

Magnetocardiographic Evaluation of Fetal Arrhythmia

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Fetal arrhythmias have an incidence of 1-2%. About 10% of them are sustained arrhythmias which are serious due to their high mortality and morbidity. A number of interventions or in utero therapies have been tried with some success. In addition to development of effective therapies, there is need for improved methods of diagnosis and for monitoring the course of therapy.

Fetal magnetocardiography (fMCG) is a noninvasive technology for obtaining functional cardiac information from the human fetus in utero, and is the only technique that can assess fetal heart rate and rhythm with high precision. In this research, three studies were performed to evaluate fMCG assessment of fetal arrhythmia: assessment of congenital atrioventricular block (CAVB), detection of cardiac repolarization abnormalities, and simultaneous fMCG and ultrasound image recording.

fMCG were recorded from 22 subjects with CAVB. Both ventricular and atrial heart rate and rhythm were accurately assessed. The need for immediate pacing within 24 hours after delivery could be predicted from our data.

Abnormal cardiac repolarization renders the heart susceptible to lethal ventricular tachyarrhythmias, increasing the risk of sudden cardiac death in all ages; however little is known about the incidence and etiology of T-wave abnormalities *in utero*. QT interval and T-wave alternans were assessed from

fMCG recordings obtained from 120 subjects. QTc in normal sinus rhythm was accurately described by Bazett's formula; however, QTc in fetal arrhythmia exhibited a systematic deviation at heart rate extremes. The dependence of QT on RR in arrhythmia was approximately described by $QT \sim RR^{0.8}$. T-wave alternans was detected in fetal arrhythmia subjects with suboptimal outcome.

The feasibility of performing fMCG and ultrasound imaging simultaneously was demonstrated. Despite large magnetic interference from the scanner, the application of simple measures and appropriate signal processing techniques yielded fMCG recordings of sufficient quality to compute fetal heart rate tracings and averaged waveforms.

fMCG can accurately assess fetal arrhythmias, and the combination of fMCG with ultrasound offers new possibilities for assessment of fetal well-being and fetal cardiac function.