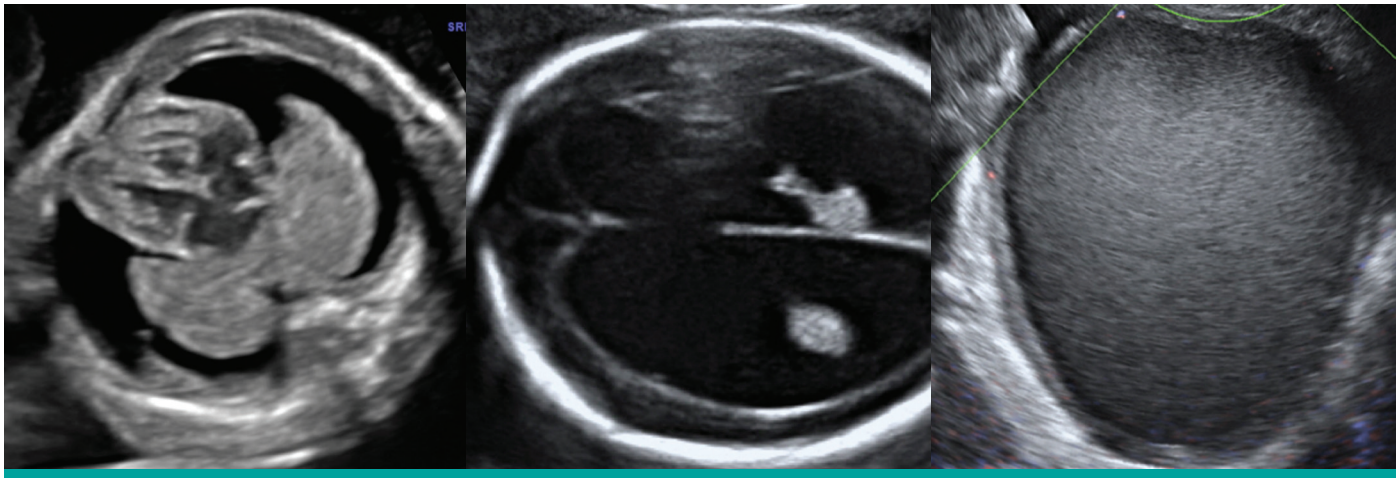

Advances in Ultrasound **in Obstetrics and Gynecology**

Saturday, October 15, 2016

Omni Shoreham Hotel • Washington, DC

Educational Symposia

Accreditation with Commendation

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Saturday, October 15, 2016

Symposia At Sea

Practical Approach to Ultrasound in Obstetrics and Gynecology

Book By March 26, 2017

Liability in OB/GYN Ultrasound: Minimizing Risk and Improving Outcomes

James M. Shwayder, M.D., J.D.
Professor and Chair
Department of Obstetrics and Gynecology
University of Mississippi Medical Center
Jackson, MS

Liability in Ob-Gyn Ultrasound: Minimizing Risk and Improving Outcomes

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Liability in Ob-Gyn Ultrasound: Minimizing Risk and Improving Outcomes

James M. Shwayder, M.D., J.D.

Disclosures: None

Outline

- Malpractice, as it relates to ultrasound
- Areas that pose the greatest risk with ultrasound
- Most common errors that lead to litigation
- Practices that can help reduce your exposure to litigation
- Case examples

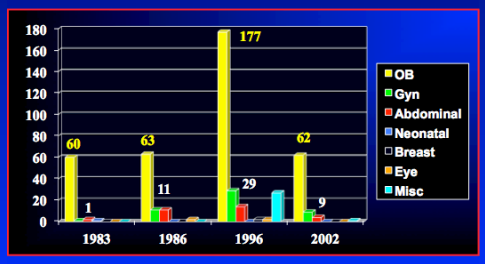
Legal Concept
Malpractice

Elements of Negligence
1. Duty
2. Breach of that duty
3. Proximate cause of injury
4. Damages

Burden of Proof

Medical malpractice
- Civil action
- Burden of proof = "preponderance of the evidence"
- Something > 50%

Cases by Specialty Area



RC Sanders. J Ultrasound Med 2003; 22: 1009-15.

Types of Errors

- Perception errors
- Interpretation errors
- Failing to suggest the next appropriate procedure
- Failure to communicate

M.M. Raskin. *Liability of Radiologists*, in Legal Medicine. Am College of Legal Med. 6th edition. 456-460.

Perception Errors

The abnormality is seen in retrospect but it is missed when interpreting the initial study.

- Error rate in radiology is ~ 30%[1]
- Question: Was it below the standard of care for the physician not to have seen the abnormality.[2]
- Most suits are settled
  - 80% are lost if cases go to jury verdict

[1] Berlin and Hendrix. *Perceptual Errors and Negligence.* Am J Roentgenol 1996; 170: 863-67.
[2] L. Berlin. *Malpractice Issues in Radiology: Defending the "Missed" Radiographic Diagnosis.* Am J Roentgenol 2001; 176: 317-32.

Missed Diagnosis
New Jersey

- Four ultrasounds performed during pregnancy
- Images lacked clear anatomic landmarks, thus no accurate measurements of fetus made
- Physician reviewed one ultrasound
- Sonographer reported on three ultrasounds
  - "Structural irregularities that require further evaluation"
- Physician told the patient the "ultrasounds were completely normal"

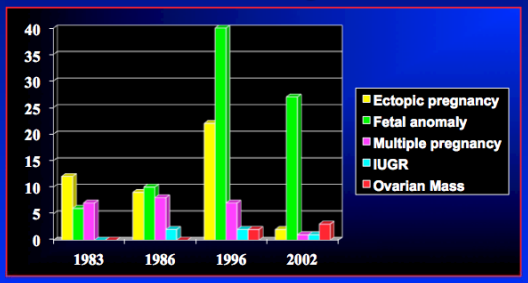
Missed Diagnosis
New Jersey

- Midline facial defect
- Cleft palate
- Club foot
- Lower-limb anomalies
- Limited cognitive and communication skills

Missed Diagnosis
New Jersey

- Suit against physician
- Suit against professional group he owned
  - Performs ultrasounds
- Settlement = $1.98 million

Missed Diagnosis



RC Sanders. J Ultrasound Med 2003; 22: 1009-15.

Ultrasound - Liability

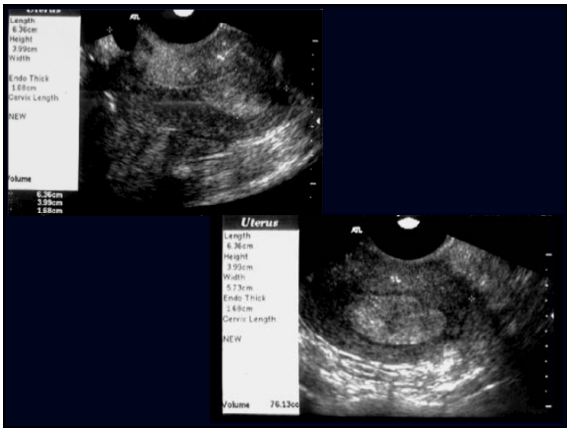
- Failure to conduct additional testing upon inability to visualize all four chambers of the heart during a routine sonogram
  - $4,200,000
- Failure to detect meningomyelocele on ultrasound at 15 weeks. Ultrasound reported as normal. (coupled with lack of AFP testing)
  - $4,350,000
- Failure to detect severe hydrocephalus
  - $5,500,000

Delay in Diagnosis
North Carolina

- 46 year old patient presented with abnormal uterine bleeding
- Physician assistant saw patient
- No biopsy performed
- Ultrasound = negative
  - Subsequently could not produce photograph taken at the time of ultrasound

Delay in Diagnosis
North Carolina

- 18 months later presented with persistent bleeding
- Physician assistant again saw patient
- No biopsy performed
- Ultrasound = negative
  - Photograph for second ultrasound found: showed existence of tumor



Delay in Diagnosis
North Carolina

- After another 10 months, sought care from another physician
- Physician performed biopsy
- Endometrial carcinoma
- Patient died from disease

Delay in Diagnosis
North Carolina

- Suit filed against 1st physician
  - After defendant physician's deposition
  - No expert testimony required
- Settled for $800,000

Legal Concepts

- Res ipsa loquitur
  - But for the failure to exercise due care the injury would not have occurred
    - Delay in diagnosis and subsequent death
- Respondeat superior
  - An employer is liable for the wrong of an employee if it was committed within the scope of employment

Ultrasound Examination

- Personnel
  - Training
  - Supervision
- Performance of the study
  - AIUM guidelines
  - Appropriate images

Interpretation Errors

The abnormality is perceived but is incorrectly described

- Most often occur due to lack of knowledge or faulty judgment
  - Malignant lesion called benign
  - Normal variant is called abnormal
- The best defense is an appropriate differential diagnosis, preferably including the correct diagnosis
- Lawsuits involving interpretation errors
  - 75% are won if cases go to jury verdict

Vaginal Bleeding

- 36 y.o. G3P2002
- Seen in ED on 5/29/10 (Saturday)
- c/o spotting on Thursday and Friday
- No LMP noted

Vaginal Bleeding

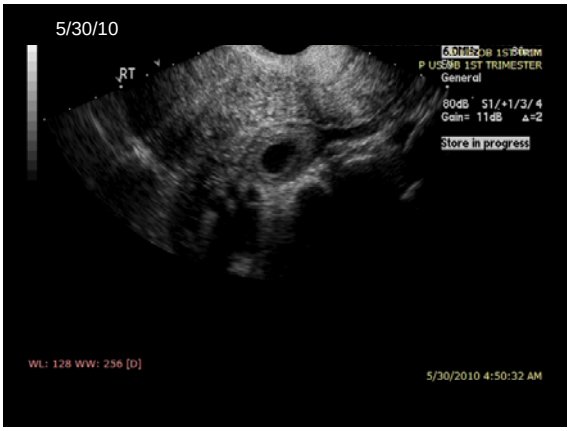
Examination

- VSS
- Point tenderness in the RLQ and suprapubic region
- No vaginal bleeding
- No CMT. No adnexal fullness

Vaginal Bleeding

- hCG = 209
- H/H = 12.7/35.9

5/30/10



PAIN R/O ECTOPIC BETA 209

PELVIC ULTRASOUND

The uterus is normal The endometrial canal is empty and about 1 1 cm in depth No intrauterine gestational sac is seen
The ovaries are normal in size in the right ovary there is a 1 5-cm cyst/follicle
No significant free pelvic fluid
No abnormal pelvic mass

IMPRESSION: Mild thickening of the endometrium No intrauterine gestational sac is seen In a pregnant patient the above findings are consistent with an early intrauterine gestation, an ectopic pregnancy or abortion Correlation with quantitative beta-hCG levels as well as clinical follow-up is recommended and depending upon the clinical situation, follow up ultrasound may be helpful

ED visit 6/04/10

- ED: RLQ Pain
- Rating: 8
- No vaginal bleeding
- Exam:" Abdomen: Mild tender, no tenderness in the right inguinal area. There is no abdominal tenderness. No guarding or rebound."
- NOTE: No pelvic performed in the ED

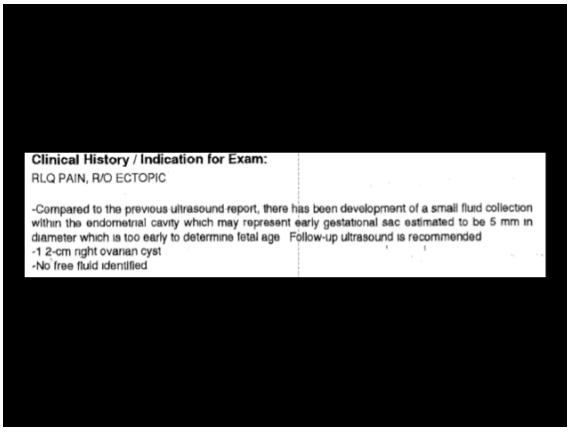
Lab

- hCG = 2399
- H/H = 12.6/36.0

6/04/10

6/04/10

6/04/10



Physician's office 6/07/10

- 36 yo. f/u from ED
- No bleeding
- Menstrual-like cramping
- "Seen in ER for pain."
- "Last hCG – 2399"
- "RT OVARIAN CYST WAS SEEN. NO FF"
- VSS

6/07/10

6/07/10

6/07/10

Table of Contents

The vagina was normal.
Cervix normal, the uterus was normal, and the uterine adnexae were normal.

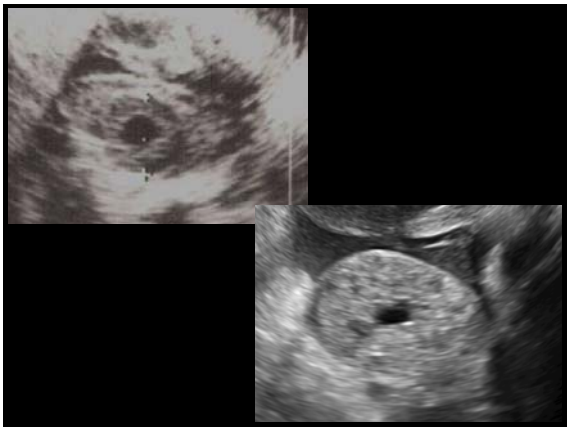
LMP: 4/27/2010.
U/S SHOWS NO IUP. THERE IS A DOUBLE RING LIKE STRUCTURE SEEN ON U/S TODAY < 2. CM NO FF.
Chaperone present.

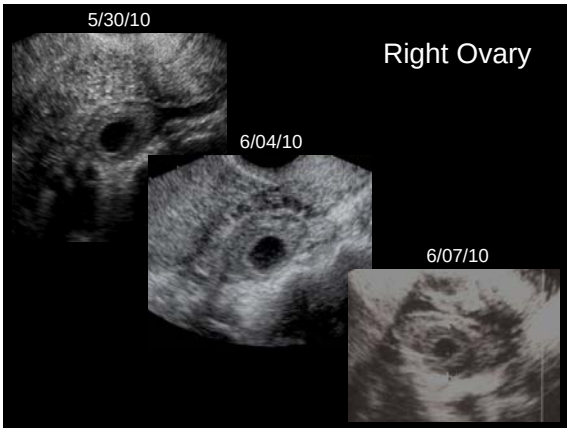
Assessment

- Ectopic pregnancy

Plan

- Serum HCG, beta subunit, quantitative
- Follow-up visit 4 DAYS

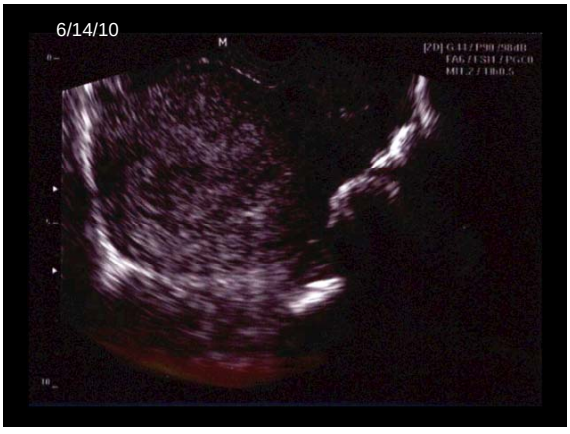




6/19/10
hCG summary

• 5/30/10	209
• 6/04/10	2,399
• 6/07/10	Methotrexate given
• 6/07/10	6,484

Physician's office
6/14/10



Physician's office
6/14/10

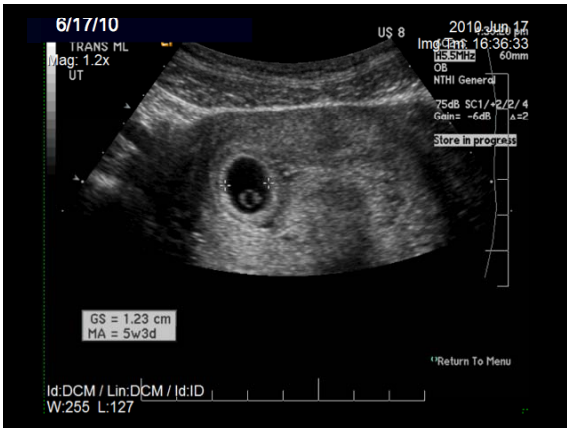
Sterile speculum exam:
VAG U/S EMPTY UTERUS; NO FREE FLUID 3 CM RT CYST BUT OVARIES BILAT WNL

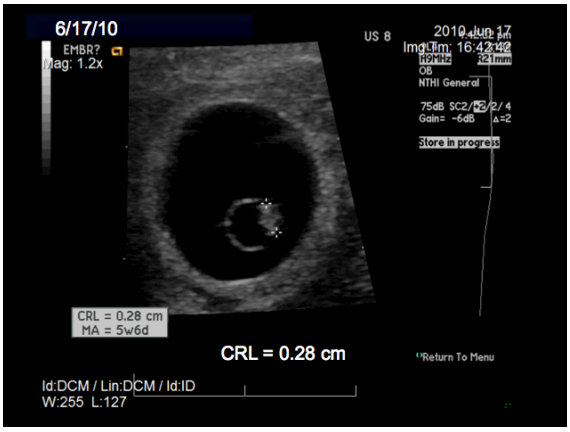
Impression: Postop Check

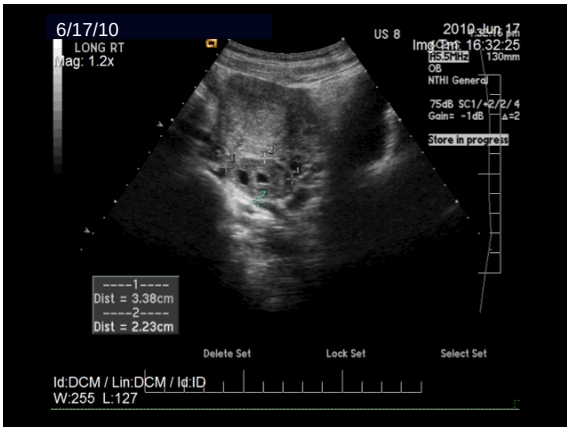
PLAN:
Return in

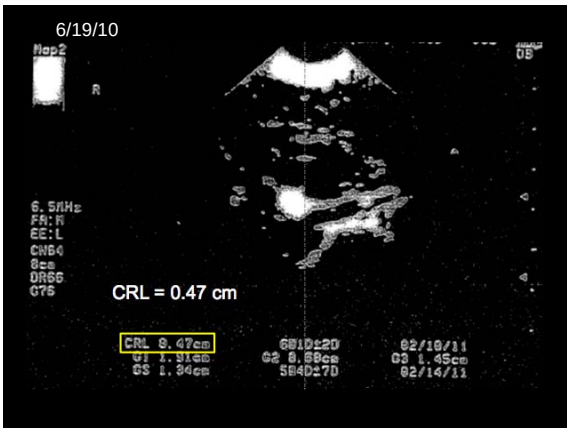
7 DAYS RPT BETA CALL ON WEDS FOR RESULTS>>>EXPECT ABOUT 650

Additional Notes:
ECTOPIC PREC









Performance

- Incomplete study
- Poor image quality

Equipment

- Contemporary equipment
- Proper maintenance (PM)
- Image capture and retention

Image Retention

- Preferably digital capture and retention
- Maintain for the specific SOL for your state (jurisdiction)

Interpretation Errors

- Fluid within the endometrium
- Cyst in right ovary
- Did not review the prior images when interpreting the current study

Interpretation Errors

8/01/05
- LMP = 6/09/05
- EGA = 7w5d
- EDD = 3/16/06

Ultrasound
- Small fetal pole with cardiac activity
- EGA = 5w2d
- EDD = 3/29/06

Interpretation Errors

9/06/05
- EGA = 12w5d (dates); 10w5d (US)
- Ultrasound
  - No images were documented
  - No formal report
  - Written note
    - "1x1 cm yolk sac. No fetal pole. No CA"

Interpretation Errors

9/26/05
- LMP = 6/09/05
- EGA = 15w5d (dates)
- EGA = 13w4d (ultrasound)
- No physical examination documented
- "Offered expectant management vs. D&C."
- "Rx: Cytotec"

Interpretation Errors

9/30/05
- Passed 61 gm male fetus
- 13-16 weeks with no grossly evident congenital abnormalities

Interpretation Errors
Settlement

$600,000

Interpretation Errors

9/06/05
- EGA = 12w5d (dates); 10w5d (US)
- Ultrasound
  - No images were documented
  - No formal report
  - Written note
    - "1x1 cm yolk sac. No fetal pole. No CA"

Recommendations

- Clinician
  - Was the 1x1 gestational sac a Nabothian cyst?
- Avoid "quick peeks" with the ultrasound
- Confirm findings that do not correlate with prior findings
- Document properly
- Examine patients

Image Retention

- Preferably digital capture and retention
- Maintain for the specific SOL for your state (jurisdiction)

Misdated Fetus

28 y.o.G3P2002 (Prior C/S x 2)

- LMP = 7/05/08
- EDC = 4/12/09
- Oligomenorrhea

Misdated Fetus

10/31/08

- EGA = 16w4d
- PE: Unable to palpate fundus due to body habitus. FHT's 160

Misdated Fetus

11/02/08 Ultrasound

- Small for dates
- EGA (dates) = 17 weeks
- "Live, intrauterine pregnancy with a gestational age of 9w4d ± 6 days. The EDD is 4/10/09."
- EGA (US) = 9w4d
- EDD (US) = 6/03/09

Misdated Fetus

12/14/08

- Office visit for abdominal pain
  - 15 5/7 weeks by ultrasound
  - 23 2/7 weeks by dates
- Exam: "Uterus is normal"

Misdated Fetus

- 4/05/09 Elective repeat C-Section
  - 39 2/7 weeks by dates
  - 31 6/7 weeks by ultrasound
- Male
  - Weight = 1710 gm
  - Apgar = 9,9
  - Ballard 31 weeks

Newborn Course

- Prematurity
- Respiratory distress syndrome
- Necrotizing enterocolitis

Misdated Fetus

- Deposition
- Review of records
  - FH < EGA on a consistent basis
- Settled $980,000

Failure to Communicate

- Final written report is considered the definitive means of communicating the results of an imaging study or procedure
- Direct or personal communication must occur in certain situations
  - Document communication
- Cause of action: Failure to communicate in a timely and clinically appropriate manner

[1] M.M. Raskin. *Why Radiologists Get Sued.* Applied Radiol 2001; 30: 9-13.
[2] ACR *Standard for Communication*

Failing to Suggest the Next Appropriate Procedure

The prudent radiologist/physician will suggest the next appropriate study or procedure based upon the findings and the clinical information.

- The additional studies should add meaningful information to clarify, confirm or rule out the initial impression
- The recommended study should never be for enhanced referral income
- Generally, the radiologist is not expected to follow up on the recommendation.
  - Exception: Beware of reinterpreting images on multiple occasions [1]

[1] *Montgomery v. South County Radiologists, Inc.*, 49 S.W.2d 191 (2001).

Recommendations

- Sonologist
  - Make specific recommendations when appropriate
- Clinician
  - Read the entire radiology report, not just the summary diagnosis
  - Correlate the radiologic diagnosis with the clinical findings

Failure to suggest next procedure Failure to communicate

- 33 y.o. G3P2002
- Quad screen at 15 weeks
  - Risk of Down Syndrome = 1/1100
- US performed at 19w1d in radiology
- Reported as “normal”
- No mention of subtle findings
  - UPJ = 4.3 and 4.4
  - EIF noted

Likelihood Ratios for DS with Isolated Markers

Marker	AAURA	Nyberg	Bromley	Smith-Bindman
Nuchal fold	18.6	11	12	17
Hyperechoic bowel	5.5	6.7	NA	6.1
Short humerus	2.5	5.1	5.8	7.5
Short femur	2.2	1.5	1.2	2.7
EIF	2.0	1.8	1.4	2.8
Pyelectasis	1.5	1.5	1.5	1.9
Normal	0.4	0.36	0.22	??

Isolated Marker

- EIF
  - LR = 1.4 – 2.8
  - Adjustment
- Risk of Down's
  - Originally 1 in 1100
  - Adjusted 1 in 392-785
- No amnio

Pyelectasis

- 7400 patients
- 25% of patients with Down's had pyelectasis
- Incidence of Down's = 3% if pyelectasis is present
- Abnormal:
  - 15-20 weeks ≥ 4 mm
  - 20-30 weeks ≥ 5 mm
  - > 30 weeks ≥ 7 mm

Benacerraf et al. Obstet Gynecol 1990; 76: 58.

Isolated Marker

- UPJ = 4.3 and 4.4
- Pyelectasis
  - LR = 1.5 – 1.9
  - Adjustment
- Risk of Down's
  - Originally 1 in 1100
  - Adjusted 1 in 579-733
- No amnio

Prevalence of Markers and Likelihood Ratios

# Markers	DS = 164	Nml = 656	LR
0	32	575	0.2
1*	32	66	1.9
2	20	13	6.2
3	40	2	80

* Individual LR better
Benacerraf et al. Radiology 1994; 193: 135-140

Failure to Communicate

- 33 y.o. G3P2002
- Quad screen at 15 weeks
  - Risk of Down Syndrome = 1/1100
- 2 markers: LR = 6.2
- Adjusted Risk for DS = 1/177

Failure to Communicate

Defense
- Radiologist
  - They round to the nearest whole number.
  - This patient's UPJ's were thus 4 and WNL
  - The UPJ dilation was < 5 mm, which is "normal" in their lab
  - EIF is a worthless marker and of no consequence
  - It is the obstetrician's duty to recommend amniocentesis to the patient

Failure to Communicate

Defense
- Obstetrician
  - The radiologist's report was "normal" with no mention of subtle markers for DS.
  - I had no reason to recommend amniocentesis
  - Had I known of the subtle findings I would have recalculated the patient's risk and would have recommended amniocentesis

Failure to Communicate

Radiologist

Defense
- The UPJ dilation was < 5 mm, which is "normal in their lab"

Plaintiff's cross
- The defendant radiologist had provided the syllabus from a recently attended CME course provided by the parent institution, that indicated that ≥ 4 mm was abnormal for < 20 weeks EGA

Failure to Communicate

Radiologist

Defense
- EIF is a worthless marker. We don't even mention it.

Plaintiff's expert
- As an isolated finding, EIF is a very poor marker. However, it should at least be mentioned in the report. Further, in the presence of additional markers, for example pyelectasis, EIF carries more significance.
- Both subtle findings should have been noted in the report and recommendations made to recalculate the patient's risk for DS and amniocentesis if appropriate

Failure to Communicate

Verdict

Obstetrician

Defense Verdict

Radiologist

Plaintiff Verdict
- Misinterpreted the images
- Duty to report the findings to the obstetrician. If he had done so, the duty for further counseling, evaluation, and treatment would have transferred to the obstetrician.

Failure to Communicate

Verdict

Plaintiff Verdict

Radiologist
- Failing to appropriately communicate the findings to the obstetrician resulted in the continuation of an abnormal pregnancy that the patient, had she known of the abnormality, would have terminated.

Wrongful Birth

Reed v. Campagnolo

The court ruled that "… parents may maintain an action for wrongful birth if the physician fails to disclose the availability of tests which would have detected birth defects present in the fetus and if the woman would have had an abortion had she known the fetus's deformities"

Reed v. Campagnolo, 810 F.Supp. 167 (D.Md. 1993)

Ultrasound Examination

- AIUM Accreditation
- Establishes policies and procedures
  - "Best Practices"

Equipment

- Contemporary equipment
- Proper maintenance (PM)
- Image capture and retention

Ultrasound Examination

- Performance of the study
- Interpretation of the study
- Communication of results
- Documentation

Defensibility

- If the components of a complete examination are documented, appropriately interpreted, and communicated the case is more defensible.
- The lack of any component places the case at risk.

Keepsake Ultrasounds

"Keepsake" Malpractice

Any malpractice claim concerning keepsake video production will be a case of first impression.

Entertainment Ultrasound
Case of First Impression

Colorado 2009
- Down's Syndrome
- Alleged missed anomaly during "Keepsake Ultrasound" in the 3rd trimester

Entertainment Ultrasound
Case of First Impression

Colorado 2009
- Shorten femur at 31 weeks
- Termination is available up to 34 weeks in Boulder, Colorado

Entertainment Ultrasound
Case of First Impression

- Entertainment ultrasound is not an approved medical practice
- Question
  - Was this medical malpractice?
  - Was this a case of commercial negligence?
  - Was this a breech of an entertainment agreement?

COPIC Insurance Co.
Coverage Limitations

"Your professional liability policy covers acts of negligence in the course of providing medical care. This type of activity may fall outside this definition; *therefore you may be denied coverage*."

Copiscope, No. 114, July 2003.

Entertainment Ultrasound

- Settled for undisclosed amount, rumored to be $1 M

Liability Risks
Different scenarios

Least

- Untrained technician-no physician oversight
- RDMS sonographer-no physician oversight
- RDMS sonographer-physician oversight
  - No prior physician-patient relationship
- RDMS sonographer-physician oversight
  - Current patient

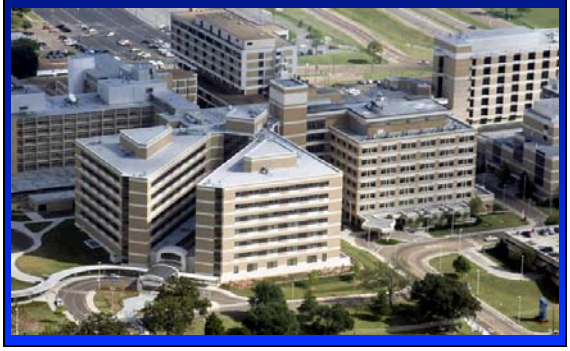
Most

Outline

- Malpractice
- Most common errors that lead to litigation
- Practices that can help reduce your exposure to litigation

THE UNIVERSITY OF MISSISSIPPI MEDICAL CENTER

Thank You



Notes

Three and Four Dimensional Ultrasound in Obstetrics

Jude P. Crino, M.D.
Assistant Professor, Maternal-Fetal Medicine
Director, Perinatal Ultrasound
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Contribution Not Received in Time for Inclusion.


Notes

Notes


Notes

Notes

Fetal Growth Restriction: Diagnosis and Management

Alfred Abuhamad, M.D.
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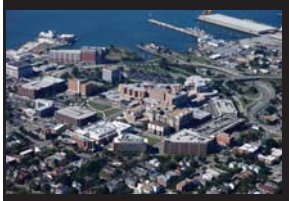
Vice Dean for Clinical Affairs
Eastern Virginia Medical School
Norfolk, VA

Fetal Growth Restriction: Diagnosis & Management



EVMS Fetal Cardiovascular Center

Alfred Abuhamad, MD.
Eastern Virginia Medical School

Fetal Growth Restriction

Complex Problem:

- Various published definitions
- Poor detection rates
- Limited preventive or treatment options
- Multiple associated morbidities
- Increased likelihood of perinatal mortality

FGR

Treatment:

- Bed rest
- Aspirin
- Nutrient supplements with Calcium/Zinc
- Maternal oxygenation
- Heparin
- Plasma volume expansion
- Calcium channel blockers
- Hormonal therapy
- Smoking cessation

No Benefit

ACOG IUGR bulletin 2000. Reaffirmed 2010

Fetal Growth Restriction

NICHD Fetal Imaging Forum 2 May 2015

- Multisociety representation

To develop a consensus on the diagnosis and optimal management of the singleton pregnancy with fetal growth restriction (FGR).

Definition

- Fetal Growth Restriction (FGR) is sonographically estimated fetal weight (SEFW) <10% for GA (PRENATAL STATUS)
- Small for gestational age (SGA) is actual birth weight (BW) < 10% for GA (POSTNATAL STATUS)

ACOG PB 2013; RCOG GG 2013; SOGC 2013; RCPI 2014

Definition

Other diagnostic criteria:

- SEFW < 5%
- SEFW < 3%
- AC < 10%
- AC < 5%
- Ac < 3%

Risk Factors for FGR

Maternal
- Advanced maternal age
- Chronic medical diseases
  - Hypertension
    - Chronic hypertension
    - Gestational hypertension
  - Pregestational diabetes mellitus of advanced classes
  - Renal disease
  - Hyperthyroidism
  - Hemoglobinopathies
  - Autoimmune disease
    - Systemic lupus erythematosus
  - Cyanotic cardiac disease
  - Antiphospholipid antibody syndrome
- Inadequate nutrition, malabsorption, and poor weight gain
- Medication exposure
  - Phenytoin
  - Valproic acid
  - Trimethadione
  - Warfarin
  - Cyclophosphomide
- Substance abuse
  - Tobacco
  - Alcohol
  - Cocaine
  - Methamphetamines
  - Narcotics

Fetal
- Multiple gestation
- Infection
  - Rubella
  - Cytomegalovirus
  - Herpes
  - Toxoplasmosis
  - Malaria
  - Syphilis
  - Chagas disease
- Anomalies
- Chromosomal and genetic
  - Trisomy 13
  - Trisomy 18
  - Congenital heart defects
  - Gastroschisis

Placental
- Single umbilical artery
- Abnormal cord insertion
  - Velamentous
- Bilobed or circumvallate placenta
- Small placenta
- Confined placental mosaicism

ACOG PB 134, 2013

Screening – ACOG Opinion

- All pregnant women should be screened for risk factors (medical and obstetric history)
- Fundal height measured at each visit > 24 weeks
  - If fundus cannot be palpated, e.g. obesity, multiple gestation, sonography is preferred
- Sonographic screening may be used in the presence of risk factors
- No evidence that routine sonography, serum analytes, or uterine artery Doppler improve outcomes

ACOG PB 134, 2013


General obstetrics

Poor effectiveness of antenatal detection of fetal growth restriction and consequences for obstetric management and neonatal outcomes: a French national study

I Monier,* B Blondel,* A Ego,*,† M Kaminiski,* F Goffinet,*,‡ J Zeitlin*

- Singleton births, all French maternity units in 2010, over 1 week period
- Routine US between 30 and 35 weeks
- 22% of SGA infants were suspected of FGR (but outcome was not better if FGR was suspected)
- 50% of infants suspected of FGR were not SGA (increased risk of provider-initiated early delivery in this group)

Fetal Growth Restriction

Prenatal detection:

- Undetected in 30 - 50% of cases
- Incorrectly diagnosed in 50% of cases

ACOG IUGR bulletin 2000. Reaffirmed 2010
Acta Obstet Gynecol Scand 1998;77:643
J Obstet Gynecol 1996;16:77

Fetal Growth Restriction

- FGR vs. SGA, single or distinct entity?
- Should we rethink approach to FGR?
  - Small EFW
  - Small EFW with abnormalities

NICHD-Fetal Imaging Forum 2 – May 2015

Diagnosis

- Fetal biometry
  - BPD, HC, AC, FL
  - Transverse cerebellar diameter between 14 and 24 weeks correlates with GA in weeks (it is unchanged in FGR)
  - Fetuses with abdominal wall defect are often over-diagnosed with FGR

Goldstein I, Am J Obstet Gynecol, 1987

Formulas for SEFW

Ultrasound Obstet Gynecol 2005; **25**: 80–89
Published online 26 October 2004 in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/uog.1751

A systematic review of the ultrasound estimation of fetal weight

N. J. DUDLEY
Medical Physics Department, Nottingham City Hospital, Nottingham, UK

- Review of studies employing 7 different regression equations for EFW

Formulas for SEFW

- No consistently superior method of assessment emerged
- Similar systematic and random errors between formulas
- Wide intra and inter-observer variability identified
  - Use average of multiple measurements
  - Improvement in image quality
  - Uniform calibration of equipment
  - Regular audits for quality assurance

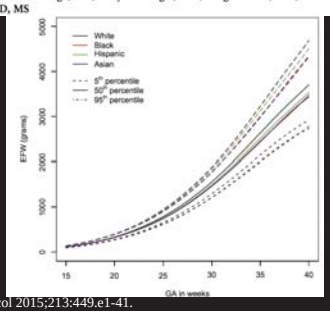
Dudley N, UOG 2005

Weight Percentiles

- Population Norms
  - "one size fits all
  - Unadjusted for factors that affect fetal size
- Customized Norms
  - "one size does not fit all"
  - Adjusted for factors that affect fetal size (fetal gender, ethnicity, parity, parental size, altitude, maternal co-morbidity)

Racial/ethnic standards for fetal growth: the NICHD Fetal Growth Studies

Germaine M. Buck Louis, PhD, MS; Jagteshwar Grewal, PhD, MPH; Paul S. Albert, PhD; Anthony Sciscione, DO; Deborah A. Wing, MD; William A. Grobman, MD, MBA; Roger B. Newman, MD; Ronald Wapner, MD; Mary E. D'Alton, MD; Daniel Skupski, MD; Michael P. Nageotte, MD; Angela C. Ranzini, MD; John Owen, MD, MSPH; Edward K. Chien, MD; Sabrina Craigo, MD; Mary L. Hediger, PhD; Sungduk Kim, PhD; Cuilin Zhang, MD, MPH, PhD; Katherine L. Grantz, MD, MS



Am J Obstet Gynecol 2015;213:449.e1-41.

Intergrowth-21

- Multicenter international study – 7 countries
- Longitudinal growth 4321 low-risk pregnant women from 14 weeks to 42 weeks
- Biometric charts for BPD, HC,OFD, AC and FL were developed
- Goal is to describe how fetuses SHOULD grow, as opposed to traditional charts that describe how fetuses DO grow
- Question: outcome studies to confirm superiority over current existing charts

Papageorghiou AT, Lancet, 2014

Fetal Growth Restriction

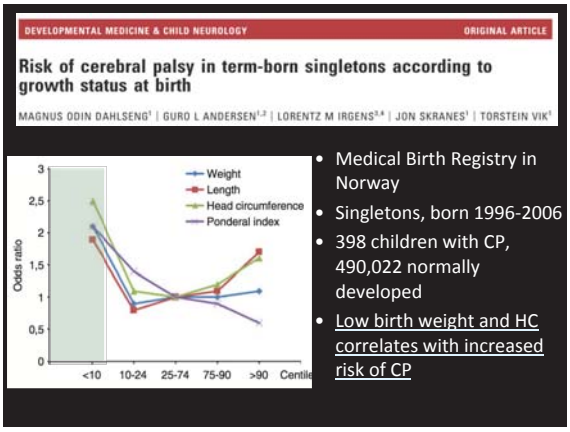
Outcome:

- Low Apgar scores & cord pH < 7.0
- Increased NICU admissions & sepsis
- Increased stillbirth and neonatal mortality
- Increased learning disabilities
- Increased adult onset cardiovascular disease

ACOG IUGR bulletin 2000. Reaffirmed 2010

SGA: Morbidity and Mortality

- Hypoglycemia
- Hyperbilirubinemia
- Hypothermia
- IVH
- NEC
- Seizures
- Sepsis
- RDS
- Cerebral Palsy
- Neonatal death



- Medical Birth Registry in Norway
- Singletons, born 1996-2006
- 398 children with CP, 490,022 normally developed
- Low birth weight and HC correlates with increased risk of CP

Fetal Assessment

Non-invasive tests:

- Fetal kick counts
- Non-stress test
- Biophysical profile
- Doppler assessment

Invasive tests:

- Amniocentesis
- Cordocentesis

No ideal test for all growth restricted fetuses.

Cardiovascular Adaptation of FGR

Early Changes / FGR

Arterial Redistribution

Brain Sparing Reflex

- ↑ impedance in UA (↑S/D)
- ↓ impedance in MCA (↓ PI)

Value of CPR

Fetal Hypoxemia

Blood Flow Redistribution

Brain Sparing Reflex

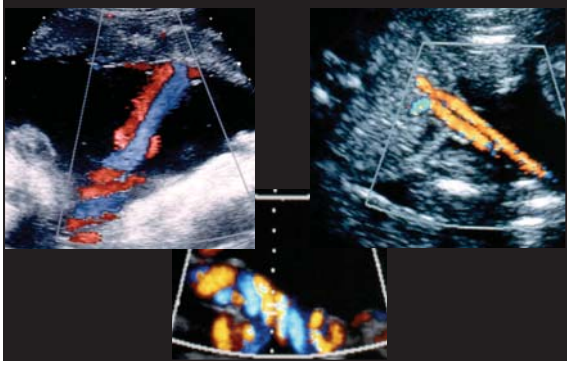
Increased

- **Heart**
- **Brain**
- **Adrenal**
- **Spleen**

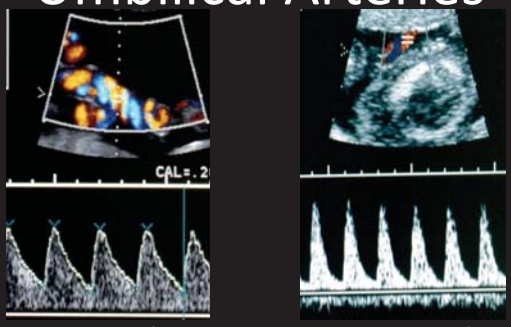
Decreased

- **Lungs**
- **GI**
- **Skeletal**
- **Other**

Umbilical Arteries



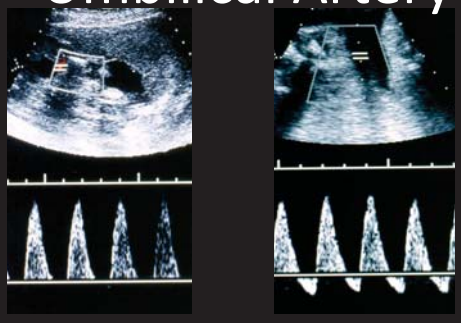
Umbilical Arteries



Normal Waveform

Abnormal Waveform

Umbilical Artery



AEDF

REDF

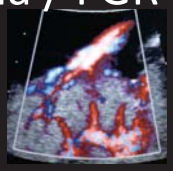
Fetal Hypoxemia / FGR

UA ↑ Impedance

- Obliteration of small muscular arteries in tertiary stem villi
- For A/REDF, need > 70 % placental obliteration

Ultrasound Obstet Gynecol 1997;9:271
AJOG 1989;161:1055

Fetal Hypoxemia / FGR



UA ↑ Impedance

- Meta-analysis of 18 trials (> 10,000 women), concluded that use of UA Doppler in high-risk women reduced perinatal death & obstetric interventions

Syst Rev 2010;(1):CD007529

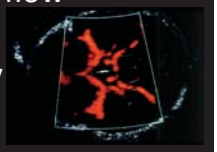
Should Doppler be performed in low-risk women as a screening test?

Meta-analysis of 4 trials found no difference in outcome

Cerebral Vasculature

Middle Cerebral Artery

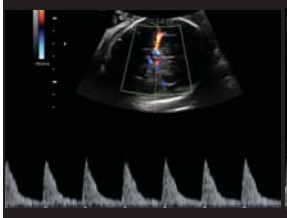
- Most accessible cerebral vessel
- Carries 80 % of cerebral flow
- Constant 3% - 7% of CO
- Excellent reproducibility



AJOG 1993;169:1393

Circle of Willis

Middle Cerebral Artery



Normal Waveform

Abnormal Waveform

Cerebral Placental Ratio (CPR)

- Ratio of MCA PI to UA PI
- Used to assess brain sparing
- Blood flow centralization present if CPR < 5% for GA or < 1.08 (similar accuracy) – associated with adverse perinatal outcome
- Can identify FGR fetuses at risk of cesarean sections for NRFHR

Bahado-Singh RO, AJOG, 1999
Cruz-Martinez R, Obstet Gynecol, 2011
Odibo A, JUM, 2005

The role of brain sparing in the prediction of adverse outcomes in intrauterine growth restriction: results of the multicenter PORTO Study

TABLE 3
CPR in comparison with UA Doppler in the prediction of adverse perinatal outcomes

	Adverse perinatal outcome		
Predictor	Sensitivity	Specificity	OR (95% CI)
UA (PI >95th centile)	85% (35/41)	54% (454/840)	6.9 2.9–16.5
UA (PI >95th centile, AEDF, REDF)	90% (37/41)	54% (452/831)	10.8 3.8–30.5
CPR (PI) <1.0	66% (27/41)	85% (721/840)	11.7 6.0–22.9

CPR = MCA PI / UA PI

Am J Obstet Gynecol 2014;211:288

Late Changes / FGR

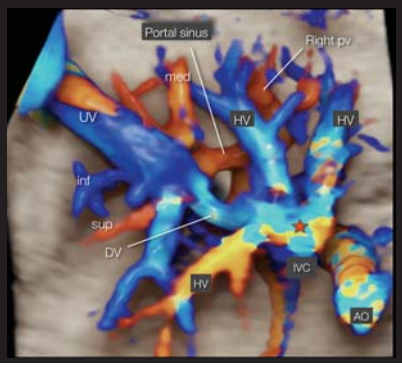
Elevated Central Venous Pressure

Cardiac Decompensation

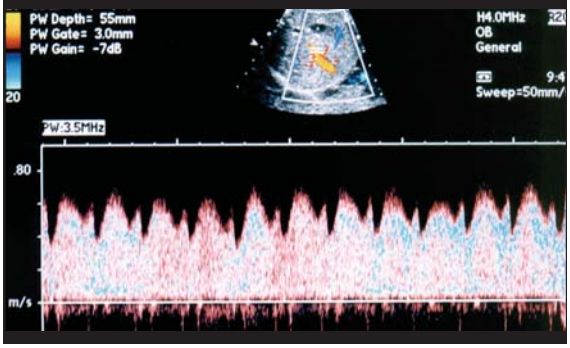
- ↑ EDP in RV (↑ afterload)
- ↑ Cardiac stiffness

Ultrasound Obstet Gynecol 1996;7:401

Ductus Venosus



Ductus Venosus



Ductus Venosus

Abnormal Waveforms

FGR

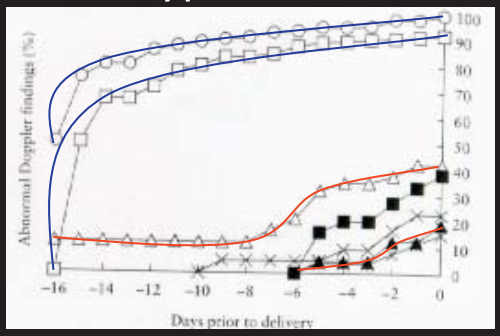
Early Changes

- Biometric changes
- Arterial Doppler

Late Changes

- Venous Doppler
- Heart rate tracing

Fetal Hypoxemia / FGR

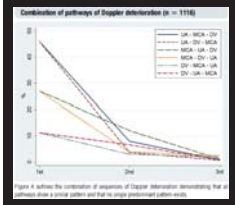


Ultrasound Obstet Gynecol 2002;19:140

RESEARCH www.AJOG.org

OBSTETRICS

Predictable progressive Doppler deterioration in IUGR: does it really exist?



- Multiple potential pathways of Doppler deterioration in IUGR
- UA→ MCA → DV is no more common than other pathways
- Abnormal UA and MCA Doppler are strongest predictors of adverse perinatal outcome
- Only marginal added benefit to DV and cardiac indices

Unterscheider J, Am J Obstst Gynecol, 2013

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SMFM Clinical Guideline www.AJOG.org

Doppler assessment of the fetus with intrauterine growth restriction

Society for Maternal-Fetal Medicine Publications Committee, with the assistance of Eliza Berkley, MD; Suneet P. Chauhan, MD; and Alfred Abuhamad, MD

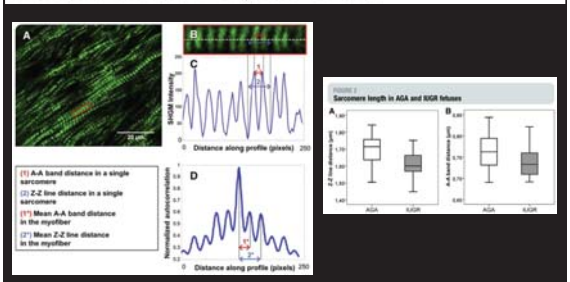
- In high-risk pregnancies with suspected FGR UA Doppler assessment significantly decreases likelihood of IOL, cesarean delivery and perinatal death
- UA Doppler surveillance should be started when fetus is viable and FGR suspected
- DV, MCA and other vessels Dopplers have some prognostic value for FGR fetuses, but currently lack of RCT showing benefit and they should be reserved for research protocols

Cardiac Function & FGR

OBSTETRICS

Cardiac dysfunction is associated with altered sarcomere ultrastructure in intrauterine growth restriction

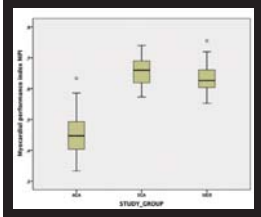
Jesus Igor Iruretagoyena, MD; Anna Gonzalez-Tendero, MSc; Patricia Garcia-Canadilla, MSc; Ivan Amat-Roldan, PhD; Iratxe Torre, PhD; Alfons Nadal, MD; Fatima Crispi, MD; Eduard Gratacos, MD



Am J Obstet Gynecol 2014;210:550.e1-7

Cardiac function in early onset small for gestational age and growth restricted fetuses

Wassim A. Hassan [a], Jeremy Brockelsby [a], Medhat Alberry [a], Tiziana Fanelli [a], Juriy Wladimiroff [a], Christoph C. Lees [a,b,c,*]



Importantly, the myocardial performance index is raised in small for gestational age fetuses before the arterial and venous Doppler abnormalities that characterize hypoxia are evident.

SGA: AC < 5th%
IUGR: AC < 5th% + Abnormal UA Doppler

European Journal of Obstet & Gynecol and Reproductive Biology 171 (2013) 262

Neonatal Outcome in FGR?

Perinatal morbidity and mortality in early-onset fetal growth restriction: cohort outcomes of the trial of randomized umbilical and fetal flow in Europe (TRUFFLE)

- Fetal outcome was better than expected
- Perinatal death was uncommon (8%)
- 70% survived without severe neonatal morbidity.

Ultrasound Obstet Gynecol 2013; 42: 400–408

Perinatal morbidity and mortality in early-onset fetal growth restriction: cohort outcomes of the trial of randomized umbilical and fetal flow in Europe (TRUFFLE)

Poor Prognostic Factors:

- Presence and severity of maternal hypertensive conditions
- Gestational age at diagnosis
- Gestational age at delivery

Ultrasound Obstet Gynecol 2013; 42: 400–408

PORTO vs. ULTRA TOT

	PORTO	ULTRA TOT
Hypertensive diseases/ preeclampsia	12% (134)	28% (232)
GA at enrollment	30.1±3.9	31.3±5.7
GA at delivery	37.8 ± 3.0	35.7±3.6
Birth weight (grams)	2495 ± 671	2039 ± 675
NICU admission	28% (321)	24% (196)
Apgar<7 at 5 min.	1% (13)	7.4% (62)
Stillbirth	4 (1:280)	N/A
Neonatal death	4 (1:280)	19 (1:44)

Unterscheider et al 2013 – EVMS 2015

Timing of Delivery?

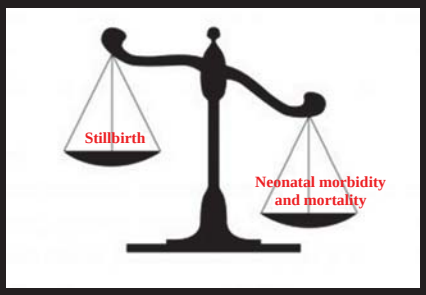
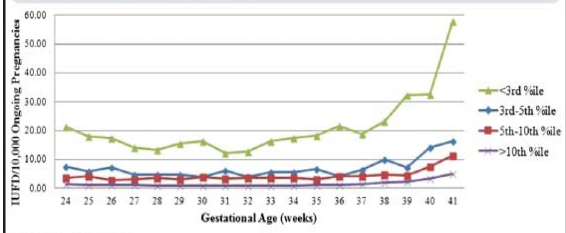


FIGURE
Risk of IUFD by gestational age



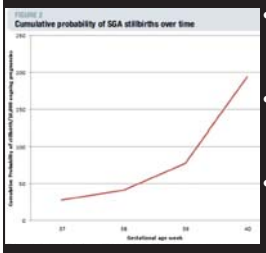
IUFD, intrauterine fetal death.

Pilliod. The risk of intrauterine fetal death in the SGA fetus. Am J Obstet Gynecol 2012.

Pilliod R, AJOG, 2012

Risk of stillbirth after 37 weeks in pregnancies complicated by small-for-gestational-age fetuses

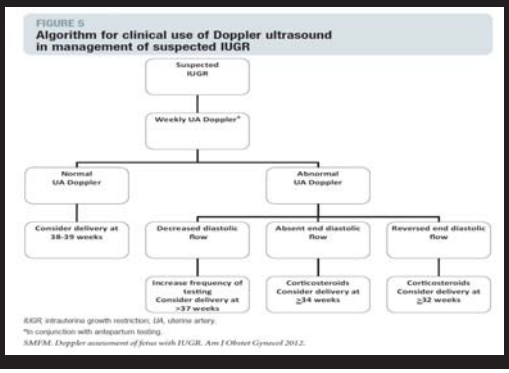
Amanda S. Trudell, DO; Alison G. Cahill, MD, MSCI; Methodius G. Tuuli, MD, MPH; George A. Macones, MD, MSCE; Anthony O. Odibo, MD, MSCE



- Cumulative risk of stillbirth increases for each week after 37 weeks
- The increased risk becomes significant at 39 weeks for FGR < 10%
- FGR <5% there is a significant over 2-fold risk of stillbirth at 38 weeks compared to 37 weeks

Delivery Timing with Abnormal Dopplers

FIGURE 5
Algorithm for clinical use of Doppler ultrasound in management of suspected IUGR



IUGR, intrauterine growth restriction; *UA*, uterine artery.

*In conjunction with antepartum testing.

SMFM. Doppler assessment of fetus with IUGR. Am J Obstet Gynecol 2012.

Induction of Labor vs. Expectant Management in FGR?


European Journal of Obstetrics & Gynecology and Reproductive Biology

Which intrauterine growth restricted fetuses at term benefit from early labour induction? A secondary analysis of the DIGITAT randomised trial

- The Disproportionate Intrauterine Growth Intervention Trial at Term
- Randomized trial (650 women randomized to IOL or expectant management)
- 36+0 weeks to 41+0 weeks
  - Singleton, cephalic, suspected IUGR
  - Included normal and abnormal Dopplers

DIGITAT Trial

- No significant differences
  - Primary composite adverse neonatal outcome
  - Rate of operative delivery or cesarean
  - MAIN scores
- No fetal or neonatal deaths in either group
- No difference in developmental or behavioral outcomes at 2-year follow up
- IOL before 38 weeks associated with > NICU admit
- Either strategy acceptable

Boers KE, AJOG, 2012
Van Wyk L, AJOG, 2012

Summary: Delivery Timing

Uncomplicated FGR (nl UA Dopplers)

1. EFW 5 -10% - delivery at 39 weeks
2. EFW < 5% - delivery at 37 weeks

Complicated FGR (abnormal UA Dopplers)

1. Elevated UA Dopplers (DEDF) - 37 weeks
2. AEDF: corticosteroids → delivery if ≥ 34 weeks
3. REDF: corticosteroids → delivery if ≥ 32 weeks

FGR – Mode of Delivery

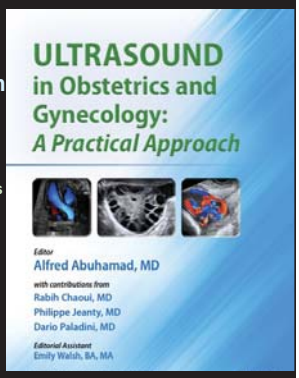
- No RCTs for MOD for FGR
- Several small observational studies
  - Demonstrate that FGR is a risk factor for cesarean
- No evidence to suggest VD (or IOL) is contra-indicated for FGR
- Even with abnormal UA Dopplers, a reasonable chance for VD

Horowitz, KM et al. J MFNM 2014
Li, H et al. Acta Obstet Gynecol Scand 2003
Chavakula, PR et al. Int J Gynecol Obstet 2015
Maslovitz, S et al. Arch Gyn Obstet 2009
Ben-Haroush, A et al. Acta Obstet Gynecol Scand 2004
Visentin, S et al. J U Med 2014

Conclusion

- FGR is poorly detected & Incorrectly diagnosed
- FGR is associated with increased neonatal morbidity & mortality
- Abnormal arterial Doppler substantially increases adverse outcomes in FGR
- Abnormal cardiac function is seen before conventional Doppler abnormalities in FGR
- Presence of hypertensive conditions increases adverse outcomes in FGR

Free Download:
www.openultrasound.com



More than 20,000 downloads in less Than 24 months

- Spanish
- Chinese
- Italian
- Portuguese
- Russian
- Korean

Notes

Case Presentations of Genetic Syndromes

Elena Sinkovskaya, M.D., Ph.D.
Assistant Professor
Director of Research
Division of Maternal-Fetal Medicine
Department of Obstetrics & Gynecology
Eastern Virginia Medical School
Norfolk, VA


Notes

Notes


Notes

Notes

Ultrasound in the Evaluation of Abnormal Uterine Bleeding

James M. Shwayder, M.D., J.D.
Professor and Chair
Department of Obstetrics and Gynecology
University of Mississippi Medical Center
Jackson, MS

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Ultrasound in the Evaluation of Abnormal Uterine Bleeding

James M. Shwayder, M.D., J.D.
Professor and Chair
Obstetrics and Gynecology
University of Mississippi School of Medicine
Jackson, Mississippi

Ultrasound in the Evaluation of Abnormal Uterine Bleeding

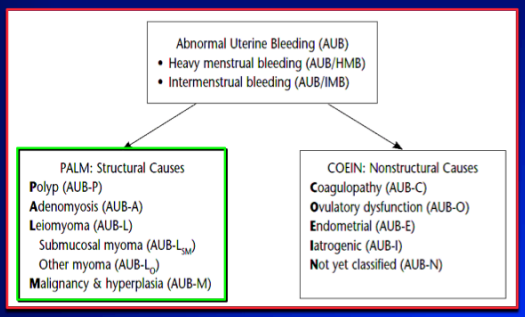
James M. Shwayder, M.D., J.D.

Disclosures: None

Learning Objectives

- Understand the relative value of different methods of evaluating the endometrium in patients with abnormal uterine bleeding
- Be able to better predict the presence of significant pathology in different age groups
- Be able to describe the unique capabilities of ultrasound
- Take home pearls in the evaluation of AUB with ultrasound

PALM-COEIN



ACOG Practice Bulleting. Diagnosis of Abnormal Uterine Bleeding in Reproductive-Aged Women. Number 128, July 2012

Endometrial Evaluation
Histologic Evaluation

- Options
  - Endometrial biopsy
  - Dilatation and curettage
- Diagnosis best made by tissue biopsy
  - Hormonal dysregulation
  - Endometritis
  - Endometrial hyperplasia
  - Diffuse malignancy

Endometrial Evaluation
Visual Evaluation

- Options
  - Hysteroscopy
  - Transvaginal sonography (TVS)
  - Saline-infusion sonohysterography (SIS)
  - 3D Ultrasound/SIS
- Diagnosis best made by visualizing the endometrial cavity for *focal anatomic causes*
  - Polyps
  - Submucous myomas
  - Focal malignancy

Does *age* affect the likelihood that the cause of AUB is amenable to a sonographic diagnosis?

Age-Based Findings at Hysteroscopy

Age Group (#)		Normal		Abnormal	
		%	#	%	#
≤ 29	14	64%	9	36%	5
30–39	58	45%	36	55%	22
40–49	105	42%	44	58%	61
50–59	43	28%	12	76%	31
> 60	18	33%	6	67%	12
Total	238	45%	107	55%	131

Indman PD, J Reprod Med 1995; 40: 545-548

Age-Based Findings at *SIS*
(filling defects)

Age	(#)	Normal		Abnormal	
		%	#	%	#
≤ 29	38	68.4%	26	31.6%	12
30–39	80	62.5%	50	37.5%	30
40–49	152	68.4%	104	31.6%	48
50–59	43	60.4%	26	39.6%	17
> 60	28	60.7%	17	39.3%	11
Total	*341*	65.4%	223	34.6%	118

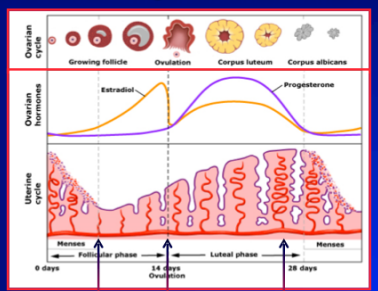
Brown and Shwayder, AIUM Annual Meeting 2007

Age-Based Findings at *Surgery*
(filling defects)

Age	(#)	Normal		Abnormal	
		%	#	%	#
≤ 29	38	73.7%	28	26.3%	10
30–39	80	67.5%	54	32.5%	26
40–49	152	70.4%	107	29.6%	45
50–59	43	67.4%	29	32.6%	14
> 60	28	64.3%	18	35.7%	10
Total	*341*	69.2%	236	30.8%	105

Brown and Shwayder, AIUM Annual Meeting 2007

Timing of Studies



G, P
LMP
BC
Surgery

≤ 5 mm | 10 mm | 15-18 mm

13 y.o. G0 with AUB

- Began menses age 11
- Heavy bleeding x 10 months
- hCG = negative

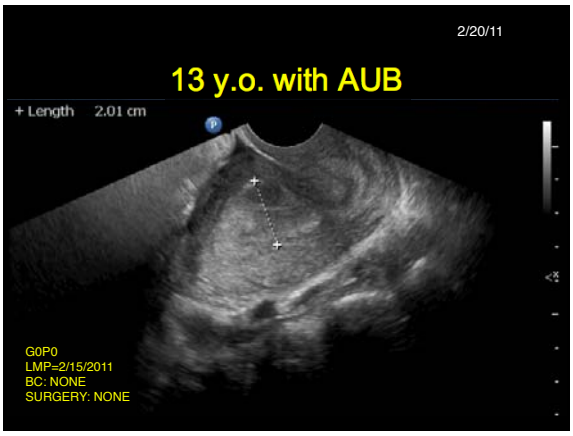
Adolescent Females

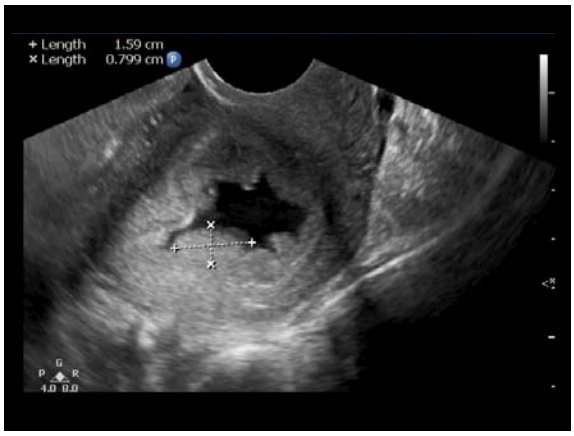
- "Immature" pituitary-hypothalamic axis
  - First 2 - 3 years following menarche
- Coagulation Disorders
  - 19% of adolescent patients with AUB
    - 25% if initial Hb < 10 gm/dL
    - 50% if hospitalization required

Claessens and Cowell, Am J Obstet Gynecol 1981; 139: 277-280

13 y.o. G0 with AUB

- Coagulation evaluation: WNL
- Minimal response to oral contraceptives
- hCG = negative
- Referred for ultrasound





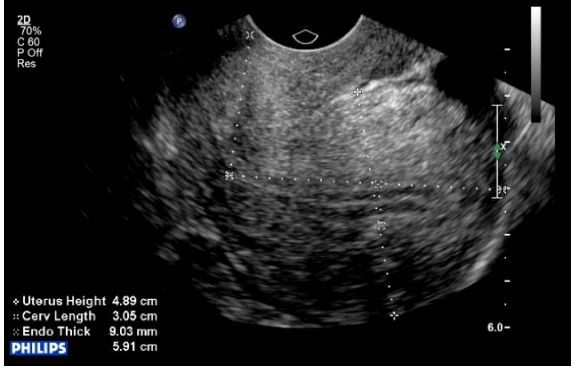
Advantage

- Preop diagnosis
- Preparation for surgery
  - Appropriate equipment
  - Preop medications

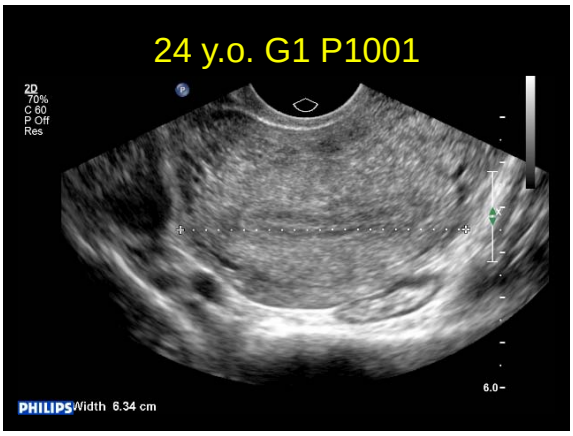
24 y.o. G1 P1001

- Presents with irregular, heavy bleeding for 8 months
- Delivered 1 year previously
- Breast fed x 2 months
- On oral contraceptives before pregnancy
- hCG: negative

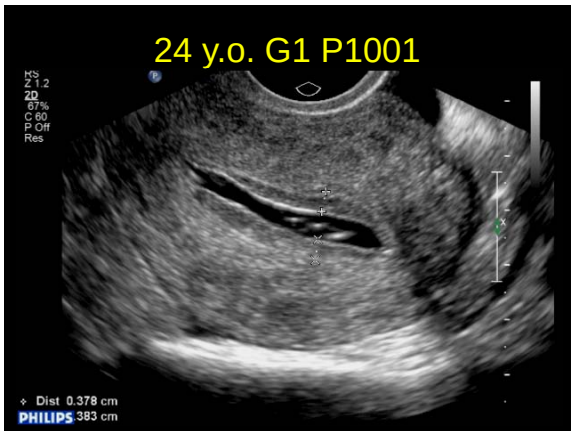
24 y.o. G1 P1001



24 y.o. G1 P1001



24 y.o. G1 P1001



24 y.o. G1 P1001

Additional history

- Finds bruises on her thighs frequently
- Has bloody noses ~ 2 x a month
- Her mother had a hysterectomy for heavy bleeding

Pathogenesis of AUB

Coagulopathies – Who to Evaluate?

History of 2 or more of the following:

- Bruising of > 5 cm 1-2 times/month
- Epistaxis 1-2 times per month
- Frequent gum bleeding with flossing or brushing teeth
- Family history of bleeding symptoms

Kouides et al. Fertil Steril 2005; 84: 1345-51.

The American College of Obstetricians and Gynecologists
WOMEN'S HEALTH CARE PHYSICIANS

COMMITTEE OPINION

Number 580 • December 2013 (Replaces No. 451, December 2009)

Von Willebrand Disease in Women

- Heavy menstrual bleeding since menarche
- One of the following conditions:
  - Postpartum hemorrhage
  - Surgery-related bleeding
  - Bleeding associated with dental work
- Two or more of the following conditions:
  - Epistaxis, 1 to 2 times per month
  - Frequent gum bleeding
  - Family history of bleeding symptoms

Age and Menorrhagia

- 115 women with menorrhagia
- Age 35.4 ± 11.9 years (13-53)

Age	#	%
< 19	25	21.8%
20-44	65	56.5%
> 45	25	21.7%

Philipp et al. Obstet Gynecol 2005;105:61-66.

Age and Menorrhagia

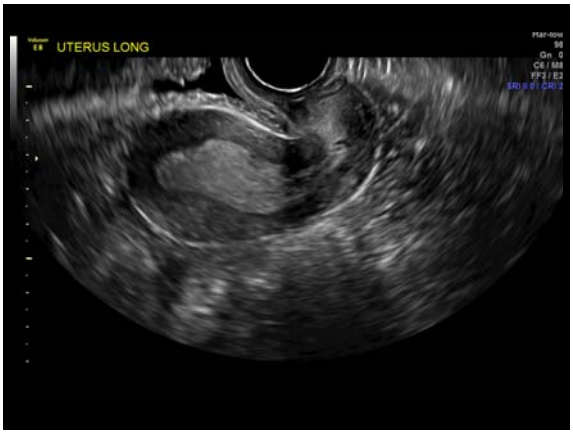
Abnormality	Total	≤ 19	20-44	≥ 45	*p*
Platelet aggregation	44	44	48	32	*.48*
Von Willebrand's factor	7	4	8	8	*.78*
Coagulation factor	5	8	6	0	*.34*
Any abnormality	47	48	52	32	*.32*

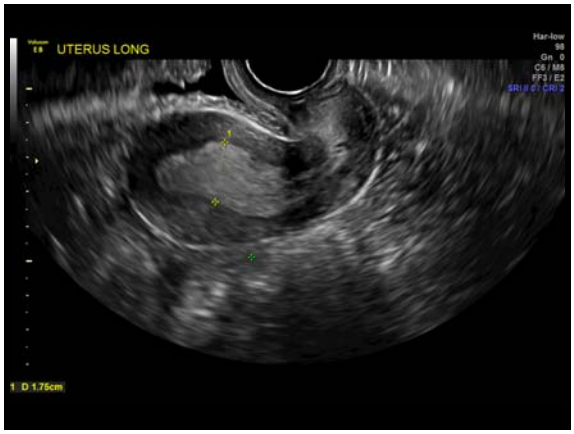
Values are percentages

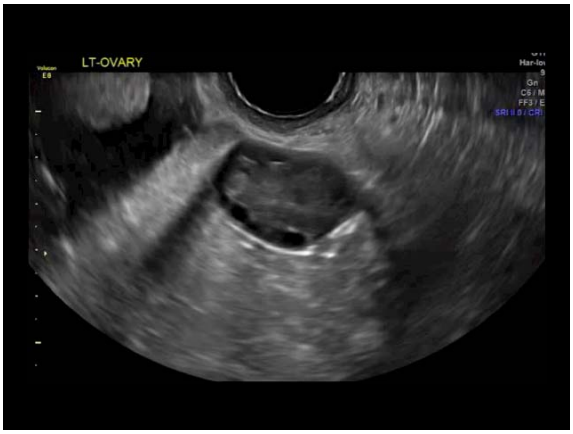
Philipp et al. Obstet Gynecol 2005;105:61-66.

28 y.o. - Menometrorrhagia

- LMP = 9/01/15 (Study on 9/08/15)
- BC: Pills
- Surgery: None
- BMI = 69







Pathology

ENDOMETRIUM, BIOPSY:

- Simple glandular hyperplasia without cytologic atypia.

PCO and Endometrial Cancer

- Chronic anovulation
  - RR = 3.1 (1.1 – 7.3)[1]
- Obesity
  - RR = 2.6 to 3.0[2]

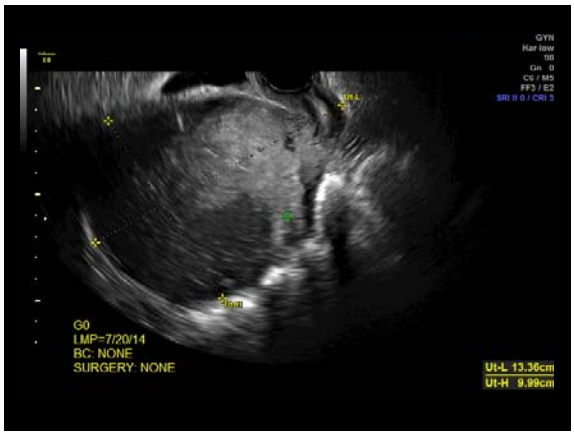
[1]Coulam et al. Obstet Gynecol 1983; 61: 403-407.
[2]Hardiman et al. Lancet 2003; 361: 1810-1812.

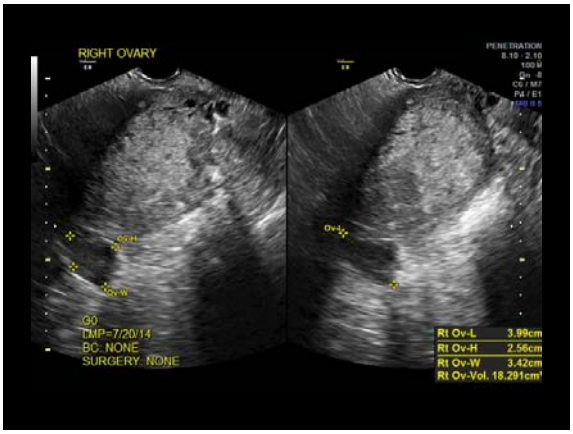
Endometrial CA and Age ≤ 45

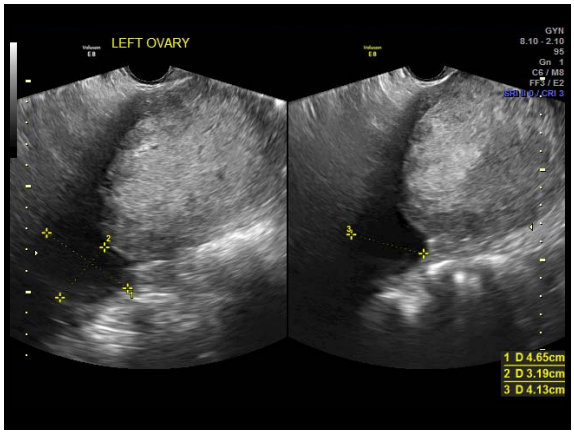
Pellerin and Finan. Am J Obstet Gynecol 2005; 193: 1640-44.

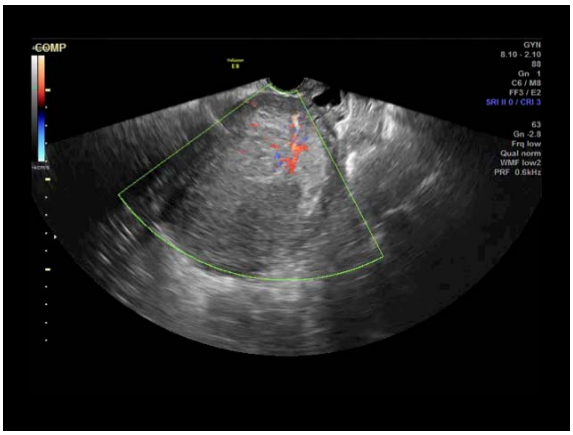
24 y.o. with Oligomenorrhea/ Menorrhagia

- G0
- Long-standing oligomenorrhea, now with menorrhagia
- BMI 73.2 kg/m^2









Endometrial Biopsy

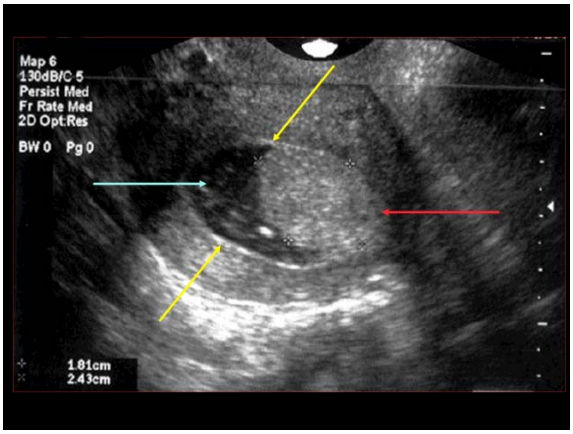
- Well-differentiated adenocarcinoma of the endometrium

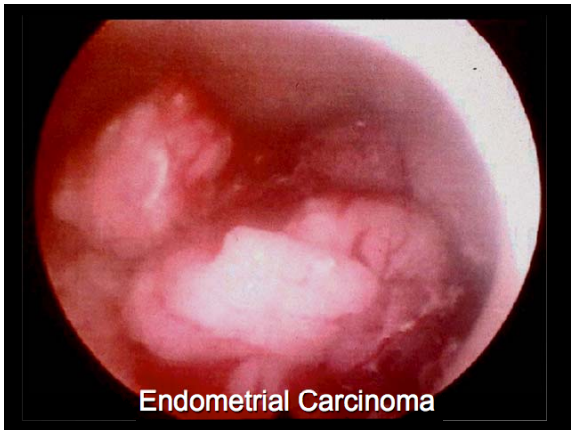
Endometrial Evaluation
Histologic Evaluation

- Options
  - Endometrial biopsy
  - Dilatation and curettage
- Diagnosis best made by tissue biopsy
  - Hormonal dysregulation
  - Endometritis
  - Endometrial hyperplasia
  - Diffuse malignancy

Postmenopausal Bleeding

- 58 yo G1P1001 with persistent postmenopausal bleeding
- Endometrial biopsy x 3
  - Tissue insufficient for diagnosis





Pipelle endometrial sampling. Sensitivity in the detection of endometrial cancer.

Author	Year	#	Sens	Journal
Zorlu	1994	26	95%	Gyn Ob Invest
Stovall	1991	40	97.5%	Obstet Gyn
Guido	1995	65	83%	J Reprod Med
Van den Bosch	1995	140	44.6%	Obstet Gyn

Evidence: II-1

Pipelle endometrial sampling. Sensitivity in the detection of endometrial cancer.

65 Patients with known endometrial cancer

- Endometrial biopsy prior to hysterectomy
- Adequate for analysis 63 of 65 97%
- Malignancy detected 54 of 65 83%
  - Missed: 5 on polyp
    3 disease < 5% of surface area
    All < 50% of the surface

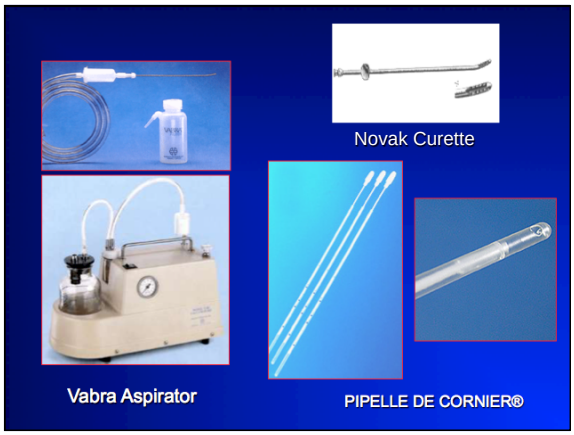
Guido et al. J Reprod Med 1995;40:553-555.

A comparison of Pipelle device and the Vabra aspirator

25 Patients scheduled for hysterectomy

- Percent surface area sampled
- Pipelle 4.2% ± 0.92%
- Vabra Aspirator 41.6% ± 5.7% (p<0.0001)
- Mean number of quadrants sampled (4 ant/4 post)
- Pipelle 2.4 ± 0.41
- Vabra aspirator 7.4 ± 0.42 (p < 0.0001)

Rodriguez, Yaqub, and King. Am J Obstet Gynecol 1993;168: 55-59.



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Rodriguez, Yaqub, and King. Am J Obstet Gynecol 1993;168: 55-59.

How should we investigate women with postmenopausal bleeding?

76 Postmenopausal women

- Pipelle in outpatient clinic
- TVS prior to outpatient hysteroscopy/D&C
  - Abnormal: Endometrial thickness > 5 mm
- Hysteroscopy and Curettage

Gupta et al, Acta Obstet Gynecol Scand 1996;75:475-479.

Type II-1

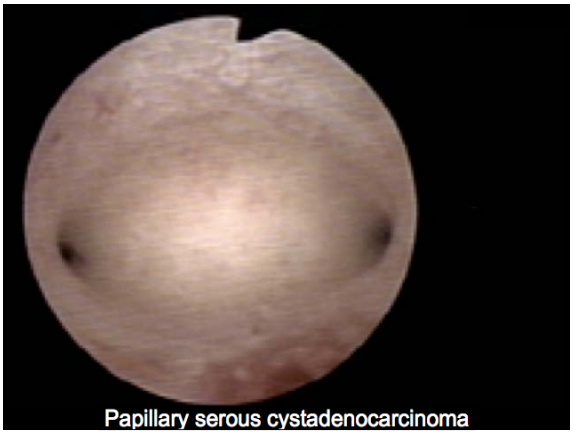
How should we investigate women with postmenopausal bleeding?

- Pipelle
  - Successful 70%
  - Sensitivity: 70%
- TVS
  - Sensitivity: 83%
  - Specificity: 77%
  - Positive predictive value: 54%
  - Detected 5 ovarian tumors
    - (3 missed on pelvic exam, 2 malignant)

Gupta et al, Acta Obstet Gynecol Scand 1996;75:475-479.

Postmenopausal Bleeding

- 61 yo G3P1021 with postmenopausal bleeding
- Spotting x 2 months



Papillary serous cystadenocarcinoma

Postmenopausal Bleeding

- 63 yo G2P1011 with postmenopausal bleeding
  - For 3 days
  - 3 weeks ago

ACOG COMMITTEE OPINION

Number 440 • August 2009

The Role of Transvaginal Ultrasonography in the Evaluation of Postmenopausal Bleeding

- Endometrial thickness < 5 mm
  - 82% could have a biopsy performed
  - 27% had adequate tissue
  - 73% had TIFD

ACOG Committee Opinion, Number 440, August 2009

ACOG COMMITTEE OPINION

Number 440 • August 2009

The Role of Transvaginal Ultrasonography in the Evaluation of Postmenopausal Bleeding

- Initial evaluation may be with either EMB or TVS
- Endometrial thickness > 4 mm should trigger further evaluation
  - EMB
  - Sonohysterography
  - Hysteroscopy
- EMB with TIFD requires additional evaluation

Endometrial Thickness and Postmenopausal Bleeding

Reference	ET (mm)	#	# CA	NPV (%)
Karlsson 1995	≤ 4	1168	0	100

Risk of Cancer = 1/917

Epstein 2001	≤ 5	97	0	100
Gull 2003	≤ 4	394	0	100

Postmenopausal Bleeding

- Endometrium = 3.9 mm
- Option A
  - No further bleeding
- Option B
  - Repeat episode of bleeding 8 months later

Can Ultrasound Replace D&C?

- 394 postmenopausal women referred for PMB (1987-1990)
- Menopausal if > 1 year w/o bleeding
- Ultrasound and D&C
- 10 year follow-up (n = 339)

Gull et al. Am J Obstet Gynecol 2003; 188: 401-08. Göteborg, Sweden

Recurrent PMB - None

Endometrial Thickness	#	CA
≤ 4 mm	134	0
5-7 mm	31	0
≥ 8 mm	22	0
Unmeasurable	4	0
TOTAL	191	0

Gull et al. Am J Obstet Gynecol 2003; 188: 401-08.
Göteborg, Sweden

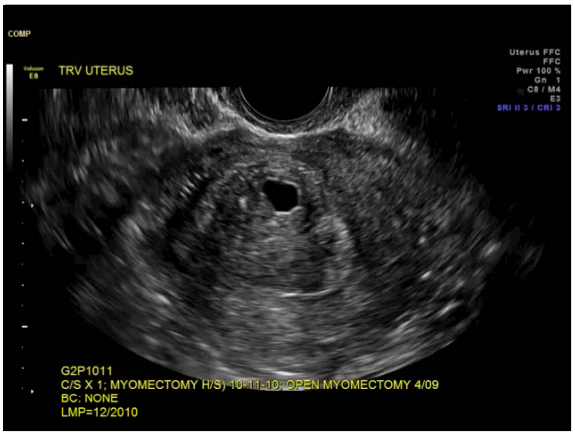
Recurrent PMB - Yes

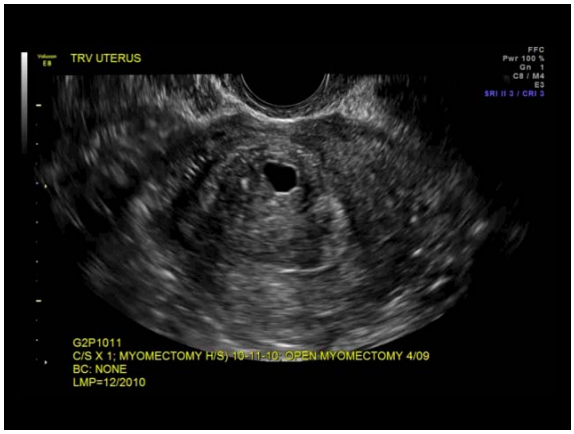
Endometrial Thickness	#	CA	Hyper	CA or Hyperp
≤ 4 mm	28	0	2 7.1%	2 7.1%
5-7 mm	9	3 33.3%	1 11.1%	4 44.4%
≥ 8 mm	28	4 14.3%	5 17.9%	9 32.1%
Unmeasurable	1	0	0	0
TOTAL	66	7 10.6%	8 12.1%	15 22.7%

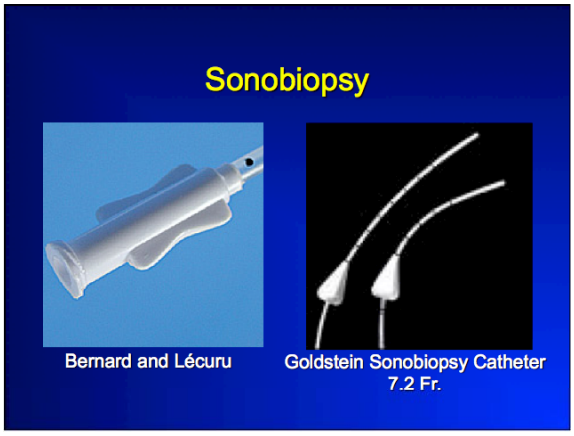
Sonohysterography

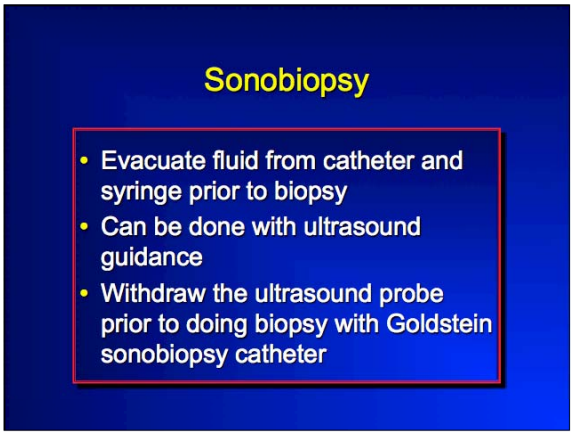
38 y.o. G2P1011

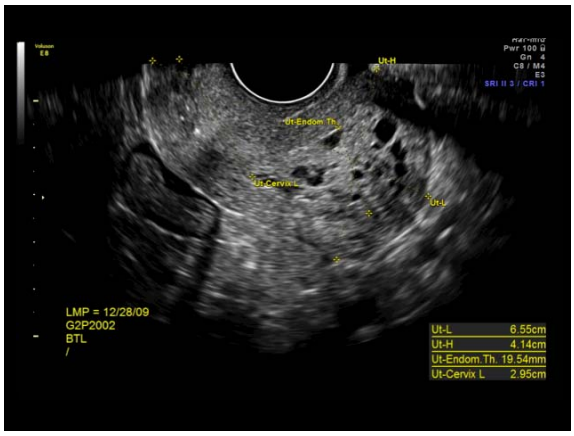
- c/o of irregular and heavy bleeding
- Myomectomy 2009
- Hysteroscopic myomectomy 10/11/10
- C-section x 1











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Endometrial Aspiration at SIS Age > 50

- 603 patients
- Indication
  - PMB 73.8%
  - Thickened endometrium 15.3%
  - Suspected polyp 9.3%
  - Abnormal Pap 1.7%

Rotenberg et al. Obstet Gynecol 2015;125(2):414-23.

Endometrial Aspiration at SIS

- Simultaneous
  - Endometrial aspiration in all cases
- Sequential
  - Endometrial aspiration only if SIS is abnormal
    - Polyps
    - Focal lesion
    - Thickened endometrium

Rotenberg et al. Obstet Gynecol 2015;125(2):414-23.

Endometrial Aspiration at SIS

If proliferative endometrium = Normal
- Screen positive = surgery 4.5%
- Missed hyperplasia or cancer 13.3%

If proliferative endometrium = Abnormal
- Screen positive = surgery 13%
- No missed hyperplasia or cancer

Rotenberg et al. Obstet Gynecol 2015;125(2):414-23.

Conclusions

- Ultrasound is a reasonable first step in evaluation in patients with AUB
- ~ 1/3 will have an endometrial polyp or submucous myoma regardless of age

Conclusions

- Consider coagulopathies in patients based on historical information
- Consider endometrial biopsy as first-line evaluation in obese patients with long-standing oligo/amenorrhea

Conclusions: Endometrial Thickness ≤ 4

- TVS endometrial thickness ≤ 4 mm is a reasonable threshold to avoid initial endometrial biopsy or SIS
- Recurrent abnormal vaginal bleeding requires further evaluation

Conclusions: Proliferative Endometrium

- Postmenopausal bleeding
- Proliferative endometrium on EMB may be abnormal
- May warrant further evaluation

Thank You

James Shwayder, MD, JD

Professor and Chair
Obstetrics and Gynecology
University of Mississippi
Jackson, Mississippi

Wiser Hospital for Women and Infants


Notes

Notes

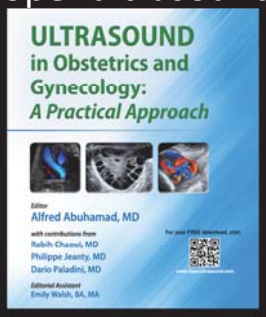
Adnexal Masses: What's Benign and What's Malignant?

Alfred Abuhamad, M.D.
Professor and Chairman
Department of Obstetrics and Gynecology
Vice Dean for Clinical Affairs
Eastern Virginia Medical School
Norfolk, VA

Adnexal Masses: What's benign & What's Malignant?

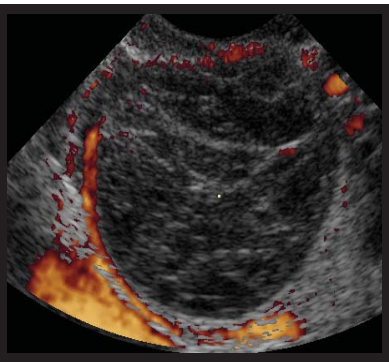
Alfred Abuhamad, MD
Eastern Virginia Medical School

www.openultrasound.com



Free download – open access

25 year old, referred with left pelvic pain, US of left adnexa



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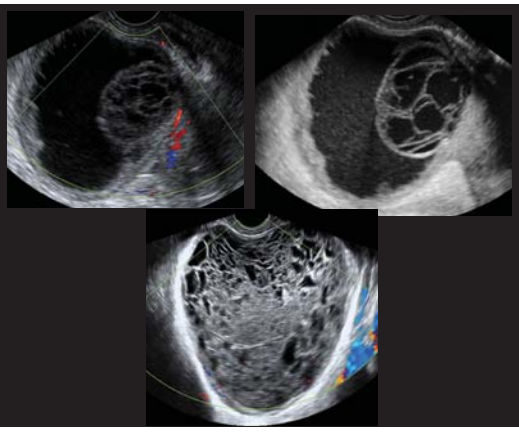
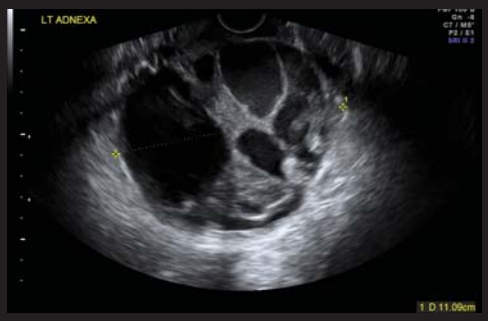
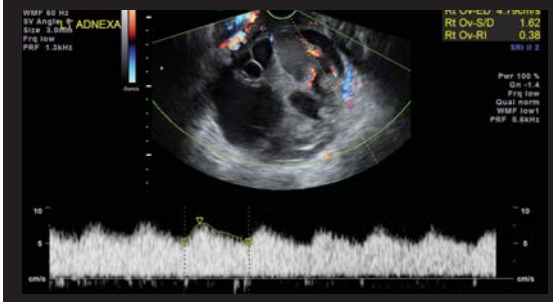




28 years old – 11 weeks pregnant - asymptomatic



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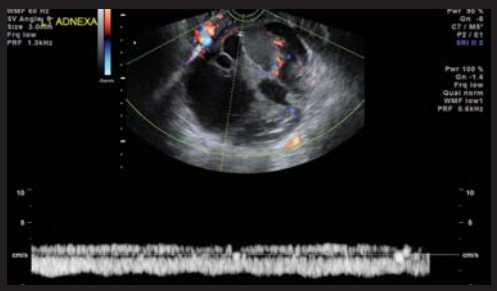
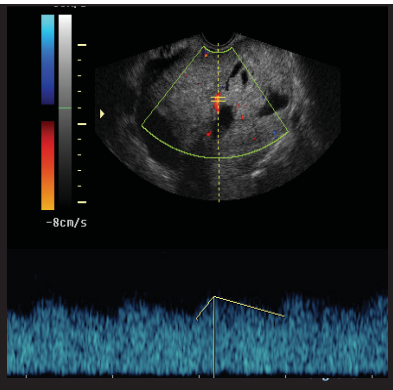


28 years old – 11 weeks pregnant - asymptomatic

33 year old, G0, undergoing IVF – left adnexal mass, asymptomatic



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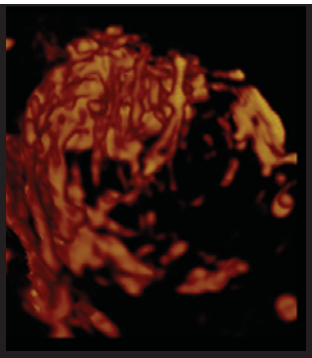

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24 year old – pain in right lower quadrant

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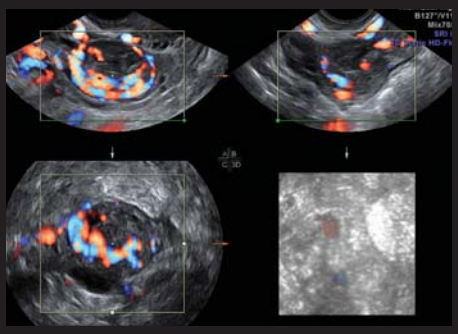


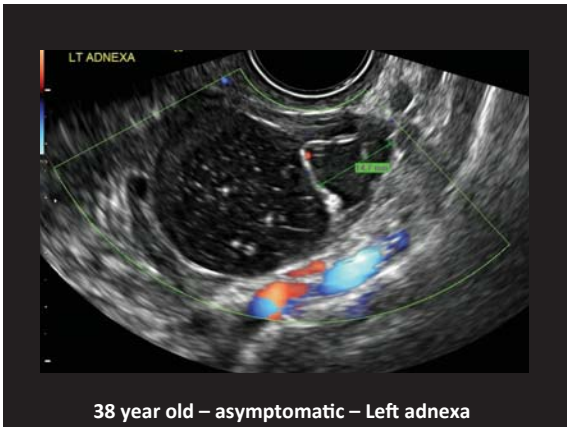
24 year old – pain in right lower quadrant

24 year old – pain in right lower quadrant

BHCG- 22

24 year old – pain in right lower quadrant

38 year old – asymptomatic – Left adnexa



38 year old – asymptomatic – Left adnexa

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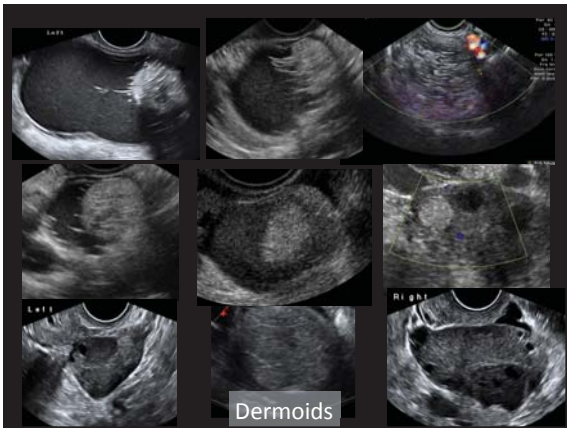
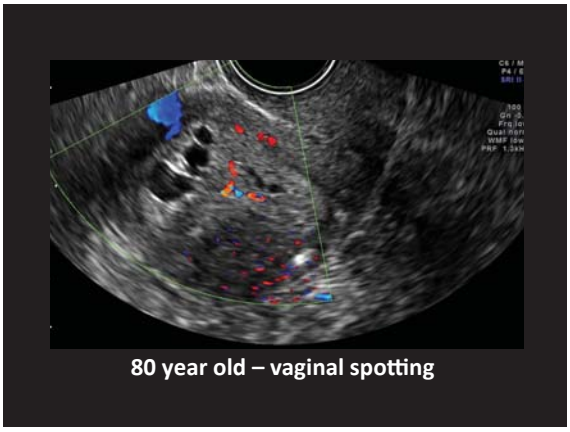
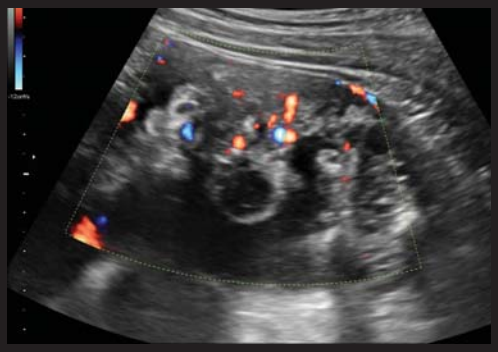


80 year old – vaginal spotting

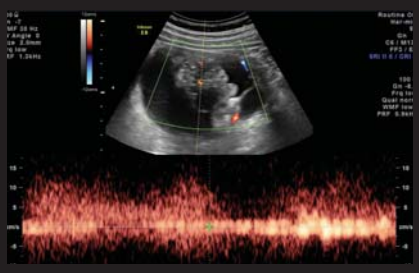


80 year old – vaginal spotting

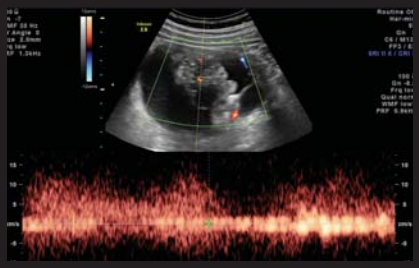
28 year old – pregnant at 31 weeks – L adnexa



28 year old – pregnant at 31 weeks – L adnexa



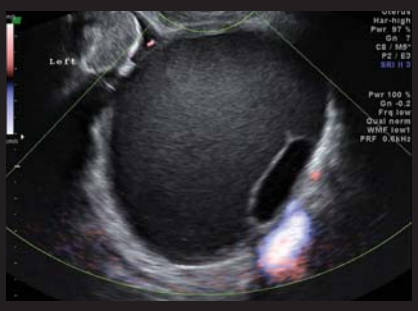
28 year old – pregnant at 31 weeks – L adnexa



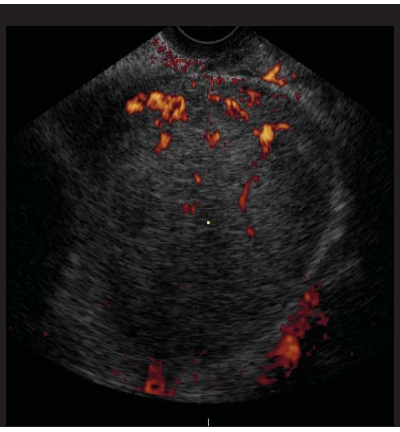
28 year old – pregnant at 31 weeks – L adnexa

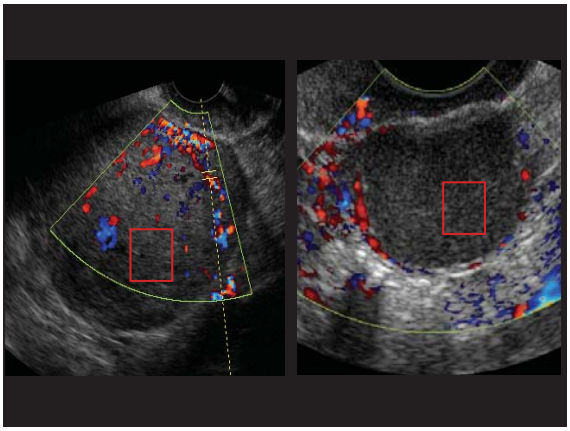
Immature Teratoma with neuronal elements

34 year old referred with a large left pelvic mass – History of infertility



34 year old referred with a large left pelvic mass – History of infertility





53 year old referred for pelvic pain, S/P TAH, LSO

53 year old referred for pelvic pain, S/P TAH, LSO

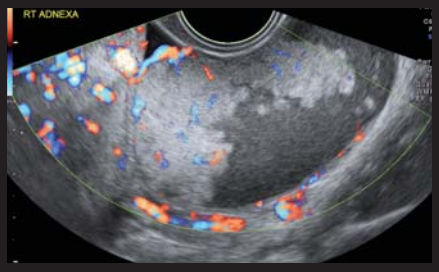
53 year old referred for pelvic pain, S/P TAH, LSO

53 year old referred for pelvic pain, S/P TAH, LSO

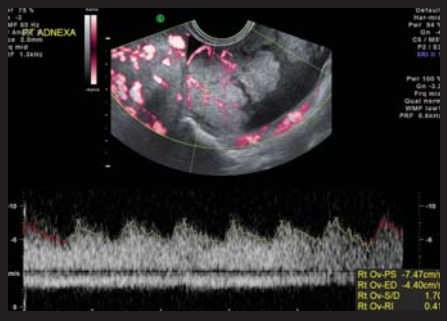
31 year old – 12 weeks pregnant

31 year old – 12 weeks pregnant

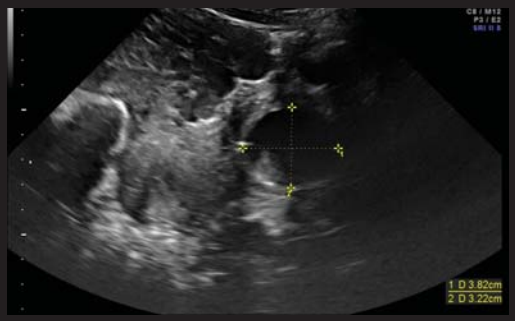
41 year old - referred with Rt sided fullness, large mass on exam



41 year old - referred with Rt sided fullness, large mass on exam

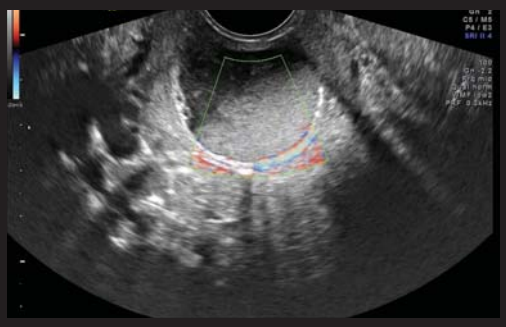


41 year old - referred with Rt sided fullness, large mass on exam



24 year old, at 20 weeks gestation, referred for evaluation of midline pelvic mass

24 year old, at 20 weeks gestation, referred for evaluation of midline pelvic mass



24 year old, at 20 weeks gestation, referred for evaluation of midline pelvic mass

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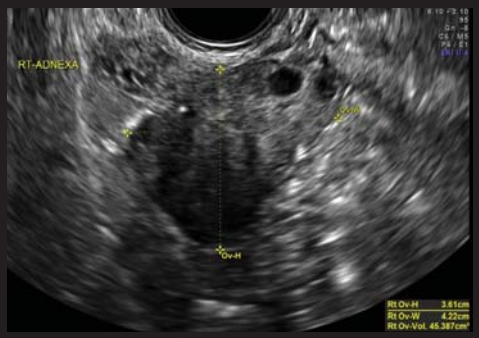
29 year old , referred to assess the RT Ovary



29 year old , referred to assess the RT Ovary

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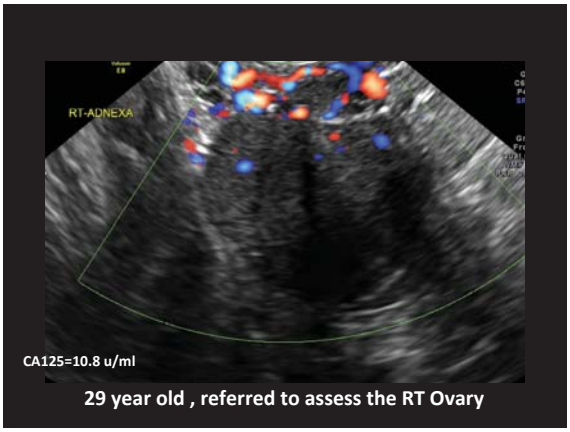
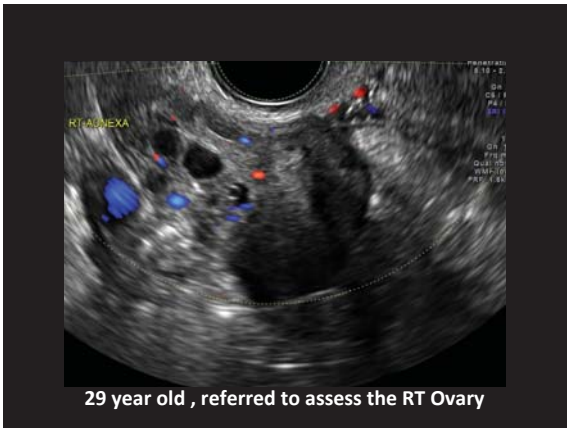
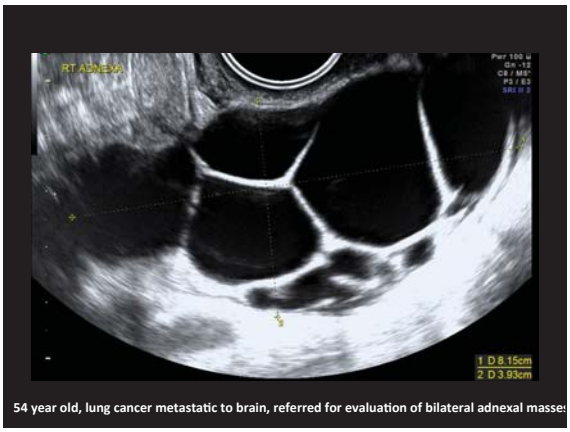


CA125=10.8 u/ml

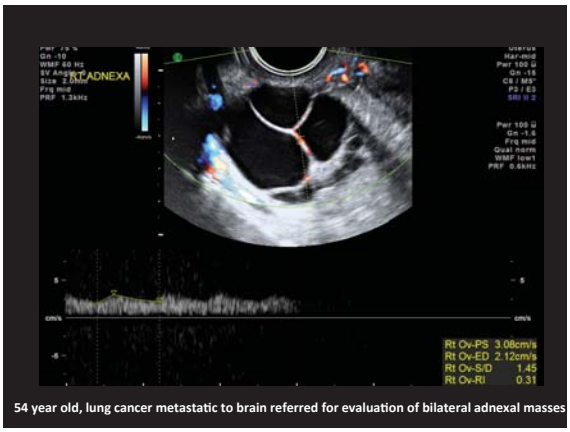
29 year old , referred to assess the RT Ovary



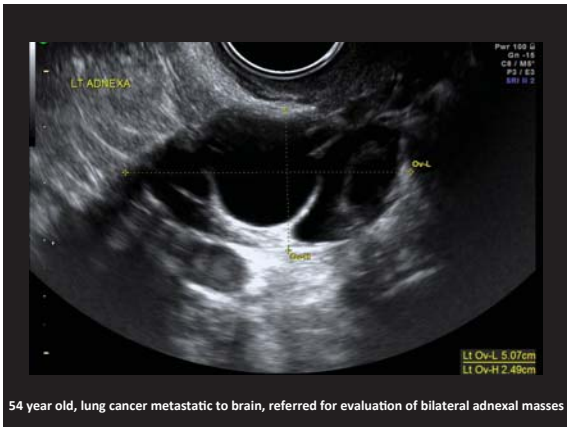
29 year old , referred to assess the RT Ovary



54 year old, lung cancer metastatic to brain, referred for evaluation of bilateral adnexal masses



54 year old, lung cancer metastatic to brain referred for evaluation of bilateral adnexal masses

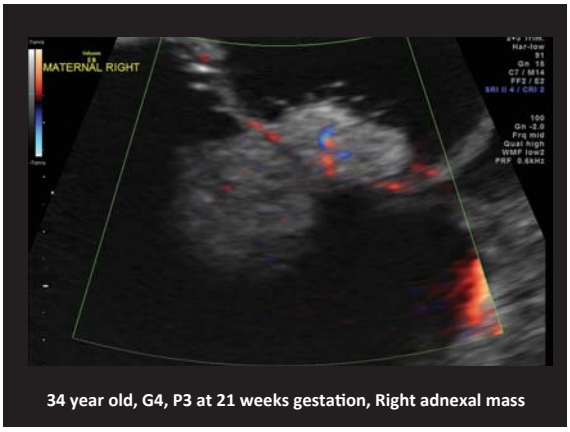


54 year old, lung cancer metastatic to brain, referred for evaluation of bilateral adnexal masses

54 year old, lung cancer metastatic to brain, referred for evaluation of bilateral adnexal masses

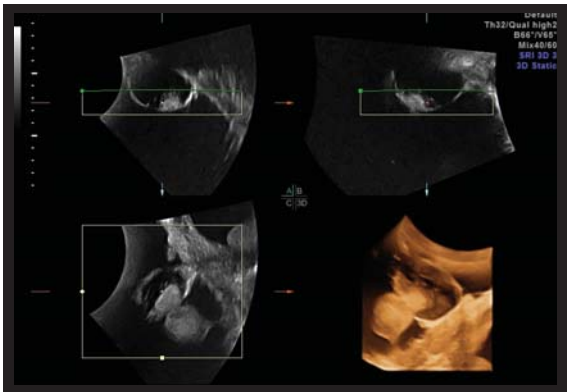
34 year old, G4, P3 at 21 weeks gestation, Right adnexal mass

34 year old, G4, P3 at 21 weeks gestation, Right adnexal mass



34 year old, G4, P3 at 21 weeks gestation, Right adnexal mass

34 year old, G4, P3 at 21 weeks gestation, Right adnexal mass



34 year old, G4, P3 at 21 weeks gestation, Right adnexal mass

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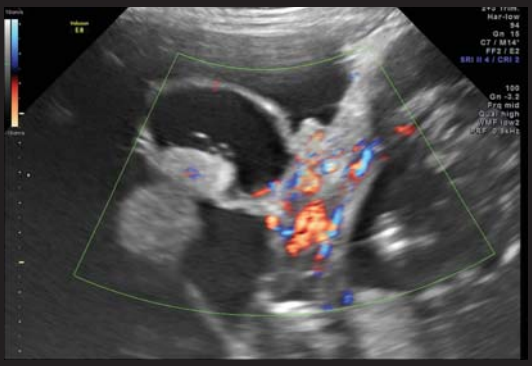
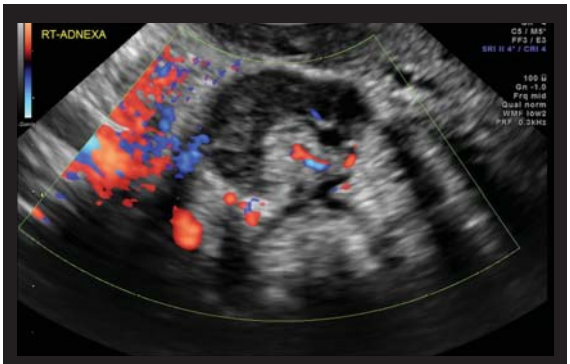


34 year old, G4, P3 at 21 weeks gestation, Right adnexal mass

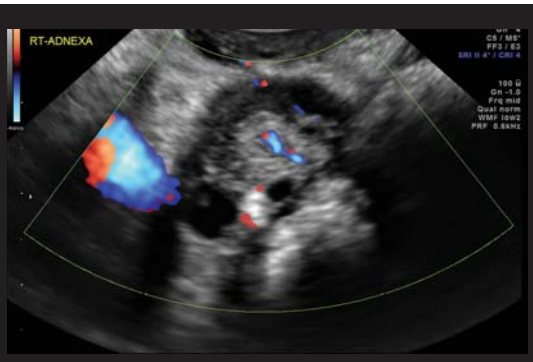
34 year old, G4, P3 at 21 weeks gestation, Right adnexal mass

54 year old, enlarged right ovary

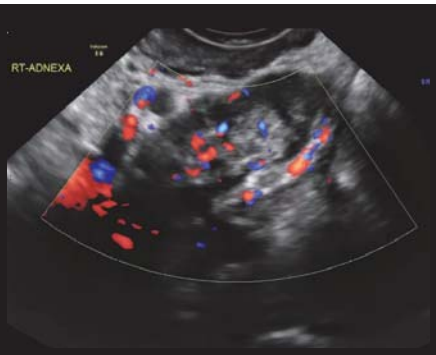
54 year old, enlarged right ovary



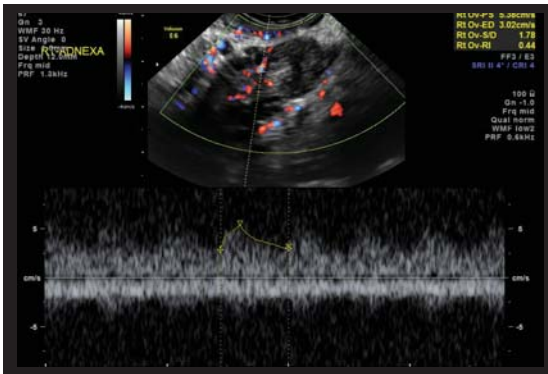
54 year old, enlarged right ovary



54 year old, enlarged right ovary

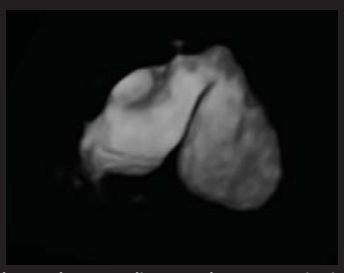


54 year old, enlarged right ovary



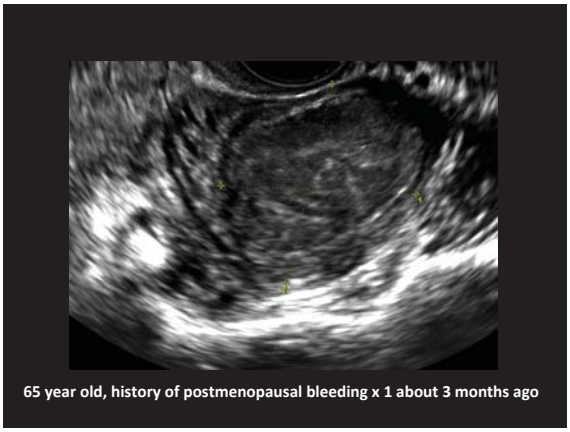
54 year old, enlarged right ovary

75 year old, complex mass discovered on CT scan in right adnexa



75 year old, complex mass discovered on CT scan in right adnexa

65 year old, history of postmenopausal bleeding x 1 about 3 months ago



65 year old, history of postmenopausal bleeding x 1 about 3 months ago

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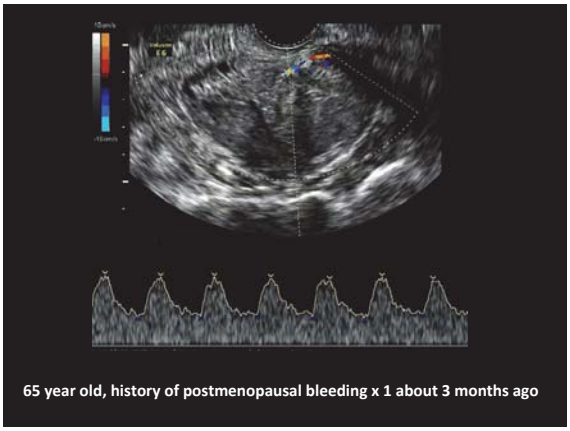
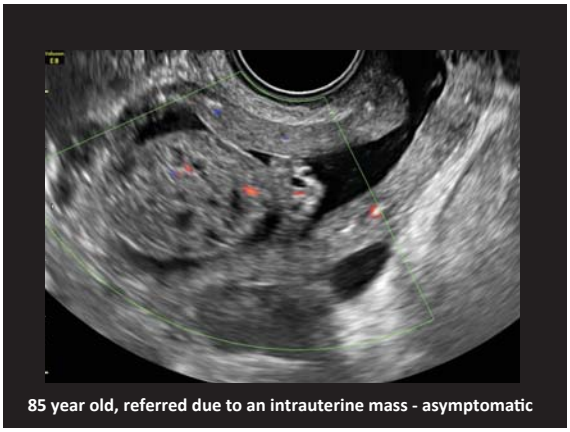


65 year old, history of postmenopausal bleeding x 1 about 3 months ago

85 year old, referred due to an intrauterine mass - asymptomatic



85 year old, referred due to an intrauterine mass - asymptomatic

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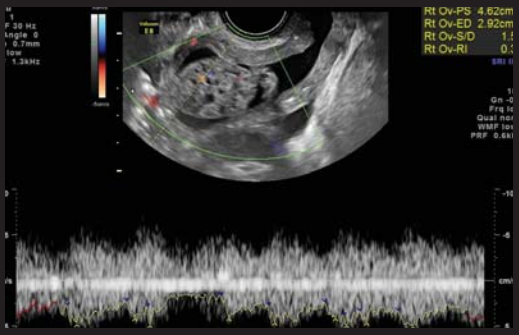
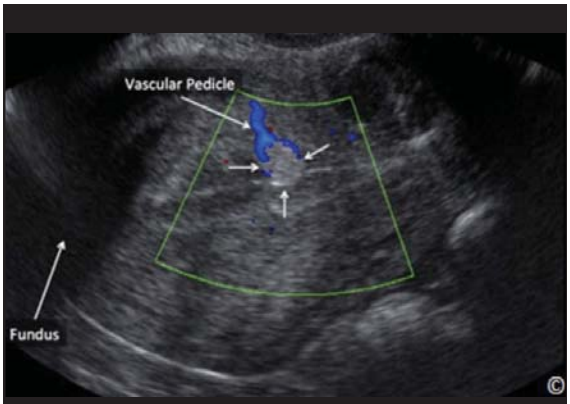
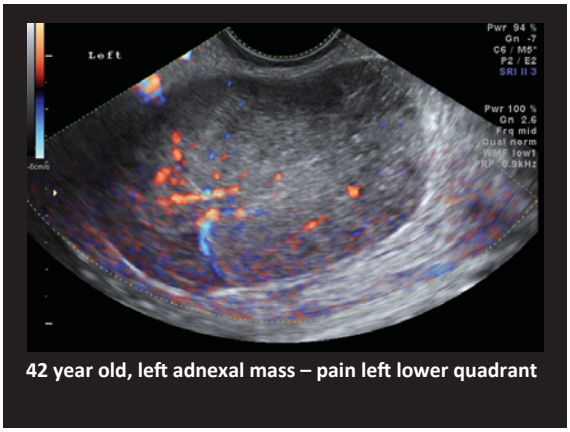
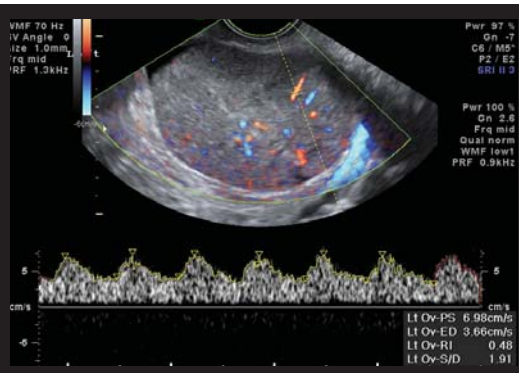


85 year old, referred due to an intrauterine mass - asymptomatic

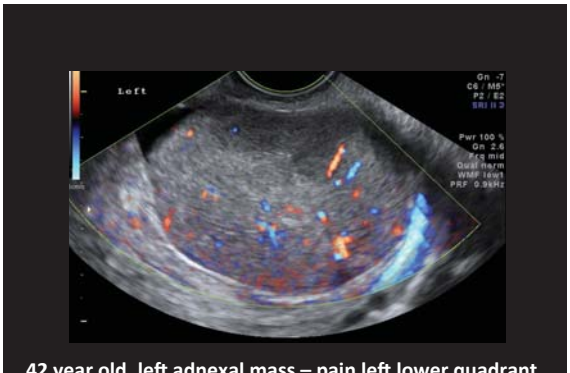




42 year old, left adnexal mass – pain left lower quadrant



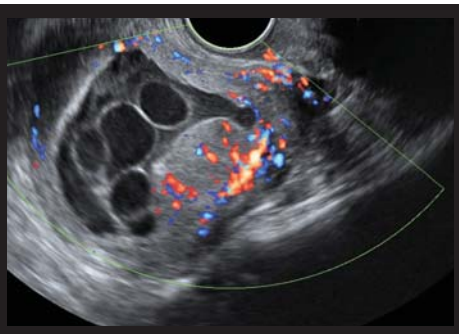
42 year old, left adnexal mass – pain left lower quadrant



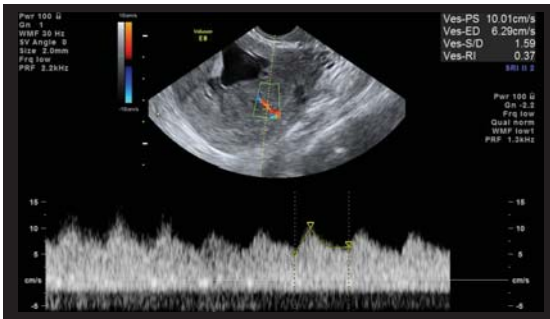
42 year old, left adnexal mass – pain left lower quadrant

50 year old – referred for an evaluation of a uterine mass

50 year old – referred for an evaluation of a uterine mass



50 year old – referred for an evaluation of a uterine mass



50 year old – referred for an evaluation of a uterine mass

Notes

Notes

Ultrasound in the Diagnosis and Management of Ectopic Pregnancy

James M. Shwayder, M.D., J.D.
Professor and Chair
Department of Obstetrics and Gynecology
University of Mississippi Medical Center
Jackson, MS

Ultrasound in the Evaluation of Ectopic Pregnancy and PUL

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Ultrasound in the Evaluation of Ectopic Pregnancy and PUL

James M. Shwayder, M.D., J.D.

Disclosures: None

Learning Objectives

- Nomenclature regarding pregnancy of unknown location (PUL)
- Alternative approaches the diagnostic dilemma of evaluating a patient with a possible ectopic pregnancy.
- Understand the value of various diagnostic tests.
- Gain insight into the ultrasound findings in patients with an ectopic pregnancy

Consensus Nomenclature

1. Definite ectopic pregnancy (EP)
2. Probable EP
3. PUL
4. Probable intrauterine pregnancy
5. Definite IUP

Barnhart et al. Fertil Steril 2011; 95: 857-866

Consensus Nomenclature

- Definite ectopic pregnancy (EP)
  - Extrauterine gestational sac with yolk sac and/or embryo (with or without cardiac activity)
- Probable EP
  - Inhomogeneous adnexal mass or extrauterine sac-like structure

Barnhart et al. Fertil Steril 2011; 95: 857-866

Consensus Nomenclature

- Probable intrauterine pregnancy
  - Intrauterine echogenic sac-like structure
- Definite IUP
  - Intrauterine gestational sac with yolk sac and/or embryo (with or without cardiac activity)

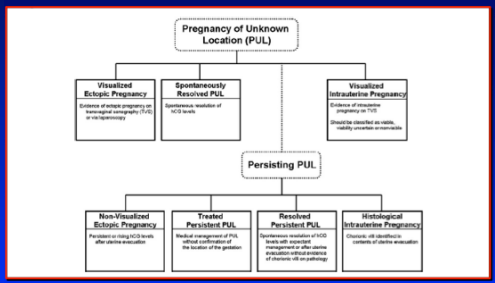
Barnhart et al. Fertil Steril 2011; 95: 857-866

Consensus Nomenclature

- PUL
  - no signs of either EP or IUP

Barnhart et al. Fertil Steril 2011; 95: 857-866

Pregnancy of Unknown Location



Barnhart et al. Fertil Steril 2011; 95: 857-866

CP 1

Case Presentation

- 28 y.o. G1P0 presents with pelvic pain and scant vaginal spotting.
- LMP ~ 4-5 weeks ago
- + UPT at home
- Exam: VSS
  Uterus AV, NT, TNS
  Adnexa: NT, without masses
- hCG = 874 IU/L

Increase in hCG in early pregnancy

Sampling Interval (days)	% Increase
1	29
2	66
3	114
4	175
5	255

Kadar et. al. Obstet Gynecol 1981; 58: 162 (Yale)

Increase in hCG in early pregnancy

- Doubling time = 2.98 days
- 15% of normal pregnancies had abnormal ß-hCG increases

Kadar et. al. Obstet Gynecol 1981; 58: 162 (Yale)

Increase in hCG in early pregnancy

Days	Range	Median
1	1.24 – 1.81	1.50
2	1.53 – 3.28	2.24
3	1.88 – 5.94	3.35
4	2.33 – 10.76	5.00
7	4.38 – 63.88	16.73

Barnhart et al. Obstet Gynecol 2004; 104: 50-55.

CP 1

Case Presentation

Day 1	hCG = 874 IU/ml
Day 3	hCG = 1,056 IU/ml
Day 5	hCG = 1,110 IU/ml

Threshold vs. Discriminatory Levels

Threshold level
- Lowest ß-hCG level at which a normal intrauterine pregnancy can be detected

Discriminatory level
- The level of ß-hCG above which all normal intrauterine pregnancies should be seen

Threshold vs. Discriminatory Levels

Threshold level
- ß-hCG = 400-500 mIU/mL (1st IRP)

Discriminatory level
- ß-hCG = 1000-1500 mIU/mL (1st IRP)

Dependencies
- Transducer frequency, uterine position, body habitus, operator experience/ability

Evidence Against the hCG Discriminatory Level

- January 1, 2000 - December 31, 2010
- TVS and β-hCG on same day
- No intrauterine fluid collection
- Subsequent embryonic or fetal cardiac activity

Doubilet and Benson, J Ultrasound Med 2011; 30:1637-1642

Evidence Against the hCG Discriminatory Level

hCG (3-4th IS)	# (202)	%
<1000	162	80.2
1000-1499	19	9.4
1500-1999	12	5.9
2000	9	4.5

Doubilet and Benson, J Ultrasound Med 2011; 30:1637-1642

Reevaluation of Discriminatory and Threshold Levels

- 651 patients
- TVS and β-hCG within 6 hours of each other
- Known intrauterine pregnancies
- Findings visualized 99% of the time
- 1st, 3rd, or 4th International Standard – 2nd I.S.~ ½ that of others

Connolly et al. Obstet Gynecol 2013;121:65-70.

Reevaluation of Discriminatory and Threshold Levels

hCG = mIU/mL	Gestational Sac	Yolk Sac	Embryo
Threshold level	390	1094	1394
Discriminatory level	3510	17,716	47,685

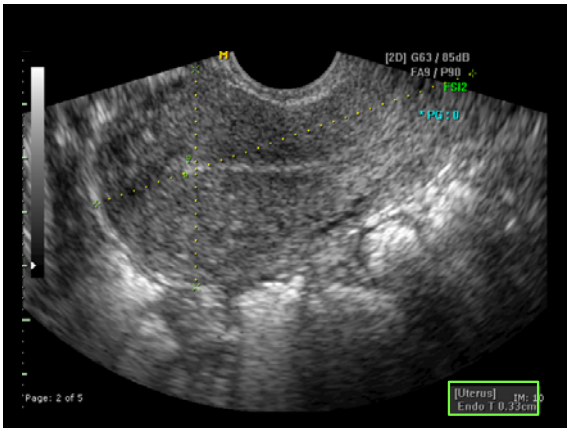
Connolly et al. Obstet Gynecol 2013;121:65-70.

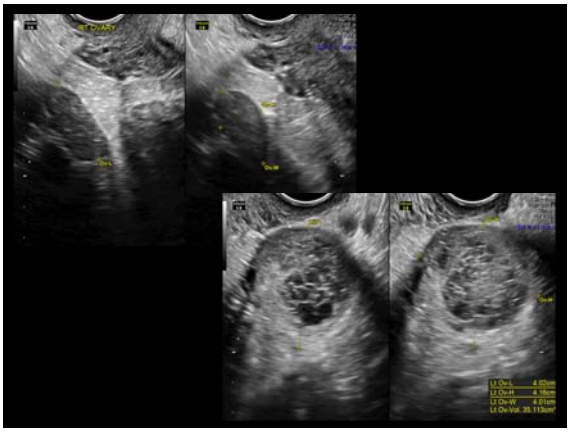
Reevaluation of Discriminatory and Threshold Levels

Table 2. Discriminatory and Threshold Values: Serum β-Human Chorionic Gonadotropin Levels

	Current Study (99% Predicted Probability of Detection, Milli-International Units/mL Reported as Third International Standard)	Prior Studies[4–14] (Milli-International Units/mL Reported as First International Reference Preparation or Third International Standard)
Discriminatory values		
Gestational sac	3,510	1,000–2,000
Yolk sac	17,716	7,200
Fetal pole	47,685	5,100–10,800
Threshold values		
Gestational sac	390	500–1,000
Yolk sac	1,094	5,400
Fetal pole	1,394	24,000

Connolly et al. Obstet Gynecol 2013;121:65-70.





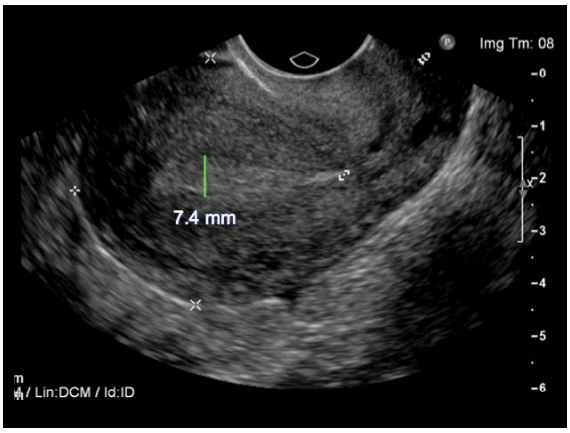
CP 1

Case Presentation

- TVS
  - Uterus
    - No evidence of IUP
  - Ovaries
    - Corpus luteum - left
  - Adnexa
    - No definite adnexal pathology
- Current terminology PUL
- Treatment MTX 50 mg/m²

Case Presentation

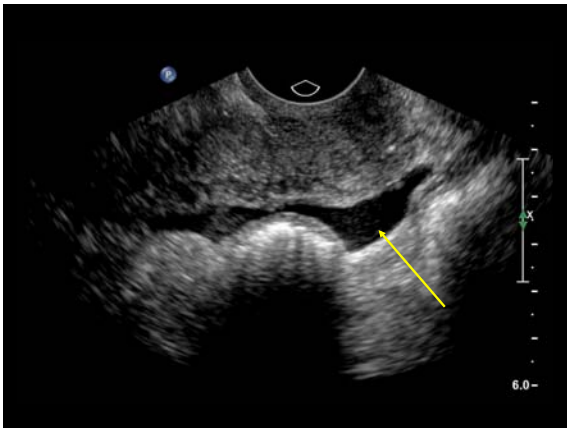
- 24 y.o. G2P0010 presents with scant vaginal spotting and pain
- LMP ~ 5 weeks ago
- Exam: VSS
  Uterus NSSC, NT; Adnexa: NT
- Initial: hCG = 710 IU/L
- Repeat in 2 days: hCG = 980 IU/L

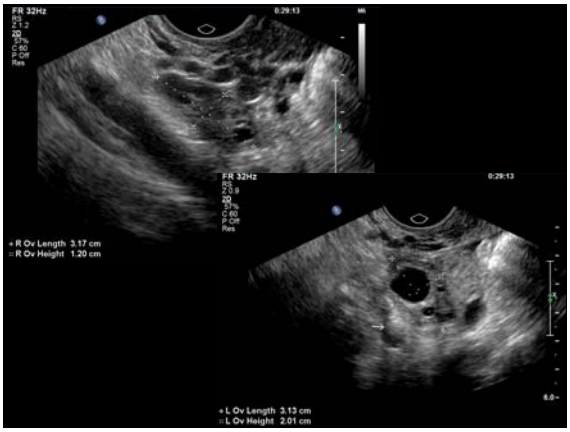


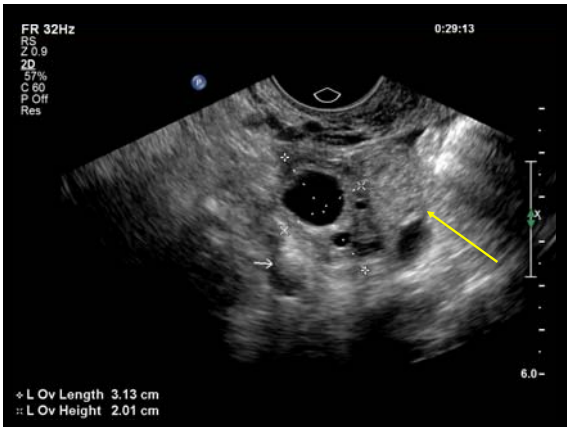
Endometrial Thickness in Ectopic Pregnancy when hCG < Discriminatory Zone

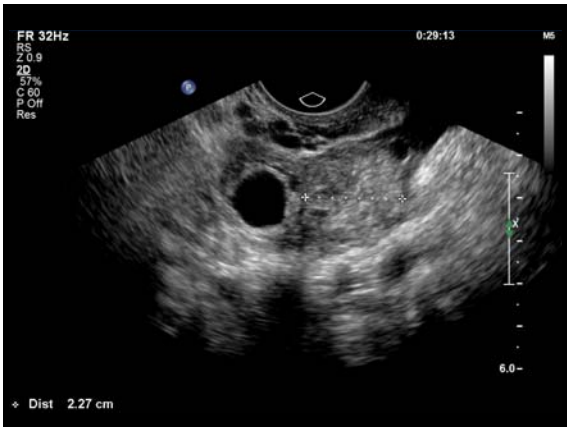
Outcome	Mean (mm)	Range (mm)
Intrauterine pregnancy	13.42	± 0.68
Spontaneous abortion	9.28	± 0.88
Ectopic pregnancy	5.95	± 0.35
Abnormal pregnancy (97%)	≤ 8	

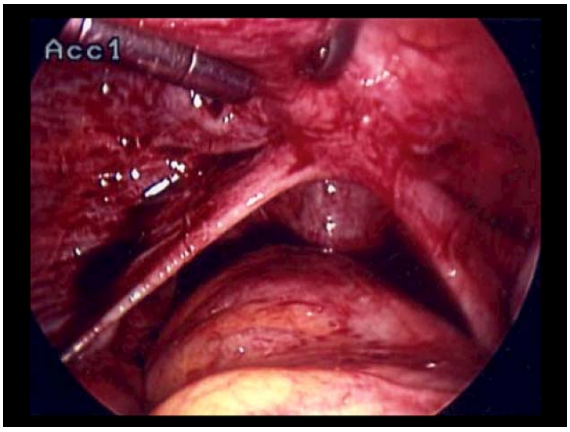
Spandorfer and Barnhart. Fertil Steril 1996; 474-47.

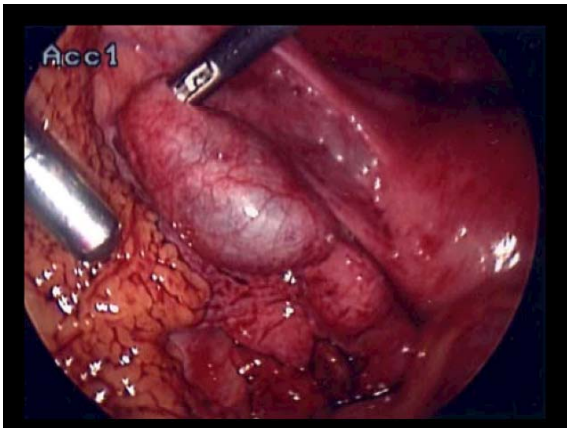






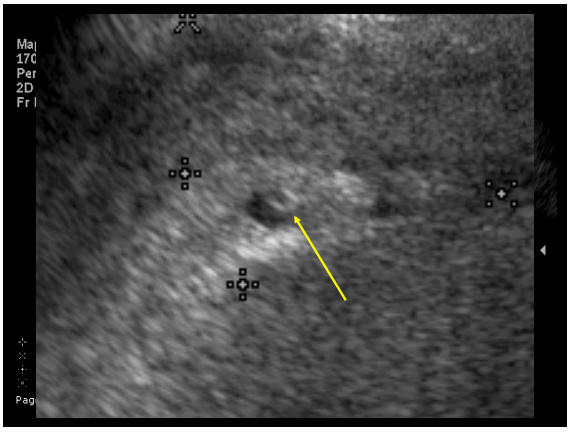


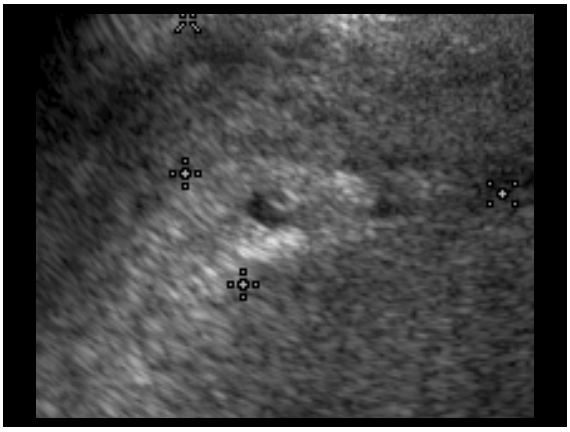




Case Presentation - #3

- 28 y.o. G1P0 presents with pelvic pain and scant vaginal spotting.
- LMP ~ 7 weeks ago
- Exam: VSS
  Uterus TNS;
  Mild adnexal discomfort
- hCG = 4,634 IU/L





Intrauterine Fluid with Ectopic Pregnancy

229 patients with ectopic	#	%
• No intrauterine fluid	191	83.4
• Intrauterine fluid	38	16.6
– Adnexal mass	33	86.8

Benson et al. J Ultrasound Med 2013;32:389-393.

Intrauterine Fluid with Ectopic Pregnancy

38 patients	#	%
• Type A	31	81.6
– Pointy edged	30	78.9
– Echoes	28	73.7
– Located with the cavity	21	55.3
• Type B	7	18.4
– Smooth walled		
– Located in decidua or uncertain		

Benson et al. J Ultrasound Med 2013;32:389-393.

Pointed edge

Echoes or debris

Type A

Within the uterine cavity

Benson et al. J Ultrasound Med 2013;32:389-393.

Type B

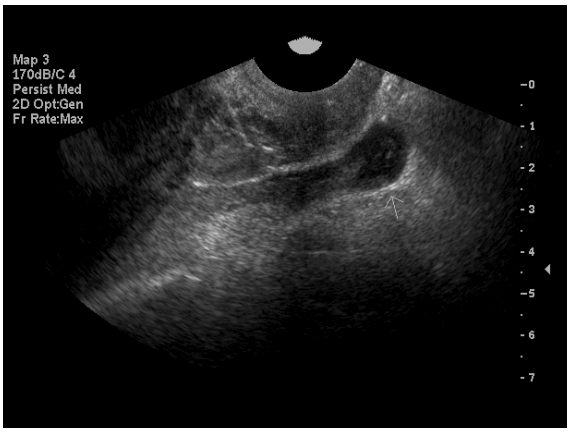
Ectopic Pregnancy

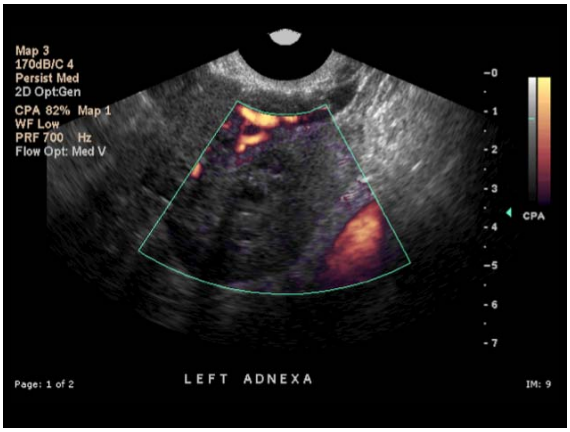
Intrauterine Pregnancy

Benson et al. J Ultrasound Med 2013;32:389-393.

Conclusions

- Findings
  - A smooth-walled anechoic intrauterine cystic structure
  - No adnexal mass
- Probability
  - Intrauterine pregnancy 99.8%
  - Ectopic pregnancy 0.02%





TVS for Diagnosing Ectopics

Reviewed 10 studies

- 2216 patients
- Ectopic = 565 25.5%
- No ectopic = 1651 74.5%

Brown and Doubilet, J Ultrasound Med 1994; 13: 259 (Harvard)

TVS for Diagnosing Ectopics

Inclusion criteria

- Clinical suspicion of ectopic pregnancy
- All patients underwent TVS
- All cases of EP were surgically confirmed
- No adnexal masses were excluded, except simple cysts

Brown and Doubilet, J Ultrasound Med 1994; 13: 259 (Harvard)

TVS for Diagnosing Ectopics

Criteria for ectopic pregnancy

A: Adnexal embryo with heartbeat

B: Adnexal mass containing yolk sac or embryo

C: Adnexal mass with central anechoic area and hyperechoic rim ("tubal ring")

D: Any adnexal mass other than a simple cyst or an intraovarian lesion

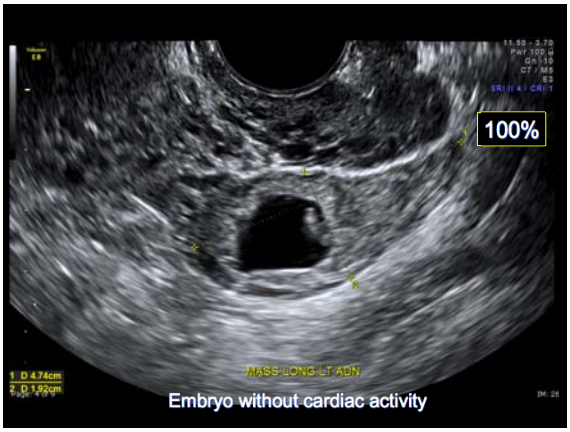
Brown and Doubilet, J Ultrasound Med 1994; 13: 259

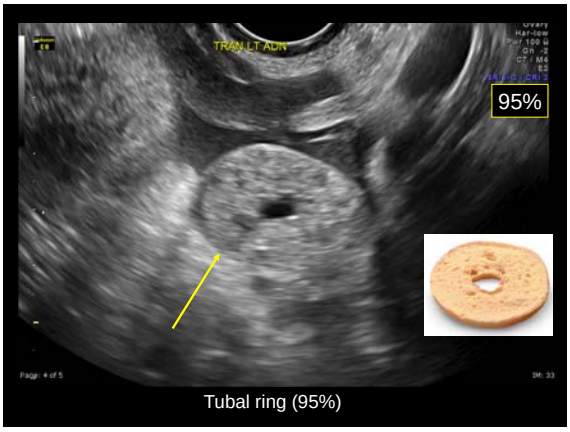
Adnexal Findings

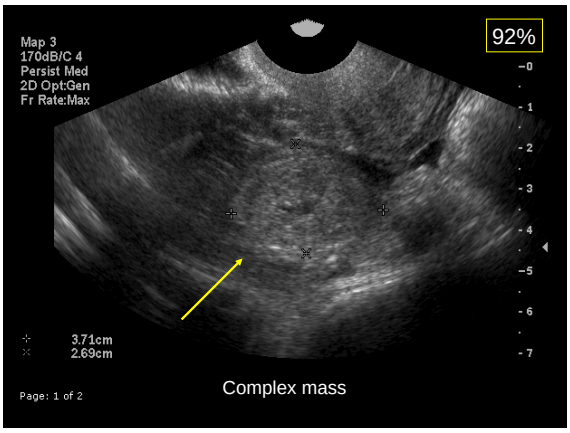
TVS Criteria for Ectopic Pregnancy

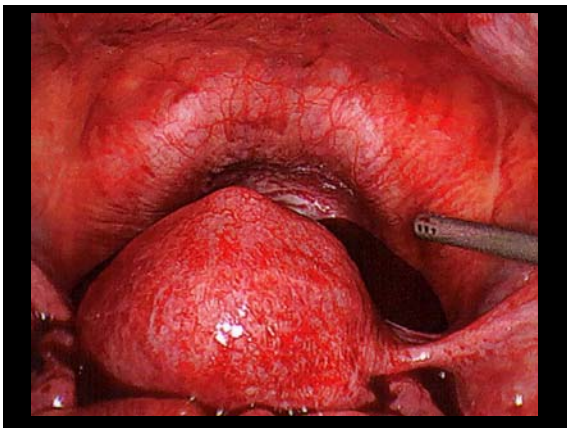
TVS Finding	Likelihood of Ectopic
Extrauterine embryo + heartbeat	100%
Adnexal mass with yolk sac or embryo without heartbeat	100%
Tubal ring	95%
Complex or solid adnexal mass No tubal ring, yolk sac, embryo	92%

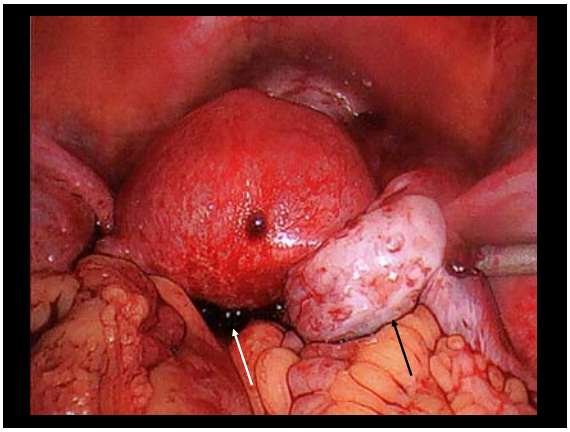
Brown and Doubilet, J Ultrasound Med 1994; 13: 259

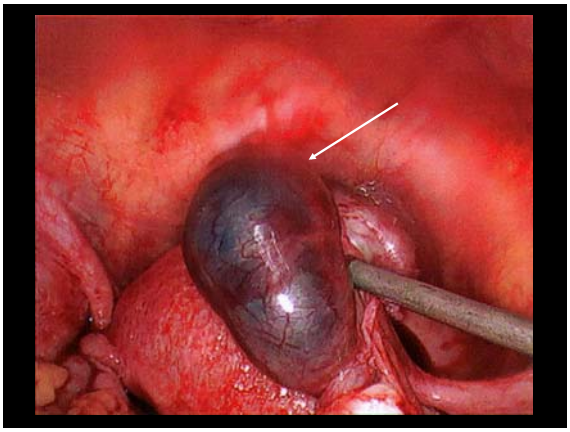












Diagnosing Ectopic Pregnancy
Six Strategies

- Ultrasound followed by quantitative hCG
- Quantitative hCG followed by ultrasound
- Progesterone followed by ultrasound and quantitative hCG
- Progesterone followed by quantitative hCG and ultrasound
- Ultrasound followed by repeat ultrasound
- Clinical examination

Garcia and Barnhart. Obstet Gynecol 2001; 97: 464-70
(U. of Penn)

Diagnosing Ectopic Pregnancy
Six Strategies-Outcomes

Strategy	Missed EP/ 10,000	Interrupted IUP/10,000
US ⟶ hCG	0	70
hCG ⟶ US	0	122
P ⟶ US ⟶ hCG	24	25
P ⟶ hCG ⟶ US	24	39
US ⟶ US	0	121
Clinical Exam	940	0

Garcia and Barnhart. Obstet Gynecol 2001; 97: 464-70

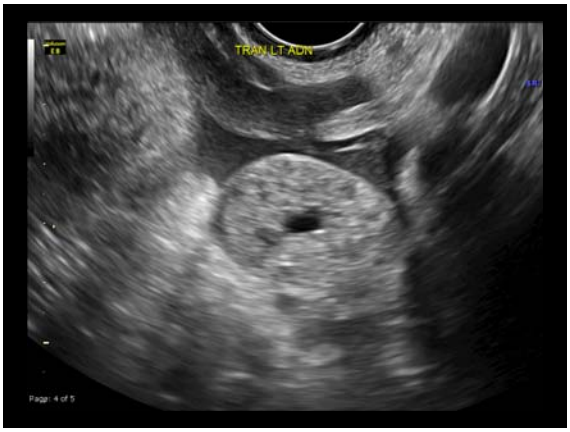
Diagnosing Ectopic Pregnancy
Six Strategies-Recommendations

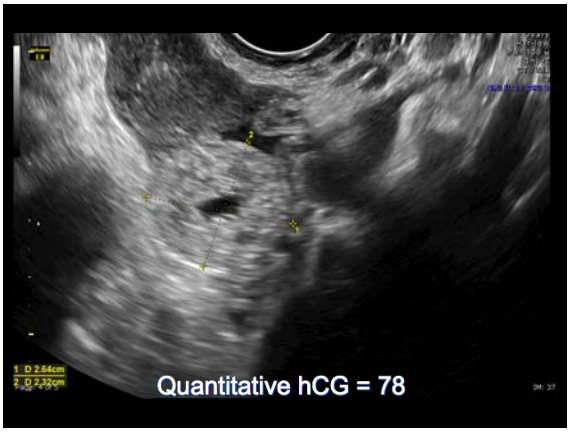
- Ultrasound followed by hCG
- hCG followed by ultrasound
- Either progesterone protocol
  - More missed ectopic pregnancies
- Ultrasound followed by repeat ultrasound
  - May be applicable in poorly compliant patient
- Clinical exam only – NOT recommended

Garcia and Barnhart. Obstet Gynecol 2001; 97: 464-70

Case Presentation

- 41 G2P0010 with LMP 3 weeks ago
- c/o vaginal bleeding and abdominal pain
- Unprotected intercourse x 10 years
- + UCG





Ectopic Pregnancy

hCG Dynamics with Spontaneous Resolution of Ectopic

Helsinki, Finland
118 patients
Entry criteria
- Decreasing or stable hCG
- No signs of rupture/intraperitoneal hemorrhage
- Adnexal mass < 4 cm
- No cardiac activity

Korhonen, Stenman, Ylostalo. Fertil Steril 1994; 61: 632-36 (Finland)

Ectopic Pregnancy

hCG Dynamics with Spontaneous Resolution of Ectopic

Helsinki, Finland
- TVS q 1-3 days
- Serial hCG until < 10 IU/L (3rd IS)
- Laparoscopy
  - Increasing hCG levels
  - Increasing abdominal pain
  - Intra-abdominal hemorrhage on TVS

Korhonen, Stenman, Ylostalo. Fertil Steril 1994; 61: 632-36

Ectopic Pregnancy

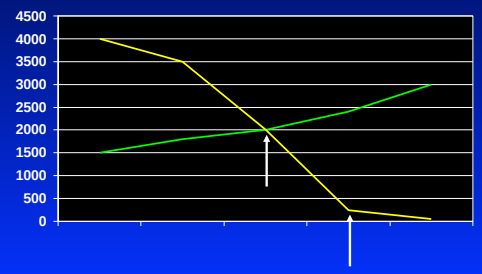
hCG Dynamics with Spontaneous Resolution of Ectopic

Rate of Spontaneous Resolution

hCG < 200 IU/L	88%
hCG > 2000 IU/L	25%

Korhonen, Stenman, Ylostalo. Fertil Steril 1994; 61: 632-36

Initial hCG

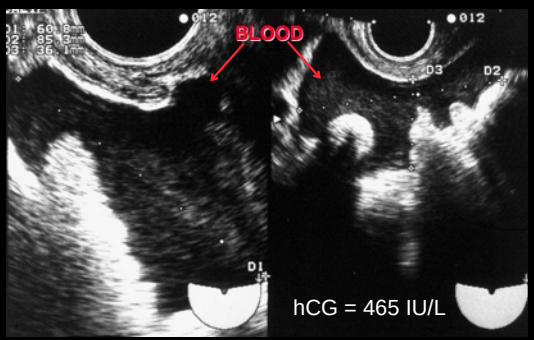


Case Presentation

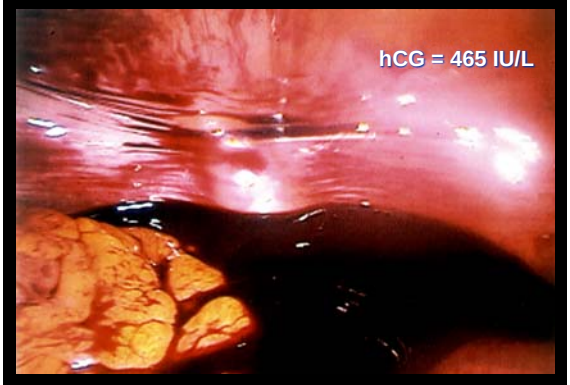
- 36 y.o. G3P0020 seen in ER with c/o slight spotting and mild abdominal discomfort
- Uterus: Mid-position, TNS
- Adnexa: No definite masses
- hCG = 357 IU/L
- Hct = 36.4
- D/C home with F/U 2 days in WCC

Case Presentation

- WCC
  - c/o increasing pain and weakness



hCG = 465 IU/L



Serum hCG and Tubal Rupture

ß-hCG (IU/L)	Unruptured	Ruptured
< 100	9.2%	11.4%
100 – 999	47.3%	38.6%
1000 - 9,999	38.2%	38.6%
> 10,000	5.3%	11.4%

Saxon et al. Obstet Gynecol 1997; 90: 46
(McGill, Cleveland Clinic)

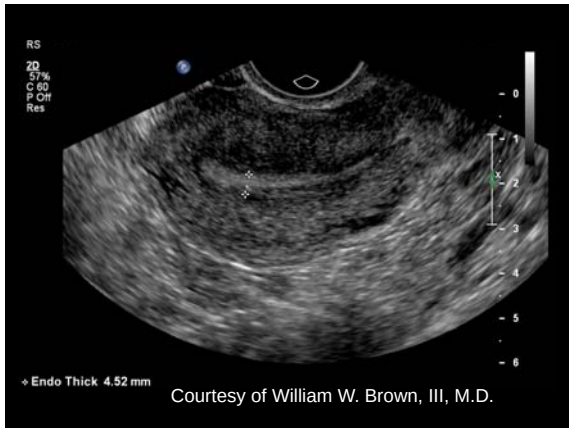
Serum hCG and Tubal Rupture

hCG, mIU/mL	Unruptured	Ruptured	Rupture Rate %
< 1000	53	14 (41.2%)	20.9
1000-1999	14	6 (17.6%)	30.0
> 2000	38	14 (41.2%)	26.9

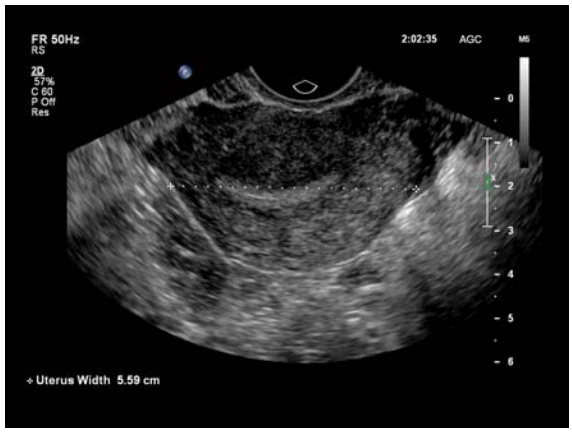
Frates et al. J Ultrasound Med 2014; 33:697-703.

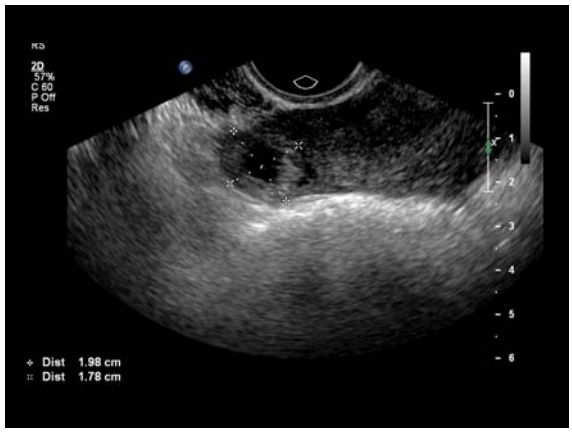
Case presentation

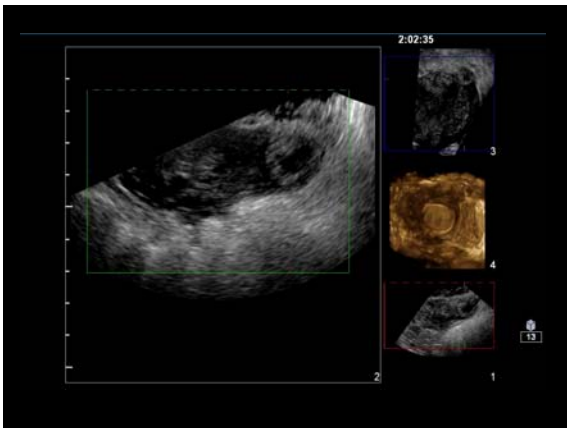
- 28 y.o. G2P0010
- Presents with pelvic pain and vaginal spotting
- LMP = 7 weeks ago
- hCG: positive

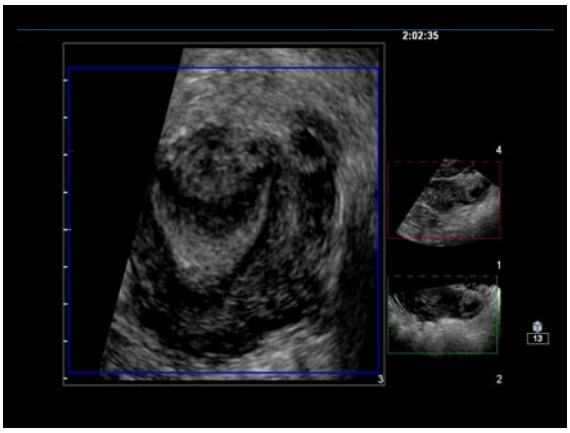


Courtesy of William W. Brown, III, M.D.





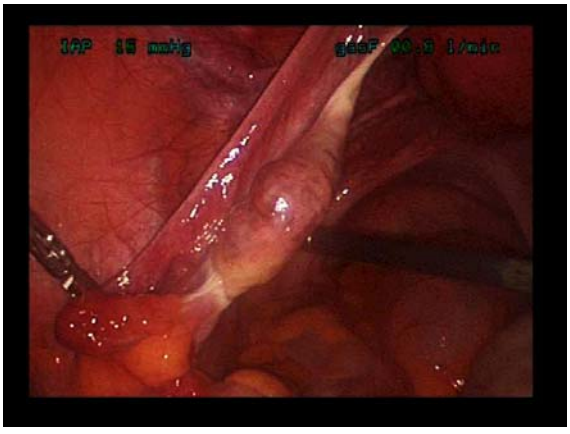


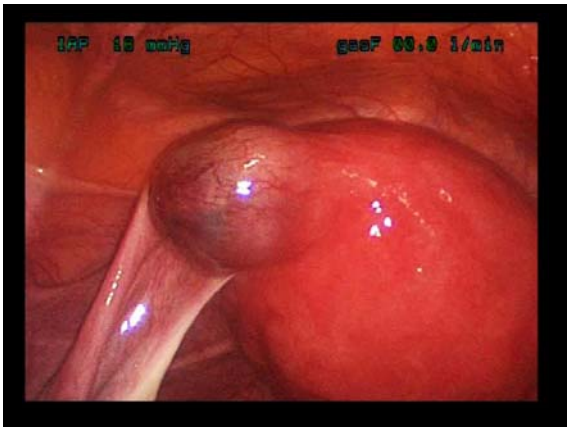


Ultrasound Diagnosis of Interstitial Pregnancy

- Empty uterine cavity
- Chorionic sac > 1 cm from the lateral edge of the uterine cavity (endometrium)
- Thin (<5 mm) layer of myometrium surrounding the chorionic sac

Timor et al. Obstet Gynecol 1992;79:1044





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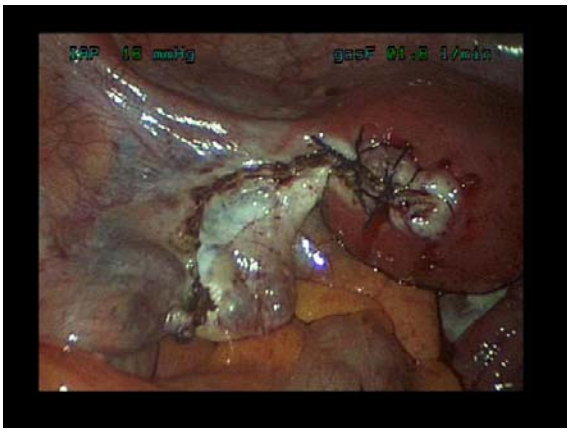
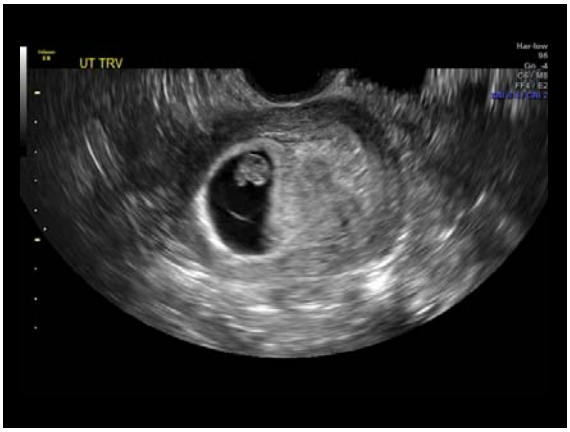
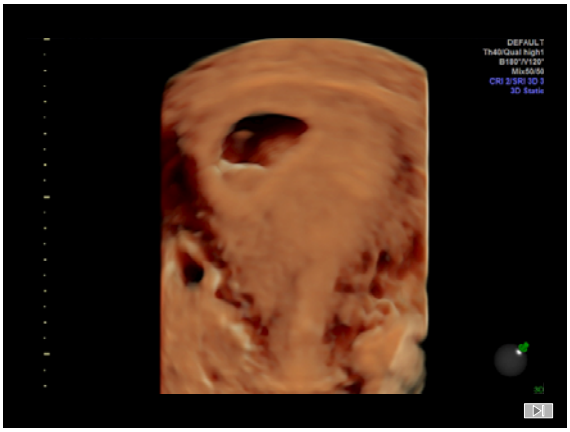


Terminology

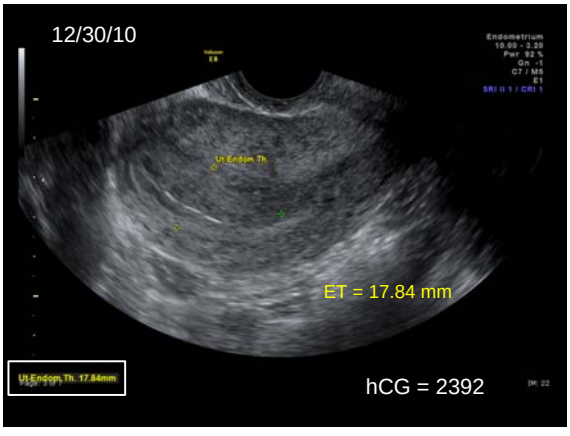
- Interstitial pregnancy
  - Embryo implants in the interstitial or intramural portion of the Fallopian tube
- Cornual pregnancy
  - Pregnancies that occur in a rudimentary horn, unicornuate uterus, cornual region of a septate uterus, a bicornuate uterus, or a uterus didelphys
- Angular pregnancy
  - Embryo implants in one of the lateral angles of the uterine cavity, medial to the utero-tubal junction

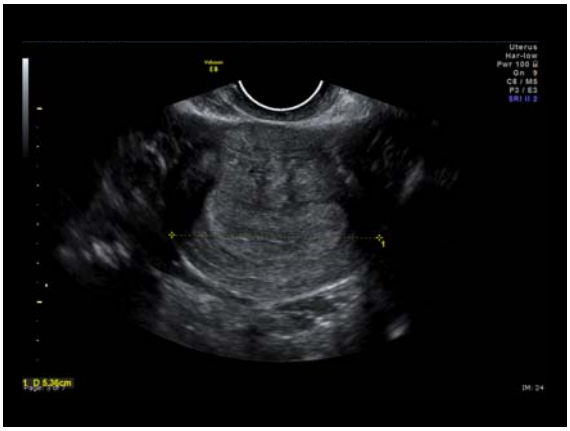


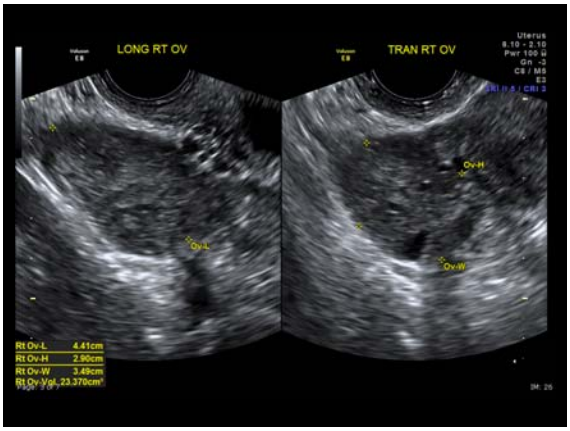


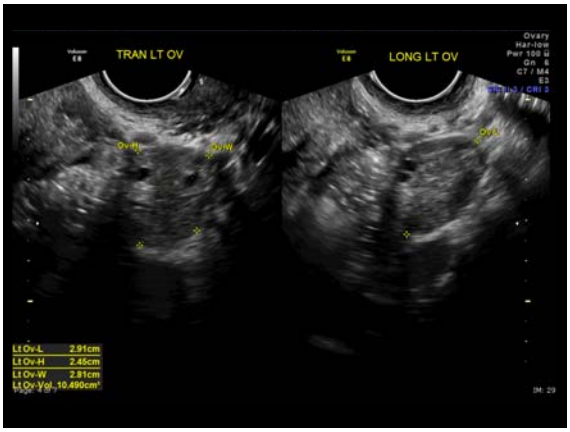
Case Presentation

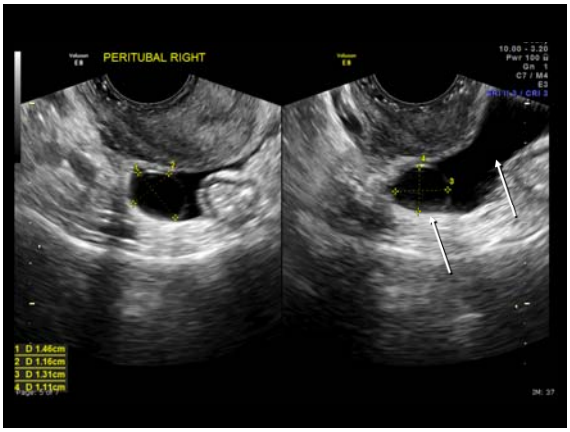
- 23 y.o. G2P1001
- Enters c/o slight spotting and cramping
- LMP = Unknown
- UCG = positive
- hCG = 2,392

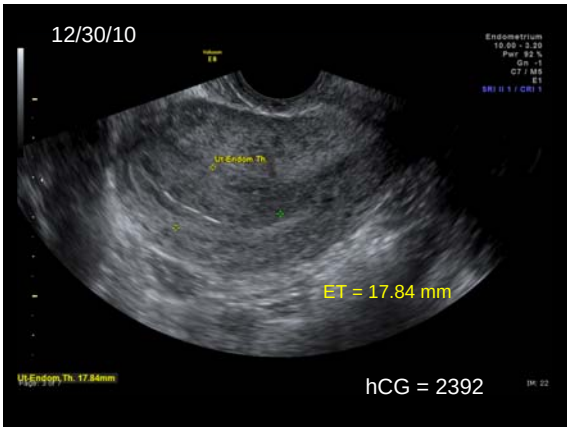












Consensus Nomenclature

- Pregnancy of unknown location (PUL)
  - Possible IUP
    - Increased endometrial thickness

Barnhart et al. Fertil Steril 2011; 95: 857-866

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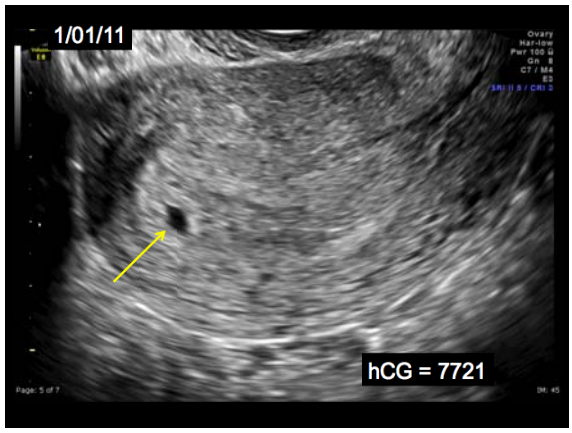
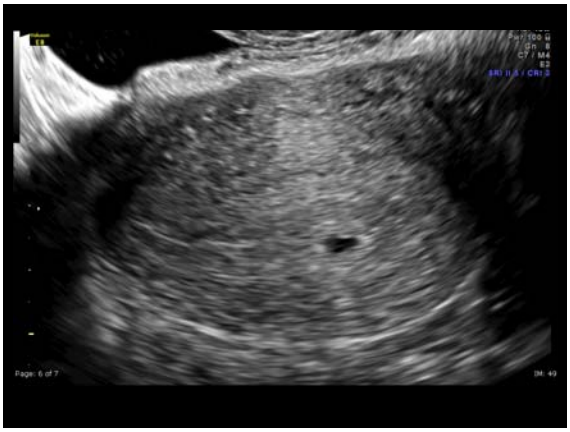
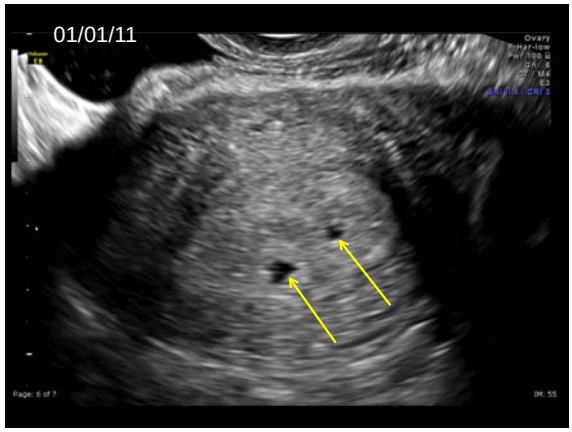
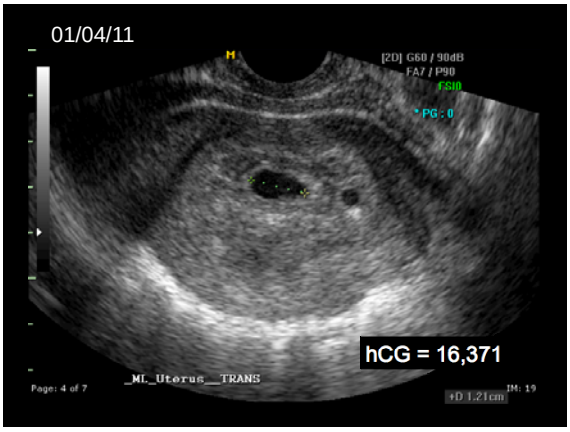
Quantitative hCG

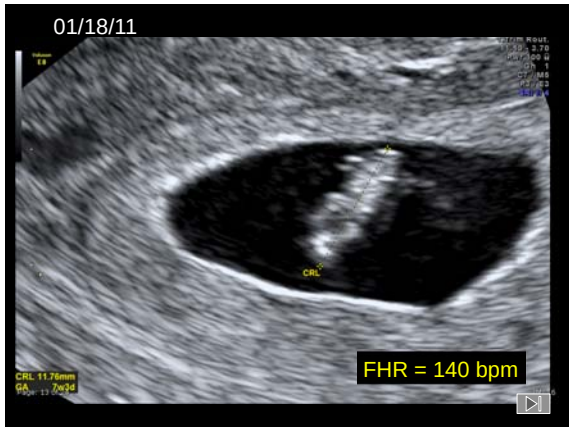
12/30/10	2392
1/01/11	7721











Ectopic Pregnancy-Summary

- Ultrasound can be justified prior to obtaining a quantitative hCG
  - ~ 50% of ruptured ectopics had hCG levels below the discriminatory zone (<1000 IU)
- Endometrial thickness when hCG < discriminatory level
  - An endometrial thickness ≤ 8 mm is associated with an abnormal pregnancy 97% of the time

Ectopic Pregnancy-Summary

- The discriminatory level has changed
  - It may be as high as 2500-3500 IU/L
- A cystic structure within the endometrium, in the absence of an adnexal mass
  - Is associated with an IUP in > 99% of patients

Ectopic Pregnancy-Summary

- Finding an IUP r/o ectopic pregnancy
  - Exception: heterotopic pregnancy
    - (1:667-1:30,000)
- Finding of embryo ± heart beat or yolk sac in adnexa
  - Diagnostic of ectopic pregnancy
- No IUP. Complex/solid mass, sep from ovary
  - 92% likelihood of ectopic

THE UNIVERSITY OF MISSISSIPPI MEDICAL CENTER

Thank You


Notes

Notes

Hands On Scanning Demonstration: The Pelvic Ultrasound Examination

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University of Mississippi Medical Center
Jackson, MS

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Cardiac Imaging: Tips To Improve Diagnosis of CHD

Alfred Abuhamad, M.D.
Professor and Chairman
Department of Obstetrics and Gynecology
Vice Dean for Clinical Affairs
Eastern Virginia Medical School
Norfolk, VA

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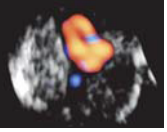
The Approach to Fetal Cardiac Imaging in Early Gestation

EVMS Fetal Cardiovascular Center



Alfred Abuhamad M D

Chronology of Cardiac Development

Feature	Weeks of development (from fertilization)
Angiogenetic 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 9th 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

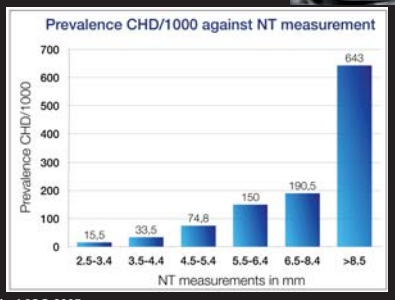
- Caution in detailed anatomic cardiac evaluation at less than 10 weeks gestation

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

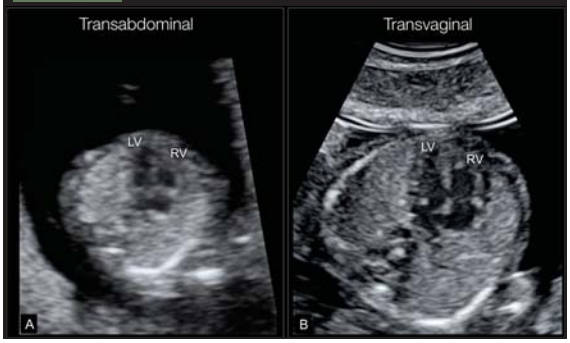
- Most optimal < 13 weeks
- Fetus in transverse lie

Cardiac Imaging in Early Gestation

Transvaginal

Cardiac Imaging in Early Gestation

13 Weeks



Transabdominal Approach

13 Weeks

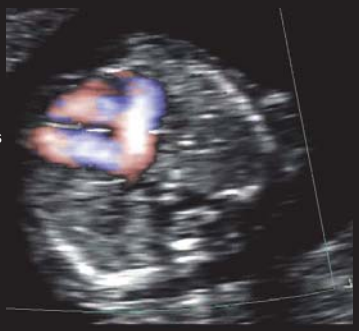
- 4CV
- PV

11

Transabdominal Approach

13 Weeks

- 4CV
- Cardiac axis
- Left PV



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Transabdominal Approach

13 Weeks

- 3VT

13

Transabdominal Approach

13 Weeks

- IVC
- SVC
- Short axis

14

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 16.1 Optimization of Grayscale Examination in Early Cardiac Scan

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

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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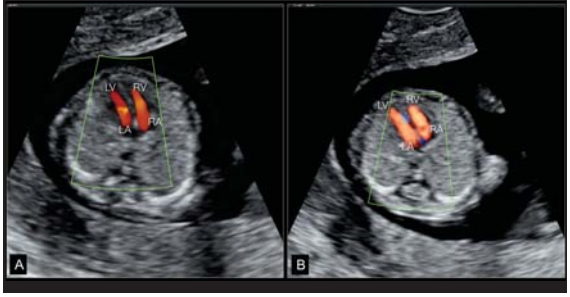
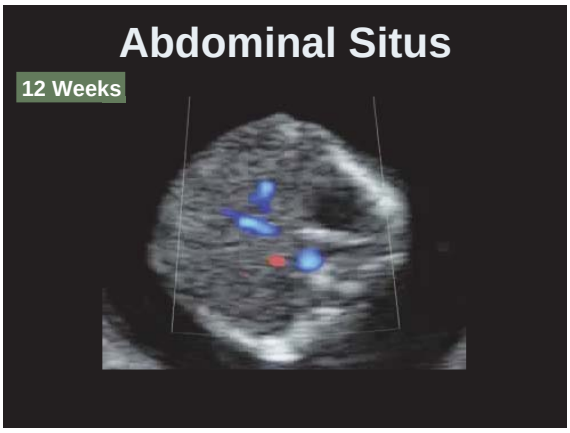
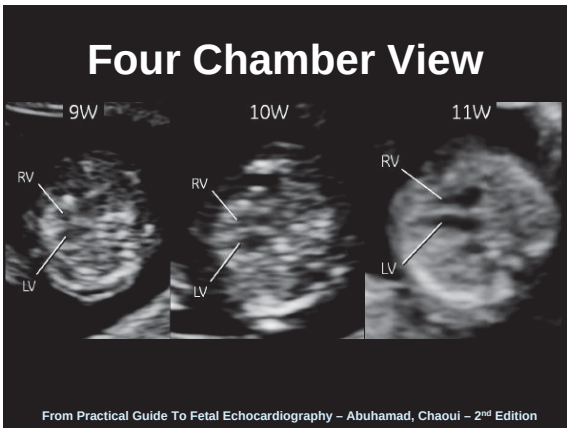
Color Doppler in Early Echo

13 Weeks

Color Doppler **High Definition/Power Doppler**




Abdominal Situs
12 Weeks


Four Chamber View
9W
10W
11W
RV
LV
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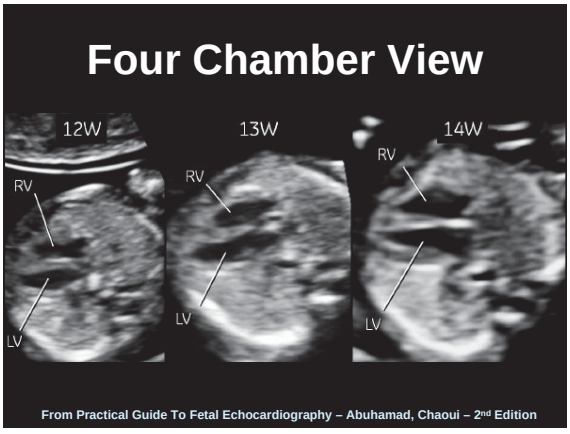
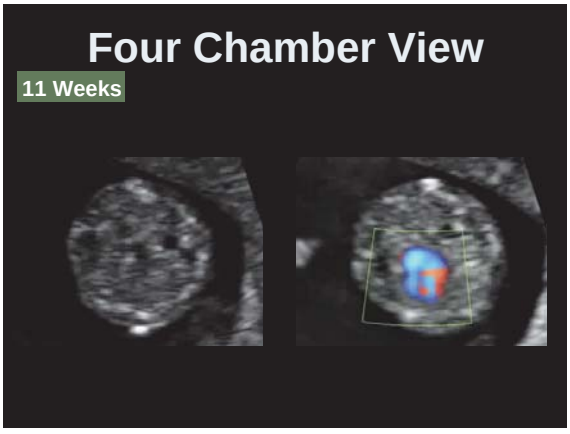
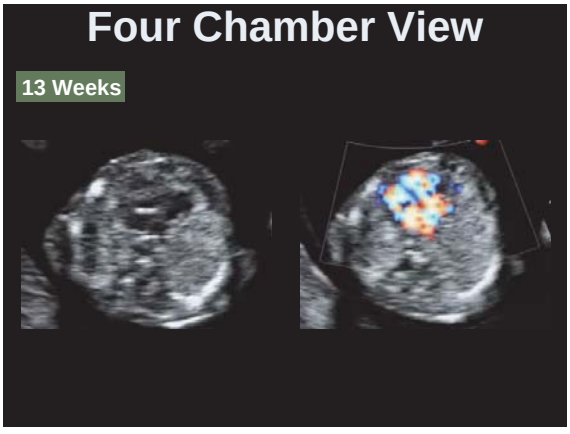
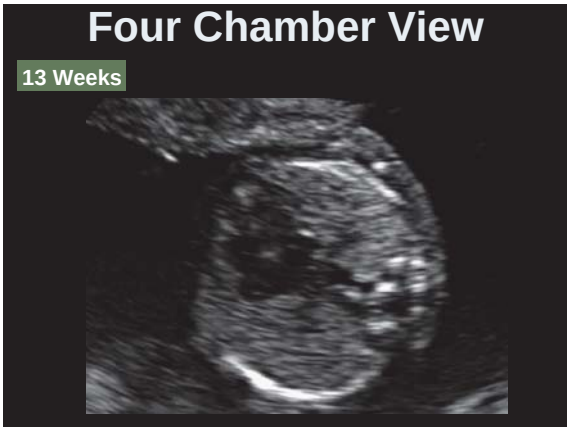

Four Chamber View
12W
13W
14W
RV
LV
From Practical Guide To Fetal Echocardiography – Abuhamad, Chaoui – 2nd Edition

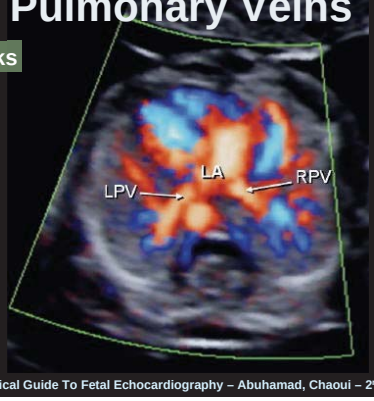

Four Chamber View
11 Weeks


Four Chamber View
13 Weeks


Four Chamber View
13 Weeks

Pulmonary Veins

12 Weeks



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Pulmonary Veins

11 Weeks

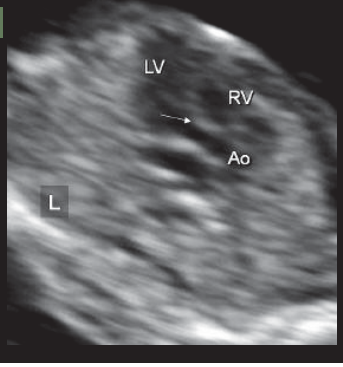
Pulmonary Circulation

12 Weeks

Outflow Tracts

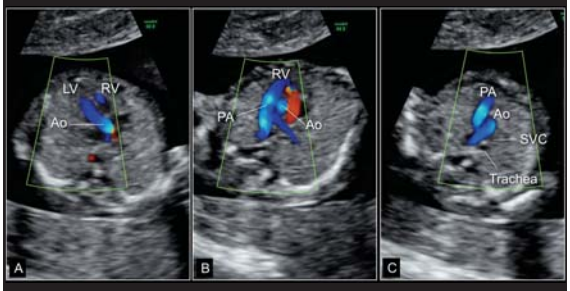
Left Ventricular Outflow

13 Weeks



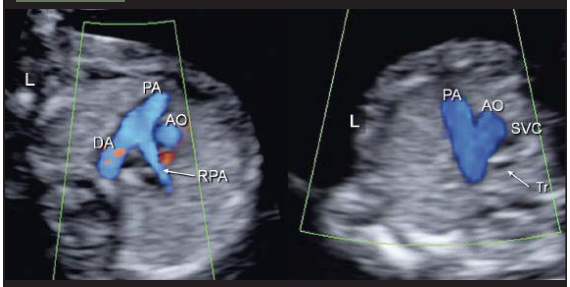
Outflow Tracts – LVOT-RVOT-3VT

13 Weeks



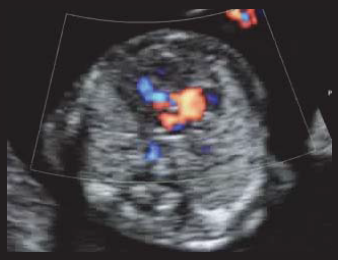
Outflow Tracts – 3V / 3VT

13 Weeks



Outflow Tracts – 3V / 3VT

12 Weeks



Outflow Tracts-3VT

13 Weeks

Outflow Tracts-3VT

13 Weeks

Aortic & Ductal Arches

13 Weeks

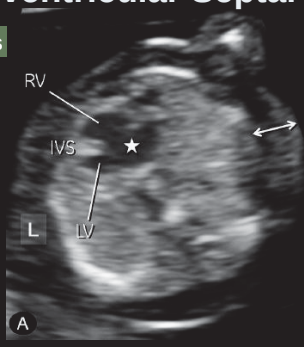
Abnormal Anatomy

Heterotaxy

12 Weeks

Atrioventricular Septal Defect

12 Weeks



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Atrioventricular Septal Defect

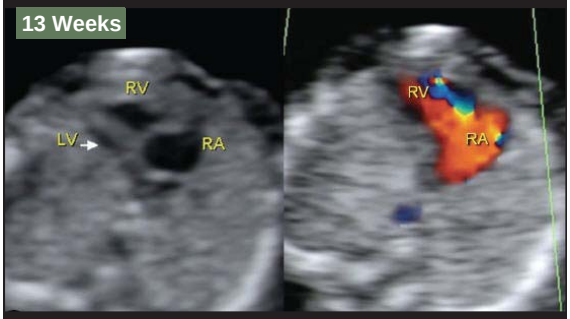
12 Weeks

Atrioventricular Septal Defect

12 Weeks

Hypoplastic Left Heart Syndrome

13 Weeks



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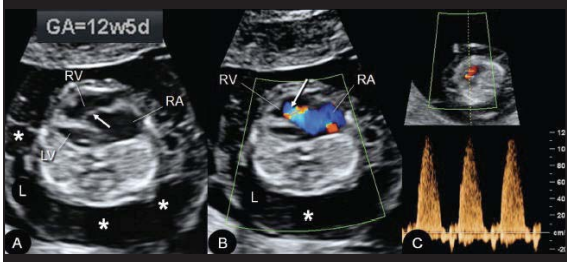
Hypoplastic Left Heart Syndrome

12 Weeks

Ebstein Anomaly

13 Weeks



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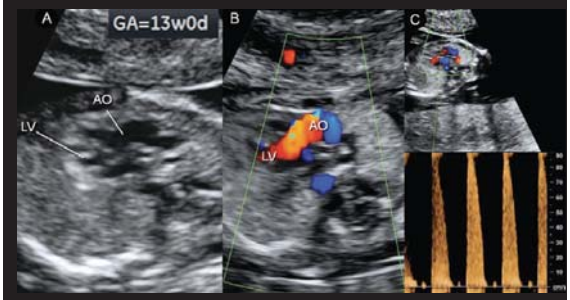
Aortic Stenosis

13 Weeks



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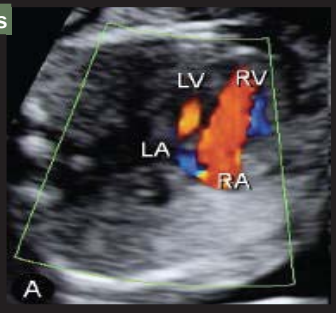
Coarctation of Aorta

13 Weeks



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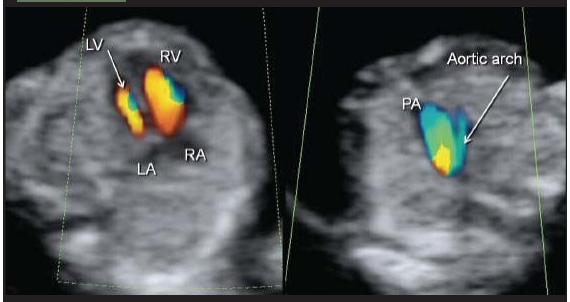
Coarctation Aorta

14 Weeks



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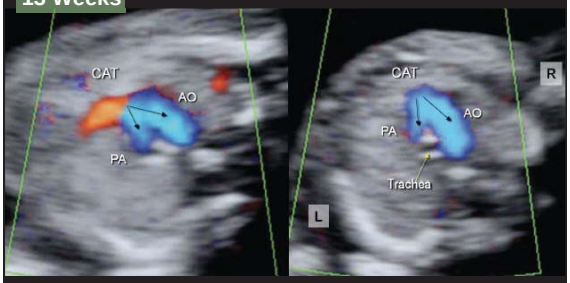
Common Arterial Trunk

13 Weeks



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Tetralogy of Fallot

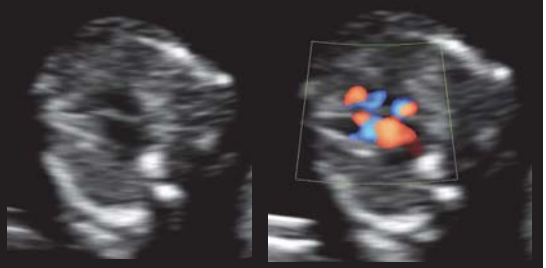
13 Weeks

Ventricular Septal Defect

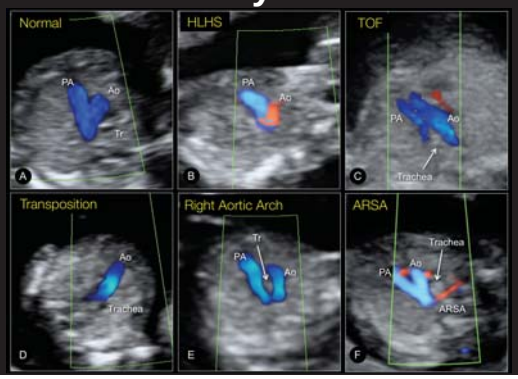
13 Weeks

Ventricular Septal Defect

12 Weeks



3VT in Early Gestation



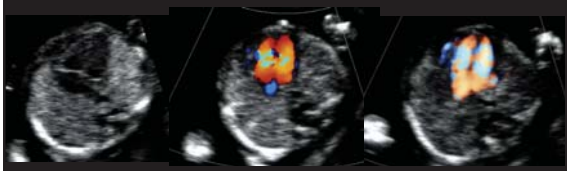
Cardiac Axis in the First Trimester

Cardiac Axis

11 0/7 to 14 6/7 Weeks

Cardiac Axis

4 Chamber View



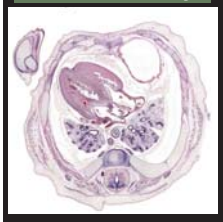
2D | 2D+color Doppler | 2D+HD-color Doppler

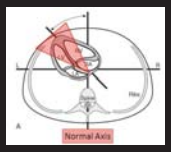
Cardiac Axis

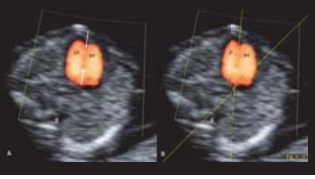
12 Weeks

Cardiac Axis

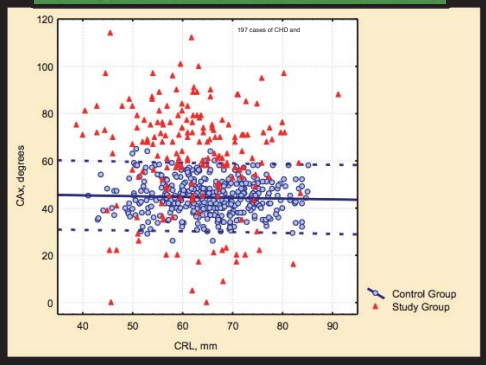
9 Weeks - 52 days







197 fetuses with CHD and 394 controls



Obstet Gynecol 2015;125:453–60

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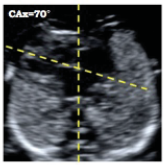
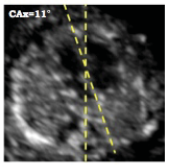
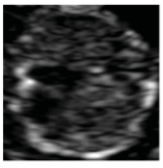
197 fetuses with CHD and 394 controls

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%







Obstet Gynecol 2015;125:453–60)

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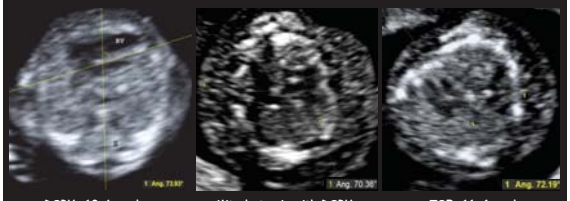
Cardiac Axis in Early Gestation

Left Deviation



DORV, 12+6 weeks

Mitral atresia with DORV 11+6 weeks

TOF, 11+4 weeks

Cardiac Function

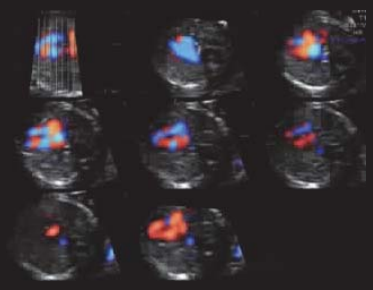
Parameter	Mean ± SD
GA, wk	13 ± 0.7
CRL, mm	79 ± 7
FHR, beats/min	154 ± 8
MV E/A ratio	0.6 ± 0.1
MV E V_{max}, cm/s	27 ± 6
MV A V_{max}, cm/s	45 ± 9
IVRT, ms	41 ± 6
ICT, ms	36 ± 9
Left MPI	0.5 ± 0.1
Aortic PSV, cm/s	26 ± 7
Aortic TVI, cm	3.6 ± 1.1
TV E/A ratio	0.6 ± 0.1
TV E V_{max}, cm/s	29 ± 6
TV A V_{max}, cm/s	48 ± 9
Right MPI	0.5 ± 0.1
Pulmonary artery PSV, cm/s	32 ± 14
Pulmonary TVI, cm	4.1 ± 1.9
Nuchal translucency, mm	1.5 ± 0.3
Ductus venosus PI	1.0 ± 0.6
Umbilical artery PI	1.5 ± 0.3
Umbilical vein PSV, cm/s	11 ± 2.4

Table of Contents

4D Ultrasound and Early Fetal Echocardiography

4D Ultrasound

11 Weeks

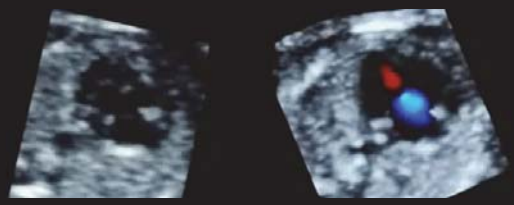


Mitral Atresia – 4D

13 Weeks

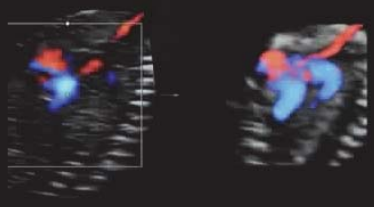
AV- Canal – 4D

14 Weeks



Coarctation Aorta-4D

12 Weeks



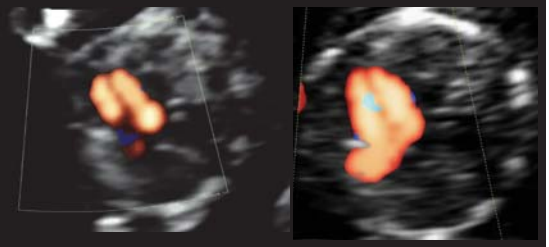
PATIENT: 33 year old - G2P0

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

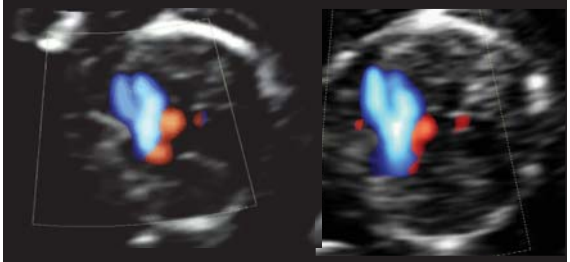
GA AT PRESENTATION: 12+0 weeks

12+0 weeks - TVUS

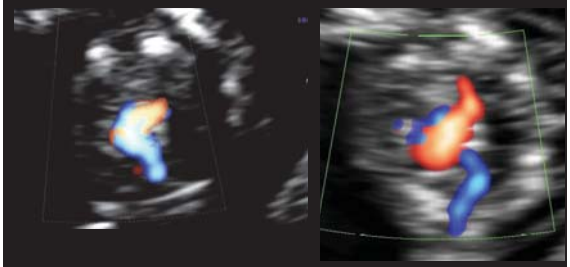
12+0 weeks - TVUS



12+0 weeks - TVUS



12+0 weeks - TVUS



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-Hirschorn syndrome

Pregnancy outcome: termination at 15+1 weeks

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 fo
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 sc

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 as 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. BREZINKA, G. TER HAAR and K. MARŠÁL) on behalf of the Board of the International Society of Ultrasound in Obstetrics and Gynecology (ISUOG)

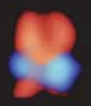
Cardiac Imaging in Early Gestation

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

Free Download

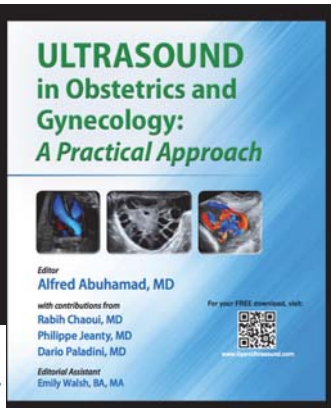
www.openultrasound.com

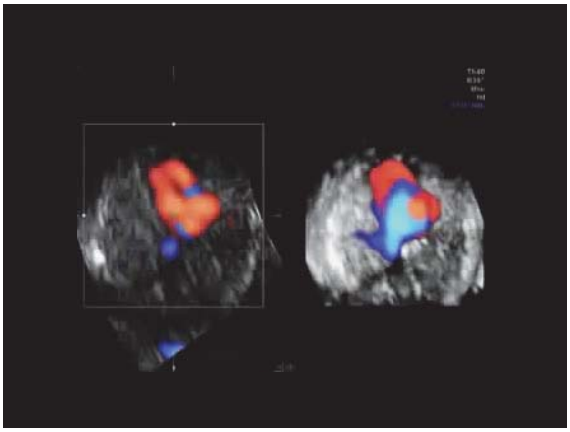
More than 22,000 Downloads in less than 24 months

Translated to:
- Spanish
- Chinese
- Korean
- Italian
- Portuguese
- Russian
- Farsi
- Creole*
- Greek*

***: Pending**

EVMS Fetal Cardiovascular Center






Notes

Notes

The Role of the 3 Vessel Trachea View in Screening and Diagnosis for Conotruncal Anomalies

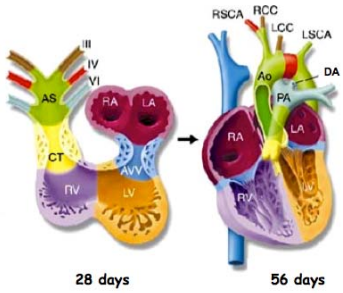
Elena Sinkovskaya, M.D., Ph.D.
Assistant Professor
Director of Research
Division of Maternal-Fetal Medicine
Department of Obstetrics & Gynecology
Eastern Virginia Medical School
Norfolk, VA

Advances in Ultrasound in Obstetrics and Gynecology
October 14-15, Washington DC

The Role of the Three-vessel Trachea View in Screening and Diagnosis for Conotruncal Anomalies?

Elena Sinkovskaya MD, PhD
Division of Maternal-Fetal Medicine
Eastern Virginia Medical School

What is conotruncus?

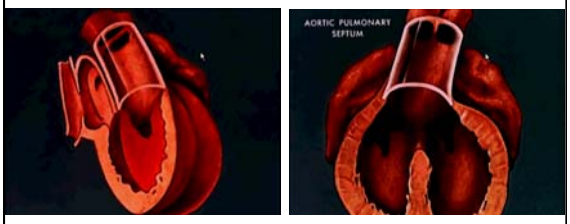


28 days 56 days

CONOTRUNCUS = Conus Cordis + Truncus Arteriosus

Embryogenesis of conotruncus

5th – 8th week



What are the conotruncal anomalies?

Human embryo at 25 days

- Common arterial trunk
- Tetralogy of Fallot
- Transposition of the great arteries
- Double outlet right ventricle
- Double outlet left ventricle
- Interrupted aortic arch
- Aortopulmonary window

Ultrasound Views:

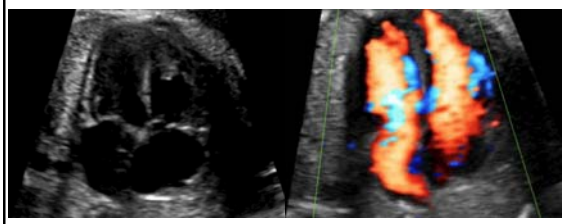
4-chamber view | LVOT view | RVOT view | 3 vessel-trachea view

- How many great vessels are seen?
- How ventricles and great vessels are connected?
- What is the size of great vessels?
- Is VSD present or absent?
- What is the relation of the great vessels to the defect?

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

Differential Diagnosis – common features

4-chamber view looks normal, but…



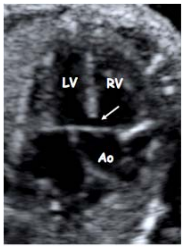
CARDIAC AXIS
may be displaced to the left

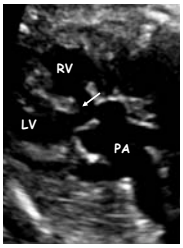
Differential Diagnosis – common features

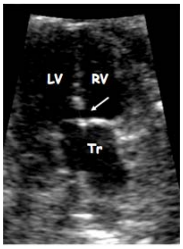
Perimembranous VSD

Differential Diagnosis – common features

Vessel overrides the IVS



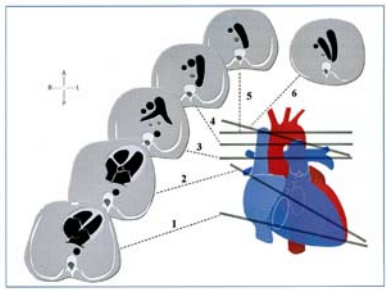




Tetralogy of Fallot | Taussig-Bing anomaly | Common arterial trunk

ALWAYS follow the vessels

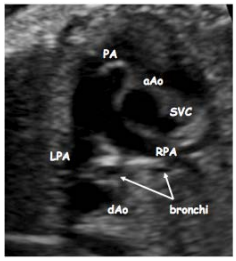
Transverse and paratransverse views of the fetal upper thorax



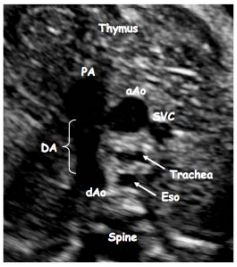
1. 4-chamber view
2. 5- chamber view
3. 3-vessel view
4. View of ductus arteriosus
5. View of aortic arch
6. 3-vessel-trachea view

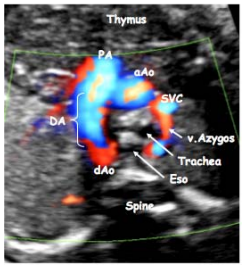
From "Echocardiographic anatomy in the fetus." Chiappa E.M et al.

Three-vessel view

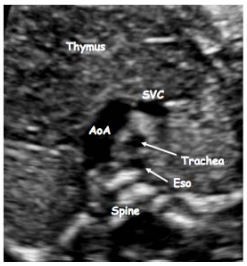


Arterial duct view

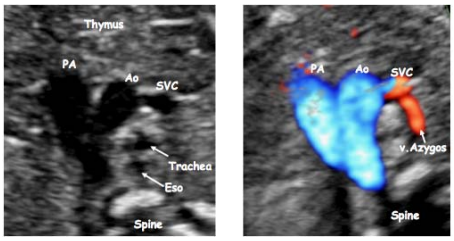




Aortic arch view



Three-vessel-trachea view

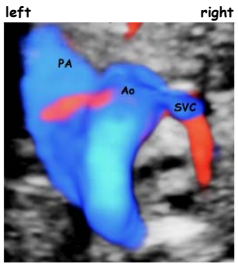


How to read three-vessel view ?

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

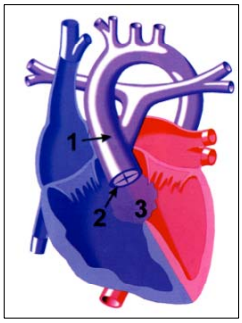
- Number of vessels
- Size of vessels
- Alignment of vessels
- Arrangement of vessels
- Relation to the trachea
- Pattern of blood flow

Normal 3VTV



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";

Common Arterial Trunk (CAT)

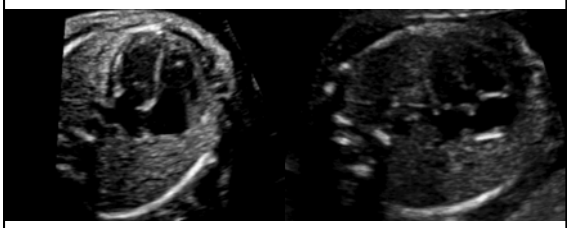


1. Pulmonary artery originates from CAT
2. Single vessel overriding IVS (CAT)
   (usually has 4 leaflets)
3. Large ventricular septal defect

From www.PedHeart.com

Common Arterial Trunk

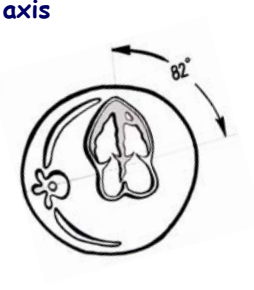
4-chamber view



NORMAL HEART CAT

Common Arterial Trunk

Cardiac axis



Common Arterial Trunk

Outflow tracts

NORMAL HEART

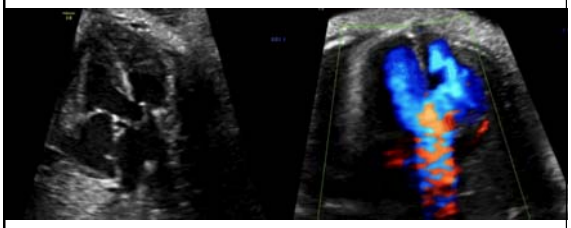
- Two crossing great vessels
- PA arises from RV, Ao – from LV
- IVS is intact

CAT

- Single great vessel - trunk
- PA/Ao arises from trunk
- Malalignment VSD

Common Arterial Trunk

Outflow tracts



Blood flow to CAT from both ventricles – "Y" sign

Common Arterial Trunk

Outflow tracts

NORMAL HEART

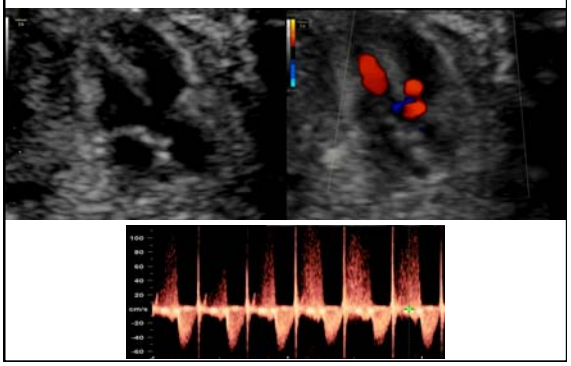
- Ao – transverse
- PA - longitudinal
- AoV with 3 leaflets

CAT

- Single vessel - transverse
- Valve has 1-6 (usually 4) leaflets

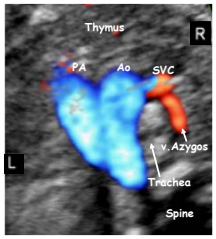
Common Arterial Trunk

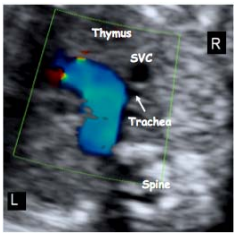
Truncal valve



Common Arterial Trunk

3 vessel trachea view





NORMAL HEART

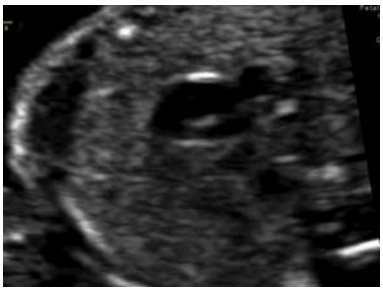
- 3 vessels (PA,Ao,SVC)
- V - shape

CAT

- 2 vessels (trunk, SVC)
- Variable appearance

Common Arterial Trunk

3 vessel view



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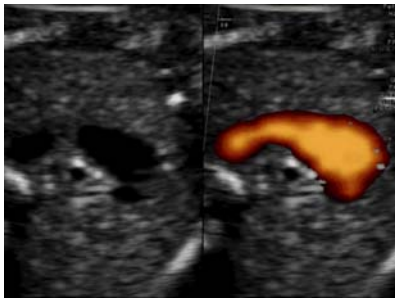
Common Arterial Trunk

3 vessel view

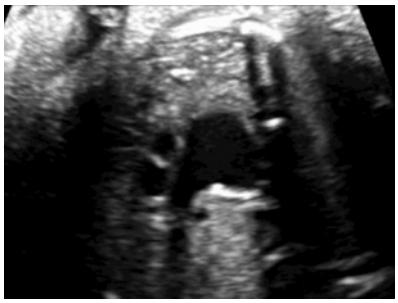
Common Arterial Trunk

3 vessel trachea view

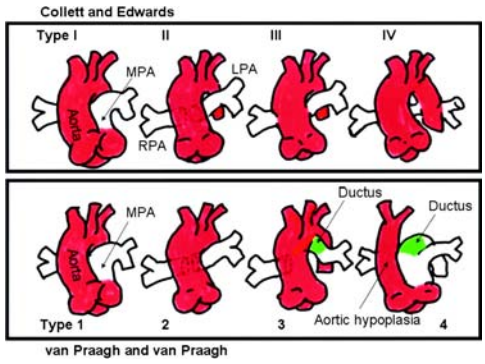


Common Arterial Trunk

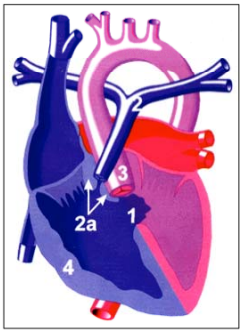
3 vessel trachea view



Spectrum of CAT



Tetralogy of Fallot

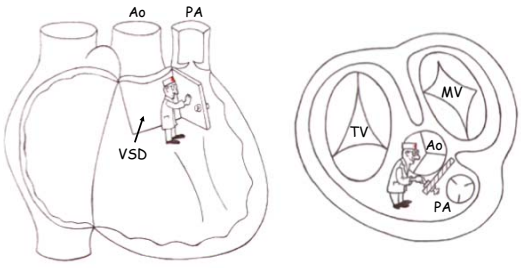


1. Large ventricular septal defect
2. Right ventricle outflow tract obstruction:
   - Infundibular stenosis (2a) – 70%
   - Pulmonary valve atresia – 30%
   - Absent pulmonary valve – <1%
3. Enlarged aorta overriding VSD
4. Right ventricular hypertrophy

From www.PedHeart.com

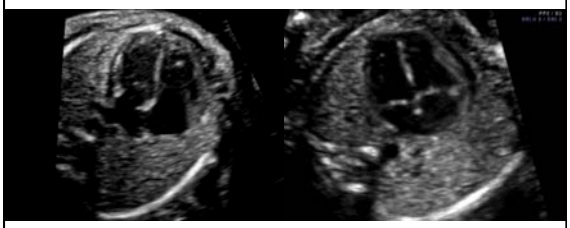
Tetralogy of Fallot

Embryology



Tetralogy of Fallot

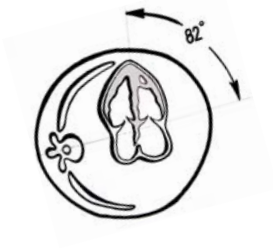
4-chamber view



NORMAL HEART | ToF

Tetralogy of Fallot

Cardiac axis



Tetralogy of Fallot

LVOT view

NORMAL HEART

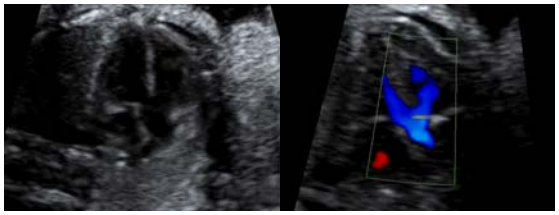
- Aorta arises wholly from LV
- Ventricular septum intact

ToF

- Aorta arises from both ventricles
- Subaortic VSD

Tetralogy of Fallot

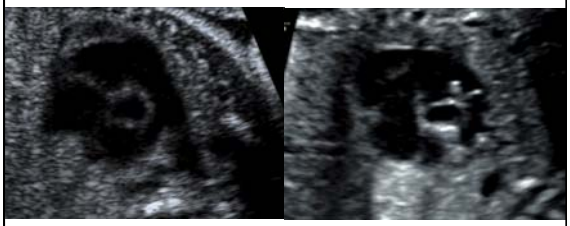
LVOT view



Blood flow to Ao from both ventricles – "Y" sign

Tetralogy of Fallot

RVOT view



NORMAL HEART

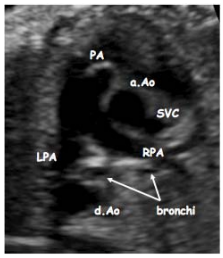
- PA normal in size
- PV opens and closes freely

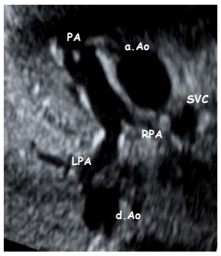
ToF

- PA is small
- Stenosis of PV and/or RVOT

Tetralogy of Fallot

3 vessel view





NORMAL HEART

PA> Ao > SVC

ToF

PA < Ao

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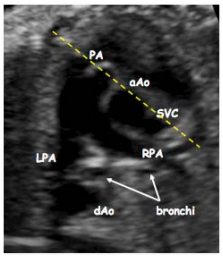
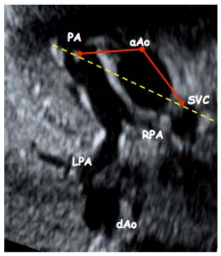
Tetralogy of Fallot

3 vessel view



NORMAL HEART

- Normal vessel alignment



ToF

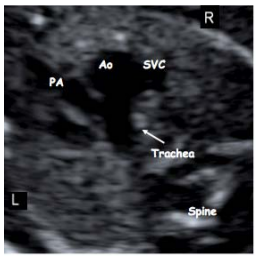
- Abnormal vessel alignment

Tetralogy of Fallot

3 vessel view

II. Abnormal vessel size:

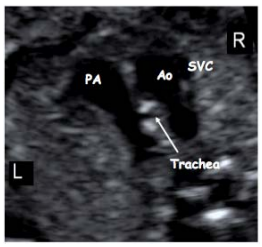
PA is smaller than Ao



Tricuspid atresia

III. Abnormal vessel relationship:

abnormal relation to the trachea



"U shape"

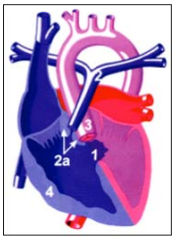
Right-sided Aortic Arch + left-sided Ductus Arteriosus

Tetralogy of Fallot

3 vessel-trachea view

Right -sided aortic arch and DA

Spectrum of ToF

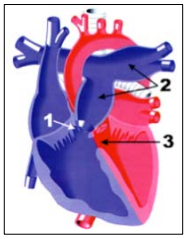


Pulmonary Stenosis

~ 70%

Pulmonary Atresia

~ 30%

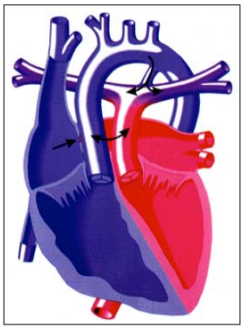


Absent pulmonary valve

~ 1%

From www.Ped-Heart.com

Transposition of Great Arteries



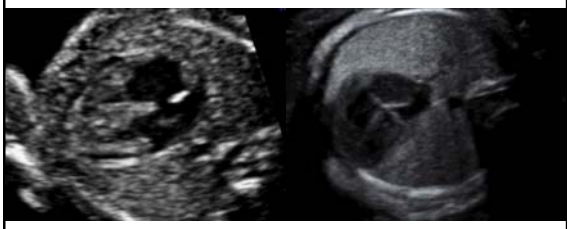
- Ao arises anteriorly and from RV;
- PA arises from LV;
- TGA results to complete separation of the pulmonary and systemic circulations;

Concomitant cardiac anomalies:

- Ventricular septal defect - 40%;
- LVOR obstruction – 5%
- VSD+LVOT obstruction – 10%
- Anomalies of coronary arteries – 50%

From www.PedHeart.com

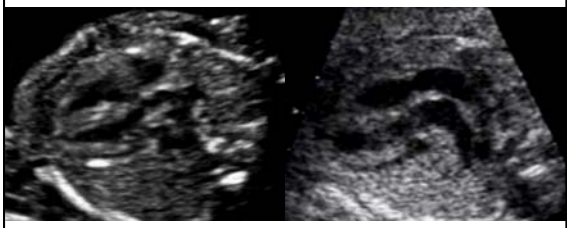
Transposition of Great Arteries
4-chamber view



NORMAL HEART

TGA

Transposition of Great Arteries
LVOT view



NORMAL HEART
- Aorta arises wholly from LV
- Crossing of great arteries

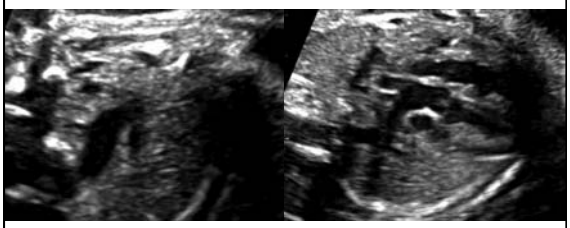
TGA
- Aorta arises wholly from RV
- Great vessels are parallel

Transposition of Great Arteries
RVOT view

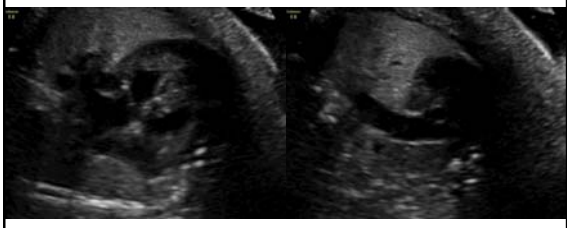
NORMAL HEART
- Ao – transverse
- PA - longitudinal
- PA is anterior

TGA
- Ao and PA - transverse
- Ao is anterior

Transposition of Great Arteries
Outflow tracts views



Transposition of Great Arteries
Outflow tracts views

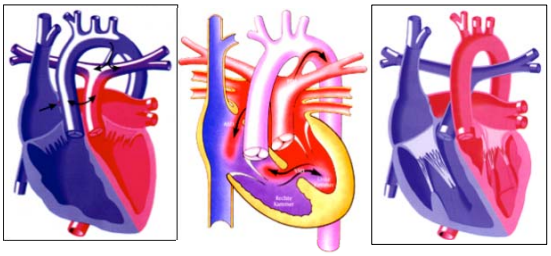


Transposition of Great Arteries

3VTV views

D-TGA

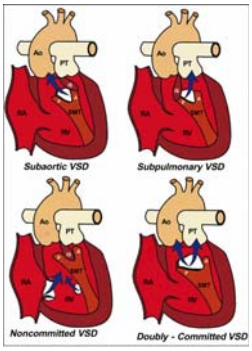
Spectrum of TGA



D-TGA | D-TGA or L-TGA + VSD | L-TGA

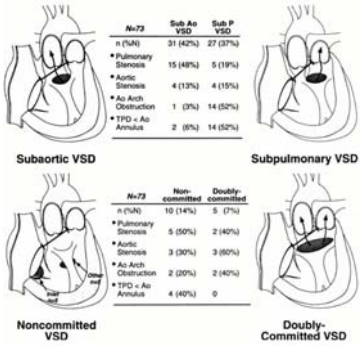
Diagnosis ????

Double Outlet Right Ventricle



1. Ao and PA arise from RV
2. Large ventricular septal defect
   - subaortic
   - subpulmonary
   - subarterial (doubly committed)
   - non-commited (remote)
3. Obstruction:
   - subpulmonary
   - subaortic

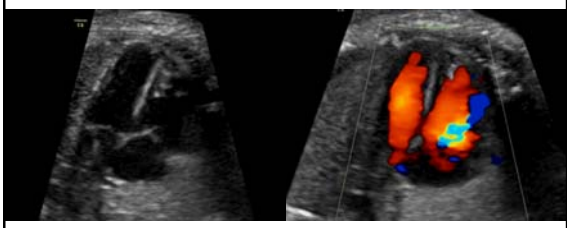
Spectrum of DORV



Aoki M. et al.; J Thorac Cardiovasc Surg 1994;107:338-350

Double Outlet Right Ventricle

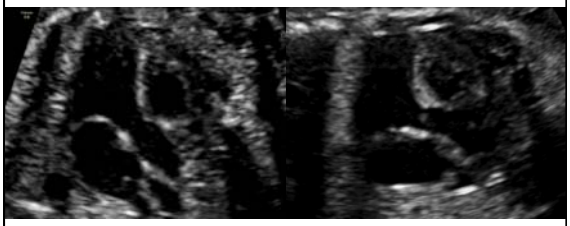
4-chamber view



NORMAL HEART or DORV ???

Double Outlet Right Ventricle

LVOT view

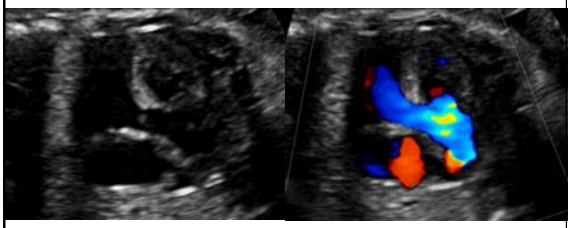


NORMAL HEART
- Aorta arises wholly from LV
- Ventricular septum intact
- Ao- mitral continuity present

DORV
- One of the vessels overrides IVS
- Malalignment VSD
- Ao-mitral continuity absent

Double Outlet Right Ventricle

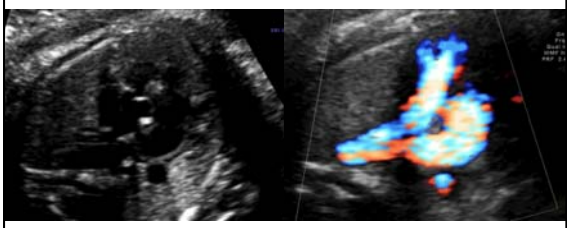
LVOT view



Blood flow to Ao from both ventricles – "Y" sign

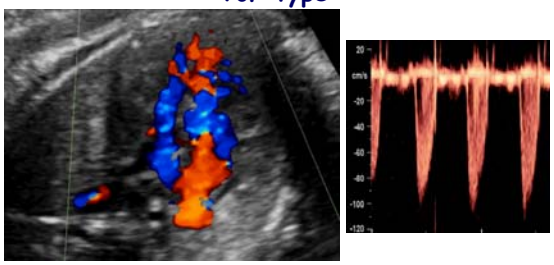
Double Outlet Right Ventricle

ToF type



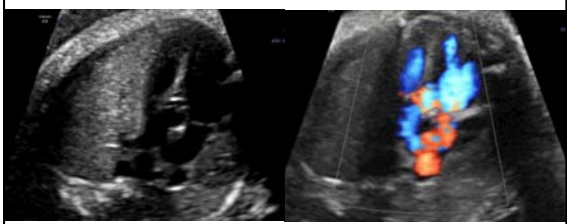
Double Outlet Right Ventricle

ToF type



Double Outlet Right Ventricle

TGA type



Blood flow to Ao from both ventricles – "Y" sign

Double Outlet Right Ventricle

TGA type

Taussig-Bing anomaly

Double Outlet Right Ventricle

RVOT view

NORMAL HEART

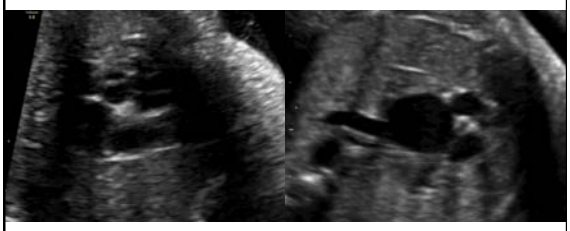
- Ao – transverse
- PA – longitudinal
- PA is anterior

DORV

- Ao and PA – transverse
- Ao and PA are side by side

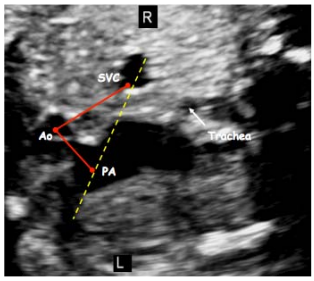
Double Outlet Right Ventricle

Vessels size



III. Abnormal vessel relationship:

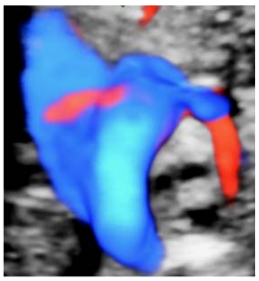
abnormal alignment



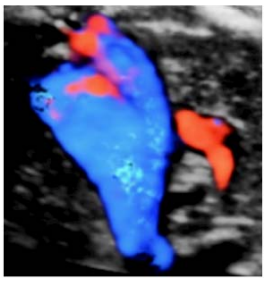
Double Outlet Right Ventricle

Double Outlet Right Ventricle

3 vessel-trachea view

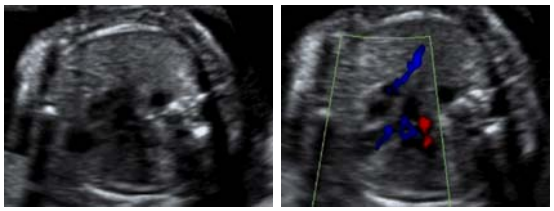


Normal heart



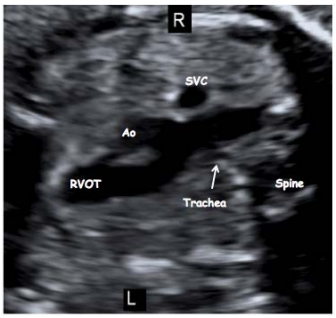
Double outlet right ventricle with subaortic stenosis

What's the diagnosis?



What's the diagnosis?

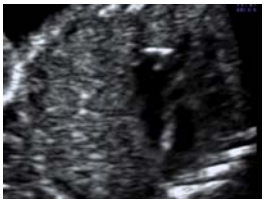
What's the diagnosis?



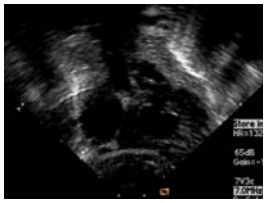
"Y" - shape

Echocardiography

Prenatal



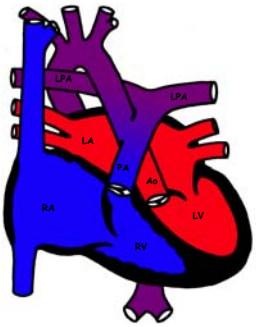
Postnatal

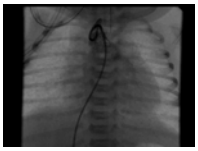


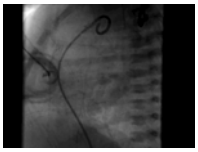
What's the diagnosis?

1. Interrupted Aortic Arch type A
2. Common arterial trunk type A1 + right AoArch
3. Hemitruncus (one of PA from Aorta) + right AoArch
4. Aortopulmonary window + right AoArch

What's the diagnosis?







Take-home message

The 3VTV is an essential component to fetal echocardiography as it adds significantly to the complete diagnosis of heart defects


Notes

Notes

Case Presentations of Fetal Cardiac Malformations

Elena Sinkovskaya, M.D., Ph.D.
Assistant Professor
Director of Research
Division of Maternal-Fetal Medicine
Department of Obstetrics & Gynecology
Eastern Virginia Medical School
Norfolk, VA


Notes

Notes


Notes

Notes

The Role of Ultrasound in the Diagnosis of Placenta Accreta

Alfred Abuhamad, M.D.
Professor and Chairman
Department of Obstetrics and Gynecology
Vice Dean for Clinical Affairs
Eastern Virginia Medical School
Norfolk, VA

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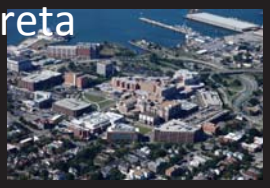
The Role of Ultrasound in the Diagnosis of Placenta Accreta



Alfred Abuhamad, MD.
Eastern Virginia Medical School

Lecture Outline

- Placenta previa
- Vasa previa
- Placental abruption
- Morbidly adherent placenta

Placenta Previa

Fetal Imaging Consensus Meeting

Placenta Previa

- Diagnosis of placenta previa is overestimated at less than 16 weeks of gestation
- At > 16 weeks, if the placental edge is ≥ 2 cm from the internal os, the placental location should be reported as **normal**

JUM May 2014 33:745-757

Fetal Imaging Consensus Meeting

Placenta Previa

- If the placental edge is < 2 cm from the internal os, but not covering the internal os, the placenta should be labeled as **low-lying**
- If the placental edge covers the internal cervical os, the placenta should be labeled as **placenta previa**
- *The terms partial previa, marginal previa and complete previa should be abandoned*

JUM May 2014 33:745-757

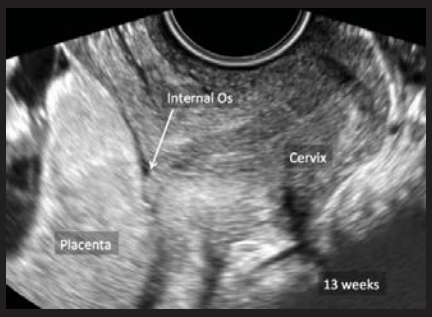
Fetal Imaging Consensus Meeting

Placenta Previa

- For all low-lying placentas and placenta previas, follow-up is recommended at 32 weeks
- if still low-lying or previa at 32 weeks, a follow-up ultrasound is recommended at 36 weeks
- Color Doppler is recommended to rule-out vasa previa for low-lying placentas in the third trimester and resolving previas
- Transvaginal ultrasound should be used for the diagnosis when placenta previa is suspected

JUM May 2014 33:745-757

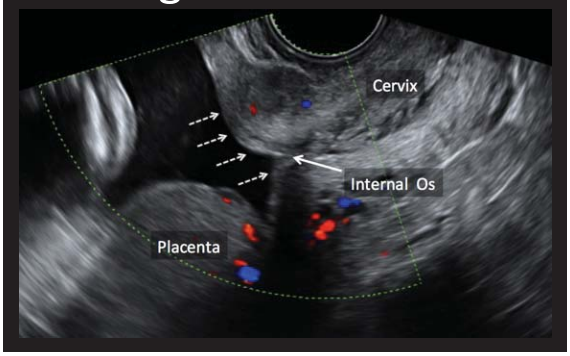
Placenta Previa



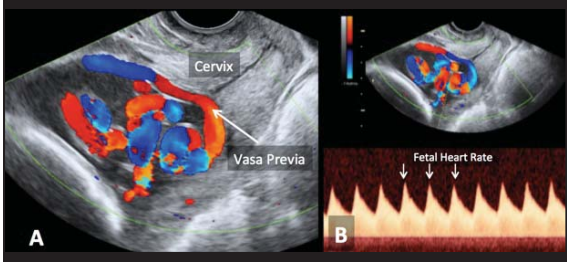
Low-Lying Placenta

Normal Placenta

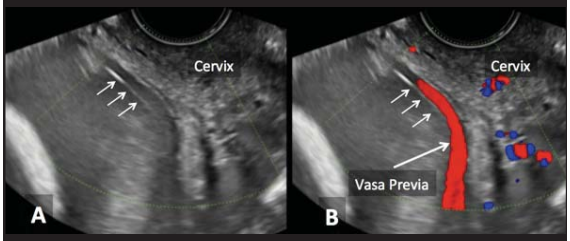
Ruling out Vasa Previa



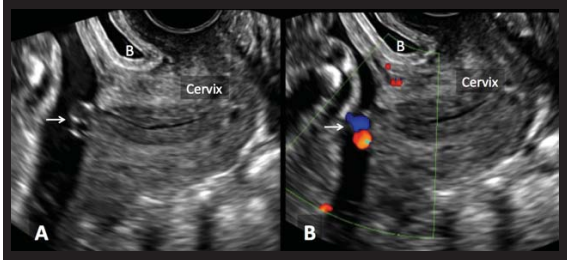
Vasa Previa



Vasa Previa



Vasa Previa



Placental Abruption

Placenta Accreta

- US findings in First Trimester
- US Findings in Second & Third Trimesters
- MRI Findings
- Recent Literature - controversy
- Optimizing your US Diagnosis

Novel Pathologic Entity

- First described in the 20th century
- First reports in 1930's
- Suggest that the entity did not exist or was quite rare before the 1930's

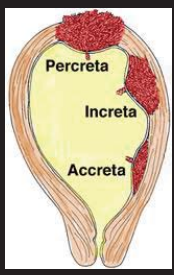
Surgery Gynecol Obstet 1937;64:178-200

Terminology

- **Morbidly adherent placenta:** **abnormal implantation of the placenta into the uterine wall**
- **Placenta accreta**: placental villi adhere directly to the myometrium
- **Placenta increta**: placental villi invade into the myometrium
- **Placenta percreta**: placental villi invade through the myometrium and into the serosa

Frequency

- **Placenta accreta**: 75 %
- **Placenta increta**: 18 %
- **Placenta percreta**: 7 %



Am J Obstet Gynecol 1997;177:210-214

Pathogenesis

Three Theories

- *Primary defect of trophoblast function, leading to excessive invasion of myometrium*
- *Secondary basalis defect due to failure of normal decidualization in area of uterine scar allowing an abnormally deep trophoblastic infiltration*
- An abnormal vascularization resulting from the scaring process after surgery with secondary localized hypoxia leading to both defective decidualization and exessive trophoblastic invasion

J Obstet Gynaecol Br Emp 1959;66:353-64 - Placenta 1987;8:399-409 – Placenta 2008;29:639-45
Cell 1992;71:355-7 – Am J Obstet Gynecol 2011;204:411.e1-411

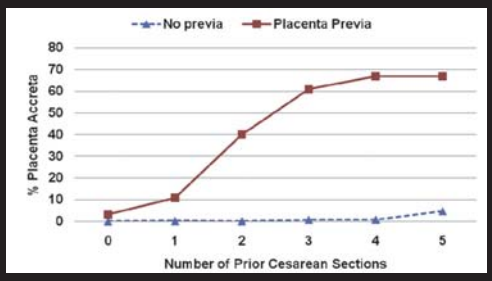
Incidence

- Overall is around 3/1000 deliveries
- Increase over past several decades
- Estimated at 1/10,000 in the 1960's
- Main reason for increase is change in cesarean section rates

Am J Obstet Gynecol 2010:203(5):403-9 – Clin Obstet Gynecol 2010;53(1):228-36

Risk Factors

Cesarean Section/Placenta Previa



Clin Perinatol 2011;38:285-296 Obstet Gynecol 2006;107:1226-32

Risk Factors

TABLE 8.5 Risk Factors for Placenta Accreta

- Placenta previa and prior cesarean section
- Advanced maternal age
- Multiparity
- Prior uterine surgery
- Prior uterine irradiation
- Endometrial ablation
- Asherman's syndrome
- Leiomyomas
- Uterine anomalies
- Hypertensive disorders in pregnancy
- Smoking

Abuhamad A - Ultrasound in Obstetrics and Gynecology: A Practical Approach

Ultrasound Parameters

TABLE 8.6 Ultrasound Diagnostic Findings in Placenta Accreta

- Gestational sac implanted in the lower uterine segment - Cesarean section scar implantation	1
- Multiple vascular lacunaes in the second trimester	2
- Loss of normal hypoechoic retroplacental zone - Multiple vascular lacunaes in the third trimester - Abnormality in uterine-serosa-bladder interface - Retroplacental myometrial thickness of less than 1 millimeter - Turbulent blood flow on color Doppler through the lacunae - Extension of villi into myometrium, serosa or bladder	3

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Sonographic Findings

First Trimester

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Sonographic Findings

First Trimester

- Sac implanted in lower segment (Prior CS)
- Multiple irregular vascular spaces

AJR 2002; 179:535 – J Ultrasound Med 2003;22:19-23
Ultrasound Obstet Gynecol 2006;28:178-182

Sac in Lower-Segment

First Trimester

Sonographic Findings

Gestational Sac Location

- Data base of 90,435 births
- Placenta accreta in 20
- First trimester scan in 7/20
- Sac in lower segment in 6/7

J of Ultrasound in Med **2003;22:19**

Sonographic Findings

Gestational Sac Location

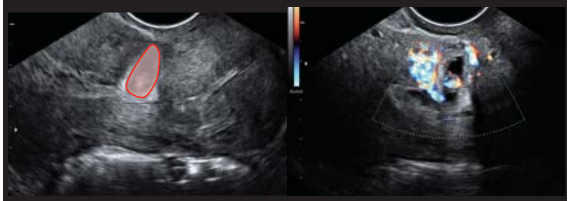
Table 1. Summary of Patients

Pt	Prev Csd	GA Scan, wk	Sac Location	Procedure	Pathologic Finding	ICU	Other
1	2	6.5	Low	UA ligation	NA	Yes	Sheehan
2	4	6	Low	Hysterectomy	Percreta	No	None
3	2	6	Low	Hysterectomy	Increta	No	None
4	2	6	Low	Hysterectomy	Accreta	No	None
5	2	10	Low	Hysterectomy	Accreta	Yes	None
6	2	6	Low	Hysterectomy	Accreta	Yes	None
7	0	10	Fundal	Hysterectomy	Increta	Yes	None

GA indicates gestational age at first scan; ICU, intensive care unit; NA, not applicable; Prev Csd, previous cesarean delivery; Pt, patient; Sheehan, Sheehan syndrome (anterior hypopituitarism); and UA, uterine artery.

J of Ultrasound in Med **2003;22:19**

Cesarean Scar Pregnancy



Cesarean Scar Pregnancy

Cesarean Scar Pregnancy

Post Treatment with MTX into Sac (10 days)

Sonographic Findings

Second & Third Trimester

15 – 20 Weeks

Sonographic Findings

Multiple vascular lacunae within placenta at 15 – 20 weeks

Sonographic Findings

Multiple vascular lacunae within placenta at 15 – 20 weeks

Sonographic Findings

Multiple vascular lacunae within placenta at 15 – 20 weeks

Table II Sensitivity and positive predictive value of ultrasound diagnostic criteria for placenta accreta at 15 to 20 weeks of gestational age

	Sensitivity		Positive predictive value	
Diagnostic criteria	n/N	%	n/N	%
Any criteria	12/14	86	12/19	63
≥ 2 Criteria	8/14	57	8/9	89
Lacunae	11/14	79	11/12	92*
Clear space (isolated)	1/14	7	1/7	14
Clear space (with other)	7/14	50	7/8	88
Bladder serosa wall	3/14	21	3/3	100

* Includes transient abnormal findings that were not confirmed by a follow-up scan.

Am J Obstet Gynecol 2004;190:1135-40

Sonographic Findings

Second & Third Trimester

Beyond 20 Weeks

Multiple vascular lacunae within placenta

Multiple vascular lacunae within placenta

Multiple vascular lacunae within placenta

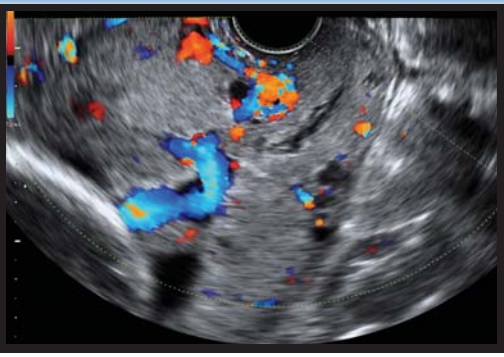
Personal Observation

Multiple vascular lacunae have very high predictive power in association with a placenta previa

Multiple vascular lacunae within placenta

Multiple vascular lacunae within placenta

Multiple vascular lacunae within placenta



Pathogenesis of Placental Lacunae

Placental tissue alterations resulting from long-term exposure to pulsatile blood flow

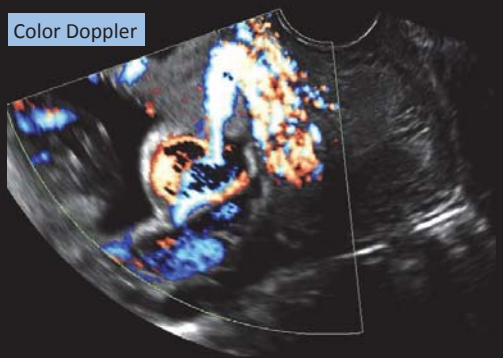
Radiology 1997;205:773-6 – J Ultrasound Med 1999;18:853-6 – AJOG 1990;163:723-727
Am J Obstet Gynecol 2004;190:1135-40 – Radiographics 2008;28:1905-16

Lacunae – Blood Flow

Gray Scale

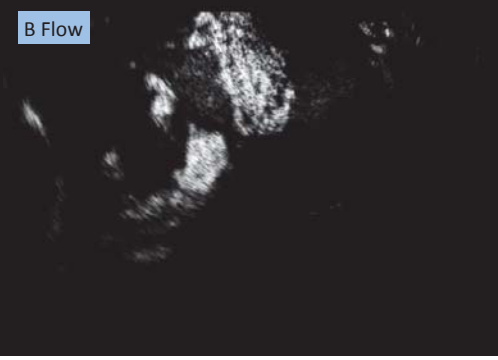
Lacunae – Blood Flow

Color Doppler



Lacunae – Blood Flow

B Flow



Lacunae in Placenta Accreta

Table 3. Utility of lacunae in the diagnosis of PAD

Study	Sensitivity (%)	Specificity (%)	PPV	NPV
Cali et al.[35]	73	86	60	90
Comstock et al.[34]	93		93	
Wong et al.[36]	100	28	21	100
Yang et al.[37], Gr. ≥ 1	86.9	78.6	76.9	88
Yang et al.[34], Gr. ≥ 2	100	97.2	93.8	100

Gr 1 = grade 1 (one to three lacunae), Gr. 2 = grade 2 (four to six lacunae).

BJOG 2014;121:171–182

Sonographic Findings

Multiple vascular lacunae within placenta (# Lacunae)

Table 2 Distribution of adherent placenta according to lacunar grade

Adherent placenta	Grading: Grade 0 (n = 25)	Grade 1 (n = 10)	Grade 2 (n = 11)	Grade 3 (n = 5)
None	22	6	—	—
Accreta	3	4	1	—
Increta	—	—	5	4
Percreta	—	—	5	1
Total	25	10	11	5

G 0 = 0 lacunae
G 1 = 1-3 lacunae
G 2 = 4-6 lacunae
G 3 = > 6 lacunae

Ultrasound Obstet Gynecol 2006;28:178-182 - JUM 1992:11;333-343

Sonographic Findings

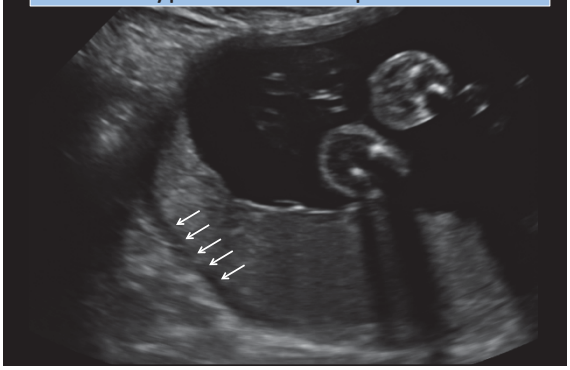
Loss of hypoechoic retroplacental zone

Also referred to as loss of clear space between placenta and uterus

Obstet Gynecol 2004;104:527-30
Obstet Gynecol Surv 1998;53:509-17

Normal hypoechoic retroplacental zone

Normal hypoechoic retroplacental zone



Loss of hypoechoic retroplacental zone

Loss of hypoechoic retroplacental zone

Loss of Hypoechoic Retroplacental Zone in Placenta Accreta

Table 1. Utility of the clear space in diagnosis of PAD

Author	Sensitivity (%)	Specificity (%)	PPV	NPV
Comstock et al.[34]	73		14	
Wong et al.[36]	100	35	20	100
Cali et al.[35]	90.2	80.8	57	96.7

BJOG 2014;121:171–182

Loss of hypoechoic retroplacental zone

- False positive rate of 21% or higher
- Should not be used alone
- Angle dependent, can be absent in normal anterior placentas

Obstet Gynecol 2004;104:527-30 - Obstet Gynecol Surv 1998;53:509-17
Obstet Gynecol 2004; 190:1135-1140 – J Ultrasound Med 1992;11:333-343 –
Radiology 1980;134:475-478 – RCOG; 2005:26. Green-top Guideline No. 27.2011:26

Sonographic Findings

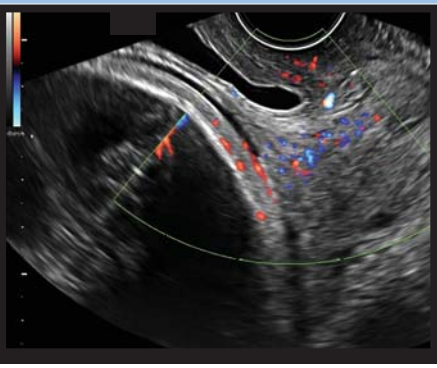
Abnormality of the uterine serosa-bladder interface

- Interruption of line
- Thickening of line
- Irregularity of line
- Increased vascularity on color Doppler

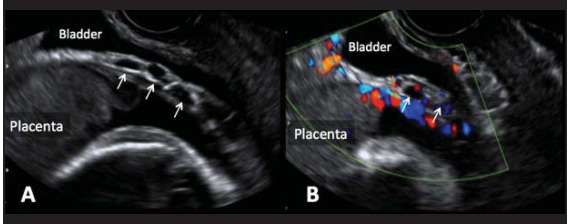
Ultrasound Obstet Gynecol 2005;26:89-96 – Obstet Gynecol 2006;108:573-81

Normal uterine serosa-bladder interface

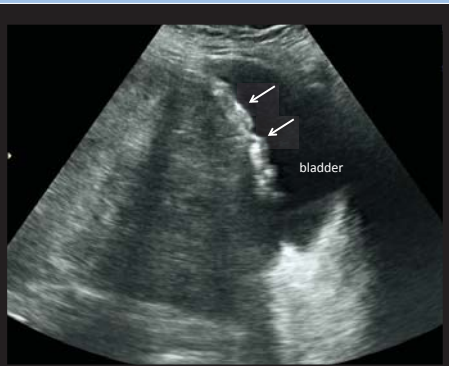
Normal uterine serosa-bladder interface



Abnormality of the uterine serosa-bladder interface



Abnormality of the uterine serosa-bladder interface



Abnormality of the uterine serosa-bladder interface

Abnormality of the uterine serosa-bladder interface

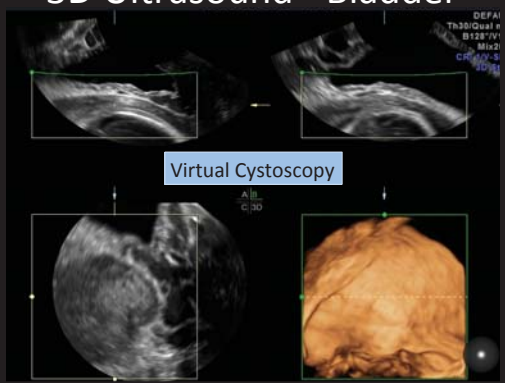
Bladder Wall in Placenta Accreta

Table 2. Utility of interrupted bladder line in the diagnosis of PAD

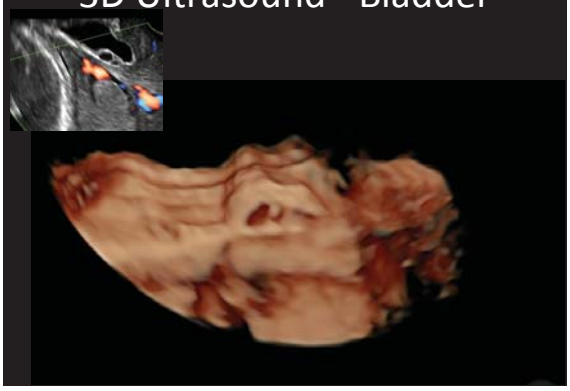
Study	Sensitivity (%)	Specificity (%)	PPV	NPV
Cali et al.[35]	70	99	96	92
Comstock et al.[34]	20		75	
Wong et al.[36]	11	100	100	88

BJOG 2014;121:171–182

3D Ultrasound - Bladder



3D Ultrasound - Bladder



Sonographic Findings

Other Signs

- Retroplacental myometrial thickness of < 1 mm
- Turbulent blood flow through the lacunae on Doppler ultrasonography
- Abnormal bridging vessels on color Doppler

Radiology 1997;205:773-6 – J Ultrasound Med 1999;18:853-6 – Am J Obstet Gynecol 2004;190:1135-40 - Obstet Gynecol 2004;104:527-30 – Ultrasound Obstet Gynecol 2005;26:89-96 – Obstet Gynecol 2006;108:573-81

Table of Contents

Prenatal identification of invasive placentation using ultrasound: systematic review and meta-analysis

F. D'ANTONIO, C. IACOVELLA and A. BHIDE

Table 2 Pooled values for sensitivity, specificity, positive and negative likelihood ratios (LR+ and LR−) and diagnostic odds ratio (DOR) for ultrasound overall and the different ultrasound signs in the identification of invasive placentation

Diagnostic method	Studies (n)	Patients (n)	Sensitivity (95% CI) (%)	Specificity (95% CI) (%)	LR+ (95% CI)	LR− (95% CI)	DOR (95% CI)
Ultrasound (overall)	23	3707	90.72 (87.2–93.6)	96.94 (96.3–97.5)	11.01 (6.1–20.0)	0.16 (0.11–0.23)	98.59 (48.8–199.0
Placental lacunae	13	2725	77.43 (70.9–83.1)	95.02 (94.1–95.8)	4.52 (2.5–8.1)	0.29 (0.20–0.43)	24.32 (9.13–64.8)
Loss of hypoechoic space	10	2633	66.24 (58.3–73.6)	95.76 (94.9–96.5)	5.64 (2.3–14.1)	0.38 (0.20–0.69)	21.98 (6.8–70.6)
Abnormalities of uterus–bladder interface	9	2579	49.66 (41.4–58.0)	99.75 (99.5–99.9)	30.56 (8.1–115.5)	0.51 (0.34–0.77)	93.70 (35.5–247.5
Color Doppler abnormalities	12	714	90.74 (85.2–94.7)	87.68 (84.6–90.4)	7.77 (3.3–18.4)	0.17 (0.10–0.29)	69.02 (22.8–208.9

Ultrasound Obstet Gynecol 2013; 42: 509–517

MRI Findings

MRI Findings

- Uterine bulging
- Heterogeneous signal intensity within the placenta
- Dark intra-placental bands on T2-weighted images
- Abnormal placental vascularity
- Focal interruptions in the myometrial wall
- Tenting of the bladder
- Direct visualization of invasion of near organs

Magn Reson Imaging 2007;25:87–93 – Radiographics 2008;28:1905-1916
AJR 2011:197:1514-1521

MRI Findings

Uterine Bulging

Radiographics 2008;28:1905-1916 – AJOG 2010; 430-439.

MRI Findings

Dark intra-placental bands

Radiographics 2008;28:1905-1916

MRI Findings

Abnormal placental vascularity

Clinical Radiology 2009; 64:511-516

MRI Findings

Direct visualization of invasion of near organs

Clinical Radiology 2009; 64:511-516

Prenatal identification of invasive placentation using magnetic resonance imaging: systematic review and meta-analysis

F. D'ANTONIO*, C. IACOVELLA*, J. PALACIOS-JARAQUEMADA†, C. H. BRUNO‡, L. MANZOLI§¶ and A. BHIDE*

Table 3 Summary estimates of sensitivity, specificity, positive and negative likelihood ratios (LR+, LR−) and diagnostic odds ratio (DOR) of different magnetic resonance imaging (MRI) signs for the detection of invasive placentation

MRI sign	Studies (n)	Total sample (n)	Sensitivity (%) (95% CI)	Specificity (%) (95% CI)	DOR (95% CI)	LR+ (95% CI)	LR− (95% CI)
Uterine bulging	5*	119	79.1 (60.3–90.4)	90.2 (76.2–96.4)	34.8 (7.46–162.4)	8.06 (2.93–22.2)	0.23 (0.11–22.2)
Heterogeneous signal intensity	6*	143	78.6 (57.7–90.8)	87.7 (50.4–98.0)	26.2 (3.85–177.8)	6.38 (1.22–33.3)	0.24 (0.12–0.52)
Dark intraplacental bands on T2-weighted MRI	6*	146	87.9 (70.9–95.6)	71.9 (55.6–84.0)	18.6 (4.12–83.8)	3.13 (1.76–5.56)	0.17 (0.06–0.48)
Focal interruption of myometrium	4*	119	92.0 (79.2–97.2)	75.6 (50.4–90.4)	35.5 (5.03–250.9)	3.77 (1.54–9.23)	0.11 (0.03–0.35)
Tenting of bladder	2†	74	80.0 (28.0–99.5)	98.6 (92.2–100)	119 (9.9–1436)	31.5 (5.9–168)	0.28 (0.07–1.09)

*Computations based on hierarchical summary receiver–operating characteristics model. †Computations based on DerSimonian–Laird random-effect model.

Ultrasound Obstet Gynecol 2014;44:8-16

MRI & Accreta

Fetal Imaging Forum - 2013

MRI may be useful in determining
- Extent of invasion and involvement of structures when percreta is suspected
- When there is increased suspicion for placenta accreta based on clinical factors but the ultrasonography is nondiagnostic.

J Ultrasound Med 2014; 33:745–757

IMAGING

Accuracy of ultrasound for the prediction of placenta accreta

Zachary S. Bowman, MD, PhD; Alexandra G. Eller, MD; Anne M. Kennedy, MB BCh, BAO; Douglas S. Richards, MD; Thomas C. Winter III, MD, MA; Paula J. Woodward, MD; Robert M. Silver, MD

- 55 patients with accreta and 56 controls (previa)
- De-identified US studies
- Reviewed by 6 investigators, blinded to Dx

Am J Obstet Gynecol 2014;211:177

IMAGING

Accuracy of ultrasound for the prediction of placenta accreta

Zachary S. Bowman, MD, PhD; Alexandra G. Eller, MD; Anne M. Kennedy, MB BCh, BAO; Douglas S. Richards, MD; Thomas C. Winter III, MD, MA; Paula J. Woodward, MD; Robert M. Silver, MD

- Placental lacunae (OR 1.4 – 95% CI, 1.3-1.6)
- Loss of retroplacental space (OR 2.2 – 95% CI, 1.6-3.0)
- Irregular bladder wall (OR 1.3 – 95% CI, 1.0-1.6)
- Color Doppler abnormalities (OR 1.3 – 95% CI, 1.1-1.4)

Am J Obstet Gynecol 2014;211:177

Why Such Disparity?

How do I optimize my ultrasound diagnosis?

How to Optimize US Diagnosis?

1-Understand Relevance of a-Priori Risk

NIPT -

NIPT + T18

Ultrasound predictors of placental invasion: the Placenta Accreta Index

Martha W. F. Rac, MD; Jodi S. Dashe, MD; C. Edward Wells, MD; Elysia Moschos, MD; Donald D. McIntire, PhD; Diane M. Twickler, MD

OR estimates and CIs of each parameter used in Placenta Accreta Index

Parameter	OR	95% CI
Grade-3 lacunae	10.8	1.4–83
No. of cesarean deliveries	9.6	2.5–37.1
Placental location	3.9	1.1–14.1
Grade-2 lacunae	2.9	0.6–12.7
Bridging vessels	2.3	0.6–8.7
Sagittal smallest myometrial thickness	1.0	0.8–1.2

Am J Obstet Gynecol 2014

Ultrasound Parameters

TABLE 8.6 Ultrasound Diagnostic Findings in Placenta Accreta

- Gestational sac implanted in the lower uterine segment
- Cesarean section scar implantation
- Multiple vascular lacunaes in the second trimester
- Loss of normal hypoechoic retroplacental zone
- Multiple vascular lacunaes in the third trimester
- Abnormality in uterine-serosa-bladder interface
- Retroplacental myometrial thickness of less than 1 millimeter
- Turbulent blood flow on color Doppler through the lacunae
- Extension of villi into myometrium, serosa or bladder

Placenta Previa
Prior CSs
Anterior Placenta

Abuhamad A - Ultrasound in Obstetrics and Gynecology: A Practical Approach

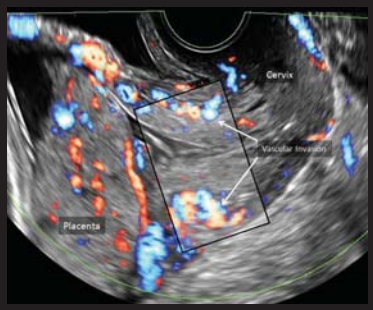
How to Optimize US Diagnosis?

2-Optimize Ultrasound Imaging

- Always use the transvaginal approach
- Evaluate placenta in real time
- Always add color Doppler in low velocity
- Carefully assess the lower segment / cervical area (look for cervical invasion)
- Develop expertise

Invasion of Cervical Stroma

Ultrasound Marker for PPH



SMFM Pregnancy Meeting 2015 – Poster # 261

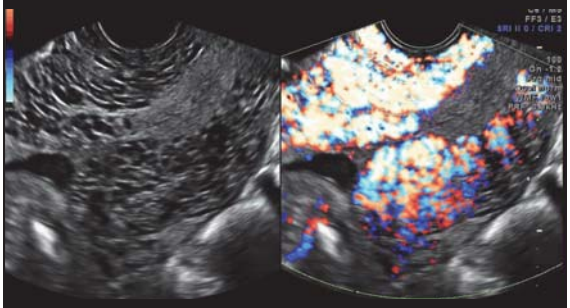
Invasion of Cervical Stroma

Ultrasound Marker for PPH

SMFM Pregnancy Meeting 2015 – Poster # 261

Invasion of Cervical Stroma

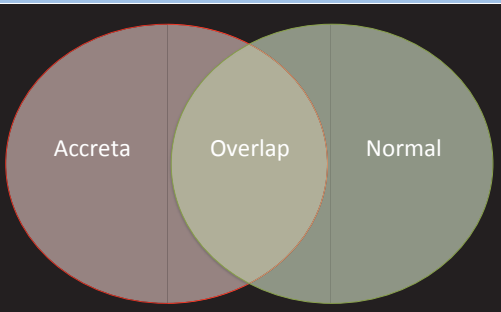
Ultrasound Marker for PPH



SMFM Pregnancy Meeting 2015 – Poster # 261

How to Optimize US Diagnosis?

3-Understand US Overlap between Normal & Accreta



Ultrasound predictors of placental invasion: the Placenta Accreta Index

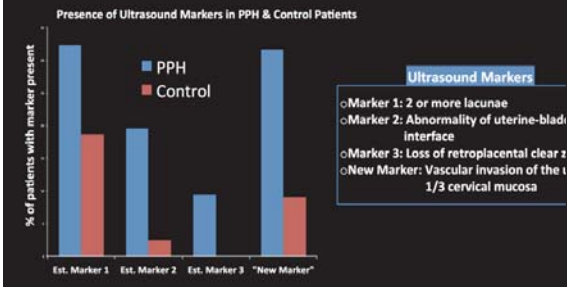
Martha W. F. Rac, MD; Jodi S. Dashe, MD; C. Edward Wells, MD; Elysia Moschos, MD; Donald D. McIntire, PhD; Diane M. Twickler, MD

Ultrasound parameters of entire cohort

Variable	Placental invasion, n = 54	No placental invasion, n = 130	*P* value
Anterior placentation	38 (70)	36 (28)	< .001
Lacunae			< .001
Grade 0	11 (20)	62 (48)	
Grade 1	15 (28)	52 (40)	
Grade 2	10 (19)	12 (9)	
Grade 3	18 (33)	4 (3)	
Bridging vessels	35 (65)	24 (18)	< .001
Sagittal smallest myometrial thickness, mm	0.9 [0.0,2.2]	2.4 [0.0,4.0]	< .001
Uterine-bladder interface thickness, mm	2.4 [0.0,4.0]	3.3 [2.4,4.0]	.003

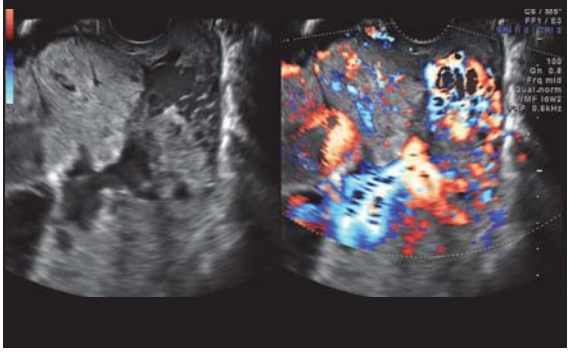
Am J Obstet Gynecol 2014

Ultrasound Markers in PPH & Controls



118 patients matched to 118 controls (age, parity & mode of delivery)

Accreta



Previa - Normal

Risk for Accreta?

How to Optimize US Diagnosis?

4-Report Results as Risk Profile for PPH

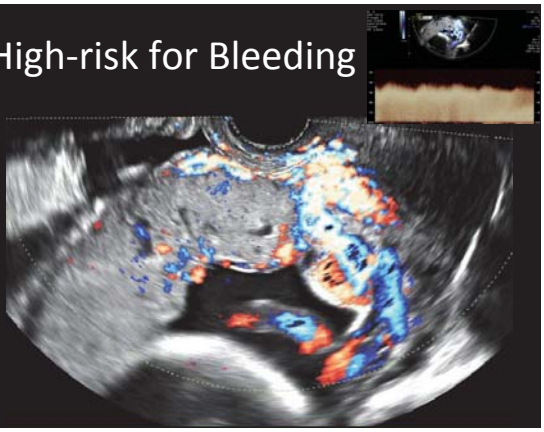
- Until we have large prospective data on US diagnosis,

How to Optimize US Diagnosis?

4-Report Results as Risk Profile for PPH

- High-risk for bleeding
- Intermediate-risk for bleeding
- Low-risk for bleeding

High-risk for Bleeding



Low Risk for Bleeding

Intermediate Risk for Bleeding

Intermediate Risk for Bleeding

Ultrasound predictors of placental invasion: the Placenta Accreta Index

Martha W. F. Rac, MD; Jodi S. Dashe, MD; C. Edward Wells, MD; Elysia Moschos, MD; Donald D. McIntire, PhD; Diane M. Twickler, MD

Sensitivity, specificity, and positive and negative predictive values at each PAI score

PAI	n	Probability of invasion, % (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)
>0	1	5 (1–15)	100 (68–100)	19 (10–31)	38 (27–49)	100 (72–100)
>1	1	10 (4–22)	97 (82–100)	47 (34–61)	47 (34–61)	97 (82–100)
>2	2	19 (10–32)	93 (77–99)	58 (44–70)	52 (38–66)	94 (81–99)
>3	4	33 (22–47)	86 (68–96)	68 (54–79)	57 (41–72)	91 (78–97)
>4	6	51 (36–66)	72 (53–87)	85 (73–93)	70 (51–85)	86 (75–94)
>5	6	69 (50–83)	52 (33–71)	92 (81–97)	75 (51–91)	79 (68–88)
>6	2	83 (63–93)	31 (15–51)	100 (94–100)	100 (66–100)	75 (64–84)
>7	2	91 (73–97)	24 (10–44)	100 (94–100)	100 (59–100)	73 (62–82)
>8	5	96 (81–99)	17 (6–36)	100 (94–100)	100 (48–100)	71 (60–81)

Am J Obstet Gynecol 2014

How to Optimize US Diagnosis?

5-Be Conservative

- High-index of suspicion
- When in doubt – call intermediate risk
- False + results are OK

Management

EVMS Accreta Clinic

- Diagnosis is based on probability; low risk – moderate risk – High risk
- Patients seen in one clinic – Accreta Clinic
- Protocol for preoperative coordination of care
- Check list to ensure adequate preoperative preparation & counseling
- Multidisciplinary team – MFM, Ob Anesthesia, Intervention radiology, Urology All
- All surgery in main OR
- ICU postop care

Multidisciplinary Care Team

- Experienced pelvic surgeon /maternal – fetal medicine
- Skilled nursing team
- Blood bank team
- Experienced anesthesia team
- Skilled urologist
- Experienced intensivist
- Experienced interventional radiologist

Multidisciplinary Care Team

Table 4. Maternal Morbidity in Cases of Suspected Accreta Stratified by Delivery Site

	Multidisciplinary Care Center (n=60)	Standard Care Center (n=23)	P
Estimated blood loss (L)	2.6 (0.15–9)	4.0 (0.6–23)	.096*
Maternal admission to intensive care unit	18 (30)	9 (39)	.437
Early reoperation	2 (3)	9 (41)	<.001†
Coagulopathy‡	17 (28)	9 (41)	.278
Large-volume blood transfusion			
4 or more units of packed red cells	25 (42)	16 (70)	.023
Cystotomy	22 (37)	10 (43)	.568
Ureteral injury	4 (7)	4 (17)	.208†
Infectious complications	18 (30)	5 (23)	.590†
Wound infection	8 (13)	4 (18)	
Intraabdominal infection	4 (7)	0	
Vaginal cuff cellulitis	2 (3)	0	
Pyelonephritis	4 (7)	1 (5)	
Pneumonia	0	0	
Postoperative length of stay (d)	4 (3–13)	5 (2–26)	.280
4 or fewer	31 (52)	11 (48)	
5–8	24 (40)	6 (26)	
9 or more	5 (8)	6 (26)	
Hospital readmission within 6 wk	7 (12)	3 (13)	1.000†
Delayed reoperation§	5 (8)	3 (13)	.679†
Early composite morbidity‖	28 (47)	17 (74)	.026
Late composite morbidity¶	12 (20)	5 (22)	1.000†

Obstet Gynecol 2011;117:331

Planned Delivery

- 93% of patients with placenta accretas report hemorrhage after 35 weeks

Planned Delivery

- Associated with shorter OR times
- Lower frequency of transfusions
- Lower ICU admission

Obstet Gynecol 2011;117:331 – AJOG 1996;175:1632-1638

Planned Delivery

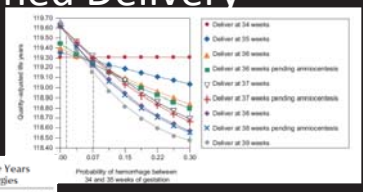


Table 5. Ranked Quality-Adjusted Life Years Outcomes of Different Strategies

Rank	Strategy	QALY
1st	Scheduled delivery at 34 wk	119.31
2nd	Scheduled delivery at 35 wk	119.11
3rd	Scheduled delivery at 36 wk	119.05
4th	Scheduled delivery at 36 wk pending amniocentesis	119.02
5th	Scheduled delivery at 37 wk	118.99
6th	Scheduled delivery at 37 wk pending amniocentesis	118.96
7th	Scheduled delivery at 38 wk	118.86
8th	Scheduled delivery at 38 wk pending amniocentesis	118.84
9th	Scheduled delivery at 39 wk	118.74

QALY, quality-adjusted life year.

At 34 - 35 weeks – following steroids

Obstet Gynecol 2011;117:331

Massive Transfusion

- Recommend a 1:1 ratio of pRBC to FFP

Surgical Management

Surgical Management

- Consider transfer to a tertiary center
- Consider ultrasound mapping of placental implantation site preoperatively
- Cesarean hysterectomy with placenta left in situ
- Staged surgical approach (intervention radiology)
- Conservative management

Conservative Treatment
Placenta left in situ

Total cases	**167**
Successful conservative management	**131 (78%)**
Spontaneous placental resorption	**87 (75%)**
Severe maternal morbidity	**10 (6%)**

Obstet Gynecol 2010 Mar;115(3):526

Staged Surgical Approach

TABLE 4
Patient demographics and outcomes

Variable	Staged procedure	Cesarean hysterectomy	*P* value
Age, y[a]	35.8 ± 1.1 (33–41)	36.9 ± 1.24 (23–44)	.28
Parity, n	2.0 ± 0.19	1.9 ± 0.20	.55
Gestation at delivery, wk[a]	36.9 ± 0.6 (33–38.5)	33.4 ± 1.50 (16–39)	.54
Blood loss, mL[a]	553 ± 119 (200–1200)	4517 ± 711 (700–11,000)	.0001
Units transfused, n[a]	0.5 ± 0.38 (0–3)	7.9 ± 1.83 (0–32)	.0013
Required transfusion, n	2	16	.001
In the intensive care unit, d[a]	0.13 ± 0.125 (0–1)	0.89 ± 0.332 (0–5)	.152
Admission to the intensive care unit, n	1	7	.16
Length of postoperative stay, d[a]	6.63 ± 0.8 (4–10)	8.28 ± 0.41 (5–13)	.107
Preoperative radiology, h[a]	0.59 ± 0.09	0.59 ± 0.09	
Total operative time, h[a]	2.91 ± 0.37	2.67 ± 0.26	
Total anesthetic time, h[a]	6.59 ± 0.35	2.67 ± 0.26	.0001

[a] Data are given as mean ± SE (range).
Angtmann. Surgical management of placenta accreta. Am J Obstet Gynecol 2010.

Am J Obstet Gynecol 2010;202:38.e1-9.

National Registry

- Standardize US markers of Accreta
- Track US markers in a prospective way
- Collect data on conservative management
- Facilitate randomized trials

Table 1 Unified descriptors, as suggested by the European Working Group on Abnormally Invasive Placenta (EW-AIP), for ultrasound (US) findings in AIP

US finding	*EW-AIP suggested standardized definition*
2D grayscale	
Loss of "clear zone" (Figure 1)	Loss, or irregularity, of hypoechoic plane in myometrium underneath placental bed ("clear zone")
Abnormal placental lacunae (Figure 2)	Presence of numerous lacunae including some that are large and irregular (Finberg Grade 3), often containing turbulent flow visible on grayscale imaging
Bladder wall interruption (Figure 3)	Loss or interruption of bright bladder wall (hyperechoic band or 'line' between uterine serosa and bladder lumen)
Myometrial thinning (Figure 4)	Thinning of myometrium overlying placenta to < 1 mm or undetectable
Placental bulge (Figure 5)	Deviation of uterine serosa away from expected plane, caused by abnormal bulge of placental tissue into neighboring organ, typically bladder; uterine serosa appears intact but outline shape is distorted
Focal exophytic mass (Figure 6)	Placental tissue seen breaking through uterine serosa and extending beyond it; most often seen inside filled urinary bladder
2D color Doppler	
Uterovesical hypervascularity (Figure 7)	Striking amount of color Doppler signal seen between myometrium and posterior wall of bladder; this sign probably indicates numerous, closely packed, tortuous vessels in that region (demonstrating multidirectional flow and aliasing artifact)
Subplacental hypervascularity (Figure 8)	Striking amount of color Doppler signal seen in placental bed; this sign probably indicates numerous, closely packed, tortuous vessels in that region (demonstrating multidirectional flow and aliasing artifact)
Bridging vessels (Figure 9)	Vessels appearing to extend from placenta, across myometrium and beyond serosa into bladder or other organs; often running perpendicular to myometrium
Placental lacunae feeder vessels (Figure 10)	Vessels with high-velocity blood flow leading from myometrium into placental lacunae, causing turbulence upon entry
3D ultrasound ± power Doppler	
Intraplacental hypervascularity (Figure 11)	Complex, irregular arrangement of numerous placental vessels, exhibiting tortuous courses and varying calibers
Placental bulge	(as in 2D)
Focal exophytic mass	(as in 2D)
Uterovesical hypervascularity	(as in 2D)
Bridging vessels	(as in 2D)

2D, two-dimensional; 3D, three-dimensional.

Ultrasound Obstet Gynecol 2016; **47**: 271–275

Take Home Message

- Know the new classification of Previa
- Know the risk factors for vasa previa
- Ultrasound is suboptimal for diagnosis of abruption
- Know the maternal risk factors for accreta
- Know the Ultrasound markers of placenta accreta
- Never rule-out placenta previa by an abdominal ultrasound
- MRI is never helpful if ultrasound is diagnostic of an accreta
- Consider delivery at 34-35 weeks for accreta
- Plan – Plan – Plan

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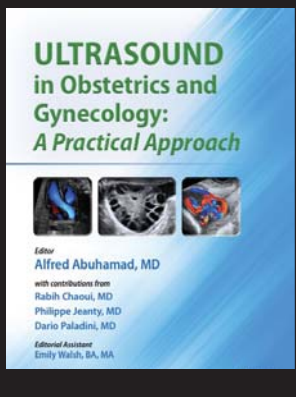

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