Feasibility of non invasive fetal electrocardiographic interval measurements using blind source separation with reference in an outpatient clinical setting

Ashish Doshi MD PhD, Mary T. Donofrio MD, Ahsan Khandoker PhD, Kevin Cleary PhD, Hisashi Tomita PhD, Sayaka Oshio MD, Yoshitaka Kimura MD, Anita Krishnan MD

Background: While structural congenital heart disease can readily be diagnosed using fetal echocardiography, abnormalities of the fetal electrical conduction system cannot be diagnosed with present techniques. Non-invasive maternal abdominal fetal electrocardiography (fECG) is a potentially powerful tool that can be used for diagnosis and monitoring of fetal arrhythmias, but significant technical difficulty exists in extracting the low-amplitude fECG signal from maternal signal and noise. We report our experience measuring electrocardiographic intervals in a sample of fetuses with and without congenital heart disease using a novel fECG device (Cloudsense Ltd, Japan).

Objective: Determine the feasibility of measuring fetal electrocardiographic intervals with a novel fetal electrocardiographic device in a sample of fetuses with and without congenital heart disease in a typical clinical setting.

Methods: In this pilot feasibility study, we enrolled 16 women who presented to an outpatient fetal cardiology clinic after completion of a clinically indicated fetal echocardiogram. Electrodes were placed on the maternal abdomen and fECG signal was obtained for at least 10 minutes. Post-processing was performed on one minute of high-quality raw signal by the device vendor using proprietary methods. For each patient, fetal P-wave duration, PR interval, QRS duration, rate-corrected QT interval (QTc), and RR interval were obtained.

Results: Interpretable signals were obtained in all subjects. Estimated gestational age ranged from 19 weeks to 36 weeks. Ten fetuses had no significant cardiovascular abnormalities noted on fetal echocardiography. Six fetuses had either congenital heart defects or hemodynamically-significant cardiovascular findings. Mean RR interval and P-wave duration did not differ between fetuses with and without congenital heart disease. Mean PR interval, QRS duration, and QTc trended being longer in the group with cardiovascular abnormalities; however the sample size was too small for statistical analysis. Two fetuses were noted to have abnormal conduction/rhythm abnormalities: one with prolongation of the QTc interval and one with premature ventricular contraction.

Conclusions: In this pilot study, we demonstrated the feasibility of measuring standard electrocardiographic intervals in a heterogeneous population of fetuses through a range of gestational ages. The test was easily incorporated into a busy clinical setting. Future work will include defining normal values and correlating in utero ECG findings with postnatal outcomes in fetuses with cardiovascular abnormalities.
Electrocardiographic intervals in fetuses with and without congenital heart disease

- RR interval
- P-wave duration
- PR interval
- QRS duration
- QTc interval