Fetal Cardiac Imaging in Early Gestation

Alfred Abuhamad M.D.

Chronology of Cardiac Development

<table>
<thead>
<tr>
<th>Feature</th>
<th>Weeks of development (from fertilization)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angiogenic clusters</td>
<td>Early 3</td>
</tr>
<tr>
<td>Formation of heart tubes</td>
<td>Early 3</td>
</tr>
<tr>
<td>Cardiac pumping</td>
<td>Early 3</td>
</tr>
<tr>
<td>Fusion of heart tubes</td>
<td>Early 3</td>
</tr>
<tr>
<td>Looping of heart tube</td>
<td>Mid 3</td>
</tr>
<tr>
<td>Appearance of interventricular septum</td>
<td>Mid 4th week</td>
</tr>
<tr>
<td>Septum primum</td>
<td>End 5th week</td>
</tr>
<tr>
<td>Appearance of endocardial cushions</td>
<td>End 4</td>
</tr>
<tr>
<td>Septum ridges</td>
<td>Late 4th week</td>
</tr>
<tr>
<td>Coronary sinus</td>
<td>Late 5th week</td>
</tr>
<tr>
<td>Septum secundum</td>
<td>Late 6th week</td>
</tr>
<tr>
<td>Fusion of endocardial cushions</td>
<td>Early 6</td>
</tr>
<tr>
<td>Dilatation of membranous septum</td>
<td>Mid 7th week</td>
</tr>
</tbody>
</table>


From Practical Guide To Fetal Echocardiography – Abuhamad, Chaoui – 2nd Edition

Cardiac Imaging in Early Gestation

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

9 Weeks Gestation

Color Doppler helps but still

NT and CHD

Prevalence CHD/1000 against NT measurement

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

**Transvaginal**

- Most optimal < 13 weeks
- Fetus in transverse lie

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Cardiac Imaging in Early Gestation

**Transvaginal**

![Image of ultrasound scan]

Transabdominal Approach

**13 Weeks**

- 4CV
- PV

Transabdominal Approach

**13 Weeks**

- 4CV
- Cardiac axis
- Left PV
Transabdominal Approach

- 3VT

Transabdominal Approach

- IVC
- SVC
- Short axis

Early Fetal Echocardiography

Indications (10 - 14 weeks)

- Increased NT
- Reverse flow in Ductus Venosus
- Tricuspid / mitral regurgitation
- Abnormal cardiac axis
- Other (suspected abnormality)

Early Fetal Cardiac Imaging

<table>
<thead>
<tr>
<th>TABLE 16.1 Optimization of Grayscale Examination in Early Cardiac Scan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focus in dorsoventral position (NT position)</td>
</tr>
<tr>
<td>Magnify image</td>
</tr>
<tr>
<td>Narrow sector width</td>
</tr>
<tr>
<td>Fetal themes to occupy one-third of ultrasound screen</td>
</tr>
<tr>
<td>Use high contrast image setting</td>
</tr>
<tr>
<td>Use moderate-to-high resolution transducer</td>
</tr>
<tr>
<td>Inspect from apical to right lateral of fetal heart</td>
</tr>
</tbody>
</table>


Early Fetal Cardiac Imaging

Color Doppler in Early Echo

<table>
<thead>
<tr>
<th>TABLE 16.2 Optimization of Color Doppler Examination in Early Cardiac Scan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start with grayscale optimization before activating color Doppler</td>
</tr>
<tr>
<td>Use a narrow color Doppler box</td>
</tr>
<tr>
<td>Use mid velocity color Doppler range</td>
</tr>
<tr>
<td>Use mid-to-high persistence</td>
</tr>
<tr>
<td>Use low color Doppler gain</td>
</tr>
<tr>
<td>Use low power output</td>
</tr>
<tr>
<td>Use bidirectional Doppler if available</td>
</tr>
</tbody>
</table>

Abdominal Situs

12 Weeks

Four Chamber View

11 Weeks

Four Chamber View

13 Weeks

Four Chamber View

13 Weeks
Pulmonary Veins

12 Weeks

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Pulmonary Veins

11 Weeks

Outflow Tracts

Outflow Tracts – LVOT-RVOT-3VT

13 Weeks

Outflow Tracts – 3V / 3VT

13 Weeks
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
3VT in Early Gestation

Cardiac Axis in the First Trimester

Cardiac Axis

Cardiac Axis

Cardiac Axis

Cardiac Axis

Cardiac Axis

Cardiac Axis

Cardiac Axis
197 fetuses with CHD and 394 controls
CARDIAC AXIS ABNORMALITIES (74%)

**LEFT DEVIATION**
- above 97.5th percentile equal or greater 60°
  - 110/197 cases
  - 55.8%

**RIGHT DEVIATION**
- below 2.5th percentile less than 30°
  - 19/197 cases
  - 9.6%

**NON-IDENTIFIABLE**
- absent/non-visualized interventricular septum
  - 17/197 cases
  - 8.6%

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**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

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**12+0 weeks - TVUS**
**CHD:** Tetralogy of Fallot with pulmonary stenosis - ARSA

Small omphalocele

Two vessel umbilical cord

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**DIAGNOSIS**

**Case #2**

**Patient:** 32 year old - G1P0

**Reason for referral:** First trimester screening

**GA at presentation:** 13+2 weeks (2013)

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**Genetic Counseling:**

*Work up for chromosomal anomalies*

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

**Pregnancy outcome:** termination at 15+1 weeks

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**13+2 weeks - TVUS**
DIAGNOSIS

- Transposition of Great Arteries

Genetic Counseling:

Work up for CHD: TGA

<table>
<thead>
<tr>
<th>Tests Offered</th>
<th>Patients Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chorionic villus sampling</td>
<td></td>
</tr>
<tr>
<td>Amniocentesis at 16 wks</td>
<td></td>
</tr>
<tr>
<td>NIPT for trisomy 13,18, 21</td>
<td>NIPT for trisomy 13,18, 21</td>
</tr>
<tr>
<td>Universal carrier screening</td>
<td>Universal carrier screening</td>
</tr>
<tr>
<td>Early Morphologic US</td>
<td>Early Morphologic US</td>
</tr>
<tr>
<td>Early Fetal Echocardiogram</td>
<td>Early Fetal Echocardiogram</td>
</tr>
<tr>
<td>Pediatric Cardiology consult</td>
<td>Pediatric Cardiology consult</td>
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</tbody>
</table>

NIPT results: Negative for trisomy 13, 18, 21

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

- 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

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 TIs 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.

Early Fetal Imaging
Spectral Doppler Safety - ISUOG

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

Biosafety and Safety Committee (K. SALVESEN, C. LEES, J. ABRAHOMICZ, C. BREZNIKA, G. TER HAAR and K. MAKSIĆ) 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

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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