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Research Paper

Effect of ageing process on diastolic function of the heart

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ABSTRACT

Background: Ageing is associated with progressive structural and functional cardiac changes. Diastolic dysfunction is a common age-related abnormality and contributes significantly to cardiovascular morbidity. Echocardiography is a key non-invasive tool for assessing diastolic function and evaluating changes in left ventricular (LV) and left atrial (LA) structure and performance.
Objective: To investigate the impact of the ageing process on left ventricular diastolic function using echocardiographic assessment.
Methods: This cross-sectional study was conducted at Al-Najaf Center for Cardiac Surgery and Transcatheter Therapy / Al-Sader Teaching Hospital. A total of 50 patients aged 38–86 years were included. All participants underwent two-dimensional (2D) echocardiography to evaluate diastolic function parameters. Statistical analysis was performed to assess the relationship between age and diastolic function, with significance set at $P<0.05$.
Results: The findings demonstrated a significant decline in left ventricular diastolic function with increasing age ($P<0.05$). Echocardiographic indices of diastolic performance showed progressive impairment across older age groups, indicating worsening ventricular relaxation and compliance.
Conclusion: Left ventricular diastolic function deteriorates significantly with advancing age. Ageing is an important determinant of diastolic dysfunction, highlighting the need for early detection and monitoring using echocardiography.

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1. INTRODUCTION

Diastolic dysfunction (DD) is a general word for a number of physiological mechanisms that enable the left ventricle, or LV, to be filled with enough blood to meet the body's current needs while maintaining just enough pressure to avoid pulmonary congestion [1], [2], [3], [4], Causes of diastolic dysfunction include the following: [5]

- Hypertrophy of the left ventricle
- Ischemia
- Pericardial disease
- Remodeling and fibrosis (post myocardial infarction or in chronic heart failure)
- Age > 65 years

Heart remodeling, particularly left ventricular (LV) remodeling, is defined as a complex alteration in the structure and function of the heart that advances with the age of the patient [6], is linked to an increased risk of cardiovascular morbidity and mortality [7]. Therefore, it is critical to clarify the mechanisms of LV remodeling in order to provide medical care for the aged people. Numerous studies have demonstrated a correlation between ageing and LV remodeling; however, it is unclear whether this is a direct or indirect relationship because ageing is also associated with the development and aggravation of a number of diseases that impact structural/functional LV remodeling, including hypertension, obesity, diabetes, chronic kidney disease, and hyperlipidemia [8]. Echocardiography is essential for assessment of left ventricular diastolic function. According to the most recent guidelines published by the European Society of Cardiology, echocardiography is a Class I Level C recommendation because of its safety, availability, and accuracy in the diagnosis and treatment of heart failure [8].

According to current guidelines for Doppler echocardiography, diastolic function should be assessed via early to late diastolic transmitral flow velocity (E/A), and left ventricular filling pressure should be estimated using E to early diastolic mitral annular tissue velocity (E/e'). (4) E/A ratio < 0.8 has been identified as a straightforward yet powerful biomarker of LVDD [9].

level of structural integrity, there is an increase in connective tissue matrix content [10], [11], [12], a decrease in myocyte number [11], an increase in myocyte size [12]. Apoptosis and cell necrosis produce a decrease in the quantity of myocytes [13].

2. RELATED WORK

The results of Dugo and colleagues about assessment of diastolic function by echocardiography in elderly people, showed that diastolic function of the left ventricle signifinatly decrease with advenced age. [14] In another study, about diastolic dysfunction in elderly patients , they showed that the "physiological" diastolic dysfunction in the aged can be explained by a decline in passive left ventricular filling qualities and a worsening of left ventricular relaxation. [14] Another study reported that an early slowing of LV relaxation and diastolic suction begins in early middle age, with the greatest drop reported in elderly people, and a decrease in ventricular relaxation is likely responsible for the changes in LV diastolic filling with senescence [15].

Essential for assessment of left ventricular diastolic function. According to the most recent guidelines published by the European Society of Cardiology, echocardiography is a Class I Level C recommendation because of its safety, availability and accuracy in the diagnosis and treatment of heart failure numerous studies have demonstrated a correlation between ageing and LV remodeling; however, it is unclear whether this is the most frequent pathologic cause of elevated afterload is arterial hypertension, which results in left ventricular (LV) hypertrophy (LVH) and wall thickening in order to maintain tissue perfusion and pump function. LVH is closely linked to preclinical cardiovascular abnormalities, elevated cardiovascular morbidity and mortality.

3. METHODOLOGY

3.1. Study Sample

The study population consists of patients with negative coronary artery disease (CAD) confirmed by percutaneous coronary intervention (PCI) who are participating in a population-based cross-sectional study. They were taken from the echocardiology department of Al-Najaf Center for Cardiac Surgery and Transcatheter Therapy/Al-Sader Teaching Hospital. The study included 50 patients ranging in age from 38 to 86 years. They all underwent 2D echocardiography to evaluate diastolic function. We only recruited patients with sinus rhythm, a left ventricular ejection fraction of 55% or more, no valvular disease, no evidence of pulmonary hypertension, negative CAD confirmed by PCI, and with no right ventricular dysfunction.

Every participant was informed about the study's objectives, procedures, and methods, considering the option to participate or not. They gave express and willing consent. The study was also approved by the ethical committee of University of Kufa, Faculty of Medicine.

3.2. Echocardiographic Assessment

Each participant was submitted to 2D echocardiographic assessment for systolic and diastolic function. Regarding diastolic function, patients were categorized into Grade 0 which is normal, grade I which is impaired relaxation, grade II that is pseudonormal, grade III restrictive and grade IV diastolic dysfunction irreversibly restrictive. [16] In this study, early to late diastolic transmitral flow velocity (E/A) have been used for assessment of left ventricular diastolic function. The machine used for echocardiographic assessment was GE Vivid E9 Ultrasound System which was a high performance digital ultrasound imaging system.

3.3. Statistical Analysis

The data was analyzed using version 26 of the Statistical Package for Social Science (SPSS) software. Categorical variables were expressed as frequencies and percentages, and the Chi-square test have been used to measure their level of significance and correlations. The P value of 0.05 was employed in this study. P values < or =0.05 were considered significant.

4. RESULTS AND DISCUSSION

Table 1 lists the frequency of Demographic Characteristics and diastolic function of the patients. Table 2 lists the relationship between age and the patients' diastolic function. Table 3 shows the relationship between gender and the patients' diastolic function and Table 4 shows the relationship between HTN and the patients' diastolic function. The study's findings clearly indicate a steady decline in left ventricular diastolic function with aging, (P value = 0.01). It also found a positive correlation between HTN and DD (P value= 0.03). There is no significant relationship between gender and diastolic function (P value = 0.1).

Table 1. Demographic Characteristics and Risk Factors of the Patients

Category	Number (n)	Percentage (%)	Mean Age
30-49	5	10%	68.2 ± 1.6
50-69	29	58%	59.55 ± 11.04
70-89	16	32%	63.88 ± 10.8
Total	50	100%	61.8 ± 10.7
Male	33	66%	
Female	17	34%	
Hypertensive	41	82%	
Non-Hypertensive	9	18%	

Grade 0	2	4%	
Grade I	22	44%	
Grade II	16	32%	
Grade III	10	20%	

Table 2. The Relationship between Age and the Patients' Diastolic Function

Age	Diastolic Function				Total	P Value
	Grade 0	Grade 1	Grade 2	Grade 3		
30-49	2 (4%)	3 (6%)	0 (0%)	0 (0%)	5 (10%)	0.001
50-69	0 (0%)	14 (28%)	10 (20%)	5 (10%)	29 (58%)	
70-89	0 (0%)	5 (10%)	6 (12%)	5 (10%)	16 (32%)	
Total	2 (4%)	22 (44%)	16 (32%)	10 (20%)	50 (100%)	

Table 3. The Relationship between Gender and the Patients' Diastolic Function

Gender	Diastolic Function				Total	P Value
	Grade 0	Grade 1	Grade 2	Grade 3		
Male	2 (4%)	17 (34%)	7 (14%)	7 (14%)	33 (66%)	0.1
Female	0 (0%)	5 (10%)	9 (18%)	3(6%)	17 (14%)	
Total	2 (4%)	22 (44%)	16 (32%)	10 (20%)	50 (100%)	

Table 4. The Relationship between HTN and the Patients' Diastolic Function

Htn	Diastolic Function				Total	P Value
	Grade 0	Grade 1	Grade 2	Grade 3		
Hypertensive	2 (4%)	13 (26%)	16 (32%)	10 (20%)	41(82%)	0.03
Non-hypertensive	0 (0%)	9 (18%)	0 (0%)	0 (0%)	9 (18%)	
Total	2 (4%)	22 (44%)	16 (32%)	10 (20%)	50 (100%)	

Regarding age, our finding was consistent with a number of earlier studies. [1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15] Toba and collegues stated that Regardless of LV hypertrophy, age was independently connected with LV concentric/functional alterations, indicating that aging is independently engaged in the development of LV remodelling [6]. Another study showed that Age considerably reduced the E/A ratio ($P < 0.001$), whereas gender had no effect ($P = 0.298$). E/e ratio was higher in women than in males ($P < 0.001$) and increased considerably with age ($P < 0.001$) [16].

On the level of structural integrity, there is an increase in connective tissue matrix content [16], [17], [18] a decrease in myocyte number1 [17], and an increase in myocyte size [18]. Apoptosis and cell necrosis produce a decrease in the quantity of myocytes [19]. Fibroblasts replace lost myocytes, causing the remaining myocytes to enlarge. Interstitial fibrosis results from the fibroblasts' production of collagen, which makes the heart less flexible and more rigid [20]. Both systolic contraction and diastolic relaxation are impacted by the less flexible and stiffer ventricle [21]. Systolic contraction time prolongation and left Ventricular hypertrophy (LVH) are caused by persistently high afterload [22] by rigid vasculature. In turn, early diastole is impacted by prolonged systolic contraction [21].

Regarding hypertension, Bamaiyi concluded that left ventricular mass index (LVMI) and relative wall thickness (RWT) only contribute a small amount to the effect of BP on diastolic function, despite the fact that structural LV remodelling is independently linked to alterations in LV diastolic performance. Therefore, it is likely that the majority of BP-associated reductions in LV diastolic performance are a transition phase unrelated to LV hypertrophy or concentric remodelling [23]. The most frequent pathologic cause of elevated afterload is arterial hypertension, which results in left ventricular (LV) hypertrophy (LVH) and wall thickening in order to maintain tissue perfusion and pump function. LVH is closely linked to preclinical cardiovascular abnormalities, elevated cardiovascular morbidity and mortality [24]. [23] Adolescents with increased blood pressure are at risk for subclinical alterations in their systolic and

diastolic cardiac function [25]. According to another study, around 48% of patients with newly diagnosed but untreated hypertension exhibit abnormalities in their left ventricle's diastolic function [26].

Regarding gender, our study had shown no difference between male and female regarding diastolic function, P > 0.05. Shim and colleagues in their study about gender difference regarding the effect of arterial stiffness on the diastolic function of the heart, stated that the measurements of arterial stiffness and LV diastolic function strongly correlate only in females [27]. Carvalho and colleagues also had a result different from ours. Their study showed that even with normal aging, women's diastolic function declines more quickly than men's [17]. This difference between results may be caused by the huge difference in sample size as their study included 14,298 patients, and difference in the age group as the ages of the two oldest and youngest patients were 98 and 7, respectively.

5. CONCLUSION

This study found that left ventricular diastolic function of the heart significantly declines with age. Hypertension, Bamaiyi concluded that left ventricular mass index (LVMI) and relative wall thickness (RWT) only contribute a small amount to the effect of BP on diastolic function, despite the fact that structural LV remodelling is independently linked to alterations in LV diastolic performance. Therefore, it is likely that the majority of BP-associated reductions in LV diastolic performance are a transition phase unrelated to LV hypertrophy or concentric remodelling. [23] The most frequent pathologic cause of elevated afterload is arterial hypertension, which results in left ventricular (LV) hypertrophy (LVH) and wall thickening in order to maintain tissue perfusion and pump function. LVH is closely linked to preclinical cardiovascular abnormalities, elevated cardiovascular morbidity and mortality [24]. [23] Adolescents with increased blood pressure are at risk for subclinical alterations in their systolic and diastolic cardiac function. [25] According to Another study, around 48% of patients with newly diagnosed but untreated hypertension exhibit abnormalities in their left ventricle's diastolic function [26].

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Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Fatima F. Al-Muhanna	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	
Amina A. B. Al-Dejeli	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓		

C: **C**onceptualization
M: **M**ethodology
So: **So**ftware
Va: **Va**lidation
Fo: **Fo**rmal analysis
I: **I**nvestigation
R: **R**esources
D: **D**ata Curation
O: Writing- **O**riginal Draft
E: Writing- Review & **E**diting
Vi: **Vi**sualization
Su: **Su**pervision
P: **P**roject administration
Fu: **Fu**nding acquisition

Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Informed Consent

All participants were informed about the purpose of the study, and their voluntary consent was obtained prior to data collection.

Ethical Approval

The study was conducted in compliance with the ethical principles outlined in the Declaration of Helsinki and approved by the relevant institutional authorities.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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