

## **Understanding Fetal Cardiac Output and Pulsatility Indices in Different Congenital Heart Defects. The Effect of Fetal Hemodynamics on Fetal Growth**

**Tarek Alsaied, MD, Stephanie Tseng, MD, Eileen King, PhD, Eunice Hahn, MD, Allison Divanovic, MD, Mounira Habli, MD, James Cnota, MD**

**Background:** The impact of combined cardiac output (CCO) and cerebral autoregulation on fetal growth may vary in different congenital heart defects. The objective of this study is to compare serial measures of fetal growth; CCO, middle cerebral and umbilical pulsatility indices (PI) in four groups: hypoplastic left heart (HLHS), non-HLHS single ventricle (SV), transposition of great arteries (TGA) and normal controls.

**Methods:** Serial fetal echocardiograms from 18 to 38 weeks of gestation between 2011-2015 were reviewed. CCO was calculated using valvar area, velocity time integral and heart rate. CCO was indexed for fetal weight (iCCO). PIs were calculated using systolic, diastolic and mean velocities. Anthropometric measures were recorded. Regression models were used to study CCO, PIs and fetal anthropometric trends over gestational age accounting for repeated measures. PIs and iCCO were then compared among groups in 2 periods; < 30 and > 30 weeks using Tukey-Kramer test for multiple comparisons. Multivariate analysis was used to determine the association of CCO and PIs at 30 weeks with subsequent birth weight and head z scores.

**Results:** Studies from 109 fetuses were reviewed: HLHS (n=30), SV (n=20), TGA (n=17) and controls (n= 42). CCO increased in all 4 groups through gestation. Middle cerebral PI was lower in HLHS and higher in SV compared to controls suggesting a different cerebral blood distribution. Umbilical PI decreased through gestation in all groups. Fetal weight in HLHS and SV plateaued at the end of gestation compared to controls and TGA. Head circumference in all groups but controls plateaued at the end of gestation (Figure). CCO positively correlated with birth weight z scores (p=0.03). Birth head z scores differed by group with no significant correlation with CCO or cerebral PI.

**Conclusions:** CCO positively correlates with birth weight and may provide a mechanism to understand differences in fetal growth in congenital heart defects. A brain sparing mechanism in HLHS is supported by lower cerebral vascular resistance.

Gestational age group	Study group	Middle Cerebral Artery PI	P value	Umbilical Artery –PI	P value	iCCO	P value
Below 30 weeks of gestation	HLHS	1.40± 0.06 <sup>a</sup>	0.006	1.17±0.04	0.08	440±31 <sup>c</sup>	0.009
	SV	1.74± 0.07		1.24±0.04		433±29 <sup>b</sup>	
	TGA	1.69±0.11		1.14±0.06		610±47	
	Normal	1.55±0.07		1.31± 0.04		501±27	
After 30 weeks of gestation	HLHS	1.43±0.06 <sup>a</sup>	<.0001	1.03±0.04	0.07	409±25	0.18
	SV	1.89±0.07 <sup>b</sup>		1.12± 0.05 <sup>b</sup>		343±29	
	TGA	1.59±0.09		0.92±0.06		438±37	
	Normal	1.62±0.09		1.00±0.06		412±35	

<sup>a</sup>HLHS and SV are significantly different.

<sup>b</sup>SV and TGA are significantly different.

<sup>c</sup>HLHS and TGA are significantly different.

