

Detection of Subclinical Left Ventricular Dysfunction in Hypertensive Patients Using Speckle Tracking Echocardiography

Thesis

Submitted for partial fulfillment of master degree of cardiology

BY

Reham Atef Mohamed EL Okl

M.B., B.C.H

Supervisors

Professor Dr. Amal MohamedAyoub

Professor of Cardiology

AinShams University

Dr.Viola William Keddeas

Fellow of Cardiology

AinShams University

Dr. Yasmin Abdel Razek Esmael

Lecturer of Cardiology

AinShams University

Faculty of Medicine

AinShams University (2015)

Acknowledgements

I always feel deeply indebted to my God, the real guide and the real supporter.

Really, the accomplishment of this work was due to so many contributors, without the valuable, genuine guidance, sincere and helpful participation; this study would not be achieved.

No words can describe my deep gratitude to Doctor **Amal Mohamed Ayoub**; Professor of cardiology; Ain Shams University, she was the person who closely supervised the progress of our work with great interest and without her continuous guidance and unlimited help, this work would not come to light

I would like to express my profound thanks, sincere and deep gratitude to Doctor **Viola William**, Fellow of cardiology Ain Shams University for her valuable and generous support she was the person who really did this work. And follow up its progress.

I am particularly indebted to Doctor **Yasmine Abd Al Razek**, Lecturer of cardiology, Ain Shams University for her excellent collaboration and suggestions which have been of great help in the preparation of this work.

Finally, with great pleasure I wish to thank all the staff members of the Cardiology Department of Ain University Hospital especially Dr **Osama Ali Diab**, Assistant professor of cardiology, Ain Shams University for his kind and sincere help in the statistical analysis. He really made a great effort in analyzing the data of our study.

A special thanks for my father and the soul of my mother for their great support to me all the time, continuous guidance and unlimited help.

Reham Atef

Contents

<i>ITEM</i>	<i>Page</i>
Acknowledgment.....	I
List of abbreviations.....	II
List of tables.....	V
List of figures.....	VIII
Introduction.....	1
Aims of the work.....	3
Review of literature:	(4-85)
❖ Chapter Hypertension.....	4
❖ Chapter2: LV Geometric Adaptation in Hypertensive.....	41
❖ Chapter 3: Diastolic Dysfunction in hypertensive patients.....	50
❖ Chapter4:LV Systolic Dysfunction in Hypertensive Patient.....	62
❖ Chapter5: Detection of Systolic LV dysfunction by 2-D Speckle tracking Echocardiography.....	70
Patients and methods.....	86
Results.....	111
Discussion.....	140
Study Conclusions.....	150
limitations.....	151
Recommendations	152
Summary	153
References.....	157
Arabic summary.....	XI-XII

LIST OF ABBREVIATION

A	Atrial kick mitral inflow velocity
A`	Atrial annular velocity
ABI	Ankle brachial index
ABP	Arterial blood pressure
ABPM	Ambulatory Blood Pressure Monitoring
ACEI	Angiotensin convertor enzyme inhibitor
ARBs	Angiotensin convertor enzyme inhibitor
ASE	American Society of Echocardiography
BB	Beta blockers
BMI	Body mass index
BP	Blood pressure
BSA	Body surface area
CHD	Cardiovascular heart disease
CI	Confidence interval
CKD	Chronic kidney disease
DBP	Diastolic Blood Pressure
DD	Diasdtolic dysfunction
DT	Deceleration time
E	Early mitral inflow velocity
E`	Early diastolic annular velocity
EAE	European Association of Echocardiography.
EAS	European atherosclerosis Society
EAT	Epicardial atrial thickness
ECG	Electrocardiogram
ED	End Diastolic
EDV	End diastolic volume
EF	Ejection fraction
eGFR	Estimated glomerular filtration rate
ES	End systolic
ESRD	End stage renal disease

ESV	End systolic volume
GFR	Glomerular filtration rate
GLS	Global longitudinal strain
H	Height in cm
HF	Heart failure
HFpEF	Heart failure with preserved ejection fraction
HTN	Hypertension
IDDM	Insulin dependent diabetes mellitus
ISH	Ischemic heart disease
IVRT	Isovolumetric relaxation period
L	Length
LA	left atrium
L_o	Intial length
LS	Longitudinal strain
Lt	Length in a given time
LV	Left ventricle
LVH	left ventricular hypertrophy
LVIDd	LV internal dimensions in diastole
LVIDs	LV internal dimensions in systole
LVMi	Left Ventricular mass index
MAPSE	Mitral annular plane systolic excursion
MI	Myocardial infarction
MRI	Magnetic resonance imaging
NIDDM	Non-Insulin dependent diabetes mellitus
OD	Organ damage
OR	Odds ratio
PAD	Peripheral arterial disease
PWT	Posterior wall thickness
PWV	Pulsed wave velocity
r	Radius
RAS	Renin angiotensin system
RCTs	Randomized controlled trials
RF	Risk factors
ROI	Region of interest
RSWMA	Resting segmental wall motion abnormality

S	Systolic velocity of mitral annulus
SBP	Systolic blood pressure
SCORE	Systemic coronary risk evaluation
SD	Standard deviation
SPSS	Statistical package for social science
SR	Strain rate
STE	Speckle tracking echocardiography
SWT	Septal wall thickness
T	Tension in LV wall
TDI	Tissue Doppler imaging
V	Velocity
V_p	Velocity of propagation
Vs.	versus
W	Weight in kg
ε	Strain rate

List of figures

- Figure 1. Stratification of total CV risk in categories of low, moderate, high and very high risk according to SBP and DBP and prevalence of RFs, asymptomatic OD, diabetes, CKD stage or symptomatic CVD.....page11.
- Figure 2. Initiation of lifestyle change, antihypertensive drug treatment and Targets of treatment.....page36.
- Figure 3 Possible combinations of classes of anti-hypertensive drugs.....page39.
- Figure 4. Different patterns of LV geometry.....page44.
- Figure 5. Pathophysiological pathways through which aortic stiffness may contribute to the development of diastolic dysfunction.....page59.
- Figure 6. Strain curves in the radial, circumferential and longitudinal planes.....page73.
- Figure 7. Regions of interest (kernels) represented in the end-diastole (ED) and end-systole (ES).....page75.
- Figure 8. Different components of left ventricular myocardial deformation that can be measured by speckle-tracking echocardiography.....page80.
- Figure 9. Circumferential-Longitudinal strain.....page81.

- Figure 10. Speckle-tracking echocardiography analysis of myocardial deformation showing measurements of longitudinal strain, radial strain, and circumferential strain.....page 82.
- Figure 11. Illustration of measurement of LV dimensions and EF By M- Mode Echocardiography.....page 92.
- Figure 12. Illustration of Measurement of EF by Biplane Simpson Method.....page 93.
- Figure 13. (A) Illustration of LA diameter by M-Mode echocardiography, (B) LA volume measurement in apical four chamber view.....page 95.
- Figure 14. Illustration of measurement of Mitral annular Plane systolic excursion (MAPSE)page 97.
- Figure 15. Illustration of Transmitral inflow velocity measured by Pulsed Wave Doppler.....page 98.
- Figure 16. Illustration of offline color coded Tissue Doppler Imaging of mitral annular velocity.....page 100.
- Figure (17) Steps involved in speckle-tracking echocardiograph.....page 107.
- Figure 17` Bull's eye display of segmental and global peak-systolic longitudinal strain.....page 108.
- Figure 18. Comparison between hypertensive group and control group in BMIpage 116.
- Figure 19. Different patterns of LV geometry in hypertensive group of our study.....page 118.

- Figure 20. Comparison between hypertensive group and control group in LV mass Index.....page 119.
- Figure 21. Comparison between hypertensive group and control group in mean LA volume.....page 119.
- Figure 22. Comparison between hypertensive group and control group in mean MAPSE.....page 124.
- Figure 23. comparison between hypertensive group and control group in mean GPLS.....page 124.
- Figure 24. Correlation between LV Ejection fraction (LV EF) (%) and LV mass index among whole study sample.....page 127.
- Figure 25. Correlation between GPLS and LV mass index among whole study sample.....page 128.
- Figure 26. Correlation between mean GPLS and LV diastolic function among whole study sample.....page 134.
- Figure 27. Correlation between mean BMI, normal LV systolic function, and subclinical LV systolic dysfunction among hypertensive group.....page 139.

List of Tables

- Table 1. Definitions and classification of office blood pressure levels.....Page 5.
- Table 2. Factors (other than office BP) influencing prognosis; used for stratification of total CV risk.....page9.
- Table 3. Total cardiovascular risk assessment.....page10.
- Table 4. Instructions for correct office BP measurement.....page18.
- Table 5. Personal and family medical history.....page21.
- Table 6. Laboratory investigations.....page22.
- Table 7. Recommendation for Blood pressure management, history and physical Examination.....
.....page23.
- Table 8. Predictive value, availability, reproducibility and cost-effectiveness of some markers of organ damage.....page28.
- Table 9. Recommendation of Search for asymptomatic organ damage.....page30.
- Table 10. Recommendation of Blood pressure goals in hypertensive patients..... page33.
- Table 11. Summary of recommendations on treatment strategies and choice of drugs.....page38.

- Table 12 Summary of recommendations on treatment strategies and choice of drug.....page40.
- Table13.Speckle-TrackingEchocardiography Terminology.....page78.
- Table 14. Classifications of BMIpage88.
- Table 15. Different Echocardiography Parameters to differentiate normal LV diastolic filling pattern from pseudo normal pattern.....page102.
- Table (16) Demographic characteristics of hypertensive group and control groups.....page113.
- Table (17) M-Mode and two dimensional finding in hypertensive group and control groups.....page114.
- Table 18.Grading of Diastolic function in hypertensive and control groups.....page120.
- Table 19.Tissue Doppler mitral annular velocities in hypertensive group and control group.....page121.
- Table 20. Different LV systolic function parameters in hypertensive group and control group.....page 123.
- Table 21.Correlations of different parameters among the whole study sample.....Page 126.
- Table 22. Correlation among hypertensive group.....page 129.

- Table 23. Comparison between subjects with no DD, DD grade1, and DD grade2 among the whole study sample.....page132.
- Table 24. Comparison between patients with and without LV systolic dysfunction among the hypertensive group.....page137.
- Table 25. Predictors of LV systolic dysfunction among hypertensive group.....page138.

Introduction

Hypertension is one of the most common diseases among population; it is the leading attributable risk factor for developing heart failure with preserved EF, which is today a hypertension related complication almost as common as stroke. Heart failure is usually a progressive condition that begins with risk factors for LV dysfunction (e.g., hypertension), proceeds to asymptomatic changes in cardiac structure (e.g., LV hypertrophy) and function (e.g., impaired relaxation), and then evolves into clinically overt heart failure, disability and death.

(Tocci et al., 2008)

Patients with hypertension usually present with concentric remodeling or concentric LV hypertrophy, despite of having normal-sized LV chamber and normal EF, even in the presence of a reduced longitudinal systolic function.

(Imbalzano et al., 2011)

Echocardiography is used to assess early subclinical changes in systolic and diastolic LV function. Nowadays, tissue speckle tracking provide additional information about global and regional cardiac function over and beyond classical

M-mode and 2D echocardiography, pulsed-wave Doppler & tissue Doppler index (TDI).

(Rover et al., 2006)

Tissue Speckle tracking analyze speckle artifacts in the echo image to obtain information of myocardial contractility and also on relaxation. Speckles are small areas of higher echogenicity which are caused by reflections, refraction, and scattering of echo beams. By tracking such speckles in the wall of the left ventricle throughout the cardiac cycle it is possible to obtain information on the direction and velocity of motion.

Comparing the motion of individual speckles to each other allows us to analyze the deformation of the myocardium.

(Saha et al., 2012)

Aim of the work

We aim to use Speckle Tracking echocardiography (Longitudinal Strain pattern) to detect subclinical left ventricular dysfunction in hypertensive patients with normal systolic function detected by 2D Echocardiography