Addis Ababa University College of Health Science Department of Internal Medicine

Myocardial Performance in Left Ventricular Hypertrophy and Clinical Correlates Among Hypertensive Patients Having Follow-up at Tikur Anbessa Specialized Hospital, Addis Ababa Ethiopia

By Hayat Oumer (MD, Internist, Adult Cardiology Fellow)
Advisors: Dejuma Yadeta (MD, Internist, Cardiologist, Assoc. Professor)
Senbeta Guteta (MD, MPH, Internist, Cardiologist, Professor)

A research Thesis Submitted to Addis Ababa University College of Health Sciences for Partial Fulfillment of Subspeciality Certificate in Adult Cardiology

March 2024

Acknowledgment

I would like to thank Addis Ababa university college of health science TASH department of internal Medicine in accepting my research topic and giving me the opportunity to practice and contribute. I would also like to extend my deepest gratitude to my clinical advisors Dr. Dejuma Yadeta and professor Senbeta Guteta for their unwavering support and guidance in the conception and preparation of this paper.

Abstract

Background: In hypertensive patients with left ventricular hypertrophy, myocardial performance index, is a diagnostic tool that asses both diastolic and systolic dysfunction that cannot be otherwise detected by conventional methods.

Objective: To determine the relationship between myocardial performance index with left ventricular hypertrophy and its clinical corelates among hypertensive patients at TASH.

Methods: A prospective cross-sectional study from September 15, 2023-December 15,2023 at Tikur Anbessa Specialized hospital. All consecutive patients with hypertension and without exclusion criteria were recruited. Association between left ventricular hypertrophy and myocardial performance index was assessed along other clinical corelates.

Results: 64 / 93 participants (68.8%) were females. LVH was detected only in 14/93(15%). 79/93(84.9%) of participants. No association was detected between myocardial performance index and left ventricular hypertrophy. Both systolic and diastolic blood pressure influence development of an abnormal myocardial performance.

Conclusion: High blood pressure is associated with abnormal myocardial performance but not left ventricular hypertrophy.

Key words: Left Ventricular Hypertrophy, Myocardial Performance Index, Hypertension

Contents

List of Figures

List of tables

Acronym

2D: 2 Dimension

3D: 3 Dimension

ASE: American society of echocardiography

DBP: Diastolic blood pressure

ET: Ejection time

hs-cTnT: High sensitivity cardiac troponin

IVCT: Isovolumic contraction time

IVRT: Isovolumic relaxation time and

IVSDd : Interventricular septal dimension in diastole

LV: Left ventricle

LVEF: Left ventricular ejection fraction

LVH: Left ventricular hypertrophy

LVIDd: Left ventricular internal dimension in diastole

LVMI: left Ventricular mass index

LVPWDd: Left ventricular posterior wall dimension in diastole

MPI: Myocardial performance index

RWT: Relative wall thickness

SBP: Systolic blood pressure

TDI: Tissue doppler imaging

TI: Tei index

USA: United States of America

1. Introduction

1.1 Background

Hypertension, the leading cause of atherosclerotic cardiovascular disease and death worldwide is defined as having high blood pressure above 140/90(1). The prevalence of hypertension is increasing in low and middle income countries including Ethiopia and recent systematic review shows 19.6% prevalence of hypertension among Ethiopian population with higher prevalence among the urb an population (23.7% vs 14.7%(2,3). Left ventricular hypertrophy (LVH) is the consequence of uncontrolled hypertension where there is an increase in left ventricular mass, in response to pressure overload, (4). Increased hemodynamic load in the heart can lead to compensatory response such as increased crossbridge formation according to Frank Starling Law, augmentation of muscle mass to bear the extra load and recruit neurohormonal mechanisms to increase contractility (4).

American Society of echocardiography (ASE) recommends assessment of LV hypertrophy using LV mass for all hypertensive patients. There are different methods to calculate LV mass in linear, 2D, and 3D echocardiography. The linear measurements rely on measurements of LV internal dimension, interventricular septal (IVS) thickness and posterior wall (PW) thickness in diastole and values greater than 9 for women and greater than 10 for men are considered abnormal (5). Left ventricular mass (LVM) is then calculated from LV linear dimensions as $\mathrm{LVM} = 0.8\,\{1.04[(\mathrm{LVIDd} + \mathrm{PWDd} + \mathrm{IVSDd})3\,(\mathrm{LVIDd})3]\} + 0.6\,\mathrm{g}.)$. Extensive validation of this formula has been performed from necropsy specimens(6) . The normal ranges of LVM index (LVMI) are $< 95\ \mathrm{g}/m^2$ for women and $< 115 g/m^2$ for men according to the ASE chamber quantification guideline (7).

Myocardial performance index (MPI) also known as Tei index, first used initially by Tei and his co-workers in 1995 is a simple, noninvasive, easy-to-estimate, and reproducible echocardiographic measurement that is independent of arterial pressure, heart rate, ventricular geometry, atrioventricular valve regurgitation, afterload, and preload(8). It is calculated as isovolumic contraction time (IVCT) + isovolumic relaxation time (IVRT)/ejection time (ET) and includes both systolic and diastolic time intervals to assess the global cardiac dysfunction. MPI is a useful tool for evaluating cardiac function in various clinical conditions, such as heart failure, myocardial

infarction, and cardiomyopathy. A higher MPI value indicates poorer cardiac function, while a lower MPI value indicates better cardiac function. Presence of systolic dysfunction results in a prolongation of isovolumic contraction time (IVCT) and isovolumic relaxation time (IVRT) while the ET shortens making the Tei index > 0.4(5,7,9) . In clinical conditions where there is subtle systolic dysfunction that is not detectable on routine echocardiography, MPI combining both systolic and diastolic function assessment can be a very helpful tool to asses LV performance with just a single parameter as it has been determined to be an accurate clinical index of LV global function (8,10). MPI is also proven to corelate with invasive measurement derived assessment of LV systolic and diastolic function (10). Moreover, abnormal MPI is an independent predictor of adverse cardiovascular outcome including death (11).

1.2 Magnitude of the problem

LVH is very common in patients with hypertension with a prevalence that ranges from 42.7 % in cross sectional community-based studies to 71.7 % in hospital-based studies (12,13). The wide variability in prevalence can also be explained by the different sets of criteria and different setups used in different studies.

It has been established that echocardiographically estimated left ventricular mass and geometry are important risk factors for adverse cardiovascular out comes due to progressive ischemic compromise, systolic and /or diastolic dysfunction, arrhythmias and sudden cardiac death. According to the study from New York USA, in older individuals with hypertension, presence of LVH was associated with 3.33 times increased risk of coronary events, 2.76 times increased risk of new stroke, and 3.69 times new congestive heart failure.(14) . In addition, the Left Ventricular Mass and Cardiovascular Morbidity in Essential Hypertension (MAVI) study revealed a continuous and strong relationship between LV mass and subsequent cardiovascular morbidity. Therefore, the detection, prevention, and reversal of LVH are important goals in hypertension management (15).

In hypertensive patients with normal LVEF, MPI can be considered as an indicator of diastolic dysfunction and an early indicator of systolic dysfunction that cannot be otherwise detected by conventional methods (16). Moreover, effective treatment of hypertension is associated with improvements in MPI in patients with hypertensive left ventricular hypertrophy according to SILVIHIA (the Swedish Irbesartan in Left Ventricular Hypertrophy Investigation Versus Atenolol)

study(17) . This study aims to see the relationship between LV hypertrophy as assessed by LV mass index and myocardial performance index.

2. Literature review

2.1.Myocardial performance in LVH

Myocardial performance index was first used in individuals with in individuals with dilated cardiomyopathy by Tei and his colleagues and has shown to be a useful indicator of both systolic and diastolic function in such population(8). Subsequently the role of MPI in hypertensive individuals was studied by Seon Min Kang and his colleagues in 1998 showed significantly higher MPI values among hypertensive individuals(18).

To see the effect of hypertension and LVH on myocardial performance index using tissue doppler derived indices (TDI), a study from Turkey assessed 48 subjects who were hypertensive and 20 subjects who were normotensive. Subjects were further categorized in to three groups as having hypertension and LVH in group one, hypertension without LVH in group two and those without hypertension as a control group. The results revealed abnormal Tei index in hypertensive individuals in general but with greater extent in patients with LVH than those without LVH(19).

Another cross-sectional study from Mersin Turkey with an objective to see the association between high-sensitivity troponin T, left ventricular hypertrophy, and myocardial performance index on 537 consecutive newly diagnosed hypertensive patients showed an increase in Tei index among patients with LVH. Patients were classified into high and low MPI using cut off value of 0.4 and those in the high MPI group, were older and had higher systolic and diastolic blood pressure, higher values of LVPWDd, IVSDd, RWT, LVMI, IVRT, and IVCT, and lower ET values compared with patients in the low MPI group. Systolic and diastolic blood pressures (SBP, $r = 0.264$, $p < 0.001$), (DPB r=0.282, p<0.001), serum creatinine level ($r = 0.238$, $p < 0.001$), uric acid ($r = 0.160$, $p = 0.005$) RWT ($r = 0.256$, p<0.001), LVMI (r=0.509, p<0.001), and hs-cTnT ($r = 0.652$, $p < 0.001$) have a significant association with MPI values (21).

A study done in Egypt by Elmasry and colleagues on the effect of left ventricular geometry on myocardial performance index in hypertensive patients studied 70 subjects (60 hypertensive Patients and 10 control subjects). Concentric hypertrophy was the commonest pattern of abnormal geometry (36.7%), followed by eccentric hypertrophy (20%), and concentric remodeling (15%). There was a direct and statistically significant correlation between MPI and LVPWDd, IVSDd, LVIDd, LVISd, LV mass & LVMI. The highest MPI was noted among patients with concentric

hypertrophy (0.78 ± 0.19), then eccentric hypertrophy (0.72 ± 0.12) and lowest in concentric remodeling patients (0.64 ± 0.24) (13).

In another cross-sectional study from Nigeria to assess the relationship between tei index and left ventricular geometric patterns in a hypertensive population, an abnormal tei index was detected in 26.8% from a total of 142 subjects over a year period. There was no significant association between any LV geometric pattern as assessed by remodeling type and abnormal Tei index(20) .

2.2. Clinical Profiles That Influence LV Remodeling

According to the Swedish Irbesartan in Left Ventricular Hypertrophy Investigation Versus Atenolol (SILVIHIA) study which studied the effect of antihypertensive treatments on MPI in 93 patients with LVH, peripheral vascular resistance and LV systolic function were the two parameters that correlate with an improvement in MPI. However, changes in systolic or diastolic blood pressure, E/A-ratio, left ventricular mass index, relative wall thickness, or heart rate showed no significant associations with changes in MPI (17).

A study from Japan that assed the relationship between Tei index and echo and clinical parameters in 219 hypertensive and 100 normotensive individuals in Kagawa Japan with the mean age of 67±11 and 69±7 for normotensives and hypertensives respectively showed no statistically significant difference. LVMI and Doppler indices of diastolic dysfunction did not corelate with Tei index and but it showed that only E velocity and RWT are the independent determinants of Tei index in hypertensive patients(11).

The presence of abnormal MPI in hypertensive individuals is a settled issue, however the association between LVH and MPI values is inconsistent in different studies. This study aims to determine association between MPI values and LVH among hypertensive patients and factors that may influence it.

3. Objective of the study

3.1. General objective

To determine myocardial performance as assessed by Tei index (Myocardial performance index) among hypertensive patients with LVH and its clinical correlates having follow-up at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia

3.2. Specific objectives

- ✓ To determine myocardial performance in LVH using Tei index among hypertensive patients having follow up at Tikur Anbessa specialized hospital, Addis Ababa Ethiopia
- ✓ To identify correlation between clinical profiles and myocardial performance index in patients with LVH.

4. Significance of the study

Diastolic dysfunction is almost always present in patients with hypertensive heart disease while systolic function is preserved, if not hyperdynamic, on conventional echocardiographic studies. The left ventricular myocardial performance index (MPI) is a better marker of both left ventricular systolic and diastolic dysfunction in hypertensive patients with preserved LVEF(16). Abnormal MPI and LVH are associated with adverse clinical outcomes including heart failure and CV death(17) whereas, antihypertensive drugs have favorable impact on regression of both abnormal MPI and LVH . Therefore, better understanding of hypertension related LV dysfunction will lead to optimization of the management of HTN.

5. Materials and Method

5.1. Study Design and Setting

A prospective cross-sectional study was conducted at Tikur Anbessa specialized hospital, Addis Ababa Ethiopia from September 15, 2023 to December 15, 2023.

Established in 1972, Tikur Anbessa specialized hospital is the largest government hospital and teaching medical institution in Ethiopia with the capacity of more than 700 beds. The cardiology unit in the department of internal medicine is the most burdened unit that serves more than 2000 patients in the outpatient clinics. cardiology fellows and consultant cardiologists perform more than 400 echocardiography every month.

5.2. Source Population

All patients with hypertension having follow up at TASH during the study period were considered as source population.

5.3. Study population

All patients with hypertension and appointed for an echocardiography at TASH cardiac unit during the study period were study population.

5.4. Sample size

All consecutive hypertensive were considered in this study. using single population proportion method and taking 50 % prevalence of abnormal MPI in LVH as there is scarcity of data to use as a reference, the calculated sample size was 38 4. However, the limited duration of the study and the limited number of patients that come to the echo lab forced us to include all consecutive patients with hypertension who came to the echocardiography lab during the specified study period.

5.5. Inclusion and exclusion criteria

Inclusion criteria: all patients with HTN and above the age of 40 that came to TASH echo lab and gave informed consent.

Exclusion criteria: individuals with LV systolic dysfunction, arrythmia, significant mitral valve lesion (22), significant aortic stenosis.

5.6. Variables in the study

Dependent variable: Myocardial Performance Index was a dependent variable in the present study which is obtained by Tei index.

Independent variables

Clinical and demographic variables: Age, Sex, BMI, SBP, DBP, duration of HTN diagnosis, history of treatment for HTN, history of DM, duration of DM if present, history of CKD and duration of CKD if present were considered as candidate independent variables.

Echocardiographic variables: LVMI, LV geometry by RWT (concentric LVH, eccentric LVH, concentric remodeling, normal), grade of diastolic dysfunction senior cardiology fellows at TASH collected the data

5.7. Data Collection

Echocardiography

Standard two-dimensional and Doppler echocardiography was performed using Vivid E9 GE Medical System, with a 2.0–3.5-MHz transducer by cardiology fellows with a supervision of cardiologists. LV end-diastolic diameters (LVIDd), end-diastolic interventricular septal thickness (IVSDd), and end-diastolic LV posterior wall thickness (PWDd) was measured at end diastole according to the established standards of the American Society of Echocardiography(7) . Left ventricular mass (LVM) was calculated using linear method cube formula which is LVM = 0.8 $\{1.04[(LVIDd + PW + IVSd)3\ (LVIDd)3]\} + 0.6\ g$. LVM was indexed to BSA (LVM/body surface area.). LV mass index (LVMI) was considered as normal if 43-95g in females and 49 -115g in males. Diagnosis of LV hypertrophy was made if LVMI was > 95 gm/m² for females and > 115 gm/m² for males (7). Relative wall thickness (RWT) was measured at end diastole as the ratio of $(2 \times LVPWDd)/LVIDd$. RWT of 0.42 or less was considered normal. RWT Values greater than 0.42 were considered abnormal. Diagnosis of concentric LVH was made if RWT was abnormal and LVMI was high. Diagnosis of eccentric LVH was made if LVMI was high but RWT was normal. Concentric remodeling was diagnosed if RWT was high but LVMI was normal(5) . The pulsed-wave Doppler recording of the mitral inflow velocities was obtained from apical four-chamber views by placing the sample volume between the tips of the mitral leaflets (22). Conventional Doppler indices was measured, including: the peak early (E) and late (A) trans mitral filling velocities and the ratio of early to late peak velocities (E/A) and deceleration time. The

isovolumic relaxation time (IVRT) was measured from closure of the aortic valve to opening of the mitral valve. The isovolumic contraction time (IVCT) was obtained from closure of the mitral valve to opening of the aortic valve. The ejection time (ET) was measured from the opening to the closure of the aortic valve on the LV outflow velocity profile (7). MPI was determined by using the equation: MPI=(ICT+IVRT)/ET and values greater than 0.4 was taken as abnormal (7,8). Tissue Doppler imaging was performed with sample volume placed at the lateral wall of the mitral annulus from the apical four-chamber view to asses e'(22) . Measurements were calculated from an average of three consecutive cardiac cycles. LA volume was measured using biplane volumetric method in both apical four and two chamber views (7).

In addition to the echocardiographic parameters, clinical data like age, sex, BMI, blood pressure at the time of data collection, history of drug treatment for high blood pressure, duration of hypertension diagnosis, history of diabetes mellites and CKD along with treatment history were collected through a structured interview initially prepared in English and then translated to Amharic. A Kobo Toolbox based mobile data collection tool was used to gather all required data.

5.8. Data Quality control

A 2 days training was given for data collectors about how the data be collected using Kobo Toolbox mobile data collection tool and the objective of the study. All components of data quality were checked by the supervisors and the author of the research.

5.9. Statistical Analysis

The data collected in Kobo Toolbox were exported to Stata software version 14 for further management and analysis. Representation of categorical data were done using the frequency and percentage. The continuous type of data was reported in different ways of descriptive statistics like mean and standard deviation. Categorical variables were compared between the groups using the chi-square (X^2). An independent samples *t* test was used in the analysis of continuous variables. All significant ($p < 0.05$) variables in the univariate analysis were candidate variables for further regression analysis, then variables with $p<0.05$ were included in the final model.

Since the dependent variable myocardial performance index is continuous variable, linear regression analysis was employed to identify which independent variable has a potential to affect the response variable (MPI)

5.10. Ethical consideration

Ethical clearance was obtained from Institutional Review Board (IRB) of Tikur Anbessa Specialized Hospital department of internal medicine and individual informed consent was obtained from each participant.

5.11. Operational definition

LVH: LVMI > 95 gm/m² for females and 115 gm/m² for males using the linear measurements(7).

Hypertension: Systolic blood pressure ≥140mmHg or diastolic BP ≥90 (23).

Reduced EF: EF<50% (24)

Preserved EF: EF ≥ 50 % (25)

Impaired Myocardial performance: MPI > 0.4 will be taken as impaired (7,8)

Arrythmia: tachyarrhythmia and excessive bradycardia with beat-to-beat variability including high degree AV block (22).

Significant mitral valve lesion: more than mild rheumatic MR or MS, mitral annular calcification (22).

Significant Aortic Stenosis: more than moderate AS that may influence LV remodeling(7).

6. Results

6.1. Descriptive results

6.1.1. Clinical profile

A total of 93 patients were included of whom sixty-four (68.8%) were females while 29 (31.2%) were males. The mean age of participants was 59.4 (SDV 10.03) with minimum age of 40 and maximum age of 88.

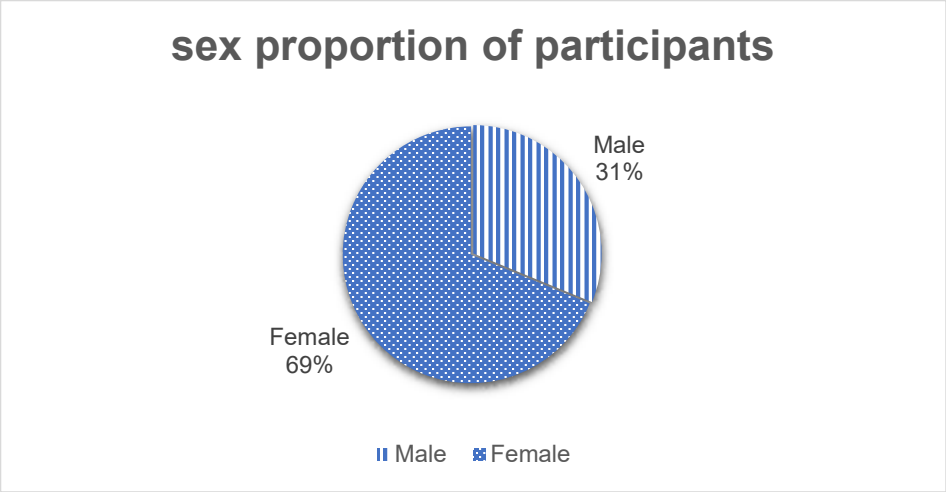

Figure1: sex proportion of respondents, n=93, hypertensive patients at TASH 2023

Diabetics accounted for 47 (50.54%) participants and 11 (11.83%) had chronic kidney disease. Regarding body mass index of respondents, 31 (33.33%) had normal BMI, 33 (35.48%) of them were overweight and the remaining 29 (31.18) were obese with a mean BMI of 27.85± 4.9 (see figure 2, table 1 and supplementary data).

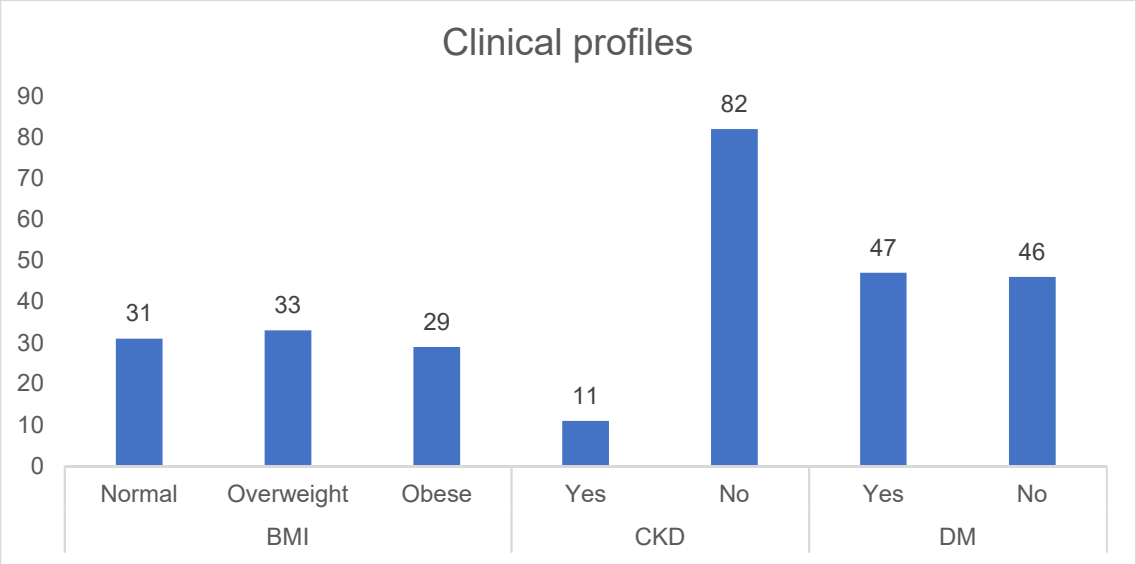

Figure 2: clinical profile of patients with hypertension that underwent echocardiography, TASH 2023

Table 1: Clinical status of respondents among hypertensive patients, n=93, TASH 2023.

covariate	category	Freq.	Percent
sex	Female	64	68.8

	Male	29	31.2
Treatment of HTN	Yes	90	96.77%
	No	3	3.23%
Blood pressure	<120/80	6	6.45%
	120/80-139/89	32	34.41%
	140/90-159/99	40	43.01%
	>159/99	15	16.13%
BMI	Normal	31	33.33%
	Overweight	33	35.48%
	Obese	29	31.18%
Diabetes status	Yes	47	50.4
	No	46	49.6
CKD	Yes	11	11.8
	No	82	88.2

The mean duration of hypertension was 8 years with duration less than 5 years from diagnosis in 49(52 %). The mean systolic blood pressure of participants was 141 mmHg (SDV17.98 mmHg) with a range of SBP from 95 mmHg to maximum 190 mmHg. Whereas, the mean DBP was 82.28±10.45(see table two). Ninety (96.77%) were on anti-hypertensive treatment while only three patients were not on treatment during the study period. When we have a look on to blood pressure control, 32 (35.5%) had their blood pressures under <140/90, was 6 patients < 120/80 (6.6%) while 55 (61%) had SBP > 140 mmHg while on antihypertensive management.

Table 2: Descriptive measures of continuous variables, n=93, TASH, 2023.

Variable	Mean	Std. Dev.	Min	Max
Age	59.4	10.03	40.00	88.00
SBP	141.45	17.98	95.00	190.00
DBP	82.28	10.45	60.00	109.00
BSA	1.82	0.19	1.45	2.45
BMI	27.85	4.93	19.14	39.06

6.1.2. Echocardiographic data

From the total 93 participants 70(75%) participants had LV wall thickness of > 9 for females and > 10 for males. However, when LVMI was used only 14 (15.1%) had evidence of LVH using the LVMI cutoff >95 gm/m² for females and > 115 gm/m² for males while the remaining 56 (60.2%) of all subjects had only concentric remodeling (high RWT with normal LVMI) (table 3, figure 3). There is a statistically significant discrepancy in diagnosing LVH using LV wall thickness criteria versus LVMI (see table 10 on the appendix). This removed the diagnosis of LVH from 80 % of the participants that would have been otherwise diagnosed as having LVH based on their LV wall thickness. Most of the subjects 63 (67.7%) had diastolic dysfunction while 30 participants (32.3%) didn't meet the criteria for diastolic dysfunction. When we see the MPI, 79 (84.9%) had abnormal MPI (>0.4) while 14 (15.1%) had normal (<0.4) MPI. The mean MPI was 0.55 (SDV 0.14) with minimum 0.31 and maximum 0.95.

Table 3: Echocardiography Characteristics of the study participants, among hypertensive patients at TASH, 2023, n=93

Variable	Category	count	Percent
LVMI	Normal	79	84.9%
	High	14	15.1%
RWT	Concentric hypertrophy	13	14.0%
	Eccentric hypertrophy	1	1.1%
	Concentric remodeling	56	60.2%
	Normal geometry	23	24.7%
Diastolic dysfunction	Yes	63	67.7%
	No	30	32.3%
MPI	Normal	14	15.1%

	Abnormal	79	84.9%

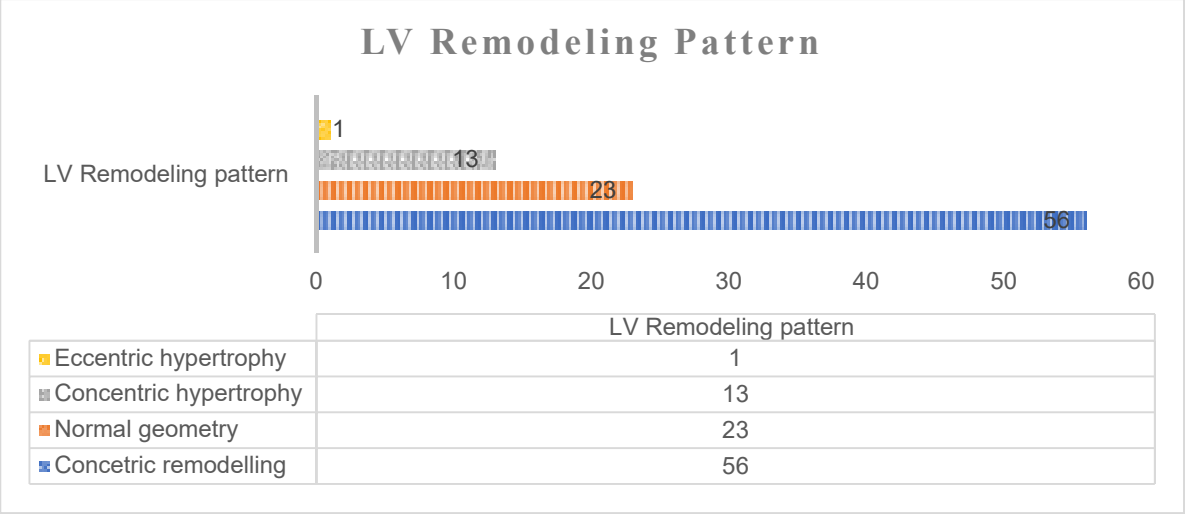

Figure 3:LV remodeling pattern using relative wall thickness, n= 93, TASH 2023

6.2. Association between clinical variables and MPI

This study tried to see association between LVMI and MPI along with clinical variables regarding the abnormality of myocardial performance index. As indicated in Table 4, there is no difference between males and females, treatment status of patients, DM and non-DM, CKD and non-CKD and diastolic dysfunction status at 95% confidence level of Chi2 distribution.

Table 4: Association between clinical characteristics with MPI (n=93) among hypertension patients at TASH 2023.

variable	category	MPI		total	Chi2 (C-1)	P-value
		Normal	Abnormal			
Sex	Male	5	24	29	0.1577	0.691
	Female	9	55	64		
History of treatment for HTN	Yes	14	76	90	0.5494	0.459
	No	0	3	3		
Presence of DM	Yes	8	39	47	0.2877	0.592
	No	6	40	46		

Presence of CKD	Yes	2	9	11	0.0955	0.757
	No	12	70	82		
Diastolic dysfunction	Yes	12	51	63	2.4361	0.119
	No	2	28	30		

Abbreviation: MPI myocardial performance index, C-l degree of freedom of Chi2 distribution with C number of category

Table 5: All candidate independent variables in the regression analysis, TASH 2023

logmpi	$\hat{\beta}$	Std. Err.	t	P Value	[95% $\hat{\beta}$ Interval]
Age	0.0006563	0.0012764	0.51	0.609	-0.0018829- 0.0031954
Gender	0.0736651	0.0340309	2.16	0.033	0.0059668-0.1413634
SBP	-0.0020806	0.0007313	-2.84	0.006	-0.0035354-(-0.0006258)
DBP	0.0027797	0.0012672	2.19	0.031	0.0002589-0.0053005
BMI	-0.0042934	0.0038416	-1.12	0.267	-0.0119355-0.0033487
BSA	0.0554163	0.0993011	0.56	0.578	-0.1421253- 0.2529579
History_of_Treatment_HTN	0.038	0.069	0.550	0.586	-0.099-0.174
Presence_of_DM	0.004	0.024	0.170	0.864	-0.044-0.053
Presence_of_CKD	-0.024	0.038	-0.630	0.529	-0.100-0.052
LVMI	-0.0001434	0.000566	-0.25	0.801	-0.0012694- 0.0009827

$\hat{\beta}$ regression coefficient, t normal distribution with n-1 degree of freedom, _onst the intersection points of regression graph.

6.3. Linear regression analysis of association between MPI value and continuous variables:

Since the dependent variable myocardial performance index is continuous variable, linear regression analysis was employed to identify which independent variable has a potential to affect the response variable (MPI). First all independent variables were analyzed in the regression model against myocardial performance index then variables that had a maximum p-value were omitted from the model and the remaining variables were reanalyzed step by step. This step was continued until all remaining candidate variables had a p-value less than 0.05.

After all steps were done, none of variables were significant. Therefore, the normality of the response variables was checked and it was not normal. So, it was transformed to normal data using logarithm transformation method. Then, the regression analysis was made by all independent variables against the logarithm of MPI. The histogram on figure 3 shows that the response variable become normal after normalization using logarithm transformation made.

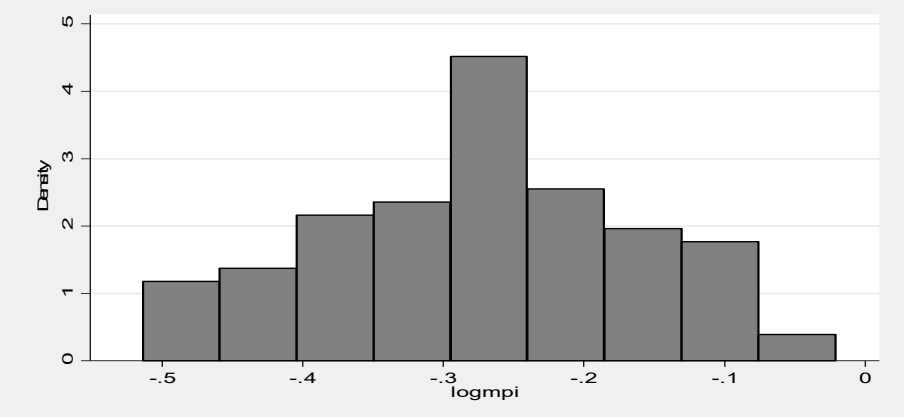

Figure 3: Histogram of log (MPI)

Then after normality checking, regression analysis was proceeded. As indicated in Table 5, Systolic blood pressure has a regression coefficient -0.002 [95 % CI -0.003, -0.001, p<0.007]. This revealed that when systolic blood pressure decreases by 1 mmHg, the logarithm myocardial performance index will decrease by 0.002. Another significant variable is diastolic blood pressure with regression coefficient 0.002 [95 % CI 0.0001, 0.005, p<0.035 This finding indicates that there is a positive association between diastolic blood pressure and myocardial performance index. When diastolic blood pressure increases by 1 mmHg, log myocardial performance index increases by 0.002.

Table 6: linear regression analysis of SBP, DBP and pulse pressure (n=93), TASH 2023

logmpi	$\hat{\beta}$	Std. Err.	t	$p > t$	[95% $\hat{\beta}$ Interval]
SBP	-0.002	0.001	-2.780	0.007	-0.003- -0.001
DBP	0.002	0.001	2.140	0.035	0.0001- 0.005
Pulse pressure	-0.00197	0.0006516	-3.02	0.003	-0.0032595- -0.0006707

SBP: systolic blood pressure, DBP: diastolic blood pressure,$\hat{\beta}$ regression coefficient, t normal distribution with n-1 degree of freedom, _onst the intersection points of regression graph.

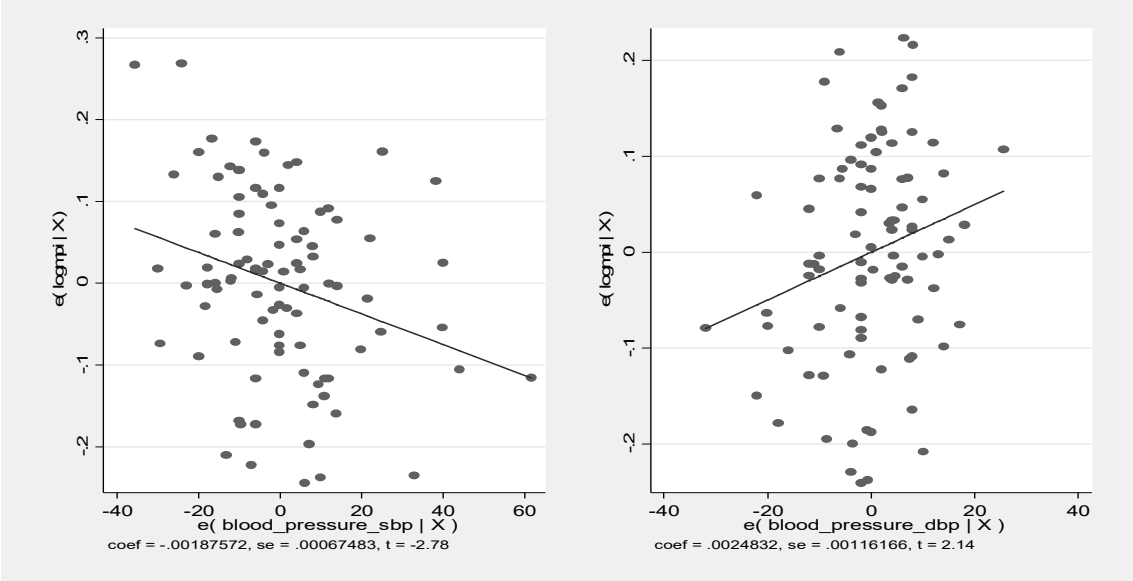

Figure 4: correlation of systolic and diastolic blood pressor with abnormal MPI, n=93, TASH 2023

7. Discussion

This study evaluated the association of hypertension related LVH with abnormal myocardial performance using myocardial performance index also known as Tei index.

The mean age of the participants in our study is slightly older than the study done in Nigeria by Kamilu et al (59.4± 10.3 vs 55.9±10.7)(23) and 10 years older than the mean age shown by study from turkey(18), whereas our patients are much younger than the ones from Japan(15) indicating possible geographical and genetic factors influencing age at development of hypertension.

Contrary to evidence from SILVIHIA study, study done in Japan by Hisashi and colleagues and Elamasry et al, an Egyptian study, where men accounted for majority of cases or are equal in proportion with females, we have majority of female participants(9,15,16).

Diabetes is a very common comorbid condition among hypertensive patients and we found 50.54% of patients to have diabetes which is higher than what is seen in a study from Japan where the prevalence of diabetes was 27%(15) and Nigeria by kamilu et al which is only 9 %(23). The high prevalence of diabetes in Addis Ababa and the higher proportion of obesity in our participants could explain the high prevalence of diabetes in our setting(24).

Evidence of LVH was present in only 15% of the participants while concentric remodeling was the commonest LV geometric change (60.2%) and normal LV geometry was present in 24.7 % of the participants. The prevalence of LVH in our study was found to be much lower than that from a community-based study in China where the prevalence of concentric LVH was 20.2 %, and concentric remodeling was less prevalent (24.7%) (8). Similar finding was seen in the Egyptian study where concentric LVH and concentric remodeling was present 36.7% and 15% respectively(9).This could have possibly been due to the fact that majority of respondents are female and concentric remodeling is more common in women than men, However our study didn't show any significant difference in remodeling pattern between the two gender groups. The other possibility is the short duration of hypertension from diagnosis. The mean duration of hypertension diagnosis was 8 years. The third reason could be the lower grade of hypertension (mean SBP=141mmHg) even though this is on treatment blood pressure. Fourthly, the criteria used to define LVH is adopted from ASE guideline which is designed and validated in the United States of America, a setup that is totally different from ours, may not be applicable to use in our setting.

As it has been consistently shown in previous studies the high prevalence of prolonged MPI in hypertensive individuals is noted in our study as well with a prevalence of 84.9%(9,14,18). The mean MPI was 0.55(SDV 0.14) which is slightly higher than SILVIHIA study (0.45±0.11) and lower than the older study by Seok et al(14). The lower mean blood pressure in our set up and even more so in SILVIHA study may have resulted in lower mean MPI as compared to the one done in 1998 where blood pressure targets were much higher than the contemporary management.

This study didn't find a significant association between MPI and left ventricular hypertrophy. Among the clinical corelates that could affect MPI, only SBP, DBP, and pulse pressure were found to have significant association. Consistent finding was seen in SILVIHIA study where LVMI had no association with MPI and the study from Turkey by Kaypakli and colleagues where only blood pressure , serum creatinine and high sensitivity cardiac troponin were the significant determinants of abnormal MPI(17).On the other side, studies by Keser et al from Turkey, and Elmasry et al from Egypt show a positive association between LVMI and MPI(9,18).One important difference between this later studies and our study is the lower proportion of individuals with LVH and majority of our respondents had concentric remodeling which is clearly less associated with abnormal MPI as compared to concentric hypertrophy(9). The small number of participants as a result of short study period could have also impacted the result.

8. Conclusion

High blood pressure (systolic blood pressure, diastolic blood pressure, wide pulse pressure) is associated with the development of abnormal myocardial performance despite having normal LV systolic function on conventional echocardiography. However, no significant association is found between LVH and myocardial performance index.

9. Strength of the study

This is a prospective cross-sectional study with no missing data and echocardiographic measurements were taken intentionally for the purpose of the study.

The study has also tried to integrate clinical and echocardiographic variables so that comprehensive assessment can be provided.

10. Limitations of the study

The limited time frame has limited the study to stop at a total of 93 patients which may have affected the outcome of the study.

11. Recommendation

- To continue the study and recruit more participants so that larger number of participants can be recruited and the results could be more conclusive.
- The reason for the significantly huge discrepancy between reporting LVH using LV wall thickness and LVMI assessment using the cuboid formula in our set up needs further study including validation of LVMI cutoff values.
- As hypertension related LV remodeling is a continuous process that progresses from concentric remodeling to hypertrophy, subsequent follow up of this patient is recommended to see a progression or regression of the remodeling process.

Reference

1. Norm R.C. Campbell,a,b,* Melanie Paccot Burnens,c Paul K. Whelton,d Sonia Y. Angell,e Marc G. Jaffe,f Jennifer Cohn,g Alfredo Espinosa Brito,h Vilma Irazola,i Jeffrey W. Brettler,j Edward J. Roccella,k Javier Isaac Maldonado Figueredo,l Andres Rosende,b and Pedro Ordunez, pharmacological treatment of hypertension: Policy, implications for the region of the Americas. 2021 World Health Organization guideline on pharmacological treatment of hypertension: Policy implications for the region of the Americas.

2. Unger T, Borghi C, Charchar F, Khan NA, Poulter NR, Prabhakaran D, et al. 2020 International Society of Hypertension Global Hypertension Practice Guidelines. Hypertension. 2020 Jun;75(6):1334–57.

3. Kibret KT, Mesfin YM. Prevalence of hypertension in Ethiopia: a systematic meta-analysis. Public Health Rev. 2015 Dec;36(1):14.

4. Chirinos JA, Segers P, De Buyzere ML, Kronmal RA, Raja MW, De Bacquer D, et al. Left Ventricular Mass: Allometric Scaling, Normative Values, Effect of Obesity, and Prognostic Performance. Hypertension. 2010 Jul;56(1):91–8.

5. Marwick TH, Gillebert TC, Aurigemma G, Chirinos J, Derumeaux G, Galderisi M, et al. Recommendations on the Use of Echocardiography in Adult Hypertension: A Report from the European Association of Cardiovascular Imaging (EACVI) and the American Society of Echocardiography (ASE)†. Journal of the American Society of Echocardiography. 2015 Jul;28(7):727–54.

6. Reichek N, Helak J, Plappert T, Sutton MS, Weber KT. Anatomic validation of left ventricular mass estimates from clinical two-dimensional echocardiography: initial results. Circulation. 1983 Feb;67(2):348–52.

7. Lang RM, Badano LP, Mor-Avi V, Afilalo J, Armstrong A, Ernande L, et al. Recommendations for Cardiac Chamber Quantification by Echocardiography in Adults: An Update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. Journal of the American Society of Echocardiography. 2015 Jan;28(1):1-39.e14.

8. Tei C, Ling LH, Hodge DO, Bailey KR, Oh JK, Rodeheffer RJ, et al. New index of combined systolic and diastolic myocardial performance: a simple and reproducible measure of cardiac function--a study in normals and dilated cardiomyopathy. J Cardiol. 1995 Dec;26(6):357–66.

9. Lancellotti P, Zamorano JL, Habib G, Badano LP, European Association of Cardiovascular Imaging, editors. The EACVI Textbook of Echocardiography. 2. Edition. Oxford: Oxford University Press; 2017. 651 p.

10. Tei C, Nishimura RA, Seward JB, Tajik AJ. Noninvasive Doppler-derived myocardial performance index: Correlation with simultaneous measurements of cardiac catheterization measurements. Journal of the American Society of Echocardiography. 1997 Mar;10(2):169–78.

11. Hisashi Masugata,MD, Shoichi Senda,MD, Fuminori Goda, MD,Ayumu Yamagami,MD,Hiroyuki Okuyama ,MD, Takeaki Khono ,MD, et al. Independent determinants of the tei index in hypertensive patients with preserved left ventricular systolic function. int heart journal. 50.

12. WANG S xia, XUE H, ZOU Y bao, SUN K, FU C yan, WANG H, et al. Prevalence and risk factors for left ventricular hypertrophy and left ventricular geometric abnormality in the patients with hypertension among Han Chinese. Chinese Medical Journal. 2012;125(01):21–6.

13. Tarek M Elmasry*, Mohammed F Abd-Elbary, Kamal A Marghany and Mohammed S Abo-Elmagd. The Effect of Left Ventricular Geometry on Myocardial Performance Index in Hypertensive Patients. J Clin Exp Cardiolog, an open access journal. Volume 9(• Issue 1 • 1000570).

14. Aronow WS. Hypertension and left ventricular hypertrophy. Ann Transl Med. 2017 Aug;5(15):310.

15. Verdecchia P, Carini G, Circo A, Dovellini E, Giovannini E, Lombardo M, et al. Left ventricular mass and cardiovascular morbidity in essential hypertension: the MAVI study. Journal of the American College of Cardiology. 2001 Dec;38(7):1829–35.

16. Kono M, Kisanuki A, Takasaki K, Nakashiki K, Yuasa T, Kuwahara E, et al. Left ventricular systolic function is abnormal in diastolic heart failure: Re-assessment of systolic function using cardiac time interval analysis. Journal of Cardiology. 2009 Jun;53(3):437–46.

17. Liljedahl S, Kahan T, Lind L, Ã□rnlÃ¶v J. The Effects of Antihypertensive Treatment on the Doppler-Derived Myocardial Performance Index in Patients with Hypertensive Left Ventricular Hypertrophy: Results from the Swedish Irbesartan in Left Ventricular Hypertrophy Investigation Versus Atenolol (SILVHIA). Echocardiography. 2009 Aug;26(7):753–8.

18. seon Min Kang, Jong -Won Ha, See Joong Rim, Namsik Chung. index of myocardial performance using Doppler derived parametres in the evaluation of Left ventricular function in patients with essential hypertension. yonsei medical journal. 39.

19. Keser N, Yildiz S, Kurtoğ N, Dindar I. Modified TEI Index: A Promising Parameter in Essential Hypertension? Echocardiography. 2005 Apr;22(4):296–304.

20. Kamilu M Karaye. Relationship between tei index and left ventricular geometric patterns in a hypertensive population.

21. Kaypakli O, Gür M, Gözükara MY, Uçar H, Kivrak A, Şeker T, et al. Association between high-sensitivity troponin T, left ventricular hypertrophy, and myocardial performance index. Herz. 2015 Nov;40(7):1004–10.

22. Nagueh SF, Smiseth OA, Appleton CP, Byrd BF, Dokainish H, Edvardsen T, et al. Recommendations for the Evaluation of Left Ventricular Diastolic Function by Echocardiography: An Update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. Journal of the American Society of Echocardiography. 2016 Apr;29(4):277–314.

23. Williams B, Mancia G, Spiering W, Agabiti Rosei E, Azizi M, Burnier M, et al. 2018 ESC/ESH Guidelines for the management of arterial hypertension. European Heart Journal. 2018 Sep 1;39(33):3021–104.

24. McDonagh TA, Metra M, Adamo M, Gardner RS, Baumbach A, Böhm M, et al. 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure. European Heart Journal. 2021 Sep 21;42(36):3599–726.

25. Heidenreich PA, Bozkurt B, Aguilar D, Allen LA, Byun JJ, Colvin MM, et al. 2022 AHA/ACC/HFSA Guideline for the Management of Heart Failure: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. Circulation [Internet]. 2022 May 3 [cited 2023 Jun 19];145(18). Available from: https://www.ahajournals.org/doi/10.1161/CIR.0000000000001063

26. Addisu Tadesse Sahile1 and Getabalew Endazenew Bekele2. Prevalence of Diabetes Mellitus and Associated Factors in Addis Ababa Public Health Facilities, Addis Ababa, Ethiopia, 2016. Published online 2020 Feb 25.

Appendix

Table 6, measures of central tendency and variance for BMI, LVMI, duration of hypertension, n=93, among hypertensive patients who had echocardiography at TASH , 2023

Variable	Mean	Std. Dev.	Min	Max
BMI	27.85038	4.92918	19.14062	39.0625
LVMI	82.91818	22.97586	35.21124	156.1346
Duration_HTN(in years)	8.080652	8.621596	0	40

Table 2: comparison of MPI at different blood pressure levels, n=93, TASH 2023

SBP_spectrum	MPI_Category		Total
	Abnormal	Normal	
120-139	28	4	32
140-159	32	8	40
<120	6	0	6
>159	13	2	15
Total	79	14	93

Table 3: Duration of hypertension among hypertensive patients who had echocardiography during the study period, n=93, TASH 2023

Duration_of HTN	Freq.	Percent	Cum.
3-5 years	25	26.88	26.88
6-10 years	24	25.81	52.69
<3 years	24	25.81	78.49
>10 years	20	21.51	100

Total	93	100	

Amharic Version Interview

ስለ ጥናቱ መረጃ ፡

ሰላም፡ ዶ/ር ሃያት ዑመር እባላለሁ. በጥቁር አንበሳ ስፔሻላይዘድ ሆስፒታል የመጨረሻ አመት የልብ ህክምና ሰብ ስፔሻሊቲ ተማሪ ስሆን “myocardial performance in left ventricular hypertrophy”በሚል ርእስ ጥናት እያደረኩ ነው. የጥናቱ ዋና ዓላማ የልብ ጡንቻ መወፈር በልብ ስራ ብቃት ላይ የሚያመጣዉን ተጽእኖ ለማየት ነው.

ይሄንን ለማከናወን ጥቂት ጊዜ ወስደን ጥያቄ እንጠይቅዎታለን፣ ከዚያም የልብ ምርመራ በ አላትራሳዉንድ እንሰራልዎታለን. ምንም አይነት ሰዉነትን ዘልቆ የሚገባ ነገር አንጠቀምም. በልብ አልትራሳዉንድ ምርመራ ምክንያት የሚመጣ ምንም አይነት ጉዳት የለም. እንዲያዉም ለሚከታተልዎት ሀኪም ስለ ልብዎት የመጭመቅ አቅም መረጃ ሊሰጥ ይችላል . ከፍተኛ የደም ግፊት በ ልን ላይ ያለዉን ተፅእኖ በማሳየት ምናልባትም የዚህ ጥናት ዉጤት ለወደፊት የደም ግፊት ህክምና አሰጣጥን ሊያሻሽል ይችላል .

ይህ ጥናት ማንነትን አይገልፅም. የእርስዎን ማንነት የሚመለከት ምንም አይነት መረጃ አንጠይቅም ወይም አናስቀምጥም. ከእርስዎ የምንወስደዉ መረጃ ሚስጥራዊነት ሙሉ በሙሉ የተጠበቀ ነዉ. ለዚህ ጥናት ምንም አይነት ክፍያ እንዲከፍሉ አይጠየቁም

ፈቃደኝነት መጠየቂያ ቅፅ፡

በጥናቱ ለመሳተፍ ከተስማሙ ጥቂት ጊዜ ወስጄ ጥያቄ እጠይቅዎትና በማሽን የታገዘ የልብ አልትራሳዉንድ ምርመራ አደርግልዎታለሁ. ፈቃደኛ ካልሆኑ በጥናቱ ያልመስማማት ሙሉ መብት አለዎት.

ከላይ ያለዉን የጥናቱን መረጃ በደንብ አንብበዉ በጥናቱ ለመሳተፍ ከተስማሙ ከዚህ በታች ፊርማዎትን ያስቀምጡ

መመሪያ፡ ለሚከተሉት ጥያቄዎች ትክክለኛዉን መልስ ይንገሩን

ክፍል አንድ

1. እድሜ--------
2. ጾታ፡
   I. ወንድ
   II. ሴት
3. ክብደት (በኪሎ)----------
4. ቁመት (በሜትር)--------
5. የደም ግፊት ህክምና ታሪክ አለዎት
   i. አዎ
   ii. የለም
   II. የደም ግፊት እንዳለብዎት ካወቁ ስንት ጊዜ ሆነዎት ----------

III. የየደም ግፊት መድሃኒት ይወስዳሉ;

6. የስኪር መብዛት አለብዎት

   i. አዎ

   ii. የለም

II. መልስዎ አዎ ከሆነ፣የስኪር መብዛት እንዳለብዎት ካዎቁ ስንት ጊዜ ሆነ(በ ዓመት);_____

III. መድሃኒትስ ይዎስዳሉ;

   i. አዎ

   ii. የለም

7. ስር የሰደደ የኩላሊት በሽታ አለብዎት

   i. አዎ

   ii. የለም

II. መልስዎ አዎ ከሆነ፣የኩላሊት ችግር እንዳለብዎት ካዎቁ ስንት ጊዜ ሆነ(በ ዓመት);

III. መድሃኒትስ ይዎስዳሉ;

   i. አዎ

   ii. የለም

አመሰግናለሁ. አሁን ወደ ለልብ ምርመራ እንሄዳለን

English version interview

Information Sheet: English Version

Hello, my name is Hayat Oumer. I am a final year cardiology fellow working at TASH cardiology unit doing research on myocardial performance in left ventricular hypertrophy. The aim of the study is to assess the effects of left ventricular enlargement (hypertrophy) on myocardial performance.

To achieve this, we need to take few minutes to ask you some questions through an interview and then we will do echocardiography (ultrasound of your heart) to see your heart. We will only be using an ultrasound.

No invasive techniques will be used and no harm will be caused by the echocardiography, in fact having an echocardiography may give information to the doctor that is treating you about your heart's contractile function. The results of the study may change the current way of hypertension treatment by showing the impact of high blood pressure on your heart.

This study is anonymous. The information you give us will be kept confidential. We will not be collecting or retaining any information about your identity. You will not be required to pay for anything.

Consent form:

If you agree to participate in this study, I will take a few minutes to ask you some questions and we will do echocardiography. You have the option to decline to participate in this study if you feel uncomfortable.

Signature

_____

I. Demographic profile

1. Age(years) _____
2. Sex: Male ___Female ____
3. Weight (in Kg)_____
4. Height (in meters) _____
5. BMI_____
6. BSA_____
7. History of HTN:
   I. Have ever been diagnosed with HTN. Yes ____No_____
   II. Duration of hypertension _____years
   III. Do you take drugs for your hypertension Yes ____No_____
8. History of DM
   I. Have you ever been diagnosed with DM Yes ____No_____
   II. If your answer is yes to question number 8, for how long have been diabetic? _____years
   III. Do you take drugs for your diabetes?
9. History of CKD:
   I. Have you ever been told that you have CKD? Yes ____No____

10. If you answer yes to question number 10, for how long have you known?

_____years

Thank you very much , now we will proceed with the physical examination and echocardiography part.

Clinical Profile

1. Blood pressure: SBP: _____ DBP: _____
2. Serum cr. on follow up: _____

II. Echo profile

A. Dimensions

1. LV IVSId(in cm)_____
2. LV PWId(in cm):_____
3. LVDId(in cm): _____
4. RWT:_____
5. LVMI:_____
6. EF:_____

B. Diastolic function

1. LA volume _____
2. E/A_____
3. DT(microsecond)_____
4. E'_____
5. E/E'_____
6. TR_____
7. Grade of diastolic dysfunction _____

C. MPI

1. IVRT(in microsecond)_____
2. IVCT(in microsecond) :_____
3. ET(in microsecond):