ISSN (Print): 2663-9491 ISSN (Online): 2789-6897

Original Article

Echocardiography Parameters of Diastolic Function in Patients with Atrial Fibrillation

DOI: dx.doi.org

Syed Obydur Rahman[1*], Kartick Chandra Halder[1]

Received: 24 November 2024
Accepted: 30 November 2024
Published: 15 December 2024

Published by:
Gopalganj Medical College,
Gopalganj, Bangladesh

*Corresponding Author

ABSTRACT

Introduction: *Echocardiographic assessment of left ventricular diastolic function in patients with atrial fibrillation is variable from beat to beat, and the left atrium is enlarged despite normal atrial pressures, making estimation based on the usual guidelines difficult and inaccurate. The introduction of additional echocardiographic parameters is therefore necessary, which is challenging and leads to different results.* ***Objective:*** *To find out the study various aspects of diastolic function in patients with atrial fibrillation.* ***Methods & Materials:*** *It was a hospital based prospective cross-sectional observational study conducted at Bangabandhu Sheikh Mujib Medical College Hospital, Faridpur, Bangladesh from January to June 2023. A total of 100 patients were included in the study. All consecutive patients attending above mentioned places of study based on inclusion criteria and during period of study were enrolled.* ***Results:*** *Total of 100 patients were studied. About one third (35.0%) had diastolic dysfunction. Ratio of E/e'(14.65 ± 2.21 Vs 7.66 ± 1.18) , E/Vp (1.57 ± 0.14 Vs 1.20 ± 0.11), isovolumetric relaxation time (53.06 ± 13.82ms Vs 89.33 ± 9.88ms) and deceleration time of pulmonary venous diastolic wave (203.09 ± 26.13ms Vs 292.25 ± 36.32ms) were significantly different in patients with diastolic dysfunction compared to patients without diastolic dysfunction with sensitivity of 90.6%, 84.4%, 81.2% and 78.1% respectively.* ***Conclusion:*** *Diastolic dysfunction is a common phenomenon in patients with atrial fibrillation. Echocardiographic parameters such as E/e` ratio, isovolumic relaxation time, E/Vp ratio, and diastolic lung wave delay time have been found to be highly sensitive in detecting diastolic dysfunction.*

Keywords: *Atrial Fibrillation, Diastolic Dysfunction, Echocardiography*

(The Insight 2024; 7(1): 240-247)

1. *Assistant Professor (Cardiology), Bangabandhu Sheikh Mujib Medical College, Faridpur, Bangladesh*

INTRODUCTION

Diastolic dysfunction, regardless of its cause, has a significant impact on symptom status, functional capacity, medical management, and prognosis in both systolic and diastolic heart failure (HF). When systolic dysfunction is clearly present, the central clinical question is the presence or absence of elevated filling pressures. In this context, restrictive filling patterns are highly specific for increased pulmonary artery occlusion pressure[1,2]. Diastolic function is difficult to assess in patients with atrial fibrillation (AF) because of the disappearance of mitral inflow A waves due to the loss of organized atrial activity in AF[3]. The disappearance of the A wave makes it impossible to calculate diastolic function from the mitral inflow E/A ratio. At the same time, the beat-to-beat variability of cycle length in atrial fibrillation requires multiple measurements to ensure high accuracy. Therefore, average calculations should be made from 5-10 strokes or 3 consecutive strokes. Measurement of various indices of left atrial function to assess diastolic function may be inaccurate, since in patients with atrial fibrillation, left atrial enlargement often occurs despite elevated filling pressures. Therefore, the derivation of diastolic function in patients with atrial fibrillation must utilize all these secondary and/or additional echocardiographic parameters[4]. Diastolic dysfunction is determined to be present if >50% of the variables if LA volume index is >34 ml/m2, TR velocity is >2.8 m/s, and average E/e' is >14, and septal e' velocity <7 and lateral e' velocity <10. To diagnose atrial fibrillation, your provider will likely do one or more heart or blood tests. Electrocardiograms, or EKGs, record your heart's electrical activity. Data from your pacemaker or implanted defibrillator, if you have one, may also be helpful. Current American Society of Echocardiography (ASE) guidelines focus on the following parameters for assessment of diastolic function in patients with AF[5]. However, there are many limitations to echocardiography calculation of diastolic function. No single index yield robust criteria and thus multiple indices are required to increase the sensitivity of diagnosis[6]. Moreover, diastolic function is related to myocardial relaxation and passive LV properties and is modulated by myocardial contractility. Myocardial relaxation on the other hand is determined by load, inactivation and non-uniformity[5]. Hence, all these parameters of assessment are skewed with various situations like mitral valvular/ annular pathology, loading conditions including atrial fibrillation and systolic dysfuction including wall motion abnormality. The objective of the study was to study various aspects of daistolic function in patients with atrial fibrillation. While myolysis is the dominant structural change in atrial tachycardia, fibrosis is the underlying structural change in heart failure. Additionally, mechanism for AF development in tachycardia-induced atrial myopathy is multiple wavelet re-entry; while delayed afterdepolarization is the underlying mechanism for AF development in heart failure[7]. The disparity in mechanisms of development of AF may partly explain the authors`

findings as they correlate echo-Doppler parameters with LAP.

METHODS & MATERIALS

It was a hospital based prospective cross-sectional observational study conducted at Bangabandhu Sheikh Mujib Medical College Hospital, Faridpur, Bangladesh from January to June 2023. Total 100 patients were included in the study. All consecutive patients attending above mentioned places of study based on inclusion criteria and during period of study were enrolled.

Inclusion Criteria:

- Age ≥ 18 years
- Atrial fibrillation
- Normal Left Ventricular Ejection Fraction (LVEF) ie, LVEF ≥ 50% [5].
- Patient giving consent for study.

Exclusion Criteria:

- Paroxysmal atrial fibrillation
- Arial fibrillation with fast ventricular response (HR >110/min).
- Pacemaker/ICD/ CRT in situ
- Past h/o radio frequency ablation for atrial fibrillation
- Previous Left atrial/ atrial appendage or mitral valve re pair or cardiac surgery
- Severe mitral regurgitation
- Mitral stenosis or mitral annular calcification

Detail clinical history, past medical/surgical history, general physical examination, systemic evaluation, Chest X-ray (CXR), Electrocardiography (ECG), necessary laboratory investigations and 2D Trans Thoracic Echocardiography were recorded over working proforma. The working proforma was validated by subject committee, National Academy of Medical Sciences. American Society of Echocardiography (ASE) guidelines-based estimation of echocardiography parameters was accomplished.[8] Diastolic echocardiography parameters were also obtained as per ASE guidelines. [5] Diastolic dysfunction was considered to occur when three or more of four specific echocardiographic parameters (thresholds) were determined in a patient. To diagnose atrial fibrillation and atrial flutter, an electrophysiologist will perform a physical examination, measure heart rate using an electrocardiogram (ECG), check blood pressure, and ask about family history. The doctor may recommend additional laboratory tests, imaging tests, and noninvasive monitoring. An EKG records the electrical activity of the heart and can be performed with 12 leads, fewer than 12 leads, or one lead. Several other medical devices (such as automated blood pressure cuffs and pulse oximeters) have been developed with algorithms to detect irregular heartbeats that may or may not be atrial fibrillation.

Data were entered into work sheet (Microsoft Excel) and statistical analysis was done using IBM Statistical Package for Social Science (SPSS) software, version 21. Continuous variables were listed as mean ± standard deviation and categorical variables were presented as number or percentage. After processing

of all available information, statistical analysis of their significance was done. Chi square test assessed statistical significance between clinical parameters in those patients with and without diastolic dysfunction. Confidence Interval (CI) of 95% and value of $P < 0.05$ were considered significant.

RESULTS

Total of 100 patients were enlisted for study more than half were males (54.0%). Various atherosclerotic risk factors were present. Common were smoking (39.0%), hypertension (33.0%), chewing tobacco (19.0%), diabetes mellitus (8.0%), renal disease (5.0%), obesity (4.0%) and peripheral arterial disease (2.0%). About one third ie, 35.0% of the patients had diastolic dysfunction (**Table I**).

Table – I: Baseline Characteristics

Variables	*n*	%
Age (years), (Mean±SD)	61.07± 10.89	
Gender		
Male	54	54
Female	46	46
Smoking	39	39
Tobacco Chewers	19	19
Hypertension	33	33
Diabetes Mellitus	8	8
Renal Disease	5	5
Peripheral Artery Disease	2	2
Obesity	4	4
Dyslipidemia	10	10
Left Ventricular Ejection Fraction (%),(mean ± SD)	63.6 ± 2.9	
Left Ventricular Diastolic Dysfunction	35	35

Patients with diastolic dysfunction were slightly elderly and atherosclerotic risk factors have no clinically significant association in patient with left ventricular diastolic dysfunction (**Table II**).

Table – II: Significance of Clinical Parameters

Variables	Diastolic Dysfunction Present	Diastolic Dysfunction Absent	*p*-value
Age (years), (mean ± SD)	63.37 ±11.30	59.83 ±10.55	0.138
Gender			

Male	17	37	
Female	19	27	0.293
Smoking	15	24	0.507
Tobacco Chewer	7	12	0.961
HTN	11	22	0.839
DM	1	7	0.236
Renal Disease	2	3	0.514
Peripheral Artery Disease	0	2	0.463
Obesity	2	2	0.957
Dyslipidemia	3	6	0.923

All the echocardiography diastolic parameters used during the study had high sensitivity with highest being E/e' ratio **(Table III and IV)**.

Table – III: Echocardiography Diastolic Parameters

Echo Parameters	LVDD Present	LVDD Absent	*p*-value
E/e' Ratio	14.65 ± 2.21	7.66 ± 1.18	<0.001
IVRT (ms)	53.06 ± 13.82	89.33 ± 9.88	
E/Vp Ratio	1.57 ± 0.14	1.20 ± 0.11	
DT of Pulmonary Diastolic wave	203.09 ± 26.13	292.25 ±36.32	

Table – IV: Frequency and Sensitivity of Echocardiography Diastolic Parameters

Echo Parameters	Frequency	Sensitivity (%)	*p*-value
E/e' Ratio	29	90.6	< 0.001
IVRT (ms)	26	81.2	
E/Vp Ratio	27	84.4	
DT of Pulmonary Diastolic wave	25	78.1	

DISCUSSION

Diastolic dysfunction can occur with or without the clinical syndrome of heart failure and with normal or abnormal systolic function. Diastolic dysfunction represents an abnormal mechanical characteristic, whereas diastolic heart failure represents a clinical syndrome. Diastolic dysfunction is a problem with diastole, the first part of the heartbeat. Normally, during diastole, the lower chambers of the heart relax and fill with blood. Diastolic dysfunction occurs when the lower chambers of the heart do not relax normally. Total 100 patients were enlisted for study more than half were males (54.0%). The participants of this study were mostly in late adulthood (mean age of 61.07± 10.89 years) and about one third of the patient had diastolic dysfunction. Additionally, patient having diastolic dysfunction were slightly elder than those without diastolic dysfunction revealing the fact

that age of the patient a vital role in prevalence of diastolic dysfunction. Similar findings were observed in different studies done by various authors[8,9]. A study by ***Kosiuk J et al.*** revealed that 38% of patients were affected by left ventricular diastolic dysfunction[9]. Age is one of the main factors in atrial fibrillation and diastolic dysfunction, making older adults more susceptible to both of these abnormalities. Age-related collagen deposition in the myocardium leads to a physiological increase in left ventricular filling pressure. This leads to an increased tendency to atrial fibrillation and diastolic dysregulation[8,10]. Various echocardiographic parameters assess cardiac diastolic function. These include transmitral flow velocity, pulmonary venous flow velocity, mitral annular velocity, blood flow propagation velocity, left atrial size, strain, strain rate, and torsion. However, clinically all of these parameters may not be feasible as in case of atrial fibrillation[4]. Hence only a few echocardiography parameters were used. Various atherosclerotic risk factors were present. Common were smoking (39.0%), hypertension (33.0%), chewing tobacco (19.0%), diabetes mellitus (8.0%), renal disease (5.0%), obesity (4.0%) and peripheral arterial disease (2.0%). About one thirdie, 35.0% of the patients had diastolic dysfunction. This study showed that the ratio of E/e' in patients with diastolic dysfunction was significantly higher (14.65 ± 2.21) compared to those without diastolic dysfunction (7.66 ± 1.18) and E/e' ration was highly sensitive in discriminating diastolic dysfunction. Many studies had documented similar findings. ***Kusunose K et al***. in their research stated that single beat E/e' ≥11.0 obtained by dual doppler echocardiography in patients with atrial fibrillation with preserved systolic function could predict diastolic dysfunction with elevated filling pressure sensitivity of 90%[11]. ***Sohn et al.*** in their study reported that an increase in E/e' ratio (≥11.0) was present in patient with diastolic dysfunction and this could also predict elevated left ventricular filling pressure apart from diastolic dysfunction with a sensitivity of 75%[12]. Iso-Volumetric Relaxation Time (IVRT) in patients with diastolic dysfunction was found to be 53.06 ± 13.82ms in this study and this parameter had a moderate sensitivity of 81.2%. Literatures have shown that IVRT measured with use of continuous wave doppler can be used in patients with atrial fibrillation and is inversely proportional to left atrial pressure[13]. The ratio of E/Vp in this study in patient with diastolic dysfunction was found to be significantly higher (1.57 ± 0.14 Vs 1.20 ± 0.11) compared to those without diastolic dysfunction with a moderate specificity of 84.4%. Various researches have justified that slope method of mitral to apical flow propagation can be used effectively in patient with atrial fibrillation to assess diastolic function. In patients with atrial fibrillation with high filling pressure there was slow mitral-to-apical Vp as there is high intraventricular pressure[14]. Therefore, as the severity of diastolic dysfunction increases, E/Vp ratio also increases[15]. The Deceleration Time (DT) of diastolic pulmonary venous wave in this study was traced to be 203.09 ± 26.13ms with a sensitivity of 78.0%. This blunted reaction changed

into synchronous with different studies. Chirillo F, et al. of their have a look at confirmed terrible correlation of DT with growth in left atrial stress. Calculated DT >220ms anticipated everyday left atrial stress with 100% sensitivity[16]. Doppler echocardiography has its personal demanding situations and barriers in assessing LV diastolic feature withinside the presence of AF via way of means of the range in cycle length, the absence of prepared atrial activity, and the common incidence of LA expansion no matter filling pressures[17]. It is important to stick to ASE pointers concerning imaging and size of each E and e′ in the event that they have been to reliably examine diastolic feature and estimate LAP[17].

Conclusion

In concluded, left ventricular diastolic dysfunction is common in patients with atrial fibrillation. Echocardiographic parameters such as E/e` ratio, isovolumic relaxation time, E/Vp ratio, and diastolic pulse wave delay time have been found to be highly sensitive in detecting diastolic dysfunction.

Funding

This research was funded by the authors themselves.

Conflict of Interest

The authors declare no conflict of interest.

REFERENCES

1. *Giannuzzi P, Imparato A, Temporelli PL, et al. Doppler-derived mitral deceleration time of early filling as a strong predictor of pulmonary capillary wedge pressure in postinfarction patients with left ventricular systolic dysfunction. J Am Coll Cardiol 1994; 23:1630–7.*
2. *Kapila R, Mahajan RP. Diastolic dysfunction. Contin EductAnaesth Crit Care Pain. 2009; 9:29-33.*
3. *Redfield MM, Jacobsen SJ, Burnett JC Jr, et al. Burden of systolic and diastolic ventricular dysfunction in the community: appreciating the scope of the heart failure epidemic. JAMA 2003; 289:194–202.*
4. *Morrissey C. Echo for diastology. Ann Card Aneasth.2016;19(Suppl 1): S12-S18. https://doi.org/10.4103/0971-9784.192585*
5. *Nagueh SF, Appleton CP, Gillebert TC,et al.Recommendationsfor the evaluation of left ventricular diastolic function by echocardiography. J Am Soc Echocardiorg. 2009;22(2):107-33.https://doi.org/10.1016/j.echo.2008.11.023*
6. *Mottram PM, Marwick TH. Assessment of diastolic function: what the general cardiologist needs to know. Heart.2005; 91:681-95. https://doi.org/10.1136/hrt.2003.029413*
7. *Casaclang-Verzosa G, Gersh BJ, Tsang TS. Structural and functional remodeling of the left atrium: clinical and therapeutic implications for atrial fibrillation. J Am Coll Cardiol. 2008; 51:1–11.*
8. *Kosiuk J, Belle YV, Bode K, et al. Left ventricular diastolicdysfunction in atrial fibrillation: predictors and relation with symptom severity. J Cardiovasc Electrophysiol. 2012;23(10):1073-7.*
9. *Kosiuk J, Buchta P, Gaspar T, et al. Prevalence and predictor of worsened left ventricular diastolic dysfunctionafter catheter ablation of atrial fibrillatrion. Intl J Cardiol. 2013;168(4):3613-15. https://doi.org/10.1016/j.ijcard.2013.05.047*
10. *Henein MY, Lindqvist P. Assessment of left ventricular diastolic function by doppler echocardiography. Cardia Fail Rev. 2015;1(2):87-9.*
11. *Kusunose K, Yamada H, Nishio S, et al. Clinical utility of single beat E/e' obtained by dual doppler echocardiographyin patients with atrial fibrillation with preserved systolic function. J Am Coll Cardiol Img. 2009; 2:1147-56.*

12. *Sohn DW, Song JM, Zo JH, et al. Mitral annular velocity inthe evaluation of left ventricular diastolic function in atrial fibrillation. J Am Soc Echocardiogr. 1999; 12:927-31.*
13. *Weiss JL, Frederiksen JW, Weisfeldt ML. Hemodynamicdeterminants of the time-course of fall in canine left ventricular pressure. J Clin Invest. 1976; 58:751-776.*
14. *Nagueh SF, Kopelen HA, Quinones MA. Assessment of left ventricular filling pressure by doppler in the presence of atrial fibrillation. Circ. 1996:94:2138-45.*
15. *Carej S, Raffa S, Zito C. Assessment of diastolic function in heart failure and atrial fibrillation. In: Guliza MM (eds) Emerging pathologies in cardiology. Springer, Milano:181-7.*
16. *Chirillo F, Brunazzi MC, Barbiero M, et al.Estimating MeanPulmonary Wedge Pressure in Patients With Chronic Atrial Fibrillation From Transthoracic Doppler Indexes of Mitral and Pulmonary Venous Flow Velocity. J Am Coll Cardiol. 1997;30(1):19-26.*
17. *Nagueh SF, Smiseth OA, Appleton CP, et al. Recommendations for the evaluation of left ventricular diastolic function by echocardiography: an update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. Eur Heart J Cardiovasc Imaging. 2016; 17:1321–1360.*