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QUANTITATIVE INTRAVENOUS DIGITAL SUBTRACTION ANGIOGRAPHY (DSA)--A MONKEY MODEL. Gregory G. Janos, J. Anthony Seibert, Hugo G. Bogren, Andrew G.

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First pass intravenous DSA was performed on 8 Rhesus monkeys: 5-normal (N), 1-aortic stenosis (AS), 1-ventricular septal defect (VSD) and 1-mitral regurgitation (MR). Their weights ranged from 2.8 to 7.5 kgs. Cineangiograms recorded at 30 fps using a 256 x 256 matrix were analyzed for left to right shunt (Qp/Qs) using the gamma variant method and beat-to-beat left ventricular ejection fraction (EF) using densitometric analysis of background corrected end diastolic and end systolic images. The results are as follows:

Dx	HR	EF%*	Qp/Qs
AS	120	90	1.0
VSD	120	70	1.3-1.4
MR	150	74	1.0
N	144 ± 27**	72 ± 11**	1.0

*Average of three successive beats

**Mean ± S.D.

For the entire group, the 3 EF measurements varied from one another by an average of 2%.

Thus, quantitative intravenous DSA is possible in the very small subject with rapid heart rates. The monkey model may be useful for further development of methods in quantitative cardiac DSA.

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ASSESSMENT OF ADEQUACY OF PULMONARY ARTERY BANDING BY TWO-DIMENSIONAL ECHOCARDIOGRAPHY

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The goal of banding the pulmonary artery in children with complex heart disease is to reduce distal PA systolic pressure to less than 0.5 systemic and insure low pulmonary vascular resistance for future repair. To assess the hypothesis that two-dimensional echocardiography (E) measurements could be used to non-invasively predict tightness of the PA band by measuring its diameter, we examined 12 patients with PA band. Of the 10 patients who underwent cardiac catheterization, 8 had distal systolic PA pressure less than 0.5 systemic and 2 more than 0.5 systemic. None had LV outflow tract obstruction or pulmonary vascular obstructive disease. The E measurements were obtained from the short axis parasternal view at the level of the great arteries. The internal diameter of the PA band (d) and PA annulus (D) were obtained in diastole. The d/D ratios correlated significantly with the measured systolic pressure ratios of distal PA to proximal PA. ($r=0.99$, $p<0.001$). The two patients not catheterized had d/D ratios of 0.4 and 0.53, respectively. The former had an excellent clinical improvement, while the latter remained in heart failure. We conclude that: 1) distal PA pressure can be assessed non-invasively by measuring systemic pressure and E d/D, 2) attainment of a distal d/D ratio less than 0.5 resulted in less than 0.5 systemic distal PA pressure and clinical improvement in patients without LV outflow tract obstruction, 3) it is possible that the circumference of an adequate PA band could be predicted pre-operatively.

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HEMODYNAMIC ASSESSMENT OF PULMONARY INSUFFICIENCY AFTER TETRALOGY OF FALLOT REPAIR. Rae-Ellen W. Kavey, MD, Bernard Schneider, MD, Henry M. Sondheimer, MD,

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Pulmonary insufficiency (PI) has been implicated in the etiology of VPCs and biventricular dysfunction after repair of Tetralogy of Fallot (TF). To assess this, 50 consecutive postop TF patients with clinical PI were evaluated prospectively with branch pulmonary artery (PA) angiography at follow-up catheterization. Group I consisted of 23 pts who cleared contrast from the right heart normally, within 2 beats of injection; Group II consisted of 27 pts who required 3-12 beats to clear the right heart ($\bar{x}=6$). Groups did not differ significantly in age at surgery or evaluation, or in residual RV hypertension. They were compared for RV size by M-mode echocardiography using RV/LV diastolic dimension ratio, for RV and LV ejection fractions (EF) by radionuclide ventriculography, and for grade of VPCs on treadmill exercise and/or ambulatory ECG. Findings are summarized below:

	GROUP I	GROUP II	P
RV/LV ($N1 \leq .5$)	0.65 (0.5-0.89)	0.91 (0.60-1.50)	<.005
RVEF ($N1 \geq 45\%$)	41% (18-61)	29% (12-47)	<.01
LVEF ($N1 \geq 55\%$)	61% (50-78)	48% (7.64)	<.005
VPCs, Grade 3&4	0/23 (0%)	7/27 (26%)	<.03

In this study, prolonged right heart opacification after branch PA injection correlated significantly with RV dilatation, biventricular dysfunction and high grade ventricular ectopy. After TF repair, branch PA angiography provides a useful adjunctive method of assessing the variable impact of pulmonary insufficiency.

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THE AGE DEPENDENCY OF MYOCARDIAL EXCITATION-CONTRACTION COUPLING. Thomas S. Klitzner, William F. Friedman, UCLA Medical Center, Dept. of Peds., L.A.

Mechanisms of excitation-contraction coupling in mammalian ventricle may be age dependent. Accordingly, sucrose gap voltage clamp techniques were developed to control membrane potential while simultaneously measuring membrane current and developed tension in right ventricular papillary muscles to compare newborn (NB) (less than 10 days of age) and adult (A) New Zealand white rabbits. Steady state net membrane currents generated by voltage clamp steps of varying amplitude were similar in the two age groups. However, clamp step induced tension in NB heart developed continuously to a steady state level maintained for the length of the clamp step. Tension was a monotonically increasing function of membrane potential at all clamp durations. In contrast, clamp step induced tension in A heart developed an early peak and relaxed to a lower steady state level. Early phasic tension increased with increasing clamp potential from -60 to 0 mV and then declined with increasing clamp amplitude, while steady state tension increased monotonically with membrane potential. Since the characteristics of steady state tension and current are similar in the two age groups, we suggest the latter tension is generated by transport of calcium across the sarcolemma by a mechanism present at birth, whereas the process of phasic tension matures with age, probably reflecting advancing formation and function of the sarcoplasmic reticulum. It is clear that a developmental approach to cellular cardiac physiology is required to create a valid framework from which to view cardiac function and its therapeutic manipulation in the clinical setting.

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CARDIOVASCULAR ADJUSTMENTS DURING RECOVERY FROM CHRONIC NEONATAL ASPHYXIA IN PIGLETS. Melinda S. Kwong (Spon. Edmund A. Egan) SUNYAB, Children's

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Prolonged, repeated episodes of asphyxia were induced in newborn piglets to determine cardiovascular adjustments in the post-asphyxial period. Ten piglets (<24 hours age) had catheters placed in the right and left ventricles and the descending aorta under general anesthesia. Animals were subjected to 8 episodes of asphyxia by rebreathing into a bag to last gasp over a 2 hour period. Immediately after the last episode, the pH and base deficit were $7.01 \pm .12$ and -20 ± 3 . The insult induced prolonged seizures and persistent changes in activity in 9 of 10 animals and organ hemorrhage in 4. Organ blood flow was measured prior to asphyxiation and 1 hour after recovery by radioactive microsphere injection. Arterial blood gases prior to and 1 hour post-asphyxia were respectively pH- $7.44 \pm .08$, pCO_2 - 42 ± 5 Torr, pO_2 - 61 ± 10 Torr, B.D.- 2 ± 1 ; pH- $7.20 \pm .21$, pCO_2 - 32 ± 12 Torr, pO_2 - 75 ± 19 Torr, B.D.- 14 ± 3 . Blood flow one hour post-asphyxia increased significantly to the heart, adrenal and liver and decreased significantly to the small bowel, large bowel, kidney, spleen and skin. Blood flow to the brain decreased from 86 ± 13 cc/100 gm to 45 ± 5 cc/100 gm ($p<.0$) and was no longer related to pCO_2 . In spite of normal heart rate, hemodynamic pressures, arterial oxygenation, and ventilation at one hour post-asphyxia, there are major changes in organ perfusion, and the distribution of cardiac output, and autoregulation of brain blood flow.

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MAGNETIC RESONANCE IMAGING IN CHILDREN WITH CONGENITAL HEART DISEASE

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Electrocardiographic (ECG)-gated magnetic resonance imaging (MRI) studies were done on 23 children ages 1-17 yrs. with a 0.6 Telsa super-conducting magnet using coronal, transverse, sagittal and left anterior oblique planes. A spin echo pulsing sequence with a 30 msec time to echo delay was used. Two dimensional sections 0.75cm-1.0cm thick were obtained with an average scanning time of 4 min per viewing plane. Diagnoses included: tetralogy of Fallot (10), atrial septal defect (5), ventricular septal defect (3), single atrium (1), transposition of great arteries (1), subaortic stenosis (1), intracardiac tumor (2). All diagnoses were confirmed by cardiac catheterization and/or echocardiography. MRI studies gave precise, diagnostic visualization of cardiac malformations in 21/23 cases. The transverse view afforded excellent visualization of ventricular and atrial septal defects, main pulmonary artery and its branches. The coronal view demonstrated the aortic arch, right ventricular outflow and inflow tracts. The sagittal view delineated aortic arch and right ventricular outflow tract anatomy. The left anterior oblique view localized ventricular septal defects, aortic arch abnormalities and demonstrated aortic override in tetralogy of Fallot. In cardiac tumors, the size, location and extent of myocardial attachment was well delineated by MRI. In summary, MRI is a safe, accurate, non-invasive test which gives detailed information of cardiac anatomy in congenital heart disease.