
به نام خدای خوبیها

Fetal Growth Restrictio

Homeira Vafaei , MD

Professor of OB-GYN

Vice-President of Iranian perinatology Association

Maternal-Fetal medicine subspecialits

Shiraz University of Medical Sciences

Introduction

- FGR occurs in **up to 10% of pregnancies**
- Leading cause of **perinatal morbidity & mortality**
- Antenatal treatment is not available

➢ **Clinical Goals :** Identify FGR, Determine cause, Assess Severity, Timing of delivery

Identify fetuses at highest risk of demise

- Distinguish **constitutional small** from **pathologic growth**

➢ **Key challenges:**

- Heterogeneous entity
- Cause often not prenatally determinable
- Balance: iatrogenic preterm birth **vs.** stillbirth

Introduction

- Fetal growth is a dynamic process and its assessment requires multiple observations of fetal size over time

◆The fetus failing to reach its genetically predetermined growth potential.

◆ A specified decline in the EFW or AC percentile over serial assessments (> 50 percentile);

and

◆various abnormal Doppler findings

TOPICS

- Definition
- Risk factors
- Screening
- Prevention
- Diagnosis and evaluation
- Management
- Delivery time

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Definitions – Key Terms

Term	Definition
FGR	EFW or AC <10th percentile
Severe FGR	EFW or AC <3rd percentile
Early-onset FGR	<32 weeks
Late-onset FGR	≥32 weeks
SGA newborn	Birth weight <10th percentile
Placental insufficiency	Most common cause; diagnosis of exclusion

- **ACOG (2021a) and SMFM (2020) :**
  - ❖ EFW <10th percentile for gestational age

    OR

  - ❖ AC <10th percentile for gestational age.
- **ISUOG:**
  - ➢ EFW < 3rd percentile with highest mortality and morbidity
  - ➢ Assessment and monitoring should be done if :
  - ➢ EFW< 10th OR AC < 10th percentile or Growth velocity is less than expected according to growth charts
  - ➢ Reduced growth velocity is normally taken to be a fall between consecutive ultrasound scans of >50 percentiles for AC or, more commonly, EFW
  - ◆ Progressive increase in the risk of stillbirth in pregnancies with a predicted birth weight below the 25th percentile

Definitions: SGA vs. FGR

Feature	Small-for-Gestational Age (SGA)	Fetal Growth Restriction (FGR)
Definition	Size (EFW/AC) < 10th percentile	Fetus fails to reach genetic growth potential
Risk	Not necessarily increased risk	Increased perinatal & long-term morbidity/mortality
Key Point	"Small but healthy"	May be >10th percentile but still FGR
Stand-alone Criterion	None	EFW/AC < 3rd percentile (any gestation)

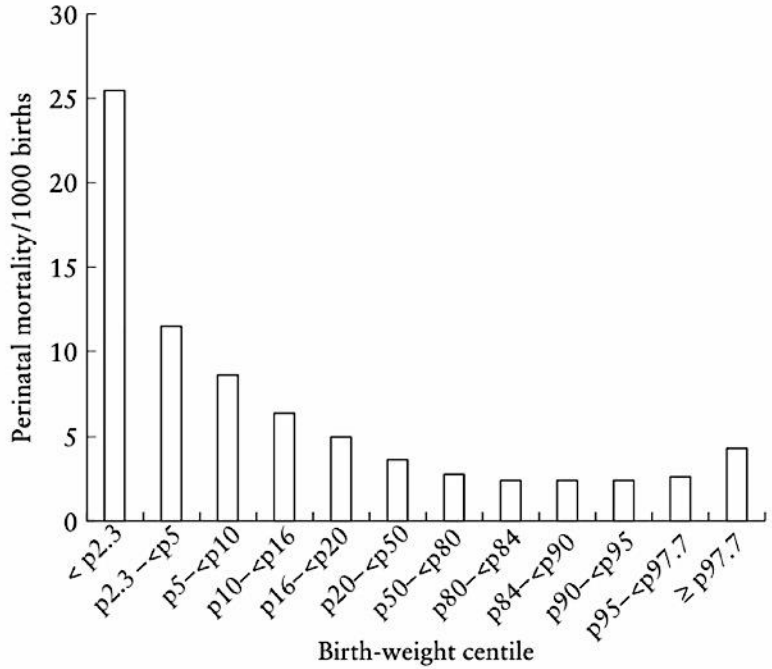
Isolated criterion for FGR: EFW or AC < 3rd percentile (even without other Doppler changes)

Size alone is insufficient. Use the 3rd percentile as a red flag for FGR. A drop in growth velocity (e.g., >50 percentiles between scans) also warrants suspicion.

Distinguishing SGA from FGR - Tools

- To differentiate SGA from FGR (when EFW/AC is 3rd-10th percentile), use:
- **Doppler Velocimetry (Key Tool)**
  - Uterine Artery (UtA) - Placental perfusion
  - Umbilical Artery (UA) - Placental resistance
  - Middle Cerebral Artery (MCA) - Fetal brain-sparing
- **Fetal Growth Velocity:** Drop of >50 percentiles (e.g., 70th → 20th)
- **Customized Growth Charts:** Adjust for maternal height, weight, ethnicity, parity, fetal sex
- **Recommendation:** Doppler helps distinguish SGA from FGR (Good Practice Point)
- A structurally normal fetus with EFW 7th percentile, normal UA/MCA Dopplers, and normal growth velocity is likely SGA. Add abnormal UA PI or brain-sparing, and it becomes FGR.]

FIGURE 1
Perinatal mortality according to birthweight percentile



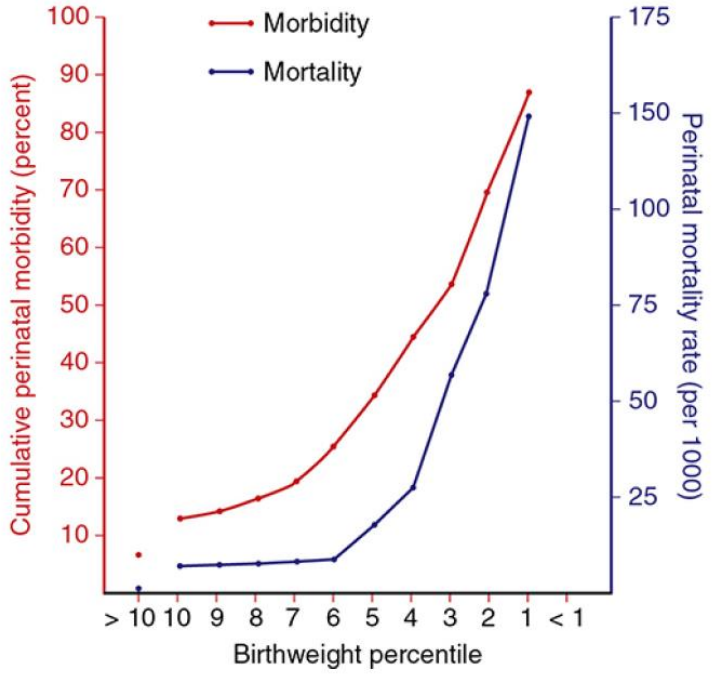
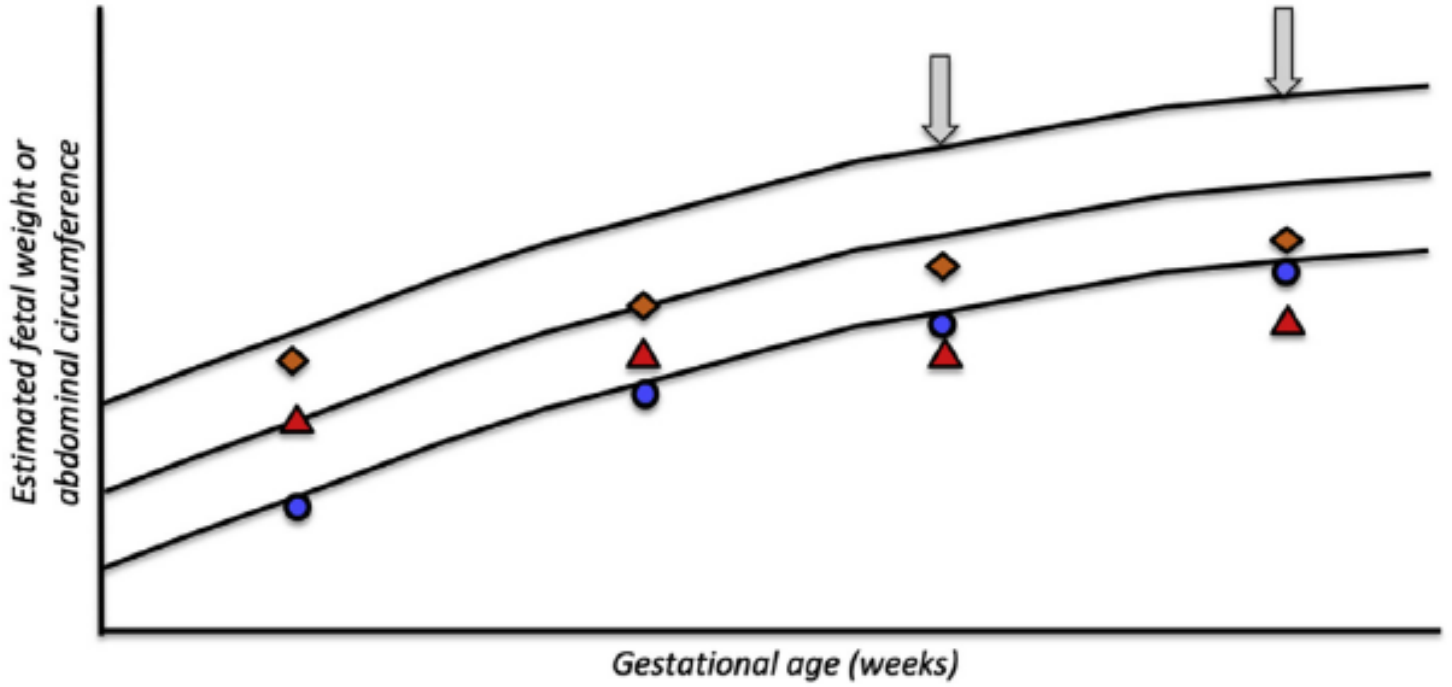


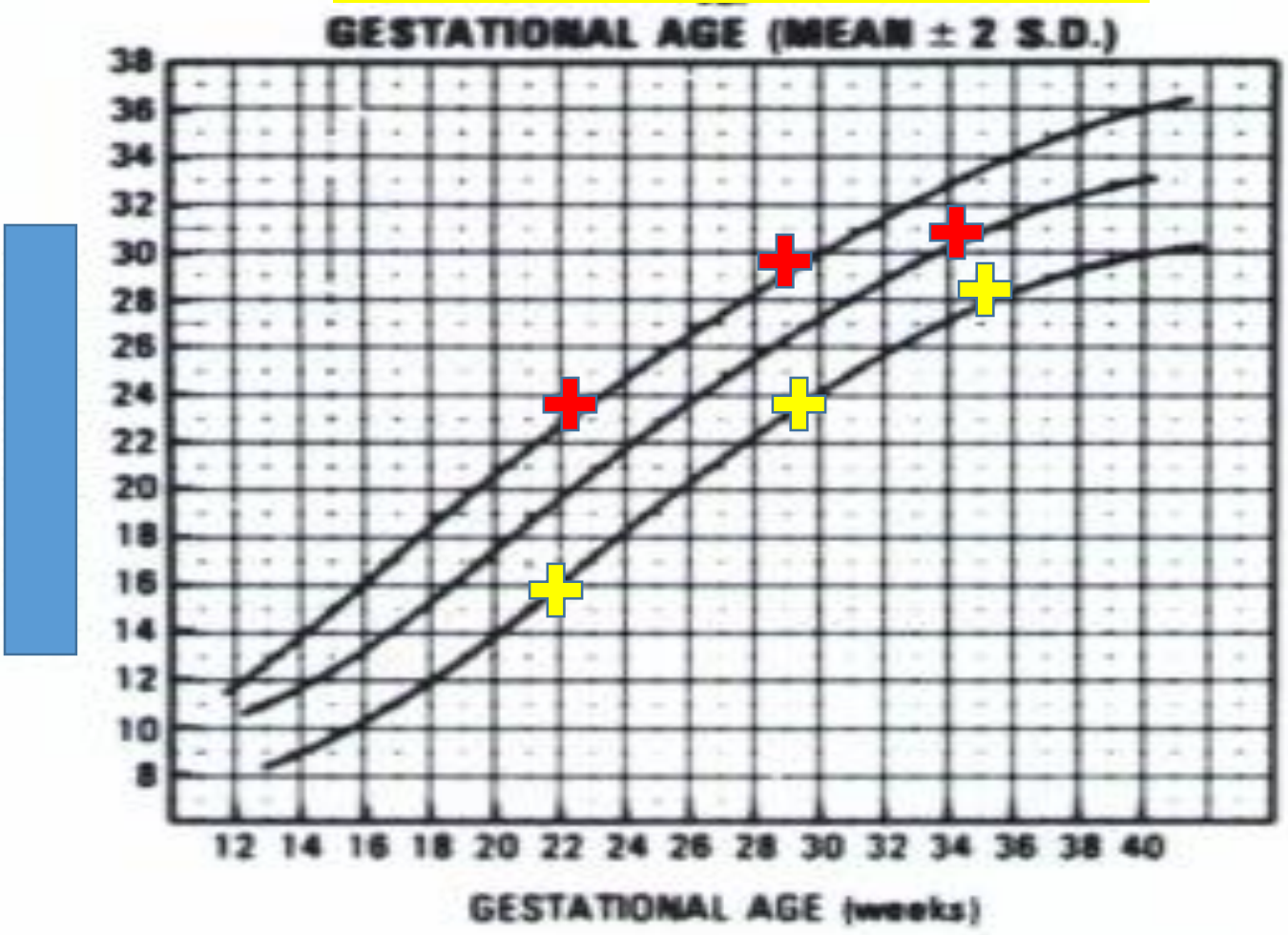
FIGURE 2

Patterns of fetal growth in SGA and FGR



GROWTH POTENTIAL

EFW



Initiation of Fetal Surveillance

- Start at gestational age when delivery would be considered for perinatal benefit
- **Before initiating surveillance** (especially for extreme prematurity):
- Multidisciplinary counseling:
  - Obstetrics
  - Maternal-Fetal Medicine
  - Neonatology
- Modalities:
- Serial EFW (every 2–4 weeks)
- Doppler (UA, MCA, DV)
- BPP & NST/CTG

Complications of FGR

- Increased perinatal mortality and morbidities
- Stillbirth
- Prematurity
- Low Apgar score
- Acidosis, metabolic disturbance
- Adverse effect on cognitive function
- Learning difficulty
- Increased risk of metabolic diseases in adulthood

Screening – Benefits & Harms

- **Benefits**
- Enables formal fetal surveillance
- Reduces stillbirth risk via timed delivery
- **Harms**
- Overdiagnosis
- Parental anxiety
- Unnecessary interventions:
  - Antenatal testing
  - Induction of labor
  - Iatrogenic preterm birth

Screening for FGR

Universal Screening:

Review medical/obstetric history for risk factors at each visit.

Serial fundal height measurements after 24 weeks.

Finding suggestive of FGR: Discrepancy >3 cm between weeks and measurement.

Limitations of Fundal Height:

Maternal obesity, uterine leiomyomas, multiple gestation.

Ultrasound Screening: Preferred in cases with maternal factors increasing FGR risk or when fundal height is inaccurate.

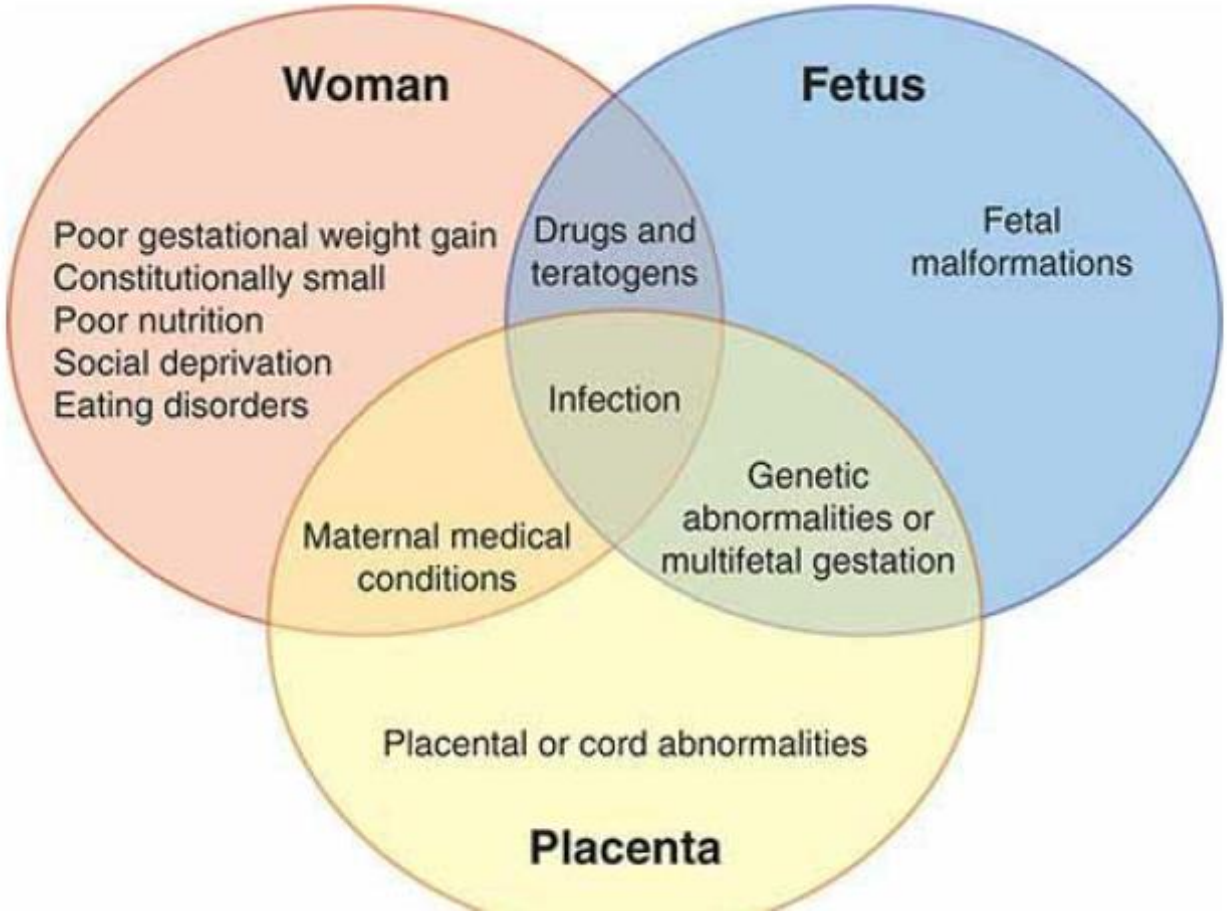
Note: Universal 3rd-trimester ultrasound is NOT proven to improve outcomes.

Risk Factors for FGR

•**Maternal**:
•chronic hypertension, diabetes,
• collagen vascular disease, APS,
• substance use, certain meds

•**Fetal**: genetic anomalies, congenital infections (CMV, toxo, rubella, syphilis)
•**Placental**: insufficiency, velamentous cord, circumvallate placenta,
•single umbilical artery

Risk Factors and Etiologies



- Fetal genetic abnormalities
- Fetal infection
- Fetal structural anomaly
- Multiple gestation
- CPM
- Ischemic placental dis
- Gross cord and placental abnormalities
- Maternal genetic factors
- **Maternal medical and obstetric conditions**
- Environmental factors

- ART
- Low prepregnancy weight, poor gestational weight gain,
- malabsorption, poor nutritional status
- Teratogens
- Residing at high Altitude
- Short interpregnancy Interval
- Extremes of maternal Age
- Abnormal maternal biochemical markers
- Discrepancy between CRL and accurate menstrual history by 2 to 6 days

Screening Strategies

Approach	Method
Risk-based	Select high-risk pregnancies for ultrasound surveillance
Universal	Routine 3rd-trimester ultrasound in all

Evidence

- Routine US after 24 weeks does **not** significantly reduce perinatal mortality (RR 1.01)
- No increase in C-section rate
- 75–80% of SGA newborns remain undetected antenatally

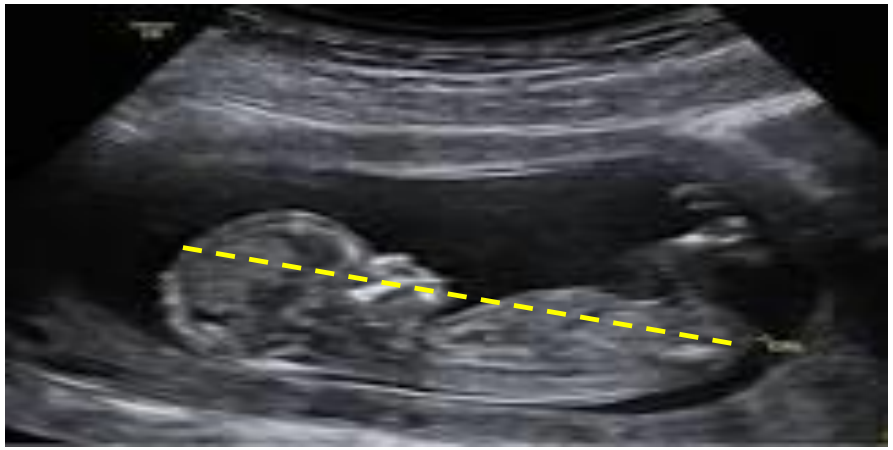
Our Approach

- **Low-risk pregnancies**
- Fundal height measurement starting at 24 weeks
- If lag ≥4 cm or inadequate assessment → ultrasound
- **High-risk pregnancies**
- Growth scan starting at 26- 28 weeks
- Repeat every 3–4 weeks (not ≤2 weeks)
- **Always**
- Encourage tobacco/substance cessation
- Low-dose aspirin for preeclampsia risk (start before 16 weeks)

Diagnosis

- Accurate Dating
- Fundal height
- Serial ultrasonography
- Uterine and Fetal Color Doppler

DATING OF PREGNANCY



- Pregnancy dating is best established when first-trimester **CRL** is used

IVF: Date of ET + 2 week + 3-5 days

TWIN : Redate according to larger CRL

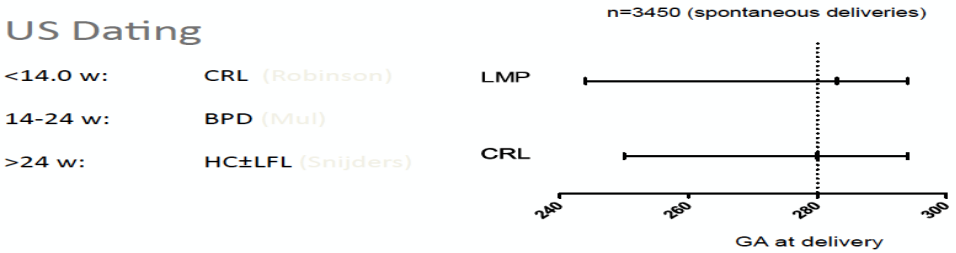


Table 1. Guidelines for Redating Based on Ultrasonography

Gestational Age Range*	Method of Measurement	Discrepancy Between Ultrasound Dating and LMP Dating That Supports Redating
≤13 6/7 wk	CRL	
• ≤ 8 6/7 wk		More than 5 d
• 9 0/7 wk to 13 6/7 wk		More than 7 d
14 0/7 wk to 15 6/7 wk	BPD, HC, AC, FL	More than 7 d
16 0/7 wk to 21 6/7 wk	BPD, HC, AC, FL	More than 10 d
22 0/7 wk to 27 6/7 wk	BPD, HC, AC, FL	More than 14 d
28 0/7 wk and beyond†	BPD, HC, AC, FL	More than 21 d

Fundal Height (HoF)

- **wide range of sensitivities: 13 to 86 percent of small fetuses**
- Factors that may affect sensitivity:
  - Maternal body mass index
  - Parity
  - Ethnic group
  - Amniotic fluid volume
  - Leiomyoma

- This technique appears to perform best when all of the measurements are obtained by the same clinician using the unmarked side of the tape (to reduce bias and plotted to refect fetal growth for the individual patient ("customized")

Diagnostic Evaluation - US

- **Ultrasound is the best method**
- **Required Components when EFW/AC <10th percentile:**
  - **Serial fetal biometry** (every 3-4 weeks; not more than every 2 weeks due to error margin).
  - **Amniotic fluid assessment**.
  - **Fetla Dopplers (Umbilical artery (UA) Doppler)**
  - **Uterine arteries Doppler**
  - **Fetal anatomy survey** (if not already done) to assess for structural/genetic abnormalities.
  - **Biophysical profile**

Diagnosis- US BASED

- **EFW or AC <10th percentile** → small fetus
- **<3rd percentile** → highly likely FGR (even with normal Dopplers)
- **3rd–10th percentile** → require supporting evidence:
  - Abnormal Doppler
  - Declining growth trajectory
- Evaluation of a single biometric fetal measurement
- defines the size and not fetal growth

SMFM/ACOG/AIUM criteria: higher sensitivity (55% vs 29%) but lower specificity (93% vs 98%) than ISUOG

Supporting Characteristics

- **Maternal**
- Vascular disease, tobacco, drugs, certain medications
- **Fetal**
- Genetic syndromes, congenital anomalies, infections
- **Ultrasound markers**
- Oligohydramnios (especially with EFW <3rd)
- Polyhydramnios + FGR → aneuploidy risk
- **Doppler**
- Uterine artery: high resistance, notching
- Umbilical artery: PI >95th, ARED flow
- Middle cerebral, ductus venosus

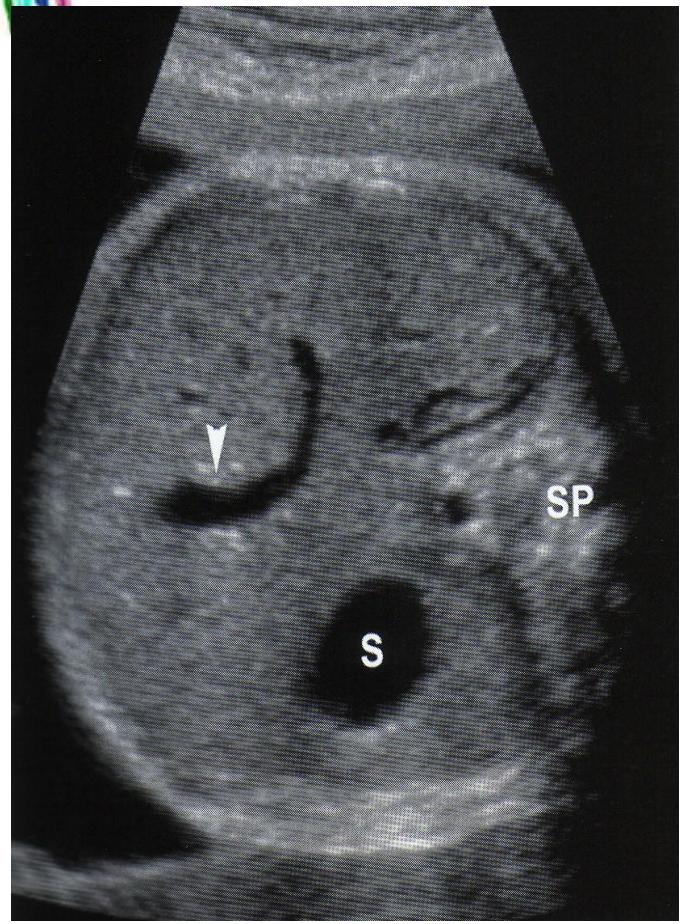
POTENTIAL SONOGRAPHIC FINDINGS IN FGR

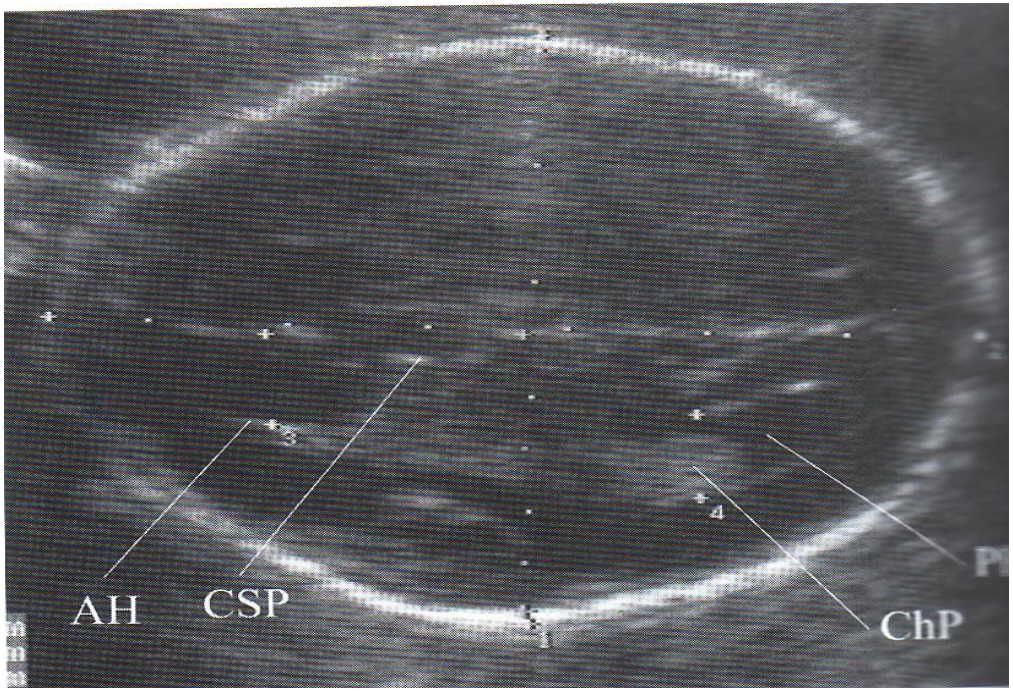
- ***EFW:*** The sensitivity, specificity, positive, and negative predictive values of EFW for FGR <10th percentile are approximately 90, 85, 80, and 90 percent, respectively
- **Population based charts Vs customized**
- Variuos Formula
- BPD, HC, AC, FL
- **ISUOG , SMFM :** Population-based fetal growth references (such as Hadlock) in determining fetal weight percentiles (GRADE 1B)

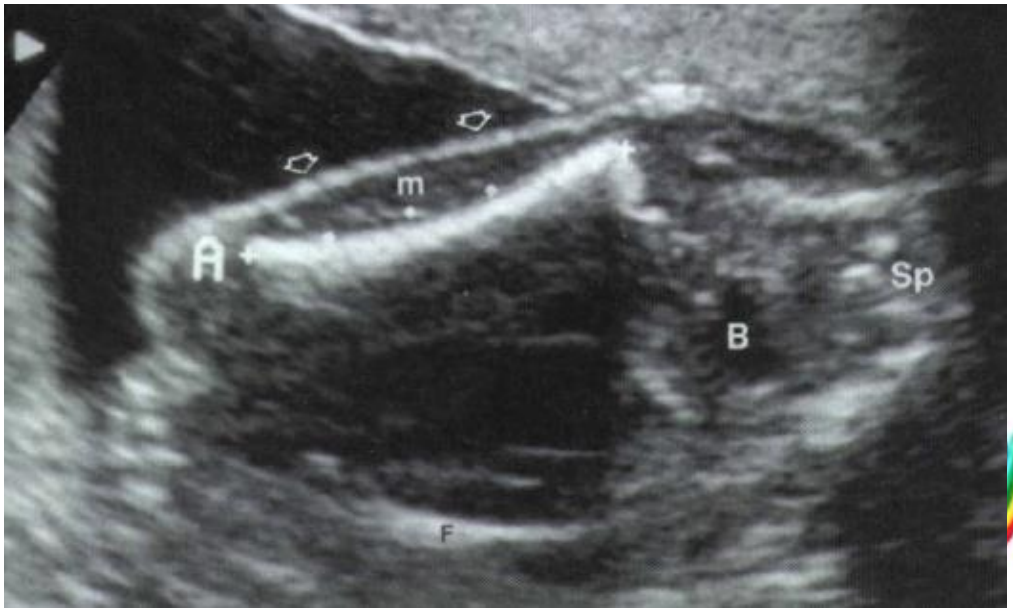
Ultrasonographic estimation of fetal weight

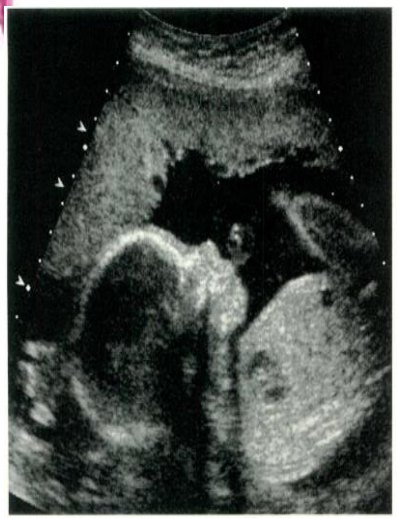
- ***AC:*** **The most sensitive for detection** of FGR when it is asymmetric and when measured near term
- **Amniotic fluid volume:** The PORTO study: amniotic fluid volume abnormalities did not independently increase the risk for adverse outcomes in FGR.
- **Biometric ratios:** HC/AC and femur length (FL)/AC ratios
- **Soft tissue**: Fetal thigh circumference , fetal midcalf, midthigh, or abdominal wall, and cheek-to-cheek diameter
- **3-D sonography:** Highly promising in the clinical setting of FGR, 3 – D thigh, femur, or humerus volume measurement was simple and more accurate

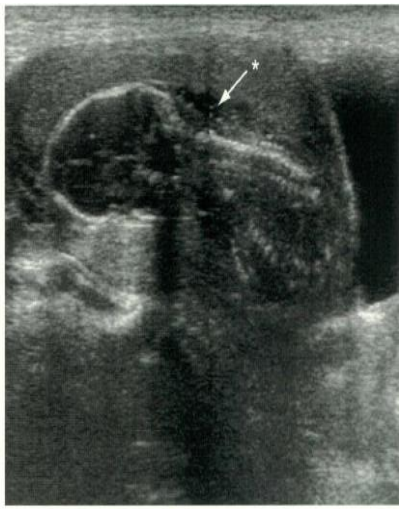
BPD, HC, AC , FL, EFW







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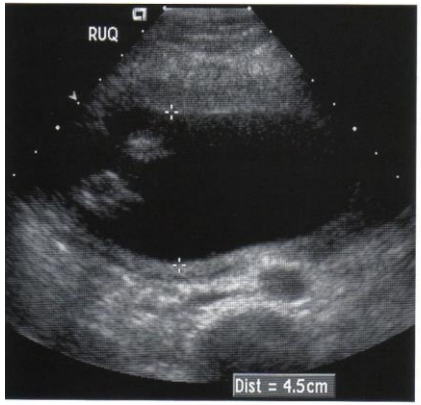
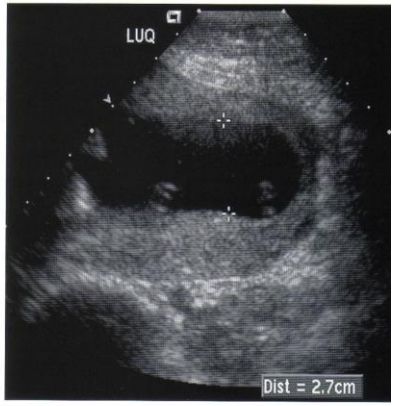
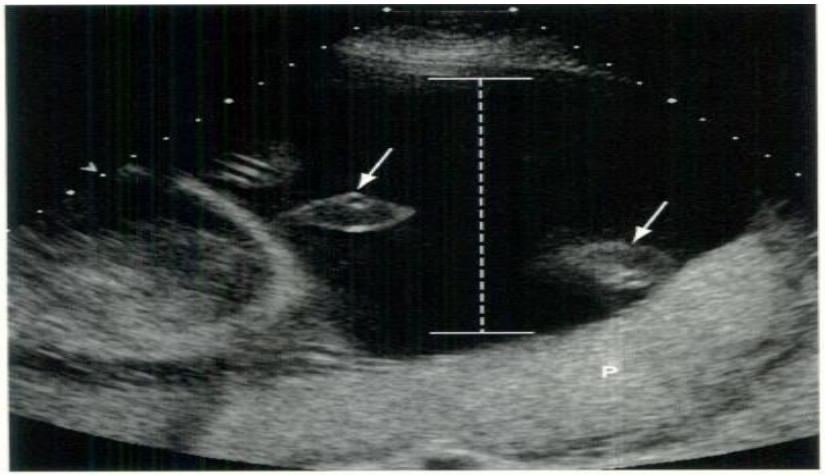

RUQ
Dist = 4.5cm


LUQ
Dist = 2.7cm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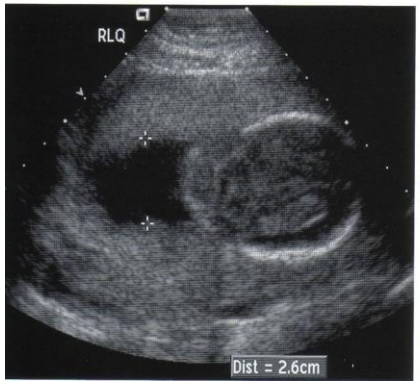

RLQ
Dist = 2.6cm

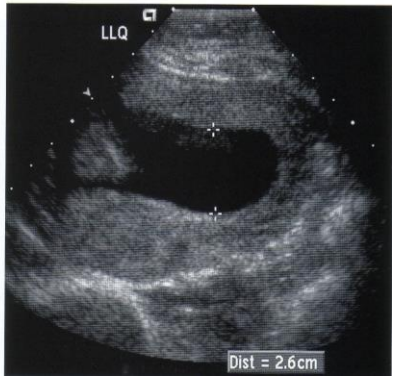
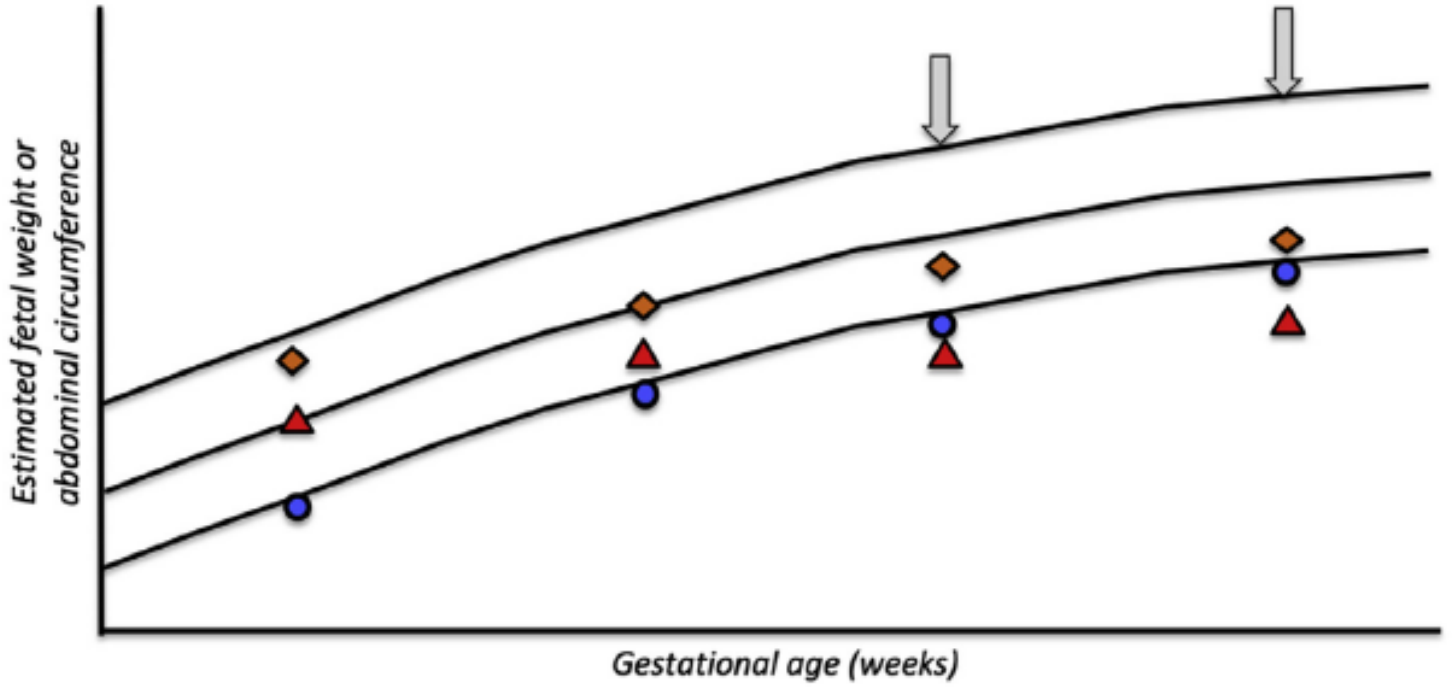

LLQ
Dist = 2.6cm

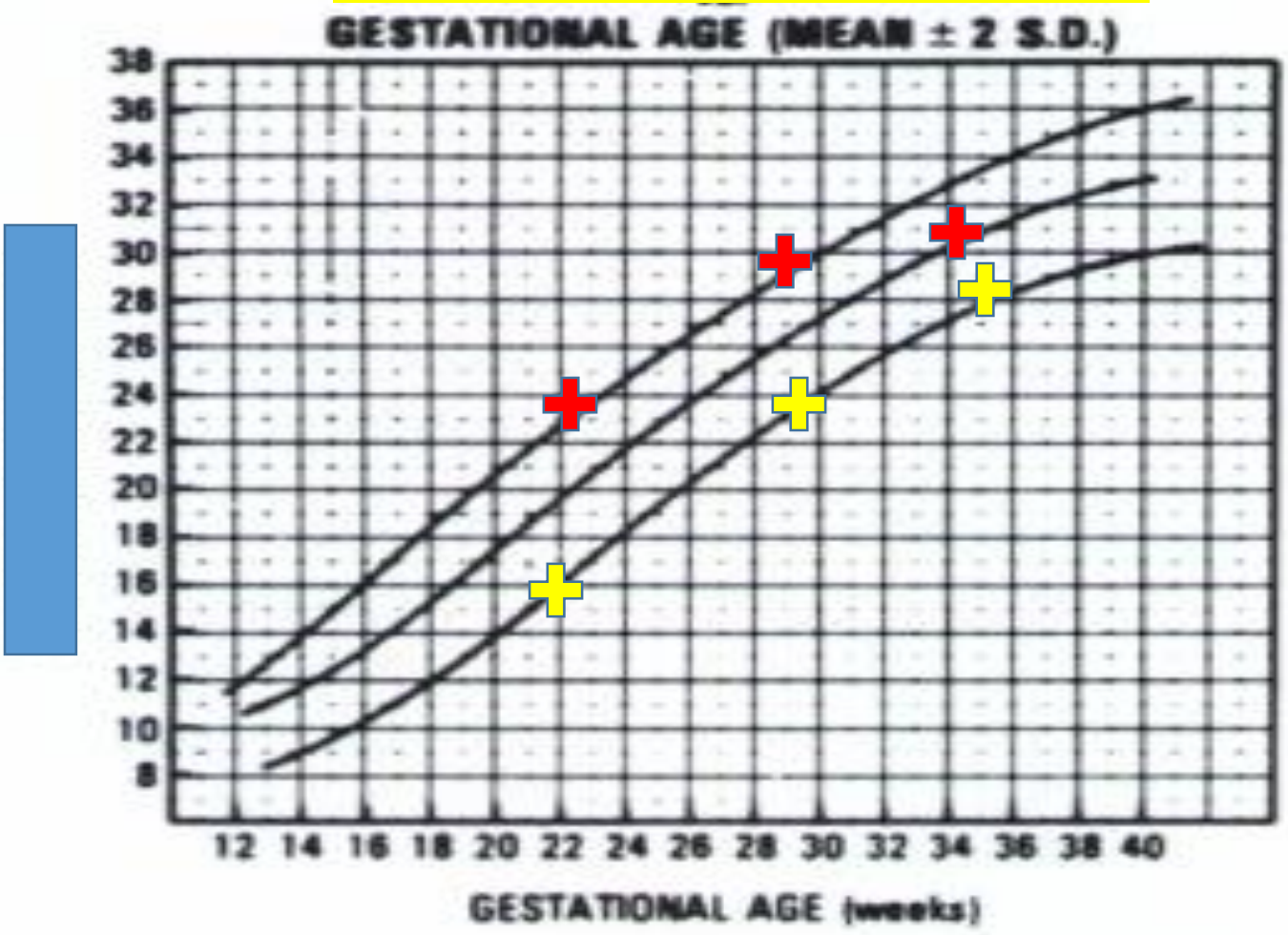
FIGURE 2

Patterns of fetal growth in SGA and FGR



GROWTH POTENTIAL

EFW



DOPPLER STUDY

- **Assessment of Doppler flow with appropriate intervention can reduce perinatal mortality**
- **Fetoplacental Doppler plays a central role in:**

➢ Identification , severity

➢ Surveillance

➢ Management

➢ Timing of delivery

➢ Differentiation from a constitutionally small fetus.

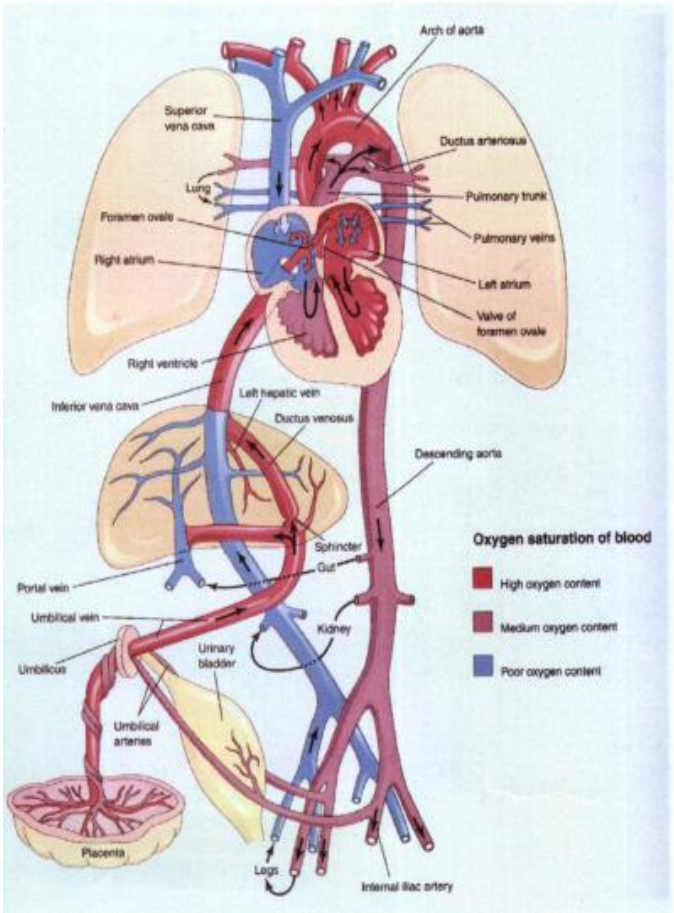
➢ Distinction between early and late FGR

- It allows for the identification of uteroplacental insufficiency and/or fetal cardiovascular adaptation to hypoxemia.

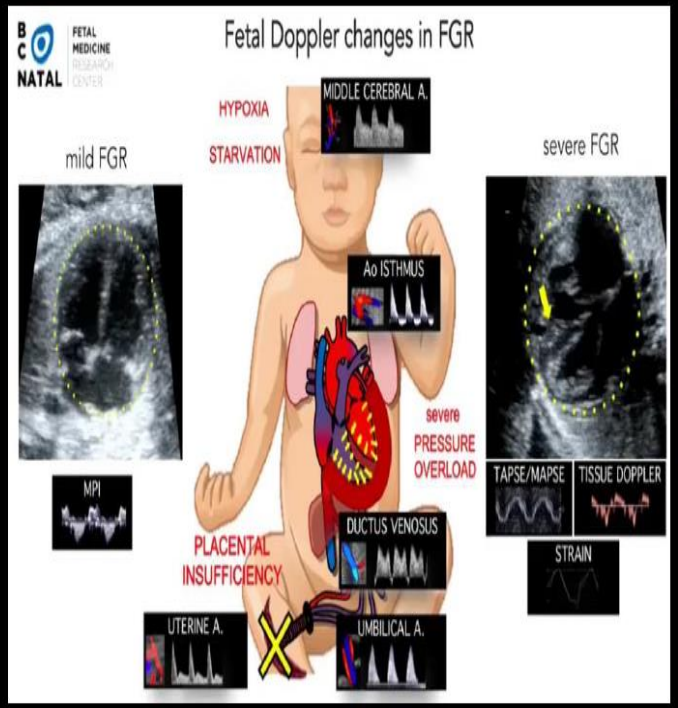
◆Uteroplacental function through evaluation of the uterine and umbilical arteries

◆Fetal Dopplers: MCA, Ductus venosus

❖ Improves outcomes when used with standard surveillance (NST/BPP)



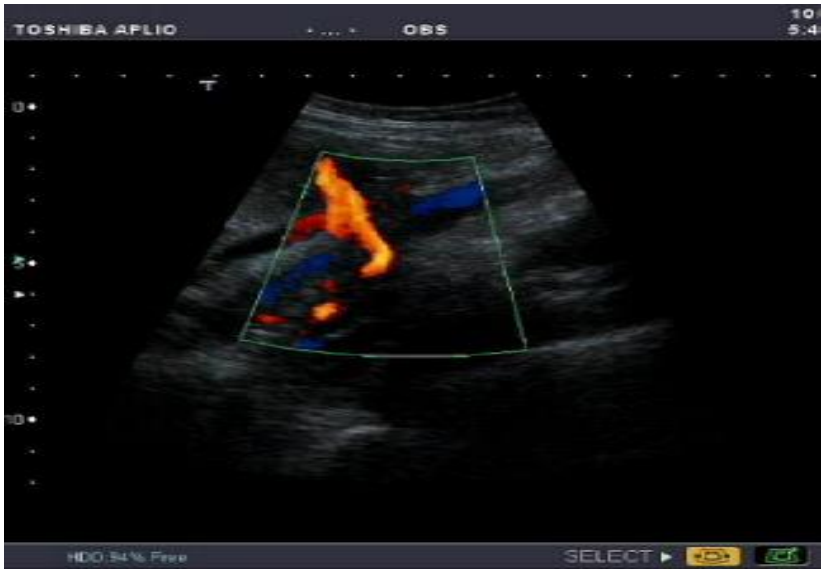
Which Doppler?!

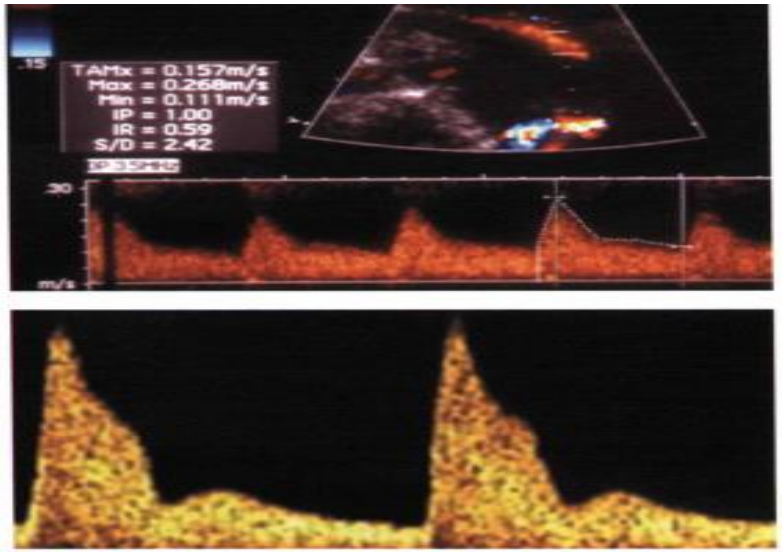


Uterine artery
Umbilical artery
MCA Doppler
Ductus venous

Uterine artery Doppler

- In normal pregnancies, spiral artery remodeling results in a low impedance circulation
- FGR is characterized by failure of trophoblastic invasion of the myometrial spiral arteries, resulting in reduced uteroplacental perfusion
- Abnormal uterine artery Doppler, defined as a PI > 95th percentile for gestational age is associated with adverse pregnancy outcomes, including preeclampsia, FGR, and perinatal Mortality



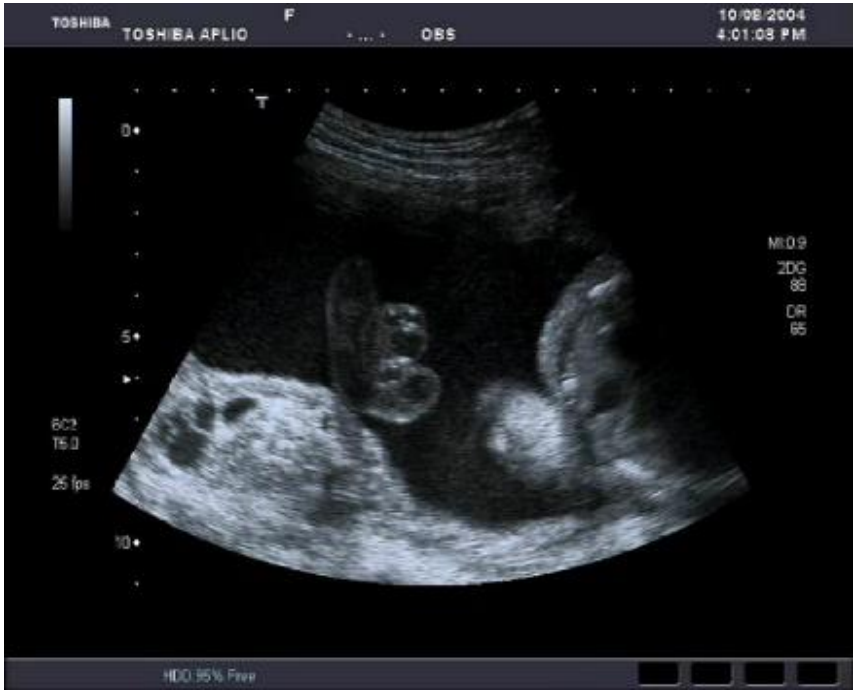


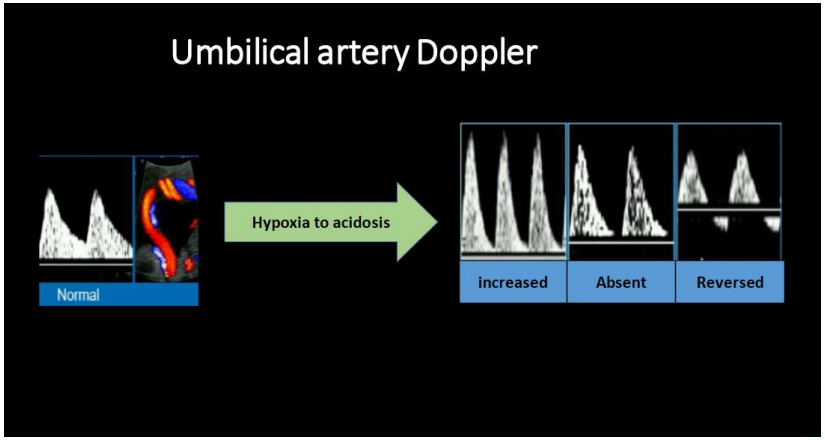
Umbilical artery Doppler

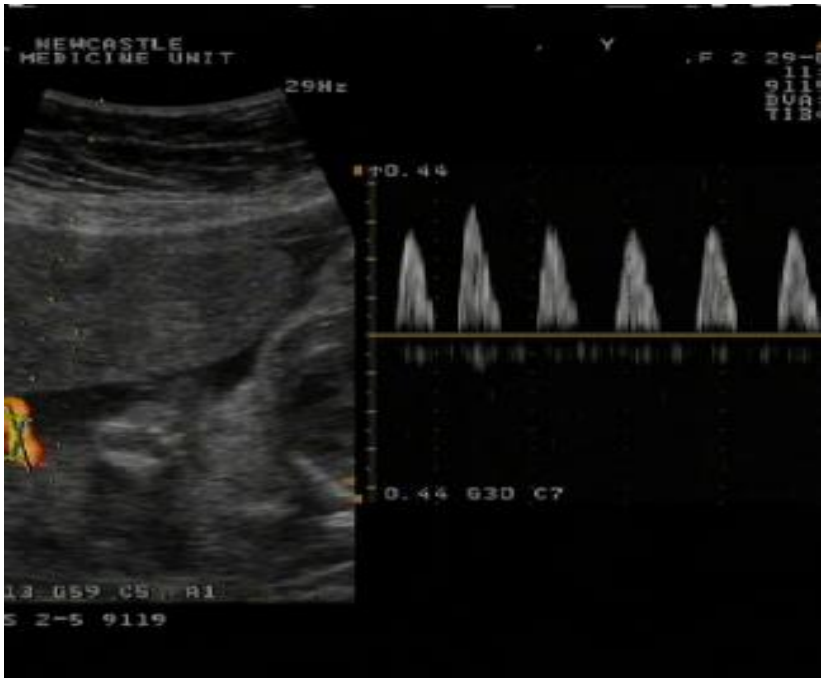
- An abnormal UA Doppler :
- **placental insufficiency** and can help **differentiate FGR from the constitutionally small fetus.**
- Incorporation of UA Doppler in the management of high-risk pregnancies : ***significantly reduce the risk of perinatal death, induction of labor, and cesarean delivery***
- UA Doppler **does not reliably predict adverse pregnancy outcome in late-onset FGR.**

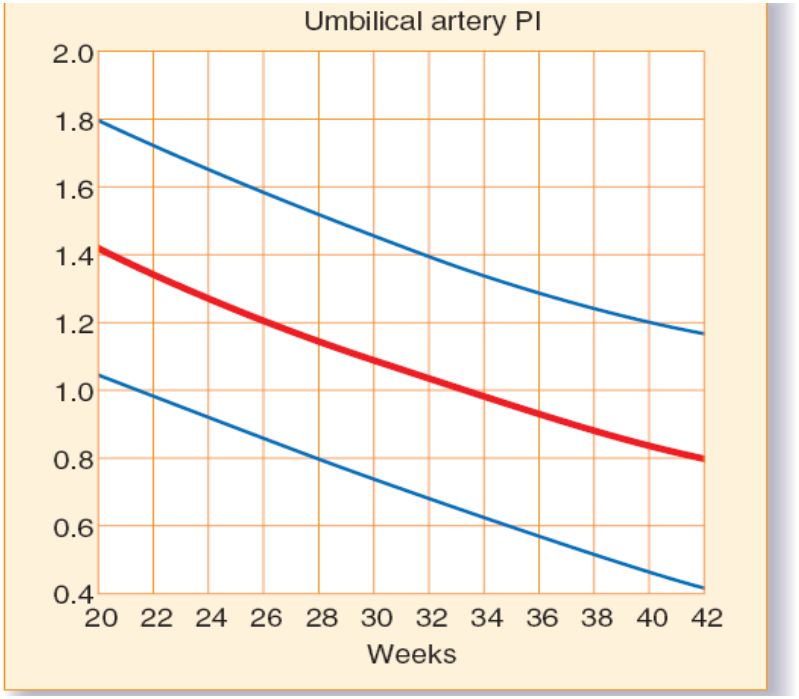
Umbilical artery Doppler

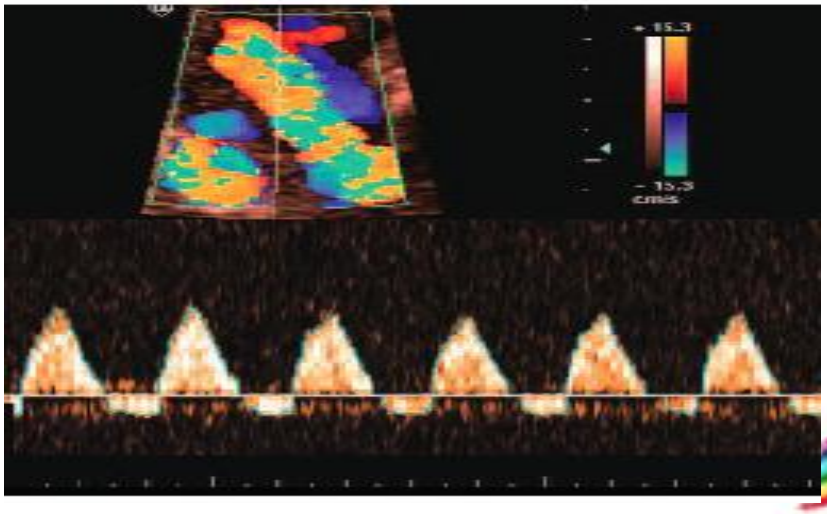
- Increased PI : When 30 percent of the villous vasculature ceases to function
- Absent or Reversed EDF : When 60 to 70 percent of the villous vasculature is obliterated, poor prognosis
- Reversed EDF is associated with poorer neonatal outcomes than absent diastolic flow.






NEWCASTLE
MEDICINE UNIT
29Hz
0.44
0.44 G3D C7


Umbilical artery PI
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
20 22 24 26 28 30 32 34 36 38 40 42
Weeks



Normal UA Doppler: 0.3% perinatal mortality.

Abnormal UA Doppler: 1.4% mortality, 11.5% adverse outcome (PORTO).

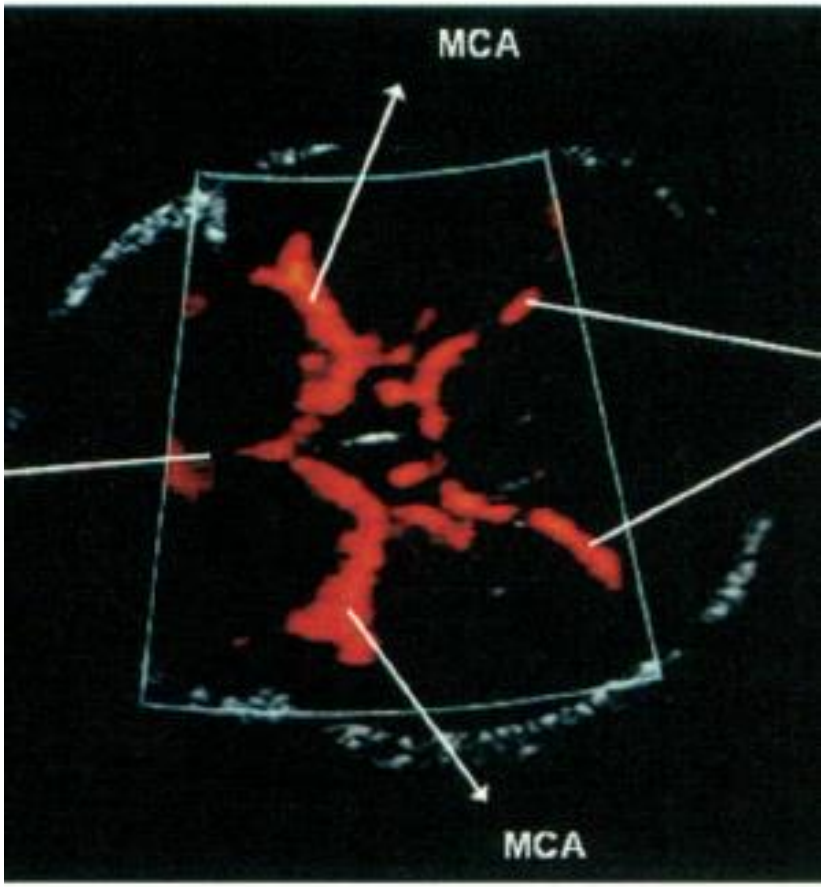
Reversed diastolic flow: 5x higher mortality than absent flow.

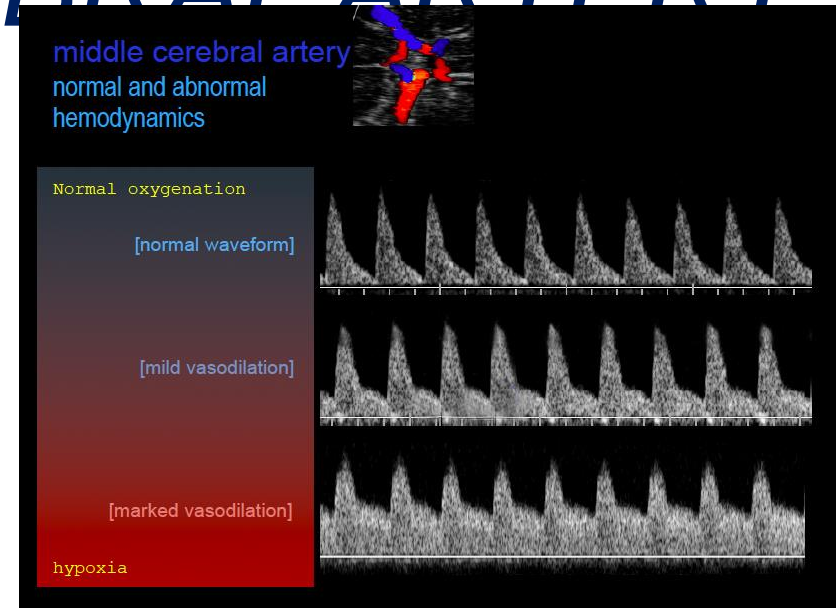
Waveform	Severity	Implication
Normal (High diastole)	None	Reassuring
Reduced Diastole (PI >95th)	Mild-Mod	Increased surveillance
Absent End-Diastolic (AEDV)	Severe	High risk
Reversed End-Diastolic (REDV)	Critical	Highest risk

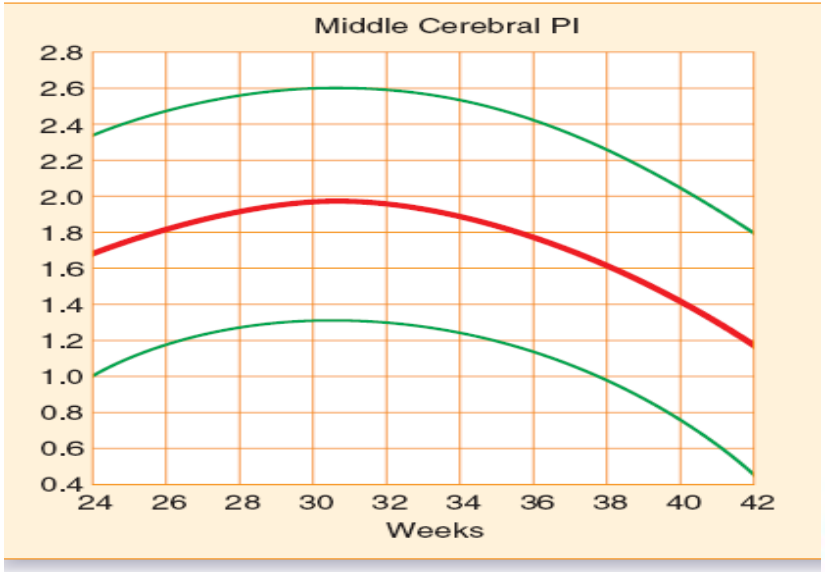
Middle cerebral artery Doppler

- The largest vessel of the fetal cerebral circulation and carries about 80% of cerebral blood flow
- Fetal hypoxemia associated with growth restriction results in cerebral vasodilation, an early adaptive mechanism termed **the brain-sparing effect**.
- Measurement of flow through the MCA can identify cerebral vasodilation, which can be quantified using PI or the cerebroplacental ratio (CPR): MCA PI/ UA PI
- MCA Doppler is one of the first parameters that becomes abnormal in FGR (Late)
- MCA Doppler seems to guide **monitoring** before 32 weeks of gestation but there is no evidence that it should be used to determine delivery timing.
- **MCA Doppler did not add useful information beyond umbilical artery and ductus venosus Doppler assessments for optimizing the timing of delivery (TRUFFLE)**
- Ominous sign: Normalization of MCA PI after prior abnormality (Loss of brain sparing)
- Clinical trials are needed to evaluate the effectiveness of CPR in guiding clinical management, especially in late-onset FGR

MIDDLE CEREBRAL ARTERY







Emerging Ratios & Growth Velocity

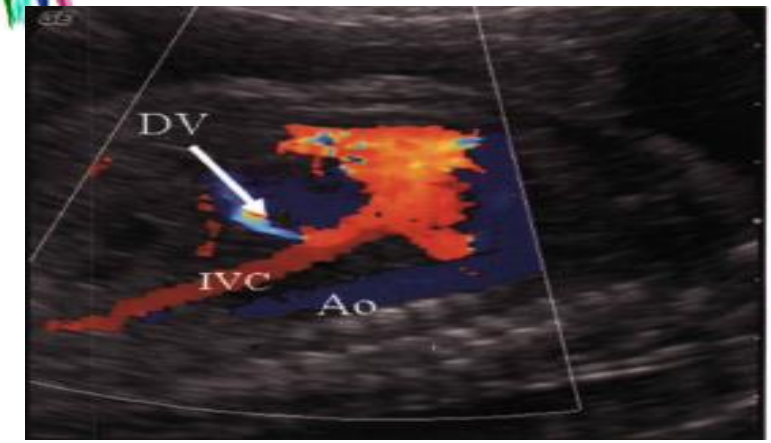
- **Cerebroplacental Ratio (CPR = MCA PI / UA PI):**
  - Reflects placental status + fetal compensation.
  - A low CPR indicates fetal blood flow redistribution (brain sparing) and is predictive of adverse neonatal outcome?
  - Only abnormal Doppler in some late-onset FGR.
  - **Limitation:** No standardized threshold (<1, <5th %ile?); more data needed.
- **Umbilicocerebral Ratio (UCR = UA PI / MCA PI):**
  - Inverse of CPR. Abnormal >0.8
- **Growth Velocity:**
  - Not routinely recommended by ACOG/SMFM.
  - A percentile drop >50 (e.g., 75th to 20th) predicts complications, but EFW alone remains standard.

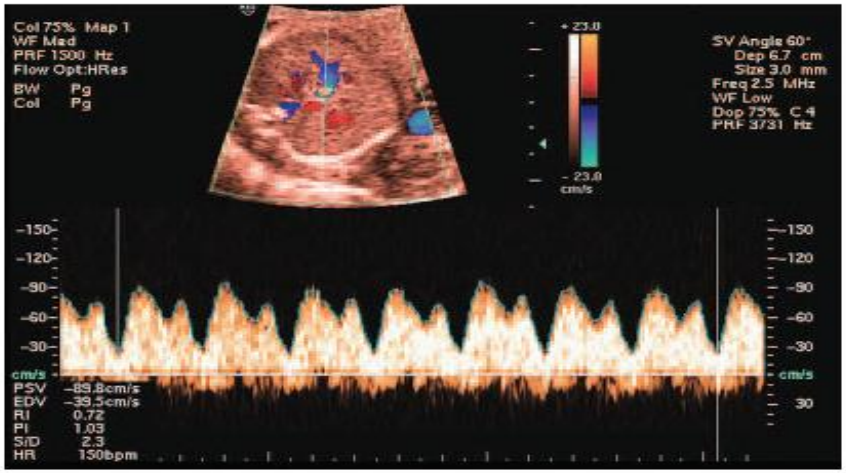
Ductus venosus

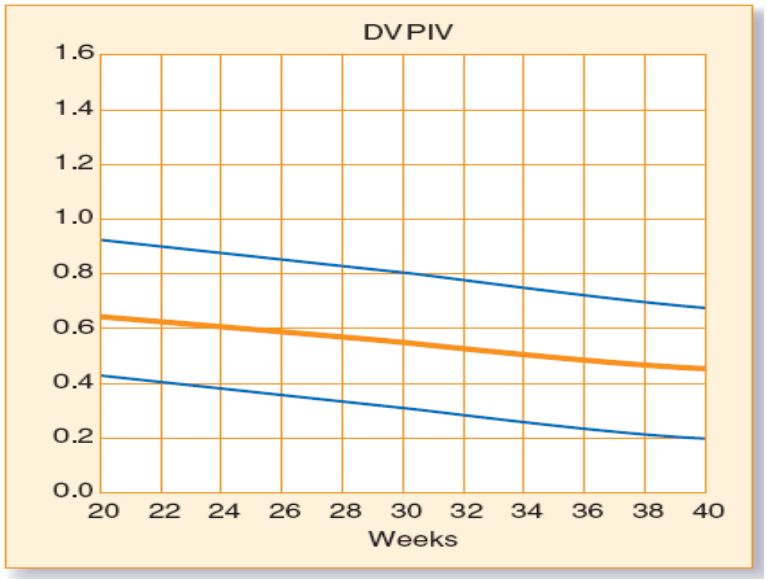
- Reflects cardiac afterload and right atrial pressure.
- Reflects cardiac afterload and right atrial pressure.
- Predictive for Acidemia (pH <7.20):
- Reflect an advanced stage of fetal compromise, associated with increased perinatal morbidity and mortality
- Absent or reversed A-wave of the ductus venosus and a frequency of stillbirth of 20%; the risk of stillbirth with a reversed A-wave was 46%

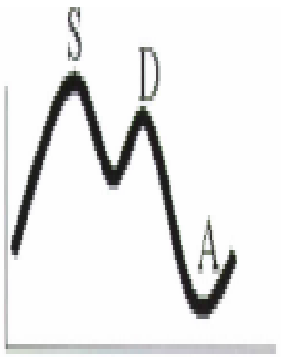
❖***Improved survival rate without neurologic damage in comparison with cSTV (TRUFFLE)***

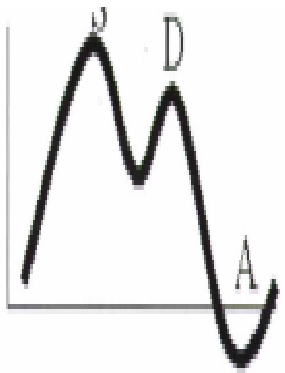
DUCTUS VENOSUS DOPPLER











Fetal Descending Aorta

- An elevated PI in the fetal descending aorta is associated with:
- FGR and adverse outcomes, such as severe FGR, NEC, nonreassuring fetal heart rate patterns, and perinatal mortality
- The sensitivity and specificity of absent EDF in the descending aorta for prediction of FGR with FHR abnormalities are approximately 85 and 80 percent, respectively
- Higher rates of cesarean delivery, right ventricular failure, and perinatal mortality.

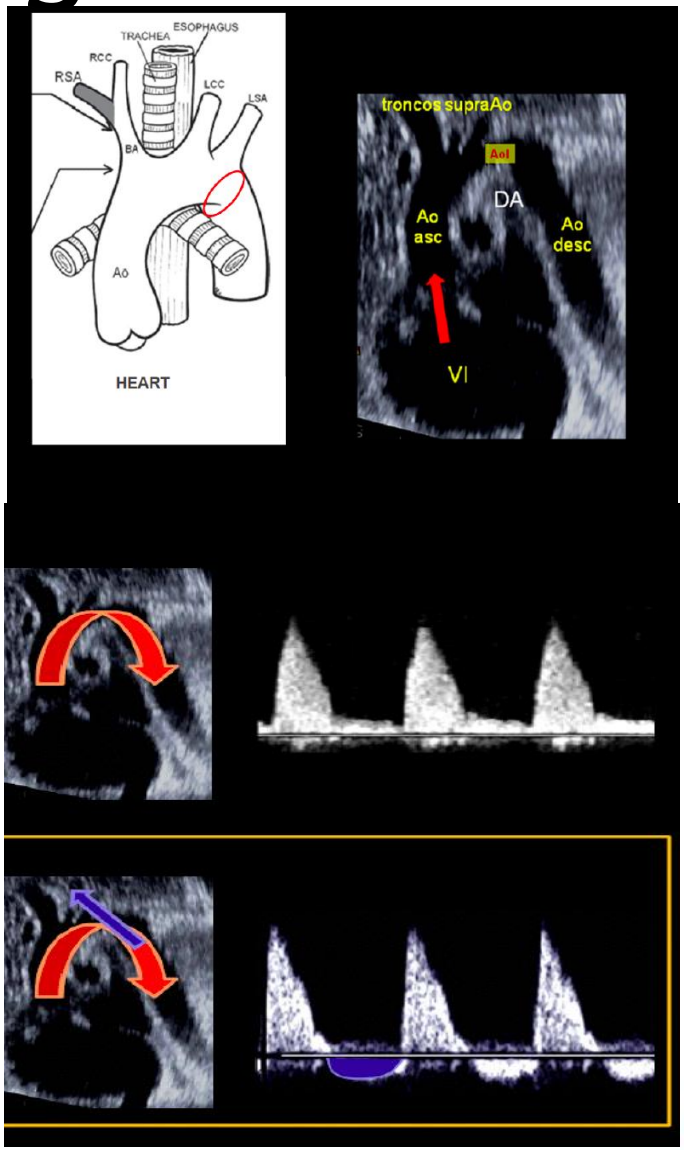
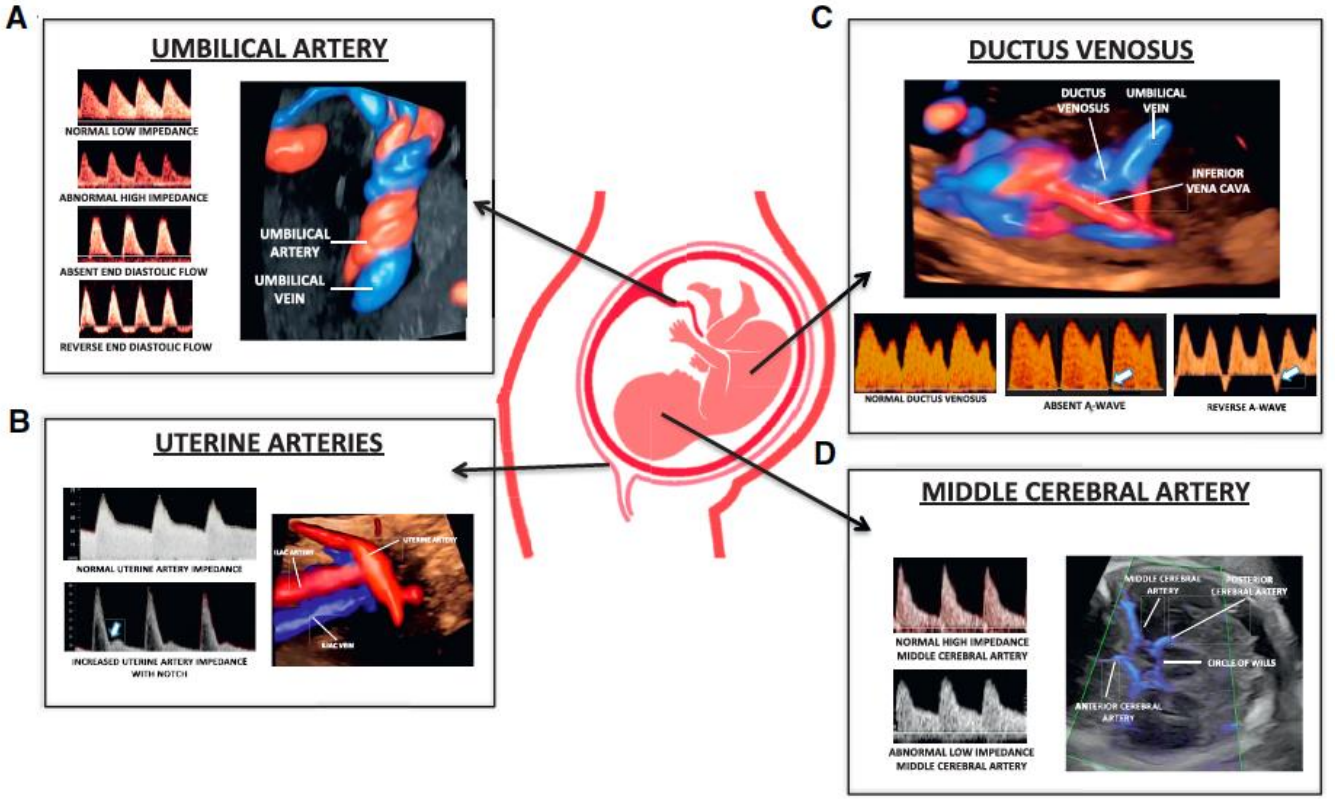


FIGURE 3
Uteroplacental-fetal vascular components evaluated with Doppler velocimetry



Delphi Consensus Criteria for FGR Diagnosis(2016)

TABLE 1

Delphi consensus criteria for the definition of early and late fetal growth restrictions[5]

Early FGR: GA<32 wk, in the absence of congenital anomalies	Late FGR: GA≥32 wk, in the absence of congenital anomalies
AC or EFW of <third percentile or UA-AEDF Or 1. AC or EFW of <10th percentile combined with 2. Uta-PI of >95th percentile and/or 3. UA-PI of >95th percentile	AC or EFW of <third percentile Or at least 2 of 3 of the following: 1. AC or EFW of <10th percentile 2. AC or EFW crossing percentiles of >2 quartiles on growth percentiles 3. CPR of <5th percentile or UA-PI of >95th percentile

AC, abdominal circumference; *AEDF*, absent end-diastolic flow; *CPR*, cerebroplacental ratio; *EFW*, estimated fetal weight; *FGR*, fetal growth restriction; *GA*, gestational age; *PI*, pulsatility index; *UA*, umbilical artery; *UtA*, uterine artery.

Lees. Diagnosis and management of suspected fetal growth restriction. Am J Obstet Gynecol 2022.

Two Phenotypes of FGR

Characteristic	Early-Onset FGR	Late-Onset FGR
GA at Diagnosis	< 32 weeks	≥ 32 weeks
Prevalence	~30%	~70%
Doppler Pattern	UA/MCA/Ductus Venosus abnormalities	Mainly cerebral redistribution (low MCA PI)
Placental Pathology	Poor implantation, vascular malperfusion	Subtle, altered diffusion
Maternal HTN	Very frequent (~70%)	Not frequent
Perinatal Mortality	High	Low, but still significant

Cut-off: 32 weeks is the agreed threshold to separate early vs. late FGR. These are different diseases. Early-onset is severe placental insufficiency with high prematurity risk. Late-onset is milder but often missed and still associates with adverse outcomes.]

Main clinical characteristics of early / late FGR

Table 1 Main clinical characteristics of early- and late-onset fetal growth restriction (FGR)

Characteristic	*Early-onset FGR*	*Late-onset FGR*
Main clinical challenge	Management	Detection
Prevalence	30%	70%
Gestational age at manifestation	< 32 weeks	≥ 32 weeks
Ultrasound findings	Fetus may be very small	Fetus not necessarily very small
Doppler velocimetry	Spectrum of Doppler alterations that involves umbilical artery, middle cerebral artery and ductus venosus	Cerebral blood-flow redistribution
Biophysical profile	May be abnormal	May be abnormal
Hypertensive disorders of pregnancy	Frequent	Not frequent
Placental histopathological findings	Poor placental implantation, spiral artery abnormalities, maternal vascular malperfusion	Less specific placental findings, mainly altered diffusion
Perinatal mortality	High	Low
Maternal cardiovascular hemodynamic status	Low cardiac output, high peripheral vascular resistance	Less marked maternal cardiovascular findings

Different clinical and biophysical characteristic of early FGR

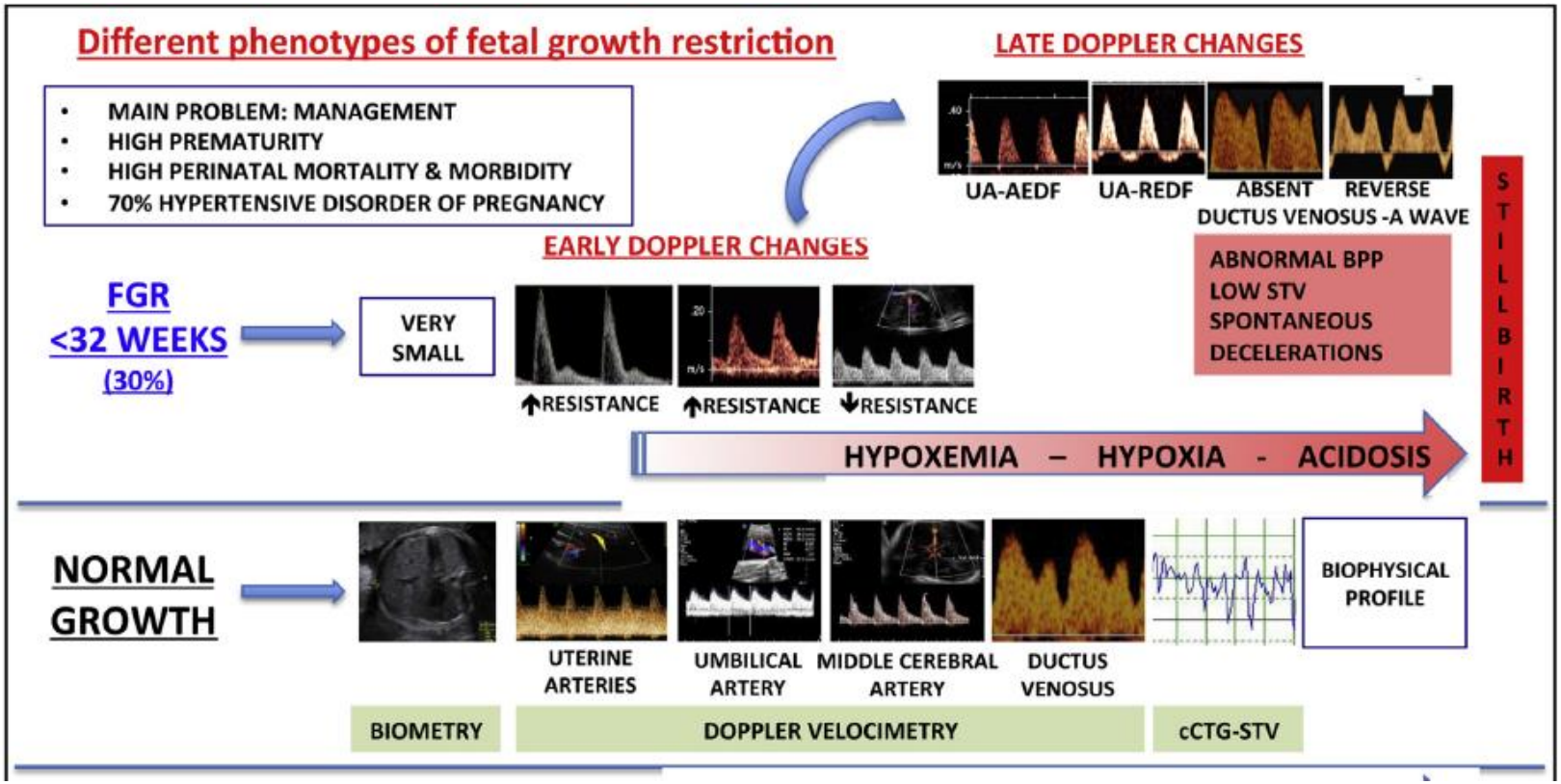
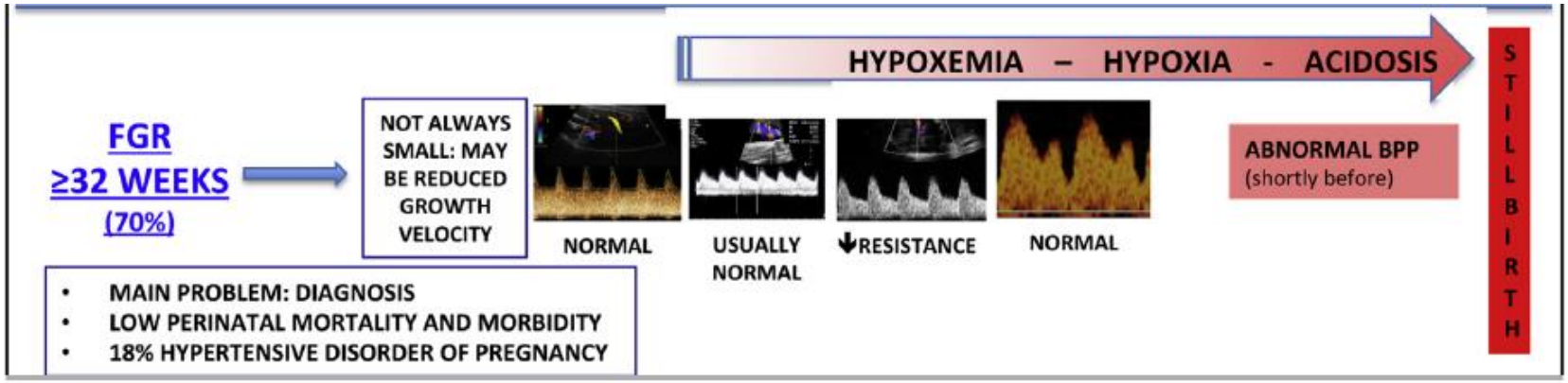


TABLE 4

Surveillance and timing of birth in late-onset small for gestational age/fetal growth restriction (≥32 wk)

Country	United Kingdom	New Zealand	Canada	Ireland	United States	France
UA Doppler frequency	Every 2 wk if UA Doppler normal, twice weekly if abnormal UA Doppler	Every 2 wk if UA Doppler normal, at least weekly if abnormal UA Doppler	Every 2 wk	Every 2 wk if UA Doppler normal, at least weekly if abnormal UA Doppler	From gestational age where delivery considered for fetal benefit; every 1–2 wk to assess for deterioration[b]	2–3 Weekly if Doppler studies normal, more frequent if severe FGR; weekly if UA Doppler abnormal
Cerebral Doppler studies	MCA Doppler >32 wk with normal UA Doppler	MCA Doppler and CPR every 2 wk ≥34 wk; if Doppler(s) abnormal repeat at least weekly	MCA and DV Doppler studies but gestation not specified	MCA optional if UA Doppler abnormal —should not be used to indicate delivery	Insufficient evidence to support use of MCA Doppler in clinical practice	Cerebral artery Doppler every 2–3 wk if normal UA Doppler; increase frequency if UA Doppler abnormal
CTG	Not as only form of surveillance	Not as only form of surveillance; at least weekly if abnormal UA, MCA, CPR, uterine artery Doppler or EFW <3rd centile	Not as only form of surveillance, consider if BPP abnormal	Not specified	Not as only form of surveillance; if abnormal UA Doppler, twice-weekly CTG and/or BPP[b]	"Essential element in assessment of SGA fetus," frequency not specified
BPP	Do not use	Not as only form of surveillance	Weekly	Not standard	Not as only form of surveillance; if abnormal UA Doppler, twice-weekly CTG and/or BPP[b]	Not discussed

Different clinical and biophysical characteristic of late FGR



Doppler Surveillance – Key Parameters

Vessel	Finding	Significance
Uterine Artery	Mean PI > 95th centile	Placental insufficiency / maternal malperfusion
Umbilical Artery (UA)	PI > 95th → Absent EDF → Reversed EDF	Increasing placental resistance; Reversed EDF is pre-terminal
Middle Cerebral Artery (MCA)	PI < 5th centile	Brain-sparing (fetal hypoxemia)
Cerebroplacental Ratio (CPR)	< 5th centile	More sensitive for hypoxia than MCA alone
Ductus Venosus (DV)	Absent/Reversed a-wave	Impending acidemia; indicates need for delivery

Caution: Wide variability in reference ranges exists. Use local, validated charts.

[Presenter Notes: The sequence in severe early FGR: ↑UA PI → ↑UtA PI → ↓MCA PI (brain-sparing) → ↓CPR → ↓DV a-wave → ↓STV → terminal changes.]

Symmetric Vs asymmetric FGR

- Based on the ratio between HC and AC.
- **Growth and developmental delay** have been evaluated from birth to the age of 4 years and shown to be **similar** in symmetric and asymmetric growth-restricted preterm newborns

❖**HC/AC was not found to be an independent predictor of adverse pregnancy outcomes**

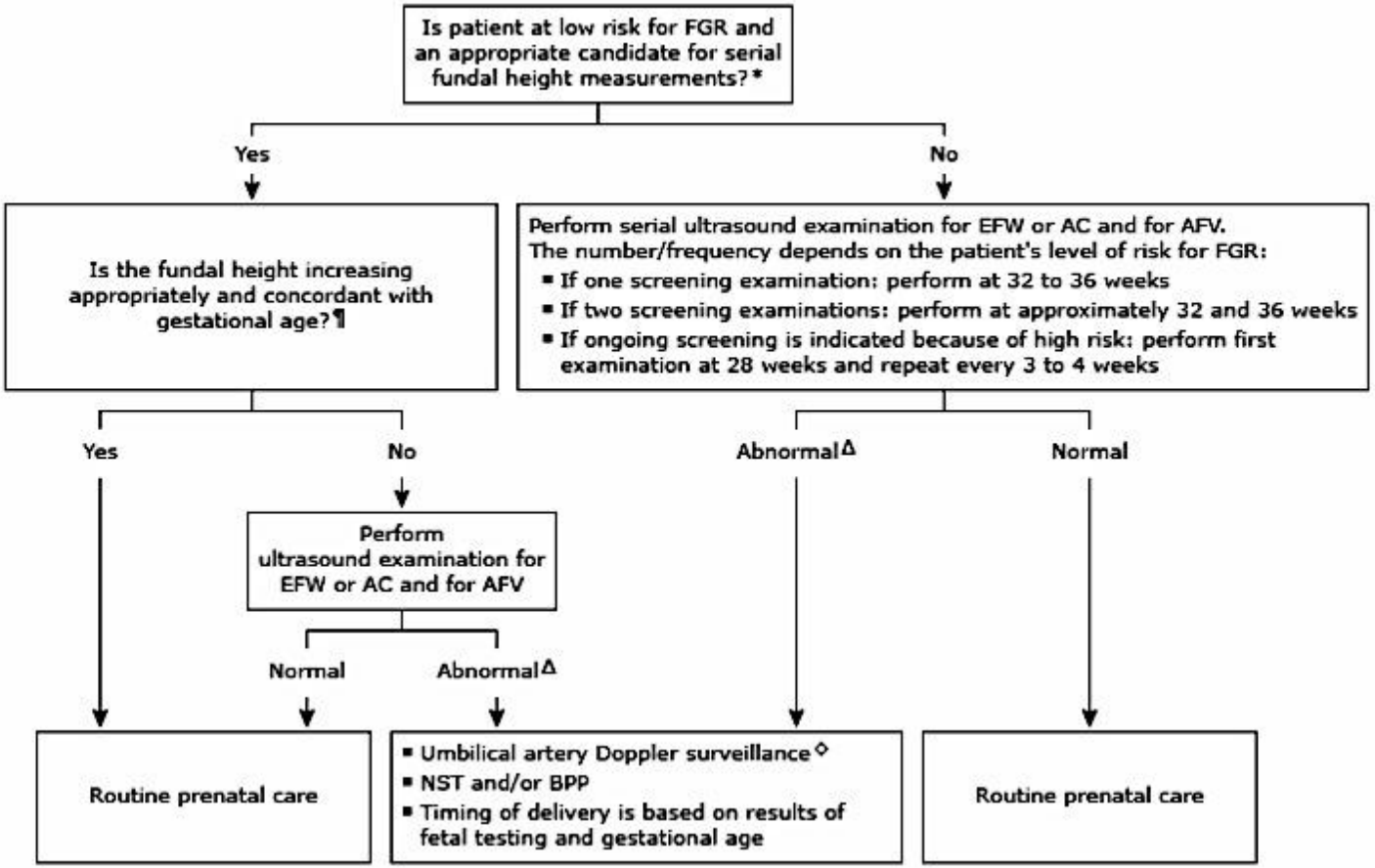

Is patient at low risk for FGR and an appropriate candidate for serial fundal height measurements?*
Yes
No
Is the fundal height increasing appropriately and concordant with gestational age?¶
Perform serial ultrasound examination for EFW or AC and for AFV.
The number/frequency depends on the patient's level of risk for FGR:
If one screening examination: perform at 32 to 36 weeks
If two screening examinations: perform at approximately 32 and 36 weeks
If ongoing screening is indicated because of high risk: perform first examination at 28 weeks and repeat every 3 to 4 weeks
Yes
No
Abnormal Δ
Normal
Perform ultrasound examination for EFW or AC and for AFV
Normal
Abnormal Δ
Routine prenatal care
Umbilical artery Doppler surveillance ◇
NST and/or BPP
Timing of delivery is based on results of fetal testing and gestational age
Routine prenatal care

TABLE 3

Third-trimester ultrasound in low and high-risk women

Country	United Kingdom	New Zealand	Canada	Ireland	United States	France
Screening with routine third-trimester ultrasound in low-risk women	Not recommended	Not recommended	Not recommended	Not recommended	Not recommended	Recommended at 32 wk
Criteria for serial scanning	≥1 Major risk factor, unsuitable for fundal height monitoring, abnormal uterine artery Doppler (including notching); scans from 26–28 wk	Major risk factor(s) or unsuitable for fundal height monitoring; gestation to start scanning depends on severity of risk factors	Not specified	Women with risk factors from 26 wk	Previous SGA, other risk factors or unsuitable for fundal height monitoring	Not specified
Recommended biometry charts	EFW customized chart; no evidence to recommend 1 specific method of measuring AC nor which centile chart to use	EFW customized chart; AC on Australasian Society for Ultrasound in Medicine population charts	EFW or AC on population chart; charts not specified	EFW customized chart; biometry–chart not specified	EFW and biometry; charts not specified	EFW customized, biometry using French population ultrasound charts
Umbilical artery Doppler?	Yes–from 26–28 wk in high risk	If fetus small on biometry, or reduced growth velocity	If fetus small on biometry	Yes–criteria not specified	Yes–criteria not specified	Yes–criteria not specified
Interval between scans in suspected SGA/FGR	3 wk	2–3 wk	2 wk	2–4 wk	3–4 wk	3 wk

AC, abdominal circumference; *EFW*, estimated fetal weight; *FGR*, fetal growth restriction; *SGA*, small for gestational age.

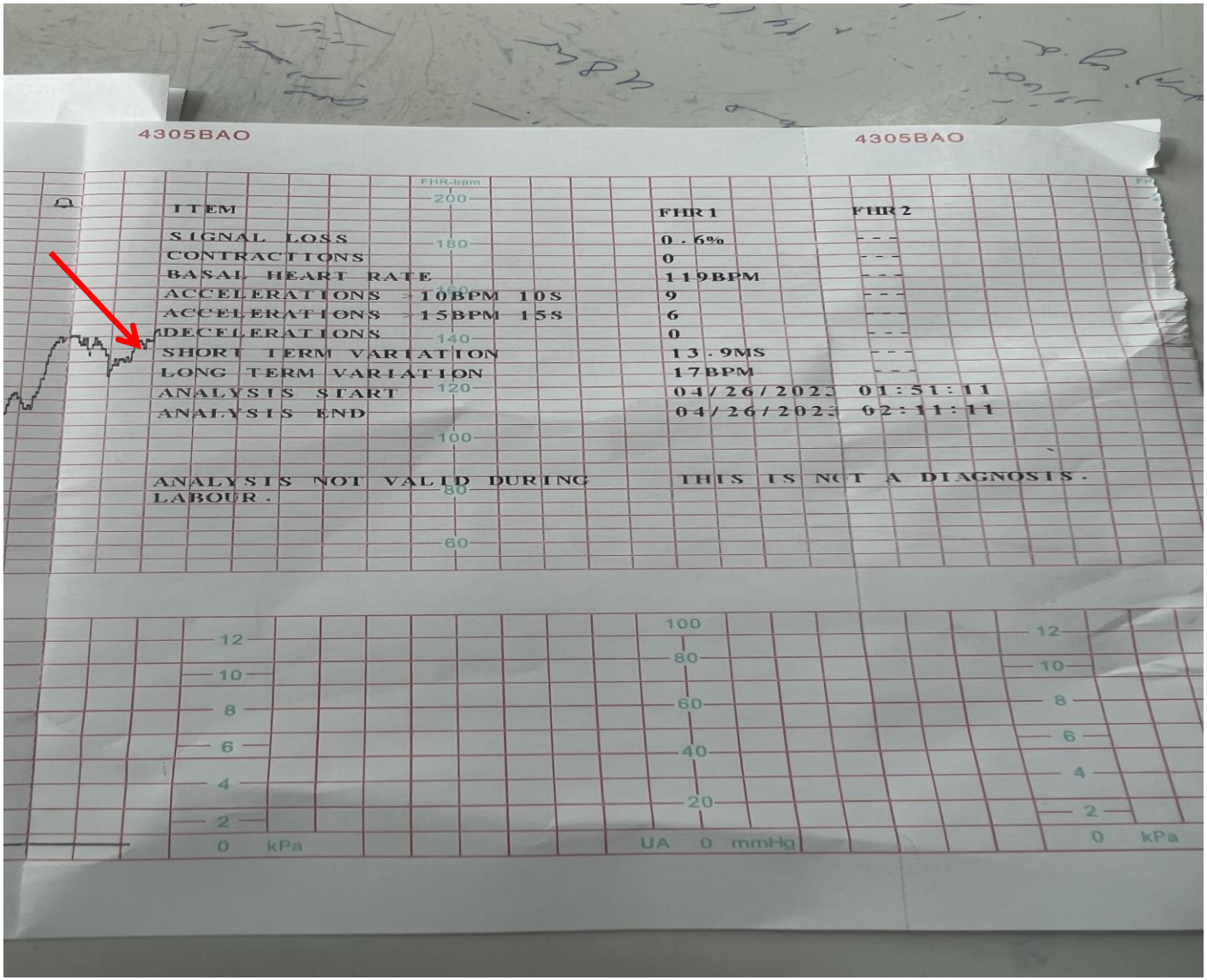
McCowan. Evidence-based national guidelines for management of suspected fetal growth restriction. Am J Obstet Gynecol 2018.

Doppler & Fetal Monitoring – Key Controversies

Organization	UA/MCA/DV Recommendation
SMFM, ACOG, AIUM	Not for routine management
ISUOG	Supports their use

Cardiotocography and short-term variation

- A reactive CTG virtually excludes fetal hypoxemia
- cCTG and evaluation of STV have been validated against invasive testing in fetal hypoxemia and acidemia and represent the **only objective measure of fetal heart rate.**
- Visual inspection of conventional CTG does not provide the same information as cCTG, as CTG represents a largely subjective assessment with low intraand interobserver reproducibility.


4305BAO
4305BAO
FHR-bpm
200
180
160
140
120
100
80
60
ITEM
FHR1
FHR2
SIGNAL LOSS
0.6%
CONTRACTIONS
0
BASAL HEART RATE
119BPM
ACCELERATIONS >10BPM 10S
9
ACCELERATIONS >15BPM 15S
6
DECELERATIONS
0
SHORT TERM VARIATION
13.9MS
LONG TERM VARIATION
17BPM
ANALYSIS START
04/26/2023 01:51:11
ANALYSIS END
04/26/2023 02:11:11
ANALYSIS NOT VALID DURING LABOUR.
THIS IS NOT A DIAGNOSIS.
12
10
8
6
4
2
0 kPa
100
80
60
40
20
UA 0 mmHg
12
10
8
6
4
2
0 kPa

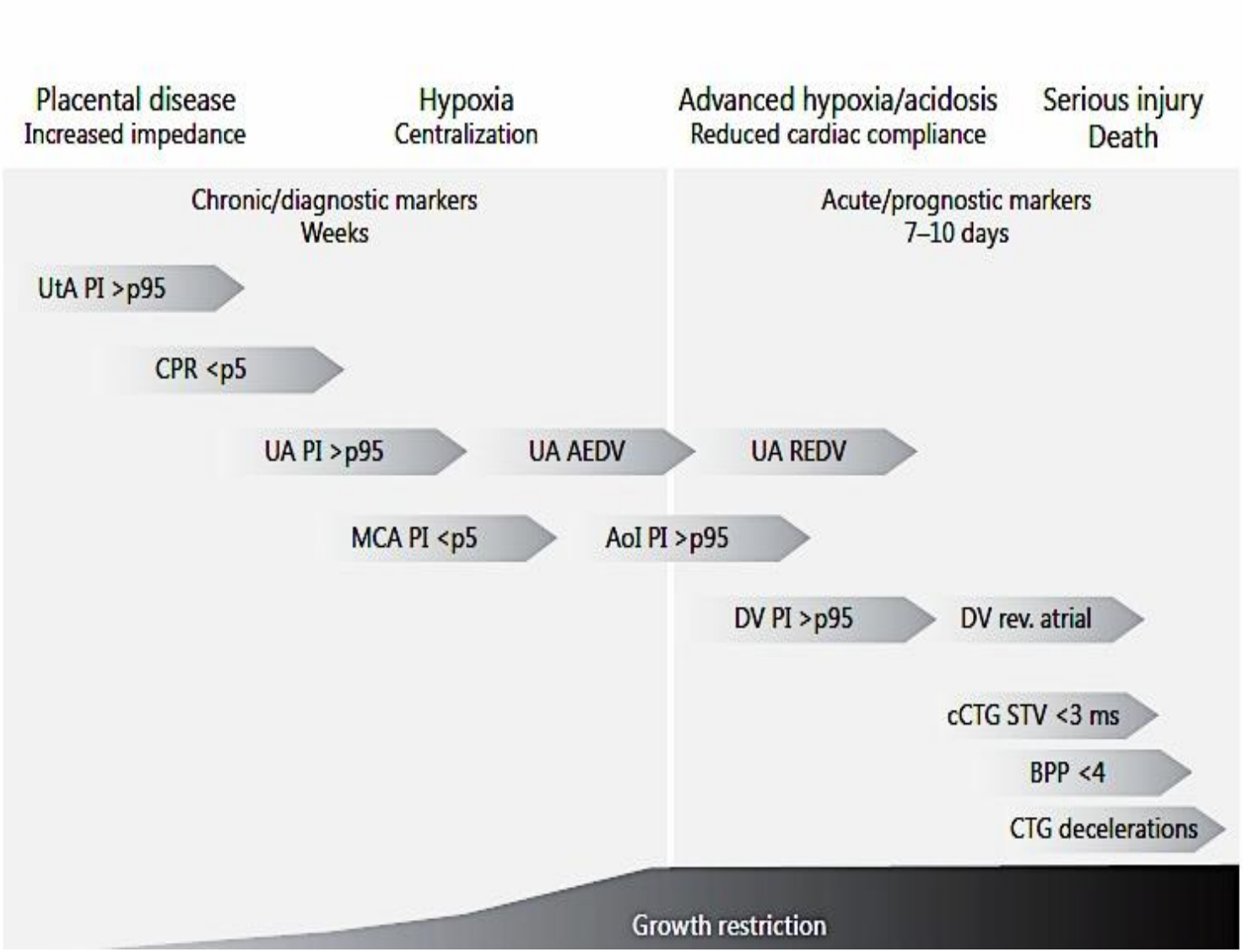
Biophysical profile scoring

- BPP becomes abnormal only shortly before stillbirth, and therefore, it is not useful in the determination of monitoring intervals
- BPP appears to become abnormal 48-72 hours after DV Doppler abnormalities in 90% of cases
- Relationship between altered BPP score and fetal pH seems to be consistent across gestational ages.

➢ A score of ≤4 is associated with a fetal pH ≤7.20,

➢ A score of <2 has a sensitivity of 100% for acidemia

- A Cochrane review concluded that available evidence from randomized controlled trials does not support the use of BPP as a test of fetal well-being in high-risk pregnancies.


Placental disease
Increased impedance
Hypoxia
Centralization
Advanced hypoxia/acidosis
Reduced cardiac compliance
Serious injury
Death
Chronic/diagnostic markers
Weeks
Acute/prognostic markers
7–10 days
UtA PI >p95
CPR <p5
UA PI >p95
UA AEDV
UA REDV
MCA PI <p5
AoI PI >p95
DV PI >p95
DV rev. atrial
cCTG STV <3 ms
BPP <4
CTG decelerations
Growth restriction

Biomarkers

- PAPP-A
- Soluble fms-like tyrosine kinase-1 (sFlt-1) to placental growth factor (PlGF) ratio
- Some reports suggest that use of the sFlt-1/PlGF ratio might be helpful in the management of and differentiation between SGA and FGR,
- The lack of interventional trial data precludes the recommendation of these tests as an adjunct to ultrasound imaging.

Stage – based management

Table 2. Stage-based classification and management of FGR

Stage	Pathophysiological correlate	Criteria (any of)	Monitoring*	GA/mode of delivery
I	Severe smallness or mild placental insufficiency	EFW <3rd centile CPR <p5 UA PI >p95 MCA PI <p5 UtA PI >p95	Weekly	37 weeks LI
II	Severe placental insufficiency	UA AEDV Reverse AoI	Biweekly	34 weeks CS
III	Low-suspicion fetal acidosis	UA REDV DV-PI >p95	1–2 days	30 weeks CS
IV	High-suspicion fetal acidosis	DV reverse a flow cCTG <3 ms FHR decelerations	12 h	26 weeks** CS

Management of fetal growth restriction

- ***Early diagnosis***
- ***Optimal fetal surveillance***
- ***Gestational Age***
- ***Fetal growth velocity***
- ***Fetal behavior (biophysical profile [BPP])***
- ***Doppler velocimetry***
- ***Timely delivery in right place with proper facilities that reduces perinatal mortality and minimizes short- and long-term morbidity***

- The single most important prognostic factor in preterm fetuses with growth restriction is GA at delivery
- A large longitudinal cohort study on FGR showed an increase of 1%-2% in intact survival for every additional day spent in utero up until 32 weeks of gestation

Management of fetal growth restriction: General considerations

- There are currently no preventative strategies or treatments for FGR that have been proven to be effective
- **NOT EFFECTIVE**: nutritional and dietary supplements or bed rest (GRADE 1B)
- Low dose ASA: provide a modest risk reduction in FGR and SGA in 2 meta-analyses (ACOG is against) if started from 12-16 weeks

Management of fetal growth restriction: General considerations

- **NO preventative strategies or treatments** for FGR that have been proven to be effective though efficient recognition and management of severe pre-eclampsia may prolong some pregnancies with early FGR.
- **KEY CONCEPTS IN EARLY FGR MX:**

❖**The timely use of steroids**,

❖**Magnesium sulfate**,

❖**Transfer to a tertiary care center**

❖**The safest mode of delivery**

Initial Evaluation

- After sonographic diagnosis, evaluate for **Maternal, Fetal, or Placental** causes (Table 2).
- **Maternal History:**
  - Hypertensive disorders (especially early-onset preeclampsia).
  - Race/ethnicity-specific standards (NICHD study: White 2790g vs. Black 2622g at 39w).
- **Fetal Anatomic Survey:**
  - 10% of FGR have anomalies; 20-60% of anomalous infants are SGA.
- **Genetic Workup (Offer if):**
  - FGR <32 weeks without clear cause.
  - FGR + Structural anomalies / Polyhydramnios / Triploidy signs.

Genetic Testing in FGR

- **Recommendation:** Microarray over karyotype (higher yield).

Modality	Yield in FGR	Key Note
Karyotype	Baseline	Detects aneuploidy only.
Microarray (CMA)	+4% in isolated FGR +10% in FGR + anomalies	Detects microdeletions/duplications.
Exome Sequencing (ES)	+4% in isolated FGR +30% in multisystem anomalies	Investigational for isolated FGR; useful for skeletal dysplasia

Genetic Causes to remember: Triploidy, Confined Placental Mosaicism (10% of unexplained FGR), Uniparental Disomy (Silver-Russell).

Infection Workup - When to Test?

- **Recommendation (SMFM):** DO NOT perform routine TORCH for isolated FGR.
- Indications for testing (CMV PCR on amniotic fluid):
- Sonographic markers (brain/liver calcifications, hydrops, echogenicity).
- Suspicious maternal history (exposure, symptoms).
- Systematic Review [Fitzpatrick et al., 2022]: Only 2.4% of TORCH screens in FGR were positive; Only 2 cases of isolated FGR turned out to be infectious (CMV).

- COVID-19: Not associated with increased FGR risk.

Determine the cause

- Maternal examination: BP, Lab data, Evaluation of vascular disease
- Antiphspholipid (acquired) testing??
- Fetal survey:
- Detailed anatomic evaluation +/- fetal Echocardiography
- NO need for TORCH study
- Screening for infection (AF PCR for CMV)
- Fetal genetic studies: Early (<24 weeks), severe (<5th percentile), and symmetrical , isolated (6/4%)
- ACOG: FGR before 32 weeks or FGR in combination with polyhydramnios or fetal malformation

Many Thanks for your attention

Saadi Thomb in Shiraz

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- ACOG: FGR before 32 weeks or FGR in combination with polyhydramnios or fetal malformation

…Management of fetal growth restriction: General considerations

- **LMWH**: has not been shown to reduce the risk of recurrent placenta-mediated pregnancy complications in at-risk women. (GRADE 1B)
- **Sidenafil :** there is no evidence to augment

uteroplacental perfusion through vasodilation, improve placental perfusion and outcome in pregnancies with FGR

- ***Early FGR : Refer to a tertiary center***

Ambulatory monitoring

❖**Consider hospitalization for selected women:**

➢who need daily or more frequent maternal or fetal assessment (eg, daily BPP score because of reversed diastolic flow) ***OR*** more often than 3 times per week

➢***ISUOG , ACOG:*** Admit women with absent/reversed flow of the umbilical artery and EFW >350gr

➢Assessment of fetal growth and weight: at least every 3-4 weeks; OR 2-week interval in cases of severe FGR or with abnormal umbilical artery Doppler

- Decision should be made on a case-by-case basis

Monitoring of Fetal Growth Restriction

- The goals of fetal monitoring are the prevention of fetal death and delivery of the fetus in the best possible condition
- In early-onset suspected FGR, fetal deterioration is heralded by progressively increasing UA impedance, most commonly expressed as PI, resistance index or S-to-D (systolic-to-diastolic) ratio.
- Strong evidence supports the use of ductus venosus Doppler in early suspected FGR for both prognostic and monitoring purposes

- Level 1 evidence supports the application of UA and ductus venosus Doppler in the monitoring of early FGR.
- High-quality observational studies support the application of the middle cerebral artery and/ or its ratios to UA in the surveillance of late suspected FGR. Collectively, these Doppler parameters can predict fetal deterioration and guide optimal surveillance intervals.

Corticosteroid prophylaxis

- Indicated if the birth is likely to occur before 34+0weeks
- Controversial efficacy in FGR – but still recommended
- ***RCOG :*** Recommends corticosteroid prophylaxis up to 35+6weeks
- ***ACOG , SMFM (2020) :*** < 34 weeks or between 34 0/7 and 36 6/7 weeks of gestation in women without contraindications (GRADE 1A).
- In fetuses with absent or reversed UA-EDF, enhanced daily surveillance is warranted during steroid administration

•**Physiologic effect**:

•Transient improvement in UA flow after betamethasone (in absent end-diastolic flow)

Magnesium sulfate prophylaxis

- Many guidelines and studies recommend magnesium sulfate prophylaxis for neuroprotection in growth-restricted fetuses,
- Though the suggested time of commencement varies, being <32–33weeks, <32 weeks, <30 weeks or <29 weeks' gestation
- ***< 32 weeks (GRADE 1A)***

Putting It All Together - Severity Assessment

- Use a multimodal approach. Frequency of testing depends on the worst finding.

Parameter	Normal (Low Risk)	Moderate Risk	Severe Risk
EFW	5th-10th %ile	3rd-5th %ile	<3rd %ile
UA Doppler	Normal PI <95th	PI >95th	AEDV / REDV
MCA Doppler	Normal PI	Reduced PI (<5th)	Loss of brain sparing
DV Doppler	Normal a-wave	Reduced a-wave	Absent/Reversed a-wave
Action	Weekly surveillance	Twice weekly + steroids	Consider delivery (esp. >34w)

Timing of birth Abnormal Doppler[a]	Deliver by 37 wk if MCA PI <5th centile or abnormal UA Doppler	Deliver by 38 wk if UA Doppler >95th, MCA <5th centile, CPR <5th centile, uterine artery >95th	Consider delivery >34 wk if Doppler studies (UA, MCA, DV) abnormal	Abnormal UA PI deliver at 37 wk or earlier if poor interval growth	Consider delivery >37 wk when decreased diastolic flow in UA	Birth from ≥37 wk depending on EFW, amniotic fluid, and Doppler measurements
Timing of birth normal Doppler	If >34 wk deliver if static growth over 3 wk; offer delivery by 37 wk with involvement of senior obstetrician	If EFW <3rd centile deliver by 38 wk; if EFW >3rd and <10th centile deliver at 40 wk unless other concern; if MCA and uterine Doppler studies not available, deliver at 38 wk	Discuss delivery vs ongoing monitoring >37 wk; if amniotic fluid volume or BPP abnormal, consider delivery	Isolated FGR (EFW <10th centile, normal UA Doppler, and AFI), delay delivery until 37 wk, no later than 40 wk	FGR with no additional abnormal parameters, deliver at 38+0 to 39+6 wk	Birth from ≥37 wk depending on EFW, amniotic fluid, and Doppler measurements
Mode of birth	If UA end-diastolic flow present, induction of labor with continuous CTG recommended	Individualize care; high risk of CS with abnormal CPR, MCA, or UA Doppler —continuous fetal monitoring from onset of labor	Not specified	Individualize care; consider CS <34 wk	FGR alone not indication for CS	Routine CS for FGR not recommended; CS recommended for very preterm FGR or severe UA Doppler abnormalities; continuous fetal monitoring in labor

Key Take-Home Points

- Size matters: <3rd %ile is the high-risk zone, not 10th %ile.
- Don't over-test: Avoid routine TORCH for isolated FGR; use Microarray for early/severe cases.
- Doppler is life-saving: UA Doppler is mandatory; DV a-wave indicates acidemia.
- Sequence is key: UA → MCA → DV deterioration guides delivery timing.
- Late FGR behaves differently: MCA may be the first to go, progression may be slow.

Managing Early-Onset FGR (< 32 weeks)

- **Setting:** Tertiary center with neonatology & MFM multidisciplinary care
- **Surveillance Frequency:** Based on severity (e.g., if UA AEDF, monitor every 2-3 days)
- **Key Protocol (based on TRUFFLE trial):**
- **Primary surveillance:** Ductus Venosus Doppler + Computerized CTG (cCTG) for Short-Term Variation (STV)
- **If cCTG not available:** Use BPP + conventional CTG
- **Adjuncts:**
- **Corticosteroids:** If delivery planned < 34 weeks (Grade B)
- **Magnesium sulfate:** For neuroprotection if delivery < 32-33 weeks (local guidelines)
- **Monitor BP/urine protein:** ~70% develop pre-eclampsia
- [Presenter Notes: No therapy exists. Delivery is the only treatment. Balance prematurity vs. hypoxia/acidemia. The TRUFFLE protocol improved 2-year neurodevelopment.]

Delivery Timing in Early-Onset FGR (per TRUFFLE)

- Personalize management at 24+0 to 25+6 weeks*
- **Deliver at ≥ 26+0 weeks if:**

Always deliver at ANY GA for:
•Maternal indication (severe pre-eclampsia, HELLP)
•Spontaneous repeated decelerations
•BPP ≤ 4
Delivery mode: Planned C-section in most cases.

GA	Indication for Delivery
26+0 to 28+6	DV a-wave at/below baseline OR STV < 2.6 ms
29+0 to 31+6	DV a-wave at/below baseline OR STV < 3.0 ms
32+0 to 33+6	UA Reversed EDF OR STV < 3.5 ms
≥ 34+0	UA Absent EDF OR STV < 4.5 ms

TABLE 5

Management of early-onset small for gestational age/fetal growth restriction (<32 wk)

Country	United Kingdom	New Zealand	Canada	Ireland	United States	France
Corticosteroids	Up to 35+6 wk	Up to 34+0 wk	Up to 34+0 wk	Up to 34+0 wk	Up to 34+0 wk	Up to 34+0 wk
Magnesium sulfate	Not specified	<30 wk[b]	Not specified	<32 wk	<32 wk	<32–33 wk
Recommended timing of delivery with AEDV and REDV	AEDV by 32 wk; REDV by 32 wk	AEDV by 34 wk; REDV by 32 wk	AEDV not specified; REDV not specified; "Requires intervention and possibly delivery"	AEDV no later than 34 wk; REDV no later than 30 wk	AEDV ≥34 wk[a]; REDV ≥32 wk	AEDV ≥34 wk; REDV ≥34 wk
Indication for delivery	Abnormal computerized CTG or DV Doppler	Not applicable –NZMFMN guideline for SGA ≥34 wk	Abnormal BPP, CTG, or DV Doppler	Abnormal computerized CTG	Abnormal fetal surveillance (CTG, amniotic fluid, or BPP)	Abnormal computerized CTG or DV Doppler
Mode of delivery	CS for AEDV and REDV	CS for AEDV and REDV	Not specified	CS for AEDV and REDV	FGR alone not indication for CS	CS for AEDV and REDV

Includes surveillance for AEDV as this usually occurs <32 wk' gestation, and >32 wk' gestation delivery is usual practice.

AEDV, absent end-diastolic volume; *BPP*, biophysical profile; *CS*, cesarean delivery; *CTG*, cardiotocograph; *DV*, ductus venosus; *FGR*, fetal growth restriction; *NZMFMN*, New Zealand Maternal Fetal Medicine Network; *REDV*, reversed end diastolic volume; *SGA*, small for gestational age.

[a] Society for Maternal-Fetal Medicine Doppler guideline[23]; [b] New Zealand magnesium sulfate guidelines.[101]

McCowan. Evidence-based national guidelines for management of suspected fetal growth restriction. Am J Obstet Gynecol 2018.

TABLE 2

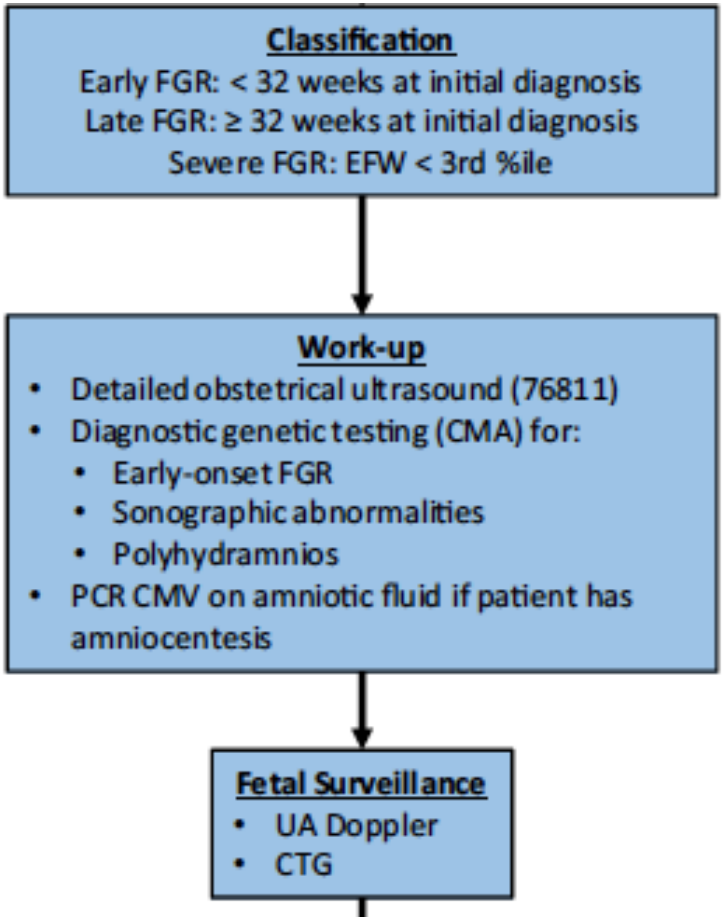
Differences between Society for Maternal-Fetal Medicine and International Society of Ultrasound in Obstetrics and Gynecology recommendations in the diagnosis, surveillance, and time of delivery decision of fetuses with suspected fetal growth restriction

Variable Diagnosis of suspected FGR	SMFM recommendations Estimated fetal weight or abdominal circumference <10th percentile	ISUOG recommendations Delphi consensus criteria
	Surveillance	
UA	Yes	Yes
Ductus venosus	No	Yes
Middle cerebral artery	No	Yes
Cardiotocography	Yes	Yes
Short-term variation	No	Yes
	Delivery timing	
Ductus venosus	No	≥26 0/7 to 31 6/7 wk: ductus venosus a-wave absent or reverse
UA reverse end-diastolic flow	30–32 wk	>30 0/7 to 32 0/7 wk
UA absent end-diastolic flow	33–34 wk	>32 0/7 to 34 0/7 wk
UA pulsatility index >95th percentile	37 wk	≥36 0/7 to 37 6/7 wk
Middle cerebral artery	No	38 0/7 to 39 0/7 wk
Short-term variation	No	≥26 0/7 to 28 6/7 wk: <2.6 ms ≥29 0/7 to 31 6/7 wk: <3.0 ms ≥32 0/7 wk: <3.5 ms ≥34 0/7 wk: <4.5 ms

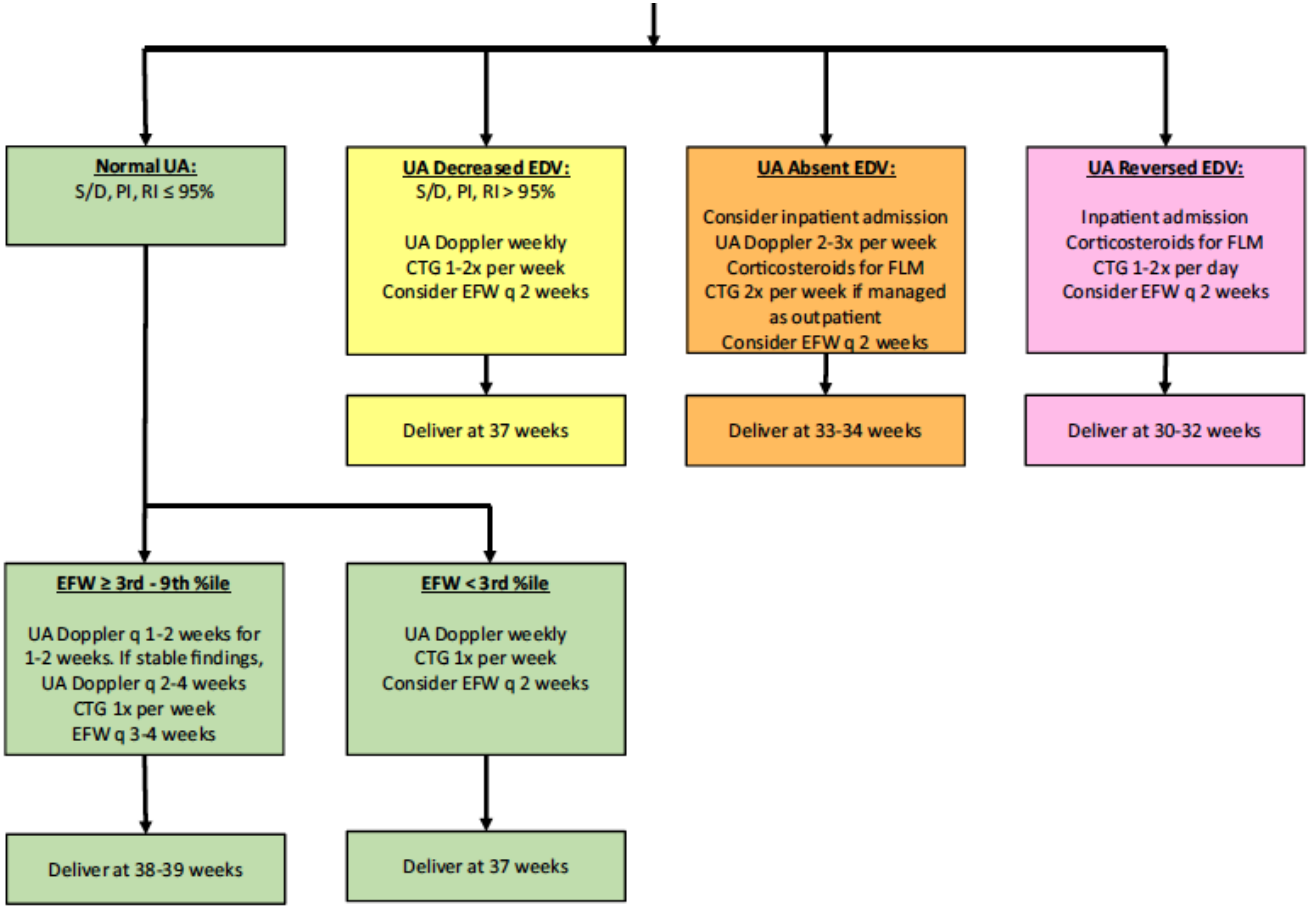
FGR, fetal growth restriction; *ISUOG*, International Society of Ultrasound in Obstetrics and Gynecology; *SMFM*, Society for Maternal-Fetal Medicine; *UA*, umbilical artery.

Lees. Diagnosis and management of suspected fetal growth restriction. Am J Obstet Gynecol 2022.

Algorithm for the diagnosis and management of fetal growth restriction (SMFM)



Algorithm for the diagnosis and management of fetal growth restriction

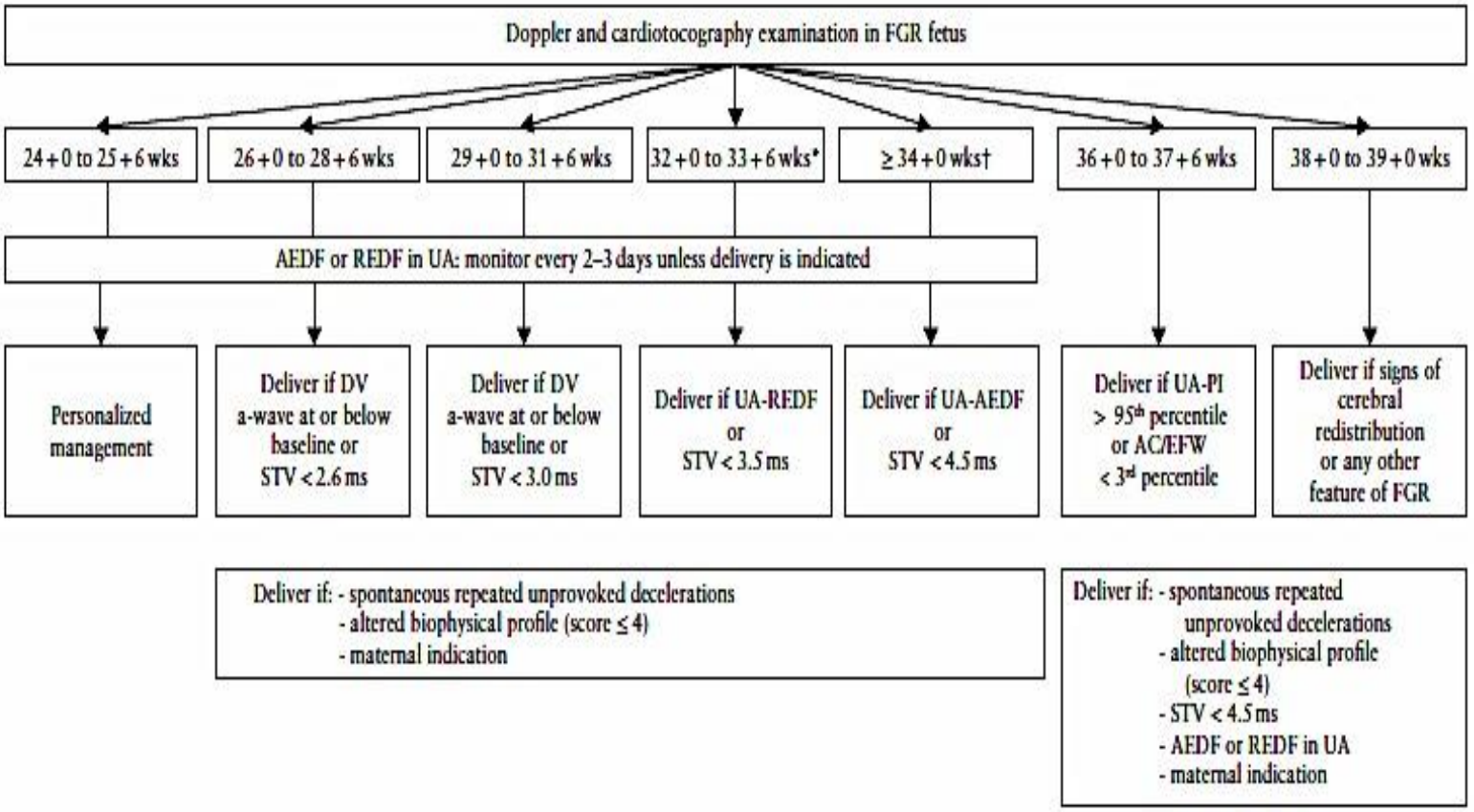


Stage – based management

Table 2. Stage-based classification and management of FGR

Stage	Pathophysiological correlate	Criteria (any of)	Monitoring*	GA/mode of delivery
I	Severe smallness or mild placental insufficiency	EFW <3rd centile CPR <p5 UA PI >p95 MCA PI <p5 UtA PI >p95	Weekly	37 weeks LI
II	Severe placental insufficiency	UA AEDV Reverse AoI	Biweekly	34 weeks CS
III	Low-suspicion fetal acidosis	UA REDV DV-PI >p95	1–2 days	30 weeks CS
IV	High-suspicion fetal acidosis	DV reverse a flow cCTG <3 ms FHR decelerations	12 h	26 weeks** CS

ISUOG



If cCTG is not available or not used, delivery timing should be based on combination of Doppler velocimetry indices (mainly ductus venosus before 30 weeks) and conventional CTG, or BPP where this is undertaken

- 24+0 to 25+6weeks: personalized management
- (GOOD PRACTICE POINT);
- ≥26+0weeks, deliver if any of the following is
- present:
- - Spontaneous repeated persistent unprovoked fetal
- heart rate decelerations (GRADE A);
- - Altered BPP (score ≤4) (GOOD PRACTICE
- POINT);

- 26+0 to 28+6weeks:
- ductus venosus a-wave is at or below baseline or STV <2.6ms
- (GRADE : A)
- 29+0 to 31+6weeks: ductus venosus a-wave is at or below baseline or STV <3.0ms (GRADE A);
- 32+0 to 33+6weeks (permitted after 30+0weeks): UA-EDF is reversed or STV <3.5ms (GPP)
- ≥34+0weeks (permitted after 32+0weeks): UA-EDF is absent or STV <4.5ms (GPP).

- Delivery at 37 weeks : Increased umbilical artery PI (>95th) OR EFW less than the 3rd percentile (GRADE 1B).
- Delivery at 33-34 weeks : AEDV of Ublical artery (GRADE 1B).
- Delivery at 30- 32 weeks : REDV (GRADE 1B).
- delivery at 38- 39 weeks of gestation : EFW is between the 3rd and 10th percentile and the umbilical artery Doppler is normal (GRADE 2C).
- Delivery at 34-37 weeks : FGR and concurrent conditions (oligohydramnios, maternal comorbidity [eg,
- preeclampsia, chronic hypertension]

Route of delivery

National *guidelines* **from 4 countries:**

◆***Elective cesarean delivery :***

- AEDF/REDF of the umbilical artery (GRADE 2C).
- Abnormal cCTG STV
- Ductus venosus Doppler alteration
- Altered BPP
- Maternal indication (GPP)

◆ ***For NVD: Continuous monitoring during labor***

Late-onset fetal growth restriction

- Late FGR is characterized by milder and more nonspecific placental lesions and/or alteration in oxygen and nutrient diffusion
- Alterations in UA Doppler and venous districts are rare
- There is an association between MCA vasodilatation (i.e. reduction in MCA-PI) or the alteration CPR and poorer perinatal outcome including:

➢ **Stillbirth,**

➢ **Higher risk of Cesarean delivery,**

➢ **Increased risk of abnormal neurodevelopment at birth and at 2 years of age**

Monitoring of late FGR

- MCA-PI and its ratios to UA-PI are the most important Doppler parameters in the surveillance of late FGR.
- **UA-PI >95th percentile: monitoring at least once or twice a week is indicated**
- **Low MCA PI : monitoring at least 2 times / week**
- the median interval between a low MCA-PI and stillbirth was ≤5 days,
- 90% of stillbirths occurred within 1week of a normal BPP score: BPP may have poor value in determining the frequency of fetal monitoring
- The measurement of MCA and CPR should be confirmed within 24 h to avoid false-positive results, especially when timing of delivery is based on this finding

Managing Late-Onset FGR (≥ 32 weeks)

- **Pathophysiology:** Milder placental dysfunction → mainly cerebral redistribution
- **Surveillance:**
- **Primary Doppler:** MCA PI and CPR (UA Doppler often normal)
- **Frequency:**
  - If UA PI > 95th → 1-2x/week
  - If low MCA PI → consider twice-weekly (median interval to stillbirth ≤ 5 days after 34 weeks)
- **Note:** BPP has poor predictive value in late FGR (may be normal even before stillbirth)
- **Corticosteroids:** Debate exists; most guidelines recommend only if < 34 weeks (RCOG says up to 35+6)
- [Presenter Notes: Late FGR is harder to manage because evidence from RCTs on delivery timing is lacking. Do not rely on BPP; it is often falsely reassuring.]
-

Delivery Timing in Late-Onset FGR (Expert Opinion)

GA	Finding	Action
Any GA	Spontaneous decelerations, BPP ≤ 4, maternal indication	Deliver immediately
36+0 to 37+6	UA PI > 95th centile OR EFW/AC < 3rd centile	Deliver
38+0 to 39+0	Evidence of cerebral redistribution (low CPR/MCA PI) OR any FGR feature	Deliver
≥ 34 weeks	Isolated EFW 5th–10th, normal Dopplers	Deliver by 38+0 (Grade A evidence)

Key evidence (DIGITAT trial): Induction for suspected FGR after 38 weeks did not increase C-sections and reduced extremely low birth weight & pre-eclampsia.

Intrapartum: Continuous fetal monitoring indicated.

[Presenter Notes: The DIGITAT trial supports induction over expectant management at term. Do not let SGA pregnancies go beyond 39 weeks.]

How and when to deliver

- Delivery should be based on biophysical assessments or maternal indication
- **Late FGR + UA-PI above the 95th percentile**: delivery is beyond 36+0weeks and not later than 37+6weeks
- **Late FGR + signs of cerebral blood-flow redistribution:** delivery at around 38+0weeks and not later than 38+6weeks.
- Depending on the clinical situation (parity, EFW, cervical findings), induction of labor may be undertaken,
- Continuous fetal heart rate monitoring during labor should be undertaken

FETUSES WITH A REDUCTION IN GROWTH RATE BUT NOT FGR

- Follow these fetuses with weekly biophysical profiles and (? Doppler)and consider delivery at 38 weeks
- An alternative is to increase fetal testing to twice a week nonstress test [NST] and one biophysical profile [BPP] with delivery at 39 weeks

Small-for-gestational age

- Fortnightly assessment of fetal growth is recommended
- Late-SGA fetuses with abnormal uterine artery PI at diagnosis, compared to those without, are more likely to progress to brain sparing, in other words ‘cross over’ to FGR, and this usually occurs at earlier gestational-age epochs.
- Even late-SGA fetuses with normal uterine artery PI can progress to brain sparing, albeit less frequently and 1–2 weeks later than fetuses with abnormal uterine artery

When and how to deliver

- Universal induction of labor at term may be more beneficial than expectant management in terms of reduced perinatal mortality
- Consider delivery after 38+0weeks of gestation, and the pregnancy should not exceed 39+0weeks, in order to reduce the risk of severe growth restriction or stillbirth in fetuses identified as SGA.
- Continuous fetal heart rate monitoring in labor should be performed in these cases

Management of Confirmed SGA (Not FGR)

Definition: EFW/AC 3rd-10th percentile with normal Dopplers & growth velocity

Surveillance:

At diagnosis: Assess UtA, UA, MCA, CPR

Follow-up:

Fetal growth: Every 2 weeks

UA/MCA/CPR: weekly (late SGA ≥ 32 weeks)

Key Point: Even SGA may have subtle placental issues; not always benign.

- **Delivery:**
- Plan delivery starting at **38+0 weeks**
- Do not exceed **39+0 weeks** (Grade A recommendation)
- Induction is appropriate
- Continuous fetal monitoring in labor
- The DIGITAT trial showed that in the expectant management arm, more neonates had birth weight < 3rd percentile and more mothers developed pre-eclampsia. Therefore, even constitutionally small fetuses should be delivered by 39 weeks.

Summary Algorithm

- **Step 1: Is EFW/AC < 10th centile?**
- No → Continue routine care
- Yes → Go to Step 2
- **Step 2: Is EFW/AC < 3rd centile OR UA AEDF?**
- Yes → **Diagnose FGR** (any GA)
- No → Go to Step 3
- **Step 3: Evaluate additional criteria (per Delphi)**
- Early (<32w): UtA >95th or UA >95th + EFW 3rd-10th → **FGR**
- Late (≥32w): Two of (a) EFW 3rd-10th, (b) crossing >2 quartiles, (c) CPR <5th or UA >95th → **FGR**
- If no additional criteria → **SGA**
- **Step 4: Manage accordingly**
- **Early FGR:** Tertiary care, DV + cCTG, deliver per TRUFFLE criteria
- **Late FGR:** MCA/CPR q1-2wk, deliver by 38-39 weeks if abnormal
- **SGA:** Deliver at 38-39 weeks

Key Take-Home Messages

- **SGA ≠ FGR.** Use Doppler and growth velocity to differentiate.
- **EFW/AC < 3rd centile = FGR** (deliver by 37-38 weeks).
- **Early-onset (<32w):** Focus on UA and **Ductus Venosus** for delivery timing. Manage in tertiary center.
- **Late-onset (≥32w):** Focus on **MCA/CPR**. BPP is often misleading.
- **Do not let SGA exceed 39 weeks** (Grade A evidence).
- **No effective therapy** – timely delivery prevents stillbirth and morbidity.

Prevention in subsequent pregnancies

- Recurrence : 20%
- FGR in the first pregnancy is associated with increased risk of stillbirth in the subsequent pregnancy even if the fetus is appropriate size for gestational age
- Treat the cause before next pregnancy
- Remove risk factors
- Aspirin: Low-dose aspirin may be effective when FGR is secondary to preeclampsia
- Heparin does not reduce the risk of recurrent placenta-mediated late pregnancy complications
- Fetal assessment and growth scan?

Management of subsequent pregnancies

- Risk of recurrence: 20% (ACOG)
- FGR in the first pregnancy is associated with increased risk of stillbirth in the subsequent pregnancy even if the fetus is appropriate size for gestational age
- Fetal assessment and growth scan?

TABLE 6

Recommendations from small-for-gestational-age guidelines where >50% consensus is achieved

Country	United Kingdom	New Zealand	Canada	Ireland	United States	France
Definition of FGR on ultrasound	EFW <10th customized centile, or AC <10th population centile	EFW <10th customized centile or AC ≤5th population centile	EFW <10th or AC <10th population centiles	EFW <10th customized centile	EFW <10th population centile	EFW <10th customized centile
Risk assessment at booking?	Yes	Yes	Yes	Yes	Yes	Yes
Fundal height measurement	Serial fundal height on customized chart from 24 wk; ultrasound if <10th centile, slow or static growth	Serial fundal height on customized chart from 26 wk; ultrasound if reducing velocity or fundal height <10th centile	Serial fundal height —if less than gestation (wk) by >3 cm, ultrasound scan recommended	Serial fundal height on customized chart if available	Serial fundal height at every visit—ultrasound if >3 cm discrepancy with gestation	Serial fundal height screening from 22 wk leading to ultrasound if abnormal—reference chart not specified
Prevention: low-dose aspirin	Low-dose aspirin <16 wk in women with risk factors for preeclampsia	Women at high risk of growth restriction, consider low-dose aspirin 100 mg daily starting <20 wk	Low-dose aspirin for prior preeclampsia, growth restriction, or ≥2 SGA risk factors	Low-dose aspirin 75 mg daily for major SGA risk factors at <16 wk; consider heparin in individual cases	Insufficient evidence to recommend	Low-dose aspirin if previous: preeclampsia <34 wk or FGR <5th centile; 100—160 mg nocte start <16 wk
Prevention: smoking cessation and other interventions	Smoking cessation; no evidence for dietary measures	Smoking cessation in early pregnancy	Smoking cessation —any stage in pregnancy	Smoking cessation—any stage in pregnancy	Tobacco modifiable risk factor; no evidence for bed rest or dietary measures	Smoking cessation and support to become alcohol and drug free before pregnancy; limit multiple pregnancy in assisted reproductive technology; no evidence for bed rest

Early pregnancy biomarkers	PAPP-A <0.415 MoM —major risk; use of PAPP-A for population screening not recommended	If PAPP-A <0.2 MoM major risk factor; use of PAPP-A for population screening not recommended	If ≥2 serum parameters of aneuploidy screen abnormal (threshold unspecified) increased SGA risk	Low PAPP-A <0.4 MoM risk factor for FGR	No evidence for improved outcome	Not discussed
Uterine artery Doppler for high-risk women?	At 20 wk if ≥3 minor risk factors	At 20—24 wk in high-risk women	At 19—23 wk in women with risk factors	Not recommended	No evidence for improved outcome	Not discussed
Fundal height measurement	Serial fundal height on customized chart from 24 wk; ultrasound if <10th centile, slow or static growth	Serial fundal height on customized chart from 26 wk; ultrasound if reducing velocity or fundal height <10th centile	Serial fundal height—if less than gestation (wk) by >3 cm, ultrasound scan recommended	Serial fundal height on customized chart if available	Serial fundal height at every visit —ultrasound if >3 cm discrepancy with gestation	Serial fundal height screening from 22 wk leading to ultrasound if abnormal—reference chart not specified
Prevention: low-dose aspirin	Low-dose aspirin <16 wk in women with risk factors for preeclampsia	Women at high risk of growth restriction, consider low-dose aspirin 100 mg daily starting <20 wk	Low-dose aspirin for prior preeclampsia, growth restriction, or ≥2 SGA risk factors	Low-dose aspirin 75 mg daily for major SGA risk factors at <16 wk; consider heparin in individual cases	Insufficient evidence to recommend	Low-dose aspirin if previous: preeclampsia <34 wk or FGR <5th centile; 100—160 mg nocte start <16 wk
Prevention: smoking cessation and other interventions	Smoking cessation; no evidence for dietary measures	Smoking cessation in early pregnancy	Smoking cessation—any stage in pregnancy	Smoking cessation—any stage in pregnancy	Tobacco modifiable risk factor; no evidence for bed rest or dietary measures	Smoking cessation and support to become alcohol and drug free before pregnancy; limit multiple pregnancy in assisted reproductive technology; no evidence for bed rest

Screening with routine third-trimester ultrasound in low-risk women	Not recommended	Not recommended	Not recommended	Not recommended	Not recommended	Recommended at 32 wk
UA Doppler?	Yes—from 26—28 wk in high risk	If fetus small on biometry, or reduced growth velocity	If fetus small on biometry	Yes—criteria not specified	Yes—criteria not specified	Yes—criteria not specified
UA Doppler frequency	Every 2 wk if UA Doppler normal, twice weekly if abnormal UA Doppler	Every 2 wk if UA Doppler normal, at least weekly if abnormal UA Doppler	Every 2 wk	Every 2 wk if UA Doppler normal, at least weekly if abnormal UA Doppler	From gestational age where delivery considered for fetal benefit; every 1—2 wk to assess for deterioration[a]	2—3 Weekly if Doppler studies normal, more frequent if severe FGR; weekly if UA Doppler abnormal

TABLE 6

Recommendations from small-for-gestational-age guidelines where >50% consensus is achieved *(continued)*

Country	United Kingdom	New Zealand	Canada	Ireland	United States	France
Cerebral Doppler studies	MCA Doppler >32 wk with normal UA Doppler	MCA Doppler and CPR every 2 wk ≥34 wk; if Doppler(s) abnormal repeat at least weekly	MCA and DV Doppler studies but gestation not specified	MCA optional if UA Doppler abnormal —should not be used to indicate delivery	Insufficient evidence to support use of MCA Doppler in clinical practice	Cerebral artery Doppler every 2–3 wk if normal UA Doppler; increase frequency if UA Doppler abnormal
CTG	Not as only form of surveillance	Not as only form of surveillance; at least weekly if abnormal UA, MCA, CPR, uterine artery Doppler, or EFW <3rd centile	Not as only form of surveillance, consider if biophysical profile abnormal	Not specified	Not as only form of surveillance; if abnormal UA Doppler, twice-weekly CTG and/or biophysical profile[a]	"Essential element in assessment of SGA fetus," frequency not specified
Corticosteroids	Up to 35+6 wk	Up to 34+0 wk	Up to 34+0 wk	Up to 34+0 wk	Up to 34+0 wk	Up to 34+0 wk
Mode of delivery	CS for AEDV and REDV	CS for AEDV and REDV	Not specified	CS for AEDV and REDV	FGR alone not indication for CS	CS for AEDV and REDV

AC, abdominal circumference; *AEDV*, absent end diastolic volume; *CPR*, cerebroplacental ratio; *CS*, cesarean delivery; *CTG*, cardiotocography; *DV*, ductus venosus; *EFW*, estimated fetal weight; *FGR*, fetal growth restriction; *MCA*, middle cerebral artery; *REDV*, reversed end diastolic volume; *SGA*, small for gestational age; *UA*, umbilical artery.

[a] SMFM guideline.

McCowan. Evidence-based national guidelines for management of suspected fetal growth restriction. Am J Obstet Gynecol 2018.

Box 3. Recommendations for monitoring, timing, and mode of delivery in pregnancies with suspected fetal growth restriction

Diagnosis	Finding	Risk of stillbirth	Suggested monitoring [a]				Timing of delivery	Mode of delivery
			Monitoring setup	Doppler	Growth	mBPP/BPP/NST		
SGA	• AC and EFW 3rd–10th percentile • Normal Doppler	Low	Out-patient	UA and MCA every 1–2 wk	Every 2 wk	≥37 wk consider 1–2 times per wk [b]	37–39 wk	Labour induction
Uncomplicated FGR	• EFW or AC <3rd percentile • Normal Doppler and fluid	Low	Out-patient	UA & MCA 1–2/wk	Every 2 wk	≥36 wk consider 1–2 times per wk [b]	37 wk	Labour induction
FGR	• Early Doppler changes: • UA PI >95th percentile, or • MCA PI <5th percentile, or • CPR <5th percentile, or • UtA PI >95th percentile • Oligohydramnios • Abnormal appearance of placenta • Suboptimal interval growth	Low	• Out-patient monitoring is reasonable in most cases • Consider steroids for fetal lung maturation	UA, MCA, and DV 1–2 times per week	Every 2 wk	1–2 times per wk	By 37 wk	Labour induction *or* Caesarean
	AEDF or REDF	Risk of stillbirth with strict monitoring protocol: a. AEDF: 0%–1% b. REDF: 1%–2% • Median time for deterioration: a. AEDF: 5 days b. REDF: 2 days	• Consider in-patient monitoring • Steroids for fetal lung maturation	UA, MCA, and DV every 1–2 days	Every 2 wk	1–2 times per day	AEDF 32–34 wk [c] REDF 30–32 wk [c]	Caesarean
	Abnormal DV	Risk of stillbirth with strict monitoring protocol: a. Elevated DV PIV: 2% b. Absent-reverse *a* wave in DV: 4%	• In-patient monitoring • steroids for fetal lung maturation	UA, MCA, and DV daily		Twice per day	26–30 wk	Caesarean

Summary of Key Recommendations

Level A (Good Evidence)	Level C (Consensus/Expert Opinion)
UA Doppler with NST/BPP improves outcomes.	FGR alone is not an indication for C-section.
Antenatal corticosteroids for preterm delivery (<34 wks, and select 34-36/7 wks).	Delivery timing depends on etiology, gestational age, and surveillance findings.
MgSO4 for neuroprotection if delivery <32 wks.	
Nutritional supplements do NOT prevent FGR.	

Conclusion

- FGR is a high-risk condition requiring a structured approach.
- **Key steps:** Accurate diagnosis (EFW/AC <10th %) → Serial surveillance (q3-4 weeks) → **Umbilical artery Doppler** → Timely delivery based on severity (EFW <3rd %, AREDF, oligo).
- Avoid ineffective interventions (supplements, bed rest).
- Multidisciplinary management (MFM, Neonatology) is essential for early preterm FGR.

Delivery Timing – General Principles

- **Upper thresholds** (limited data):
- Uncomplicated FGR: **37+0 weeks**
- UA absent diastolic flow: **33–34 weeks**
- UA reversed diastolic flow: **30–32 weeks**
- **Risk of stillbirth increases with gestational age** (37→40 weeks):
- EFW <3rd percentile: 32/10,000 at 39 weeks
- EFW ≥10th percentile: 2/10,000 at 39 weeks

Delivery by Testing Category (Reassuring Findings)

Finding	Deliver at
UA reversed diastolic flow	30+0 – 32+0 weeks
UA absent diastolic flow	33+0 – 34+0 weeks
UA PI >95th %ile	37+0 weeks
EFW <3rd %ile, no comorbidities	37+0 weeks
EFW 3rd–10th %ile, no comorbidities	38+0 – 39+0 weeks
+ oligohydramnios or comorbidities	34+0 – 37+6 weeks (individualiz

Delivery for Nonreassuring Testing

Finding	Action
Repetitive late decelerations	Prompt delivery
BPP 0 or 2/10	Deliver (perinatal mortality 125–600/1000)
BPP 4/10	Repeat in 1 hour; if persists → deliver
BPP 6/10 + oligohydramnios	Individualize, repeat in 24h
BPP 6/10 (no oligo) or 8/10 + oligo	Individualize based on Doppler, GA, maternal status

Route & Intrapartum Management

- **Cesarean** for standard indications
- **Trial of labor acceptable –** unfavorable cervix not a contraindication
- **If UA reversed flow** → offer scheduled cesarean (many do not tolerate labor)
- **Cervical ripening**: mechanical methods preferred (balloon catheter) – lower adverse outcomes than prostaglandins
- **Magnesium sulfate** for neuroprotection if <32 weeks
- **Continuous fetal monitoring** during labor

Pediatric Outcomes

Parameter	Finding
Fetal/neonatal death (early-onset FGR)	12% / 8%
Common morbidities	RDS (34%), ROP (13%), sepsis (30%)
Long-term risks	HTN, DM2, coronary disease, CKD
Neurodevelopment (early-onset FGR)	12% cognitive impairment / CP

Maternal & Recurrence Risks

- **Maternal**: Increased long-term cardiovascular disease risk (OR 1.09–3.50)
- **Recurrence of SGA**:
- After 1 SGA birth: 23% risk in next pregnancy
- Increases with number of prior SGA births
- **Uteroplacental insufficiency** can manifest differently across pregnancies:
- FGR, preterm birth, preeclampsia, abruption, stillbirth

Prevention in Subsequent Pregnancies

- Accurate early dating + serial growth scans
- Address modifiable factors: smoking, alcohol,
- nutrition, short interpregnancy
- interval (<6–12 months)
- **Low-dose aspirin** if preeclampsia risk factors
- (FGR recurrence reduced: RR 0.56)
- **No role for**:
- Routine LMWH or unfractionated heparin (no benefit, increased risk/cost)
- Exception: obstetric antiphospholipid syndrome

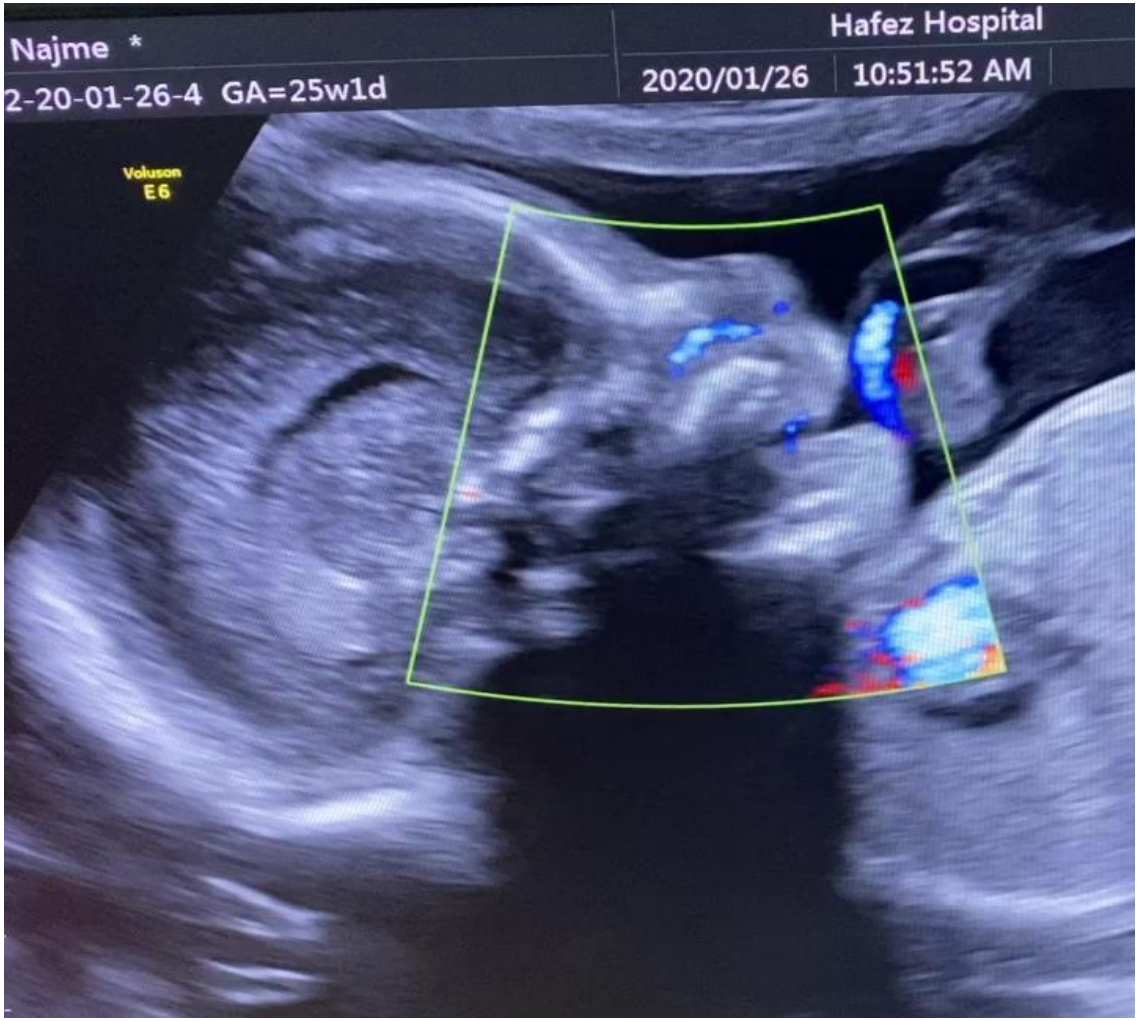
Neonatal Complications – Part 1

- **Preterm birth** (increased risk of RDS, NEC, BPD, ROP)
- **Perinatal asphyxia** → HIE, PPHN, meconium aspiration, organ injury
- **Impaired thermoregulation** (high surface area, low reserves)
- **Hypoglycemia** (low glycogen stores, poor counterregulatory response)

Neonatal Complications – Part 2

- **Hypocalcemia** (especially if preterm or asphyxiated)
- **Hyperbilirubinemia** (↑ RBC mass, ↓ hepatic function)
- **Polycythemia / Hyperviscosity** (↑ erythropoietin from hypoxia)
- **Feeding difficulties** (poor suck-swallow coordination)
- **Impaired immune function** (persistent T-cell deficits)

Many Thanks for your Attention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Special Populations – Uncertain GA & Twins

- **Uncertain gestational age**
- Serial US ≥2 weeks apart
- Assess interval growth (normal: ~30–35 g/day at 32–34 weeks)
- Abnormal interval growth + oligohydramnios + abnormal Dopplers → FGR
- **Multiple gestation**
- Growth similar to singletons until ~32 weeks
- Dichorionic: independent risk per fetus
- Monochorionic: higher risk due to discordant placental sharing

Surveillance Protocol by Doppler Category

UA/MCA Doppler	Management
Both normal	Weekly UA/MCA + BPP
Abnormal UA or MCA, but diastolic flow present	2x/week Doppler + BPP + NST
Abnormal + comorbidities (oligohydramnios, preeclampsia)	Hospitalization, individualized
UA absent/reversed diastolic flow	Admission, NST q6-12h, BPP daily, Doppler 2-3x/week + DV monitoring

DV a-wave abnormality = advanced compromise, but not alone an indication for delivery.