

## Left Ventricular Diastolic Dysfunction in South Indian Essential Hypertensive Patient

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### ABSTRACT

**Background:** It is well known that hypertension is an important cause for diastolic dysfunction. Hence we aimed to evaluate the application of Doppler echocardiography in determining left ventricular diastolic dysfunction in patients with essential hypertension. **Methodology:** Present study is based on analysis of 60 (33 males, 27 females) patients of essential hypertension coming to outpatient department and admitted to S.S.Hospital attached to S.S.Institute of Medical sciences, and Research Centre Davanagere, during January 2013 to December 2013. 60 age and sex matched controls were analysed for diastolic function. Detailed history and physical examination was done. Cases and Controls were subjected to ECG, CXR, USG abdomen, routine investigations and Doppler Echocardiography. **Results:** A total of 60 patients were studied. 24 patients showed diastolic dysfunction with E/A ratio  $<1$ , with increased atrial filling fraction. Out of 24 (males 15, female 9) patients 15 showed LVH. Out of 36 patients with normal diastolic function (E/A  $\geq 1$ ) 9 had LVH. There was significant difference in various diastolic filling parameters in cases with diastolic dysfunction compared to cases with normal diastolic function. **Conclusion:** Our findings suggest that myocardial damage in patients with essential HTN affects diastolic dysfunction before systolic dysfunction. LVH was significantly associated with diastolic dysfunction. There was significant difference in various diastolic filling parameters in cases with diastolic dysfunction compared to cases with normal diastolic function.

**Key words:** Doppler echocardiography; essential hypertension; diastolic dysfunction; congestive heart failure

### INTRODUCTION

Cardiovascular diseases (CVDs) are the most prevalent cause of death and disability worldwide. This is true for developed countries as well as developing countries like India which are expected to face a phenomenal increase in the burden of chronic diseases in the near future. Hypertension remains the most common, readily identifiable and reversible risk factor for myocardial infarction, stroke, heart failure, atrial fibrillation, aortic dissection and peripheral arterial disease. Because of escalating obesity and population aging in developed and developing countries the global burden of hypertension is rising and projected to affect 1.5 billion persons, one third of the world's population, by the year 2025. Thus hypertension remains the leading causes of death worldwide and one of the world's great public health problems<sup>1</sup>. Hypertension is highly prevalent in India. Several regional small surveys in last two decades with varying protocols have reported a prevalence which varies from 6.15% to 36.36% in men and 2% to 39.4% in women in urban areas and 3 to 36% in men and 5.80%

to 37.2% in women in rural areas<sup>2</sup>. Recent studies give an idea about its increasing prevalence attributable to rapid alteration of lifestyle in developing countries like India.

The assessment of cardiac performance has focused traditionally on systolic function, where as diastole was considered of secondary importance. However diastolic function has also been found to play an important role in cardiac morbidity and mortality of heart failure patients and to influence both preload and afterload<sup>3</sup>. Several clinical studies have reported that 30% to 50% of patients with congestive heart failure have preserved left ventricular systolic function and isolated diastolic dysfunction, i.e. isolated diastolic heart failure<sup>4-6</sup>. Preliminary data from Framingham study indicate that hypertension is the most common underlying cardiovascular disease in patients with isolated diastolic heart failure. Hypertension is postulated to impair diastolic function via multiple mechanisms even without impairment of systolic function<sup>7,8</sup>. This has important therapeutic implications, can also help physicians for planning, early intervention strategies. Thus diastolic dysfunction can be used as an early indicator, as it is a precursor to increased left ventricular mass, left ventricular hypertrophy and clinical left ventricular failure. Although intraventricular pressure and volume measurements are still most widely used for the assessment of diastolic function, a number of noninvasive techniques have been used for the clinical assessment of diastolic function in patients with coronary, valvular, hypertensive or myocardial heart disease. Doppler echocardiography is frequently used to assess diastolic function in humans<sup>3</sup>. The current study was designed to assess the diastolic dysfunction in patients with essential hypertension with preserved left ventricular function by Doppler echocardiography.

## **MATERIALS AND METHODS**

### **STUDY DESIGN**

This was a prospective cross sectional study where hypertensive patients attending the out-patient department, and admitted to various wards of S.S. Hospital attached to S.S. Institute of Medical Sciences and research centre Davanagere, Karnataka, India were selected randomly for enrollment into the study, after consideration of inclusion and exclusion criteria. A detailed history was taken, clinical examination and investigations performed as per proforma.

**STUDY SUBJECTS:** A total of 60 patients diagnosed to have Essential hypertension with preserved systolic function (EF > 50%) were studied from January 2013 to December 2013. Total of 60 age and sex matched Controls were enrolled in the study to obtain the normal diastolic parameters. Informed consent was taken from all the study subjects. In both cases and controls, investigations were done in the clinical biochemistry laboratory of S.S.Hospital, Daanagere. Echocardiographic studies were performed by a qualified cardiologist.

**INCLUSION CRITERIA:** Patients above 18 years of age who are ambulatory and asymptomatic patients diagnosed with essential hypertension.

**EXCLUSION CRITERIA:** Patients with cardiovascular pathology like ischemic heart disease, congestive heart failure, valvular heart disease, congenital heart disease, atrial fibrillation, BP > 200/120 mmHg and Patients with diabetes mellitus, renal disease, secondary hypertension.

### **METHODOLOGY:**

A detailed clinical history of subjects was taken as per proforma (Annexure I & II). Each subject underwent a detailed physical examination & systemic examination. A standard 12 lead ECG was recorded in all subjects to look for any abnormalities. Routine hematological and biochemical investigations including, hemoglobin

concentration, blood sugars, blood urea and serum creatinine, lipid profile were done. USG abdomen and chest X-ray were done to rule out any abnormality.

**STATISTICAL METHODS:**

The statistical software namely MICROSOFT EXCEL 2007, MEDCALC and GENSTAT version 9.0 were used for the analysis of data and Microsoft Word and Excel have been used to generate graphs, tables etc.

**OBSERVATION AND RESULTS**

**Table 1. Echo parameters of cases and controls**

Echo parameters	Cases (n=60) Mean ± SD	Controls (n=60) Mean ± SD
EF %	61.32±4.02	63.18±3.33
LVIDS (cms)	29.28±2.44	31.17±2.74
LVIDD (cms)	47.08±3.80	50.42±2.54

EF: ejection fraction

LVIDS: left ventricular internal diameter systolic.

LVIDD: left ventricular internal diameter diastolic.

LVIDS and LVIDD were lower in cases compared to controls. Ejection fraction was normal (>50%) in both cases and controls (Table 9).

**Table 2. Comparison of E/A ratio of cases and controls**

E/A ratio	Cases (n=60)	Controls (n=60)	P value	significance
Range	0.65-1.53	1.08-1.61	<0.001	HS
Mean ± SD	1.11±0.29	1.34±0.12		

HS:Highly Significant.The E/A ratio ranged from 0.65 to 1.53 in cases with a mean of 1.11±0.29. In controls E/A ratio ranged from 1.08 to 1.61 with mean of 1.34±0.12. E/A ratio was significantly lesser in cases, when compared to controls (p=<0.001) (Table 11).

**Table 3. Comparison of Atrial filling fraction ie VTIA/VTIM ratio of cases and controls**

VTIA/VTIM ratio	Cases (n=60)	Controls (n=60)	P value	significance
Range	0.26-0.46	0.2-0.29	<0.001	HS
Mean ± SD	0.35±0.06	0.23±0.02		

HS: Highly Significant. The VTIA/VTIM ratio ranged from 0.26 to 0.46 in cases with a mean of  $0.35 \pm 0.06$ . In controls VTIA/VTIM ratio ranged from 0.2 to 0.29 with mean of  $0.23 \pm 0.02$ . Atrial filling fraction was significantly greater in cases, when compared to controls ( $p < 0.001$ ) (Table 12).

### ASSESSMENT OF DIASTOLIC DYSFUNCTION IN CASES

A total of 60 patients with essential hypertension were evaluated for diastolic function of LV by Doppler echocardiography. E/A ratio  $\geq 1$ , is taken as having normal diastolic function. E/A ratio  $< 1$ , is taken as having diastolic dysfunction. Accordingly various echocardiographic parameters are compared in both the groups.

**Table 4. Diastolic dysfunction defined by E/A ratio in cases**

Diastolic function defined by E/A ratio	Number (n=60)	%
Normal	36	60.0
DD	24	40.0

Normal- E/A ratio  $\geq 1$ , DD- E/A ratio  $< 1$ .

**Table 5. Age distributions of cases with DD defined by E/A ratio.**

Age	Normal	%	DD	%
25-35	4	11.11	1	4.1
36-45	8	22.22	4	16.6
46-55	12	33.34	8	33.4
56-65	8	22.22	8	33.4
66-75	4	11.11	3	12.5
Total	36	100	24	100
Mean+/- SD	51.17 $\pm$ 10.95		56.46 $\pm$ 9.58	

P=0.0591 Not Significant

In our study, patients with hypertension were in the age ranging from 30-90 years, with mean age of 51 years in normal group and 56 years in DD group. Age groups were comparable. There was no significant difference among the two groups.

**TABLE 6. Correlation of LVH and Diastolic Dysfunction**

LVH	Normal	DD	X <sup>2</sup> *Value	Significance
Present	9 (25%)	15 (63%)	8.43	P=0.0037 Significant
Absent	27 (75%)	9 (37%)		

X<sup>2</sup> test Chi square test

There were 24 (40%) patients with LVH in study group. 15(63%) in DD group and 9(25%) in normal group. LVH is significantly associated with LVH(p=0.003).

**Table 7. Correlation of Systolic blood pressure with diastolic function( defined by E/A ratio).**

Systolic BP in mm Hg	Normal (n=36)	DD (n=24)	P value	Significance
≤ 140	4(11.11%)	0	.91	NS
141-150	13(36.11%)	6 (25%)	.365	NS
151-160	11(30.55%)	8 (33.33%)	.821	NS
> 160	8(22.22%)	10 (41.66%)	.107	NS

In normal group 66.66% patients had systolic BP of 141-160 mm Hg. In DD group 42% patients had systolic BP of >160 mm Hg. There is no significant association of systolic BP with DD.

**Table 8. Correlation of diastolic blood pressure with diastolic function (defined by E/A ratio)**

Diastolic BP in mm Hg	Normal (n=36)	DD (n=24)	p value	Significance
<80	8(22.2%)	2 (8%)	0.157	NS
80-90	10(27.8%)	10(42%)	1	NS
>90	18(50%)	12(50%)	1	NS

Most patients i.e 50% had diastolic BP > 90 mm Hg, both in DD and Normal group. There is no significant association diastolic BP with DD.

**Table 9. Correlation of Diastolic function (defined by E/A ratio) with duration of hypertension**

Duration of hypertension	Normal (n=36)	DD (n=24)	p value	Significance
≤ 1 yr	10 (27.8%)	4 (16.7%)	.319	NS
1-3 yr	11(30.5%)	6 (25%)	.640	NS
>3 yr	15(41.7%)	14 (58.3%)	.206	NS

15 (41.7%) patients in normal group and 14(58.3%) patients in DD group had HTN for more than 3 years duration. Duration of HTN is not significantly associated with DD.

**Table 10. Doppler echocardiographic indices of the patients with essential hypertension in normal and DD groups (mean±sd).**

Echo Doppler Index	Normal (n=36)	DD (n=24)	P value	Significance
E-v (cm/sec)	77.89±6.71	64.21±4.76	P<0.001	HS
A-v (cm/sec)	58.75±7.17	82.5±5.88	P<0.001	HS
E/A Ratio	1.33±0.10	0.78±0.08	P<0.001	HS
VTIA (cm)	4.07±0.53	5.88±0.87	P<0.001	HS
VTIM (cm)	12.93±1.25	14.14±1.08	P<0.001	HS
VTIA/VTIM	0.31±0.02	0.41±0.04	P<0.001	HS
LVIDd (mm)	47.83±3.40	45.96±4.15	P>0.05	NS
LVIDs (mm)	29.58±2.27	28.83±2.65	P>0.05	NS
EF%	63.03±3.37	58.75±3.58	P<0.001	HS
IVRT (m sec)	81.64±5.37	116.08±8.61	P<0.001	HS

\*Student's Unpaired t Test.. S =Significant, HS= Highly Significant, NS=Not Significant

E-velocity (cm/sec) was decreased in DD group compared to normal group (64.21 ± 4.76 Vs 77.89 ± 6.71) P value was highly significant P<0.001 A-velocity (cm/sec) was increased in DD group compared to normal group. Data was highly significant. P<0.001 (82.5 ± 5.88 Vs 58.75 ± 7.17). E/A Ratio – was reduced in DD group compared to normal group (0.78 ± 0.08 Vs 1.33 ± 0.10). Data was highly significant. P<0.001.

- VITA (cms) was increased in DD group compared to normal group ( $5.88 \pm 0.87$  Vs  $4.07 \pm 0.53$ ). Data was highly significant.  $P < 0.001$ .
- VITM (cms) was increased in DD group compared to normal group ( $14.14 \pm 1.08$  Vs  $12.93 \pm 1.25$ ). Data was highly significant.  $P < 0.001$ .
- VITA / VTIM ratio was increased in DD group compared to normal group ( $0.41 \pm 0.04$  Vs  $0.31 \pm 0.02$ ). Data was highly significant.  $P < 0.001$ .
- LVIDd (mm) did not change in our DD group compared to normal group ( $45.96 \pm 4.15$  Vs  $47.83 \pm 3.40$ ). Data was not significant.  $P > 0.05$ .
- LVIDs (mm) did not change in the DD group compared to normal group. Data was not significant.  $P > 0.05$ .
- Ejection fraction was lesser in DD group compared to normal group ( $58.75 \pm 3.58$  Vs  $63.03 \pm 3.37$ ). Data was highly significant.  $P < 0.001$ .
- IVRT(m sec) is increased in DD group compared to normal group ( $116.08 \pm 8.61$  vs  $81.64 \pm 5.37$ ). Data was highly significant.  $P < 0.001$ .
- Analysis of Data shows that diastolic filling abnormalities are common in patients with impaired relaxation, than in patients with normal relaxation.

**TABLE 11. COMPARISON OF E/A RATIO (HTN WITH DD)**

Echodoppler Index	Present study Measurements	Rovner et al.
E-Velocity	$64.21 \pm 4.76$	$75.0 \pm 21.0$
A-Velocity	$82.50 \pm 5.88$	$69.0 \pm 20.0$
E/A Ratio	$0.78 \pm 0.08$	$1.1 \pm 0.5$

- E/A ratio was reduced in the present study suggesting increased late mitral flow.

**ATRIAL FILLING FRACTION:**

Atrial filling fraction in primary hypertension is not compared with the above-mentioned study, as the authors did not elucidate the same. So atrial filling fraction measurement of present study is compared with that of the Framingham heart study.

**TABLE 12. COMPARISON OF ATRIAL FILLING FRACTION (HTN WITH DD):**

Echo doppler Index	Present study	Framingham Heart Study
Atrial filling fraction	$0.41 \pm 0.04$	$0.31 \pm 0.08$

Atrial filling fraction in our study group is higher implying that atrial contribution to ventricular filling was higher which is due to decrease in the ventricular compliance.

**TABLE 13.COMPARISON OF ISOVOLUMETRIC RELAXATION TIME (HTN WITH DD)**

<b>Echodoppler Index</b>	<b>Present study</b>	<b>Rovner et al.</b>
Isovolumic relaxation time	116.08 ± 8.61	112.0 ± 29.0

Isovolumetric relaxation time of present study is increased and is similar to the findings of Rovner et al.<sup>9</sup>

### **DISCUSSION AND CONCLUSION**

Our findings suggest that myocardial damage in patients with essential HTN affects diastolic dysfunction before systolic dysfunction. LVH was significantly associated with diastolic dysfunction. There was significant difference in various diastolic filling parameters in cases with diastolic dysfunction compared to cases with normal diastolic function. There was no association of diastolic dysfunction with sex, systolic BP, diastolic BP and duration of hypertension. Doppler echocardiography is a valuable noninvasive method to detect left ventricular diastolic impairment and the intentional assessment of diastolic function is advisable for early detection of LV dysfunction before clinical symptoms appear.

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