Obstetric Doppler US

- Doppler US provides a unique window to the fetoplacental circulation.
- US of the umbilical artery is an integral component of managing the fetus with growth restrictiontion.
- Doppler US of the middle cerebral artery, as a noninvasive means of detecting fetal anemia.
- screening for women more likely to develop preeclampsia by evaluation of the uterine artery.
- Depiction three-vessel umbilical cord, identify loops of cord that migh

be mistaken for fluid pockets prevents the overestimation of amniotic fluid volume, and mapping the placental site of insertion of the umbilical cord.

- decrease fetal exposure to as low as reasonably achievable(ALARA), in accordance with the ALARA principle.
- appropriate baseline, scale, and sweep speed, to maximize the ease of analysis of the waveform.
- Technical errors in the angle of insonation and in samplevolume size and placement, as well as incorrect selection othe wall filter, may lead to misinterpretation of findings and management errors.
- It important to note that Doppler US examinations of the fetoplacentalcirculation have no role in screening low-risk pregnancies.
- Doppler US of the umbilical cord only becomes abnormal when large amounts of the placental tertiary villous arteriesare obliterated.

- Fetalexposure to energy during US is affected by many factors, including the power output, the depth and type of structures being interrogated (bone vs soft tissue), the length of the examination, and the type of transducer.

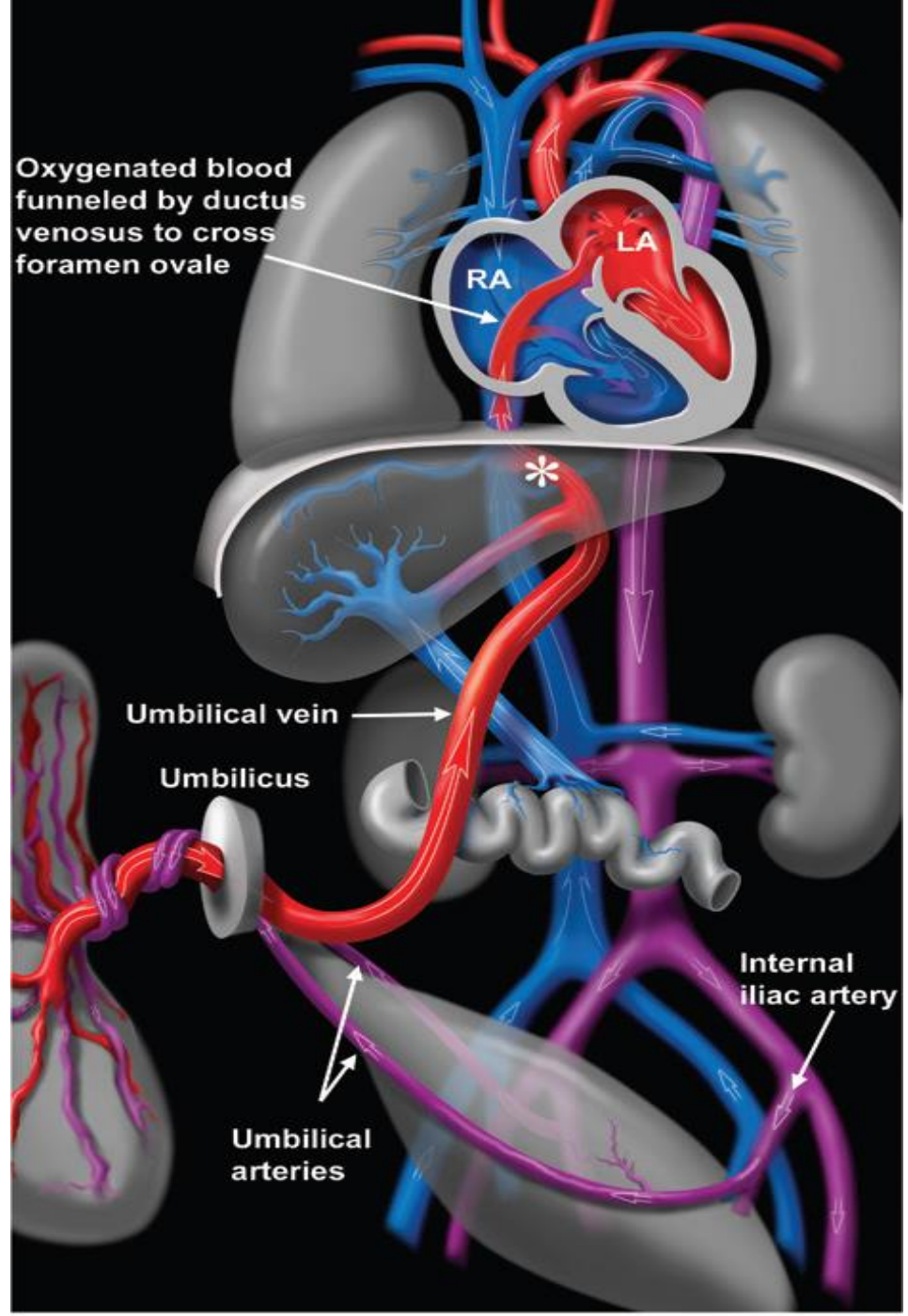
The mechanical index and the thermal index are on-screen guides to the relative risk of potentially harmful US-induced bioeffects.

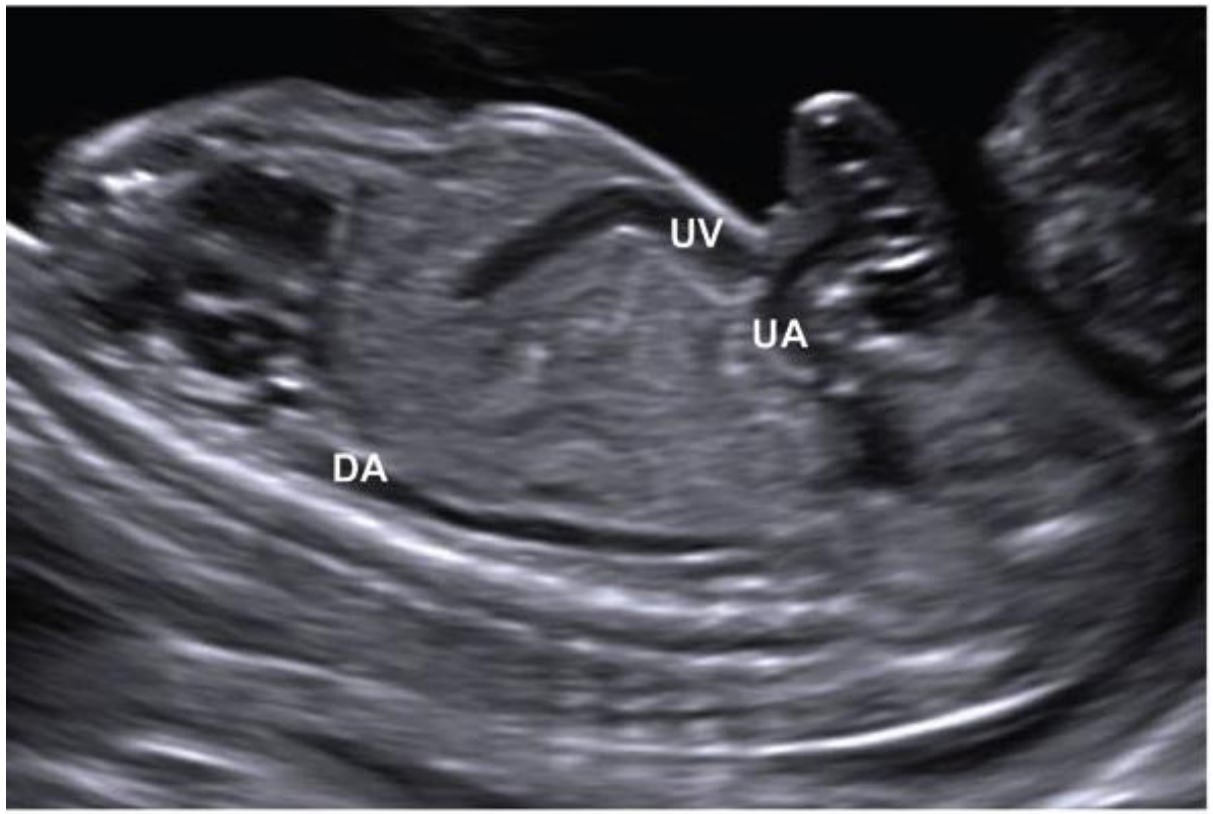
- The mechanical index should be 1.0 or less. (ie, interaction of US with gas bubbles)

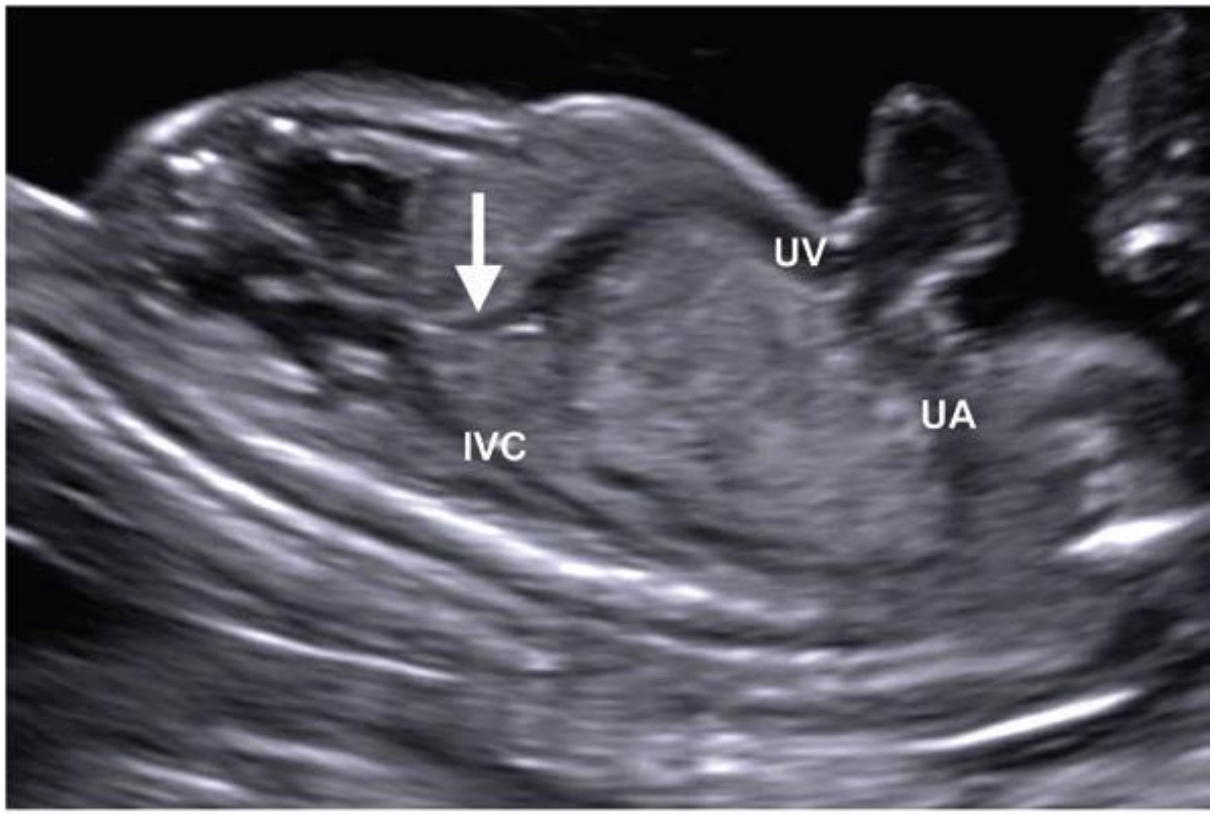
- The thermal index is a relative indicator of temperature rise and potential tissue damage from thermal effects. The thermal risk is related to the amount of energy absorbed, which varies by tissue type (bone > soft tissue > amniotic fluid).
- The power output changes according to the size and depth of the

color box, which should be kept as small as possible to include only the area of interest.

- Spectral Doppler US has an even higher energy output and hence a greater heating potential.
- thermal index should be 1.0 or less.


Oxygenated blood funneled by ductus venosus to cross foramen ovale
RA
LA
*
Umbilical vein
Umbilicus
Internal iliac artery
Umbilical arteries


UV
UA
DA

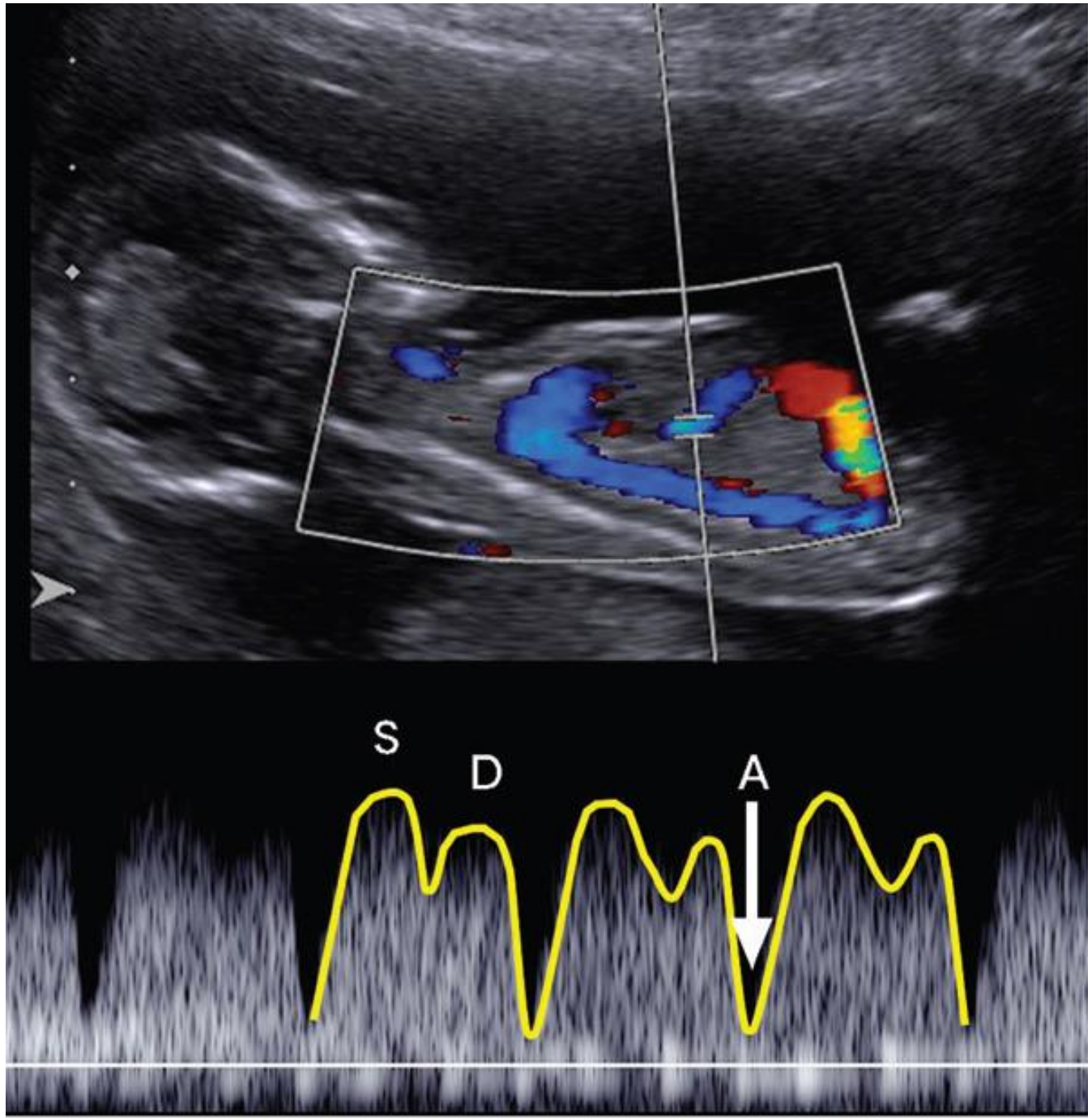

UV
UA
IVC

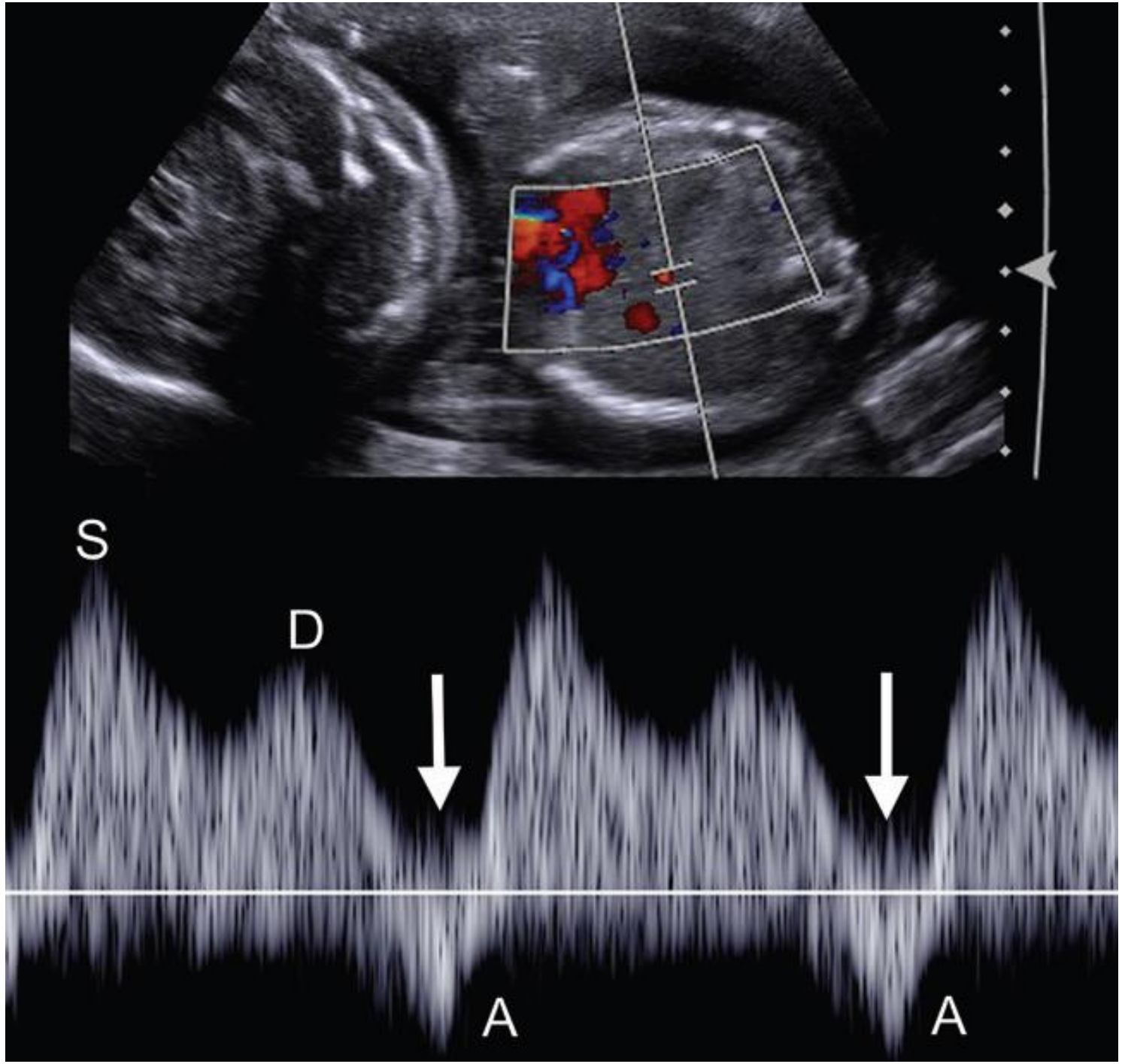
- When placental resistance increases, the abnormal pressures produce increased afterload, which can impair right ventricular function. The right ventricle accounts for more than 50% of the cardiac output in the fetus; thus, any process that has a negative effect on right ventricular function adversely influences fetal well-being.
- The maternal side of the fetoplacental circulatory unit is represented by the uterine artery.
- Normal trophoblastic invasion causes maximum vessel distention and the uterine artery waveform changes from relatively high resistance in the nonpregnant state to a low-resistance waveform in pregnancy.

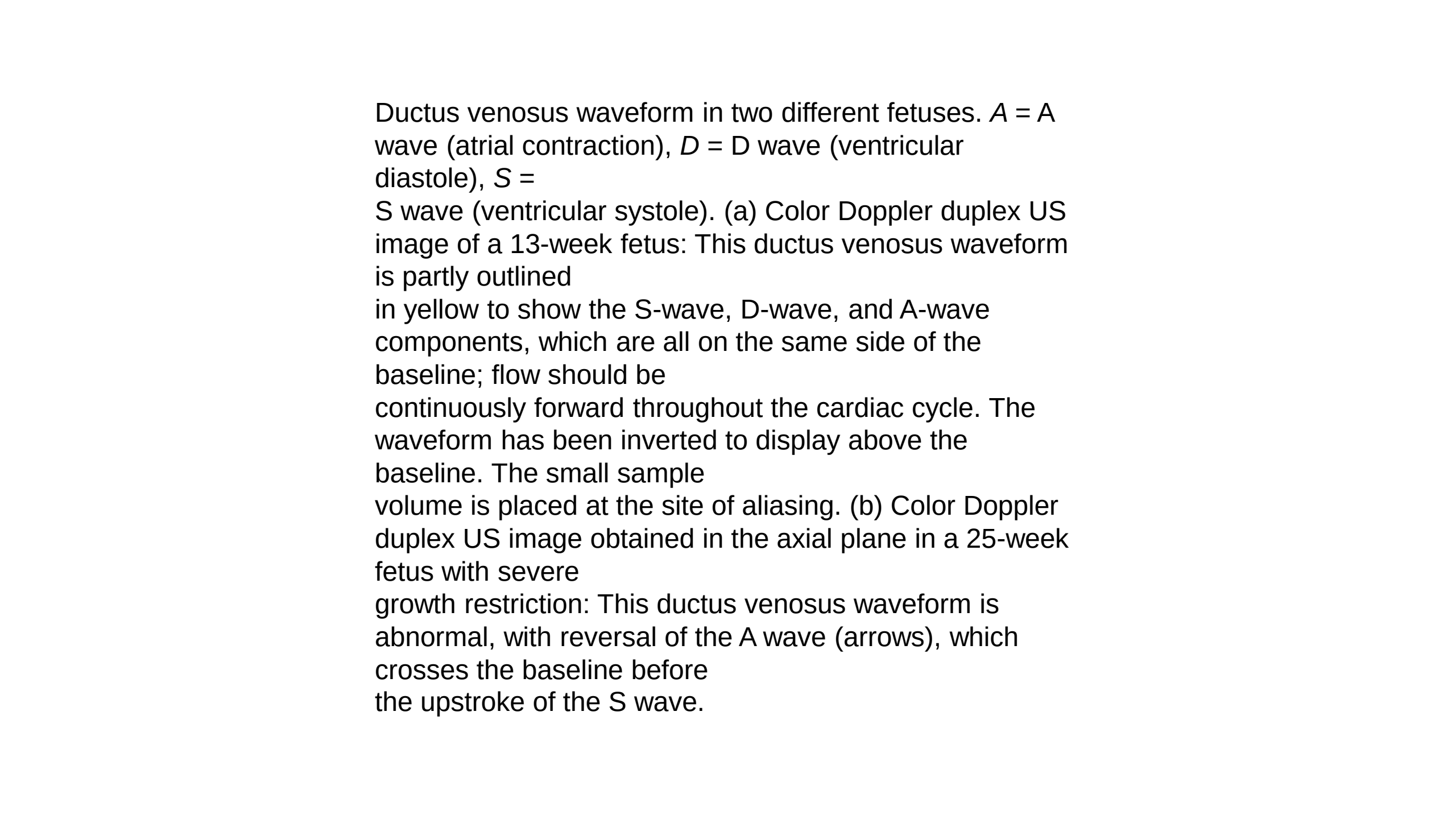
- The vessels sampled to assess the fetoplacental unit include the umbilical artery, umbilical vein, ductus venosus, middle cerebral artery, and uterine artery.
- In the first trimester, the focus of Doppler US is
- *(a)* detection of aneuploidy and an increased risk for congenital heart disease With evaluation of the ductus venosus waveform.
- *(b)* screening for women more likely to develop preeclampsia by evaluation of the uterine artery.
- In the second and third trimesters, use of Doppler US is targeted toward risk assessment in growth-restricted fetuses. (umbilical artery, middle cerebral artery, umbilical vein, ductus venosus)

Obstetric Doppler US in the First Trimester

- The ductus venosus is a small trumpet-shaped connection between the umbilical/portal system and the inferior vena cava
- Use color Doppler flow US to localize the site of aliasing between the left portal vein and the inferior vena cava.
- use a small sample volume (0.5–1 mm) to avoid contamination from the adjacent portal vein, hepatic veins, or inferior vena cava.
- The angle of insonation should be less than 30°.
- Set the filter at the lowest possible frequency (50–70 Hz) so that the A wave is not obscured, and use a high sweep speed (2–3 cm/sec).

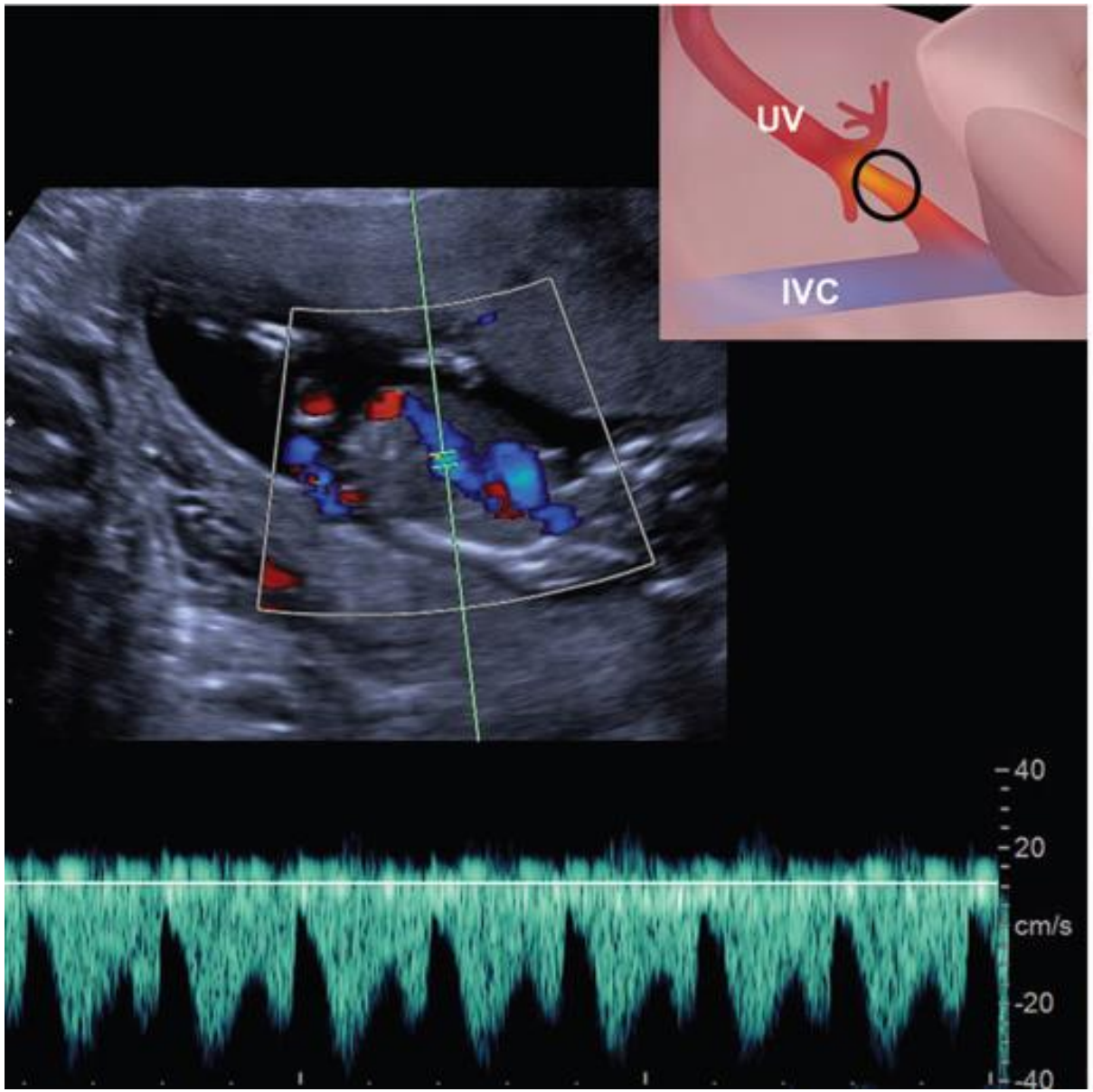

S
D
A

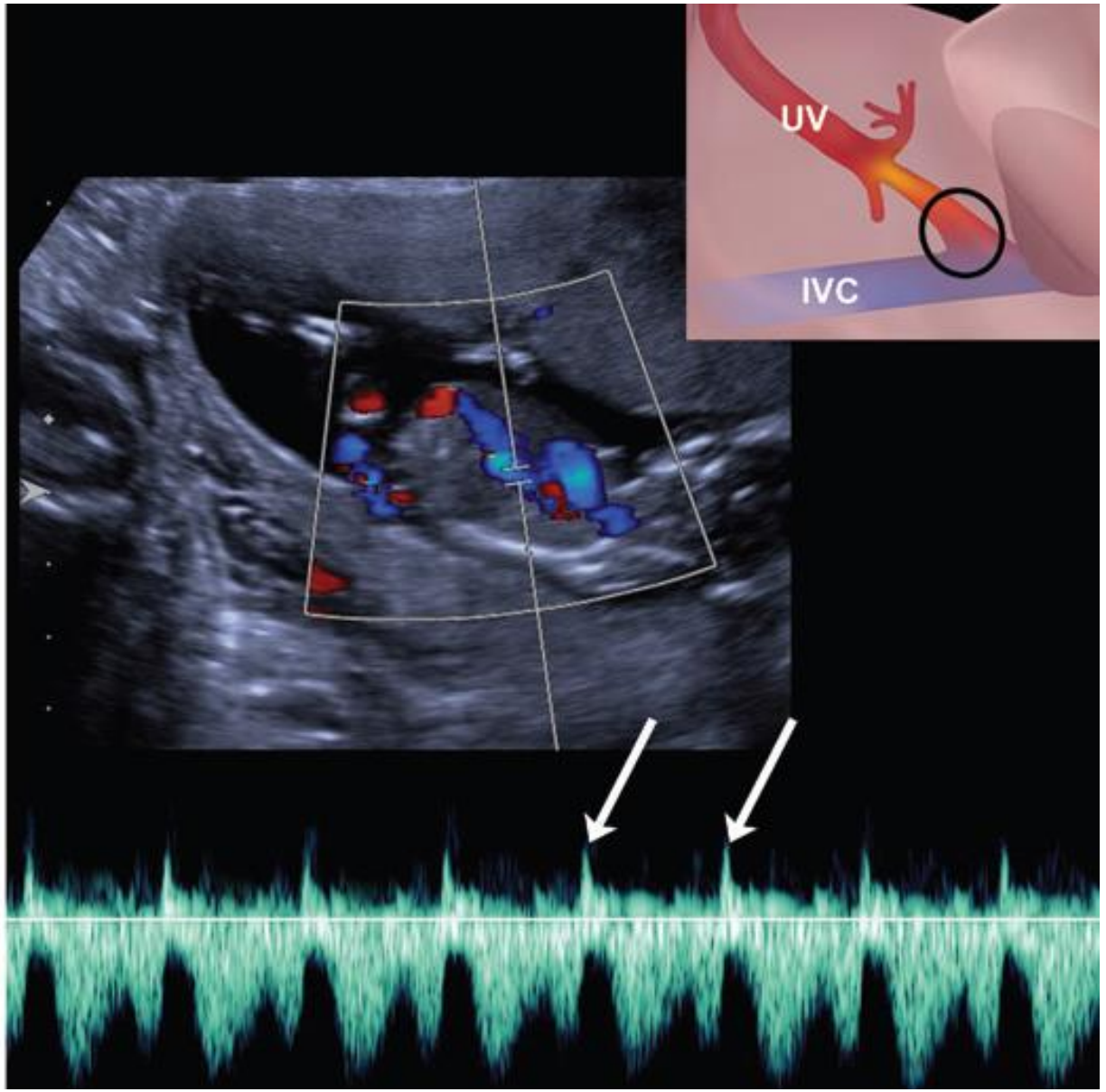

S
D
A
A

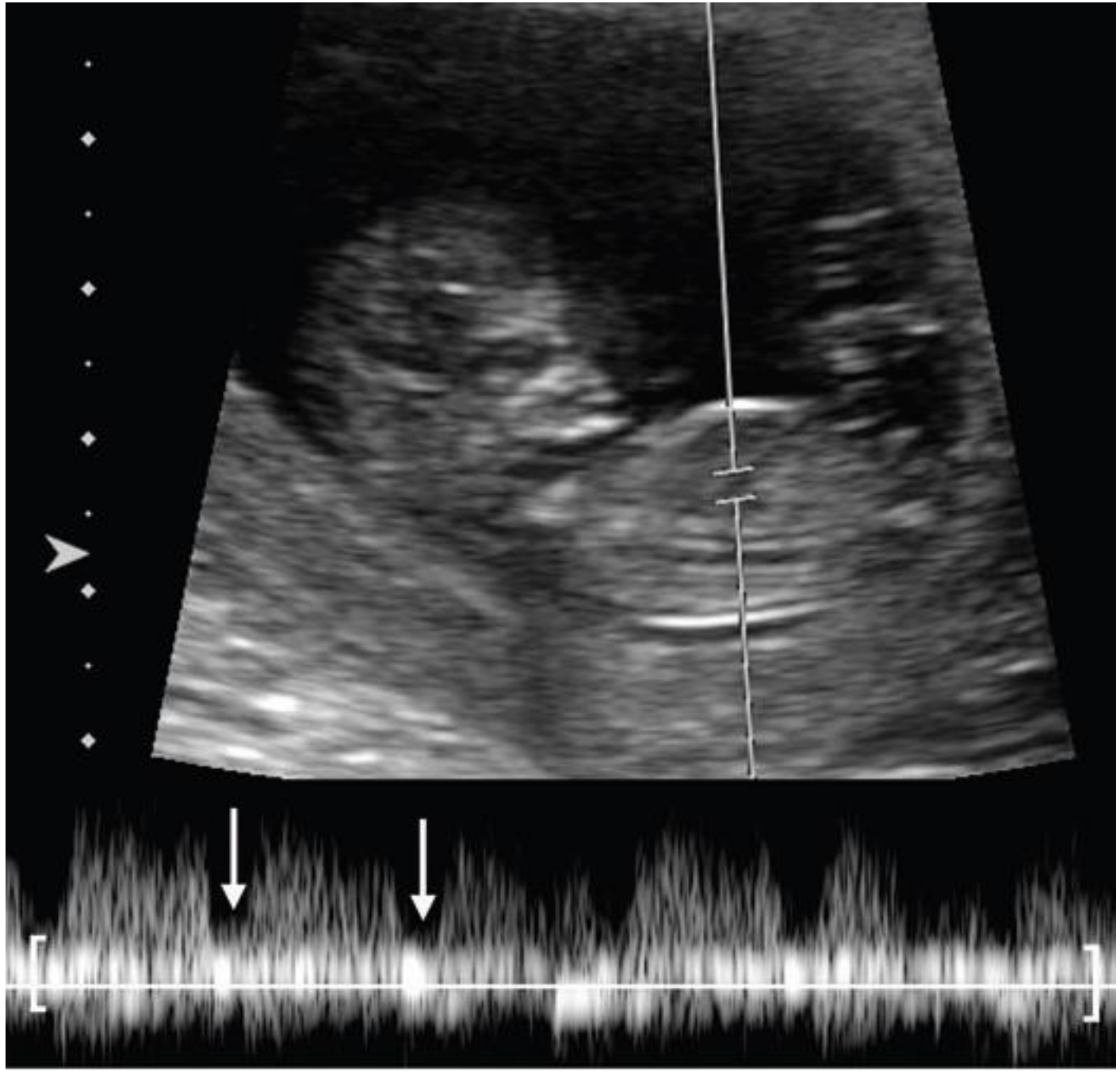


Ductus venosus waveform in two different fetuses. *A* = A wave (atrial contraction), *D* = D wave (ventricular diastole), *S* =
S wave (ventricular systole). (a) Color Doppler duplex US image of a 13-week fetus: This ductus venosus waveform is partly outlined
in yellow to show the S-wave, D-wave, and A-wave components, which are all on the same side of the baseline; flow should be
continuously forward throughout the cardiac cycle. The waveform has been inverted to display above the baseline. The small sample
volume is placed at the site of aliasing. (b) Color Doppler duplex US image obtained in the axial plane in a 25-week fetus with severe
growth restriction: This ductus venosus waveform is abnormal, with reversal of the A wave (arrows), which crosses the baseline before
the upstroke of the S wave.

- Reversal of the A wave is always abnormal. Associations include increased risk of aneuploidy and congenital heart disease ; and in twins, reversal of the A wave is a marker for increased risk of developing the twin-twin transfusion syndrome.
- The fetus should be at rest and not breathing during ductus venosus sampling.


UV
IVC
40
20
cm/s
-20
-40


UV
IVC

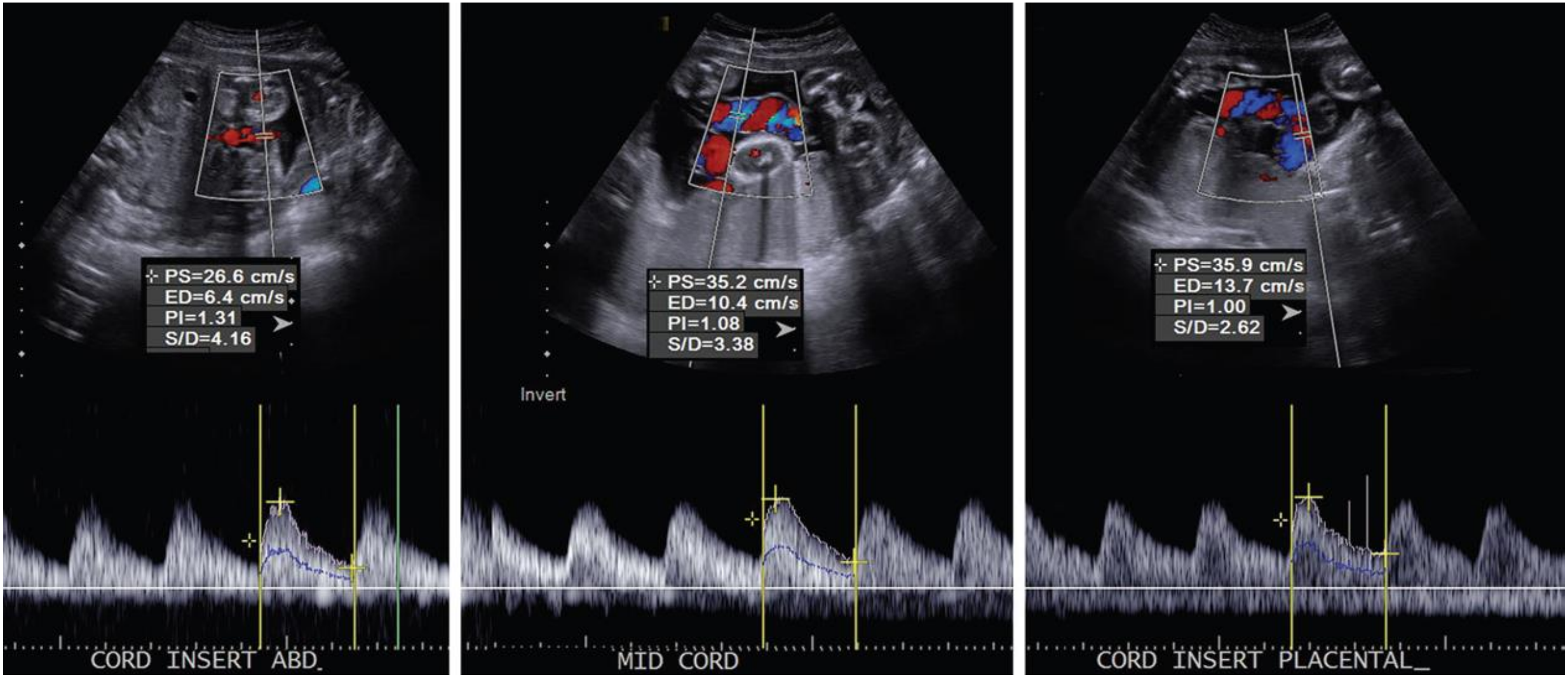


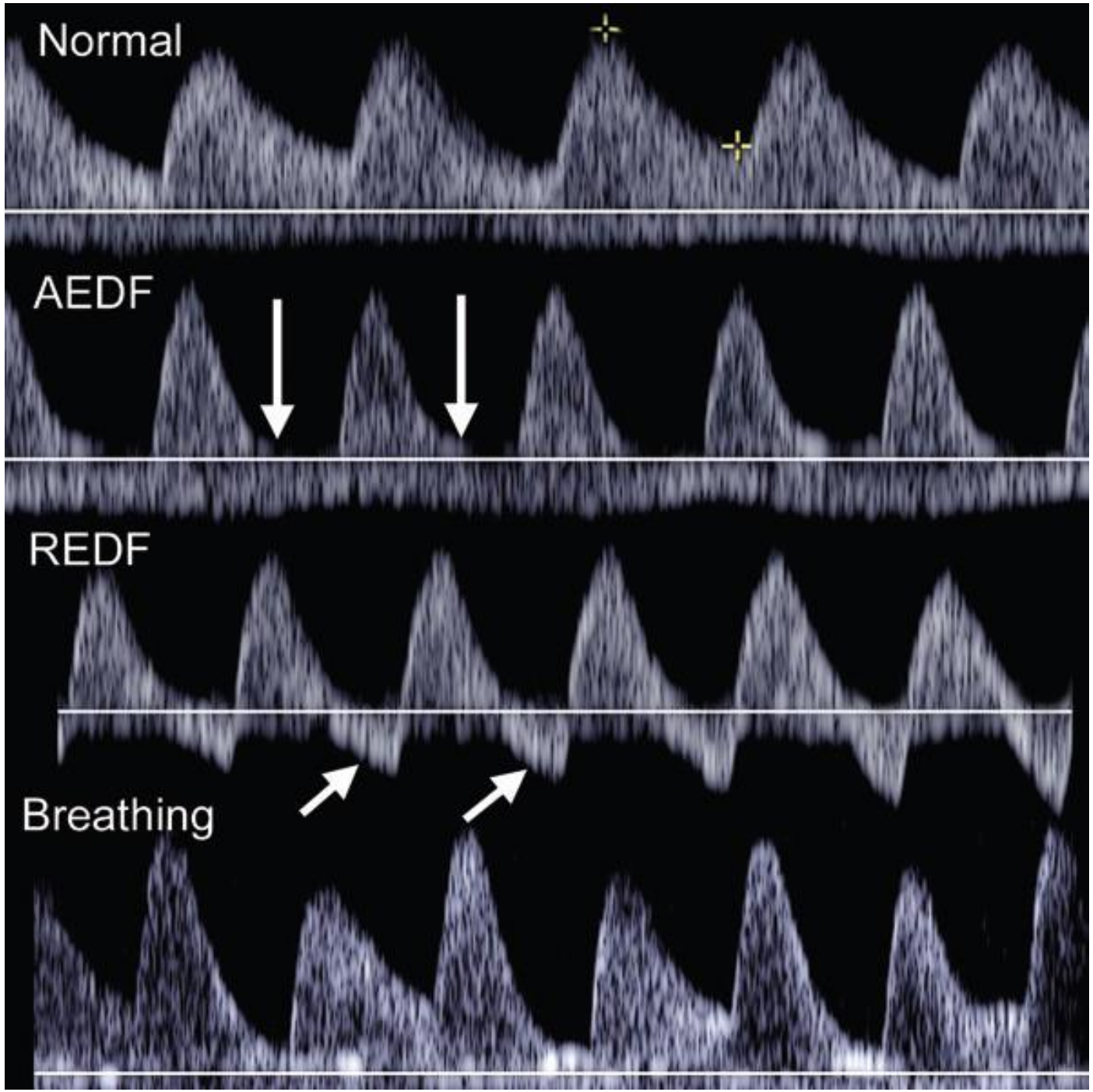
Obstetric Doppler US in the Secon and Third Trimesters

- In the second and third trimesters, Doppler US is used to assess fetal well-being and to noninvasively monitor the fetoplacental unit. The umbilical artery and the middle cerebral artery are the most important vessels sampled; supplemental information may be obtained from evaluation Of the ductus venosus and the umbilical veins.

Umbilical Artery

- The normal placental vascular bed is low resistance, S/D ratio decreases with advancing gestational age.
- At 20 weeks, the 50th percentile for the S/D ratio is 4. At 30 weeks, the 50th percentile is 2.83; and at 40 weeks, the 50th percentile is 2.18 .
- In current clinical practice, the S/D ratio and the presence of absent or reversed end-diastolic flow are used to manage fetal growth restriction (24weeks);
- Resistance is highest at the abdominal site of insertion of the umbilical cord, is intermediate in freefloating loops of the umbilical cord, and is lowest at the placental site of umbilical cord insertion.
- Thus, it is important to sample consistently when performing serial evaluations.
- In multiple gestations, it is essential to sample at,or as close as possible to, the abdominal site.
- free-floating loops in singletons .


PS=26.6 cm/s
ED=6.4 cm/s
PI=1.31
S/D=4.16
CORD INSERT ABD
PS=35.2 cm/s
ED=10.4 cm/s
PI=1.08
S/D=3.38
Invert
MID CORD
PS=35.9 cm/s
ED=13.7 cm/s
PI=1.00
S/D=2.62
CORD INSERT PLACENTAL


Normal
AEDF
REDF
Breathing

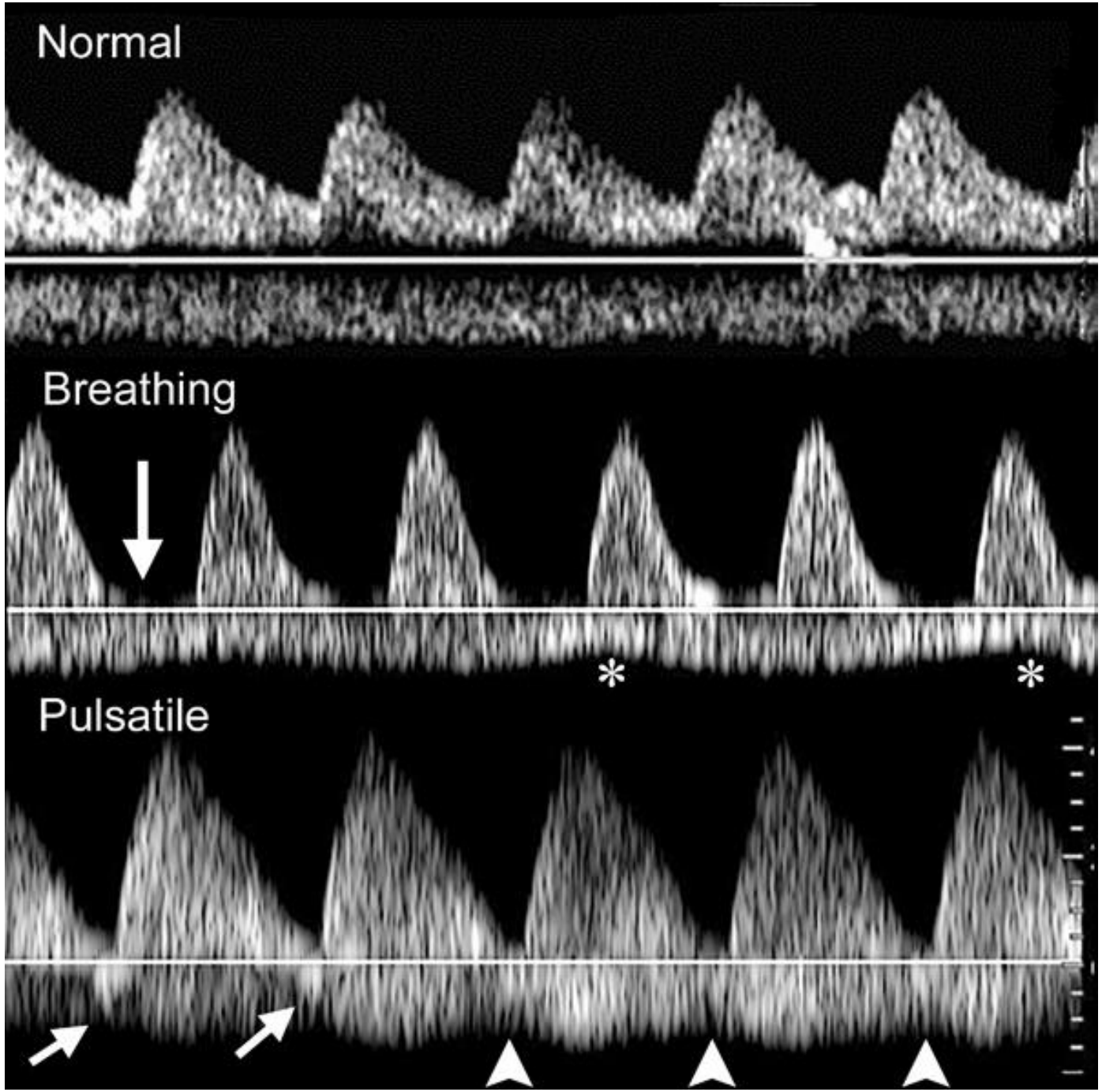
- It is thought that as much as 70% of the placental vascular bed has to be obliterated before reversed end-diastolic flow is seen.
- However, Doppler US findings may occur before heart rate changes that manifest as abnormal results of fetal nonstress testing.
- In the setting of fetal growth restriction, the guidelines of the Society for Maternal-Fetal Medicine recommend weekly Doppler US of the umbilical artery.

- When these results are abnormal, management is determined by the severity of the finding.
- With decreased diastolic flow, antenatal testing (eg, nonstress tests, amniotic fluid measurement,and biophysical profile) Doppler US is performed weekly, and delivery is considered after 37 weeks.
- When absent end-diastolic flow or reversed enddiastolic flow is present, corticosteroid therapy ,and Doppler US is performed two to three times per week, in addition to standard antenatal tests of fetal well-being.
- Goal gestational ages for delivery are 34 weeks or more with absent end-diastolic flow and 32 weeks or more with reversed end-diastolic flow.

Umbilical Vein

- Normal flow in the umbilical vein is continuous,returning oxygenated blood from the placenta to the fetus.
- Fetal breathing is a common observation in the third trimester.
- The changes in intrathoracic pressure alter flow dynamics in the vein to produce undulations in the umbilical vein waveform that are not linked to the cardiac cycle .
- Pulsatile flow in the umbilical vein is an ominous finding.
- When present, it indicates that the abnormal placental pressures have compromised right heart function such that there is back pressure through the right ventricle to the right atrium, back out the ductus venosus (which will show a decreased or reversed A wave)
- all the way into the umbilical vein, where forward flow decreases during diastole.

- approximately 30% of the incoming placental return bypasses the liver in the second trimester; this percentage drops to about 18% by 31 weeks until term.
- When placental function is impaired, a larger percentage of umbilical vein blood flow is shunted to the left side of the heart (the head-sparing effect). This shunting decreases flow to the liver, impairing liver growth and limiting fetal weight gain .


Normal
Breathing
Pulsatile

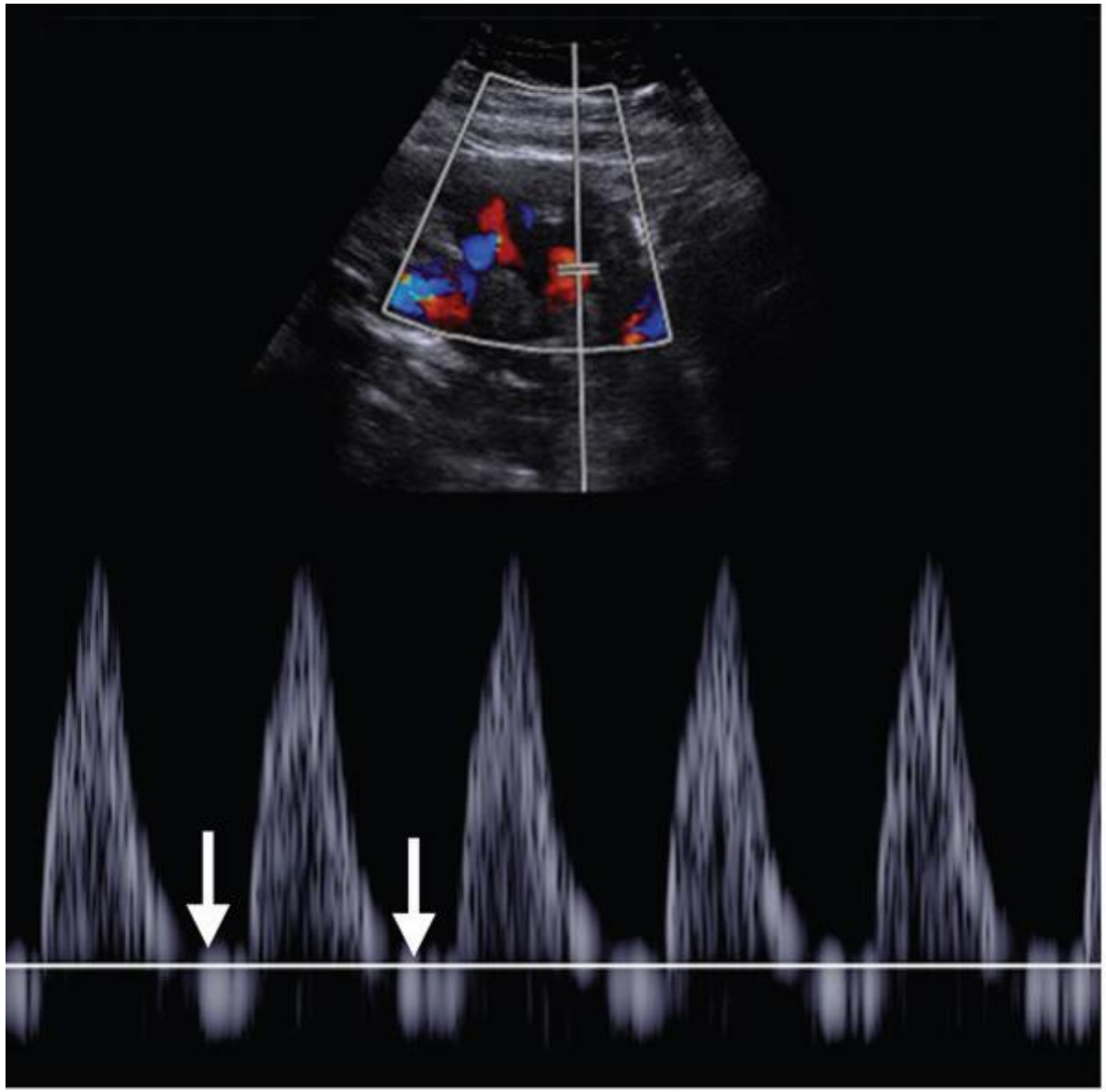
Ductus Venosus

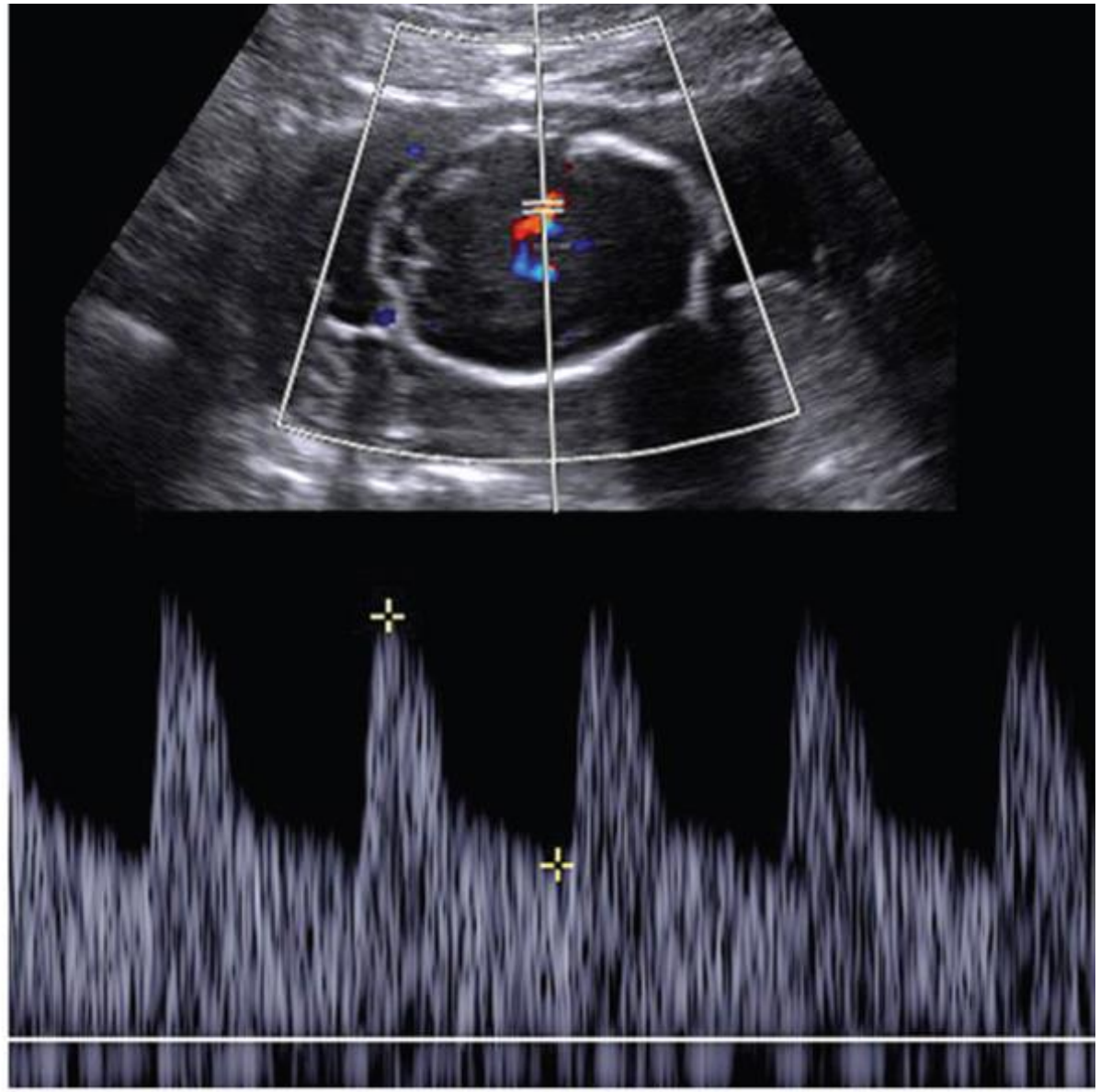
- sample the ductus venosus in an axial plane in the midline, just below the diaphragm.
- An absent or reversed A wave in the ductus venosus has been shown to be a strong predictor of stillbirth.
- when a reversed A wave is depicted in a fetus with fetal growth restriction, this finding seems to indicate that fetal survival is unlikely beyond 1 week .

Middle Cerebral Artery

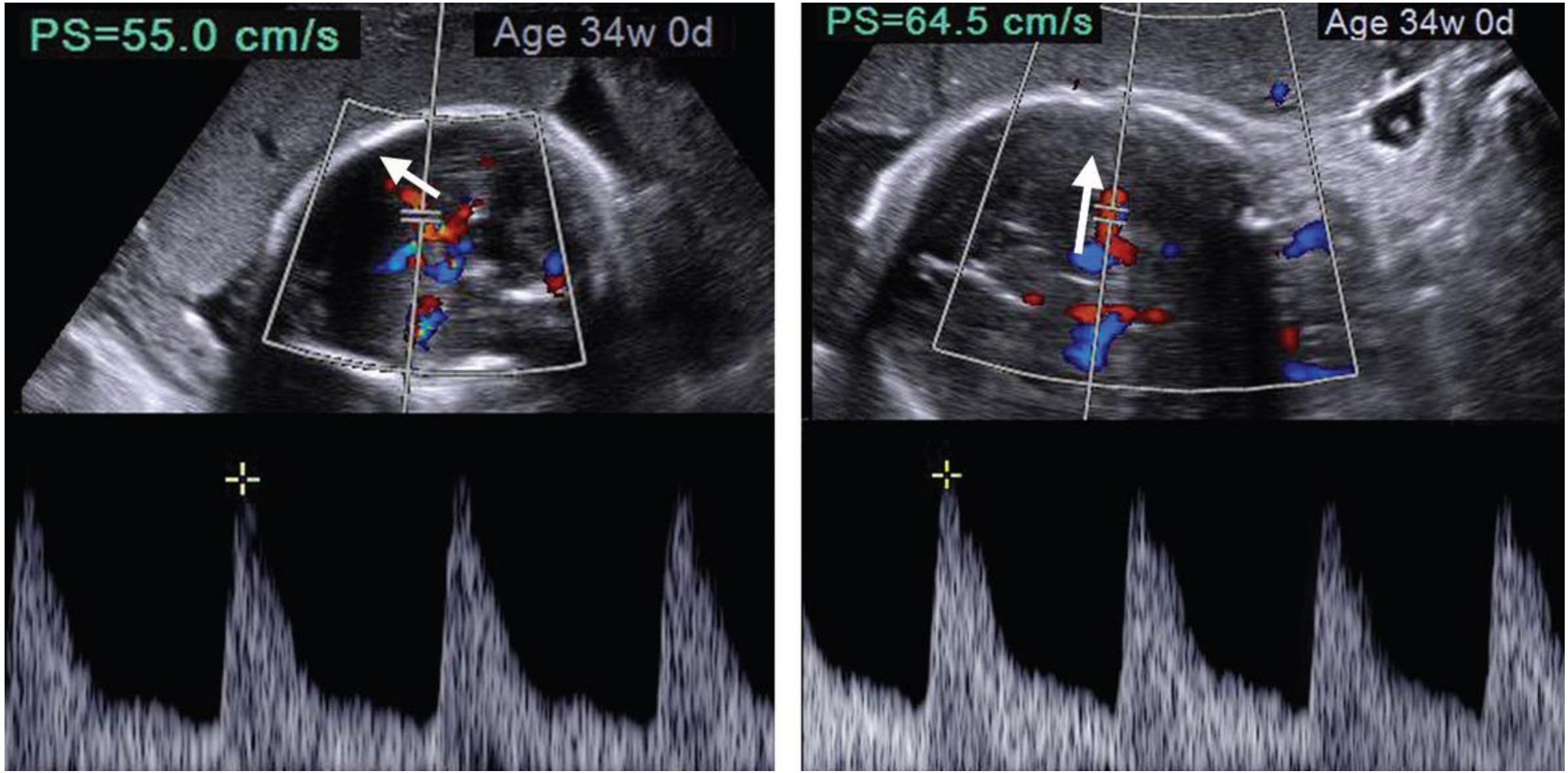
- noninvasive assessment of fetal anemia[18 weeks]
- In calculation of the cerebroplacental ratio, the PI is preferred over the S/D ratio.
- In normal circumstances, flow in the middle cerebral artery is fairly high resistance.
- flow in the umbilical artery should be low resistance.
- the S/D ratio in the umbilical artery should always be lower than that in the middle cerebral artery.

- In response to hypoxia, the fetus diverts blood flow to the brain.
- altering the ratio of the umbilical artery flow to the middle cerebral artery flow.
- a significant increase in perinatal morbidity and mortality in fetuses at risk for growth restriction who had an abnormal cerebroplacental ratio.





- In fetal anemia, flow in the middle cerebral artery increases for several reasons.
- Fluids move faster through a fixed-diameter tube as viscosity decreases.
- cerebral vasodilatation.
- Cardiac output also increases in anemic fetuses.
- The 1-mm sample volume cursor is placed within 2 mm of the origin of the middle cerebralartery with a 0° angle of insonation while the fetus is at rest and not breathing.
- The risk of fetal anemia is highest when the peak systolic velocity is more than 1.5 multiples of the median for gestational age.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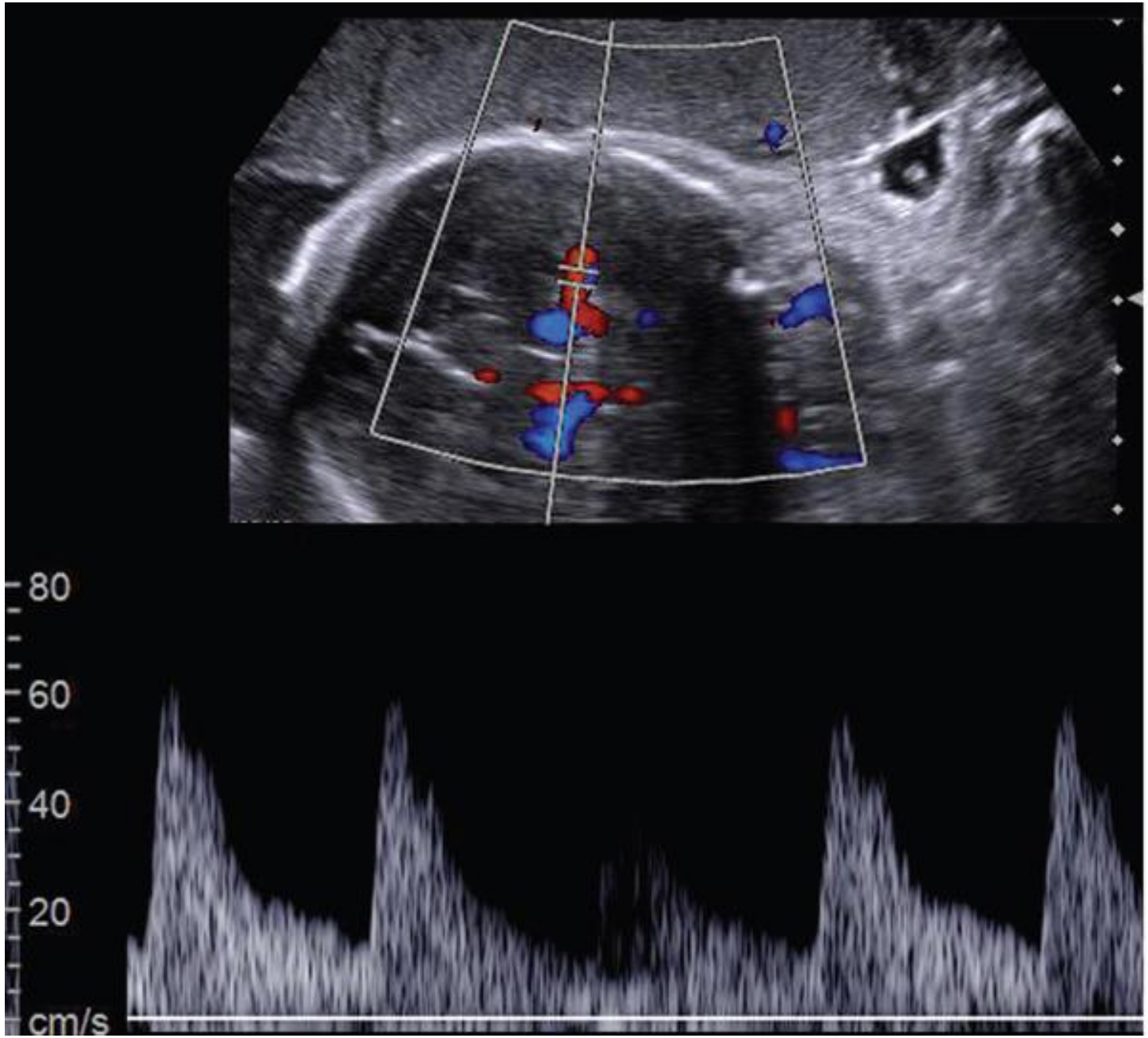
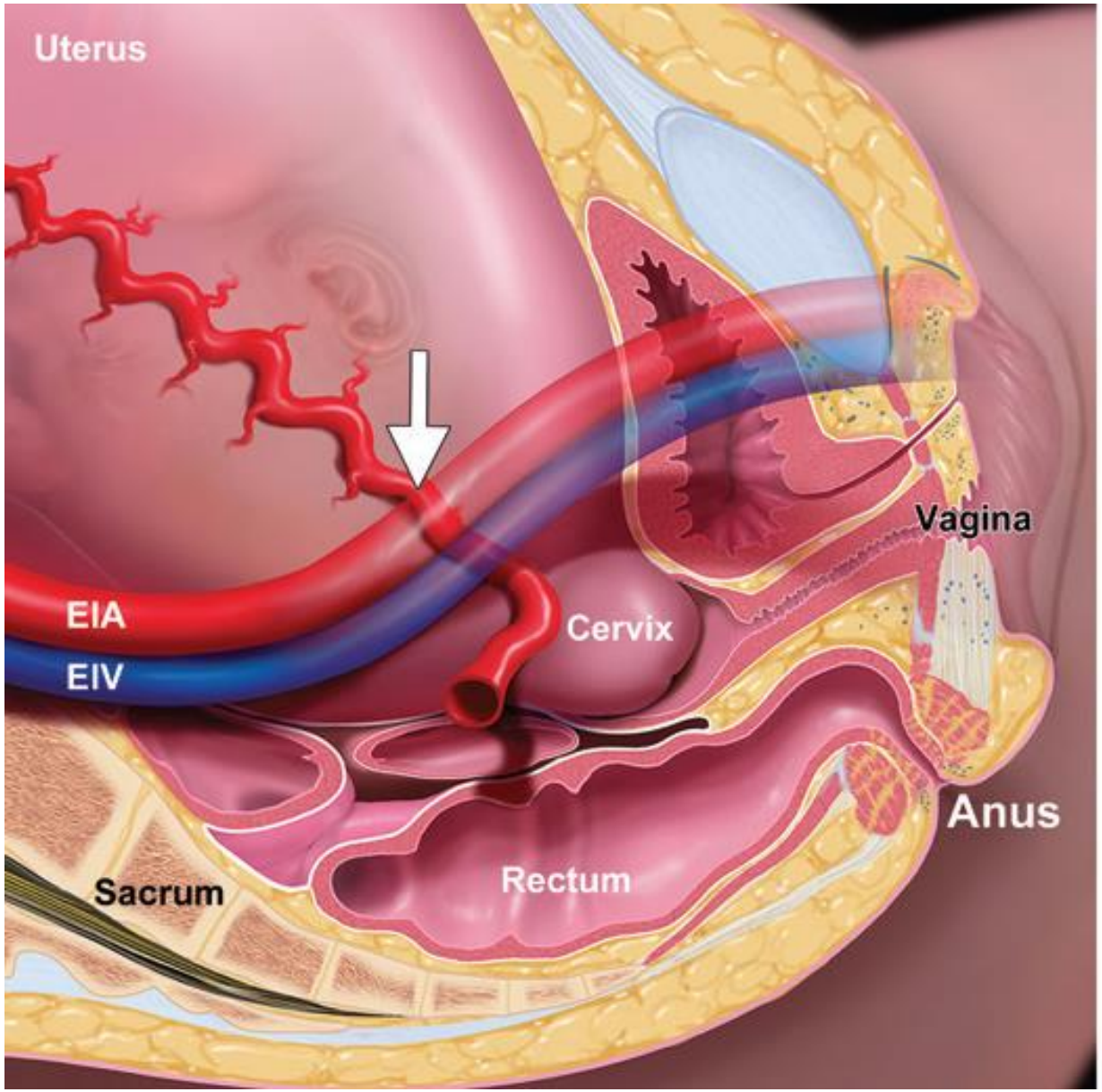
Age 34w 0d
PS=64.5 cm/s
Age 34w 0d

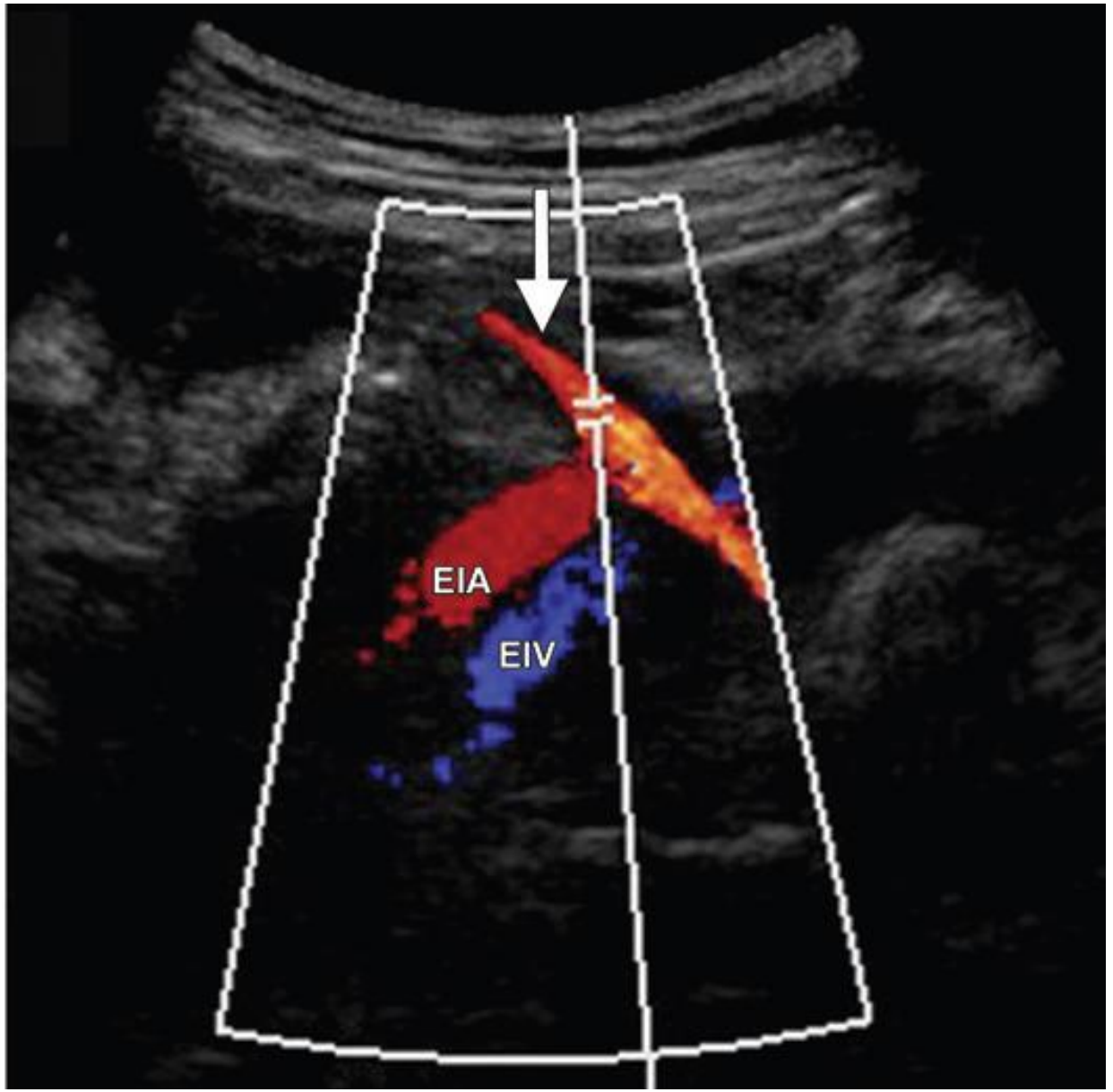

80
60
40
20
cm/s

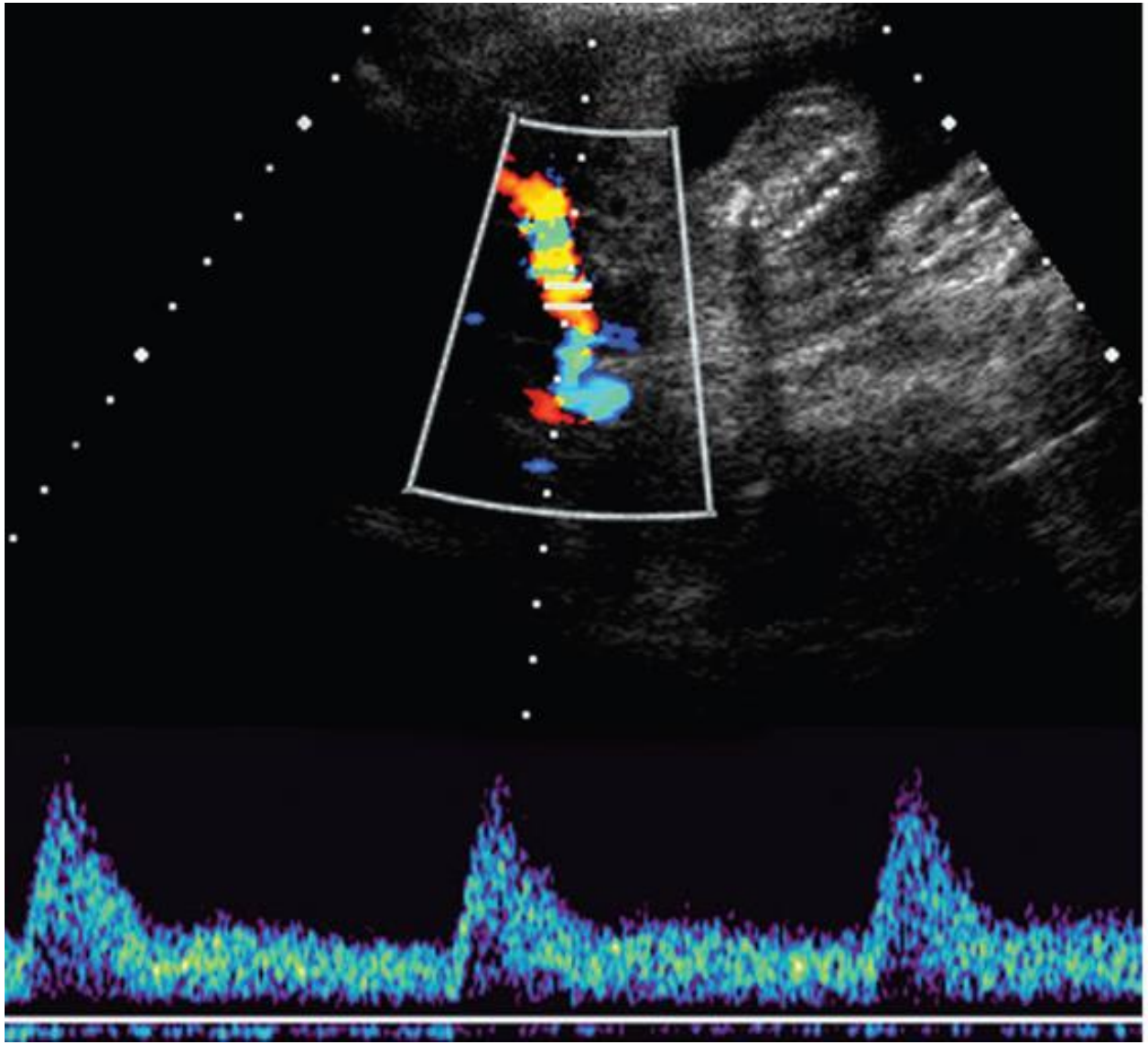
Doppler US of the Uterine Artery

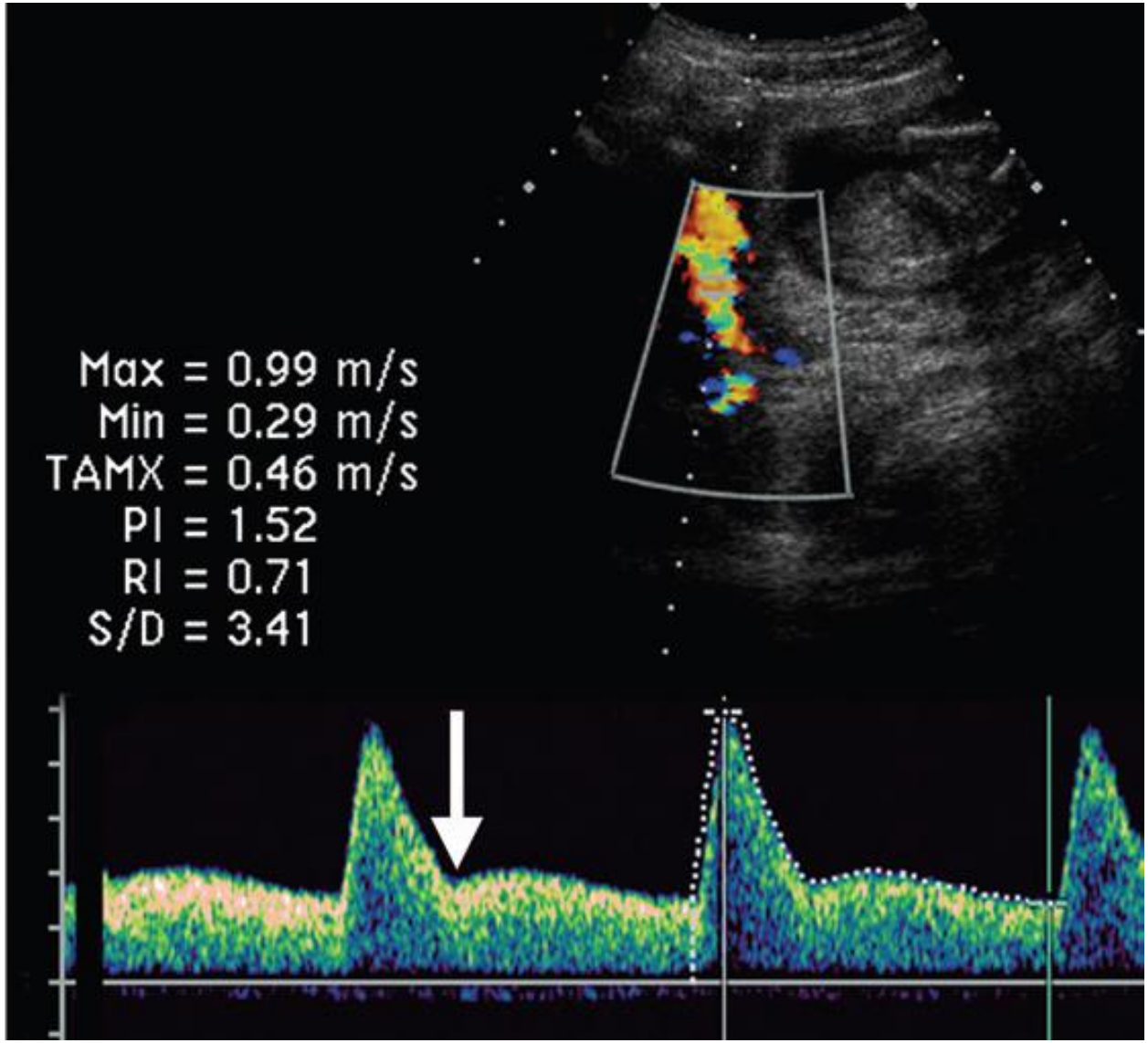
- first trimester to screen for early-onset Preeclampsia and other adverse pregnancy outcomes such as fetal growth restriction.
- the second and third trimesters, the evaluation of pregnancies complicated by fetal growth restriction.
- The uterine artery is a branch of the internal iliac artery.
- In the nonpregnant state, the waveform is high resistance with low diastolic flow and early diastolic notching.
- notching should disappear by 13 weeks.
- and low-resistance flow should be established by 20 weeks.

- An abnormal waveform is characterized by increased resistance and persistence of a diastolic notch beyond the late second trimester.
- *diastolic notch* is defined as a reduction in forward flow at the start of diastole.
- A diastolic notch has been associated, growth restriction, maternal preeclampsia.


Uterus
EIA
EIV
Cervix
Vagina
Anus
Rectum
Sacrum


EIA
EIV

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Min = 0.29 m/s
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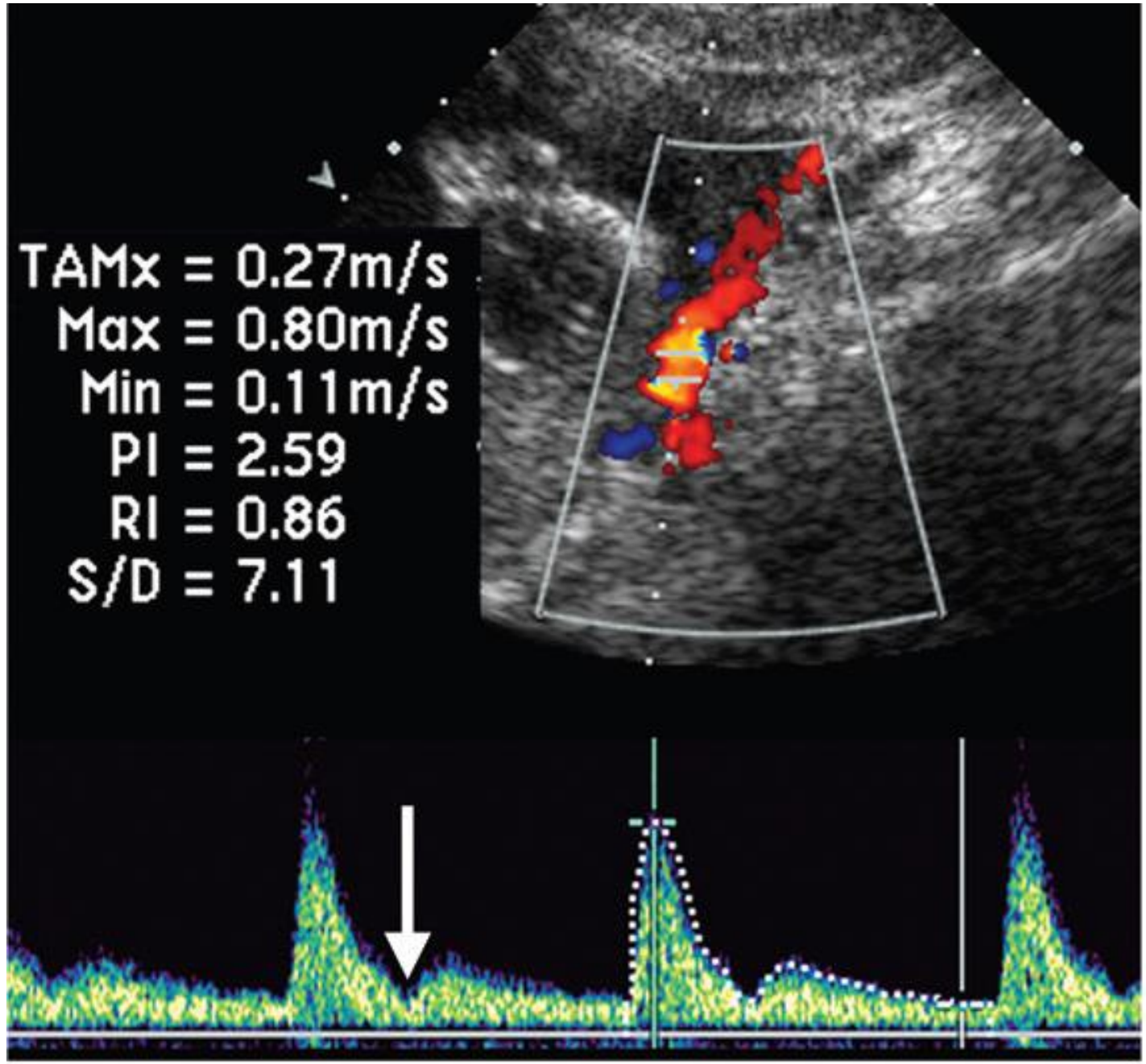
PI = 1.52
RI = 0.71
S/D = 3.41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Max = 0.80m/s
Min = 0.11m/s
PI = 2.59
RI = 0.86
S/D = 7.11