Pioneering prenatal diagnostic with gated fetal cardiac MRI

Lorna Browne, MD

Alex Barker, Ph.D

What is smart-sync?

Even today, congenital heart defects account for one third of infant mortality related to congenital anomalies. The overall detection rates vary considerably depending on the specific cardiological manifestation.[1] One reason being that fetal echocardiography can be limited by poor acoustic windows.[1] Furthermore, until recently, fetal cardiovascular magnetic resonance (CMR) imaging required complex post-processing or acquisition methods that were either static or characterized by a low spatial resolution.[1] To overcome these limitations, smart-sync, an MR-compatible Doppler ultrasound device, was developed.

smart-sync detects the cardiac motion of the fetal heartbeat and synchronizes it wirelessly with the MR system, which enables high-resolution imaging of the fetal heart in real time and provides physicians with greater diagnostic confidence. Moreover, parents benefit from visually comprehensible data, fostering the understanding of their baby's medical status. This lays the foundation for appropriate parental counseling regarding the delivery and early postnatal care. These added benefits integrate easily in the daily workflow, as the setup of smart-sync takes less than three minutes and requires no special training.

Lorna Browne, M.D, and Alex Barker, Ph.D, specialize in fetal and cardiovascular imaging at the Children's Hospital Colorado. As diagnostic radiology specialist, Dr. Browne focuses on pediatric radiology. Mr. Barker, bioengineer by trade, directs the Advanced Imaging Lab. With complementary expertise, they discuss their experiences with smart-sync.

Have you used fetal magnetic resonance imaging (MRI), possibly even fetal cardiac magnetic resonance (CMR) before?
LB: I have been doing CMR for about 20 years and fetal MRI for about 10 years. Combining CMR and fetal MRI has been challenging due to difficulties with fetal cardiac gating necessary to obtain motion-free and cine images of the fetal heart.
AB: Apart from that, we have used custom sequences such as fetal cardiac self-gating for research purposes. However, these approaches have not been feasible for the timelines expected in the clinical practice.

What is the added value of fetal CMR?
LB: Fetal CMR can be additive to fetal cardiac echocardiography diagnoses especially in cases where the fetal echo imaging is suboptimal. CMR provides a larger field of imaging, which can help bring all the puzzle pieces together. For this reason, CMR is the gold standard for ventricular functional analysis and is the only modality capable of tissue characterization.

Apart from smart-sync, have you used other modes of fetal cardiac gating?
LB: We have also used self-gating techniques, but we prefer smart-sync when imaging fetuses in the late third trimester. The real time reconstruction of the images allows you to see immediately whether motion is limiting the acquisition. Moreover, smart-sync provides superior signal to noise characteristics when used in third trimester imaging.
AB: We have used custom research sequences. However, they are not widely available through vendors and too time-intensive.

Did you or your team require additional training to build the use of smart-sync into your practice?
LB: No, incorporating smart-sync did not require further training.
AB: In fact, I have been impressed with its 'plug and play' nature. smart-sync synchronizes wirelessly with the MRI system, which has greatly reduced the need to train our technologists.

What possibilities do you feel using smart-sync has created for you?
LB: smart-sync acts as additive tool to a standard fetal MRI and echocardiography in third trimester babies, who have congenital heart disease. Also, I think it may be particularly helpful in diagnosing coarctation of the aorta, although there is not enough data yet and further research is needed. Besides, it could potentially be useful at three Tesla where vectorcardiographic gating can be less robust.
AB: In addition to standard cardiac anatomy views, we look forward to assessing further functional parameters such as tissue mapping and phase-contrast approaches. We have already obtained a number of beautiful 4D flow MRI images and are evaluating their use for our research and practice.

What do you consider the tangible benefits of smart-sync for parents and for medical professionals?
LB: The major benefits for parents include an enhanced understanding of their baby's condition and improved parental counselling. In the future, optimizing delivery care, surveillance of in utero procedures and optimizing post-natal care prior to delivery will likely be driven by diagnostics from smart-sync. Therefore, in my opinion, any practice doing fetal cardiology and fetal MRI could potentially benefit from smart-sync.

About Northh Medical
Northh Medical is a Hamburg-based company of experts in radiology, gynecology and medical engineering, focusing on cardiac MRI. Having learned of the limitations in diagnosing prenatal congenital heart disease, they felt the need to get active. Driven by innovation and pushing for scientific and clinical results, the experts at Northh Medical aim to continuously optimize their product. Thereby, Northh Medical empowers specialists for prenatal diagnosis of congenital heart disease to use cardiac MRI by providing smart-sync, a fetal cardiac gating device.

Contact
Nadja Hildwein, Sales & Marketing Manager
nh@northh.de
+49 176 831 777 22
northh medical GmbH
Röntgenstraße 24, 22335 Hamburg, Germany
www.northh.de

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