



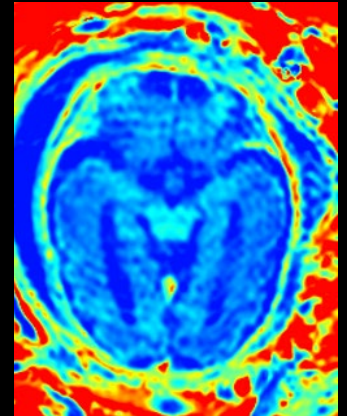
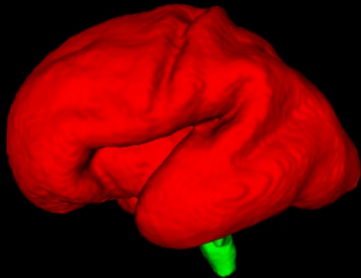
MEDICAL UNIVERSITY
OF VIENNA

NEURO PÄDIATRIE
GESELLSCHAFT FÜR NEUROPÄDIATRIE e.V.



Fetale MRT-Bildgebung

Gregor Kasprian



UNIVERSITÄTSKLINIK FÜR RADIOLOGIE
UND NUKLEARMEDIZIN

Klinische Abteilung für Nuklearmedizin



MEDIZINISCHE
UNIVERSITÄT WIEN



Wiener Gesundheitsverbund
Universitätsklinikum AKH Wien



MEDICAL UNIVERSITY
OF VIENNA



Vienna
General Hospital



Offenlegungen:

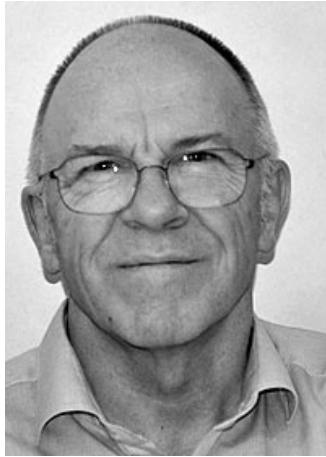


Finanzierung durch den FWF (Projekt I 3925-B27) in Kollaboration mit
der French National Research Agency (ANR)

Study Grant: OLERO/Roche, since 12/22, Speaker honorarium: Alexion

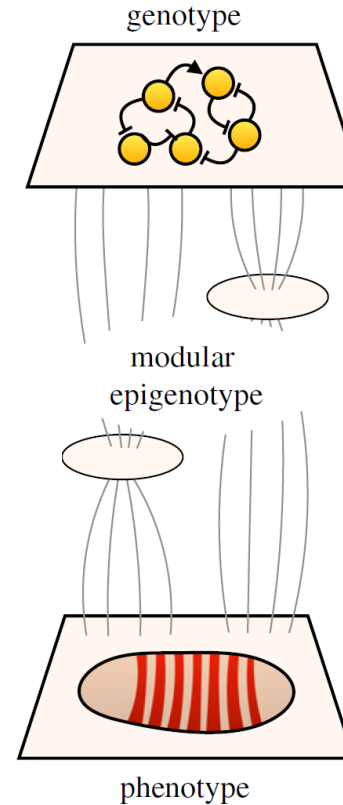
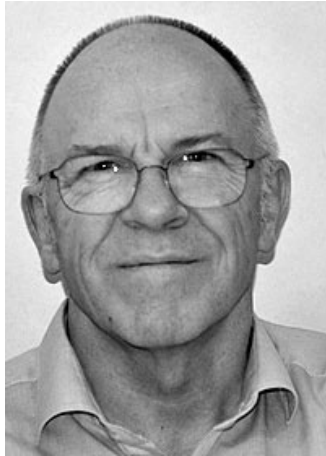
Alle Personen haben ihre oder deren elterliche Einwilligung für
audiovisuelle Aufnahmen gegeben.

„Es ist absolut unmöglich
Funktion [...] vorherzusagen“!
(Eugen Boltshauser)

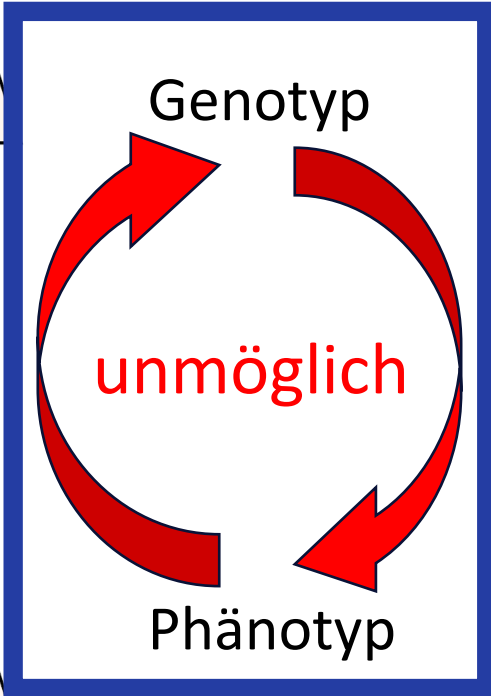


Phänotypisierung

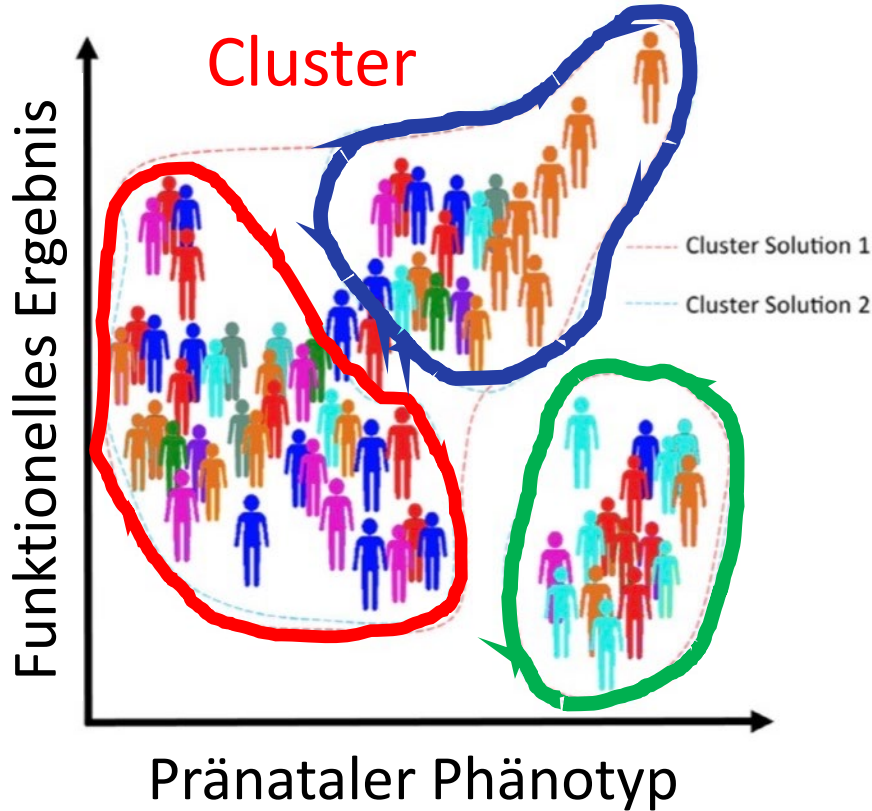
„Es ist absolut unmöglich
Funktion [...] vorherzusagen“!
(Eugen Boltshauser)









Sinnlos?



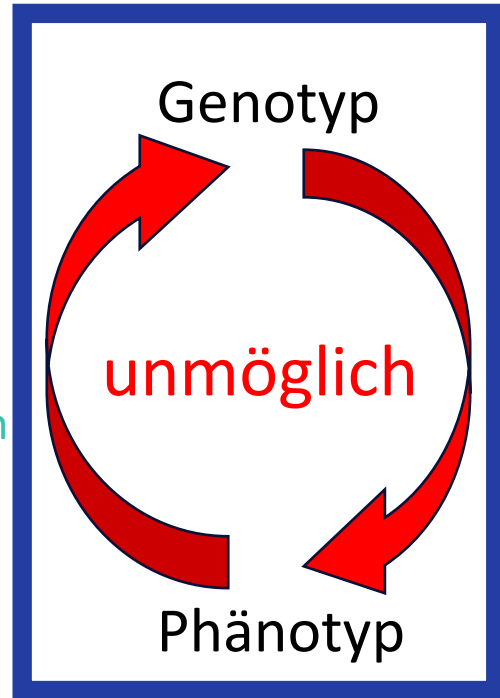
Phänotypisierung



Foi

-  erworben
-  Chromosomen
-  Chromatino-
pathie
-  Monogenetisch
-  Polygenetisch
-  Maternal/
plazentar

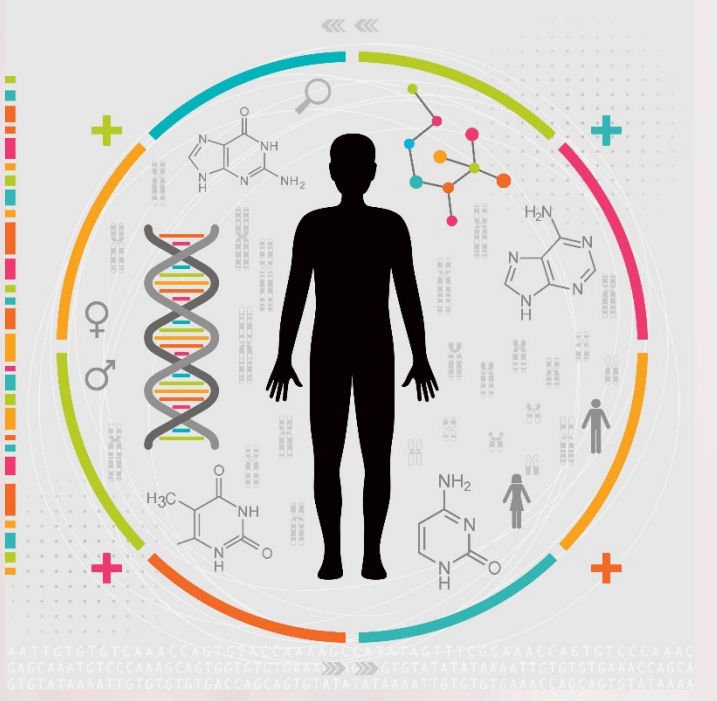
Sinnlos?



Präzisionsmedizin

“maßgeschneiderte”

Therapie und Prävention





Fetale MRT

- Indiziert von pränatalen US Expert:innen
- Kann wesentliche Zusatzinformationen liefern
- Kann eine Neurosonographie ersetzen
- **MRT Expert:innen mit entsprechender Ausbildung**

Indikationen – Meinung der Zuweiser



Definitiv indiziert (>48%):

Corpus callosum Agenesie
Anomalien der hinteren Schädelgrube
Mikrozephalie

Indiziert (30-48%):

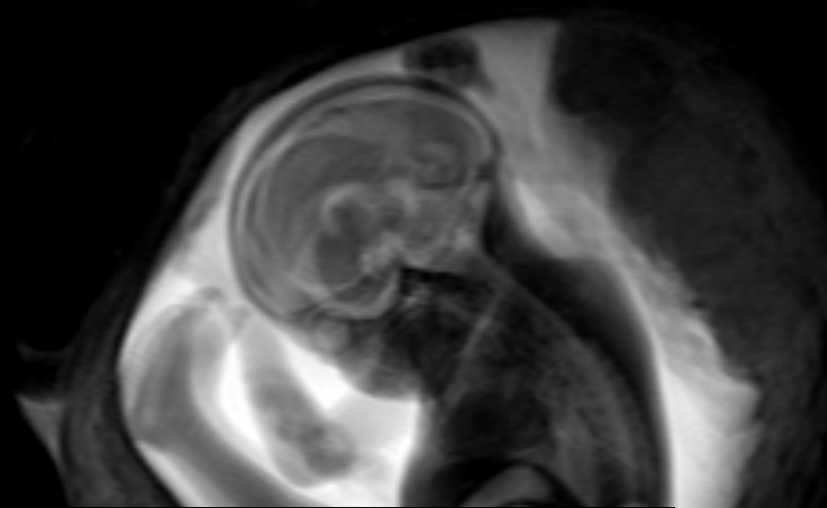
Ventrikulomegalie
Neuralrohrdefekte
Zwerchfell Hernie

Geringe Priorität (10-30%):

Lungenanomalien,
Multiple Malformationen
Bauchwanddefekte

Sehr geringe Priorität (0-10%):

Kongenitale Herzfehler,
Urogenitale Malformationen,
Zwillinge, Lippen-Kiefer-Gaumenspalten



Kongenitale Herzfehler

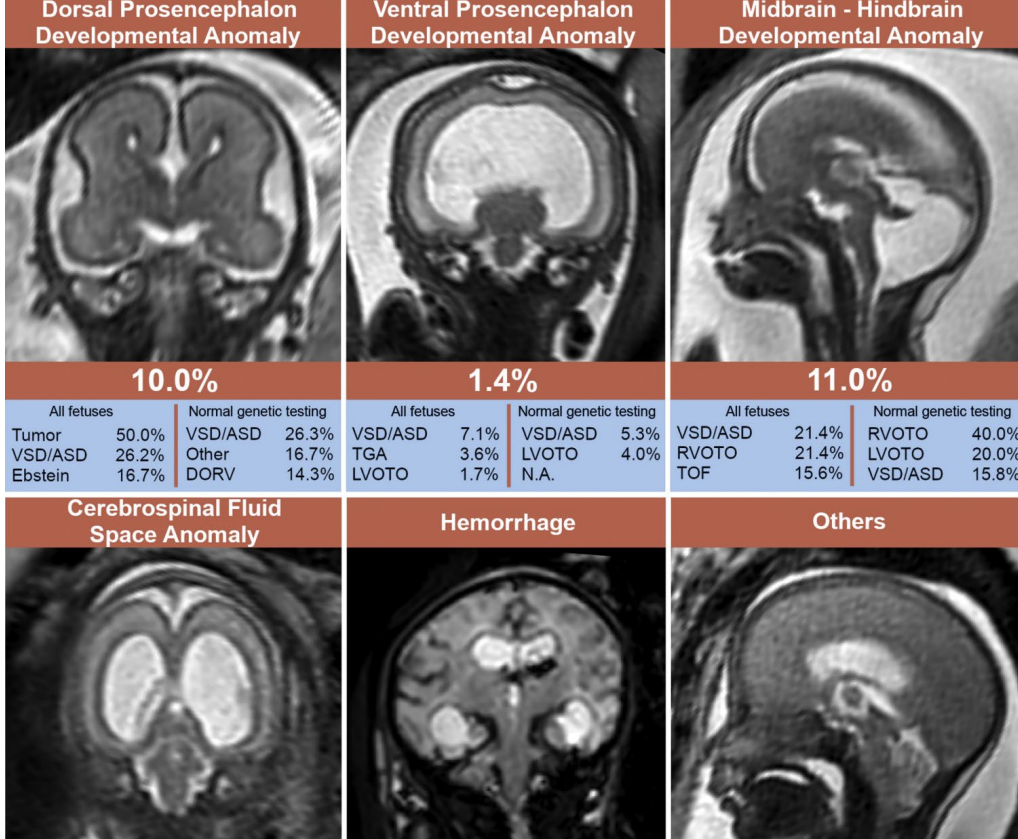
Von 429 Feten mit CHD:

243 (56.6%) extrakardiale

Auffälligkeiten

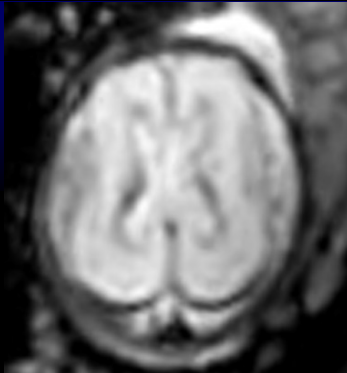
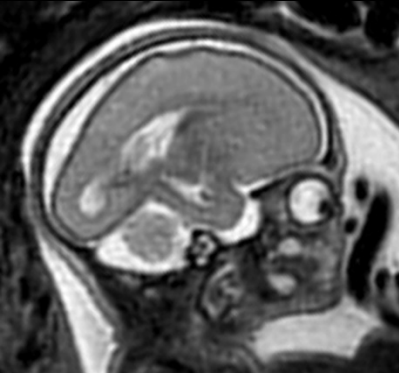
109 (25.4%) zerebrale

Es gibt kein „typisches“ kong. Vitium!

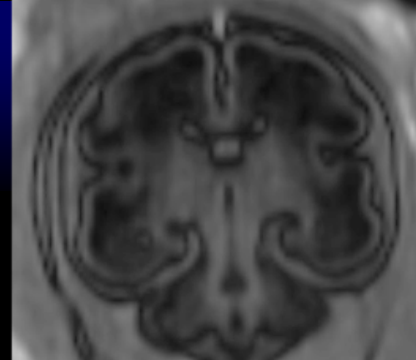




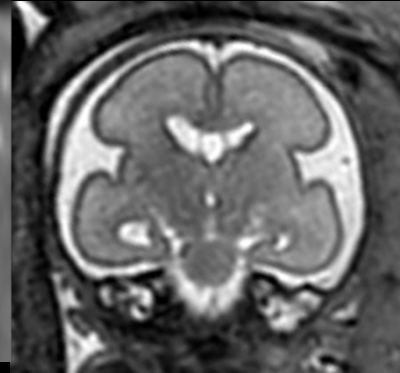
T2-w



EPI/T2*



T1w



T2-w

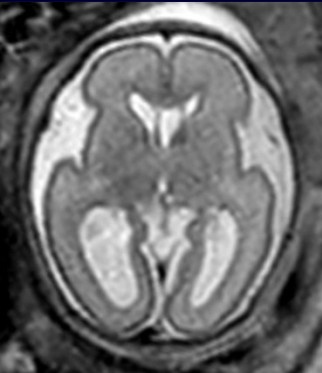


GUIDELINES

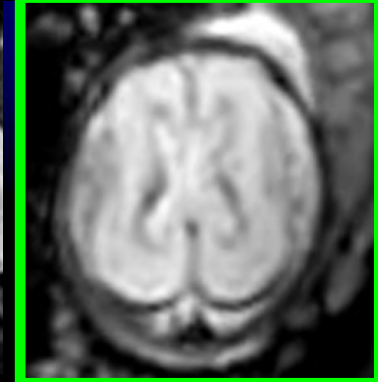
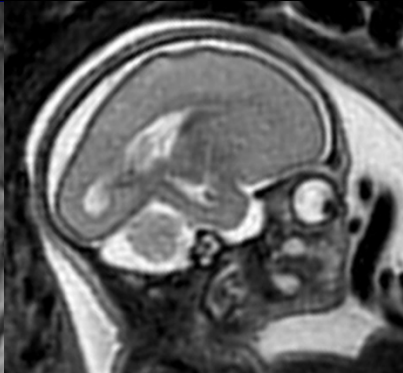
ISUOG Practice Guidelines (updated): performance of fetal magnetic resonance imaging

SCAN ME

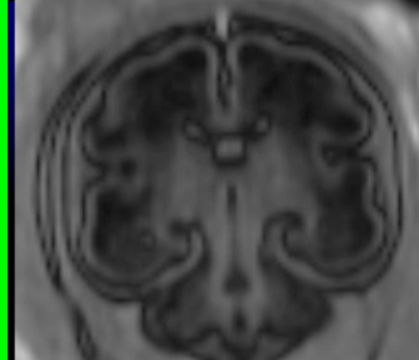




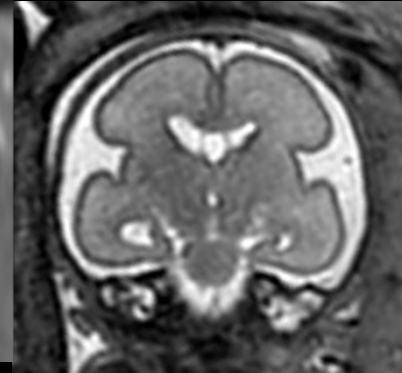
T2-w



EPI/T2*



T1w



T2-w



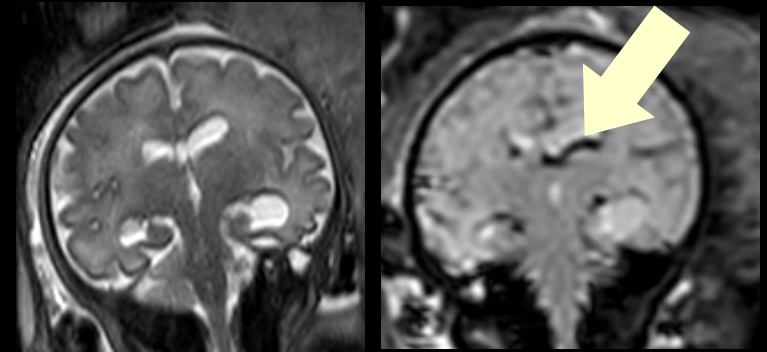
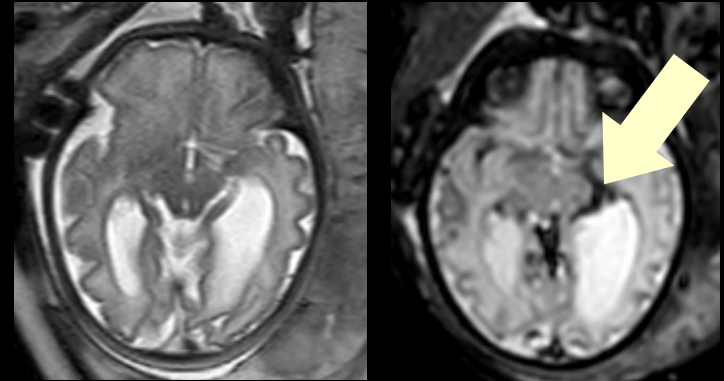
GUIDELINES

ISUOG Practice Guidelines (updated): performance of fetal magnetic resonance imaging

SCAN ME



T2*/EPI Sequenzen



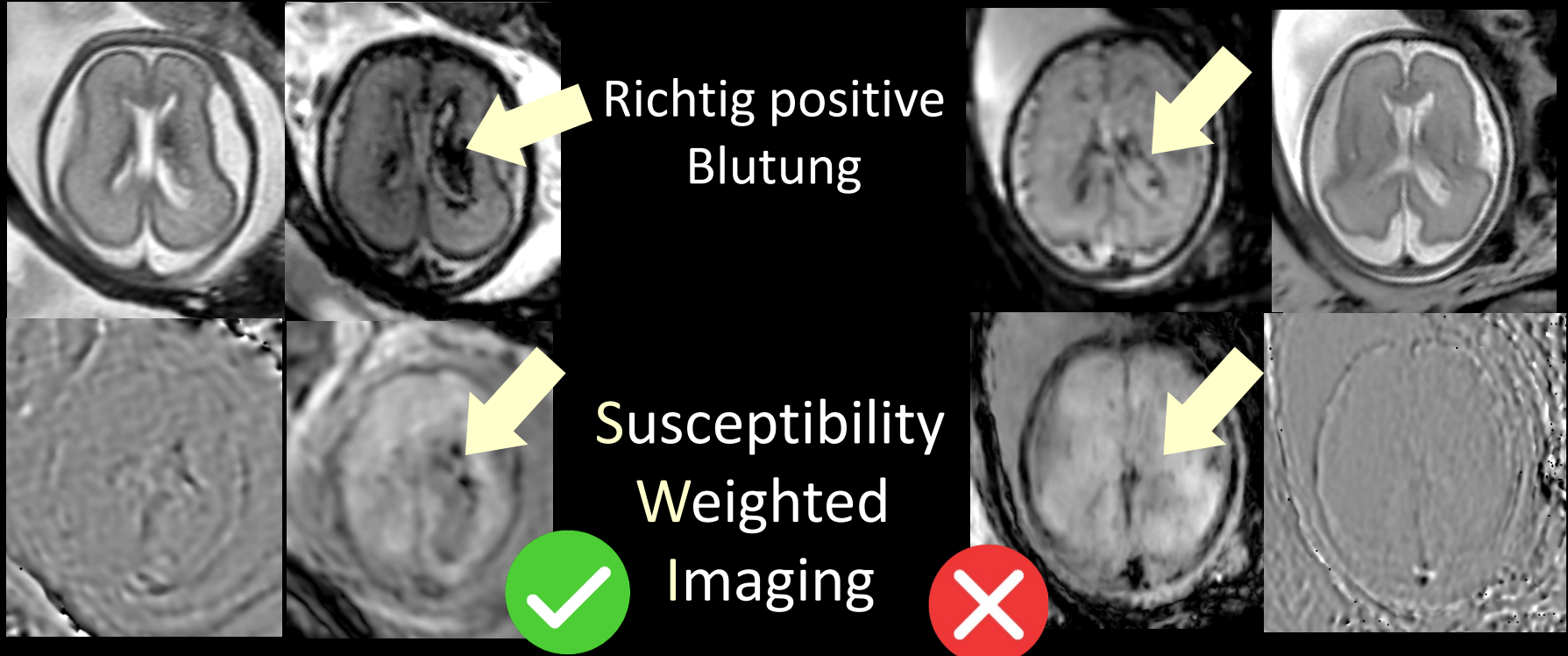
EPI/T2*: 30% mehr
Blutungen als T2-TSE!



T2*/EPI Sequenzen



Falsch Positiv



Richtig positive
Blutung

Susceptibility
Weighted
Imaging

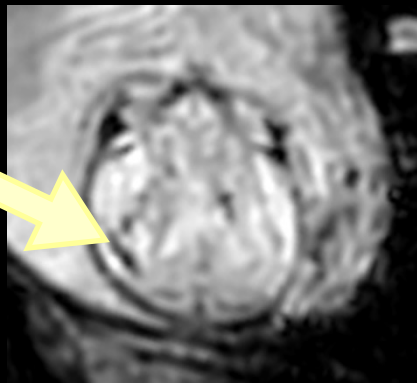


Fall

Hämosiderin!



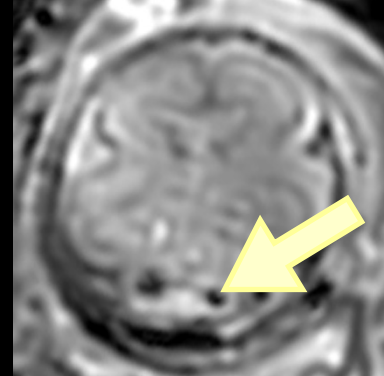
1. Schwangerschaft, 21SSW



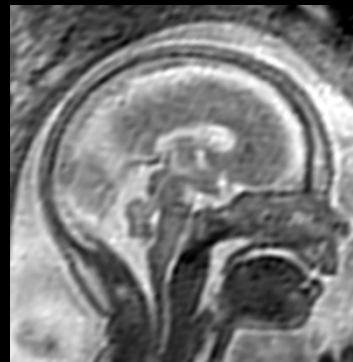
EPI



2. Schwangerschaft, 23SSW



EPI



Fall – Genetik

Trio – Whole Exome Sequencing



1. Schwangerschaft:

Vater + Fetus:

COL4A2 - Mutation

NM_001846.4:c.3207+1G>T

2. Schwangerschaft:

Vater + Fetus:

COL4A2 - Mutation

NM_001846.4:c.4684G>A

NP_001837.2:p.Asp1562Asn



Fall



Col4A1 verursacht prä- und perinatale Blutungen, Porenzephalie, rezidivierende intrazerebrale Blutungen

Gould, D.B., et al. N. Engl. J. Med. 2006; 354, 1489.

Gould, D.B., et al. Science 2005; 308, 1167.

Breedveld, G., et al. J. Med. Genet 2006; 490–495.

Sibon, I., et al. Ann. Neurol. 2007; 62, 177

Plaisier, E., et al. E., et al. N. Engl. J. Med. 2007; 357, 2687.

de Vries, L.S., et al. Ann. Neurol. 2009; 65, 12–18.

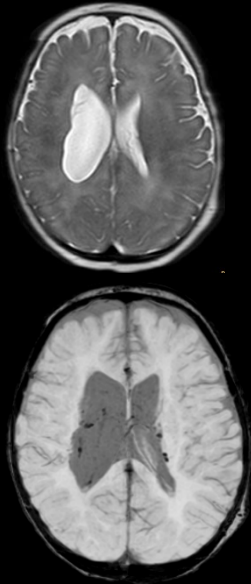
Shah, S., et al. Eur. J. Paediatr. Neurol. 2010; 14, 182–187.



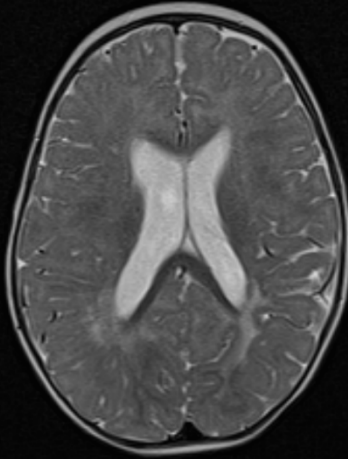
Was haben diese Patient:innen gemeinsam?



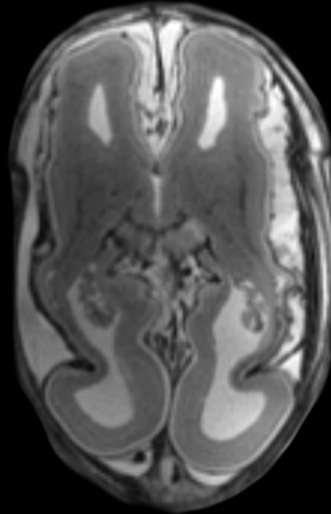
Patient 1 (7M)
T2, MIP



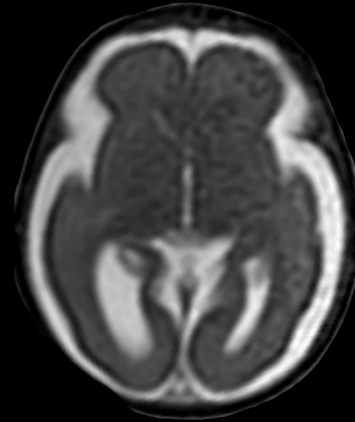
Patient 2 (10M)
T2



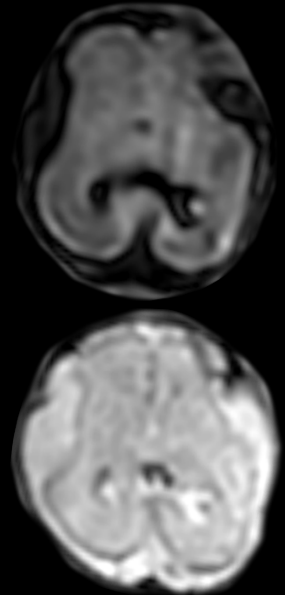
Patient 3
(p.m. 24+4)
CISS



Patient 4
(GW 24+2)
T2

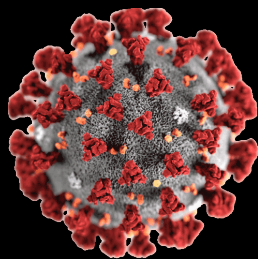


Patient 5
(GW 23+4)
*FLAIR, T2**





Patric
Kienast



Prenatal MRI of 43
pregnant women after
SARS-CoV-2-infection

Wild type
n=14 (33%)

Alpha B.1.1.7
n=5 (12%)

Delta B.1.617.2
n=3 (7%)

Omicron B.1.1.529
n=21 (48%)

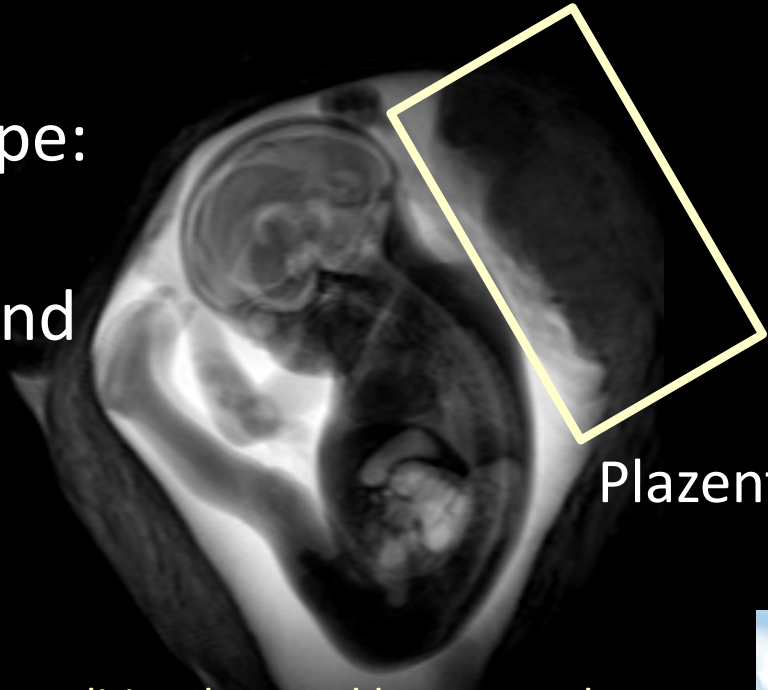


**Brain
abnormalities
in 5/43 (12%)**

COVID-19 pränatal



Plazenta in Prä-Omicron Gruppe:
verdickt (P = .048),
mehr Lobulierung (P = .046), und
Blutungen (P = .002)!
FGR in 25%.



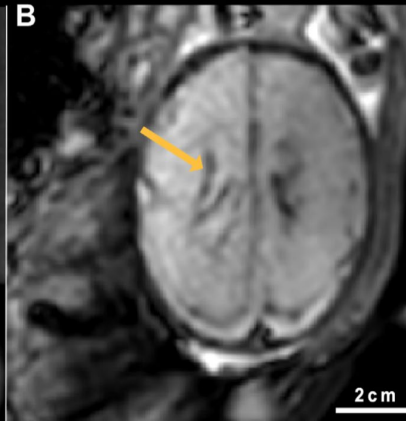
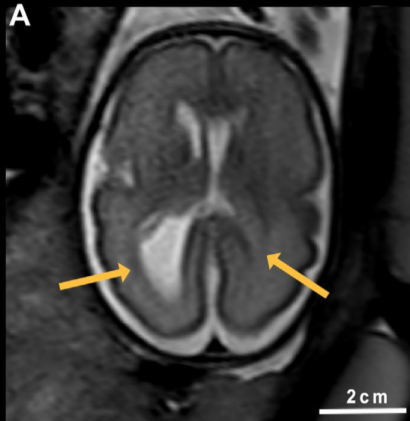
Plazenta!



Kienast P, et al. SARS-CoV-2 variant-related abnormalities detected by prenatal MRI: a prospective case–control study. The Lancet Regional Health - Europe 2023:100587

COVID-19 pränatal

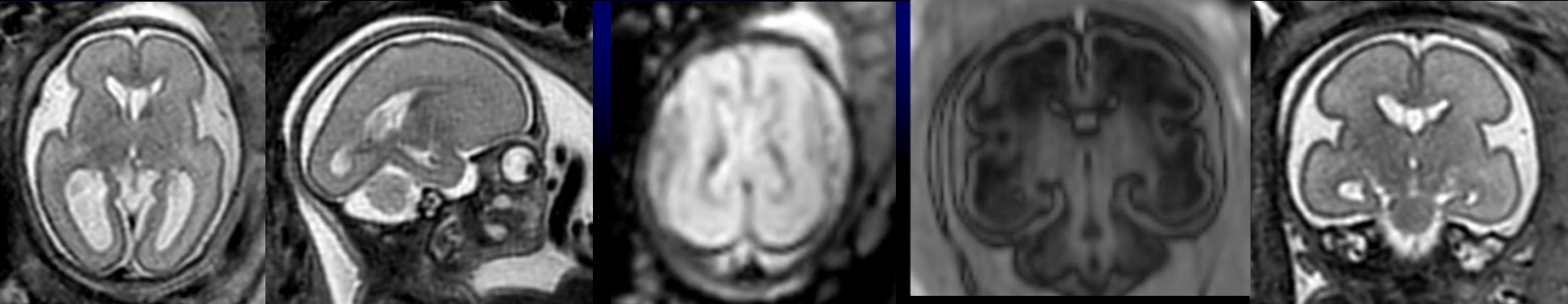
Plazenta in Prä-Omicron Gruppe verdickt (P = .048),
mehr Lobulierung (P = .046), und Blutungen (P = .002)!
FGR in 25%.



GW27+2

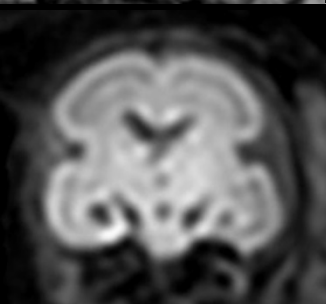


Kienast P, et al. SARS-CoV-2 variant-related abnormalities detected by prenatal MRI: a prospective case–control study. *The Lancet Regional Health - Europe* 2023:100587



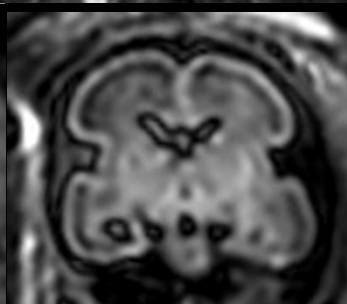
T1w

T2-w



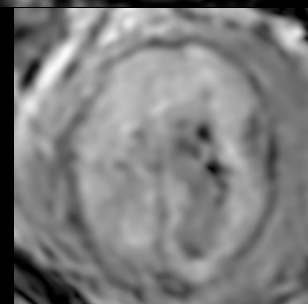
DWI

“optional”



FLAIR

neu

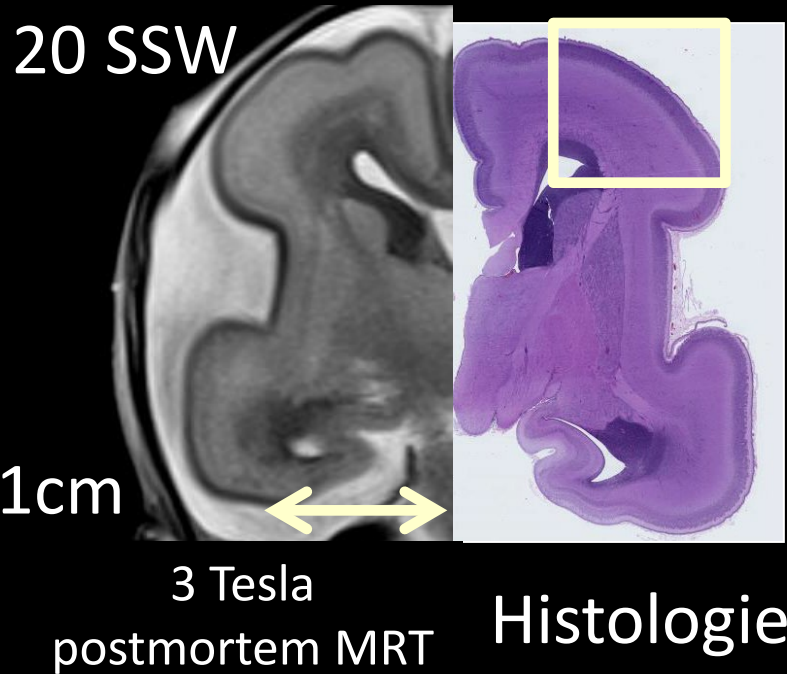


SWI

neu

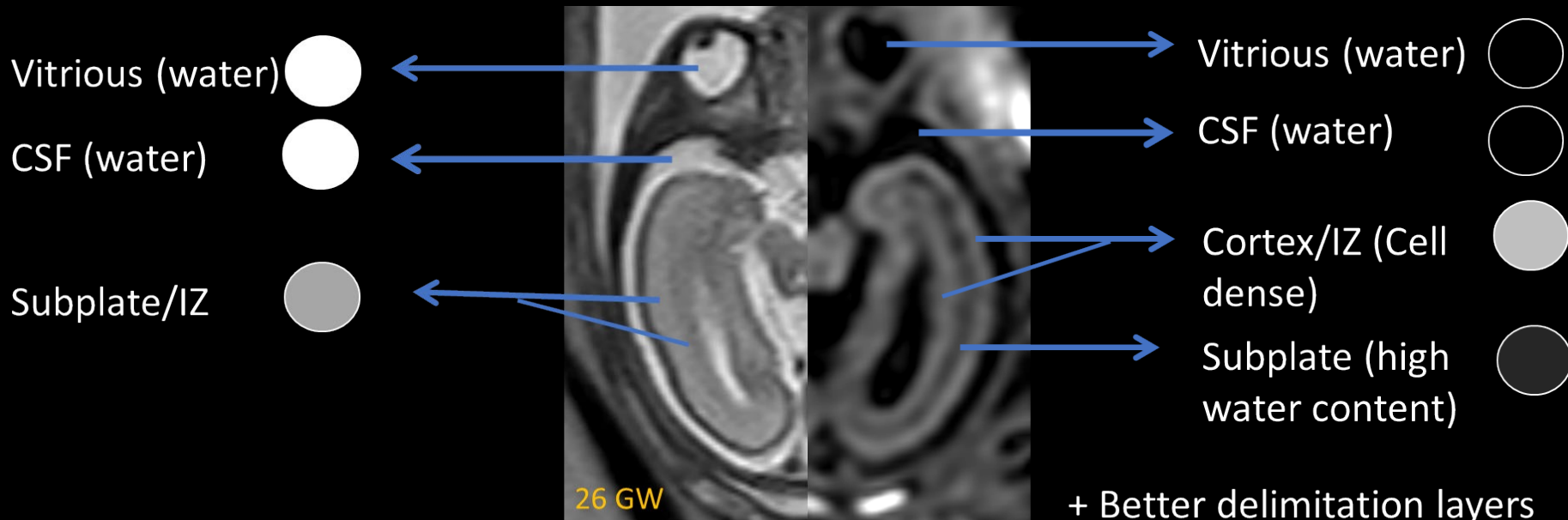
Hirnparenchym im MRT "Laminierung"

T2-w Kontrast



Hirnparenchym im MRT

EPI-FLAIR

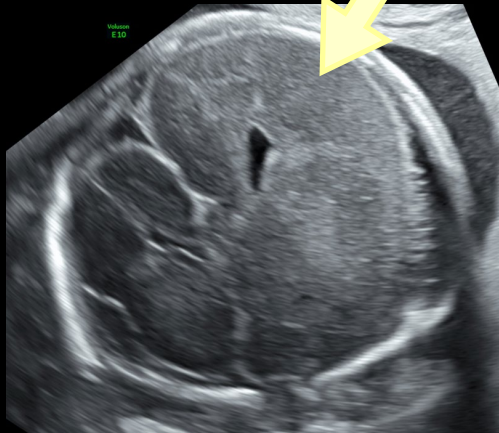


+ Better delimitation layers
+ Better delineation with CSF

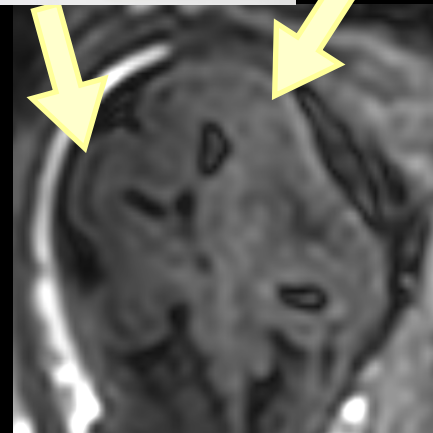
Hirnparenchym im MRT

EPI-FLAIR

US 22SSW



T2-w



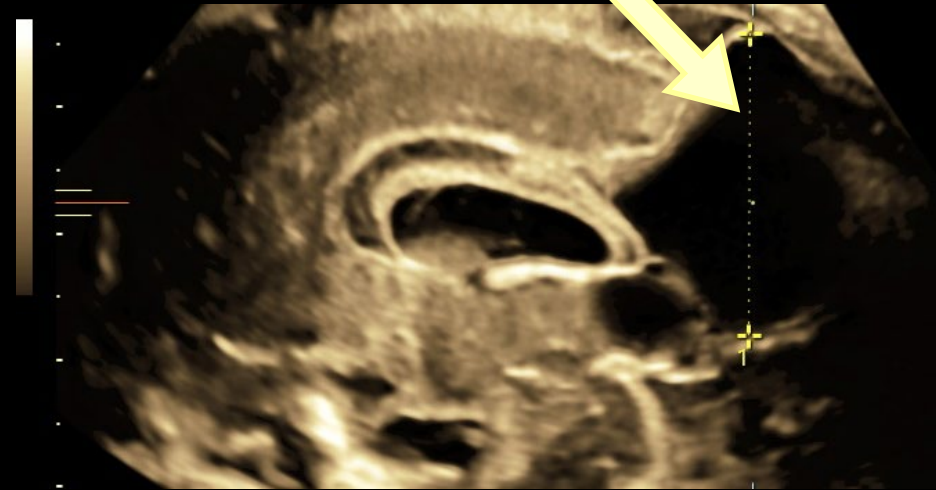
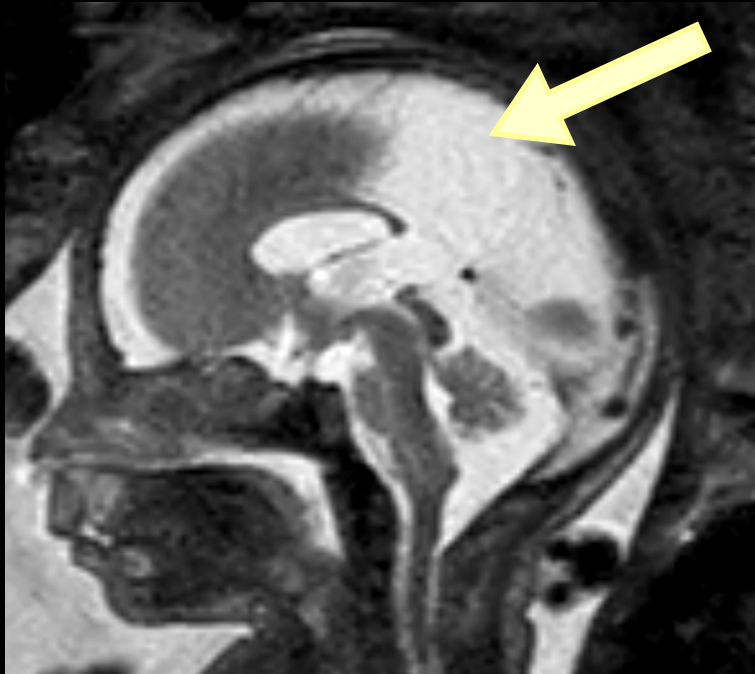
Hemimegalenzephalie

Verlust der Schichtung - Pathologie

Hirnparenchym im MRT



Interhemispherische Zyste



©E. Krampfl-Bettelheim

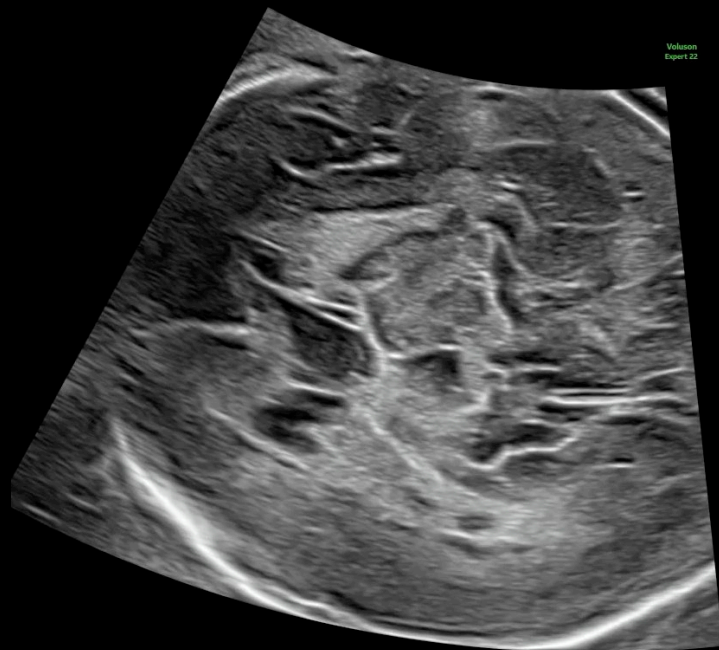


Hirnparenchym im MRT



Interhemispherische Zyste

GW 23+5



©E. Krampfl-Bettelheim

kortikale Malformation?

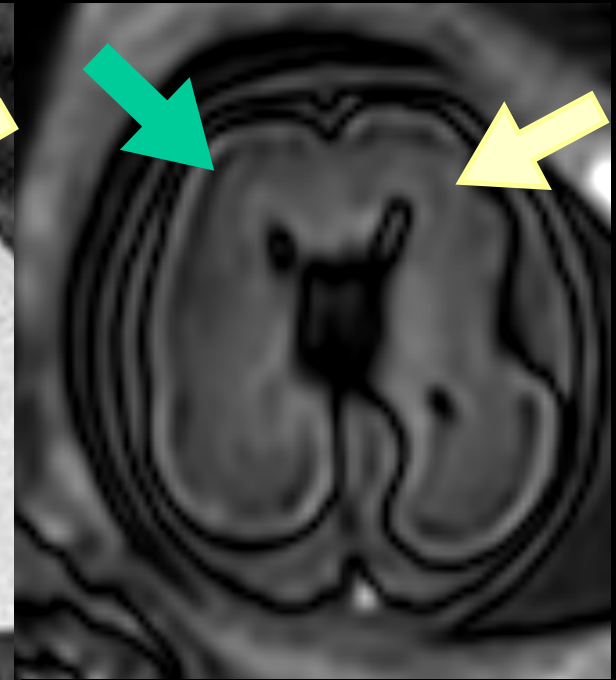
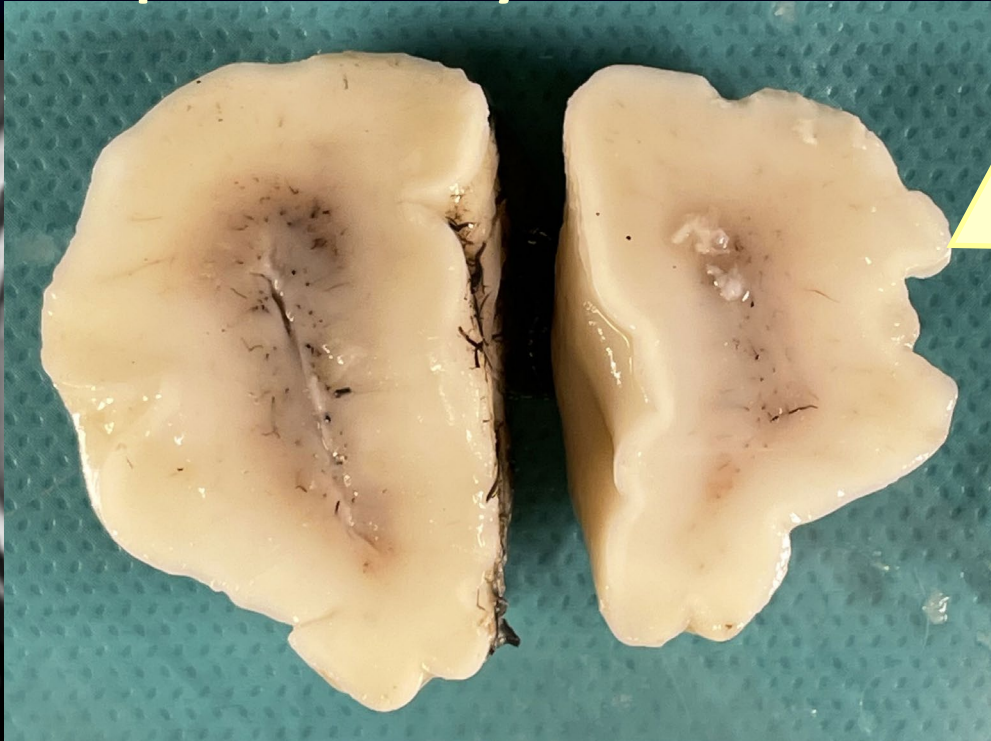


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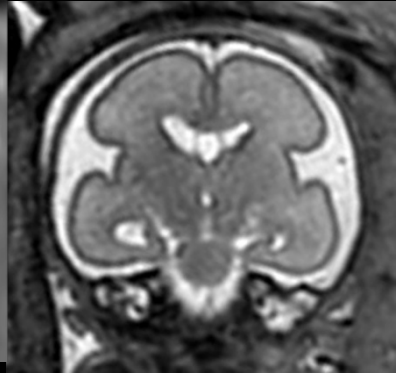
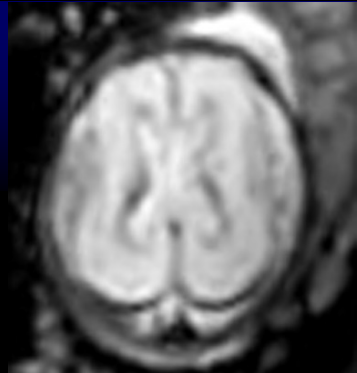
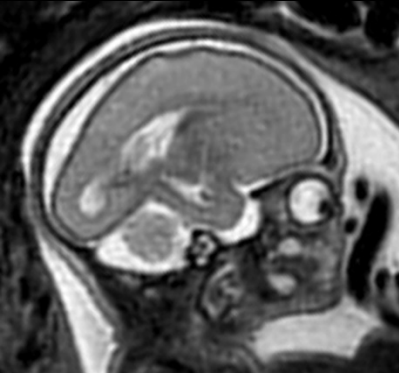
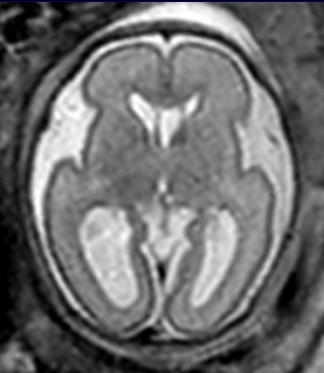
Vienna
General Hospital

Hirnparenchym im MRT



kortikale Malformation

EPI-FLAIR

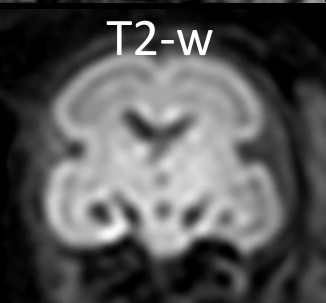


T2-w

EPI/T2*

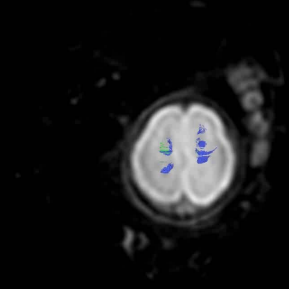
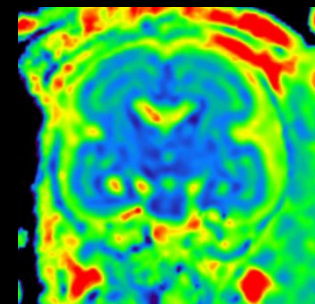
T1w

T2-w



Sc 12, m:1

MR Equipment
4052019



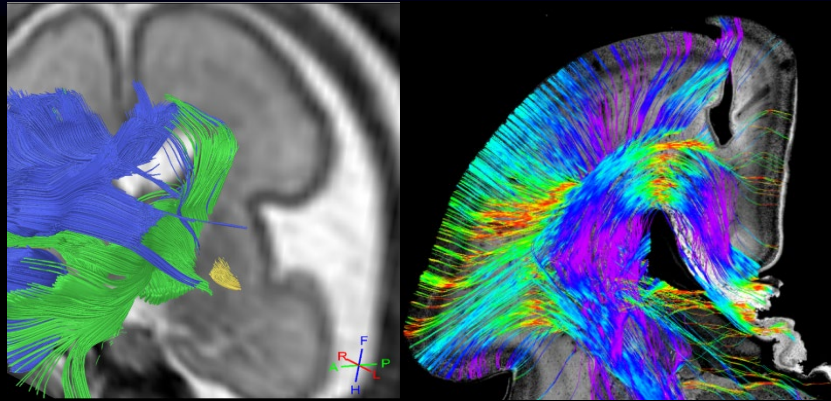
HE-PS



Fetal Diffusion tensor Imaging

Traktographie

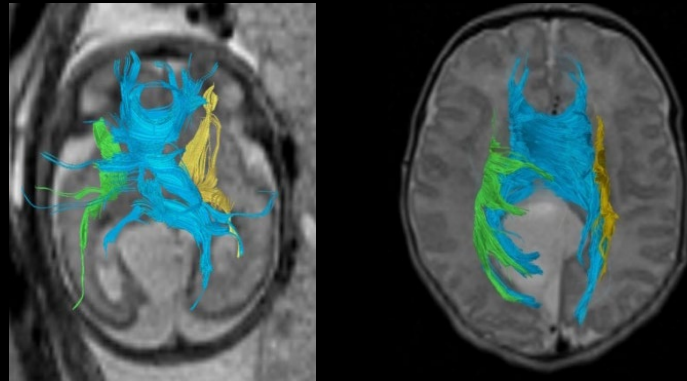
PubMed >50 Veröffentlichungen



DTI korreliert mit Histologie

Mitter C, et al.

Frontiers in Neuroanatomy. 2015



DTI korreliert mit postnataler MRT

Song JW, et al.

Pediatric Radiology 2018;48:486-498

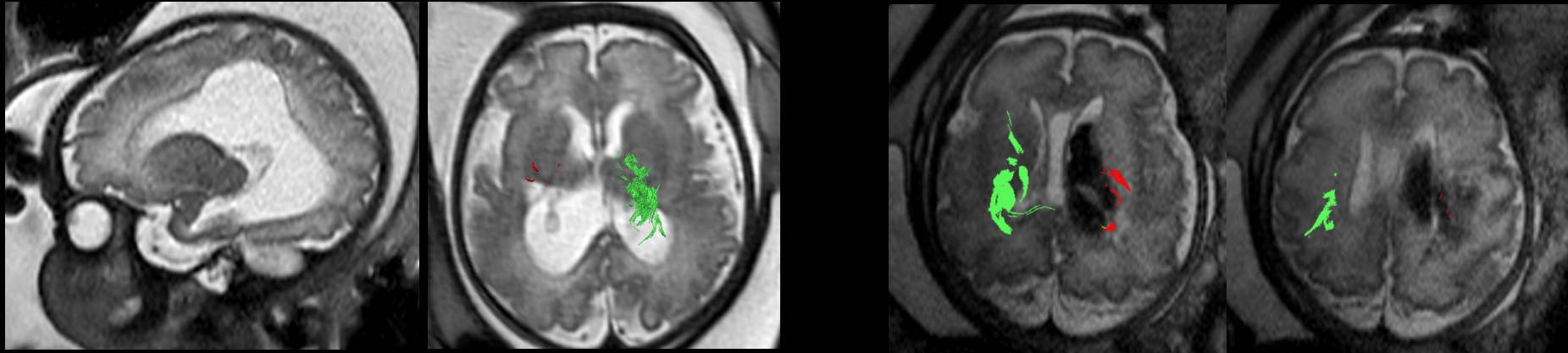


Klinische Wertigkeit?

E. Hadi



DTI/Traktographie bei intraventrikulärer Blutung



Motorisches Defizit: 31.3% der Fälle mit Einbezug der Pyramidenbahn
versus 5.1% ohne!

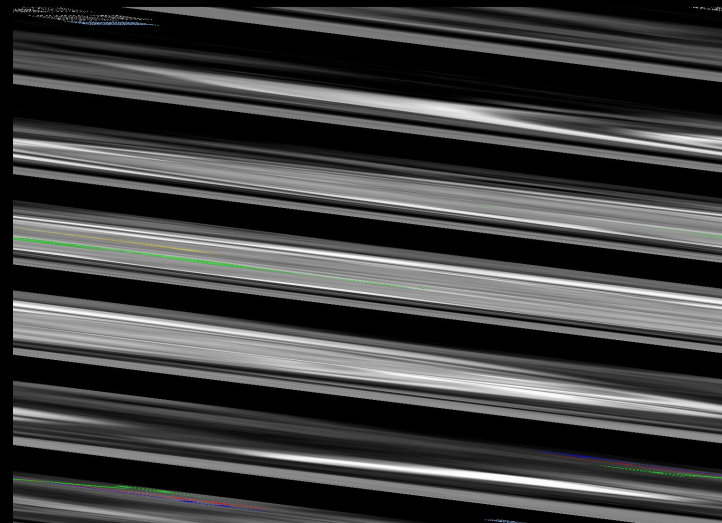
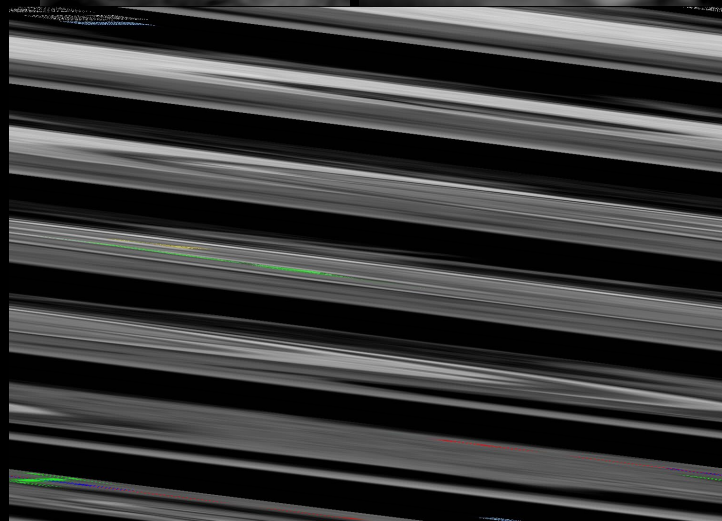
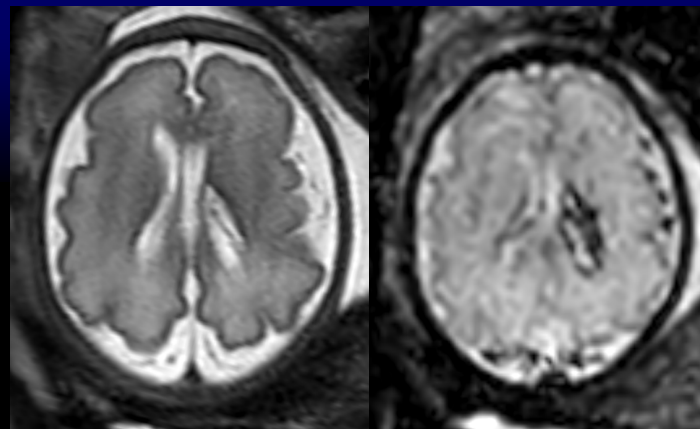
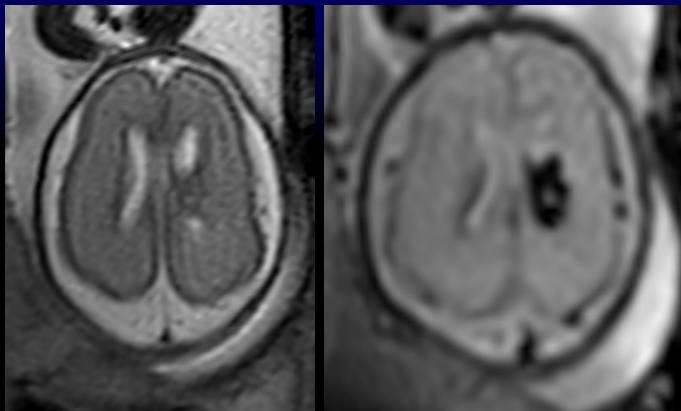


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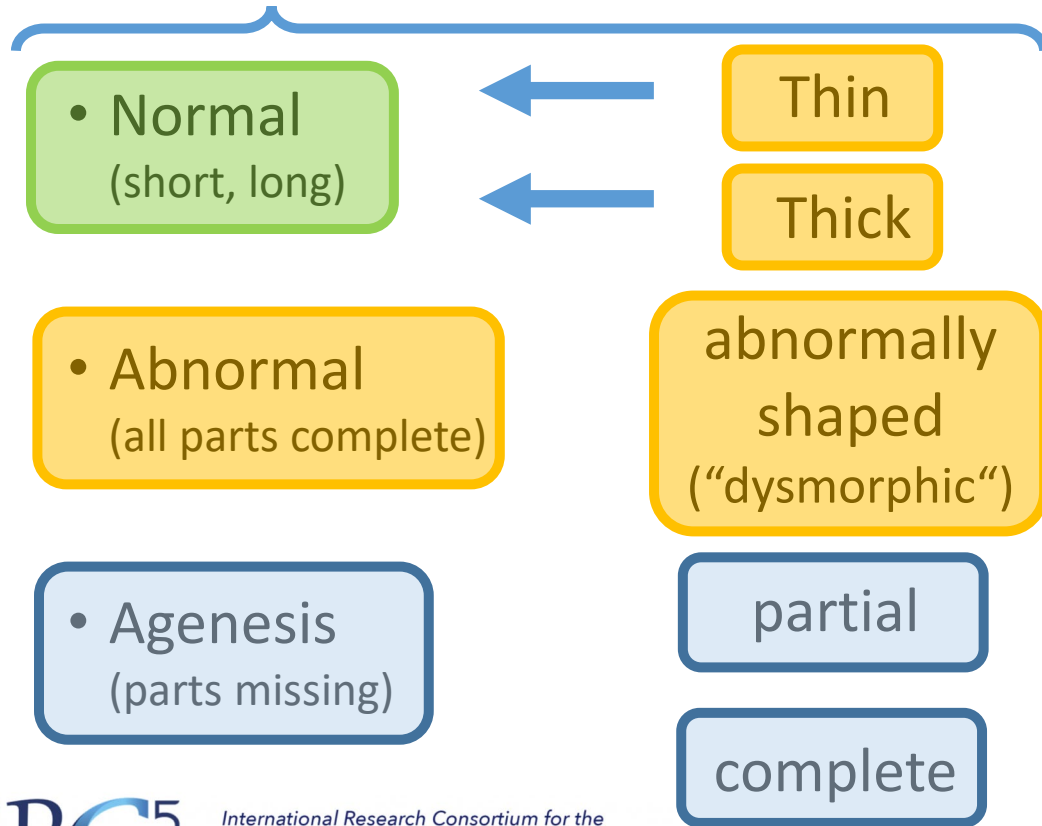


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General Hospital

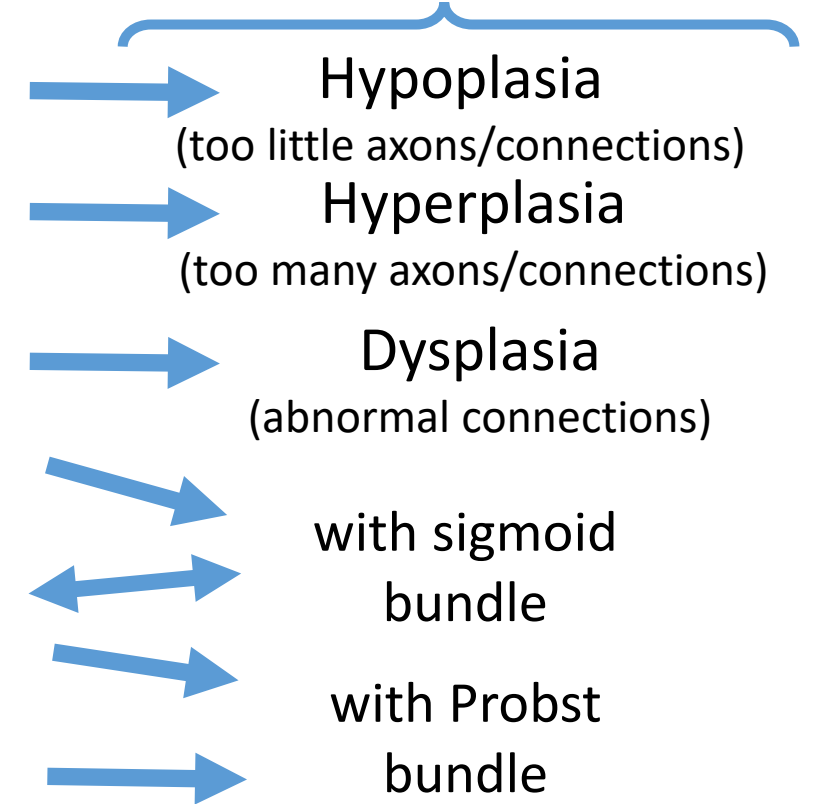
In preparation



Imaging: US/MRT



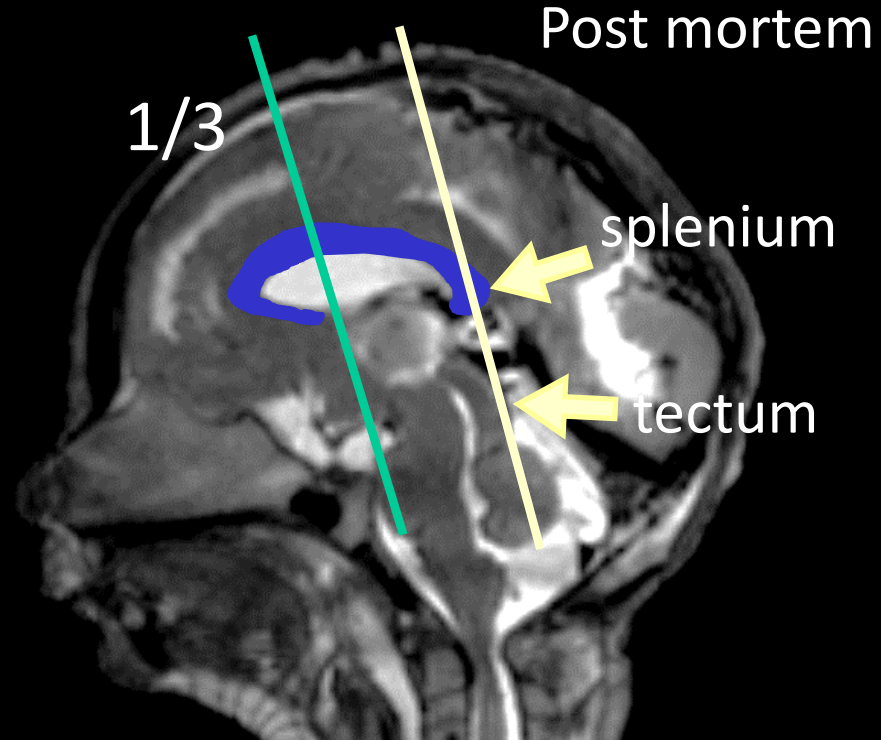
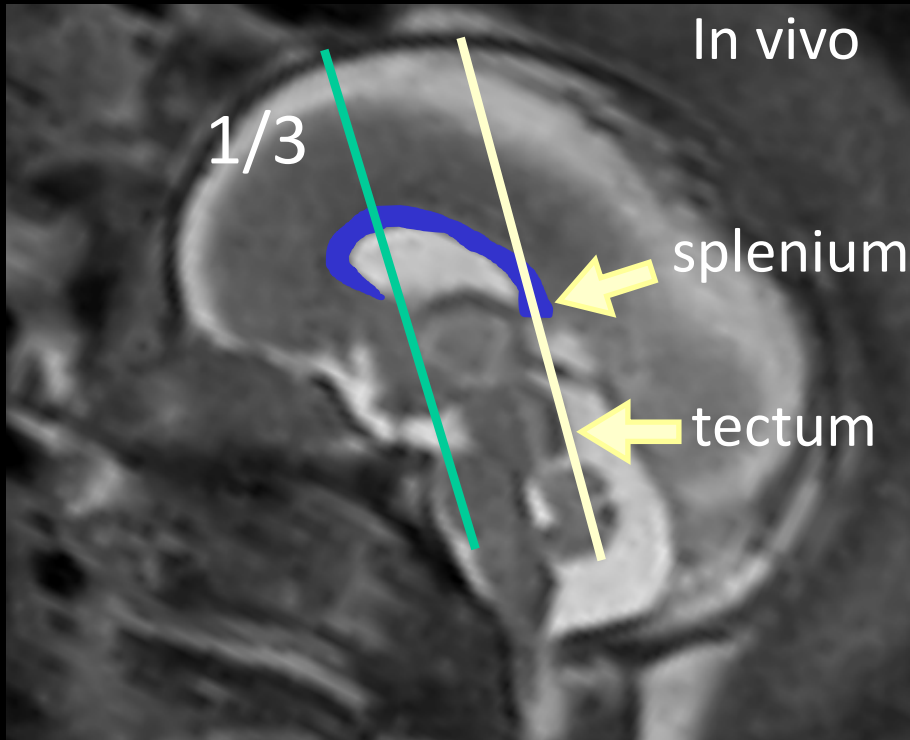
Histo/DTI



Corroenne, R. et al. Corpus callosal reference ranges: systematic review [...]. UOG 2023

Normal
(kurz, lang)

= vollständig!



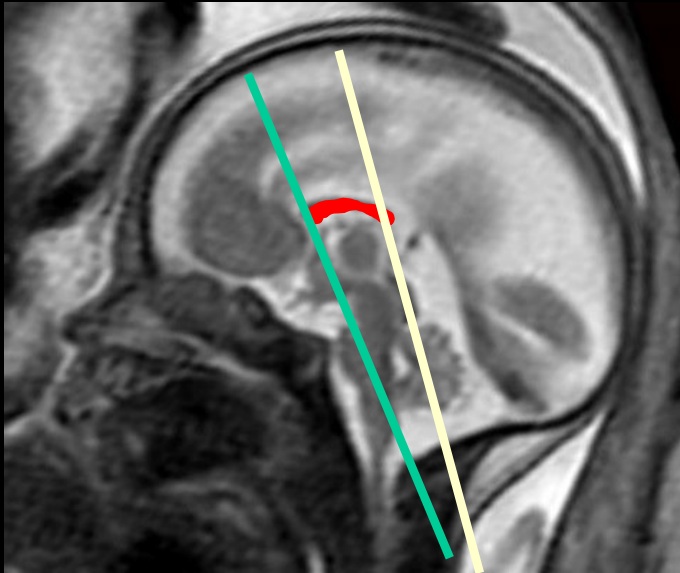


Agenesie (Anteile fehlen)

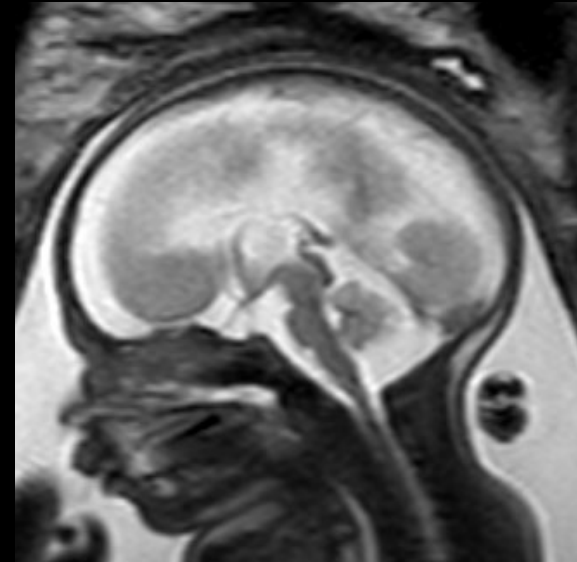


Partiell

Komplett



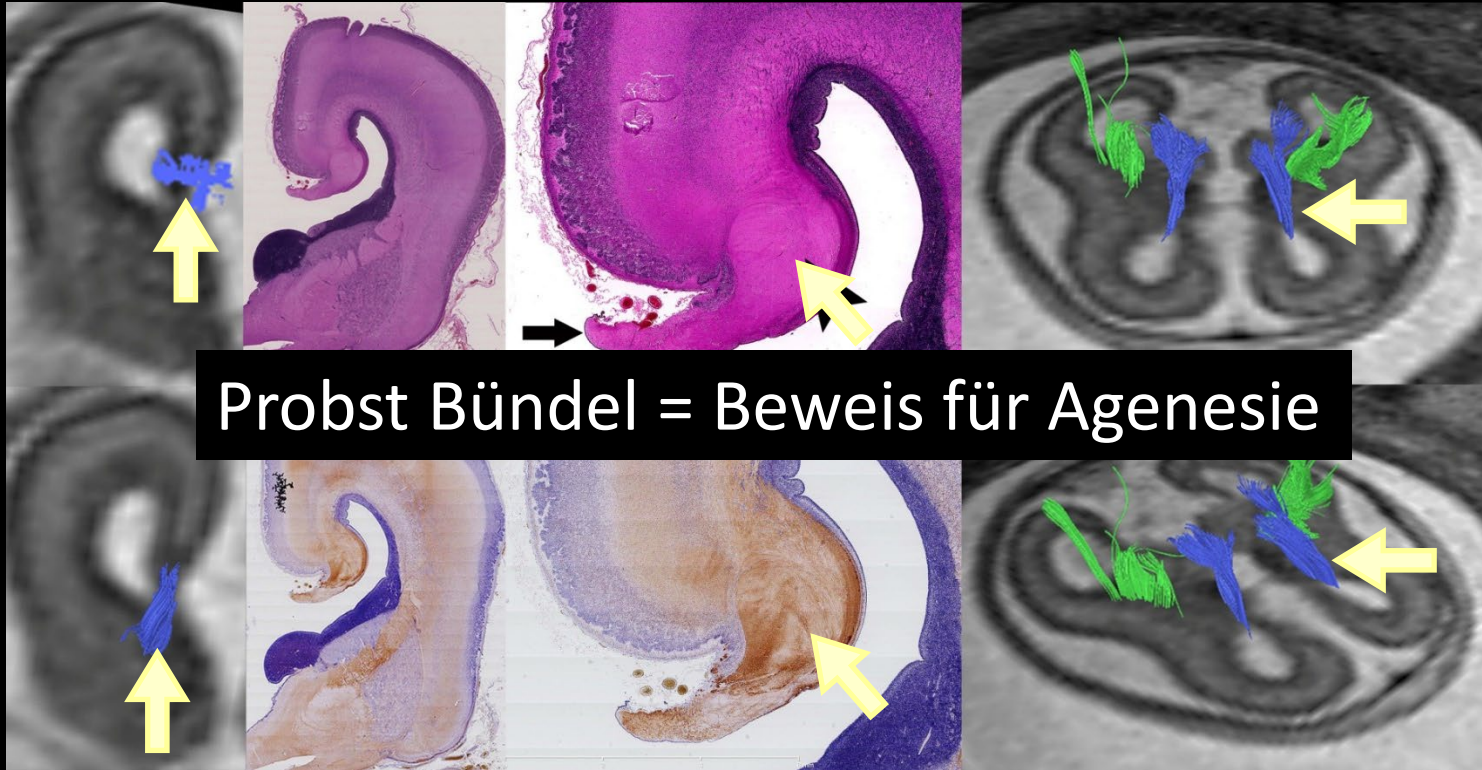
29SSW



28SSW

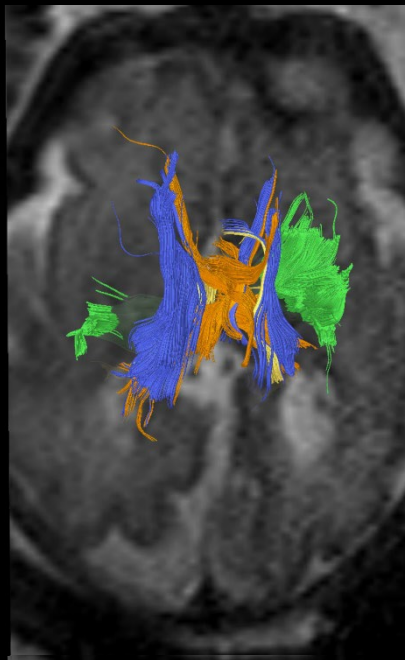
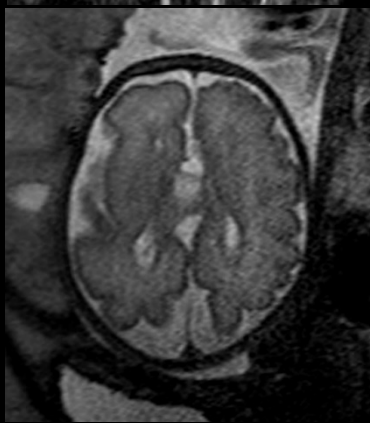
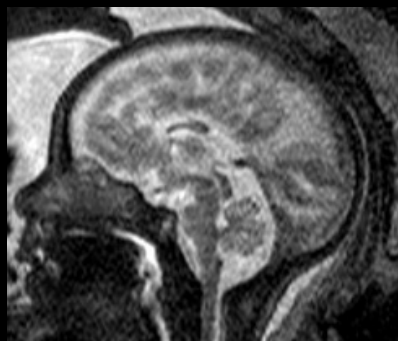
Spezifizierung

20 SSW

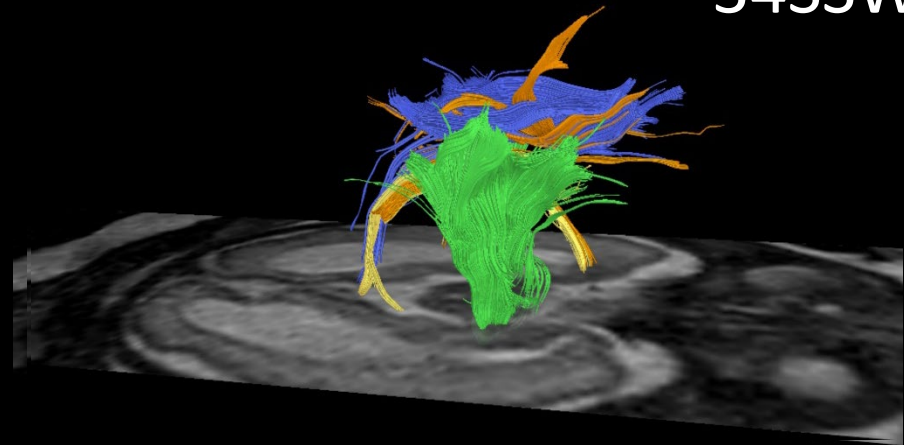


Partielle Agenesie (Teile fehlen)

34SSW



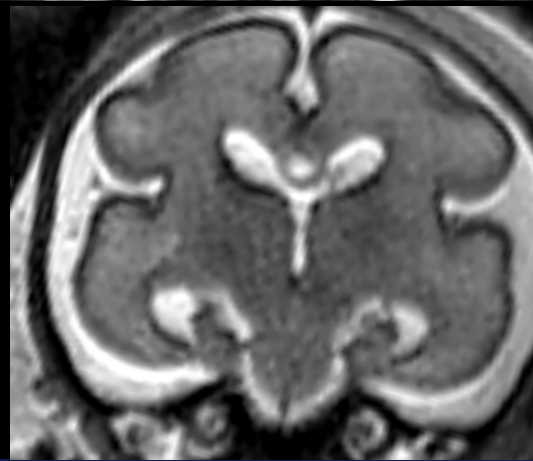
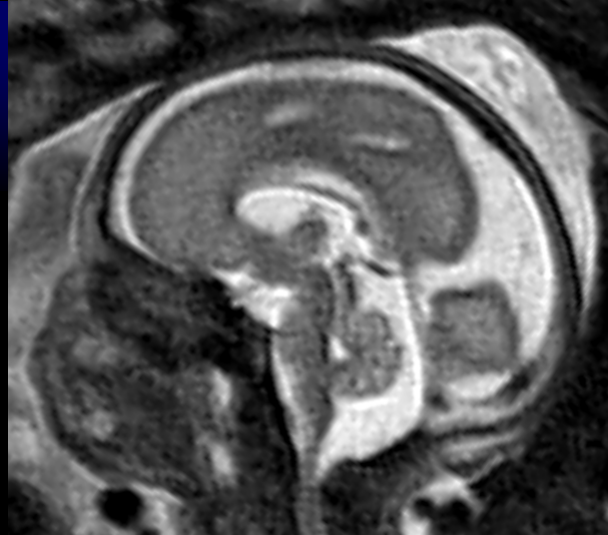
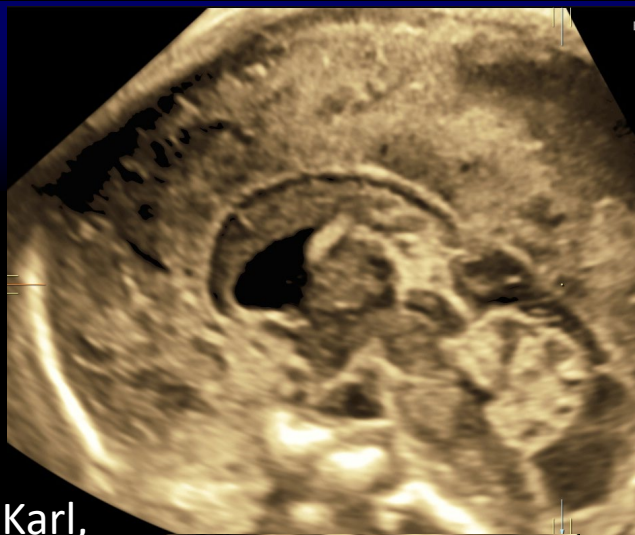
Corticospinal



Sigmoid

Fornix

Probst



©Katrin Karl,
München

26+4

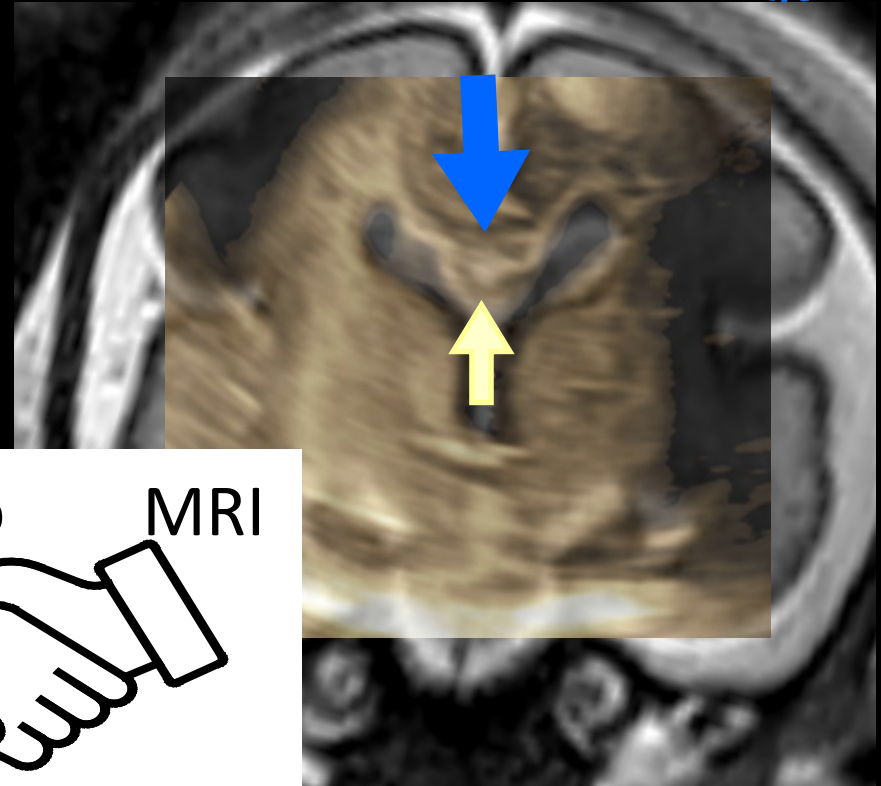
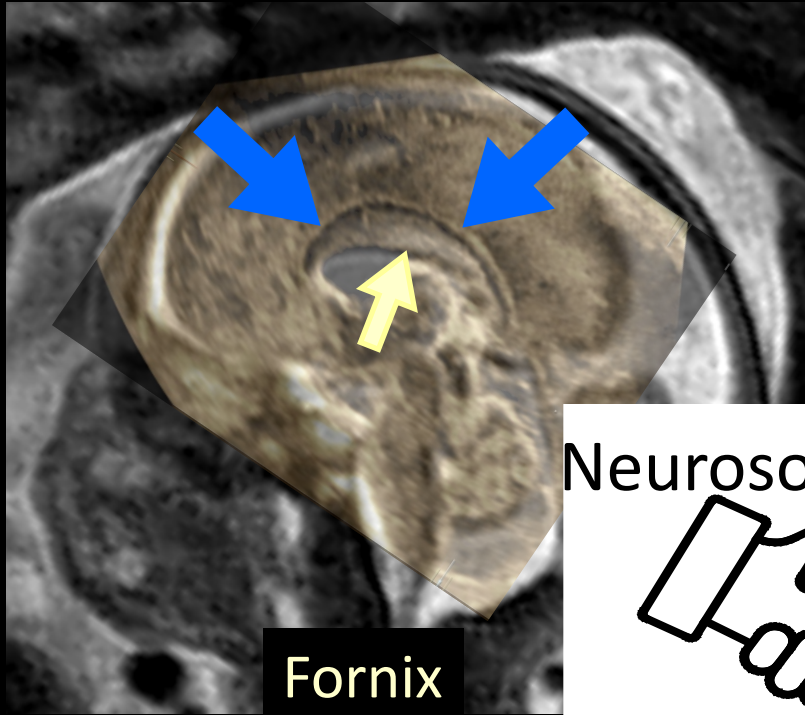
verdicktes CC?

Normales CC?

Genauere Spezifizierung



Corpus callosum

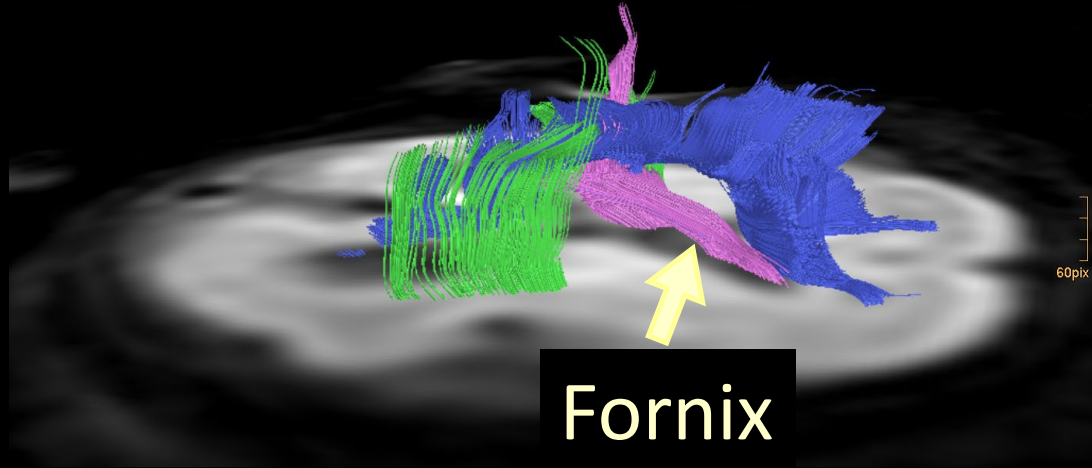
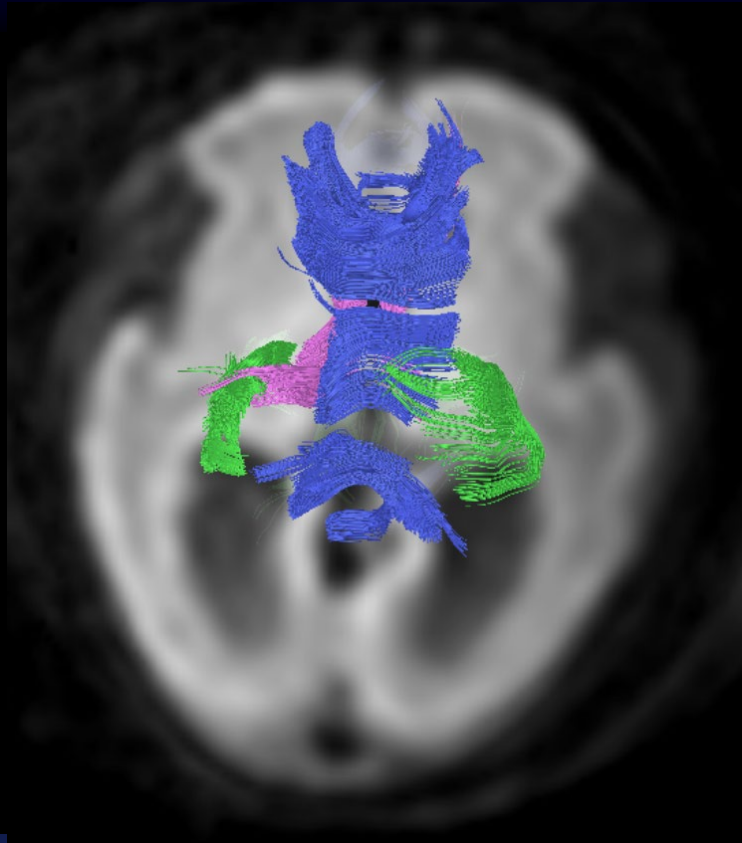


Neurosono MRI



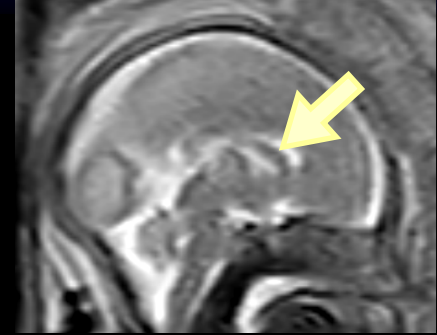
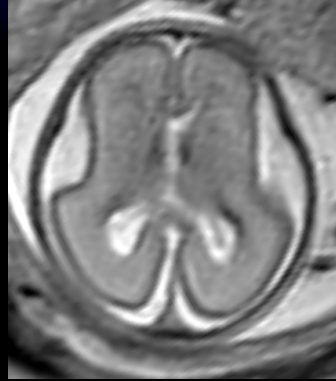
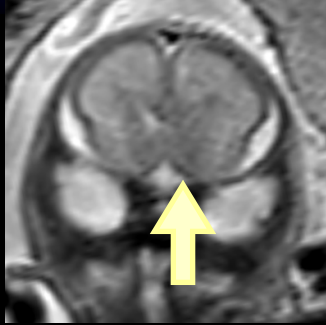
Fornix

Genauere Spezifizierung

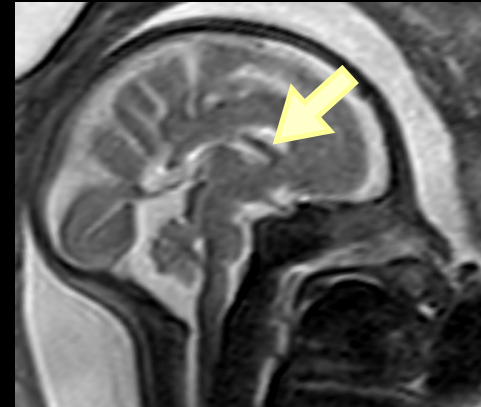
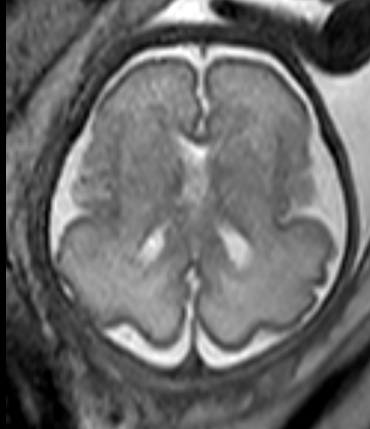


Ein weiterer Fall...

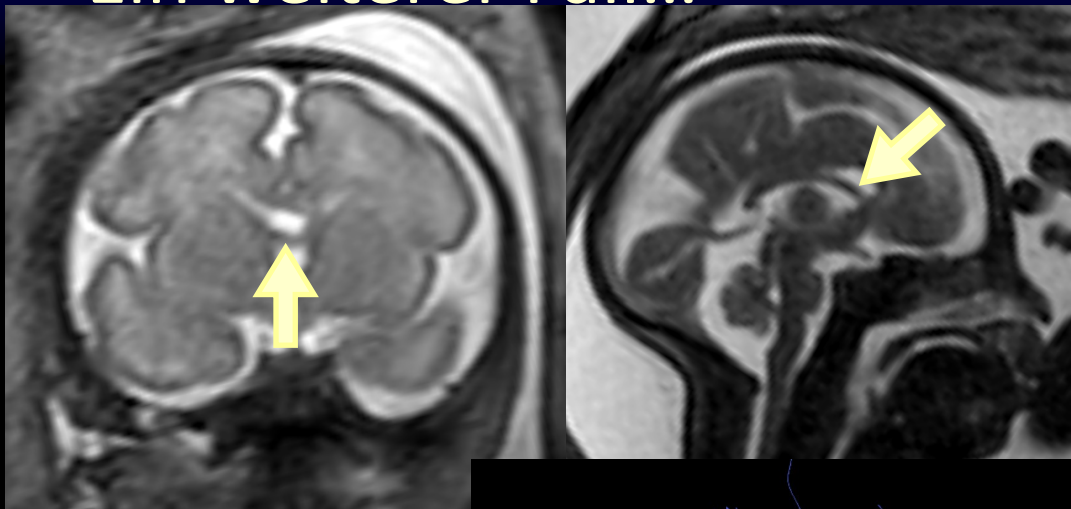
23GW



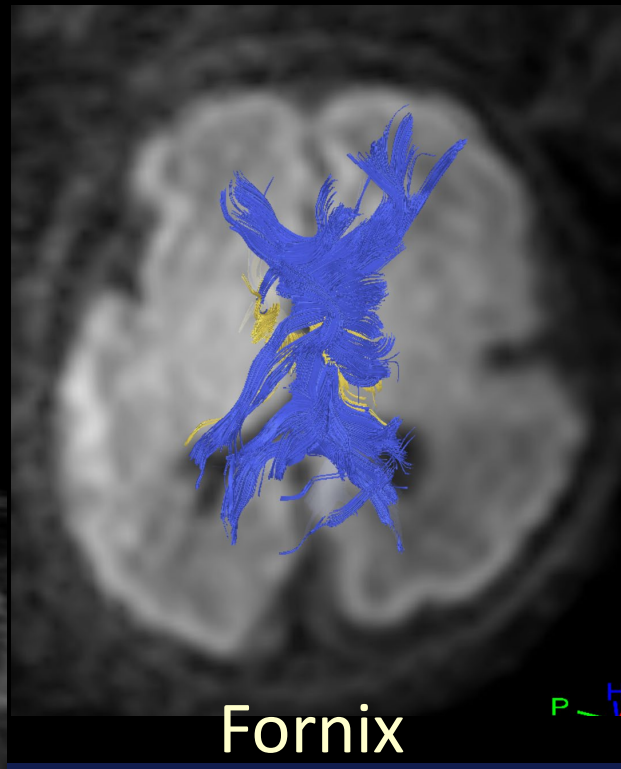
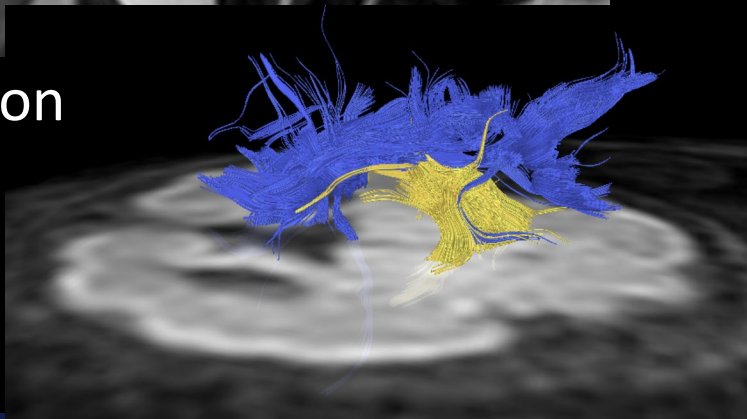
29GW



Ein weiterer Fall...

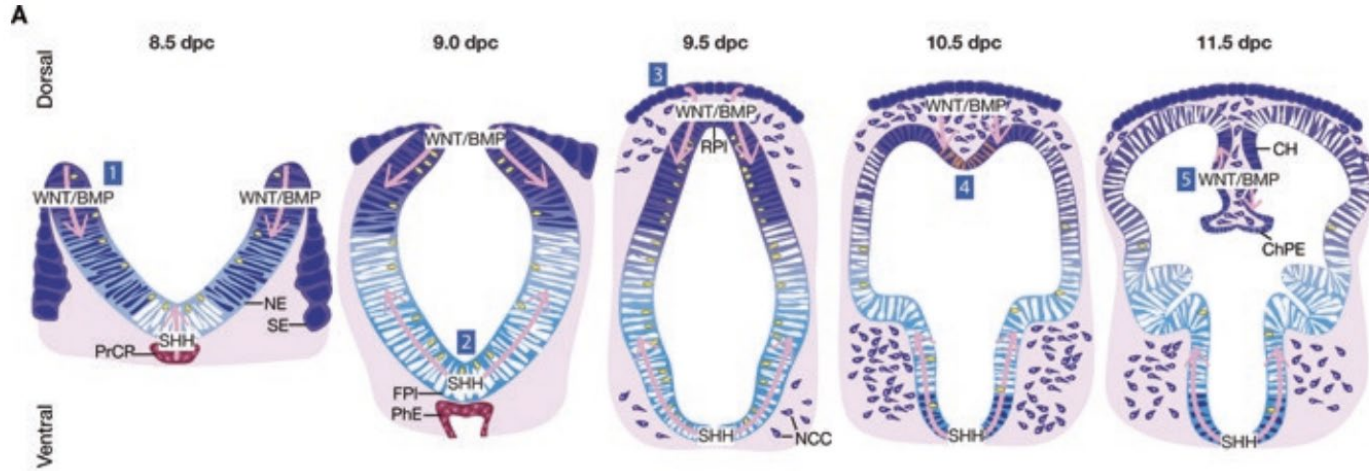


ZIC2 Gene Mutation
c.1204T>G
(p.Tyr402Asp)



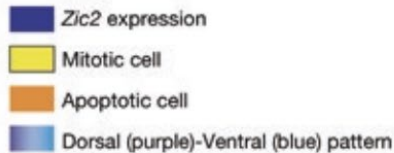
Fornix

Normal CC

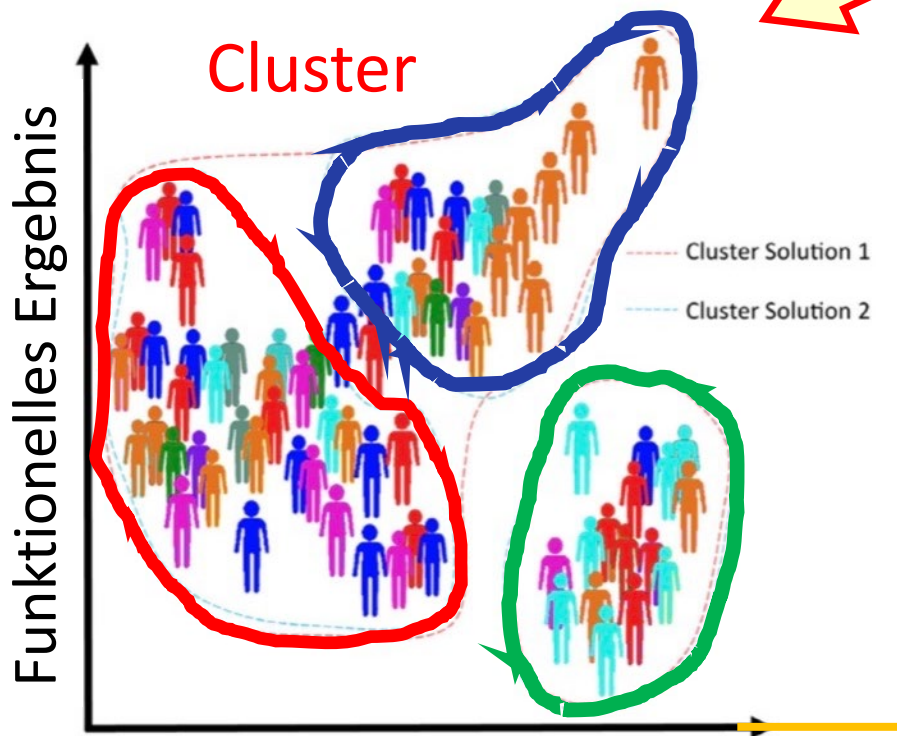


B dorsal patterning ≠ axon guidance

ZIC2 Gene Mutation



MR Phänotypisierung

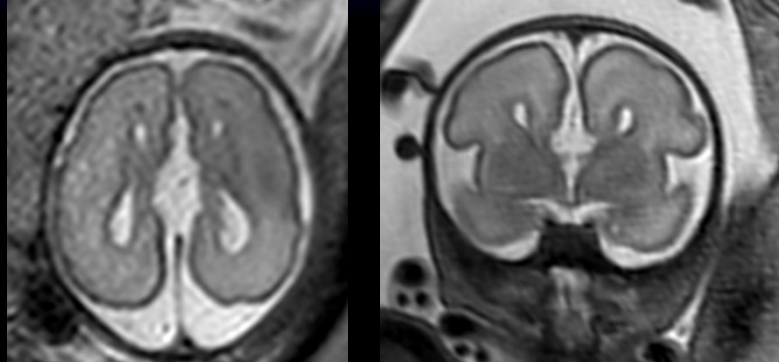


ISUOG Practice Guidelines (updated): performance of fetal magnetic resonance imaging



Neue Strategien – Neue Phänotypen

Traktographie – Interpretation?

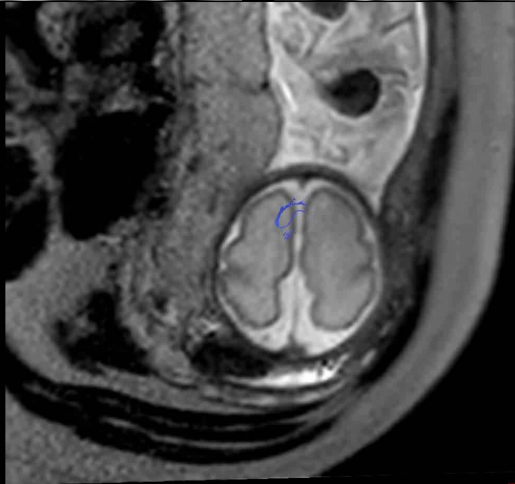


Callosum Agenesie, 26SSW

Probst Bündel

St. 30, 2, 10, 1
MR/CT/MR

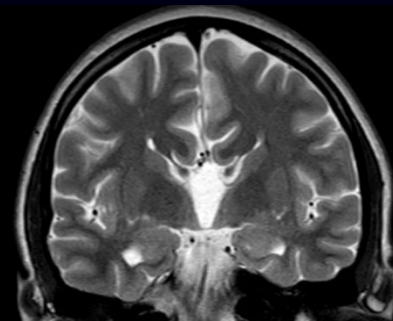
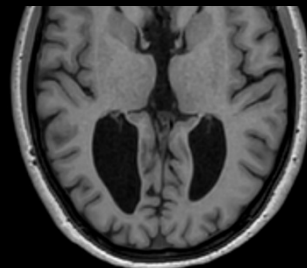
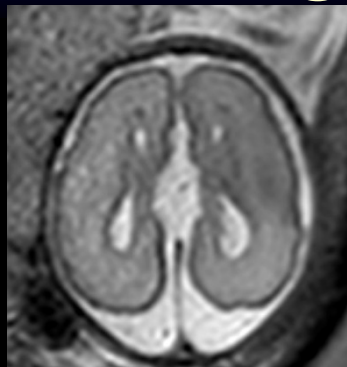
MR Fetal/Casert
20.08.2005
All Wien Neuro/radiologie



Traktographie – Interpretation?



DCC Mutation

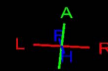
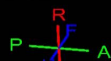
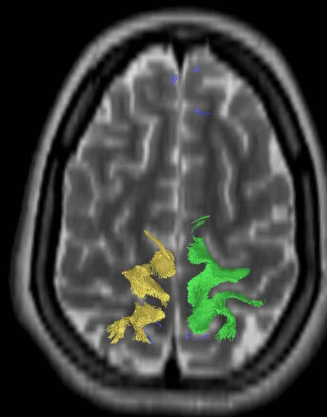
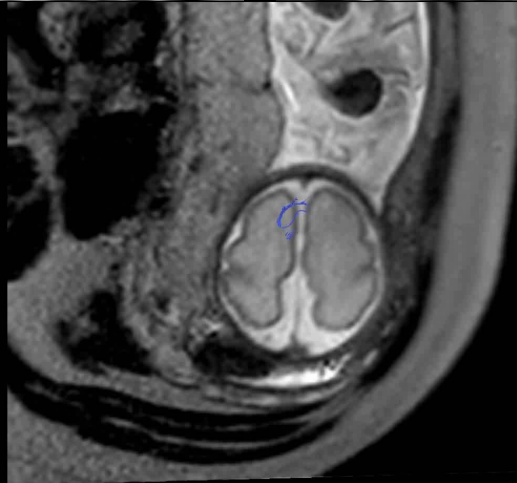


Mutter

SL 30.2, M, 1
JASATOMIC

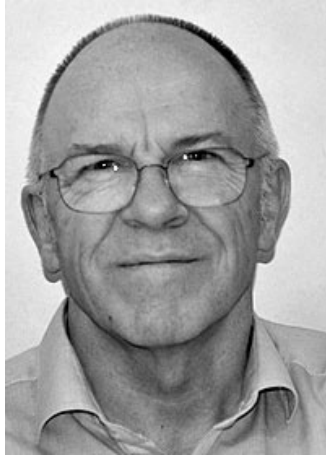
MR Fetal/Cesant
29.09.2003
AMU Wien - Institut für Radiologie

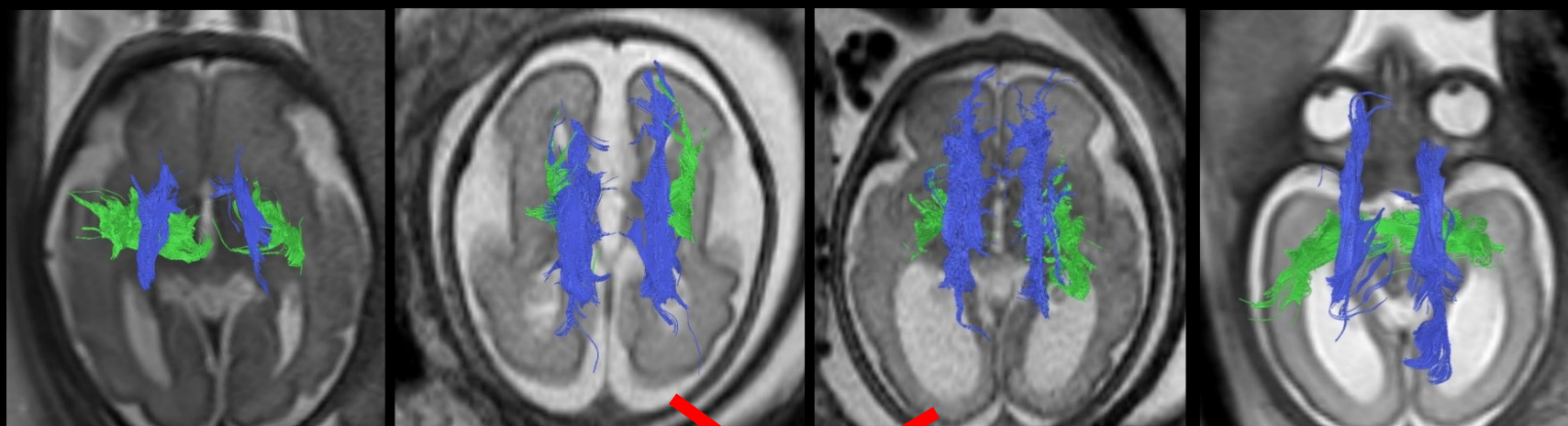
SL 30.2, M, 1
JASATOMIC



Phänotypisierung – wozu?

„Es ist absolut unmöglich
Funktion [...] vorherzusagen“!
(Eugen Boltshauser)

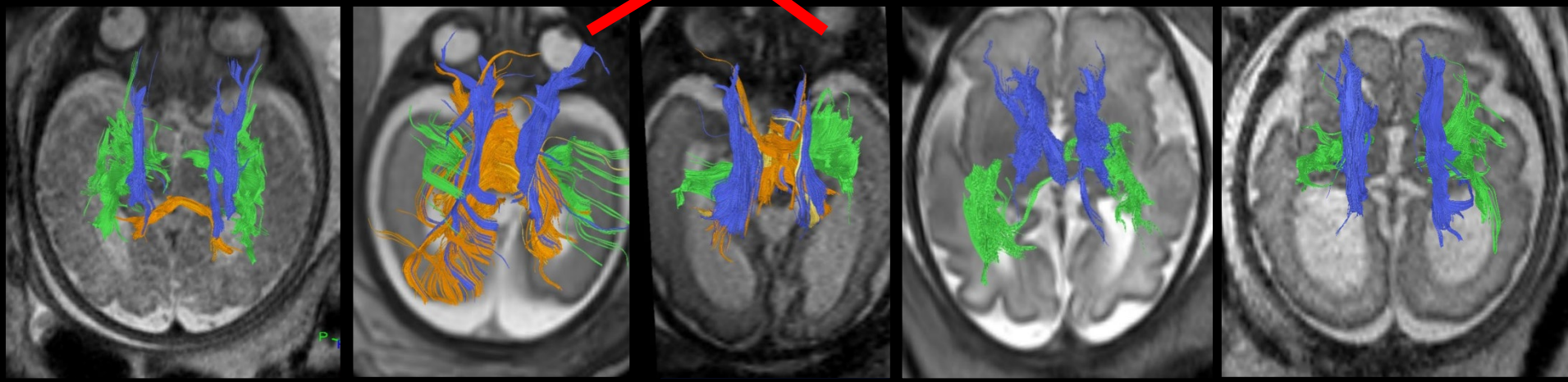




Bilder

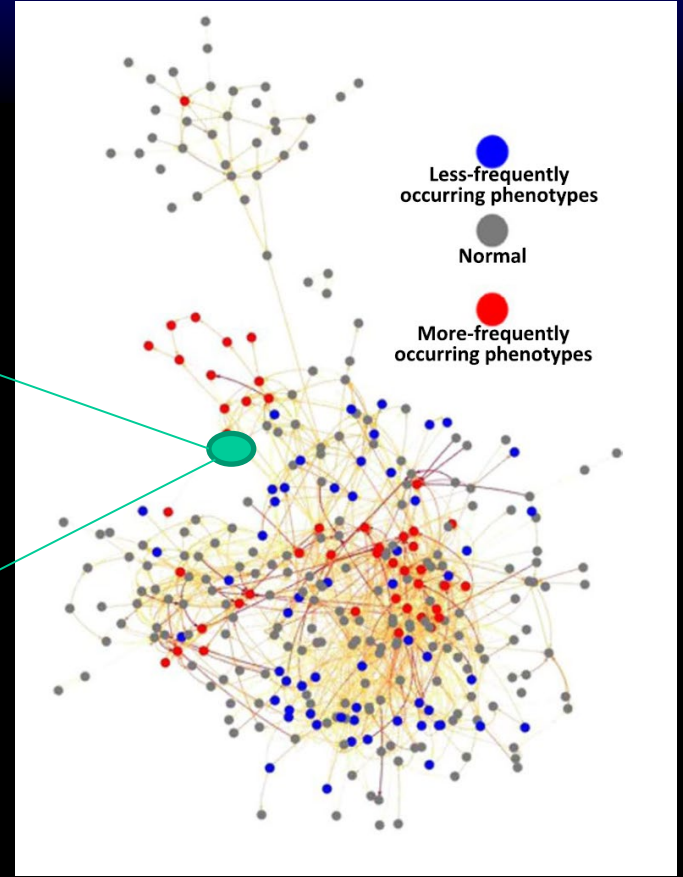
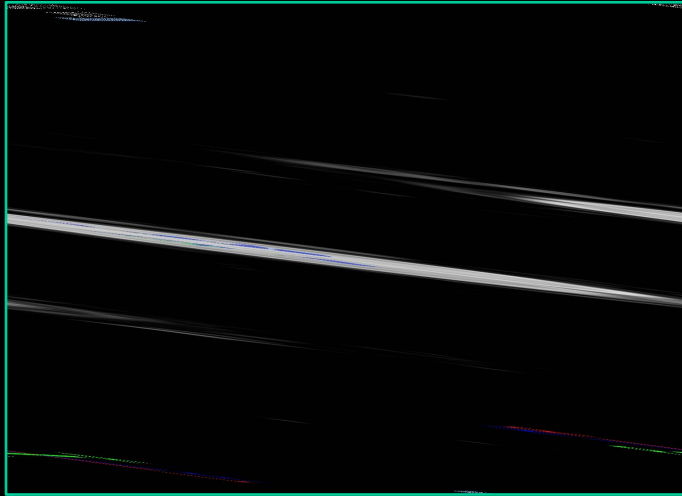


Function



Warum?

Konnektom

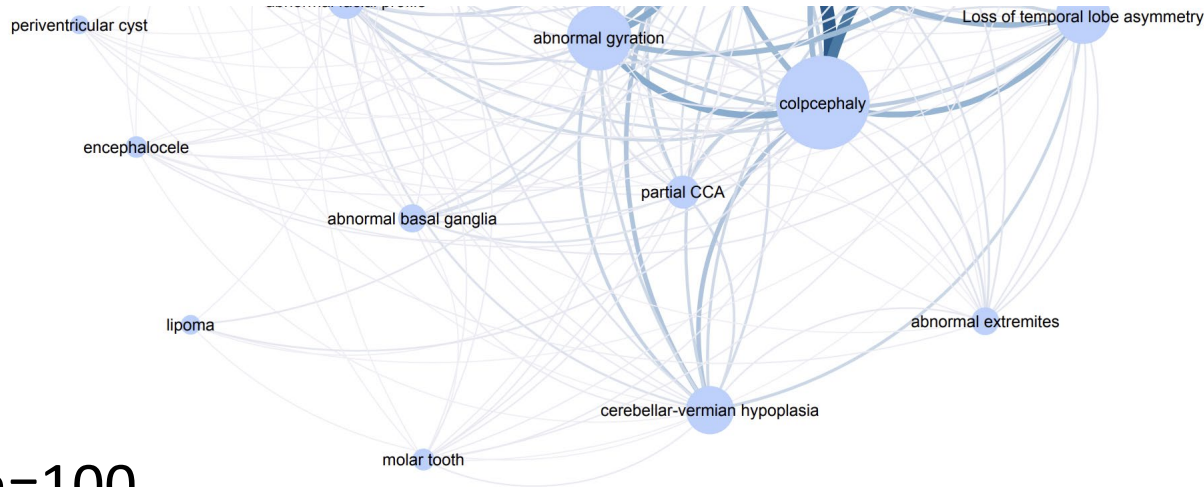


Barabási, A.L., Gulbahce, N., Loscalzo, J., 2011. Network medicine: a network-based approach to human disease. *Nature reviews Genetics* 2011:12, 56.

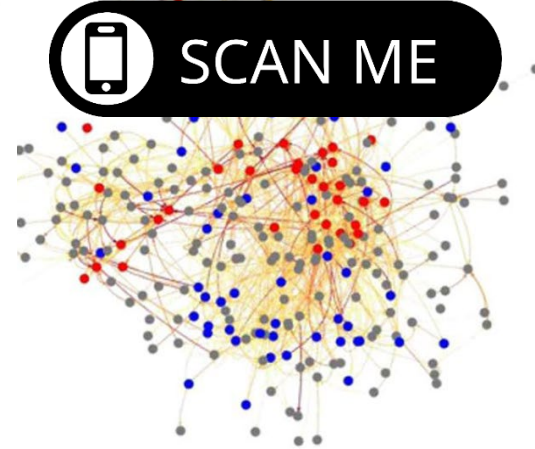


Improved neurodevelopmental prognostication in isolated corpus callosal agenesis: fetal magnetic resonance imaging-based scoring system

M. C. DIOGO^{1,2} , S. GLATTER³, D. PRAYER¹, G. M. GRUBER^{1,4}, D. BETTELHEIM⁵, M. WEBER¹, G. DOVJAK¹ , R. SEIDL³ and G. KASPRIAN¹ 

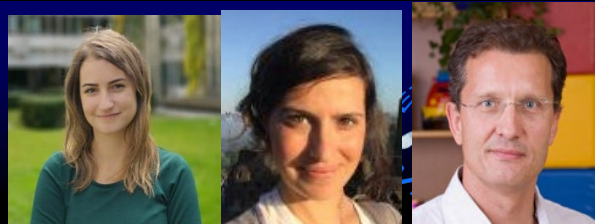


n=100



“Isolierte“ CCA

Prognostischer Score



28 GW

- 7 features
- Rating Scale
 - 0-2 points
- Sum Score
- Maximum = 11



Colpocephaly

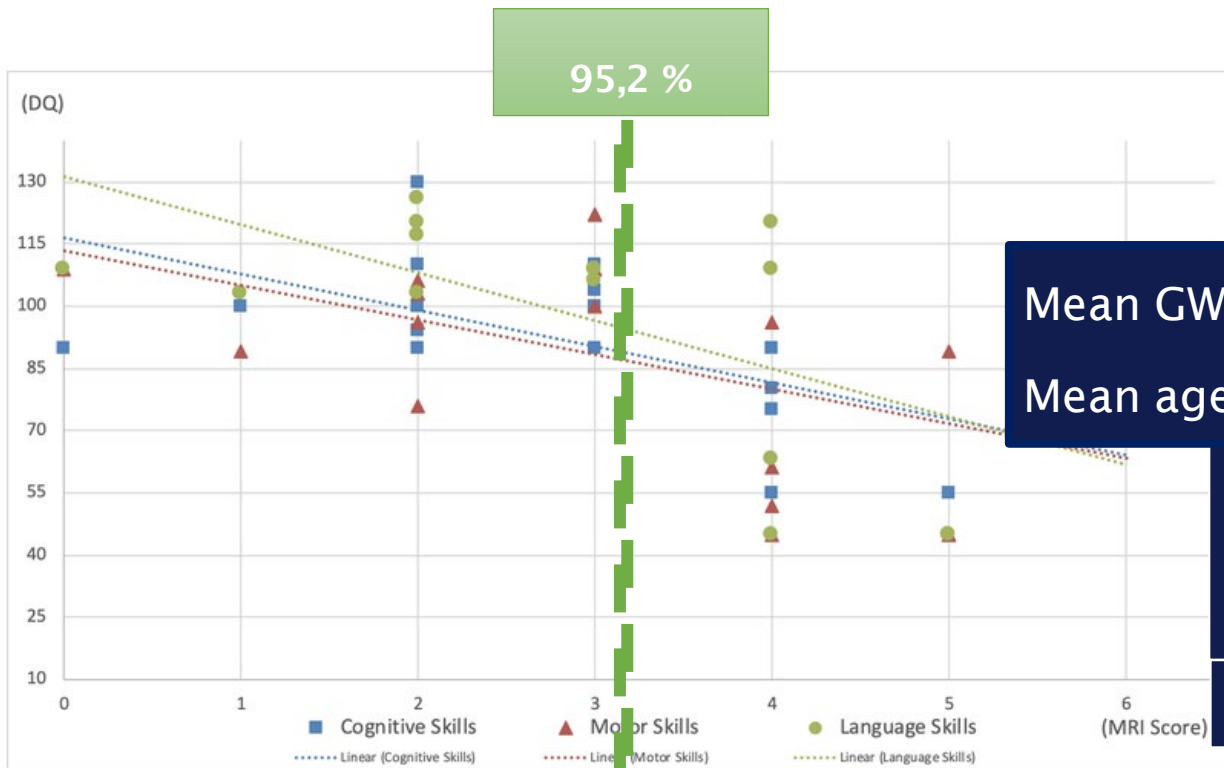
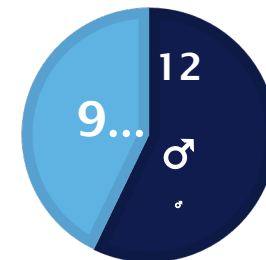


hippocampal
positioning + size

Der fetale “MRT Score”



■ Male ■ Female



Mean GW at diagnosis: **28 GW** (SD: 4,7)
 Mean age at testing: **2.1 ys** (SD: 1,6)

- **cognition** ($r = -.56, < .001$)
- **motor skills** ($r = -.41, p = .01$)
- **language** ($r = -.57, < .001$)

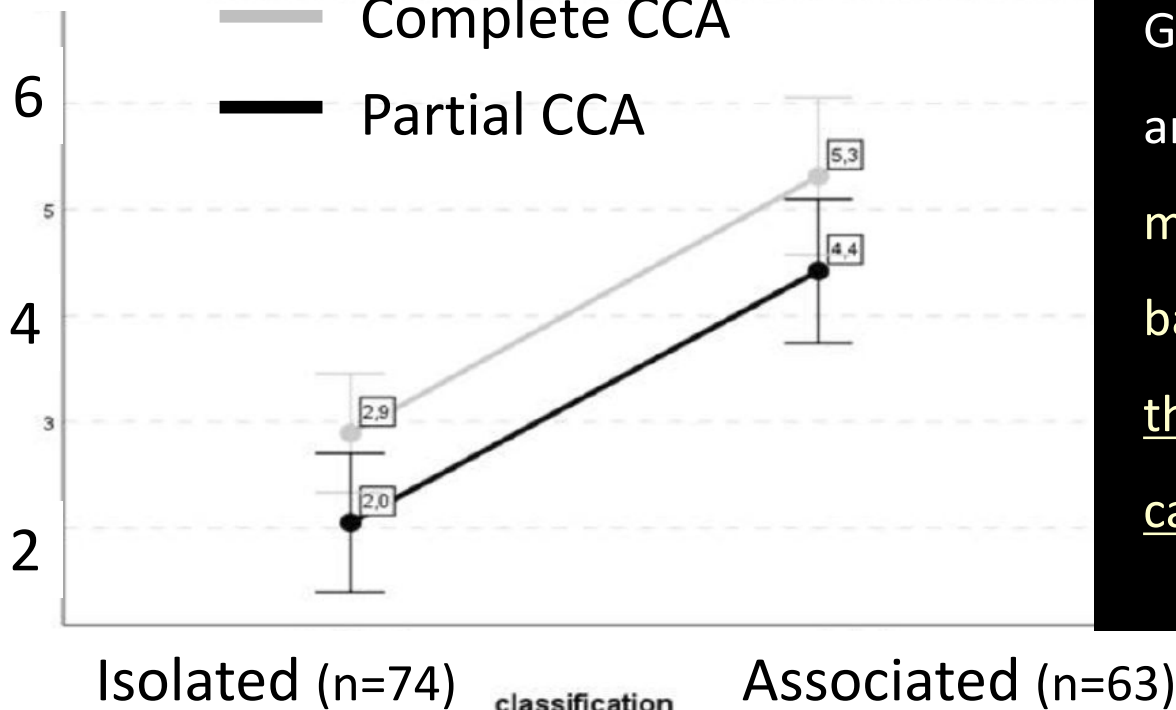
ICC = .96

CCA – prognostischer Score



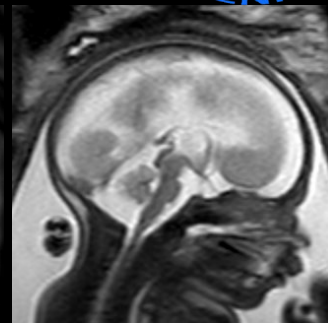
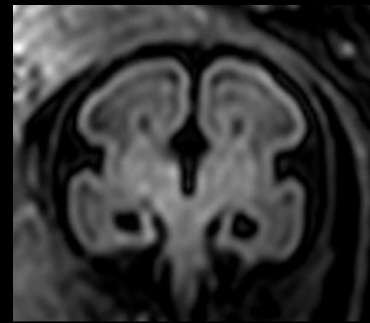
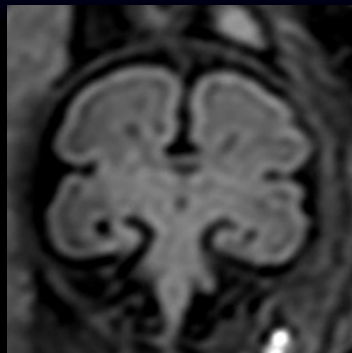
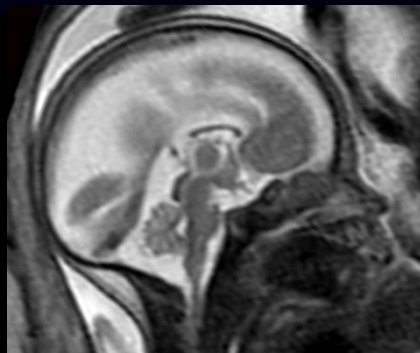
Score

— Complete CCA
— Partial CCA

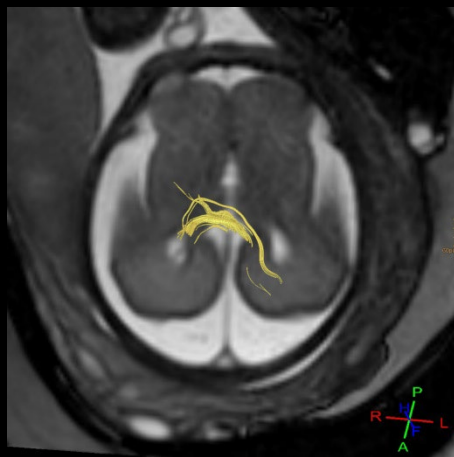


Glatter S. et al. Beyond isolated and associated: a novel fetal magnetic resonance imaging-based scoring system helps in the prenatal prognostication of callosal agenesis AJNR 2021

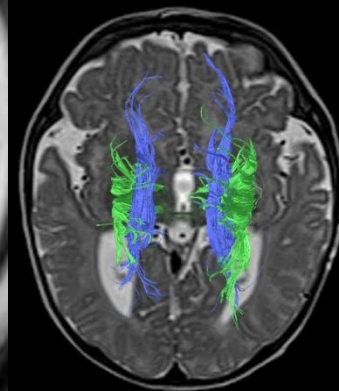
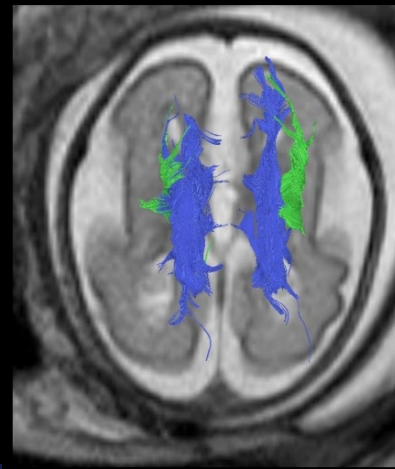
CCA – prognostischer Score



Sarah,
29GW



Bruce,
28GW



CCA – prognostischer Score



MRI Score: 2

MRI Score: 6

Sarah, 12 Monate

AIMS: 50th Percentile

Bruce, 28 Monate

Alberta infant motor scale (AIMS):
<5th Percentile

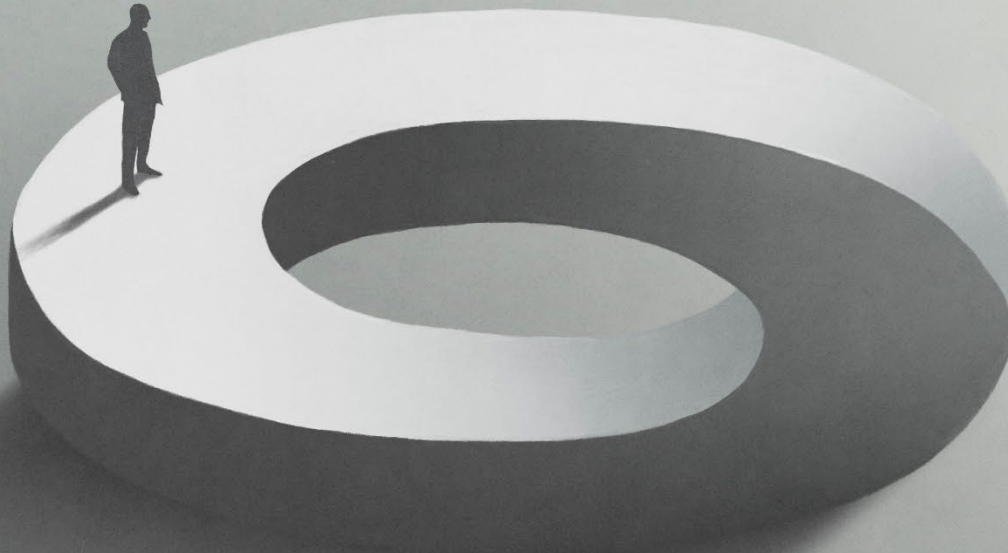


MEDICAL UNIVERSITY
OF VIENNA



Vienna
General Hospital

„Es ist absolut unmöglich
Funktion [...] vorherzusagen!“
(Eugen Boltshauser)



Aber es ist möglich Phänotypen zu charakterisieren!

Das Fetale Neurologie Team



Fetaler Neuroradiologe



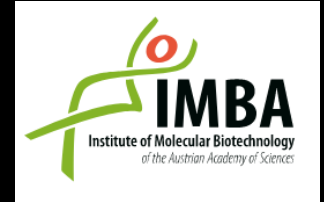
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Funding



OeNB



Fetal and Developmental (Neuro-)imaging

Daniela Prayer, Patric Kienast, Mariana Diogo, Christian Mitter, Gregor Dovjak, Florian Prayer, I. Pogledic, Marlene Stuempflen, Sarah Glatter, Michael Weber, RT Team

Computational Imaging Research Group

Georg Langs, Ernst Schwarz, Athena Taymourtash

Department of Pediatrics

Rainer Seidl, Sarah Glatter, Angelika Berger

Institute of Neurology

Christine Haberler, Romana Höftberger

Maternal Fetal Medicine

Herbert Kiss, Julia Binder, Dieter Bettelheim, Barbara Ulm, Gülen Yelinkaya-Schatten, Christof Worda, Elisabeth Krampfl- Bettelheim

Institute of Molecular Biotechnology

Jürgen Knoblich, Nina Corsini,
Catarina Da Cunha



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