To Study The Incidence Of Diastolic Dysfunction In Primary Hypertensive Patients And Factors Affecting It

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Abstract: ***Objective:*** Left ventricular diastolic dysfunction with preserved ejection fraction is associated with an increased risk of morbidity and mortality. Uncontrolled hypertension leads to number structural changes in the heart which eventually cumulates into fibrosis, myocardial wall thickness and functional alterations. The earliest detectable consequence of hypertension is diastolic dysfunction. We studied the incidence of diastolic dysfunction in primary hypertensive patients and assessed its relation with age, sex, BMI, cholesterol, stage of hypertension and rural/urban differentiation. ***Methods:*** Total 307 patients of age 30-60 year old with essential hypertension were included in prospective observational study. The patients were subjected to echocardiography, color Doppler and tissue Doppler studies. The observations were noted and compared for various parameters. ***Results:*** Out of 307 patients, 171 (55.70%) were having diastolic dysfunction. There was association advanced age and diastolic dysfunction, there was no sex discrimination for diastolic dysfunction. There was no association between diastolic dysfunction and BMI.There was association between diastolic dysfunction and smoking, cholesterol and duration and stage of hypertension. DD was less in rural hypertensives as compared to urban population. ***Conclusion:*** the incidence of diastolic dysfunction is more as the age advances;it is also more in urban area may be related with life style, as duration of hypertension increases the dd increases. Smokers and hypercholesterolemia were associated with increased incidence of DD.

Keywords: Diastolic dysfunction, mitral inflow pattern , tissue Doppler,e / e'ratio.

Introduction:

The World Health Organization attributes hypertension, as the leading cause of cardiovascular mortality and morbidity.[1] The Complications of uncontrolled hypertension are heart failure, coronary artery disease, stroke, renal disease, and peripheral arterial disease.[2]

Iriarte et al, has divided hypertensive heart disease in four groups physiopathologicaly as-1=diastolic dysfunction; 2= LVH 2a, with normal FC; 2b, with impaired FC; 3= heart failure with normal EF; 4= heart failure with depressed EF.[3] The 2005 American Heart Association/American College of Cardiology guidelines define heart failure as "a complex clinical syndrome that can result from any structural or functional cardiac disorder that impairs the ability of the ventricle to fill or eject blood".[4]

We undertook this prospective observational study focused on diastolic heart failure which develops in two-thirds of patients of hypertension.[5] The earliest detectable consequence of hypertension is diastolic dysfunction.[6] Diastolic dysfunction is isolated impairment of isovolumic ventricular relaxation and decreased compliance of the ventricles. The clinical examination cannot distinguish between the diastolic and systolic heart failure. But with the help of echocardiography we can distinguish. Tissue Doppler technology allows accurate quantification of diastolic function of heart.[7]

Hypertension precedes the development of Heart Failure in approximately 90% of patients and increases risk for HF by 2 to 3 fold. Uncontrolled hypertension leads to a number of structural changes in the heart which eventually cumulates into interstitial fibrosis, myocardial wall thickness and functional alteration such as diastolic dysfunction.[8]

Gandhi et al. showed that the occurrence of acute pulmonary edema in patients with marked hypertension was due to the isolated, transient exacerbation of diastolic dysfunction.[9] The diastolic heart failure is present when an elevated filling pressure is necessary to achieve normal ventricular filling[10] Covell JW, Ross J Jr, Mirsky I, Mirsky I shown that the substantial increase in LV diastolic pressure seen during angina pectoris was largely a consequence of diminished diastolic compliance of the ventricle. Cohen GJ, Pietrolungo DO, Thomas JD, et al & Rakowski H, Appleton C, Chan KL, et al. 1996, the use of echocardiography and Doppler techniques to assess LV diastolic relaxation and filling grew at an exponential rate. The studies regarding this provide considerable insight

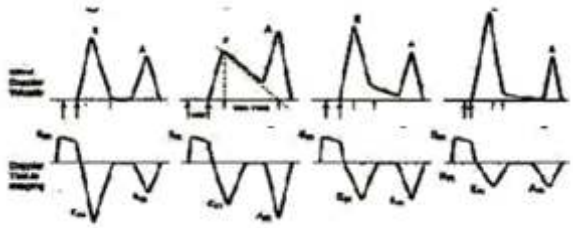
into the dynamics of LV relaxation and filling in health and disease.[11,12] Nagueh SF, Middleton KJ, Kopelen HA, et al. 1997.A most important contribution was the use of echocardiography to estimate LV filling pressure.

Redfield MM, Jacobsen SJ, Burnett JC, et al. 2003. The early identification of such patients provides a window of opportunity to prevent progression of what appears to be "preclinical heart disease".[13]

Definition of Diastolic dysfunction - Diastole is the time period during which the myocardium loses its ability to generate force and shorten and returns to an unstressed length and force. Diastolic dysfunction occurs when these processes are prolonged, slowed, or incomplete.DD describes an abnormal mechanical property; diastolic heart failure describes a clinical syndrome.[14]

Definition of Diastolic Heart Failure - Diastolic heart failure is a clinical syndrome characterized by the symptoms and signs of heart failure, a preserved ejection fraction (EF), and abnormal diastolic function. From a conceptual perspective, diastolic heart failure occurs when the ventricular chamber is unable to accept an adequate volume of blood during diastole, at normal diastolic pressures and at volumes sufficient to maintain an appropriate stroke volume. These abnormalities are caused by a decrease in ventricular relaxation and/or an increase in ventricular stiffness. Diastolic heart failure can produce symptoms that occur at rest (New York Heart Association [NYHA] class IV), symptoms that occur with less than ordinary physical activity (NYHA class III), or symptoms that occur with ordinary physical activity (NYHA class II). When diastolic pressure is markedly elevated, patients are symptomatic at rest or with minimal exertion (NYHA class III to IV). With treatment, diastolic volume and pressure can be reduced, and the patient becomes less symptomatic (NYHA class II), but the diastolic pressure-volume relationship remains abnormal.
Prevalence and Etiology: On average, 40 percent of patients with heart failure have preserved Systolic function.)Hypertension and cardiac Ischemia is the most common causes of diastolic heart failure (Table 2).

Assessment of diastolic function using doppler:
The two major determinants of diastolic dysfunction are (a) Relaxation i.e. the maximum rate of LV pressure decline (b) Compliance i.e. the ease of LV filling. Consequences of diastolic dysfunction, Increased filling pressure for a given volume, Increased LA volume and LA remodeling, Pulmonary venous hypertension Heart failure with normal EF



Echocardiography, being a simple non-invasive technique, has gained wide acceptance in the evaluation of diastolic properties of LV.

Mitral inflow Doppler: The mitral inflow Doppler is the first step in the assessment. The diastolic filling wave known as 'e' wave which is due to rapid filling of LV due to atrio-ventricular gradient in early diastole. Almost 80 % of the LV filling occurs during this phase. 'a' wave. During the late diastolic phase the LA acts as a 'booster pump' with a late diastolic filling of LV and contributes to almost 20 % of LV filling in normal subjects. Normally the 'e/a' ratio is less than 1.50:1.

Tissue Doppler Imaging (TDI): TDI is not dependent on imaging quality and tracings are easily obtainable. Early diastolic wave e' i.e. e prime or em wave and late diastolic wave a'' a prime wave (a'' at the time of atrial contraction). In HFWNEF the e' is the most important wave and a good indicator of LV myocardial relaxation and hence gets reduced in all grades of diastolic dysfunction. A value below 8 cms/sec. is seen in various grades of diastolic dysfunction.

e/e' ratio: The ratio between mitral e wave and TDI'Em wave has been shown, in large number of studies' to be a good marker for evaluating increased LV pressure. The normal e/e' should be > 8cm/Sec.[17]

LA volume: The normal value of LA volume is 22 cc+ 6 cc/msq while a value above 40 cc/ msq indicates severe abnormality

Figure 4 : LV and left atrial (LA) pressures during diastole, transmitral
Doppler LV inflow velocity, pulmonary vein Doppler velocity, and Doppler tissue velocity. IVRT indicates isovolumic relaxation time; Dec. Time, e-wave deceleration time; E, early LV filling velocity; A, velocity of LV filling contributed by atrial contraction; PVs, systolic pulmonary vein velocity; PVd, diastolic pulmonary vein velocity; PVa, pulmonary vein velocity resulting from atrial contraction; Sm, myocardial velocity during systole; Em, myocardial velocity during early filling; and Am, myocardial velocity during filling produced by atrial contraction.

Aims And Objectives:

- To study the incidence of diastolic dysfunction in primary hypertensive patients.
- To study the effects of gender, bmi, tobbaco, duration of hypertension, and various anti-hypertensive drugs on this diastolic dysfunction and
- To study the urban - rural differentiation (lifestyle) on it.

Material And Methods:

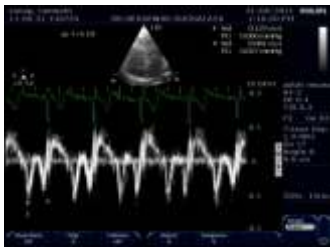
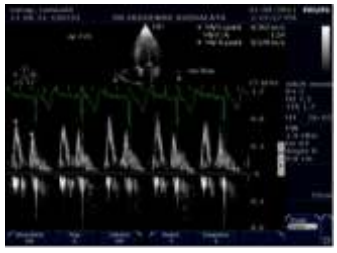
Place of Study: Dr.Hedgewar Rugnalaya
Type of Study: Prospective observational study.
Duration of Study: One year.
Study Population: Patients diagnosed to have essential hypertensive presenting to OPD/IPD were included in the study, all secondary hypertensive patients were excluded from the study.

Methodology: A written informed consent was taken from all patients, complete history & clinical examination done according to a pro forma. Duration of hypertension was taken as the period from the diagnosis of hypertension until the time of assessment, and then patients were subjected to detailed clinical examination routine hematological and biochemical examination, ECG done to rule out IHD. All those included in the study were subjected for echocardiography & tissue Doppler. Analysis was performed by using PHILIPS HD 7 and following parameters were measured

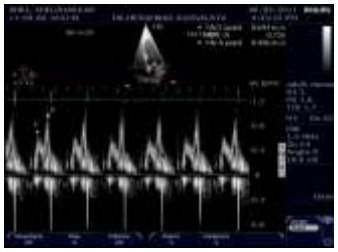
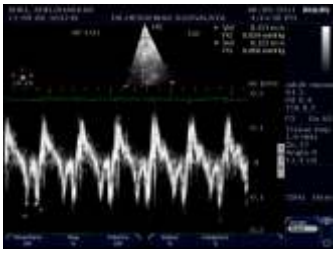
M-Mode measurements were taken, ejection fraction (EF), The E and A wave velocities were measured from pulsed wave Doppler mitral inflow velocity tracing and the E/A ratio.
The e'-wave velocities from the septum and the ratio of the Trans mitral E-wave to e' velocity (E/e' ratio) calculated. The postmenopausal state was defined as the presence of amenorrhea for at least 12 month.[15]

Figure 4 : LV and left atrial (LA) pressures during diastole, transmitral

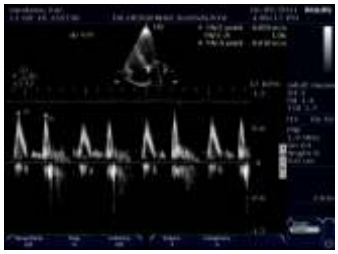
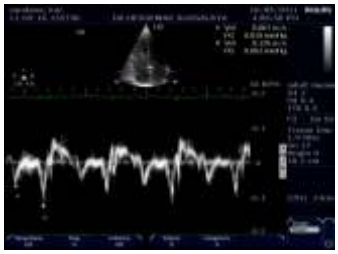
NORMAL FLOW PATTERN

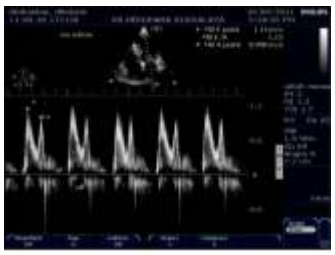
DIASTOLIC DYSFUNCTION-(Grade I)-

PSEUDO NORMAL

RESTRICTIVE PATTERN




Discussion:

The study included 307 cases fulfilling inclusion criteria, in this study we came out with following results. The 307 patients of hypertension which we have screened, 171 (55.70%) were found to having abnormal diastolic function.

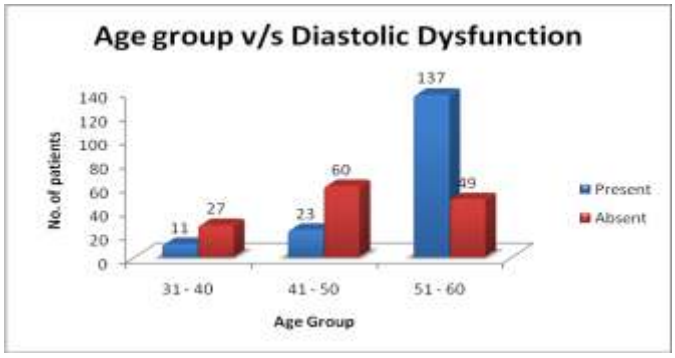
Distribution of Diastolic Dysfunction among Hypertensives

Diastolic Dysfunction	Present	Absent	Total
Hypertensive	171 (55.70%)	136 (44.30%)	307

Out of 307 hypertensive patients 171 (55.70%) were having diastolic dysfunction and 136 (44.30%) were normal. Majority i.e. 137 (74%) of the patients of diastolic dysfunction were from the age group of 51 - 60 years out of 307 patients. Similar to this Margaret M. Redfield, Steven J. Jacobsen et al in 2003 cross-sectional survey found that out of 502 patients with diastolic dysfunction 272 were above 65 years.[17]

Distribution of patients with respect to age (in yrs) and occurance of Diasolic Dysfunction

Age group	diastolic dysfunction		Total	p-value
	Present	Absent		
31 - 40	(28.9%)	27 (71.1%)	38	< 0.001
41 - 50	23 (27.7%)	60 (72.3%)	83	
51 - 60	137 (74%)	49 (26%)	186	

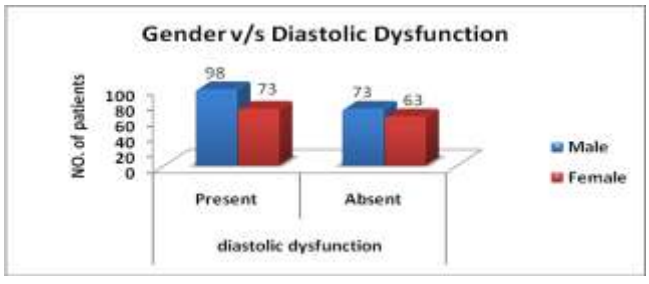


Inference: By using chi-square test p-value < 0.05 therefore is association between the occurrence of diastolic dysfunction and age (years).Majority i.e. 137 (74 %) of the patients of diastolic dysfunction were from the age group of 51 - 60 years.

Among 171 males 98 (57.3%) were having diastolic dysfunction, out of 136 females 73 (53.6 %) were found to having diastolic dysfunction.

Distribution of patients with respect to gender and occurance of Diastolic Dysfunction

Gender	diastolic dysfunction		Total	p-value
	Present	Absent		
Male	98 (57.3%)	(42.7%)	171	0.564
Female	73 (53.6%)	63 (47.4%)	136	

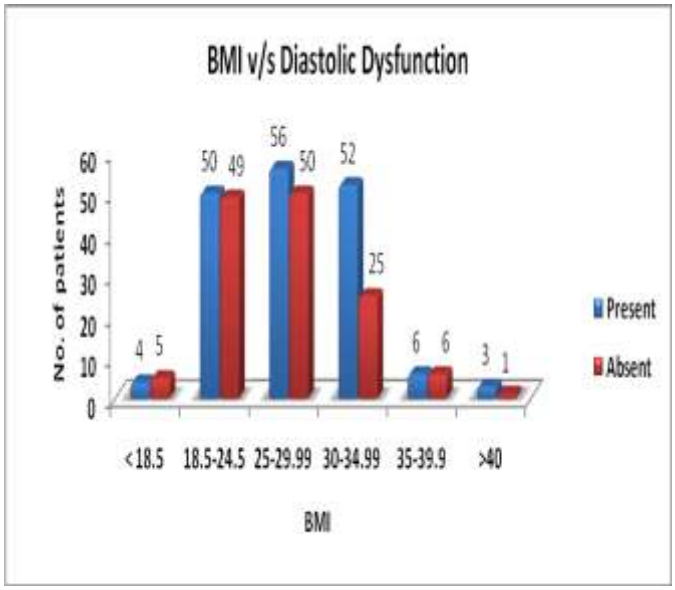


Inference : By using chi-square test p-value > 0.05 therefore is no association between the occurrence of diastolic dysfunction and gender.Among 171 males 98(57.3 %) were having diastolic dysfunction, out of 136 females 73(53.6 %) were found to having diastolic dysfunction.

Same results were found by Rolf Wachter, Claus Lüers et al in 2007 in their study of 439 hypertensive patients, were selected for participation in this study ,sex-specific analysis revealed that diastolic function was mainly limited to the male subgroup.18Contrast to this Masoudi FA, Havranek EP, Smith G, et al in 2003 in a cross-sectional study using data from retrospective medical chart abstraction of a national sample of Medicare beneficiaries hospitalized found preserved LVSF was present in 6,700 (35%), out of which 79% of whom were women.[19] In our study out of 136 female patients 72% post-menopausal patients. Out of them 99 patients 62% having DD present. Similar to our study Kangro T, Henriksen et al in 1995 found that Left ventricular diastolic function seems to be affected in the postmenopausal state, postmenopausal women have greater left ventricular wall thickness and lower peak E velocities and E/A ratios on Doppler echocardiography than premenopausal women.[20]

Distribution of patients with respect to body mass index and occurance of Diastolic Dysfunction

BMI	Diastolic dysfunction		Total	p-value
	Present	Absent		
< 18.5 Underweight	4 (44%)	5 (56%)	9	0.189
18.5-24.5 Normal	50 (51.02%)	49 (49.98%)	99	
25-29.99 Overweight	56 (52.83%)	50 (47.17%)	106	
30-34.99 Moderately obese	52 (67.53%)	25 (32.47%)	77	
35-39.9 Severely obese	6 (50%)	6 (50%)	12	
>40 Very severely obese	3 (75%)	1 (25%)	4	

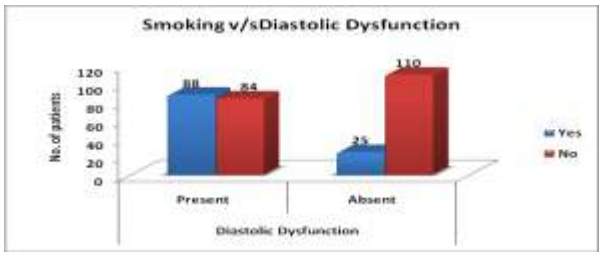


By using fisher's exact test p-value > 0.05 therefore is no association between the occurrence of diastolic dysfunction and body mass index. Majority of the patients were overweight i.e.106 (35.85%), among which 56 (58.1%) were having diastolic dysfunction. Out of 4 severely obese patient 3(75%) were having diastolic dysfunction.

Also Wael A Jaber; Venu Menon et al in 2011,Clinical records and echocardiographic findings of 21,666 consecutive patients who had an outpatient echocardiogram with normal ejection fraction (EF) > 55 % from 1996 to 2005 were reviewed increased body mass index is associated with worsening diastolic function in patients with normal systolic function.21 Similar to this Cesare Russo, Zhezhen Jin et al in 2010 evaluated in 822 participants for the LV diastolic function, was found that risk of diastolic dysfunction was significantly higher in overweight [adjusted odds ratio (OR):1.66, 95% confidence intervals (CI) 1.11-2.50] and obese subjects (adjusted OR: 1.92, 95% CI 1.24-2.95) compared to the lean group.[22]

Distribution of patients with respect to smoking and occurance of Diastolic Dysfunction.

Smoking	Diastolic Dysfunction		Total	p-value
	Present	Absent		
Yes	88 (77.87%)	25 (22.13%)	113	< 0.001
No	84 (43.29%)	110 (56.71%)	194	



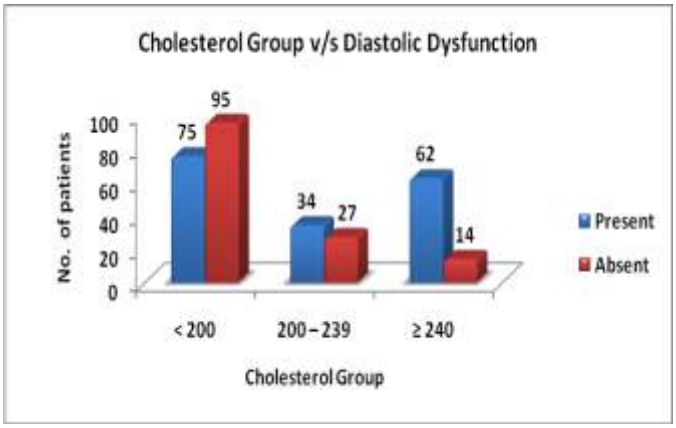
Majority of patients 194 (63.19%) were nonsmokers 110 (56.7%) were found to be normal. In 113(36.4%) smoker 88(77.87%) were having more incidence of diastolic dysfunction.

Inference: By using fisher's exact test p-value < 0.05 therefore is association between the occurrence of diastolic dysfunction and smoking. Majority of patients 194 (63.19%) were nonsmokers 110 (56.7%) were found to be normal. In 113(36.4%) smoker 88(77.87%) were having diastolic dysfunction

In 2006 Osman Karakaya, Irfan Barutcu, et al thirty chronic smokers underwent a complete transthoracic echocardiographic examination found that acute cigarette smoking impaired both left and right ventricular diastolic function in chronic smokers.[23] Similarly Ahmet Yilmaz, Kenan Yalta in 2007,hundred smokers with histories of incessant smoking for at least one year prior to the time of the investigation were included in the prospectively designed study .Conventional and relatively new parameters of cardiac diastolic function, in particular transmitral M- mode coloured flow propagation velocity , were found to be impaired in smokers demonstrating the chronic adverse effects of smoking on the diastolic function of the heart.[24] Also Alam M, Samad BA in 2002 were studied acute effects of smoking on left ventricular (LV) function in 36 healthy participants The results were similar in both smokers and nonsmokers. Acute smoking of a cigarette influences LV diastolic function in healthy participants.[25]

Distribution of patients with respect to cholestrol and occurance of Diastolic Dysfunction

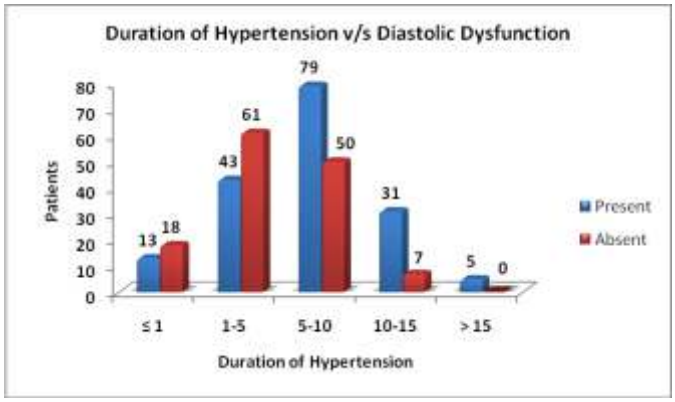
Cholesterol group	diastolic dysfunction		Total	p-value
	Present	Absent		
< 200 (desirable)	75 (44.11%)	95 (55.89%)	170	< 0.001
200 – 239 (borderline high risk)	34 (55.73%)	27 (44.27%)	61	
≥ 240 high risk)	62 (81.57%)	14 (18.43%)	76	



Out of 170 patients with desirable cholesterol levels 95(55.88%) were having normal diastolic function, and out of 76 patients with high risk cholesterol levels 62(81.57%) were having abnormal diastolic function.

Distribution of patients with respect to duration of hypertension and occurance of Diastolic Dysfunction

Duration of Hypertension	diastolic dysfunction		Total	p-Value
	Present	Absent		
≤ 1	13 (41.93%)	18 (58.07%)	31	< 0.001
1-5	43 (41.34%)	61 (58.66%)	104	
5-10	79 (61.24%)	50 (38.76%)	129	
10-15	31 (81.57%)	7 (18.3%)	38	
> 15	5 (100%)	0	5	



Inference: By using fisher's exact test p-value < 0.05 therefore is association between the occurrence of diastolic dysfunction and duration of hypertension.

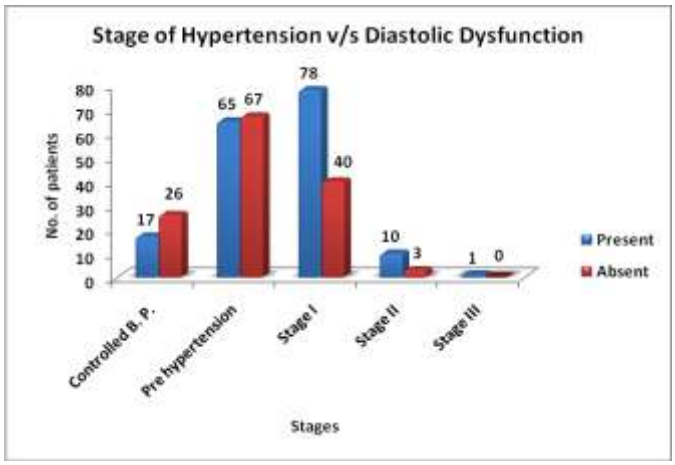
Among the 307 patients 129 (42%) were having hypertension since 5-10 years, out of which 79 (61.24%) were having diastolic dysfunction. There are 5 patients above 15 years of history of hypertension, all of them are having diastolic dysfunction. As the duration of hypertension increases incidence of diastolic dysfunction increases. In present study the blood pressure is measured before echocardiography and then staging was done according to JNC VII guideline, majority of the patient 132 (42.9%) were pre hypertensive. Among 118(38.4%) patients of stage I 78(66.1%) were having diastolic dysfunction,13 patients of stage II 10(76%) and 1 having stage III which having diastolic dysfunction i.e. 100%.

In 2006 IKE and V.O. IKEH were found Diastolic dysfunction in82.86% (87) of the 105 hypertensive patients out of which 26 (74.29%) of the 35 mildly hypertensive; 28 (80%) of the moderately hypertensive, and 33 (94.29%) of the severely hypertensive patients had diastolic dysfunction.[26]

Philips et al rather discovered abnormal left ventricular filling rates only in patients with systolic blood pressure higher than 130 mmHg, but not in those patients with SBP lower than 130 mmHg.[27]

Distribution of patients with respect to stage of hypertension (at the time of echo cardiography) and occurance of Diastolic Dysfunction

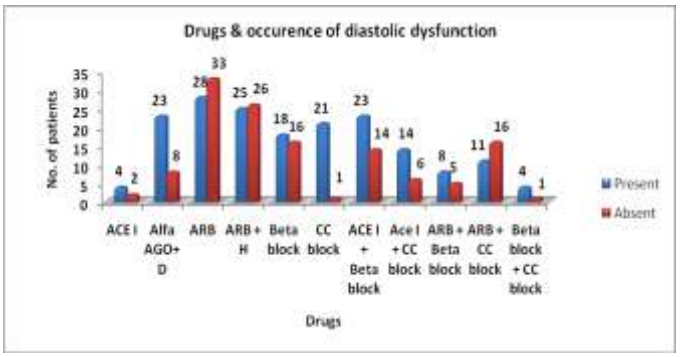
Stage of hypertension	Diastolic Dysfunction		Total	p-value
	Present	Absent		
Controlled blood pressure (< 120/80)	17 (39.53%)	26 (60.47%)	43	0.003
Pre hypertension (120–139/80–89)	65 (49.24%)	67 (50.76%)	132	
Stage I (140 – 149/ 90 – 99)	78 (66.10%)	40 (33.90%)	118	
Stage II (160 – 179/100 – 109)	10 (76.72%)	3 (23.08%)	13	
Stage III (>180/110) (>180/110)	1 (100%)	0	1	



By using fisher's exact test p-value < 0.05 therefore is association between the occurrence of diastolic dysfunction and stage of hypertension. Majority of the patient 132 (42.9%) were prehypertensive. Among 118(38.4%) patients of stage I 78(66.1%) were having diastolic dysfunction,13 patients of stage II 10(76.72%) and 1 having stage III which having diastolic dysfunction i.e. 100%.

Similarly, Slama M, Susic D, Varagic J, Frohlich ED et al showed in 2002 that diastolic dysfunction has been found in patients with hypertension, even before left ventricular hypertrophy is demonstrable.(28) In 2006 IKE and V.O. IKEH et al in study population of 69 males and 71 females found that prevalence of diastolic dysfunction in the hypertensive groups to be 82.86%.Anil Verma, Scott D. Solomon et al in 2009 hypertension and aging are closely linked and interact with each other to cause various morphologic changes in the CV system.[29]

Distribution of patients with respect to drugs and occurance of Diastolic Dysfunction



Among the 61 (19.5%) patients on ARBs 33 (53.3%) were found to be normal, similarly 51 on ARBS+ H,26 (50.98%) were normal. Out of 22 on CC blockers 21 (95.45%) were having diastolic dysfunction.

In combinations out of 27 who were on ARB + CC blockers 16 (59.25%) were normal, 5 on Beta blockers + CC blockers of which 4 (80%) were having diastolic dysfunction.

We found ARB and ARB + H are much effective antihypertensive than others, and in combination ARBs and Calcium channel blockers are more effective than others. Williams B, Lacy PS et al in 2006 recruited 2199 patients in 5 ASCOT center found that optimal blood pressure reduction using agents such as diuretics, calcium antagonists, and RAAS antagonists can reduce CV-related morbidity and mortality and is associated with enhanced myocardial relaxation, reduced central aortic stiffness, and a dramatic reduction in the incidence of heart failure.(30) Similarly Devereux, Dahlof, Gerdts, et al studied total of 960 patients with essential hypertension were enrolled at centers in 7 countries and studied by echocardiography at baseline in 2004 in the Losartan Intervention For Endpoint Reduction in Hypertension (LIFE) they demonstrated that

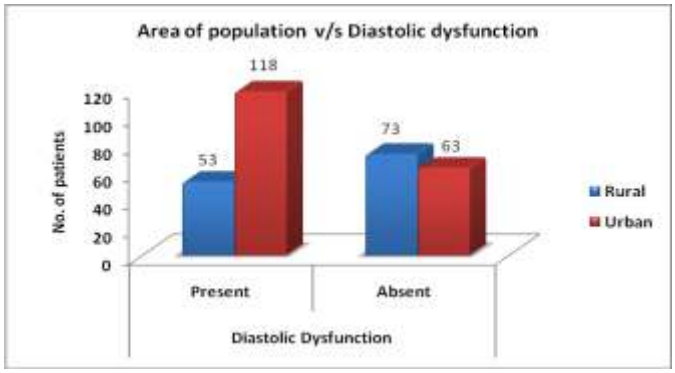
Drugs / DD	**ACE I**	**Alfa AGO + D**	**ARB**	**ARB + H**	**Beta block**	**CC block**	**ACE I + Beta block**	**Ace I + CC block**	**ARB + Beta block**	**ARB + CC block**	**Beta block + CC block**
Present	4 (66.66 %)	23 (74.19 %)	28 (45.9 %)	25 (49.02 %)	18 (52.94 %)	21 (95.45 %)	23 (62.16 %)	14 (70 %)	8 (61.53 %)	11 (40.74 %)	4 (80 %)
Absent	2 (44.44)	8 (25.81 %)	33 (54.1 %)	26 (50.98 %)	16 (47.06 %)	1 (4.55 %)	14 (37.84 %)	6 (30 %)	5 (38.47 %)	16 (59.26 %)	1 (20 %)
Total	6	31	61	51	34	22	37	20	13	27	5

treatment with the ARB losartan was associated with greater reduction in LV mass & CV symptoms compared with the use of beta-blocker therapy.[31]

Contradict to our findings Lonn E, Shaikholeslami R, Yi Q, et al compared the effects of two doses of ramipril (10 mg/day and 2.5 mg/day) v/s placebo in 506 patients in 2004 found Long-term therapy with the ACEI ramipril in the Heart Outcomes Prevention Evaluation (HOPE) study revealed favorable effects on LV structure and function by reducing LVM and LV volumes and the reduction loss in LVEF in high-risk patients who had vascular disease while controlling blood pressure and reducing CV mortality.[32]

Distribution of patients with respect to area of population and occurance of Diastolic Dysfunction

Population	Diastolic Dysfunction		Total	p-value
	Present	Absent		
Rural	53 (42.07%)	73 (57.93%)	126	< 0.001
Urban	118 (65.19%)	63 (34.8%)	181	



In 2003 Miho Kawaguchi; Ilan Hay; BarryFetics et al shown that Heart failure with preserved ejection fraction (HFNEF) is common in aged individuals with systolic hypertension and is frequently ascribed to diastolic dysfunction.[33] Majority of patients, 181 (58.6%) were from urban areas were 118(65.19%) were having diastolic dysfunction. Among the 307 patients 126 (41.04%) were from rural areas were 73 (57.93%) were found to be normal.

Inference: By using Chi-square test p-value < 0.05 therefore there is association between the diastolic dysfunction and area of population. Majority of patients,181 (58.6%) were from urban areas where 118 (65.19%) were having diastolic dysfunction. Among the 307 patients 126 (41.04%) were from rural areas where 73(57.9%) were found to be normal.

These may be because of difference in lifestyle in rural and urban population. Rural population has less sedentary lifestyle than urban population. Though, this needs further evaluation.Regular exercise and endurance training has been shown to reduce arterial pressure, improve endothelial function.[34]

Majority of the patients were overweight i.e.106 (35.85%), among which 56(58.1%) were having diastolic dysfunction. Out of 4 severely obese patient 3(75%) were having diastolic dysfunction.

As the duration of hypertension increases incidence of diastolic dysfunction increases

Majority of patients 149 (48.5%) were having sedentery lifestyle 114 (76.5%) having diastolic dysfunction.

Similar to our study Louse Bennete, Charlote Larsson et al studied men and women of 30 - 75 years of age were consecutively invited for conventional echocardiography and tissue velocity imaging (n - 1149). Structured questionnaires and physical examinations were conducted using standardized methods. Sedentary leisure time physical activity is independently associated with DD in females. Identification of a sedentary lifestyle in females increases the probability of diagnosing DD.[35]

Similarly, Armin Arbab-Zadeh, Erika Dijk, Anand Prasad et al in 2004 in twelve healthy sedentary seniors and 12 Masters athlete found that sedentary lifestyle during healthy aging is associated with decreased left ventricular compliance, leading to diminished diastolic performance. Prolonged, sustained endurance training preserves ventricular compliance with aging and may help to prevent heart failure in the elderly.[36]

Out of 170 patients with desirable cholesterol levels 95(55.88%) were having normal diastolic function, and out of 76 patients with high risk cholesterol levels 62(81.57%) were having abnormal diastolic function.

Similar to our study Pasquale Palmiero, Maria Maiello et al in 2002 in a total of 200 consecutive postmenopausal women (mean age 47.5 ± 4 years) with mild-to-moderate hypertension were studied, in women with mild-to-moderate hypertension, high total cholesterol levels and low HDL levels are associated with impaired diastolic function.[37]

Similarly Jack Rubinstein, Augusta Pelosi in 2009 also had shown that Cholesterol load in the serum and myocardium was significantly associated with decreased systolic and diastolic function by TDI.(38)

Conclusions:

- Age was one of the factors that contribute to the development of diastolic dysfunction.
- No association of gender with the development of Diastolic dysfunction.
- BMI has no link towards the susceptibility for the development of diastolic dysfunction.
- The patients with longer history of hypertension tend to have higher incidence of diastolic dysfunction.
- There is a strong correlation between stage of hypertension and occurrence of diastolic dysfunction.
- The diastolic function of the heart was found to be impaired among smokers.
- Hypercholesterolemia is associated with diastolic dysfunction.(Cholesterol more than 240 mg/dl)
- The ARBs alone or with thiazide or CCBs were more effective anti-hypertensive with respect to diastolic function.
- The urban population is more susceptible for diastolic dysfunction as compared to rural population.
- A sedentary lifestyle is associated with a decline of ventricular compliance.

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