Cardiac Dysfunction and Preeclampsia
Can Imaging Give Clues to Mechanism?

Esther F. Davis, MBBS; Adam J. Lewandowski, BSc; Paul Leeson, PhD, FRCP

A pregnancy complicated by preeclampsia identifies both a mother and child with an unusual predisposition to develop cardiovascular diseases. Therefore, characterization of biological pathways common to both preeclampsia and cardiovascular disease may provide novel insights into both conditions. One particular area of interest is whether known triggers for preeclampsia, such as hypoxia, inflammation, and angiogenic imbalance, may also trigger the cardiac dysfunction that has been observed in women with preeclampsia.

Cardiac Dysfunction and Preeclampsia

Early in pregnancy, women who subsequently develop preeclampsia display an increased cardiac output compared with women who have a normotensive pregnancy (Table). As the clinical syndrome of preeclampsia develops the cardiac output significantly drops, a change that coincides with increases in total vascular resistance. Some studies report a reduction in left ventricular ejection fraction, although within normal limits, and tissue Doppler imaging has been used to demonstrate reduced cardiac longitudinal systolic function. Diastolic function, assessed by mitral valve inflow and tissue Doppler imaging of the mitral annulus, also alters. Again, the changes precede disease development and worsen with disease progression. The earlier the onset of symptoms the greater and the earlier the decline in systolic function, comparable with the earlier elevations in blood pressure observed in those who develop early-onset preeclampsia.

Shahul et al have used this approach to evaluate the impact of hypertensive pregnancy disorders on myocardial function. As a result, the major finding from the article is that myocardial strain is significantly reduced in mothers with preeclampsia compared with those with non–proteinuric hypertension, despite similar blood pressures and left ventricular geometry. Additional biological factors, beyond changes in blood pressure, must account for the additional cardiac dysfunction in preeclampsia. They identify relatively greater impairment of longitudinal systolic function and propose this may reflect the fact that “…a key effector of biochemical perturbations is likely soluble fms-like tyrosine kinase-1, which causes both systemic vasoconstriction and intense small vessel myocardial vasoconstriction.” Although biologically plausible, further experimental investigation will be required to prove this association, as it is equally possible that other biological or vascular factors drive the changes in deformation. Account also needs to be taken of the current methodological variations and limitations in speckle tracking across different imaging planes. Nevertheless, the approach demonstrates how echocardiography can now be used for sophisticated evaluation of the myocardium to develop hypotheses in a way that would not have been possible with gross volumetric measures of myocardial function.

Myocardial Deformation Imaging and Preeclampsia

Speckle tracking provides a potentially powerful approach to characterize subtle changes in myocardial contraction and relaxation before gross changes in volumetric indices such as ejection fraction. Furthermore, when rigorously applied, speckle tracking avoids the inherent angle-dependent limitations of tissue Doppler imaging and provides multiplanar evaluation of myocardial deformation, from a global level, down to individual segments. This real-time evaluation of both temporal and spatial myocardial deformation introduces new possibilities to combine observations from imaging with those from basic scientific discovery. Use of advanced imaging in certain risk groups has already identified selective changes in longitudinal or circumferential strain consistent with the known impacts of factors such as hypoxia or lipids on myocardial function in experimental models. This translational approach allows validation in humans of observations and replace with hypotheses developed from experimental studies and identification of clinically relevant disease biomarkers for subsequent interventions.

Future Work

Prospective data on regional strain changes will be of interest. The angiogenic imbalance that causes preeclampsia typically seems to resolve after pregnancy, whereas there is
now evidence that cardiac changes persist for at least a year20 (Table). The severity of the long-term dysfunction varies depending on how investigators chose to define cardiac function and whether they take account of preeclampsia severity in their analysis. Nevertheless, advanced imaging studies of myocardial function in women, late after a preeclamptic pregnancy, are likely to be of value to define the long-term clinical response to disease or interventions.

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References


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Table. Previously Reported Changes in Left Ventricular Systolic and Diastolic Function in Mothers During and After Pregnancies Complicated by Preeclampsia

<table>
<thead>
<tr>
<th>Timing of study</th>
<th>Systolic Function</th>
<th>Diastolic Function</th>
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<tr>
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<td>Cardiac output</td>
<td>Ejection fraction</td>
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<tr>
<td>Early pregnancy</td>
<td>↑*</td>
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<tr>
<td>Late pregnancy</td>
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<td>≤1 y postpregnancy</td>
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<td>&gt;1 y postpregnancy</td>
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TDI indicates tissue Doppler imaging; ~, no difference in women with a preeclamptic pregnancy compared with normotensive pregnancy; ↑, increased in women with a preeclamptic pregnancy compared with normotensive pregnancy; ↓, decreased in women with a preeclamptic pregnancy compared with normotensive pregnancy; *, decreased in those who go onto develop early-onset compared with late-onset preeclampsia; and —, not reported/measured.
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