The third trimester brain

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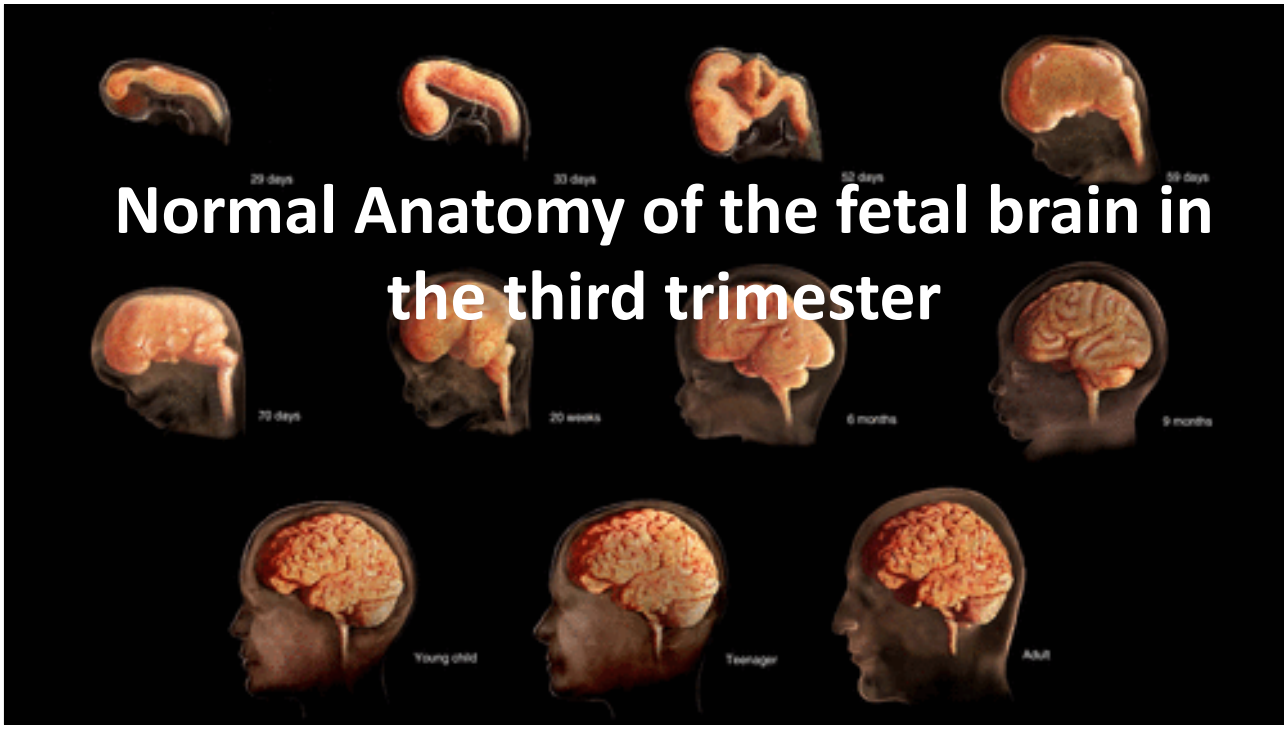
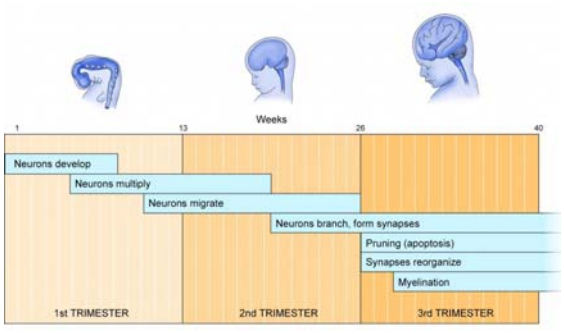
Ontario Fetal Center

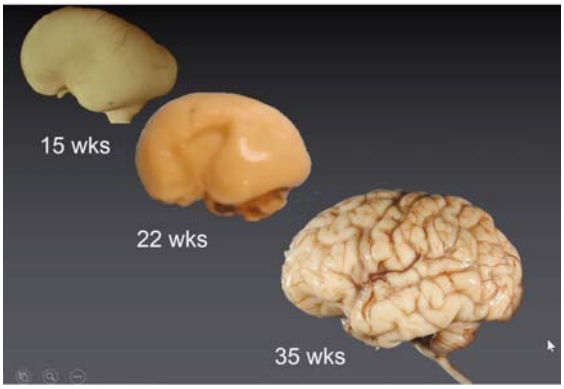
Fetal Medicine Updates, Oct 16th, 2022

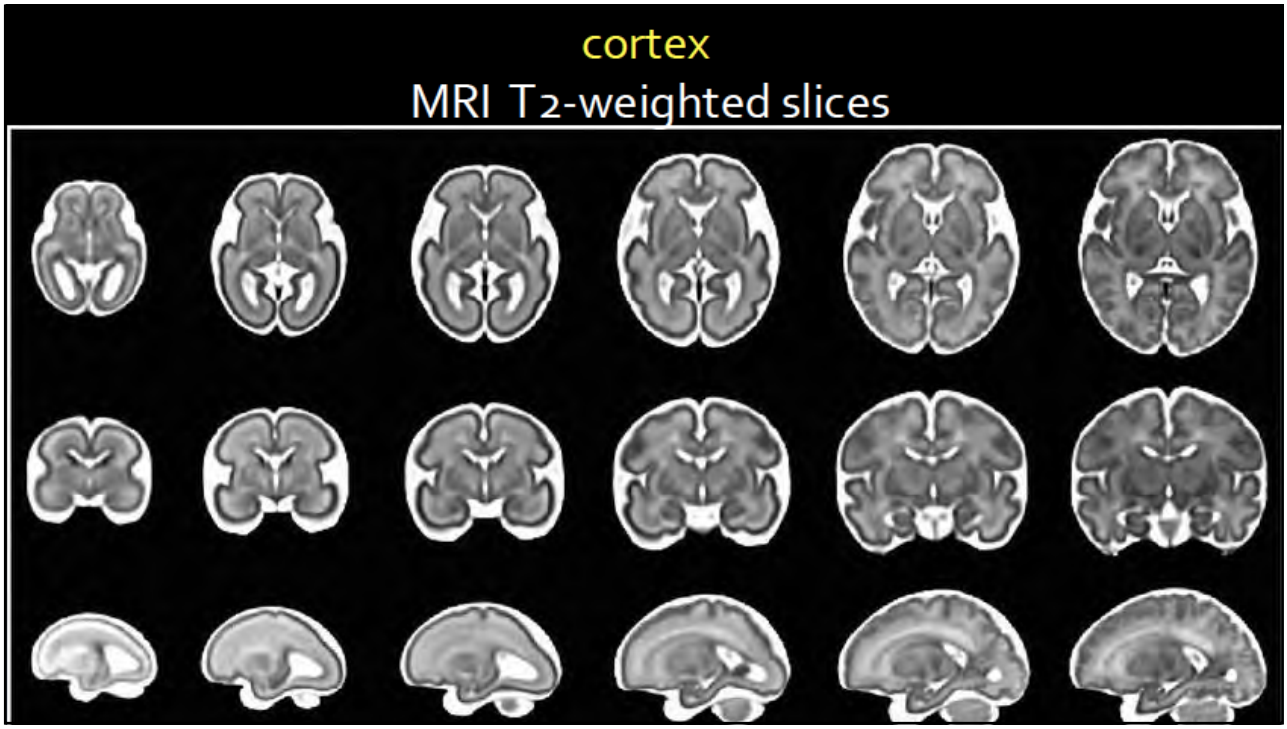
Outline

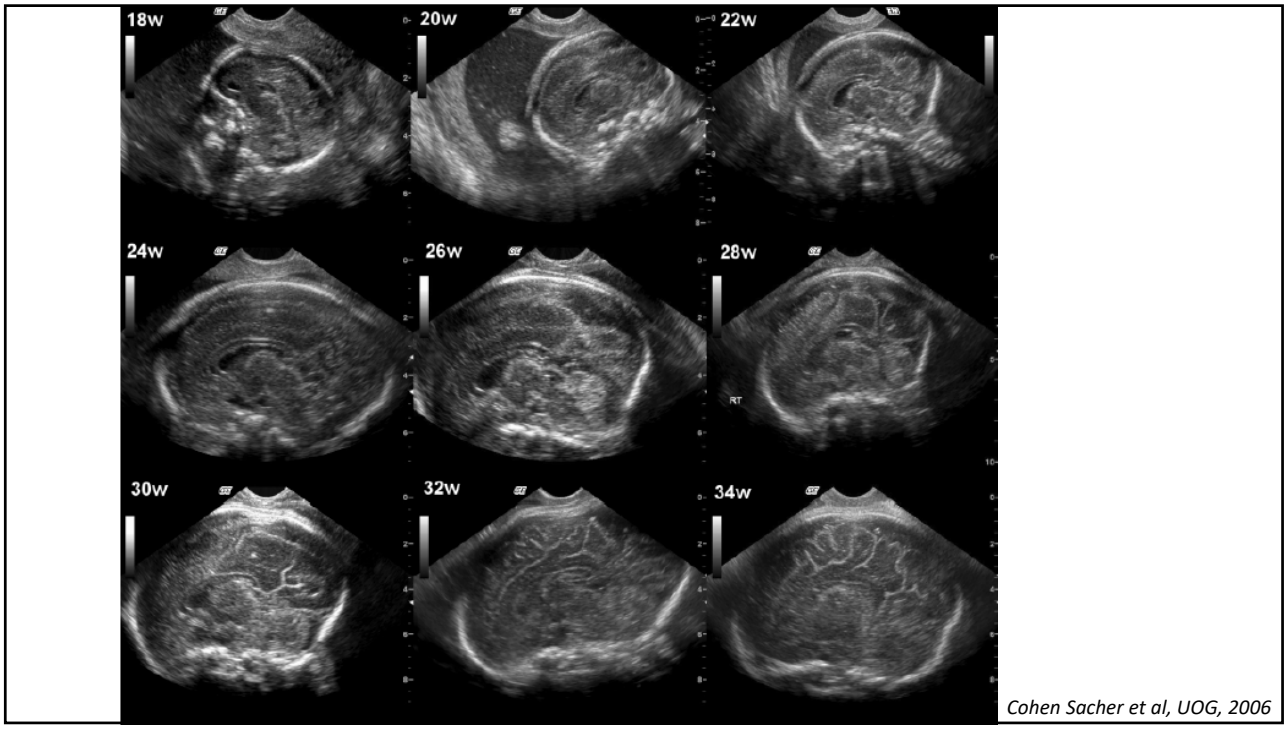
- The fetal brain in the third trimester
- Late detection of brain anomalies – (quick) review of 10 cases
- Current guidelines for third trimester ultrasound


Normal Anatomy of the fetal brain in the third trimester
29 days
30 days
70 days
20 weeks
6 months
9 months
Young child
Teenager
Adult

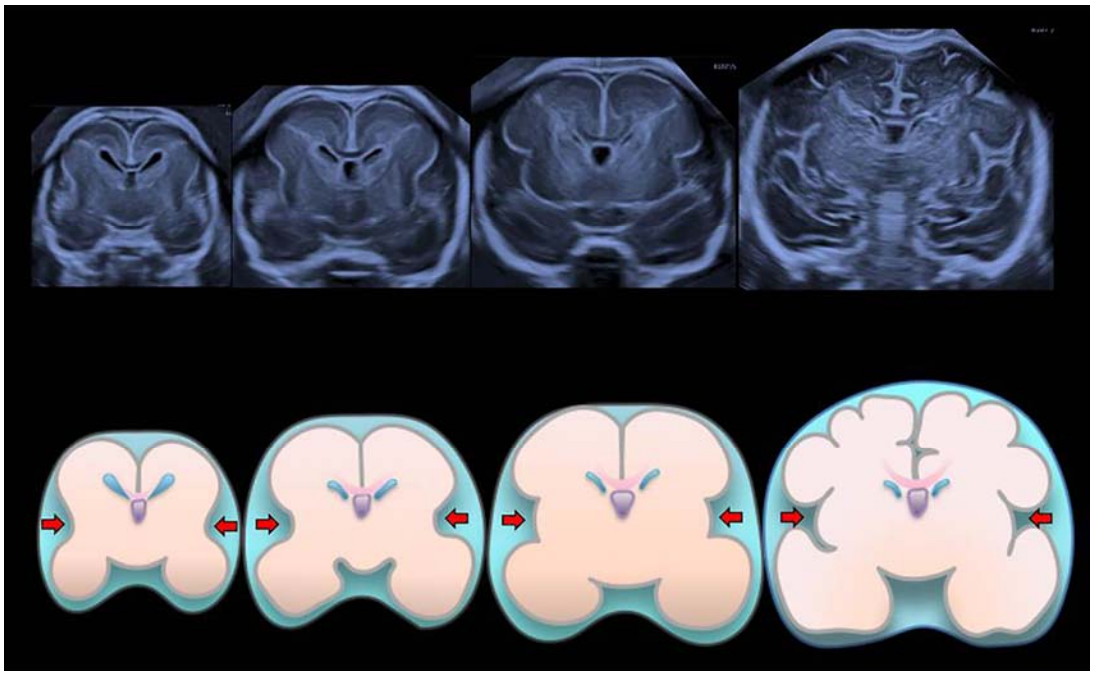

Weeks
1
13
26
40
Neurons develop
Neurons multiply
Neurons migrate
Neurons branch, form synapses
Pruning (apoptosis)
Synapses reorganize
Myelination
1st TRIMESTER
2nd TRIMESTER
3rd TRIMESTER

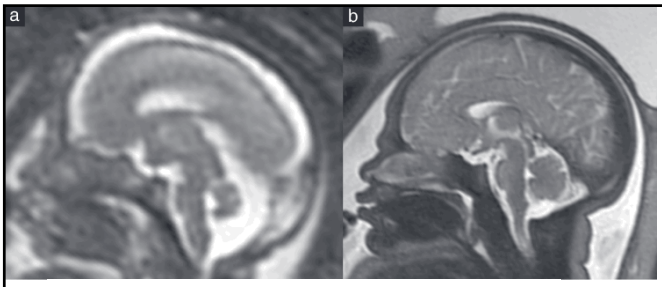

15 wks
22 wks
35 wks

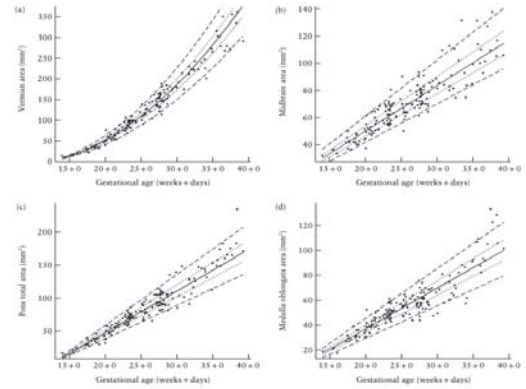




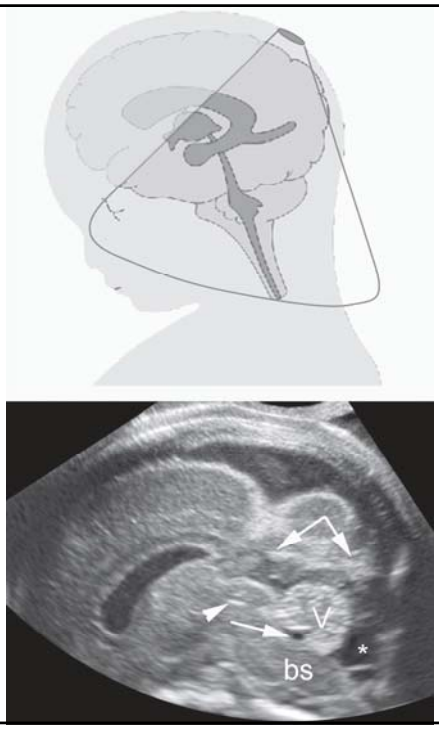
Cohen Sacher et al, UOG, 2006





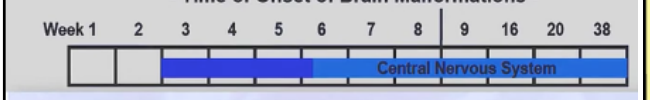


Ultrasound Obstet Gynecol2021;58: 254 – 263.



Neurodevelopmental Processes

- Time of Onset of Brain Malformations -



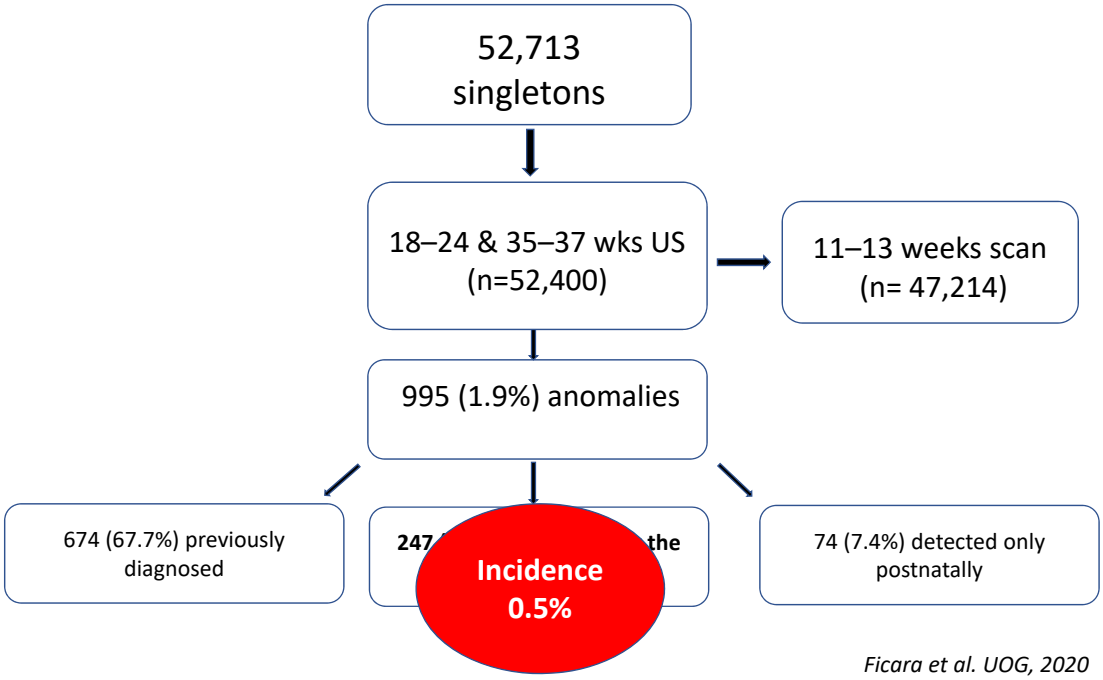
Process	Malformation	Time
Dorsal Induction	Neural Tube Defects	3-7 w.
Ventral Induction	Holoprosencephaly	5-6 w.
Neuronal Glial Proliferation	Micro/Megalencephaly	8-16 w.
Migration	Lissencephaly and heterotopia	12-20 w
Organization	(Poly)microgyria, dysplasia	>24 w.
Myelination	Hypo/dysmyelination	>24w.

Early abnormalities (NT, early anatomy scan):

- Neural tube defects
- Holoprosencephaly
- Ventriculomegaly
- Some posterior fossa abnormalities

Late abnormalities (late anatomy scan, third trimester):

- Ventriculomegaly
- Abnormalities of corpus callosum
- Posterior fossa abnormalities: Dandy-Walker spectrum, cerebellar hypopla pontocerebellar hypoplasia
- Anomalies of the brainstem
- Malformations of cortical development:
  - Disorders of proliferation: Microcephaly and Megalencephaly
  - Disorders of migration & organization: Heterotopia, Lissencephaly, Polymicrogyria
- Insults, hemorrhages, cysts and tumors, infective fetopathy



Ficara et al. UOG, 2020

Ultrasound Obstet Gynecol 2002; 20: 51–56

A normal second-trimester ultrasound does not exclude intracranial structural pathology

G. MALINGER*, T. LERMAN-SAGIE†, N. WATEMBERG†, S. ROTMENSCH*, D. LEV‡ and M. GLEZERMAN*

Table 1 Main diagnosis in 203 fetuses with central nervous system pathology

Main diagnosis	*Total* (n (%))	*Late diagnosis* (n)
Hydrocephalus—ventriculomegaly	55 (27.1)	6
Open neural tube defect	42 (20.7)	—
Anencephaly	34 (16.6)	—
Posterior fossa anomaly*	23 (11.3)	2
Corpus callosum anomaly	13 (6.4)	10
Holoprosencephaly	11 (5.4)	—
Signs of intrauterine infection†	7 (3.5)	4
Cerebral cysts	4 (2.0)	4
Hemorrhage‡	3 (1.5)	2
Macrocephaly	3 (1.5)	3
Microcephaly	3 (1.5)	1
Craniosynostosis	3 (1.5)	—
Migration disorder	1 (0.5)	1
Brain atrophy	1 (0.5)	1

34 (16.7%) were diagnosed only in the third trimester.
In 25 the second trimester scan was reported as normal!

What are we missing and how often?

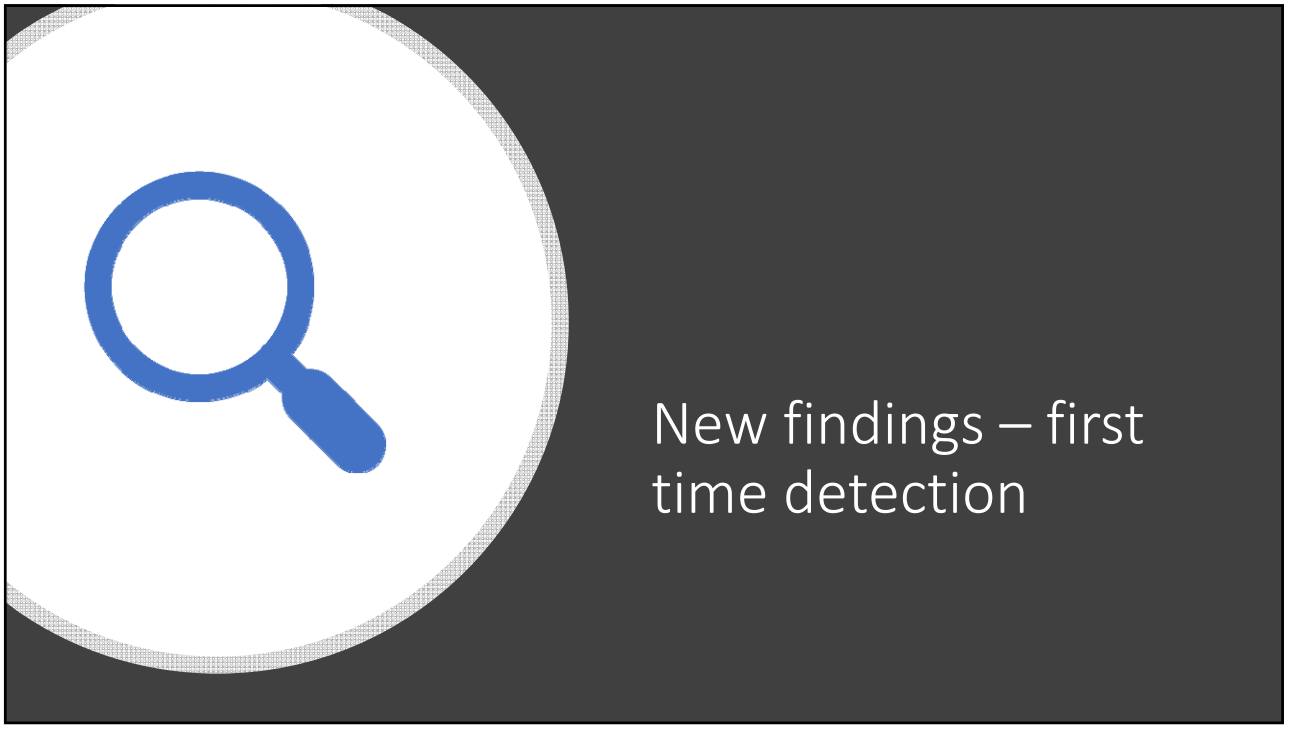
Brain anomalies presenting in the third trimester

Acquired lesions

Stroke
Hemorrhage
Infection
Tumors

Developmental anomalies

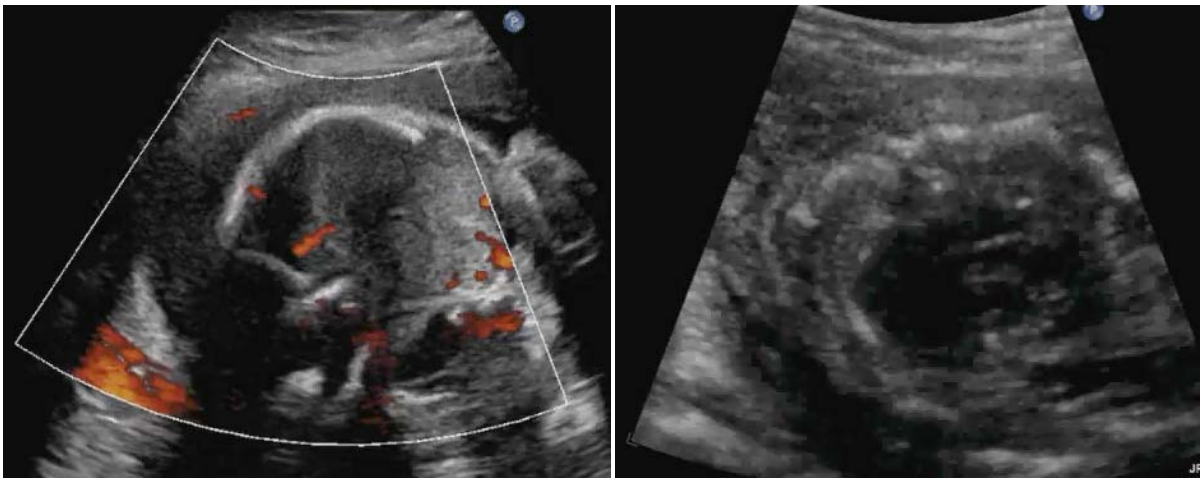
Cortical malformations
Microcephaly
Macrocephaly
(Hemi)megalencephaly
Lissencephaly
Polymicrogyria
PVNH
Tubulinopathy



New findings – first time detection

Case 1

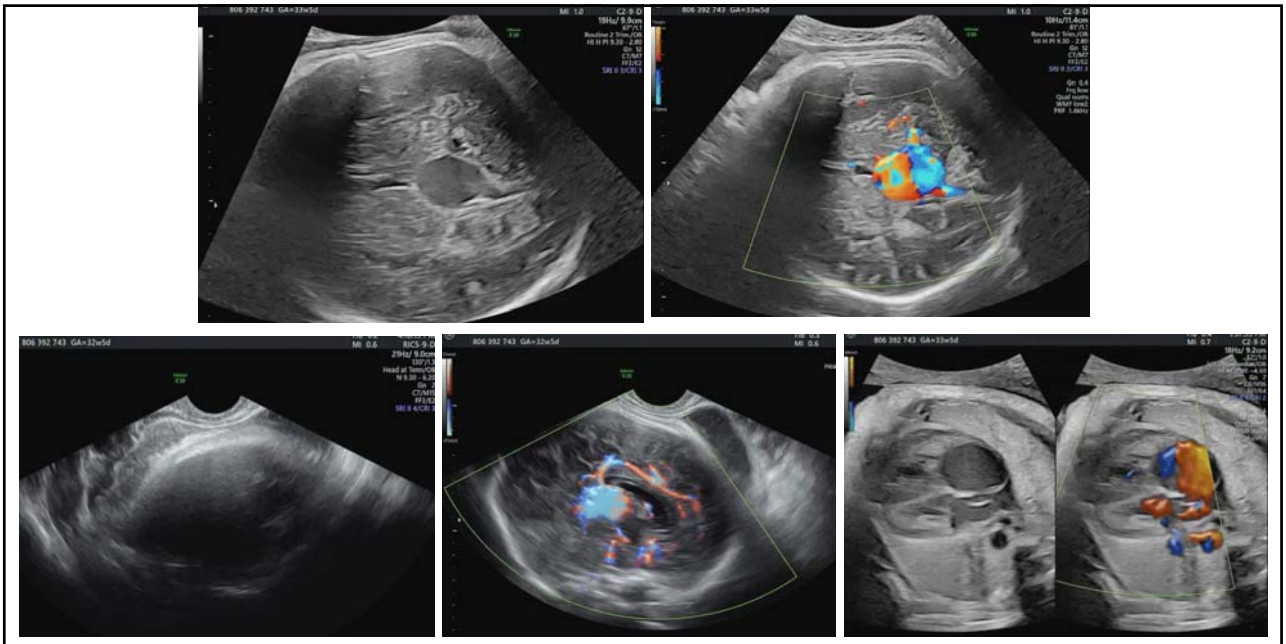
- 30 y/o G2P1
- Healthy
- Previous uncomplicated pregnancy and term SVD. Healthy female.
- Spontaneous conception
  - Normal NT and low risk FTS
  - Normal anatomy
  - 31 week ultrasound – brain mass



30+1 weeks

Case 2

- 34 y/o G2P1
- Healthy
- 1 previous term CS for IUGR. Epilepsy.
- Current pregnancy
  - Spontaneous
  - Normal NT and low risk NIPT
  - Normal anatomy
  - Midline mass on routine 31 week US



32+5 weeks

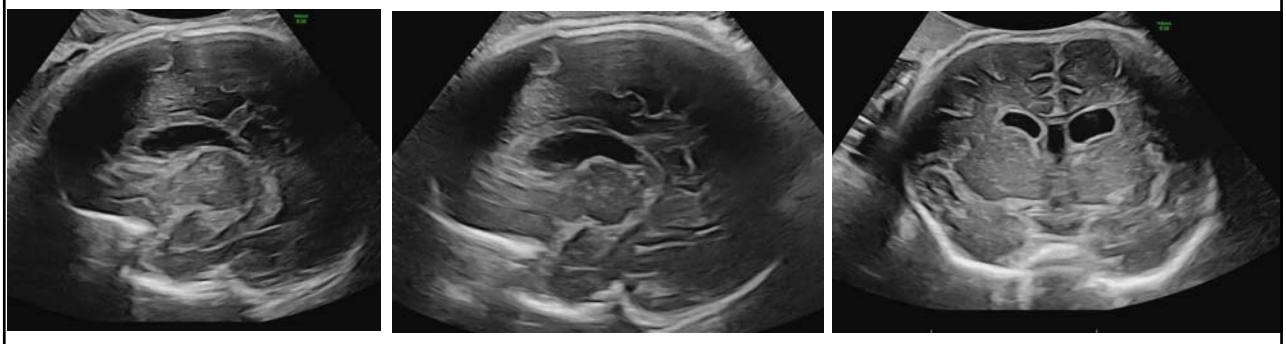
Case 3

- 35 y/o G2P0
- Healthy.
- Current pregnancy
  - Normal NT and low risk FTS
  - Normal anatomy
- 28 weeks – midline cystic brain structure

31+0 weeks

Case 4

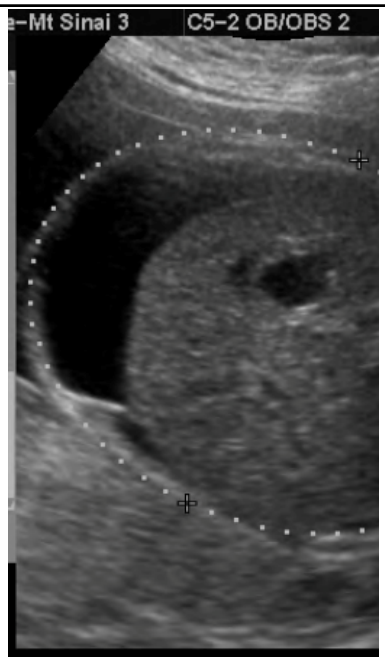
- 36 y/o G3P2
- Two previous uncomplicated pregnancies, healthy children
- Current pregnancy
  - Normal NT and low risk FTS
  - Normal anatomy
- Ultrasound 34+0 wks
  - Prominent anterior horns
- Ultrasound 36+0 wks
  - Dilated anterior horns

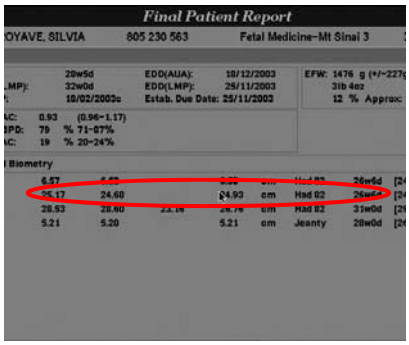


37+0 weeks

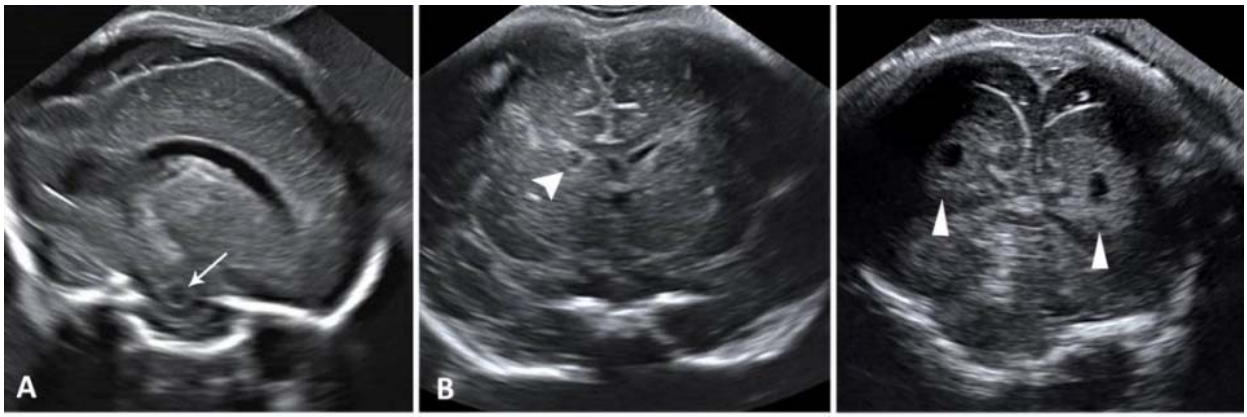
Case 5

- 30 y/o
- G2P1
- Previous uncomplicated pregnancy. Healthy 2 year old
- Current pregnancy
  - Normal NT, FTS
  - Normal anatomy
- 31 week US - small HC





32 weeks

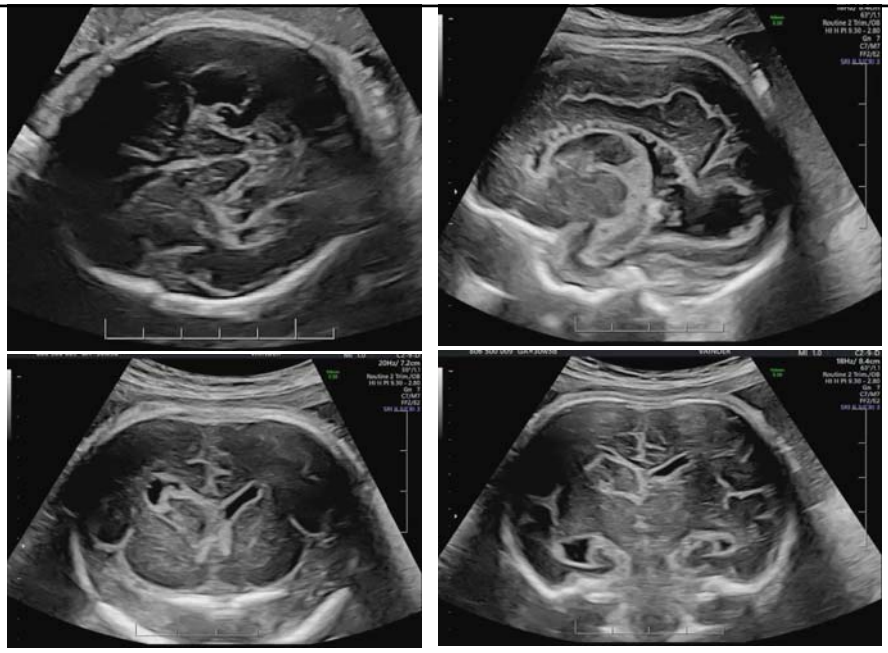


29 weeks

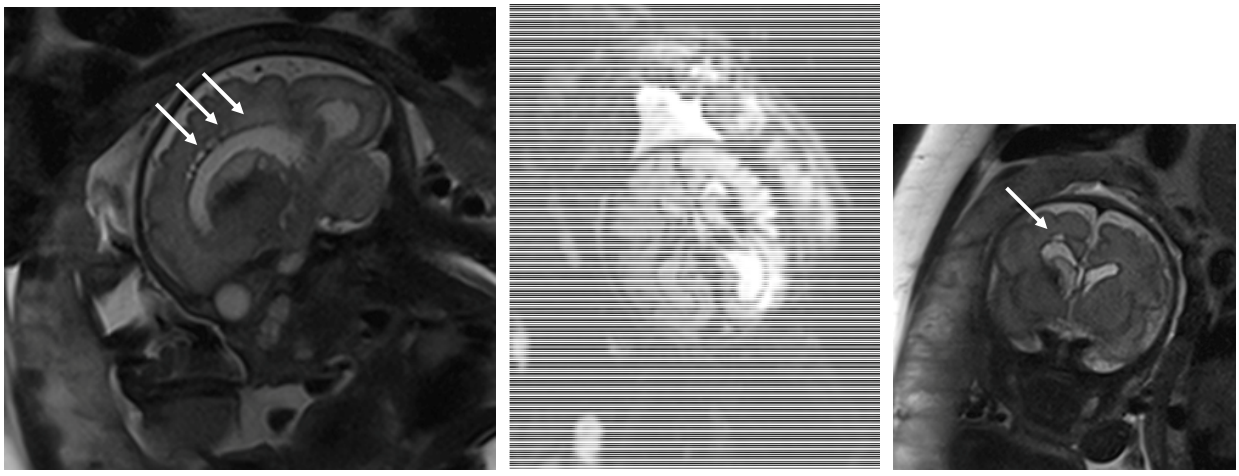
Birnbaum R et al, Prenat Diagn. 20

Case 6

- 33 y/o G5P1
- Healthy
- Previous uncomplicated pregnancy and term CS
- Sponatenous pregnancy
  - Normal NT and low risk FTS
  - Normal anatomy
  - 30 weeks - ventriculomegaly

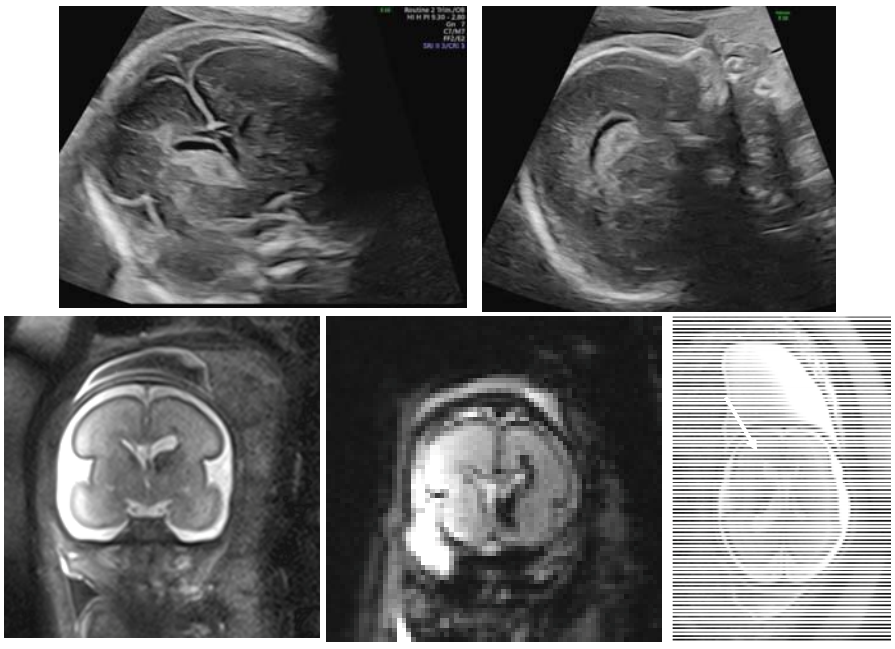


31 weeks



Case 7

- 35 y/o G1
- Graves disease
- Sponatenous pregnancy
  - Normal NT and low risk FTS
  - Normal anatomy
  - US for thyroid at 26 weeks



31 weeks

Missed diagnosis

Ultrasound Obstet Gynecol 2013; **42**: 687–690
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Agenesis of the fetal corpus callosum: sonographic signs change with advancing gestational age

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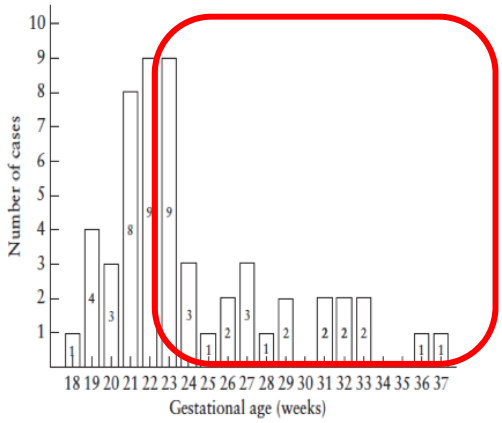
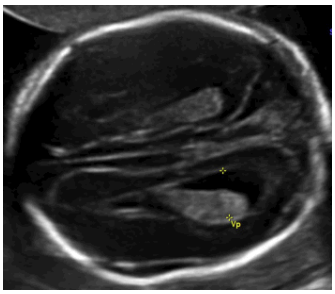




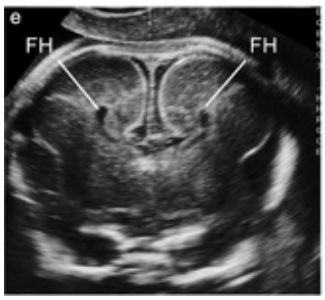
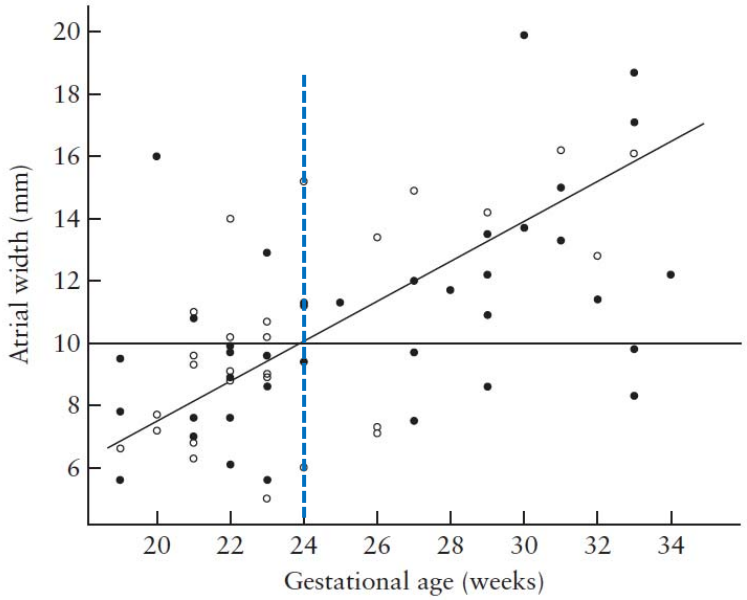


Table 1 Sonographic signs of fetal partial/total agenesis of the corpus callosum (ACC) according to gestational age

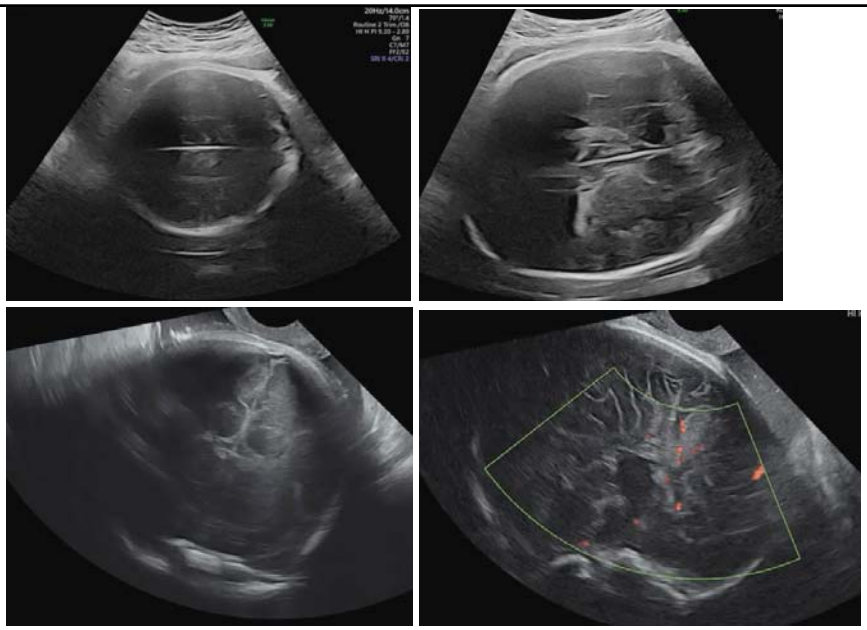
Sonographic sign	*< 24 weeks (n = 34)*	*≥ 24 weeks (n = 35)*
Atrial width > 9.9 mm	9/34 (26.5)	26/35 (74.3)
Colpocephaly	7/34 (20.6)	24/35 (68.6)
Spear-shaped ventricles	7/34 (20.6)	3/35 (8.6)
Non-visualization of CSP*	6/17 (35.3)	2/10 (20.0)

doi.org/10.1002/uog.12315



Case 8

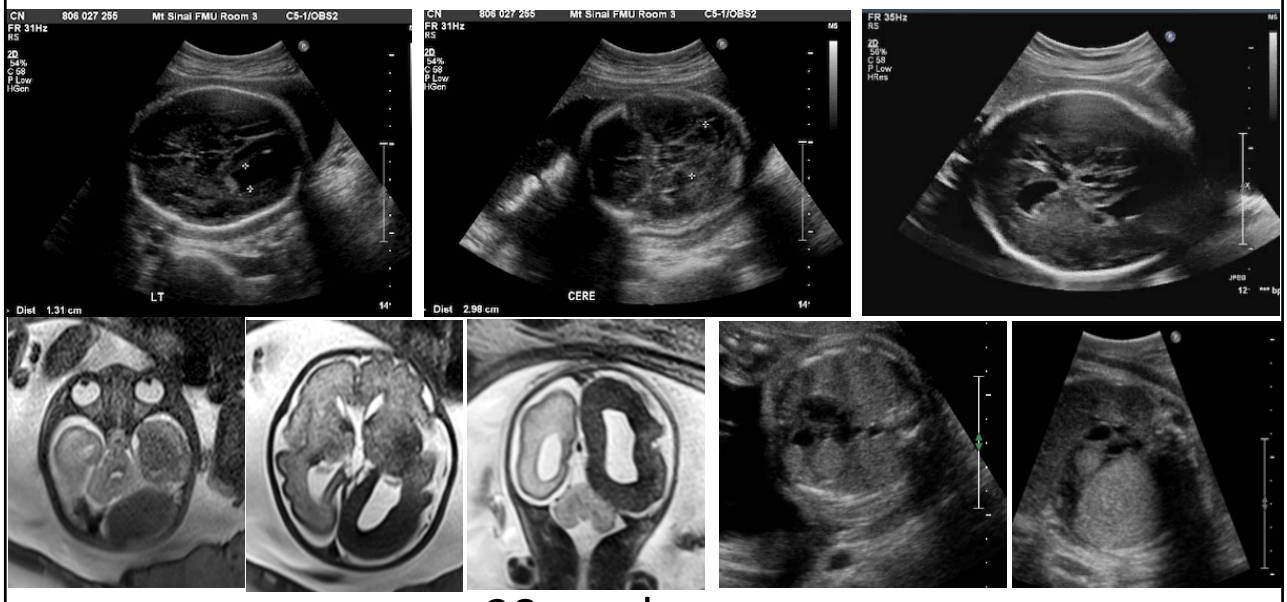
- 34 y/ G2P1
- Previous uncomplicated pregnancy
- Current pregnancy
  - NT 3mm but low risk FTS
  - Normal anatomy
  - 33 week US – ACC?, IUGR, abnormal outflow tracts
  - Echo - coA



34+5 weeks

Case 9

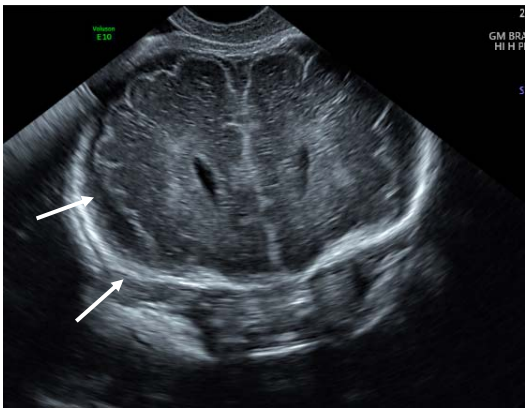
- 33 y/o G2P1
- Previous uncomplicated pregnancy. Healthy child
- Current pregnancy
  - Normal NT and FTS
  - Anatomy – normal. LV 9 mm
  - Follow up 25 weeks – Unilateral mild VM



28 weeks

Case 10

- At 22 wk, the HC = + 1.2 SD
- At 29 wk the HC = +2.8 SD, LV = 10-11 mm
- At 31 wk the HC= +3 SD LV = 10-11 mm
- At 32+1 wks neurosonography HC= **+3.6 SD**



31 weeks

courtesy of Dr Roee Birnbaum

Should we offer a third trimester ultrasound in low-risk patients?

"…in multiple gestations, in cases where the fundus cannot be palpated, in cases of maternal risk factors for FGR, an ultrasound examination is preferred as a screening tool after 24 weeks …

Offered only to at-risk women and includes

- Serial biometry
- UA Doppler

Targeted to the requirements and needs of the patient and referring doctor. Suggests to report:

- AFI
- Biometry
- UA PI
- Limited anatomy survey within the limits of late gestation, fetal lie and maternal conditions

A third-trimester scan is routinely offered to all pregnant women and is limited to:

- AFI
- Fetal presentation
- Biometric measurements

Routine third trimester ultrasound in all pregnancies

- AFI
- Presentation
- Biometry
- Placental location
- If no second trimester survey, an assessment should include:
  - Lateral brain ventricles
  - 4 chambers of heart
  - Bladder
  - Kidneys
  - Stomach

Universal third-trimester scan
Require a large portion of the anomaly scan to be repeated

Thank you

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