Assessment of Left Atrial Function by Speckle-Tracking Echocardiography in Hypertensive Patients

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Abstract: Background: We investigated left atrial (LA) function in relation to hypertension using 2-dimensional speckle-tracking echocardiography (STE) in subjects with preserved left ventricular (LV) ejection fraction, while accounting for LA enlargement and LV mass and diastolic function. **Objective**: To assessment of left atrial function by speckle-Tracking in hypertensive patient. **Material and method:** We performed standard 2-dimensional and Doppler echocardiography and LA volumetric measurements and STE strain imaging in hypertensive patients (systolic/diastolic blood pressure ≥140/90 mmHg, or use of antihypertensive drugs, n=55) and age- and sex-matched normotensive subjects (n=25). We measured the peak LA velocity, strain, and strain rate during systole and early and late diastole, respectively. We investigated the associations of interests in the presence or absence of LA enlargement (LA volume index ≥28 mL/m^2). Hypertensive and normotensive subjects had similar LV ejection fraction and LA diameter. However, hypertensive compared with normotensive subjects had enlarged LV and impaired diastolic function, and had increased LA volumetric measurements and decreased LA emptying fractions. Hypertensive patients also had impaired LA function, as measured by STE velocity, strain, and strain rate in general and in the absence of LA enlargement (P<0.0001). The differences in LA STE strain rate during LV systole and LA contraction between hypertension and norm tension in the absence of LA enlargement remained statistically significant (P<0.001), after adjustment for age, sex, and LV mass index and E/E'. **Result:** Hypertension is associated with impaired LA function, as assessed by STE strain imaging technique, even before LA enlargement develops and after LV remodeling is accounted for.

[Mohsen Salama, Abd El haleem Abo Elmagd, Mohamed El gammal, Mostafa Ismail, Ahmed Nasrah. **Assessment of Left Atrial Function by Speckle-Tracking Echocardiography in Hypertensive Patients.** *Nat Sci* 2016;14(12):150-153]. ISSN 1545-0740 (print); ISSN 2375-7167 (online). http://www.sciencepub.net/nature. 23. doi:10.7537/marsnsj141216.23.

Keywords: Assessment; Atrial; Function; Speckle-Tracking Echocardiography; Hypertensive Patients

1. Introduction

Normal left atrial (LA) structure and function is essential for the cardiac function**. (Rosca *et al.*, 2001).** Indeed, in addition to LA enlargement, LA functional abnormalities may also predict the occurrence of atrial fibrillation **(Kuppahally *et al.*, 2010)**. Recent studies suggest that LA structural remodeling and/or functional impairment might play a part in the pathogenesis and development of ventricular disorders, such as heart failure with or without preserved ejection fraction**. (Yamamoto *et al.*, 2003).** However, LA, especially its function, is insufficiently studied because of measurement difficulties. Standard echocardiography only routinely measures the LA diameter. Tissue Doppler imaging has limited accuracy of measurement and hence restricted use in clinical and even research settings. **(Edvardsen *et al.*, 2002).**

Speckle-tracking echocardiography (STE) makes it possible to measure LA function with relatively high accuracy**. (Leitman *et al.*, 2004).** More importantly, the STE strain imaging technique allows detection of LA functional impairment at the very early stage, such as in the absence of LA enlargement. We recently performed STE measurements in a series of hypertensive and normotensive subjects. In the present study, we compared hypertensive with normotensive subjects in the prevalence of LA enlargement and functional impairment as assessed by the volumetric measurement and deformation indexes, and investigated the association of LA functional impairment with LA enlargement, while accounting for left ventricular (LV) structural remodeling and diastolic dysfunction in these hypertensive and normotensive subjects.

2. Patients and methods

This study will included patients referred to echocardiography Unit in Cardiology Department, at Al-Hussein University Hospital echocardiography Unit in Islamic cardiac center, Al-Azhar University. Between December 2015 to June 2016. Using 2D-STE, the functions of the LA was measured, the study population were divided into two groups: **Group A**: included (25) normotensive individual. **Group B:** included (55) known to be hypertensive patients. All the patients were examined in the left lateral decubitus position. Standard 2D TTE examination were performed with a "Philips iE33 X Matrix" ultrasound machine using "S5-1" &"X5-1" matrix array

transducers (Philips Medical Systems, Andover, USA) equipped with STE technology, using a multi frequency (1 - 5 MHz).

3. Results:

This study included (80) patients referred to echocardiography Unit in Islamic cardiac center, Al-Azhar University. Between December 2015 to June 2016.

But there was statistically significant difference between the two groups as regard LV mass, septal thickness and posterior wall thickness, ***P value less than 0.0001***.

Table (1): Comparison of some Echocardiographic parameters between control and patients groups

Variables		M ± SD	P
LVEDD	Control	48.66 ± 2.39	0.669
	Patients	48.98 ± 3.43	
LVESD	Control	45.09 ± 62.71	0.146
	Patients	32.71 ± 3.33	
FS	Control	33.08 ± 1.65	0.578
	Patients	33.53 ± 3.93	
EF	Control	63.53 ± 3.99	**0.023**
	Patients	66.44 ± 5.65	
LVmass	Control	98.48 ± 16.48	**< 0.0001**
	Patients	121.71 ± 20.93	
Sept thick	Control	0.85 ± 0.09	**< 0.0001**
	Patients	9.36 ± 1.27	
Post thick	Control	0.81 ± 0.09	**< 0.0001**
	Patients	8.56 ± 1.04	
LAD	Control	36.80 ± 4.04	0.784
	Patients	37.05 ± 3.53	

Table (2): Doppler Echocardiographic parameters between control and patients groups

Variables		*M ± SD*	*P*
E/A	Control	1.30 ± 0.40	0.134
	Patients	1.17 ± 0.32	
V max	Control	36.15 ± 7.32	**< 0.0001**
	Patients	48.44 ± 10.87	
V preA	Control	21.79 ± 6.15	**< 0.0001**
	Patients	32.19 ± 8.68	
V min	Control	12.26 ± 4.11	**< 0.0001**
	Patients	19.50 ± 6.00	
LAEF total	Control	67.86 ± 8.00	**0.010**
	Patients	63.18 ± 7.02	
LAEF pass	Control	41.27 ± 8.79	**0.011**
	Patients	36.11 ± 7.91	
LAEF active	Control	48.38 ± 9.55	**0.005**

Table (3): Left atrium speckle tracking parameters between control and patients groups

Variables		M ± SD	P
Vs	Control	5.69 ± 0.90	**< 0.0001**
	Patients	4.43 ± 0.68	
Ve	Control	5.76 ± 1.04	**< 0.0001**
	Patients	4.35 ± 0.82	
Va	Control	5.66 ± 0.82	**< 0.0001**
	Patients	4.59 ± 0.75	
Ss	Control	46.74 ± 8.36	**0.003**
	Patients	40.75 ± 5.69	
Se	Control	21.41 ± 3.59	**< 0.0001**
	Patients	17.49 ± 2.93	
Sa	Control	26.86 ± 4.96	**0.009**
	Patients	23.53 ± 5.28	
Srs	Control	2.43 ± 0.45	**< 0.0001**
	Patients	1.95 ± 0.34	
Sre	Control	2.35 ± 0.55	**0.001**
	Patients	1.88 ± 0.50	
Sra	Control	2.71 ± 0.50	**0.001**
	Patients	2.29 ± 0.42	

4. Discussion

Our findings are 2-fold. First, hypertensive patients had high prevalence of LA enlargement, which was associated with impaired LA function, as measured by the STE strain imaging technique. Second, in the absence of LA structural enlargement, hypertension was still associated with LA functional impairment, especially during LV systole and LA contraction, even after accounting for LV remodeling and diastolic dysfunction.

Our finding on the impaired LA function as assessed by STE strain imaging during LV systole and LA contraction in the absence of LA enlargement and in the presence of hypertension extends previous observations on this topic. **(Erol *et al.*, 2002).** There is consensus that hypertension is associated with impaired LA function, regardless of the measurement techniques, such as the phasic/volumetric measurements, indexes of mitral and pulmonary vein flows, and tissue Doppler imaging or STE deformation indexes by strain imaging techniques. **(Dimitroula *et al.*, 2010).** However, these previous studies often did not account for LA enlargement or LV structural and functional remodeling or attributed the observed LA functional impairment to these atrial and ventricular abnormalities. After accounting for these apparent cardiac abnormalities, we found that hypertension was still associated with LA functional impairment, suggesting that LA strain imaging is particularly sensitive in assessing LA function in hypertension. It is possible that these 2 dynamic measurements, respectively, in the heart and systemic circulation, though separated by LV, may share common or

similar mechanisms of pathogeneses. **(Cohn *et al*., 200).** The STE strain imaging therefore might be useful in the assessment of target organ damage and in the initiation of antihypertensive treatment on several conditions, such as white-coat or masked hypertension. **(Parati et al., 2014).** In the presence of impaired LA function, even white-coat or masked hypertension might be treated with hypertensive drugs.

Using multiple echocardiographic techniques, we found that hypertensive patients with mildly elevated blood pressure might have multiple structural and functional LA and LV abnormalities. Among others, LA enlargement had high prevalence and was closely related to LA and LV functions. This confirmatory finding might be clinically relevant. Current standard echocardiography only measures LA diameter, and can only unveil abnormalities at a late and probably irreversible stage. In hypertension, a more thorough echocardiographic evaluation of LA may be necessary and useful in the choice of antihypertensive drugs and target blood pressure. There is some evidence that inhibitors of the renin-angiotensin system may provide more protection against LA diseases, such as atrial fibrillation**. (Marott *et al*., 2014).**

Our observation on the close association between LA enlargement and functional impairment is in line with the results of numerous previous studies involving various measuring techniques.[1] This consistency to some extent validates the STE strain imaging technique in general and our measurements in particular. This 2-dimensional STE strain imaging technique allows simple and rapid evaluation of 3 phases of LA function, and may be used in the clinical setting. With a relatively short term of training, an echocardiographer, experienced in standard echocardiography, can manage in operating the technique with an acceptable intra- and inter observer variability between repeated measurements.

Our study should be interpreted within the context of its limitations. First, our study population was not a random sample. Although hypertensive and normotensive patients were well-matched in sex and age, selection bias is still possible. Second, hypertension is a major risk factor of coronary artery disease. Myocardial ischemia may contribute to the difference between hypertension and normotension. However, LV ejection fraction was normal in all subjects and similar between hypertension and normotension. Diastolic function had been accounted for in statistical analyses. Third, our study is cross-sectional and noninterventional, and hence, does not allow any inference of causality or reversibility. Finally, the sample size of our study is relatively small. One of the major limiting factors is that the STE analysis is at present still quite time-consuming.

Conclusion

Hypertension is associated with impaired LA function, as assessed by STE strain imaging technique, even before LA enlargement develops and after LV structural and functional remodeling is accounted for. A major clinical implication of our finding is that STE strain imaging might be required to detect early impairment of LA function in hypertension, especially in the absence of LA and LV abnormalities on standard echocardiography. Nonetheless, because the STE analysis needs high-quality resolutions and has relatively high intra- and interobserver variability, this technique would require developed probes and software for future routine use in the clinical setting.

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11/29/2016