## **Decreased Placental Blood Flow in Fetuses with Congenital Heart Disease is** Associated with Placental Vascular Abnormalities and Impaired Fetal Growth

### Rebecca Josowitz MD PhD, Deborah Ho MD, Somya Shankar, Rebecca L. Linn MD, Zhiyun Tian MD, William J. Gaynor MD, Jack Rychik MD

#### Introduction

- The placenta and the fetal heart develop at similar times during human gestation
- Previous studies suggest the placenta is abnormal in fetuses with congenital heart disease (CHD), and may be due to abnormal vascular developmental pathways shared between both the developing heart and placenta
- Umbilical venous volume flow (UVVF) is a validated noninvasive method of assessing blood flow from the placenta to the fetus that can be performed routinely during fetal ultrasounds, and has been shown to reflect characteristics of the placenta rather than of the fetus
- Our group has previously demonstrated that midgestational UVVF is decreased in fetuses with CHD compared to normal controls

Figure 1. UVVF calculation. A. The umbilical vein diameter is measured in a free loop. B. The maximum velocity of umbilical venous flow is measured by spectral doppler

#### Hypothesis

Placental blood flow to fetuses with CHD, as measured by UVVF, will be decreased compared to control fetuses and will be associated with placental vascular abnormalities and impaired fetal growth

#### Conclusions

- UVVF reflects characteristics of abnormal placental pathology and may be a useful marker of placental malperfusion in fetuses with CHD
- Future study looking at association of UVVF and clinical outcomes is warranted





#### Methods

Single center prospective case-control study of consenting pregnant women referred to the CHOP Fetal Heart Program 38 cases (29 single ventricle, 8 TOF, 1 d-TGA), and 38 controls enrolled

• UVVF and combined cardiac output (CCO) measured during second trimester fetal echocardiograms (Figure 1) Postnatal placentas were analyzed and assigned a placental abnormality severity score (PASS) (Table 1) Biometrics collected for all newborns

Statistical significance was assessed using T-tests or Fisher's Exact Tests.



Lesion Category	Lesions Included	Grading	
Fetal Vascular	Thrombi or intramural fibrin deposition in a chorionic,	<b>2 (high grade)</b> : >1 focus of avascular villi (≥ 45 villi)	
Malperfusion (FVM)	velamentous, stem villous, and/or umbilical vessel;	or $\geq$ 2 thrombi in the chorionic plate or stem villi, or	
	avascular villi; villous stromal vascular karyorrhexis	multiple nonocclusive thrombi	
		<b>1 (low grade):</b> any fetal vascular lesions not	
		indicated as high grade	
		0: no fetal vascular lesions	
Chronic	Chronic chorionitis or amnionitis; chronic deciduitis, chronic	<b>2 (high grade):</b> ≥ 2 compartments with chronic	
Inflammation (CI)	decidual perivasculitis; chronic villitis or intravillous plasma	inflammation	
	cells; chronic intervillositis; chronic eosin/t-cell vasculitis	1 (low grade): 1 compartment with chronic	
		inflammation	
		0: no chronic inflammatory lesions	

Table 1. Placental analysis and PASS grading score

#### Results

	Controls (n=38) mean (SD)	All CHD (n=38) mean (SD)	p-value	SV (n=29) mean (SD)	p-value
Э	21.6 (2.3)	23.8 (2.5)	<.001	23.8 (2.6)	<.001
	472 (171.2)	650 (195.9)	<.001	661.9 (216.3)	<.001
)	122.4 (40.9)	97.6 (25.3)	<.001	91.7 (23.1)	<.001
	31.6 (10.9)	25.3 (11.1)	<.01	26.7 (11.7)	0.06
	0.25 (0.6)	0.53 (0.7)	0.02	0.52 (0.7)	0.06
	0.64 (0.8)	0.92 (0.8)	0.03	0.93 (0.8)	0.08
Э	39.3 (1.2)	38.6 (1.5)	<.01	38.9 (1.0)	<.05
)	0.25 (0.8)	-0.24 (1.0)	<.01	-0.2 (0.9)	<.05



Figure 2. Sample placental histopathological abnormalities. A. Intramural in a fetal stem villous vessel (40X). B. Intramural fibrin deposition in a fetal chorionic vessel (40X). C. Large focus of avascular chorionic villi (100X). D. Small focus of avascular villi (200X).

Table 2. Fetal and placental characteristics, indexed umbilical venous volume flow, and neonatal outcomes in fetuses with CHD compared to controls.

Fetuses with CHD demonstrate decreased placental blood flow in utero, higher grade placental lesions associated with FVM and CI, and decreased birth weight

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