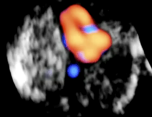


Fetal Cardiac Imaging in Early Gestation



EVMS
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Alfred Abuhamad M.D.

Chronology of Cardiac Development

Feature	Weeks of development (from fertilization)
Angiogenic clusters	Early 3
Formation of heart tubes	Early 3
Cardiac pumping	Early 3
Fusion of heart tubes	Early 3
Looping of heart tube	Mid 3
Appearance of intraventricular septum	Mid 3/late 3
Septum primum	End 3/early 4
Appearance of endocardial cushions	End 4
Conotruncal ridges	Late 4/early 5
Conotruncal septum	Early 5/mid 5
Septum secundum	Late 5/early 6
Fusion of endocardial cushions	Early 6
Obliteration of membranous septum	Mid 7/end 7 → End of 9 th menstrual week

(Adapted from O'Rahilly R, Müller F. *Human embryology and teratology*. New York: Wiley-Liss, 1992;107-117, with permission.)

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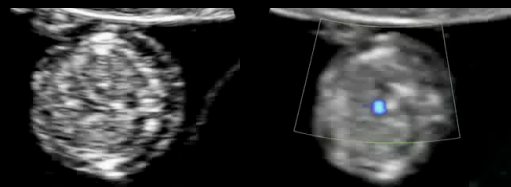
Cardiac Imaging in Early Gestation

- Caution in detailed anatomic cardiac evaluation at less than 10 weeks gestation

9 Weeks

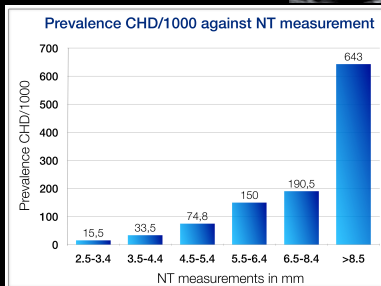


9 Weeks Gestation



Color Doppler helps but still

NT and CHD



Bahado-Singh, AJOG 2005
Clur. Prenatal Diagnosis 2009

Cardiac Imaging in Early Gestation

Approach to Examination

- Transvaginal
- Transabdominal

Cardiac Imaging in Early Gestation

Transvaginal

- Better resolution of probe
- Inconvenience to patients
- Limited probe range of motion
- Requires expertise

Cardiac Imaging in Early Gestation

Transvaginal

- Most optimal < 13 weeks
- Fetus in transverse lie

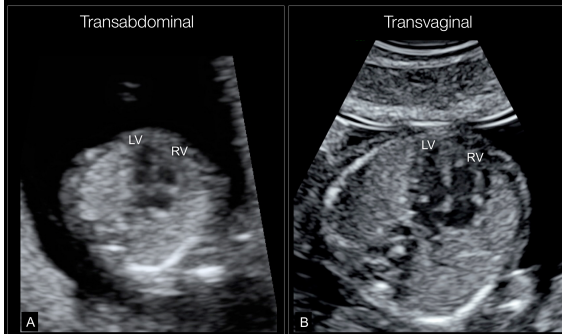
Cardiac Imaging in Early Gestation

Transvaginal



Cardiac Imaging in Early Gestation

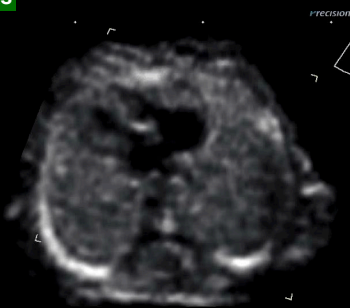
13 Weeks



Transabdominal Approach

13 Weeks

- 4CV
- PV

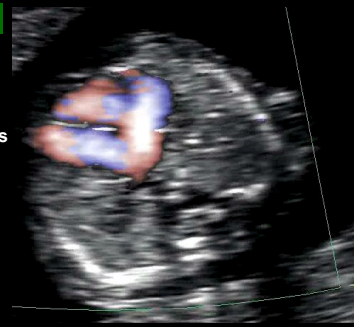


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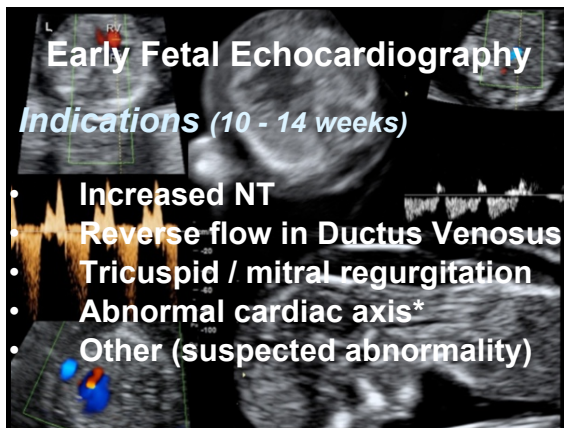
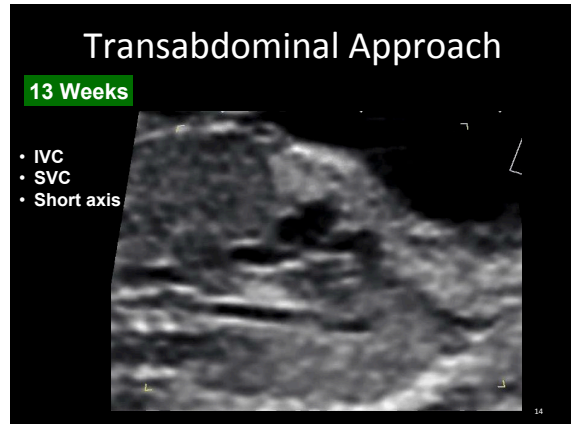
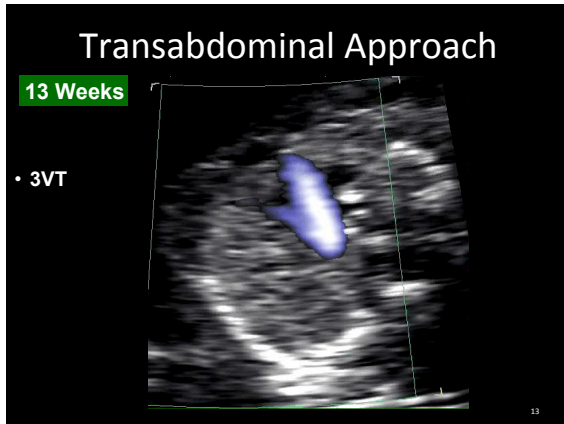
Transabdominal Approach

13 Weeks

- 4CV
- Cardiac axis
- Left PV



12



Early Fetal Cardiac Imaging

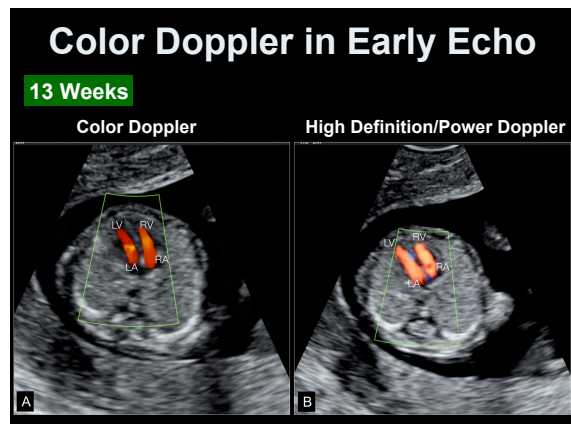
TABLE 16.1 Optimization of Grayscale Examination in Early Cardiac Scan
<ul style="list-style-type: none"> Fetus in dorsoposterior position (NT position) Magnify image Narrow sector width Fetal thorax to occupy one-third of ultrasound screen Use high-contrast image setting Use mid-to-high-resolution transducer Insonate from apical to right lateral of fetal heart

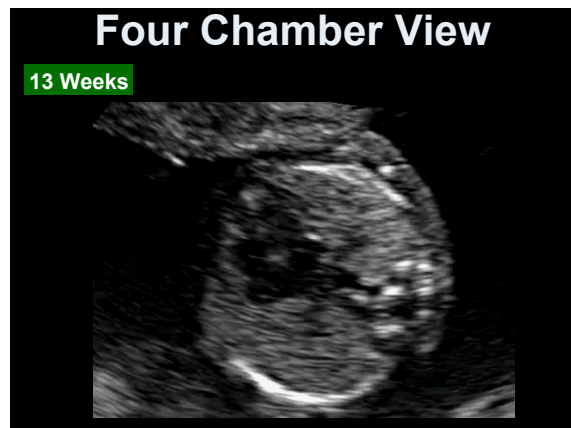
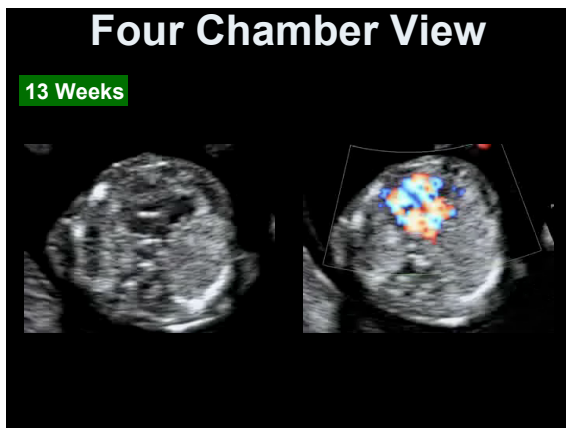
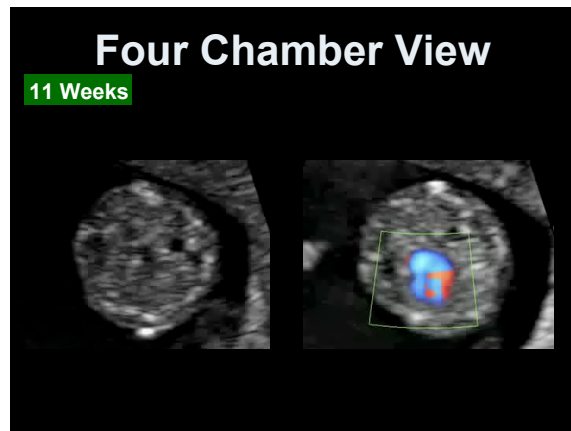
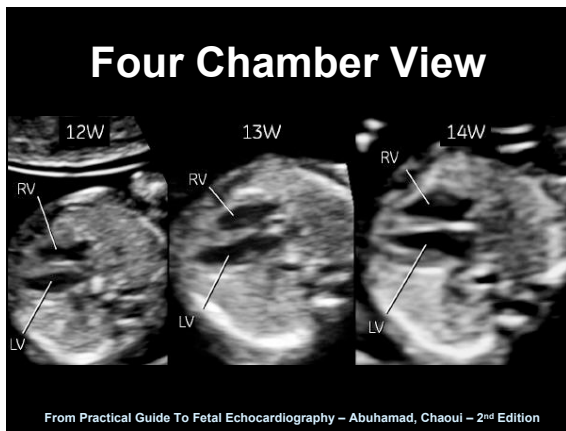
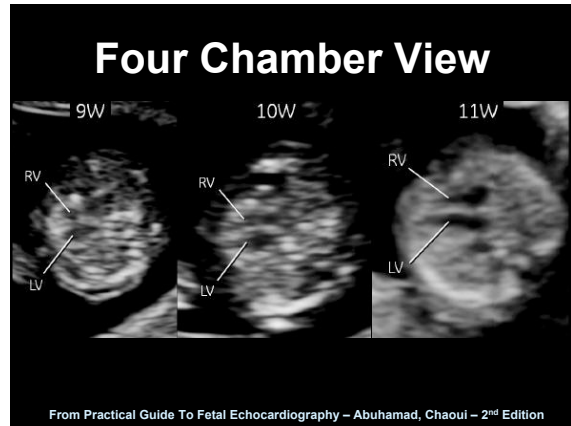
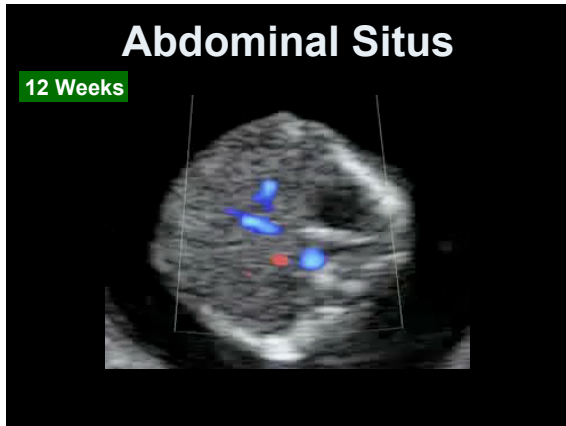
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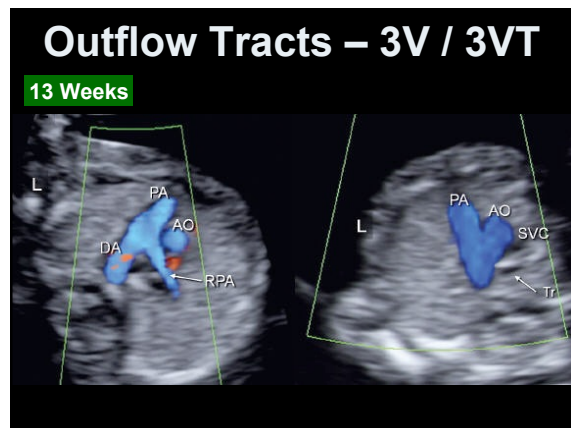
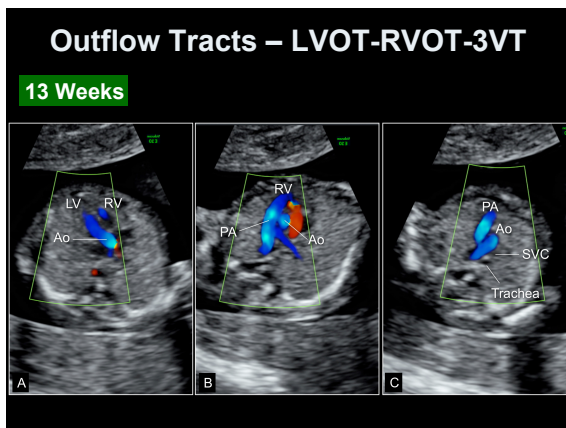
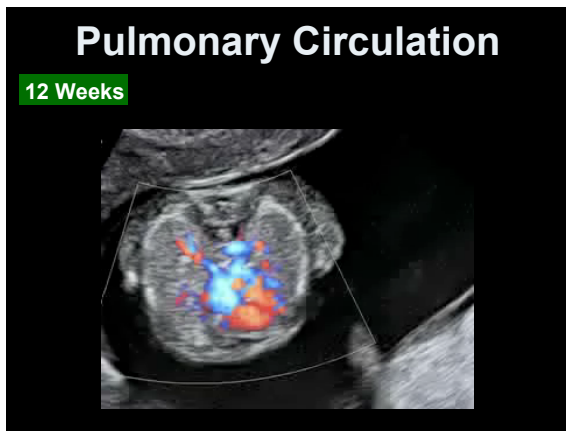
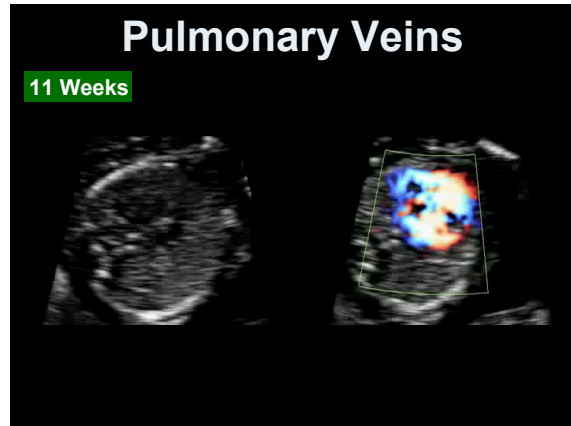
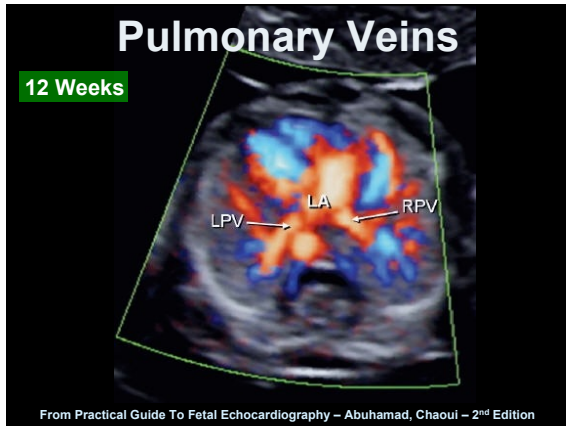
Early Fetal Cardiac Imaging

TABLE 16.2 Optimization of Color Doppler Examination in Early Cardiac Scan
<ul style="list-style-type: none"> Start with grayscale optimization before activating color Doppler Use a narrow color Doppler box Use mid velocity color Doppler range Use mid filter levels Use mid-to-high persistence Use low color Doppler gain Use low power output Use bidirectional Doppler if available

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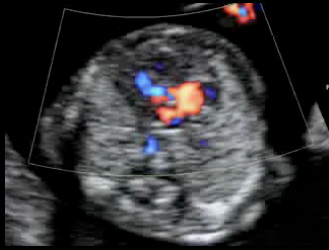






Outflow Tracts – 3V / 3VT

12 Weeks



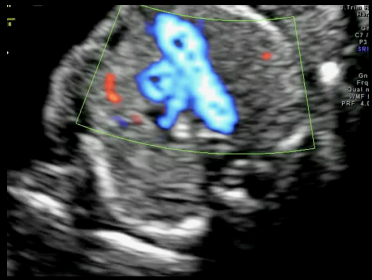
Outflow Tracts-3VT

13 Weeks



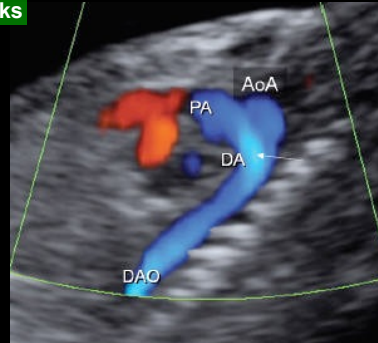
Outflow Tracts-3VT

13 Weeks



Aortic & Ductal Arches

13 Weeks



Abnormal Anatomy

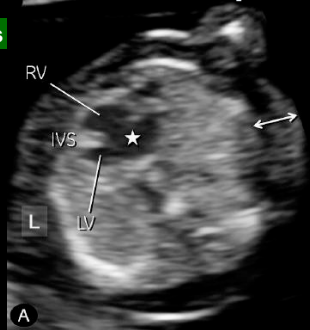
Heterotaxy

12 Weeks



Atrioventricular Septal Defect

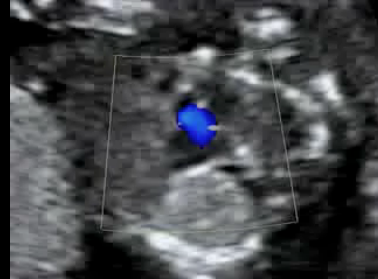
12 Weeks



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Atrioventricular Septal Defect

12 Weeks



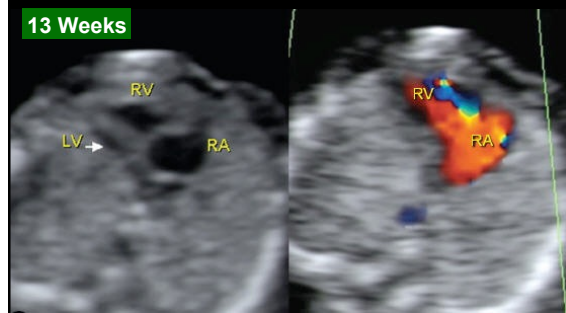
Atrioventricular Septal Defect

12 Weeks



Hypoplastic Left Heart Syndrome

13 Weeks



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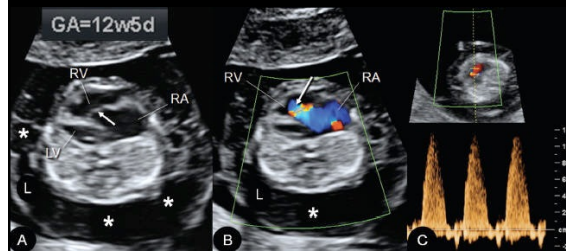
Hypoplastic Left Heart Syndrome

12 Weeks

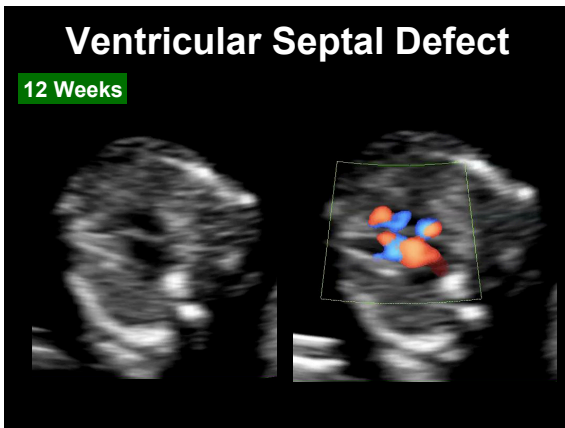
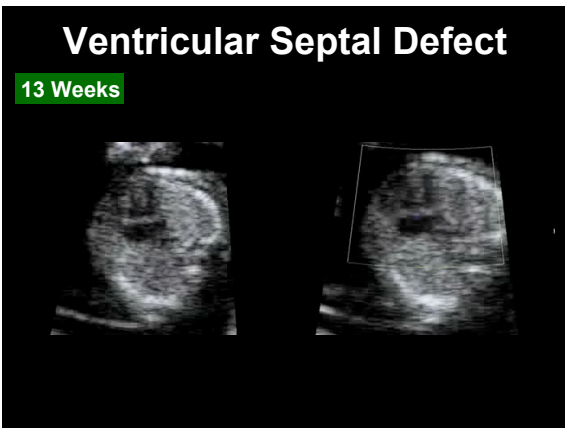
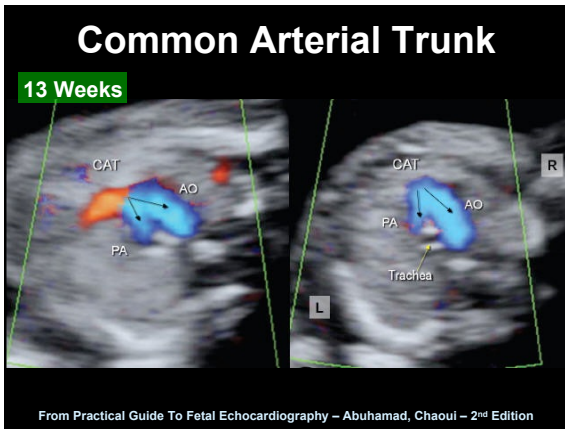
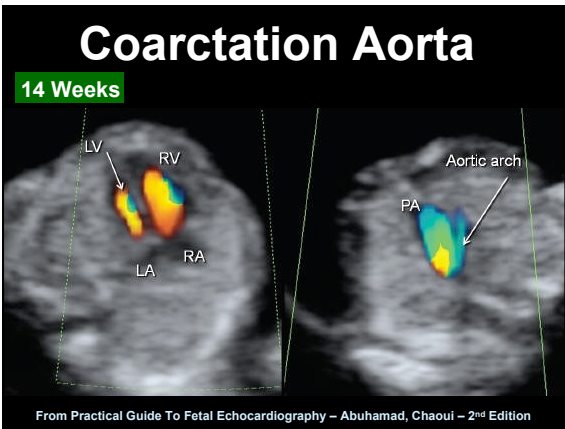
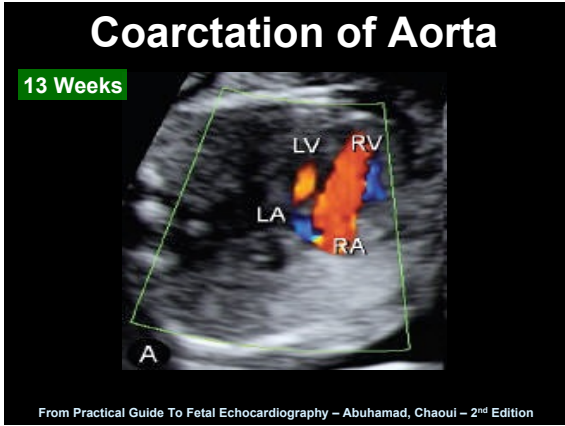
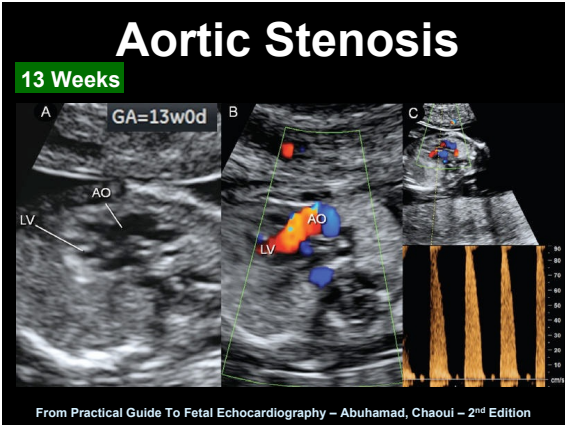


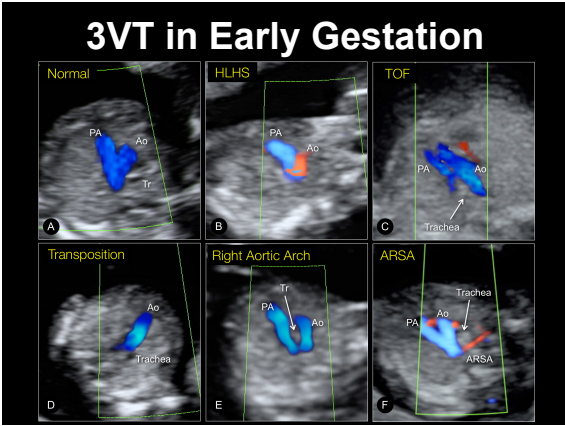
Ebstein Anomaly

13 Weeks

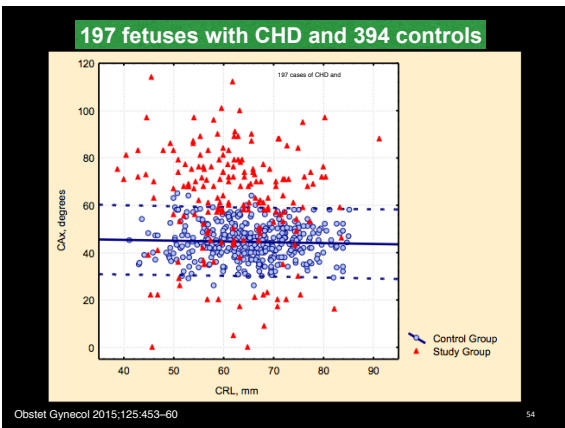
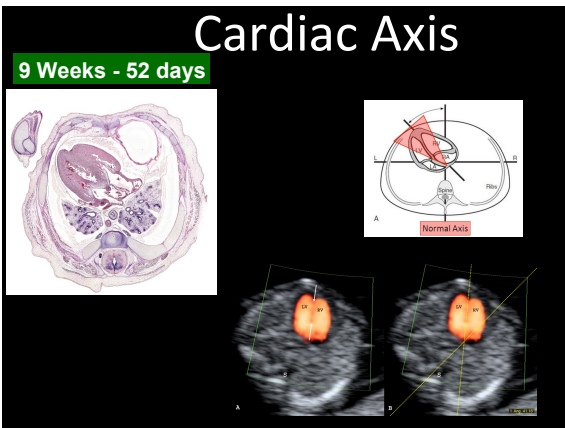
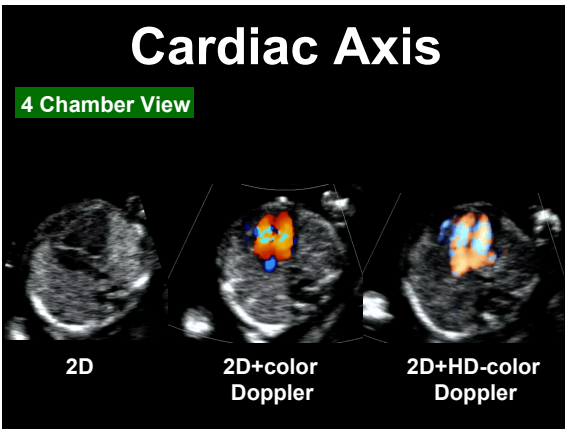
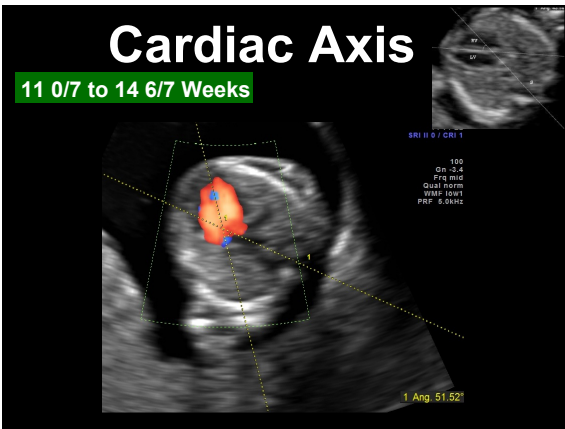


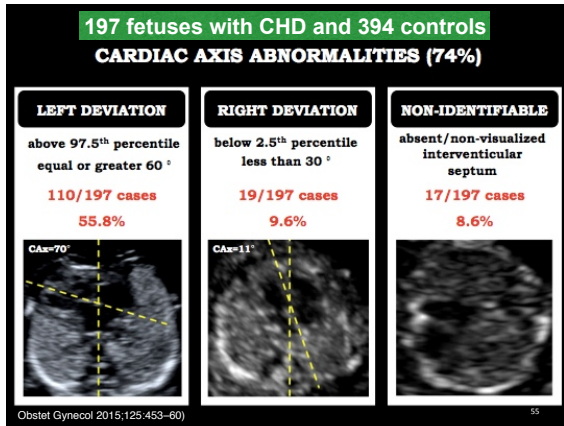
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Cardiac Axis in the First Trimester



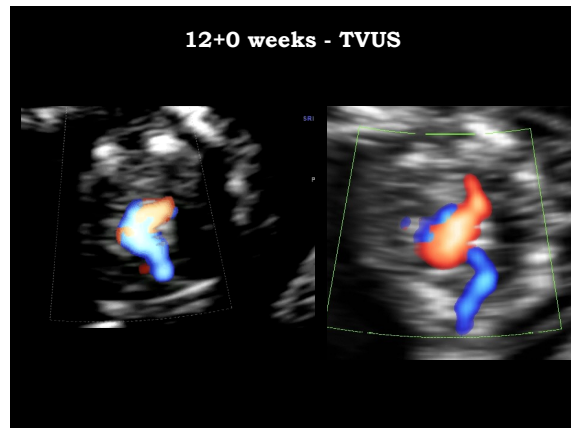
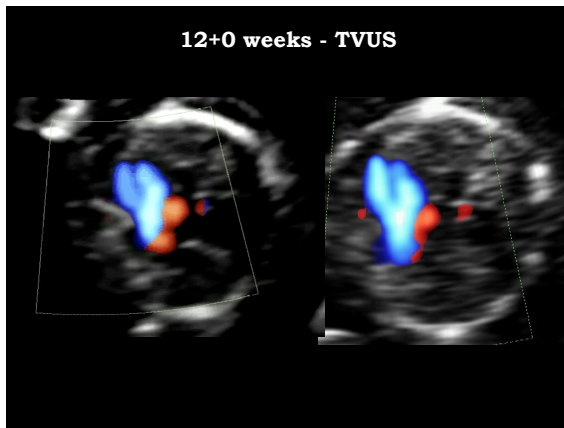
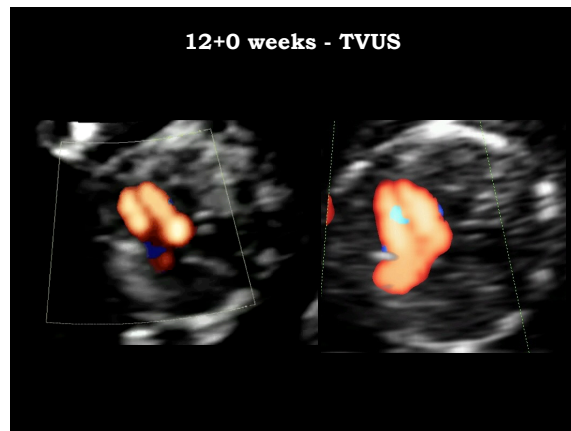
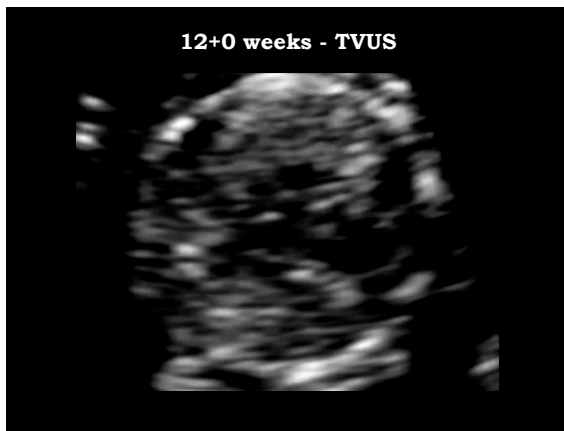


CASE #1

PATIENT: 33 year old - G2P0

REASON FOR REFERRAL: Detailed 1st trimester ultrasound with enlarged nuchal translucency noted on the outside scan

GA AT PRESENTATION: 12+0 weeks



DIAGNOSIS

CHD: Tetralogy of Fallot with pulmonary stenosis
- ARSA

Small omphalocele

Two vessel umbilical cord

Genetic Counseling:

Work up for chromosomal anomalies

Fetal Karyotype: 46XX,del(4)(p15.2) – Wolf-Hirschhorn syndrome

Pregnancy outcome: termination at 15+1 weeks

CASE #2

PATIENT: 32 year old - G1P0

REASON FOR REFERRAL: First trimester screening

GA AT PRESENTATION: 13+2 weeks (2013)

13+2 weeks - TVUS



13+2 weeks - TVUS



13+2 weeks - TVUS



DIAGNOSIS

-Transposition of Great Arteries

Genetic Counseling:

Work up for CHD: TGA

Tests Offered

- Chorionic villus sampling
- Amniocentesis at 16 wks
- NIPT for trisomy 13,18, 21
- Universal carrier screening
- Early Morphologic US
- Early Fetal Echocardiogram
- Pediatric Cardiology consult

Patients Decision

- NIPT for trisomy 13,18, 21
- Universal carrier screening
- Early Morphologic US
- Early Fetal Echocardiogram
- Pediatric Cardiology consult

NIPT results: Negative for trisomy 13, 18, 21

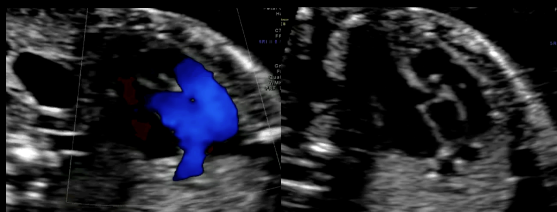
23+2 weeks



23+2 weeks



23+2 weeks



Pregnancy outcome

GA at DELIVERY: 40+1 weeks

DELIVERY: vaginal delivery

NEONATAL COURSE:

- Apgar's of 6/7 (significant cyanosis at birth)
- Balloon atrial septostomy in first hours of life
- Atrial switch surgery in 2nd week of life
- Alive & Well

Early Fetal Imaging

National Guidelines - AIUM

- d. Embryonic/fetal anatomy appropriate for the first trimester should be assessed.

<http://www.aium.org/resources/guidelines/obstetric.pdf> - 2013

Early Fetal Imaging

ISUOG Guidelines

Table 2 Suggested anatomical assessment at time of 11 to 13 + 6-week scan

Organ/anatomical area	Present and/or normal?
Head	Present Cranial bones Midline falx Choroid-plexus-filled ventricles
Neck	Normal appearance Nuchal translucency thickness (if accepted after informed consent and trained/certified operator available)*
Face	Eyes with lens* Nasal bone* Normal profile/mandible* Intact lips*
Spine	Vertebrae (longitudinal and axial)* Intact overlying skin*
Chest	Symmetrical lung fields No effusions or masses
Heart	Cardiac regular activity Four symmetrical chambers*
Abdomen	Stomach present in left upper quadrant Bladder* Kidneys*
Abdominal wall	Normal cord insertion No umbilical defects
Extremities	Four limbs each with three segments Hands and feet with normal orientation*
Placenta	Size and texture
Cord	Three-vessel cord*

<http://www.isuog.org> - 2013

Early Fetal Imaging

National Guidelines

- First trimester ultrasound remains indication driven
- If a late first trimester US is performed – evaluation for early detection of severe anomalies is reasonable
- In some experienced centers, detection of major fetal anomalies in first trimester is possible

NICHD Consensus on fetal imaging - 2013

Early Fetal Imaging

Spectral Doppler Safety - AIUM

The use of Doppler ultrasound during the first trimester is currently being promoted as a valuable diagnostic aid for screening for and diagnosis of some congenital abnormalities. The procedure requires considerable skill and subjects the fetus to extended periods of relatively high ultrasound exposure levels. Due to the increased risk of harm, the use of spectral Doppler ultrasound with high TI in the first trimester should be viewed with great caution. Spectral Doppler should only be employed when there is a clear benefit/risk advantage and both TI and examination duration are kept low.

<http://www.aium.org/officialStatements/42> - 2011

Early Fetal Imaging

Spectral Doppler Safety - AIUM

1. Pulsed Doppler (spectral, power, and color flow imaging) ultrasound should not be used routinely.
2. Pulsed Doppler ultrasound may be used for clinical indications such as to refine risks for trisomies.
3. When performing Doppler ultrasound, the displayed Thermal Index (TI) should be less than or equal to 1.0 and exposure time should be kept as short as possible (usually no longer than 5-10 minutes) and not exceed 60 minutes.
4. When using Doppler ultrasound for research, teaching, and training purposes, the displayed TI should be less than or equal to 1.0 and exposure time should be kept as short as possible (usually no longer than 5-10 minutes) and not exceed 60 minutes. Informed consent should be obtained.
5. In educational settings, discussion of first trimester pulsed or color Doppler should be accompanied by information on safety and bioeffects (e.g., TI, exposure times, and how to reduce the output power).
6. When scanning maternal uterine arteries in the first trimester, there are unlikely to be any fetal safety implications so long as the embryo/fetus lies outside the Doppler ultrasound beam.

<http://www.aium.org/officialStatements/42> - 2011

Early Fetal Imaging

Spectral Doppler Safety - ISUOG

Ultrasound Obstet Gynecol (2011)
Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/uog.9026

ISUOG statement on the safe use of Doppler in the 11 to 13 + 6-week fetal ultrasound examination

Bioeffects and Safety Committee (K. SALVESEN, C. LEES, J. ABRAMOWICZ, C. BRECZINKA, G. TER HAAR and K. MARŠÁL) on behalf of the Board of the International Society of Ultrasound in Obstetrics and Gynecology (ISUOG)

Cardiac Imaging in Early Gestation

Spectrum of CHD

- More complex abnormalities
- Higher association with aneuploidy
- Higher association with hydrops

Cardiac Imaging in Early Gestation

My Recommendations



- It is easier than you think!
- Adjust your US presets (NT+Fetal Echo)
- Attempt to look on every scan
- Look at cardiac axis (measure?)
- High definition color optimal
- Look at 3-Vessel-Trachea View

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ULTRASOUND in Obstetrics and Gynecology: *A Practical Approach*



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