BRIEF COMMUNICATION

Relationship between Left Ventricular Mass and Echocardiographic Parameters in Hypertensive Patients

Relación entre masa ventricular izquierda y parámetros ecocardiográficos en hipertensos

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ABSTRACT

Background: In hypertensive patients, the new tools incorporated in the echocardiographic evaluation of diastolic function allow the detection of left atrial changes before abnormalities of the traditional parameters develop.
Objective: The aim of this study was to analyze the impact greater ventricular mass has on atrial strain and other parameters of ventricular dysfunction in hypertensive patients.
Methods: Sixty hypertensive patients were analyzed and divided in two groups according to left ventricular mass index, using a cutoff point of 132 g/m2 in men an 109 g/m2 in women. The traditional measurements were recorded as well as tissue Doppler imaging, left atrial volume and left ventricular mass index. Left ventricular longitudinal strain and left atrial strain during the reservoir period were analyzed. Statistical analysis was performed with SPSS software using Student's t test. A p value <5 was statistically significant.
Results: Hypertensive patients with greater left ventricular mass index had a significant reduction of left atrial strain (28.35±8.44 vs. 35.83±9.33; p=0.019; 95% CI, 1.38-13.58) and higher left atrial volume (35.97±9.48 vs. 30.32±7.54; p=0.037; 95% CI, 0.34-10.95).
Conclusion: In this study, the greater increase of left ventricular mass index was accompanied by a significant reduction of left atrial strain and a significant increase of left atrial volume.

Key words: Echocardiography - Diastolic Dysfunction - Left Atrium

RESUMEN

Introducción: En pacientes hipertensos, las nuevas herramientas incorporadas en la evaluación ecocardiográfica de la función diastólica permiten detectar modificaciones auriculares antes de la aparición de alteraciones en los parámetros clásicos.
Objetivo: Analizar el impacto del incremento de la masa ventricular sobre el strain auricular y otros parámetros de disfunción diastólica en hipertensos.
Material y métodos: Se analizaron 60 pacientes hipertensos divididos en dos grupos según el índice de masa ventricular izquierda utilizando un punto de corte de 132 g/m2 en hombres y de 109 g/m2 en mujeres. Se registraron mediciones ecocardiográficas convencionales, Doppler tisular, volumen de la aurícula izquierda e índice de masa ventricular izquierda. Se analizó el strain longitudinal del ventrículo izquierdo y de la aurícula izquierdadurante el período de reservorio. Se utilizó la prueba de la t (programa SPSS); p significativa: < 0,05.
Resultados: En hipertensos con mayor índice de masa ventricular izquierda se observaron una reducción significativa del strain de la aurícula izquierda (28,35 ± 8,44 vs. 35,83 ± 9,33; p = 0,019; IC 95% 1,38-13,58) y un incremento del volumen de la aurícula izquierda (35,97 ± 9,48 vs. 30,32 ± 7,54; p = 0,037; IC 95% 0,34-10,95).
Conclusión: En este estudio, el mayor incremento del índice de masa ventricular izquierda se acompañó de una reducción significativa del strain de la aurícula izquierda y un incremento del volumen auricular.

Palabras clave: Ecocardiografía - Disfunción diastólica - Aurícula izquierda

Abbreviations

LA	Left atrial	**LVMI**	Left ventricular mass index
HTN	Hypertension		

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INTRODUCTION

The evaluation of diastolic dysfunction is a routine practice in the echocardiography laboratory. However, over 20% of evaluations show contradictory results according to traditional echocardiographic parameters. (1)

Hypertension (HTN) produces left atrial (LA) enlargement (2) leading to higher mortality, and LA volume is associated with the level of diastolic dysfunction. (3) However, between 25% and 30% of patients with diastolic dysfunction have normal LA size. (4)

The new echocardiographic techniques allow quantification of LA strain at different periods of the atrial cycle. A recent report has demonstrated acceptable intra-observer and inter-observer variability, (5) its major criticism being the difficulty to homologate normal values among the different manufacturers. (6)

Peak atrial strain at the end of the reservoir period is reduced since the early stages of HTN, even before the classical signs of diastolic dysfunction develop. (7) This change was shown to be progressive when normal patients and patients with diastolic dysfunction, with and without heart failure, were compared. (8) However, little is known about the behavior of these parameters in the different stages of diastolic dysfunction in patients without heart failure.

The aim of this study was to evaluate the changes of traditional parameters and of atrial strain in a group of young subjects with controlled HTN, normal left ventricular (LV) ejection fraction and different values of left ventricular mass index (LVMI).

METHODS

Echocardiographic data corresponding to 90 asymptomatic hypertensive patients, aged between 30 to 60 years, were prospectively recorded between January 2013 and August 2014. Patients were under pharmacological treatment, had no other relevant clinical or cardiologic conditions and had normal ejection fraction >55% (estimated by the biplane Simpson's method). Patients with arrhythmias, heart rate >90 beats per minute, valvular heart disease or suboptimal ultrasonic window were excluded. Sixty patients were analyzed and divided into two groups according to LVMI estimated by the formula recommended by the American Society of Echocardiography (ASE); Group 1: patients with normal (<116 gr/m2 in men and < 96 gr/m2 in women) or mildly increased (up to 132 g/m2 in men and 109 g/m2 in women) LVMI and Group 2: patients with higher LVMI.

All the patients underwent echocardiographic evaluation with a GE Vivid E9 ultrasound machine, using standard technique. Conventional echocardiographic measurements were performed and color tissue Doppler images were acquired at a frame rate >40 frames per second. Mitral annulus septal and lateralpulsed-wave tissue Doppler measurements were calculated off-line from the digitally stored loops of color tissue Doppler. Left atrial volume was measured in 4-chamber and 2-chamber views using the modified Simpson's rule. Left ventricular E/A ratio, as an expression of LV filling velocity, and the E/e ratio (ratio between peak mitral inflow velocity E and maximum e wave velocity measured by pulsed-wave tissue Doppler, used to estimate left ventricular filling pressure or mean LA pressure) were calculated from the average annular lateral and septal e wave tissue Doppler. Systolic longitudinal strain was obtained by speckle-tracking echocardiography in the three standard apical views. Average peak LA strain was calculated in the same fashion in the lateral, inferior and posterior walls during the reservoir period. (Figure 1)

These measurements were performed on stored cine loops acquired with a frame rate >50 frames per second using the software Echopac PC version 110.1.2 provided by GE, adapting the width of the area of interest to the atrial wall thickness. All off-line analyses were performed by the same operator on at least two stored beats. Left atrial volumes and LV mass were indexed by body surface area calculated with the Mosteller formula.

Statistical analysis

Continuous variables are expressed as mean ± standard deviation. Categorical variables are presented as numbers and percentages. Statistical calculations of continuous variables were performed using Student's t test using SPSS 18 statistical package. A p value < 0.05 was considered statistically significant.

Ethical considerations

The study was evaluated and approved by an institutional Research Committee. An informed consent, authorized by a family member or person responsible, was requested for each patient included in the study.

RESULTS

Among the 90 study patients, 30 had to be excluded due to defects in image acquisition that became evident when the off-line analysis was performed. Of the 60 patients analyzed, 40 (66.6%) had normal or slightly elevated LVMI (Group 1: 91.87±18.01 g/m2) and 20 had LVMI >132 g/m2 in men or 109 g/m2 in women (33.3%) (Group 2: 136.70±13.47 g/m2). Most patients were men (65%); with mean age of 48.4 ± 6.6 years.

There were no significant differences in the E/A ratio, the average e wave obtained at the lateral mitral annulus and septal mitral annulus, the E/e ratio or peak systolic longitudinal strain.

Patients with higher LVMI presented a significant reduction of left atrial strain and greater LA volume (Table 1).

DISCUSSION

The evaluation of diastolic dysfunction deserves special attention, as many patients with this condition will develop signs and symptoms of heart failure.

Hypertension is generally present in most patients with diastolic dysfunction. (9) Therefore, the evaluation of the presence and severity of diastolic dysfunction is particularly interesting, as it may provide a useful tool to define the moment of initiating medical treatment and to adequate it to each stage of the disease and to each particular situation.

It is well known that patients with diastolic dysfunction have greater ventricular mass and LA volume than normal subjects.

However, the traditional parameters used to evalu-

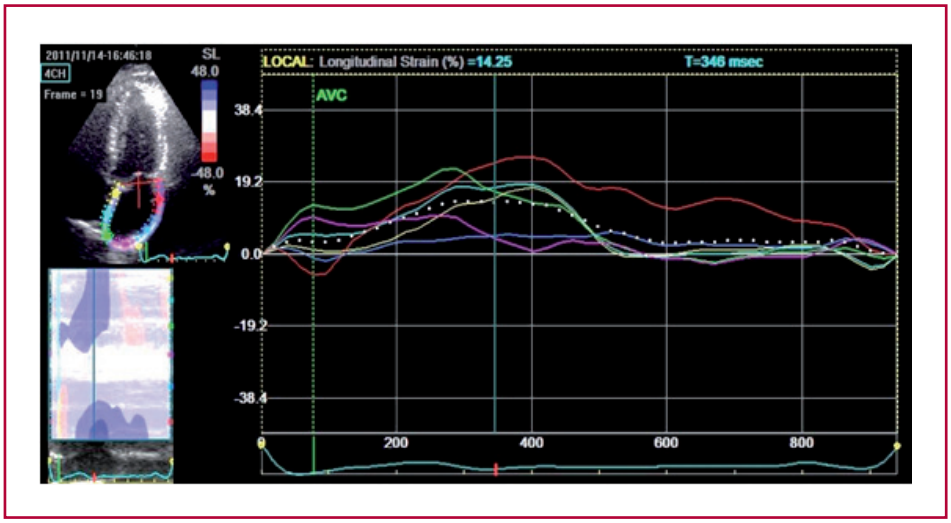

Fig. 1. A trial strain by speckle tracking in a hypertensive patient

Table 1. Student's t test for the different variables analyzed

	Group 1	Group 2	p	95% CI	
LVMI g/m2	91.87±18.01	136.70±13.47	<0.01	<0.01	<0.01
Mean LV strain	18.57±2.25	18.42±1.95	ns	ns	ns
Mean LA strain	35.83±9.33	28.35±8.44	0.019	0.019	0.019
LA volume/m2	30.32±7.54	35.97±9.48	0.037	0.037	0.037
E/e ratio	9.58±3.06	8.02±2.31	ns	ns	ns
Mean E	8.74±1.90	6.93±2.61	ns	ns	ns
E/A ratio	1.25±0.40	1.15±0.53	ns	ns	ns

* Only atrial strain showed significant differences
LVMI: Left ventricular mass index. LV: Left ventricular. LA: Left atrial.

ate diastolic dysfunction seem to have low sensitivity and show variations which depend on loading conditions and on other situations, such as heart rate, and thus may be occasionally inconclusive. (10) This occurs not only with the E/A ratio of mitral flow velocity (most commonly seen) but also with tissue Doppler velocities, which are supposedly less easily influenced. Of interest, about one third of patients with heart failure and preserved ejection fraction do not have abnormal values of the traditional parameters of diastolic dysfunction or atrial dilation. (12)

A recent publication has reported that over 20% of patients with diastolic dysfunction cannot be adequately classified based on traditional echocardiographic parameters. Thus, the authors used the E/e ratio with a cutoff point of 10 to identify patients with apparent impaired relaxation but with outcomes of pseudonormalized patients. (1) Yet, further evaluation of results shows that LA strain can also differentiate these populations with values nearly identical to those of the pseudonormal group (approximately 32%) and significantly different from patients with impaired relaxation (40%) and from normal subjects (46%).

Although the E/e ratio (a marker of LV end-diastolic pressure) is a reproducible parameter that can be easily obtained and is helpful in patients with preserved ejection fraction, its main disadvantage is the wide band of indefinite values between 8 and 13. (12, 13)

We are aware of the important impact that LV diastolic dysfunction has on the left atrium, generating higher atrial pressures with concomitant chamber dilation and impaired LA function. In this sense, the analysis of myocardial strain based on speckle tracking echocardiography has brought new elements of understanding in particular situations.

The findings of this study show that hypertensive patients who remain asymptomatic but with higher LVMI do not have greater abnormalities of the E/e ratio or e wave velocity than those present in earlier stages of the disease. In addition, we did not find a significant reduction of ventricular strain as other authors mentioned. (14) This can be due to the fact that, in our population, LVMI was lower than the one reported by these authors. Conversely, we observed an increased LA volume above normal values, and a significant reduction of atrial strain that was higher than the previously publishe done observed in early stages of the disease. (7,8)

This data suggest that changes in LA strain in diastolic dysfunction are progressive and more marked than the variations of other variables and could identify subgroups of patients with a different outcome.

Limitations

Atrial strain could not be analyzed in 30 of 90 patients due to technical limitations in image acquisition. The reproducibility of the method was not evaluated in the present study.

Some missing information, as the severity of HTN and kidney damage could have influenced the results.

CONCLUSION

In this group of hypertensive patients, the greater increase in left ventricular mass was accompanied by a significant reduction in atrial strain, already present in hypertensive patients with normal LV mass, and a significant increase in LA volume, above normal values.

Conflicts of interest

None declared.
(See authors' conflicts of interest forms in the website/ Supplementary material).

REFERENCES

1. Kuwaki H, Takeuchi M, Chien-ChiaWu V, Otani K, Nagata Y, Hayashi A, et al. Redefining diastolic dysfunction grading combination of E/A <0.75 and deceleration time >140 ms and E/ε>10. J Am Coll Cardiol Imag 2014;7:749-58. http://doi.org/bjkj
2. Vaziri SM, Larson MG, Lauer MS, Benjamin EJ, Levy D. Influence of blood pressure on left atrial size. The Framingham Heart Study. Hypertension 1995;25:1155-60. http://doi.org/q3n
3. Tsang TS, Barnes ME, Gersh BJ, Bailey KR, Seward JB. Left atrial volume as a morphophysiologic expression of left ventricular diastolic dysfunction and relation to cardiovascular risk burden. Am J Cardiol 2002;90:1284-9. http://doi.org/dzgwzs
4. Zile M, Gottdiener JS, Hetzel SJ, McMurray JJ, Komajda M, McKelvie R, et al. Prevalence and significance of alterations in cardiac structure and function in patients with heart failure and a preserved ejection fraction. Circulation 2011;124:2491-501. http://doi.org/fwvvbn
5. Morris DA, Takeuchi M, Krisper M, Köhncke C, Bekfani T, Carstensen T, et al. Normal values and clinical relevance of left atrial myocardial function analysed by speckle-tracking echocardiography: multicentre study. Eur Heart J Cardiovasc Imaging 2015;16:364-72. http://doi.org/bjkm
6. Lang R. 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. J Am Soc Echocardiogr 2015;28:1-39. http://doi.org/bhj5
7. Deschle HA, Gantesti J, Culaciati G, Casso N, Alfie L, Gingins M et al. Análisis de la deformación auricular longitudinal: alteraciones precoces en hipertensos jóvenes controlados. Rev Argent Cardiol 2014;82:126-32.
8. Kurt M, Wang J, Torre-Amione G, Nagueh SF. Left atrial function in diastolic heart failure. Circ Cardiovasc Imaging 2009;2:10-5. http://doi.org/dd5q4m
9. Gottdiener JS, McClelland RL, Marshall R, Shemanski L, Furberg CD, Kitzman DW, et al. Outcome of congestive heart failure in elderly persons: influence of left ventricular systolic function. The Cardiovascular Health Study. Ann Intern Med 2002;137:631-9. http://doi.org/q3t
10. Oh JK, Park SJ, Nagueh SF. Established and novel clinical applications of diastolic function assessment by echocardiography. Circ-Cardiovasc Imaging 2011;4:444-55. http://doi.org/fkhtp2
11. Zile MR, Gottdiener JS, Hetzel SJ, McMurray JJ, Komajda M, McKelvie R, et al. Prevalence and significance of alterations in cardiac structure and function in patients with heart failure and a preserved ejection fraction. Circulation 2011;124:2491-501. http://doi.org/fwvvbn
12. Quiñones MA. Assessment of diastolic function. Prog Cardiovasc Dis 2005;47:340-55. http://doi.org/c56rtv
13. Nagueh SF, Appleton CP, Gillebert TC, Marino PN, Oh JK, Smiseth OA, et al. Recommendations for the evaluation of left ventricular diastolic function by echocardiography. Eur J Echocardiogr 2009;10:165-93. http://doi.org/bbzm46
14. Mukherjee M, Dusaj R, Stewart K, Shapiro E, Katz R, Lewis J. Predictors of abnormal longitudinal strain using left ventricular speckle tracking in ambulatory hypertensive patients with preserved ejection fraction. J Am Coll Cardiol 2013;61:E858. http://doi.org/f26645