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Reference ranges and Z scores of functional parameters in fetal echocardiography

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Background: Fetal echocardiography is the standard-of-care in a variety of obstetrical cardiovascular circumstances. Reference values for basic fetal heart anatomic measurements are available. However, studies that propose reference values for functional parameters (doppler velocities and patterns, m-mode, cardiac output and shortening fraction) are scarce and their quality is often questionable. Furthermore, most existing reference values are not reported as Z-score equations. Improved definition of reference values with adequate statistical validation is needed for proper interpretation of these measurements in clinical settings.

Objective and methods: We aimed to propose robust reference values for fetal functional cardiac parameters. Singleton uncomplicated pregnancies with normal fetal heart were selected. When fetal position and echogenicity allowed it, a set of 62 functional measurements was performed (44 pulsed doppler related measurements and 18 M-mode measurements – see the Table). Several parametric regressions were tested to model each measurement against gestational age (GA). Variation around the predicted mean was also modeled. Z-score equations were computed and the proposed reference values were tested for residual association, residual heteroscedasticity, and departure from the theoretical normal distribution.

Results: Data from 104 fetal echocardiograms were analyzed. Parametric normalization was successful for most measurements analyzed. We were able to compute Z-score equations with minimal residual association with GA, no residual heteroscedasticity and insignificant departure from the normal distribution.

Conclusion: This study allowed computation of Z-scores for several anatomical and functional measurements, most of which did not have any published reference values. These Z-scores equations will allow echocardiographists to more accurately identify measurements that diverge from normal and thus better detect potential alterations in fetal heart function.

Table – list of selected fetal echo measurements
Cardiac output
Left cardiac output
Right cardiac output
Right/left cardiac output ratio
Effective pulmonary flow
Ductus arteriosus flow
Ductus venosus flow
Peak velocity and time velocity integral
Ascending aorta
Pulmonary artery
Ductus arteriosus
Inflow dopplers and time velocity integrals
Mitral valve E and A waves
Mitral valve E/A ratio
Tricuspid valve E and A waves
Tricuspid E/A ratio
Venous flow doppler and time velocity integrals
Inferior vena cava systolic, diastolic and a waves
Ductus venosus systolic, diastolic and a wave
Other doppler flows and calculations
Systemic venous ante/retrograde waves VTIs
Isthmus systolic ante/retrograde flows
Isthmic ratios
Left ventricular myocardial performance index
M-mode short axis and 4 chambers
LV and RV end-diastolic dimensions
LV and RV end-systolic dimensions
LV and RV shortening fraction
Wall thicknesses