

10th Annual

Fetal Echocardiography: Normal and Abnormal Hearts

Thursday AM Part 1, October 31, 2019

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NEW NATIONAL GUIDELINES FOR FETAL ECHOCARDIOGRAPHY: A SNEAK PREVIEW




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New National Guidelines for Fetal Echocardiography: a Sneak Preview



Alfred Abuhamad, MD.
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Definition of Terms

- Guidelines
 - Protocols
 - Standards
 - Policy
- Ultrasound study itself: Fetal Echocardiography 
- Certifications
 - Credentialing
 - Qualifications
- Personnel performing study: Physicians and Sonographers 
- Accreditations
- Ultrasound Laboratory: Equipment, Staff, Procedures... 

Definition of Terms



Guidelines: Systematically derived statements that help practitioners to make decisions about care in specific clinical circumstances. These should be research or evidence based

Protocol: An agreed framework outlining the care that will be provided to patients in a designated area of practice. They do not describe how a procedure is performed, but why, where, when and by whom the care is given

Standard: A statement, reached through consensus, which clearly identifies the desired outcome. Usually used within audit as a measure of success

Policy: A formal written statement detailing the particular action to be taken in a particular situation that is contractually binding



http://www.rcn.org.uk/_data/assets/pdf_file/0004/176368/Tools_8-UsingProtocols.pdf

Definition of Terms

- Guidelines
- Protocols
- Standards
- Policy

↓

Burden of Evidence
Consistency in practice
Need for Compliance

Definition of Terms



Credentiaing: is the process of establishing the qualifications of professionals, and assessing their background and legitimacy. Many healthcare institutions and provider networks conduct their own credentiaing, generally through a credentiaing specialist or electronic service, with review by a medical staff or credentiaing committee.

Personnel credentiaing is typically undertaken at commencement of employment (initial application) and at regular intervals thereafter (reappointment).



<http://www.answers.com/topic/credentiaing>



Definition of Terms

What is Accreditation?

Accreditation is a voluntary process through which a health care organization is able to measure the quality of its services and performance against nationally-recognized Standards. The accreditation process involves self-assessment by the organization and peer review of various aspects of the practice



Accredited **Ultrasound Accreditation**

Anthem adds ultrasound to list of modalities requiring accreditation – effective March 1, 2013

To help ensure the best care for our members, Anthem Blue Cross and Blue Shield and our affiliated HMO will add ultrasound to the list of modalities requiring accreditation for reimbursement effective March 1, 2013. As per the contract, providers will have one year to fulfill this requirement. This will apply to studies performed for ultrasound guidance as well. As a result, you will need to be accredited by the American College of Radiology (ACR) or American Institute of Ultrasound in Medicine (AIUM) for each piece of equipment utilized in such studies pursuant to your contract terms.

Network Update
September 2012 4 of 30

http://www.anthem.com/provider/na/15/s1/10/pw_e186524.pdf?refer=ahpprovider

as of 2013- Guidelines for Fetal Echocardiography

AIUM practice guideline for the performance of fetal echocardiography.
Fetal Echocardiography Task Force. American Institute of Ultrasound in Medicine. Clinical Standards Committee. American College of Obstetrics and Gynecology. Society for Maternal-Fetal Medicine.
J Perinat Med. 2009;37(1):5-11. doi: 10.1016/j.pnm.2009.02.022

Perinatal echocardiography: protocols for evaluating the fetal and neonatal heart.
Wood D, Respondel L, Liberman M, Puerto B, Weiner S. World Association of Perinatal Medicine Ultrasonography Working Group. *Ultrasound Obstet Gynecol.* 2008 Aug;32(2):239-42. doi: 10.1002/ulog.6115

ISUOG consensus statement: what constitutes a fetal echocardiogram?
Lee YK, Adali L, Caporaso JS, Chhabra R, Cooper J, Devereux G, Hecher K, Humeza M, Nelson T, Paladini D, Yagel S. ISUOG Fetal Echocardiography Task Force.
Ultrasound Obstet Gynecol. 2009 Jun;27(1):10-15.

Cardiac screening examination of the fetus: guidelines for performing the 'basic' and 'extended basic' cardiac scan.
International Society of Ultrasound in Obstetrics & Gynecology.
Ultrasound Obstet Gynecol. 2004 Jun;17(7):600-10

American Society of Echocardiography guidelines and standards for performance of the fetal echocardiogram.
Nechts J, Ayres N, Curran B, Goffeiner N, Homberger L, Sporek PJ, Van Der Veld M.
Cardiol Young. 2004 Feb; 14(1):109-14.

Recommendations for the practice of fetal cardiology in Europe.
Alakis L, Danzou J, Fessalova V, Hasek J, Melloraki M, Oberhansli I, Oberhoffer R, Shantalov G, Strasson J, Sorensson BE. Fetal Cardiology Working Group. Association for European Pediatric Cardiology.
J Neonol Echocardiogr. 1990 Jan;Feb;3(1):1-3.

Guidelines for physician training in fetal echocardiography: recommendations of the Society of Pediatric Echocardiography Committee on Physician Training.
Ultrasound Obstet Gynecol. 2004 Jun;17(7):600-10

Guidelines for Fetal Echocardiography

aium American Institute of Ultrasound in Medicine

ASE American Society of Echocardiography

isuog International Society of Ultrasound in Obstetrics and Gynecology

Association for European Pediatric and Congenital Cardiology

ASE-2004 Fetal Echo Guidelines

Issues with 2004-ASE Guidelines

- Excludes a major segment of performing providers
- Study component is more comprehensive than what is commonly done
- Is not a collaborative guideline

AIUM-2010 Fetal Echo Guidelines

Issues with 2011-AIUM Guidelines

- Do not clearly differentiate a fetal echo study from a 76811 (targeted Ob Scan)
- Do not allow for comprehensive evaluation of valves
- Image retention are not specified, such as the need for clips
- Are not fully collaborative (do not include ASE)

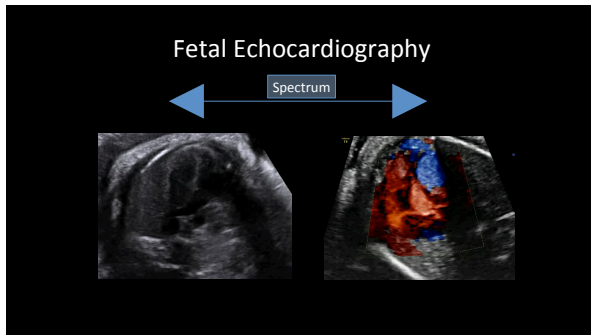
AIUM-2010 Fetal Echo Guidelines

Issues with 2011-AIUM Guidelines

Table 1. Mandatory Components of Standard Fetal/Pediatric Echocardiography

Component	AIUM, 2011 ¹ (Fetal Echo)	ISUOG, 2009 ² (Fetal Echo)	ASE, 2004 ³ (Fetal Echo)	AEFC, 2004 ⁴ (Fetal Echo)	ASE, 2004 ⁵ (Ped Echo)
Clips	No	?	?	Yes	Yes
Color flow	No	Yes	?	Yes	Yes
Valve morphology (4 valves)	No	Yes	No	No	Yes
Biplanar	No	No	Yes	Yes	Yes
Pulsed Doppler	No	No	?	No	Yes
M-mode	No	No	?	No	No

J Ultrasound Med 2011; 30:284-286



- ### AIUM- ASE 2012 Fetal Echo Guidelines
- Meeting with ASE in 2010 to develop joint guideline
 - ASE invited to collaborate on Joint Fetal Echo Guideline
 - Open communication with leadership
 - Having one guideline in the goal

AHA Scientific Statement

Diagnosis and Treatment of Fetal Cardiac Disease
A Scientific Statement From the American Heart Association

Endorsed by the American Society of Echocardiography and Pediatric and Congenital Electrophysiology Society
 The American Institute of Ultrasound in Medicine supports the value and findings of the statement.*
 The Society of Maternal Fetal Medicine supports the statement's review of the subject matter and believe it is consistent with its existing clinical guidelines.†

Mary T. Donofrio, MD, Chair; Anita J. Moon-Grady, MD; Lisa K. Heenberger, MD;
 Joshua A. Copel, MD; Mark S. Sklarsky, MD; Alfred Abshamad, MD; Beritina F. Cunico, MD;
 James C. Hahn, MD; Richard A. Jones, MD; Anita Krishnam, MD; Stephanie Lacey, DO;
 Wesley Lee, MD; Erik C. Michelfelder, Sr, MD; Owen R. Rempel, RN;
 Norman H. Silverman, MD, DSc, FAHA; Thomas L. Spray, MD, FAHA; Janette F. Strasburger, MD;
 Wayne Thoretsky, MD; Jack Ryckels, MD, on behalf of the American Heart Association Adults With
 Congenital Heart Disease Joint Committee of the Council on Cardiovascular Disease in the Young and
 Council on Clinical Cardiology, Council on Cardiovascular Surgery and Anesthesia, and Council on
 Cardiovascular and Stroke Nursing.

Circulation, 2014; 129:2183

American Heart Association
Learn and Live

2019 Fetal Echo Guidelines

- ### 2019 Fetal Echo Guidelines
- AIUM
 - ACR
 - ACOG
 - ASE
 - FHS
 - ISUOG
 - SMFM
 - SRU

- ### Indications - Fetal Factors
- Fetal echocardiography is indicated:
- Suspected cardiac structural anomaly
 - Suspected abnormality in cardiac function
 - Hydrops fetalis
 - Persistent fetal tachycardia (HR > 180 bpm)
 - Persistent fetal bradycardia (HR < 120 bpm) or suspected heart block
 - Frequent episodes or persistently irregular cardiac rhythm
 - Major fetal extracardiac anomaly
 - Nuchal translucency ≥ 3.5 mm or ≥ 99th percentile for gestational age
 - Chromosomal abnormality by invasive genetic testing or with cfDNA screening
 - Monozygotic twinning

Indications - Fetal Factors

Fetal echocardiography may be considered:

- Systemic venous anomaly (e.g. persistent right umbilical vein, left superior vena cava)
- Greater than normal nuchal translucency measurement between 3.0 to 3.4 mm

Indications - Maternal Factors

Fetal echocardiography is indicated:

- Pre-gestational diabetes regardless of HbA1C level
- Gestational diabetes diagnosed in the 1st or early 2nd trimester
- In-vitro fertilization (IVF) including intracytoplasmic sperm injection (ICSI)
- Phenylketonuria (unknown status or peri-conceptual phenylalanine level > 10 mg/dL)
- Autoimmune disease with anti-Sjogren's syndrome related antigen A (SSA) antibodies & w
- First-degree relative of fetus with CHD (parents, siblings, prior pregnancy)
- First or second degree relative with disease of Mendelian inheritance and a history of child
- Significant retinoid exposure
- First trimester rubella infection

Indications - Maternal Factors

Fetal echocardiography may be considered:

- Selected teratogen exposure (e.g. paroxetine, carbamazepine, lithium)
- Antihypertensive medication limited to angiotensin converting enzyme (ACE) inhibitors
- Autoimmune disease with SSA positivity and without a prior affected fetus
- Second-degree relative of fetus with CHD

Other Considerations

Detailed Ultrasound (76811) may be appropriate:

- Obesity (BMI ≥ 35 kg/m²)
- Selective serotonin reuptake inhibitor (SSRI) antidepressant exposure other than paroxetine
- Non-cardiac "soft marker" for aneuploidy in absence of karyotype information
- Abnormal maternal serum analytes (e.g. α -fetoprotein level)
- Isolated single umbilical artery

Other Considerations

Detailed Ultrasound (76811) may be appropriate:

- Gestational diabetes diagnosed after 2nd trimester
- Warfarin exposure
- Alcohol exposure
- Echogenic intracardiac focus
- Maternal fever or viral infection with seroconversion only
- Isolated CHD in a relative further removed than 2nd degree to fetus

Fetal Echocardiography

Grayscale Imaging (Required)

- Four-chamber view including pulmonary veins
- Left ventricular outflow tract
- Right ventricular outflow tract
- Branch pulmonary artery bifurcation
- Three-vessel view (including view with PA bifurcation and more superior view with ductal arch)
- Short-axis views ("low" for ventricles, "high" for outflow tracts)
- Long-axis view (if clinically relevant)
- Aortic arch
- Ductal arch
- Superior (SVC) and inferior vena cava (IVC)

Fetal Echocardiography

Color Doppler (Required)

- Systemic veins (including superior and inferior vena cava and ductus venosus)
- Pulmonary veins (at least two, one right vein and one left vein)
- Atrial septum and foramen ovale
- Atrioventricular valves
- Ventricular septum
- Semilunar valves
- Ductal arch
- Aortic arch

Fetal Echocardiography

Pulsed-Wave Doppler (Required)

- Right and left atrioventricular valves
- Right and left semilunar valves
- Pulmonary veins (at least two; one right vein and one left vein)
- Ductus venosus
- Suspected structural or flow abnormality on color Doppler sonography

Fetal Echocardiography

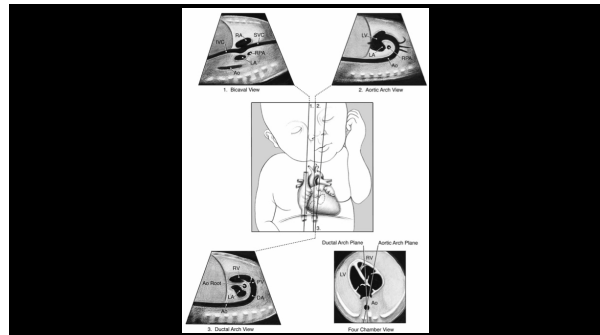
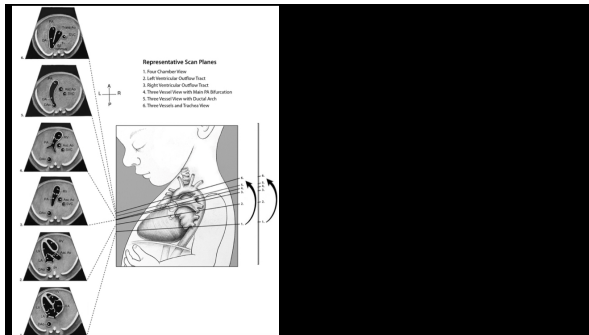
Cardiac Biometry (Required)

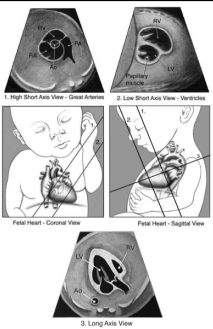
- Aortic and pulmonary valve annulus in systole (absolute size with comparison of left- to right-sided valves)
- Tricuspid and mitral valve annulus in diastole (absolute size with comparison of left- to right-sided valves)

Fetal Echocardiography

Motion Video Clips (Required)

- Axial sweep from stomach to upper mediastinum, to include 4 chamber view, arterial outflow tracts, as well as the 3 vessels and trachea view
- 4 chamber view; 2D and color Doppler ultrasound
- LVOT view; 2D and color Doppler ultrasound
- RVOT view; 2D and color Doppler ultrasound
- 3 vessels and trachea view; 2D and color Doppler ultrasound
- Short axis views (high and low); 2D and color Doppler ultrasound (*if clinically relevant*)
- Sagittal view of the aortic and ductal arches; 2D and color Doppler ultrasound





Notes 

FETAL ECHOCARDIOGRAPHY: How to OPTIMIZE THE ULTRASOUND EXAMINATION

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Fetal Echocardiography: How to Optimize the Ultrasound Examination

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Outline

- 2D Optimization
- Color Optimization
- Tips for the "challenging patient"

2D Image Optimization

Keys to better fetal imaging:

- Transducer Frequency
- Transducer Pressure
- Position on maternal abdomen
- Optimal fetal position
- System optimization

Transducer selection

Low Frequency (1-5 MHz)

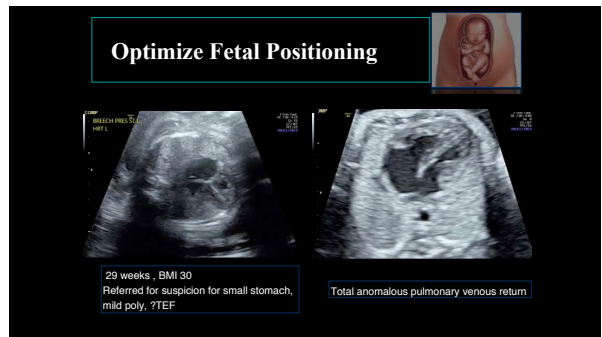
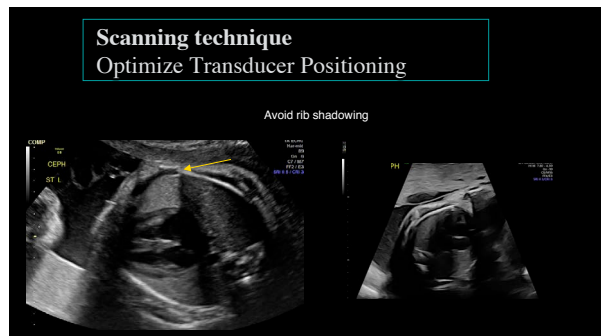
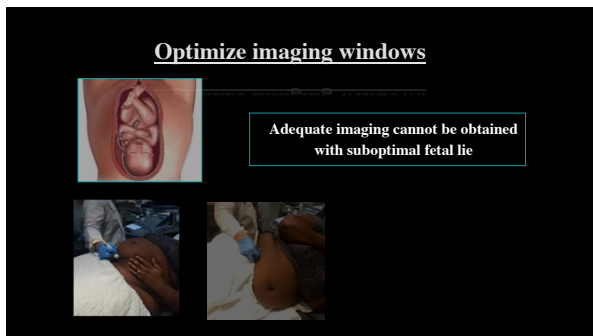
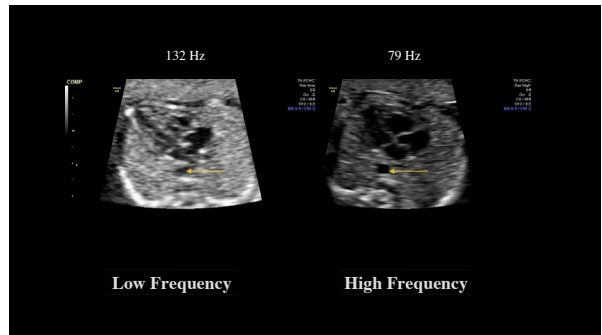
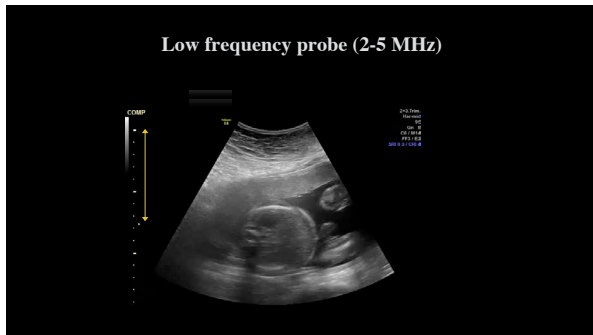
- Lower resolution
- Better Penetration
- Higher frame rates

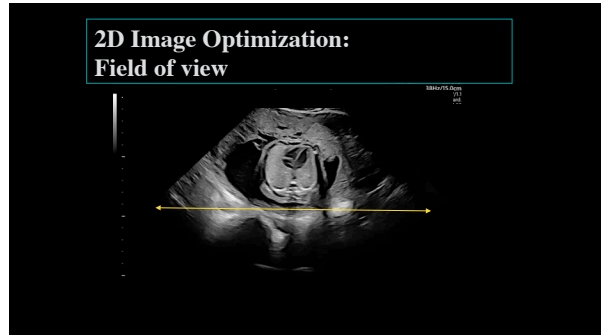
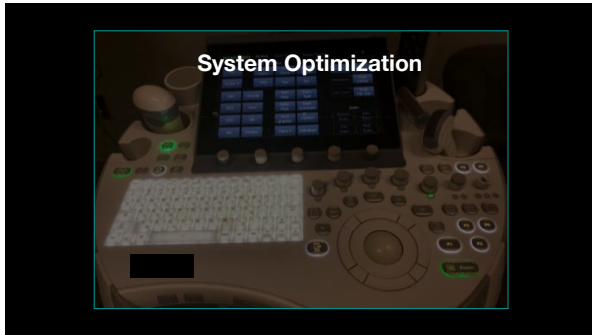
High Frequency (5-8 MHz)

- Better resolution
- Less Penetration
- Lower frame rates

Use the highest frequency possible that gives adequate penetration

Highest frequency probe (5-9 MHz)

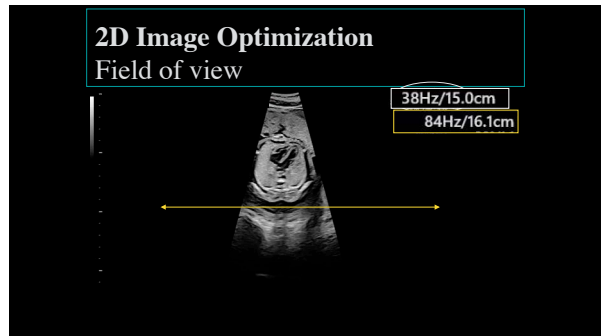




2D System Optimization: Field of View (FOV)

- Field of View
- Depth
- Zoom
- Focal Zone
- Harmonics
- Dynamic range

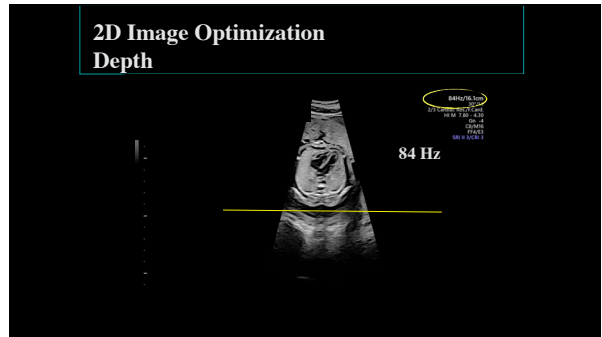
- Width of the beam
- Decreasing FOV improves resolution and frame rate
- Frame rate of 20- 25 frames/sec is perceived as "real time" to the human eye
- Hertz (Hz) = number of frames per second

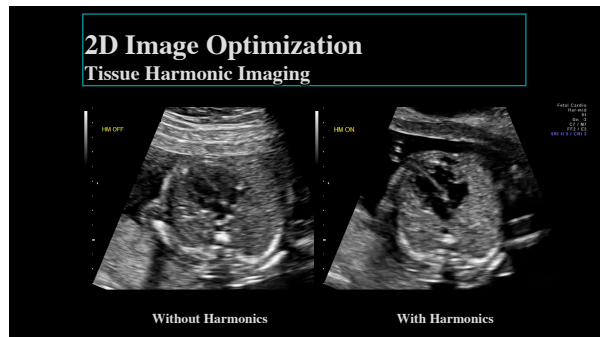
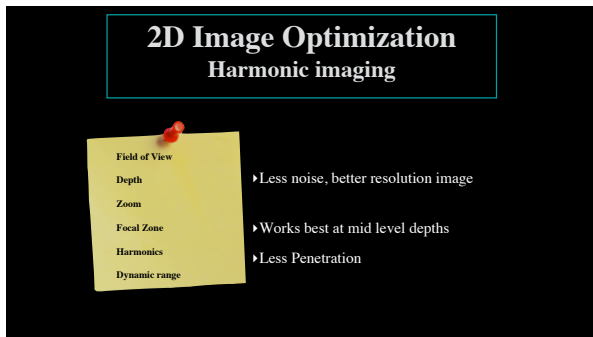
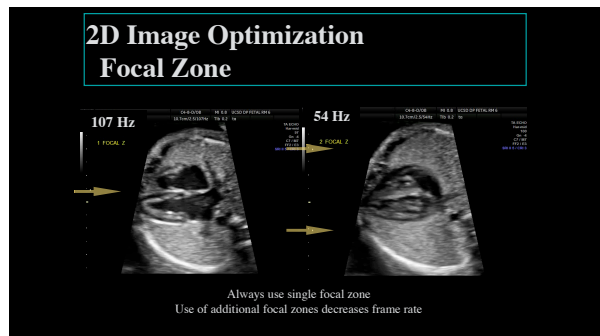
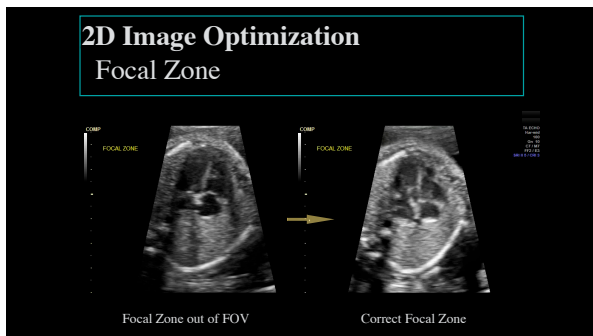
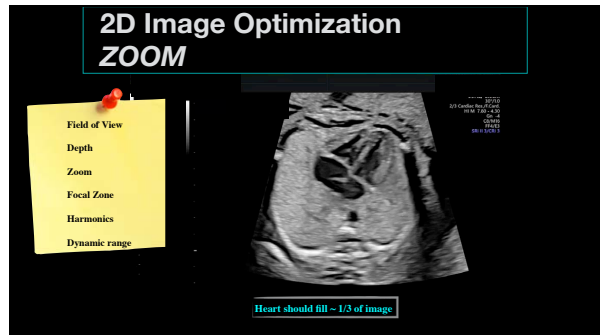
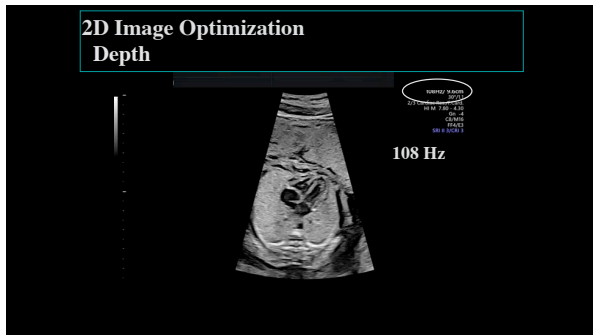


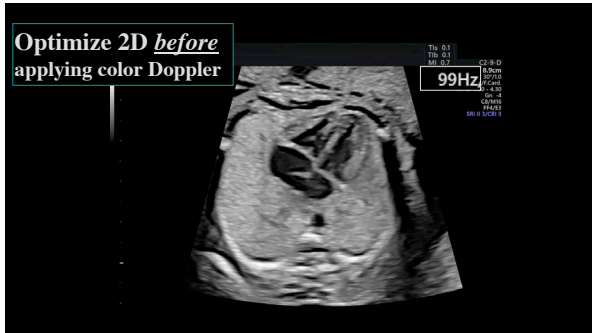
2D Image Optimization: Depth

- Field of View
- Depth
- Zoom
- Focal Zone
- Harmonics
- Dynamic range

- Directly related to frame rate
- Decreasing imaging depth improves frame rate





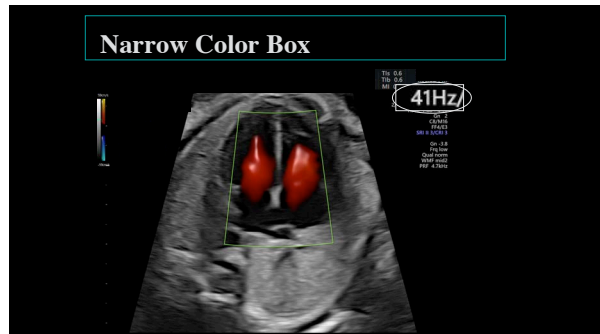


Color Doppler: Box Size

Using color Doppler significantly decreases frame rate

Color box size should be set as small as possible over the area of interest to optimize frame rate

- Box size
- PRF
- Gain
- Wall motion filter
- Balance



Velocity Scale (PRF)

Acts like a filter, concentrating on range of velocities selected

If setting is too low, color aliasing will occur- can lead to incorrect diagnosis of pathology

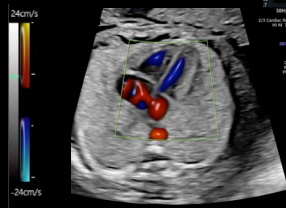
If setting is too high, color may not be displayed

- Box size
- PRF
- Gain
- Wall motion filter
- Balance

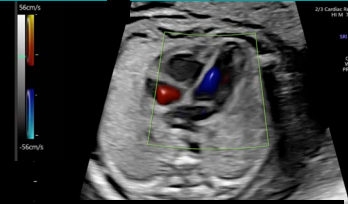
Color Doppler Imaging Velocity Scale (PRF)

High PRF (60-80cm/sec)	VS	Low PRF (~30 cm/sec)
Atrioventricular valves		Pulmonary veins
Semilunar valves		IVC/SVC
3VV/3VT		Assessment of the atrial or ventricular septum

**Incorrect Low PRF setting:
AV valves**

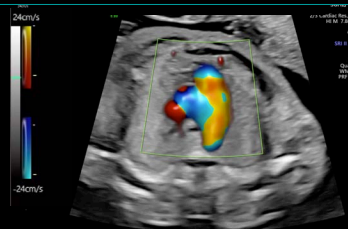


**Correction:
Increased PRF/velocity scale**

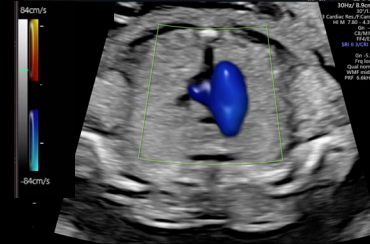


* PRF was increased from 30 cm/s (2.4 kHz) to 56 cm/s (5.0kHz)

**Incorrect Low PRF setting:
3VT**



**Correction:
Increased PRF/velocity scale**

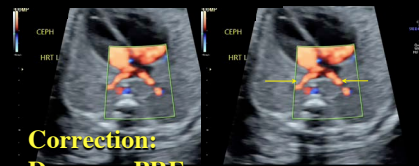


**Incorrect High PRF setting:
Assessment of pulmonary veins**

5.0 kHz
(56 cm/s)

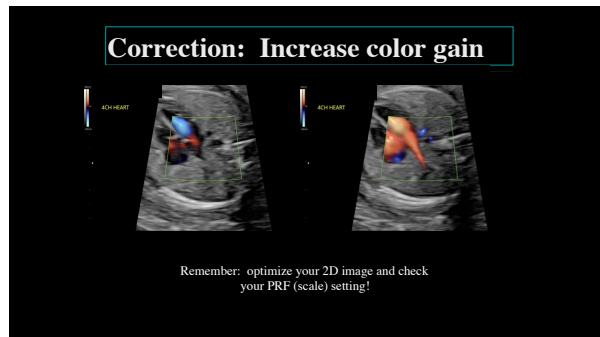
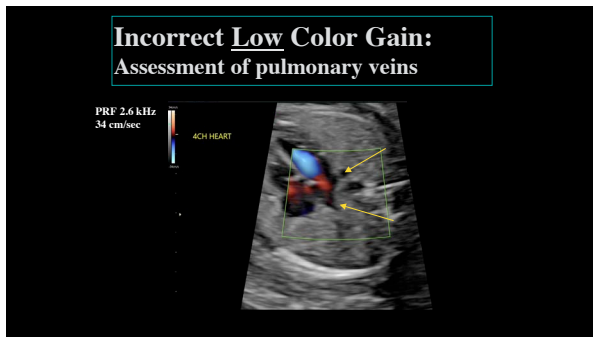
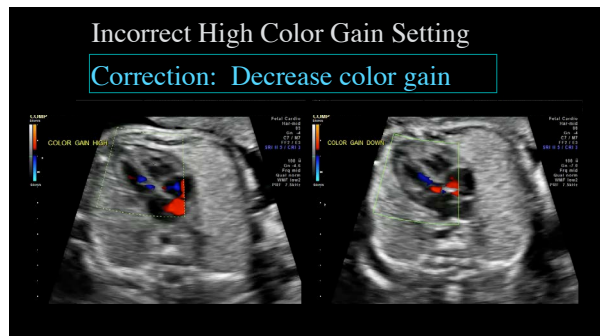
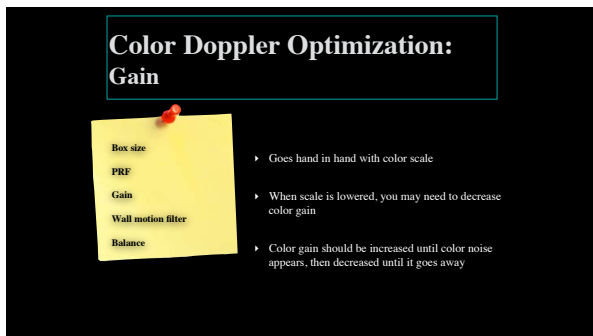
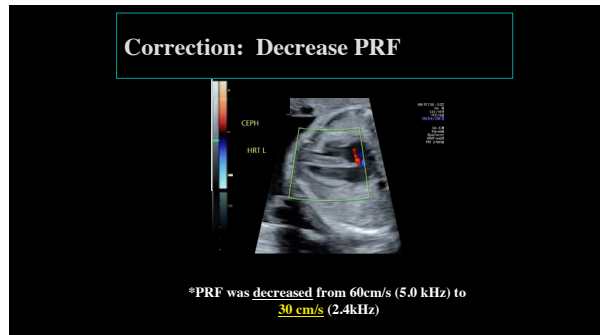
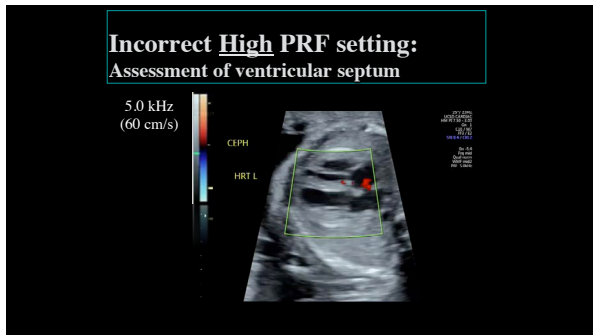


Correction: Decrease PRF



**Correction:
Decrease PRF**

Scale was **decreased** from 56cm/s (5.0 kHz) to **36 cm/s** (3.2kHz)



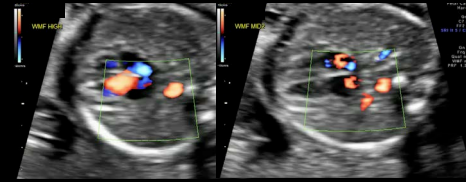
Color Doppler Optimization: Wall Motion Filter

- Box size
- PRF
- Gain
- Wall motion filter
- Balance

- ▶ Allows for elimination of signals from wall motion and other low velocity signals
- ▶ HIGH filter for flow across valves
- ▶ LOW filter for evaluation of veins

Incorrect *high* WMF setting

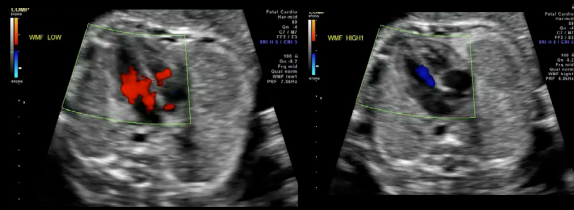
Correction: Decrease WMF



High WMF (scale at 15 cm/sec)

Low WMF

Incorrect: Low WMF Correction: Increase WMF



WMF Low

WMF low (scale at 84 cm/s)

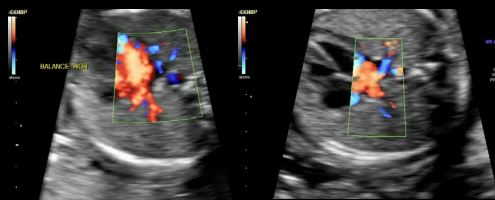
WMF High

Color Doppler Optimization: Balance (Priority)

- Box size
- PRF
- Gain
- Wall motion filter
- Balance

- ▶ Color Doppler is layered over your 2D image
- ▶ Balance function allows you to tell the system how much 2D information you want it to see vs color Doppler

Balance (Priority)



High Balance

Low Balance

Technically difficult imaging

Tips for scanning the obese patient



Increased imaging distance degrades ultrasound imaging resolution

Case 1
GA= 24 wk
BMI = 62

8 cm

8 cm

5 cm

Turn the patient on her side (decrease imaging depth)
Transducer pressure
Optimize, optimize!!
Dynamic range from 7 to 9

Case 2
GA= 22 wk
BMI 63

4 cm

BMI 63

4 cm

6 cm

Technique: Scan at the umbilicus

Scanning technique
Color Doppler in the obese patient

- 2D penetration may be adequate at a higher scanning frequency
- BUT - color penetration may be inadequate
- Transducer technology allows the sonographer to scan at a central frequency and Doppler at a lower frequency

8 cm

8 cm

30cm/s

30cm/s

23 weeks, BMI 50
Very difficult imaging....

8 cm

8 cm

30cm/s

30cm/s

Doppler frequency High

- Query right heart disproportion
- Low frequency transducer used for 2D penetration
- Sonographer lowered scale to try and get color, but that produced aliasing
- Flow (Doppler) frequency was set HIGH so penetration inadequate

Corrections/Adjustments

Flow frequency adjusted to high to LOW
Velocity scale (PRF) increased
Severe tricuspid regurgitation

Color Doppler optimization checklist

Scan in a systematic manner

1. **Color scale** - adjust based off of what you are trying to assess
2. **Gain**- turn it up until the noise appears and back down until it goes away
3. **Wall motion filter** - high for high flow/ low for low flow
4. **Balance** (high balance focuses on color, low balance for more grey scale)
5. Make sure your **color penetration** is adequate!!

Conclusions

How to Improve Imaging:

- Practice!
- Be Systematic
- Be Familiar with system controls
- Improvement comes with dedication
- Continued education
- Remember: Not just a pretty picture....

SCREENING FOR CARDIAC MALFORMATIONS IN THE FIRST & SECOND TRIMESTERS OF PREGNANCY

Elena Sinkovskaya, M.D., Ph.D.
Associate Professor of Obstetrics and Gynecology
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Division of Maternal-Fetal Medicine
Eastern Virginia Medical School
Norfolk, VA

SCREENING FOR CARDIAC ANOMALIES IN THE FIRST AND SECOND TRIMESTER OF PREGNANCY

Elena Sinkovskaya MD, PhD
Division of Maternal-Fetal Medicine

DEMOGRAPHICS OF CONGENITAL HEART DISEASE (CHD)



CHD are **the most common** congenital malformations, affecting **8-9 per 1,000** live birth and even higher percentage of fetuses



There are **~ 1000000** people alive with CHD today in USA. Incidence extrapolations for USA for CHD:

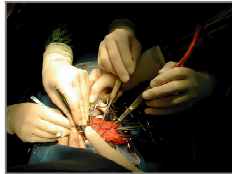
- **33,333** per year
- **2,777** per month
- **641** per week
- **91** per day
- **3** per hour

AHA, 2003

DEMOGRAPHICS OF CONGENITAL HEART DISEASE



More than **50%** of CHD requires open heart surgery performed during **first year of life** and sometimes urgent interventions during **first hours** after birth



38,000 hospitalizations a year in USA related to CHD

CHD results in **the most costly** hospital admissions for birth defects in the United States

AHA, 2003

Impact of prenatal diagnosis on outcomes of CHD

- **Improves the survival** of neonates underwent biventricular repair (Copel et al, 1997)
- **Improves the preoperative conditions** of neonates with ductal-dependent lesions (Kumar et al, 1999);
- **Reduces early neurological morbidity** in neonates with HLHS (Mahle et al, 2001)

SCREENING FOR CONGENITAL HEART DISEASE

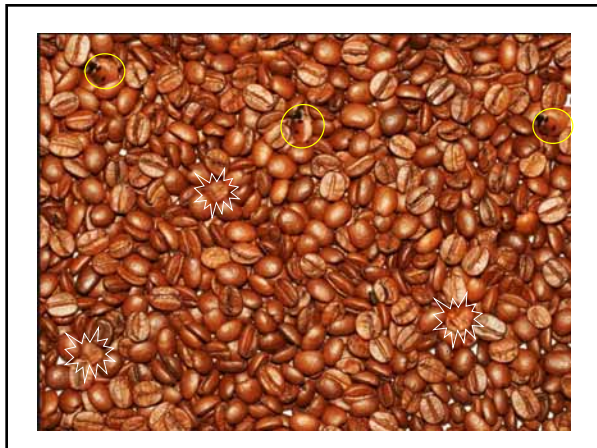
Risk Factors For Congenital Heart Disease


- Family history of congenital heart disease
- Maternal metabolic disorders (diabetes, phenylketonuria)
- Maternal teratogen exposure (drug related)
- Pregnancy of assisted reproduction
- Maternal obesity

Only 10% of CHD in the fetus occurs in high-risk pregnancies;
Routine screening of all pregnancies is necessary

Screening







PRACTICE GUIDELINES

AIUM-ACR-ACOG-SMFM-SRU
Practice Parameter for the
Performance of Standard Diagnostic
Obstetric Ultrasound Examinations



ii. Chest:
 Heart⁹⁴
 Four-chamber view, heart size, and position;
 Left ventricular outflow tract;
 Right ventricular outflow tract; and
 Three-vessel view and 3-vessel trachea view, if technically feasible.⁵¹⁻⁵⁶

Ultrasound Obstet Gynecol 2013; 41: 348-359
 Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/ulog.12403


GUIDELINES

ISUOG Practice Guidelines (updated): sonographic screening examination of the fetal heart


Screening examination of the fetal heart:
IMPORTANCE of the CHECK LIST

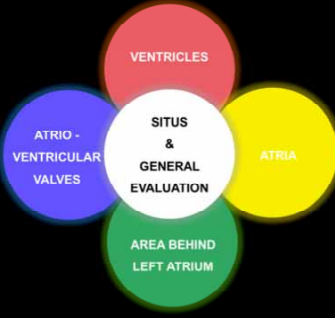



Situs and general aspects


- Fetal laterality (identify right and left sides of fetus)
- Stomach and heart on left
- Heart occupies a third of thoracic area
- Majority of heart in left chest
- Cardiac axis (apex) points to left by 45° ± 20°
- Four chambers present
- Regular cardiac rhythm
- No pericardial effusion
- Atrial chambers
 - Two atria, approximately equal in size
 - Foramen ovale flap in left atrium
 - Atrial septum primum present (near to crux)
 - Pulmonary veins entering left atrium
- Ventricular chambers
 - Two ventricles, approximately equal in size
 - No ventricular wall hypertrophy
 - Moderator band at right ventricular apex
 - Ventricular septum intact (apex to crux)
 - Atrioventricular junction and valves
- Intact cardiac crux
 - Two atrioventricular valves open and move freely
 - Differential offsetting: tricuspid valve leaflet inserts on ventricular septum closer to cardiac apex than does mitral valve

Evaluation of the 4-chamber view
5 Critical Regions



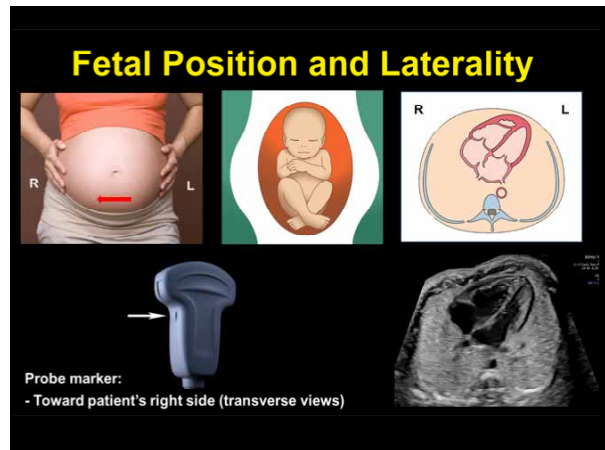
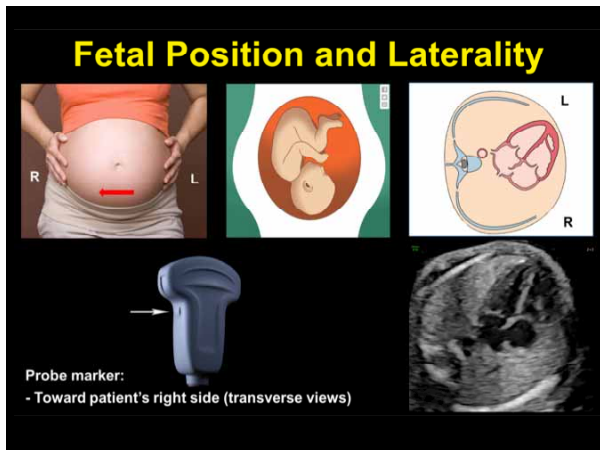


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GUIDELINES

ISUOG Practice Guidelines (updated): sonographic screening examination of the fetal heart

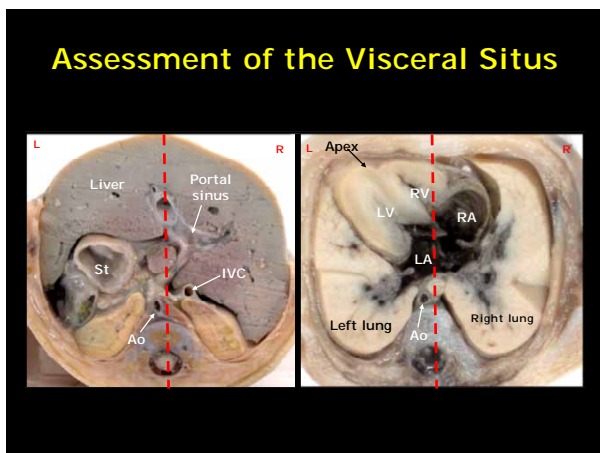
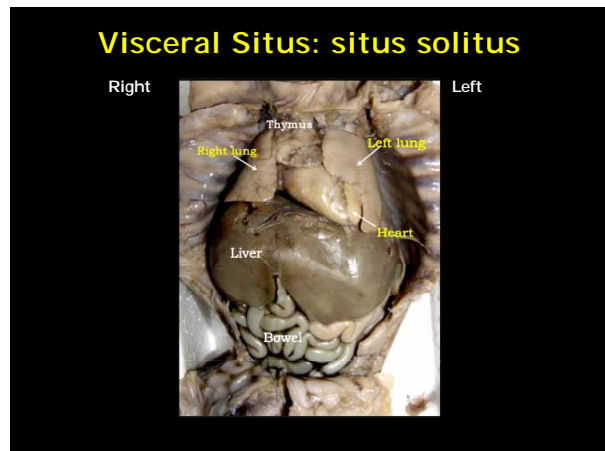
“To assess situs, it is necessary that fetal laterality i.e. identification of fetal right and left sides, be determined first, prior to ascertaining that both stomach and heart are on the left side of the fetus”.



Evaluation of the 4-chamber view

- Normal situs
- Normal cardiac position
- Normal cardiac size
- Normal cardiac axis
- Normal cardiac rhythm
- No evidence of pericardial/pleural effusion
- Four chambers present
- No evidence of cardiac masses

**SITUS
&
GENERAL
EVALUATION**



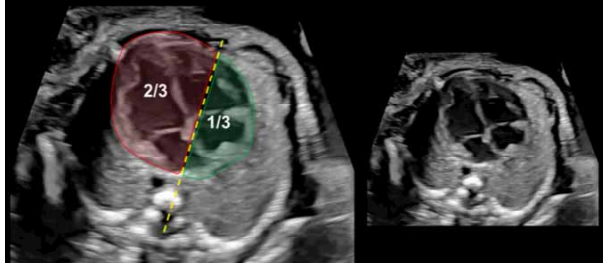
Assessment of the Visceral Situs

Normal or Abnormal?



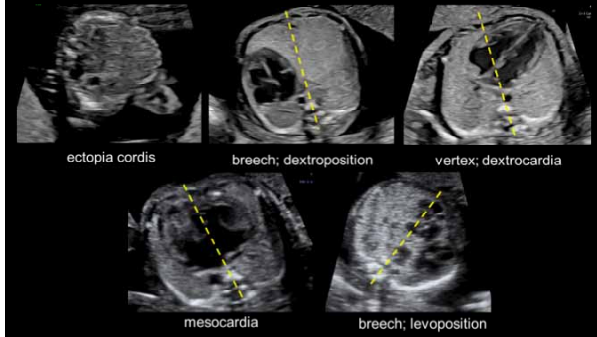
breech presentation

Normal Cardiac Position



Majority of the heart is located in the left chest

Abnormal Cardiac Position



ectopia cordis

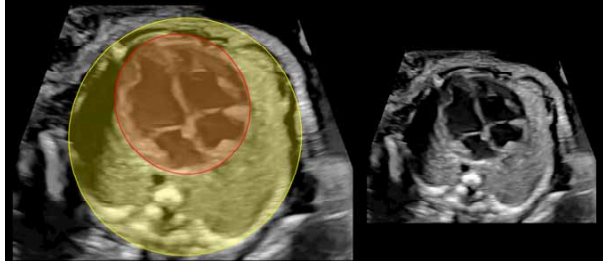
breech; dextroposition

vertex; dextrocardia

mesocardia

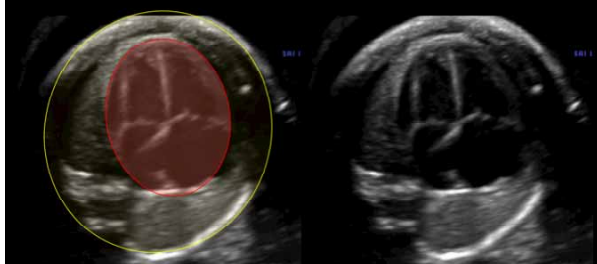
breech; levoposition

Normal Cardiac Size



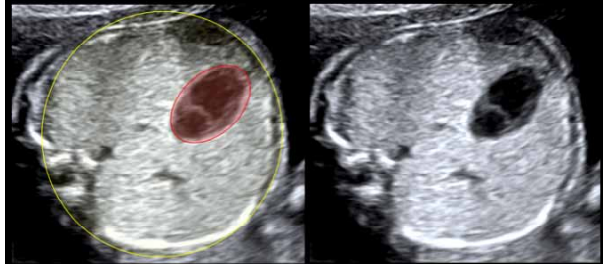
The heart occupies 1/3 of thoracic area

Abnormal Cardiac Size

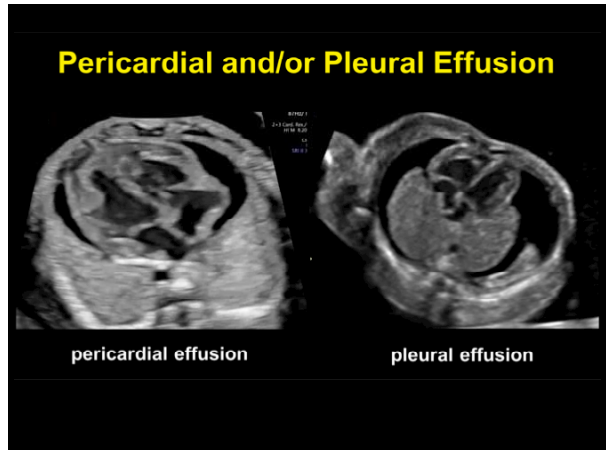
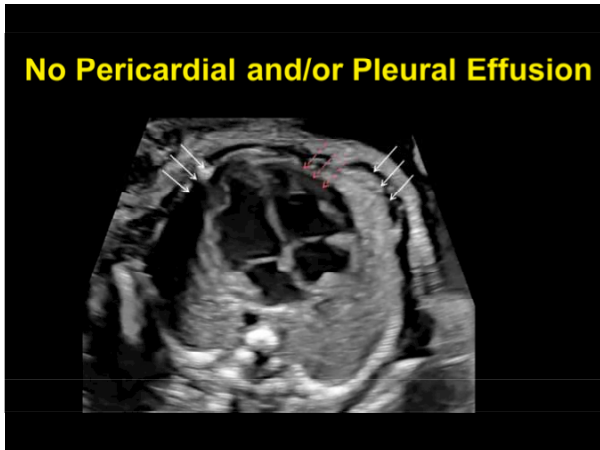
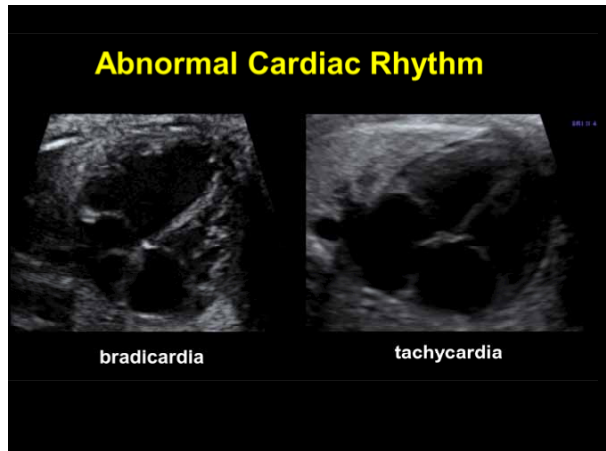
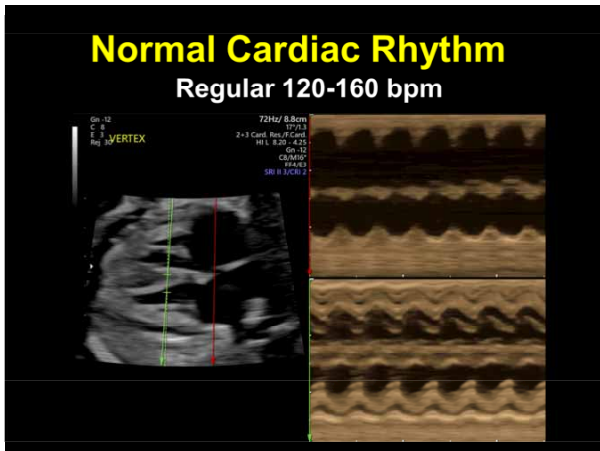
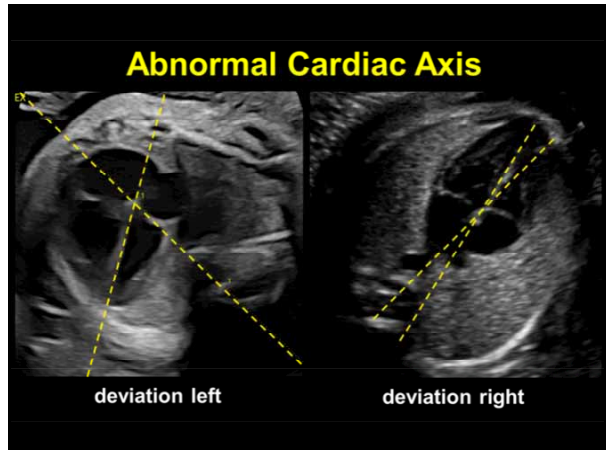
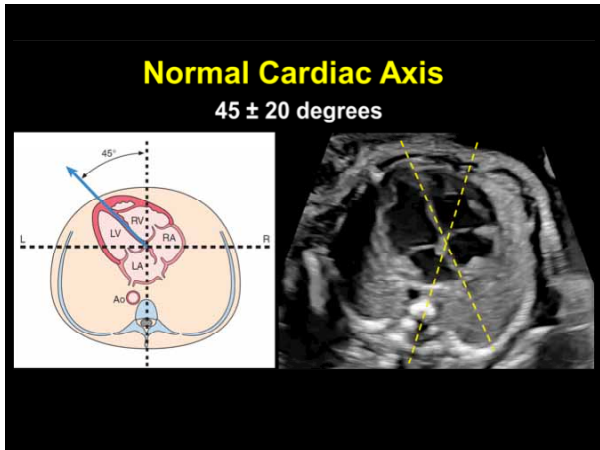


cardiomegaly

Abnormal Cardiac Size



cardiac compression



Cardiac Masses



pericardial teratoma



rhabdomyoma

Four Chambers Present



4 chambers



?? chambers

Evaluation of the 4-chamber view

- Two ventricles present
- Approximately equal in size
- Moderator band seen in the RV
- Myocardium is normal in appearance
- Normal contractility
- No evidence of septal bowing
- Interventricular septum is intact

VENTRICLES

Two ventricles present

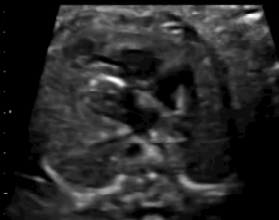


2 ventricles

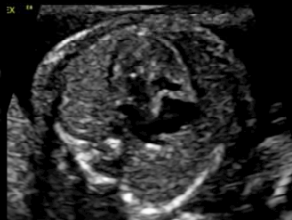


1 ventricle

Two ventricles equal in size

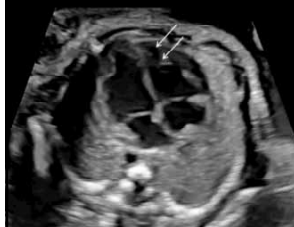


LV < RV in size



LV > RV in size

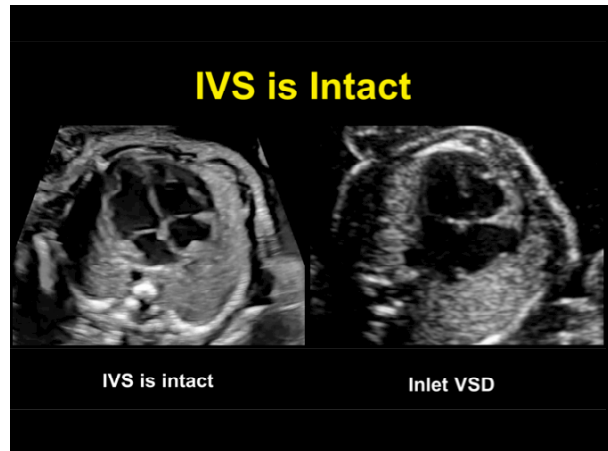
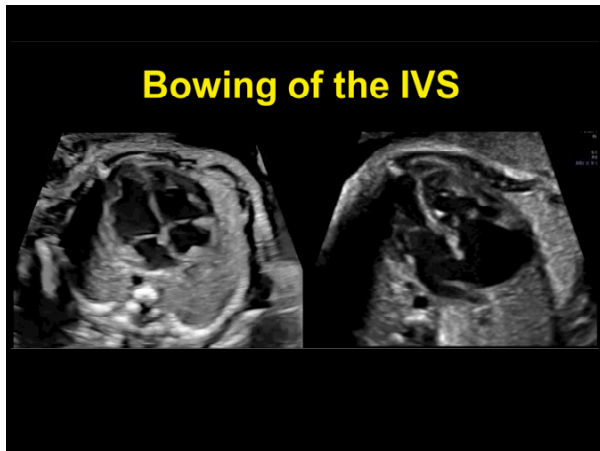
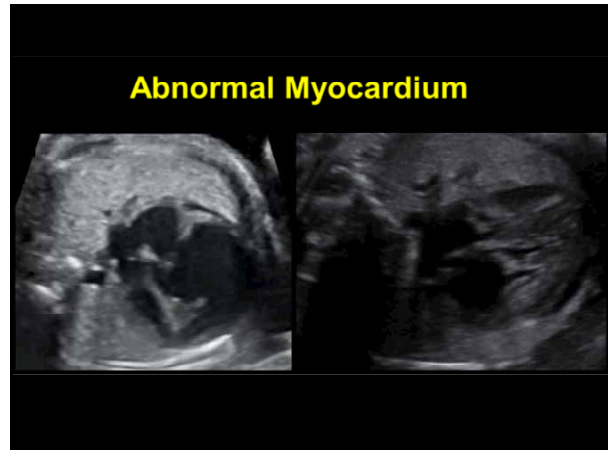
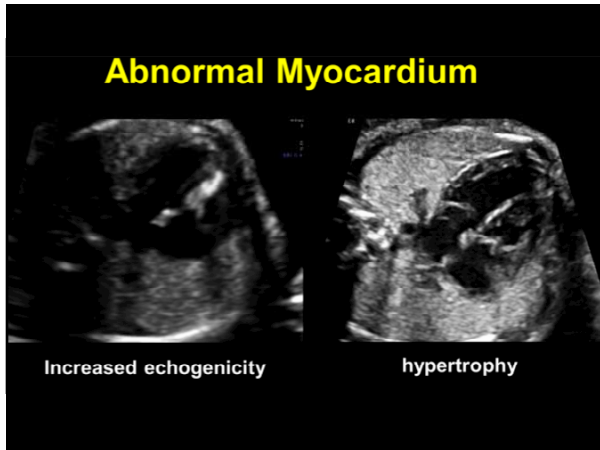
Moderator Band



Seen in the RV



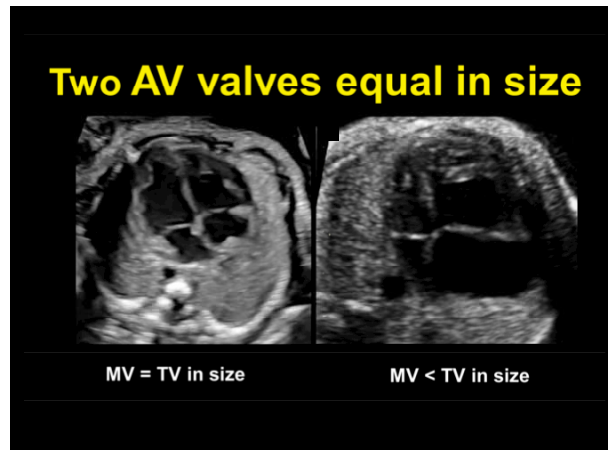
Seen in the RV?



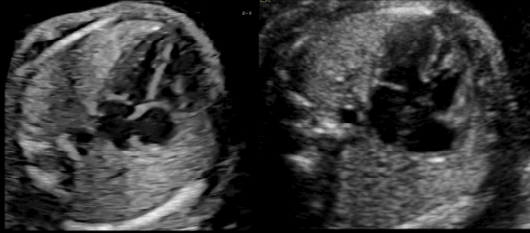
Evaluation of the 4-chamber view

- Two separate AV valve annuli are present
- Orifices approximately equal in size
- TV placed more apically
- Leaflets normal in appearance
- Leaflets move freely
- Crux of the heart is intact

ATRIO-
VENTRICULAR
VALVES



Two AV valves equal in size



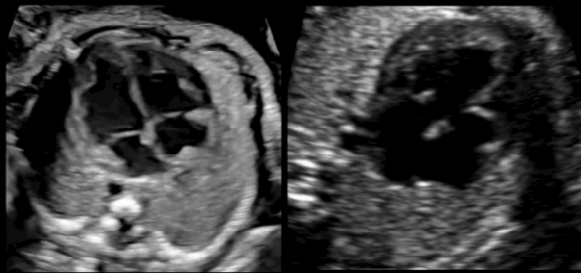
MV = TV in size

common valve

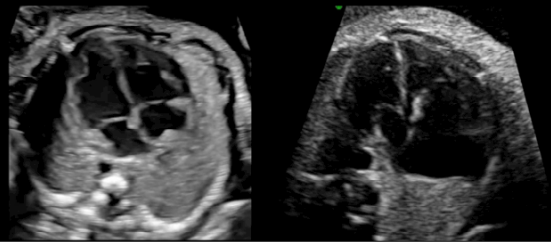
Two AV valves moving



TV placed more apically



Leaflets are Normal



Evaluation of the 4-chamber view

- Two atria present
- Approximately equal in size
- Foramen ovale flap in the LA
- Septum primum is intact
- Pulmonary veins seen entering LA



Two atria equal in size



LA = RA in size

common atrium

Two atria equal in size

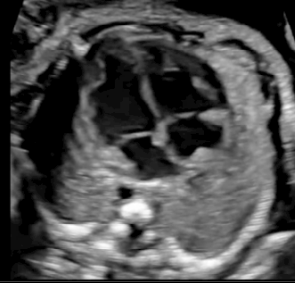


LA = RA in size

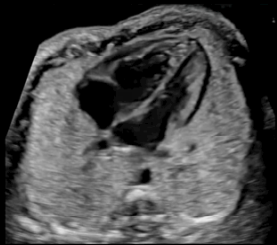


LA < RA in size

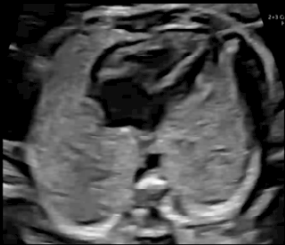
Foramen Ovale



Septum Primum is Intact



Intact crux



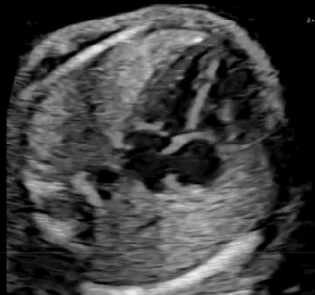
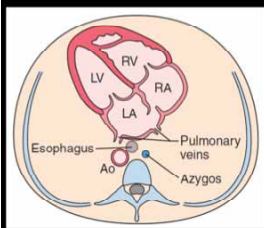
ASD

Evaluation of the 4-chamber view

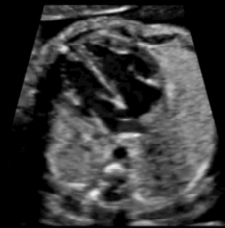
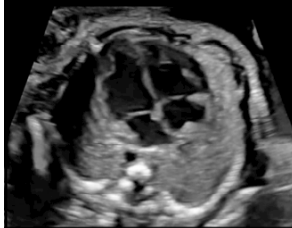
- Descending Ao is in the left chest
- No additional structures between Ao and LA
- Narrow distance between Ao and LA
- If v. Azygos seen it should be 1/3 of the aortic diameter

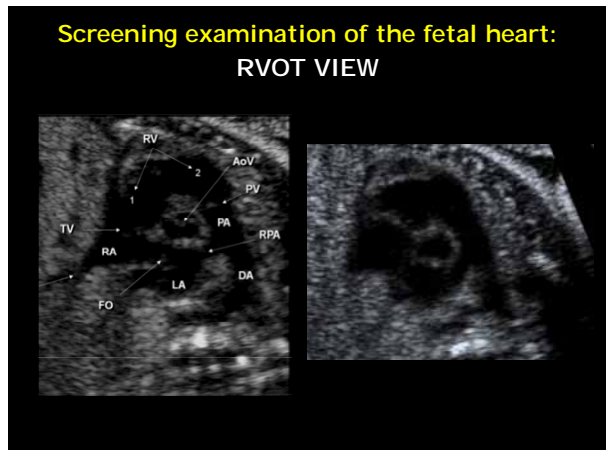
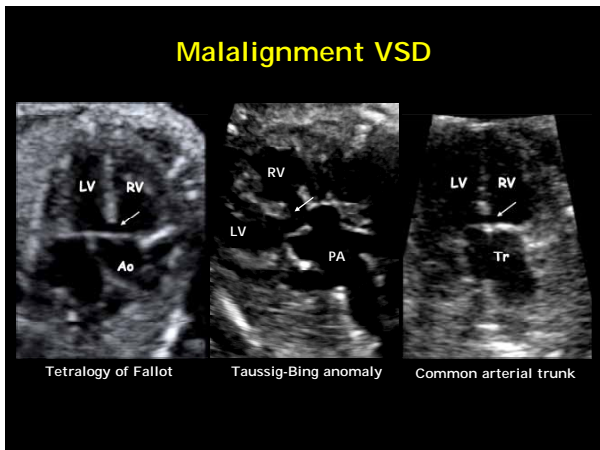
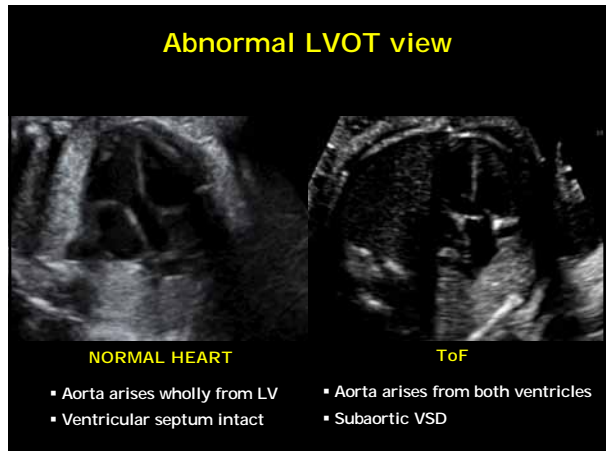
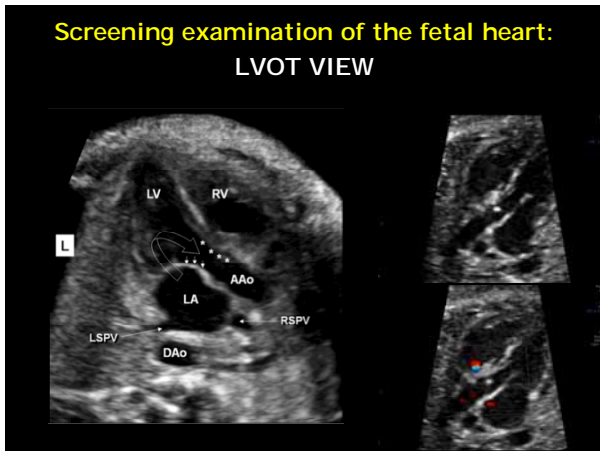
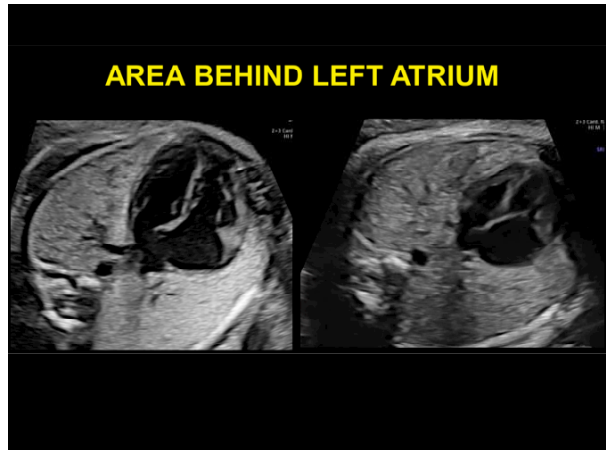
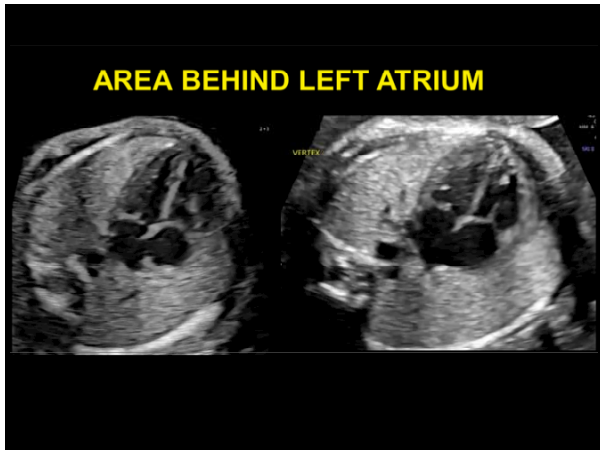
AREA BEHIND
LEFT ATRIUM

AREA BEHIND LEFT ATRIUM



AREA BEHIND LEFT ATRIUM





Abnormal RVOT view



NORMAL HEART

PA normal in size
PV opens and closes freely

ToF

PA is small
Stenosis of PV and/or RVOT

Ultrasound Obstet Gynecol 2013; 41: 348-359
Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/ouq.12403



isuog.org

GUIDELINES

ISUOG Practice Guidelines (updated): sonographic screening examination of the fetal heart

- visualization of the three-vessel view (3VV) and three-vessels-trachea view (3VTV) is desirable and should be attempted as part of the routine cardiac screening
- use of color Doppler is optional but becoming familiar with its use and adding it to routine screening is encouraged.

Why three-vessel-trachea view ?

Allows evaluation of the following anatomic regions:

Relationship of the great arteries

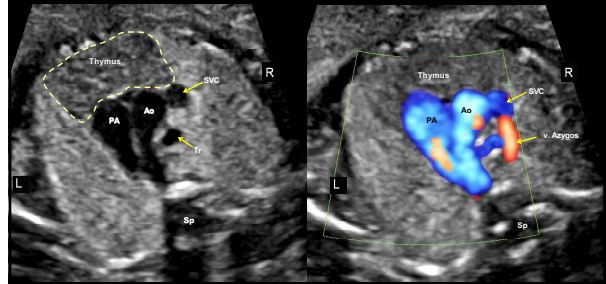
Aortic isthmus

Ductus arteriosus

Venous return

Thymus

Three-vessel-trachea view



How to read three-vessel-trachea view ?

Assessment of anatomic components of the 3VTV should include analysis of:

Number of vessels

Size of vessels

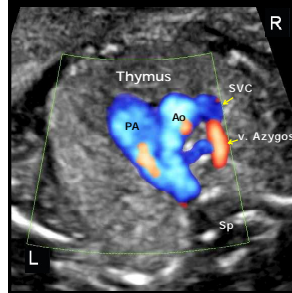
Alignment of vessels

Arrangement of vessels

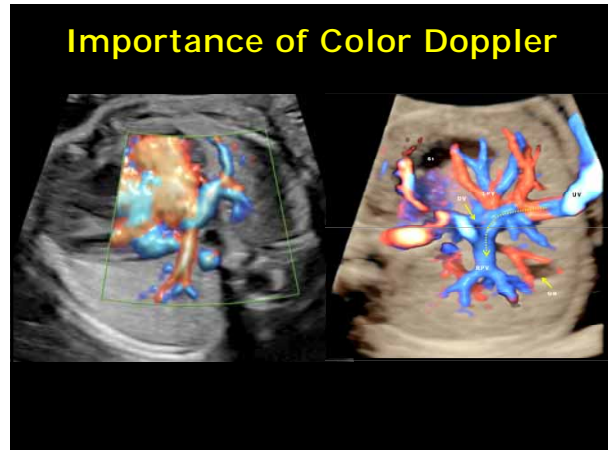
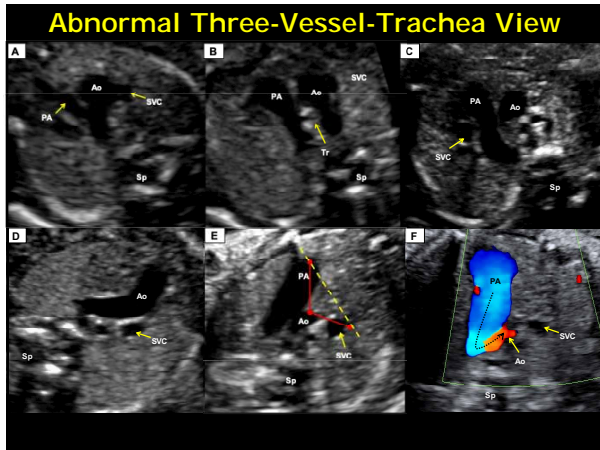
Relation to the trachea

Pattern of blood flow

Normal Three-Vessel-Trachea View

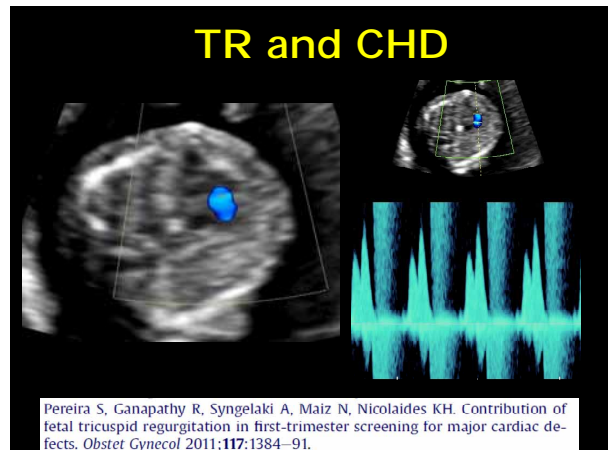
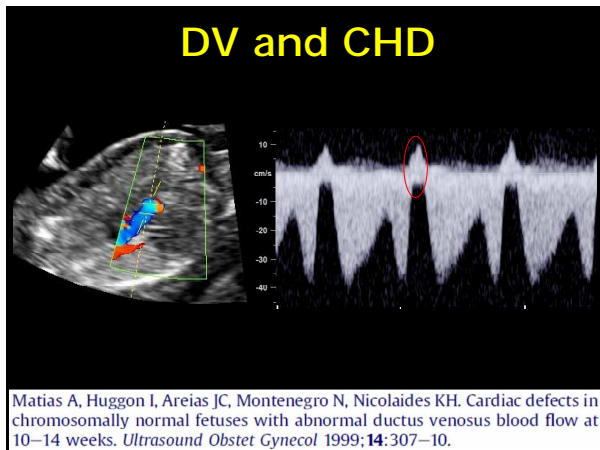
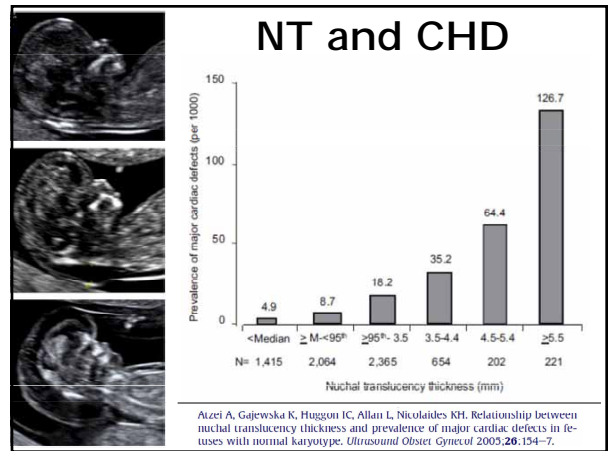


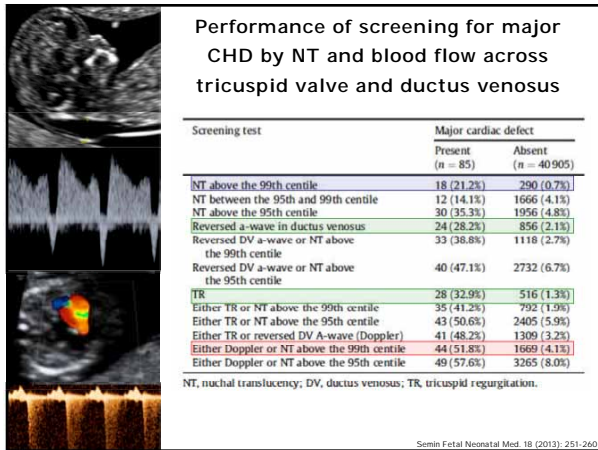
1. Number of vessels: three
 - ductal arch:
 - aortic arch:
 - superior vena cava
2. Vessel size: DA > AoA > SVC;
3. Vessels aligned along oblique line: DA is most anterior, SVC is most posterior;
4. Vessels arrangement from left to the right: DA, AoA, SVC
5. Both arches are on the left to the trachea
6. The confluence of the ductal and aortic arches with the same direction of the blood flow - "V shape"



Nuchal translucency (NT)

- > Fetus in mid-sagittal plane
- > Fetal head & neck region occupies majority of image
- > Fetal head in neutral position
- > Fetus observed away from amnion
- > Margins of NT edges clear
- > (+) calipers used
- > Horizontal crossbars placed correctly
- > Calipers placed \perp to long axis of fetus
- > Measurement at widest NT space

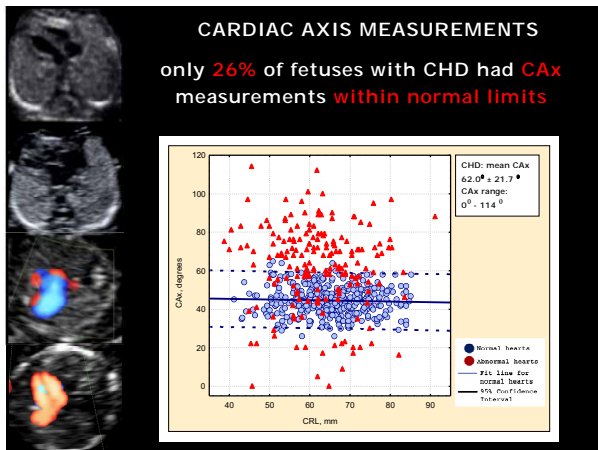
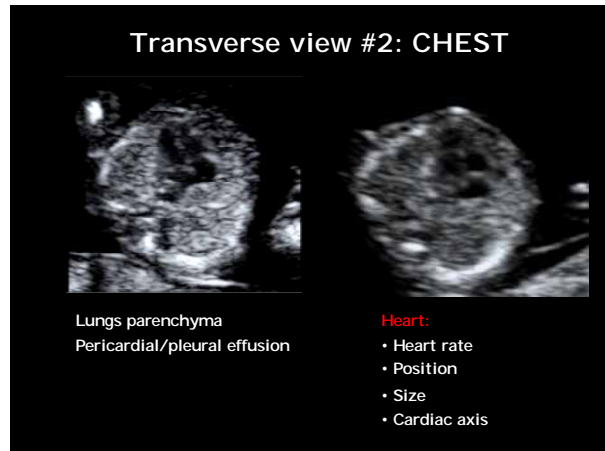
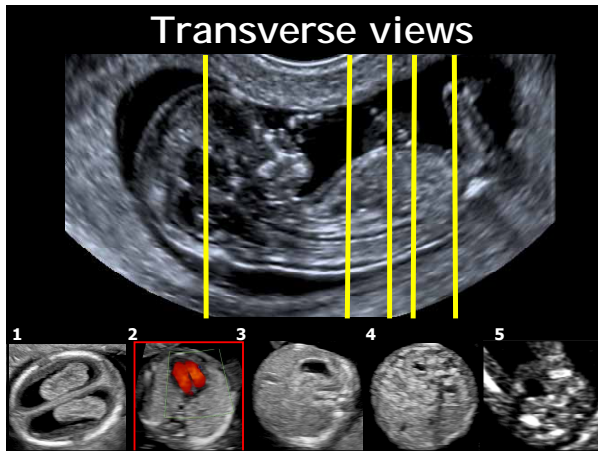




First Trimester Ultrasound Protocol

Ultrasound Obstet Gynecol 2013; 41: 102-113
Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/uog.12342

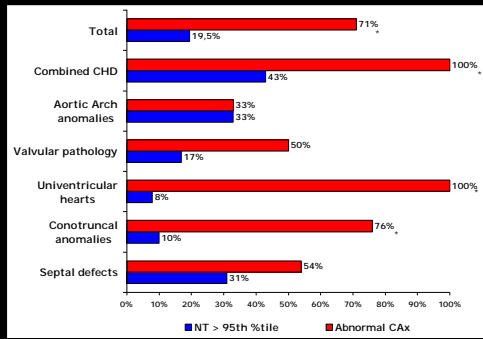
ISUOG Practice Guidelines: performance of first-trimester fetal ultrasound scan



CARDIAC AXIS ABNORMALITIES (74%)

LEFT DEVIATION	RIGHT DEVIATION	NON-IDENTIFIABLE
above 97.5th percentile equal or greater 60°	below 2.5th percentile less than 30°	absent/non-visualized interventricular septum
110/197 cases	19/197 cases	17/197 cases
55.8%	9.6%	8.6%

Prevalence of enlarged NT and abnormal cardiac axis in fetuses with CHD and normal karyotype (N=78)



* - significant difference; p<0.01

Discrepancy in Size

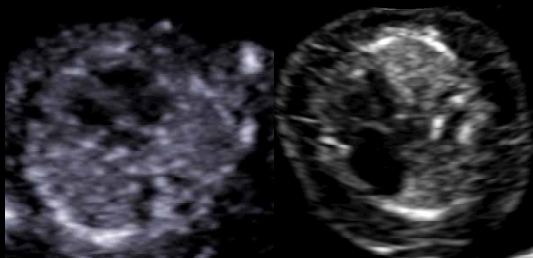
small left heart vs. small right heart



Normal CAX, CoAo, 13+3 weeks

Small CAX, HRHS, 12+4 weeks

CARDIAC SIZE

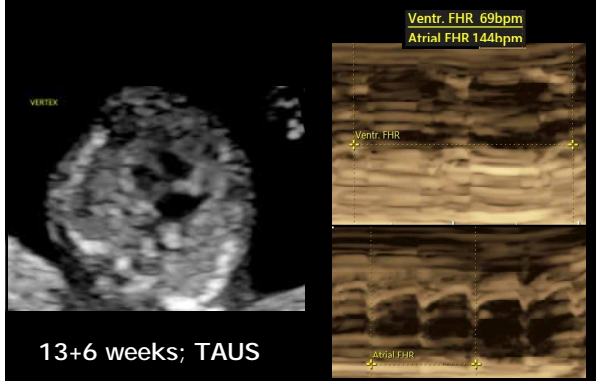


What is wrong?



13+6 weeks; TAUS

Heart Rate: Bradycardia



Prenatal Detection of Congenital Heart Defects at the 11- to 13-Week Scan Using a Simple Color Doppler Protocol Including the 4-Chamber and 3-Vessel and Trachea Views

Marcin Wischer, MD, Anna Knäuper, MD, PhD, Agnieszka Neecon, MD

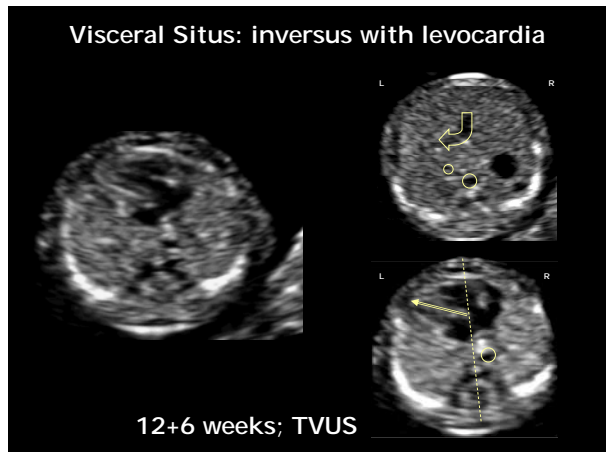
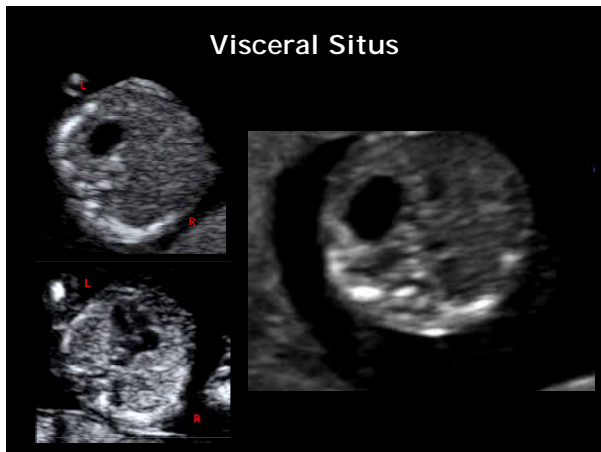
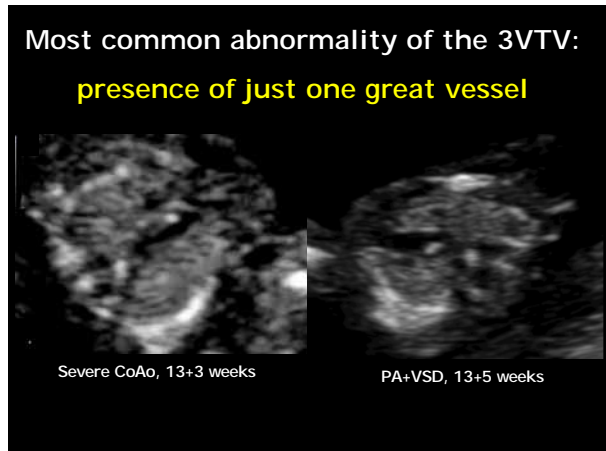
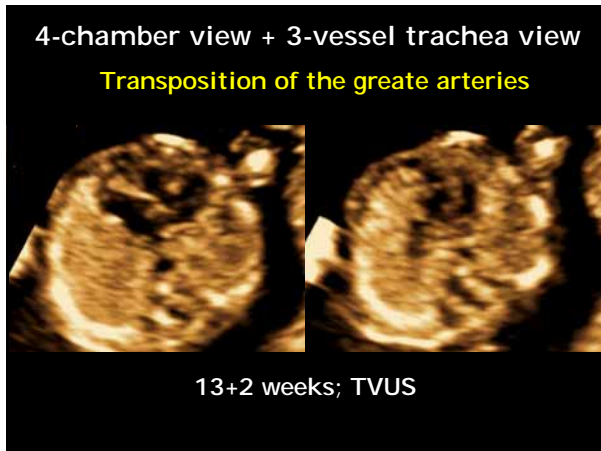
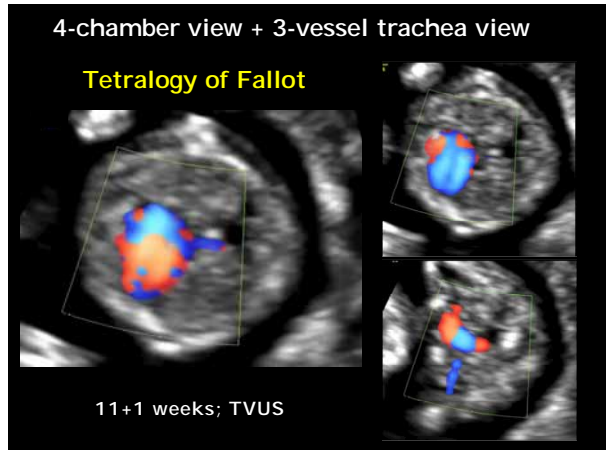
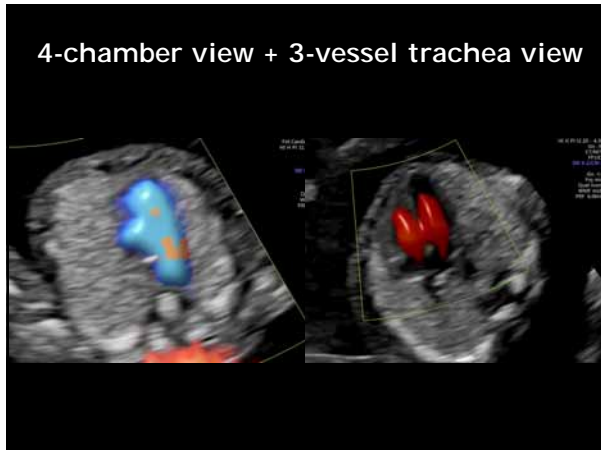
Objective—The first goal of this study was to analyze the diagnostic performance of the 4-chamber view, 3-vessel and trachea view, and their combination in color mapping during early cardiac evaluation for selecting cases suspicious of congenital heart defects. The second goal was to describe the most common abnormal flow patterns at the levels of the 4-chamber and 3-vessel and trachea views in the last first trimester.

Methods—We conducted a prospective observational study in which a simple cardiac sonographic protocol was applied in fetuses at gestational age of 11 weeks to 13 weeks 6 days.

Results—A total of 1084 patients with known postnatal or autopsy findings were included in the study. The median maternal age was 32.3 years (range, 27–60 years). The median crown-rump length was 62.2 mm (range, 55–84 mm). Overall, there were 15 cases with a confirmed congenital heart defect (1.3%), including 10 accompanied by aneuploidy. We found that our simple first-trimester cardiac protocol was an effective screening method for congenital heart defects. The most effective approach of the 3 evaluated by us was the combined application of the 4-chamber and 3-vessel and trachea views in color mapping compared to the 4-chamber and 3-vessel and trachea views alone. We defined the most common ventricular inflow patterns and the V sign. The techniques we used were simple and easy to reproduce.

Conclusions—We concluded that evaluation by two basic cardiac views allows the selection of most cases with a nonventricular heart, atrioventricular septal defect, obstruction of the aorta, pulmonary stenosis, pulmonary atresia, and conotruncal defects.

Key Words—cardiac defects; fetal echocardiography; fetal heart; first trimester; first-trimester screening; obstetric ultrasound

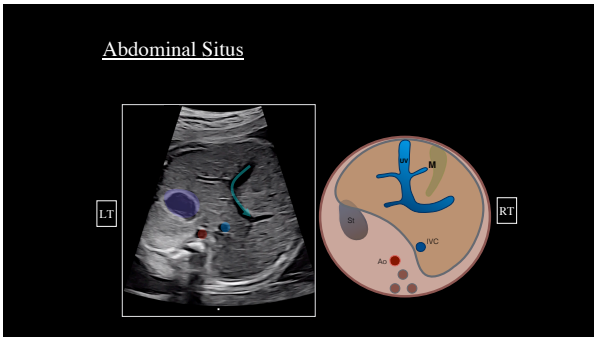
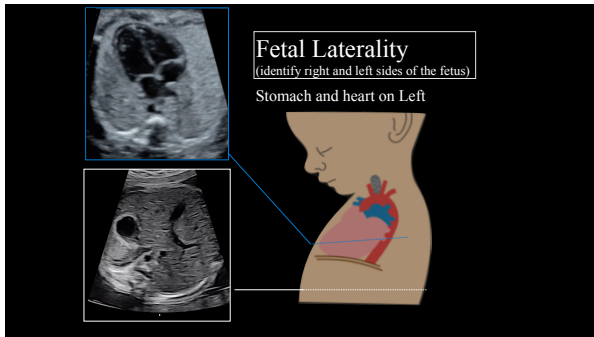
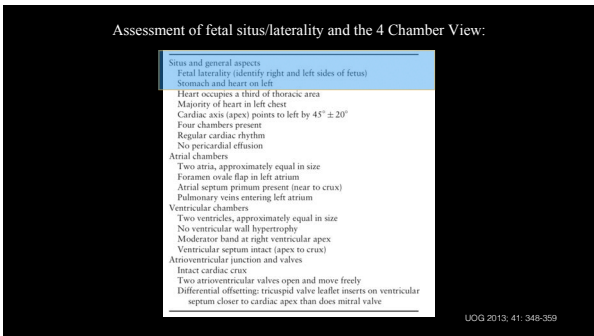
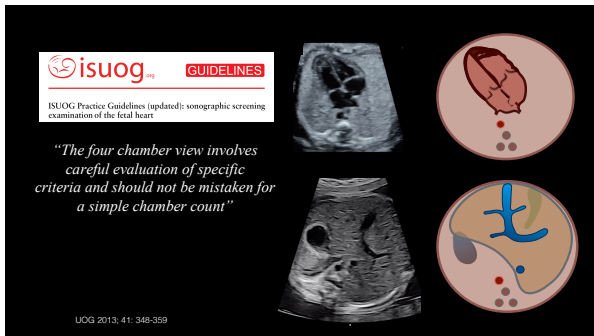
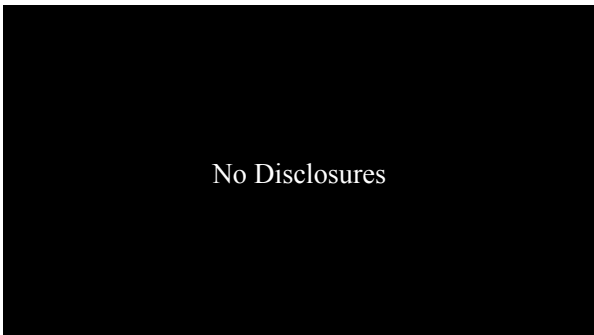
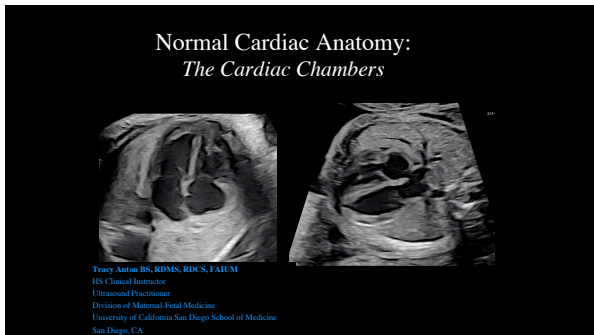


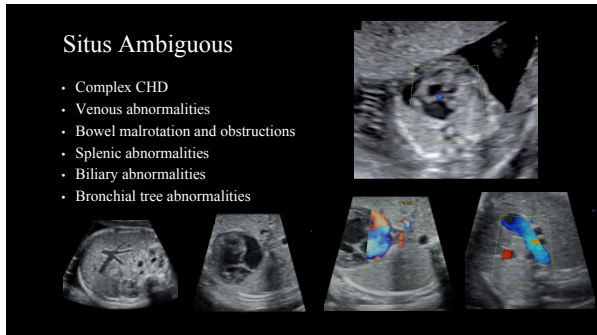
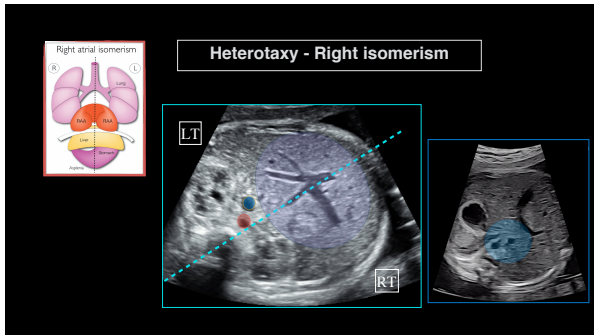
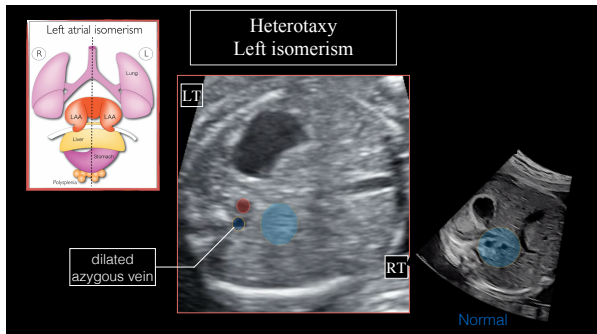
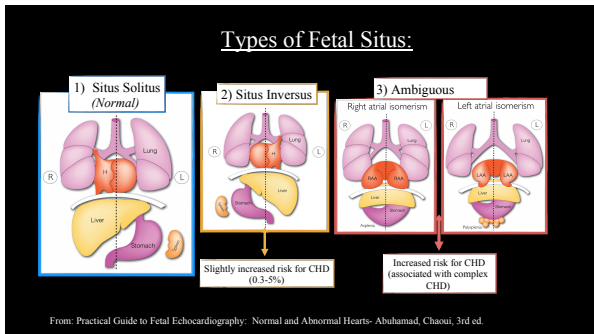
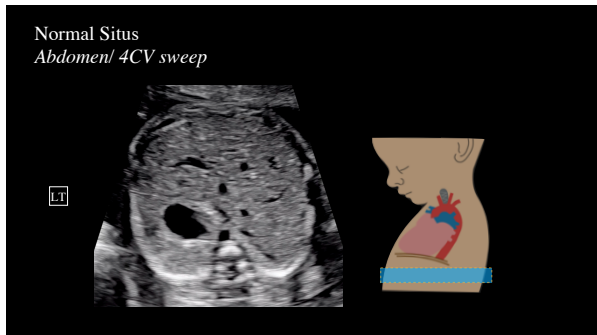
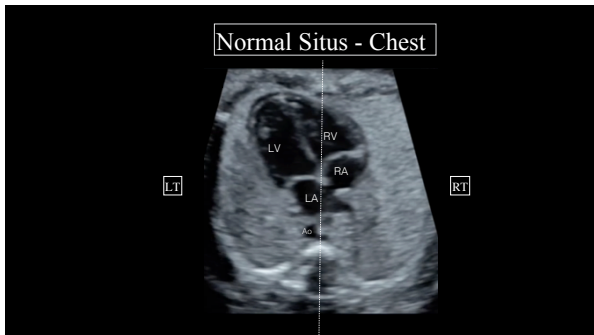
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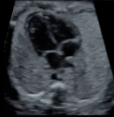
A series of horizontal lines for writing notes, starting below the 'Notes' header and extending to the bottom of the page.

NORMAL CARDIAC ANATOMY: THE CARDIAC CHAMBERS

Tracy L. Anton, BS, RDMS, RDCS, FAIUM
HS Clinical Instructor, Department of Reproductive Medicine
Ultrasound Practitioner
UC San Diego Health System, Maternal -Fetal Care and Genetics
San Diego, CA



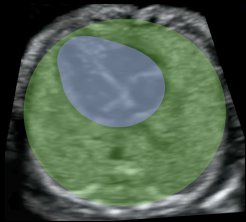




Normal 4 Chamber View

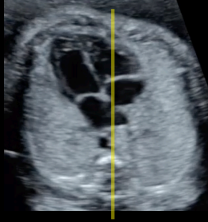
- ✓ Fetal Laterality - identify right and left (stomach and heart on left side of fetus)
- ✓ Heart occupies 1/3 of chest- majority left sided
- ✓ No pericardial effusion
- ✓ Cardiac axis 45 degrees

UOG 2013; 41: 348-359



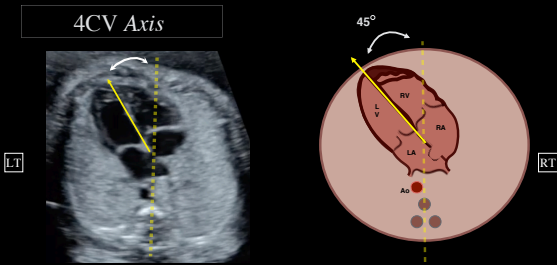
4CV

Heart occupies 1/3 of chest
No pericardial/ pleural effusions



4 CV

- Apex leftward
- Symmetrical lungs
- Majority of heart left sided
- Line dividing the chest goes through RV



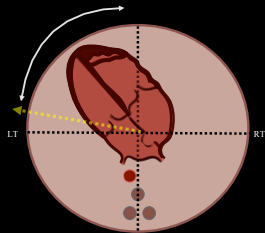
4CV Axis

Axis is leftward, 45 degrees +/- 20 degrees

Left Axis Deviation


Most abnormal axis deviation is leftward

- Associated with CHD
- Tetralogy of Fallot
- Common arterial trunk
- Ebstein's anomaly
- Coarctation of the aorta
- Pulmonic stenosis

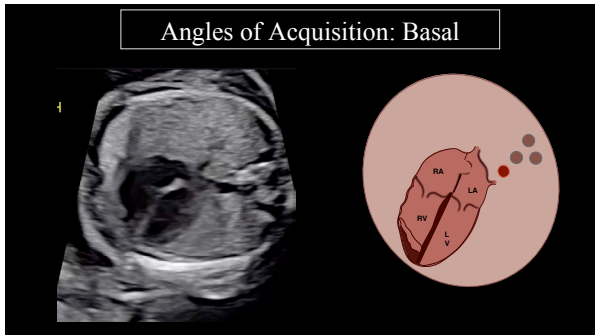
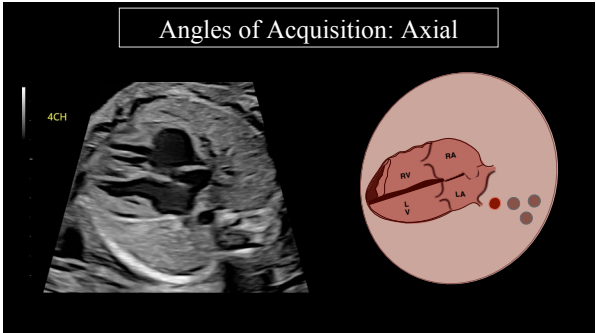
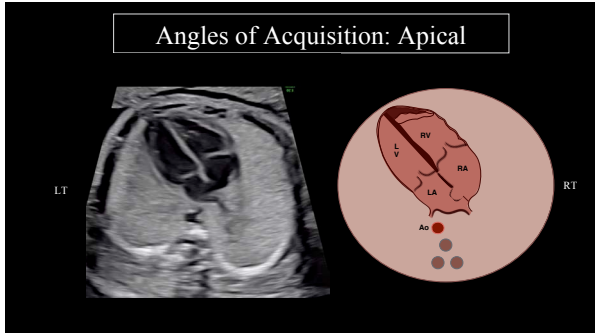
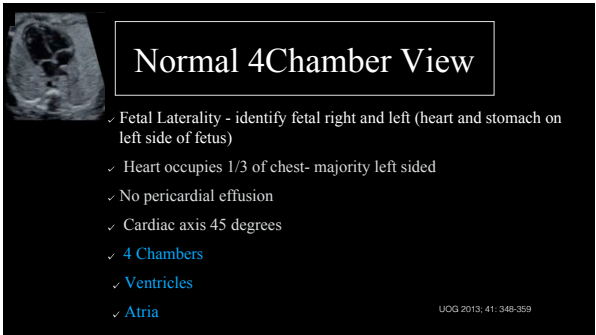


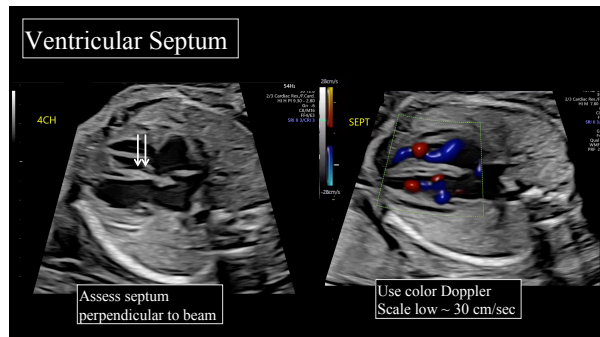
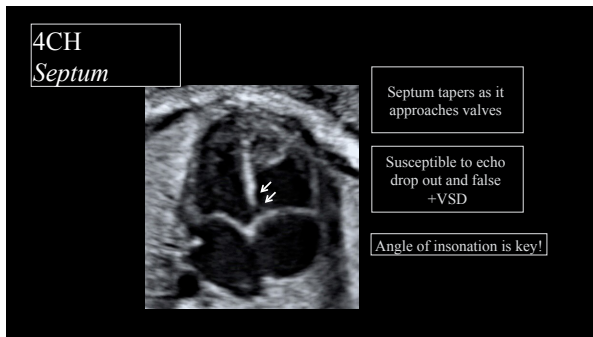
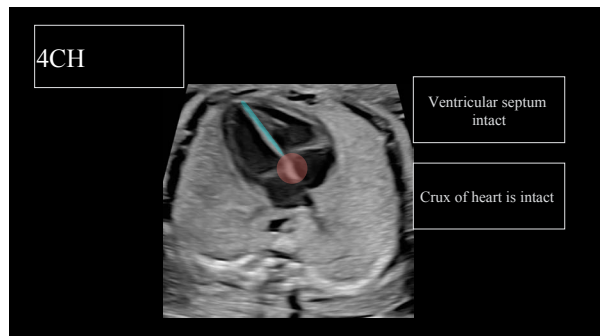
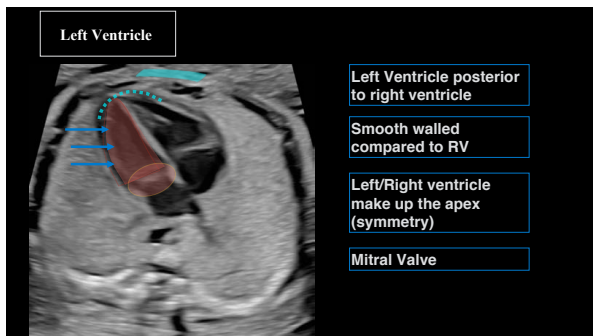
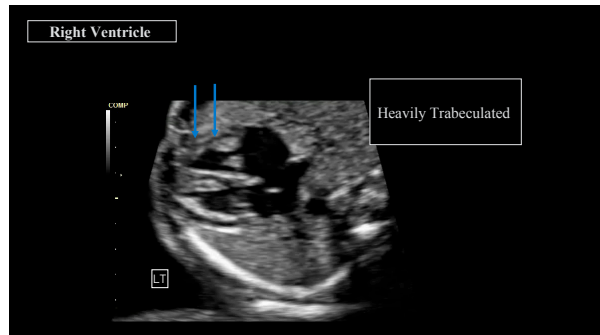
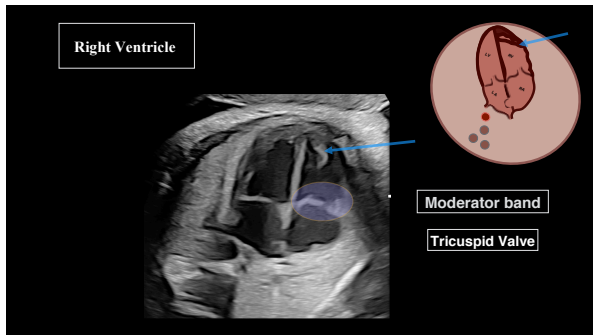
Obstet Gynecol. 1995; 85(1):97-102
Obstet Gynecol. 1995; 85(2):187-91.

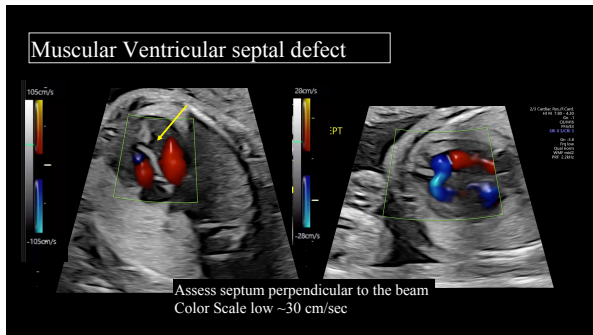
Left Axis Deviation



Tetralogy of Fallot Common arterial trunk Ebstein's anomaly



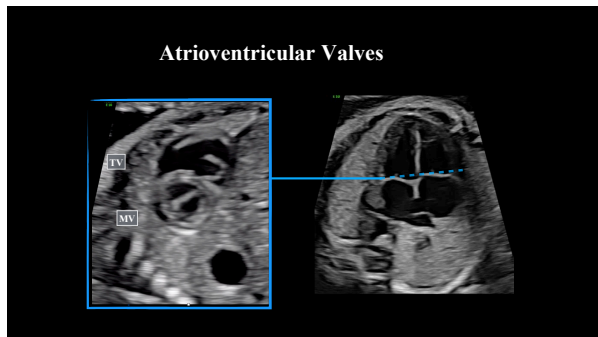
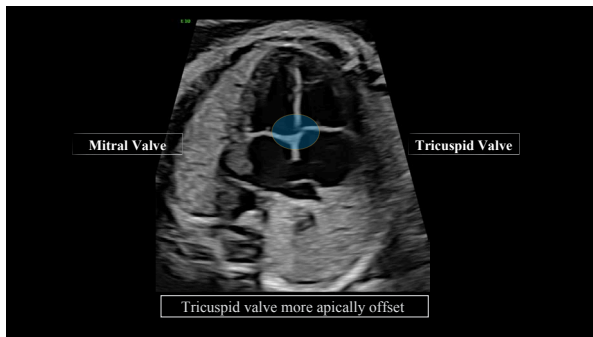
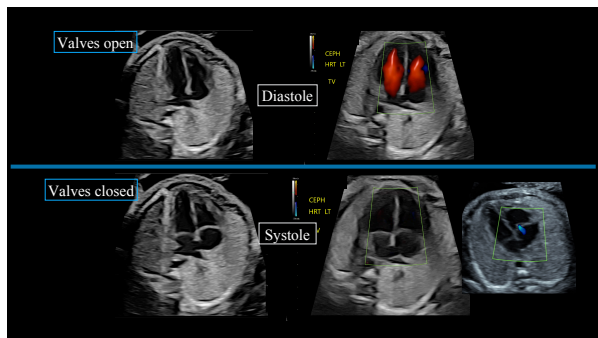
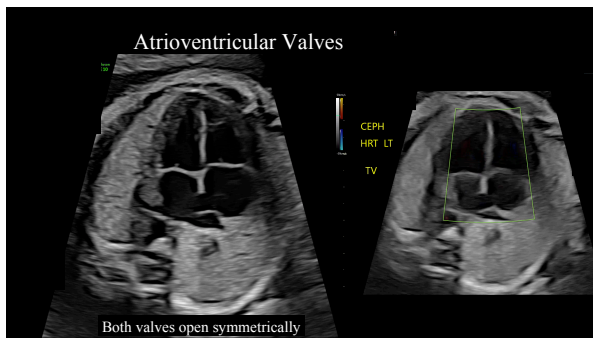




Normal 4Chamber View

- ✓ Fetal Laterality - identify fetal right and left (stomach and heart on left side of fetus)
- ✓ Heart occupies 1/3 of chest- majority left sided
- ✓ No pericardial effusion
- ✓ Cardiac axis 45 degrees
- ✓ 4 Chambers
- ✓ Ventricles
- ✓ Atria
- ✓ **Atrioventricular valves and junction**

UOG 2013, 41: 348-359



Atrioventricular Valves

Mitral valve

- 2 leaflets
- 2 papillary muscles
- No septal attachments

Tricuspid valve

- 3 leaflets
- 3 papillary muscles
- Septal attachments
- More apical insertion

Normal 4Chamber View

- Fetal Laterality - identify fetal right and left (stomach and heart on left side of fetus)
- Heart occupies 1/3 of chest- majority left sided
- No pericardial effusion
- Cardiac axis 45 degrees
- 4 Chambers
- Ventricles
- Atria
- Atrioventricular valves and junction

UOQ 2013, 41: 348-359

Left Atrium

- Most posterior chamber
- Pulmonary veins
- Descending aorta behind the left atrium - Small retroatrial space
- Foramen ovale flap
- Atrial appendage - "fingerlike" with narrow base

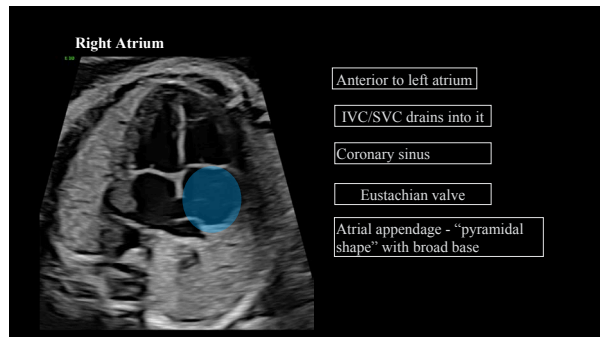
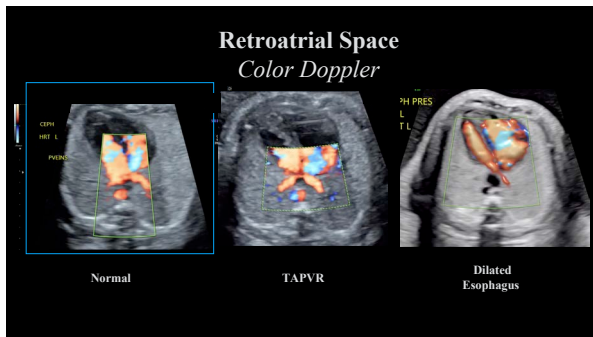
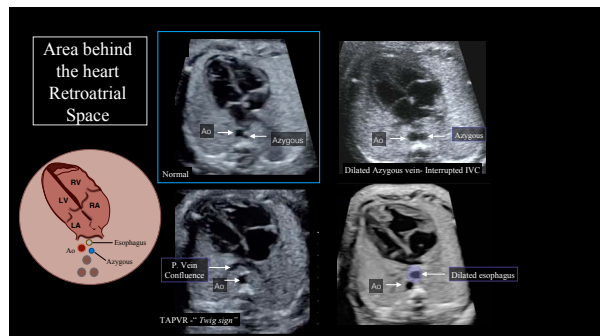
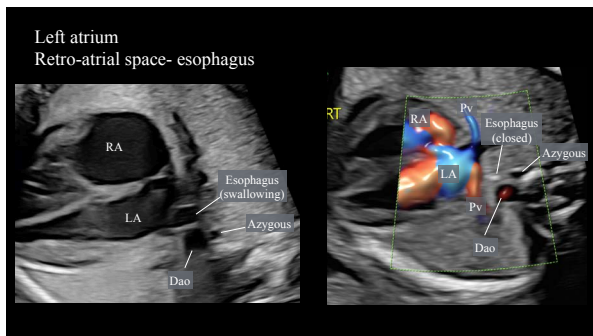
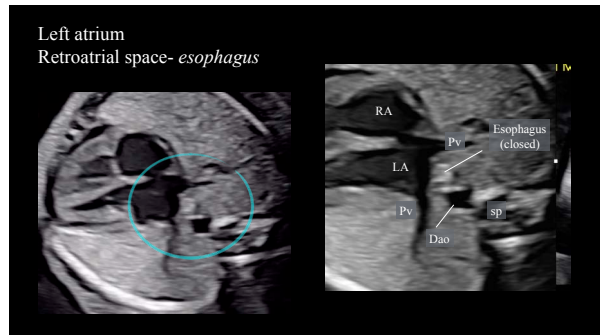
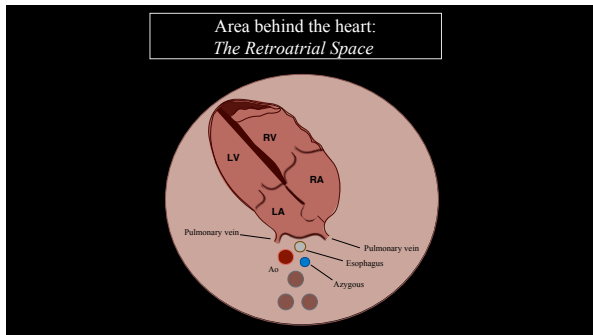
Left Atrium Foramen ovale flap

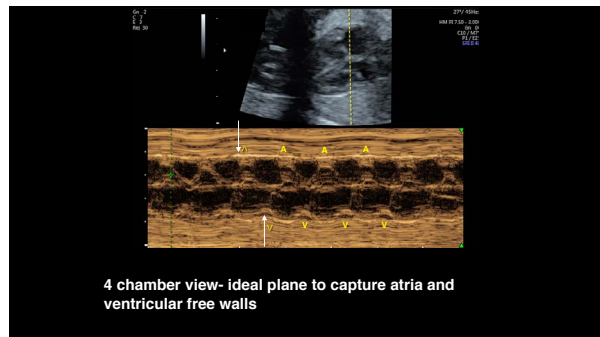
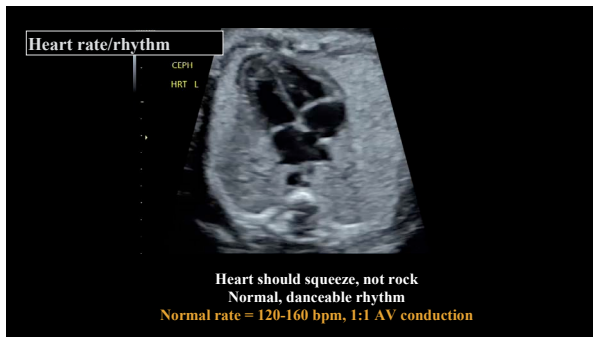
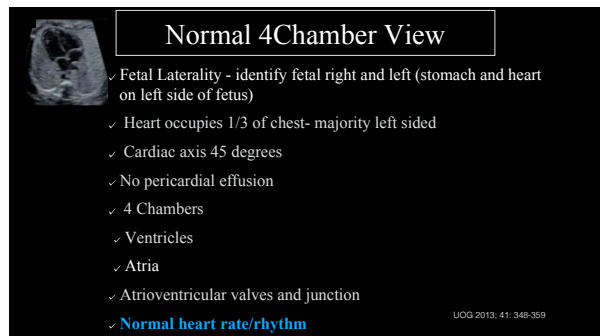
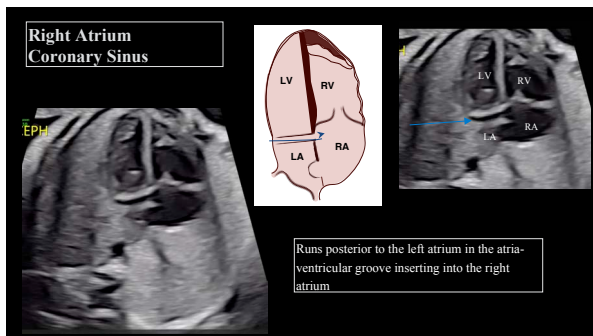
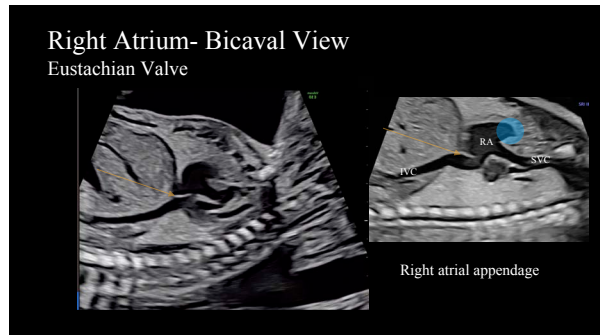
Left Atrium Pulmonary veins

Left atrium Indirect clues to normal pulmonary venous return

- Small space between left atrium and descending aorta
- Left atrium should never appear "bald"
- No confluence ("twig sign") behind left atrium
- Color Doppler flow

JUM 2014; 33: 1193-1207
JUM 2016; 35: 1193-1206





Assessment of the 4 Chamber View:

Situs and general aspects
Fetal laterality (identify right and left sides of fetus)
Stomach and heart on left
Heart occupies a third of thoracic area
Majority of heart in left chest
Cardiac axis (apex) points to left by $45^\circ \pm 20^\circ$
Four chambers present
Regular cardiac rhythm
No pericardial effusion

Atrial chambers
Two atria, approximately equal in size
Foramen ovale flap in left atrium
Atrial septum primum present (near to crux)
Pulmonary veins entering left atrium

Ventricular chambers
Two ventricles, approximately equal in size
No ventricular wall hypertrophy
Moderator band at right ventricular apex
Ventricular septum intact (apex to crux)
Atrioventricular junction and valves
Intact cardiac crux
Two atrioventricular valves open and move freely
Differential offsetting: tricuspid valve leaflet inserts on ventricular septum closer to cardiac apex than does mitral valve

UOG 2013, 41: 348-359



Notes 

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Vice Dean for Clinical Affairs
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