# A MAGNETO-MECHANICAL ASSESSMENT OF THE HUMAN FETAL HEART

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We developed a technique to simultaneously record the fetal magnetocardiogram and echocardiogram using a 37-channel superconducting quantum interference device and a battery operated pulsed-wave Doppler ultrasound scanner respectively. Thirty-seven sessions of control fetuses were used to establish normative magneto-mechanical data. Important cardiac intervals in over 35 sessions of bradycardic fetuses were analyzed and compared to those of the control population. The various bradycardic states included 2$^{nd}$ and 3$^{rd}$ degree atrio-ventricular block, sinus bradycardia, and atrial bigeminy. A mean pre-ejection period of ~60 ms was obtained in the control population (mean gestational age of ~30 weeks). Pre-ejection period in the control population was positively correlated with gestational age, QRS width and RR-interval ($p<0.05$).

Shorter pre-ejection periods were observed overall in the atrioventricular block population than in the control population. PEP shortening can be attributed to the Frank-Starling mechanism whereby large cardiac preloads result in a greater force of contraction, or greater contractility of the heart. Interestingly, the pre-ejection period of the sinus bradycardia population was longer than that of the normal population despite the longer RR intervals where one would expect to observe the same effects of the Frank-

Starling mechanism. This lengthening was attributed to QTc prolongation and channelopathies.

Although we focused mainly on ventricular pre-ejection period, we also assessed atrial pre-ejection periods in 7 fetuses with different arrhythmias. We observed mechanical PR prolongation in a channelopathy fetus, despite the normal electrical PR intervals. Ventricular pre-ejection period was also prolonged in this fetus, suggesting a causal effect of ventricular pre-ejection lengthening on mechanical PR. More studies would need to be performed in order to determine the magnitude of this effect.

In conclusion, simultaneous fetal magnetocardiography and ultrasound Doppler contributes significantly to fetal heart characterization. What was considered impossible a decade ago has now become routine in our laboratory. We hope that within the next few years, these techniques would be used more routinely in the diagnosis of electromechanical dysfunction and as a predictive tool for poor outcome in arrhythmic fetuses.