Original Article

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Echocardiographic assessment of Diastolic Function in patients with Atrial Fibrillation

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Abstract

Background and Aims: Echocardiographic assessment of left ventricular diastolic function in patients with atrial fibrillation is a challenge as loss of atrial kick (A wave), beat to beat variability and left atrium enlargement despite normal atrial pressure make usual guideline based estimation difficult and inaccurate. Hence adoption of additional echocardiography parameters are necessary which are tricky and have varied results. Hence the aim of this study was to study various aspects of diastolic function in patients with atrial fibrillation.

Methods: It was a hospital based prospective cross-sectional observational study conducted at cardiology unit, National Academy of Medical Sciences, Kathmandu and Shahid Gangalal National Heart Center, Kathmandu from 1st July 2018 to 30th June 2019.

Results: Total of 92 patients were studied. About one third (34.8%) 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 entity in patients with atrial fibrillation. Echocardiography parameters like E/e' ratio, isovolumetric relaxation time, E/Vp ratio and deceleration time of diastolic pulmonary wave were highly sensitive in detection of diastolic dysfunction.

Keywords: Atrial fibrillation, Diastolic dysfunction, Echocardiography.

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Introduction

Diastole is an input phase of heart[1] comprising of four stages i.e, iso-volumetric relaxation, rapid diastolic filling, diastasis, and atrial systole.[2,3] and diastolic dysfunction is defined as a continuum from isolated diastolic dysfunction to impaired relaxation with normal filling pressures to impaired filling (restrictive filling) with extremely elevated filling pressures[4,5]. In patient with Atrial Fibrillation (AF), assessment of diastolic function is a challenge as loss of organised atrial activity in AF vanishes mitral inflow A-wave. Loss of A-wave makes calculation of diastolic function by mitral inflow E/A ratio impossible. Simulataneously, beat to beat variation producing cycle length variability in atrial fibrillation warrants multiple measurements for accuracy. Therefore, an average of 5-10 beats or 3 consequitive beats calculations should be done. Meanwhile, in many instances patients with AF have left atrial enlargement irrespective of elevated filling pressure thus making measurement of various left atrial indices for diastolic function assessment partially incorrect. Thereupon, derivation of diastolic function in patients with AF should utilize all these secondary and/or additional echocardiography paramaeters[1].

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.

Current American Society of Echocardiography (ASE) guidelines focus on the following parameters for assessment of diastolic function in patients with AF[5].

Assessment of Lef Ventricular Diastolic Dysfucntion

Disease	Echocardiographic parameters and cut-off values
Atrial Fibrillation	Peak acceleration rate of mitral E velocity (≥1,900 cm/sec^2)
	IVRT (≤65 msec)
	DT of pulmonary venous diastolic velocity (≤220 msec)
	E/Vp ratio (≥ 1.4)
	Septal E/e' ratio (≥ 11)

Hence echocardiography derivation of LV diastolic function in patients with AF is tedious and tricky disabling us to use protocol based approach. In addition, not much similar studies are performed in our context. Thus rationale for this study is to justify effective echocardiography parameters to assess diastolic function. The objective of the study was to study various aspects of daistolic function in patients with atrial fibrillation.

Methods

It was a hospital based prospective cross-sectional observational study conducted at cardiology unit, National Academy of Medical Sciences (NAMS), Kathmandu and department of cardiology, Shahid Gangalal National Heart Center (SGNHC), Kathmandu, Nepal from 1st July 2018 to 30th June 2019 (1 year). A total of 92 patients were included in the study. Sample calculation was based on following equation:

Sample calculation:

$N= Z^2 x\ p\ x\ q/e^2$,	where, N = Sample Size
=3.84x37x63/100	p[7] = incidence of LV Dysfunction in AF patients = 37%
= 90	q=100-p=100-37=63
	Z= Confidence level at 95%= 1.96
	e = margin of error = 10%

Inclusion Criteria

1. Age ≥ 18 years
2. Atrial fibrillation
3. Normal Left Ventricular Ejection Fraction (LVEF) ie, LVEF ≥ 50% [8]
4. Patient giving consent for study

Exclusion Criteria

1. Paroxysmal atrial fibrillation
2. Arial fibrillation with fast ventricular response (HR >110/ min)
3. Atrioventcrivular Block or Left Bundle Branch Block
4. Pacemaker/ICD/ CRT in situ
5. Past h/o radio frequency ablation for atrial fibrillation
6. Previous Left atrial/ atrial appendage or mitral valve re pair or cardiac surgery
7. Severe mitral regurgitation
8. Mitral stenosis or mitral annular calcification
9. Prosthetic mitral valve
10. Wall motion abnormality

All consecutive patients attending above mentioned places of study based on inclusion criteria and during period of study were enrolled. 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 were accomplished[8]. Diastolic echocardiography parameters were also obtained as per ASE guidelines[5]. Diastolic dysfunction was labeled when three of more of the four given echocardiography parameters (cutoff values) were obtained from a single patient.

Formal permission for study was taken from subject committee, National Academy of Medical Science (NAMS). Written informed consent was taken from patient or their attendants.

Data were entered into work sheet (Microsoft Excel) and statistical analysis was done using IBM Statistical Package for Social Science (SPSS) software, version 20. 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 92 patients were enlisted for study. More than half were males (54.3%). Various atherosclerotic risk factors were present. Common were smoking (39.1%), hypertension (32.6%), chewing tobacco (18.5%), diabetes mellitus (7.6%), renal disease (4.3%), obesity (3.2%) and peripheral arterial disease (1.1%). About one third ie, 34.8% of the patients had diastolic dysfunction (Table 1).

Table 1: Baseline Characteristics

Variables	Value
Age (years), (mean ± SD)	61.07± 10.89
Gender	
Male	50
Female	42
Smoking	36
Tobacco Chewers	17
Hypertension	30
Diabetes Mellitus	7
Renal Disease	4
Peripheral Artery Disease	1
Obesity	3
Dyslipidemia	9
Left Ventricular Ejection Fraction (%), (mean ± SD)	63.6 ± 2.9
Left Ventricular Diastolic Dysfunction	32

Patients with diastolic dysfunction were slightly elderly and atherosclerotic risk factors have no clinical significant association in patient with left ventricular diastolic dysfunction (Table 2).

Table 2: Significance of Clinical Parameters

Variables	Diastolic dysfunction Present	Diastolic dysfunction Absent	p value
Age(year), (mean± SD)	63.37 ±11.30	59.83 ± 10.55	0.138
Gender			
Male	15	35	
Female	17	25	0.293
Smoking	14	22	0.507
Tobacco Chewer	6	11	0.961
HTN	10	20	0.839
DM	1	6	0.236
Renal Disease	2	2	0.514
Peripheral Artery Disease	0	1	0.463
Obesity	1	2	0.957
Dyslipidemia	3	6	0.923

Table 3: 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	<0.001
E/Vp Ratio	1.57 ± 0.14	1.20 ± 0.11	<0.001
DT of Pulmonary Diastolic wave	203.09 ± 26.13	292.25 ± 36.32	<0.001

All the echocardiography diastolic parameters used during the study had high sensitivity with highest being E/e' ratio (Table 3 and 4).

Table 4: 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%	< 0.001
E/Vp Ratio	27	84.4%	< 0.001
DT of Pulmonary Diastolic wave	25	78.1%	< 0.001

Discussion

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 patients play a vital role in prevalence of diastolic dysfunction. Similar findings were observed in different studies done by various authors[7,9]. A study done by Kosiuk J, et al found the prevalence of left ventricular diastolic dysfunction to be 38%[9]. As age is one of the main determinants for atrial fibrillation and diastolic dysfunction separately, elderly people are prone for both these abnormalities. Age related collagen deposition in the myocardium brings the physiological increase in filling pressure of the left ventricle. This results in increase in tendency for atrial fibrillation as well as dysregulation of diastolic function[7,10].

Various echocardiography parameters assess diastolic function of the heart that includes transmitral flow velocity, pulmonary venous flow velocity, mitral annular velocity, flow propagation velocity, left atrial size, strain, strain rate, and twist. However, clinically all of these parameters may not be feasible as in case of atrial fibrillation. [1]Hence only a few echocardiography parameters were used.

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]. In a study done by Nagueh SR and team, IVRT inversely correlated well with LV filling pressure in patients with atrial fibrillation[14]. Study done by Abudiab MM, et al depicted that IVRT had moderate sensitivity of 81% for high predicting diastolic dysfunction with raised filing pressure[15].

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]. In patients with abnormal left ventricular relaxation and elevated left ventricular end-diastolic pressure, filling flow propagation is rapidly attenuated in spite of the increased early transmitral velocity. Therefore, as the severity of diastolic dysfunction increases, E/Vp ratio also increases[16]. Oyama et al. found that a cut-off value of E/Vp of 1.7 was able to predict with acceptable accuracy the presence of diastolic dysfunction with high left atrial pressure in patients with AF[17].

The Deceleration Time (DT) of diastolic pulmonary venous wave in this study was traced to be 203.09 ± 26.13ms with a sensitivity of 78.1%. This blunted response was synchronous with other studies. Chirillo F, et al. in their study showed negative correlation of DT with increase in left atrial pressure. Calculated DT >220ms predicted normal left atrial pressure with 100% sensitivity[18].

With small sample size, the results of this study cannot be generalized. Selection bias while patient enrollment may have come in play.

Conclusion

Left ventricular diastolic dysfunction is common in patients with atrial fibrillation. Echocardiography parameters like E/e' ratio, isovolumetric relaxation time, E/Vp ratio and deceleration time of diastolic pulmonary wave were highly sensitive in detection of diastolic dysfunction.

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