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Cardiac imaging and functional assessment in pregnancy

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ABSTRACT

There are multiple imaging modalities available for the assessment of pregnant women with known or suspected cardiac disease. Because of its safety and general availability, echocardiography is the preferred study of choice for the evaluation of ventricular function, valvular heart disease, congenital heart disease, evaluation of the aorta, and the estimation of cardiac hemodynamics in a pregnant patient. Cardiac MRI can be performed, especially for diseases of the aorta and complex congenital heart disease. Radiation exposure for the fetus and the mother will be discussed in the use of CT angiography, nuclear imaging, and left-heart catheterization including coronary angiography for specific indications in the pregnant woman. The use of exercise testing during pregnancy for functional assessment will be presented.

Introduction

For the pregnant woman with suspected heart disease, a number of diagnostic imaging modalities are available to evaluate cardiac anatomy and function. These include echocardiography, cardiac MRI, CT scanning, nuclear imaging, and right- and left-heart catheterization. Indications and safety concerns will be reviewed. Management of the patient should be optimized by consultation with the appropriate specialists before diagnostic testing is undertaken. Ideally, women with known heart disease, collagen vascular diseases such as Marfan syndrome, or women with potential heart disease (prior chemotherapy, prior radiation, etc.) should undergo assessment prior to pregnancy to help establish their potential risks prior to conception, but many patients will present in pregnancy without a pre-pregnancy cardiac evaluation. For the pregnant woman with known or suspected heart disease, a functional assessment, in addition to a detailed history, may be important. The use of cardiac stress testing will also be discussed.

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Echocardiography

Transthoracic echocardiography

Because of its general availability and safety, transthoracic echocardiography is by far the preferred diagnostic test for cardiac imaging[1] when a cardiac diagnosis is suspected. A transthoracic echocardiogram provides information about ventricular function, valvular abnormalities, abnormalities of the aorta, and congenital abnormalities and can provide an estimation of right-sided cardiac pressures.

Indications

1. A transthoracic echocardiogram should be obtained in a pregnant woman with cardiac complaints including shortness of breath out of proportion to what is expected in a normal pregnancy, chest pain, unexplained syncope, or palpitations. Cardiac symptoms are common in normal

Table 1 – Predictors of cardiovascular risk identified by the CARPREG investigators.

Predictors for maternal cardiovascular events
Prior cardiac events (heart failure, transient ischemic attacks, or stroke) or arrhythmias
Poor functional class or cyanosis
Left-heart obstruction (MVA <2 cm^2, AVA <1.5 cm^2, peak LVOT gradient >30 mmHg)
Left ventricular systolic function (ejection fraction $<40\%$)
A point is assigned for each abnormality above. 0 point is low risk (5%), 1 point is intermediate risk (27%) and >1 point is high risk (75%)
Patients with prosthetic valves requiring anticoagulation, patients with pulmonary hypertension, and patients with dilated aortas are considered to be high risk.[1]

pregnancy, so a heightened suspicion of a possible underlying cardiac problem in patients at risk is warranted.

2. A pregnant woman presenting with or with a history of a documented arrhythmia such as atrial fibrillation or flutter or ventricular arrhythmias as these may be a marker of previously unknown cardiac disease.
3. Known heart disease in a pregnant woman who did not have a prenatal echocardiogram for risk stratification prior to pregnancy. The risk score developed by Siu for the CARPREG investigators[2] used information obtained from transthoracic echocardiography for a wide range of cardiac diseases. Table 1 summarizes the risk stratification based on the factors identified by the CARPREG investigators to predict cardiovascular risk in pregnant women.

A pregnant woman with pre-existing hypertension who is suspected of having hypertensive heart disease.[3]

4. A pregnant woman with a stroke of unknown etiology. The safety of saline contrast bubble studies for patients with suspected patent foramen ovale has not been studied/established during pregnanzcy. Colletti and Elkayam[4] in a recent review stated that saline contrast microbubbles can be used. Left ventricular contrast agents (perflutren-containing human microspheres) used primarily for better visualization of the left ventricle or for cardiac masses are category C drugs and should not be used.
5. A prior history of chemotherapy or radiation in a woman who did not undergo a pre-pregnancy cardiac evaluation.

Table 2 summarizes the role of transthoracic echocardiography in pregnancy.

Table 2 – Information provided by echocardiography and clinical indicators.

Information provided by echocardiogram
Ventricular function
Valvular abnormalities
Congenital heart disease
Estimation of cardiac pressures
Measurement of aortic size
Clinical indications
Symptoms of shortness of breath, chest pain, syncope, and palpitations
Documented arrhythmias
Known heart disease to establish CARPREG score if not done prior to pregnancy
Hypertension/hypertensive heart disease
Stroke
History of prior radiation or chemotherapy

Serial echocardiography, rather than a single study, may be indicated during pregnancy depending on the underlying cardiac abnormality. For example, for women with dilated aortic roots or enlarged ascending aortas, monthly or bimonthly echocardiographic studies are recommended according to current guidelines.[1,5] Transthoracic echocardiography has been used to study the normal hemodynamic changes during pregnancy as well.[6–9] A recent study by Savu et al.[8] showed that normal pregnancy is associated with increases in left ventricular and right ventricular chamber sizes, an increase in left atrial size, and physiologic eccentric hypertrophy (increase in wall thickness). However, left ventricular ejection fraction did not change. The value of echocardiography in the assessment of cardiac disease in pregnancy has been reviewed by Tsiaras and Poppas.[10]

Transesophageal echocardiography

Maternal echocardiography using a transesophageal approach is relatively safe during pregnancy[1] although its use should be restricted to circumstances where a transesophageal study is necessary such as before/during mitral balloon valvuloplasty or where the findings would alter the management of the patient during pregnancy (aortic dissection in settings when other modalities are not available). Pregnancy causes changes in esophageal and gastric motility, which leads to slower transit times.[11] Pregnant women have a high risk of vomiting and aspiration, and sudden changes in intra-abdominal pressure may occur with the performance of a transesophageal echocardiogram.[1] Sedation may best be handled with the help of an anesthesiologist, and fetal monitoring will be required if at a viable gestational age.

Cardiac magnetic resonance imaging (MRI)

If ultrasonography cannot provide adequate diagnostic information, and better imaging is required to optimize management of the pregnancy, cardiac MRI can be performed during pregnancy.[12–15] According to the ESC guidelines,[1] cardiac MRI may be particularly helpful in the assessment of complex congenital heart disease and for diseases of the aorta. Although the safety of MRI during pregnancy has not been firmly established, no deleterious effects on the fetus have been reported.[12–15] The main safety concerns include potential teratogenicity and acoustic damage.[12–15] Imaging should be avoided in the first trimester if possible.[1] The use of gadolinium, a class C drug, should be avoided.[12–15]