RESEARCH PAPER

Left ventricular diastolic dysfunction in patients attending a cardiology outpatient clinic

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Abstract

Background: diastolic dysfunction is an important contributor to left ventricular dysfunction and should be looked for in the assessment of our patients as it could be the cause for heart failure named as heart failure with preserved ejection fraction.

Aim: assessment of diastolic function indices in patients attending Cardiology clinic with different presentations and risk factors for heart failure.

Patients and methods*:* this are a retrospective cross-sectional study, carried out in outpatient cardiology clinic in Al- Nasiriya, from November 2021 to September 2022. Patients attending the clinic with presentation & risk factors suggestive of heart failure were fully evaluated by consultant cardiologist using transthoracic echocardiography with detailed assessment of cardiac function indices including left ventricular ejection fraction, transmittal inflow velocities, trans tricuspid regurgitation velocities & tissue Doppler evaluation for medial + lateral mitral annulus velocities. For those with increased E/e-: LA size & volume / or TR velocity > 2.8 cm^2 were recorded when applicable to categorize the degree of diastolic dysfunction.

Results: participants were 186 patients; mean age was 56.2 ± 12.2. Those with diastolic dysfunction (DD) were (42.4%), while those without DD were (57.5%). Diastolic dysfunction was significantly more in patients with hypertension (57.6%). And in those with regional wall motion abnormality (70%).

Conclusion: diastolic dysfunction is more prevalent with increase age & hypertension yet most of the time is only a grade I (just impaired relaxation). Measurement of diastolic dysfunction via transmitral flow pulse wave Doppler and tissue Doppler imaging of mitral annulus velocities is easy to be performed, adding more information to 2D echocardiography.

Keywords: LV hypertrophy, echocardiography, diastolic dysfunction

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Introduction

The heart has two alternating phases: systolic contraction and diastolic filling. Although the transition from contraction to relaxation begins prior to aortic valve closure, the traditional definition of diastole (in the ancient Greek language the term διαστολε means expansion) includes the part of the cardiac cycle starting at the time of aortic valve closure and finishing at mitral valve closure. Traditionally, diastole is divided into isovolumic relaxation, rapid early filling, diastasis, and atrial-induced filling. During isovolumic relaxation, LV pressure falls rapidly, and when LV pressure has declined below atrial pressure, a pressure gradient is established between the atrium and the ventricle, the mitral valve opens and the ventricle fills rapidly, giving rise to the early diastolic filling velocity (E velocity). During diastasis, left atrial (LA) and LV pressures almost equilibrate and

transmitral flow occurs at a low rate. Not infrequently in patients with markedly delayed relaxation, there may be a velocity peak during mid-diastole (L velocity).[1] Finally, atrial contraction causes late diastolic filling of the ventricle. mitral velocity increases as long as there is a positive transmitral pressure gradient and therefore peak velocity occurs when the gradient is zero. Then the gradient becomes negative and accounts for the deceleration of transmitral flow. The delay in velocity relative to peak gradient is due to the effect of blood inertia. Three fundamental mechanisms that contribute to diastolic dysfunction are slowing of relaxation, loss of restoring forces, and increased diastolic stiffness, and these are typically accompanied by a compensatory increase in LV diastolic pressure.[2] Different results regarding mortality in diastolic heart failure may be explained by differences in etiology and age of the patients taken into survey. Another determinant of mortality is the age, mortality in diastolic heart failure increases significantly with age. The data show that mortality at 5 years is 15% in below the 50-year-old group, 33% in 50-70-year-old group, reaching 50% in patients over 70 years old. Thus, in the elderly people over 70 years old the mortality rate for heart failure diastolic and heart failure systolic is practically equivalent, female patients have more diastolic heart failure than men. Out of the 2.4 million female patients with heart failure in the U.S., more than 50% of them have a normal systolic function[3]. HF is a major and growing public health problem in the USA, affecting approximately 5.1 million patients, and over 23 million patients worldwide.[4] More than 650,000 new patients are diagnosed with HF in the USA each year, and approximately half of them show diastolic dysfunction.[5]

Patients and Methods

This is a retrospective cross-sectional study which was carried out from November 2021 to September 2022 at a cardiology outpatient clinic in Al- Nasiriya city. Patients attending the clinic with any presentation and their data were taken for analysis, except those who have the following exclusion criteria:

1. Valvular heart disease.
2. Mitral annular calcification.
3. AF
4. Pregnancy
5. Pericardial disease.
6. Poor echo window
7. LBBB

All patients were having documented electrocardiography and bedside echocardiography on date of examination. All transthoracic examinations were performed with a commercially available cardiac ultrasound machine (VINNO G 55, CHINA) equipped with a 2.5 MHZ transducer. LV Ejection fraction was calculated by M - mode or 2D- Teicholz method in most of the cases unless RWMA noted, then Simpson's method was used. Pulsed-wave Doppler of the trans mitral inflow was obtained by the use of the apical 4-and 5-chamber views in the partial left lateral decubitus position. The parameters measured were: peak velocity of early filling (E-wave), peak velocity of atrial contraction (A-wave), and the E/A ratio.[6,7] E/e- was measured for medial + lateral mitral annulus & the average was taken and categorized < 14 as normal, > 14 as abnormal. When we took the arranged E/e- as a surrogate to classify DD: grade I <14 and > 14 in grades II & III. for those with increased E/e-: LA size & / or TR velocity > 2.8 cm^2 then grade III is diagnosed[8-10]

Statistical Analysis:

All data were analyzed by (SPSS-24). Continuous variables expressed as mean ± SD, median, minimum, and maximum, categorical variables as number and percent accordingly. Chi squared (χ^2) test was used to study the difference between variables. P-values less than 0.05 were reported as statistically significant.

Results

Study sample 186 cases, those with DD were 79(42.4%), while those without DD were 107(57.5%). Males with diastolic dysfunction were 36 from 91(39%), females were 43 from 96(45%). Those with history of hypertension were 92(49.5%), those without were 94 (50.5%). Diabetic patients were 47(25.3%), non-diabetic was 139(74.7%), those with history of ischemic heart disease were 34(18.3%), while those with no documented ischemic heart disease were 152 (81.7%). Gender distribution in the studied sample is shown in Figure (1)

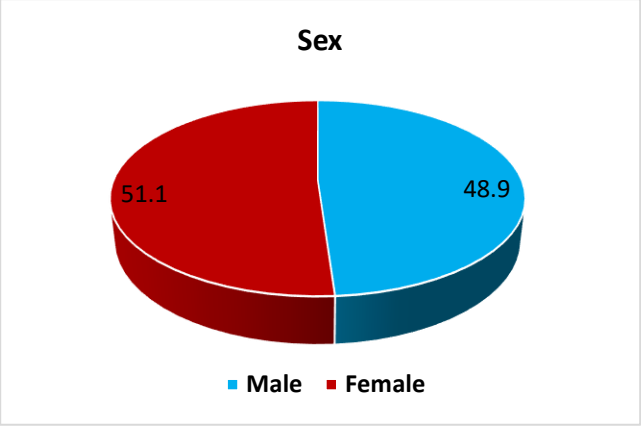

Fig 1. Gender distribution in the studied sample

Table 1. Medical characteristics of the study sample

Characteristic		Frequency	%
Presentation		**No.**	**%**
Atypical chest pain		42	22.6
Ischemic chest pain		46	24.7
Effort intolerance		25	13.4
Orthopnea		24	12.9
Exertional sob		23	12.4
Palpitation		21	11.3
Syncope		3	1.6
Oedema		2	1.1
Hypertension	Yes	92	49.5
	No	94	50.5
D.M	Yes	47	25.3
	No	139	74.7
Revascularization (PCI or CABG)	Yes	28	15.1
	No	158	84.9
IHD	Yes	34	18.3
	No	152	81.7
Total		**186**	**100**

Table 2. Echocardiographic characteristics:

		No.	%
Left atrium size	Normal	39	21.0
	Dilated	147	79.0
LVH	Yes	72	38.7
	No	114	61.3
E/A Normal		112	60.2
Increased		74	39.8
E/e-			
Normal		150	80.6
Increased		36	19.4
RWMA:			
Yes		40	21.5
No		146	78.5
Ejection fraction groups			
Reduced EF		17	9.1
Mid-range EF		12	6.5
Normal EF		157	84.4
Total		**186**	**100.0**

Cases with left ventricular hypertrophy (LVH) were 72(38.7%),). Regional wall motion abnormality (RWMA) during transthoracic echo were noted in 40 cases (21.5%). Regarding left ventricular systolic function: Normal in 157 (84.4%), mildly reduced in 12 cases (6.5%) and reduced left ventricular systolic function in 17 cases (9.1%). Males were 91 (48.9% 0, while females were 95(51.1%) Median age of those with DD was 61 years while it was 52.9 years for those who didn't have DD. This is comparable to other cross-sectional association reported between age and diastolic dysfunction: over four-year interval middle-aged and elderly persons were three times more likely to manifest poorer diastolic function than better diastolic function. This is shown in (Table-3)

Table 3. Age differences between those who have diastolic dysfunction and those who have not DD

Age		
Yes	No.	79
	Mean ± SD	61.15 ± 9.8
No	No.	107
	Mean ± SD	52.95 ± 12.69
Sig.*		**0.0001**

*** Mann-Whitney U Test**

There's a strong statistically significant association between hypertension and diastolic dysfunction (p = 0.0001). As shown in (Table-4).

Table 4. Relationships of diastolic dysfunction with hypertension.

		Diastolic dysfunction		Total	Sig.*
		Yes	No		
Hypertension	Yes	53	39	92	0.0001
		57.6%	42.4%	100%	
	No	25	69	94	
		13.4%	82.6%	100%	
Total		79	107	186	
		100.0%	100.0%	100.0%	

***Chi-Square Test**

There is high significant association between RWMA and DD (p = 0.0001)

Table 5. Relationships of diastolic dysfunction with RWMA.

		DD	No DD	Total	Sig.*
RWMA	Yes	28	12	40	0.0001
		70%	30%	100%	
	No	50	96	146	
		26.8%	73.2%	100%	

***Chi- Square Test**

Taking (hypertension & diabetes mellitus & ischemic heart disease) all together; the DD presented in 2 out of 13 cases (15.3%) which is of statistically significant association as shown below. The normal E/e- if < 14 and elevated if > 14. Accordingly, there was 36 patients with elevated E/E- this ratio was representing 19.35% of total patients. In table (6) study the association between Hypertension and E/e-, there's increased E/e- was significantly associated with HT, 27 out of 92 patients with HT and this represent 75 % of patients with increased E/e–, while 9 out of 94 patients with no HT still have increased E/e- but only represent 25% of them, the p value was (0.001).

Table 6. Relationships of E/e- with hypertension

		E/e-		Total	Sig.*
		Normal	Increased		
Hypertension	Yes	65	27	92	0.001
		43.3%	75.0%	49.5%	
	No	85	9	94	
		56.7%	25.0%	50.5%	

*Chi-Square Test

For patients with LVH: 29 out of 72 patients have increased E/e- which only represent 19.4%, (p value was highly significant (0.0001), as shown in table (7):

Table 7. Relationships of E/e- with LVH

		Normal E/e-	Increased E/e-	Total	
LVH	Yes	43	29	72	0.0001
		28.7%	80.6%	38.7%	
	No	107	7	114	
		71.3%	19.4%	61.3%	
Total		150	36	186	
		100.0%	**100.0%**	**100.0%**	

*Chi-Square Test

DD was found in 79 cases of our sample in different grades from grade I-III.

The range of EF (40-50%) and many of them are nearly at the lower normal EF& interestingly to be included in this aspect there was no significant correlation despite that most of DD patients were having normal EF & here the sample size might affect the results, yet it seems to be a consistent finding in most of our patients having only grade I DD & mostly they have normal systolic LV function.

Discussion

There are linear relationships between age and LV diastolic function occur over the adult lifespan. Moreover, despite the variable loading conditions that occur at different ages, the load that contributes most to the relationship between age and LV diastolic function is that produced by the impact of late systolic pulsatile load that starts at an early adult life and continue to an advanced age. Moreover, biological pathways that lead to heart failure with preserved ejection fraction are manifold, and understanding its pathophysiology remains in progress. The contributing factors include changes in myocardial relaxation and elastic recoil, changes in ventricular load and diastolic stiffness. Age related loss of peripheral vascular elasticity, and its effect on left ventricular load and stiffness, may play an important role in this process.[11] DD was significantly more in patients with hypertension,[12-14] LVH[15] & in those with RWMA and this were comparable to other studies[16,17] When considering DM alone or coronary artery disease alone is not shown to be significantly correlated with diastolic LV dysfunction the explanation may be affected by the duration of DM, and the control of blood sugar. This is discordant to other studies which shows significant correlation between diabetes mellitus and LV diastolic dysfunction.[18-21] In regard to LV systolic function we really should exclude patients with severe LV dysfunction as the measured parameter is greatly affected especially TDI of mitral annulus, however, their number in our patients with DD was only {4}, while those with mildly reduced EF should be included. An

important notice that increased E/e- was also found in patients with no hypertension and no LVH although the number is small & of no statistical significance but it raises the question about the possible structural LV changes that lead to progression of DD to higher grade even in the absence of most important risk factor in this aspect (i.e. HT & LVH) as in restrictive cardiomyopathy.[22]

Conclusion & Recommendations,

1. Diastolic dysfunction is more prevalent with increasing age, yet most of the time is only a grade I (just impaired relaxation), with more risk factors especially HT; progression to more severe grade can occur, and these needs follow up studies.
2. Measurement of DD via transmitral flow PW Doppler and TDI of mitral annulus velocities is easy to perform along with the routine echocardiography scan without extra cost, adding more diagnostic value to echocardiography.
3. Average E/e- is very helpful to classify DD, it is easy to be performed, and reproducible: just consider >14 or not.
4. The fact that high grades of DD is only present in small number of patients despite having all possible risk factors may raise the possible underlying structural changes in the LV that lead to more increase in LV stiffness and at the extreme presented with HFpEF, for example: more efforts to exclude restrictive cardiomyopathy.
5. The need for prospective study to examine the effect of treatment, control of risk factors & its impact on the disease progression or regression.

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دراسة قصور القلب الانبساطي لدى مرضى عيادة أمراض القلب

الخلفية: هذه دراسة مقطعية بأثر رجعي، أجريت في عيادة لاستشاري أمراض القلب للبالغين في الناصرية، جنوب العراق.

الهدف: هو معرفة مدى انتشار قصور القلب الانبساطي بين مرضى امراض القلب في ممارستنا اليومية.

المرضى والطرق: تم تسجيل إجمالي عدد ١٨٦ مريضاً في هذه الدراسة من أكتوبر ٢٠٢١ إلى أغسطس ٢٠٢٢. كان متوسط العمر(٥٦.٢ ± ١٢.٢). تم العثور على قصور القلب الانبساطي في درجات مختلفة في ٧٩ مريضا (٤٢.٤٪). كان قصور القلب الانبساطي أكثر بشكل ملحوظ في المرضى الذين يعانون من ارتفاع ضغط الدم (٥٣ من أصل ٩٢ مريضا وهو بنسبة (٥٧.٦٪) وكذلك لوحظ قصور القلب الانبساطي عند الذين يعانون من شذوذ حركة جدار البطين الأيسر الموضعية (٢٨ من أصل ٤٠ مريضا) بنسبة (٧٠٪).

النتائج: لم يلاحظ ارتباط كبير بداء السكري وأمراض القلب الإقفارية مع قصور القلب الانبساطي.

من ناحية أخرى، ليس كل المرضى الذين يعانون من ارتفاع ضغط الدم و / أو تضخم البطين الأيسر قد يتطورون إلى قصور القلب الانبساطي عالي الدرجة على الرغم من ارتفاع ضغط الدم غير المنضبط وشدة مختلفة من تضخم البطين الأيسر وكذلك عند الأشخاص الذين يعانون من شذوذ حركة جدارالبطين الأيسر الموضعية، في حين أنه لم يكن مرتبطًا بشكل كبير بداء السكري وأمراض القلب الإقفارية.

الاستنتاج: يكون قصور القلب الانبساطي أكثر انتشارًا مع تقدم العمر وارتفاع ضغط الدم. يمكن أن يحدث التقدم إلى درجة أكثر حدة من قصور القلب الانبساطي. من السهل إجراء قياس قصور القلب الانبساطي عن طريق موجة النبض عبر موجة دوبلر وتصوير دوبلر للأنسجة لسرعات الحلقة التاجية جنبًا إلى جنب مع فحص تخطيط صدى القلب الروتيني دون تكلفة إضافية، مما يضيف المزيد من العائد التشخيصي إلى فحص صدى القلب.

الكلمات المفتاحية: تضخم عضلة القلب، فحص صدى القلب، قصور القلب الانبساطي