1017-55 Thromboembolism in High Risk Patients Undergoing Bidirectional Cavopulmonary Anastomosis

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We have observed perioperative pulmonary thrombotic events (PTE) in pts following bidirectional cavopulmonary anastomosis (BCA). The risk factors for development of PTE in this group are unknown. The purpose of this study was to identify possible preoperative and immediatiate postoperative risk factors for development of PTE in pts undergoing BCA. *Methods:* We compared 4 pts (mean age 4.2 ± 5.2 yrs) with PTE following BCA to 20 BCA pts (mean age 5 ± 5.3 yrs) who did not develop perioperative PTE. Of the 4 pts who had a PTE, 3 expired within 12 days of their surgery and the 4th required emergent stenting of the thrombus on postoperative day 5. The preoperative risk factors evaluated were: age at surgery, Nakata and McGoon indices, pulmonary arterial resistence, systemic and mixed venous saturations, and the presence of bilateral SVCs. The postoperative risk factors evaluated were: CVP (mmHg), O2 saturations, pAO2, and pH (all at 0, 12, 24, 36, and 48 hours post-op). Contingency tables and multiple logistic regression analyses were preformed. *Results:* Relative to a McGoon ratio 2.0, as our patient's indices decreased by 0.5, the odds of PTE increased 14 fold ($p = 0.08$). The odds of PTE among those with bilateral SVCs was 17 times greater than the odds of PTE among those with a single SVC ($p < 0.05$). Relative to a CVP of 10 at 12 hours post-op (CVP12), as our patient's CVP increased above 20 mmHg, the odds of PTE increased 10 fold ($p < 0.05$). The associations between PTE and the predictors CVP12 and bilateral SVCs were not effected by adjustment for other variables. *Conclusion:* We consider pts undergoing BCA who have bilateral SVCs, low McGoon indices, and increased CVPs at 12 hours post-op, at greatly increased risk for perioperative PTE. We have adopted a strategy for early anticoagulation and early removal of superior vena caval lines in these pts.

1017-56 Chemoreflex and Exercise Ventilation in Univentricular Patients

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Patients with univentricular hearts have excessive exercise ventilation. We examined the chemoreflex in relation to cardiopulmonary exercise testing in two groups of univentricular patients, 10 cyanotic patients (Group A; age 30.5 ± 2.3 (SEM) years; 5 men) with palliative surgery only and 7 patients (Group B; age 29.6 ± 1.8; 3 men) with Fontan-type circulation whose hypoxemia is relieved. Ten healthy controls were also studied (Group C; age 34.7 ± 1.9; 5 men). Hypoxic and hypercapnic chemosensitivity were assessed using transient inhalations of pure N_2 and the rebreathing of 7% CO_2 in 93% O_2 respectively. Peak O_2 consumption was comparable in group A and B (21.7 ± 2.5 v 21.3 ± 2.2 mL/kg/min) but higher in C (34.7 ± 1.9, $P < 0.001$). The ventilatory response to exercise, characterized by the V_E-VCO_2 slope, was more in group A than B (43.4 v 32.1, $P = 0.04$), or C (23.4, $P < 0.001$). Resting arterial O_2 saturation was 90.6%, 95.0% ($P = 0.06$) and 99.9% ($P < 0.001$) respectively whilst that at peak exercise was 66.2%, 90.1% ($P < 0.001$) and 99.6% ($P < 0.001$). Hypoxic chemoreflex was blunted in group A compared with B (0.148 v 0.482 L/min/%SaO_2, $P = 0.04$) and C (0.311, $P < 0.01$) and correlated with the drop in O_2 saturation with exercise ($r = -0.63$, $P = 0.05$). It also correlated with the V_E-VCO_2 slope in group B ($r = 0.95$, $P < 0.01$) but not in A. Hypercapnic chemosensitivity, as judged by the slope of the ventilatory response curve to hypercapnia, was similar in all groups (1.71 v 1.85 v 1.42 L/min/mmHg CO_2, $P = 0.4$) but the X-intercept of the curve was shifted to the left in A (31.9 v 40.7 v 42.9 mmHg CO_2, $P < 0.01$), suggesting that they ventilate more for a given level of CO_2 and may explain the increased exercise ventilation. Hypercapnic chemosensitivity correlated with V_E-VCO_2 slope in group A ($r = 0.82$, $P = 0.003$) but not in B.

In conclusion, CO_2 elimination is more important in the control of ventilation in cyanotic univentricular patients whilst hypoxic chemoreflex is more so in univentricular Fontan patients.

1017-57 Abnormal Recovery From Brief Exercise in Pediatric Fontan Patients

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The maximal oxygen uptake (VO_2 max) test, traditionally used to test exercise capability in children with congenital heart defects, requires prolonged work at high intensity. Short bursts of exercise better reflect the patterns of normal activity found in children. We hypothesized that less strenuous tests would detect important abnormalities in the response to exercise in children. To examine this, 9 children (mean 12 y. o., range 8–17 y.o., 4 females) who had undergone Fontan procedures performed a voluntary maximal progressive cycle ergometer test. The patients then returned for a constant work rate test consisting of one minute of high-intensity exercise. Gas exchange was measured breath by breath. Iterative curve-fitting techniques (assuming a single exponential) were used to determine the recovery time constant (τ) for HR and VO_2 following the one minute test. The time constant represents the time required to return to 63% of pre-exercise values. Consistent with previous observations, VO_2 max was reduced (24 ± 6 ml/kg, 57% predicted). Recovery times for both HR (τ, 96 ± 26 sec) and VO_2 (τ, 53 ± 13 sec) were significantly prolonged by 355% and 151%, respectively ($p < 05$), compared with published values for normal children. The prolonged recovery times suggest substantial abnormalities of oxygen transport, and may alter the pattern of exercise in the daily lives of these children.

1017-58 Architecture of the Myocardium in Hearts With Tricuspid Atresia

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The fibrous tissue and myocardial fibres of the ventricles in hearts with tricuspid atresia were compared with normals. Interstitial fibrous tissue in four ventricular sites from each of 53 malformed hearts was quantitated using an image analyser. Comparing with a normal series of similar age range (neonate to 17 years), there was consistently more fibrous tissue in the malformed heart across the age range, even in the youngest hearts. The arrangement of the fibrous weave was examined by scanning electron microscopy in 10 hearts. It was more dense and sheath-like in the abnormal hearts compared to the filigreed appearance in normal hearts. The arrangement of the myocardial fibres was studied by gross dissection in three hearts with tricuspid atresia. The superficial layer of the left ventricle was more longitudinally arranged than normal. The quantity and quality of the interstitial fibrous tissue in the abnormal hearts are probably inherent in the malformation and could contribute to myocardial stiffness. Together with the abnormal arrangement of the myocardial fibres, the alterations in architecture of the myocardium could account for the impairment of left ventricular function which is observed from an early age in some patients with tricuspid atresia.

1017-59 A Rationale for Rapid Staging of Patients With Aortopulmonary Shunts: Increased Oscillatory Work

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When patients with a single ventricle and an aortopulmonary shunt develop a dilated and dysfunctional ventricle, it is widely assumed that this is due to the volume load imposed upon the ventricle. However, the work imposed by an increased volume load is only a portion of the total work of the ventricle. The total work of the ventricle is comprised of both static work (energy utilized to maintain volume flow) and oscillatory work (energy lost due to pulsations). We hypothesize that oscillatory work contributes significantly to total work, and is independent of volume loading. *Methods:* Both the static and oscillatory components of the vascular workload were measured in an in vitro pulsatile flow model using blood analog fluid. Comparisons of models with and without an aortopulmonary shunt were performed for cardiac outputs of 2–4 l/min. The cardiac output and the peripheral resistance were held constant for each comparison. Simultaneous pressure (P) and flow (Q) waveforms from the ascending aorta of the model were recorded and resolved into ten harmonics using Fourier series analysis. Static work was calculated as $P_{mean} \cdot Q_{mean}$. Pulsatile work was calculated as $\frac{1}{2} S P_i Q_i \cos\Theta$, where P_i and Q_i are the magnitudes of the i^{th} pressure and flow harmonics, respectively. Θ represents the phase between P and Q. *Results:* For the aortopulmonary shunt models, the pulsatile losses were significantly higher than the models without shunts for the same flow conditions (mean difference 12 ± 6.2%, $p = 0.03$). Furthermore, the pulsatile losses in this study did not correlate with the flow rate ($r = 0.37$). *Conclusions:* This study suggests that pulsatile energy losses are important in patients with aortopulmonary shunts and are independent of volume load. The single ventricle experiences increased work demands from *both* volume loading and increased oscillatory losses, and this burden may contribute to the development of a dysfunctional ventricle in these patients. These findings provide a rationale for rapid surgical staging of these patients to their next surgical procedure.