

## ECHOCARDIOGRAPHIC DETERMINANTS FOR DIASTOLIC DYSFUNCTION IN CHRONIC KIDNEY DISEASE

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### ABSTRACT

#### BACKGROUND

Diastolic dysfunction is associated with adverse outcome. There are no direct means to determine diastolic function by echocardiography, however, a multitude of echocardiography parameters assist in determining the diastolic dysfunction. The application of these parameters is not well validated in chronic kidney disease subjects.

#### MATERIALS AND METHODS

This study used echocardiography parameters to determine diastolic function in chronic kidney disease and in normal subjects.

#### RESULTS

Left atrial volume index appears to be a strong parameter for determining diastolic dysfunction in this subset.

#### CONCLUSION

Echocardiographic parameters as a standalone tool for determining diastolic dysfunction in the presence of chronic kidney disease are inadequate. Therefore, a combination of these parameters becomes mandatory to gauge the diastolic dysfunction in chronic kidney disease patients. Left atrial volume index may be proposed as a significant tool for diastolic dysfunction and it should be an essential part of echocardiographic interrogation in chronic kidney disease patients.

#### KEY WORDS

Diastolic Dysfunction, Chronic Kidney Disease

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#### BACKGROUND

Left ventricular (LV) diastolic function can be quantified by invasive and non-invasive methods. The invasive methods for quantifying the diastolic function include the peak instantaneous rate of LV pressure decline (-dP/dt), the time constant of LV relaxation (tau), and the stiffness modulus. Although, these parameters cannot be directly quantified by echocardiography examination, echocardiography remains the most pragmatic clinical method for evaluating LV diastolic function based on its omnipresence and effortless applicability. As the diastolic properties of LV is determined the congeneric contribution of left atrial (LA) phasic function to LV filling. In subjects with normal diastolic function, the relative contribution of the reservoir, conduit and contractile function of the LA to the filling of LV is approximately 40%, 35% and 25% respectively.

As relaxation mechanics of LV deteriorates, the comparative contribution of LA reservoir and contractile

function escalates while passive conduit function dominates. Eventually the LA functions as a conduit between pulmonary veins and LV as advanced diastolic dysfunction develops.<sup>(1)</sup>

The left atrial volume is a barometer of left ventricular filling pressure and reflects the severity of the left ventricular diastolic function. The determinants of left atrial volume are primarily: the left ventricular filling pressure and anthropometry determinants, age, atrial fibrillation and chronic volume overload.<sup>(2)</sup> Beyond the childhood years, the left atrial volume index (LAVI) becomes independent of age variable<sup>(3)</sup> The age related LA enlargement mirrors the pathophysiological changes that accompany advancing age rather than a consequence of chronological aging. It is clear from epidemiological studies that the leading risk factors for diastolic dysfunction are older age, systemic hypertension, chronic kidney disease, obesity and sedentary lifestyle, and myocardial ischemia.

This study aims at ascertaining the optimum echocardiographic parameter for determining the diastolic dysfunction caused by chronic kidney disease in reduced ejection patients resulting from coexisting myocardial infarction.

#### MATERIALS AND METHODS

##### Study Design

Cross Sectional Observational study.

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This study was initiated after obtaining institutional ethics committee approval for the protocol. This was a hospital based cross sectional observational study, conducted in Department of Medicine PT J N M Medical College and Dr. B R A M Hospital between July 2014 to December 2014 Raipur in patient with history of anterior wall myocardial infarction resulting in ejection fraction less than 45 percent. All the patients who satisfied the study inclusion criteria between the time frame mentioned above and who gave written informed consent were included into the study. The echocardiographic parameters for quantifying diastolic dysfunction - mitral inflow velocities (MVE and MVA), deceleration time (DT) and LA volume were determined in the two cohorts of 50 subjects in the study, one with documented chronic kidney disease and other without kidney disease respectively.

#### Assessment of LA Size

LA is asymmetrical complex three-dimensional anatomical structure. Furthermore, LA enlargement may not proceed in a uniform and stipulated manner. Therefore, anteroposterior measurement of LA by M-mode echocardiography is likely to confer an insensitive assessment of any change in LA size. On the contrary, LA volume estimated by echocardiography provides a more accurate and reproducible appraisal of LA size when compared to magnetic resonance imaging (MRI) and cine-computerized tomography (CT).

The LA size was measured at the ventricular end-systole when the LA chamber is at its superlative proportion. The pulmonary vein confluence and LA appendage are purposefully omitted during planimetry interrogation. Echocardiographic assessment of LA volume was done by area-length method.

#### Biplane Area- Length Method

Orthogonal apical views, apical four and two-chamber views were procured for quantifying of LA area and length. The length was determined from the midpoint at the plane of mitral annulus to posterior wall. Left atrial volume was then calculated on the basis of the equation  $LA\ volume = 0.85 \times (A1 \times A2) \div L$ ; where A1 and A2 were the areas of LA in four and two chamber views and L was the shortest of the lengths obtained from the orthogonal views and indexed to body surface area. This method has been recommended by the ASE guidelines for estimation of LA volume. (Lang RM et al 2005).

The LAVI (left atrial volume index) was obtained after indexing upon the body surface area for the subject.

Statistical analysis Data was entered into Microsoft excels worksheet and then imported into SPSS (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp) for analysis. Data were presented as mean +SD. Shapiro-Wilk test was used to test for normalcy of data. Mann-Whitney U test was used for comparison of data that were not normally distributed and independent samples t-test was used to compare data for normally distributed variables. A P-value < 0.05 was considered statistically significant.

The table 1 shows the comparison of echocardiographic diastolic dysfunction parameters between chronic kidney disease and normal renal function subjects.

## RESULTS

This study revealed that the usual echocardiographic determinants of diastolic dysfunction in the form of mitral inflow velocities and their ratio and the deceleration time were not evidently different between the two groups of chronic kidney disease and normal kidney function. However, the left atrial volume index was significantly higher ( $p < 0.0001$ ) in chronic kidney disease group as compared to the normal kidney function group. This finding suggests that the left atrial volume index maybe the optimum echocardiographic determinant of diastolic dysfunction assessment in patients with chronic kidney disease who have systolic dysfunction due to myocardial infarction.

Variables	CKD (21 Patients)		NON-CKD(29 Patients)		Mann-Whitney U	P-Value
	Mean	S.D.	Mean	S.D.		
Age	68.57	8.304	62.83	3.083	184.500	0.016
MVE	69.25	14.266	68.49	15.021	288.500	0.752
MVA	73.78	23.222	76.38	18.151	303.000	0.976
MVA/MVE	0.94	12.72	0.89	11.73	295.75	0.864
DT	243.14	69.183	255.79	103.080	290.000	0.775
EF	32.38	6.778	37.52	6.039	185.500	0.017
LAVI	36.24	5.403	28.38	5.185	93.500	0.0001
BMI	24.07	2.823	25.87	1.339	220.000	0.097
BSA	1.53	0.141	1.62	0.118	182.000	0.016

Table 1

## DISCUSSION

The CASCADE study<sup>(4)</sup> concluded that the diastolic function of LV was best determined by a combination of echocardiographic parameters namely Em, E/m ratio and LAVI rather than any single parameter. Mads Ersboll, Mads J. Anderson et al 2012<sup>(5)</sup> did prospective study on 843 pt of acute myocardial infarction within one week of MI with mean age of  $62.1 \pm 11.8$ yr where 74% was male. There was positive correlation seen among LAVI and age, while there was negative correlation between EF and LAVI.

Similarly, Leia Hee, Tuan Nguyen, et al 2014,<sup>(6)</sup> studied 289 unselected consecutive patients to compare stage 3 or 4 CKD (n=49) patients with those with eGFR>60 ml/min per 1.73 m<sup>2</sup> (n=240) to record the LV volume, ejection fraction and mass, left atrial volume, and function parameters. The primary endpoints were a composite of cardiac death, myocardial infarction, and congestive cardiac failure. After a follow up of median 5.6 years, there was significant difference in left atrial functions with respect to mitral valve A velocity, LAVI and atrial fraction was found, while LA ejection fraction did not show significant difference.

In our study of chronic kidney disease patients with systolic dysfunction the left atrial volume index was ascertained to be a strong and only determinant of the diastolic dysfunction where as the other parameters of mitral inflow velocities and their ratio and the deceleration time could not achieve a significance.

#### Limitations

The study is limited by the small number of study population and by more than one operator echocardiography interrogation.

**CONCLUSION**

Echocardiographic parameters as a stand alone tool for determining diastolic dysfunction in presence of chronic kidney disease are inadequate. Therefore, a combination of these parameters becomes mandatory to gauge the diastolic dysfunction in chronic kidney disease patients. Left atrial volume index may be proposed as a significant tool for diastolic dysfunction and it should be an essential part of echocardiographic interrogation in chronic kidney disease patients.

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