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ORIGINAL ARTICLE

2D-Echographic assessment of left ventricular diastolic dysfunction in severe hypertension and its correlation with physical findings, chest radiograph and electrocardiogram.

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ABSTRACT

Background: Hypertension is one of the commonest diseases that often results in end-organ damage of the heart. This study aims to assess diastolic dysfunction of the left ventricle in severe hypertension using echocardiography and Doppler examination. Correlation between echocardiographic findings and that of physical examination, chest x-ray and electrocardiography were also studied.

Methods: This hospital based study includes 50 patients whose diastolic blood pressure was more than or equal to 110 mm of Hg. Patients with valvular heart disease, diabetes mellitus and cardiomyopathy were excluded from the study.

Results: Of the 50 study subjects with severe hypertension, 34 (68%) showed abnormal relaxation type of ventricular dysfunction and it was the commonest pattern. Pseudonormal pattern was found in relatively less number of cases (n=5) and normal pattern was found in 11 patients (22%). It correlates well with apical pre-systolic bulge, S4 gallop, prominent pulmonary veins on chest films, electrocardiographic manifestations of left ventricular hypertrophy and its strain pattern suggest left ventricular diastolic function.

Conclusion: Doppler echocardiography is useful, non invasive and reliable tool for the assessment of left ventricular diastolic function. The commonest form of ventricular dysfunction seen in hypertension is abnormal relaxation pattern. Echocardiographic findings correlate well with corroborative findings of physical examination, chest x-ray and ECG. A new scoring system is developed which may be useful in those settings where Doppler echocardiographic facilities are not available.

Key words: Hypertension, Cardiomyopathy, Diastolic dysfunction, Echocardiograph, Chest X Ray, Electrocardiogram

Abbreviations: **ECG -** Electrocardiography; **LVD -** Left ventricular dysfunction; **LVH -** left ventricular hypertrophy

Introduction

Hypertension is one of the commonest diseases seen in clinical practice. It is observed in 20 to 25% of the middle aged and elderly populations and its clinical sequelae result in end-organ damage affecting heart, brain, peripheral vasculature and eyes. In developed countries, 20% of hypertensive patients have diastolic pressure of 90-109 mm Hg, 4.5% have 110-129 mm Hg and 0.5% have diastolic pressure greater than 130 mm Hg. Nearly About 50% of individuals above 70 years of age have blood pressure of 165/95 of Hg.[1] The reported prevalence of hypertension in India varies widely from 1 to 5% in rural population and 3 to 5% in urban population. A number of surveys indicate significantly higher prevalence of hypertension in the urban communities as compared to the rural ones.[2]

Diastolic dysfunction is common complication of systemic hypertension. Sustained systemic hypertension imposes hemodynamic stress on the left ventricle and initiates its hypertrophy. Hypertrophied left ventricular myocardium is stiff and fails to relax completely. This ultimately causes disturbed diastolic function of the left

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ventricle resulting in various clinical manifestations.

Advent of Doppler echocardiography has enabled recording of various flow velocities and flow patterns across the cardiac valves. Measurements of diastolic velocities across the mitral valve helps to assess diastolic function of the left ventricle.[3,4] Even in the absence of left ventricular hypertrophy, 47% of hypertensive patients have been found to have Doppler evidence of diastolic dysfunction. As most of these dysfunctions are subtle, we intended to assess its prevalence in Indian patients and correlate the echocardiographic findings with that of physical examination, chest x-ray and ECG.

METHODS

This hospital based study included 50 patients recruited from the Department of Medicine, Dr DY Patil Hospital and Research Centre, between 2010 and 2012. Diastolic blood pressure of 110 mm Hg or more is essential criterion of inclusion in the study. Patient with valvular heart disease, diabetes mellitus and cardiomyopathy were excluded.

Each participant was evaluated with detailed history of hypertension and associated symptoms.

Complete physical examination was carried out of each patient with special attention to the presence of heaving apex beat, pre-systolic bulge, S4 gallop and loud A2. Chest roentgenograms were scrutinized for evidence of prominent upper lobe pulmonary veins. Classical 12-lead ECG was assessed for evidence of left-axis deviation, left atrial enlargement, left ventricular hypertrophy and left ventricular hypertrophy with strain pattern.

Doppler echocardiography studies were carried out using commercially available echocardiograph (system V; General Electric Wipro Logic 400) with 3.5 MHz transducer. M-mode measurements were obtained according to the guidelines of the American Society of Echocardiography. Various measurements were obtained in 2D mode. Doppler interrogation of left ventricular diastolic filling was performed by placing the pulsed doppler sample volume at the tips of mitral valve leaflets and maximal velocity of early diastolic transmitral flow (peak E wave velocity) and maximal velocity of transmitral flow (peak A velocity) were obtained. The E wave deceleration time was also determined. The ratio between E- and A- wave peak velocities were subsequently derived.

RESULTS

Of the 50 patients with severe hypertension, 34 patients (68%) showed abnormal relaxation type of dysfunction in echocardiography and it was the commonest pattern. Pseudonormal pattern was found in 5 patients (10%) and normal pattern was found in 11 patients (22%). Observations are summarized in figure 1 and tables 1 to 3.

DISCUSSION

Diastolic dysfunction is common in the age group of 50 to 70 years. In both sexes abnormal relaxation pattern is the commonest pattern of diastolic dysfunction. Gardin et al also reported higher peak velocity of late diastole in both men and women with hypertension.[5] In our study also 34 patients showed abnormal relaxation type of dysfunction. Watchtell et al [6] studied the left ventricle filling patterns in patients with systemic hypertension and left ventricular hypertrophy. The study group comprised of patients with blood pressure greater than or equal to 160/90 mm Hg. Gardin et al [7] studied diastolic filling patterns in 11 patients with severe hypertension (mean BP 147/96 mm of Hg) and 66 normal subjects (mean BP 123/78 mm of Hg). Both the studies found similar diastolic filling abnormalities with

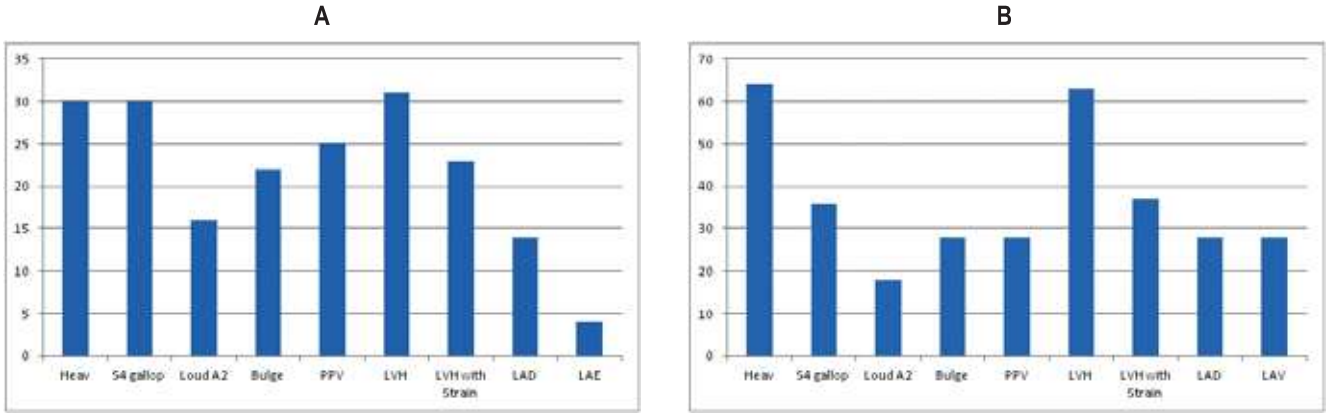

Figure 1: Correlation between the pattern of left ventricular dysfunction and clinical features. (A) Abnormal relaxation pattern of dyfunction (B) Normal pattern Heav - Having apex, Bulge - Pre-systolic bulge, PPV - Prominent pulmonary veins in x-rays, LVH - Left ventricular hypertrophy in ECG, LAD - Left axis deviation in ECG, LAE - Left atrial enlargement

Table 1: Correlation between echocardiography and physical signs

Physical signs	n (%)	Echocardiography pattern of diastolic filling		
		Pseudonormal	Abnormal relaxation	Normal
Heaving Apex	41 (17%)	4 (10%)	30 (73%)	7 (17%)
Pre-systolic bulge	26 (12%)	1 (4%)	22 (85%)	3 (11%)
S4 Gallop	36 (11%)	2 (6%)	30 (83%)	4 (11%)
Loud A2	18 (11%)	-	16 (89%)	2 (11%)

Table 2: Correlation between ECG findings and patterns of diastolic dysfunction

ECG findings	n (%)	Echocardiographic pattern of diastolic filling		
		Pseudonormal	Abnormal relaxation	Normal
LVH	40 (80%)	2 (5%)	31(77.5%)	7(17.5%)
LVH + strain	28 (56%)	1 (3.6%)	23(82.1%)	4(14.3%)
Left axis deviation	20 (40%)	3 (15%)	14 (70%)	3(15%)
LA enlargement	7 (14%)	-	4 (57.1%)	3 (42.9%)

LVH - Left ventricular hypertrophy; LA - Left atrium

Table 3: Non-electrocardiographic indicators of abnormal relaxation pattern of diastolic dysfunction

Various Findings	n (%)
Heaving apex	30 (88%)
S4 gallop	30 (88%)
Loud A_2	16 (47%)
Pre-systolic Bulge	22 (65%)
PPV in chest x-ray	25 (74%)
LVH in ECG	31 (91%)
LVH with strain in ECG	23 (68%)
Left axis deviation in ECG	14 (42%)
Left atrial enlargement in ECG	4 (12%)

LVH - Left ventricular hypertrophy, ECG - electrocardiogram,
PPV - Prominent pulmonary vein

increased peak 'A-wave' velocities in both mild and severe hypertension and concluded that the level of blood pressure does not alter the abnormalities of diastolic filling patterns in hypertension. Nick et al [8] showed that hypertensive heart disease manifests by abnormal relaxation pattern. Michael et al [9] reported reduced ratios of early to late diastolic velocities in 41 hypertensives as compared to 42 controls.

Doppler echocardiography and expertise to interpret are not available in every center. In its absence other clinical features which correlate well with echocardiographic findings can be used as predictors. Therefore we studied several physical, radiographic and electrocardiographic features in correlation with echocardiography. Heaving apex is almost equally present in both the patterns of diastolic dysfunction – namely abnormal relaxation and

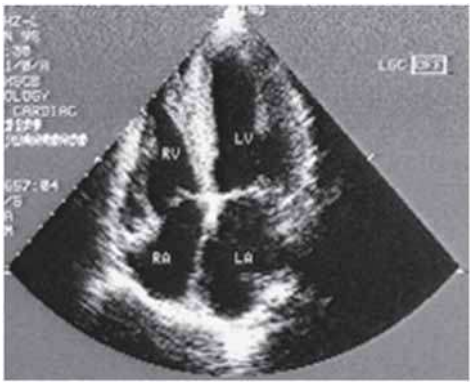

Figure 2: Diastolic dysfuction in severe hypertension 2D-echocardiographic finding

pseudonormal and is a sensitive marker of diastolic dysfunction. Pre-systolic bulge and S4 gallop is predominantly observed in abnormal relaxation pattern of diastolic dysfunction. Presence of loud A2 raises the possibility of abnormal relaxation type of diastolic dysfunction.

Left ventricular relaxation abnormality manifests on chest X-ray in the form of prominent upper lobe pulmonary veins. This is due to passive venous congestion caused by increased left atrial pressure consequent to impaired relaxation of the left ventricle. Of these 50 hypertensive patients, 30 patients showed prominent pulmonary veins. In these 30 patients 27 patients had diastolic dysfunction. Of these 25 patients had abnormal relaxation pattern and 2 patients had pseudonormal pattern. This indicates that prominent pulmonary veins could be a reliable predictor of abnormal relaxation type of left ventricular filling.

Features of severe concentric left ventricular hypertrophy in ECG are generally not associated with normal left ventricular filling pattern. Left ventricular hypertrophy with strain pattern in ECG is associated with diastolic dysfunction in general and abnormal relaxation of left ventricle in particular. Pseudonormal pattern of dysfunction was consistent with evidence of left atrial enlargement in ECG.

If each of 9 variables (heaving apex, pre-systolic bulge, loud A2, S4 gallop, prominent pulmonary veins in radiographs, LVH in ECG, LVH with strain pattern, left axis deviation and left atrial enlargement in ECG) are assigned with one point each, the total score for each pattern of diastolic filling can be calculated. In our study a mean score of 5.82 was associated with abnormal relaxation pattern of diastolic dysfunction and a mean score of 1.45 was associated with pseudonormalisation pattern. Hence in the absence of Doppler echocardiography facility, a score more than or equal to 6 appears to be a reliable predictor of abnormal relaxation type of diastolic dysfunction and a score between 3 to 6 would indicate normal left ventricular filling pattern while a score between 1 to 3 is likely to indicate pseudonormalisation.

Doppler echocardiography is useful, non invasive and reliable tool for the assessment of left ventricular diastolic function. Patient with arterial hypertension usually have diastolic dysfunction of left ventricle as evident from reversal of E to A ratio and increase in the deceleration time. Thus Doppler echocardiography is indispensible for accurate diagnosis of LVD. However, the proposed scoring system may be valuable in predicting LVD when echocardiographic facilities are not available. This scoring system needs to be validated by further studies.

Conflict of Interest: Authors declare none

Ethics: This is an observational study involving data from routine clinical care.

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