Fetal Cardiac Imaging for Congenital Heart Disease—Is Cardiac Magnetic Resonance Imaging the Future?
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Salehi et al present a single-center cohort study to determine the diagnostic utility of fetal cardiac magnetic resonance (CMR) imaging for improving the prenatal diagnosis of congenital heart defects (CHDs) when fetal echocardiogram fails to visualize the cardiac anatomy. The study included 31 fetuses with suspected CHD in whom fetal CMR was performed between gestational ages of 31 and 39 weeks due to inadequacy of fetal echocardiogram imaging. Fetal CMR affected clinical management in 26 cases (84%). Salehi et al concluded that fetal CMR improved prenatal diagnosis of CHD and thus affected clinical decision-making and counseling when fetal echocardiogram imaging was technically limited.

The field of fetal cardiology emerged in 1980 when 3 pioneers in cardiac imaging—Kleinman, Allen, and Sahn—first described 2-dimensional fetal echocardiography imaging in fetuses between 14 and 41 weeks gestational age. They demonstrated fetal cardiac anatomy in more than 350 fetuses, and Kleinman et al even identified univentricular CHD and fetal cardiac dysrhythmia. During the past 40 years, fetal echocardiography has made significant technological advances, including improved color Doppler assessment, 3-dimensional imaging, and 4-dimensional imaging. These innovations have led to high diagnostic accuracy of fetal echocardiogram imaging, allowing for identification of complex and critical CHDs as early as 12 weeks gestation as well as appropriate delivery planning and counseling.

Nevertheless, fetal echocardiography can be technically limited by factors such as maternal body habitus, oligohydramnios, uterine masses, gestational age, multiple gestation, and fetal position, which result in incomplete imaging of the fetal cardiac structures. In these cases, fetal CMR may prove to be an important adjunct to a fetal echocardiogram because it is not limited by these factors. Fetal CMR can image the fetal heart from any plane, allowing for a large field of view. There are no reported risks of fetal CMR to the pregnant mother or fetus; however, fetal CMR is significantly more expensive, requires more resources, and is time-consuming compared with fetal echocardiography. The visualization of the fetal heart by fetal CMR is challenging due to the small heart size, fast fetal heart rate, and fetal motion. Technical advances and improvements in gating and reconstruction methods have been previously described by Roy et al.

Recognizing these strengths and limitations of both fetal echocardiography and fetal CMR, the current study by Salehi et al focuses on those fetuses with unresolved, clinically important questions regarding the CHD diagnosis after fetal echocardiogram review by experienced fetal cardiologists and radiologists. They further delineate a fetal CMR method for improved visualization of specific cardiac structures and function, namely the aortic arch, pulmonary artery, arterial duct, and ventricles. With this well-defined cohort and analysis, Salehi et al optimized the utility of fetal CMR in certain CHDs for which the technical difficulties of fetal echocardiography might limit accurate diagnosis and management. Specifically, fetal CMR improved imaging of the aortic arch when the fetal echocardiogram was technically limited in 16 of 20 cases (80%). It allowed for accurate measurement of atrioventricular valve annuli and ventricular size in the borderline left ventricle or unbalanced atrioventricular septal defect to assess univentricular vs biventricular anatomy in 13 of 15 cases (87%). Finally, in late gestation hypoplastic left heart syndrome with concern for restrictive atrial septum, fetal CMR provided cine imaging of the atrial septum and pulmonary veins when fetal
echocardiograms could not. Moreover, evaluation of the lungs for lymphangiectasis further risk-stratified the degree of atrial restriction in this population. Within the cohort, the fetal CMR results affected delivery location (ie, close to patient’s home vs tertiary hospital), delivery modality (ie, vaginal vs cesarean), postnatal evaluation timing (ie, urgent vs nonurgent), and postnatal intervention (ie, ductus arteriosus dependence and need for emergent transcatheter intervention).

It is important to note that the utility of fetal CMR is limited to late gestations because larger fetal size facilitates static MR imaging. The mean gestation age at which fetal CMR was performed in the current study was 36 weeks (range, 31-39). Fetal echocardiography is most challenging at these late gestations, when there are fewer fluid pockets for scanning and more calcified bone structures impeding sound waves, and fetal CMR is proving to be a useful adjunct for these cases. However, fetal CMR is challenging at earlier gestations, when imaging small and mobile fetuses, which require even higher spatial and temporal resolution with improved motion compensation. Fetal echocardiography, in contrast, can identify significant CHD as early as 12 weeks gestation. For clinicians and families, an early understanding (ie, <24 weeks gestation) of the complexity of CHD is crucial for counseling and pregnancy decision-making. For some families, neonatal survival may require relocation to a different city or state as early as 36 weeks gestation to ensure delivery and management at a tertiary hospital. For other families, quality-of-life issues may dictate the decision not to continue a pregnancy or plan for compassionate nonintervention for their unborn child.

There is growing evidence that fetal CMR provides improved imaging of cardiac structures in late gestation, primarily when fetal echocardiogram images are suboptimal. However, fetal echocardiography remains superior for early, accurate diagnosis of fetal CHD, allowing for improved clinical management throughout the pregnancy and neonatal period. There is also less resource utilization for fetal echocardiogram compared with fetal CMR. As the utility of fetal CMR becomes more apparent, so too do the technical advances and improved image quality in fetal echocardiography during the 4 decades since its development. Although fetal CMR provides an appealing opportunity for advanced, late gestation imaging, fetal echocardiography remains the gold standard for early and accurate in utero diagnosis and monitoring of CHD and other fetal cardiovascular diseases.

ARTICLE INFORMATION

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REFERENCES


