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Research Article

Cardiac structure and function, and ventricular-arterial interaction 11 years following a pregnancy with preeclampsia

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Abstract

Preeclampsia (PE) is associated with acute left ventricular dysfunction. Whether these changes eventually resolve remains unclear. This study assessed left and right ventricular structure and function, and ventricular-arterial interaction in 15 women 11 years after a pregnancy with PE and 16 matched control subjects with a normal pregnancy. We found normal left and right ventricular dimensions, systolic function, and global left ventricular strain, with no differences between the groups. In addition, indices of diastolic function, left and right atrial size, and amino-terminal pro-brain natriuretic peptide were normal and did not differ between the groups. Women with a previous PE had impaired night/day ratios for systolic and diastolic ambulatory blood pressure. However, indices of aortic stiffness or ventricular-arterial coupling did not differ between the groups. In conclusion, we could not demonstrate remaining alterations in systolic or diastolic left or right ventricular function, or in ventricular-arterial interaction in women 11 years after PE. J Am Soc Hypertens 2016;10(4):297–306.

Keywords: Diastolic function; echocardiography; preeclampsia; systolic function; ventricular-arterial coupling.

Introduction

Preeclampsia (PE) is among the five most common causes of maternal morbidity and mortality in the developed world.[1] This multisystem disease leads to hypertension and proteinuria in the mother and may lead to intrauterine growth restriction in the fetus.[2,3] However, intrauterine growth restriction is not always seen and may be confined mainly to the early onset form of PE.[4] PE is associated with both acute and long-term cardiac and vascular abnormalities.[5–7] Women with a history of PE have increased risk of hypertension, ischemic heart disease, stroke, and venous thromboembolism in later life[8]; and those with early and more severe PE are at greater risk.[9,10]

Regarding cardiac abnormalities, PE is acutely associated with an increase in systemic afterload and cardiac work, resulting in cardiac remodeling with an increase in left ventricular (LV) mass and impairment of LV systolic and diastolic function.[5,10] These LV structural and functional abnormalities persist for some time after delivery.[5,11] Whether these abnormalities persist at long-term follow-up has, however, not been fully clarified. Furthermore, little is known about acute and long-term effects of PE on right ventricular (RV) structure and function.

The interaction between LV function and arterial load is an important determinant of cardiac function, where the transfer of mechanical energy from the heart to the arterial

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vascular bed can be assessed as the ratio between the effective arterial elastance and LV systolic elastance (ventricular-arterial coupling).[12] Alterations in ventricular-arterial coupling during normal pregnancies and PE have been reported.[13,14] Whether cardiac function and ventricular-arterial interactions are affected in women long after a pregnancy complicated by PE, however, remains to be investigated.

Recent advances in echocardiographic methodology include Doppler tissue imaging echocardiography, which has been proven to be particularly useful in the evaluation of LV diastolic function. The ratio of transmitral flow E-wave velocity to myocardial e' velocity (ie, the E/e'ratio)[15] has become widely used as an estimate of LV filling pressure in the general population and in patients with hypertension[16] or PE[5] and has been suggested to represent a more reliable index for evaluation of LV diastolic function than conventional indices based on transmitral flow E- and A-wave velocities (ie, the E/A ratio).[17] Two-dimensional speckle-tracking echocardiography for myocardial strain imaging is a new method for assessment of myocardial deformation, which is an active energy-dependent process both in systole and diastole and thus highly sensitive to increased wall stress, afterload, and ischemia.[18] We therefore hypothesized that speckle-tracking echocardiography could be valuable in the detection of subclinical LV dysfunction in women with a history of PE.

In this study, we used such new echocardiographic techniques to examine women 11 years after a pregnancy complicated by PE and women with an uncomplicated pregnancy with the aim to evaluate the possible long-term impact of PE on LV and RV ventricular structure and function and on ventricular-arterial interactions.

Methods

Study Participants and Study Design

Pregnancy data collected from hospital records were used to include 18 primiparous women with a pregnancy complicated by PE according to current recommendations.[19] The PE group was otherwise healthy nonsmoking with no known cardiovascular risk factors. The control group was 17 healthy nonsmoking women recruited in a similar manner with a normal uncomplicated pregnancy, matched for age and parity at the time of the index pregnancy, and date of delivery. All women were initially investigated with focus on vascular function (no echocardiography was performed) 15 ± 3 months after the index pregnancy, as previously reported.[20] The women were not investigated during the index pregnancy. For the purpose of the present study, all participants were again invited 11.2 ± 0.6 years after the index pregnancy to undergo cardiac and vascular examinations. Two women in the PE group and one in the control group were unwilling to attend. The index pregnancy was complicated by early and severe PE in six women, defined as a systolic and/or diastolic blood pressure (SBP, DBP) of 160/110 mm Hg or above, and proteinuria on dipstick readings of 2 + or more.[21] All participants received a questionnaire on medical history and history of subsequent pregnancies. Nine women in the PE group and all except one in the control group had been pregnant again. Mean parity at the time of the current examination was 1.9 ± 0.9 in the PE group and 2.2 ± 0.7 in the control group with a median value of 2 in both groups. The current examinations were performed 7.9 ± 3.3 and 6.6 ± 2.4 years after the last pregnancy in the PE group and control group, respectively. Detailed patient characteristics and results on metabolic and vascular function have been reported.[22]

All women gave their written consent to participate in the study. The regional Ethics Committee in Stockholm approved of the study, and all procedures followed were in accordance with institutional guidelines.

Measurements and Calculations

Examinations were performed in the morning after overnight fasting and in the supine position in a quiet room kept at constant temperature after a 20-minute period of rest. Brachial blood pressure was obtained by an oscillometric device (OMRON 705IT, OMRON Healthcare, Kyoto, Japan) on the right arm as a mean of three readings 1-minute apart. Mean arterial blood pressure was calculated as DBP + 1/3 × (SBP − DBP). Ambulatory blood pressure was recorded every 20 minutes during 24 hours (Spacelabs 90207 device, Spacelab Healthcare, Issaquah, WA, USA) on the nondominant arm. Default automatic editing was used and all recordings had >80% valid measurements. Pulse wave analysis was performed using a SphygmoCor device (AtCor Pty Ltd, West Ryde, NSW, Australia). Central blood pressure values were derived and the augmentation index was measured through the software. Pulse wave velocity was calculated from the direct carotid-to-femoral path length. For details, see the article by Östlund et al.[22]

Blood was obtained from an antecubital vein into Vacutainer tubes (Becton Dickinson, Cedex, Meylan, France) with appropriate additives. Plasma amino-terminal pro-brain natriuretic peptide (NT-pro-BNP), cholesterol, cystatin C (for calculation of estimated glomerular filtration rate), glucose, and insulin were analyzed by standard procedures. Glucose tolerance was calculated by the homeostasis model assessment as 0.167 × mmol/L fasting glucose × pmol/L fasting insulin/22.5. For details, see the article by Östlund et al.[22]

Information on offspring birth weight and placental weight was obtained from medical records. Birth weight centile was calculated using a customized centile calculator[23] taking into account Swedish reference values, gestational age of delivery, maternal weight, height, parity, and ethnic