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## Study of left ventricular diastolic dysfunction in primary hypertension-evaluation by Doppler echocardiography at aims rural hospital

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#### Abstract

**Background:** There is growing recognition that congestive heart failure caused by a Predominant abnormality in diastolic function is both common and causes significant morbidity and mortality. Hence we aimed to evaluate the application of Doppler echocardiography in determining left ventricular diastolic dysfunction in primary hypertension.

#### Objectives:

- 1) To evaluate Doppler echocardiography in determining left ventricular diastolic dysfunction (DD) in essential hypertension.
- 2) To evaluate left ventricular diastolic dysfunction in essential hypertension.
- 3) To find out early left ventricular diastolic dysfunction in essential hypertension.

**Methodology:** Present study is based on analysis of 75 patients of hypertension admitted to Adichunchanagiri Hospital and research centre from November 2012 to September 2014. Detailed history and physical examination was done. Every patient was subjected to ECG, CXR, routine investigations and Doppler Echo cardiography.

**Results:** A total of 75 patients were studied. 37 patients showed diastolic dysfunction with E/A ratio  $<1$ , with increased atrial filling fraction. Out of 37 patients, 24 showed LVH and 13 cases did not had LVH.

**Conclusion:** Study suggests that, in the early stages of hypertensive heart disease, before there is a detectable increase in left ventricular chamber size. Duration of hypertension and diastolic hypertension are also important determinants of abnormal diastolic function.

**Keywords:** Doppler echocardiography, primary hypertension, Diastolic dysfunction.

#### Introduction

Cardiovascular diseases (CVDs) are the most common 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 like coronary artery disease in the near future.

Hypertension is highly prevalent in Asian countries mainly India. Recent studies give an idea about its increasing prevalence attributable to rapid alteration of lifestyle in developing countries like India and Nepal and the neighboring south East Asian countries. Studies showed that more than a quarter of world's population had hypertension in 2000, and this proportion would increase to 29% by 2025. Men and women had similar overall prevalence of hypertension, and the prevalence increased with age consistently all over the world. Studies also negate the impact of affluence and family size and suggest that hypertension is equally prevalent in rich and poor.<sup>1</sup>

#### Objectives

1. To evaluate Doppler echocardiography in determining left ventricular diastolic dysfunction (DD) in essential hypertension.
2. To evaluate left ventricular diastolic dysfunction in essential hypertension.
3. To find out early left ventricular diastolic dysfunction in essential hypertension.

**Methodology**

**Source of Data:** The subjects are recruited from rural patients admitted to our rural hospital in ICCU under Medicine Department, at Adichunchangiri Hospital and Research Centre, B.G. Nagara, Mandya.

**Type of study:** Descriptive study

**Study Period:** November 2012 to September 2014.

**Sample Size:** 75

**Sampling Technique:** Non probability purposive sampling

Detailed history and physical examination was done. Patients with hypertension without DD were taken as controls. All patients were subjected to color Doppler echocardiographic examination.

**Inclusion Criteria**

- Patients >18 years of age
- Patients with primary hypertension

**Exclusion Criteria**

- Patients with renal disease, diabetes mellitus, secondary hypertension.

**All those included for study were subjected to;**

- M-Mode left ventricular study
- Transmitral Doppler echocardiographic study of left ventricular inflow pattern.
- Combined study of Doppler echocardiography and phonocardiography to measure isovolumetric relaxation time.

Following doppler echocardiographic indices of left ventricular function were measured.

**Doppler Study**

- Peak velocity of early mitral flow – E - velocity cm/sec.
- Peak velocity of late mitral flow – A - velocity cm/sec.
- E/A ratio
- Velocity time integral of total diastolic flow (VTIM – cms)
- Velocity time integral of atrial wave (VITA – cms)
- Atrial filling fraction (VTIA / VTIM ratio)
- Isovolumetric relaxation time (IRT in msec)

**M-Mode Left Ventricular Study**

- LVIDs (mm)
- LVIDd (mm)
- Ejection Fraction =  $(LVIDd3 - LVIDs3 / LVIDd3) \times 100$

All the patients were subjected to detailed clinical examination routine hematological and biochemical examination, FBS, urea, creatinine, SGOT, LDH, CPK, serum cholesterol, urine examination, ECG, CXR (PA View).

**Statistical Method**

Data was entered in excel format and analyzed using Epi-Info software. Descriptive statistics like frequencies and percentages were calculated. Continuous data are expressed as mean±SD and between groups are compared with unpaired student ‘t’ test. P<0.05 was significant.

**Results**

75 patients with primary hypertension admitted in Adichunchangiri hospital and research centre, attached to Sri Adichunchangiri Institute of Medical Sciences, B.G.Nagara, during November 2012 to September 2014 were analyzed.

**Table 1:** Age Distribution of study subjects

Age	Normal	%	DD	%
30-39	1	3	1	3
40-49	5	13	4	11
50-59	11	29	8	22
60-69	11	29	13	35
70-79	7	18	9	24
80-89	3	8	2	5
Total	38		37	
Mean + SD	59.76 + 11.74		62.86 + 11.56	

In our study, patients with hypertension were in the age ranging from 30-90 years, with mean age of 60 years in control group and 63 years in study group.

**Table 2:** Gender Distribution of study subjects

Sex	Normal	DD
Male	24 (63)	29 (78)
Female	14 (37)	8 (22)

There were 29 (78%) males and 8 (22%) females in the study groups. Among the study group 24 patients had LVH and 13 patients did not have LVH.

**Table 3:** Duration of Hypertension and Presence of Diastolic Dysfunction.

Duration of HTN	No of Cases	With DD	Without DD	Mean Duration
Upto 1 Year	32	9	22	0.9±0.67
Upto 2 Year	15	9	6	1.6±0.46
Upto 3 Years	13	8	5	2.6±2.1
Upto 4 Years	6	6	0	4.0±1.6
Upto 5 Years And More	9	6	3	5.7±6.1
chi-square = 13.7; degrees of freedom = 8; p value = 0.034				

Patients with a duration of essential hypertension up to 2 years had 60% (n=9) patients with presence of diastolic dysfunction in our study group and 40% (n=6) patients with absent diastolic dysfunction in our control group. Patients with essential hypertension up to 3 years had 61.5% (n=8) patients with presence of diastolic dysfunction in our study group and 39% (n=5) patients with absent diastolic

dysfunction in our control group. Patients with essential hypertension with a duration of upto 4 years had 100% (n=6) diastolic dysfunction in our study group, followed by patients with essential hypertension with 5 years and more wherein 66.6% (n=6) had presence of diastolic dysfunction in our study group.

**Table 4:** Doppler Echocardiographic Indices of the Patients with Primary Hypertension and Controls (Mean ± SD)

Echo Doppler Index	Normal (n=38)	DD (n=37)	t* Value	p Value
E-v (cm/sec)	64.53 + 7.59	60.05 + 5.99	2.82	P < 0.01
A-v (cm/sec)	52.89 + 9.86	73.81 + 6.29	10.91	P < 0.001
E/A Ratio	1.25 + 0.27	0.82 + 0.07	9.69	P < 0.001
VTIA (cm)	5.06 + 2.11	6.12 + 1.57	2.46	P < 0.05
VTIM (cm)	13.70 + 3.04	14.32 + 2.10	1.03	P > 0.05
VITA/VITM	0.35 + 0.10	0.42 + 0.09	3.52	P < 0.001
LVIDd (mm)	43.16 + 5.95	43.03 + 6.26	0.09	P > 0.05
LVIDs (mm)	30.55 + 3.67	30.62 + 5.17	0.06	P > 0.05
EF%	63.39 + 6.01	59.81 + 5.73	2.64	P < 0.05
IRT (m sec)	77.08 + 10.45	114.16 + 17.02	11.40	P < 0.001

The left ventricular filling studies by Doppler echocardiography done in study and control population were analyzed and the results are as follows.

E-velocity (cm/sec) was reduced in study group compared to control group (60.05±5.99 V/s 64.53 ± 7.59). Data was significant P<0.01. A-velocity (cms/sec) was increased in study group compared to control (73.8±6.29 V/s 52.89±9.86). Data was highly significant. P<0.001. E/A ratio were reduced in study group compared to controls (0.82±0.07 V/s 1.25± 0.27). Data was highly significant. P<0.001. VTIA (cms) was slightly increased in study group compared to control (6.12 ± 1.57 V/s 5.06 ± 2.11). Data was

significant. P<0.05. VTIM (cms) was slightly increased in study group compared to controls (14.32 ± 2.1 V/s 13.7 ± 3.04). Data was not significant. P>0.05. VTIA/VTIM ratio was increased in study group compared to controls (0.42 ± 0.09). Data was highly significant. P<0.001. LVIDd (mm) did not change in the study group compared to controls. P>0.05. Data was not significant. LVIDs (mm) did not change in the study group compared to controls. P value was not significant. Ejection fraction percentage in study group was decreased compared to controls. (59.81 ± 5.73 Vs 63.39 ± 6.01) Data was significant. P<0.05.

**Table 5:** Association of Systolic Blood Pressure and Presence of Diastolic Dysfunction

Systolic BP (mm of Hg)	No of Cases	With Diastolic Dysfunction	Without Diastolic Dysfunction	Mean±SD
130-139	17	2	15	134±1.68
140-149	14	5	9	144±9.26
150-159	9	7	2	150±18.6
160-169	14	8	6	160±12.9
170-179	9	6	3	170±5.65
>180	12	9	3	180±24.6
chi-square = 18.1 degrees of freedom = 5 ;p value = 0.003				

In this study diastolic dysfunction was more prevalent in the systolic blood pressure group of 150± 18.6 mm Hg group with 77%(n=7) had diastolic dysfunction in the study group and 23%(n=2) had no diastolic dysfunction in our control group. Diastolic dysfunction in group where systolic blood pressure > 180 mm Hg , 75%(n=9) had diastolic dysfunction and 25%(n=3) had no diastolic dysfunction in the control group followed by 170-179 mm Hg group wherein 66% (n=6) had diastolic dysfunction in the study group and 34% (n=3) had absent diastolic dysfunction in the control group, and followed by 160-169 mm Hg group, wherein 57% (n=8) had diastolic dysfunction in study group and 43% (n=6) had absent diastolic dysfunction in the control group. The following comparative values has a significant.

**Table 6:** Association of Diastolic Blood Pressure and Presence of Diastolic Dysfunction

Diastolic BP (mm of Hg)	No of Cases	With Diastolic Dysfunction	Without Diastolic Dysfunction	Mean±S.D
70-79	3	1	2	75.8±8.36
80-89	14	2	12	85.8±13.6
90-99	34	18	16	92.6±16.2
100-109	21	15	16	101±13.4
>110	3	1	2	110±1.54

Chi-square = 9.36; degrees of freedom = 4; p value = 0.048

In this study diastolic dysfunction was more prevalent with a diastolic blood pressure in the mean range of 92.6±16.2

mmHg, wherein 52.9% (n=18) had presence of diastolic dysfunction in our study group and 47% (n=16) had absent diastolic dysfunction in our control group. The following correlative analysis had a significant.

**Table 7:** Presence of ECG Wise Left Ventricular Hypertrophy and Presence of DD

	ECG Wise Left Ventricular Hypertrophy(N)	Normal ECG(N)
With DD	24	14
Without DD	13	24

Degrees of freedom = 1; p value = 0.015

In our present study, regarding association of ECG wise left ventricular hypertrophy and normal ECG with presence of diastolic dysfunction showed a more positive correlation in the group comprising ECG wise left ventricular hypertrophy wherein 63.1%(n=24) had diastolic dysfunction in our study group and 27%(n=14) had absent diastolic dysfunction in our control group. In patients with Normal ECG and sinus rhythm only 35% (n=13) had presence of diastolic dysfunction in our study group whereas 65% (n=24) had absent diastolic dysfunction in our control group. Therefore ECG wise LVH was a more significant indicator of diastolic dysfunction with a significant p value.

**Table 8:** Association of Systolic Blood Pressure with Presence of LVH and Presence of Diastolic Dysfunction

Systolic BP (mm of hg)	Left Ventricular Hypertrophy	With Diastolic Dysfunction	Without Diastolic Dysfunction	Mean±S.D
130-139	2	0	2	132±0.16
140-149	3	1	2	146.5±2.4
150-159	6	5	1	152±3.26
160-169	11	8	3	160±12.4
170-179	3	3	0	174±3.68
>180	6	5	1	180±2.6

Chi-square = 9.09; degrees of freedom = 6; p value= 0.0424

In our present study an association of systolic blood pressure with presence of ECG wise LVH and presence of diastolic dysfunction was carried out wherein diastolic dysfunction was more prevalent in the group with mean systolic blood

pressure of 160±12.4, wherein 72%(n=8) had diastolic dysfunction in our study group and 28%(n=3) had absent diastolic dysfunction in our control group.

**Table 9:** Association of Systolic Blood Pressure with Normal ECG and Presence of Diastolic Dysfunction

Systolic BP (mm of Hg)	Normal ECG	With Diastolic Dysfunction	Without Diastolic Dysfunction	Mean±S.D
130-139	14	1	13	130±16.4
140-149	5	3	2	143±2.64
150-159	3	2	1	150±3.64
160-169	3	1	2	163±2.64
170-179	5	3	2	170±0.62
>180	6	3	3	180±2.66

Chi-square = 9.29; degrees of freedom = 6; p value = 0.0486

ECG with sinus rhythm and presence of diastolic dysfunction, revealed that in the group with a mean systolic blood pressure of 143±2.64 mmHg 60% (n=3) has presence of diastolic dysfunction in our study group and 40% (n=2) had absent diastolic dysfunction in our control group. In the group with a mean systolic blood pressure of 150±3.64 mmHg, 66% (n=2) has presence of diastolic dysfunction in our study group and 34% (n=1) had absent diastolic dysfunction in our control group. In the group with a mean systolic blood pressure of 170±0.62mmHg, 60% (n=3) has presence of diastolic dysfunction in our study group and 40% (n=2) had absent diastolic dysfunction in our control group. In our present study an association was tried to be made out between levels of total cholesterol, which is a main factor of

dyslipidaemia and presence of diastolic dysfunction was found out that total cholesterol less than 200 had 51.6%(n=32) with presence of diastolic dysfunction in our study group and 49%(n=30) had absent diastolic dysfunction in our control group.

**Table 10:** Total Cholesterol and Presence of Diastolic Dysfunction

Total Cholesterol	No Of Cases	With DD	Without DD
150-200	62	32	30
201-240	13	6	7
>240	0	0	0

Chi-square = 0.128; degrees of freedom = 2; p value = 0.938

**Discussion**

**Table 11:** Comparison of E/A Ratio

Echodoppler Index	Rovner <i>et al.</i> , [2]	Schillaci <i>et al.</i> [3]	Akintunde <i>et al.</i> [4]	Present Study Measurements
E-Velocity	75.0 + 21.0	56±0.14	68.22±19.70	60.05 + 5.99
A-Velocity	69.0 + 20.0	71±0.16	62.24±17.01	73.81 + 6.29
E/A Ratio	1.1 + 0.50	0.82±0.23	1.24±0.31	0.82 + 0.07

E/A ratio was reduced in the present study because suggesting increased late mitral flow. The E/A ratio in our study was 0.82±0.07, hence was more significant with the study conducted by Schillaci *et al.* wherein the E/A ratio was 0.82±0.23.

**Atrial Filling Fraction**

Atrial filling fraction in primary hypertension is not compared with the abovementioned 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

Echo Doppler Index	Framingham Heart Study [5]	Azad Akkoc <i>et al.</i> [6]	Watchtell <i>et al.</i> [7]	Present Study
Atrial Filling Fraction	0.31 + 0.08	0.53±0.07	0.43±0.10	0.42 + 0.09

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, wherein in

this study the atrial filling fraction was 0.42±0.09, which was much comparable with a study conducted by Watchtell *et al.* Al, wherein the atrial filling fraction was 0.43±0.10.

**Table 13:** Comparison of Isovolumetric Relaxation Time

Echo Doppler Index	Rovner <i>et al.</i> [2]	Dambrauskaite <i>et al.</i> [8]	N.H. Andersen <i>et al.</i> [9]	Present Study
Isovolumic Relaxation Time	112.0 + 29.0	121±44	93±20	114.16 + 17.02

Isovolumetric relaxation time of present study is increased and is similar to the findings of Rovner *et al.*

**Table 14:** Comparison of Systolic Blood Pressure and Presence of Diastolic Dysfunction

	Z.Guan <i>et al.</i> [10]	De Simone <i>et al.</i> [11]	Wachtell <i>et al.</i> [7]	Present study
Systolic blood pressure(mmHg)	145.7±26.2	154±17	150±19	150±18.6
P value	0.028	<0.001	<0.001	0.003

The present study was compared with an association study comparing systolic blood pressure and diastolic dysfunction on 91 essential hypertensive patients, found a significant correlation. Hence when compared with the other study, conducted by Zuan Et.al, and Watchell *et al.* the presence of

diastolic dysfunction was significant in the systolic Blood pressure group of 150±18.6 mmHg compared with other study wherein its more prevalent in the group of 145.7±26.2 mmHg and 150± 19 mmHg with a significant p value (<0.003), hence the results are statistically significant.

**Table 15:** Comparison of Diastolic Blood Pressure and Presence of Diastolic Dysfunction

	Z. Guan <i>et al.</i> [10]	De Simone <i>et al.</i> [11]	Wachtell <i>et al.</i> [7]	Present study
Diastolic blood pressure(mmHg)	92.3±17.2	96.2±17	94.3±19	92.6±16.2
P value	0.048	0.045	<0.001	<0.001

The present study was compared with an association study comparing diastolic blood pressure and diastolic dysfunction on 91 essential hypertensive patients, found a significant correlation Hence when compared with the other study, conducted by Zuan Et.al, the presence of diastolic

dysfunction was significant in the diastolic blood pressure group of 92.6±16.2 mmHg compared with other study wherein its more prevalent in the group of 92.3±17.2 mmHg, with a significant p value(0.048), hence the results are statistically significant.

**Table 16:** Comparison of ECG Wise Left Ventricular Hypertrophy and Presence of Diastolic Dysfunction

	Schlegel <i>et al.</i> [12]	Dambrauskaite <i>et al.</i> [8]	N. H. Andersen <i>et al.</i> [9]	Present study(N)
ECG Wise Left Ventricular Hypertrophy And Presence Of Diastolic Dysfunction	36	44	30	24
P value	P<0.05	P=0.035	P=0.023	P=0.015

A study conducted by Schlegel et.al and N.H Anderson *et al.* assessing the usage of conventional 12 lead ECG in determining and detection and screening of coronary artery disease, hypertension and left ventricular dysfunction had

shown a significant correlation with multivariate analysis, henceforth had yielded a p value (<0.05) and p value of (0.023) which was statistically significant and well correlated with our study.

**Table 17:** Comparison of Systolic Blood Pressure and ECG Wise Left Ventricular Hypertrophy and Presence of Diastolic Dysfunction

	Pavlopoulos <i>et al.</i> [13]	De Simone <i>et al.</i> [11]	Wachtell <i>et al.</i> [7]	Present study
Systolic blood pressure(mmHg)	162±12.64	154±17	150±19	160±12.4
ECG WISE LVH	N=30	N=45	N=58	N=8
P VALUE	<0.05	<0.001	<0.001	<0.05

Our study was compared with a study conducted by Pavlopoulos Et.al wherein Systolic blood pressure in the range of 162±12.64 was associated with presence of ECG

wise left ventricular hypertrophy and presence of diastolic dysfunction with a p value(<0.05).

**Table 18:** Comparison of Systolic Blood Pressure with Normal ECG and Presence of Diastolic Dysfunction

	Thomas <i>et al.</i> [14] (N)	De Simone <i>et al.</i> [11] (N)	Wachtell <i>et al.</i> [7] (N)	Present study
Systolic hypertension + normal ECG	N= 16	N= 23	N=5	N=3
P value	0.014	0.026	0.045	<0.05

Our study was compared with a study conducted by Thomas Et.al on 225 consecutive patients with hypertension determining utility of clinical tools, physical examination, and electrocardiogram to determine LV function has shown a significant correlation wherein 102 patients with

hypertension had a presence of diastolic dysfunction with a multivariate analysis showing a p value (0.014), which was statistically significant, hence our study is too significant with a p value (<0.05).

**Table 19:** Comparison of Total Cholesterol and Presence of Diastolic Dysfunction

Total cholesterol	Eun Park et.al <sup>15</sup>	Thomas et.al <sup>14</sup>	Present study
<200	N=108	N= 16	N=32
P value	0.143	0.638	0.938

Our study was compared with another study conducted by Eun Park Et.al studying the association of epicardial fat and hypercholesterolemia and presence of diastolic dysfunction on a group of 346 subjects found to have 108 subjects with total cholesterol less than 200 with diastolic dysfunction, with a p value (0.143), which was not statistically significant.

Hence dyslipidaemia association with diastolic dysfunction is not an important determinant although significant number of patients 51.6% patients in our study had presence of diastolic dysfunction probably related to the presence of other co-morbid conditions.

**Table 20:** Comparison of Duration of Essential Hypertension and Presence of Diastolic Dysfunction

	Zuan et al. <sup>[10]</sup>	Thomas et al. <sup>[14]</sup>	Present study
Duration of HTN ( Years)	4.6±4.3	5±3.2	4.0±1.6
N	58	24	6
P Value	0.003	0.035	0.034

Our study was compared with study conducted by Zuan Et.al, wherein duration of hypertension with a mean duration of 4.6±4.3 years had maximum number of subjects with presence of diastolic dysfunction with significant p value (0.003), hence in comparison with our study, the results indicate that mean duration of essential hypertension of 4 years had higher incidence of diastolic dysfunction, wherein duration hence is an important determinant of diastolic dysfunction.

**Conclusion**

Study suggests that, in the early stages of hypertensive heart disease, before there is a detectable increase in left ventricular chamber size, sustained elevation of blood pressure is associated with abnormal left ventricular filling despite normal systolic function. Duration of hypertension and diastolic hypertension are also important determinants of abnormal diastolic function.

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