Title : AGE-RELATED CHANGES IN CORONARY BLOOD FLOW AND RESISTANCE IN CHRONICALLY INSTRUMENTED SHEEP

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Introduction: Circulatory instability often occurs when the newborn is anesthetized. In the first several weeks of life the infant's circulation is transitional in that it is changing from the fetal circulation, with its atrial and ventricular shunts, to the adult circulation. This requires the neonatal heart to function with a limited reserve. We studied the resting coronary circulation in fetal, newborn, weanling and adult sheep to determine how well flow to the myocardium matches functional needs.

Methods: 115-127 day fetuses, 4-14 day old lambs, 36-42 day old lambs, and young adult ranch cross-bred sheep were studied. Polyvinyl catheters were inserted 3-10 days prior to study and the animals allowed to recover. Left atrial (LA), pulmonary artery (PA), inferior vena cava (IVC - in fetuses only) and ascending or descending aorta (Ao) catheters were inserted and kept open during the recovery period with heparin or saline. Pressures were measured in the resting state with transducers zeroed at heart level. Flows were measured by injecting a bolus of 15μ radionuclide microspheres and sampling blood for 2 minutes from the aorta. The animals were killed, their hearts excised, weighed and fixed in formalin prior to dissecting the left and right ventricular free walls free of the ventricular septum and dicing the ventricles for counting in a gamma counter.

Results: The myocardial flow data were grouped according to age and anatomic segment (Table 1). Group mean values were compared using analysis of variance.

As an index of ventricular blood flow demand we compared the rate-pressure product (RPP) for each ventricle. LV RPP = peak Ao systolic pressure X heart rate (HR). RV RPP = peak PA systolic pressure X HR. Fetal ventricles have the same systolic pressure, so have identical RPP's. At all post natal ages RPP was greater in the LV than the RV. The newborn lambs also demonstrated an LV RPP almost twice that of any age group ($p<.05$) (Table 2).

The myocardial flow (ml/min/gram of myocardium) in response to this demand was also greatest in the newborn LV compared to all other ages ($p<.05$). When flow was divided by RPP to determine how well flow was matched to demand there was no difference among any of the post natal groups. The ratio of flows/RPP in the fetus was 50% higher in the LV reflecting lower fetal pO_2 and the presence of fetal hemoglobin which reduce O_2 delivery in utero. In the RV flow/RPP was always three to four times that of the LV possibly because RPP is not an accurate index of RV O_2 demand. Mean aortic pressure in the fetus was 47% of the adult value, however fetal flow in the LV was 45% higher. In the newborn coronary perfusion pressure was 78% of the adult but LV flow was 198% of the adult flow. The increase in newborn LV flow therefore was achieved by a marked decrease in coronary resistance.

Discussion: Our finding that coronary flow is increased in the newborn LV to match post natal increases in O_2 demand is reassuring that myocardial O_2 supply is appropriate in the resting state. However, to increase flow in the neonate, coronary resistance is decreased. The limits of flow reserve available for stress may be more closely approached in the newborn than at any other time in post natal life. Since many neonates come to the operating room with circulatory disturbances ranging from mild dehydration to shock, acidosis, and hypoxemia, coronary flow reserve may contribute to a reduced functional reserve seen at this time.

Table 1

The Relationship Of Flow In The Right And Left Ventricles vs Age (ml/min/gm)

	Fetus (N=12)	0-20 days (N=11)	36-42 days (N=3)	Adult (N=8)
Flow LV	1.75±.5	2.21±.8	1.51±.3	1.21±.2
Flow RV	2.03±.6	1.69±.8	1.24±.4	.74±.1

Table 2

The Relationship of Flow/RPP In The Right And Left Ventricles vs Age (Myocardial Flow/RPP X 10^5)

	Fetus	Newborn (0-14d)	Weanling (36-42d)	Adult
LV	16.7	11.75	11.2	9.8
RV	19.8	30.3	44.0	36.1