1214-99 Magnetocardiography in the Detection of Fetal Arrhythmias

Ellen G. Golbach, Jeroen G. Stinstra, Maria J. Petrs, Rik H. Quartero, Frits J. Klumper, Erik J. Meijboom, *Wilhelmina Childrens Hospital/UMC Utrecht, Utrecht, The Netherlands.*

Background: Fetal magnetocardiograms are recordings of the magnetic field generated by the fetal heart. Whereas other methods provide a measure for the mechanical performance of the fetal heart, fetal magnetocardiography reflects the electrophysiological phenomena directly. Fetal magnetocardiograms can be reliably obtained from 20 weeks gestational age Methods: Fetal magnetocardiograms were obtained in 16 normals, 3 SSA/SSB-positive women diagnosed with fetal complete AV-block, 2 fetal flutters and 2 with premature atrial contractions (PAC). The fetal magnetocardiograms were obtained using a 19-channel SQUID Magnetometer system, cooled by liquid Helium.
Results: Normal fetal heart rates could be reliably obtained from 20 weeks gestational age. Fetal heart rate varied from 110 to 160 bpm with a beat-to-beat variability of 5-25 bpm, P-wave duration 46±11 ms, PR-interval 98±16 ms, QRS-width 52±9 ms, T-wave and QT-segments were discernable in 50%. In the 3 complete AV-blocks measurements between 25 and 35 week gestational age, P-P interval varied from 397±36 ms to 460±16 ms. P-wave duration did differ significantly from normals, R-R interval ranged from 784±33 ms to 1063±4 ms, while QRS-width was not significantly different from normals. In case A an progression from a 2nd to 3rd degree AV-block was observed, from 784±33 to 960±62 ms for the R-R interval. Case B and C showed R-R intervals of 1063±4 ms and 1001±32 ms. In two patients with supraventricular tachycardia, fetal flutter was observed with atrial rates of respectively 438bpm and 480bpm and ventricular rates of 219bpm and 240bpm. Both showed a 2:1 atrioventricular block during flutter periods.
Fetal echography and postnatal ECG confirmed all rates and measurements. Only case B required immediate post natal pacemaker implantation.
Conclusions: Fetal magnetocardiography (MCG) is able to register fetal heart rate reliably from 20 weeks gestational age on and can be used to classify arrhythmias. It is possible to determine the atrial and ventricular rates and the duration of P-waves, PR-intervals and QRS-complex. Magnetocardiograms. Complete fetal AV-block can be documented and even progression from 2nd to 3rd degree block can be registered

1214-100 Hydrops Fetalis: Primary Cardiovascular Etiologies and Clinical Outcome in 98 Affected Pregnancies

Wendy Tsang, Mary van der Velde, Rory Windrim, Jeffrey Smallhorn, Lisa K. Hornberger, *The Hospital for Sick Children, Toronto, Ontario, Canada, The Children's Hospital, Boston, Massachusetts.*

Background: Cardiovascular disease (CD) is observed in over a quarter of pregnancies complicated by hydrops fetalis (HF). We sought to determine the distribution and spectrum of structural, functional, and rhythm-related CD associated with HF, and the clinical outcome of a large cohort of affected pregnancies. Methods: We identified all fetal cases of HF and CD from the cardiology databases of The Children's Hospital, Boston and The Hospital for Sick Children, Toronto encountered from 1987 to 2001. Pre and postnatal echocardiograms and medical records, and , when available, autopsy reports were reviewed. Results: HF and CD were diagnosed in 98 fetuses at a mean gestational age of 23.4±4.0 weeks. Of 43 with structural CD, 16 had associated severe AV or semilunar valve regurgitation, 7 had hypoplastic left heart syndrome (2 with cystic hygroma), 5 had heterotaxy syndrome with heart block, 6 had AV septal defects with chromosomal abnormalities, 3 had single ventricles, 3 had premature closure of the ductus arteriosus, 2 had cardiac tumors, and 1 had pulmonary stenosis with cystic hygroma. Of 32 fetuses with primary myocardial disease, 16 had a cardiomyopathy, 8 had myocarditis, and 8 were recipient twins in twin-twin transfusion syndrome. Finally, of 23 with primary dysrhythmias, 15 had supraventricular tachycardia, 6 had complete heart block, 1 had atrial flutter and 1 had ventricular ectopy. Of 82 cases with a documented outcome: 6 had pregnancy termination (4 structural, 1 myocardial, 1 dysrhythmia), 32 had spontaneous intrauterine demise at a mean age of 26.8±5.2 weeks (17 structural, 12 myocardial, 3 dysrhythmia), 15 died as newborns (9 structural, 5 myocardial, 1 dysrhythmia), and 29 survived beyond the neonatal period (4 structural, 11 myocardial, 14 dysrhythmias). Conclusion: Among continued pregnancies, HF in the presence of CD is associated with a high perinatal mortality, particularly for fetuses with structural heart disease (87% versus 61% with myocardial disease and 22% with primary dysrhythmia).

1214-101 Fetal Heterotaxy Syndrome: Spectrum of Heart Disease, Accuracy of Diagnosis, and Clinical Outcome

Mio Taketazu, Jane Lougheed, Jeffrey F. Smallhorn, Shi-Joon Yoo, Lisa K. Hornberger, *Division of Cardiology, The Hospital for Sick Children, Toronto, Ontario, Canada, Division of Cardiology, Children's Hospital of Eastern Ontario, Ottawa, Ontario, Canada.*

Background: Heterotaxy syndrome (HS) after birth is associated with a spectrum of heart defects and variable clinical outcomes. **Methods**: To determine the spectrum of heart defects, accuracy of diagnosis, and outcome of fetal HS, we reviewed our experience since 1992. Prenatal and postnatal echocardiograms and medical records were reviewed. **Results**: Fetal HS was identified in 62 cases. Of 42 with left atrial isomerism (LAI), 40 had interrupted inferior vena cava, 28 had AV septal defect (AVSD),12 had double outlet right ventricle (DORV), 15 had pulmonary and 9 had aortic outflow obstruction, 9 had aortic arch obstruction, 11 had anomalous pulmonary venous drainage (APVD), and 7 had AV block. Two functional ventricles were present in 68% and only 1 functional/single ventricle (SV) in 33% with LAI. Of 20 with right atrial isomerism (RAI), 16 had AVSD, 9 had DORV, 15 had pulmonary and 2 had aortic outflow obstruction, 16 had total APVD, 1 had AV block, and 80% had SV. Of the 62 cases, all intracardiac lesions were *correctly diagnosed in utero with autopsy or postnatal echo confirmation.* Systemic venous return abnormalities were correctly diagnosed in 46/53 and APVD in 22/30 (89% and 86% after 1996, respectively). Of 39 with LAI and documented outcomes, 11 had pregnancy termination, 2 with AV block were stillborn, 3 died as newborns, 3 died after the newborn period (mean age 11.4±13.8mos), and 18 are currently alive (mean age 45±34mos). In continued LAI pregnancies, SV and AVSD were more common among nonsurvivors (38% and 75% respectively) than survivors (20% and 45%, respectively), and perinatal death occurred in 3/3 with AV block. Of 18 with RAI and documented outcomes, 6 had pregnancy termination, 1 with AV block was stillborn, 4 died as newborns, and 5 died in later infancy (mean age 4.9±2.5mos). Only 2 with RAI are currently alive at 5.3 and 3.3 yrs. **Conclusion**: As observed postnatally, fetal HS is associated with a spectrum of cardiac pathology which can be diagnosed accurately in utero. Among continued pregnancies, a poor outcome is observed particularly for fetal RAI (83% mortality). Whereas, fetal LAI is associated with reasonable outcome (28% mortality) with SV, AVSD, and heart block more common among nonsurvivors.

1214-102 Cellular Insights into the Role of Endothelin-1 in the Cardiovascular Pathology of Twin-Twin Transfusion Syndrome

Liane Porepa, Catherine Barrea, Sandra Singhroy, Lisa K. Hornberger, *The Hospital for Sick Children, Toronto, Ontario, Canada.*

Background: Twin-twin transfusion syndrome (TTTS) complicates up to 20% of monochorionic multiple pregnancies. Arterio-venous shunting in the shared placenta leads to blood transfer from the donor to the recipient (RT) twin. Significant cardiovascular pathology has been shown in the RT including: biventricular hypertrophy, systolic and diastolic dysfunction, and systemic hypertension. Histological data suggests increased fetal cardiac myocyte (FCM) and vascular smooth muscle cell (FVSMC) proliferation. Recent investigations have shown higher levels of endothelin-1 (ET-1), a vasoactive peptide and mitogen, in the umbilical vein of the RT compared to the donor twin. The purpose of this study was to determine whether ET-1 induces human FCM and FVSMC proliferation and whether pulsatile mechanical stretch, used to simulate increased preload, enhances the effect of ET-1 on FCM. **Methods**: FCM and FVSMC were isolated from human fetal hearts and pulmonary arteries. Cells plated at $5x10^4$ cells/ml were grown in standard media with 5% serum, then in serum free media for 24 hours and then exposed to 0, 0.01, 0.05, 0.5, 5, 10, 100 nM ET-1 or 5% serum. FCM grown on fibronectin-coated silicon membranes were also exposed to 100 nM ET-1 with or without pulsatile mechanical stretch (5% strain, 30/minute). **Results**: ET-1 induced significant FCM proliferation at concentrations of 100 and 10 nM as measured by change in cell number (21±5% and 14±4%, respectively) and [^{3}H]thymidine incorporation for DNA synthesis (28±8% and 23±6%, respectively) compared to negative controls. ET-1 had a significantly greater effect on FVSMC with proliferation observed even at concentrations of 5 and 0.5 nM (change in cell number: 32±16% and 21±10% and [^{3}H]thymidine incorporation: 145±74% and 78±24%, respectively) which more closely approximates the concentrations previously measured in vivo. Pulsatile stretch did not enhance the mitogenic effect of ET-1. **Conclusion**: Our in vitro data suggests that ET-1, in TTTS, may play more of a direct role in FVSMC proliferation and medial thickening in the RT, perhaps resulting in indirect FCM proliferation secondary to increased afterload. It may also play less of a direct role in FCM proliferation.

ORAL CONTRIBUTIONS

874 Circulating Factors Affect Outcomes in Congenital Heart Disease Surgery

Tuesday, March 19, 2002, 4:00 p.m.-5:00 p.m.
Georgia World Congress Center, Room 256W

4:00 p.m.

874-1 The Potential Role of Plasma Neurohormones in the Follow-Up of Unoperated or Physiologically Repaired Congenitally Corrected Transposition of the Great Arteries

Ali Dodge-Khatami, Igor I. Tulevski, Gerd B. Bennink, J. F. Hitchcock, B. A. de Mol, Ernst E. van der Wall, Barbara J M. Mulder, *Dutch Heart Foundation, Amsterdam, The Netherlands, AMC, Amsterdam, The Netherlands.*

Background: Plasma neurohormones Brain Natriuretic Peptide (BNP) and Atrial Natriuretic Peptide (ANP) are secreted in increased amounts during the early states of right ventricle (RV) dysfunction. In congenitally corrected transposition (CCTGA), the overloaded systemic RV may fail and lead to tricuspid regurgitation. Variations in neurohormones over time could guide the follow-up of CCTGA patients, in serving as quantitative markers of evolving ventricular function.
Methods: Plasma neurohormones were measured in 7 unoperated and 6 physiologically repaired minimally or asymptomatic adult patients with CCTGA, as well as in 11 healthy controls.
Results: Mean ANP levels (3.9 +/- 1.3) were significantly lower in controls than in patients with CCTGA, both compared to unoperated patients (8.2 +/- 5; $p<0.04$), and to physiologically repaired patients (12.7 +/- 12; $p<0.03$). BNP levels were also lower in controls (2.5 +/- 1.8), significantly compared to physiologically repaired patients (11.8 +/- 8; $p<0.003$), and with a trend compared to unoperated patients (4.4 +/- 3; $p<0.07$).
Conclusion: Increased plasma BNP and ANP levels are sensitive markers of ventricular strain, and are higher in patients with unoperated and physiologically repaired CCTGA, as compared to controls. Monitoring changes in plasma neurohormones may serve to predict early deterioration of RV function in paucisymptomatic patients, and anticipate adequate treatment. Further studies are warranted, with emphasis on timing of neurohormone measurements.