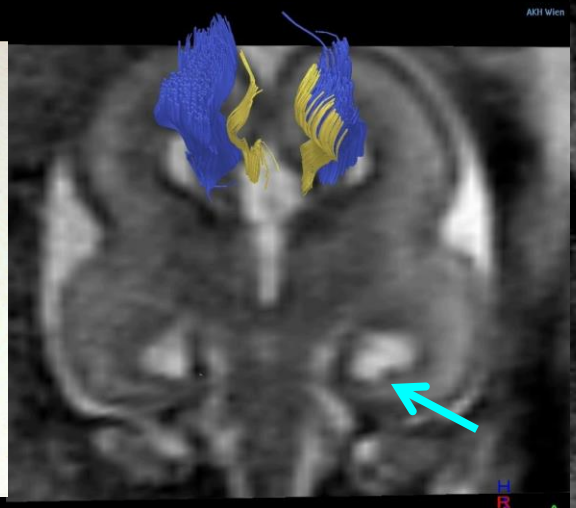
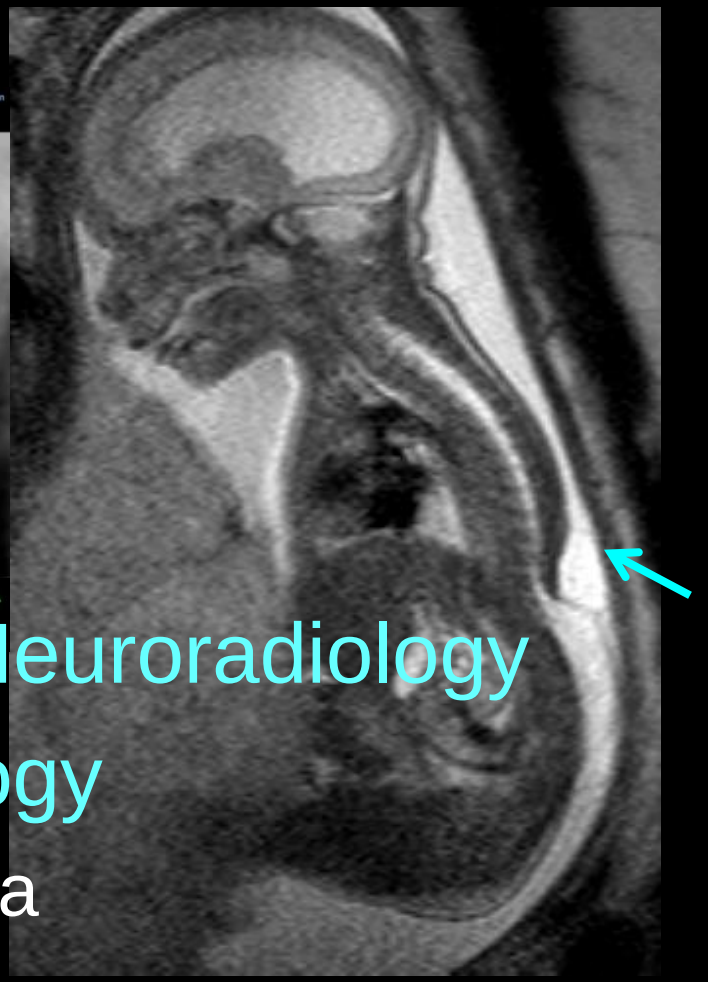
# Prenatal Diagnosis of Central Nervous System (CNS) Pathologies: does Fetal MRI help in their management?



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Medical University Vienna/Austria

# Fetal MRI: Why?

## Indications: ACOG Recommendations

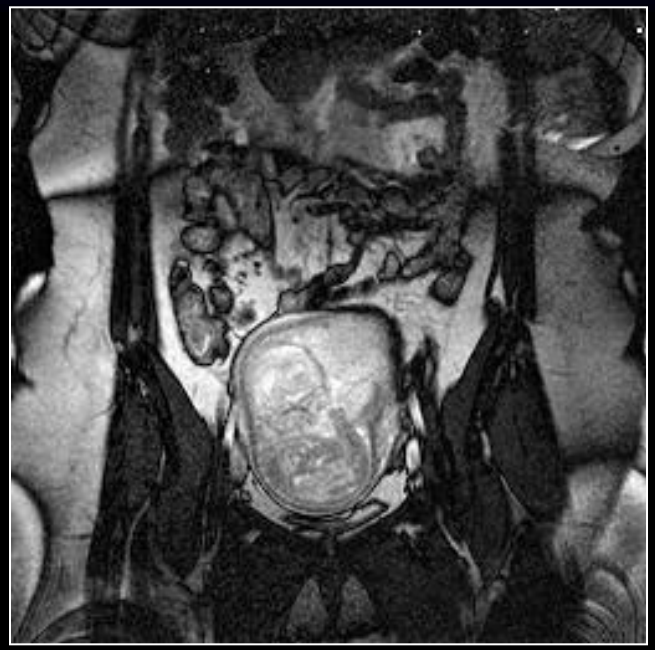
### Common Indications:

- elevated BMI
- Oligo/ Anhydramnios
- Scarring of the abdomen
- Position of the fetus that allows only restricted US assesment

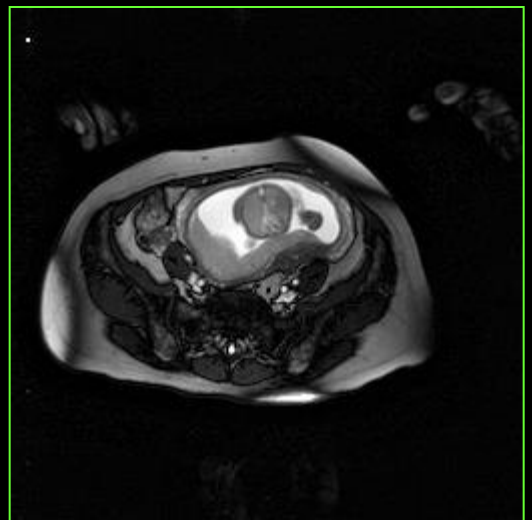
### Special Indications:

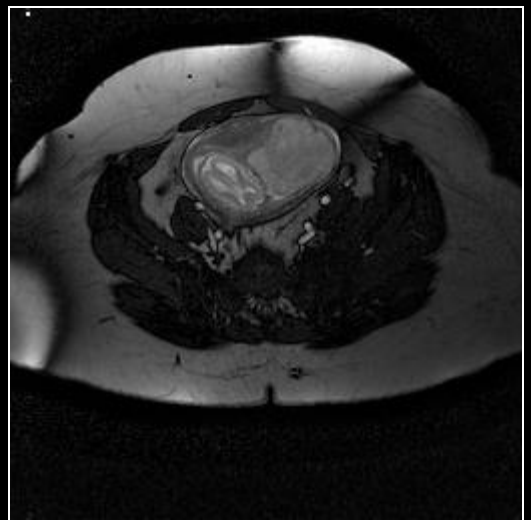
Situations, where MRI allows a better estimation of the intrauterine situation than US alone

# Increased BMI + Anhydramnios

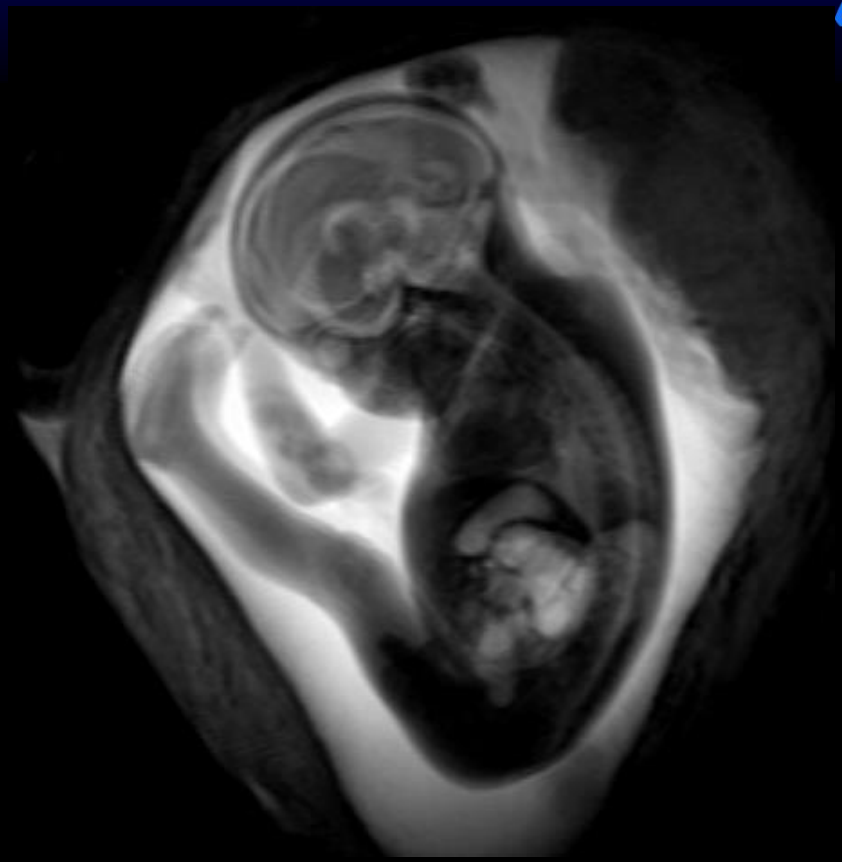


GW
19+1





# Fetal MRI: Why?



## Definitely indicated (>48%):

Callosal agenesis
Posterior fossa anomalies
Microcephaly

## Indicated (30-48%):

Ventriculomegaly
Neural tube defects
Diaphragmatic Hernia

## Low priority (10-30%):

Pulmonary anomalies,
Multiple malformations
Abdominal wall defects

## Very Low priority (0-10%):

Congenital heart defects,
Urinary tract, Twins, Cleft lip

UOG 2017, in press

# Fetal MRI: How?

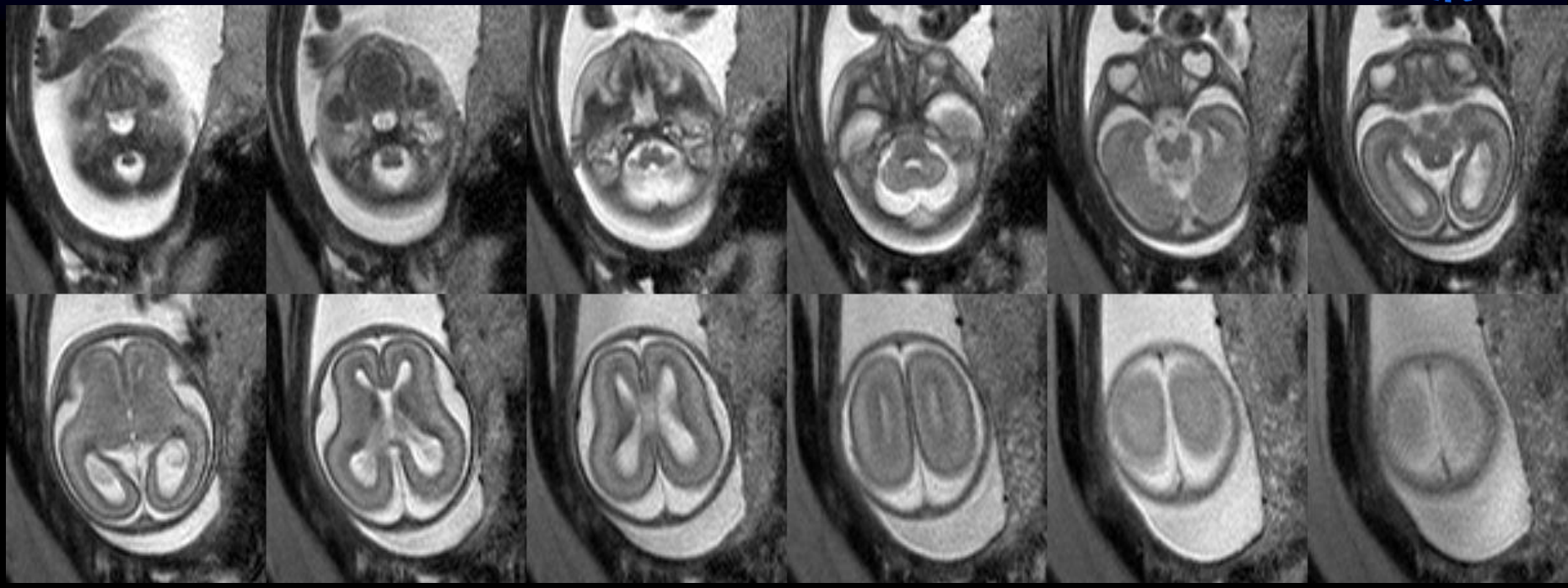
Modern 1.5 or 3T, big bores – less claustrophobia

# Fetal MRI: How?

Large coils: more receptor elements, but heavier

# Fetal MRI: How?

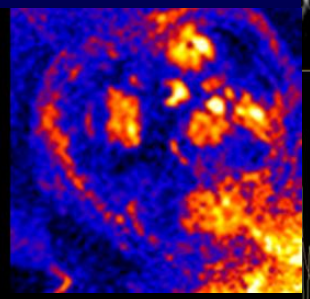
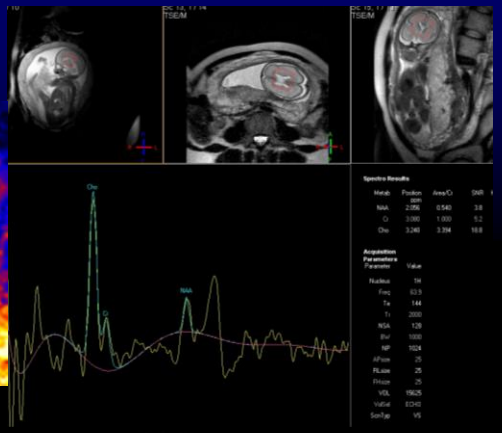
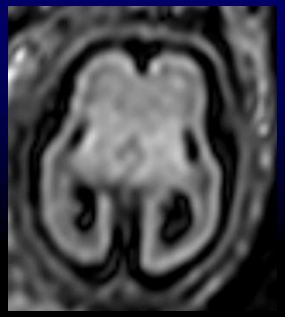
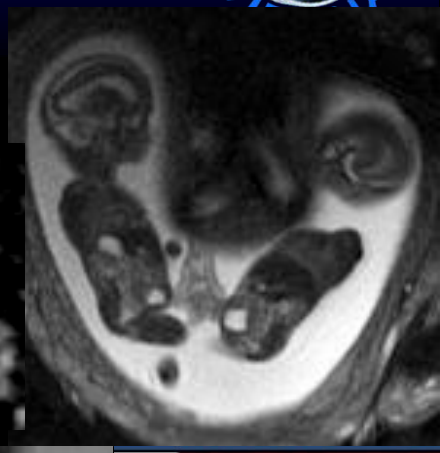
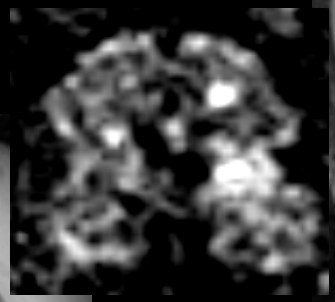
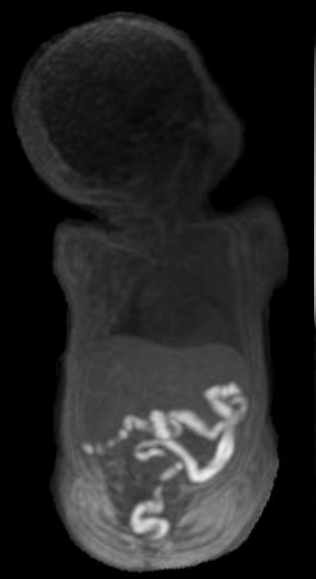
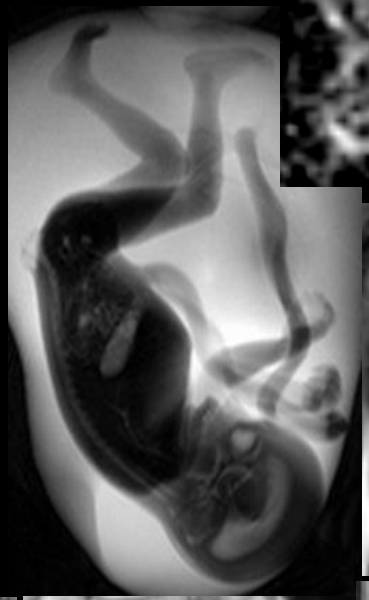
GW 20+4

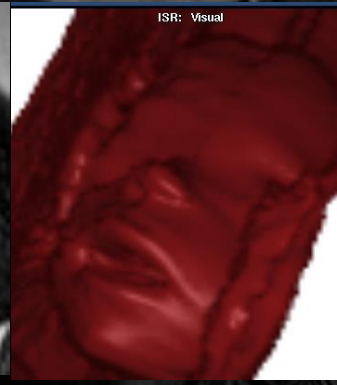


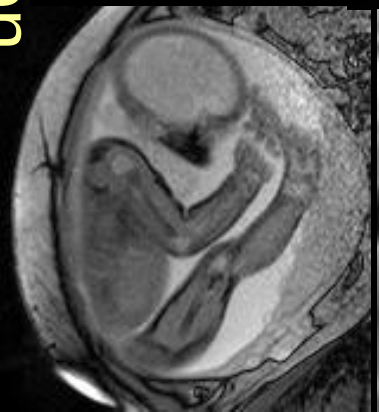
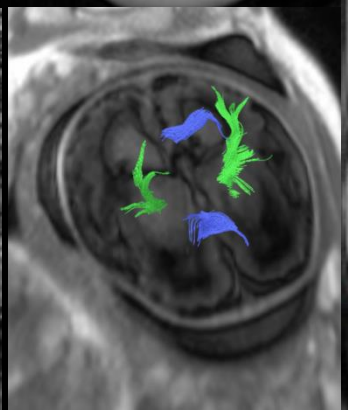
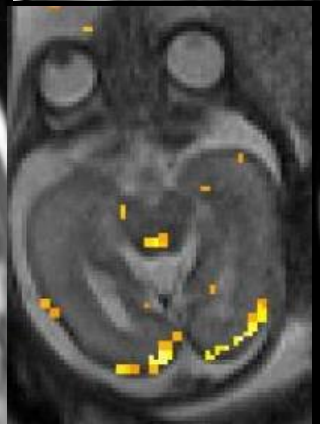
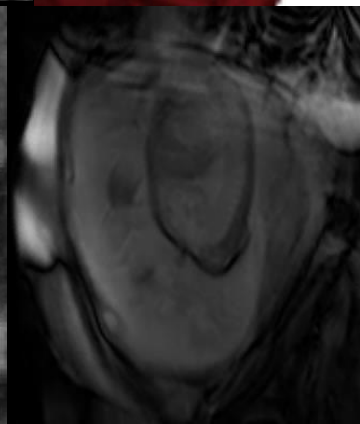
## Sequence

= Choice of parameters influencing signals, resolution…

Continuous series of images
In 20 sec



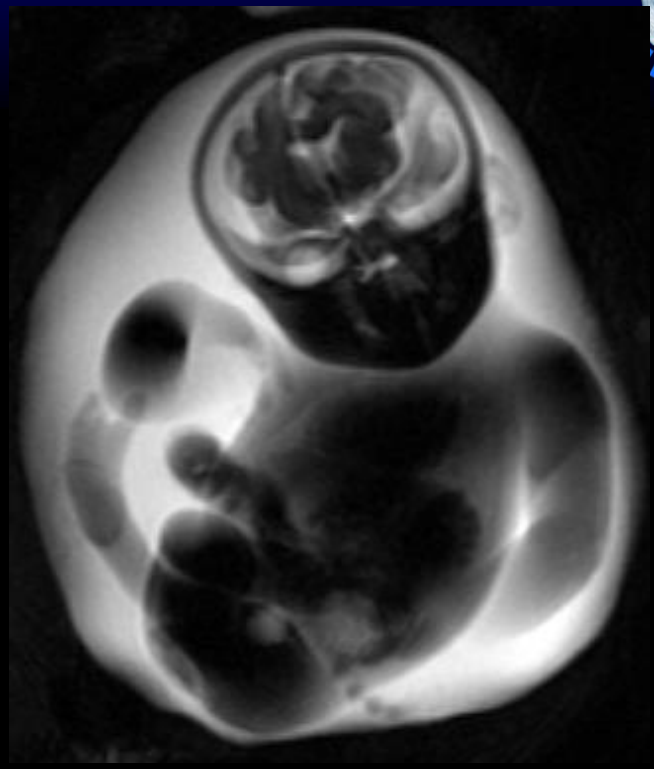
T2

T1
EPI
Angiography
FLAIR
Diffusion-
Thick slab
Dynamic
Metabolic
Perfusion-

f-MRI, 3D

information

# Questions for fetal MRI



pathology present?

no

yes

survival?

no

yes

yes
but (surgical) therapy
required

prenatal

postnatal

recurrence
risk

prognosis

# Questions for fetal MRI

pathology present?

Frequent question:
isolated ventriculomegaly
on Ultrasound

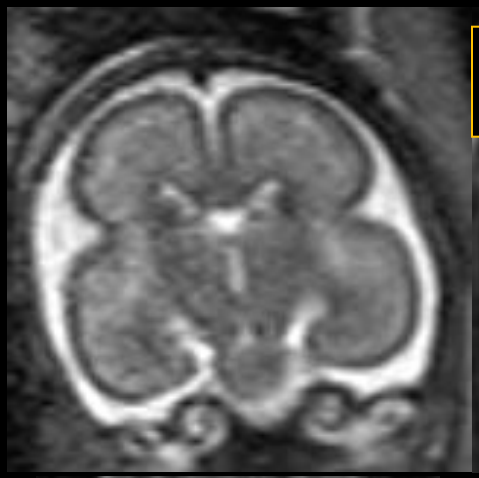
| | | **Ventricle in mm** |
|---|---|---|
| **Classification** | Normal | **<10mm** |
| | Borderline | **8.5mm – 10mm** |
| | Mild VM | **10mm – 15mm** |
| | Severe VM | >15mm |

Pagani G, Thilaganathan B, Prefumo F. Neurodevelopmental outcome in isolated mild fetal ventriculomegaly: systematic review and meta-analysis. UOG. 2014;44(3):254-60.

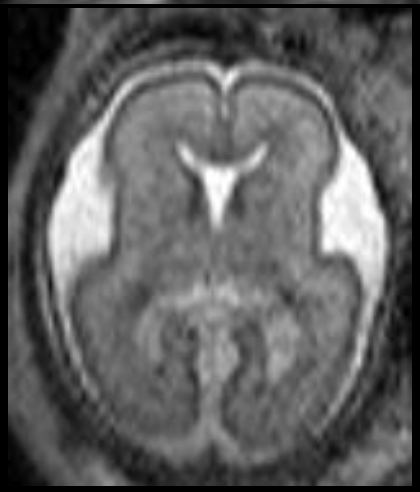
# Questions for fetal MRI

pathology present?

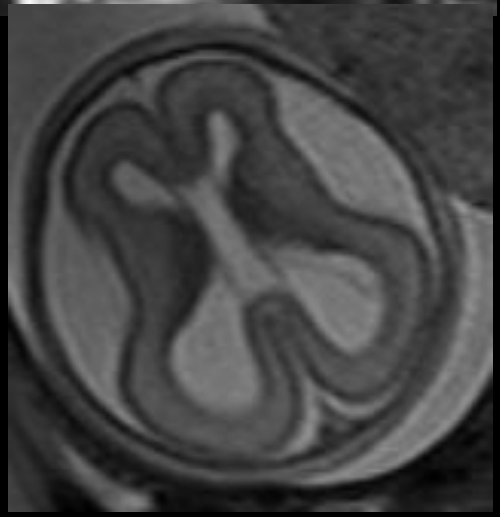
Premature gyri



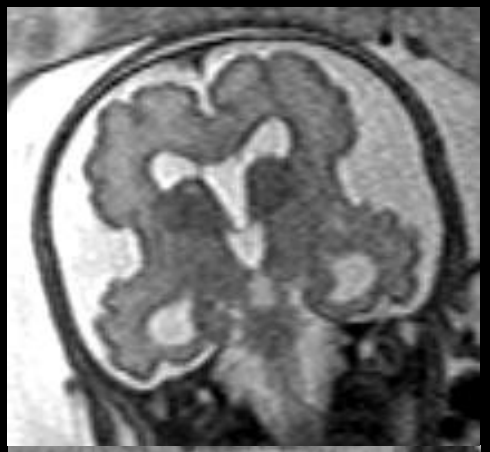
yes



GW 24 healthy



GW 23+5



GW 29+3

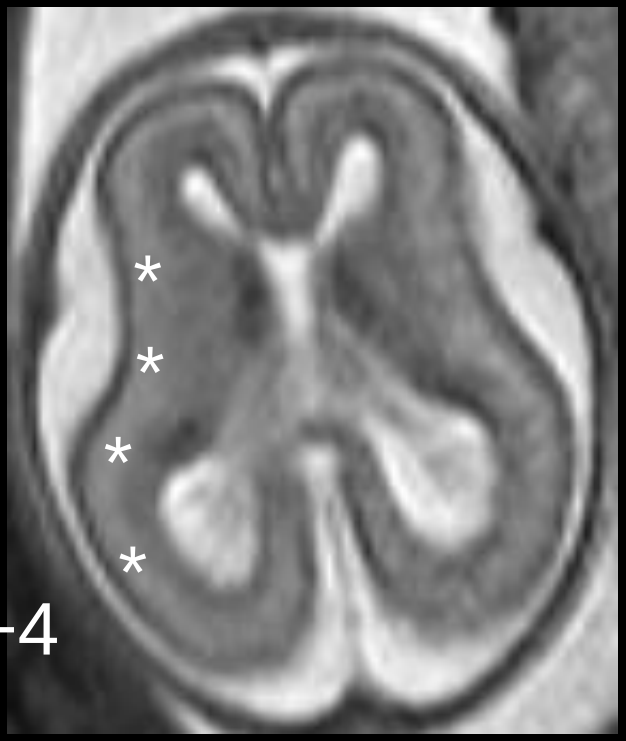
Cobble stone
Liss encephaly

# Questions for fetal MRI

pathology present?

no

MRI does not only show the surface of the brain but also the developing parenchyma




GW 20+4

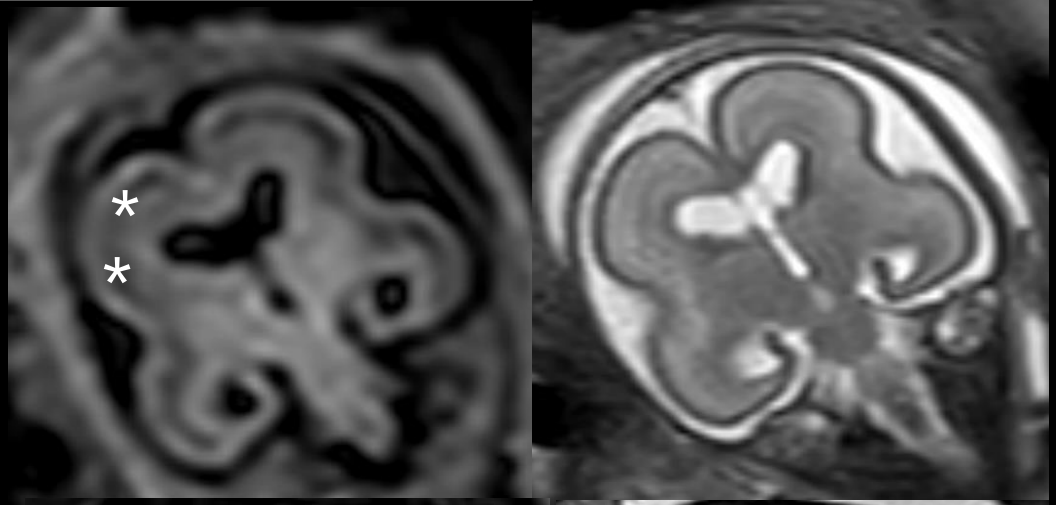
Most important structure: subplate (*) : integrity crucial for normal cortical devlopment

Kostovic I: The Anatomical Record 267 ;1-6 (2002)

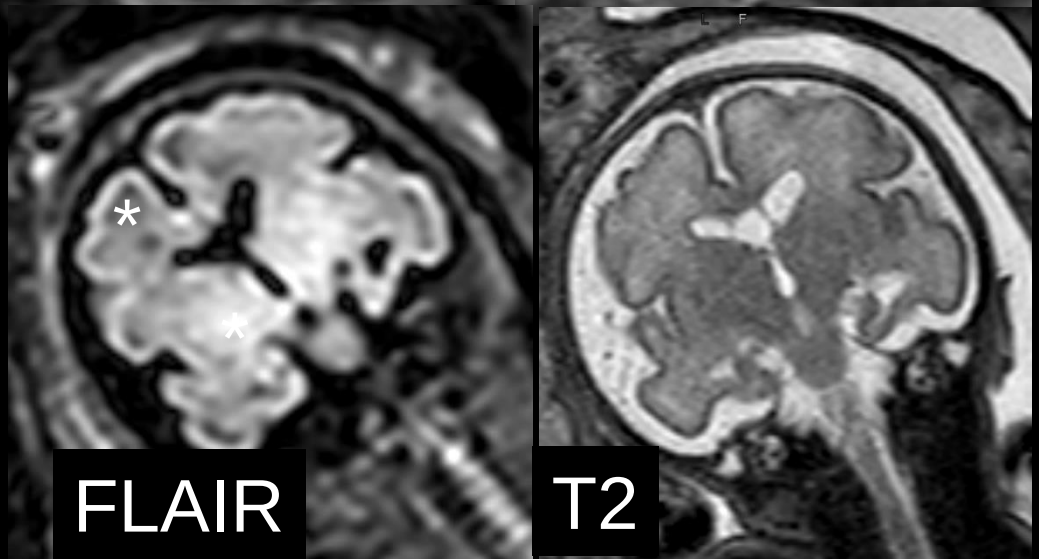
# Questions for fetal MRI

pathology present?

no




GW 23




GW 29

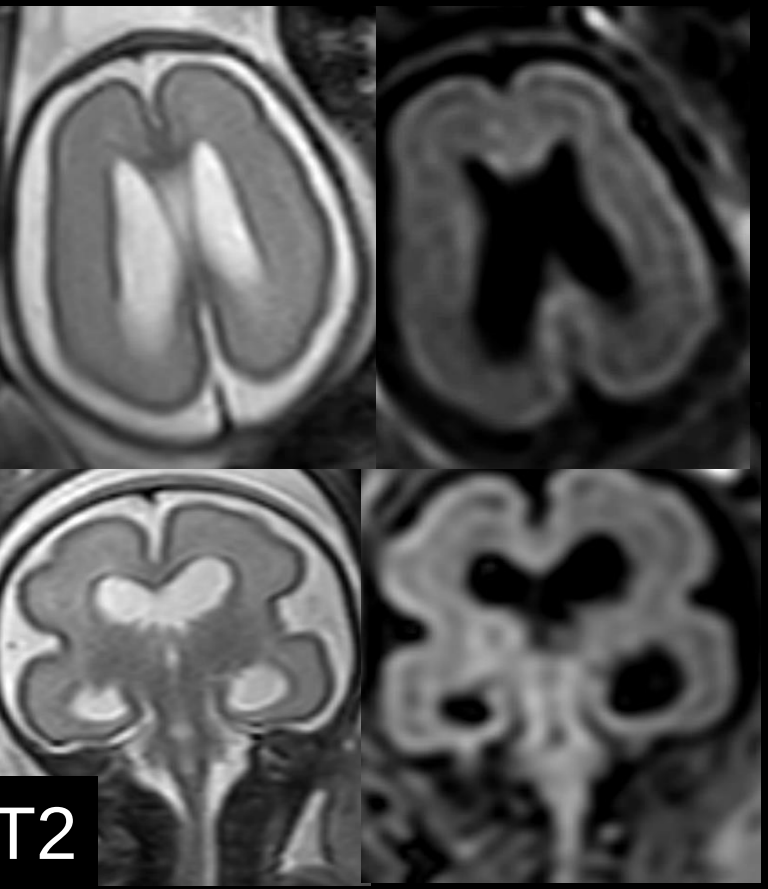
From GW 24 onwards Subplate (*) better visible on FLAIR than on T2

# Questions for fetal MRI

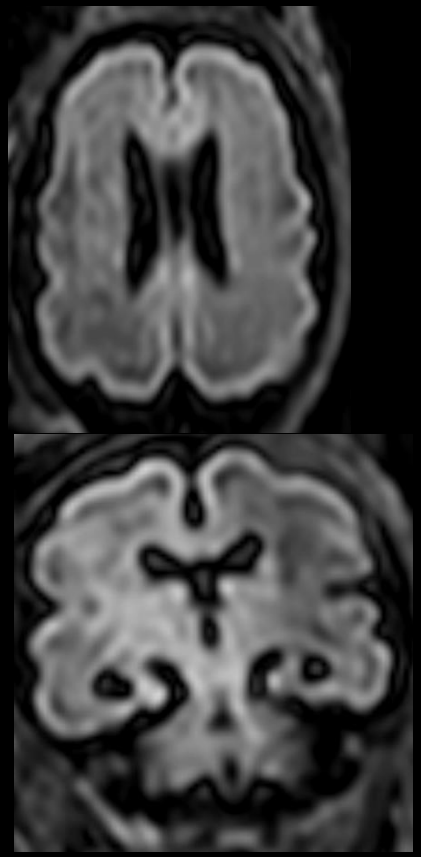
pathology present?

no

GW 26



GW 31



Borderline Ventriculomegaly
delineation of subplate
normal!

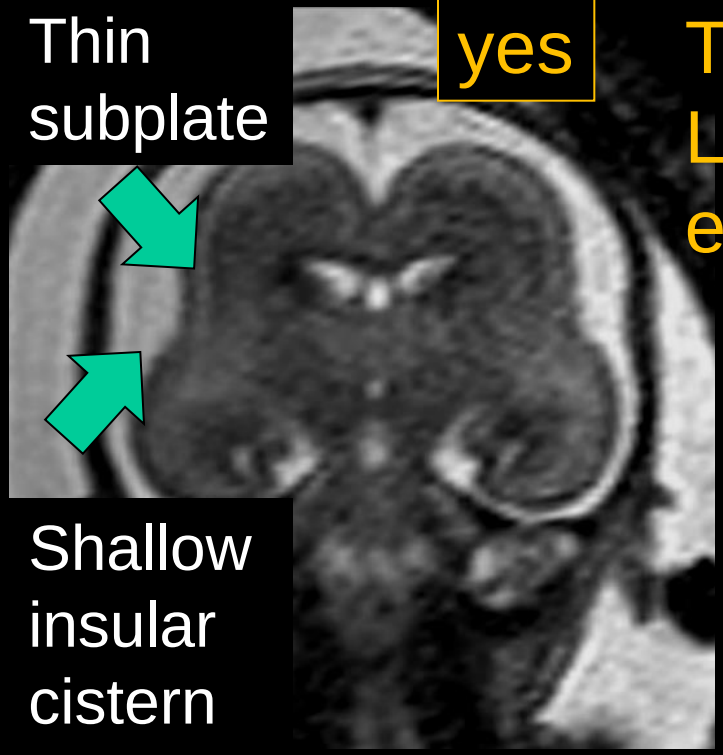
T2

# Questions for fetal MRI

pathology present?

Thin subplate

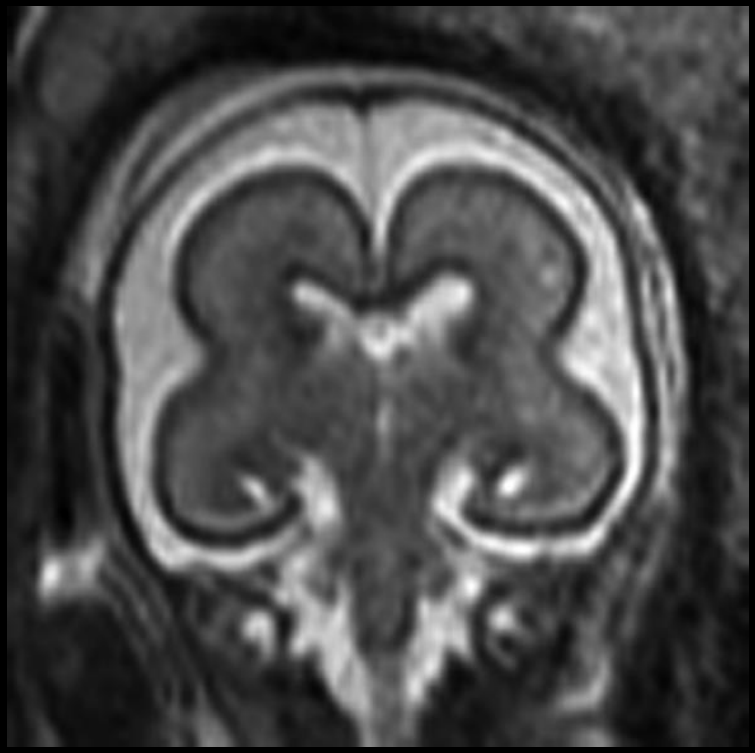
Shallow insular cistern



GW 22

yes

Type I Liss encephaly

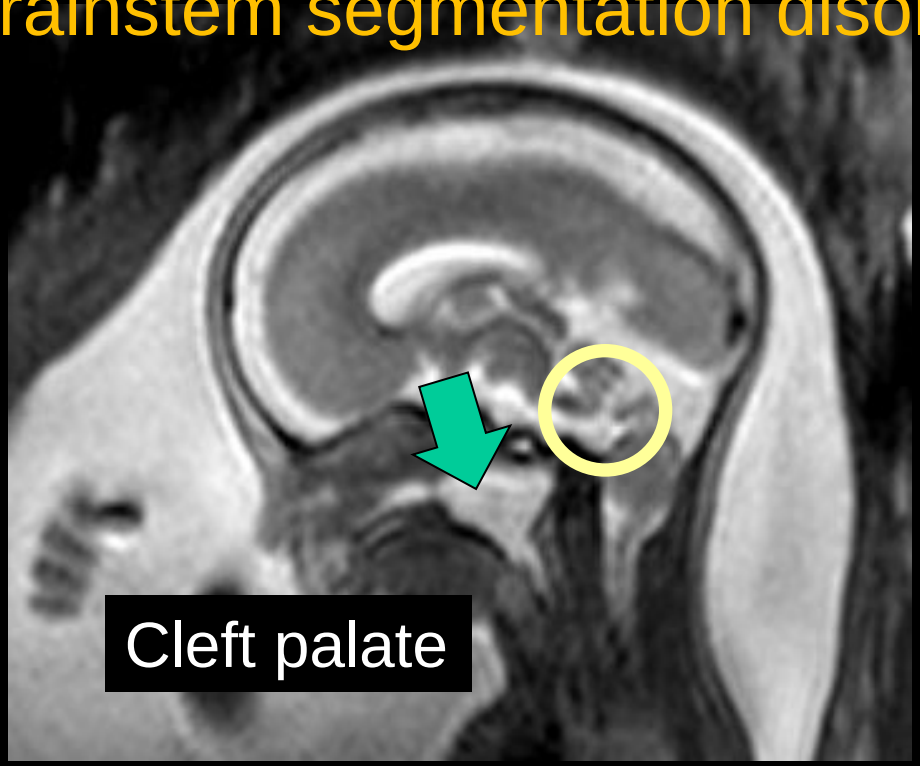


GW 20 normal

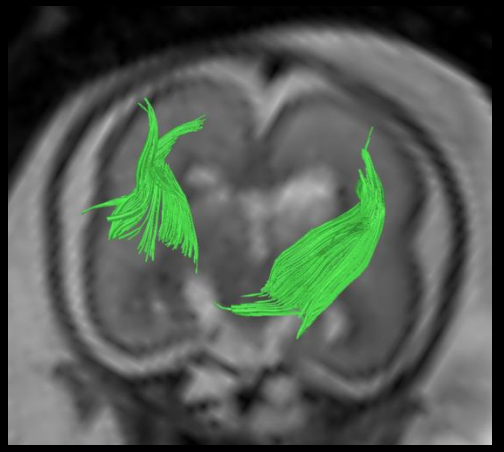
# Questions for fetal MRI

survival? no

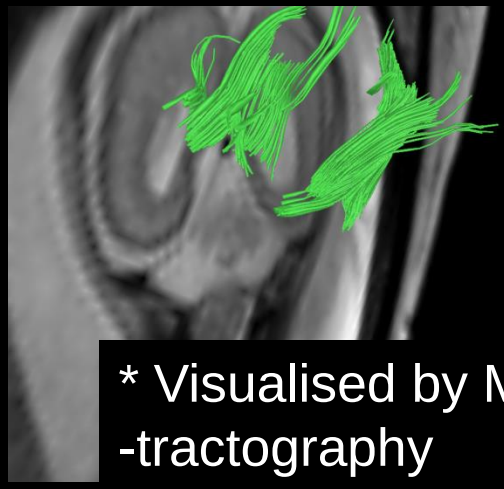
Brainstem segmentation disorder




GW 22 Brainstem interrupted



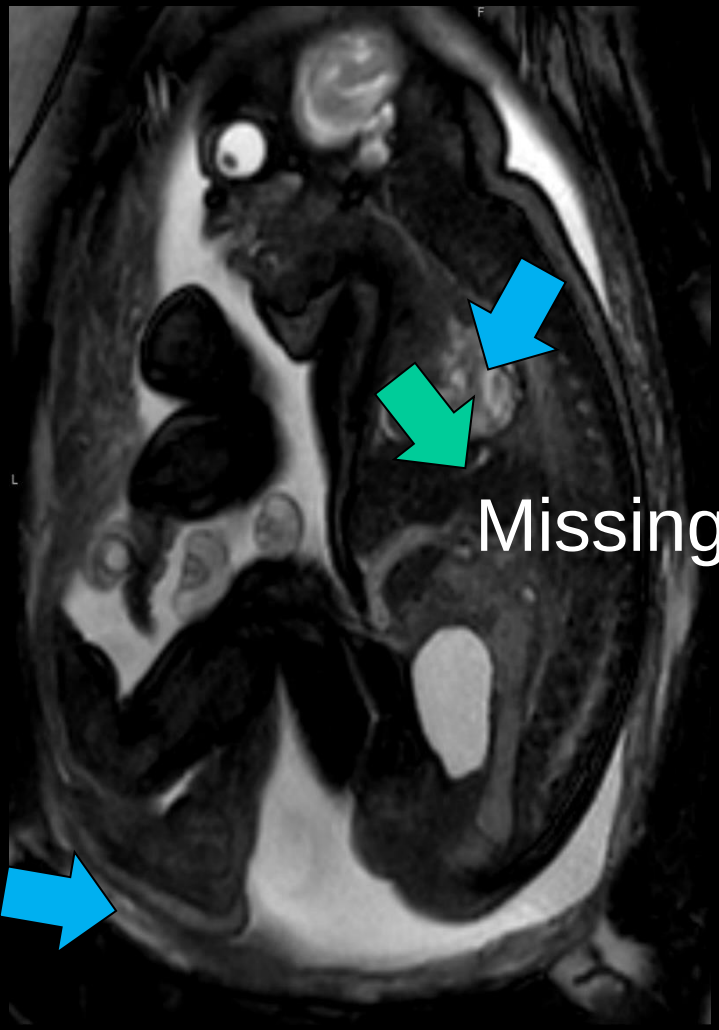
Corticospinal tract absent Infratentorially*



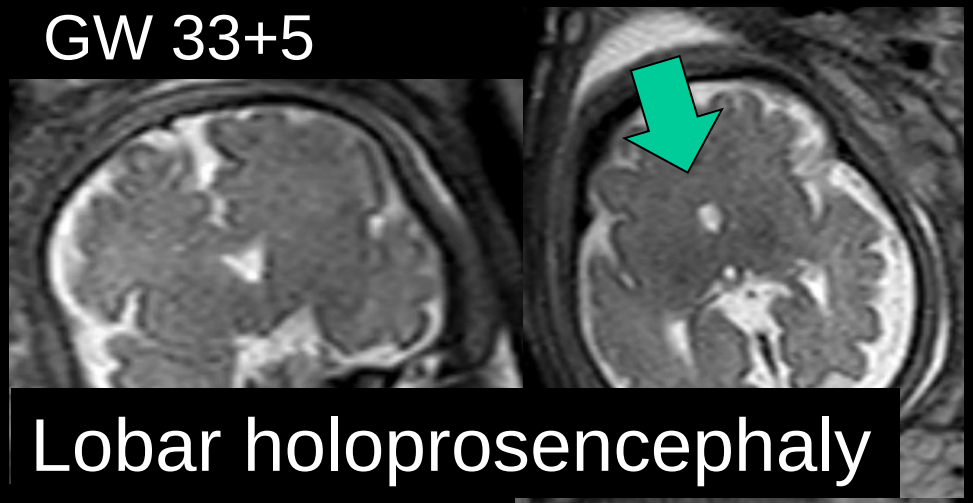
* Visualised by MRI -tractography

# Questions for fetal MRI

survival? | no | Trisomy 13



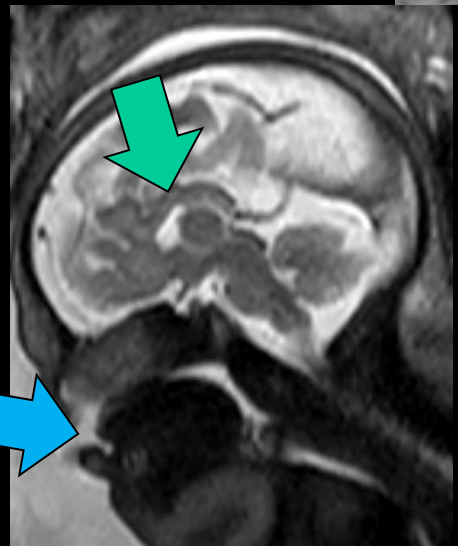
GW 33+5



Lobar holoprosencephaly

Missing venous duct

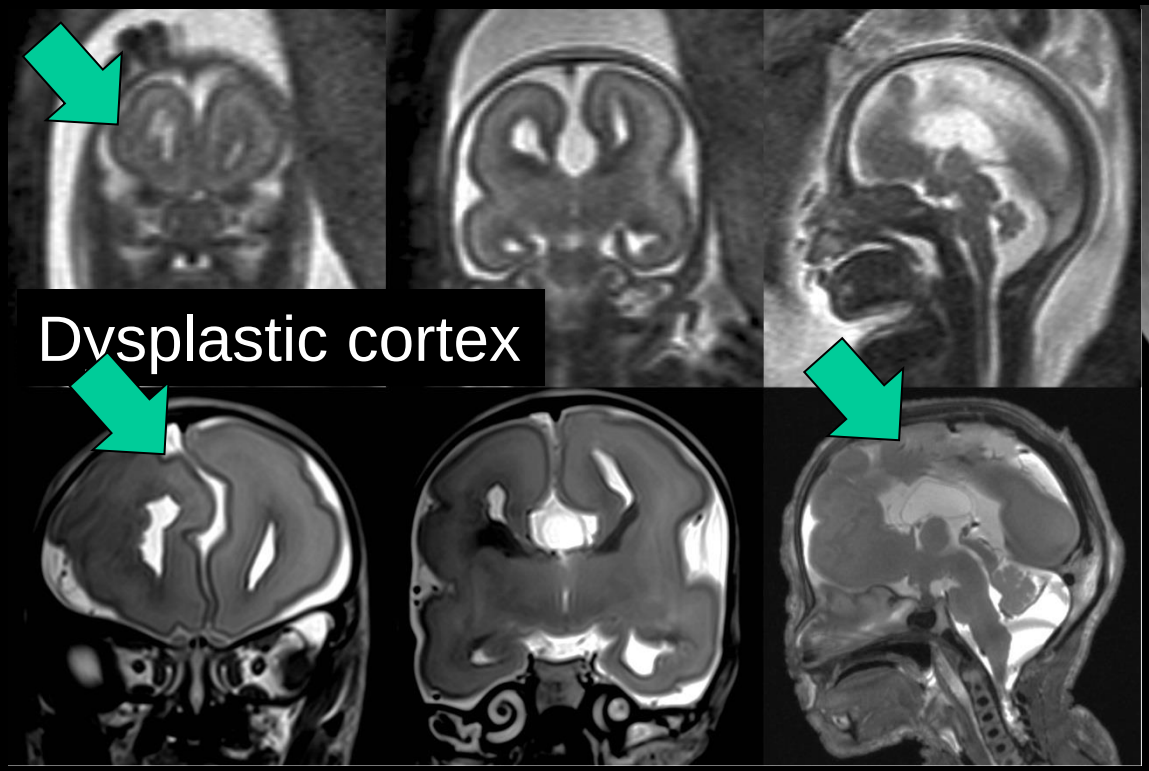
Referal because of cardiac malformation facial cleft and rocker bottom feet on US



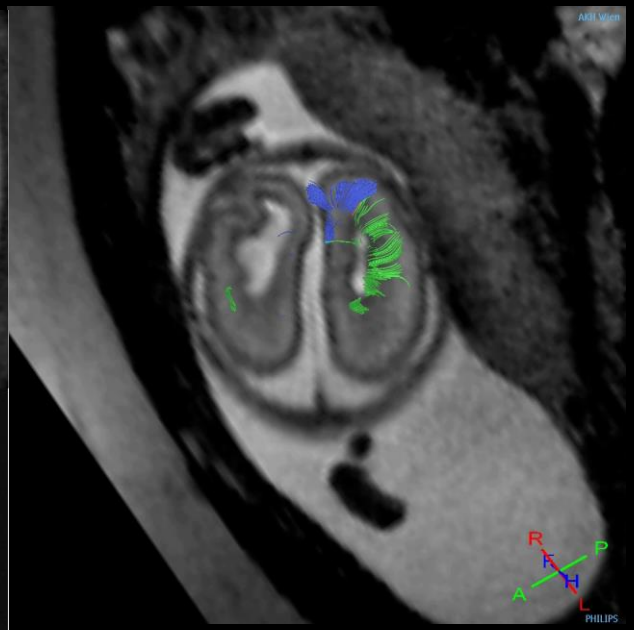
# Questions for fetal MRI

survival?

Yes. Females only…but….




GW 25 female



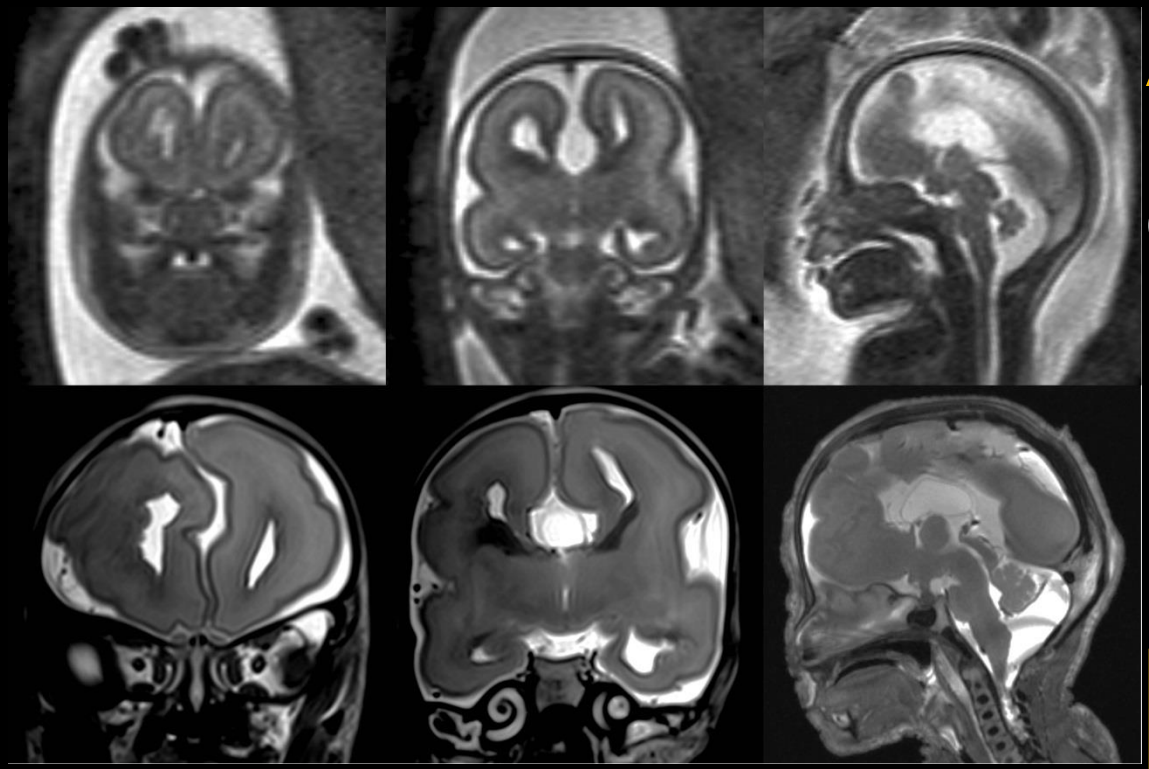
Corpus callosum agenesis with Probst Bundles*

* Visualised by MRI-tractography

# Questions for fetal MRI

survival?

Yes. Females only…but….



Aicardi syndrome
presumably X-linked dominant,

- agenesis of the corpus callosum,
- chorioretinal lacunae
- infantile spasms, with lethality in males.

Seizures
severe neurological impairment….

Fernández-Ramos JA et al. Rev Neurol.2013 Dec 1; (11):481-8.

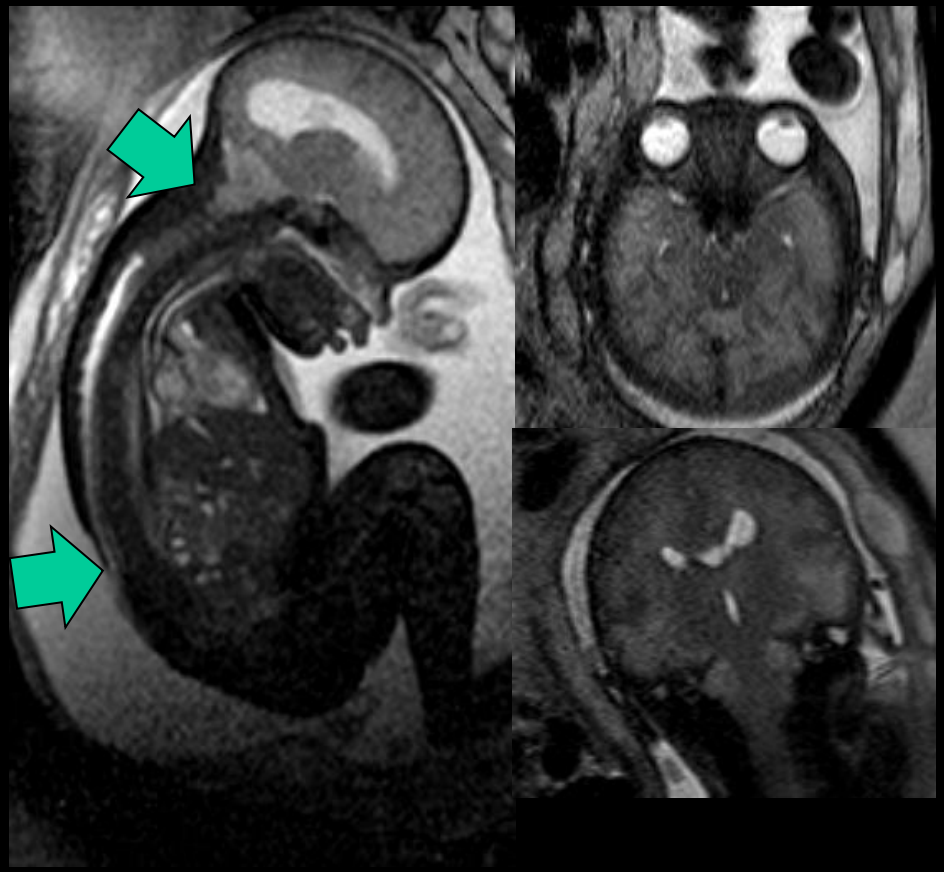
# Questions for fetal MRI

survival?

yes
but (surgical)
therapy
required

prenatal

Fetuses with
open dystaphism
improve after prenatal
closure of the cele



GW 32, Chiari II malformation

# Questions for fetal MRI

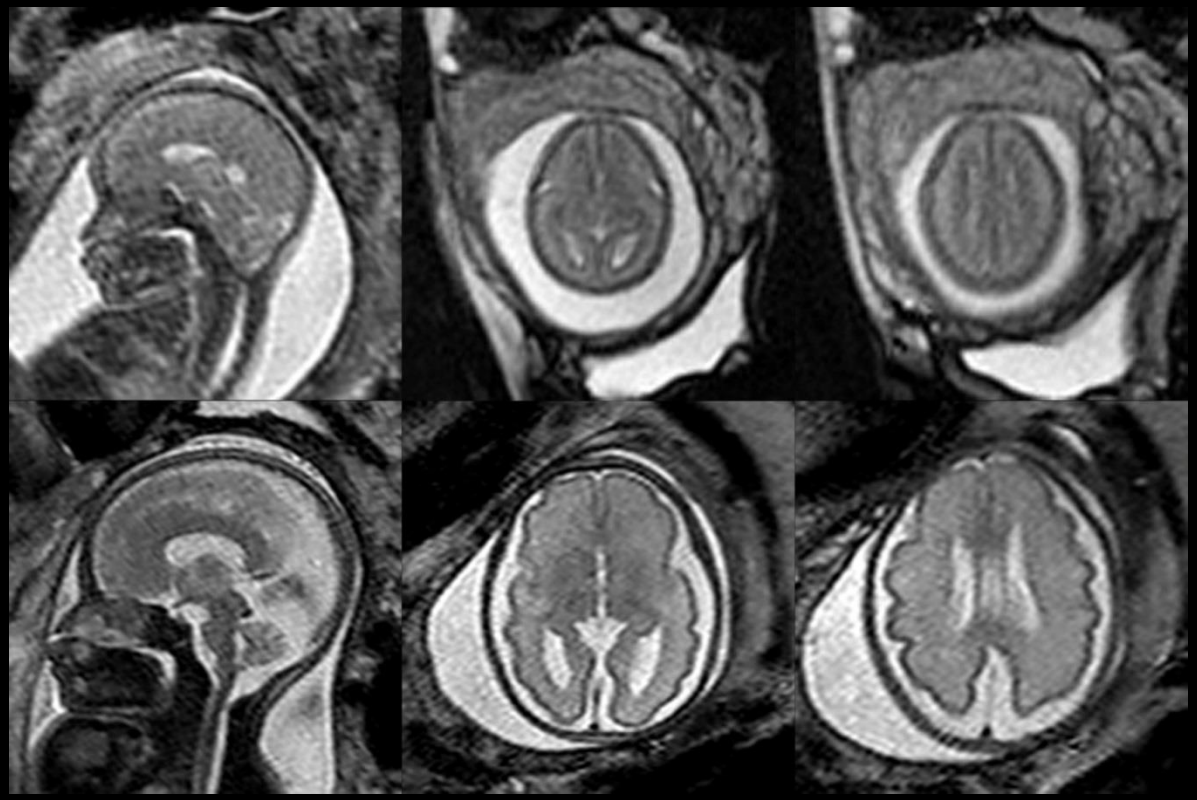
survival?

yes
but (surgical)
therapy
required

prenatal

Fetuses with
open dysraphism
improve after prenatal
closure of the cele

GW 23 before



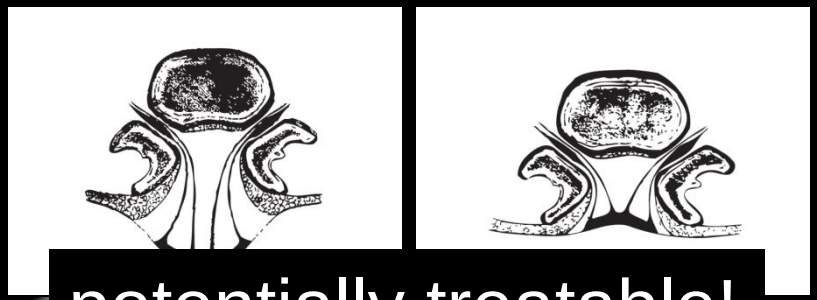
GW 28 after

Courtesy Gregor Kasprian Vienna/ Houston

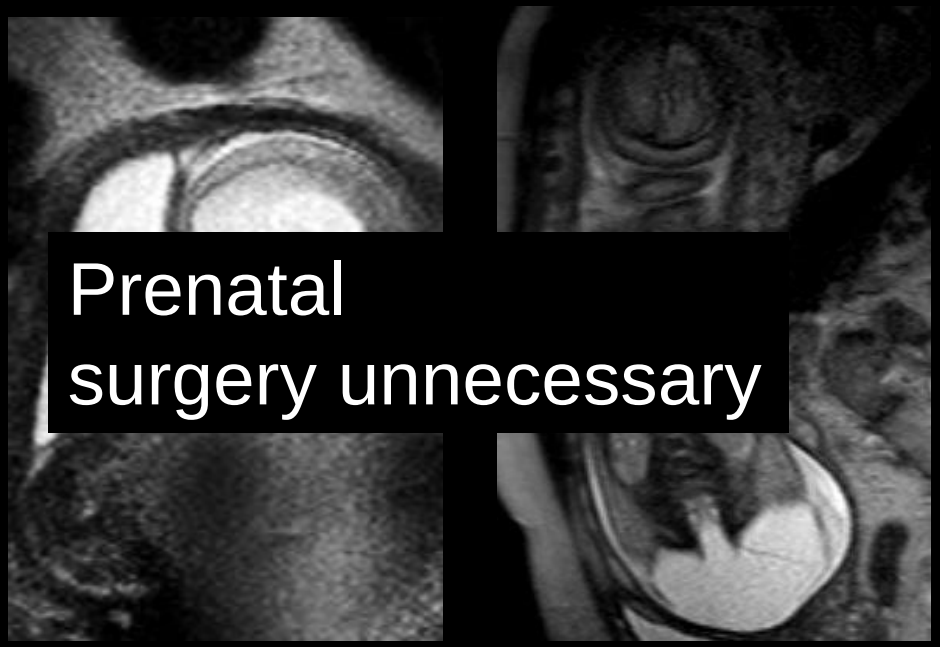
# Questions for fetal MRI

## “Spina bifida“

open neural tube defects [1] ← ? → closed neural tube defects [1]



potentially treatable!



Prenatal surgery unnecessary

Myelo-meningocele

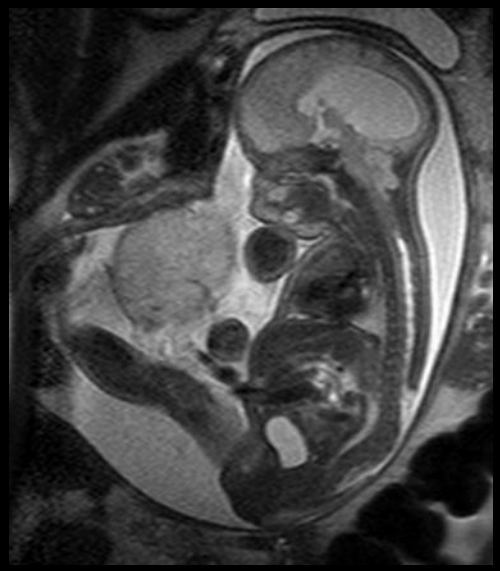
Myelocele

Meningocele

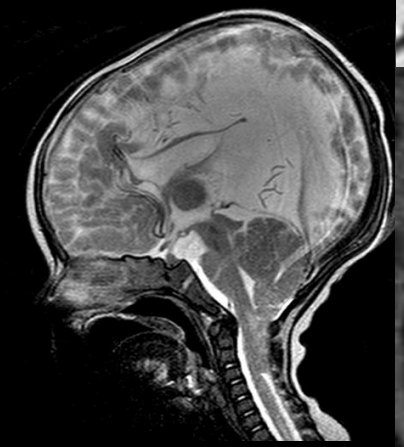
Myelo-cystocele

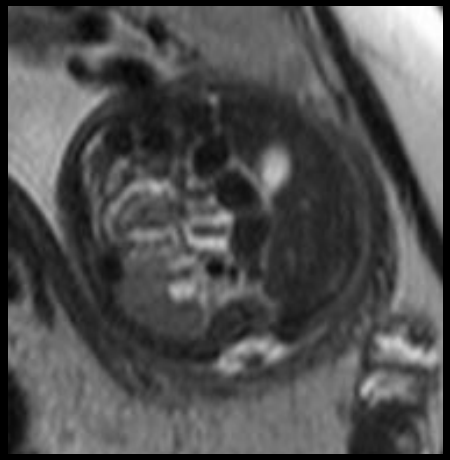
1: Tortori-Donati P, Rossi AMD, Biancheri R. Pediatric neuroradiology. Berlin ; [Great Britain]: Springer 2005.

# Questions for fetal MRI









GW 29+4

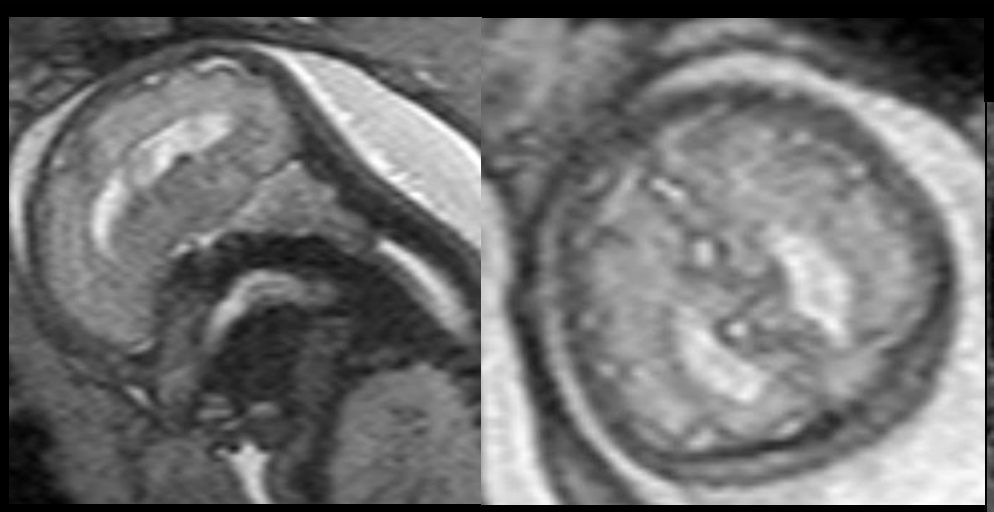
GW 31+5

# Questions for fetal MRI

survival?

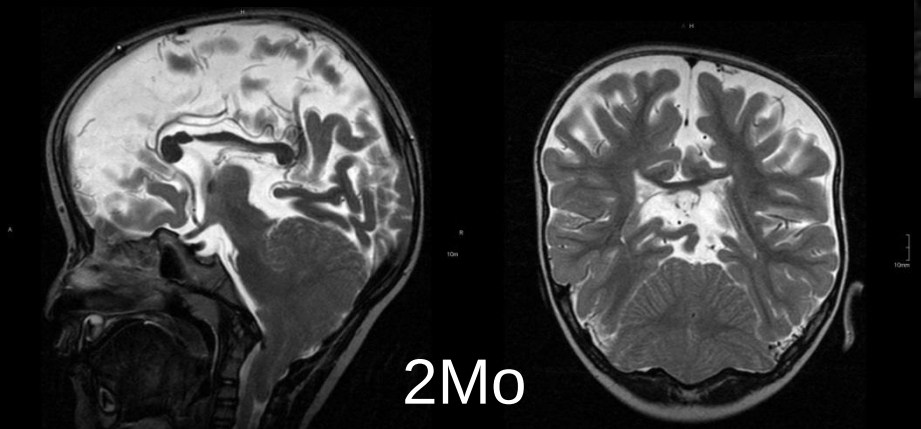
yes
but (surgical) therapy required

postnatal



GW 28+5

Postnatal shunt with less impact on vermian herniation



2Mo

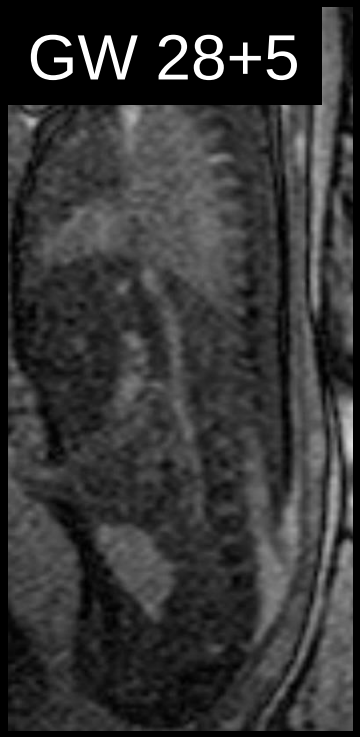
Danzer E et al. Dev Med Child Neurol. 2012;54(1):8-14.

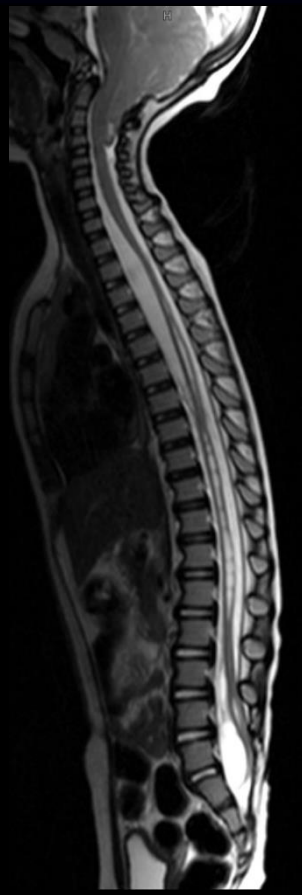
# Questions for fetal MRI

survival?

yes
but (surgical) therapy required

postnatal



3a

12a

Late spinal complications

# Questions for fetal MRI

recurrence risk

## 2 month old with seizures

Partial Callosal Agenesis?

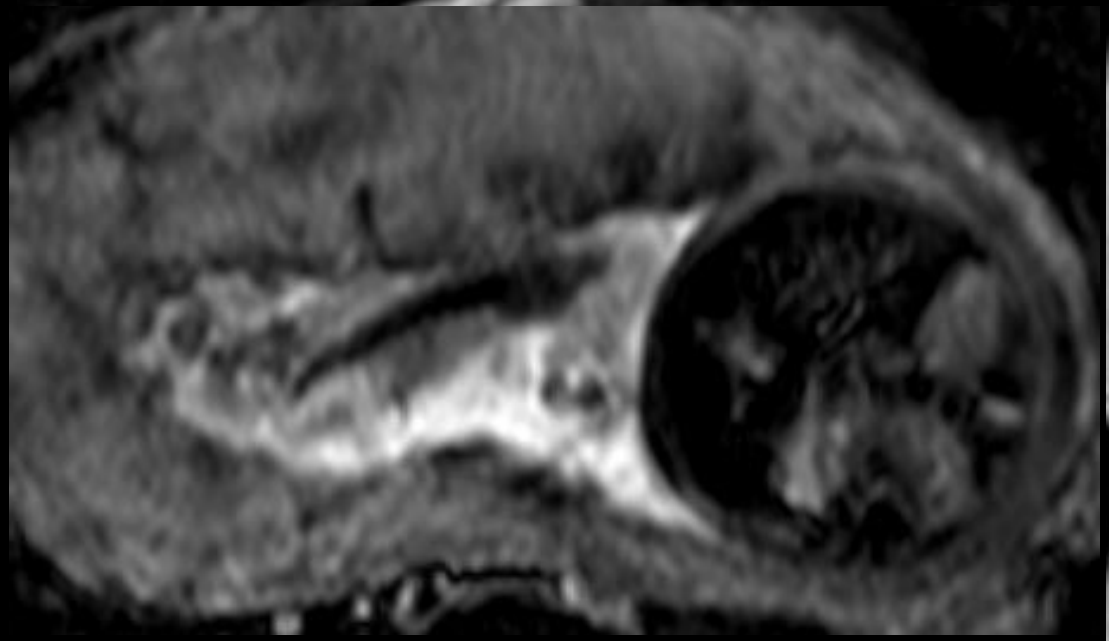
Callosal Dysgenesis?

Schizencephalic clefts?

# Questions for fetal MRI

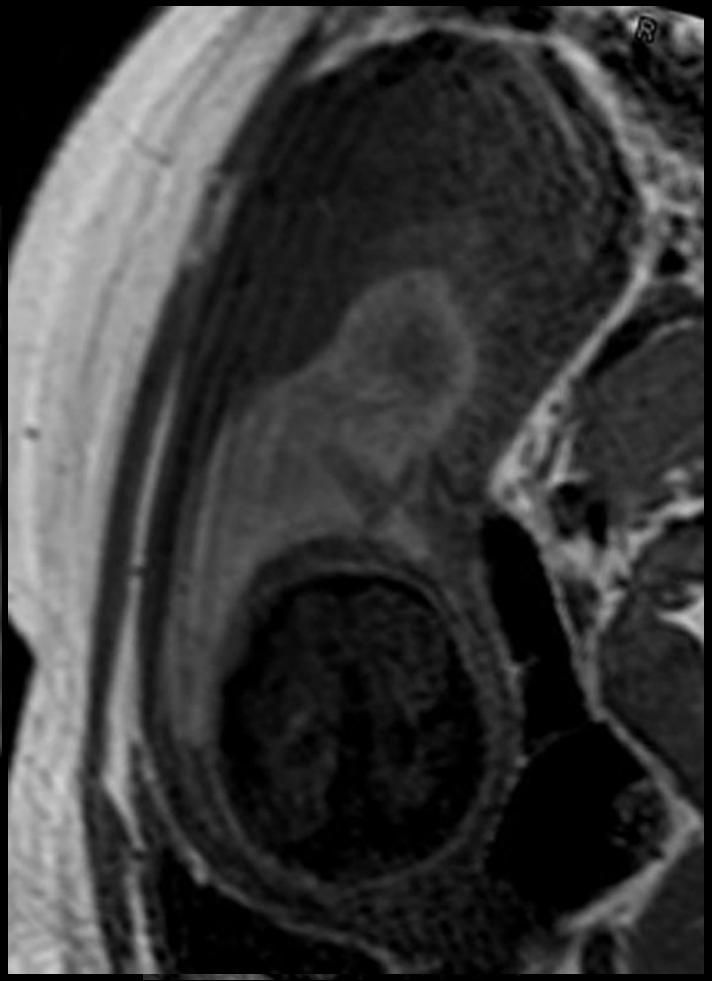
recurrence risk

Fetal Thrombotic Vasculopathy



Demised Co-Twin

GW 26

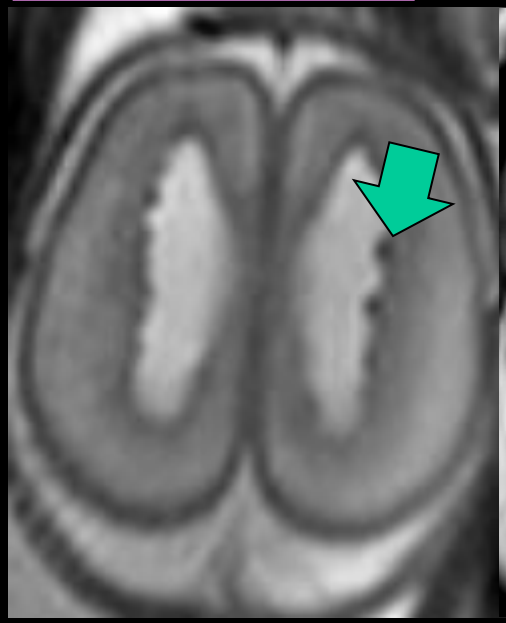


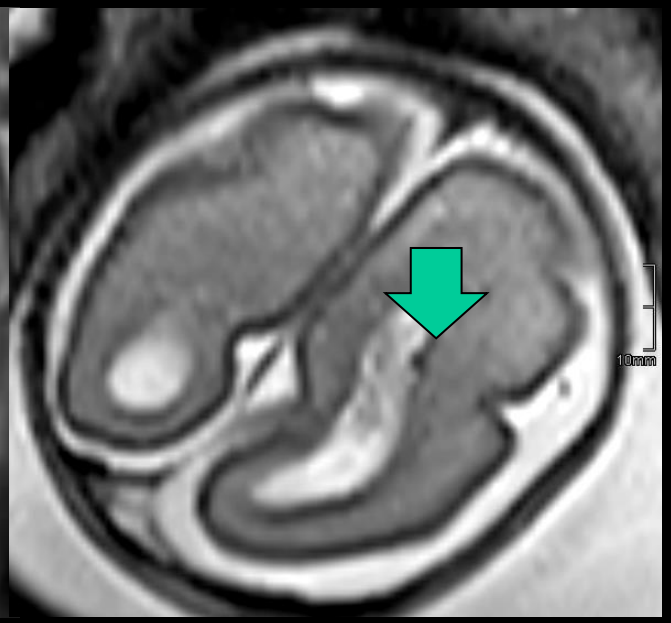
Sato Y, Benirschke K. Pediatrics. 2006;117(1):113-7.

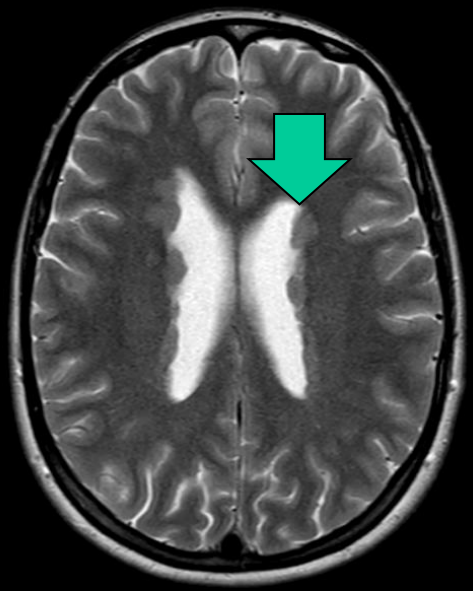
# Questions for fetal MRI

recurrence risk

Subependymal heterotopia







1st Fetus GW23+0 2nd Fetus GW21+3 mother

Filamin A gene mutation!

Parrini et al. Brain. 2006 Jul;129(Pt 7):1892-906., Brain 2006

# Questions for fetal MRI

prognosis Spinal level in open defects?

Hipflection: L1/2
Kneeextgension: L3
Kneeflection: L4
Foot dorsiflection: L5

Foot plantarflection: sacral

Lindseth RE. (1976) Treatment of the lower extremity in children paralyzed by myelomeningocele (birth to 18 months).AAOSIC Lectures 25: 76–82.

# Questions for fetal MRI

prognosis Spinal level in open defects?


GW,22


GW 20

Meningocele!

GW 22

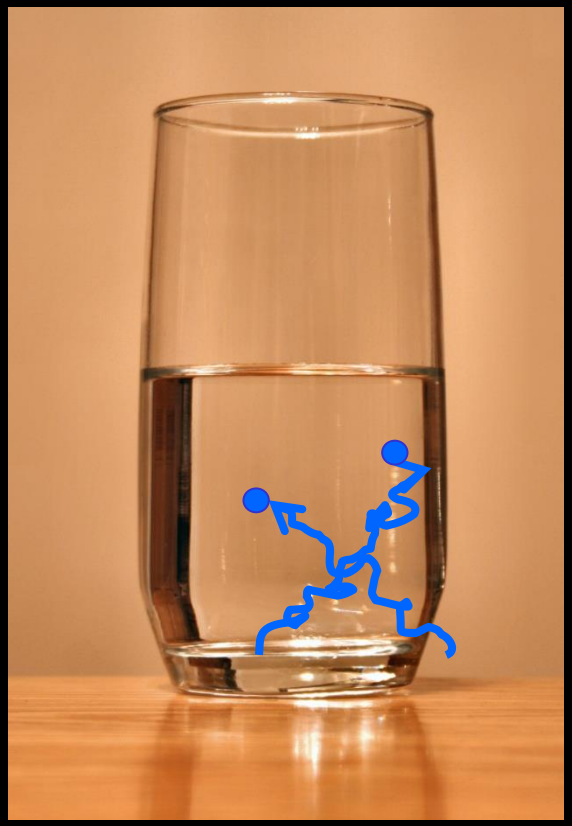
assessments correlated ± 1 Level of anatomical defect

Pedreira DA et al. Am J Obstet Gynecol. 2016

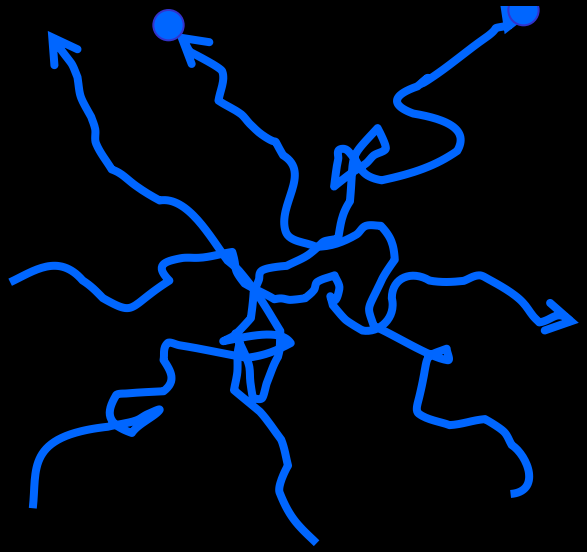
# Questions for fetal MRI

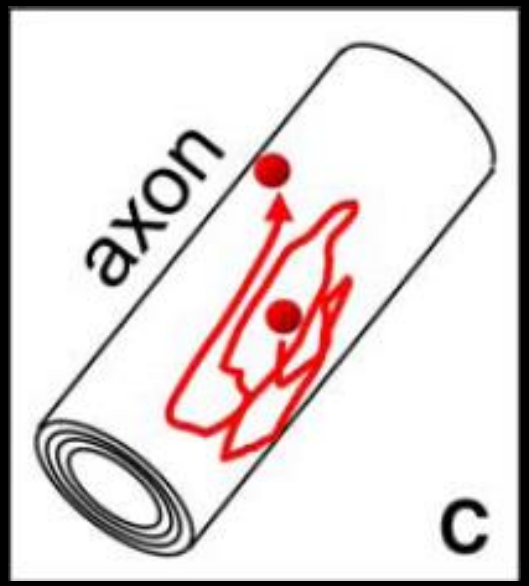
prognosis

Use of diffusion- tensor imaging



Diffusion weighted imaging measures degree and directionality of water motion in tissue






Stochastic motion
Brownian motion

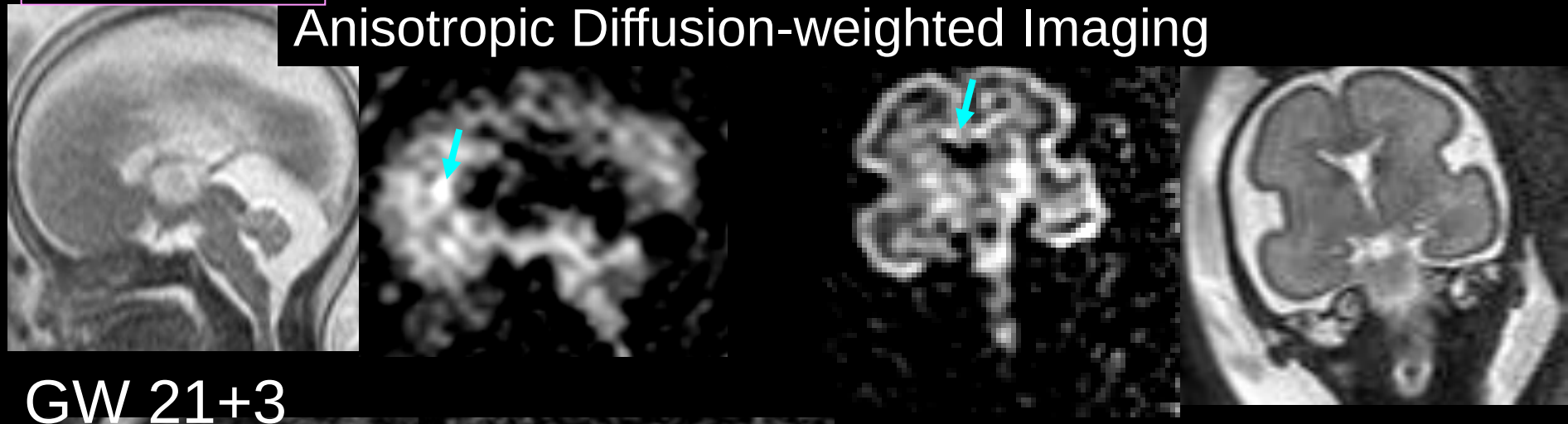
Isotropy

Anisotropy

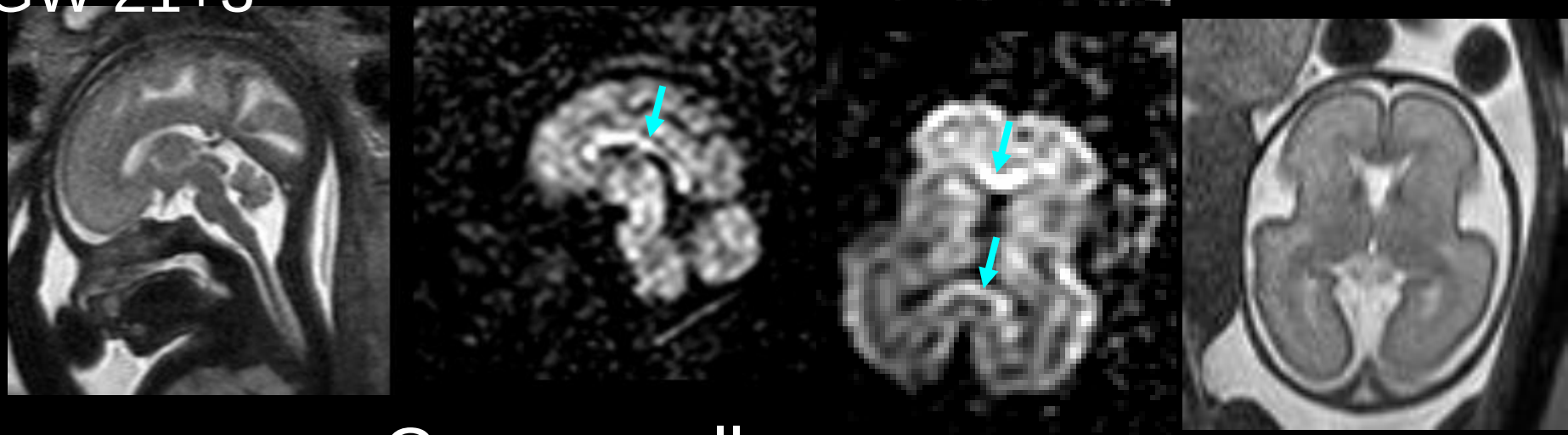
# Questions for fetal MRI

prognosis

Anisotropic Diffusion-weighted Imaging



GW 21+3

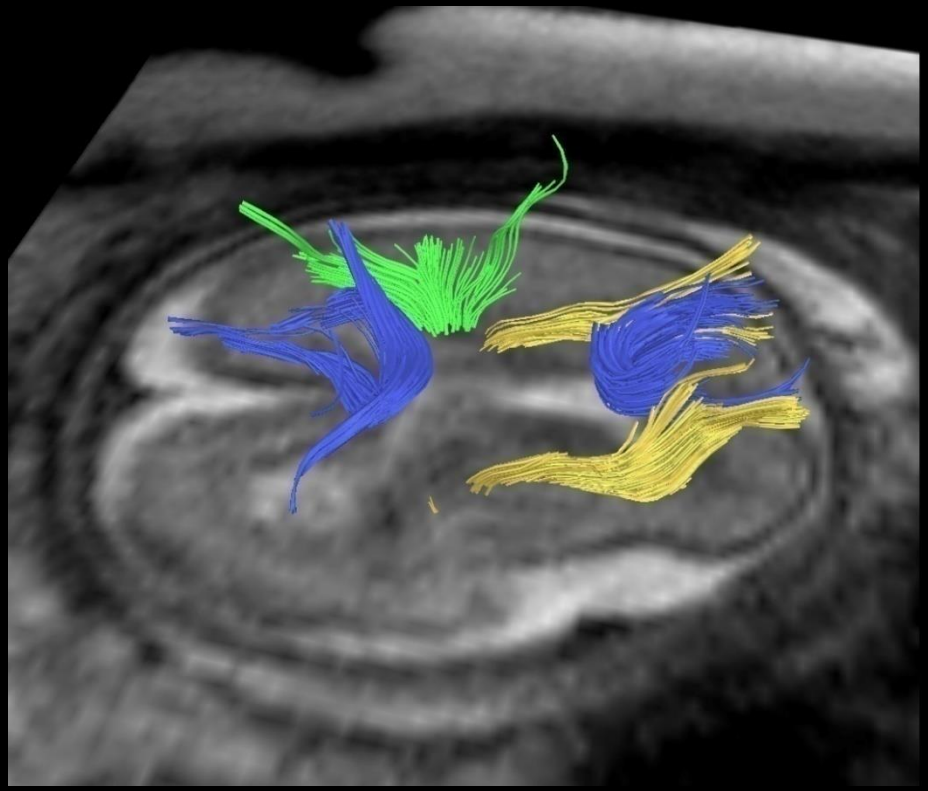


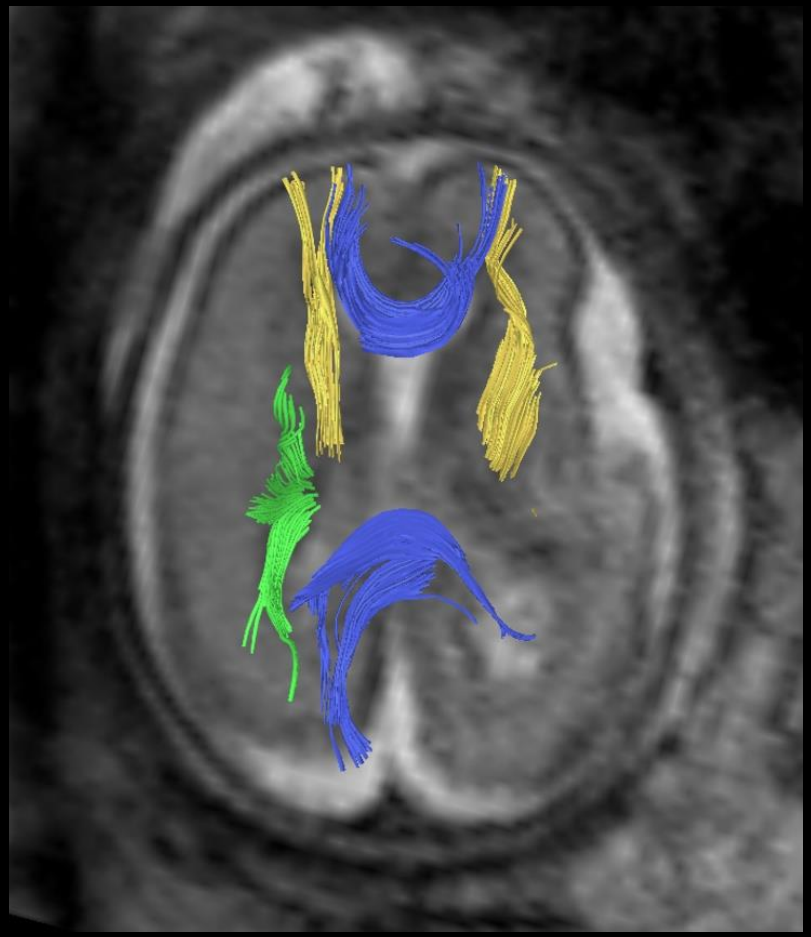
GW 25+6

Corpus callosum

# Questions for fetal MRI

prognosis



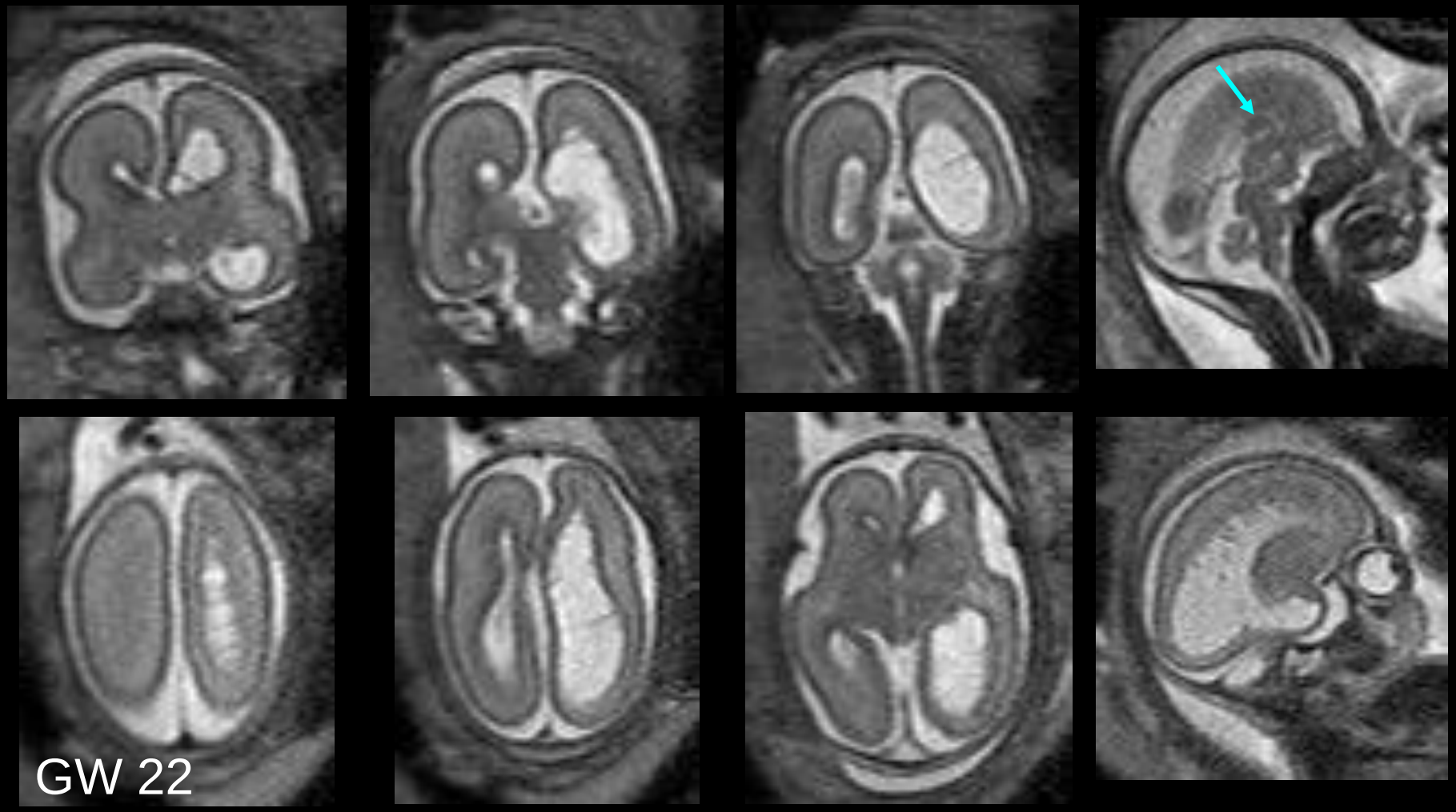


Connectivity at GW 23

# Questions for fetal MRI

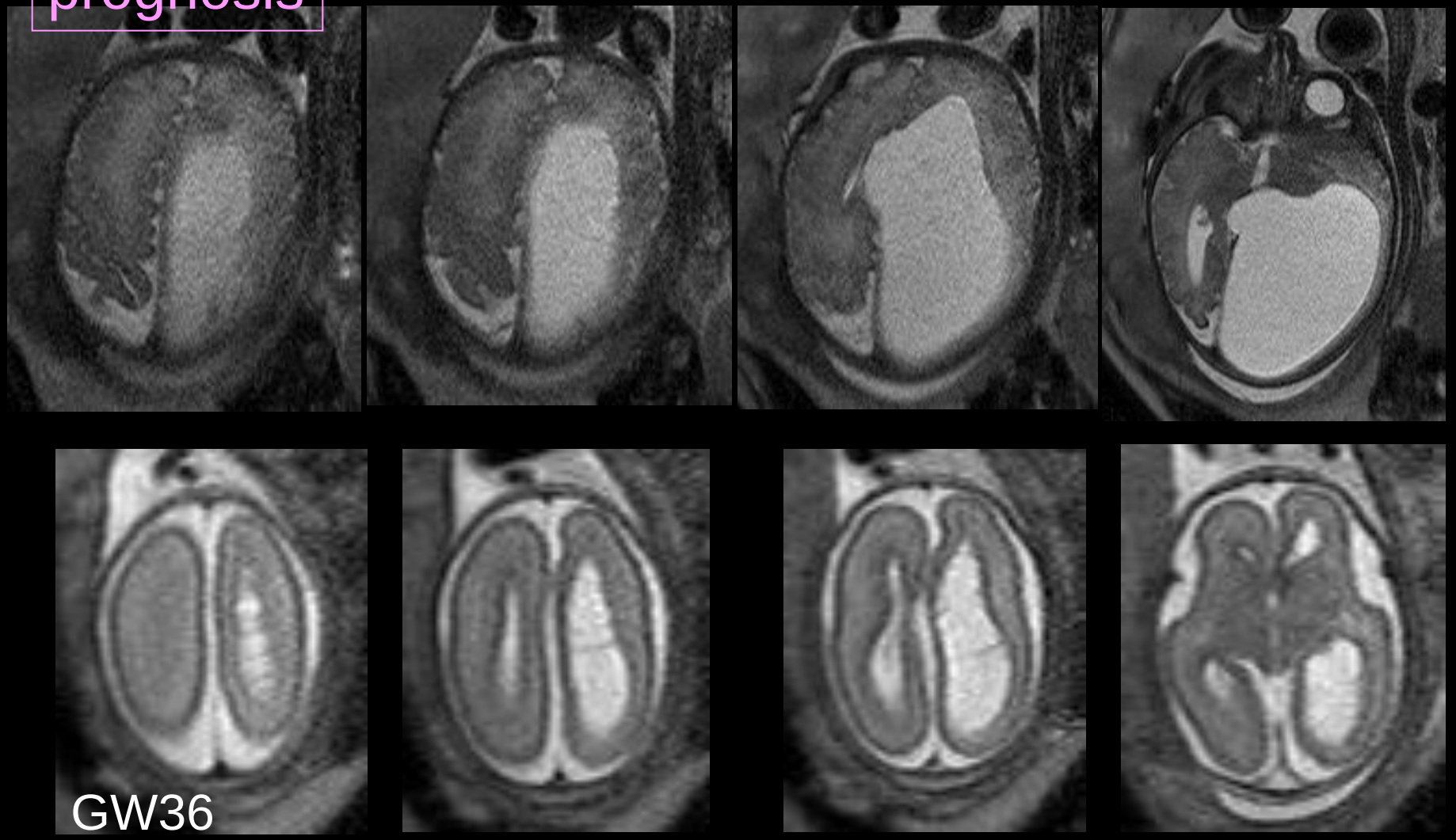
prognosis

## Callosal Hypogenesis



# Questions for fetal MRI

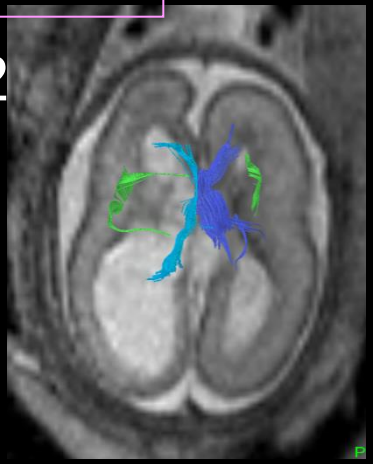
prognosis

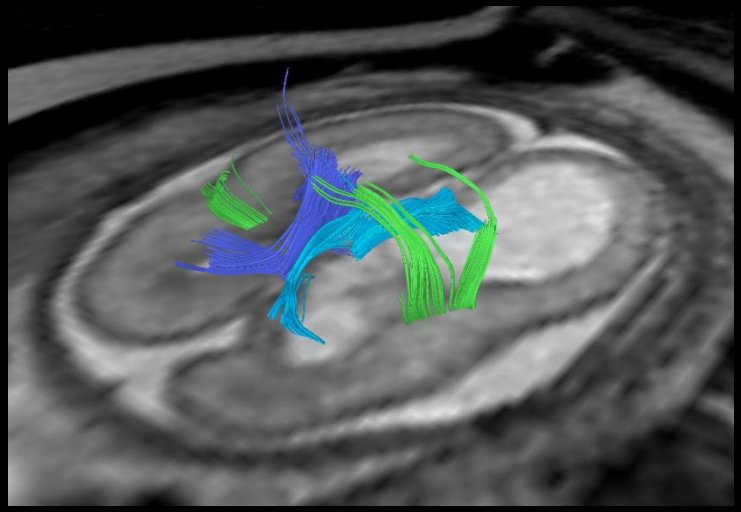


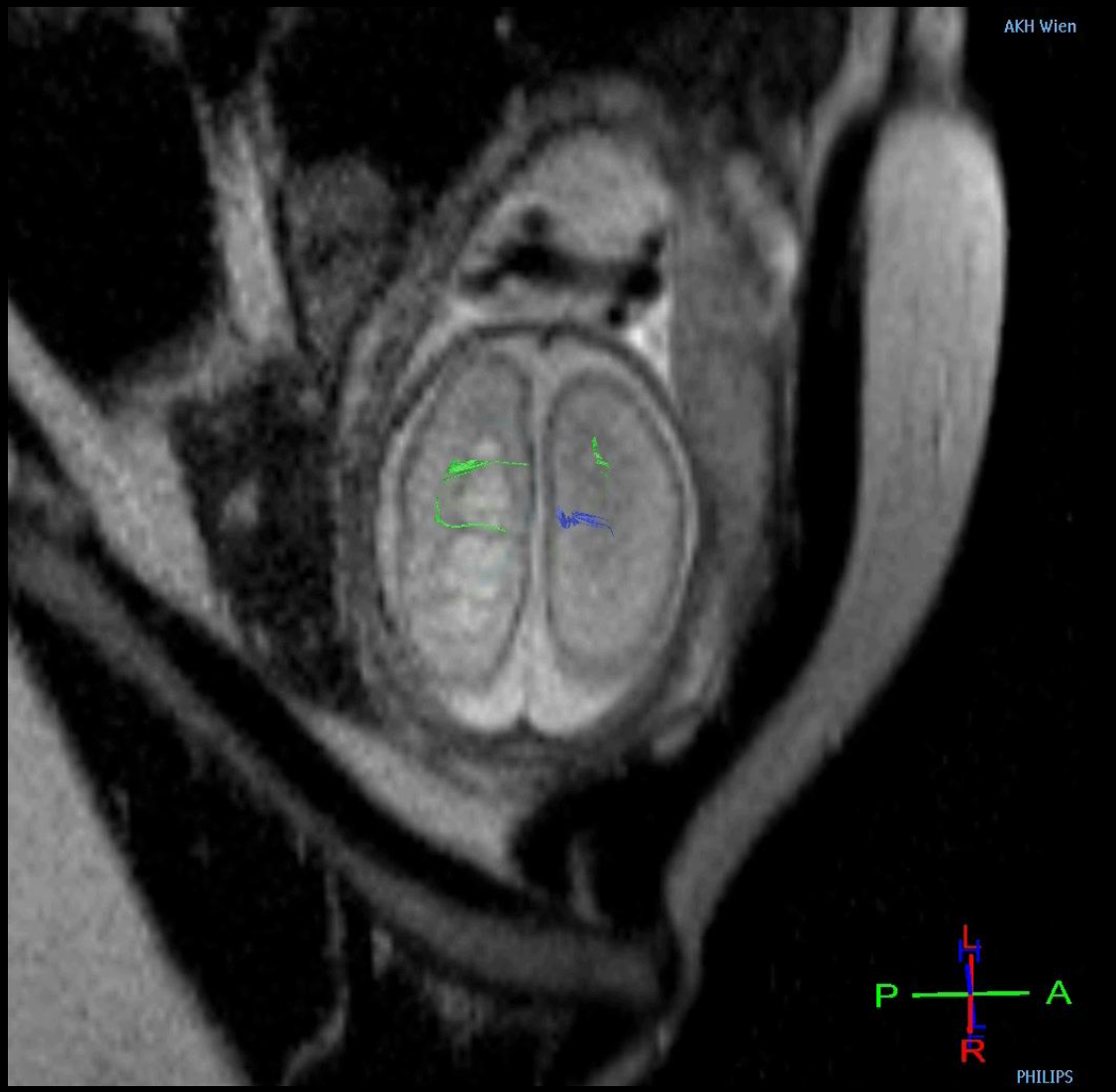
# Questions for fetal MRI

prognosis

GW 22

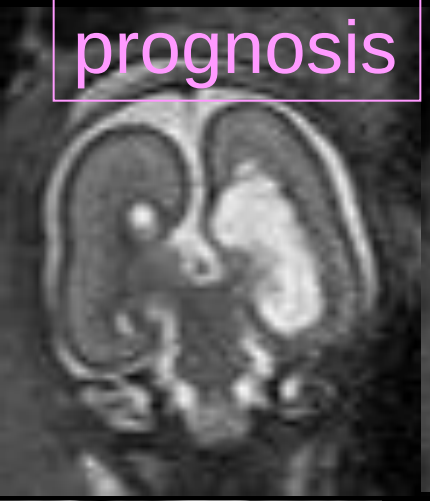


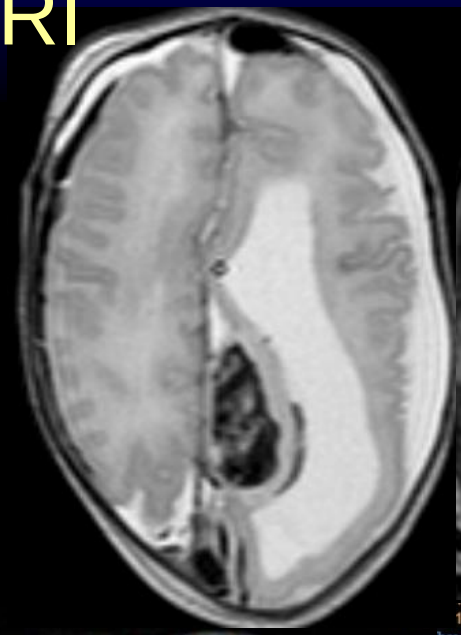


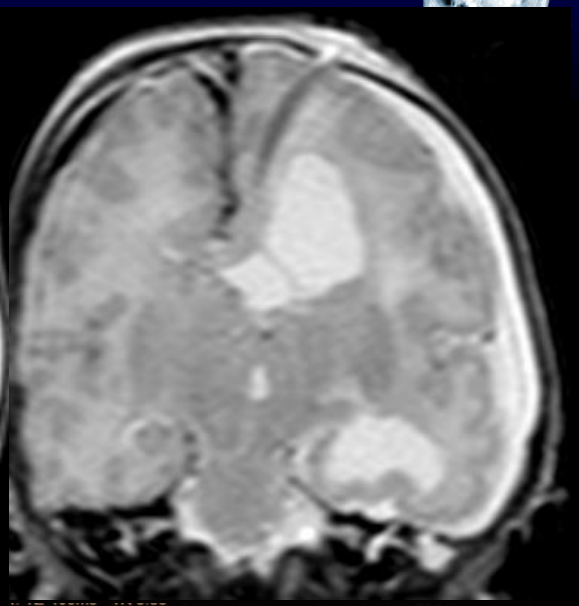


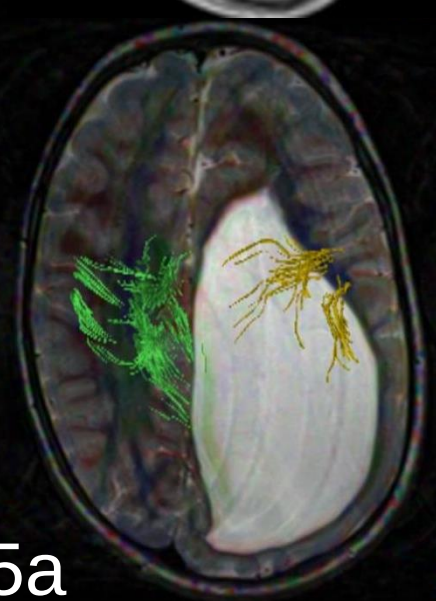
# Questions for fetal MRI

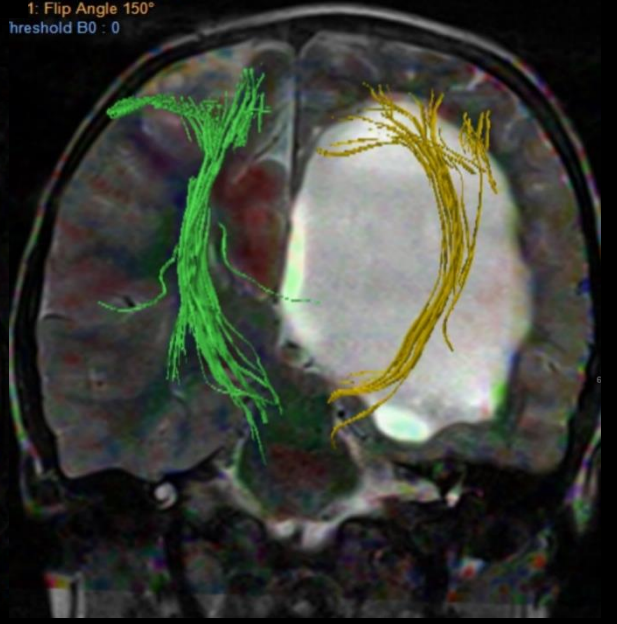
prognosis









GW 22

5a

# Questions for fetal MRI

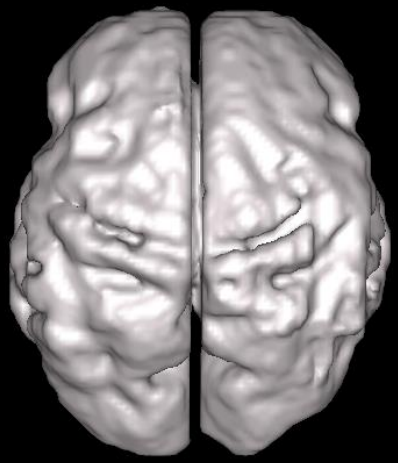
prognosis

## At 5 Years

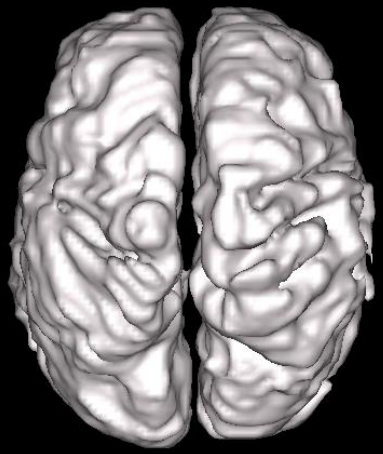
Normal intelligence
Symmetrical use of arms
Epilepsy with rare seizures,
EEG focus left
hemisphere

# Take home:

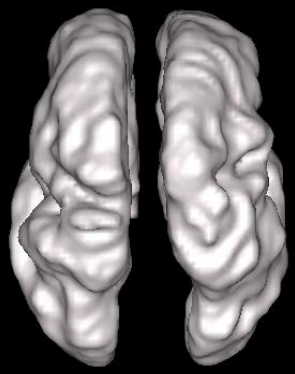
Fetal MRI can help with more accurate prenatal diagnosis and prognosis and thus support the managment of a complicated pregnancy



Normal



CC agnesis



CC agenesis with malformations

27th World Congress on Ultrasound in Obstetrics and Gynecology

16 – 19 September 2017, Vienna, Austria

Save the date

Fetal MRI
Precongress course
September 15th

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