

Comparison between the accuracy of transmitral pulsed-Doppler
echocardiography and two dimensional echocardiography using
dobutamine in detection of coronary artery disease

Thesis

Submitted For Partial Fulfillment of

M.D. Degree in Cardiology

By

Wael Mohamed Zahi Khamis El-Eswed

M.B.B.Ch

MSc cardiology

Under supervision of

Doctor / Abd Elrahman Abd Elgawad Sharaf

Professor of cardiology

Faculty of Medicine, Al-Azhar university

Doctor / Mohey Eldin Hasan Mansour El-Abbady

Professor of cardiology

Faculty of Medicine, Al-Azhar university

Doctor / Mostafa Attia Mohamed El- Sawasany

Lecturer of cardiology

Faculty of Medicine, Al-Azhar university

Doctor / Wael Mohamed Attia

Lecturer of cardiology

Faculty of Medicine, Al-Azhar University

Faculty of medicine, AL Azhar University

2013

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



Acknowledgements

Praise be to **Allah**, the **Creator** and **Sustainer** of the worlds, who has said in his **Holy Quran** “We raise to degrees (of wisdom) whom we please, but over all endued with knowledge is one, the All-knowing” (**Yusuf**, 76).

I would like to express my deepest gratitude to **Dr. Mohey El-Din El-Abbady**, *professor of Cardiology, Faculty of Medicine, Al- Azhar University* for his guidance, great help and support throughout supervising this work.

I would like to express my deepest gratitude to **Dr. Abd Elrahman Sharaf**, *professor of Cardiology, Faculty of Medicine, Al- Azhar University* for his guidance, great help and support throughout supervising this work.

My deepest appreciation to **Dr. Mostafa El- Sawasany**, *lecturer of Cardiology, Faculty of Medicine, Al- Azhar University* for his support and advise throughout supervising this work.

My deepest appreciation to **Dr. Wael Attia**, *lecturer of Cardiology, Faculty of Medicine, Al- Azhar University*, for his great support and kind motivation.

I would like to express my deepest gratitude to **Dr. Sheif Hashem**, *Cardiology consultant, Deputy Head of department of Jeddah heart institute, Dr Erfan and Bajedo general hospital* for his guidance, great help and support throughout supervising this work.

I would like to express my deepest gratitude to **Dr. Ahmed Dawood**, *Cardiology consultant, non invasive department, Jeddah heart institute, Dr Erfan and Bajedo general hospital* for his guidance, great help and support throughout supervising this work.

I would like to thank all the staff members and my colleagues in cardiology department, for their cooperation.

Wael Mohamed zahi

Subject	Page
Introduction	1
Aim of the work	3
Review of literature	
Coronary artery disease:-	4
-Prevalence and incidence	5
-Coronary artery disease mortality	7
- Quality of life	9
Different non invasive imaging modalities for the diagnosis of coronary artery disease:	10
1- anatomical imaging:	10
- Computed tomography.	10
-Magnetic Resonance Imaging	15
2- functional imaging:	17
-Nuclear Medicine Myocardial Perfusion Stress Testing.	17
-Echocardiography.	19
Dobutamine stress echocardiography:	21
-Basic pathophysiological principles	22
-Diagnostic criteria	25
- Analysis of stress echocardiograms:	27
- Indication of dobutamine stress echocardiography:	
1- Diagnosis of CAD	29
2-Risk stratification	37
3- Assessment of myocardial viability	44
4-Assesment of patients with dyspnea, pulmonary and valvular heart disease	48
-Cost effectiveness of stress echocardiography	54
-Complications of dobutamine stress echocardiography	55
- Contraindications of dobutamine stress echo	73
Diastolic function	75
-Definition of Diastolic Dysfunction:	77
- Echocardiographic evaluation of left ventricular diastolic function:	77

1-Doppler mitral inflow velocity	78
2-Pulmonary venous flow	81
3-Tissue Doppler imaging	83
4-Color flow mapping	86
5-Other approaches	88
-Effect of myocardial ischemia on diastolic function	89
Patients and methods	93
Results	99
Discussion	132
Conclusion and limitation	139
Summary	141
References	145
Arabic summary	175

List of abbreviations

2D	Two dimensional
3D	Three dimensional
4D	Four dimensional
A	Late diastolic transmitral filling velocity
A'	Late diastolic mitral anulus velocity
AC	Atrial contraction
ACC	American College of Cardiology
ADP	Adenosine-diphosphate.
AHA	American Heart Association
AMP	Adenosine-monophosphate.
Ao	Ascending aorta pressure
Ar	Retrograde flow of pulmonary venous flow
AT	Acceleration time
ATP	Adenosine-triphosphate.
CAC	Coronary artery calcium
CAD	Coronary artery disease
CCTA	Computed Tomography coronary Angiography
CFR	Coronary flow reserve
CFVR	Coronary flow velocity reserve
CHD	Coronary Heart Disease
CHF	Congestive heart failure
CI	Confidence interval
CMR	Cardiac Magnetic Resonance
CT	Computed Tomography
CVD	Cardiovascular disease
CW	Continuous wave
D	Diastolic forward flow of pulmonary venous flow
DALYs	Disability-adjusted life years
DASE	Dobutamine-atropine stress echocardiography
DBP	Diastolic blood pressure
DM	Diabetes mellitus
DSE	Dobutamine stress echocardiography
DT	Deceleration time
E	Early diastolic transmitral filling velocity

E'	Early diastolic mitral annular velocity
E/A	Ratio of the early (E) to late (A) ventricular filling velocities
EBCT	Electron beam computed tomography
ECG	Electrocardiogram
E/e'	The ratio of transmitral Doppler early filling velocity to tissue Doppler early diastolic mitral annular velocity
EF	Ejection fraction
EU	<i>European union</i>
HfpEF	Heart failure with preserved ejection fraction
HR	Heart rate
IVRT	Isovolumetric relaxation time
LA	Left atrium
LAD	Left anterior descending coronary artery
LV	Left ventricle
LVEF	Left ventricle ejection fraction
LVH	Left ventricular hypertrophy
MDCT	Multidetector row Computed Tomography
MI	Myocardial infarction
MRI	Magnetic resonance imaging
MSCT	Multi-slice computed tomography
NM	Nuclear medicine
PCWP	Pulmonary capillary wedge pressure
PET	Positron Emission Tomography
PV	Pulmonary venous
RA	Right atrial
RF	Rapid filling
ROC	Receiver operating characteristic
S	Initial forward systolic flow of pulmonary venous flow
SBP	Systolic blood pressure
SD	Standard deviation
SF	Slow filling
SFF	Systolic filling fraction
SR	Sarcoplasmic reticulum.
TDE	Tissue Doppler echocardiography
TDI	Tissue Doppler imaging
TEE	Transesophageal echocardiograph
TTDE	Transthoracic Doppler echocardiogram
TVI	Velocity time integral
UK	United kingdom

VP	Color M-mode flow propagation velocity
WMA	Wall motion abnormalities

No	Title	Page
1	Pharmacological stresses.	24
2	Demographic characteristics and risk factors in both groups.	100
3	Baseline characteristics of both groups.	102
4	Hemodynamic response of both groups to peak dobutamine.	103
5	Response of heart rate to peak dobutamine in both groups.	104
6	Response of systolic blood pressure to peak dobutamine in both groups .	105
7	Response of diastolic blood pressure to peak dobutamine in both groups .	106
8	Sensitivity, specificity and accuracy of conventional 2 D dobutamine stress echo.	107
9	Response of E wave to peak dobutamine in both groups.	109
10	Response of A wave to peak dobutamine in both groups.	110
11	Response of E/A to peak dobutamine in both groups.	111
12	Response of E wave acceleration time (ms) to peak dobutamine in both groups.	112
13	Response of E wave acceleration time (ms) to peak dobutamine in both groups.	113
14	Response of IVRT (ms) to peak dobutamine in both groups.	114
15	Response of TVI (cm) to peak dobutamine in both groups.	115
16	Response of VP (cm/s) to peak dobutamine in both groups.	116
17	Response of E/VP to peak dobutamine in both groups.	117

18	Response of different diastolic parameters to peak dobutamine.	143
----	--	-----

No	Title	Page
1	Diastolic filling of left ventricle (LV).	76
2	Pathophysiological characterisation of left ventricular (LV) filling patterns.	80
3	Pulmonary venous flow.	82
4	Tissue Doppler image.	84
5	Color m mode propagation velocity.	87
6	Measurement of flow propagation velocity (vp) from color M-mode Doppler.	97
7	Demographic characteristics and risk factors in both groups.	101
8	Baseline characteristics of both groups.	102
9	Response of heart rate to peak dobutamine in both groups.	104
10	Response of systolic blood pressure to peak dobutamine in both groups.	105
11	Response of diastolic blood pressure to peak dobutamine in both groups .	106
12	Sensitivity, specificity and accuracy of conventional 2 D dobutamine stress echo.	108
13	Response of E wave to peak dobutamine in both groups.	109
14	Response of A wave to peak dobutamine in both groups.	110
15	Response of E/A to peak dobutamine in both groups.	111
16	Response of E wave acceleration time (ms) to peak dobutamine in both groups.	112
17	Response of E wave deceleration time (ms) to peak dobutamine in both groups.	113
18	Response of IVRT (ms) to peak dobutamine in both groups.	114
19	Response of TVI (cm) to peak dobutamine in both groups.	115
20	Response of VP (cm/s) to peak dobutamine in both groups.	116
21	Response of E/VP to peak dobutamine in both groups.	117
22	Sensitivity, specificity and accuracy of conventional DSE and response of E wave to peak dobutamine for diagnosis of CAD.	124
23	Sensitivity, specificity and accuracy of conventional DSE and response of E/A ratio to peak	125

	dobutamine for diagnosis of CAD.	
24	Sensitivity, specificity and accuracy of conventional DSE and response of E acceleration time to peak dobutamine for diagnosis of CAD.	125
25	Sensitivity, specificity and accuracy of conventional DSE and response of TVI to peak dobutamine for diagnosis of CAD.	126
26	Sensitivity, specificity and accuracy of conventional DSE and response of VP to peak dobutamine for diagnosis of CAD.	126
27	Sensitivity, specificity and accuracy of conventional DSE and response of E/VP to peak dobutamine for diagnosis of CAD.	127
28	Transmitral flow (1)at rest (2) at peak dobutamine of 50 years old female with normal coronary angiography.	128
29	transmitral flow (1) at rest (2) at peak dobutamine of 57 years old male subject with normal coronary angiography.	128
30	Transmitral flow (1) at rest (2) at peak dobutamine of 44 years old male patient with significant mid LAD lesion.	129
31	transmitral flow (1) at rest (2) at peak dobutamine of 60 years old male patient with significant proximal LCX lesion.	129
32	VP (1) at rest (2) at peak dobutamine in 40 years old male subject with normal coronary angiography.	130
33	VP (1) at rest (2) at peak dobutamine of 43 years old male with normal coronary angiography.	130
34	VP (1) at rest (2) at peak dobutamine in 60 years old male patient with significant proximal LCX lesion.	131
35	VP (1) at rest (2) at peak dobutamine in 49 years old male patient with significant proximal LAD lesion.	131

INTRODUCTION

&

AIM OF THE WORK

Introduction

Diastolic dysfunction precedes systolic dysfunction during the development of myocardial ischemia. Therefore, detection of diastolic dysfunction during diagnostic stress tests could be useful in the identification of myocardial ischaemia (**Hoffmann et al, 1999**). Nevertheless, in clinical practice the diagnosis of ischaemia during imaging stress tests has primarily focused on the induction of systolic dysfunction (**Zamorano et al., 1998**).

It is well known that after a brief episode of severe ischaemia, prolonged myocardial dysfunction with gradual return of contractile activity occurs, a condition termed myocardial stunning. Stunning has been demonstrated to occur in patients with coronary artery disease after both exercise- and dobutamine-induced ischemia (**Barnes et al, 2000**). This stunning affects both systolic and diastolic function (**Castelláet al., 2006**).

Impaired relaxation is an early event during the ischaemia. A proposed metabolic explanation is that there is impaired generation of energy, which diminishes the supply of ATP required for the early diastolic uptake of calcium by SR, and cytosolic calcium level delays its return to normal in the early diastolic period. This effect may in part be the cellular basis for the abnormal myocardial relaxation detected in patients with ischaemic heart disease (**Opie et al., 1997**).

The mitral flow velocity curve, during pulsed-wave Doppler echocardiographic recordings, provides a considerable amount of information about the diastolic filling characteristics of the left ventricle. It is most likely that CAD has direct influence on Doppler parameters of mitral flow (**Mazeika et al .,1994**).

Many investigators have compared dobutamine stress-echocardiography (DSE) with dipyridamole stress-echocardiography and exercise stress testing for diagnosis of CAD and results have shown that DSE was superior to other forms of stress echocardiography (**Previtali et al., 1993**).

However limited information exists regarding the relationship of left ventricular diastolic filling parameters measured by Doppler echocardiography during dobutamine stress echocardiography (DSE) and stress-induced symptoms or myocardial ischemia (**Nakajima et al., 2009**).

Ohara and his colleagues found that detection of the diastolic dysfunction during dobutamine stress echocardiography for coronary artery disease could improve diagnostic sensitivity of the test (**Ohara et al., 2011**).

This study was therefore undertaken to characterize the effects of dobutamine stress echocardiography on pulsed Doppler transmitral indices in controls and CAD patients with and without inducible asynergy to determine the diagnostic usefulness of this approach.

Aim of work

The purpose of the present study was to evaluate the added value of transmitral Doppler flow indices during dobutamine stress echocardiography and to compare sensitivity, specificity and diagnostic accuracy of these indices with conventional dobutamine stress echocardiography.