therapeutic strategy [9].

Left ventricular hypertrophy may occur even in the absence of pressure changes, due to the myocytes size increase. In addition, in the very old, amyloid deposits accumulate in interstitial space.

2. Changes in the heart geometry

In the elderly, the ascending aorta shifts rightward, and the basal interventricular septum moves posterior, leading to left ventricular ejection tract narrowing. Left atrium and aortic root dilates in both genders. Increased epicardial fat widens the echolucent pericardial stripe, both anterior and posterior, particularly in women. The atrial septum thickens and becomes stiffer [2].

With aging, basal interventricular septum bends leftward, bulging into the left ventricular outflow tract. This is due to decreased long axis dimensions, but also to the rightward shift of the ascending aorta. The basal ventricular septal bulge into the left ventricular outflow tract may mimic hypetrofic cardiomyopathy. The resemblance is even greater as both the old heart and the hypertrofic cardiomyopathy associate small cavities, thick ventricular walls and dilated atria. The differences consist in the dilation of the ascending aorta in the elderly, associated with the thickening and calcification of the aortic cusps [3].

3. Valvular fibrosis and calcification

With aging, fibrosis and valvular calcifications appear especially mitral and aortic ring calcifications.

Aortic sclerosis is a common finding in clinical practice, characterized by the calcium and fibrous tissue deposition in aortic valve, with the thickening of aortic valvular leaflets, without narrowing the ejection tract of the LV. The aortic sclerosis lesions show many histological similarities with atherosclerotic lesions [10].

The frequency of aortic sclerosis is around 26% in the population over 65 and increases with age [11].

Over time, aortic sclerosis may progress to clinically manifest aortic stenosis, and therapeutic options are limited. Statin, ACE-inhibitors, ARBs and bisphospho-nates trials have been performed to investigate aortic sclerosis treatment, but none of these therapeutic classes has proved its effectiveness. It has been hypothesized that these therapeutic classes could be effective in the early stages of valvular calcification, but not in advanced ones, when aortic stenosis is present [12].

Calcium and fibrous tissue deposit occurs not only in aortic valve, but also in the mitral ring and can lead over time to mitral regurgitation and / or stenosis.

The prevalence of mitral ring calcification varies between 5 and 42%, depending on the age, sex, diagnostic imaging method, and the associated risk factors [13]. A study including elderly subjects (over 90 years old) who underwent autopsy showed a direct correlation between mitral ring calcification and age [14]. Mitral calcification lesions are very similar to aortic sclerosis lesions and atherosclerosis.

Due to life expectancy growth and limited therapeutic options, the prevalence of this condition increased in recent years. Balloon valvuloplasty is not recommended due to valvular calcifications, and open surgery is burdened by many complications, especially in elderly. In addition, transcatheter valve implantation

is difficult due to mitral calcifications and due to particular anatomy of the mitral apparatus [15].

Conduction system fibrosis, sinus node cells diminution, fat and collagen quantity increase in the sinus node and atrioventricular node fibrosis are also over time changes, but they cannot be detected by ultrasound.

Functional echocardiographic changes - Systolic and diastolic function

In patients over 50 years old, left ventricular ejection fraction decreasing below 55% is correlated with 3-fold increase in the risk of developing heart failure and with risk of death doubling [16, 17]. A study of 4257 patients enrolled in the Framingham trial showed an increased prevalence of asymptomatic systolic left ventricular dysfunction with age, higher in men (86%). In almost half of the cases the patients had a myocardial infarction history [18].

The Cardiovascular Health Study found that although the risk of heart failure death in elderly is lower in people with normal ejection fraction compared to the risk of heart failure death in those with low ejection fraction, more deaths have been associated with normal ejection fraction. This can be explained by the higher prevalence of preserved ejection fraction heart failure, higher than decreased ejection fraction heart failure [16].

Even if, over time, the ejection fraction remains preserved, speckle tracking changes in the contractile function may occur. In a study published by Zghal, the echocardiographic changes were analyzed in 45 elderly patients and 45 young patients without cardiovascular disease, and no differences were identified regarding the ejection fraction in the 2 groups. However, it was found that the overall longitudinal strain was significantly lower in elderly patients. There were no differences between the transversal global strain and the circumferential global strain in young vs. old people [19].

The prevalence of normal ejection fraction heart failure increases with age, particularly in women. Advanced age and female gender are associated with increases in vascular and ventricular systolic and diastolic stiffness even in the absence of cardiovascular disease [20]. Ventricular diastolic stiffness may contribute to the pathogenesis of preserved ejection fraction heart failure.

Patients with preserved ejection fraction heart failure are usually older compared to those with low ejection fraction heart failure. At the same time preserved ejection fraction heart failure appears more often in women than in men [21].

About half the patients presenting heart failure symptoms have diastolic dysfunction with preserved ejection fraction. Diastolic dysfunction, whether or not associated with heart failure symptoms, correlates with increased all causes mortality [22].

The protodiastolic left ventricular filling is proportional to the mitral valve anterior leflet closure rate. With aging, the E-F slope decrease, this may indicate early diastolic filling age-decreasing [23].

Right Ventricle Systolic and Diastolic Function

A MRI study of 120 healthy patients, (of which 60 women and 60 men) analyzing the right ventricle correlation between systolic and diastolic function, concluded that right ventricle mass and volume decreased significantly with age, while the ejection fraction increased. Regarding diastolic function, E wave decreased, A wave increased, with the decrease of the E / A ratio. Increased body surface area was associated with increased right ventricle mass, volume and E wave amplitude [24].

DISCUSSIONS

Over time, echocardiographic changes are more frequent, reflecting the existing cardiac pathology. The high prevalence of hypertension in the elderly leads to LVH and diastolic LV dysfunction. In patients

with chronic coronary syndromes, kinetic changes of LV walls frequently occur, left ventricular aneurysms can be identified, and the ejection fraction decreases. The most common valve disease etiology in elderly is degeneration. The rhythm disorders cause the heart cavities dilation leading to a vicious circle They maintain the arrhytmia and over time lead to the cardiac function impairment (initially the diastolic function is affected, then the systolic function is affected).

On the other hand, some physiological changes that occur in the elderly's heart may become severe enough to lead to clinically manifest cardiac dysfunction. Mitral ring calcification can lead over time to mitral regurgitation, mitral stenosis or heart block. Calcific deposits in the aortic valve can transform aortic sclerosis into clinically manifest aortic stenosis. Focal and localized deposition of amyloid, without clinical expression at first, can turn into symptomatic senile cardiac amyloidosis, fatal in the absence of treatment [3].

There are 3 types of cardiac amyloidosis, depending on the type of proteins deposits: AL type amyloidosis, hereditary transtyretin amyloidosis (ATTRm) and ATTRwt amyloidosis (wild type transtyretin amyloidosis). Among them, wild-type transtyretin amyloidosis is age-specific and it is also called senile cardiac amyloidosis. Cardiac amyloidosis symptoms are nonspecific, and diagnosis is often difficult. In order to treat amyloidosis, it is important to identify the type of protein deposits. AL-type amyloidosis is associated with reduced survival compared to ATTRwt amyloidosis, and although it has been attempted to develop differential diagnostic algorithms between the two types of amyloidosis, the gold standard for diagnosis remains the histological examination [25].

CONCLUSIONS

In elderly, physiological cardiac changes decrease the heart functional reserve and also the disease manifestation threshold. The association of multiple comorbidities is present, but the cardiovascular disease is one of the main causes of mortality at elderly patients. On the other hand, a number of physiological changes may mimic cardiovascular disease or may lead, by their aggravation, to the symptomatic cardio-vascular diseases (mitral / aortic calcifications / amyloid deposition) appearance. In this context, for a complete and correct heart disease diagnosis in elderly patients, it is necessary for the clinician to know the echocardiographic changes that occur in this age category: LV remodeling, changes in heart geometry, valvular calcifications, and functional changes. Frequently is difficult to obtain a good ultrasound view in the elderly. Age, gender, and body size should be taken into account when interpreting echocardiographic findings.

Conflicts of interest

The authors declare no conflicts of interest.

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