

EP08.78 Divergent gestational trends of fetal echocardiographic biomarkers in congenital heart defects: data from the international multicentre CAIFE study

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Introduction

Congenital heart defects (CHD) are a leading cause of morbidity and mortality in fetuses and neonates. The CHD prenatal detection rate by echocardiography remains widely variable and, in many countries, inadequate. Understanding how fetal echocardiographic measurements (biomarkers) change with gestational age is essential for identifying abnormal development trends that could facilitate CHD detection.

Methods

- We curated a multicentre cohort from the international Clinical Artificial Intelligence Fetal Echocardiography (CAIFE) study, which included 375 normal fetal heart cases and 284 fetal CHD cases.
- For each echocardiographic biomarker, we fitted an ordinary least squares regression model that included groups (normal vs. one CHD type), gestational age (15–40 weeks), and their interaction term.

- The interaction term assessed whether the slope dependent on gestational age differed between groups, indicating distinct developmental trends.
- Due to imbalances in group sizes, we applied heteroskedasticity-robust standard errors to ensure valid statistical inference.

Results

In the normal fetal heart group, 48 biomarkers displayed significant associations with gestational age (all $p < 0.01$). Different types of CHD exhibited distinct sets of biomarker differences, characterized by either a significant difference in the intercept or in the slope compared to the normal group. All CHD types showed significant variations from normal gestational trends in specific biomarkers (*Table 1*).

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CHD	CHD (n)	Divergent biomarker (n)	Significantly divergent biomarkers
Tetralogy of Fallot	77	3	AscAo ESD, PA ESD, PV ESD
Coarctation of the aorta	76	7	AscAo ESD, AV ESD, DA dimension, LA ESA, LV EDA, LV ESA, MV EDD
Hypoplastic left heart syndrome	42	24	AI dimension, AI/DA dimension, AscAo ESD, AV/PV ESD, AV ESD, DescAo ESD, LA ESA, LA ESD, LA/RA ESA, LA/RA ESD, LV EDA, LV EDD, LV EDL, LV ESA, RV EDA, MV EDD, MV/TV EDD, RV ESA, RA ESD, PLAS, RA SI, RA ESA, TV EDD

Table 1. Selected CHD showing significantly divergent gestational trends of specific echocardiographic measurements (biomarkers) compared to normal fetal hearts. Abbreviations: AI, aortic isthmus; AscAo, ascending aorta; AV, aortic valve; DescAo, descending aorta; DA, ductus arteriosus; EDA, end-diastolic area, EDD, end-diastolic dimension; ESA, end-systolic area; ESD, end-systolic dimension; MV, mitral valve; LA, left atrial; LV, left ventricular; PLAS, post left atrium space; PV, pulmonary valve; RA, right atrial; RV right ventricular; SI, sphericity index; TV, tricuspid valve.

Conclusions

- Our findings highlighted distinct developmental trends in echocardiographic biomarkers for specific types of fetal CHD.
- These trends may provide valuable insights for the early identification and differentiation of CHD types, thereby improving prenatal detection, perinatal management, and outcome prediction.
- This research could enhance the development and training of AI algorithms for the detection of fetal CHD.