

The effect of blood pressure on left atrial size and function assessed by 3-dimensional echocardiography

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This editorial refers to ‘Cumulative blood pressure from early adulthood to middle age is associated with left atrial remodelling and subclinical dysfunction assessed by three-dimensional echocardiography: a prospective post hoc analysis from the coronary artery risk development in young adults study’ by H.D. Vasconcellos et al., pp. 977–984.

Left atrial dimensions and function are altered in numerous cardiovascular diseases and have been associated with an excess of mortality.¹ In hypertension, the increased left ventricular filling pressures lead to reduced early diastolic emptying and enhanced contraction of the left atrium at the end of the diastole to ensure adequate left ventricular preload. The response of the left atrium to the chronically increased left ventricular filling pressures consists of left atrial enlargement and impaired function. How and when these changes develop over time can be better elucidated by longitudinal population-based studies such as the Coronary Artery Risk Development in Young Adults (CARDIA).² A total of 5115 individuals aged 18–30 years were included between 1985 and 1986 at four different sites in the United States and were followed up during 30 years to investigate the determinants of the development of clinical and subclinical cardiovascular disease. Subsequent analyses have shown that cumulative blood pressure may represent better the chronic exposure that damages the cardiovascular system than a single measurement at the time of risk evaluation. A high cumulative blood pressure in early adulthood was associated with increased risk of left ventricular diastolic dysfunction and coronary atherosclerosis in middle age.^{3,4}

Vasconcellos et al.⁵ provide further evidence on the effect of cumulative blood pressure on left atrial size and function assessed with 3D transthoracic echocardiography at the year-30 examination. Adequate 3D transthoracic echocardiographic data for left atrial evaluation were available in 1033 individuals. Maximum, minimum, and pre-atrial contraction volumes of the left atrium were measured and phasic functions were derived. In addition, global left atrial longitudinal strain measured at the end of the ventricular systole

(reservoir strain) and strain rate at the early and late ventricular diastole were derived. The cumulative blood pressure was defined by summing the product of average millimetres of mercury and the years between each two consecutive visits over 30 years of follow-up.

Higher cumulative systolic blood pressure from early adulthood throughout middle age was associated with adverse left atrial remodelling, with higher left atrial volumes, increased reservoir, and booster pump functions but impaired early diastolic strain rate indicating impaired conduit function. Furthermore, higher cumulative diastolic blood pressure was associated with enhanced booster pump function, impaired early diastolic strain rate, and increased late diastolic strain rate. Race had a significant interaction in the association between cumulative systolic blood pressure and left atrial pre-atrial contraction volume and booster pump function, but the interaction was only significant for African-Americans.

While it is clear that strict control of blood pressure in general population early in life is imperative to avoid injury of the cardiovascular system and reduce the risk of atherosclerosis and heart failure, the methodology to assess the consequences of blood pressure on the cardiovascular system has not been established. Transthoracic echocardiography remains the imaging technique of first choice to evaluate the effects of blood pressure at cardiac level: left ventricular wall thickness and mass, left ventricular systolic and diastolic function, and left atrial size are key components of the echocardiographic report.⁶ From 2D echocardiography, normative reference values for left atrial diameter and volume have been derived in numerous registries and are included in current recommendations.⁷ In addition, the prognostic implications of 2D echocardiography derived measurements of the left atrium have been extensively explored. Armstrong et al.⁸ demonstrated that among 4082 participants of the CARDIA study in whom the left atrial diameter could be measured on the M-mode recordings of the parasternal long-axis view at the 5-year follow-up, each one standard deviation increase in left atrial diameter indexed for body surface area was associated 26% increased risk of cardiovascular events. Similarly, among 2412 participants with

available measurements of the left atrial area on the apical four-chamber views, an increase of 1 SD in left atrial area indexed for body surface area was associated with 42% increased risk of cardiovascular events.⁸

However, 2D echocardiography may not capture the pattern of left atrial remodelling and has been shown to significantly underestimate left atrial volumes when compared with computed tomography or cardiovascular magnetic resonance.^{9,10} The present study provides the largest evidence to date on the left atrial size and function assessed with 3D transthoracic echocardiography in middle age individuals, including relatively equal number of men and women and African-American and whites.⁵ In addition, reproducibility data are also provided highlighting the good intra- and inter-observer reproducibility for left atrial volume assessment but still modest inter-observer reproducibility for left atrial strain measurements. As acknowledged by the authors in the limitations, the selection of patients based on good quality of 3D transthoracic echocardiography data is an important bias and hampers the generalizability of the results to the general population.

Furthermore, it would have been interesting to study the association between 3D left atrial size and functions and clinical outcomes such as heart failure, atrial fibrillation and stroke in such large population. In 439 patients with high prevalence of cardiovascular disease, Wu *et al.*¹¹ showed the incremental prognostic value of minimum left atrial volume measured with 3D echocardiography. The association between left atrial reservoir strain and risk of stroke in patients with atrial fibrillation has also been demonstrated.¹² The present study may set the basis to close the circle and correlate cumulative blood pressure with changes in left atrial size and function and occurrence of cardiovascular events during follow-up.

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References

- Hoit BD. Left atrial size and function: role in prognosis. *J Am Coll Cardiol* 2014;**63**: 493–505.
- Friedman GD, Cutter GR, Donahue RP, Hughes GH, Hulley SB, Jacobs DR Jr *et al.* CARDIA: study design, recruitment, and some characteristics of the examined subjects. *J Clin Epidemiol* 1988;**41**:1105–16.
- Allen NB, Siddique J, Wilkins JT, Shay C, Lewis CE, Goff DC *et al.* Blood pressure trajectories in early adulthood and subclinical atherosclerosis in middle age. *JAMA* 2014;**311**:490–7.
- Kishi S, Teixido-Tura G, Ning H, Venkatesh BA, Wu C, Almeida A *et al.* Cumulative blood pressure in early adulthood and subclinical dysfunction in middle age: the CARDIA study. *J Am Coll Cardiol* 2015;**65**:2679–87.
- Vasconcellos HD, Moreira HT, Ciuffo L, Nwabuo CC, Yared G, Ambale-Venkatesh B *et al.* Cumulative blood pressure from early adulthood to middle age is associated with left atrial remodelling and subclinical dysfunction assessed by three-dimensional echocardiography: a prospective *post hoc* analysis from the coronary artery risk development in young adults study. *Eur Heart J Cardiovasc Imaging* 2018;**19**:977–84.
- Perrone-Filardi P, Coca A, Galderisi M, Paolillo S, Alpendurada F, de Simone G *et al.* Non-invasive cardiovascular imaging for evaluating subclinical target organ damage in hypertensive patients: a consensus paper from the European Association of Cardiovascular Imaging (EACVI), the European Society of Cardiology Council on Hypertension, and the European Society of Hypertension (ESH). *Eur Heart J Cardiovasc Imaging* 2017;**18**:945–60.
- Lang RM, 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. *Eur Heart J Cardiovasc Imaging* 2015;**16**:233–70.
- Armstrong AC, Liu K, Lewis CE, Sidney S, Colangelo LA, Kishi S *et al.* Left atrial dimension and traditional cardiovascular risk factors predict 20-year clinical cardiovascular events in young healthy adults: the CARDIA study. *Eur Heart J Cardiovasc Imaging* 2014;**15**:893–9.
- Agner BF, Kuhl JT, Linde JJ, Kofoed KF, Akeson P, Rasmussen BV *et al.* Assessment of left atrial volume and function in patients with permanent atrial fibrillation: comparison of cardiac magnetic resonance imaging, 320-slice multi-detector computed tomography, and transthoracic echocardiography. *Eur Heart J Cardiovasc Imaging* 2014;**15**:532–40.
- Badano LP, Miglioranza MH, Mihăilă S, Peluso D, Xhaxho J, Marra MP *et al.* Left atrial volumes and function by three-dimensional echocardiography: reference values, accuracy, reproducibility, and comparison with two-dimensional echocardiographic measurements. *Circ Cardiovasc Imaging* 2016;**9**:e004229.
- Wu VC, Takeuchi M, Kuwaki H, Iwataki M, Nagata Y, Otani K *et al.* Prognostic value of LA volumes assessed by transthoracic 3D echocardiography: comparison with 2D echocardiography. *JACC Cardiovasc Imaging* 2013;**6**:1025–35.
- Leung M, van Rosendaal PJ, Abou R, Ajmone Marsan N, Leung DY, Delgado V *et al.* Left atrial function to identify patients with atrial fibrillation at high risk of stroke: new insights from a large registry. *Eur Heart J* 2018;**39**:1416–25.