Ultrasound in Obstetrics and Gynecology

Lotta Herling
M.D., Specialist in Obstetrics and Gynecology
Centre for Fetal Medicine
Karolinska University Hospital

KAROLINSKA
University Hospital

Obstetrics and Gynecology

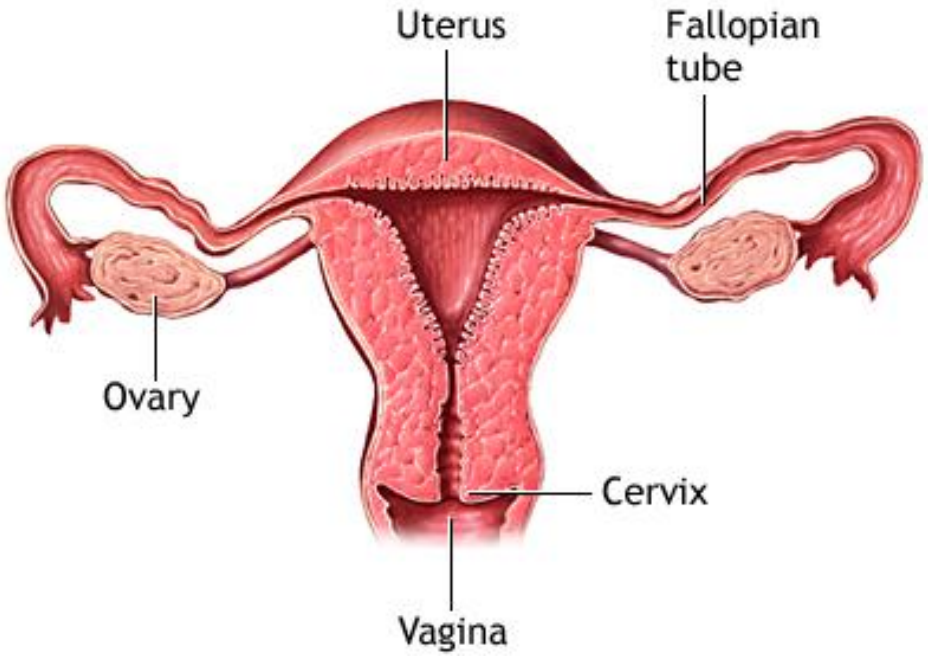
Obstetrics:

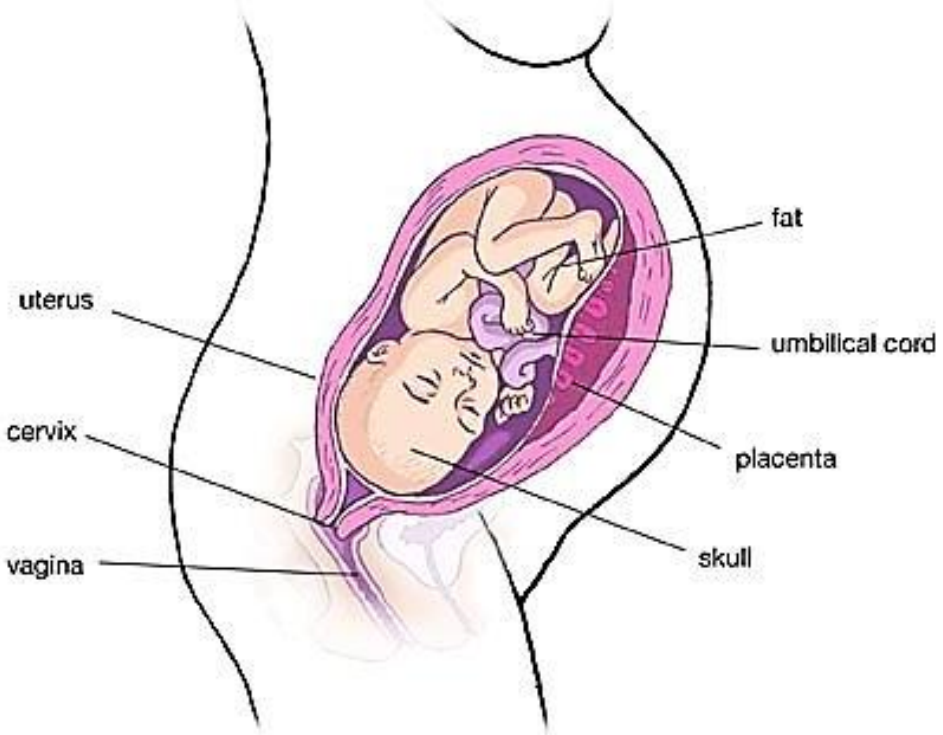
- Pregnancies – management, maternity health care, fetal and maternal complications, delivery and complications such as cesarean sections

Gynecology:

- Problems with bleeding, abdominal pain due to cysts and other conditions, cancer, operation in gynecological organs, during *in vitro* fertilization, terminations, complications in early pregnancies such as miscarriages

Basic Anatomy





Where and Why Ultrasound?

Outpatient clinic

Gynecological emergency department

Invasive procedures in Fetal Medicine unit

Labor ward

Safety Aspects

- **VERY IMPORTANT WHEN USING ULTRASOUND IN PREGNANCIES!**
- Early in pregnancy – rapid cell division, organ development and less developed blood flow to take away produced heat.
- Later in pregnancy caution on the use of colour Doppler in areas close to bone/ soft tissue surfaces where heat can be generated.
- Ultrasound appears to be safe during pregnancy.
- Noticed – unexplained weak association between ultrasound and non-right handedness in boys.

Safety Aspects

- MI – *mechanical index* – an indicator of the likelihood of mechanical bioeffects (for instance cavitation).
- TI – *thermal index* – translate the acoustic output of an ultrasound machine into a quantity that correlates with the risk of causing an adverse effect due to a thermal mechanism.
- Important that scans are done for correct medical reasons. Scanning for souvenir images only should be avoided.
- Potential clinical benefit should outweigh any theoretical or potential risks!
- **ALARA** – **A**s **L**ow **A**s **R**easonably **A**chievable – exposure should be kept as low as possible.

isuog.org

GUIDELINES

Safety Statement - International Society of Ultrasound in Obstetrics and Gynecology (ISUOG)

- Thermal index (TI) and mechanical index (MI) not perfect indicators of risk but currently most practical and understandable methods of estimating the potential of risks
- B-mode and M-mode appears to be safe for all stages of pregnancy
- Spectral and color Doppler may produce high intensities and routine examination by this modality during the embryonic period is rarely indicated

isuog.org

GUIDELINES

- Pulsed Doppler (spectral, power and color flow imaging) ultrasound should not be used routinely in in the 11 to 13+6-week
- Pulsed Doppler ultrasound may be used for clinical indications such as to refine risks for trisomies
- When performing Doppler ultrasound, the displayed thermal index (TI) should be ≤1.0 and exposure time should be kept as short as possible (usually no longer than 5–10 min) and should not exceed 60 min.

Safety Aspects - Conclusion

No reported incidents of human fetal harm in over 40 years of extensive use of medically indicated diagnostic ultrasound.

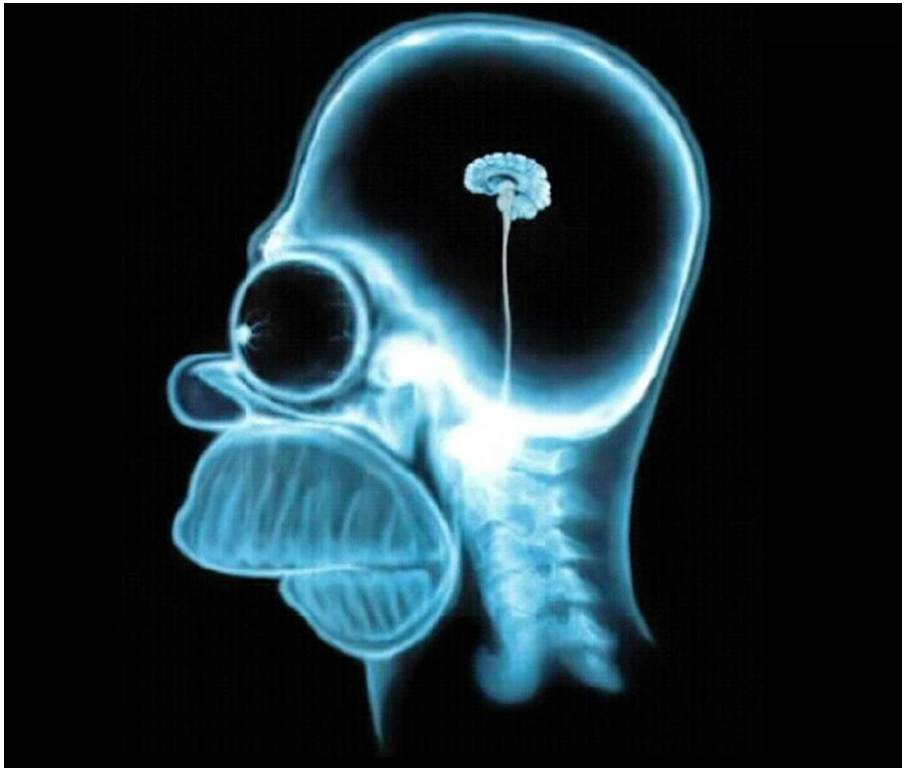
Nevertheless, ultrasound involves exposure to a form of energy, so there is the potential to initiate biological effects.

Some of these effects might, under certain circumstances, be detrimental to the developing fetus.

Therefore, the uncontrolled use of ultrasound without medical benefit should be avoided.

Safety Aspects

Important in order to minimize possible risks…



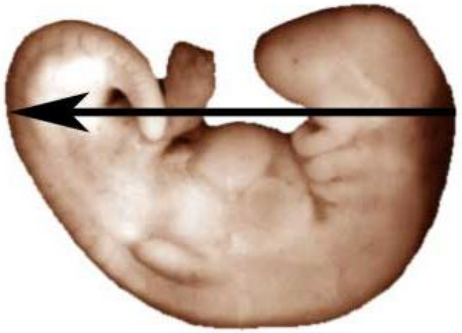
Abdominal and Vaginal Ultrasound

- Abdominal probe:
  - Lower frequency
  - Will reach further into the abdomen
  - Lower resolution
- Vaginal probe:
  - Higher frequency (5-7 MHz)
  - Closer to uterus target organ
  - Higher resolution

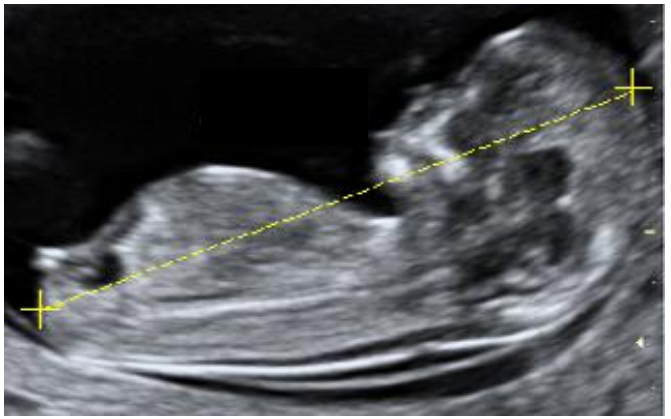
Application in Obstetrics

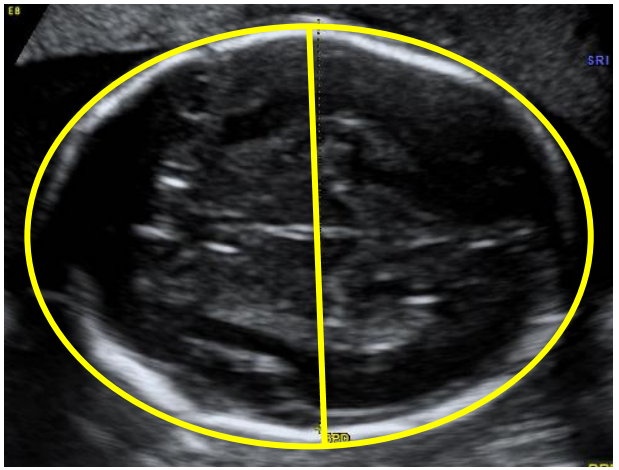
- **Dating of pregnancy**
- Identification of twins, triplets etc.
- **Assessment of fetal growth**
- **Identification and management of malformations**
- Invasive procedures such as sampling of amniotic fluid and placenta
- **Treatments such as blood transfusions**, emptying of excessive amniotic fluid
- **Measurement of cervical length** to assess risk of preterm labor
- Assessment of fetal and placental position

Dating the Pregnancy



- = deciding the age of the fetus and estimate the due date / time for delivery.
- Early up to 12-13 weeks measurement of crown-rump length (CRL).
- Later from 13 weeks to approx. 24 weeks measurement of head – biparietal diameter (BPD) or head circumference (HC).



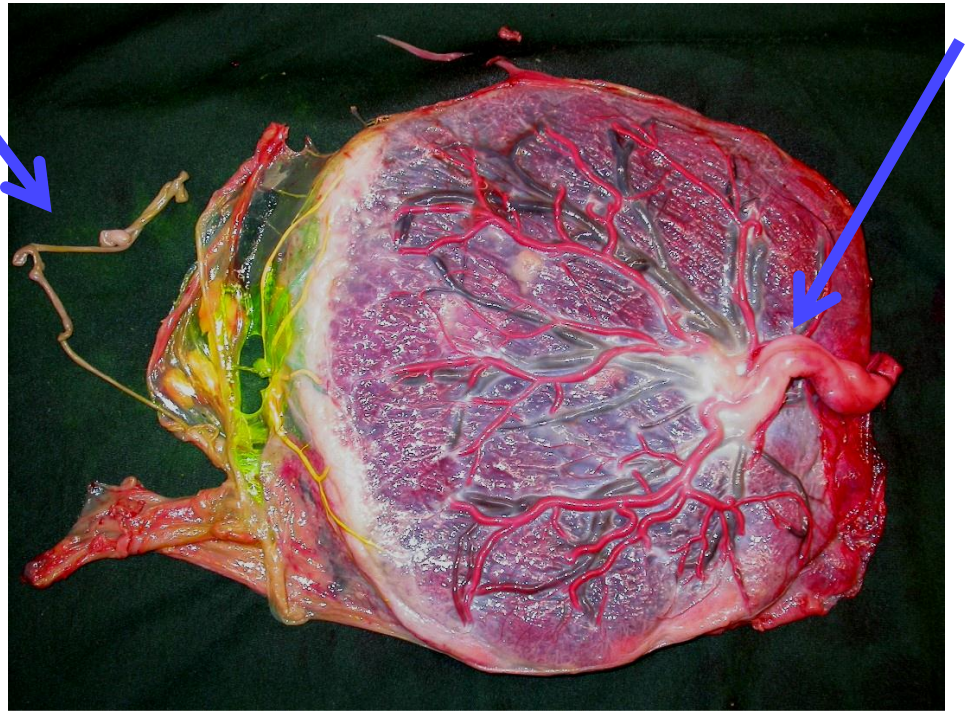


Estimating Fetal Growth

Estimating Fetal Growth - the Cause Often in the Placenta

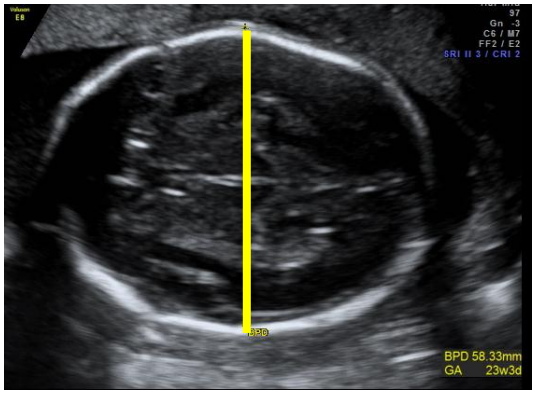
Umbilical cord of small twin

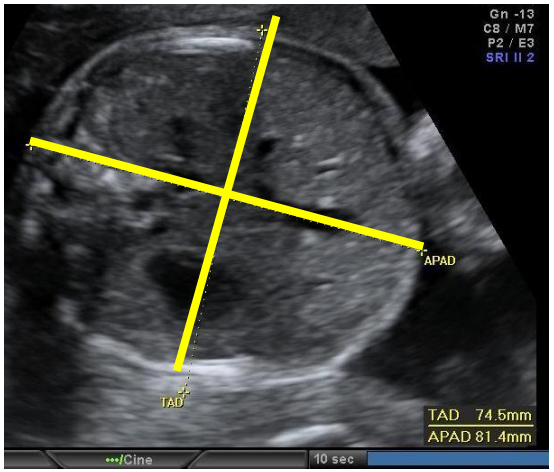
Umbilical cord of large twin

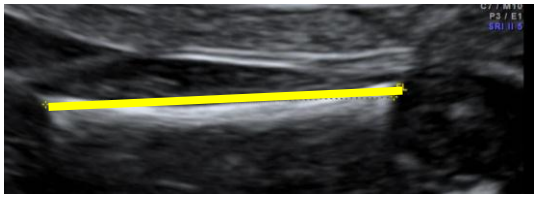


How Do We Estimate Fetal Growth?

- By measuring the head, the abdomen and the length of the thigh bone.
- Gives an estimation of weight and weight discrepancy compared to the average sized baby in the current gestational week.
- Sometimes very difficult in multiple gestations, late in pregnancy and if mother is over-weight.

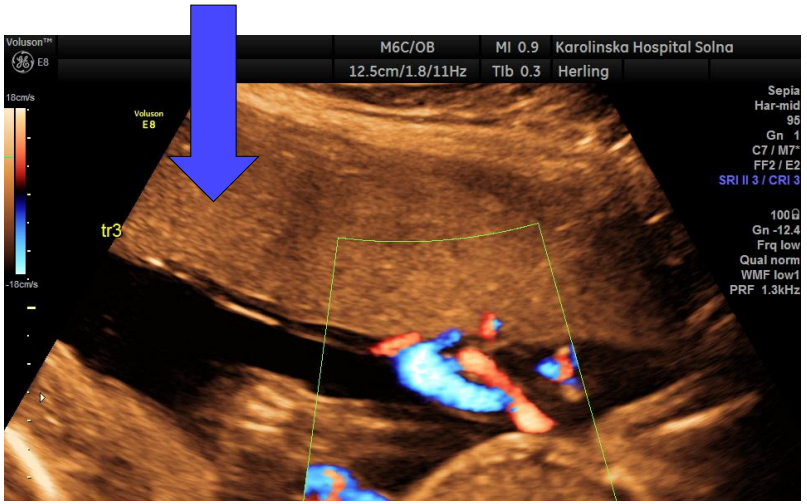


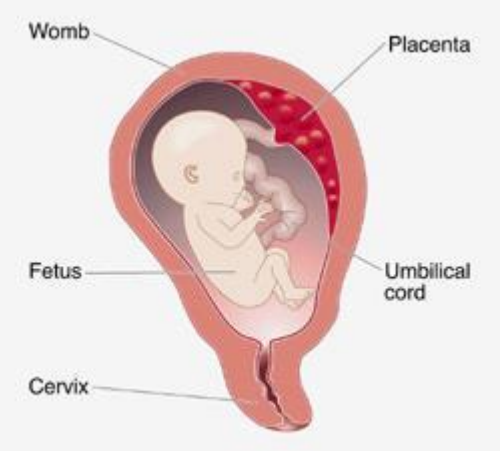




How Do We Manage Impaired Growth? (Intrauterine Growth Restriction – IUGR)

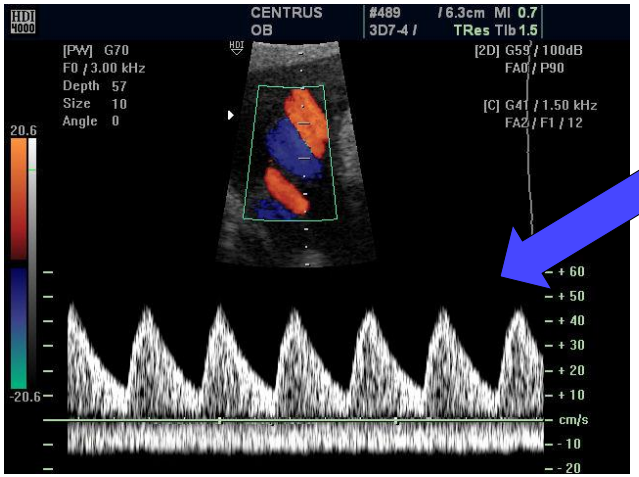
- Cannot from visualizing the placenta with ultrasound say a lot about its function.
- Use surrogat measures such as blood flow in the umbilical artery to get an idea about the resistance to flow.
- A high resistance indicates a malfunctioning placenta.
- Higher resistance = worsening function



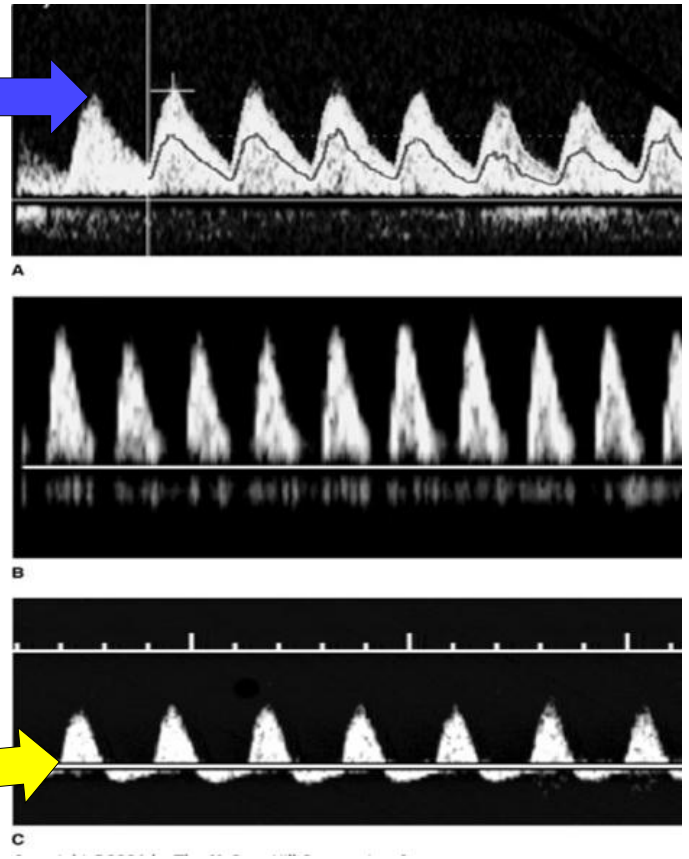


Impairment of Blood Flow in Umbilical Cord (Umbilical Artery)

…a sign of worsening fetal condition….

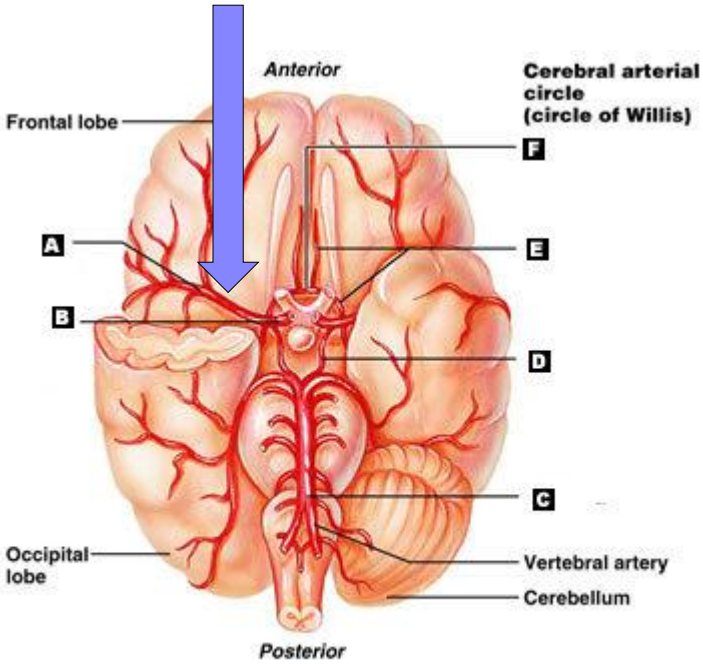


From normal to pathological with a reversed blood flow in the second part of the cardiac cycle



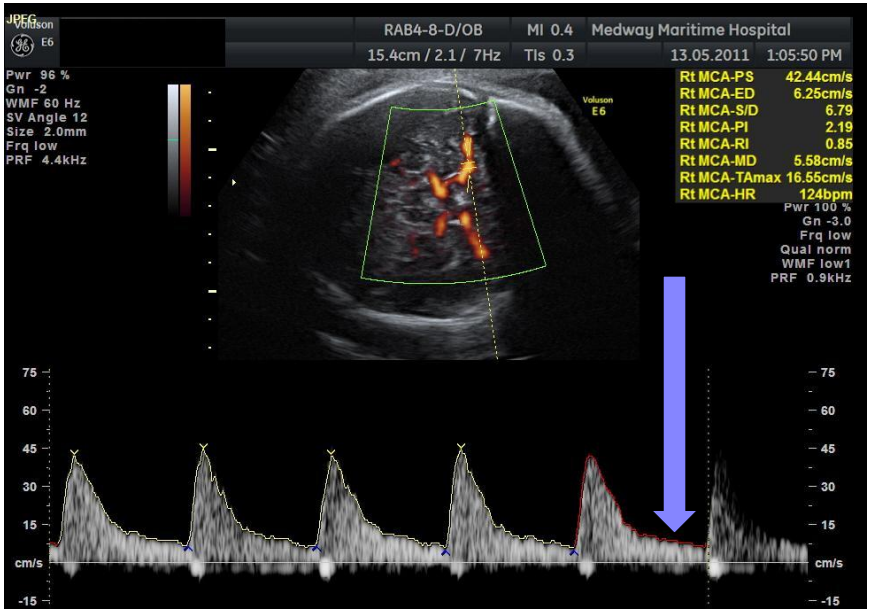
How Is the Fetus Coping?

- Assessment with Doppler in important fetal blood vessels
- Redistributing its blood flow by making blood flow to head, brain and adrenals a priority?
- Lowering the resistance to flow in brain circulation…measurement of blood flow in **the middle cerebral artery**

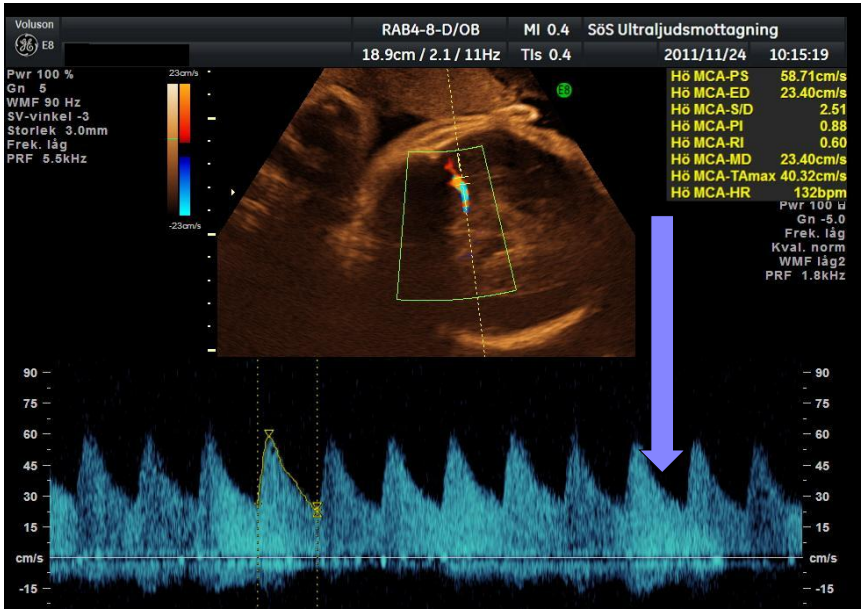


Blood Flow in the Middle Cerebral Artery

Normal blood flow



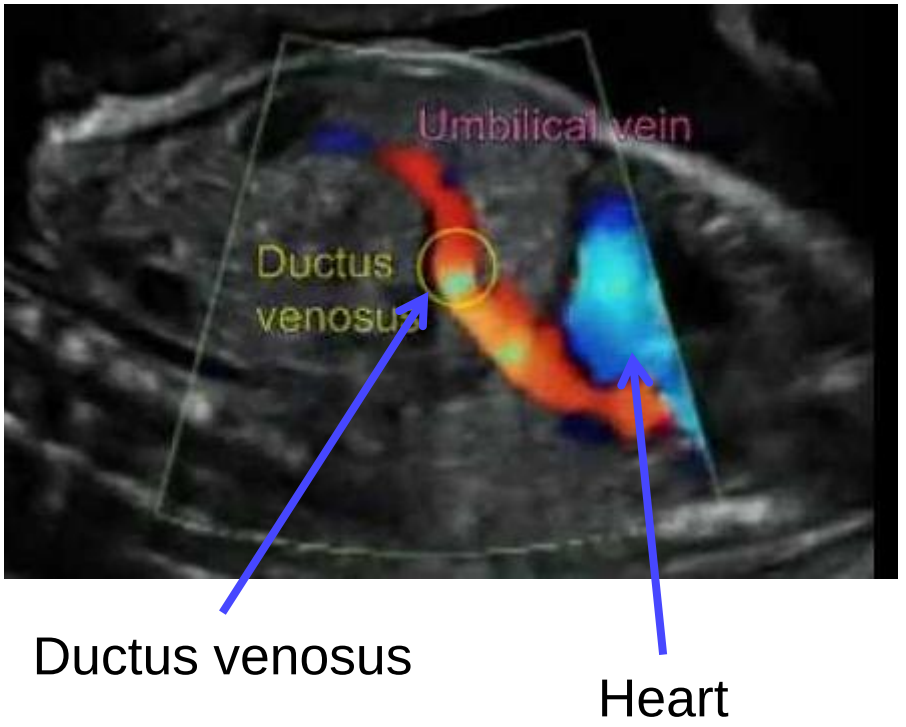
Pathological blood flow



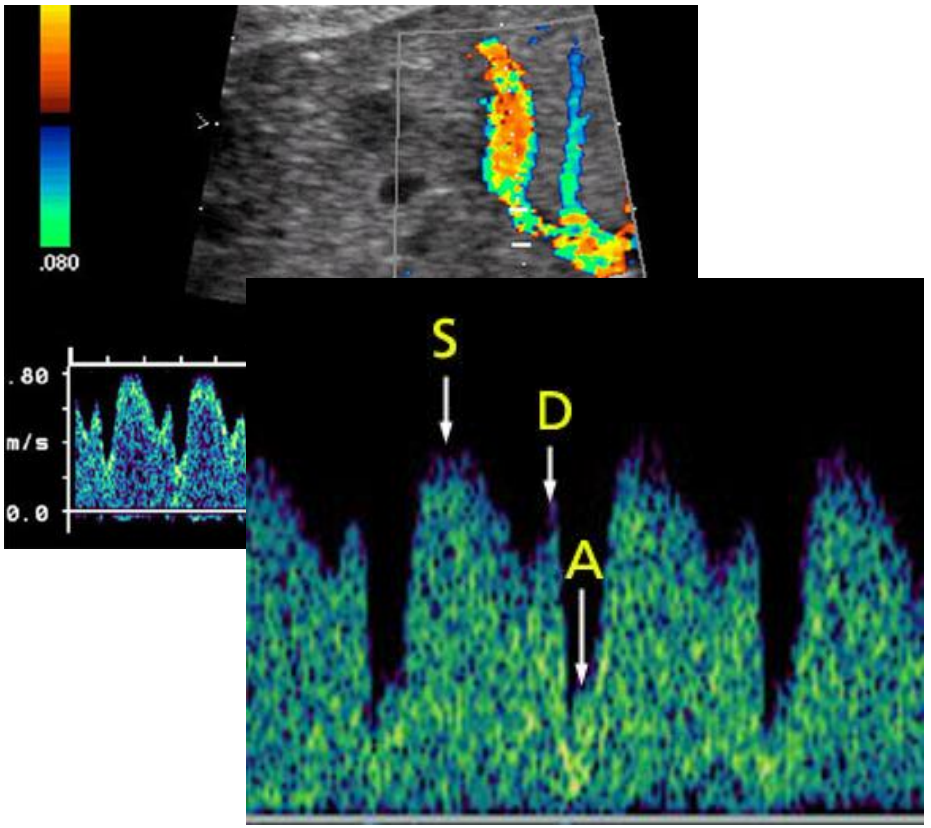
Increased blood flow at the end of the cardiac cycle = brain a priority

How Is the Fetus Coping…Cont.

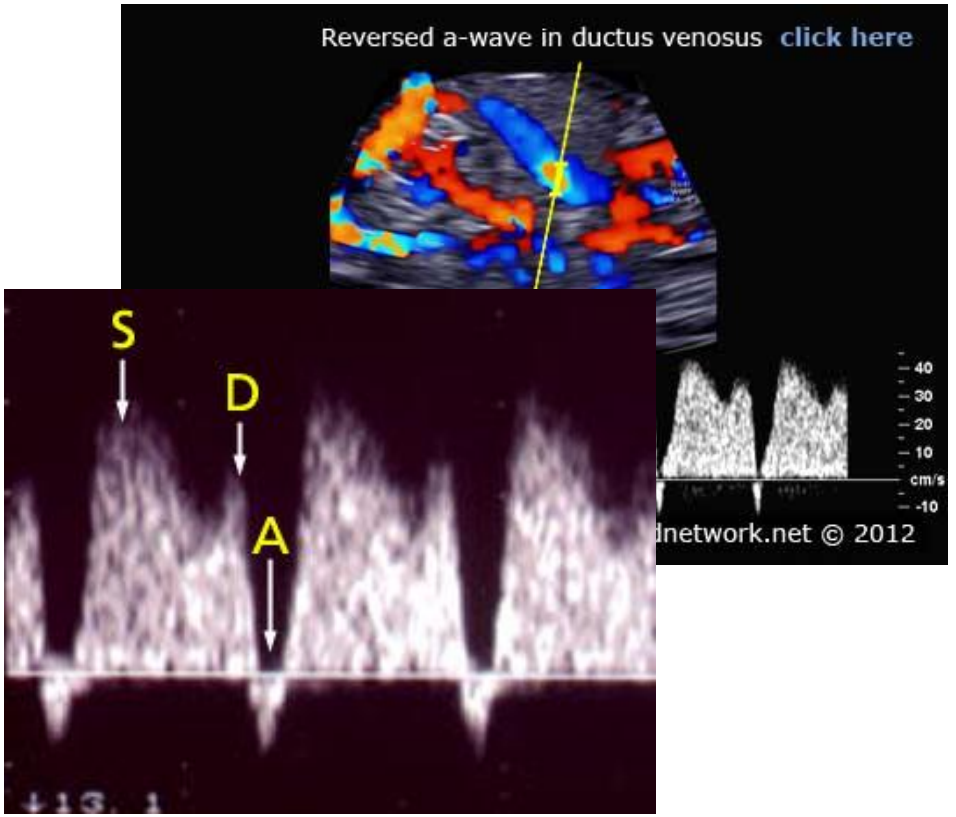
- Does the fetus show any signs of cardiac failure?
- Assessment of a blood vessel with a size of a few millimeters in the fetal abdomen.
- Propells oxygenated blood straight away from the placenta into the heart.
- When backwards flow at the end of the cardiac cycle = heart failure.



Blood Flow in the Ductus Venosus



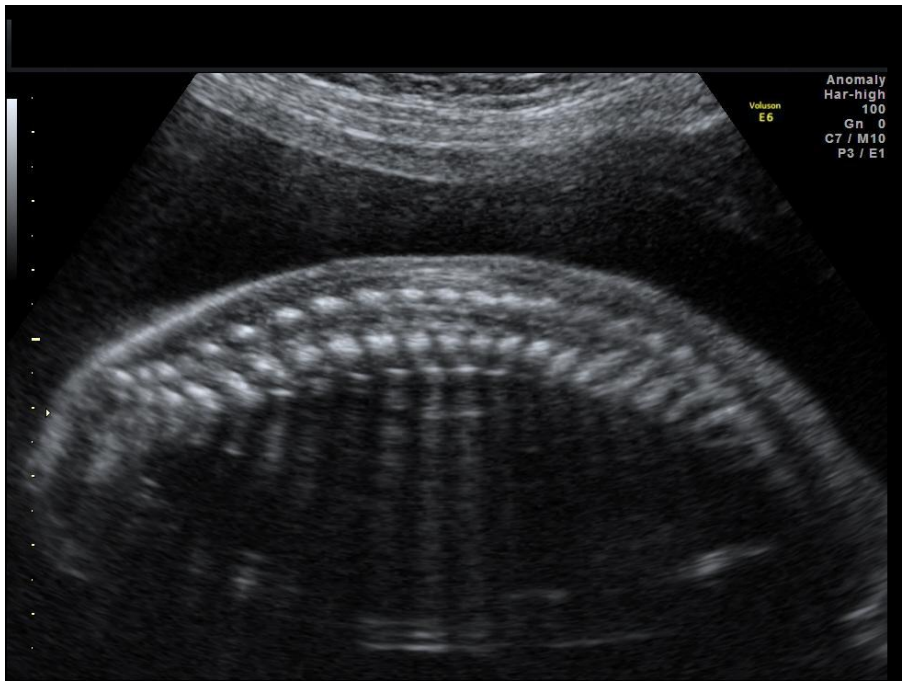
Normal blood flow

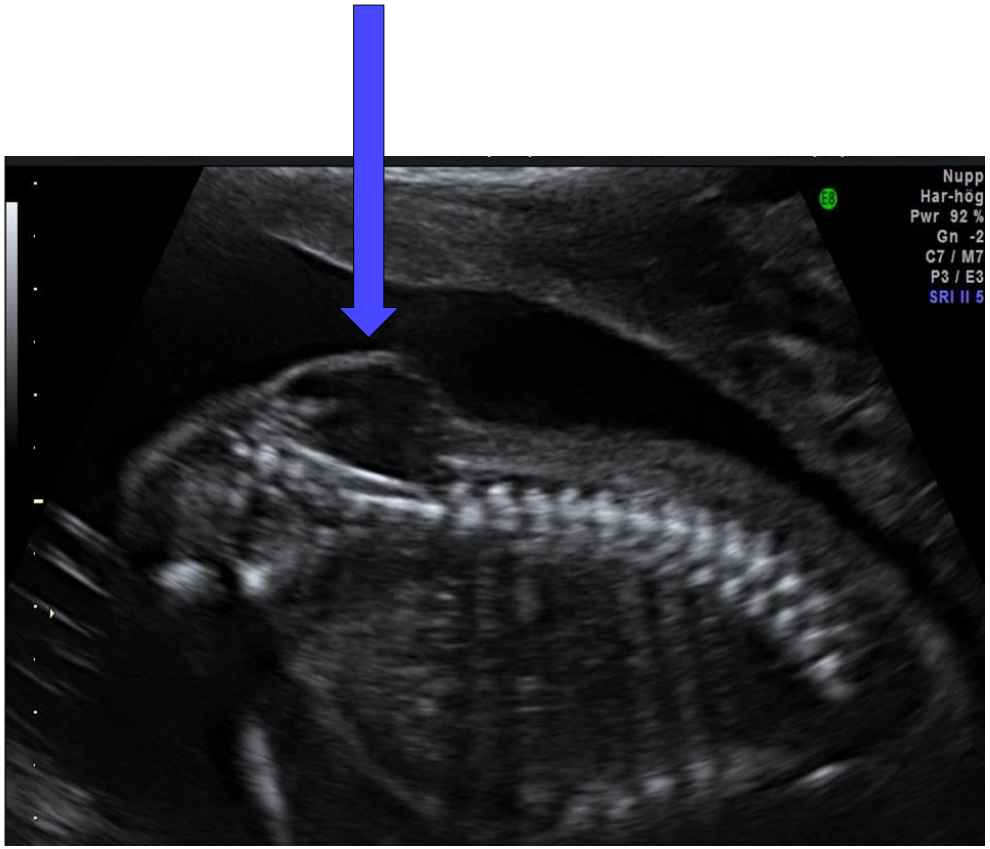


Abnormal blood flow – reversed a-wave

Identification of Malformations

2D/ B-mode

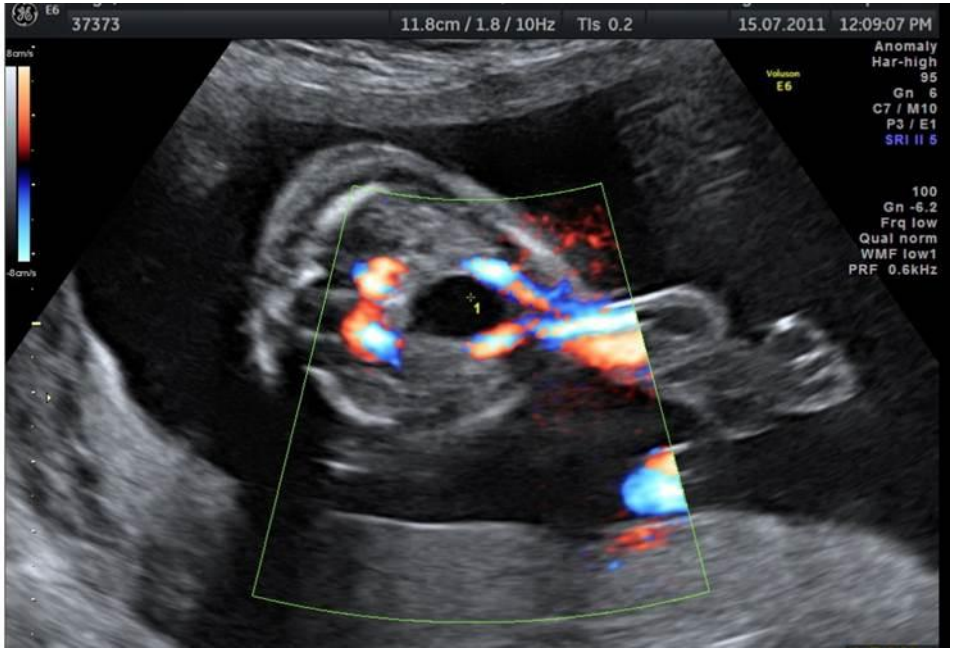




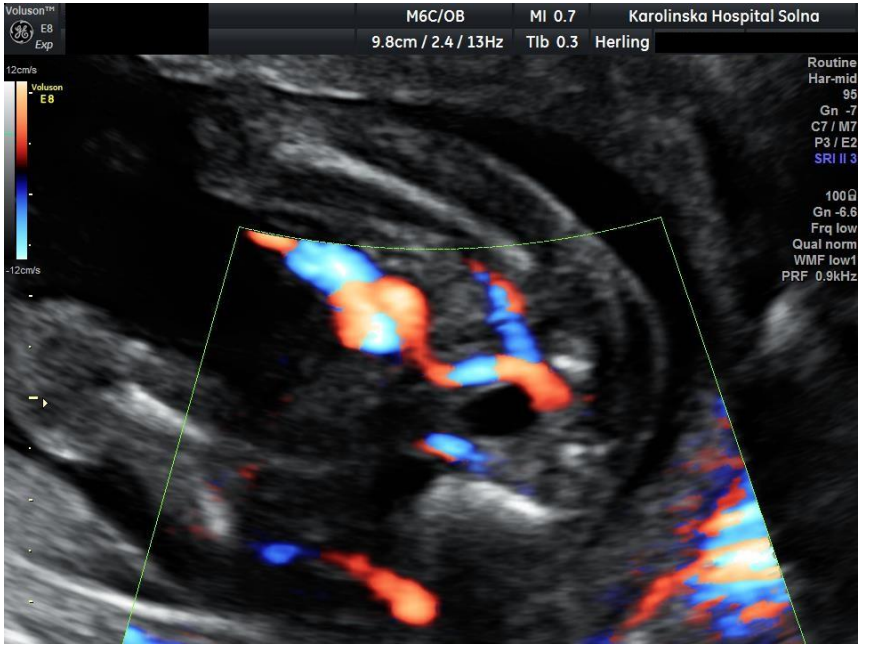
Normal spine (from the side) Abnormal spine with myelomeningocele

Identification of Malformations Cont.

Through the use of Doppler (power Doppler)



Two umbilical arteries surrounding the urinary bladder= normal



One umbilical artery surrounding the urinary bladder

Identification of Malformations Cont.

Sometimes with the assistance of 3D ultrasound

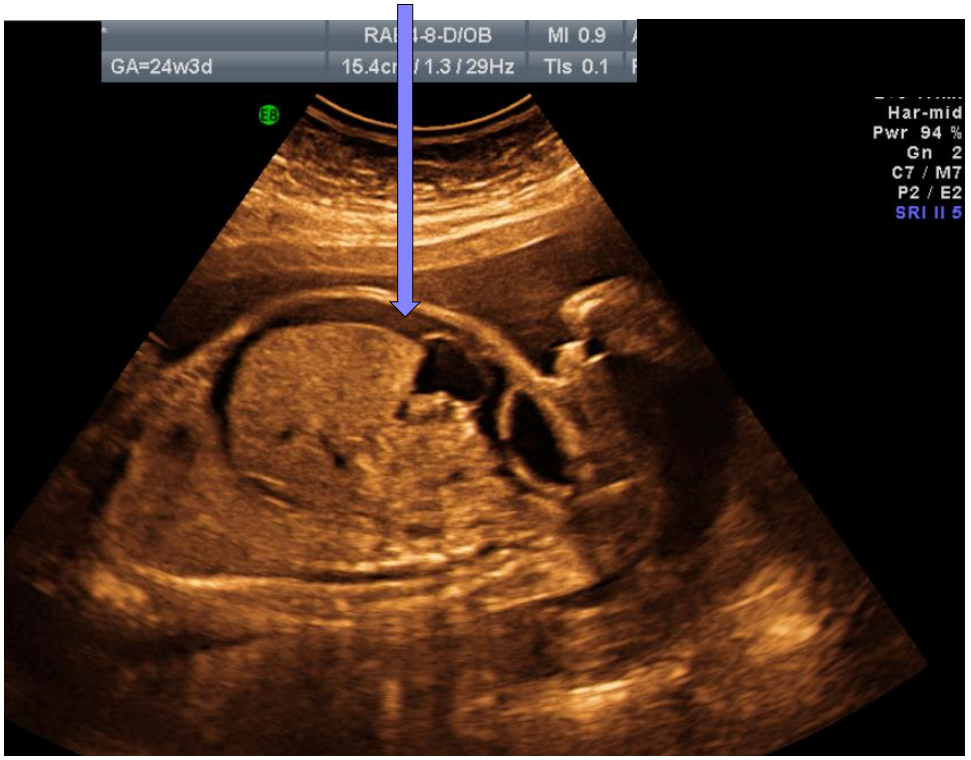
Intact lip

Cleft lip

Treatments – Blood Transfusion to the Fetus in the Womb

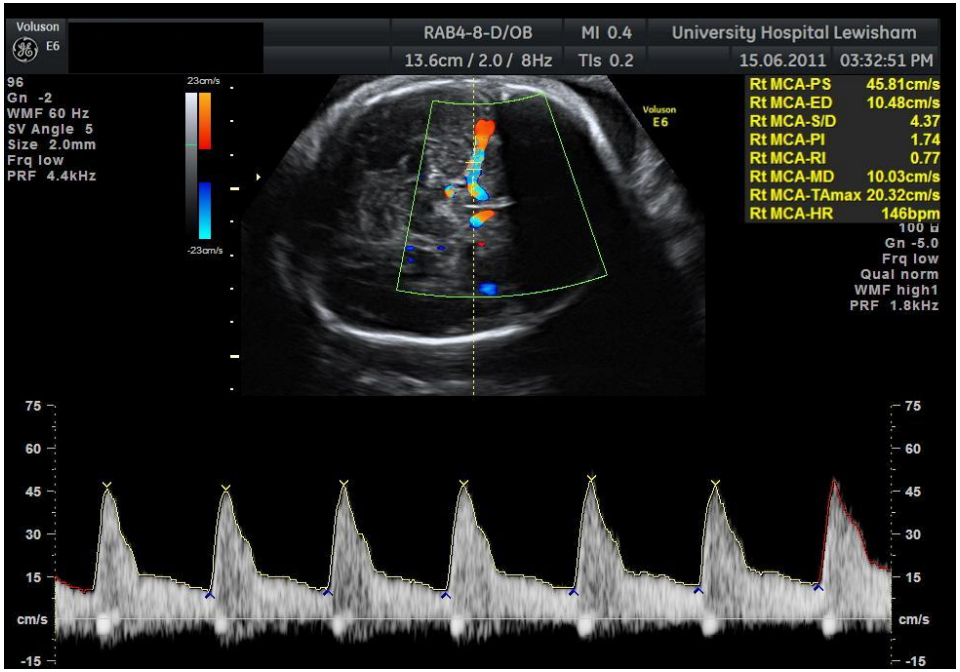
- Mother experienced decreased fetal movements in week 24.
- Fetus with fluid in the abdomen (ascites) gives suspicion of anemia (low blood count).

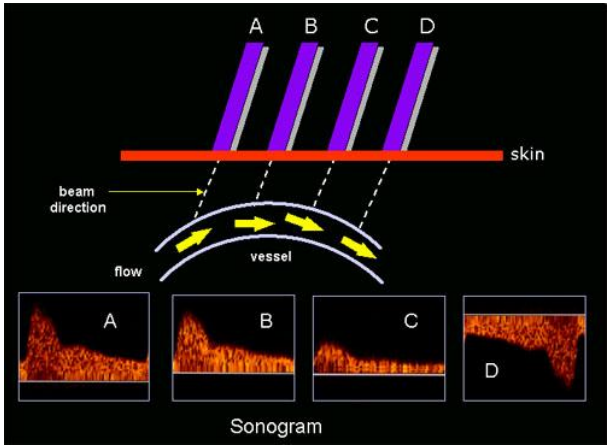
Ascites = black area



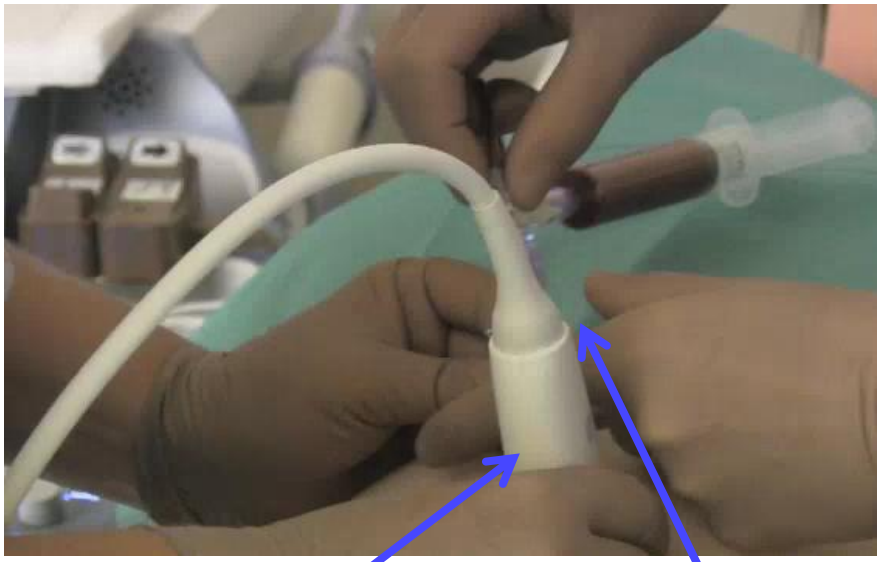
Is the Fetus Anemic?

- Check middle cerebral artery - peak velocity of blood flow in systole.
- If the peak systolic velocity is very high it indicates anemia.
- To verify a blood sample will be taken from the fetus in the umbilical cord or from a vessel inside the liver.

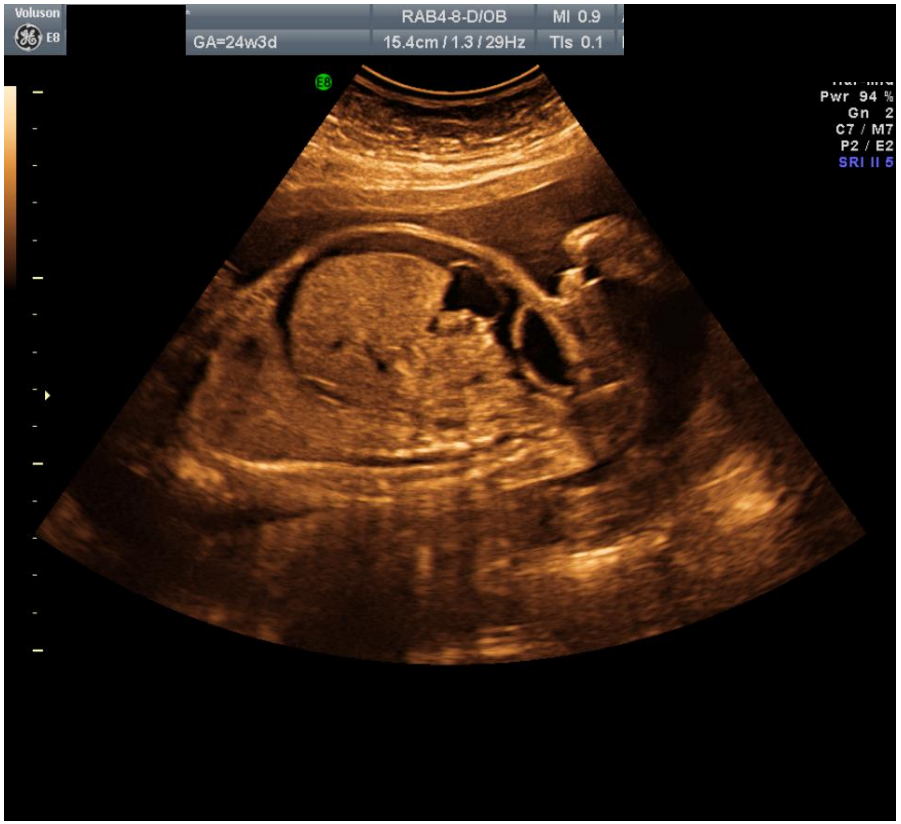




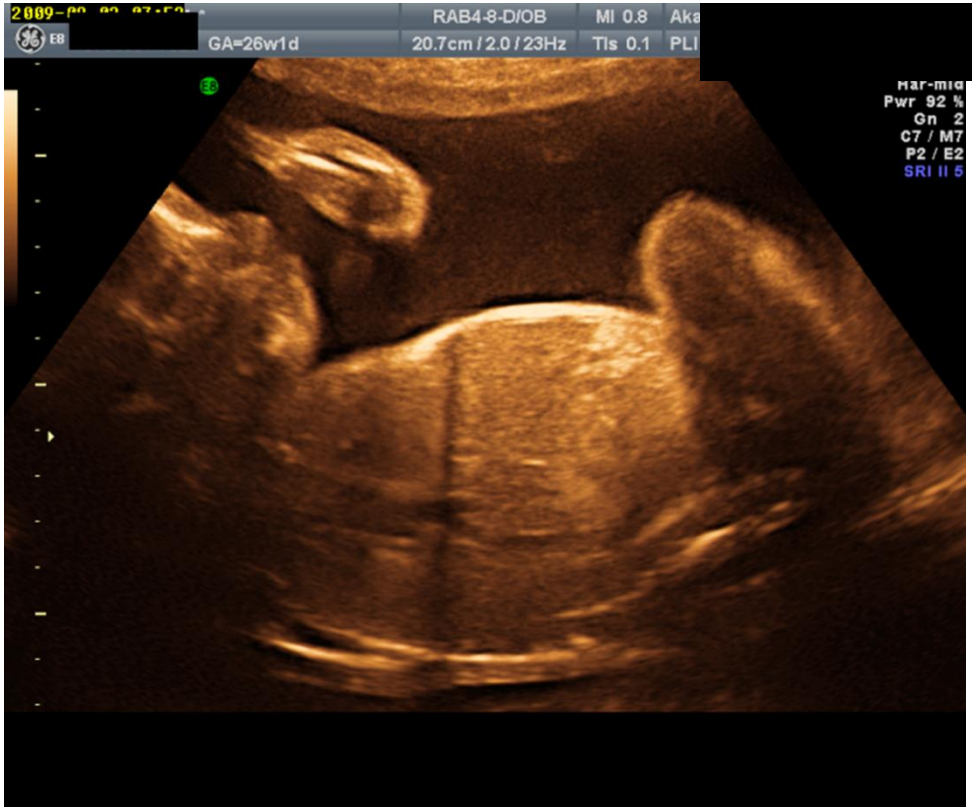
Ultrasound Guided Blood Transfusion to the Fetus



After 2 Blood Transfusions…



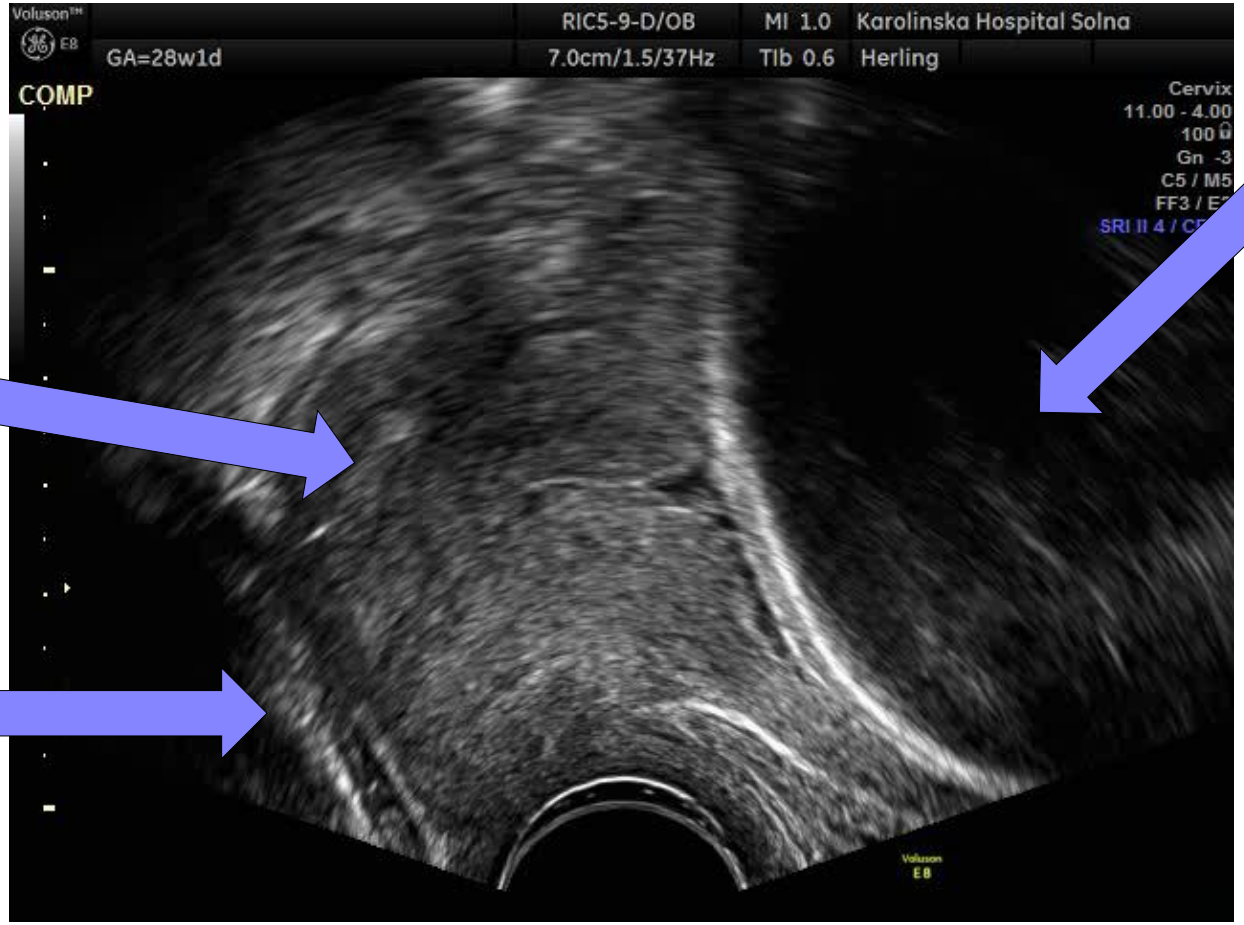
Before



After – no ascites

Threatening Preterm Labor - Cervix…Dynamic...

Fetal head



Cervix

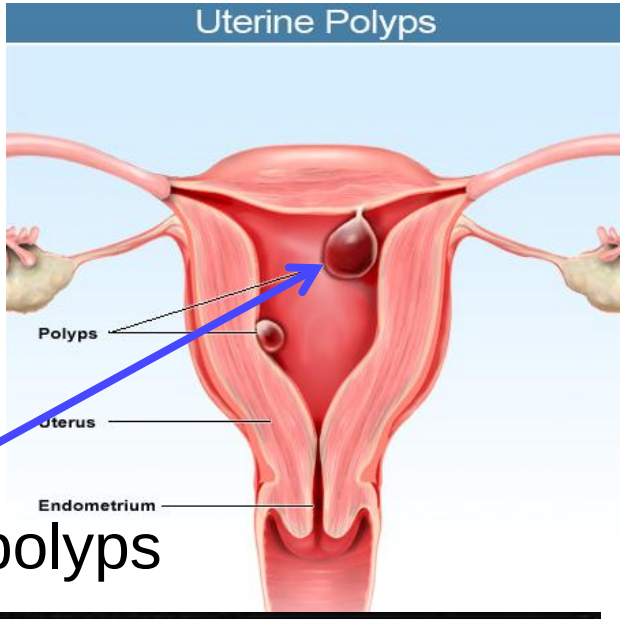
Vagina

Applications in Gynecology

Ultrasound useful in assessment of:

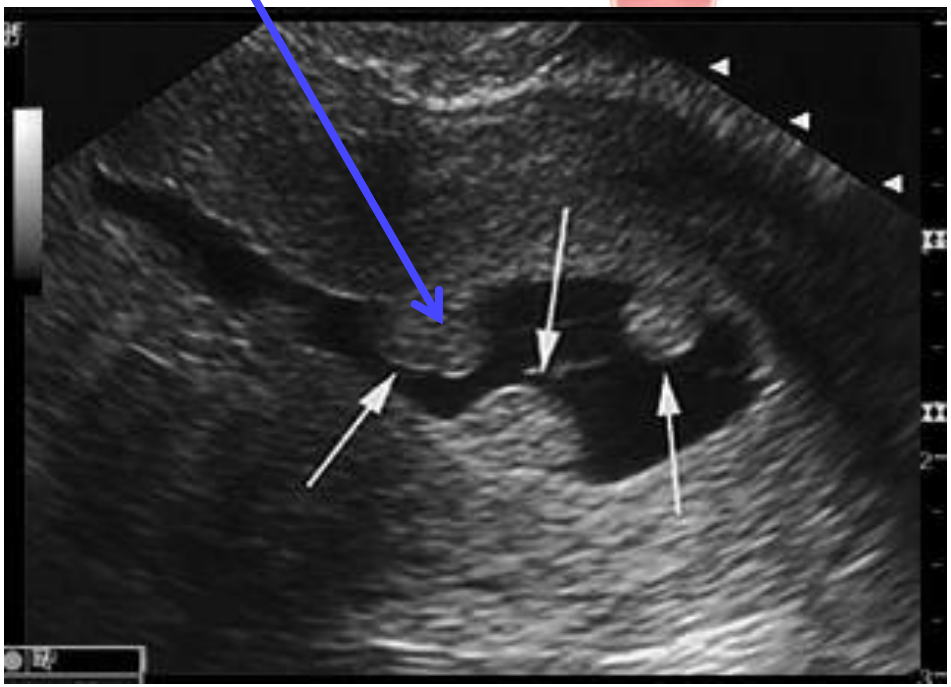
- **Bleeding complications**
- Low abdominal pain
- **Cysts** – benign and malignant (cancer)
- **Early pregnancy**
- Miscarriage
- Reproductive medicine – *in vitro* fertilization (IVF)
- Uterine anomalies

Bleeding Complications

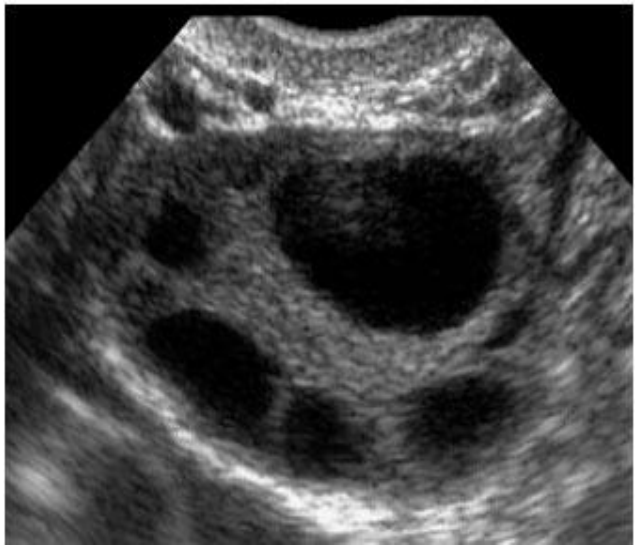


Normal uterus

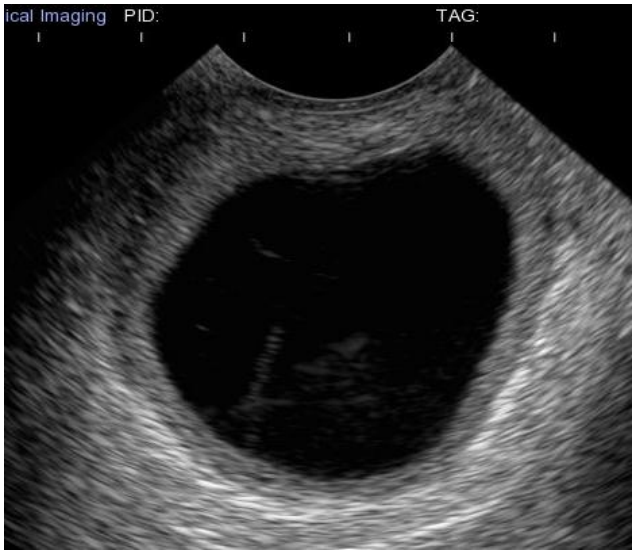
Uterus with polyps

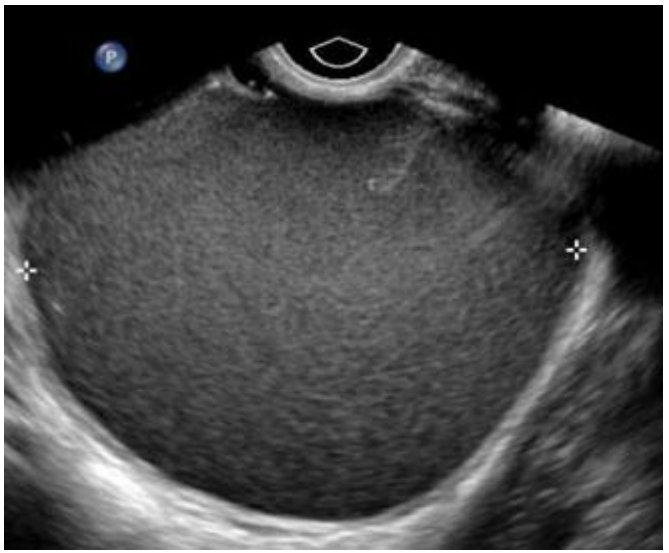


Normal Ovary and Benign cysts



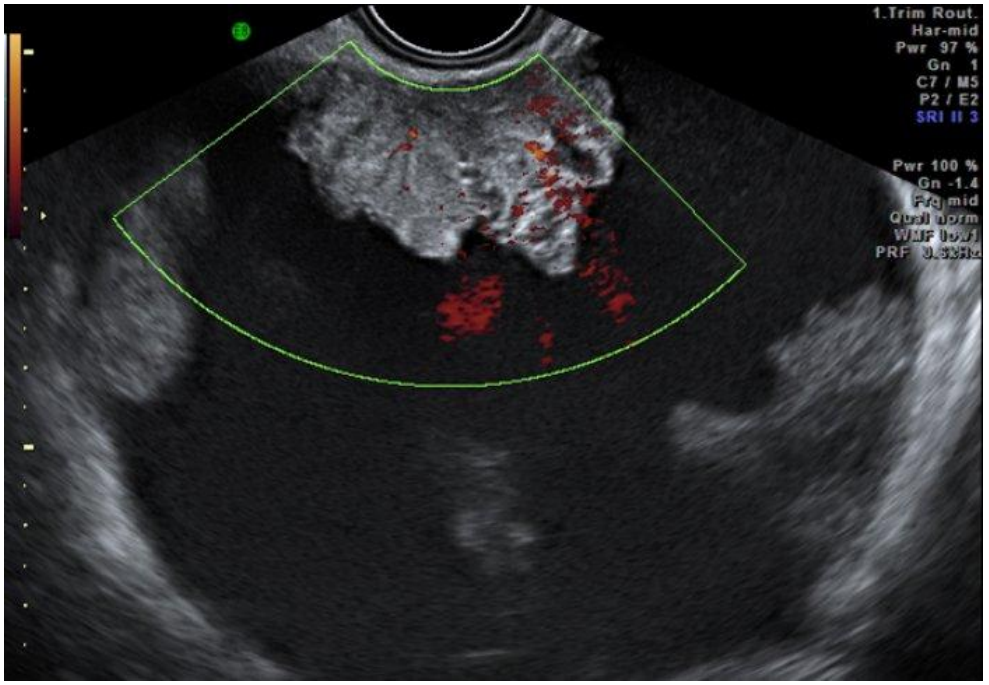
Normal ovary





Benign cysts in ovary – smooth cyst walls, homogenous content, nothing protruding

Malignant Cysts (Cancer)

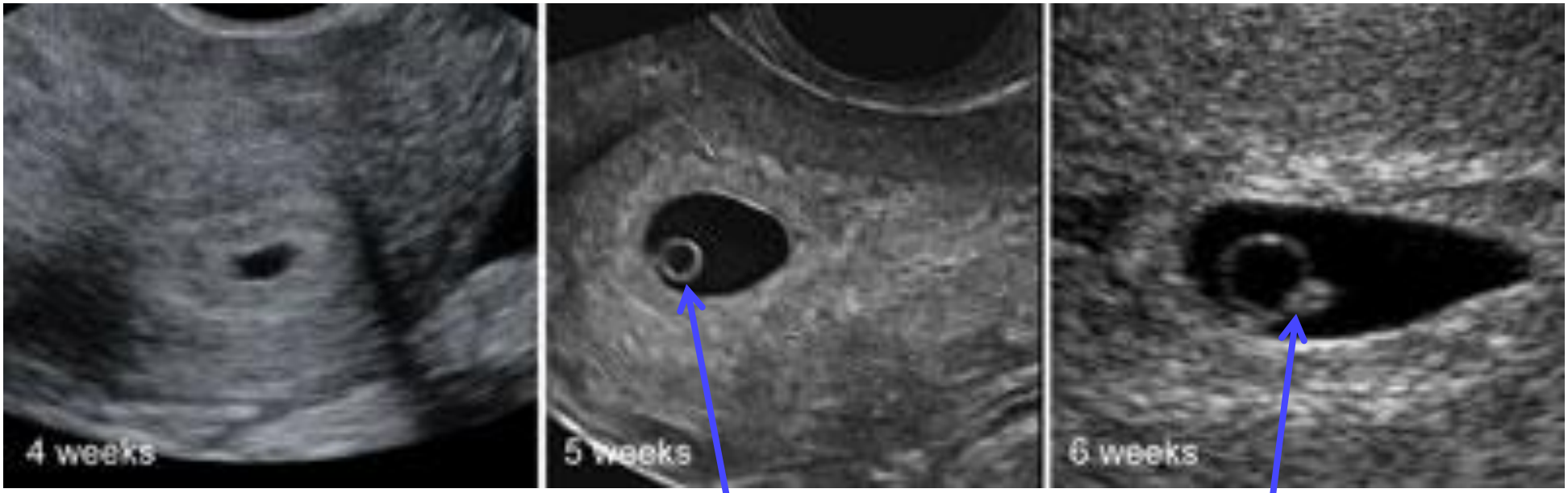


Strong suspicion of malignant cysts – irregular wall, multiple cysts or walls, protruding elements with blood flow

Early Pregnancy

- Assess viability = heart activity
- Localisation of pregnancy – inside uterus? outside = extra-uterine pregnancy?
- Assess age of pregnancy / fetus

Early Pregnancy



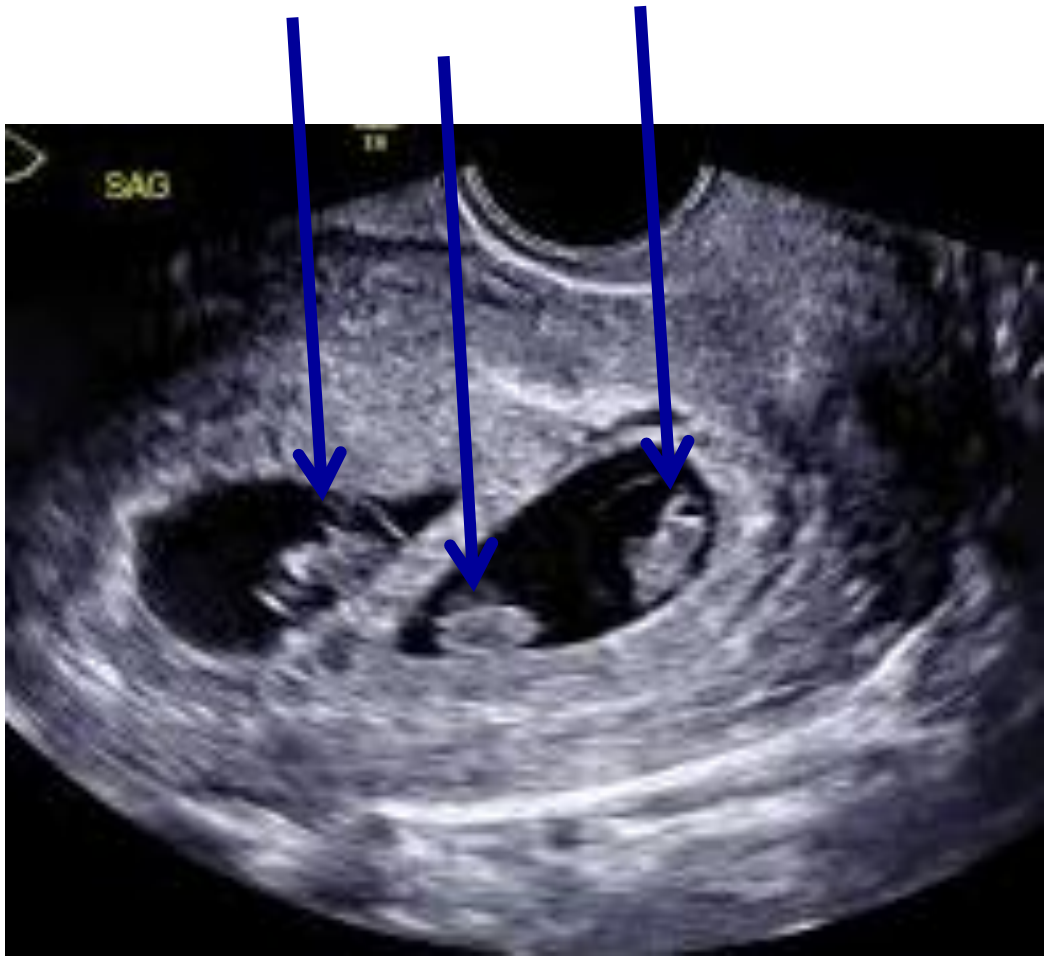
Initially a fluid filled sac

..then a yolk sac…

..and eventually an embryo

Early Pregnancy

…or three…like in triplets…



Good Things With Ultrasound

- Easy accessible
- No radiation so can be used in pregnancy
- Can get close to target organ with vaginal probe with increased resolution
- Can be used for many different clinical questions as a complement to other investigations
- Possible to evaluate blood flow

Limitations

- Obesity a limitation in abdominal scans
- Late in pregnancy increased depth, skeleton that shadows so sometimes difficult to see
- If no amniotic fluid almost impossible to see structures adequately
- Fetal and maternal movements make scanning and use of Doppler challenging at times
- Operator dependent

What We Would Like to See But Can Not…

- We would like to know more about function than just blood flow as a surrogat measure…for instance
  - Cardiac function (tissue Doppler?)
  - Function and consistency of cervix (elastography?)
  - Placental function (perfusion imaging???)

It would also be good to see

- With better resolution at increasing depths
- To see anastomoses on the placental surface

Final Remarks

- Use ultrasound in many different settings
- Important clinical tool
- Safety important in pregnancy
- B-mode, 3D, color, power and pulsed Doppler are mainly used
- We use it for diagnosis, monitoring, sampling and treatment

Thank you

for your attention!