Manual of operation

FETAL ECHOCARDIOGRAPHY

CORE LABORATORY ECHOCARDIOGRAPHY

Pediatric Cardiac Center
Queen Silvia Children´s Hospital
Sahlgrenska Academy
University of Gothenburg
Sweden

General instructions (I)

System settings should be adjusted with an emphasis on maintaining high frame rates (eg, using a narrow field of view, small imaging depth, single acoustic focus, and narrow color Doppler ultrasound region of interest box) with application of acceptable acoustic output levels under the ALARA (as low as reasonably achievable) principle.

AIUM Practice Parameter for the Performance of Fetal Echocardiography, J Ultrasound Med 2020; 39:E5–E16

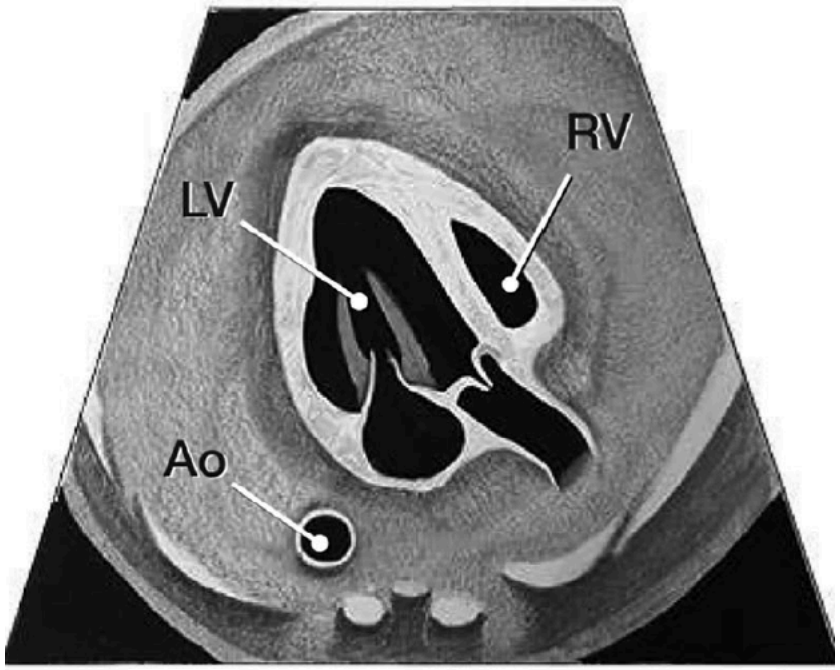
General instructions (II)

The degree of image

magnification should be adjusted

so that the heart fills about one-

third of the imaging sector display.



AIUM Practice Parameter for the Performance of Fetal Echocardiography, J Ultrasound Med 2020; 39:E5–E16

ALARA Principle

The potential benefits and risks of each examination should be considered. The ALARA principle should be observed for factors that affect the acoustic output and by considering the transducer dwell time and total scanning time.

AIUM Practice Parameter for the Performance of Fetal Echocardiography, J Ultrasound Med 2020; 39:E5–E16

Store and transfer Echo images - DICOM format

Still images and clips should be transfered to the FTPS server using DICOM-format

Colour flow doppler

- Select appropriate transducer
- Optimise angle of insonation, angles > 30 ° will result in inaccuracy
- If there is aliasing, imaging at less depth, thus increasing the Pulse Repetition Frequency (PRF)
- Set scale to range of expected velocities
- Use CW Doppler for expected high velocity flow, e.g. mitral regurgitation

Fetal Cardiology, A Practical Approach to Diagnosis and Management, Simpson, Zidere, Miller, Springer, 2018

PW and CW Doppler

- Adjust the gate width, not too narrow nor to wide
- Adjust baseline for optimal visualisation
- Use CW Doppler for expected high velocity flow, e.g. mitral regurgitation

Fetal Cardiology, A Practical Approach to Diagnosis and Management, Simpson, Zidere, Miller, Springer, 2018

2D measurements

- The 2-dimensional measured at the maximal dimension of the structure
- Valve dimensions from hinge point to hinge point
- Vascular structures from inner edge to inner edge
- Dimensions are measured in millimetres (mm)
- All dimensions should be noted with one decimal

Doppler measurements

- Velocities are measured in cm/s
- Pressure gradients in mmHg

Cardiac Function Assessment

Left heart function should be qualitatively assessed.

Signs of cardiomegaly, atrioventricular valve regurgitation, and hydrops fetalis are key circulatory findings that can indicate fetal cardiac dysfunction.

AIUM Practice Parameter for the Performance of Fetal Echocardiography, J Ultrasound Med 2020; 39:E5–E16

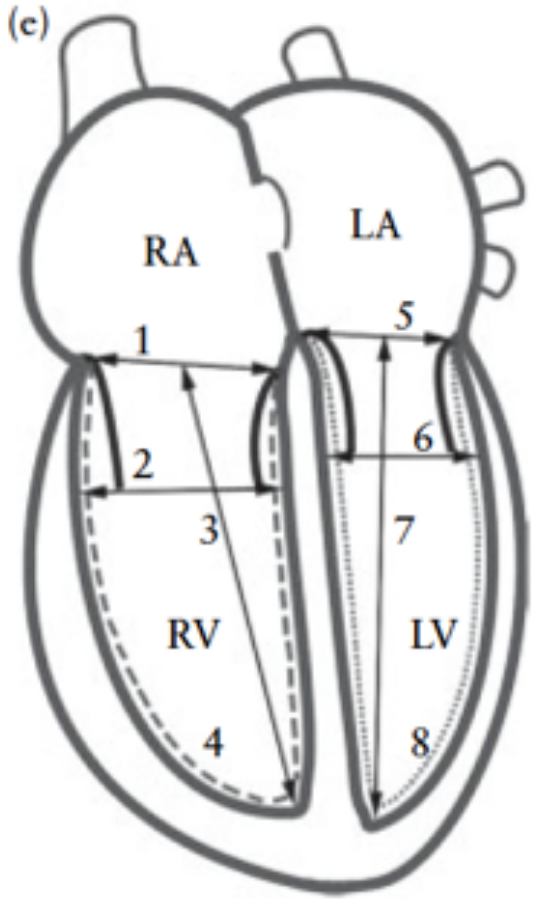
Instructions I

- Each submitted echo exam should include clips (with and without colour), still images of measured structures and spectral Doppler registrations. Note, the still image should be the still image where measurements were made. The following views should be included; 4-chamber view, LV outflow tract view, three-vessel-tracheal view, view over foramen ovale, RV outflow tract and long axis of the aortic arch (if possible). Spectral Doppler registrations of all four valves, pulmonary venous flow, formamen ovale flow and aortic arch flow.

Instructions ll

- A minimum of 3-5 consecutive cardiac cycles is required. Obtain images avoiding excessive transducer movement. More data may be obtained at the discretion of the Echocardiographer. All M-mode and Doppler spectral data is to be recorded in frozen screen format.
- Always use the optimal Nyquist Limit (arterial or venous as appropriate) for all color Doppler.
- Always use the optimal frame rate (depth, sector width) for each patient and avoid changing depths unnecessarily.
- Always use minimal PW/CW angle to flow direction and do not use angle correction.
-

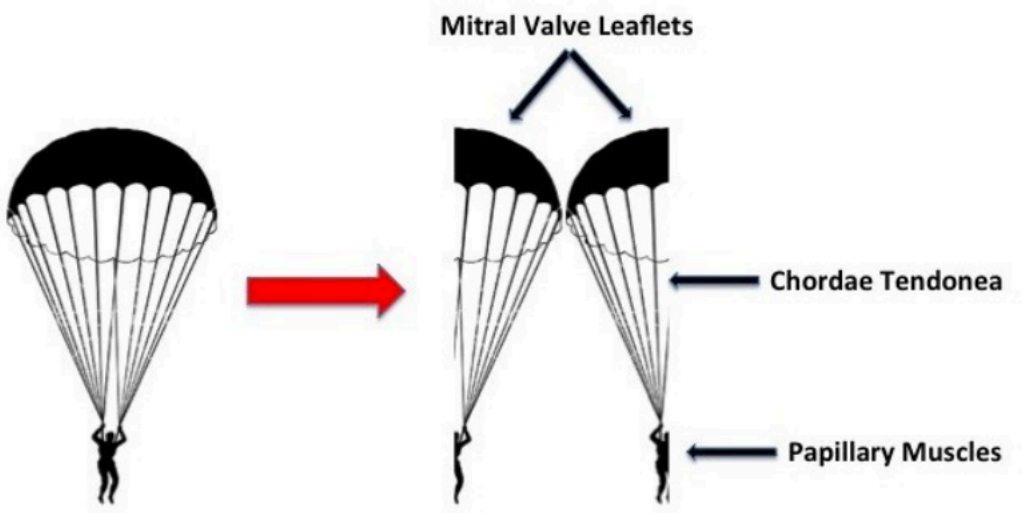
Mitral valve annulus diameter



- Mitral valve annulus diameter (5)
- 4- chamber view
- End-diastole

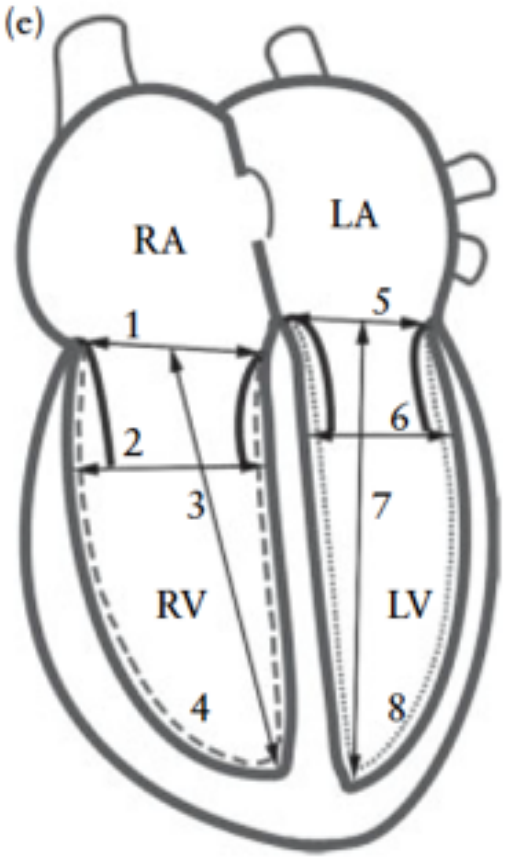
Development of Z-scores for fetal cardiac dimension from echocardiography, Schneider, Daubeney et al 2005 (Fig. 1)

Parachute mitral valve



- Single papillary muscle or one severely hypoplastic papillary muscle

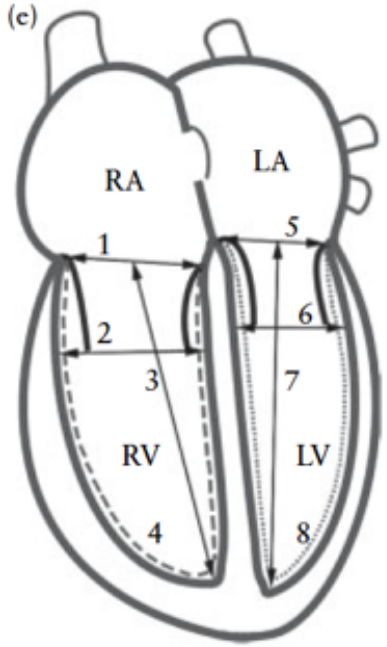
Tricuspid valve annulus diameter



- Tricuspid valve annulus diameter (1)
- 4- chamber view
- End-diastole

Development of Z-scores for fetal cardiac dimension from echocardiography, Schneider, Daubeney et al 2005 (Fig. 1)

Left ventricle dimensions



- Left ventricular inlet length in end-diastole (7)
- Left ventricular end-diastolic diameter (6)

Development of Z-scores for fetal cardiac dimension from echocardiography, Schneider, Daubeney et al 2005 (Fig. 1)

Left ventricle function

- Systolic function
    - Subjective assessment
- Normal
- Mild depression
- Moderate depression
- Severe depression

Endocardial fibroelastosis, EFE

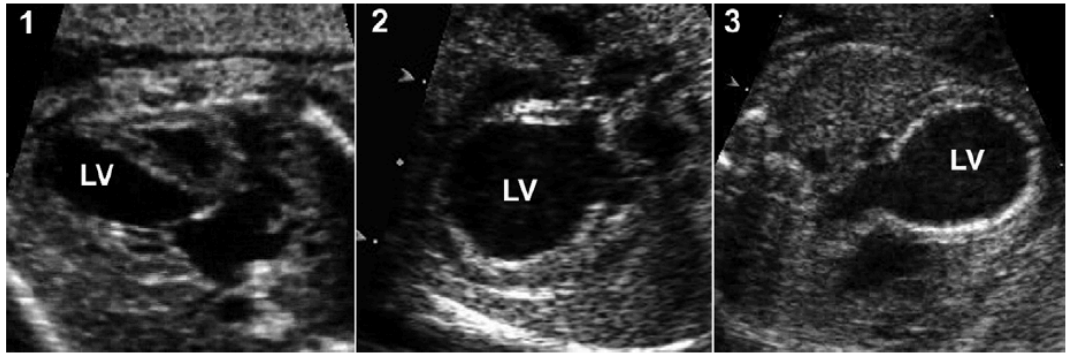
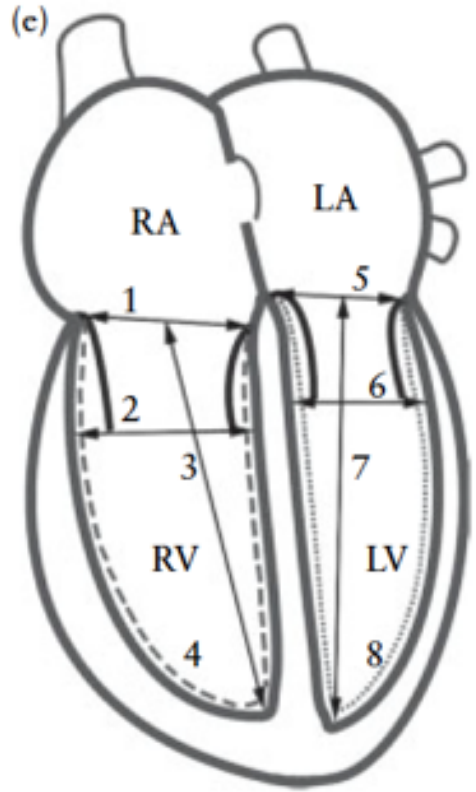


Figure 1. Preintervention echocardiographic images demonstrating examples of LV EFE grade 1, 2, and 3.

- Grading
  - None (0)
  - Mild (1), scattered echogenic spots within the LV, including the mitral valve papillary muscles
  - Moderate (2), non-contiguous echogenic patches throughout the LV
  - Severe (3), contiguous echogenic lining of the LV

Assessment of left ventricle endocardial fibroelastosis in fetuses with aortic stenosis and evolving hypoplastic left heart syndrome, McElhinney, Tworetzky et al 2010 (Fig.2)

Right ventricle dimensions



- Right ventricular inlet length (3)
- Right ventricular end-diastolic diameter (2)

Development of Z-scores for fetal cardiac dimension from echocardiography, Schneider, Daubeney et al 2005 (Fig. 1)

Aortic valve diameter

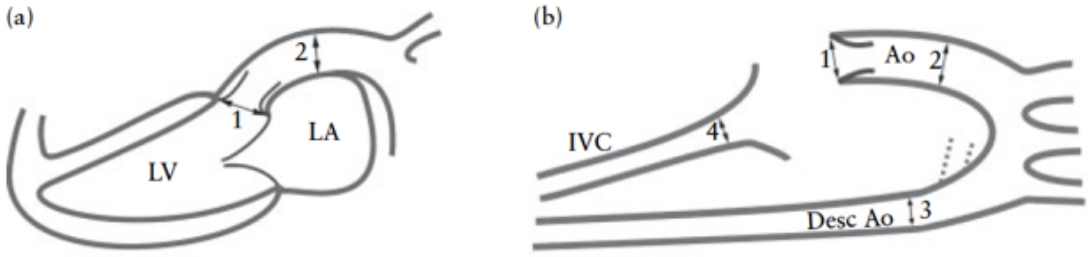
We recommend to measure the

aortic valve **when closed** and

therefore better visible.

Reference Ranges for the Size of the Fetal Cardiac Outflow Tracts From 13 to 36 Weeks Gestation, Vigneswaran et al, Circ Cardiovasc Imaging. 2018;11:e007575. DOI: 10.1161/CIRCIMAGING.118.007575

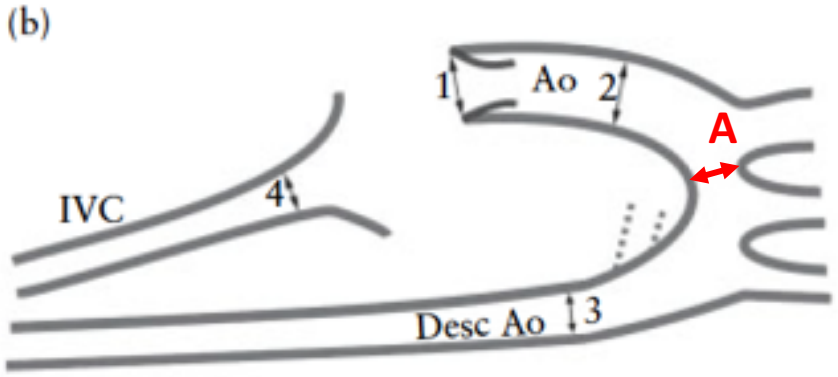
Ascending aorta dimension



- Vascular structures are measured from inner edge to inner edge

Development of Z-scores for fetal cardiac dimension from echocardiography, Schneider, Daubeney et al 2005 (Fig. 1)

Aortic arch diameter sagittal



- Aortic arch diameter sagittal, between the brachiocephalic trunc and the left common carotid carotid artery (A)

Aortic isthmus (I)

Three vessel-and tracheal view

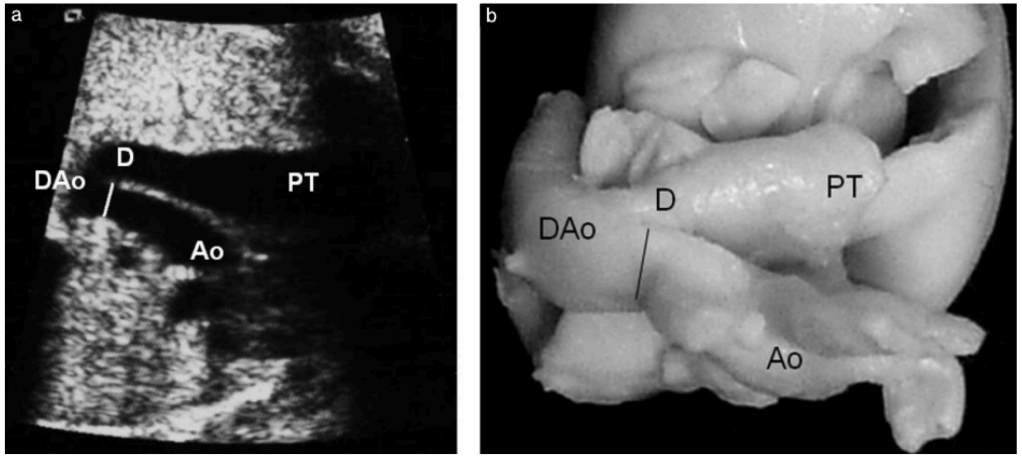


Figure 2 (a) Three vessel and trachea ultrasound image of an abnormal aortic arch showing the pulmonary trunk (PT) leading into the arterial duct (D). The isthmus is measured as shown by the line just before it enters the descending aorta (DAo) and the duct is measured directly above it. (b) Fetal heart specimen simulating the three vessels and trachea view of the ultrasound image and orientated in the same way. Ao, aortic arch.

Sagittal view

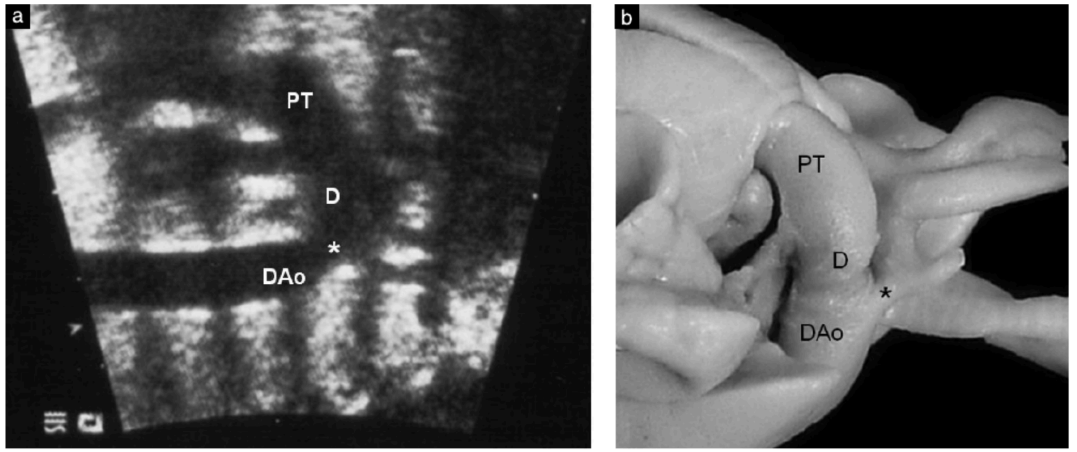


Figure 1 (a) Sagittal ultrasound image of an abnormal aortic arch at 22 weeks' gestation. (b) Fetal heart specimen simulating the sagittal view of the ultrasound image and orientated in the same way. The distal isthmus (*) is partially overlapped by the arterial duct (D) before it enters the descending aorta (DAo). PT, pulmonary trunk.

Z-scores of the fetal aortic isthmus and duct: an aid to assessing arch hypoplasia, Pasquini et al, Ultrasound Obstet Gynecol 2007;29:628-633

Aortic isthmus (II)
- 3VT is the recommended view

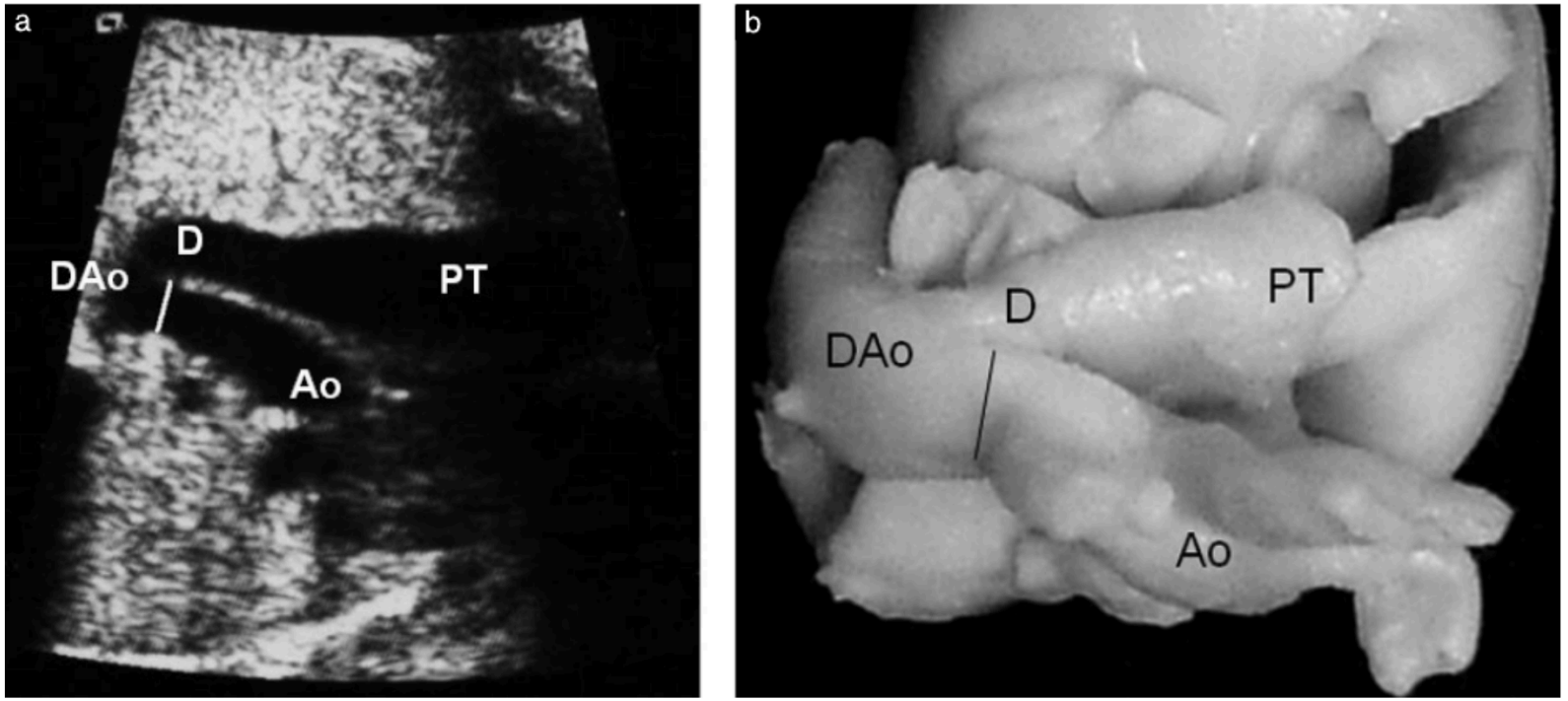


Figure 2 (a) Three vessel and trachea ultrasound image of an abnormal aortic arch showing the pulmonary trunk (PT) leading into the arterial duct (D). The isthmus is measured as shown by the line just before it enters the descending aorta (DAo) and the duct is measured directly above it. (b) Fetal heart specimen simulating the three vessels and trachea view of the ultrasound image and orientated in the same way. Ao, aortic arch.

Z-scores of the fetal aortic isthmus and duct: an aid to assessing arch hypoplasia, Pasquini et al, Ultrasound Obstet Gynecol 2007;29:628-633

Mitral inflow

- Biphasic, E- and A-wave
- Fused, fusion of the E-and A-wave but not monophasic
- Monophasic, only A-wave
- No inflow

AV-valve inflow duration (ms) to cardiac cycle length (ms)

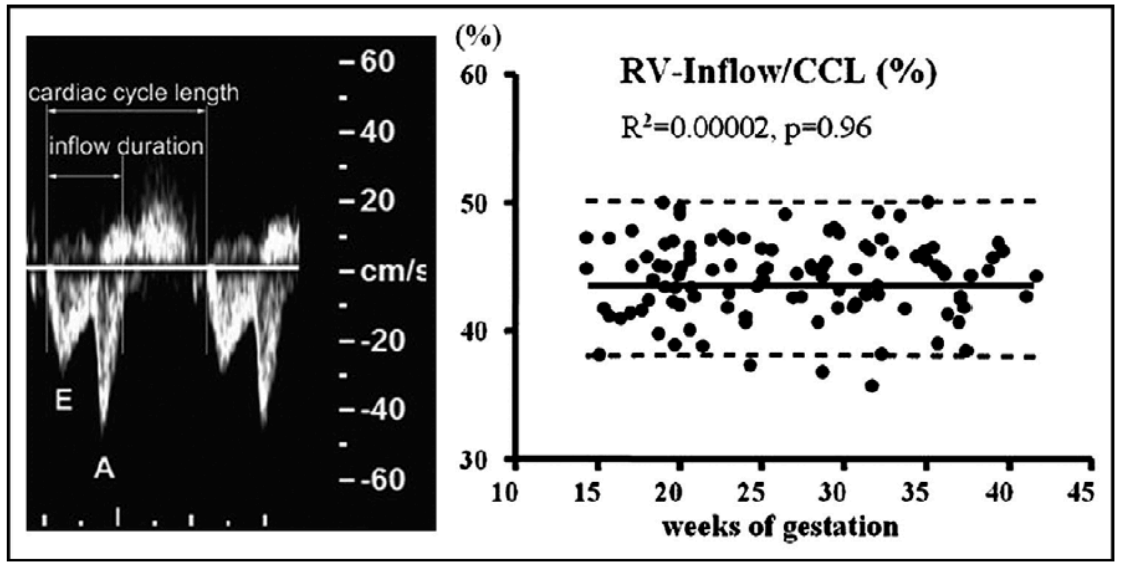


Figure 2. *Left,* RV or TV inflow duration was measured as the time interval between the onset of the E wave and the cessation of the A wave and expressed as a percentage of the duration of the corresponding cardiac cycle length (CCL). *Right,* normal range of CCL-corrected RV Doppler inflow duration. Data are expressed as means with 95% confidence intervals.

Determinants of Outcome in Fetal Pulmonary Valve Stenosis or Atresia With Intact Ventricular Septum, Roman and Jaeggi, The American Journal of Cardiology, 2007

Pulmonary venous Doppler

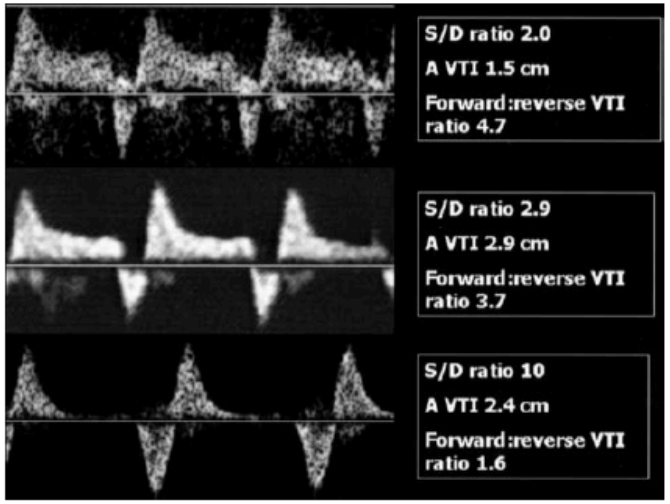


Figure 1. Pulmonary venous Doppler flow profiles in 3 fetuses with HLHS ultimately requiring EAS in the newborn period. Note the significant variability in the S/D-wave ratio, A-wave VTI, and forward flow/reverse flow VTI ratio.

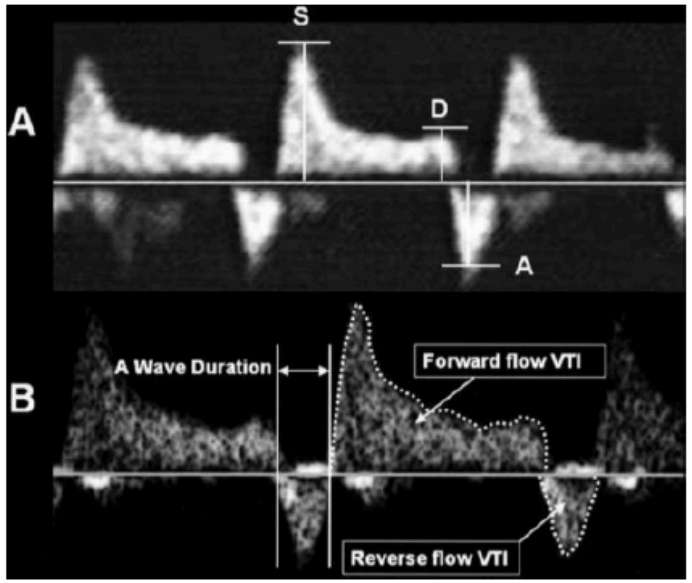


Figure 2. Measurement of pulmonary venous Doppler waveforms. A, Peak S-wave, D-wave, and A-wave (flow during atrial systole) velocity; B, measurement of A-wave duration, forward-flow VTI, and reverse-flow (A-wave) VTI.

Predictive Value of Fetal Pulmonary Venous Flow Patterns in Identifying the Need for Atrial Septoplasty in the Newborn With Hypoplastic Left Ventricle, Michelfelder and Franklin, DOI: 10.1161/CIRCULATIONAHA.105.534180, 2005

Thanks for your cooperation and support

CORE LABORATORY ECHOCARDIOGRAPHY

Pediatric Cardiac Center
Queen Silvia Children´s Hospital
Sahlgrenska Academy
University of Gothenburg
Sweden