Assessment of Left Atrial Functions in Hypertensive Patients with Diastolic Dysfunction using Strain and Strain Rate Imaging

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By

Marwa Abdelfattah Hassanin

M.B.B.Ch

Supervisors

Prof. Dr. Adel Zaki

Professor of Cardiovascular Medicine

Cairo University

Prof. Dr. Hossam Eldin Elhossary

Assistant Professor of Cardiovascular Medicine

Cairo University

Dr.Ghada Sayed Mahmoud

Lecturer of Cardiovascular Medicine

Cairo University

Faculty of Medicine

Cairo University

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Marwa Abdelfattah Hassanin

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Abstract:

Objectives: Diastolic dysfunction is important prognostic indicator for a diverse number of cardiac conditions, The purpose of this study was to investigate the relationship between left atrial (LA) myocardial function and left ventricular (LV) diastolic dysfunction in subjects with hypertension using Strain (SI) and strain rate (SR) imaging.

Methods: Thirty seven control subjects and fourty two hypertensive patients were included in this study, the hypertensive group was subdivided into two groups, depending on the presence or absence of diastolic dysfunction (D.D), the first group included twenty two subjects and represents the hypertensive patients without diastolic dysfunction, and the second included twenty subjects and represents hypertensive patients with diastolic dysfunction.

Results: LA myocardial strain rate parameters were all significantly affected compared to the control group, left atrial function is affected in the hypertensive with D.D group as shown by the reduced average PALS, average SR S, and average SR E and elevated average SR A values.

Conclusion: Speckle tracking derived SR imaging is a useful noninvasive method for quantifying regional LA myocardial function, which is closely associated with different degrees of LV diastolic dysfunction in subjects with preserved LVEF even in the presence of normal standard indexes of LA function.

Keywords: hypertension, left atrium, diastolic dysfunction, strain and strain rate imaging , speckle tracking.

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List of Abbreviations

2D	2 dimensional
AF	Atrial fibrillation
AP4	Apical 4 chamber
AV	Aortic valve
AVC	Aortic valve closure
BMI	Body mass index
BP	Blood pressure
BSA	Body surface area
CCT	Cardiac computed tomography
CHD	Coronary heart disease
CMR	Cardiac magnetic resonance
CT	Computed tomography
CV	Cardiovascular
CW	Continous wave
DD	Diastolic dysfunction
DHF	Diastolic heart failure
DT	Deceleration time
ECG	Electrocardiogram
EDT	deceleration time of peak E velocity
EF	Ejection fraction
FS	Fractional shortening

GL	Global longitudinal
HFNEF	Heart failure with normal ejection fraction
HR	Heart rate
HTN	Hypertension
IVRT	Isovolumetric relaxation time
IVS	Interventricular septum
JNC	Joint national committee
LA	Left atrium
LA CSI	Left atrial contraction strain index
LAEF	Left atrial ejection fraction
LAKE	Left atrial kinetic energy
LAV	Left atrial volume
LAVi	Left atrial volume indexed to body surface area
LV	Left ventricle
LVEDd	Left ventricular end diastolic dimension
LVEDP	Left ventricular end diastolic pressure
SR A	Atrial Strain Rate in Late Diastole
LVEDV	Left ventricular end diastolic volume
LVESd	Left ventricular end systolic dimension
LVESV	Left ventricular end systolic volume
LVH	Left ventricular hypertrophy
MRI	Magnetic resonance imaging

PA	Pulmonary artery
PACS	Peak atrial contraction strain
PALS	Peak atrial longitudinal strain
PR	Pulmonary regurgitation
PW	Posterior wall
RA	Right atrium
ROI	Region of intrest
SCD	Sudden cardiac death
SD	Standard deviation
SR	Strain rate
SR E	Atrial Strain Rate in Early Diastole
SR S	Atrial Strain Rate Systole
STE	Speckle tracking echocardiography
TDI	Tissue doppler imaging
TPLS	Time to peak longitudinal strain
TR	Tricuspid regurgitation
TTP	Time to peak strain
TTP SR A	Time to peak strain rate A
TTP SR E	Time to peak strain rate E
TTP SR S	Time to peak strain rate S
VTI	Velocity time integral
ε	Strain

Introduction

The left atrium (LA) plays an important role in the whole cardiac function ***(Ying-Ying Liu et al., 2011).*** The left atrium serves multiple functions, acting as a reservoir during ventricular systole, as a conduit for blood from the pulmonary veins to the left ventricle during early diastole, as an active contractile chamber that augments left ventricular filling in late diastole and as a suction source that refills itself in early systole. In total, the atria contribute to 30% of cardiac output ***(Liza Thomas, 2007).*** So the reservoir, conduit, and contractile functions of the left atrium are integral to overall cardiac performance ***(Andrew-To et al., 2011).***

The active contractile component of the left atrium has an important role in patients with ventricular dysfunction as a 'booster pump' to augment ventricular volume. Augmented left atrial booster function is one of the mechanisms compensating for decreased early filling in patients with reduced left ventricular compliance, whereas a loss of atrial contraction, as a result of atrial fibrillation or ventricular pacing, reduces cardiac output by approximately 15–20% ***(Stefanadis et al., 2001).***

There is significant interplay between left atrial and left ventricular function, such that events during each phase of "left atrial phasic function" are affected by factors from both the left atrium and left ventricle ***(Andrew-To et al., 2011).***

Left atrial size is used to be a marker of left ventricular diastolic function ***(Dominic-Leung et al., (2008),*** as during diastole, the left atrium is directly exposed to left ventricular pressure that increases with worsening left ventricular diastolic dysfunction. Consequently, left atrial pressure increases in order to maintain adequate left ventricular filling. This results in increased left atrial wall tension and dilatation of the left atrium ***(Guan et al., 2010).*** Therefore, left atrial volume provides an integration of the severity and chronicity of left ventricular diastolic dysfunction ***(Dominic-Leung et al., 2008).***

High blood pressure has a high prevalence in the general population ***(Hildo-Lamb et al., 1999).*** Left atrial structural and functional changes occur in patients with hypertension. Left atrial enlargement is commonly found by echocardiography in patients with hypertension and is associated with increased risks for atrial fibrillation and diastolic heart failure ***(Kokubu et al., 2007).***

Previous echocardiographic and radionuclide studies have shown impaired diastolic heart function in hypertension, even in the absence of left ventricular hypertrophy, whereas systolic function is still preserved ***(Hildo-Lamb et al., 1999).***

Diastolic dysfunction plays an important role in the pathophysiology of heart failure, especially in patients with preserved systolic function. It has been demonstrated that different degrees of left ventricular diastolic dysfunction are related to long-term mortality compared with normal patients. Contributing up to 30% of total left