

## Original Research Article

# Assessment of diastolic function in patients with aortic valve diseases

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### ABSTRACT

**Background:** Valvular heart disease (VHD) are prevalent and impose significant impact on heart function. Diastolic Dysfunction (DD) is less appreciated than Systolic Dysfunction (SD). The aim of this study was to assess the Diastolic Function (DF) in patients with Aortic Valve (AV) diseases as risk factors predisposing to DD.

**Methods:** Cross-section study that involved 34 patients with AV diseases and other 10 controls. All patients are assessed for diastolic dysfunction by transthoracic echo Doppler study. M-mode echocardiography was used to measure cardiac dimensions and wall thickness. LV mass was measured on echocardiogram at rest.

**Results:** Among the 34-patients, 19 (55.8%) of them were male patients and 15(44.2%) of them were female patients. The data showed that there were 12 patients with Aortic Stenosis (AS), eight patients with AORTIC regurgitation (AR), six patients with Aortic Sclerosis (ASCL) and 8 patients with combined AR-AS. Around third of the patients (35.3%) had Grade II DD followed by grade I and Grade III. However, around 14.7 % didn't have any dysfunction. Overall, there was 77% of the patients with AV diseases.

**Conclusions:** Author concluded that Aortic Valve diseases is significantly related to- the development of diastolic dysfunction and the DD is influenced by severity of AV diseases.

**Keywords:** Diastolic function, Disease, Heart, Valve

## INTRODUCTION

Valvular heart disease (VHD) encompasses a number of common cardiovascular conditions that account for 10% to 20% of all cardiac surgical procedures in the United States. A better understanding of the natural history coupled with the major advances in diagnostic imaging, interventional cardiology, and surgical approaches have resulted in accurate diagnosis and appropriate selection of patients for therapeutic interventions.<sup>1</sup>

Aortic stenosis (AS) is the most common valvular lesion that affects 2-7% of the population age >65 years worldwide. Increased afterload caused by the stenotic

valve inevitably leads to systolic and diastolic dysfunction.<sup>2</sup>

Aortic stenosis progresses gradually over time, and the Aortic Valvular Area (AVA) decreases by 0.1 cm every year, contributing to Left Ventricular Systolic Dysfunction (LVSD) by increasing afterload.<sup>3</sup>

A substantial portion of patients with heart failure (HF) have nearly preserved left ventricular Ejection Fraction (EF), generally above 40 or 50% and are classified as having diastolic heart failure or heart failure with preserved ejection fraction.<sup>4-6</sup> The terms "diastolic HF" and "systolic HF" are often used instead of "HF with preserved EF" or HF with reduced EF", respectively.

Risk factors predisposing to primary DD are: Hypertension, Cardiomyopathy, Hypertrophic, Restrictive, Infiltrative, Coronary artery disease, Diabetes mellitus, Obesity, Constrictive pericarditis and Aging.<sup>7-8</sup>

Because diastole comprises approximately two-thirds of the cardiac cycle, left ventricular diastolic pressure is transmitted to the left atrium and hence the pulmonary veins for a relatively longer period than is systolic pressure. Transmission of elevated diastolic pressures to the pulmonary venous bed can be a substantial driving force for development of pulmonary hypertension. So, the diseases that elevate diastolic pressure are often more likely to be associated with secondary pulmonary hypertension than diseases with isolated elevation of systolic pressure.<sup>9</sup> This is because the process of left ventricular relaxation is more energy dependent than contraction and abnormalities of left ventricular diastolic function occur earlier than systolic dysfunction in virtually all cardiac diseases.<sup>10</sup> When symptoms and signs of heart failure developed, these patients are referred to as having diastolic heart failure or more recently heart failure with preserved EF.<sup>11</sup>

Among the various underlying diseases causing diastolic heart failure, hypertensive heart disease is the most common and ischemic heart disease is the second most common in clinical practice.<sup>12</sup>

Traditional parameters of DF were measured at the mitral leaflet tips over three consecutive cardiac cycles and included peak mitral E and A early and late diastolic peak filling velocities) waves, E/A ratio, and mitral E wave D.T. The normal values for E wave, A wave, E/A ratio, and the E wave deceleration time.<sup>13-15</sup>

The pulmonary veins flow was not routinely performed because of the presumed difficulty in imaging this flow.<sup>8</sup> Normal pulmonary vein inflow consists of a diastolic and systolic phases as well as an atrial reversal (aortic regurgitation) called the pulmonary vein A wave.<sup>9</sup>

There is limited data about the effect of AS on diastolic dysfunction in Iraq, thus author carried out this study to determine the effect of AS on DD.

## METHODS

This is a cross-sectional study design which involved 34 patients with aortic valve diseases from 6<sup>th</sup> of April 2011 up to 20<sup>th</sup> of October 2011. Those patients were compared with 10 subjects as a control group. All patients are assessed for diastolic dysfunction by transthoracic echo Doppler study (Philips) in Najaf cardiac surgery center.

Transthoracic Doppler echocardiography examination was performed in left lateral decubitus position. Standard parasternal and apical views were used to assess the systolic and diastolic dysfunction.<sup>16</sup>

M-mode echocardiography was used to measure cardiac dimensions and wall thickness. LV mass was measured on echocardiogram at rest.

The differentiation between normal diastolic transmitral flow pattern and pseudonormal pattern was performed with the use of either Valsalva maneuver or pulmonary vein inflow pattern.<sup>17</sup> In patients with normal filling pressure, the Valsalva maneuver decreases both the E and A velocities and lengthens deceleration time (DT) while in patient with pseudonormalised pattern Valsalva maneuver will disclose the genuine abnormal pattern. In addition, in patients with a restrictive filling pattern the reversibility of advanced diastolic dysfunction was assessed with the Valsalva maneuver.<sup>18</sup>

In this study, the left atrial size was measured by the following methods:

1- Using M-mode echocardiography, the measurement was performed at end-systole when L.A volume was greatest.<sup>19</sup> Normal value in this view is (2-4 cm).

2-Planimetry of left atrial area from the four chamber view.<sup>19</sup> Normal value for L.A area in this view is less than 20 cm<sup>2</sup>.<sup>20</sup>

Other techniques for assessment of DF: Additional assessment of DF can also be made by cardiac catheterization, radionuclide angiography, and magnetic resonance imaging or computed topographic scanning.<sup>17</sup>

Since there is no one parameter that clearly defines DD and predicts elevated filling pressure, evaluation of DF required integration of the anatomic and physiologic information gathered from all the different methods.<sup>18</sup> Inclusion criteria were adult, able to give consent and diagnosed for more than a year. Exclusion criteria were patient who had added congenital anomalies or unable to give consent.

## Statistical analysis

The social package statistical service (SPSS) version 22.0 was used for categorical variables and p value <0.05 was considered to indicate statistical significance. Calculations were done also via SPSS.

## RESULTS

Among the 34-patients, 19(55.8%) of them were male patients and 15(44.2%) of them were female patients. The distribution of various types of Aortic valve disease are shown below. It is noticed that AS was the most reported disease followed by AR and AR-AS (Table 1).

The distribution of diastolic dysfunction of this patient according to the grading is shown below. Around third of the patients (35.3%) had Grade II DD followed by grade I

and Grade III. However, around 14.7 % didn't have any dysfunction (Table 2).

**Table 1: Incidence of different types of asterion.**

Valve diseases	n	%
AS	12	35.3%
AR	8	23.5%
AR-AS	8	23.5%
A SCL	6	17.7%
Total	34	100%

**Table 2: Distribution of patients according to the degree of D.D.**

Diastolic function	n	%
N.D.F	5	14.7
Grade-I	10	29.4
Grade-II	12	35.3
Grade-III	7	20.6
Total	34	100

In regards to the association of D.F. and AV disease, there was a significant difference in the DD between patients with AV disease and control. Overall, there was 77% of the patients with AV diseases (Table 3).

**Table 3: distribution of D.D and A.V diseases.**

D.F.	A.V. diseases	Control	Total
Impaired	29(100%)	0(0%)	29
Normal	5(33%)	10(77)	15
Total	34(77%)	10(23%)	44

A comparison was made between different AV disease and grade of DF. It was shown that grade II DF was the most highly reported among AS (67%) and AR-AS patients (50%). While, grade III was the most reported among AR patients (50%) (Table 4).

**Table 4: the relationship between A.V diseases and grade D.F.**

AV diseases	Grade-I	Grade-II	Grade-III	N.D.F.	Total
AS	1(8%)	8(67%)	0(0%)	3(25%)	12(100%)
AR	2(25%)	0(0%)	4(50%)	2(25%)	8(100%)
AR-AS	1(13%)	4(50%)	3(38%)	0(0%)	8(100%)
A.SLC+AR	6(100%)	0(0%)	0(0%)	0(0%)	6(100%)
Total	10(29%)	12(35%)	7(21%)	5(15%)	34(100%)

**DISCUSSION**

The presence of AV diseases is associated with adverse outcomes in many clinical conditions like myocardial ischemia and its relation to heart failure has also been appreciated. 21-23 Recent studies have demonstrated that AV disease is highly prevalent in patients who have heart

failure and is strongly associated with systolic dysfunction.24-25 Approximately , less 50% of patients who have heart failure have preserved systolic function , thus the association of AV diseases with diastolic dysfunction was assessed in this study.

The results of this study showed no privilege of aortic stenosis over aortic regurgitation in causing diastolic dysfunction and vice versa (p >0.05). This is probably due to the fact that, although different pathologies of the aortic valve had different mechanisms for causing diastolic dysfunction but yet they share a common end-result which is the ventricular hypertrophy.

The results of this study showed significant association between AVD and diastolic dysfunction (P value - 0.001). These results are consistent with those of other studies where Bruno et al, found that aortic valve stenosis not only causes diastolic dysfunction but also the diastolic function was improved after surgical repair of the stenosed valve. Left ventricular muscle mass is significantly increased in patients with aortic stenosis (due to pressure overload) resulting in restricted ventricular relaxation and thus diastolic dysfunction.

The same results were obtained regarding aortic regurgitation where a relationship exists between diastolic ventricular function and coronary flow phasic distribution, in which an abnormal coronary perfusion pressure is probably the major determinant of altered myocardial perfusion in aortic regurgitation ventricular hypertrophy and diastolic function may also be involved.<sup>26</sup>

AV diseases has a range of effects on cardiac structure, including myocyte hypertrophy and interstitial fibrosis leading to left ventricular hypertrophy. over time functional changes occur, with impaired left ventricular relaxation and compliance leading to D.D.<sup>26</sup>

Myocardial factors can be divided into structures and processes within the cardiac muscle cell (cardiomyocyte), within the extracellular matrix (ECM) that surrounds the cardiac muscle cell, and that activate the autocrine or paracrine production of neurohormones.<sup>27</sup> Each of these mechanisms are active in the major pathological processes that result in diastolic dysfunction and heart failure. Myocardial and extra myocardial mechanisms<sup>28</sup>, cellular and extracellular mechanisms, and neurohumoral activation each play a role in the development of diastolic heart failure caused by ischemia, pressure-overload hypertrophy, and restrictive and hypertrophic cardiomyopathy.<sup>29</sup>

Left ventricular muscle mass was significantly increased in patients with A.s and regurgitation and left ventricular relaxation was significantly prolonged.<sup>30</sup>

Diastolic stiffness increases in A.S early with parallel to the increase in interstitial fibrosis, whereas relaxation rate

decreases with a reduction in left ventricular muscle mass \Diastolic heart failure sometimes presents with concentric hypertrophy, as opposed to systolic heart failure, which sometimes presents with eccentric hypertrophy.<sup>31</sup>

D.D is characterized by elevated diastolic pressure in the left ventricle despite essentially normal/physiologic end diastolic volume (EDV). Histologic evidence supporting diastolic dysfunction demonstrates hypertrophy of the cardiomyocytes, increased interstitial collagen deposition and/or infiltration of the myocardium. These influences collectively lead to a downhill spiral in dispensability of the myocardium.<sup>32-33</sup>

## CONCLUSION

In Conclusion Aortic valve diseases is significantly related to the development of diastolic dysfunction when other known causes of diastolic dysfunction are excluded. Despite any type of A.V diseases can result in any grade of diastolic dysfunction ranging from mild to severe form with this study, diastolic dysfunction appears to be influenced by severity of aortic valve diseases

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