

Mini Review

Diastolic Function during Hypertensive Disorders of Pregnancy

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INTRODUCTION

Hypertensive disorders of pregnancy (HDP), including preeclampsia, gestational hypertension, and chronic hypertension, can significantly impact the heart's structure and function; pregnancy per se requires cardiovascular systemic adaptations; gestational hypertension and preeclampsia exhibit decreased placental perfusion due to the shallow cytotrophoblast invasion of the spiral arteries, ischemia of the placenta is suggested to cause dysfunction of the maternal vascular endothelium which result in increased arterial blood pressure, renal excretory changes and increased maternal inflammation; reduction of blood flow promotes a pro-inflammatory state in the maternal vasculature, which has adverse consequences for mother and developing fetus; these changes during normal pregnancy are well tolerated but during HPD the heart has to towering performance to deal with oxidative stress, acute inflammation, hormonal disturbances, endothelial and microcirculatory dysfunction, immune dysregulation, cardiomyocyte and extracellular matrix dysfunction [1].

Signs or symptoms of heart failure during pregnancy are difficult to discern; fatigue, decreased exercise capacity, shortness of breath and lower extremity oedema are the most common symptoms but deterioration of functional class alone is not indicative of hospitalization; in a small subset of patients can present cardiogenic shock; most patients experience clinical trajectories from complete to partial recovery of systolic and diastolic function as well as normal atrial function [2].

During HPD the development of startling heart failure should be monitor by electrocardiography, chest radiography, echocardiography and laboratory assessment including natriuretic peptide levels and High sensitive cardiac troponin T levels (hs-cTnI), as proposed by different groups around the world specially for those preterm preeclampsia women with hs-cTnI > 5-fold increased; besides a N-terminal pro brain type natriuretic peptide levels >200pg/mL; follow up should raise concern for combined heart failure and preeclampsia and could added value of hscTnI suggests potential for further improving cardiac screening and risk stratification during HPD.

In a recent, large, prospective, population based-cohort of middle aged woman in the UK, it was found that having a history of gestational hypertension was strongly associated with greater risk of incident cardiovascular disease, heart failure, diastolic dysfunction, high mortality rates maternal and fetal complications; although preeclampsia usually carries a 3-fold increased risk of non- pregnancy related hypertension later in life.

Trough echocardiography is possible to monitor systolic and diastolic function as well as atrial function; the impact of Hypertensive Pregnancy Disorders (HDP) on Left Atrial Size and Diastolic Function are key cardiovascular parameters affected in these conditions [3].

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LEFT ATRIAL SIZE MECHANISM OF ENLARGEMENT

Chronic elevated blood pressure increases the afterload on the left ventricle (LV), leading to diastolic dysfunction and increased filling pressures. This overload is transmitted back to the LA, causing left atrial enlargement; during preeclampsia, endothelial dysfunction and vasoconstriction exacerbate these effects [4].

Clinical Findings

1. Increased left atrial volume index (LAVI): A marker of chronic pressure overload; enlarged LA is a potential indicator of long-term cardiovascular risk in women with a history of HDP.

2. Diastolic Function Pathophysiology: HDP can cause left ventricular hypertrophy (LVH) due to sustained pressure overload. LVH impairs relaxation, leading to diastolic dysfunction, which is common in preeclampsia and chronic hypertension [5].

Assessment parameters: e/a ratio

May show a reduced ratio (impaired relaxation) or pseudonormal patterns. E/e' ratio: Elevated, indicating increased filling pressures.

Left atrial strain (assessed via speckle-tracking echocardiography)

May be reduced in diastolic dysfunction.

Preeclampsia and long-term cardiovascular risk: Women with preeclampsia or other HDP are at increased risk of developing chronic hypertension, heart failure (especially HFpEF), and atrial fibrillation later in life; left atrial enlargement and diastolic dysfunction can be early indicators of these risks.

Echocardiography is essential for assessing cardiac structure and function in HDP; long-term follow-up with cardiovascular risk management is recommended for women with a history of HDP; echo provides valuable insights into the cardiovascular changes associated with hypertensive pregnancy disorders (HDP), including gestational hypertension, preeclampsia, and chronic hypertension in pregnancy. These changes primarily affect the left atrium (LA), the diastolic function and left ventricle systolic function [6].

ECHOCARDIOGRAPHIC FINDINGS IN HYPERTENSIVE PREGNANCY DISORDERS

Left Atrial Size and Function Enlarged Left Atrium

1. LA volume index (LAVI): Increased ($>34 \text{ mL/m}^2$), indicating chronic pressure overload due to elevated filling pressures.

2. Reduced LA strain: Speckle-tracking echocardiography may show impaired LA function, reflecting elevated LV filling pressures.

3. Diastolic function impairment is common in HDP due to left ventricular hypertrophy (LVH) and elevated systemic vascular resistance [7].

E/A Ratio (Mitral inflow velocities)

Grade I dysfunction: Reduced E/A ratio (<0.8), indicating impaired relaxation.

Grade II dysfunction: Pseudonormal E/A ratio ($0.8\text{--}2.0$), indicating elevated filling pressures.

Grade III dysfunction: Restrictive filling ($E/A > 2.0$), severe diastolic dysfunction.

E/e' Ratio (Mitral inflow velocity to mitral annular velocity): Elevated (>14), suggesting increased LV filling pressures.

Deceleration Time (DT): Shortened ($<150 \text{ ms}$) in severe diastolic dysfunction, reflecting elevated pressures [8].

LEFT VENTRICULAR CHANGES

Left Ventricular Hypertrophy (LVH): Increased LV wall thickness due to chronic pressure overload.

Increased LV mass index (normal: $<95 \text{ g/m}^2$ for women).

LV Geometry: Subtle concentric remodeling or hypertrophy is common in HDP.

Systolic Function: Usually preserved in HDP (normal ejection fraction, EF), but subtle dysfunction can be detected with advanced techniques like global longitudinal strain (GLS).

Reduced GLS ($<16\%$) may indicate early systolic dysfunction despite normal EF [9].

PULMONARY HYPERTENSION

Elevated pulmonary artery systolic pressure (PASP) due to increased left-sided pressures, which may contribute to pulmonary congestion [10].

PERICARDIAL EFFUSION

In severe preeclampsia, a small pericardial effusion may be present, secondary to systemic inflammation and endothelial dysfunction.

CARDIAC OUTPUT AND STROKE VOLUME

Alterations in cardiac output (CO) and stroke volume

Earlier studies suggested that women with preeclampsia have reduced plasma volume; however, recent evidence is consistent that the suppressed plasma renin activity, higher blood pressure and subsequent decrease in glomerular filtration rate seen in preeclampsia are consistent with vasoconstriction and overfilled circulation rather than true hypovolemia.

Early HDP: Increased CO due to hyperdynamic circulation.

Late/severe cases

Reduced CO due to LV dysfunction and increased vascular resistance; severe heart failure will require hospitalization and use of intravenous diuretics in addition to vasodilators that reduce afterload; in those extreme severity cases, the use of intraortic balloon Counterpulsation or ventricular assistance may be indicated.

ABNORMAL SPECKLE-TRACKING FINDINGS

Global Longitudinal Strain (GLS): Reduced GLS indicates subclinical LV systolic dysfunction.

Left atrial strain

Reduced during reservoir and conduit phases, correlating with diastolic dysfunction.

Clinical Utility of Echocardiographic

Findings Risk Stratification: Identifying diastolic dysfunction and LA enlargement can predict heart failure with preserved ejection fraction (HFpEF), and atrial fibrillation risk.

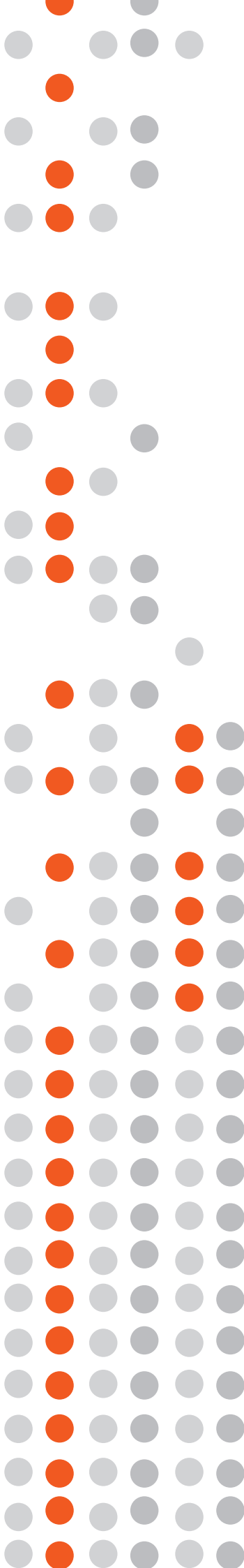
Long-term Follow-Up: Women with abnormal findings during pregnancy are candidates for cardiovascular screening postpartum; preeclampsia is not a pregnancy limited condition of course it has a significant long-term effect on the well-being of the mother and her child.

Together with a multidisciplinary team of maternal fetal medicine physicians, cardiologists, neonatologists, obstetrics nurses, anesthesiologists a comprehensive delivery plan for follow up safely on an outpatient woman who need careful and close surveillance to ensure a safe and well- planned birth [11].

Vaginal delivery is recommended for most HPD pregnancies if there are no obstetrical conditions as cesarean delivery can be associated with increase fluid shifts that worsens HPD. However, cesarean delivery may be needed when hemodynamic instability. In the postpartum setting, these high risk inpatients should remain at least 72hrs on continuous cardiac monitoring given the risk for fluid overload and heart failure decompensation in the setting of significant fluid shifts and uterine resorption, evidence suggests that endothelial dysfunction that begins during pregnancy persists long after delivery, numerous prospective studies have documented higher risk of chronic hypertension, ischemic heart disease, stroke; postdelivery echocardiography may be clinically indicated but is not routinely required and haemodynamics cardiac normalization can take up to 2 weeks after delivery, so close monitoring should occur during this fourth trimester; these 12 weeks after delivery represents a critical time of transition that affords many opportunities to optimize woman's cardiovascular health; the cardiologists follow-up is essential and monitoring plan with a cardio-obstetrics multidisciplinary team improve maternal health systems in the peripartum and postpartum periods specially for HPD [12].

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