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THE RELATIONSHIP BETWEEN LONGITUDINAL FRACTIONAL SHORTENING AND DIASTOLIC FUNCTION IN INDIVIDUALS WITH HYPERTENSION AND THE GLOBAL LONGITUDINAL STRAIN VALUE IN PATIENTS WITH HYPERTENSIVE HYPERTROPHY FOR SUBCLINICAL LV DYSFUNCTION.

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ABSTRACT:

Background:

Patients with hypertrophy can measure the global longitudinal strain value for subclinical left ventricular failure, which may assist lower cardiovascular morbidity and death, if longitudinal fractional shortening and diastolic function are detected early. The study aims to forecast the incidence, prevalence, and early identification of GLS in hypertension hypertrophy patients and longitudinal shortening and LV dysfunction in hypertensive patients.

Material:

Our prospective Observational study included 81 cases hypertension patients and 81 healthy controls, all had done conventional echocardiography 2D m-mode and Global longitudinal strain.

Results:

Our research demonstrates that hypertension patients with left ventricular hypertrophy have significantly lower global longitudinal strain values and strain ejection fractions. In our study population of 162 patients, 53 patients are found to have normal LFS value>1.33 and remaining 109 patients had abnormal LFS values <1.33. Among 81 patients with hypertension 19 patients had normal LFS values with diastolic dysfunction Remaining 62 patients had abnormal LFS values whereas 57 patients with diastolic dysfunction and 5 with normal diastolic function. When identifying subclinical impairment, speckle tracking echocardiogram is more important than 2D conventional echocardiography.

Conclusion:

Global longitudinal strain echocardiography identified early deterioration of LV systolic function in hypertensive patients with maintained EF in traditional 2D m-mode and hypertrophied LV as a result of pressure overload.

Keywords: Longitudinal Fractional shortening (LFS), Ejection fraction (EF), Global longitudinal strain (GLS), Hypertension (HTN), Left ventricle (LV).

INTRODUCTION:

One of the most prevalent illnesses in the population is hypertension. Hypertension (HTN) is a primary cause of heart failure although the particular routes by which HTN leads to heart failure are not determined. Heart failure with reduced ejection fraction (HFrEF) or heart failure with preserved ejection fraction (HFpEF) can result from a number of different pathways. (1) It produces left ventricular (LV) pressure overload, a well-known risk factor for cardiovascular disorders. This leads to a number of geometric alterations that eventually lead to diastolic heart failure and/or heart failure with LV systolic dysfunction. (2) In contrast to primary hypertension, secondary hypertension refers to a broad spectrum of clinical diseases where the rise in blood pressure (BP) has a known cause. (3) Although changes in LV diastolic function linked to left ventricular hypertrophy (LVH) can be detected by conventional echocardiography, global LV systolic function frequently persists until late in the course of the disease, making it challenging to interpret subtle changes in LV contractile function in the early stages. (4) The assessment of global cardiovascular risk must consider the possibility that early detection of LV dysfunction prior to the development of LVH could be a clinical finding that would support aggressive treatment intended to reduce cardiovascular morbidity and death. (5) Patients with prehypertension, newly diagnosed, treated, uncontrolled, or resistant hypertension despite normal LVEF demonstrated a significant reduction in GLS and global circumferential strain (GLS). (6,7) Specifically, a number of investigations have demonstrated that individuals with secondary hypertension exhibit more severe diastolic dysfunction and LV remodeling than those with essential hypertension. (8,9) The aim of the current study was to forecast the incidence, prevalence, and early identification of GLS in hypertension hypertrophy patients and longitudinal shortening and LV dysfunction in hypertensive patients.

MATERIALS AND METHODOLOGY:

The investigation was done in Chettinad Super Speciality Hospital, Kelambakkam. The period of study is extended between Dec 2018 to April 2019. This investigation is prospective Observational study was approved by the ethical committee. The current investigation examines transthoracic echocardiography data from isolated hypertension patients with LV hypertrophy who did not have CAD or any other structural heart disease. Based on the inclusion and exclusion criteria every patient had been selected. Out of the 162 cases, 81 are hypertension patients, and the remaining 81 are normal.

Echocardiography:

Echocardiographic examination was performed (with Esoate and Vivid S5, GE medical system) using commercially available equipment. Following the guidelines of the American Society of Echocardiography, images were taken of patients in the left lateral decubitus position at end-expiration. The parasternal long- and short-axis views, apical four-chamber view, two-chamber view, and apical long-axis view were used to collect all standard measures. M-mode echocardiography was used to quantify the LV dimensions, followed by the biplane (modified Simpson's technique). For women and men, LV hypertrophy (LVH) was defined as LVMI > 95 g/m2 and ≥ 115 g/m2.

2-D LV Strain Analysis:

Longitudinal strain was recorded in apical 4 chamber, 3 chamber and 2 chamber views as well as a parasternal short-axis view at the papillary muscle level were used for the 2D speckle tracking analysis. Longitudinal and circumferential strains were evaluated using apical views, while circumferential and radial strains were evaluated using short-axis parasternal views. Multilayer longitudinal and circumferential strains were assessed using a modified version of 2D strain software (Q-analysis). While GCS and GRS were computed in short-axis at the level of papillary muscles, GLS was assessed in an apical 4-chamber, 2-chamber, and apical long-axis view. In the end-systole, the automatic tracking of the endocardial contour was evaluated. In order to ensure that the complete LV thickness was included in all observed echocardiographic views, the program automatically provided LV myocardium tracking, and the region of interest was manually adjusted to assure the best tracking of the endocardium and epicardium. The program then produced segmental and global longitudinal strain (GLS) after dividing the LV myocardium into six segments in each image. The longitudinal strain was shown below the baseline because the myocardium typically shrunk longitudinally during systole. Peak systolic longitudinal strain for each cardiac segment was calculated from these graphs.

Statistical Analysis:

SPSS version 15.0, the Statistical Package for Social Sciences, was utilized. Frequencies and percentages were used to express categorical data, and mean ± SD was used to express continuous data. The unpaired t-test was used to compare continuous variables. A multiple logistic regression model included variables with clinical relevance or P-values <0.2 on univariate analysis. The P-value <0.05 was considered as statistically significant.

Result:

There were 162 participants, of which 81 had hypertension and 81 were controls. Among 162 patients, 53 patients are found to have normal LFS value>1.33 and remaining 109 patients had abnormal LFS values <1.33.

Table 1: Descriptive and Clincal Data

	Mean ±SD
EF%	62.43 ±2.37
E	0.64 ±0.16
A	0.73 ±0.18
E/A	0.98 ±0.59
DT	183.27 ±33.70
Sm	0.11 ±0.14
Em	0.10 ±0.07
Am	0.12 ±0.08
Em/Am	0.88 ±0.33
LFS(s)	6.40 ±0.90

LFS (d)	7.59 ±4.37
LFS	0.13 ±0.14

Table 2: Conventional echocardiographic parameters of the 2 groups

Parameters	GROUPS			
	HTN	CONTROLS		
	Mean±SD	Mean±SD	t-Value	P-Value
EF%	62.04±2.38	62.81±2.30	-2.114	0.036
E	0.64±0.17	0.63±0.16	0.095	0.924
A	0.77±0.19	0.68±0.15	3.141	0.002
E/A	0.95±0.74	1.01±0.39	-.599	0.550
DT	188.95±36.35	177.58±29.98	2.172	0.031
Sm	0.09±0.02	0.13±0.19	-2.009	0.046
Em	0.09±0.03	0.11±0.09	-2.222	0.028
Am	0.11±0.03	0.13±0.11	-1.921	0.057
Em/Am	0.86±0.30	0.90±0.37	-0.728	0.468
LFS(s)	6.61±0.86	6.19±0.89	3.085	0.002
LFS (d)	8.02±6.12	7.16±0.79	1.262	0.209
LFS	0.09±0.04	0.17±0.19	-3.562	0.000

Table 2 lists the conventional echocardiographic data of patients with systemic hypertension and controls. The results showed that hypertensive patients had significantly greater EF, A, DT, SM, EM, AM, and LFS (P < 0.001).

Table 3: CROSSTABS

LFS * DD * HTN Crosstabulation						
HTN				DD		Total
				Normal	Abnormal	
Present	LFS	LFS > 0.133 Normal	Count	0	19	19
			Row %	.00	100.00	100.00
			Col %	.00	25.00	23.46
		LFS ≤0.133 Abnormal	Count	5	57	62
			Row %	8.06	91.94	100.00
			Col %	100.00	75.00	76.54
	Total		Count	5	76	81
			Row %	6.17	93.83	100.00
			Col %	100.00	100.00	100.00
Absent	LFS	LFS > 0.133 Normal	Count	5	29	34
			Row %	14.71	85.29	100.00
			Col %	35.71	43.28	41.98

		LFS ≤0.133 Abnormal	Count	9	38	47
			Row %	19.15	80.85	100.00
			Col %	64.29	56.72	58.02
	Total		Count	14	67	81
			Row %	17.28	82.72	100.00
			Col %	100.00	100.00	100.00
Total	LFS	LFS > 0.133 Normal	Count	5	48	53
			Row %	9.43	90.57	100.00
			Col %	26.32	33.57	32.72
		LFS ≤0.133 Abnormal	Count	14	95	109
			Row %	12.84	87.16	100.00
			Col %	73.68	66.43	67.28
	Total		Count	19	143	162
			Row %	11.73	88.27	100.00
			Col %	100.00	100.00	100.00

Table 3 shows the Longitudinal fractional shortening was 0.09± 0.04 in patients with Hypertension and 0.17±0.19 in normal controls. The two groups differed with respect to the mean LFS value, which were lower in patients with Hypertension than in normal controls. We considered from our study population LFS values > 0.133 to be normal.

➢ Among 81 patients with hypertension 19 patients had normal LFS values with diastolic dysfunction Remaining 62 patients had abnormal LFS values whereas 57 patients with diastolic dysfunction and 5 with normal diastolic function.

In patients with hypertension, 76 patients had diastolic dysfunction and 5 patients had normal diastolic function.

➢ Among 81 controls, 34 patients had normal LFS value; Among the 34 patients,29 patients had Diastolic dysfunction and the remaining 5 patients had normal diastolic function.

The Remaining 47 patients had abnormal LFS values; Among them 38 patients had diastolic dysfunction and the remaining 9 patients had normal diastolic function.

In the control population, 67 patients had diastolic dysfunction and 14 patients had normal diastolic function.

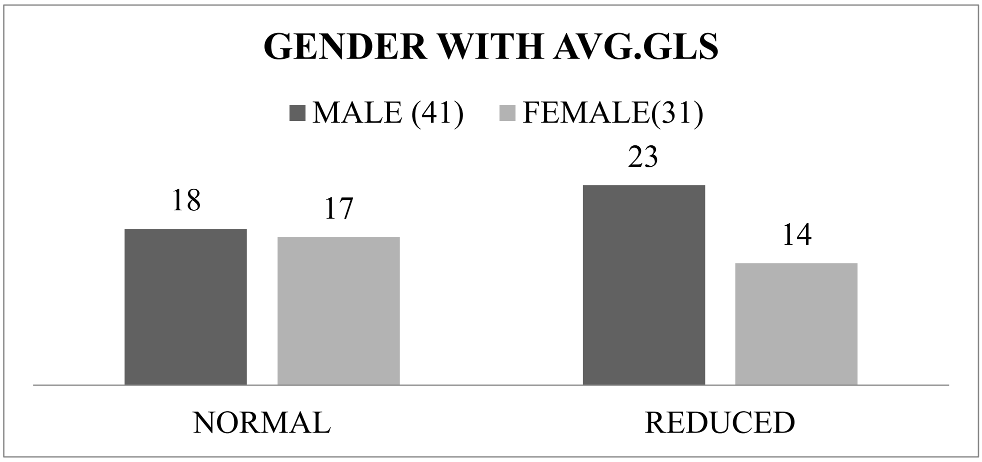
➢ In our study population of 162 patients; 53 patients are found to have normal LFS values > 1.33, among them 48 patients had diastolic dysfunction and 5 patients had normal diastolic function.

➢ The Remaining 109 patients had Abnormal LFS values ≤1.33, among them 95 patients had diastolic dysfunction and14 patients had normal diastolic function.

Overall, 162 patients, 19 patients were found to have normal diastolic function; 143 patients were found to have abnormal diastolic function.

Longitudinal fractional shortening was 0.09± 0.04 in patients with Hypertension and 0.17±0.19 in normal controls. The two groups differed with respect to the mean LFS value, which were lower in patients with Hypertension than in normal controls. The diastolic function parameters were not significantly correlating with LFS value in patients with hypertension.

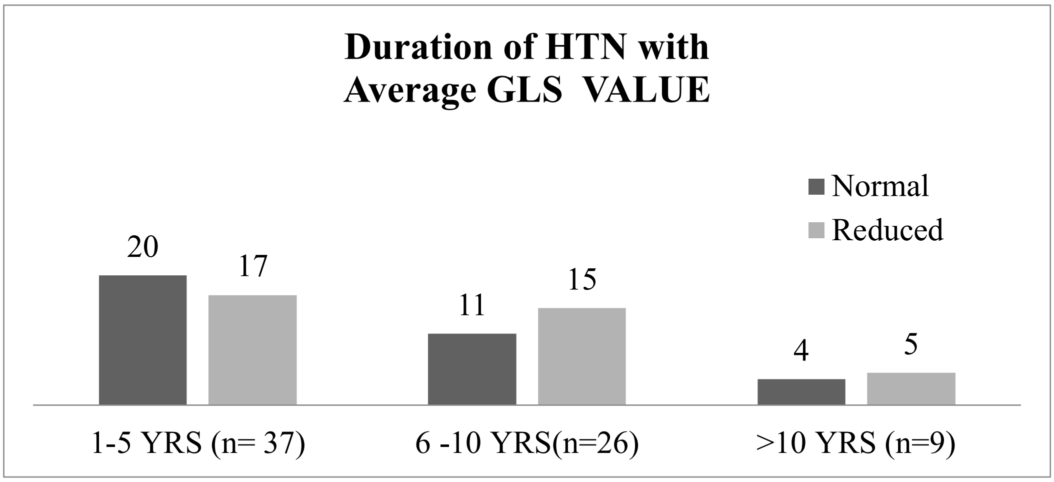
Table 4: Average GLS versus Gender:



In this study, 43.91% of male patients had normal GLS value whereas 56.09% of male patients had reduced GLS value

In hypertensive female patients, 54.84 % had normal GLS value and 45.16% had reduced GLS value

Table 5: Duration of HTN with Average GLS:



In Patients with disease duration of 1-5 years, 54.05% of patients had normal longitudinal strain value and 45.95% of patients had reduced GLS value.

Among 26 patients with disease duration of 6-10 years, 42.31% of patients had normal GLS value and 57.69% of patients had reduced GLS value.

In patients with duration of more than 10 years ,44.44% of patients had normal average GLS value and 55.56% of patients had reduced average GLS value.

Table 6: Strain EF with Strain value:

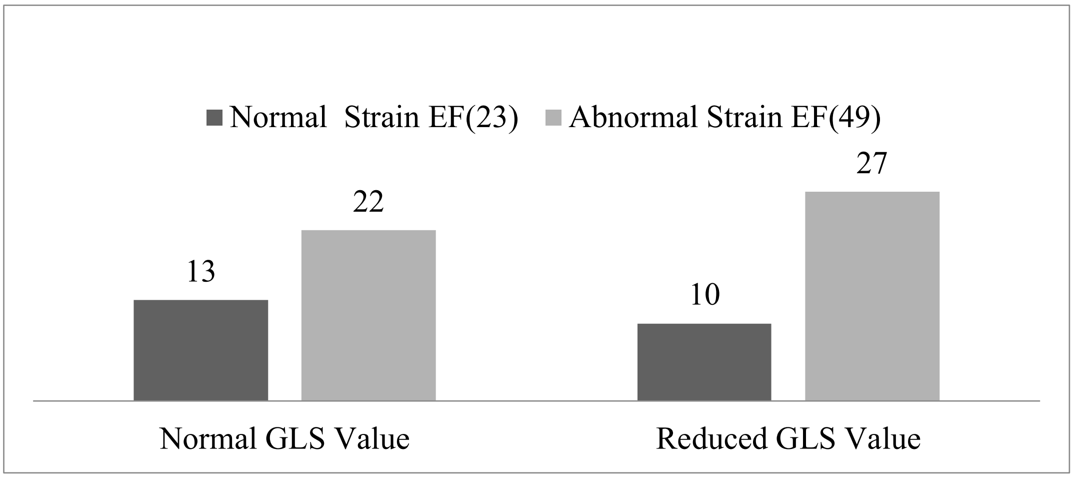
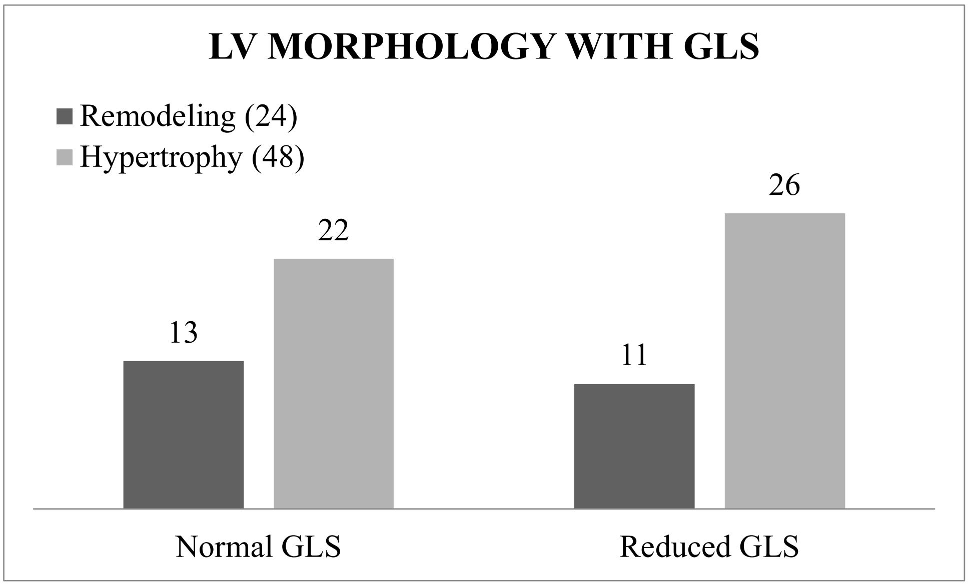


Table 6 shows, among 72 patients, 23 patients (31.94%) had strain detected normal Ejection Fraction and 49 patients (68.06 %) had reduced strain ejection fraction.

Table 7: LV morphology with GLS:



Concentric remodeling was referred as normal Left ventricular mass with increased relative wall thickness. In 24 patients with LV morphology of concentric remodeling 11 patients (45.83%) had reduced strain value.

Among 72 patients, 48 patients with LV morphology of concentric hypertrophy (both LV mass and relative wall thickness increased) in whose 54.17% of patients showed abnormal longitudinal strain value.

Table 8: COMPARISON BETWEEN NORMAL GLS AND REDUCED GLS

	Mean ±SD	Mean±SD	P-Value
Male	17.36±1.917	14.27±0.968	<0.0001
Female	18.24±1.476	14.20±0.966	<0.0001
LVH	17.87±1.815	14.12±0.993	<0.0001

Conc. Remodeling	17.65±1.697	14.53±0.829	<0.0001
LVMI	119.5±21.149	125.6±28.750	(ns)
RWT	0.598±0.105	0.583±0.086	(ns)

Table 8 shows, In LVH patients, LV mass index was higher in patients with subclinical LV systolic dysfunction than in patients with normal GLS value.

Discussion:

Our study shows the two groups differed with respect to the mean LFS value, which were lower in patients with Hypertension than in normal controls. The diastolic function parameters were not significantly correlating with LFS value in patients with hypertension. If global EF and fractional shortening (FS) are normal in hypertensive patients, then LV systolic function is typically regarded as normal. However, regional systolic anomalies are not considered by the EF and FS, which solely represent the global heart contractile activity. (14)

In our current study, normal GLS was statistically significant with reduced GLS. Arterial hypertension and hypertensive heart disease are characterized by increased LV afterload and interstitial fibrosis, which are linked to decreased LV longitudinal function as measured by GLS (10,11,12) and this is evident in patients with normal LV geometry and LVEF as well as those with LVH. (13)

In 2014, Tulika et al. studied 72 hypertension patients with intact EF. They suggested that the early signs of LV systolic dysfunction in hypertension with apparently normal LV systolic function was in the axial axis, while systolic shortening in circumferential and radial axes remained conserved. (15)

Although not statistically significant, LVMI, RWT was higher in hypertension patients with subclinical LV systolic dysfunction in reduced GLS than in hypertensive patients with normal GLS. (control, hypertension with normal GLS, and hypertensive with reduced GLS), may help to explain this.

A study done by Saghir et al indicated that hypertensive persons with LVH had significantly decreased systolic longitudinal strain and strain rate values compared with control subjects. (16) Also, in the study by Tulika et al, LVMI and DBP were revealed to be independent predictors of lower global strain in longitudinal axis. (15) Narayanan et al reported that LVMI and DBP were independent predictors of reduced global strain in longitudinal axis. (17) Additionally, Schillaci et al. showed that even in the absence of target organ damage, there is a persistent correlation between elevated LV mass and cardiovascular risk in critical HTN. (18) Compared to patients with normal GLS, hypertensive patients with lower GLS had a considerably higher BMI. This conclusion is comparable to that of the study by Ballo et al, which comprised 112 hypertension participants and revealed independent negative correlation between BMI and myocardial contractility. (19)

Multidirectional LV strain is associated with characteristics of LV diastolic function and LV filling pressure (E/A, E/e′). (20) Lee et al. tracked 95 hypertension patients for 7 years and observed no change in GLS between individuals who experienced cardiovascular events and those who did not. (21)

Conclusion:

In conventional echocardiography M-Mode Ejection fraction of LVH patients was normal or even increased but 2D LV longitudinal strain unmasked the underlying LV dysfunction which can useful to prevent patient from worsening of disease-causing heart failure or end organ damage.

In our study, longitudinal strain value was significantly reduced in 51.39% patients and strain ejection fraction was attenuated in 68.06% with left ventricle hypertrophy which shows significant subclinical or intrinsic LV systolic dysfunction.

The LFS does not correlate with Diastolic dysfunction in patients with hypertension and it is not a sensitive index for evaluating long axis systolic function in hypertensive patients. We found that prevalence of Diastolic Dysfunction was found to be similar in patients with normal and abnormal longitudinal fractional shortening in both hypertension and normal groups.

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