Antepartum fetal surveillance

Dr. Seham Abufraijeh

Introduction

- The primary goal of antenatal testing is to :

1. Identify fetuses at risk of **intrauterine neurologic injury** or **death** .
2. prevent these adverse outcomes, and improve neonatal outcome (mostly to deliver or to apply intrauterine fetal therapy).

Introduction

- The first prenatal visit initiates a process of monitoring.
- A plan for fetal assessment begins to emerge based on identification of family, historical, and maternal risk factors.
- Specific fetal information, including data from first- and second-trimester screening, biochemical testing, and growth evaluation, further refine the plan.

Indications for antenatal surveillance

Maternal Conditions

- Hyperthyroidism
- Cyanotic heart disease
- Chronic renal disease
- Diabetes
- Symptomatic heamoglopinopathy

Placental Conditions

- Antiphospholipid antibody syndrome
- Systemic lupus erythematosus
- Hypertensive disorders, including pregnancy-induced hypertension
- Thrombophilia
- Marked placental anomalies

Indications for antenatal surveillance

Fetal Conditions

- Decreased fetal movement
- Amniotic fluid abnormalities (Oligohydramnios, Polyhydramnios)
- Intrauterine growth restriction
- Post-term pregnancy
- Alloimmunization
- Macrosomia
- Fetal anomalies or aneuploidy
- Multiple gestation

Miscellaneous

- In vitro fertilization pregnancy
- Previous stillbirth
- Prior neurologic injury
- Previous recurrent abruption
- Obesity

When to initiate fetal surveillance

- The American College of Obstetricians and Gynecologists(ACOG), suggest starting monitoring at **26 to 32** weeks.
- If the threshold of viability at a tertiary institution is **24** weeks and the presentation is severe like fetal growth restriction, monitoring is likely to be started early.
- Tests should be repeated at least weekly or more frequently according to the test and the severity of the condition.

Antepartum fetal surveillance methods

- **Fetal movement counting**
- Non Stress Test (NST)
- Contraction Stress Test (CST)
- Biophysical Profile (BPP)
- Modified Biophysical Profile
- Doppler Velocimetry

Fetal movement count

- Kick counts are easy to perform, inexpensive, convenient, and keep the patient aware of her fetus usual behavioral pattern.
- Maximal activity is between **28-32** weeks gestation .
- Gradual reduction toward term:
  - due to the fetus/amniotic fluid volume ratio.
  - maturing fetus with longer sleep cycles.
- Highest incidence of fetal movement usually occur in the late evening.

Fetal movement count

Chronic hypoxia

↓

Attempt to reduce oxygen consumption

and

conserve energy

↓

Reduction or cessation of

fetal body movements

Fetal movement count

- There is no consensus regarding an appropriate definition of Decreased Fetal Movement (DFM).
- This is due to wide biologic variation in normal fetal movement among healthy fetuses , as well as the wide variation in maternal perception of fetal activity.
- Reassuring fetal kick count defined as:

  -Perception of at least 10 FMs during 12 hours of normal maternal activity.

  -Perception of least 10 FMs over 2 hours when the mother is at rest.

Fetal movement count

- women with third trimester DFM are more likely to have pregnancies complicated by **impaired fetal growth**, **preterm birth**, **neonatal depression**, **emergency delivery**, and **fetal or neonatal death** than women with normal fetal movement.
- When stillbirth occurred, movements diminished rapidly and stopped 12 to 24 hours prior to fetal death

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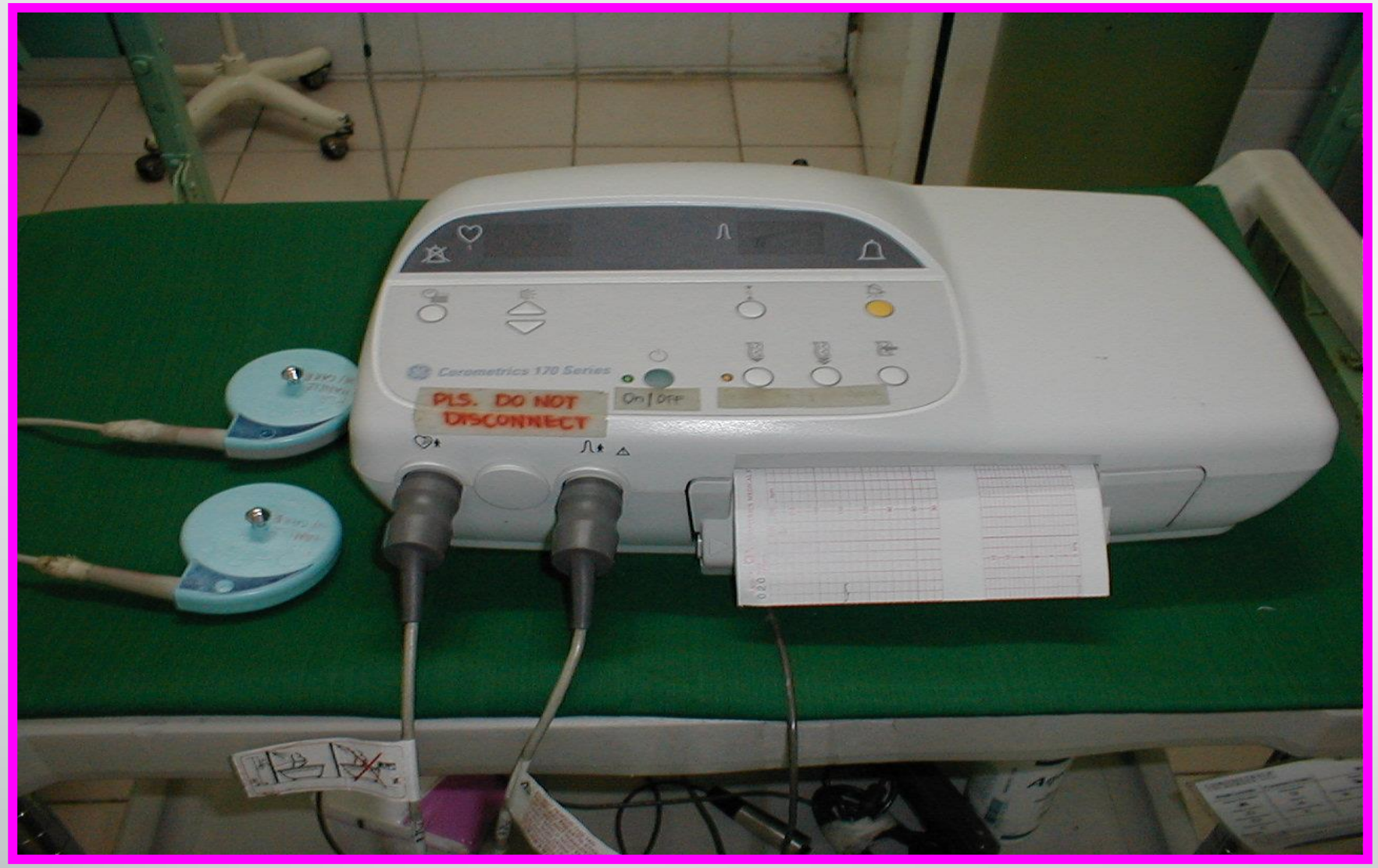
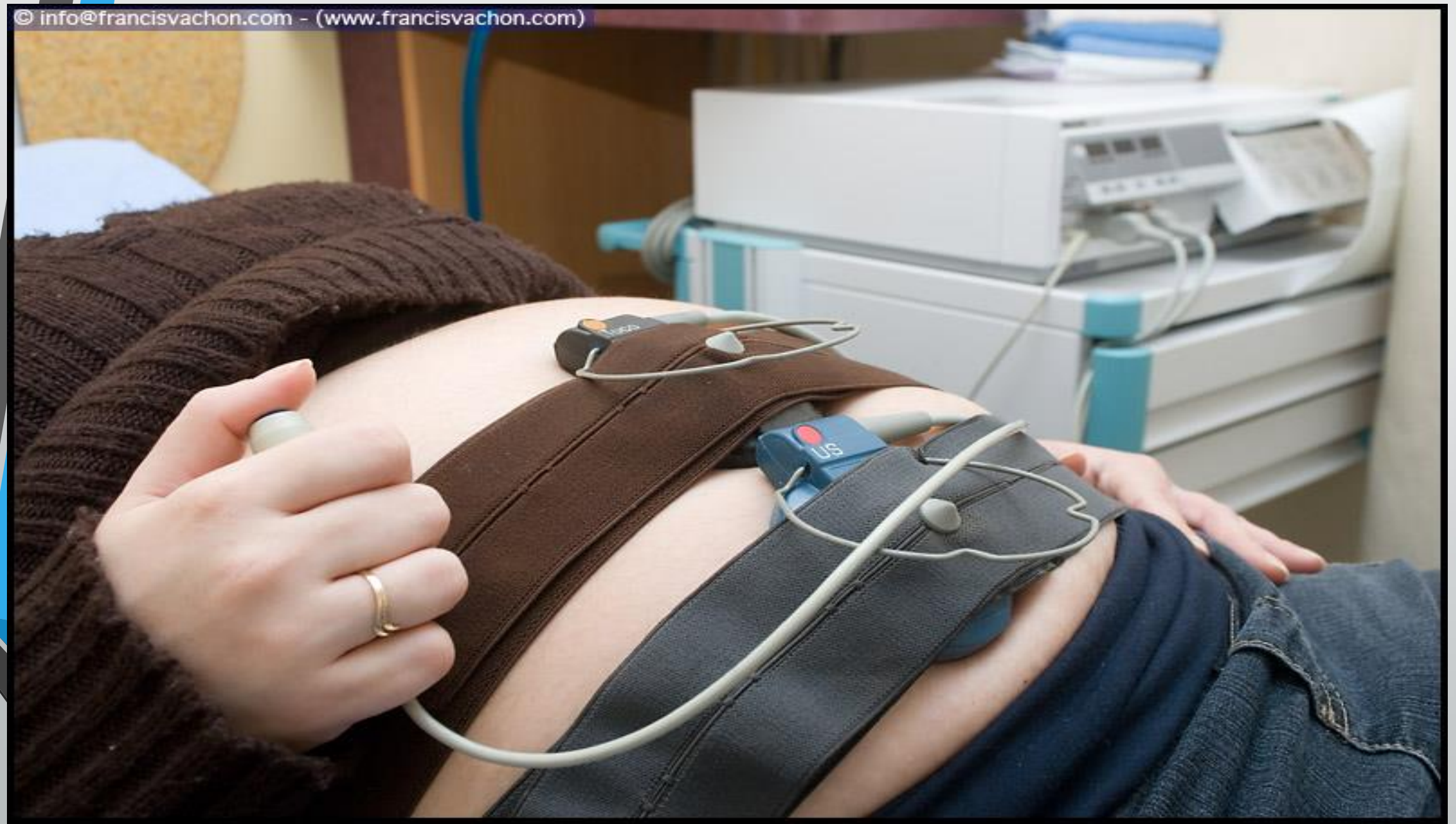
Non Stress Test (NST)

- Assess the fetal heart rate (FHR) in response to fetal movement.
- This is based on the hypothesis that the HR for fetus who is **not** acidotic will temporarily accelerate in response to fetal movement.
- NST is also affected by fetal state and maturation, maternal state and medications, and diurnal biorhythms.



Electronic fetal monitors are used to both determine the FHR and continuously record it in graphical form.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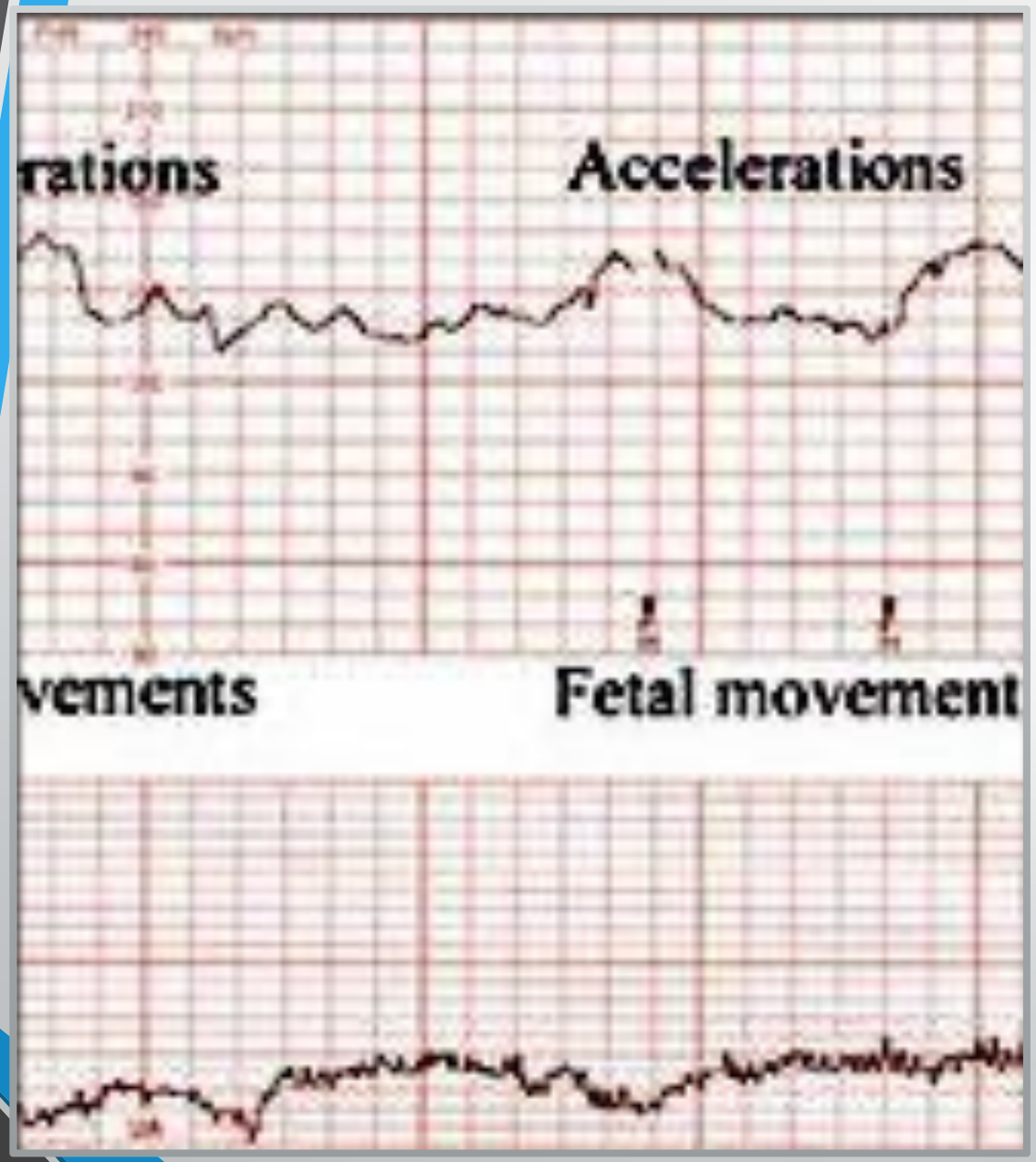
Non Stress Test (NST)

- Baseline FHR
- FHR variability (beat to beat variation)
- Acceleration
- Deceleration

Non Stress Test (NST)

- The parasympathetic and sympathetic nervous system(autonomic nervous system), regulates the FHR.
- The parasympathetic effect slows FHR, and responsible for FHR variability.
- Sympathetic stimulation accelerates the FHR .
- Blockade of sympathetic activity decreases baseline FHR and blunts accelerations.



The ultrasound probe transmits the fetal heart rate in beats per minute.
Each small vertical square is 5 beats.

Each small horizontal square is 1 minute .

The pressure transducer

transmits the intrauterine pressure generated by uterine contractions in mm Hg.

Each small vertical square is 10 mm Hg

Each small horizontal square is 1 minute .

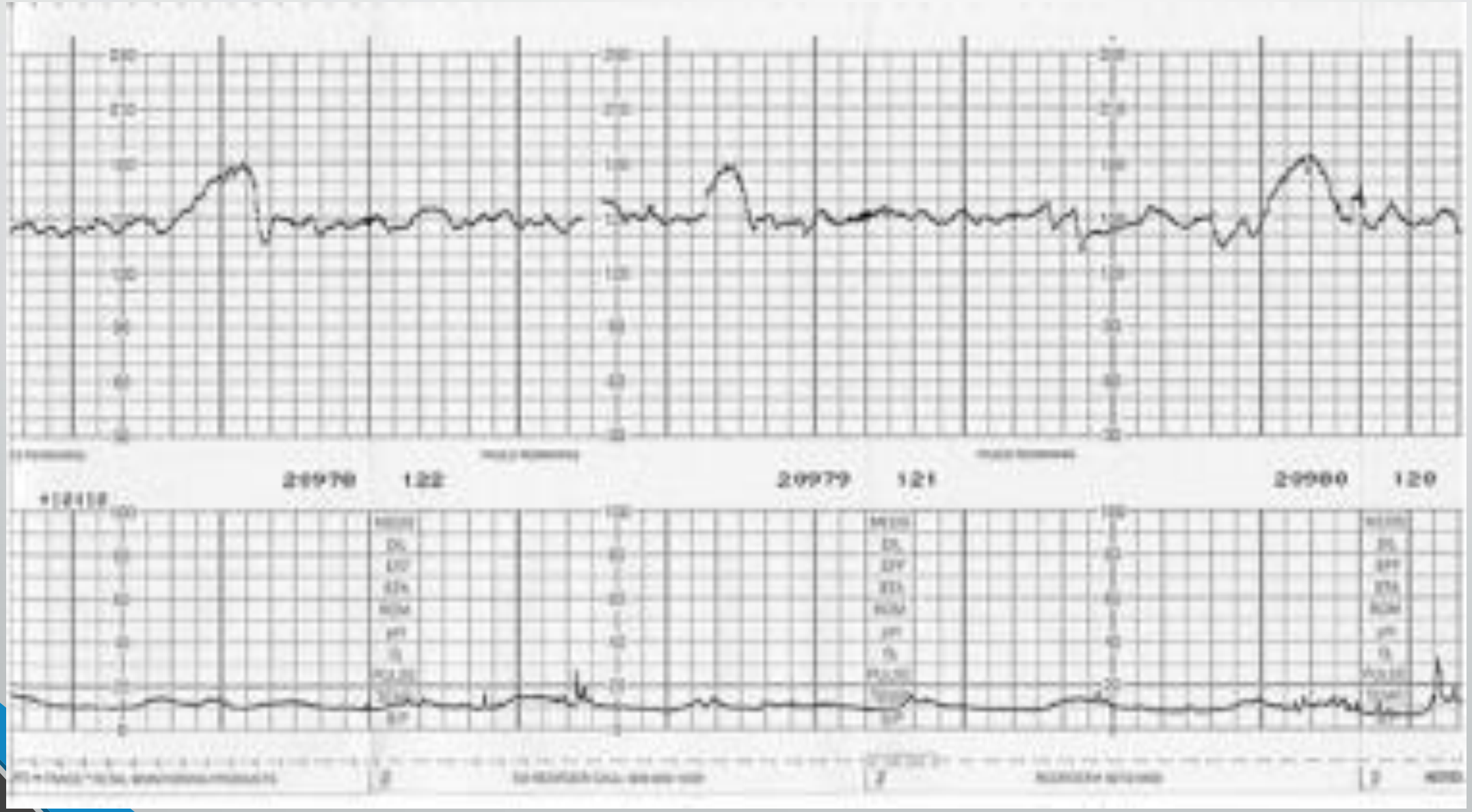
Non Stress Test (NST)

- The test is **reactive** if there are **2 or more** fetal heart rate accelerations reaching a peak of at least **15 bpm** above the baseline rate and lasting for at least **15 seconds** from onset to return in a **20-minute** period.

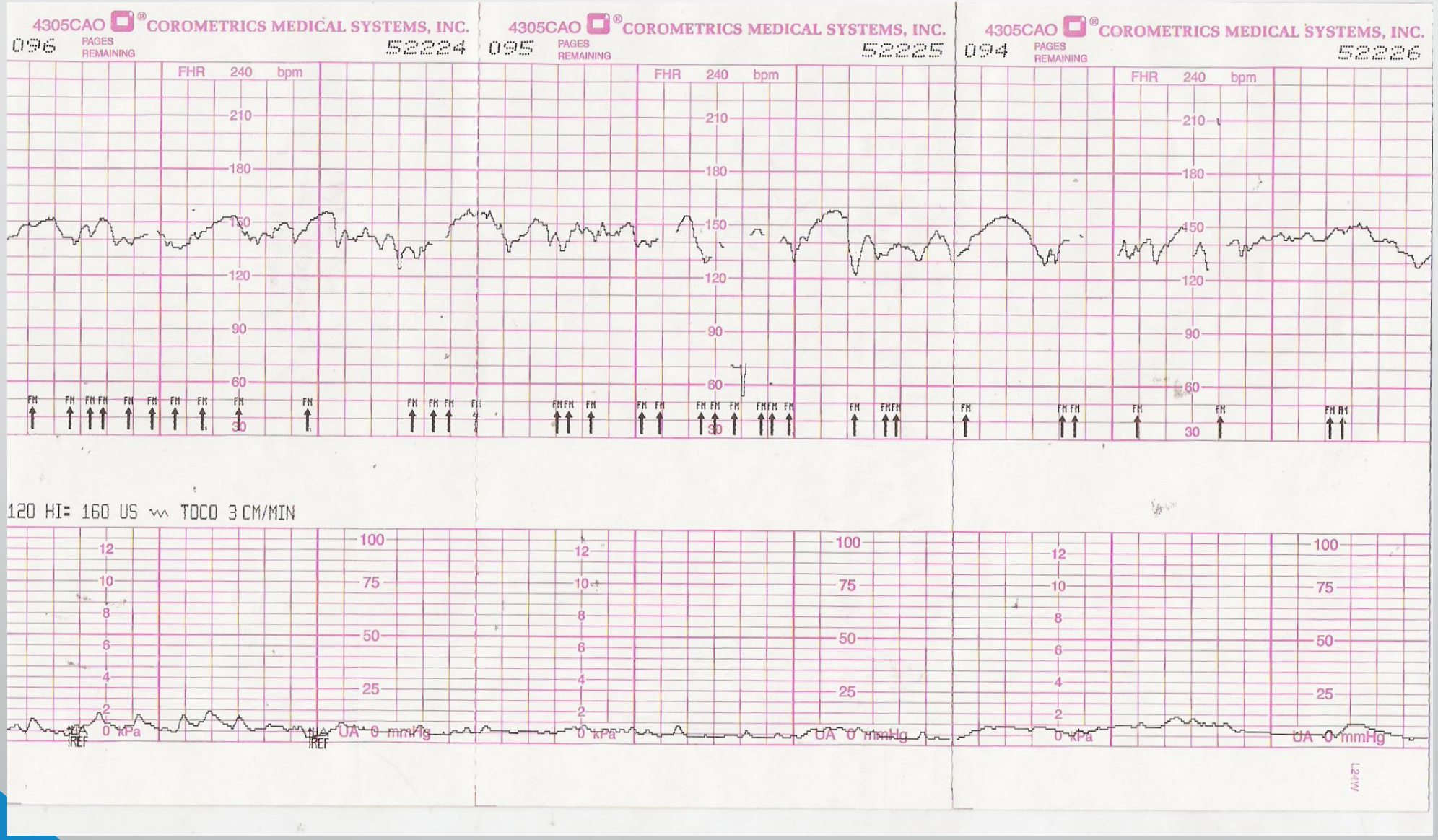
- The **nonreactive** NST result is defined by an FHR monitoring interval that does not meet the criteria previously described. Defined as one that does not show such accelerations over a **40-minute** period.

- Nonreactive NST can be due to fetal immaturity, quiet fetal sleep, or maternal smoking .

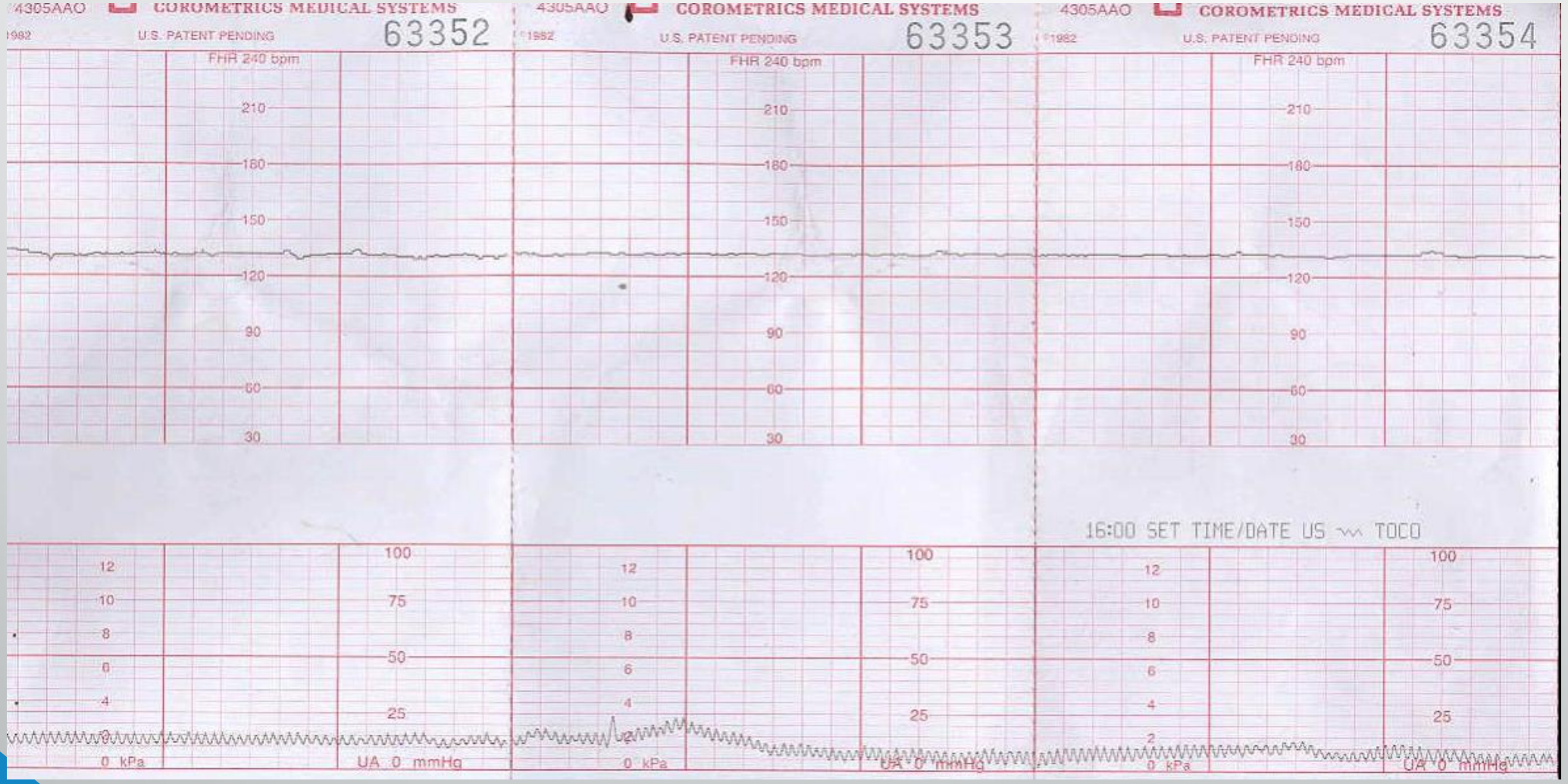
Reactive NST



Reactive NST



Non reactive NST



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Contraction stress test (CST)

- The contraction stress test (CST) is usually performed using oxytocin (also called oxytocin challenge test OCT).
- A diluted solution of oxytocin is infused until 3 contractions occur within 10 minutes.
- It evaluates the response of the fetal heart rate to induced contractions and was designed to unmask poor placental function.
- This is based on the theory that **uterine contractions transiently worsen fetal oxygenation**, leading to FHR deceleration in a marginally compromised fetus with a limited placental function.

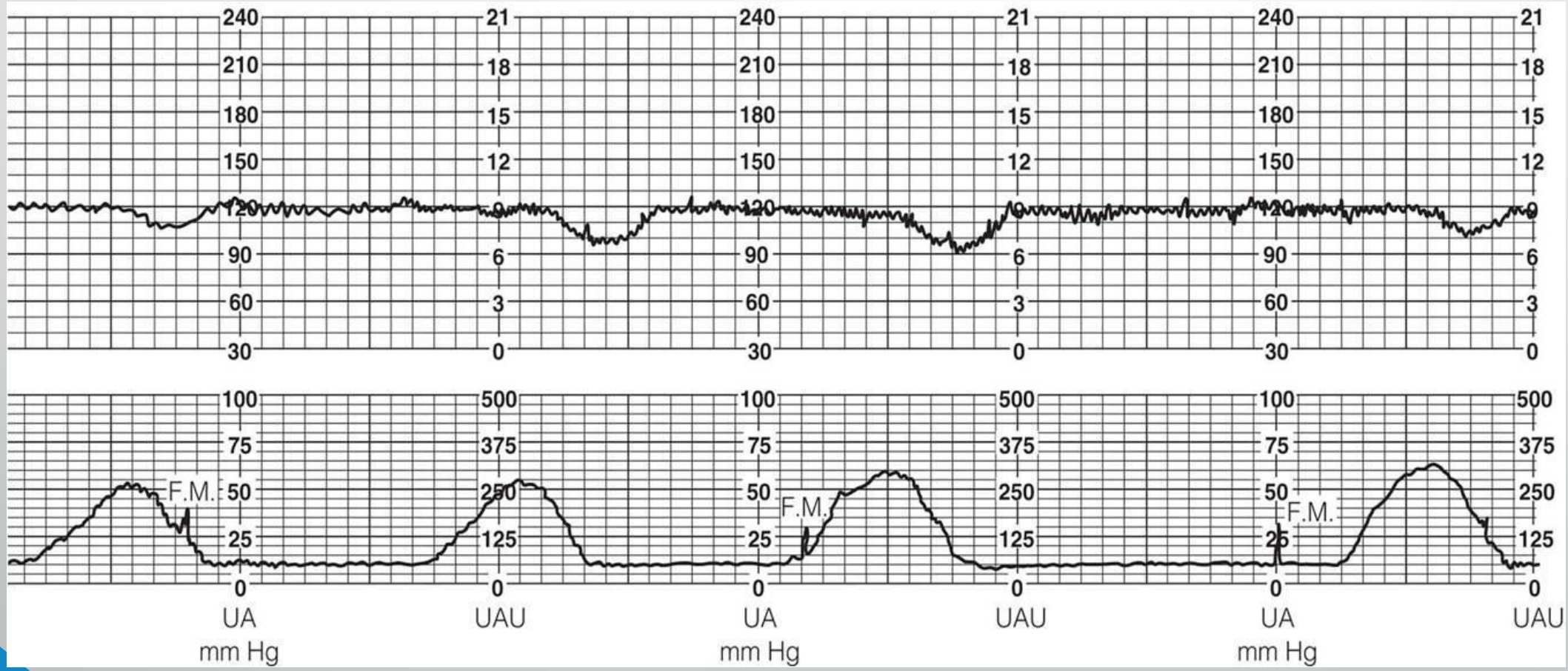
Contraction stress test (CST)

- **Positive CST** if late decelerations occur with more than **50%** of the induced contractions (even if the goal of three contractions in 10-minutes has not yet been reached)

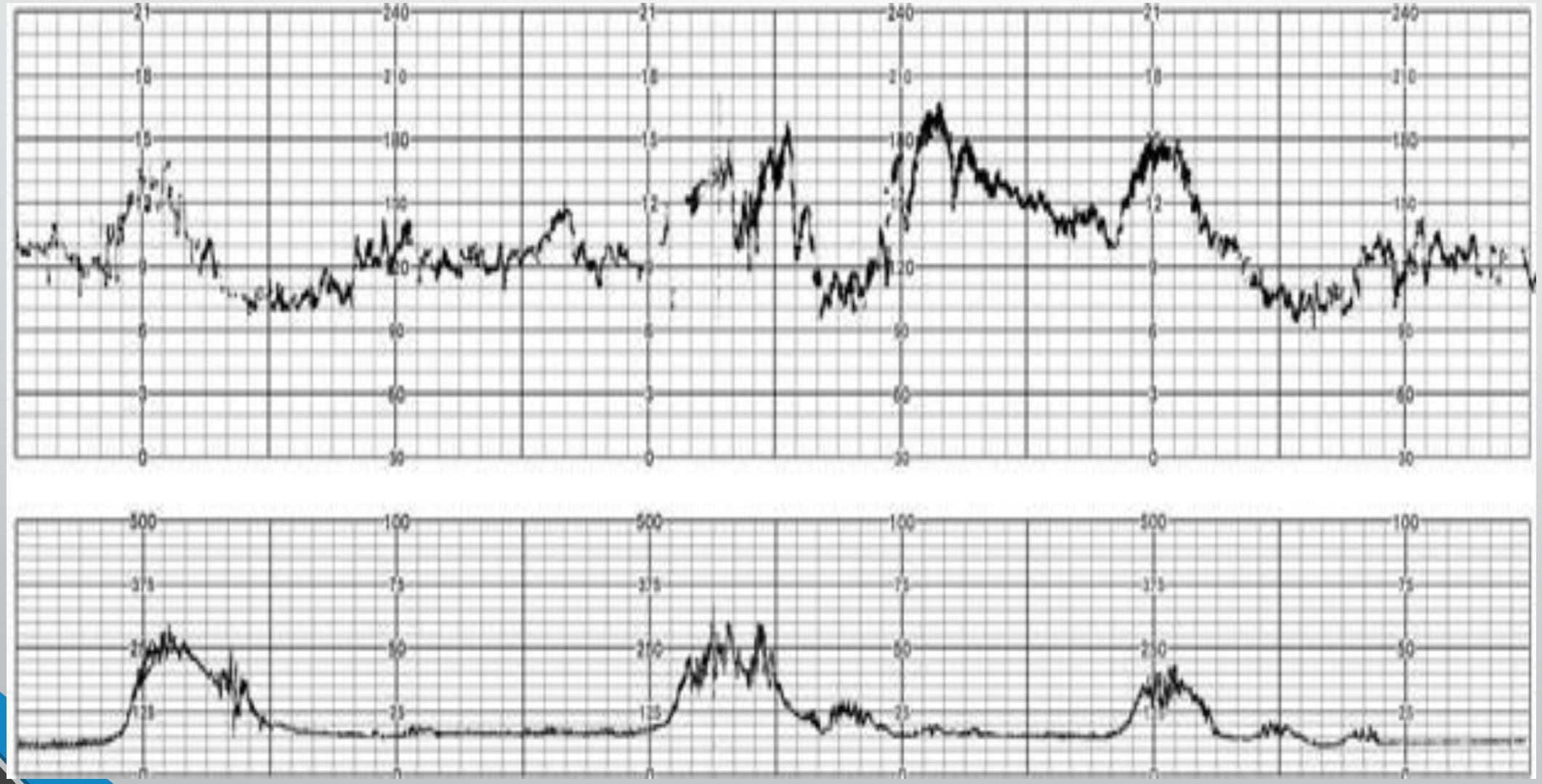
- **Negative CST** has a normal baseline fetal heart rate tracing without late decelerations.

- **An equivocal test** is defined as repetitive decelerations, not late in timing or pattern.

Positive CST



Negative CST



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Biophysical Profile (BPP)

- The **BPP** relies on hypothesis that multiple parameters of fetal well-being are better predictors of outcome than any single parameter.
- Includes **5** variables , with a total possible score of **10.**
- **The BPP combines** :

  - NST
  - Ultrasonographic estimation of amniotic fluid volume
  - Assessments of fetal breathing
  - Fetal body movements
  - Fetal tone

Biophysical Profile (BPP)

- It is noninvasive.
- Easily learned and performed.
- Accurate mean for predicting the presence of significant fetal acidemia, which is the most common cause of fetal death.
- Assesses indicators of both acute hypoxia (NST, breathing, body movement) and chronic hypoxia (AFV).
- The risk of fetal death within one week of a normal biophysical assessment is estimated to be **1 in 1300**.

Biophysical Profile (BPP)

Biophysical Variable	Normal (Score = 2)	Abnormal (Score = 0)
Fetal breathing movements	- 1 or more episodes of ≥30 sec within 30 min , intermittent	Absent or no episode of ≥30 sec within 30 min Continuous breathing without cessation
Gross body movements	At least 3 discrete body/ limb movements within 30 min (episodes of active continuous movement considered as a single movement) Includes fine motor and rolling movements but not rapid eye or mouthing movements	- <3 episodes of body/limb movements within 30 min
Fetal tone	- 1 or more episodes of active extension with rapid return to flexion of fetal limb(s) or trunk (opening and closing of hand and mouth considered normal tone)	- Slow extension with return to partial flexion - movement of limb in full extension. - absent fetal movement, or flaccid extremity positions, abnormal fetal posture
Reactive FHR	2 or more episodes of acceleration of ≥15 bmp and of >15 sec associated with fetal movement within 20 min	FM and accelerations not coupled Insufficient accelerations, absent accelerations, or decelerative trace. Minimal or absent variability.
Qualitative AFV	1 or more pockets of fluid measuring ≥2 cm in vertical axis without fetal cord	Either no pockets or largest pocket <2 cm in vertical axis

Factors Affecting the Biophysical Profile

Activity	FHR	FT	FM	FBM	AFV
Fetal sleep	⇓	⇓	⇓	⇓	
Early gestational age	⇓			⇓	
Late gestational age (>42 wk)	⇓	⇓		⇓	⇓
Maternal magnesium administration	⇓			⇓	
Artifical rupture of membranes				⇓	⇓
Labor, preterm labor				⇓	
Antenatal corticosteroids	⇓ variability		⇓	⇓	

Systematic Application of Biophysical Profile Scoring

BPP	Interpretation	Predicted PNM/1000(within 1wk)	Recommended manegment
10/10 **8/10** (normal AFV) **8/8** (NST not performed)	Nonasphyxiated	Less than 1/1000	Conservative (No acute intervention on fetal basis; serial testing indicated by disorder)
8/10 (oligo)	Chronic fetal compromise	89/1000	If mature (≥37 wk), deliver If immature, antenatal steroids , serial testing (twice weekly)

Systematic Application of Biophysical Profile Scoring

6/10 (normal AFV)	Equivocal test; fetal asphyxia is not excluded	Depends on progression (61/1000 on average)	If term deliver If immature, repeat test in 24 h and if ≤6/10, deliver
6/10 (decreased AFV)	Chronic asphyxia with possible acute	90/1000	Factor in gestational age If ≥32 wk, deliver If <32 wk, test daily
4/10 (normal AFV)	Acute asphyxia likely	90/1000	Factor in gestational age If ≥32 weeks, deliver If ≤32 wk, test daily

Systematic Application of Biophysical Profile Scoring

4/10 (decreased AFV)	acute on chronic asphyxia very likely	90/1000	If ≥26 wk, deliver
2/10 (normal AFV)	Acute fetal asphyxia likely with chronic decompensation	125/1000	If ≥26 wk, deliver (frequently requires cesarean section)
0/10	Severe, acute asphyxia virtually certain	600/1000	If fetal status is viable, deliver immediately by cesarean section

Biophysical Profile (BPP)

- A reassuring BPS (BPS of 8 to 10) should be repeated periodically (weekly or twice weekly) until delivery when the high-risk condition persists.

- Frequency of testing increases in direct proportion to the severity of the maternal or fetal condition.

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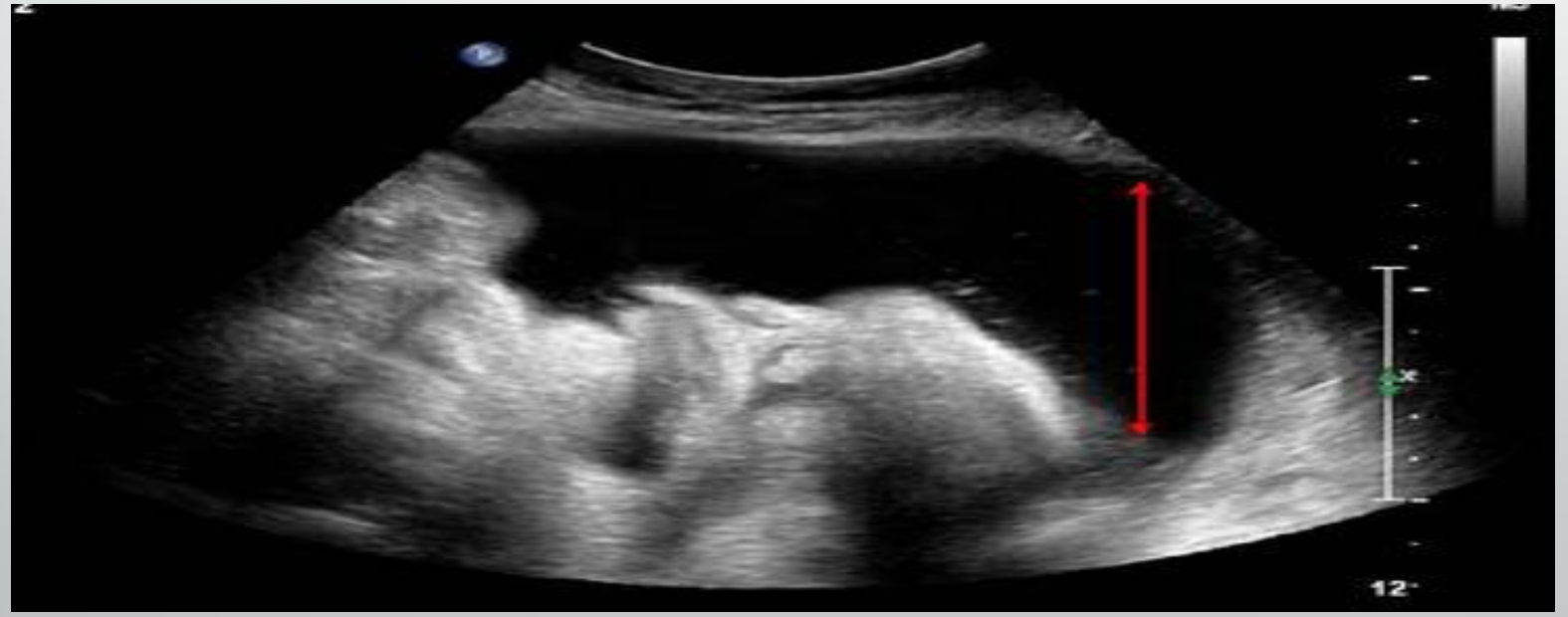
Modified Biophysical Profile

- The modified biophysical profile was developed to **simplify** the examination and **reduce the time** necessary to complete testing.
- Assessment of **amniotic fluid volume** and **non stress testing** appears to be as reliable predictor of long-term fetal well-being as the full BPP.
- If either the NST or the AFI is abnormal, a complete BPP or CST is performed.
- The rate of stillbirth within one week of normal test is the same as with full BPP, **0.8/1000** .

Assessment of amniotic fluid volume

- The **Deepest Verticle Pocket** (DVP) measurement refers to the vertical dimension of the largest pocket of amniotic fluid not containing umbilical cord or fetal extremities .

  - Oligohydramnios DP < 2 cm
  - Normal DP 2.1 - 8 cm
  - Polyhydramnios DP > 8 cm



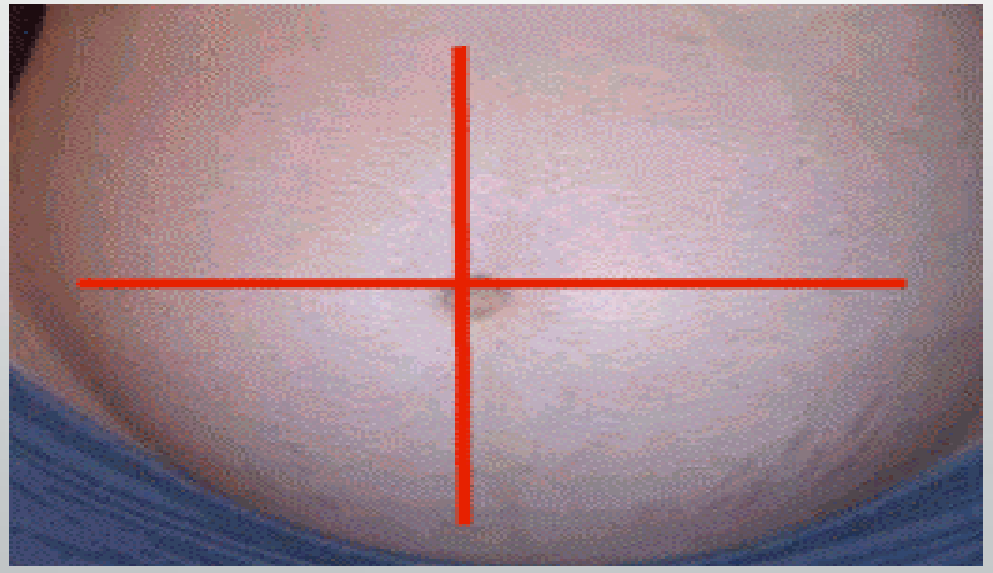
Assessment of amniotic fluid volume

- **The amniotic fluid index (AFI) measurement is calculated by first dividing the uterus into four quadrants using the linea nigra for the right and left divisions and the umbilicus for the upper and lower quadrants.**
- **The sum of maximum vertical amniotic fluid pocket diameter in each quadrant not containing cord or fetal extremities is the AFI.**

  - Oligohydramnios — 0 to <5 cm

  - Normal — 5 -25 cm

  - Polyhydramnios — > 25 cm



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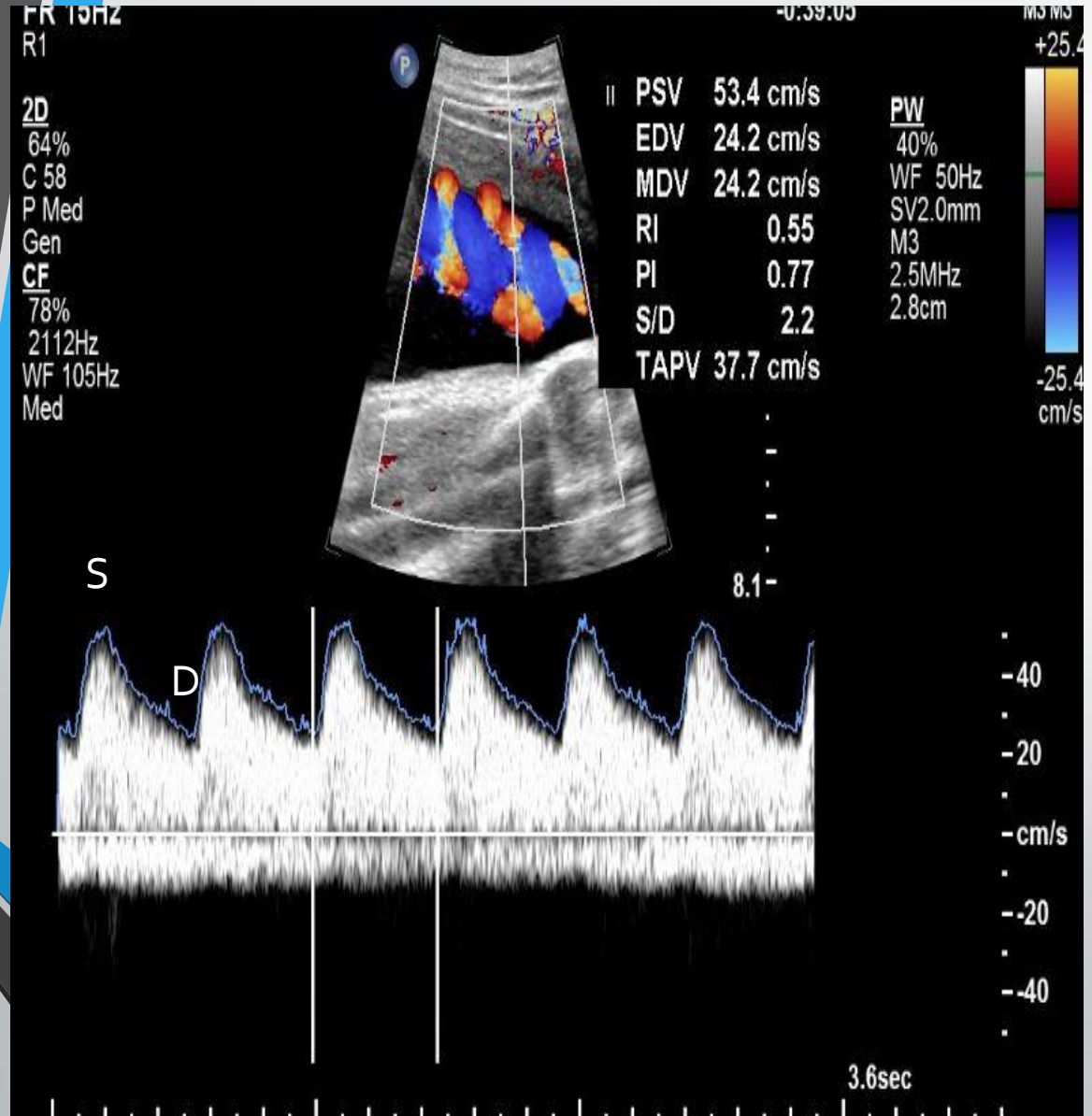
Doppler Velocimetry

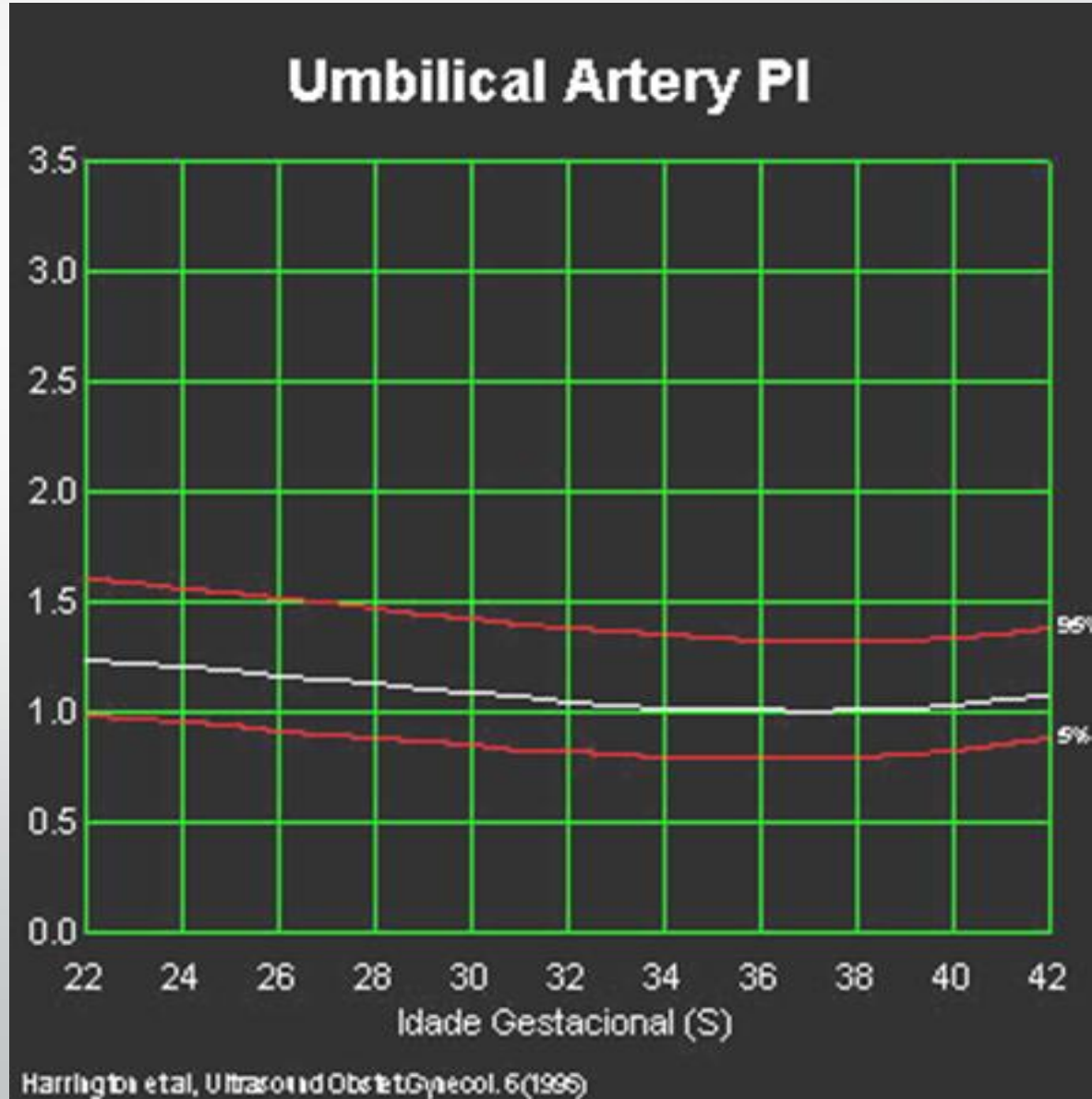
- Measurement of blood flow velocities in the maternal and fetal vessels gives information about utero-placental blood flow and fetal responses to physiologic challenges.
- Non-invasive technique .
- Vessels that can be studied :
  - Uterine artery
  - umbilical artery
  - Middle cerebral artery
  - Ductus venosus
  - Umbilical vein

Umbilical artery

- the umbilical arteries purely reflects resistance of the placental circulation.
- Normal umbilical artery resistance falls progressively through pregnancy, reflecting the increased numbers of tertiary stem villous vessels.
- Umbilical artery Doppler is beneficial in the management of high-risk pregnancies, especially those complicated by fetal growth restriction and placental insufficiency due to preeclampsia or maternal conditions.

Umbilical artery

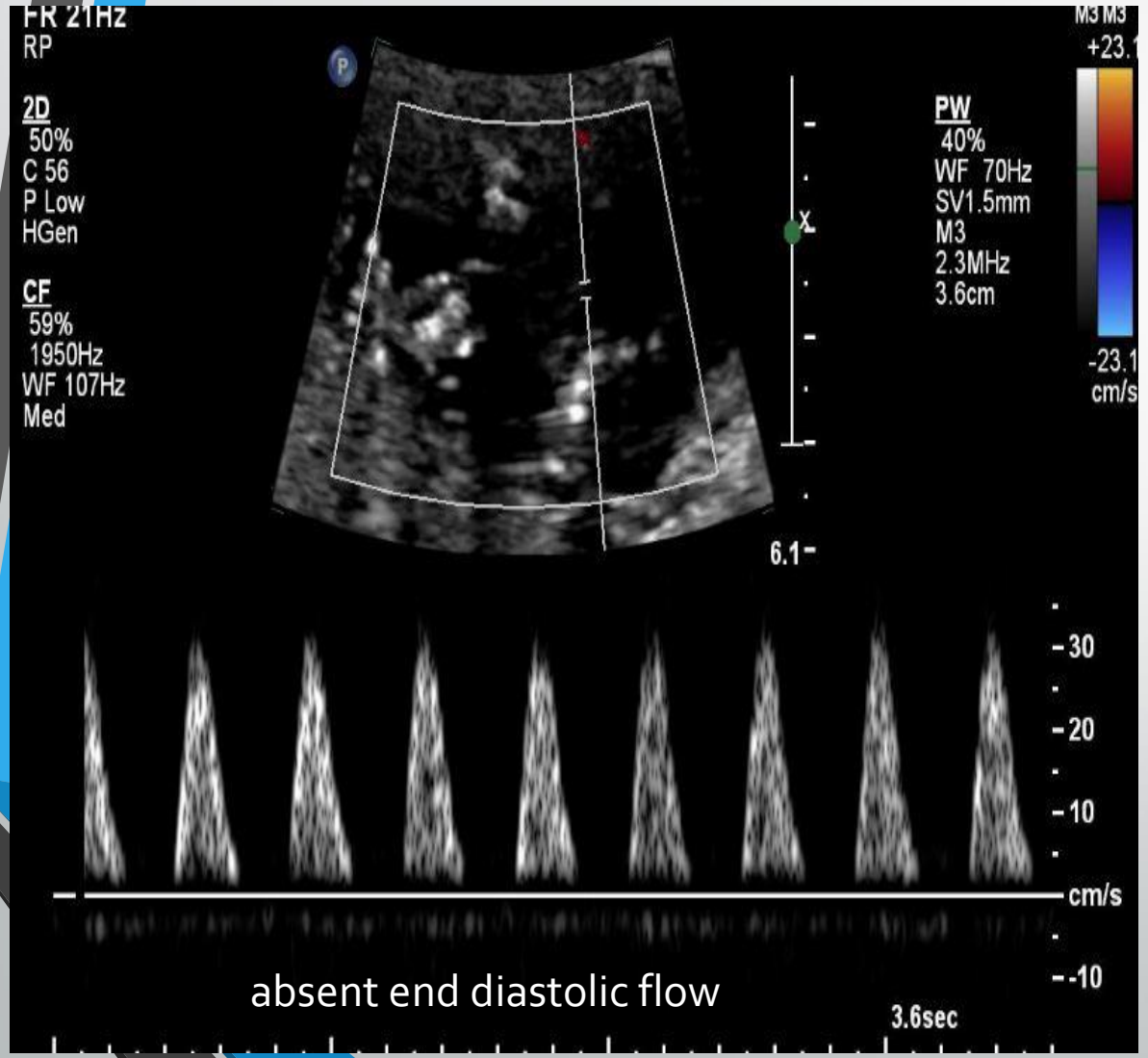




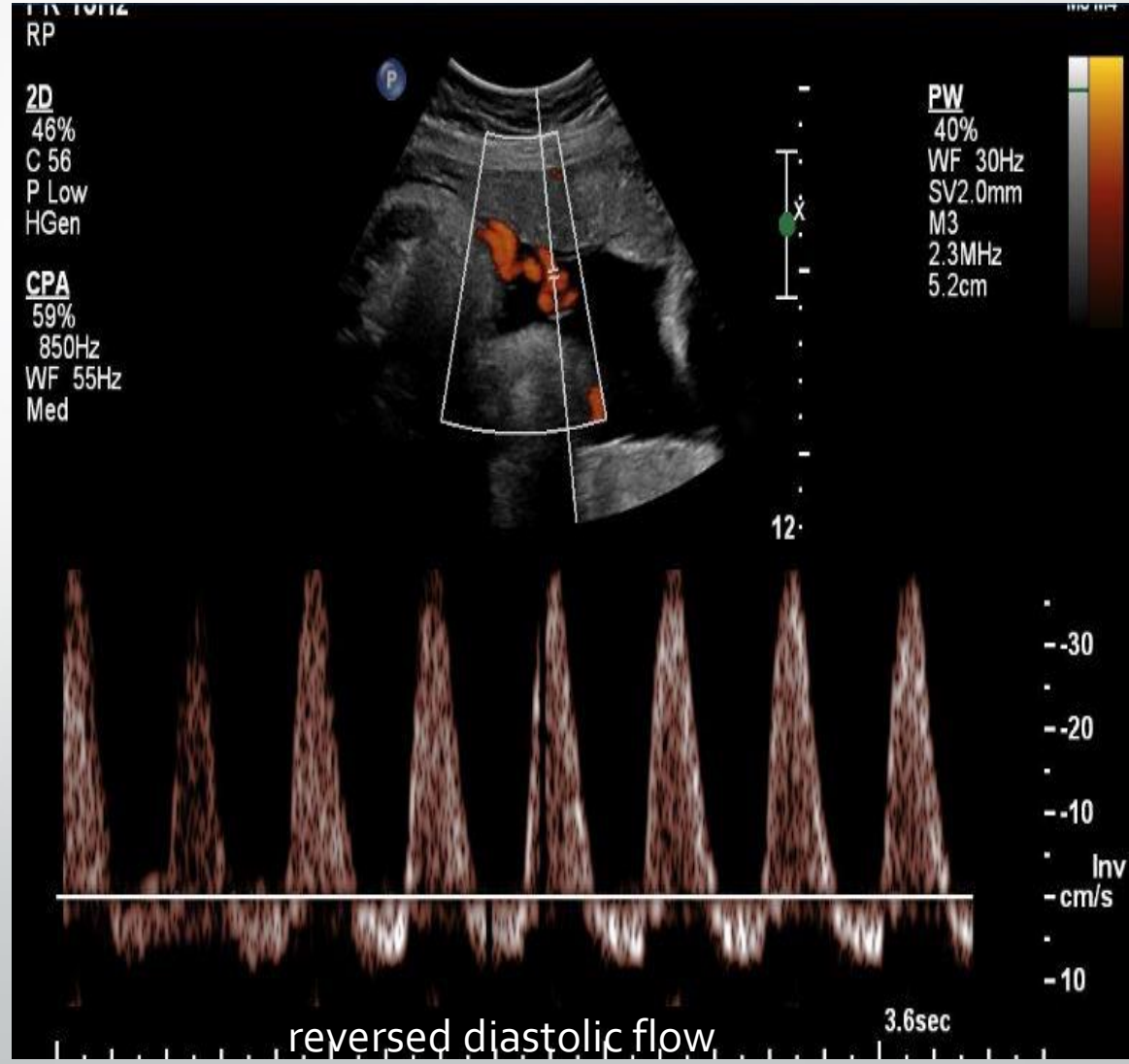
Umbilical artery

- The most important prognostic feature of the umbilical artery waveform is the end-diastolic flow.
- As umbilical artery resistance rises ,diastolic velocities fall and ultimately become absent (absent end diastolic velocity **AEDV**).
- As resistance rises even further, an elastic component is added, which induces reversed end-diastolic velocity (**REDV**) as the insufficient, rigid placental circulation recoils after being distended by pulse pressure

Umbilical artery



absent end diastolic flow



reversed diastolic flow

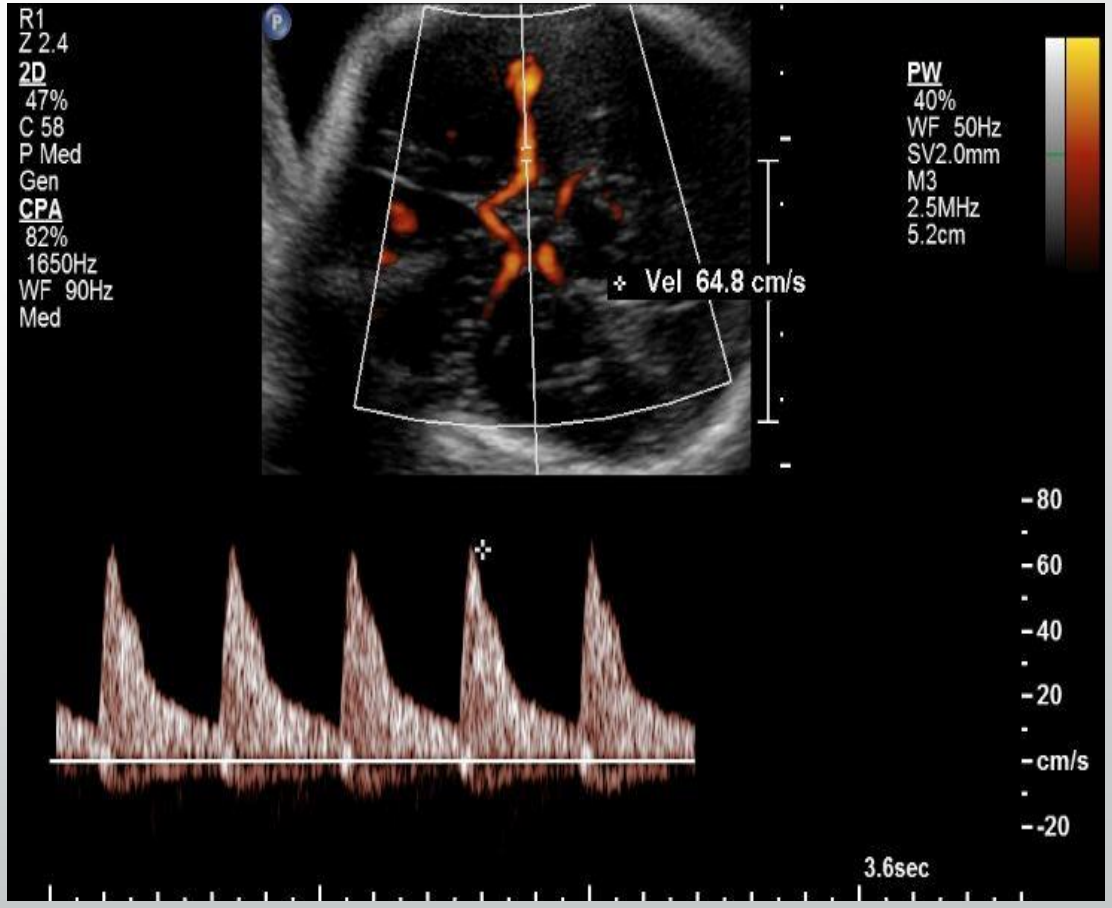
Umbilical artery

abnormality	BPP Frequency	Decision to Deliver
Elevated indices only	Weekly	Abnormal BPP or term or >36 wk with no fetal growth
AEDV	Twice weekly	Abnormal BPP or >34 wk Conversion to REDV
REDV	Daily	Any BPP <10/10 or >32 wk of dexamethasone given

Middle cerebral artery

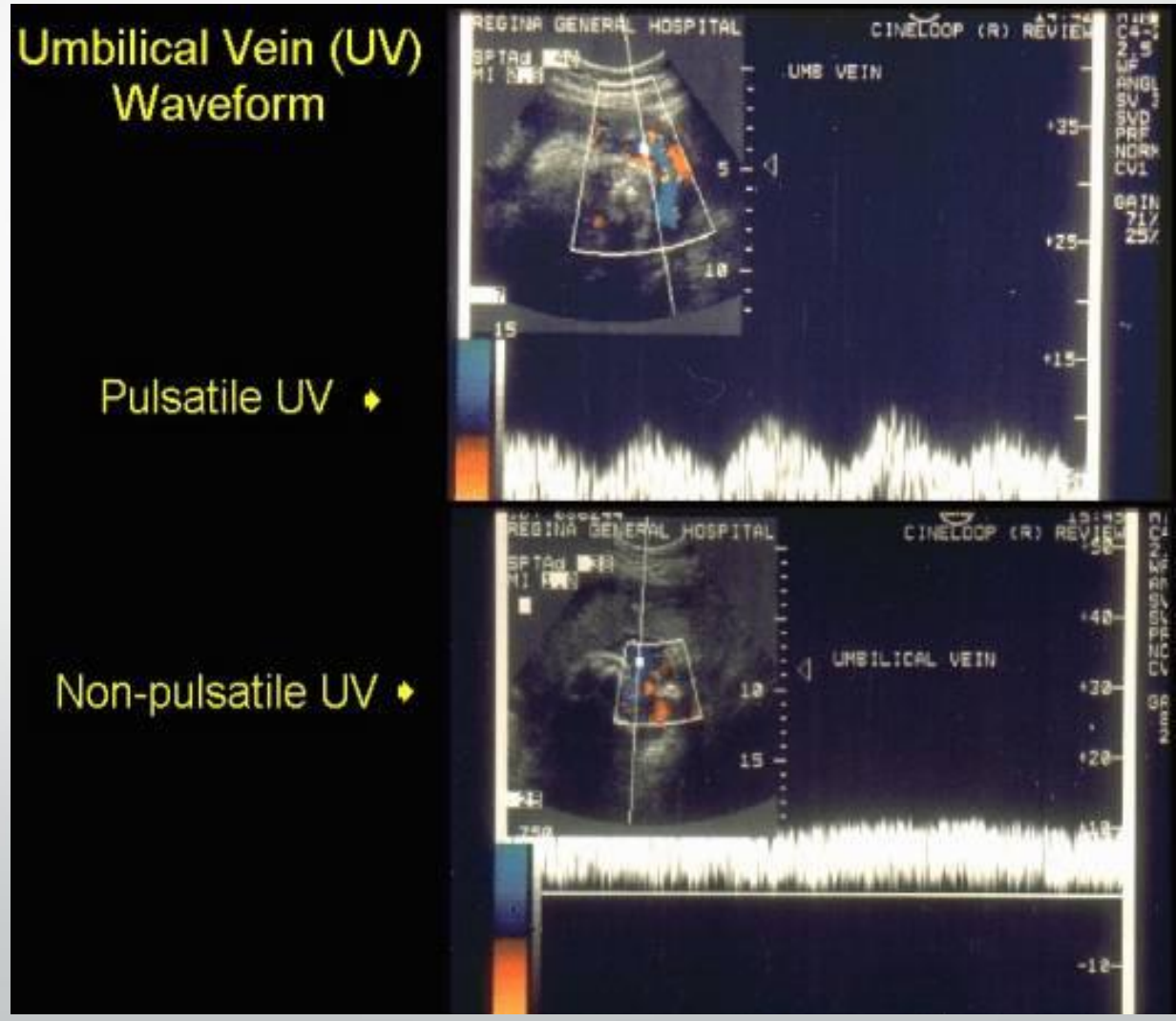
- In the compromised fetus, systemic blood flow is redistributed from the periphery to the brain, "brain-sparing effect" .

- Doppler assessment of the fetal middle cerebral artery peak systolic velocity has emerged as the best tool for predicting fetal anemia in at-risk pregnancies.



Umbilical Vein

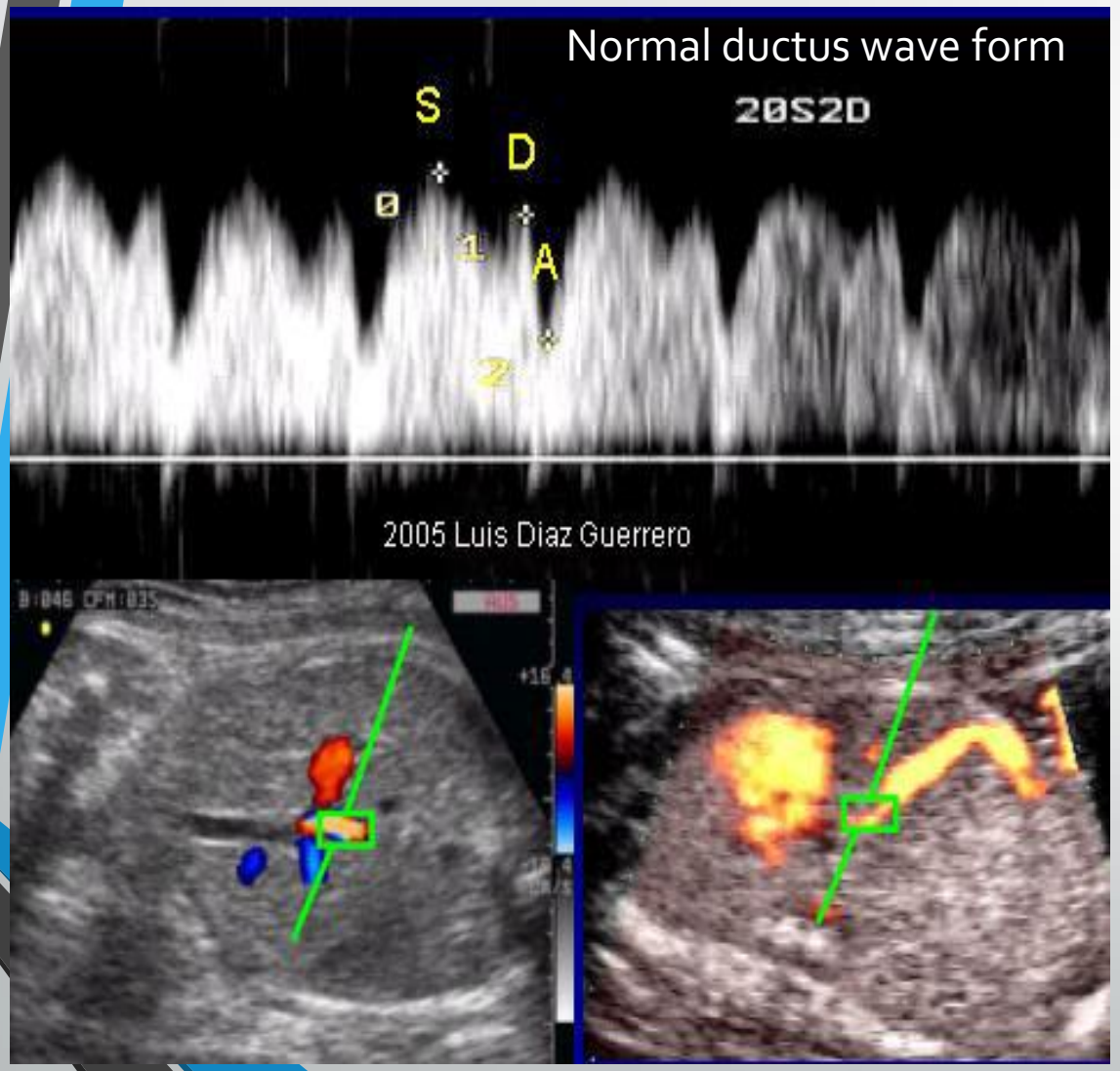
- Blood flow in the umbilical vein is continuous in normal pregnancies after 15 weeks of gestation.
- In pathological states, such as fetal growth restriction, flow in the umbilical vein may be **pulsatile**, which reflects cardiac dysfunction related to increased afterload.

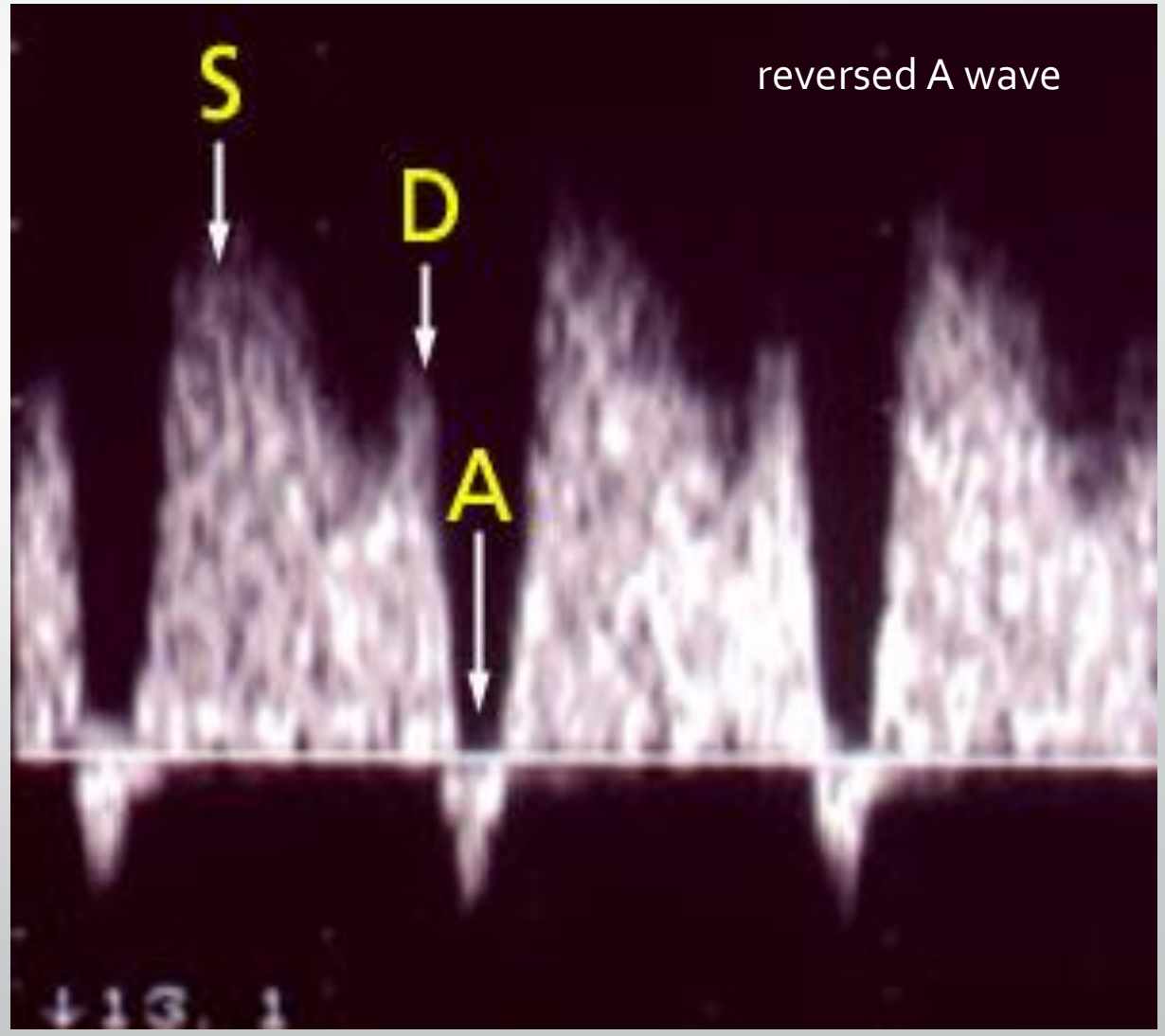


Ductus Venosus

- The ductus venosus regulates oxygenated blood in the fetus , and is resistant to alterations in flow except in the most severely growth restricted fetuses.
- Ductus venosus deterioration frequently precedes and strongly predicts changes in BPP that require delivery.

Ductus Venosus





Emerging methods

- **Fetal magnetoencephalography** :
- Allows direct assessment of fetal cortical and brainstem function.
- Noninvasive
- Uses an array of ultrasensitive magnetic field detectors, that allows direct continuous recording of fetal electrocortical signals
- can record fetal brain activity in response to auditory and visual stimuli applied to the maternal abdomen.