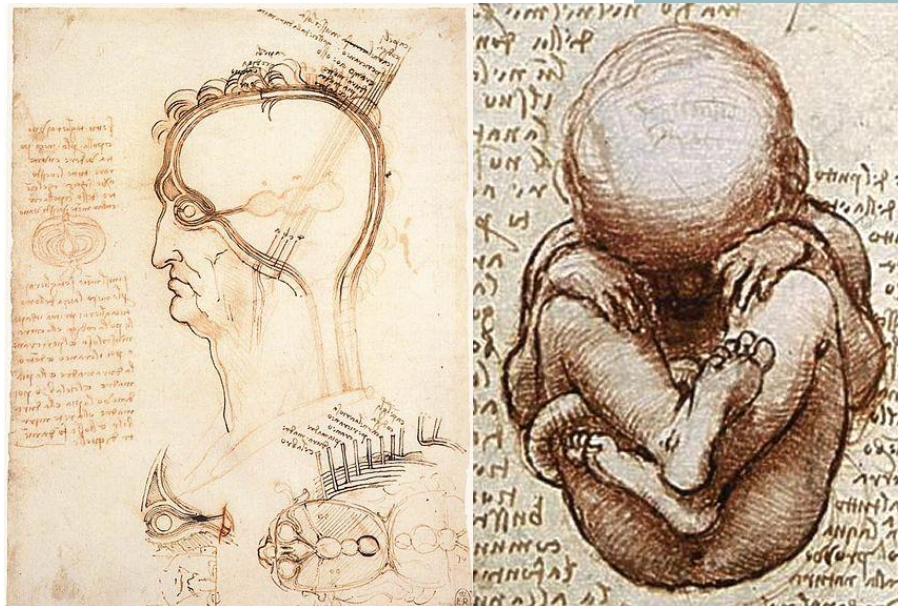


# Fetales Gehirn: Normalbefunde und häufige Fehlbildungen

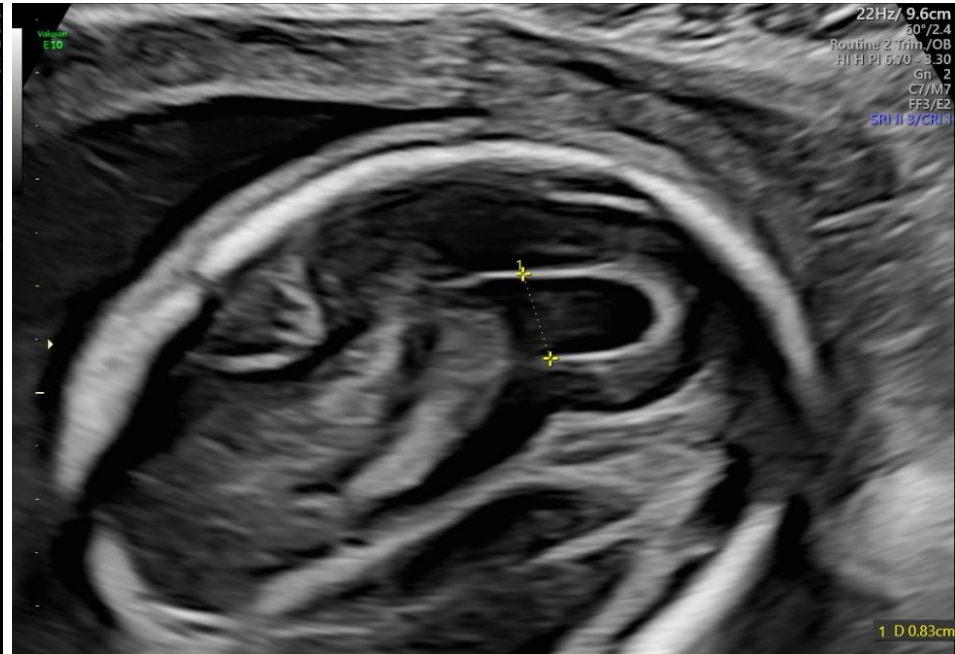
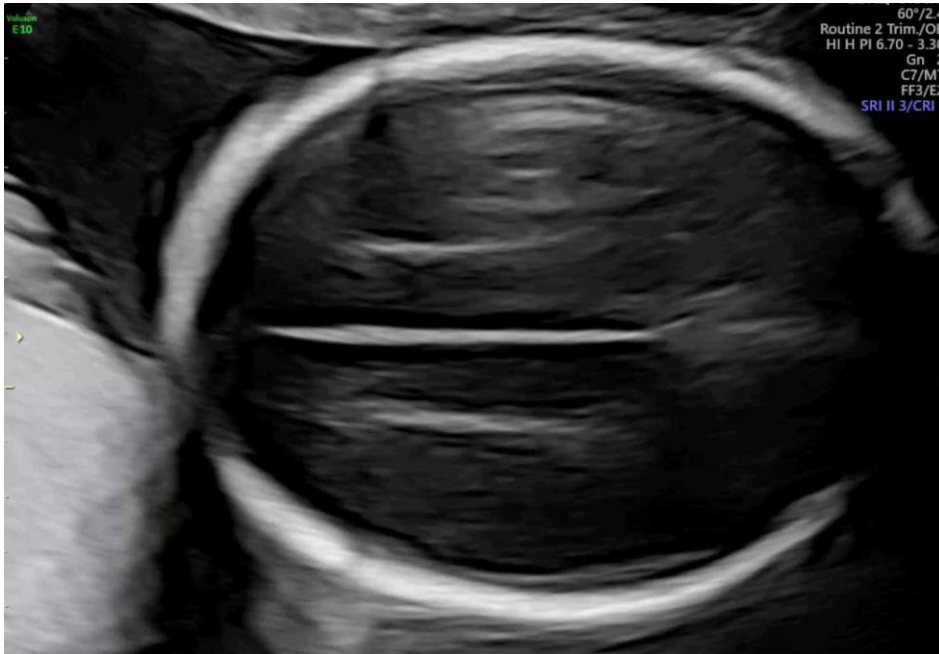
Barbara Pertl, Graz



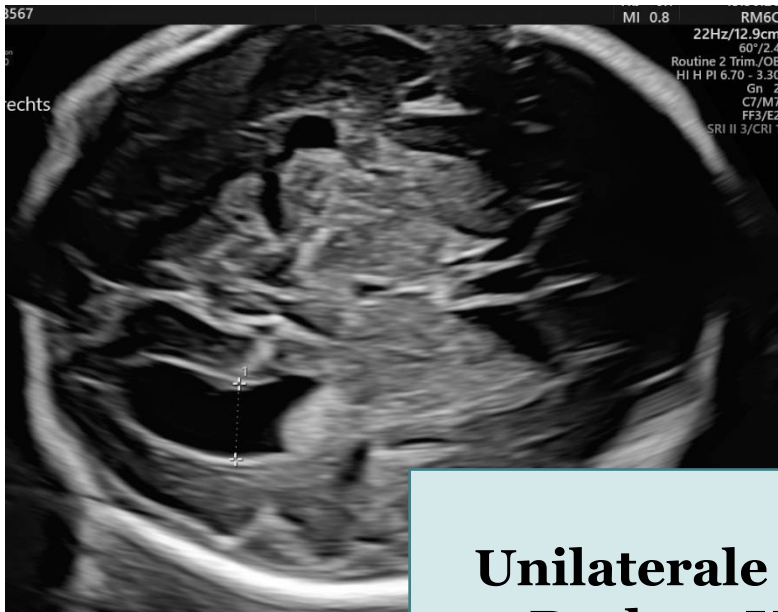
**PB** 22+6 SSW

**Rechter Seitenventrikel  
9,2 mm**

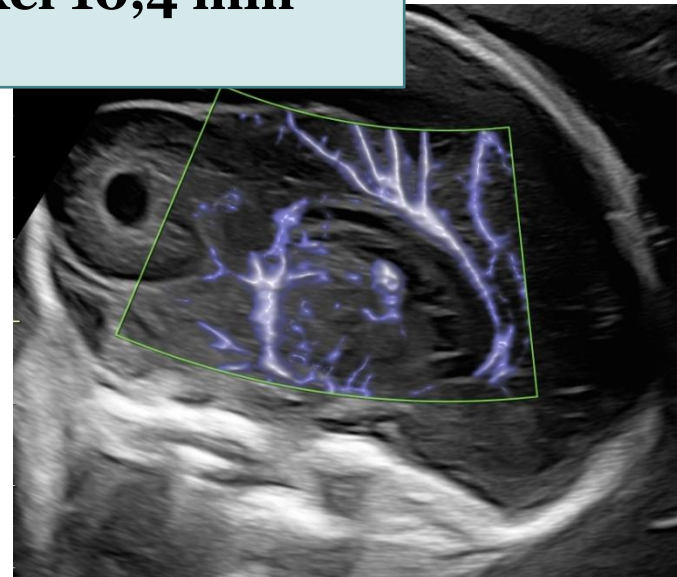
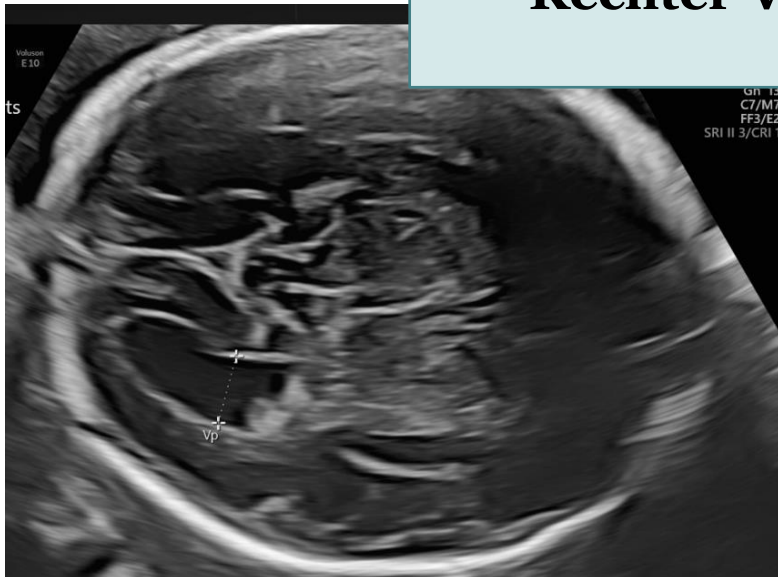
**Linker Seitenventrikel  
8 mm**



**PB** 28+6 SSW



**Unilaterale Ventrikulomegalie:  
Rechter Ventrikel 10,4 mm**



# 1. Basisuntersuchung

- Kopfform

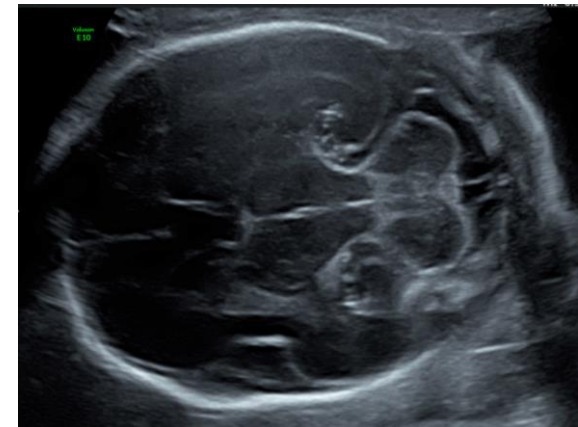
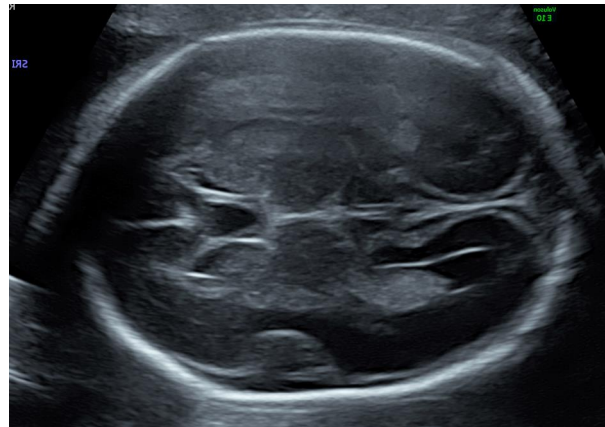
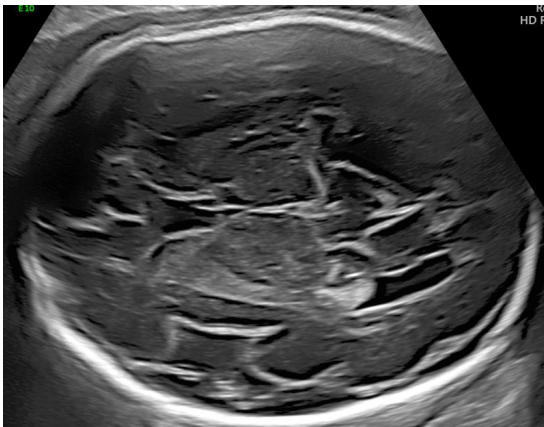
- Seitenventrikel
- Cavum septi pellucidi
- Thalami
- Cerebellum
- Cisterna magna
- Wirbelsäule

Ultrasound Obstet Gynecol 2020; 56: 476–484  
Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/uog.22145

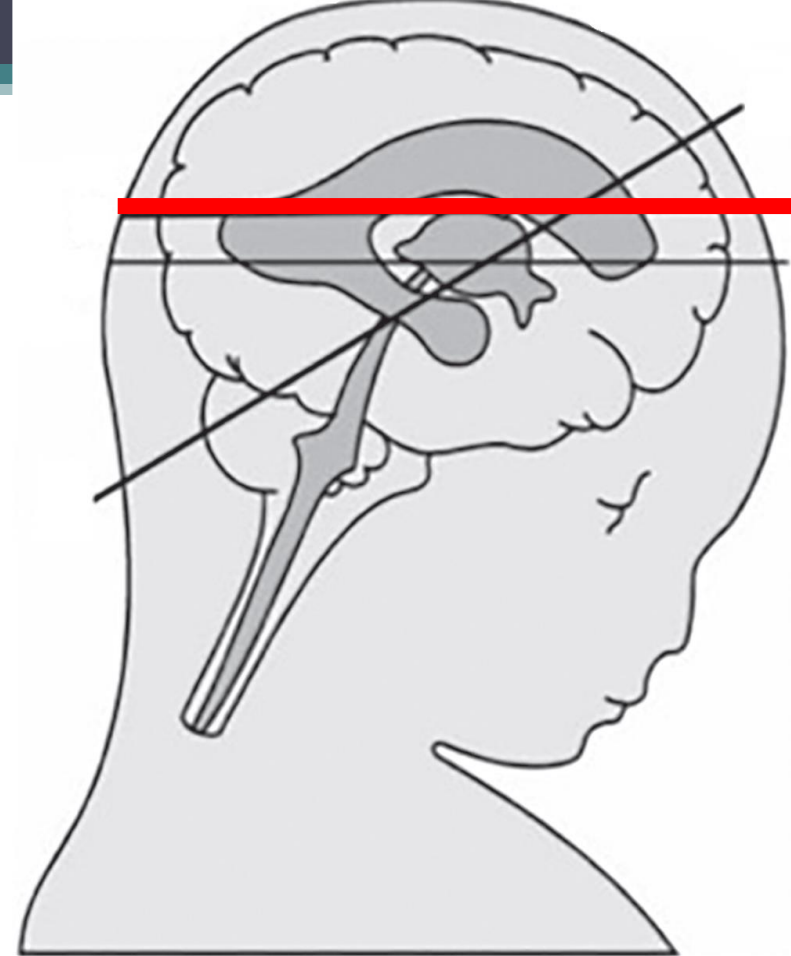
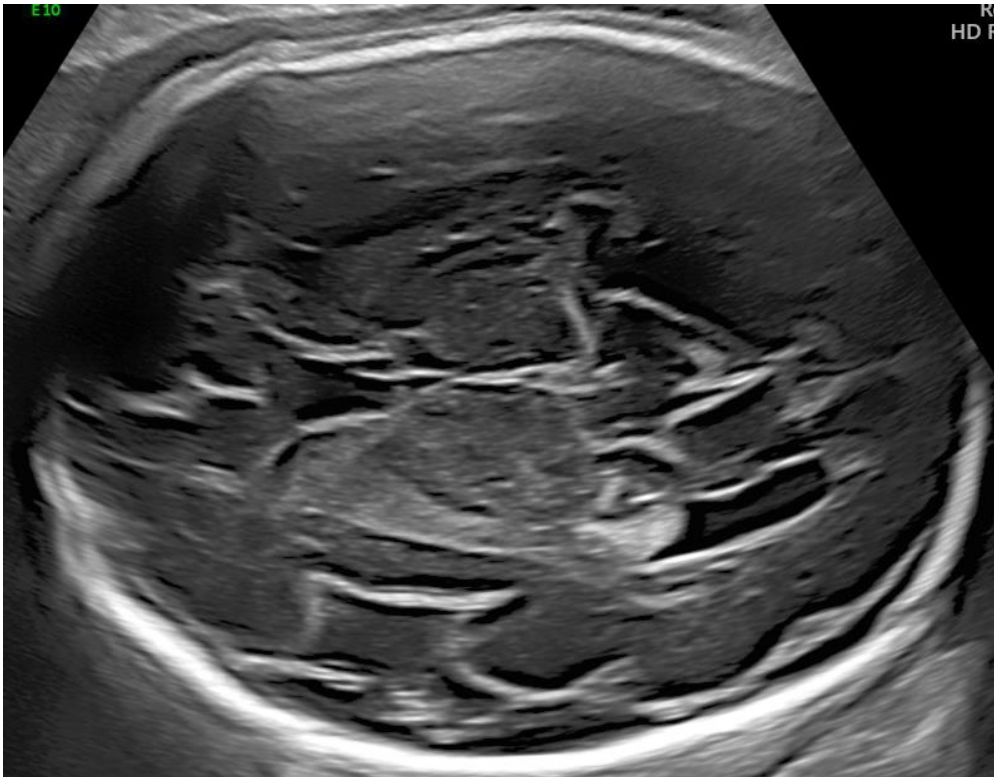


**GUIDELINES**

ISUOG Practice Guidelines (updated): sonographic examination of the fetal central nervous system. Part 1: performance of screening examination and indications for targeted neurosonography

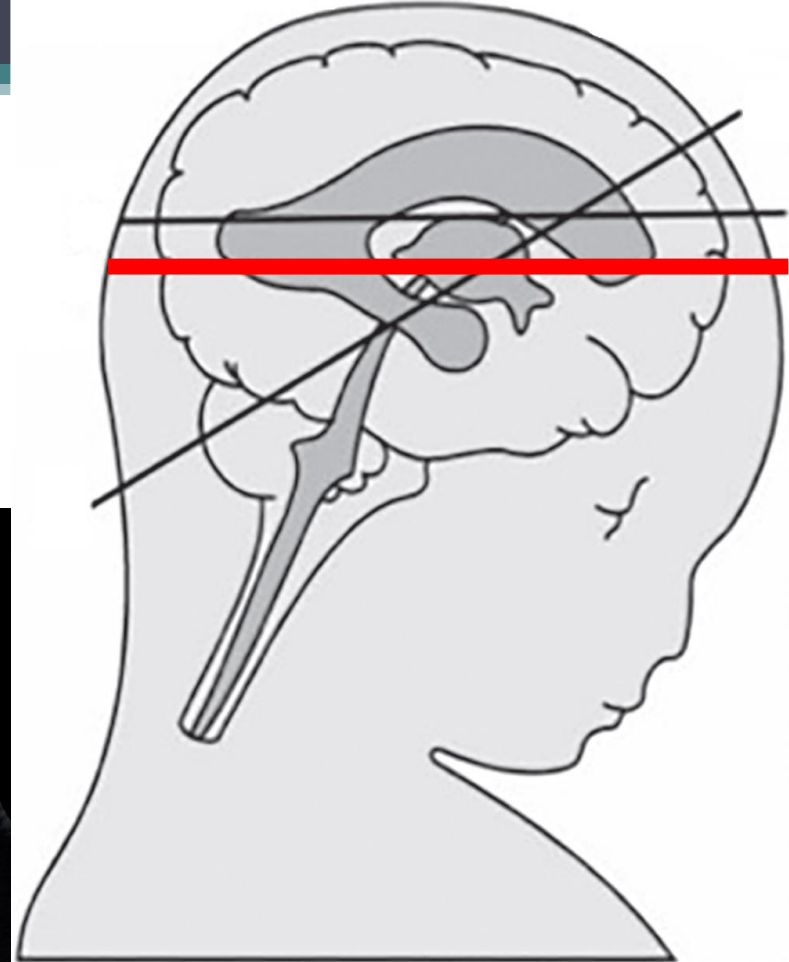


# Transventrikuläre Ebene (Messung der Atriumweite)

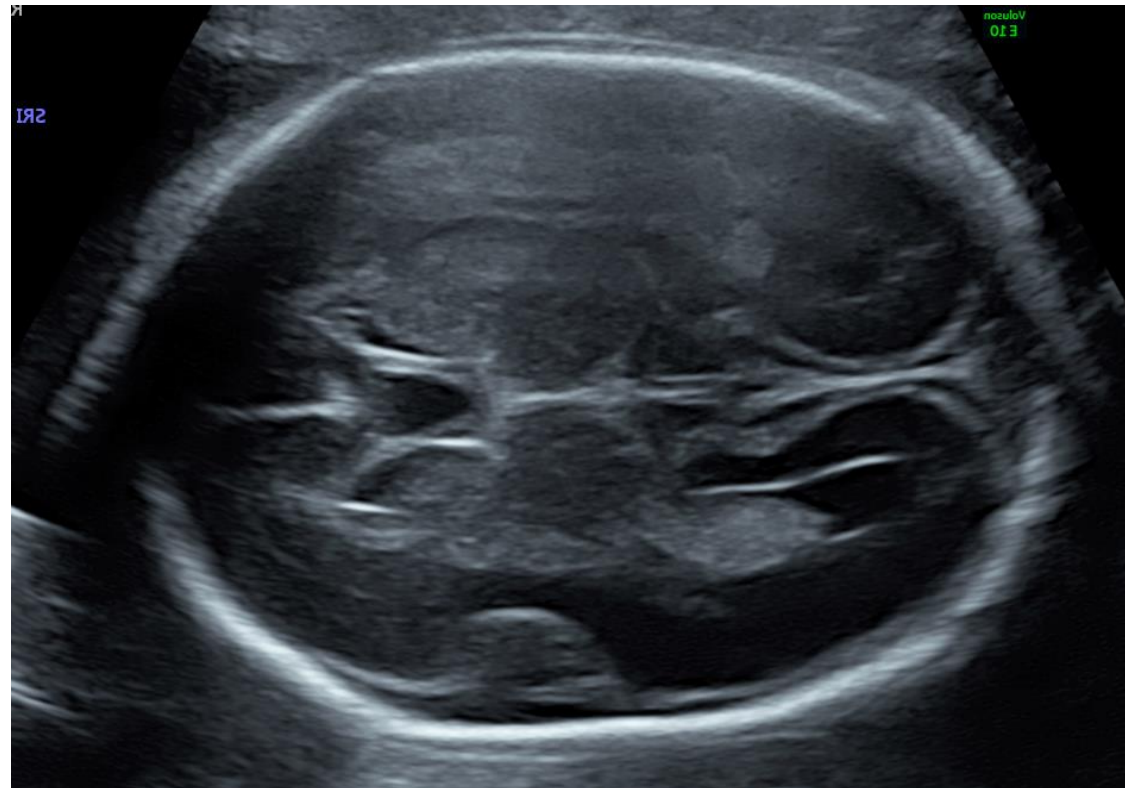


- Seitenventrikel (Vorder- und Hinterhörner)
- Cavum septi pellucidum

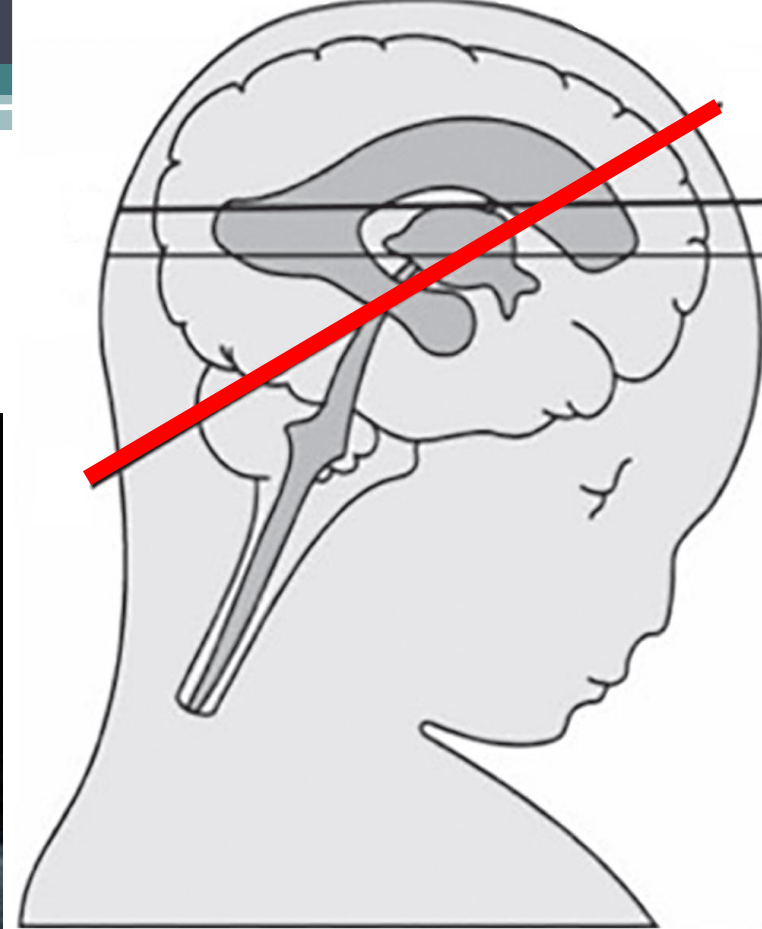
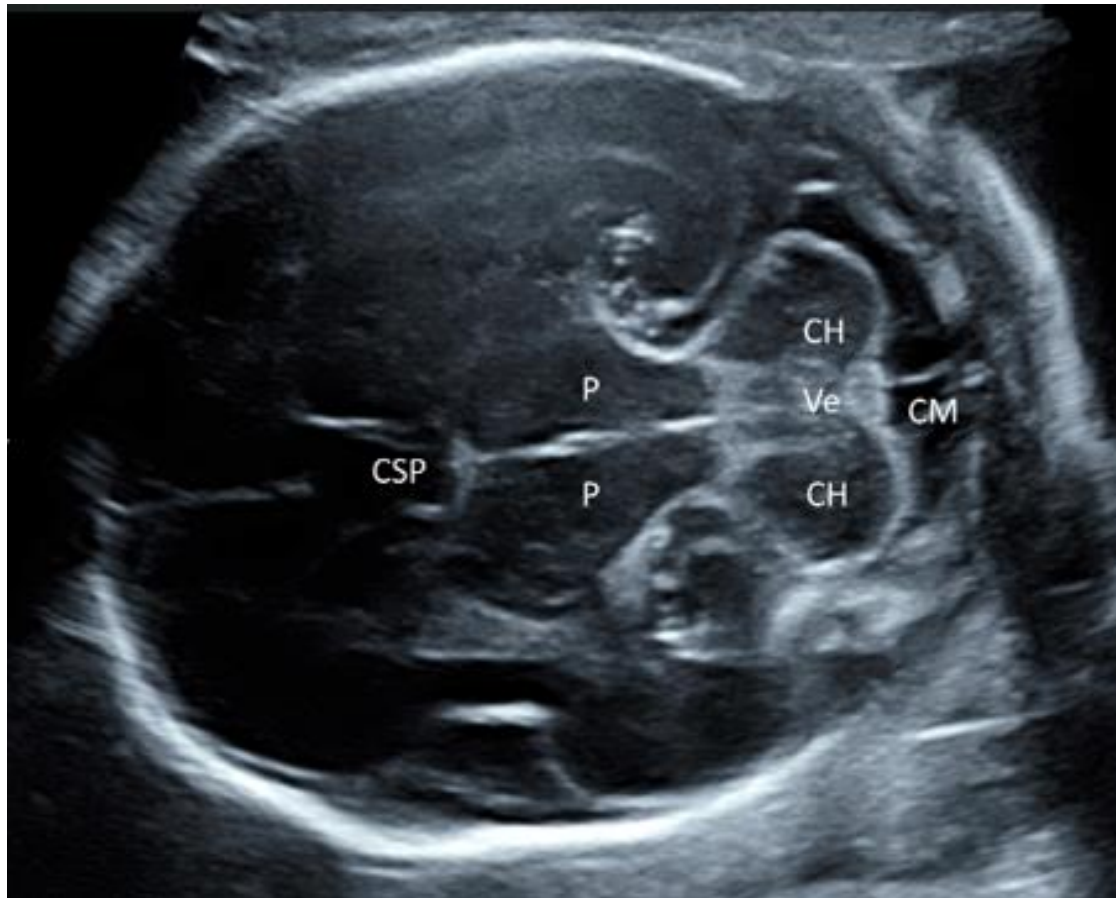
# Transthalamische Ebene (Biometrie des Kopfes, kaudal der ventrikulären Ebene)



- Cavum septi pellucidi
- Vorderhörner
- Thalami
- Insula, Sylvische Fissur



# Transzerebelläre Ebene



- Cerebellum
- Cisterna magna
- Pedunculi cerebri
- 4. Ventrikel (kaudal)

# Seitenventrikel



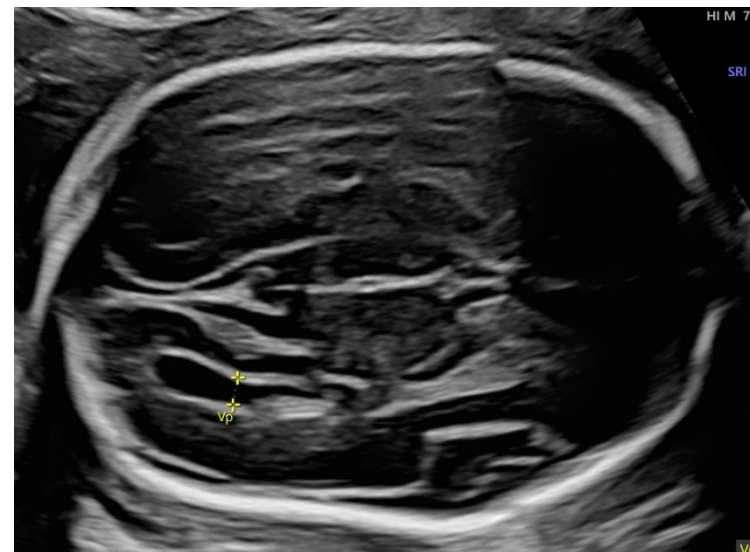
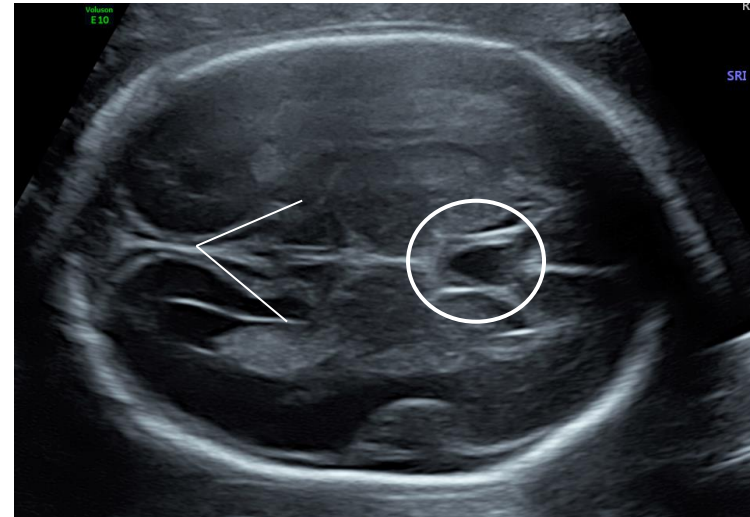


# Standards der Seitenventrikelmessung I

(Guibaud 2008): Messung des Atriums

## Primäre Kriterien

- Exakte axiale Ebene
- Anatomische Ebene
  - Leitstruktur vorne: CSP oder Fornix
  - Leitstruktur hinten: V- Shape der Cisterna ambiens
- Lokalisation des Atriums (Hinterhorn wird als erstes weiter)
- Leitstruktur Sulcus parietooccipitalis



# Standards der Seitenventrikelmessung II

(Guibaud 2008)

## Sekundäre Kriterien

- Kaliper Plazierung
- Adäquate Bildgröße

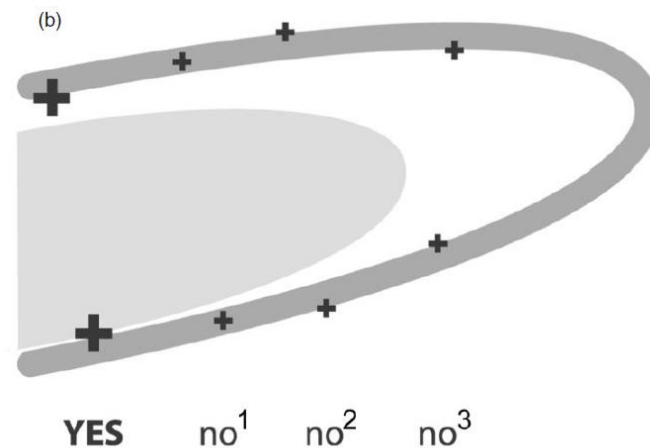
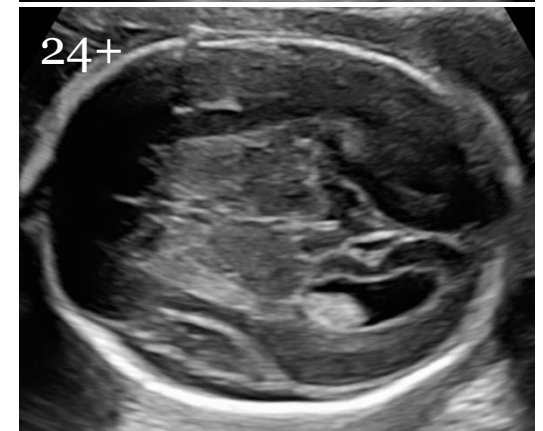
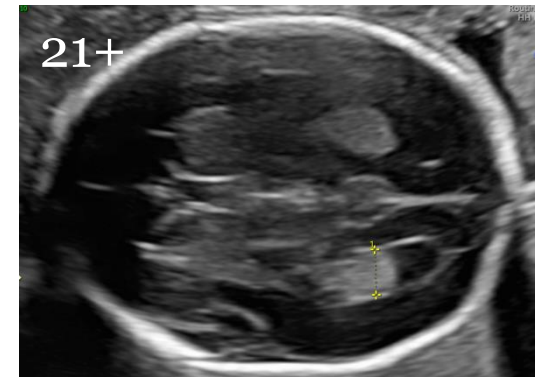
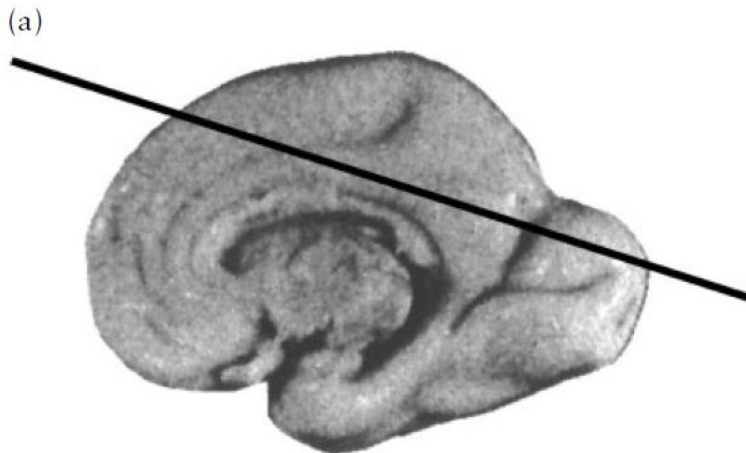


Table 1 Image-scoring method

Criterion	Score	Anatomical/technical requirements
Primary criteria		
1. Strict axial plane	0–2	1a. Midline structures equidistant from proximal and distal calvarial margins 1b. Midline perpendicular to ultrasound beam
2. Adequate anatomical level	0–1	Anterior landmark: cavum septi pellucidi or fornix columns Posterior landmark: fluid-filled triangular V-shape of the ambient cistern
3. Location of the atrium	0–1	Measurement performed opposite the internal parieto-occipital sulcus
Secondary criteria		
4. Caliper placement	0–2	4a. Measurement perpendicular to inner and outer borders of the ventricle 4b. 'On to on' measurement (junction of ventricular lumen and ventricular wall)
5. Adequate image size	0–1	Axial transventricular plane occupying the whole screen with visualization of both proximal and distal calvarial margins

# Sulcus parietooccipitalis

- Liegt gegenüber dem Übergang zwischen Atrium und Hinterhorn der Seitenventrikel
- Darstellbar an der medialen Wand der Hemisphäre ab der 20. SSW: zuerst als schmale Vertiefung
- Dann im 3. Trimester zunehmende Vertiefung



*Ultrasound Obstet Gynecol* 2007; 29: 109–116

Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/uog.3909

THE INTERNATIONAL SOCIETY OF



ISUOG

**ULTRASOUND**

in Obstetrics & Gynecology

**GUIDELINES**

**Sonographic examination of the fetal central nervous system:  
guidelines for performing the ‘basic examination’ and the  
‘fetal neurosonogram’**

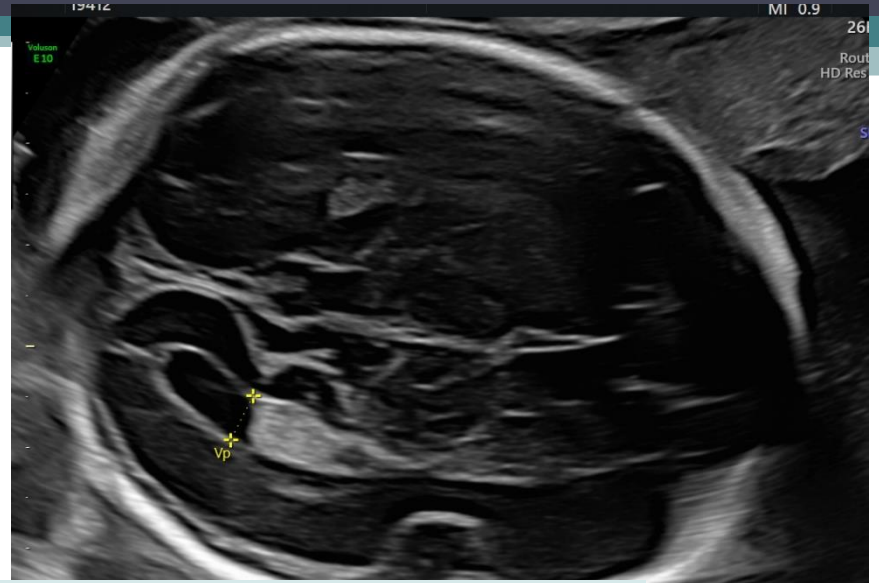
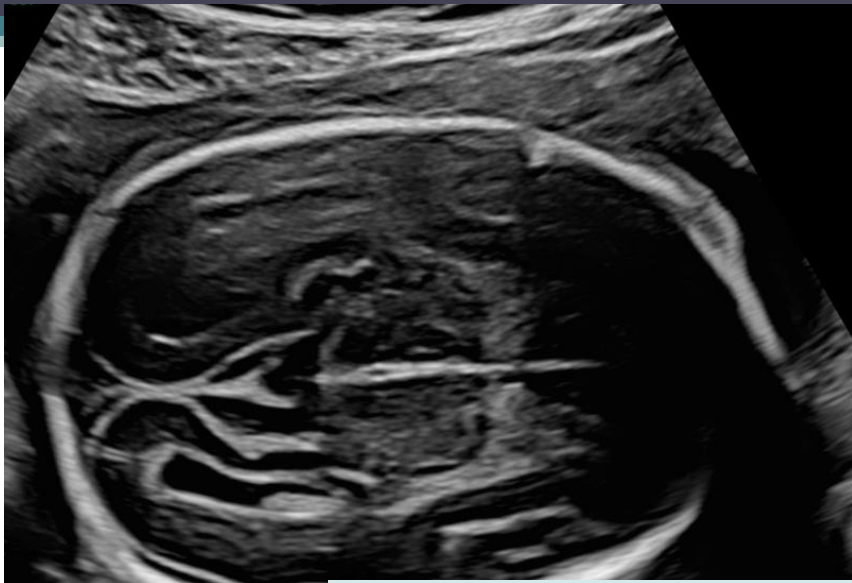
*Ultrasound Obstet Gynecol* 2020; 56: 476–484

Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/uog.22145

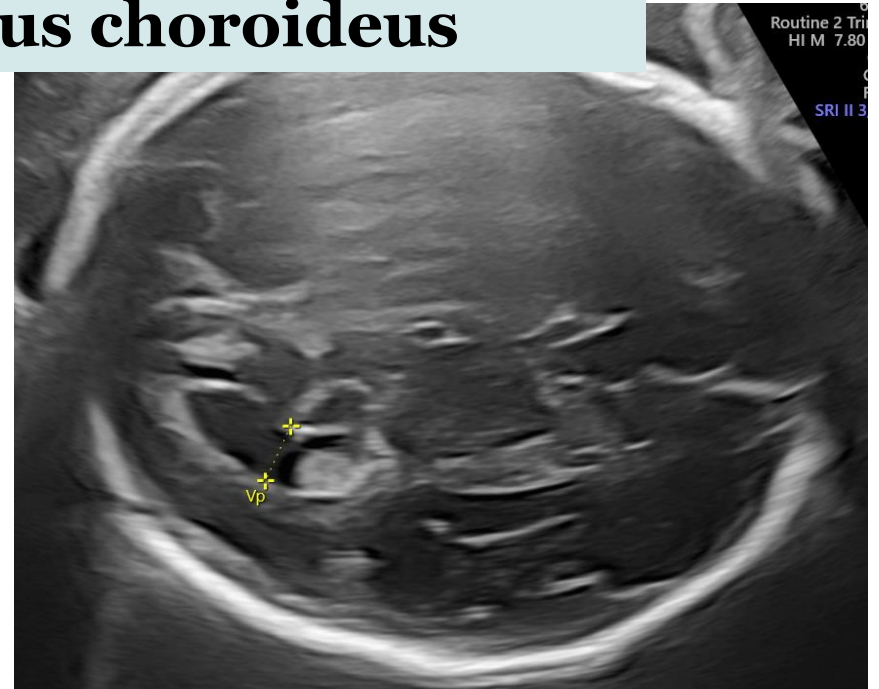


**GUIDELINES**

**ISUOG Practice Guidelines (updated): sonographic  
examination of the fetal central nervous system. Part 1:  
performance of screening examination and indications for  
targeted neurosonography**



## Sulcus parietooccipitalis versus Glomus des Plexus choroideus



# Kriterien für die korrekte Messung des Seitenventrikels

SMFM Consult Series

[smfm.org](http://smfm.org)

## Fetal Ventriculomegaly

Society for Maternal-Fetal Medicine (SMFM); Mary E. Norton, MD; Nathan S. Fox, MD; Ana Monteagudo, MD; Jeffrey A. Kuller, MD; and Sabrina Craigo, MD

### BOX

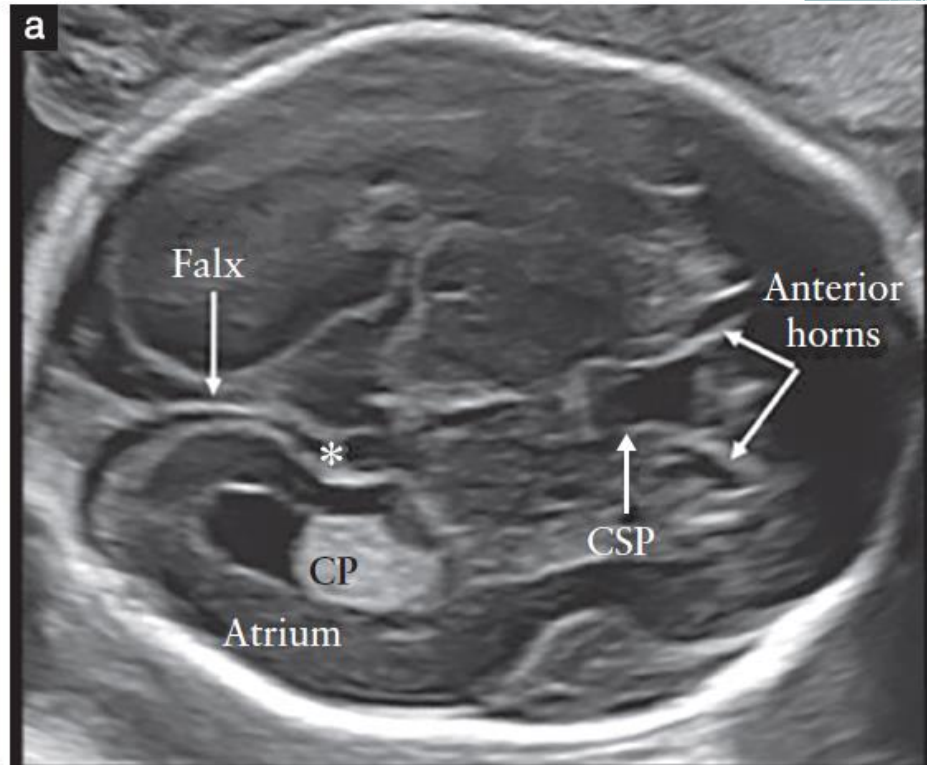
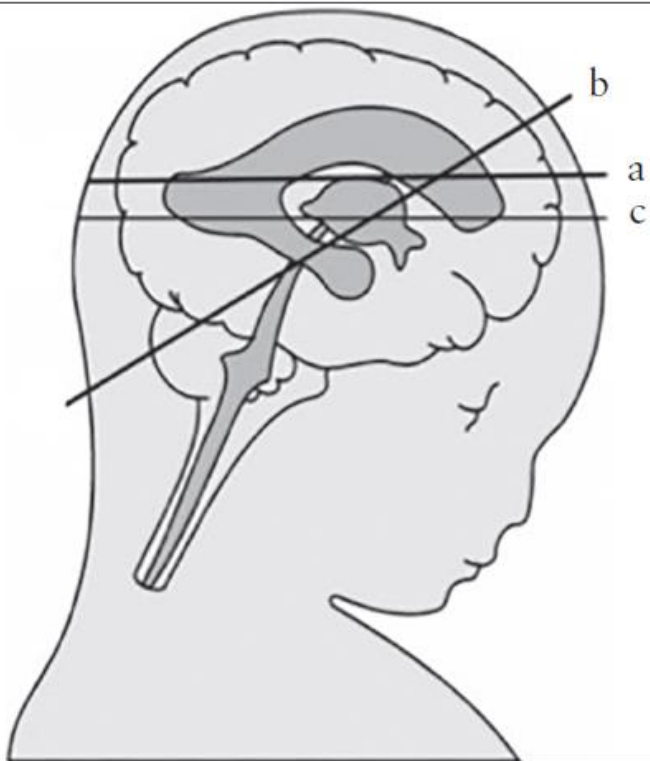
#### Criteria for appropriate measurement of lateral cerebral ventricle

1. The head is in the axial plane.
2. The image is magnified appropriately so that fetal head fills the most of the image.
3. The focal zone is at the appropriate level.
4. The cerebral ventricles are symmetrical in appearance.
5. The midline falx is imaged.
6. The atrium and occipital horn of the lateral ventricle (LV) are clearly imaged.
7. The atrium of the LV is measured at the level of the parietooccipital groove.
8. The calipers are placed on the medial and lateral walls of the atrium perpendicular to the long axis of the ventricle.

SMFM. SMFM Anomalies Consult Series #3. Am J Obstet Gynecol 2020.

# Ventrikulomegalie

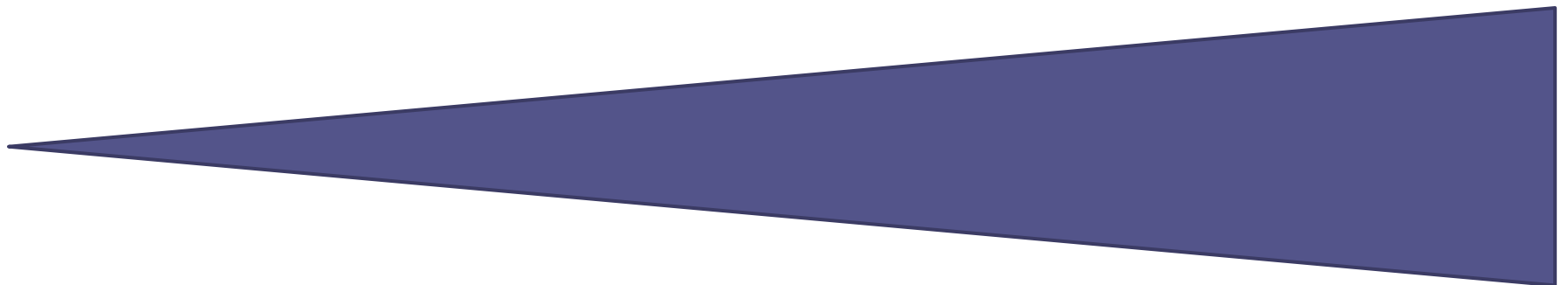




normal

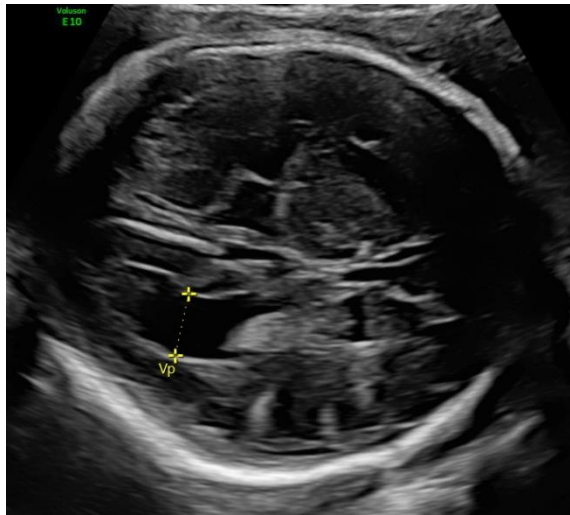
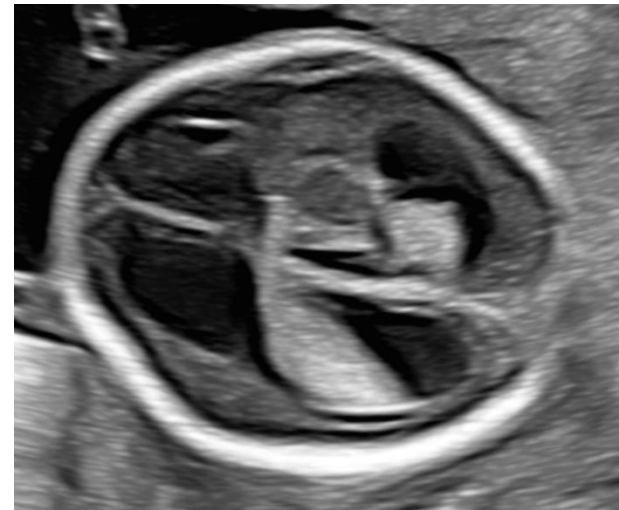
Ventrikulomegalie

(Hydrocephalus)

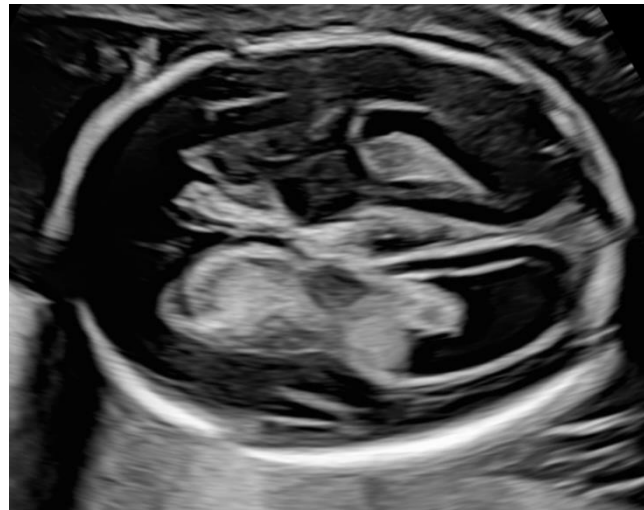




# Definition Ventrikulomegalie



Mild  $\geq 10-12$  mm



Moderat 12,1-15 mm

Schwer  $>15$  mm

Hydrocephalus: erhöhter Liquordruck  
Verschmälerung bzw. Obliteration des  
Subarachnoidalraums, Makrozephalie

# Ventrikulomegalie Grenzwert 10mm

Salomon UOG 2007

- 0,6 bis 0,9% der Feten  $\geq 10$  mm
- Männliche Feten 0,2 mm größer
- Ventrikelweite  $\geq 10$  mm guter und praktikabler Cut-off
- 10mm entsprechen 3 bis 4 SD vom Mittelwert
- Unilateral-bilateral

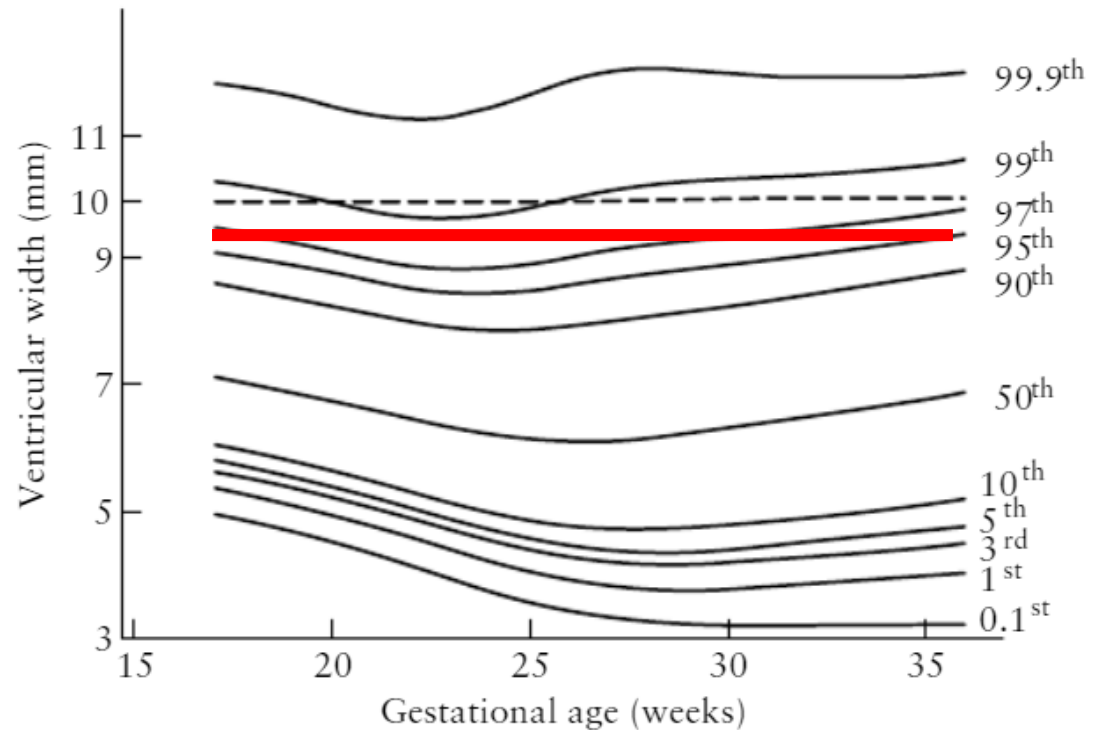
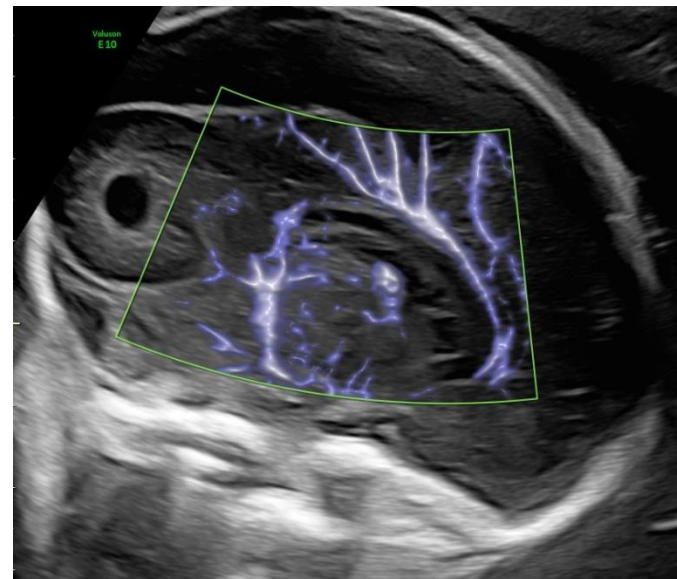
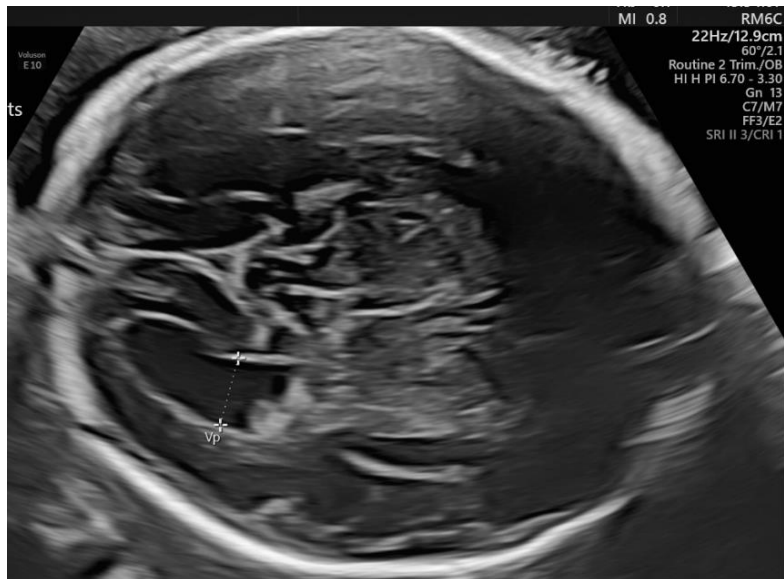
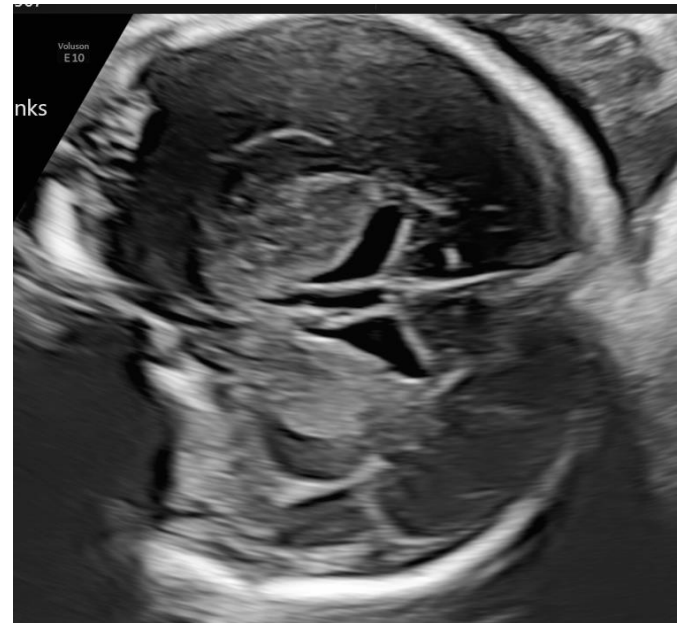
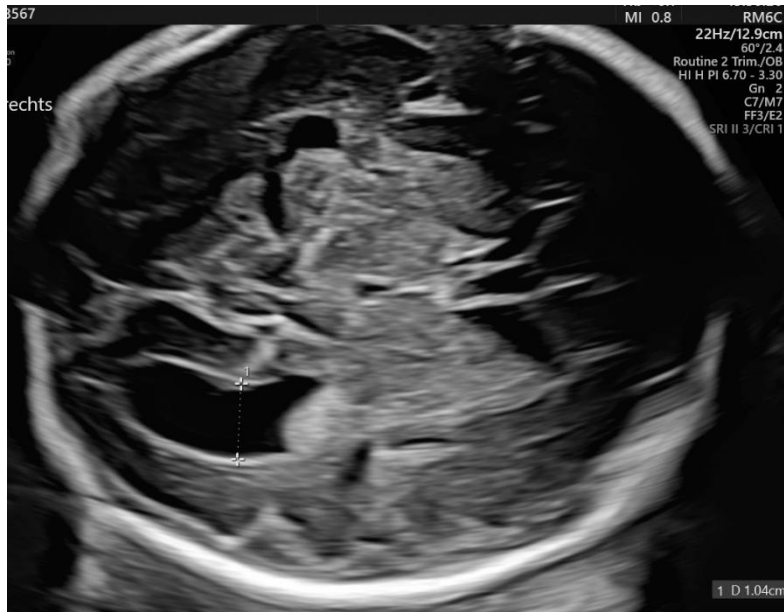


Figure 2 Reference ranges showing centiles for ventricular width throughout gestation. Although significant, the changes throughout gestation do not seem clinically relevant. The usual 10-mm cut-off (dashed line) selects around 1% of fetuses throughout gestation.

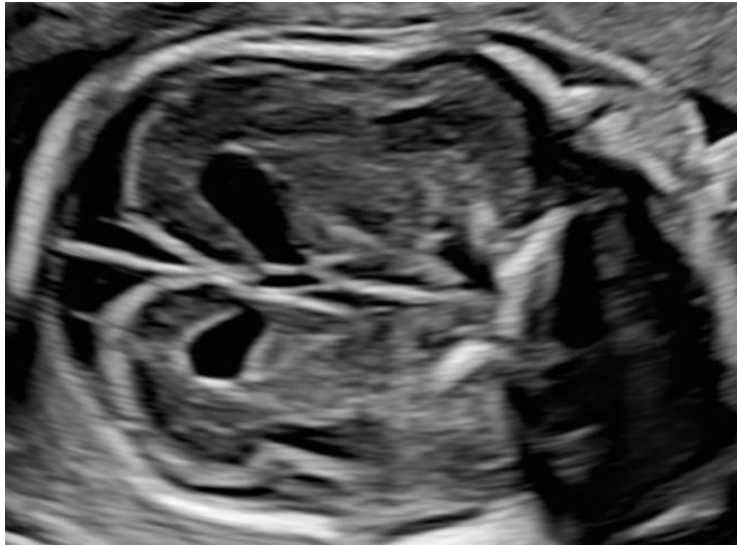
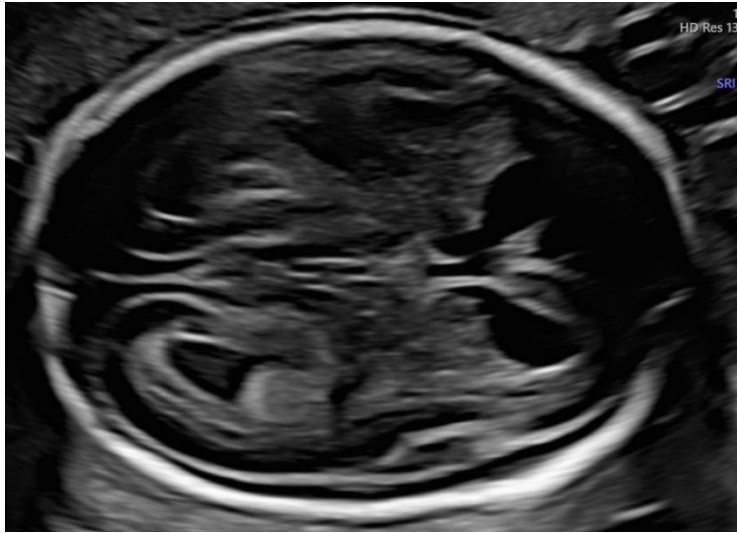
**PB: 28+6 SSW**

**Ventrikelweite 10,4mm**

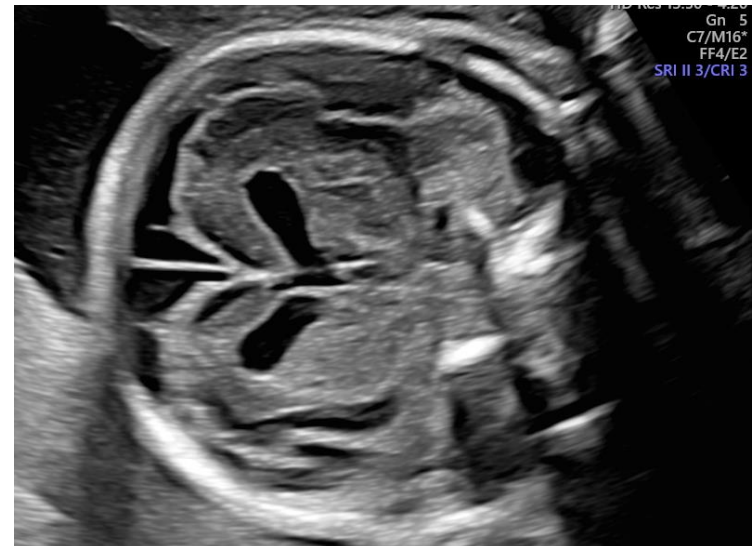


# ZB CMV- Infektion

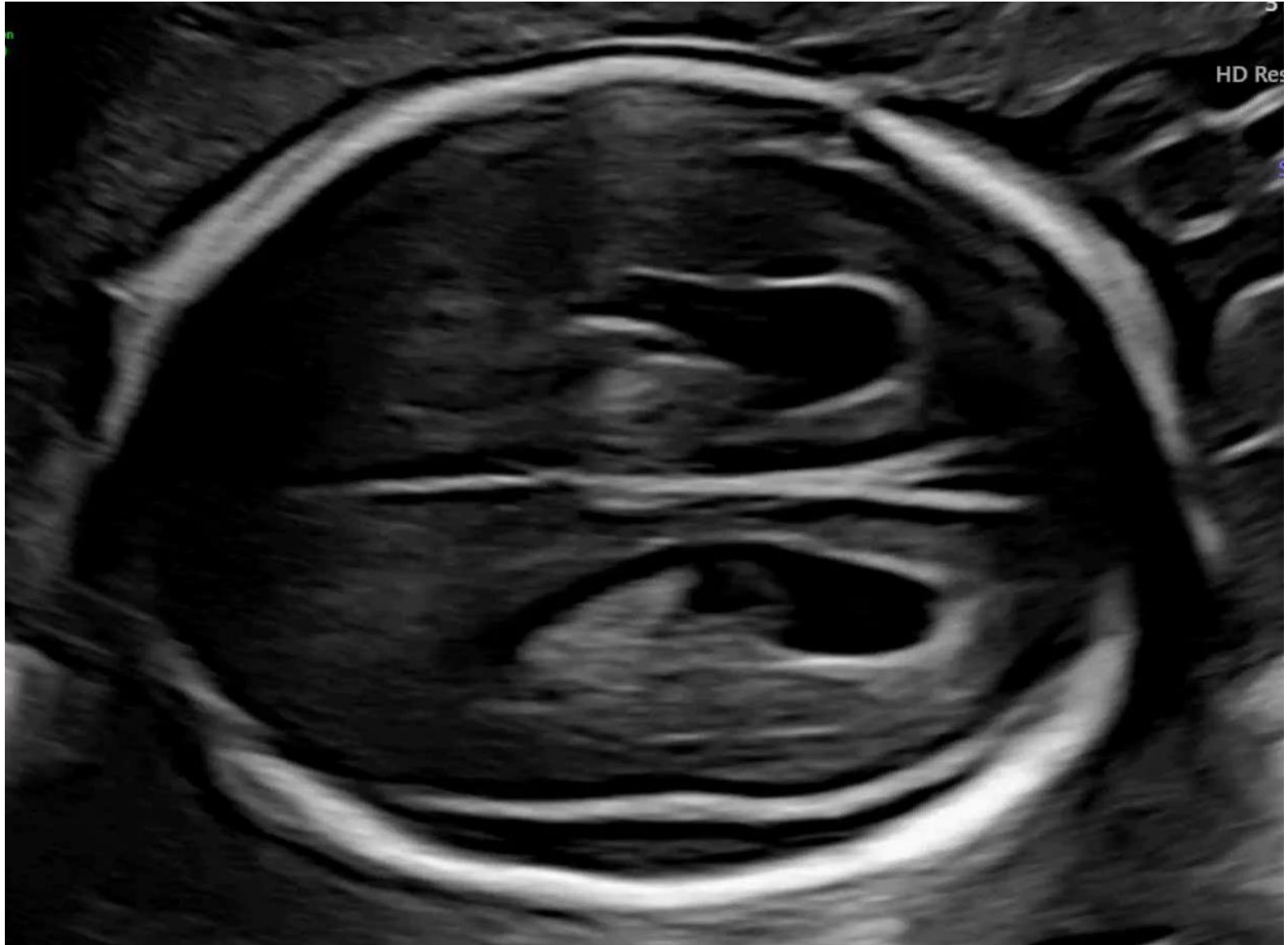
21+4 SSW



22+6 SSW

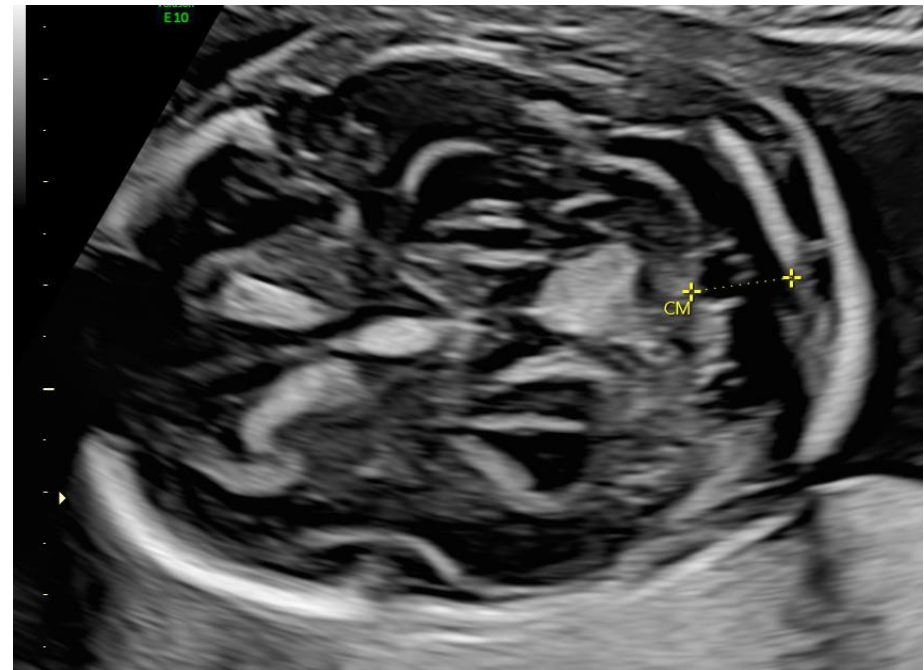
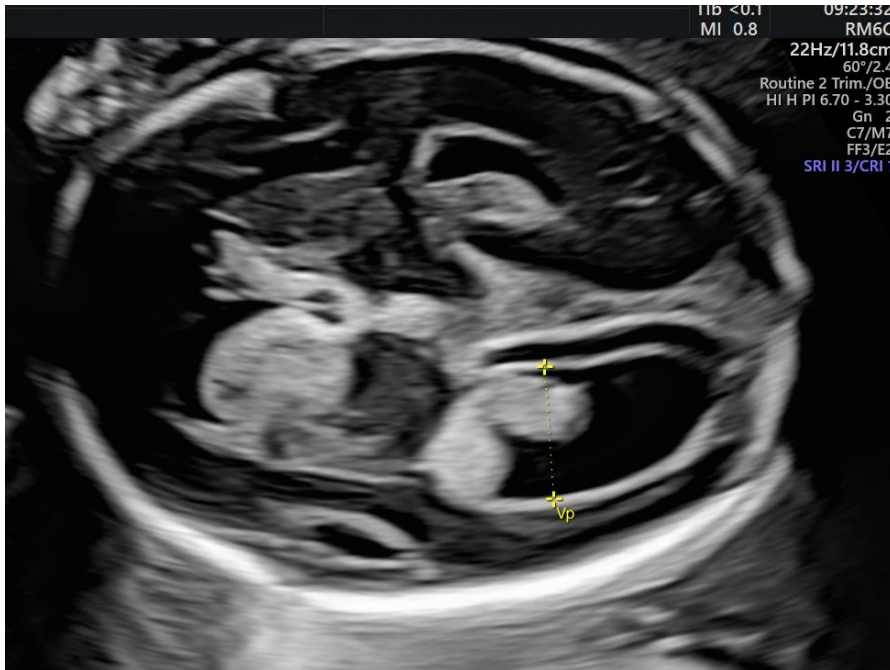


**ZB** 21+4 SSW

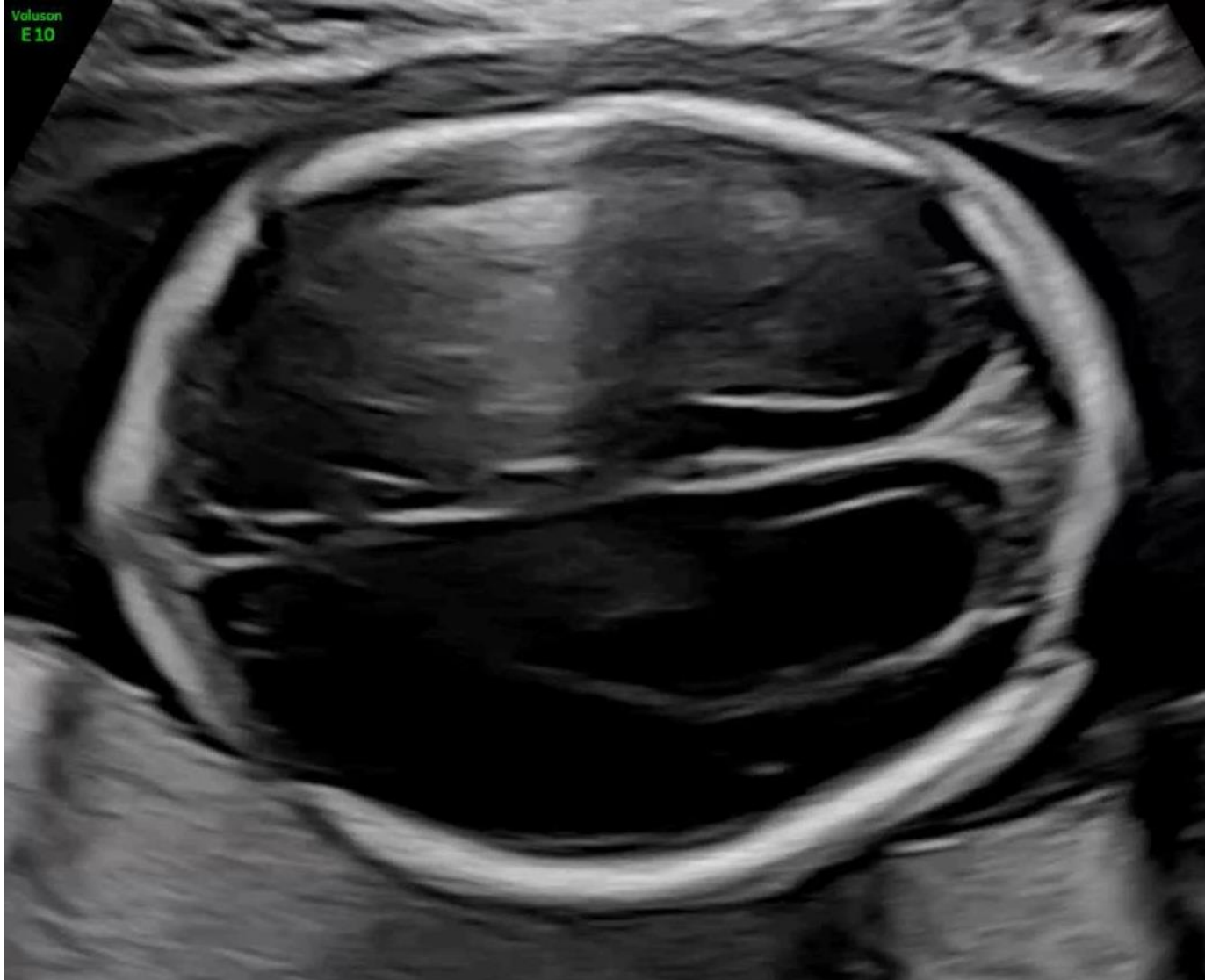


**VJH** 22+5 SSW

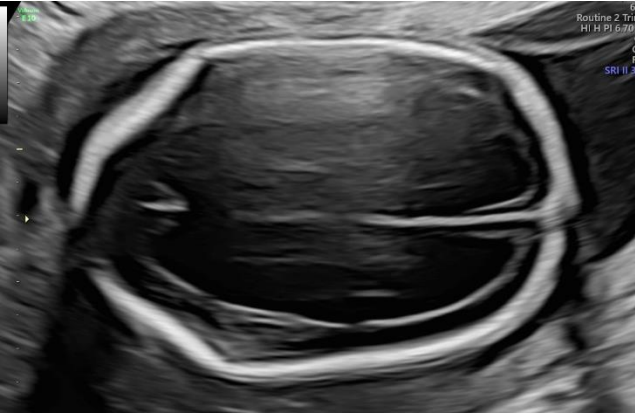
intracerebrale Blutung, Ventrikelweite 13mm



**VJH** 22+5 SSW



**WC** 22+1 SSW





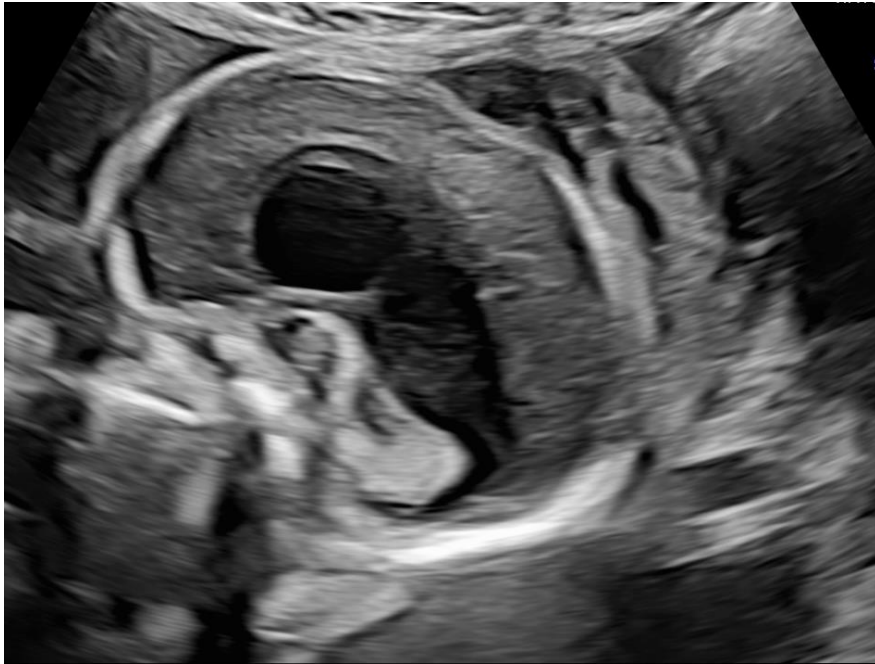
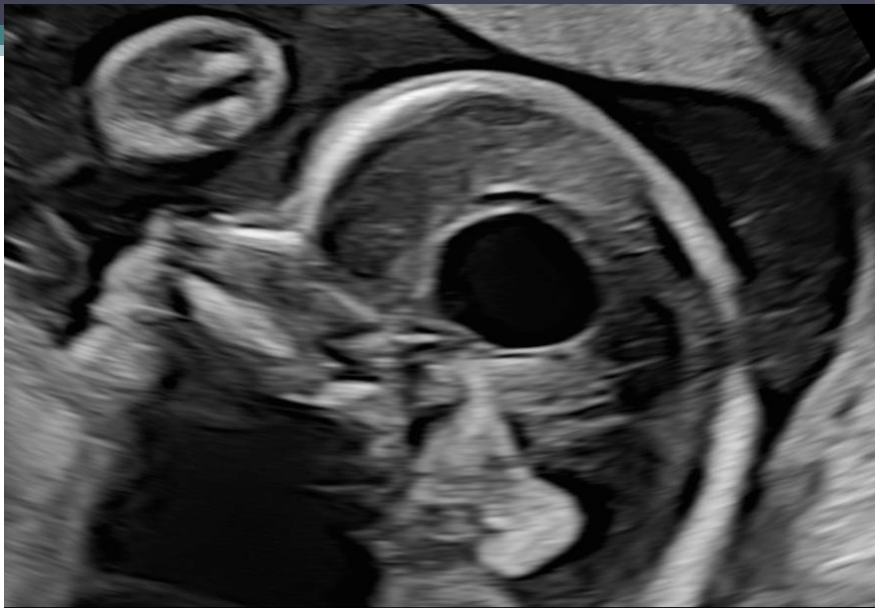


MRI: Vermis bis auf  
HWK 3/4 disloziiert

Voluson  
E10

60°/2.1  
Routine 2 Trim./OB  
HI H PI 6.70 - 3.30  
Gn 2  
C7/M7  
FF3/E2  
SRI II 3/CRI 1





## Cavum septi pellucidi?

MRI (Kline-Fath et al, Prenat Diagn 2018):  
Bei progressivem Hydrocephalus bei Aquäduktstenose Verlust des Septum pellucidum

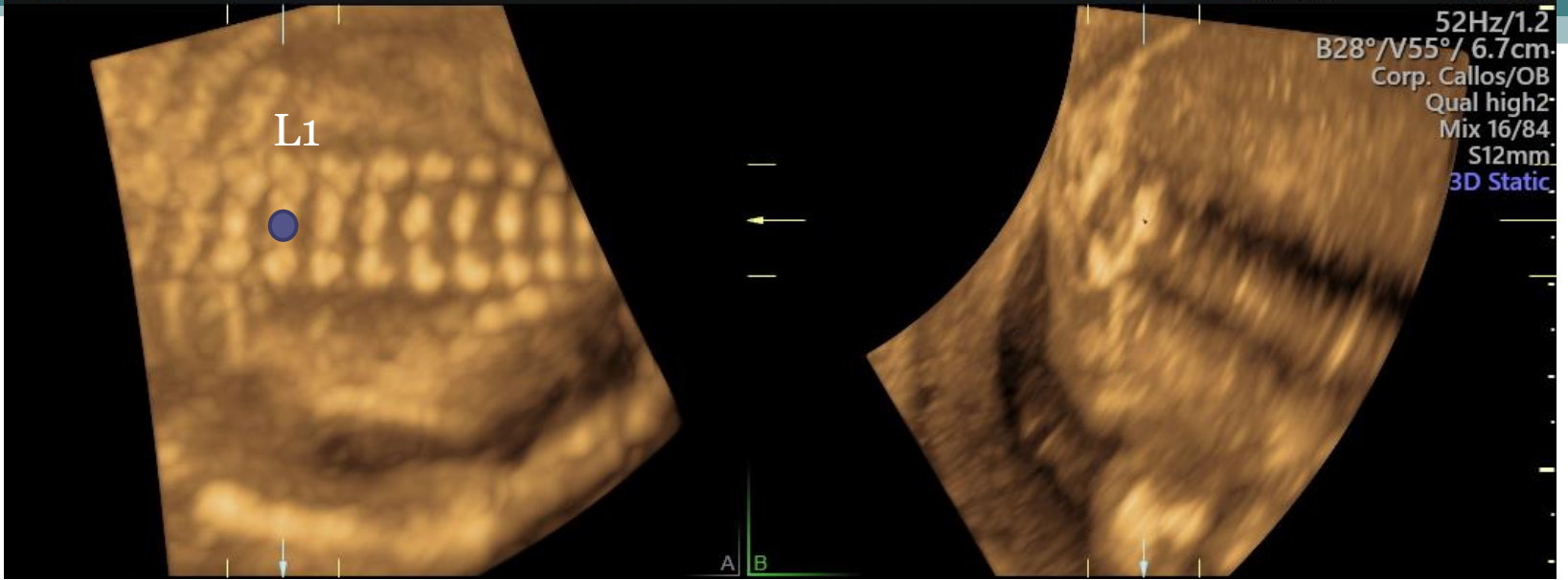
MRI und USCH (Li et al, AJR 2011): Bei Ventrikulomegalie in ca 10% Septum pellucidum Anomalien

# Höhe des Läsion? 3D Rendering Mode



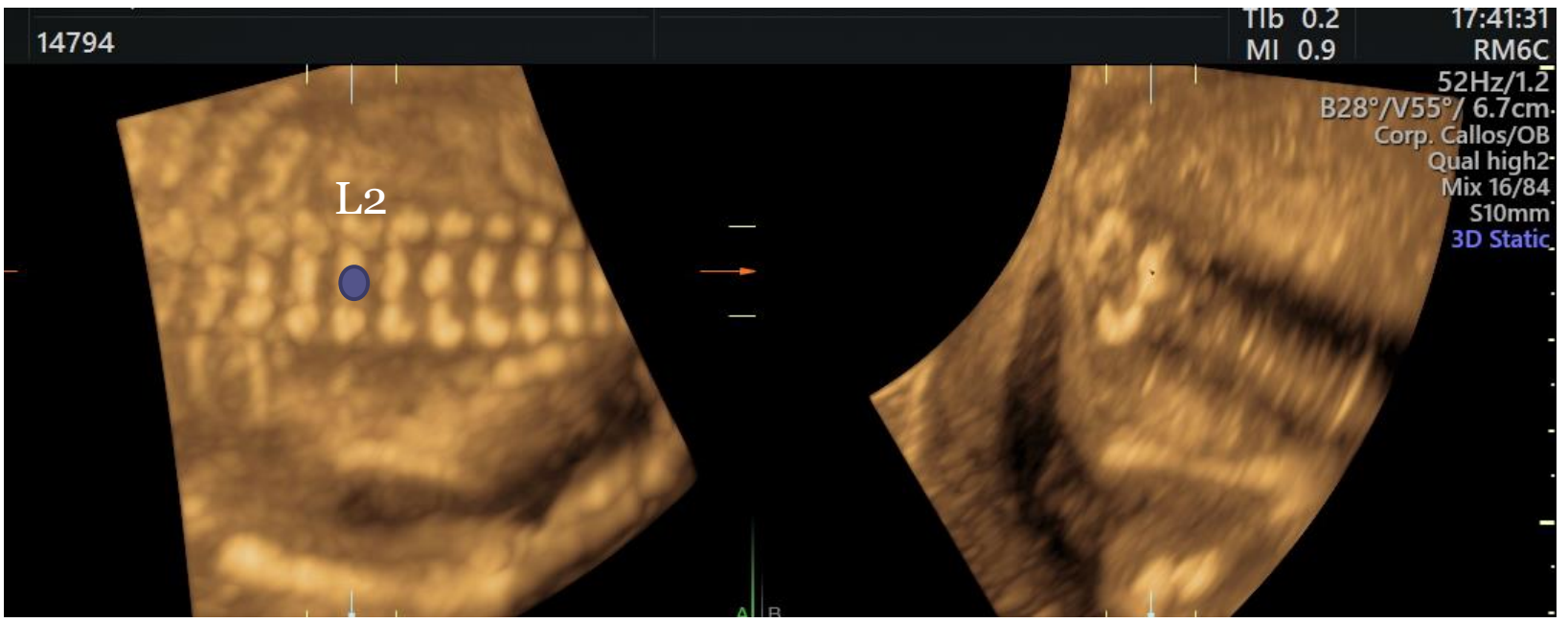
14794

TI 0.2 17:41:31  
MI 0.9 RM6C  
52Hz/1.2  
B28°/V55°/ 6.7cm  
Corp. Callos/OB  
Qual high2  
Mix 16/84  
S12mm  
3D Static



14794

TI 0.2 17:41:31  
MI 0.9 RM6C  
52Hz/1.2  
B28°/V55°/ 6.7cm  
Corp. Callos/OB  
Qual high2  
Mix 16/84  
S10mm  
3D Static



L794

MI 0.9

RM

52Hz/  
B28°/V55°/ 6.7c  
Corp. Callos/  
Qual hig  
Mix 16/  
S10n  
3D Sta

L3



A B

L794

MI 0.9

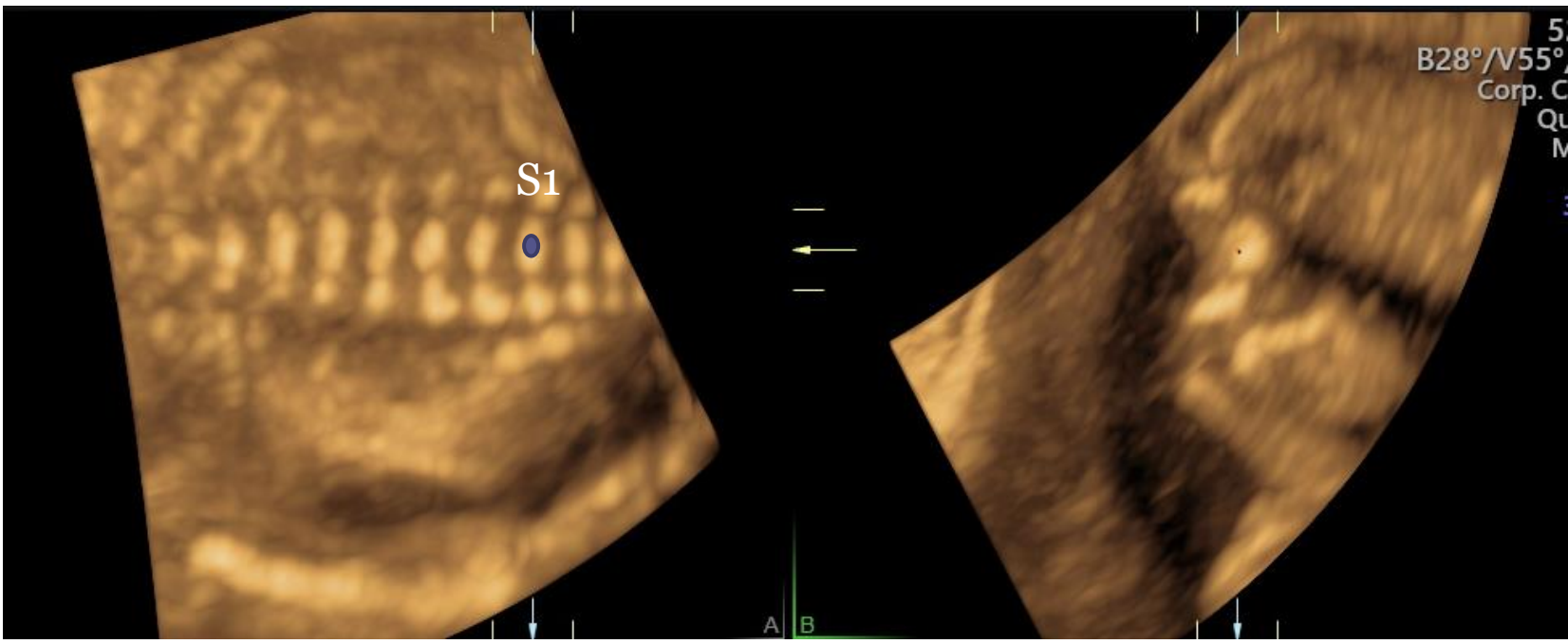
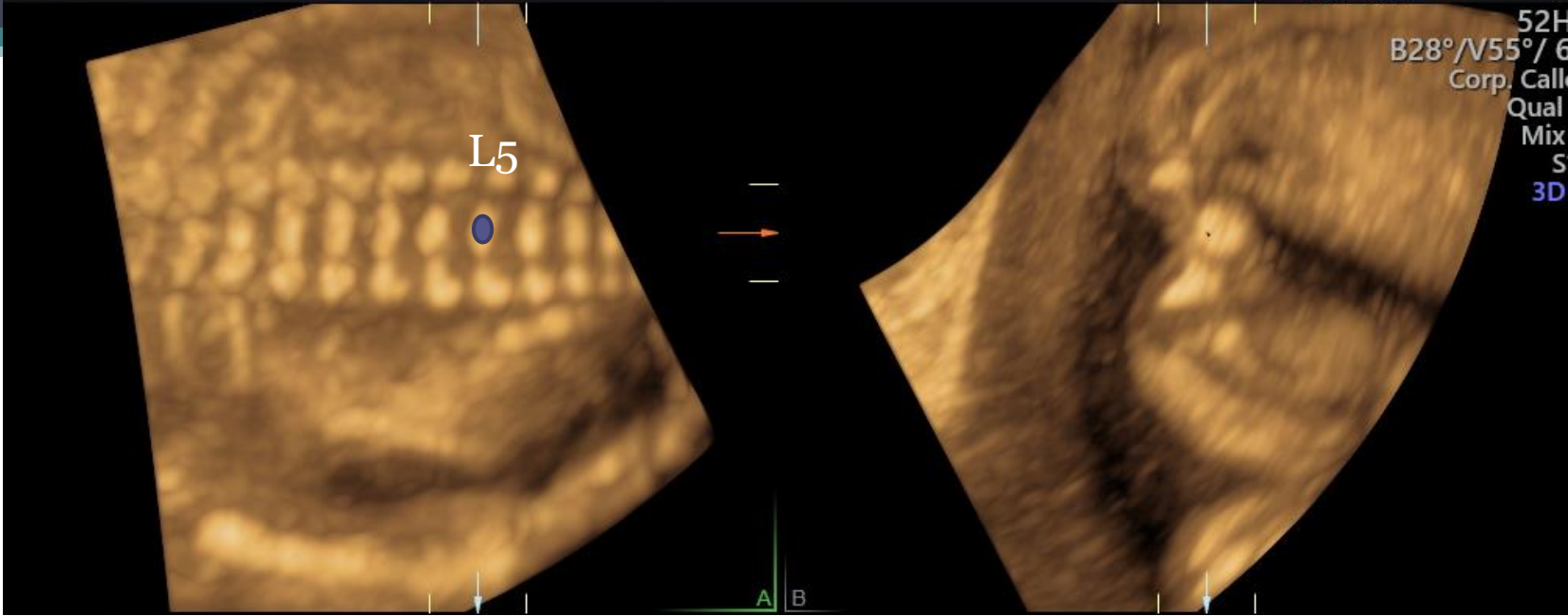
RM

52Hz/  
B28°/V55°/ 6.7  
Corp. Callos  
Qual hi  
Mix 16  
S10  
3D St

L4



A B



# Workup

- 1. Größe und Form des Seitenventrikels
- 2. Assoziierte Fehlbildungen: isoliert versus nicht-isoliert
- 3. Genetische Abklärung, Screening auf fetale Infektionen
- 4. Trend der Ventrikelweite: stabil, Regression, Progression

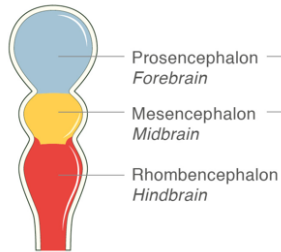


# 3. und 4. Ventrikel

A decorative graphic consisting of a solid teal horizontal bar that spans the width of the slide. Below this bar, on the right side, there are several horizontal lines of varying lengths and colors, including teal and white, creating a layered, stepped effect.

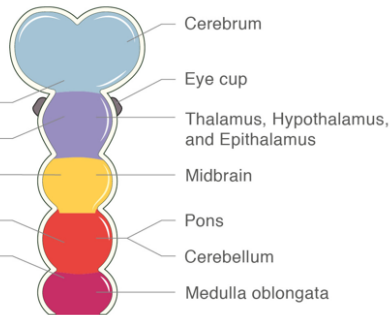
# Ventrikelsystem

## THREE PRIMARY BRAIN VESICLES

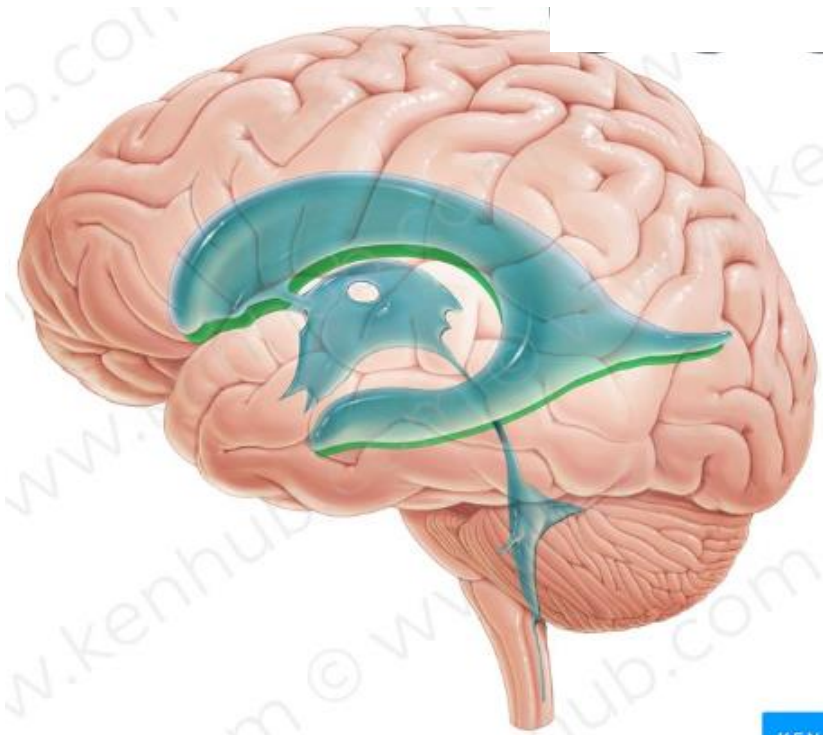


Three-to four-week embryo

## FIVE SECONDARY BRAIN VESICLES

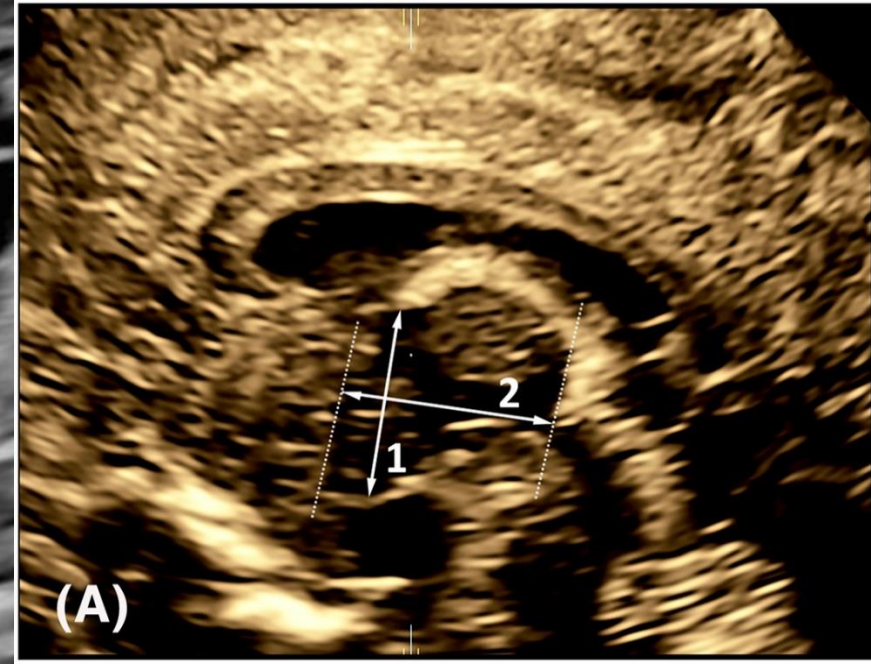
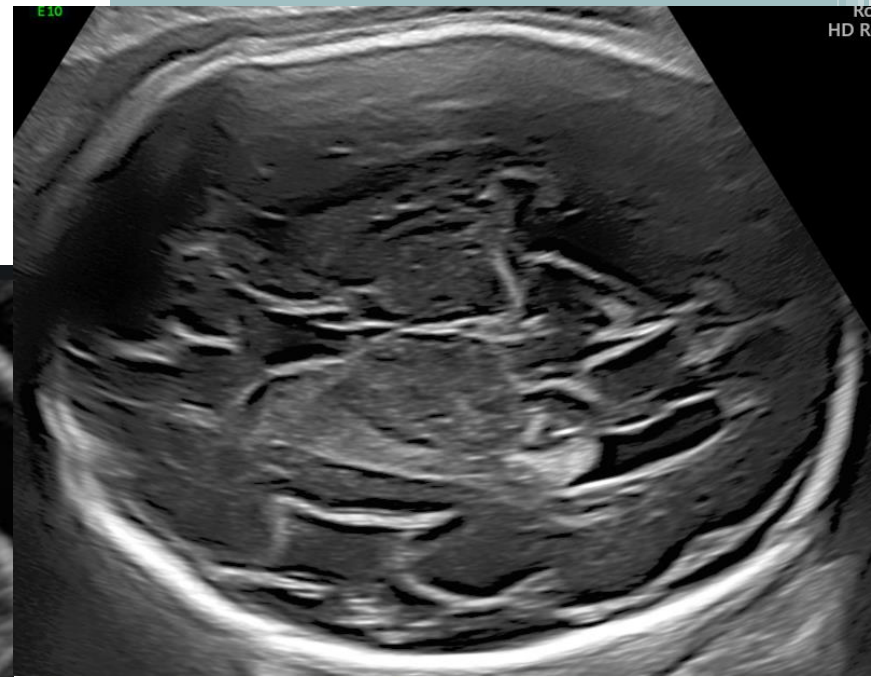
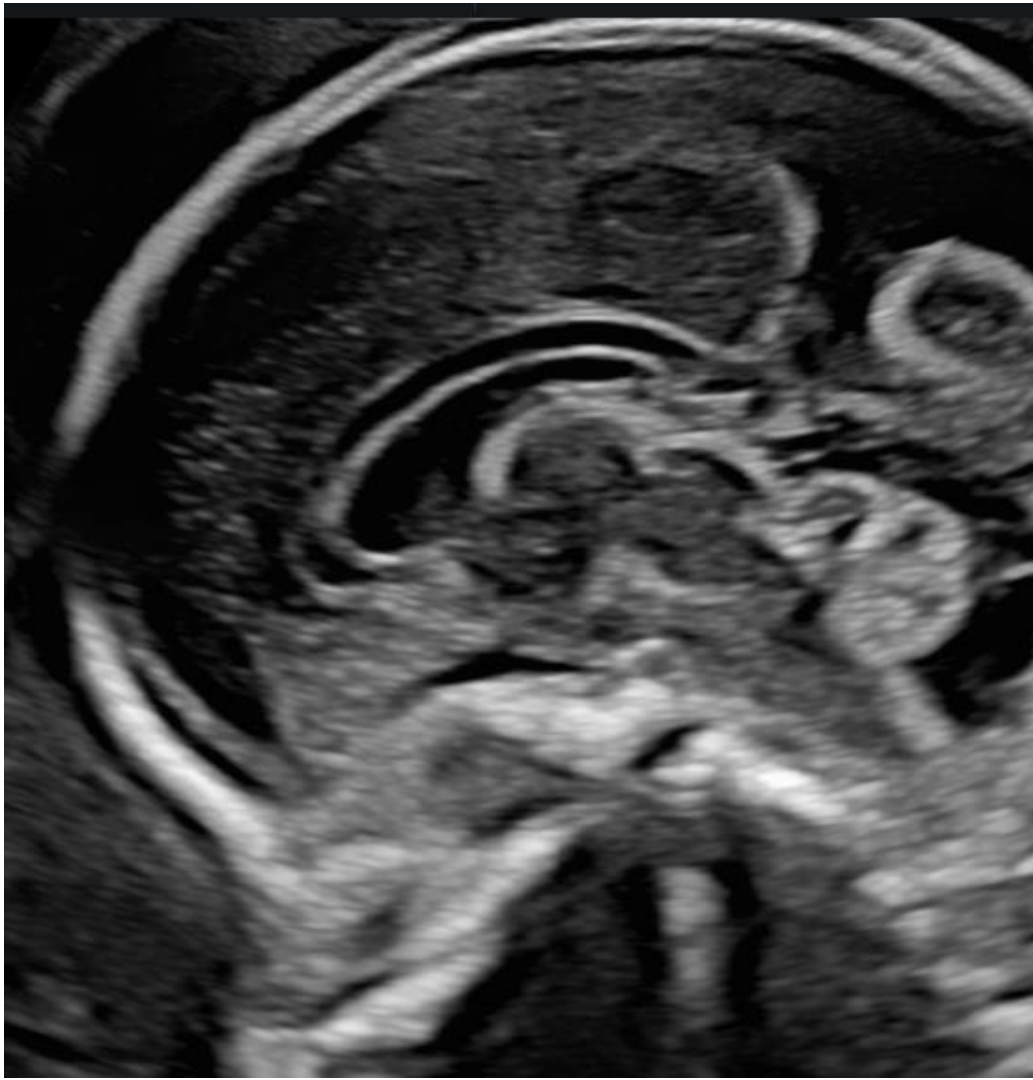


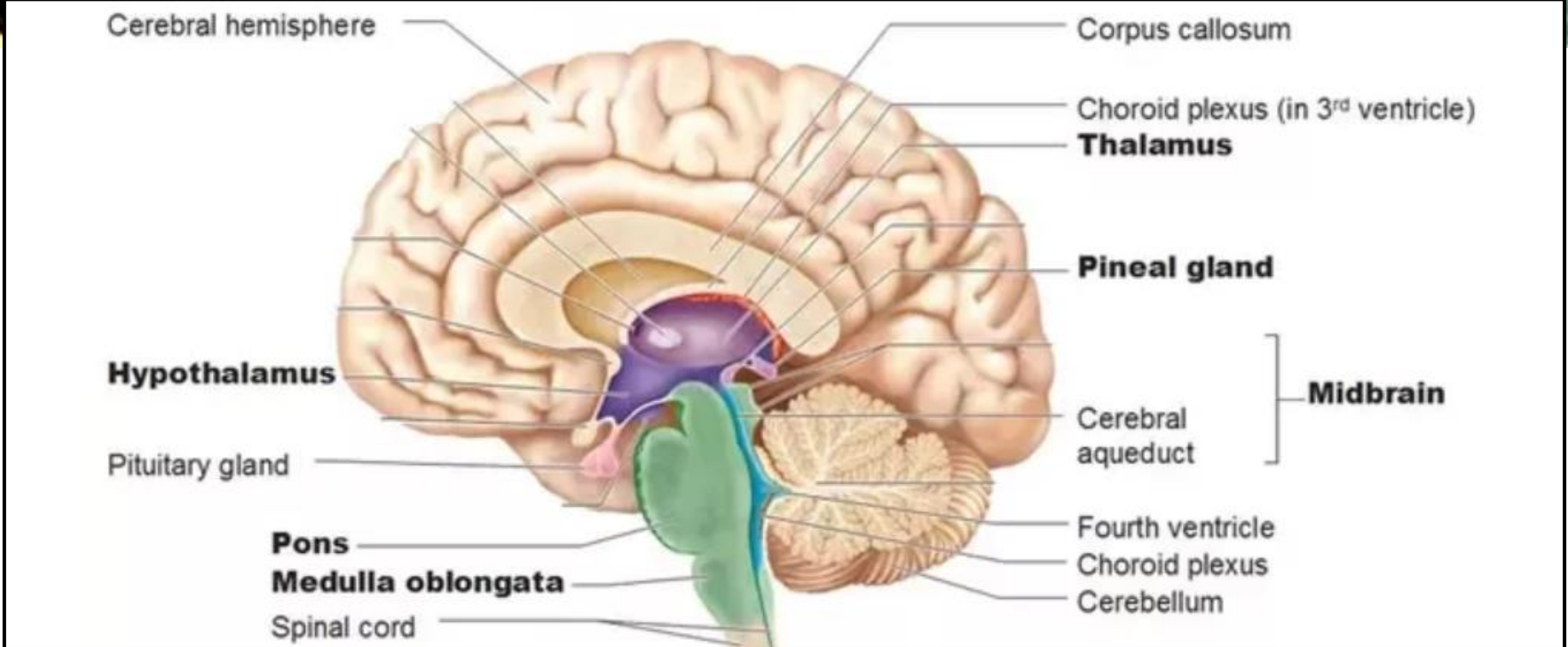
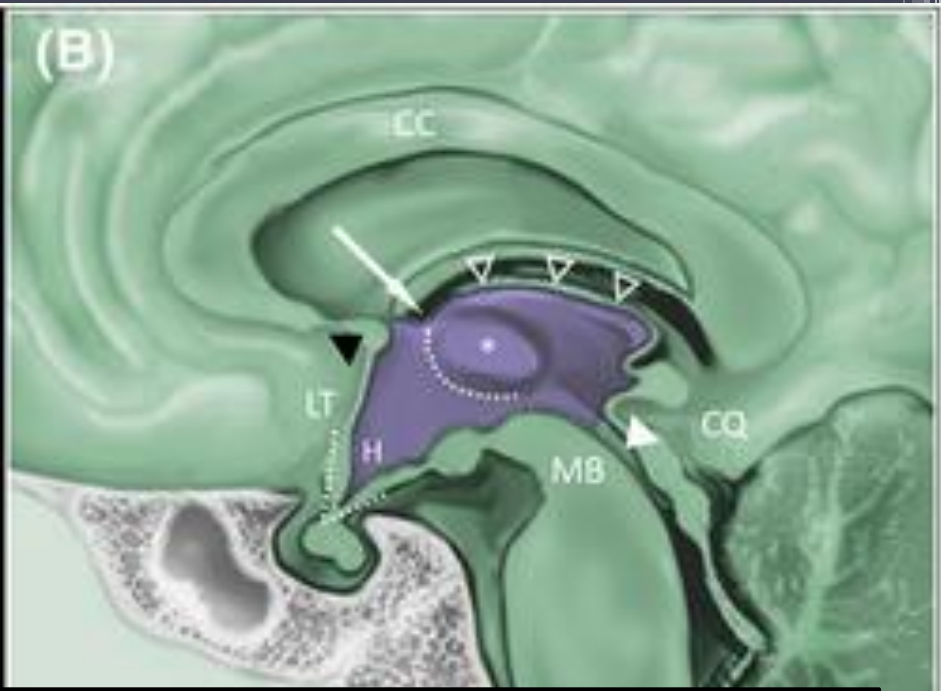
Five-week embryo



# 3. Hirnventrikel

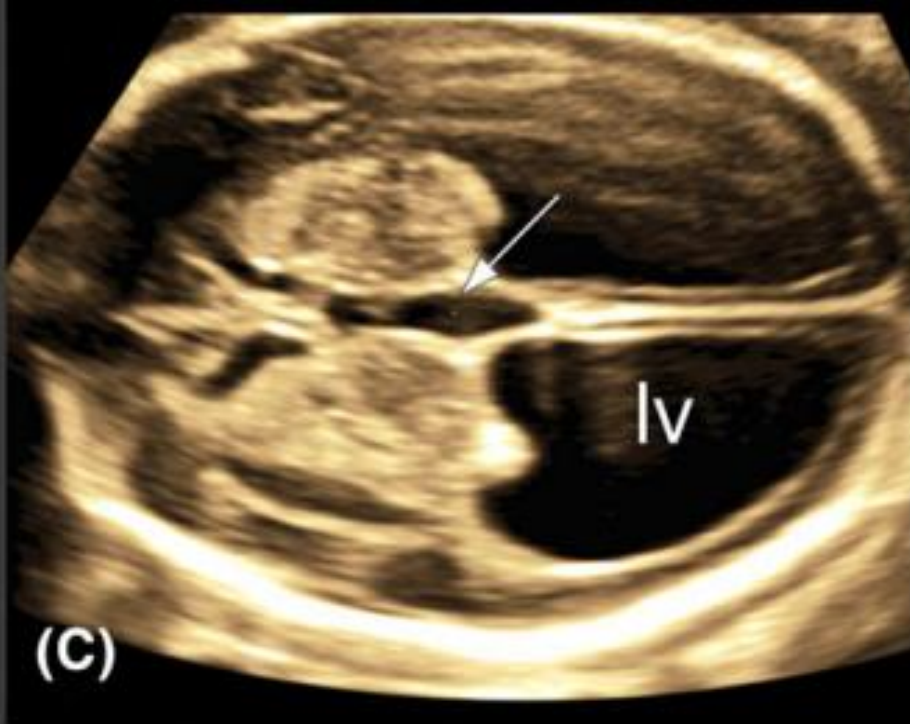
(Birnbaum et al, 2019)



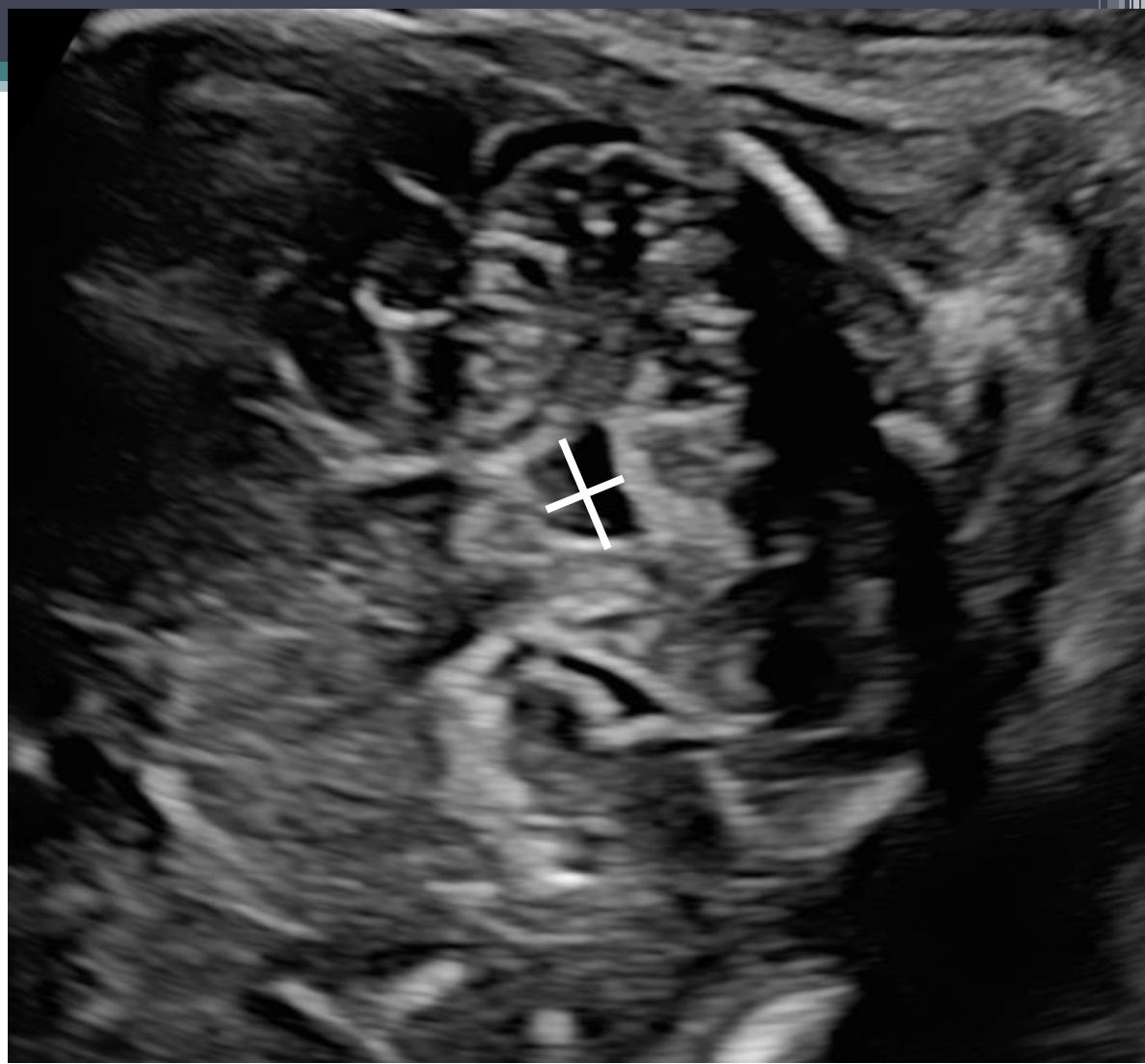


# 3. Ventrikel bei Aquäduktstenose

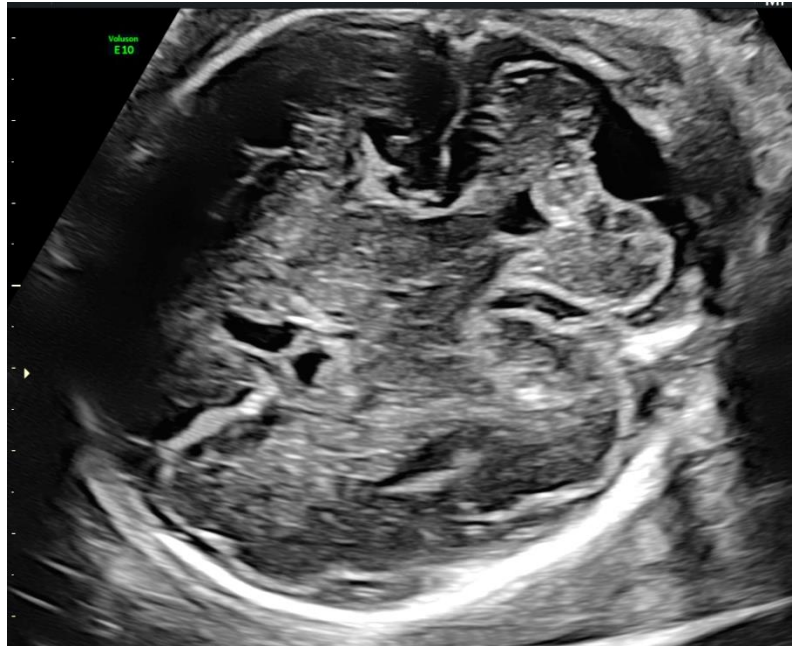
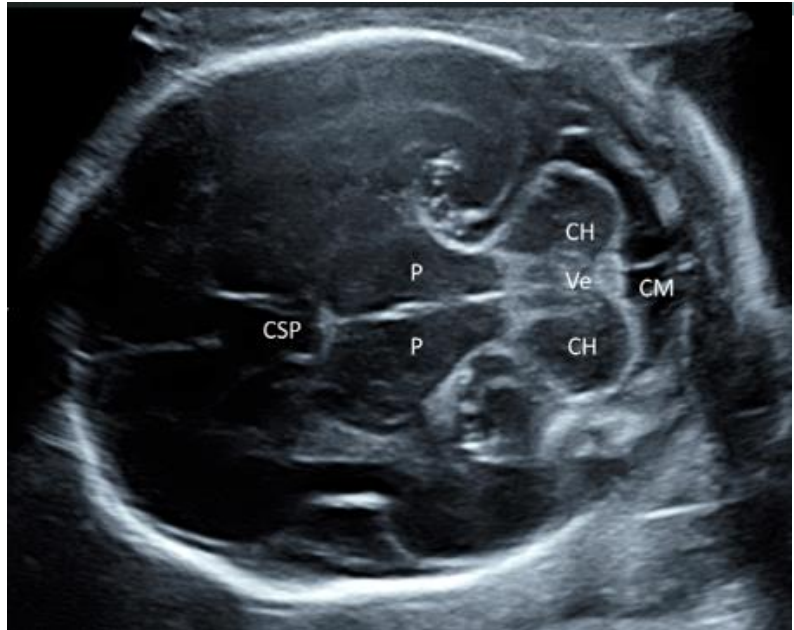
(Birnbaum et al, 2018)



## 4. Ventrikel

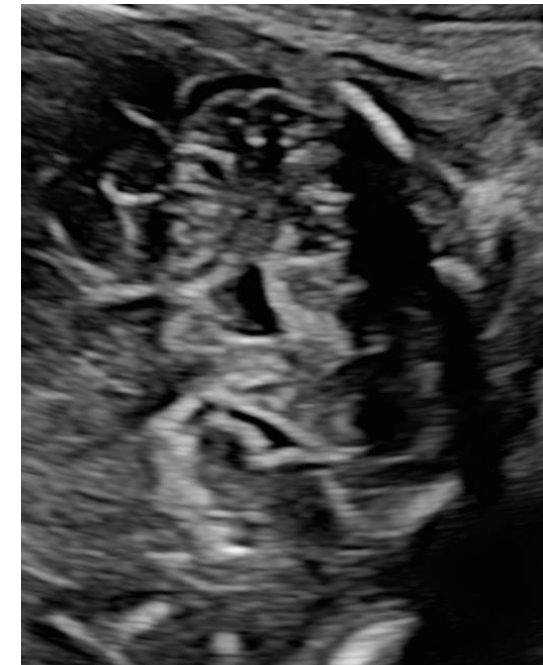
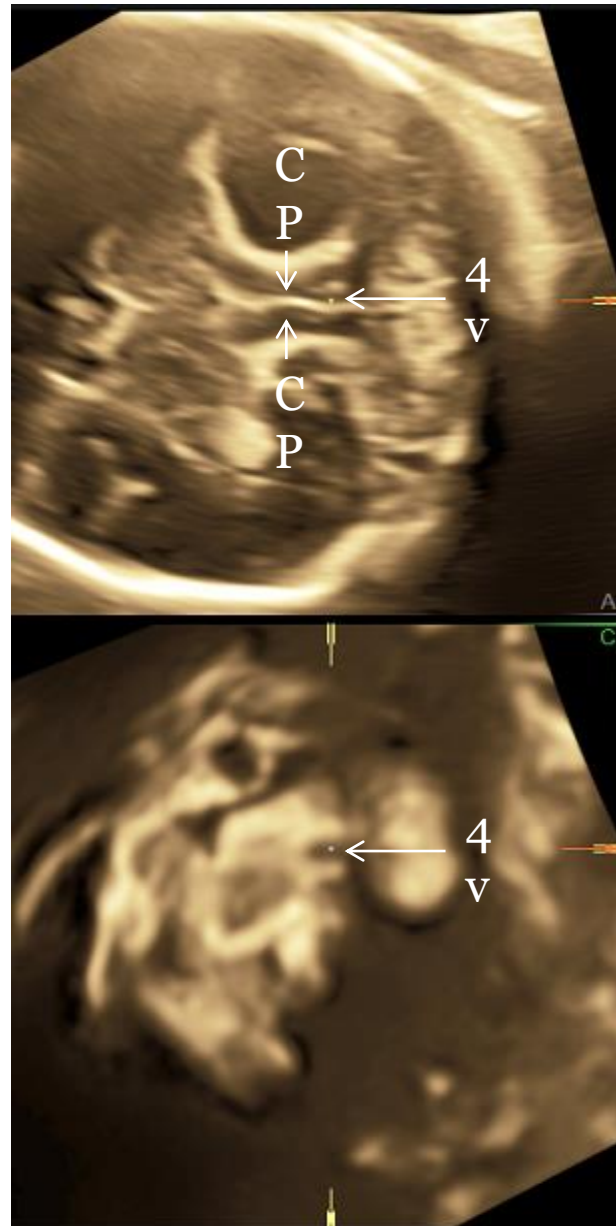


Durchmesser des 4. Ventrikels transversal größer als anterioposterior (Verhältnis  $>1$ ) (Haratz, 2018)



# Joubert Syndrom

- Kleinhirnhypoplasie
- Verdickte obere Kleinhirnstiele
- ap Durchmesser des 4. Hirnventrikels > transversaler Durchmesser





# Basisuntersuchung

- Head shape
- Lateral ventricles

## Sylvische Fissur

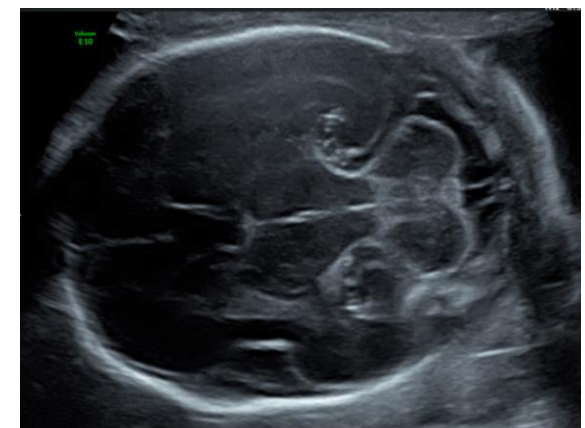
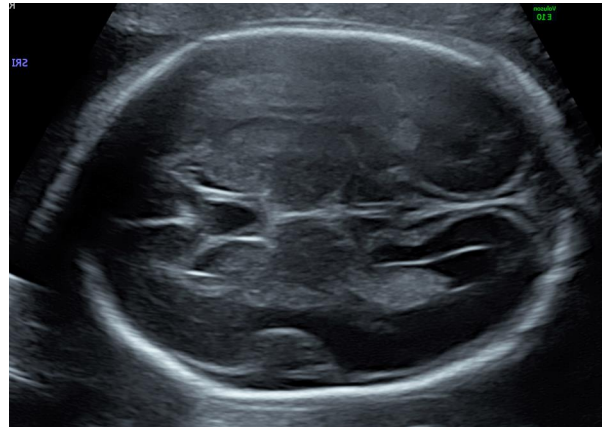
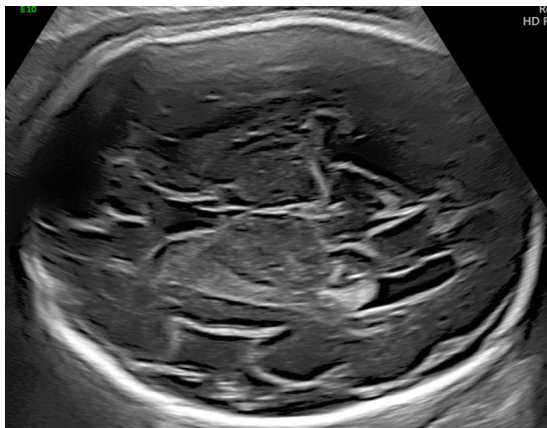
- Cerebellum
- Cisterna magna
- Spine

Ultrasound Obstet Gynecol 2020; 56: 476–484  
Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/uog.22145



**GUIDELINES**

ISUOG Practice Guidelines (updated): sonographic examination of the fetal central nervous system. Part 1: performance of screening examination and indications for targeted neurosonography

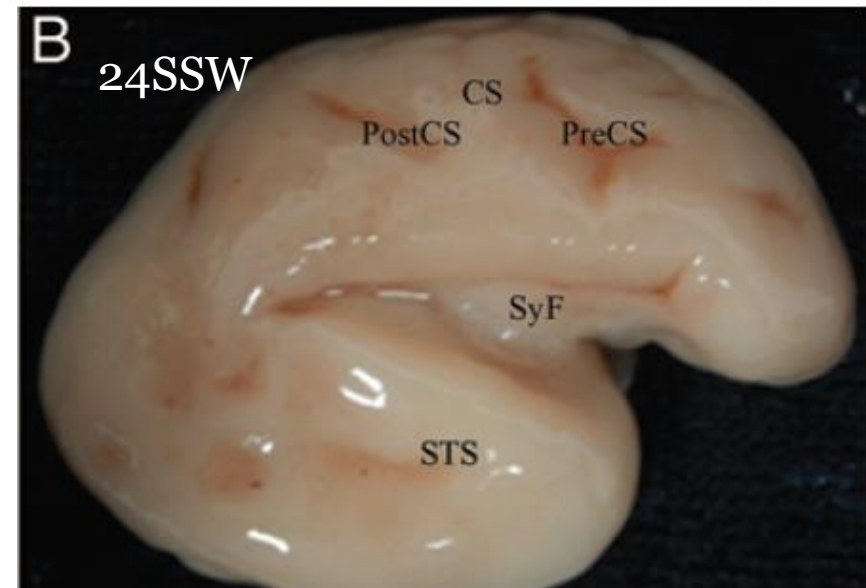
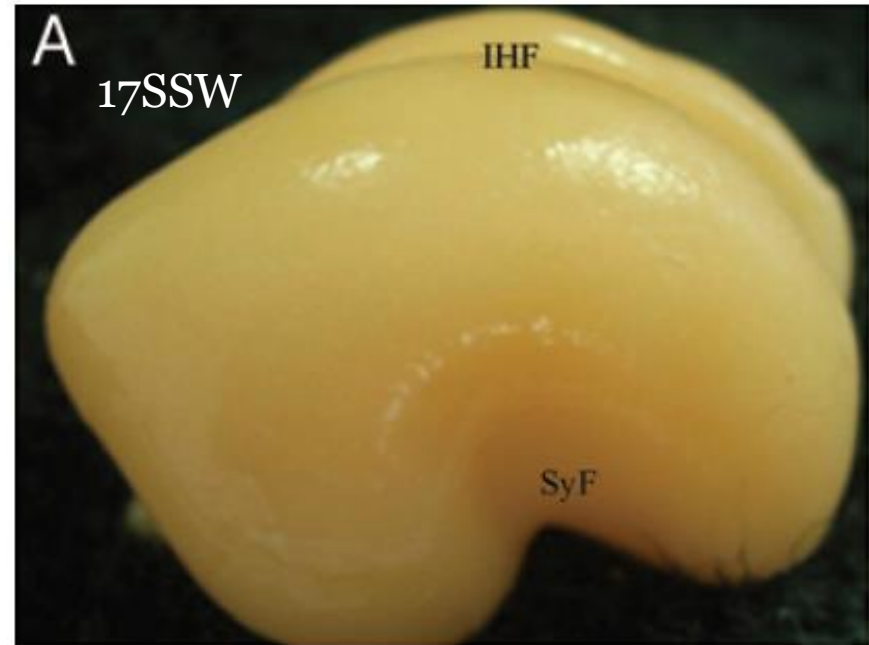


# Sylvische Fissur

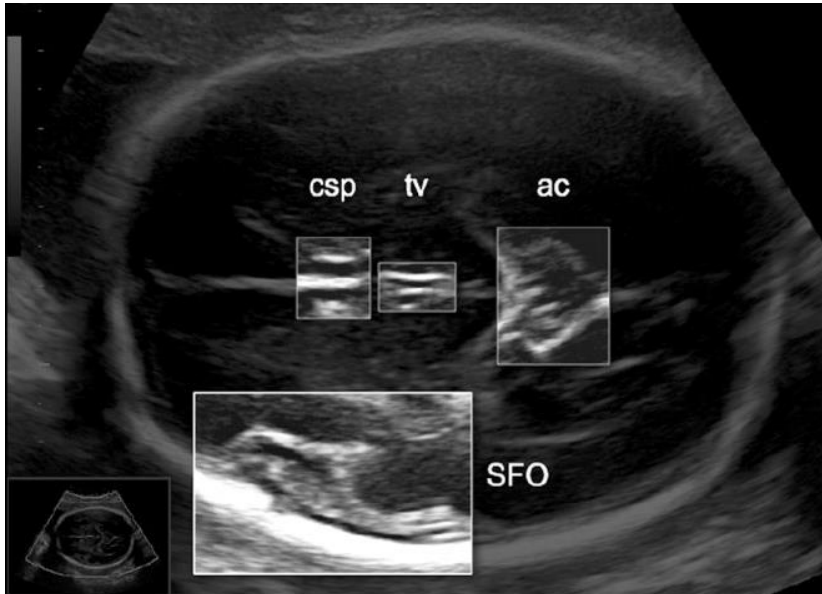
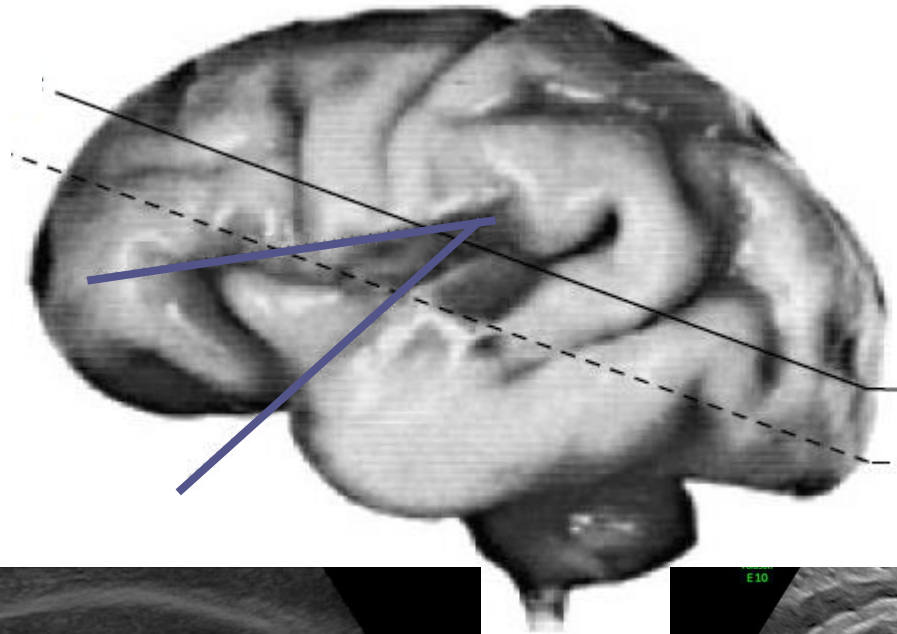


# Sylvische Fissur

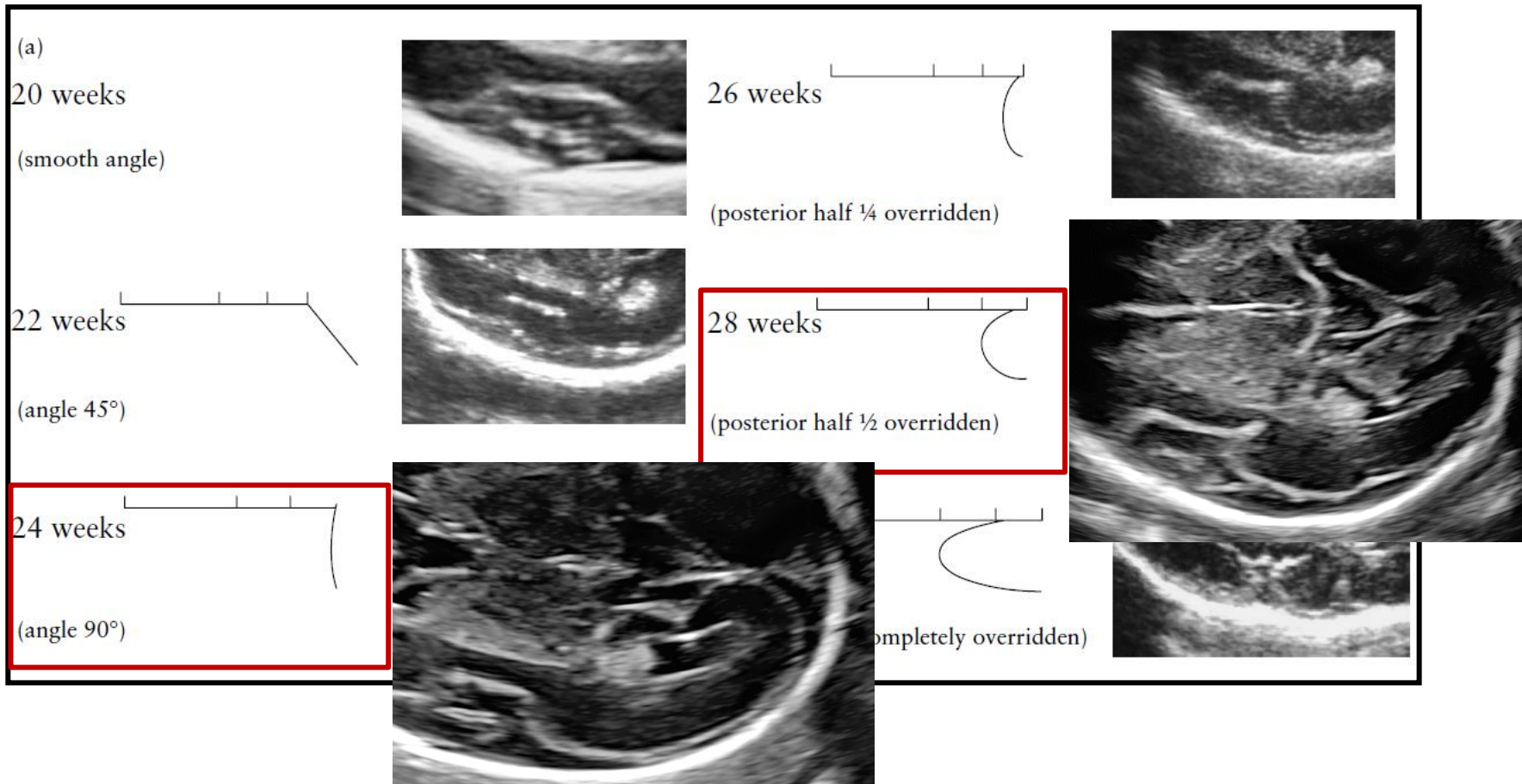
- **Marker für kortikale Entwicklung**
- **Vorteil: Darstellung in der axialen Schnittebene, kann im Rahmen der Basisuntersuchung beurteilt werden**
- Koronarschnitte bei erweiterter Neurosonographie
- Entwicklung der Sylvischen Fissur: operculization process (SFO)



# Messung der Sylvischen Fissur (Quarelllo 2008): Cavum septi pellucidi oder Fornix, 3.Ventrikel, Cisterna ambiens

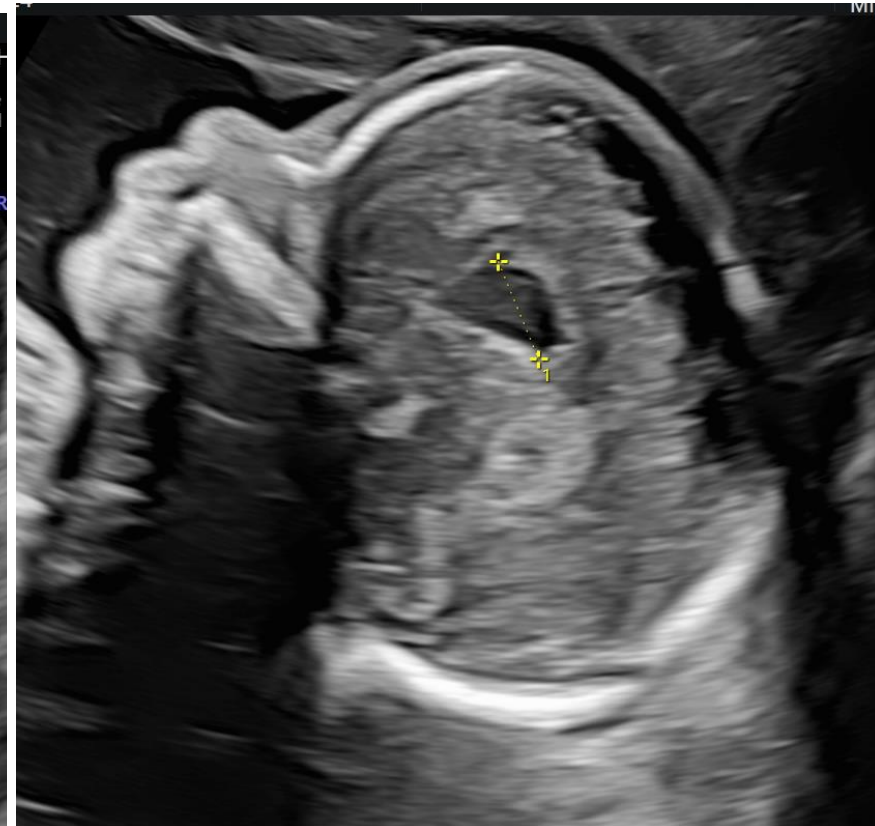


# Überwachsen der Insula durch den Temporallappen: Score von 1-10 (Quarello 2008)



## GV 23/0 SSW

- Beidseitige Ventrikulomegalie: Atrium 13mm
- TCD im Normbereich, Vermishöhe mit 13 mm ebenfalls im Normbereich, Vermis mäßiggradig aufwärts rotiert
- Corpus callosum verkürzt (außen-außen 19 mm, innen-innen 11mm)



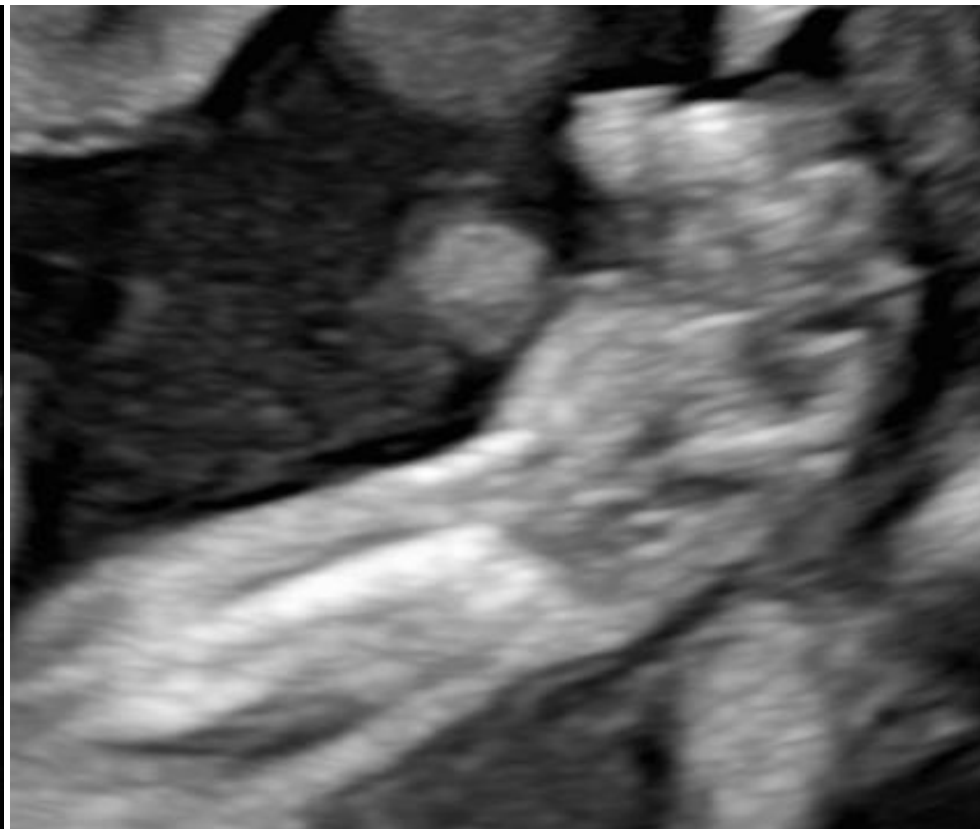
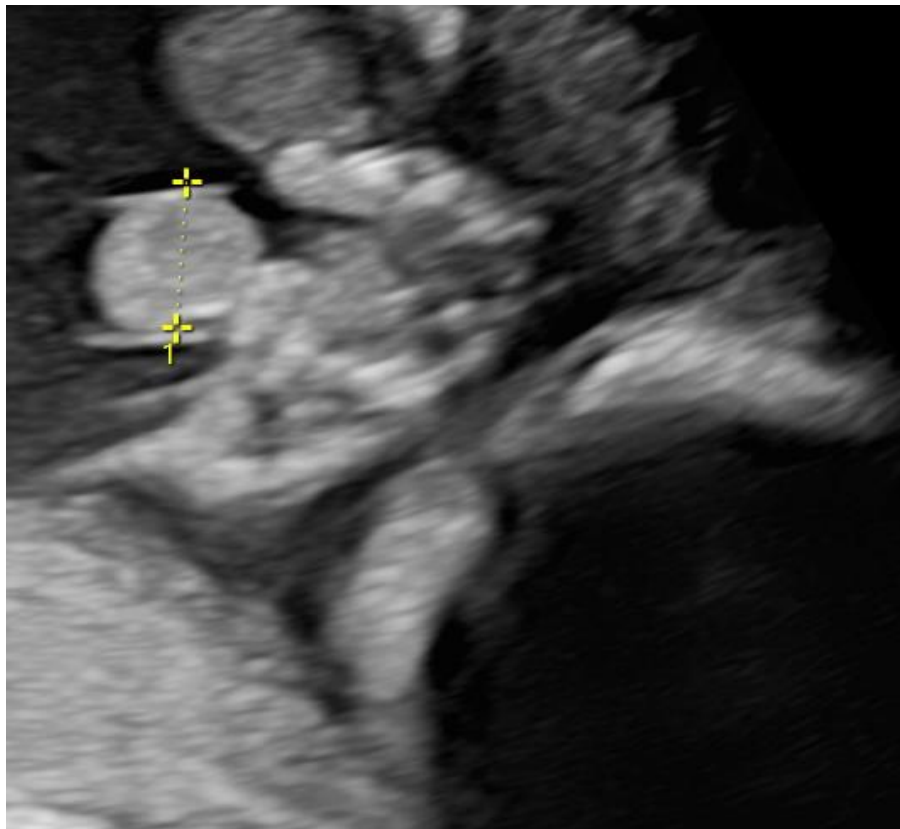
Auffällige Sylvische Fissur (sehr flach und nicht der SSW  
entsprechend)

**G** 23/0 SSW



## G 23/0 SSW

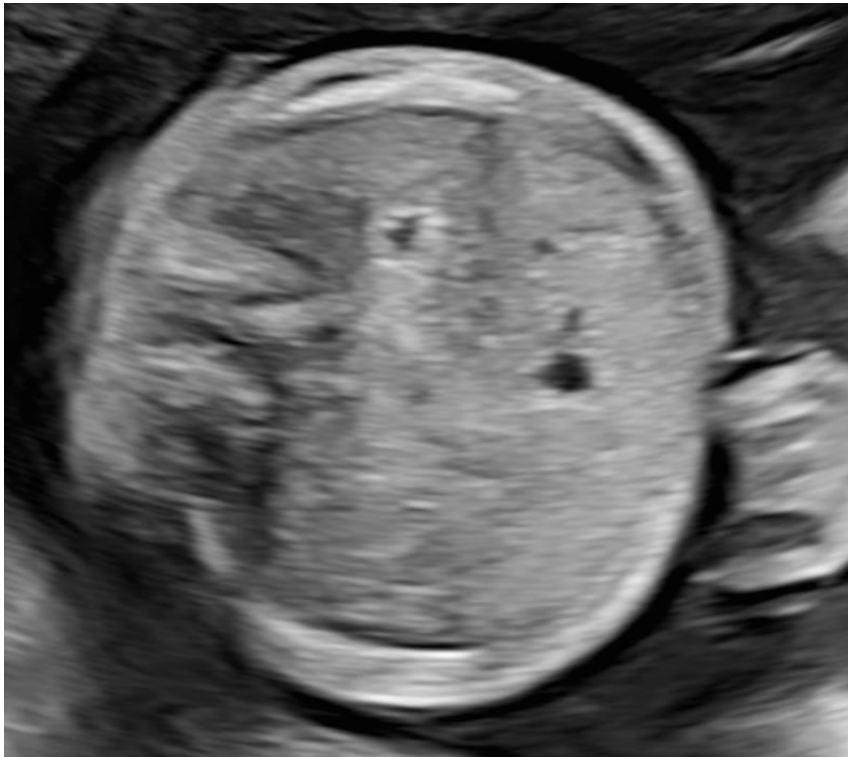
linke Hand postaxial rundliche Struktur von ca 1cm, a.e. einem 6. Finger entsprechend





Kleine Omphalozele

Kleiner Magen: Verdacht auf Ösophagusatresie



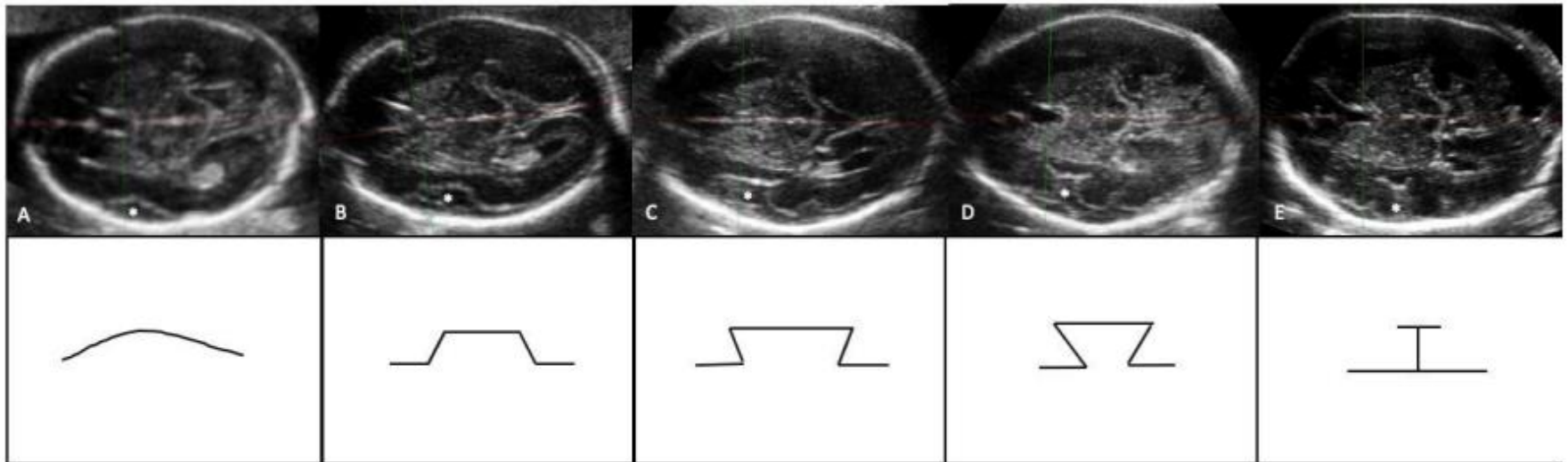
# Miller Dieker Syndrom: Deletion am Chromosom 17 (17p13.3-17q13.2)

Miller-Dieker Syndrom: Lissencephalie, Microcephalie, Fehlbildungen, schwere Entwicklungsverzögerungen



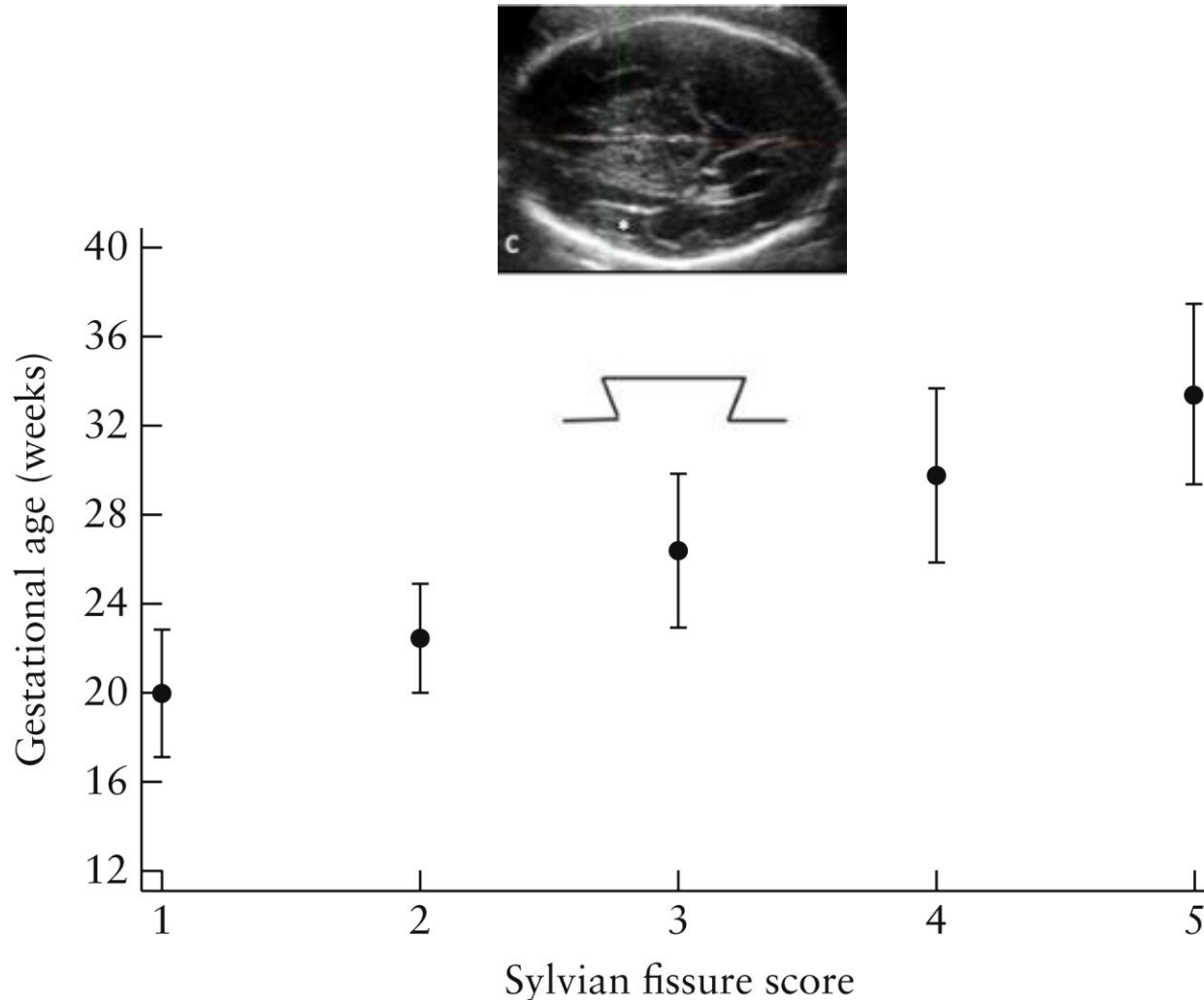
# INTERGROWTH-21st Project: Sylvian fissure maturation

**Supplementary Figure S1.** Sylvian fissure maturation scores



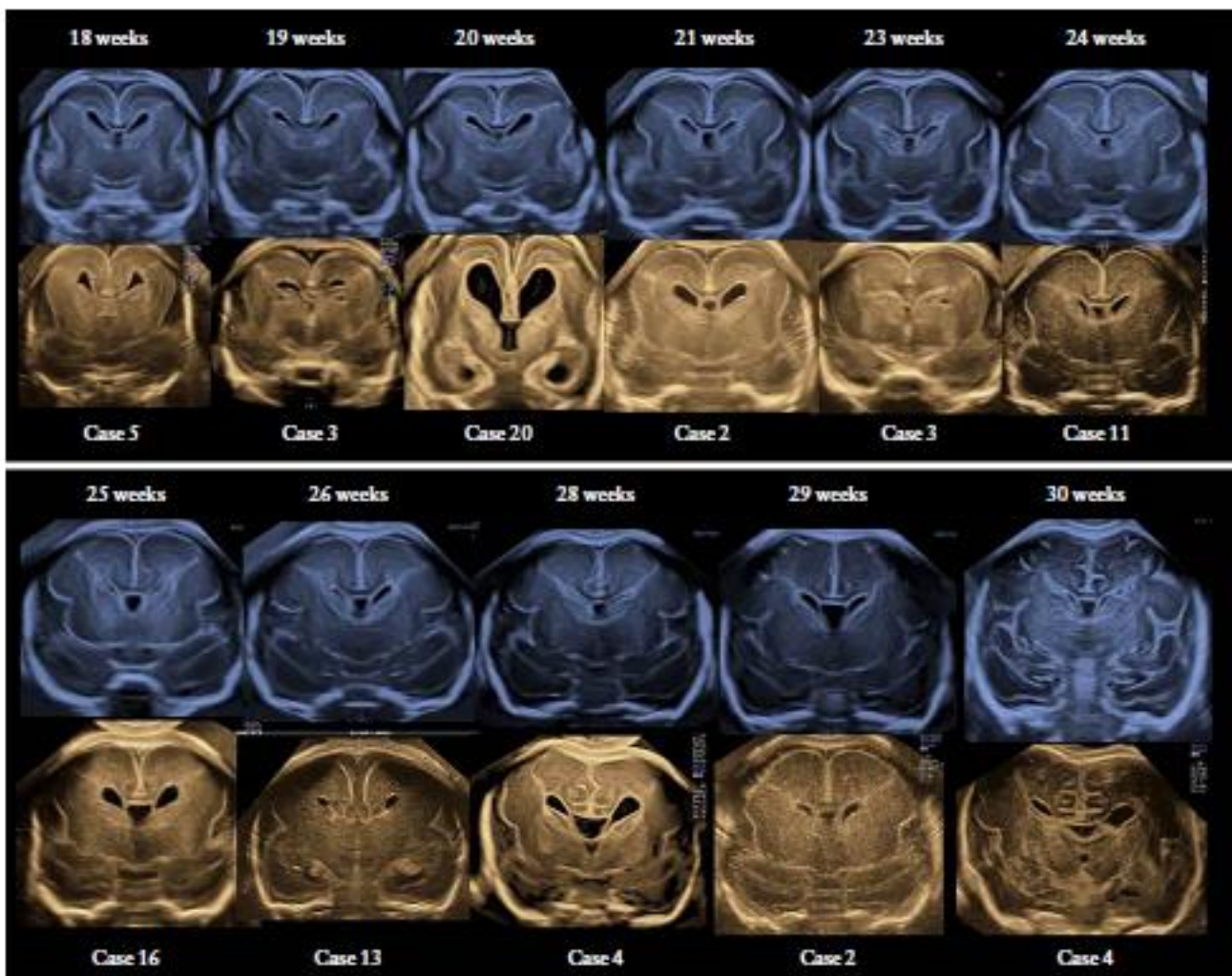
Scoring system for Sylvian fissure maturation. (A) Grade 1, smooth indentation; (B) Grade 2, obtuse angular shape; (C) Grade 3, acute angular shape (<50% operculization); (D) Grade 4, angular closure until most of the insula is covered (>50% operculization); (E) Grade 5, complete closure or operculization

# Fetal cerebellar growth and Sylvian fissure maturation: international standards from Fetal Growth Longitudinal Study of INTERGROWTH-21st Project (UOG 2021)

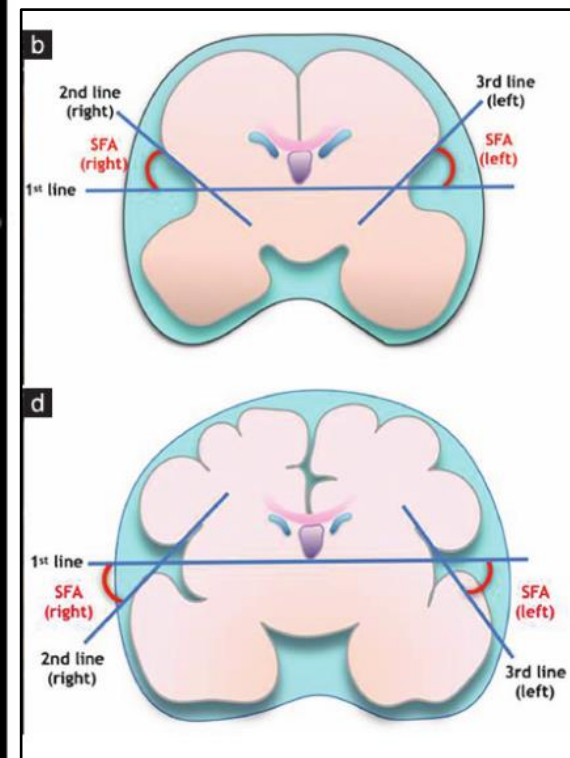


## Increased Sylvian fissure angle as early sonographic sign of malformation of cortical development

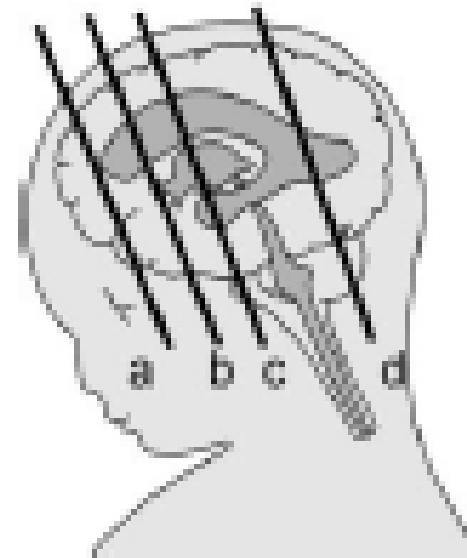
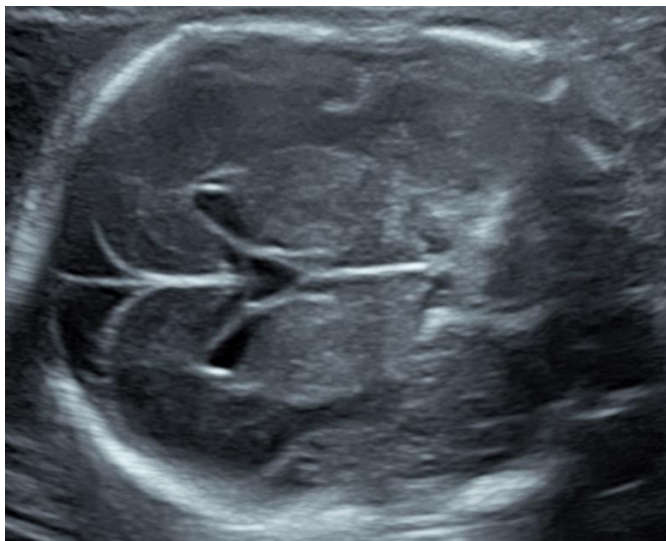
R. K. POOH<sup>1</sup>, M. MACHIDA<sup>1</sup>, T. NAKAMURA<sup>1</sup>, K. UENISHI<sup>1</sup>, H. CHIYO<sup>1</sup>, K. ITOH<sup>2</sup>, J. YOSHIMATSU<sup>3</sup>, H. UEDA<sup>4</sup>, K. OGO<sup>4</sup>, P. CHAEMSAITHONG<sup>5</sup> and L. C. POON<sup>5</sup>



- Transvaginal Koronarebene

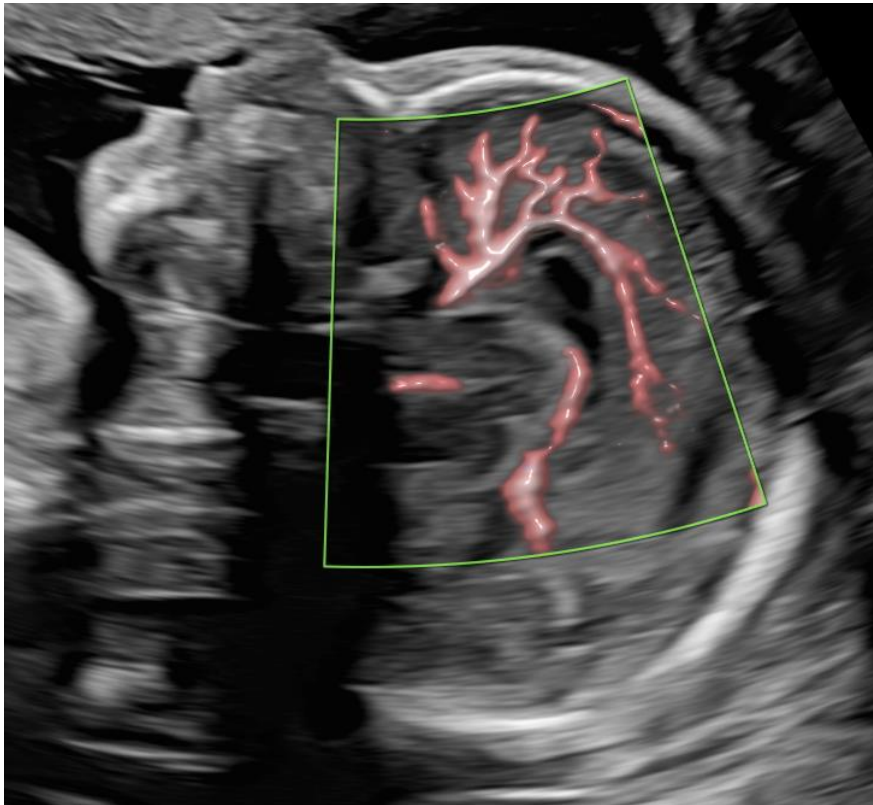


# Step 2: Erweiterte Neurosonographie



# Midsagittale Ebene

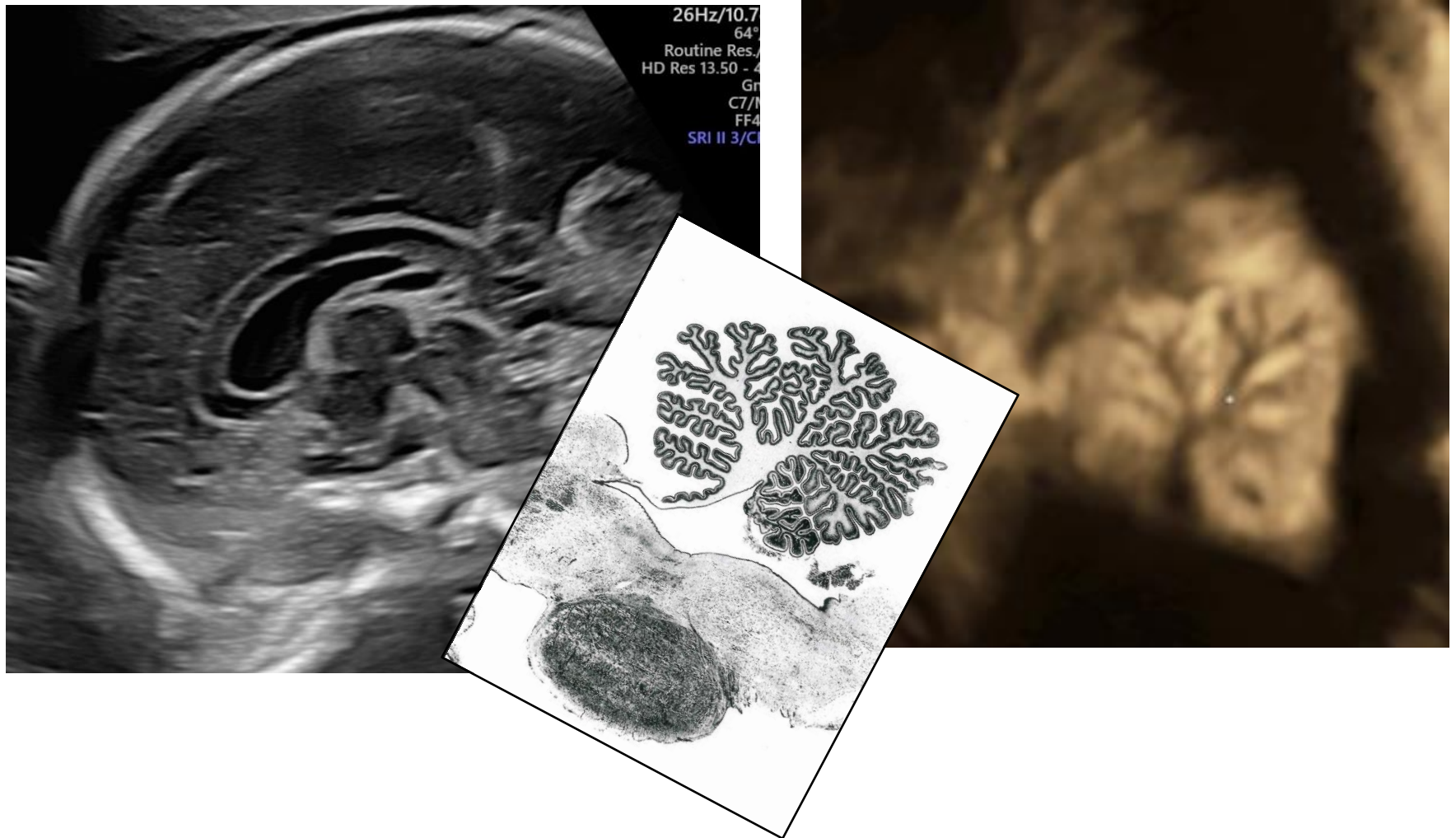
## Midsagittale vordere Ebene



## Midsagittale hintere Ebene



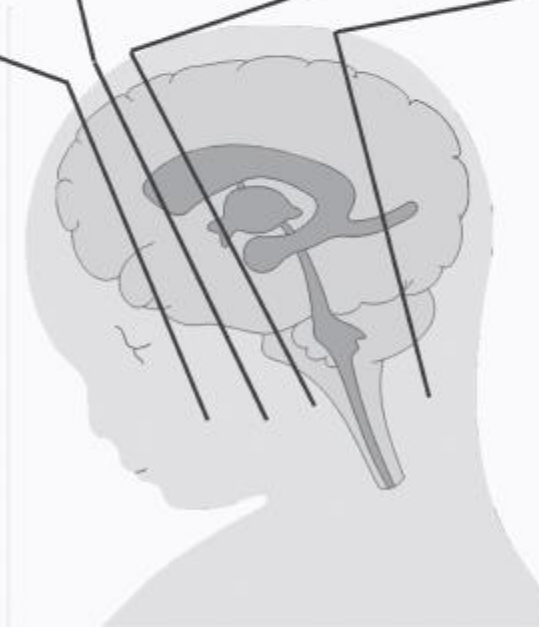
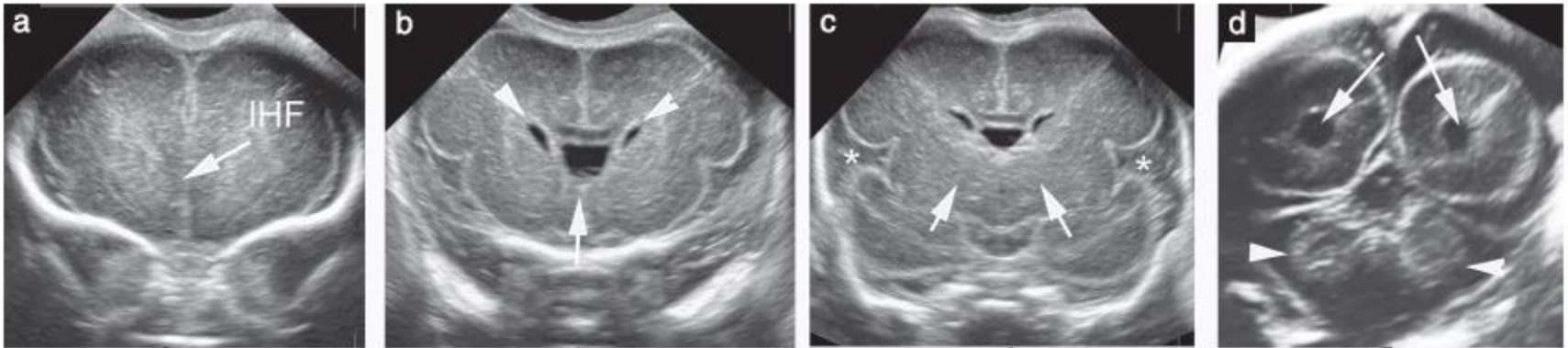
# Midsagittale Ebene, 3D Ultraschall



Corpus callosum, Fornices, Sylvischer Aquädukt, Vermis



# Koronare Schnittebenen



Ultrasound Obstet Gynecol 2021  
Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/uog.23616

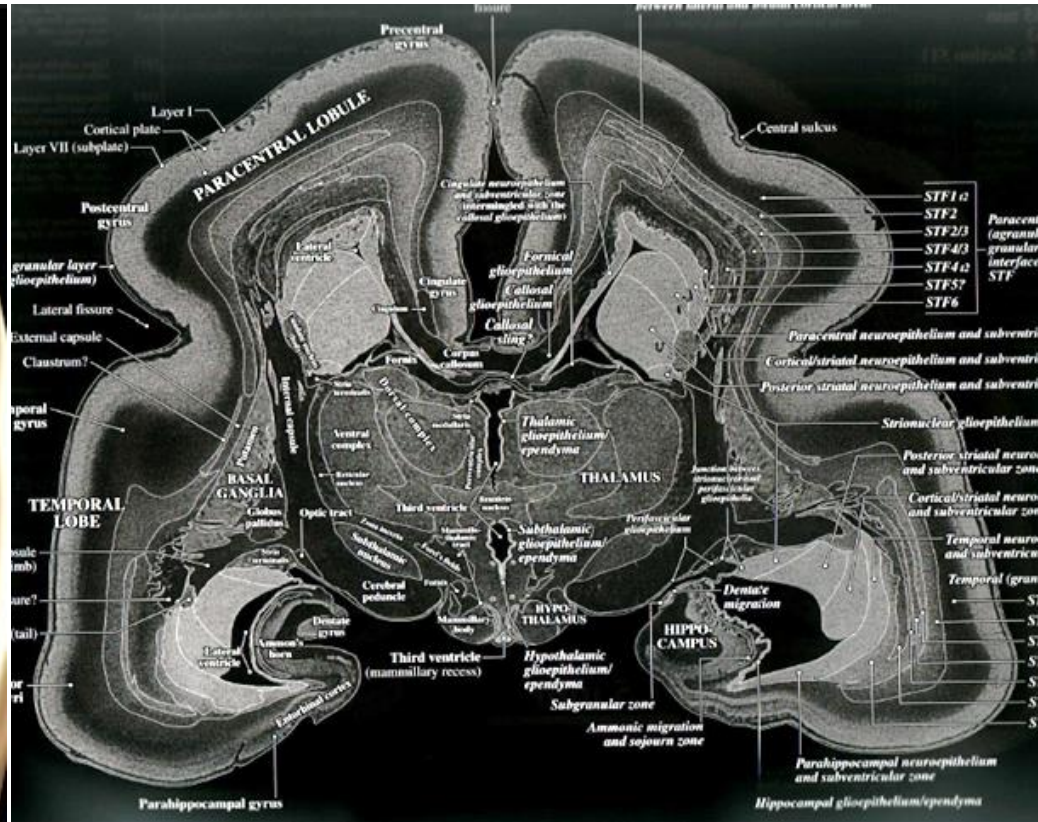
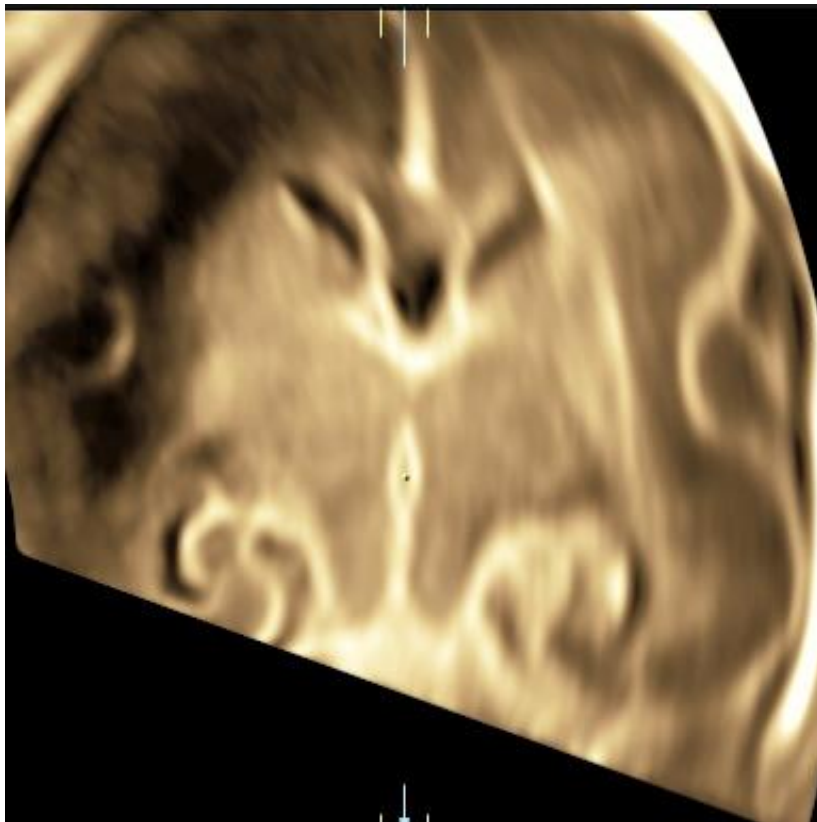
 **isuog**.org

**GUIDELINES**

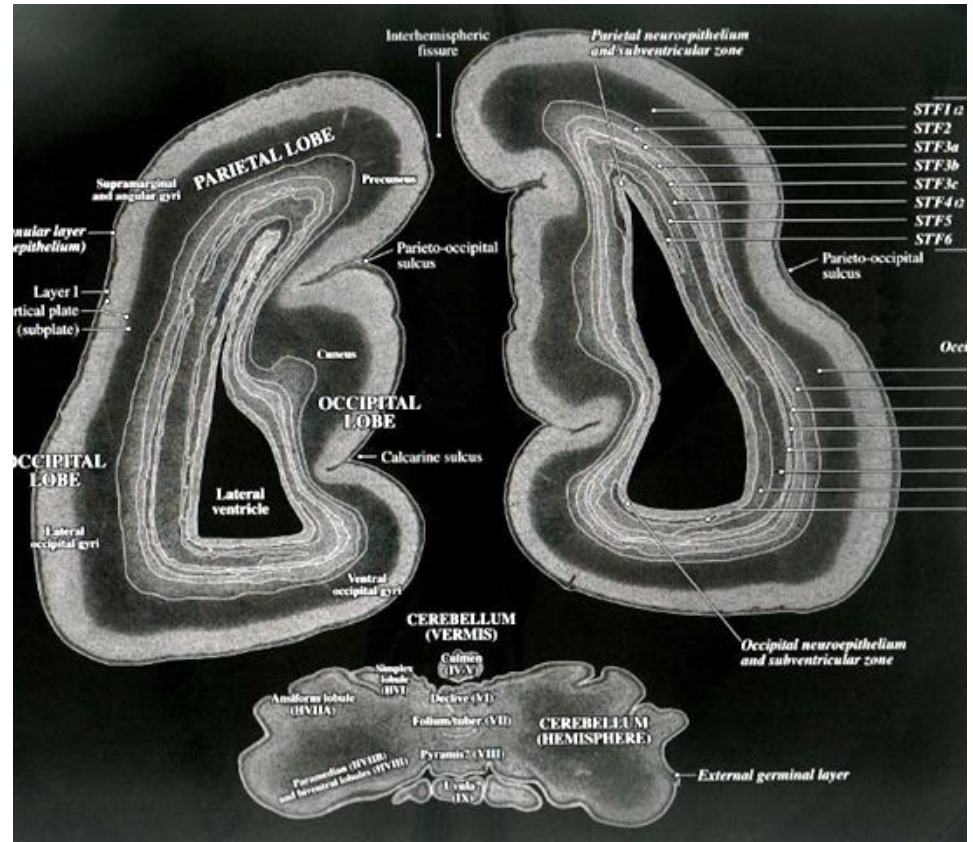
ISUOG Practice Guidelines (updated): sonographic examination of the fetal central nervous system. Part 2: performance of targeted neurosonography



### 3. Transthalamische Ebene: Thalami, Corpus callosum, Cavum septi pellucidi, 3. Ventrikel, Sylvische Fissur



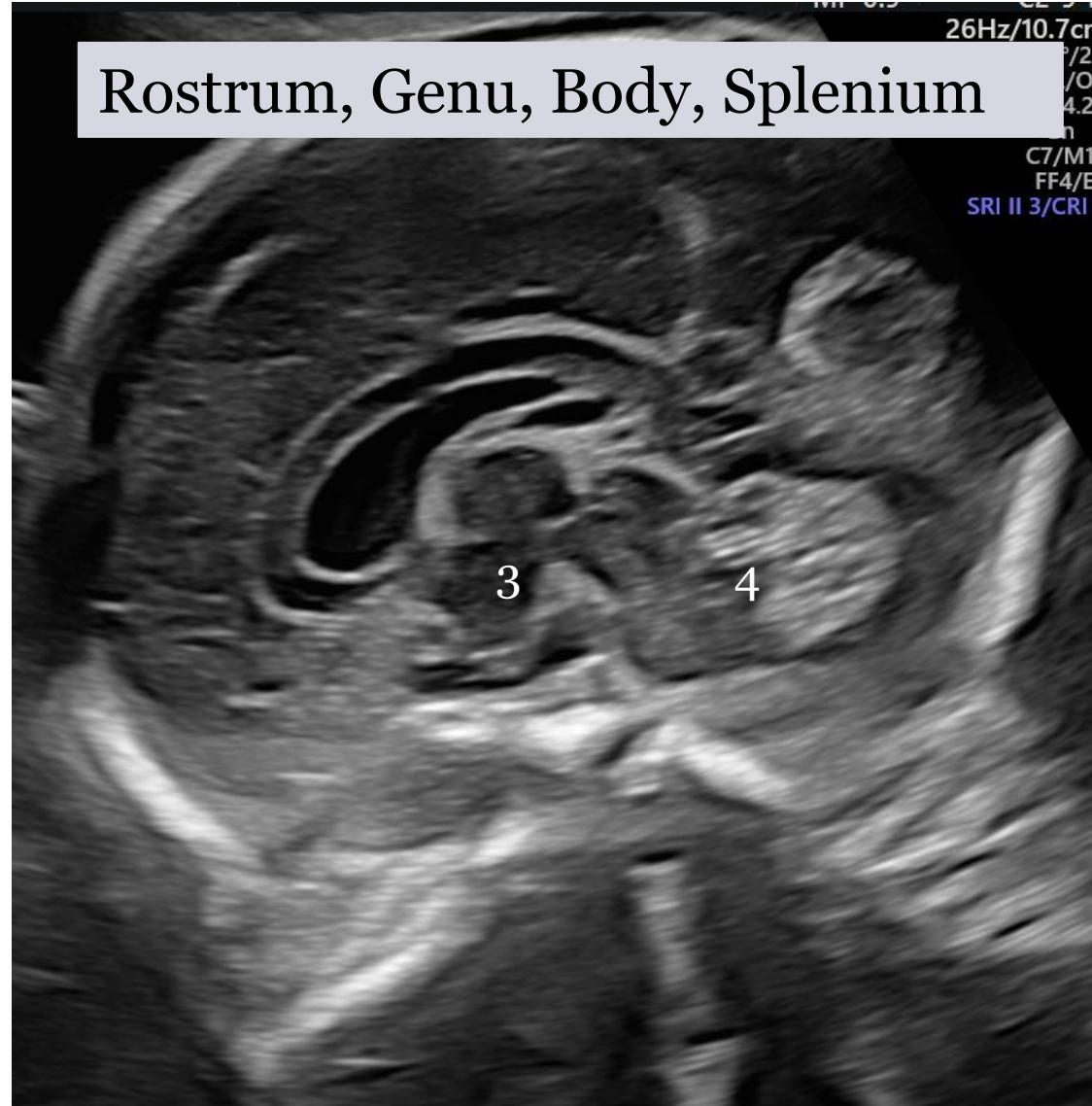
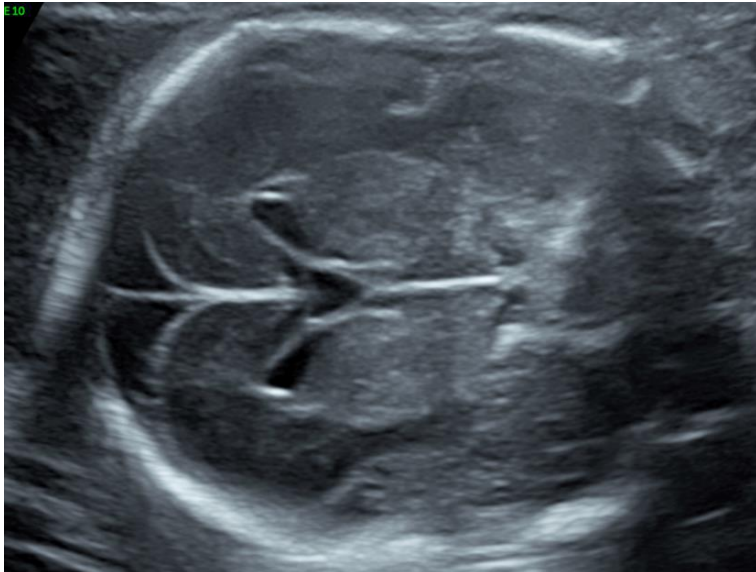
# 4. Transcerebelläre Ebene: Cerebellum, Fissura calcarina, Hinterhörner



# Corpus callosum und Cavum septi pellucidi

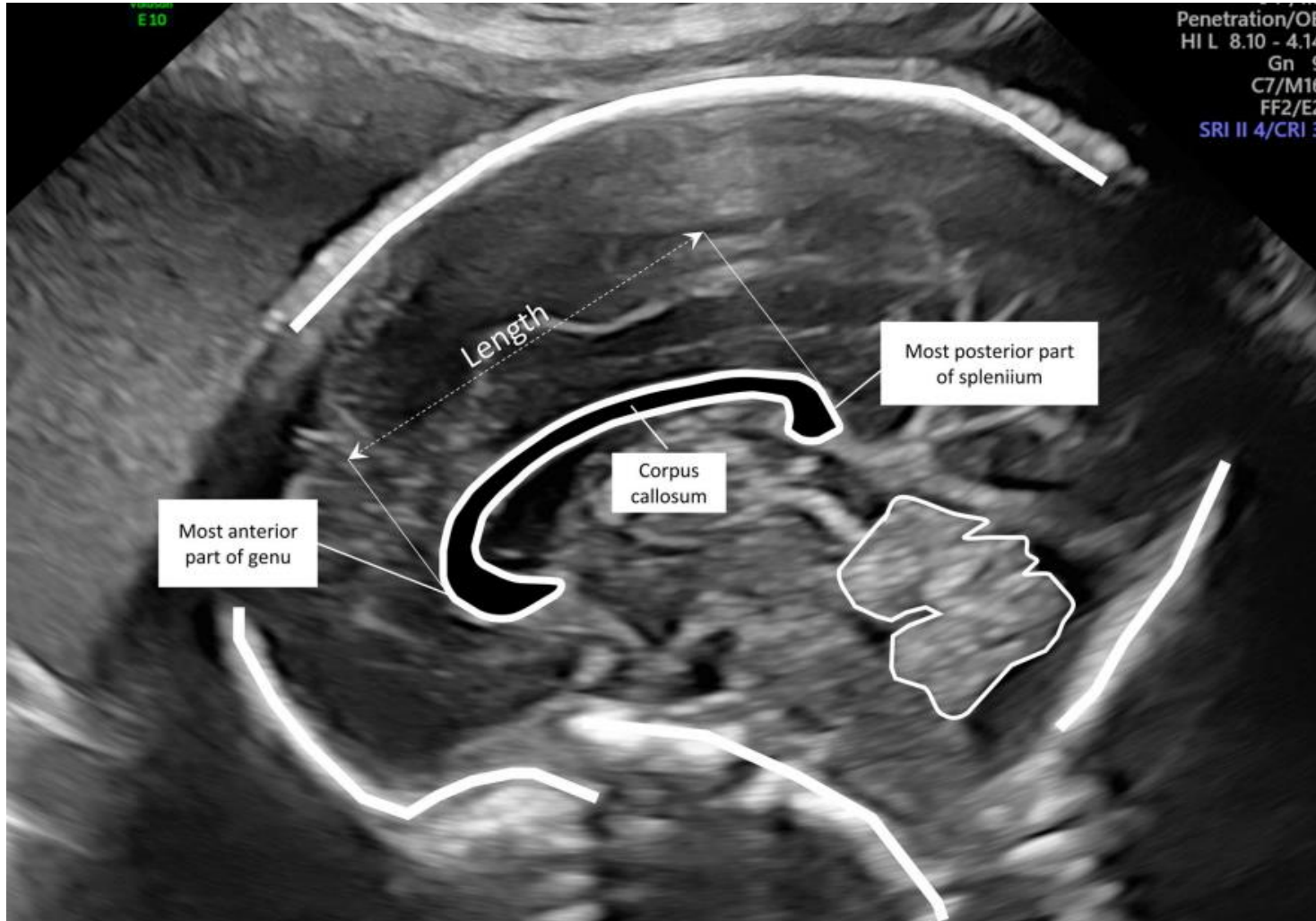


# Corpus callosum



# Normwerte für Corpus callosum und Cavum septi pellucidi:

Meta-Analyse Rosenbloom et al, 2021



# Rosenbloom, 2021: Meta-Analyse 2D Studien

**Table 4.** Corpus Callosum Length Across Gestation (mm) From Random-Effects Meta-analysis: 2-Dimensional Studies

Gestational Age (Week)	Author																Total N	Mean	Lower Bound 95% CI	Upper Bound 95% CI	I-Squared	P (Heterogeneity)								
	Goldstein				Zhang				Cignini				Achiron										Tsur							
	n	Mean	SD	Weight	n	Mean	SD	Weight	n	Mean	SD	Weight	n	Mean	SD	Weight							n	Mean	SD	Weight				
16					14	9.4	2.34	49.5%									4	3.75	0.50	50.4%					18	6.55	1.01	12.08	98.6%	<.01
17					15	12	2.71	49.8%					8	6.24	1.75	50.2%					23	9.11	3.47	14.76	97.4%	<.01				
18					11	14	2.68	58.3%					7	12.51	2.68	41.7%					18	13.38	11.94	14.82	24.5%	.25				
19					18	16.6	1.81	62.8%	7	18.78	13.33	0.5%	21	15.78	2.55	36.8%					46	16.31	15.65	16.97	0.0%	.45				
20					20	18.7	2.14	30.9%	75	21.02	1.43	36.4%	21	20.38	1.80	32.7%					116	20.09	18.83	21.35	90.9%	<.01				
21	15	22.5	2.1	22.1%	21	22.2	2.64	21.7%	1002	23.2	1.54	25.5%	21	20.38	1.86	23.5%	35	23.30	13.04	7.23%	1094	22.17	20.80	23.55	92.3%	<.01				
22	21	26.1	2.4	20.6%	26	23.9	2.60	20.8%	1322	25.3	1.65	23.4%	18	22.39	1.72	21.7%	54	25.62	8.97	13.51%	1441	24.59	23.24	25.94	93.4%	<.01				
23	44	27.7	2	24.7%	33	25.6	2.68	22.2%	217	27.3	1.76	26.5%	22	24.45	2.85	19.7%	27	26.02	8.97	6.85%	343	26.37	25.35	27.40	89.0%	<.01				
24	43	29.1	1.8	22.7%	25	26	2.18	21.5%	31	29.2	1.86	22.3%	18	27.61	2.59	19.8%	4	30.00	2.35	13.82%	121	28.30	26.96	29.63	91.4%	<.01				
25	25	31.2	0.2	23.9%	30	29	2.41	18.6%	34	31.1	1.97	20.5%	23	29.65	2.29	17.9%	4	31.57	0.83	19.07%	116	30.56	29.77	31.35	88.9%	<.01				
26	17	33.6	2.1	24.8%	30	31.8	2.54	26.4%	26	32.8	2.08	28.4%	18	31.44	3.09	18.3%	4	31.20	5.66	2.19%	95	32.46	31.61	33.30	59.3%	.04				
27					35	33.8	2.62	37.4%	29	34.5	2.18	44.4%	12	34.33	2.49	14.3%	6	32.28	3.38	3.93%	82	34.11	33.57	34.64	1.5%	.39				
28					25	34.6	3.03	34.1%	24	36.0	2.29	45.0%	9	34.44	2.79	18.8%	7	35.50	8.26	2.09%	65	35.21	34.31	36.10	29.3%	.24				
29					36	35.5	3.84	29.6%	33	37.4	2.4	39.0%	10	36.4	3.06	19.2%	8	36.95	3.78	12.28%	87	36.58	35.53	37.64	51.8%	.10				
30					29	37.7	3.68	19.6%	33	38.7	2.51	48.0%	12	38.33	1.87	31.4%	28	38.01	15.87	1.02%	102	38.37	37.78	38.97	0.0%	.69				
31					17	36.5	0.97	30.3%	43	39.9	2.61	29.4%	10	37.3	1.57	28.7%	23	39.21	11.09	11.71%	93	38.03	36.06	40.00	94.3%	<.01				
32					28	38.5	2.45	34.4%	38	40.9	2.72	34.8%	7	40.43	2.23	27.5%	21	37.50	19.78	3.30%	94	39.83	38.22	41.44	79.8%	<.01				
33					30	38.2	2.95	32.5%	20	41.8	2.83	31.8%	4	38.5	4.44	17.0%	7	41.57	5.31	18.69%	61	40.03	37.51	42.54	85.0%	<.01				
34					12	39.8	3.23	22.9%	6	42.6	2.94	17.3%	6	42.5	1.05	37.1%	6	41.88	2.30	22.68%	30	41.75	40.50	43.00	58.1%	.07				
35					27	42.6	4.04	64.9%	4	43.2	3.04	17.0%	5	45.6	3.85	13.3%	7	43.17	7.59	4.79%	43	43.13	41.90	44.36	0.0%	.47				
36					14	44.7	3.98	3.26%	3	43.66	3.15	1.1%	2	44	0.28	95.4%	11	41.34	15.05	0.18%	30	44.01	43.64	44.39	0.0%	.85				
37					12	45	4.09	11.3%	3	43.98	3.26	44.5%	3	44.67	0.87	62.1%	3	43.10	1.46	22.18%	21	44.33	43.55	45.11	0.0%	.40				
38					25	44.2	2.54	100%													25	44.20	43.20	45.20	—	—				
39					16	43.2	2.67	100%													16	43.20	41.89	44.51	—	—				

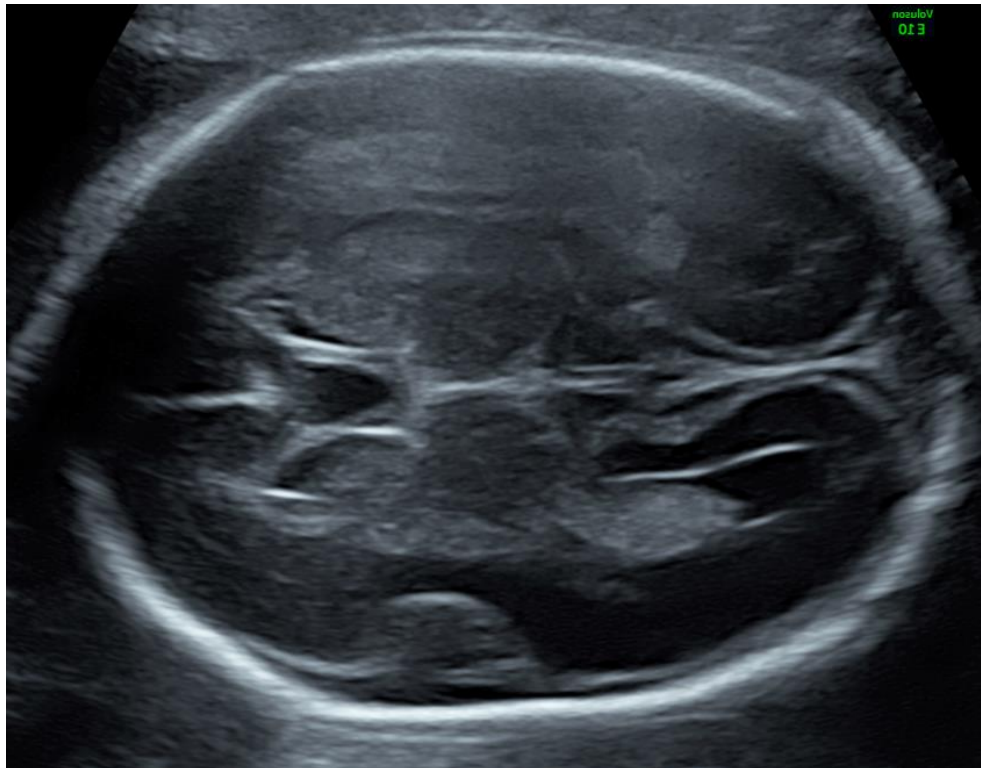


# Rosenbloom, 2021: Meta-Analyse 3D Studien

**Table 5.** Corpus Callosum Length Across Gestation (mm) from Random-Effects Meta-analysis: 3-Dimensional Studies

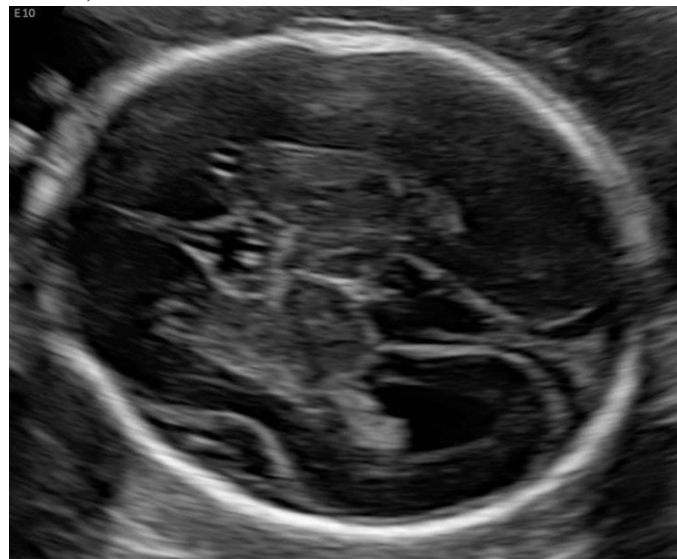
Gestational Age (Week)	Author												Total N	Mean	Lower Bound 95% CI	Upper Bound 95% CI	I-Squared	P (Heterogeneity)					
	Araujo				Miguelote				Rizzo														
n	Mean	SD	Weight	n	Mean	SD	Weight	N	Mean	SD	Weight	N	Mean	SD	Weight								
18								22	24.05	2.31	100%	22	24.05	2.31	100%	22	24.05	2.31	100%	23.08	25.02	—	—
19								35	24.42	3.20	100%	35	24.42	3.20	100%	35	24.42	3.20	100%	23.36	25.48	—	—
20	23	18.49	2.59	50.0%				33	26.40	3.00	50.0%	56	22.45	2.59	50.0%	56	22.45	2.59	50.0%	14.69	30.20	99.1%	<.001
21	23	20.81	2.59	50.1%				24	27.73	2.87	49.9%	47	24.27	2.59	49.9%	47	24.27	2.59	49.9%	17.49	31.04	98.7%	<.001
22	25	23.02	2.59	50.7%				20	28.49	3.66	49.3%	45	25.72	2.59	49.3%	45	25.72	2.59	49.3%	20.36	31.08	96.9%	<.001
23	24	25.11	2.59	37.3%	22	26.09	1.62	43.7%	20	28.33	5.14	19.0%	66	26.15	2.59	19.0%	66	26.15	2.59	24.90	27.40	71.2%	.031
24	22	27.08	2.59	30.6%	14	28.46	1.07	45.9%	25	28.10	3.55	23.5%	61	27.95	2.59	23.5%	61	27.95	2.59	27.07	28.84	59.4%	.085
25	16	28.94	2.59	28.0%	10	29.52	1.44	50.5%	23	30.44	3.59	21.6%	49	29.56	2.59	21.6%	49	29.56	2.59	28.42	30.27	13.1%	.316
26	16	30.68	2.59	48.5%				25	33.20	2.40	51.5%	41	31.98	2.59	51.5%	41	31.98	2.59	29.51	34.45	89.8%	.002	
27	18	32.31	2.59	30.3%	23	33.7	1.36	45.0%	24	34.41	3.72	24.7%	44	33.45	2.59	24.7%	44	33.45	2.59	32.43	34.48	64.9%	.058
28	21	33.82	2.59	29.4%	22	35.11	0.98	37.9%	23	36.43	2.11	32.7%	66	35.16	2.59	32.7%	66	35.16	2.59	33.99	36.34	85.7	.001S
29	22	35.21	2.59	49.4%				23	37.26	2.44	50.6%	45	36.25	2.59	50.6%	45	36.25	2.59	34.24	38.25	86.6%	.006	
30	23	36.49	2.59	57.9%				25	36.98	3.17	42.1%	48	36.65	2.59	42.1%	48	36.65	2.59	35.89	37.50	0.0%	.559	
31	21	37.65	2.59	25.9%	22	37.48	1.71	56.4%	32	36.43	3.91	17.7%	75	37.34	2.59	17.7%	75	37.34	2.59	36.75	37.92	8.1%	.337
32	21	38.69	2.59	79.7%	17	38.38	1.28	23.3%				38	38.45	2.59	23.3%	38	38.45	2.59	37.92	38.99	0.0%	.631	
33	18	39.62	2.59	100.0%								18	39.62	2.59	100.0%	18	39.62	2.59	38.42	40.82	—	—	

# Cavum septi pellucidi (CSP)



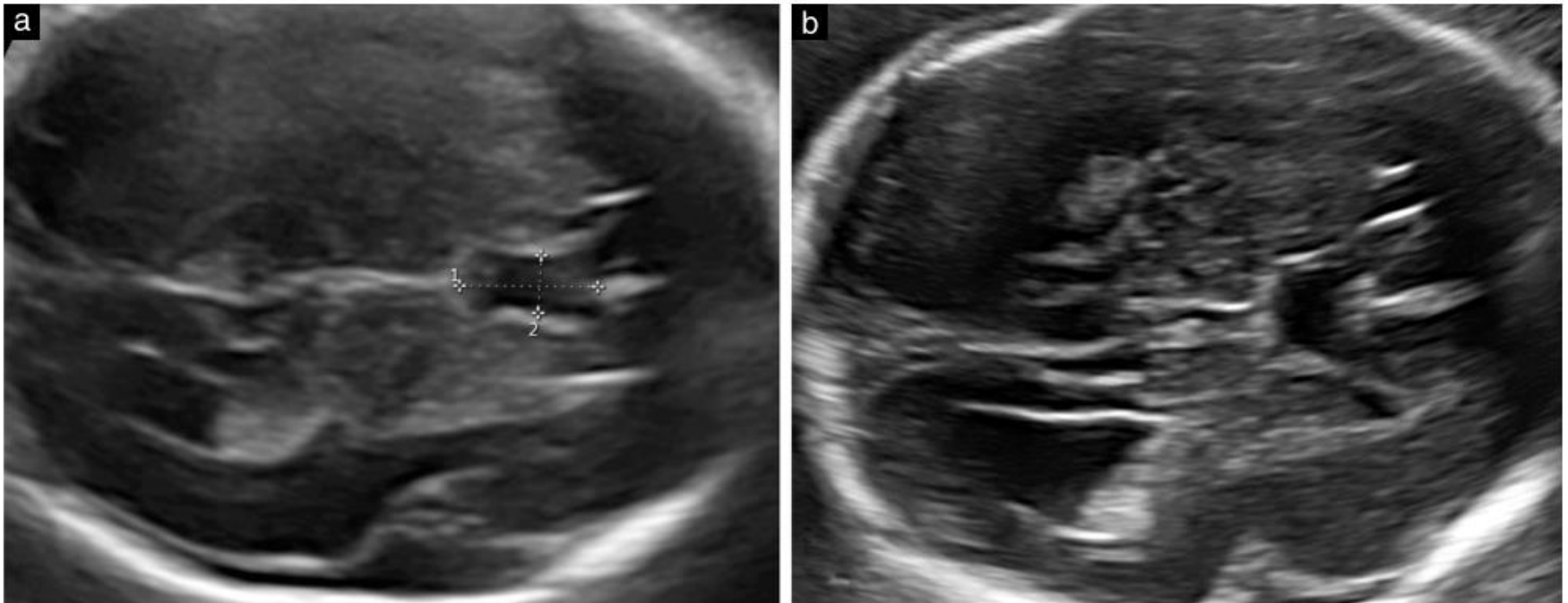
# Cavum septi pellucidi (CSP)

- Cavum septi pellucidi: sollte zwischen 17 – 20 and 37 SSW darstellbar sein
- Fehlende Darstellbarkeit des CSP assoziiert mit Fehlbildungen der Mittellinienstrukturen (Corpus callosum Agenesie)
- Bei Nicht-Darstellbarkeit des CSP bzw des Septum pellucidum: Holoprosencephalie, schwerer Hydrocephalus, septo-optische Dysplasie
- Abnorme Form: partielle ACC, Trisomie 18, 22q11



# Cavum septi pellucidi ratio als Marker für partielle ACC (Karl et al, 2017)

- CSP Länge zu Weite Ratio  $<1,5$  in 80%



# Agnesie des Corpus callosum(ACC)

**AI** 21+4 SSW, fehlendes Cavum septi pellucidi (CSP), normale Ventrikelweite

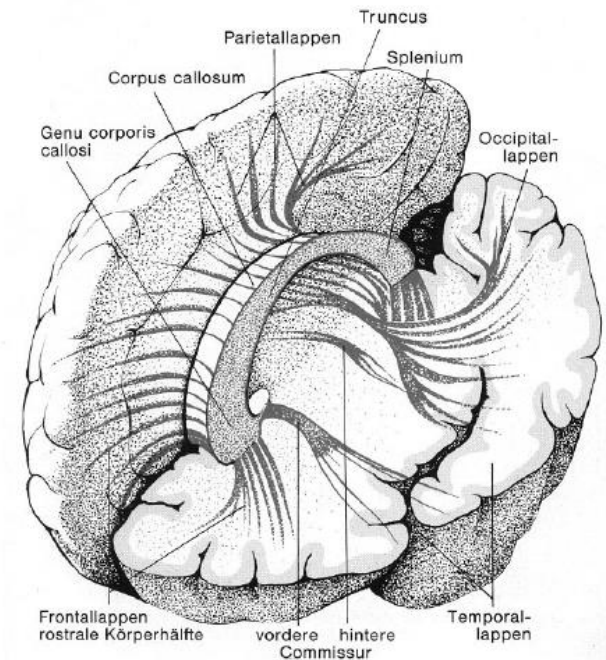
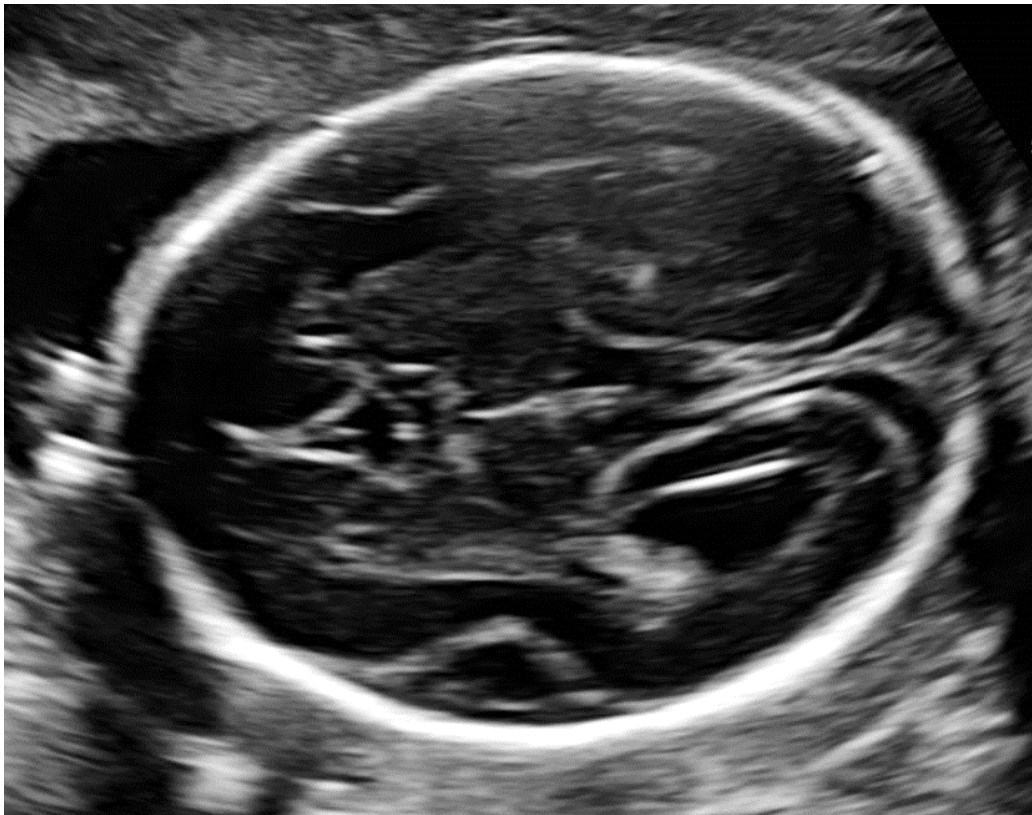
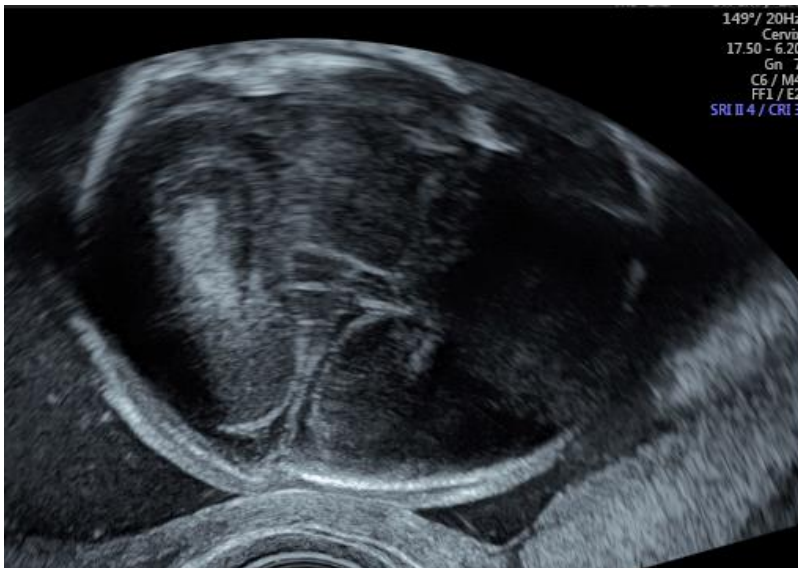
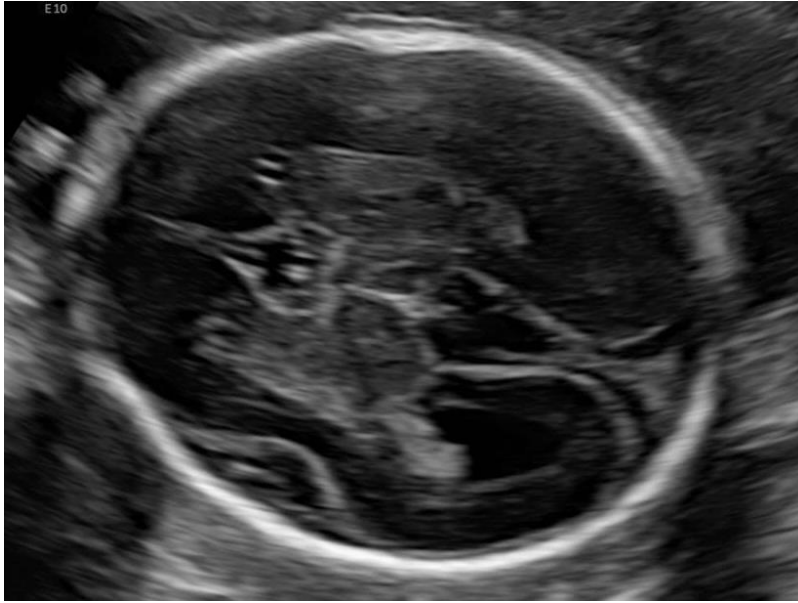


Abbildung 3: das Corpus Callosum und seine Bestandteile

Quelle: [http://www.neuro.psychologie.uni-saarland.de/downloads/06/VL6\\_14\\_6\\_06.pdf](http://www.neuro.psychologie.uni-saarland.de/downloads/06/VL6_14_6_06.pdf)

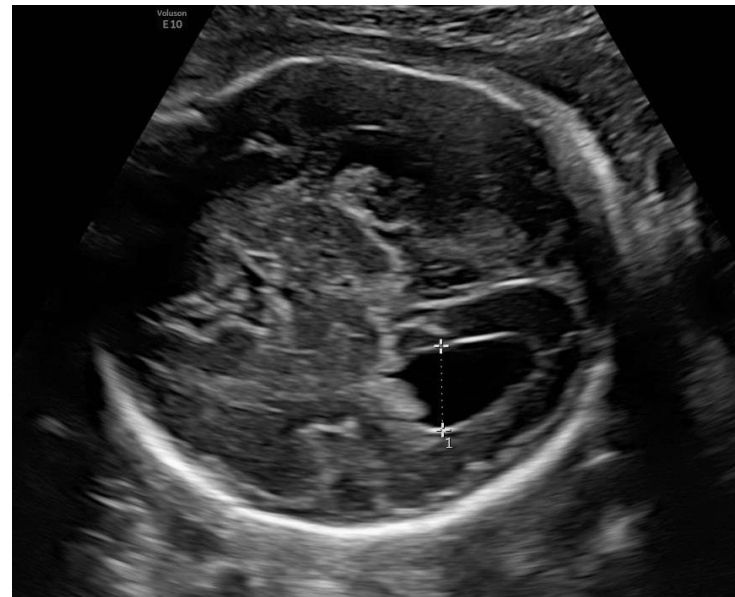
# Agnesie des Corpus callosum

**AI** 21+4 SSW



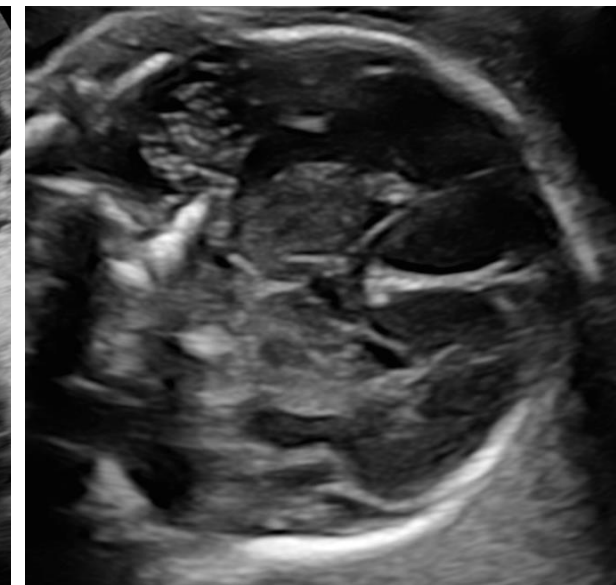
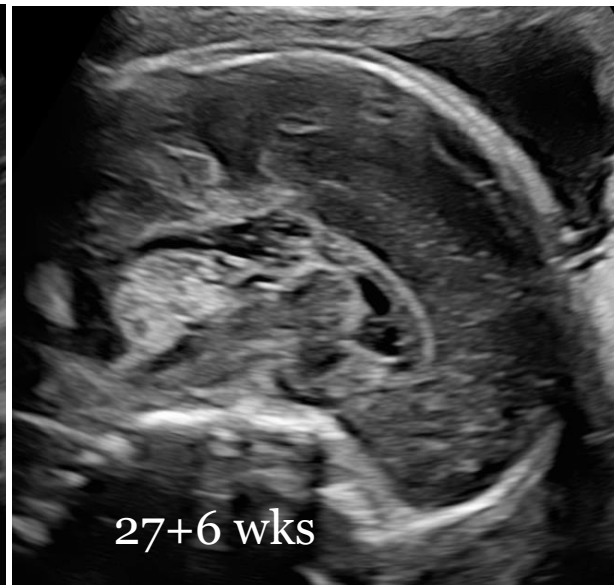
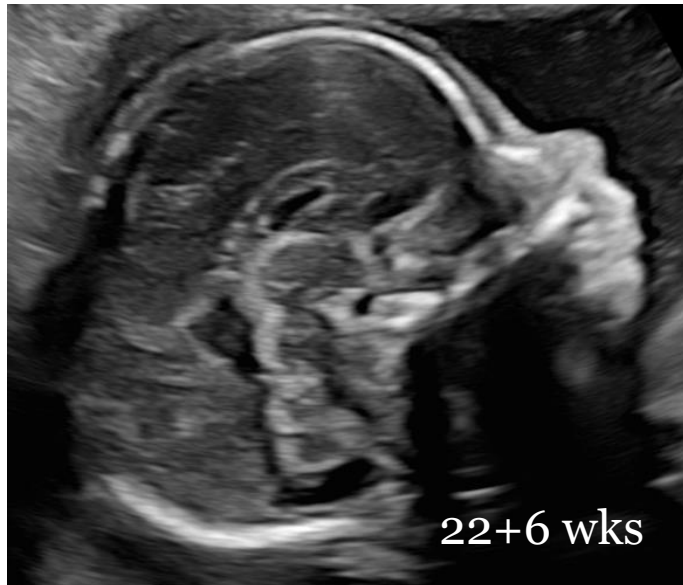
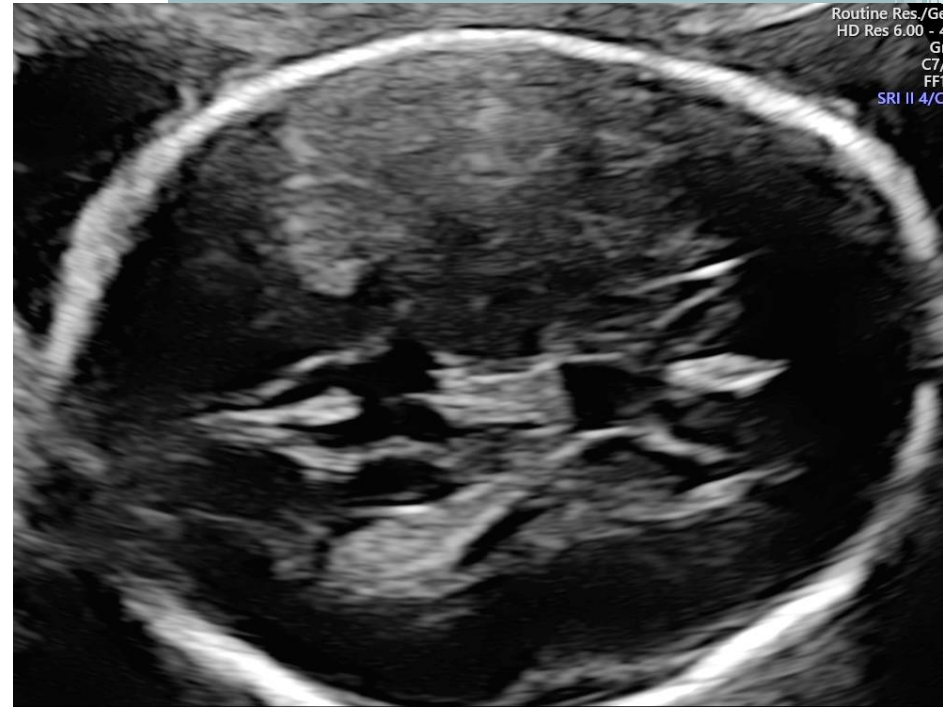
**AI** 25+5 and 28+5 wks

- MRI 25+5 SSW: ACC, Kolpocephaly (tear drop shape der Hinterhörner), abnorme Gyrierung
- US 28+5 SSW: Kolpocephaly 13 mm
- Neuropädiatrisches Konsil: keine weitere (genetische) Evaluierung gewünscht



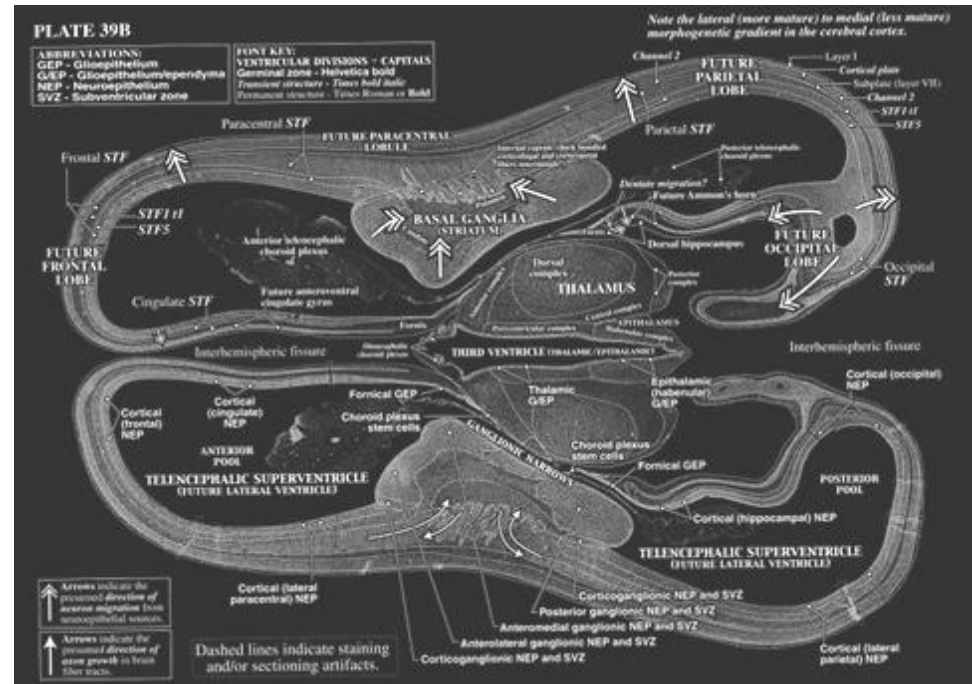
# Partielle ACC

**UMM:** 22+6 and 27+6 SSW

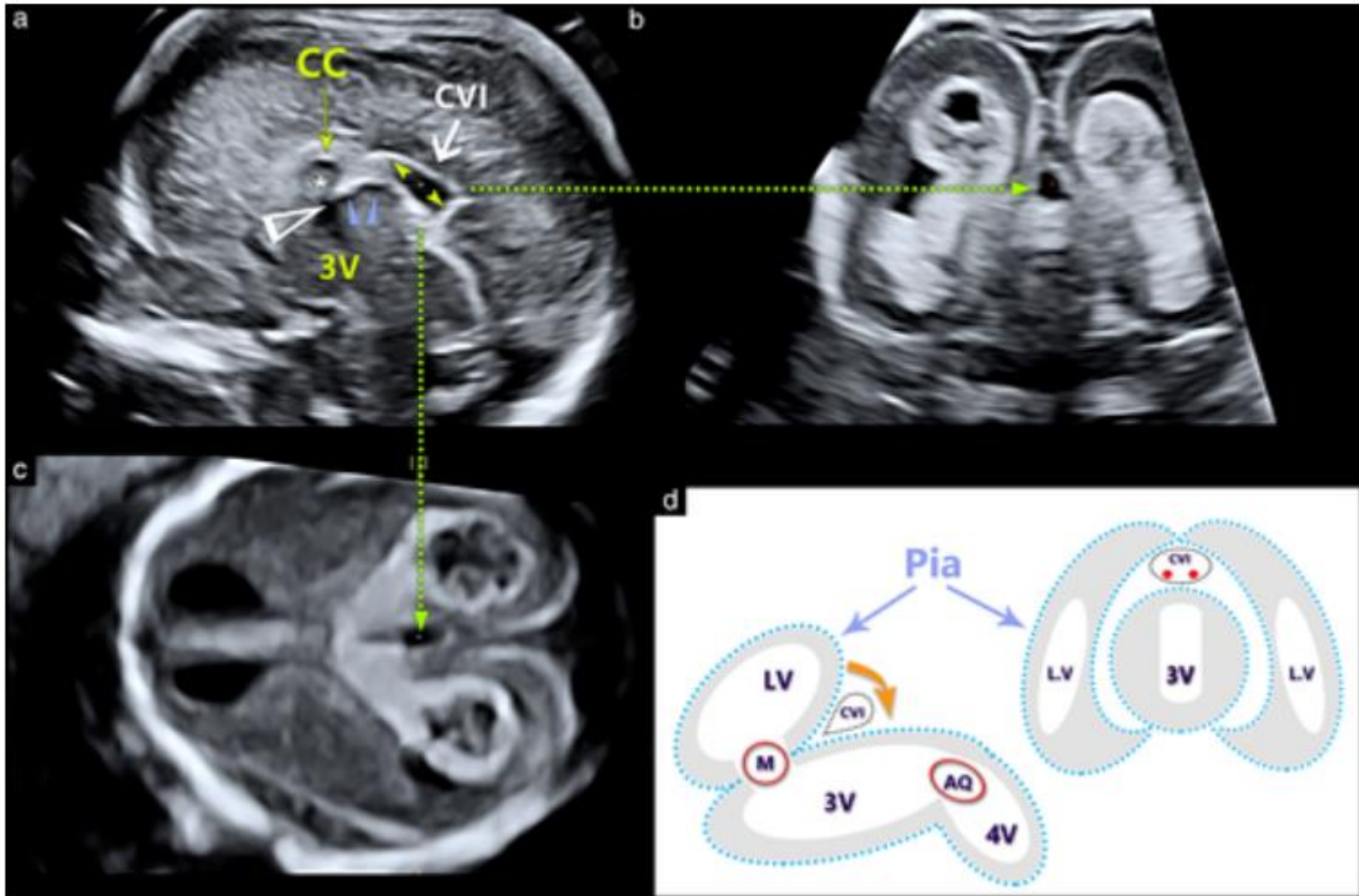




# Ersttrimester: CSP oder 3. Ventrikel oder.....??



# Cavum veli interpositi (Birnbaum et al, 2021)

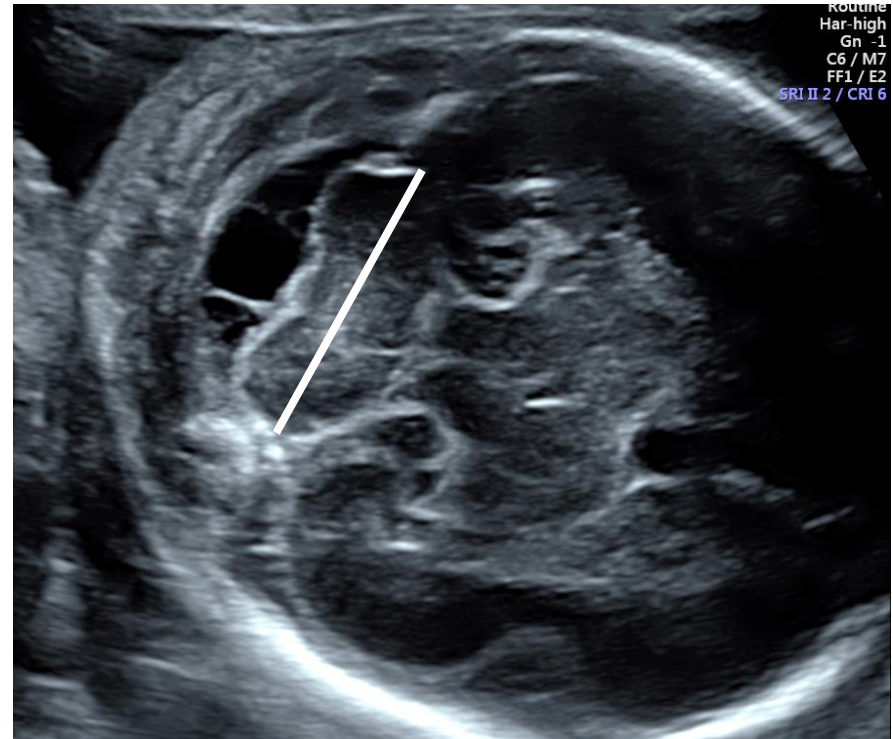


# Cerebellum: Biometrie



# Cerebellum (und Cisterna magna)

- Messung des transversalen Durchmessers des Cerebellums (TCD): Goldstein 1987, Snijders 1994, Vinkesteyn 2000, Verburg 2008, Sherer 2007, Chavez 2003, Hill 1990 and 1994
- Messung außen-außen, Cerebellum symmetrisch, Pedunculi cerebri sichtbar Verburg 2008



# Quality scores für die Messung des transcerebellären Durchmessers (TCD) (Donadono et al, 2021)

Table 2. Comparison of centiles value.

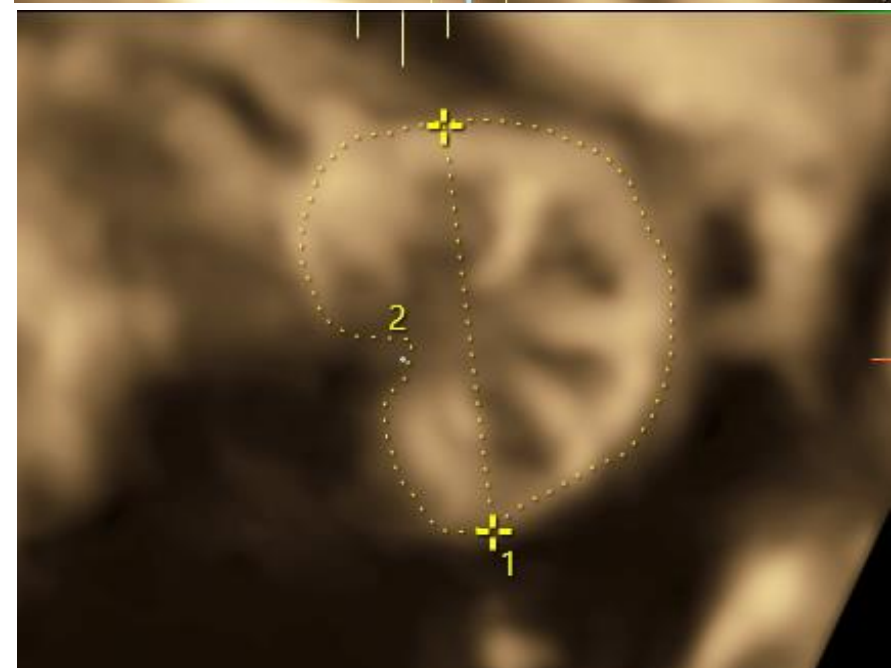
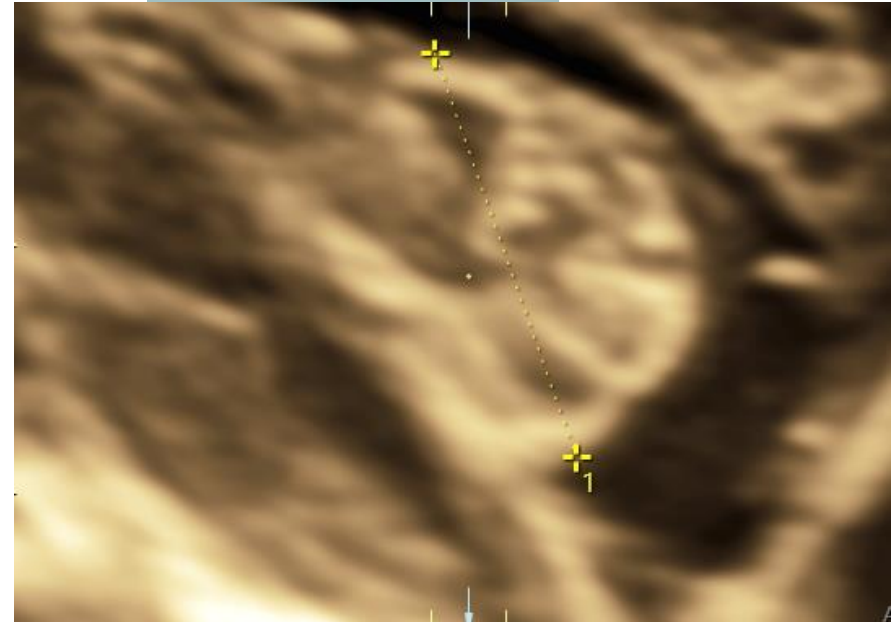
Study	GA Included	20 Weeks					28 Weeks				32 Weeks			
		Score	Centile			SD	Centile			SD	Centile			SD
			5	50	95		5	50	95		5	50	95	
<b>TCD studies</b>														
Rodriguez-Sibaja [39] 2020	14-42	25	19	20.5	21.9	0.87	30.3	32.9	35.5	1.57	37.3	40.8	44.2	2.11
Verburg [47] 2008	16-36	17	18.6	20.3	22.0	1.03	30.3	33.0	35.7	1.64	37.8	41.0	44.2	1.95
Koning [31] 2017	9-32	16	19.1	20.8	22.4		32.9	34.6	36.2		40.8	42.4	44.1	
Araujo Junior [12] 2015	18-24	14	17.9	19.9	22.8									
Chavez [16] 2003	14-38	12	17.7	20.4	23.0	0.20	28.2	32.4	36.6	0.35	34.4	39.5	44.7	0.46
Smith [42] 1986	14-32	12	18.8	20.5	22.1		29.4	31.0	32.6		34.6	36.3	37.9	
Snijders [43] 1994	14-40	12	19.0	21.0	24.0	0.03	29.0	32.0	36.0	0.03	34.0	37.0	42.0	0.03
Chang [15] 2000	20-40	10	15.4	20.3	25.3		27.8	32.7	37.7		34.0	38.9	43.8	
Joshi [28] 2010	15-38	10	19.1	20.7	22.3		31.3	32.9	34.6		37.4	39.1	40.7	
Takano [45] 2018	14-40	10	17.9	19	20	0.6	28.6	31.2	33.7	1.6	34	37.3	40.6	2
Vinkesteijn [48] 2000	17-34	10	18.8	20.7	22.8		29.3	32.3	35.7		36.7	40.4	44.6	
Hayata [25] 2015	14-36	9	19.3	19.9	20.5	0.36	29.4	31.7	34.0	1.40	35.8	38.1	40.4	1.40
Goldstein [21] 1987	13-40	8		20.0				31.0				38.0		
Hata [24] 1989	17-40	8	19.9	21.5	23.2		31.4	33.0	34.7		37.2	38.8	40.4	
Lei [32] 1998	16-40	8	19.0	21.0	25.8		25.8	36.6	34.5		32.0	43.0	44.9	
Serhatlioglu [41] 2003	16-38	8	20.0	21.7	23.3		32.9	34.6	36.2		39.7	41.3	43.0	

# TCD cutoff?

- Es gibt in der Literatur keinen definierten Cutoff, ab dem über weitere Abklärungsschritte und Follow-up Untersuchungen beraten werden muss (Haratz, 2018)
- Attalah 2019: Outcome of fetuses with small cerebellum:
- 12344 Feten, 4% hatten TCD unter der 5. Perzentile:
  - 26% strukturelle Fehlbildungen, v.a. ZNS und Herz
  - 8% Chromosomenstörungen
  - 7% IUFD
  - Normales neurologisches Outcome in 73 bis 54%

# Vermis

- **Vermishöhe (1): maximaler sagittaler Durchmesser: Culmen – Uvula**
- Maximaler anteroposteriore Durchmesser (2): Fastigium – maximal ap Durchmesser
- **Vermis Fläche und Umfang (3)**



# Biometrie des Vermis: Vermishöhe

- Vermian height: Cignini (Plos 1 2016)
- Different biometric parameters: Vinals (UOG 2005), Zhao (Eur J Radiol 2018), Spinelli (Ultrasound Int Open 2016), Katorza (AJNR 2016), Leibovitz (UOG 2014)

**Table 2. Fetal Cerebellar Vermis Height (mm) according to gestational age.**

GA	n	M	SD	95% CI
20 <sup>+0</sup> -20 <sup>+6</sup>	636	11.27	0.58	10.69-11.85
21 <sup>+0</sup> -21 <sup>+6</sup>	4549	11.96	0.67	11.29-12.63
22 <sup>+0</sup> -22 <sup>+6</sup>	4160	12.71	0.76	11.95-13.47
23 <sup>+0</sup> -23 <sup>+6</sup>	692	13.50	0.85	12.65-14.35
24 <sup>+0</sup> -24 <sup>+6</sup>	89	14.32	0.94	13.38-15.26
25 <sup>+0</sup> -25 <sup>+6</sup>	66	15.16	1.03	14.13-16.19
26 <sup>+0</sup> -26 <sup>+6</sup>	56	16.01	1.12	14.89-17.13
27 <sup>+0</sup> -27 <sup>+6</sup>	52	16.85	1.21	15.64-18.06
28 <sup>+0</sup> -28 <sup>+6</sup>	36	17.67	1.30	16.37-18.97
29 <sup>+0</sup> -29 <sup>+6</sup>	47	18.47	1.39	17.08-19.86
30 <sup>+0</sup> -30 <sup>+6</sup>	51	19.22	1.48	17.74-20.70
31 <sup>+0</sup> -31 <sup>+6</sup>	77	19.91	1.57	18.34-21.48
32 <sup>+0</sup> -32 <sup>+6</sup>	53	20.54	1.66	18.88-22.20
33 <sup>+0</sup> -33 <sup>+6</sup>	26	21.09	1.75	19.34-22.84
34 <sup>+0</sup> -34 <sup>+6</sup>	6	21.54	1.84	19.70-23.38
35 <sup>+0</sup> -35 <sup>+6</sup>	9	21.90	1.93	19.97-23.82

GA, Week<sup>+days</sup>; n, number of fetuses; M, mean in millimeters; SD, standard deviation; CI, confidence interval.

doi:10.1371/journal.pone.0147528.t002



# Biometrie Referenzen und Vergleich 2D- und 3D-Ultrasound und MRI (Katorza 2016)

**Table 1: Median, 5th, and 95th percentiles for SI measurements**

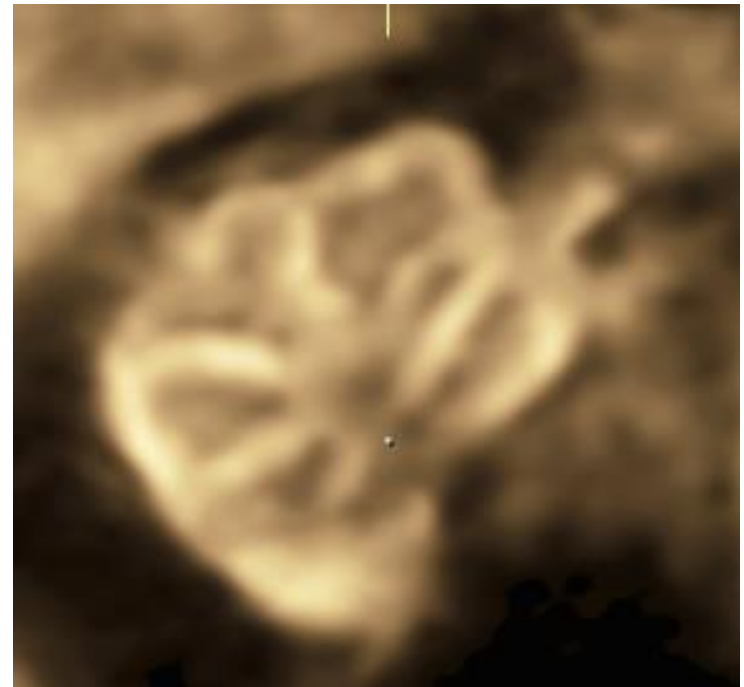
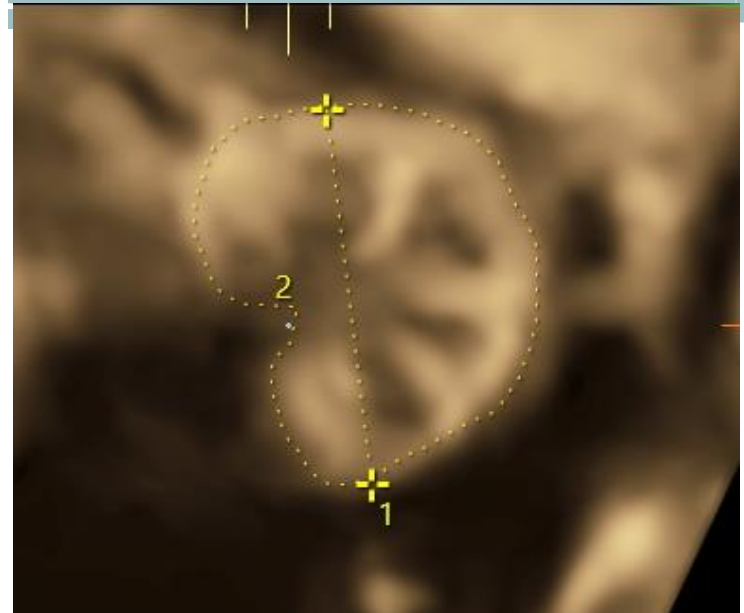
Gestational Age (wk)	Imaging Modality								
	US 2D			US 3D			MRI		
	%5	Median	%95	%5	Median	%95	%5	Median	%95
21	10.69	11.95	12.57	11.10	12.30	14.60			
22	10.42	12.72	14.40	11.50	13.60	14.90			
23	11.71	12.79	13.84	13.00	14.40	16.50			
24	13.33	13.79	14.82	13.40	15.35	17.50			
25	13.85	15.17	16.66	14.50	16.00	17.80			
26	13.75	16.09	18.45	15.60	16.80	19.50			
27	14.05	17.07	18.78	16.70	18.70	20.20	13.30	14.13	15.05
28	16.08	17.09	19.72	16.30	18.80	23.80	13.66	14.58	15.73
29	17.29	18.72	20.33	18.10	20.00	22.20	13.25	16.02	17.54
30	17.83	18.56	19.62	18.40	20.50	23.60	15.77	17.38	20.76
31	18.03	19.34	20.75	18.10	21.30	23.80	16.16	18.02	19.34
32	17.68	19.33	20.59	19.00	21.40	26.60	16.75	18.67	20.12
33	16.78	20.93	22.94	20.70	22.70	24.50	18.37	19.48	21.21
34	19.11	20.38	23.34	20.40	22.30	28.50	17.90	19.56	21.30
35	19.62	21.75	24.29	20.90	22.00	27.00	18.27	19.83	23.29

**Note:**—%5 indicates 5th percentile; %95, 95th percentile.

- **Resultat:** niedrigsten Werte MRI < 2D < 3D
- **Konklusion:** Bildgebung spezifische Referenzdaten sollten verwendet werden für Messung des Vermis

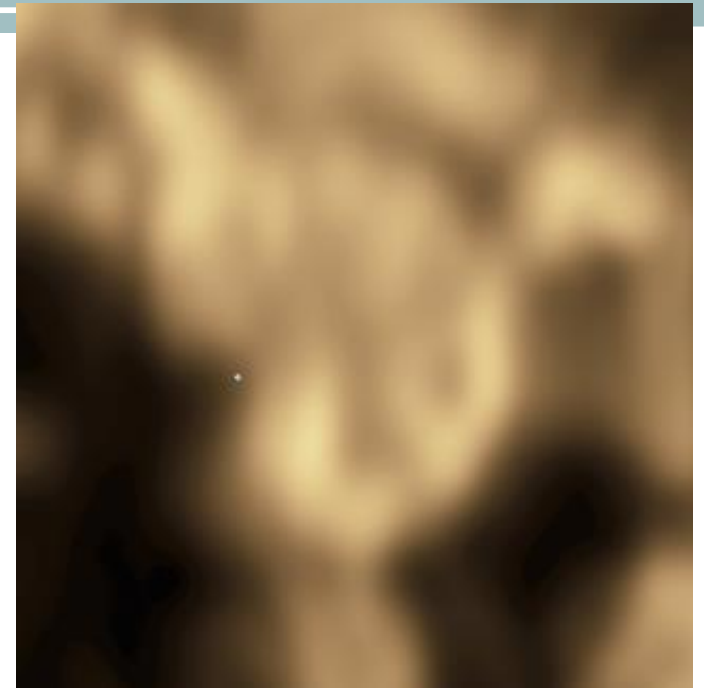
# Vermisbiometrie cutoff?

- Vermisfläche bester Marker zur Beurteilung vom Vermisfehlbildungen, gute intra- und interobserver reliability, jedoch kein Cutoff definiert (Xie et al, 2019)
- Vermisfläche bester Parameter zur Unterscheidung BPC versus DandyWalkerMalformation und Vermishypoplasie: signifikant geringere Vermisfläche (Paladini et al, 2019)
- Vermisfläche/BIP: Cutoff 1,1, gültig für die gesamte Schwangerschaft



# PB: 22+0 SSW, Organscreening

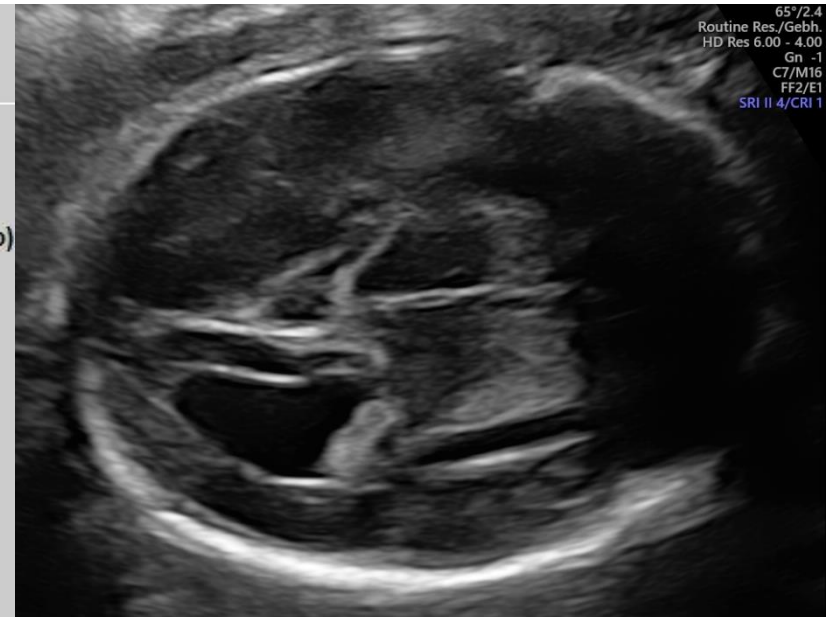
- TCD unter p5
- Vermishöhe unter p5
- Pons 8mm (mean 9mm)
- Ventrikulomegalie 11mm



## Biometrie / Anatomie

Fetus 1	Neuer Fetus		
BPD	56,7 mm	—●—	FOD
KU	201,7 mm	—●—	CM
TCD	19,5 mm	●—  —	Hinterhorn (HSVp)
TAD			AAP
AU	171,1 mm	—●—	FL
Humerus	33,5 mm	●—  —	
BPD / FOD	0,79	—●—	KU / AU
BPD / FL	1,64	—●—	
Schätzwicht	Hadlock (BPD-KU-AU-FL)		

Perzentile

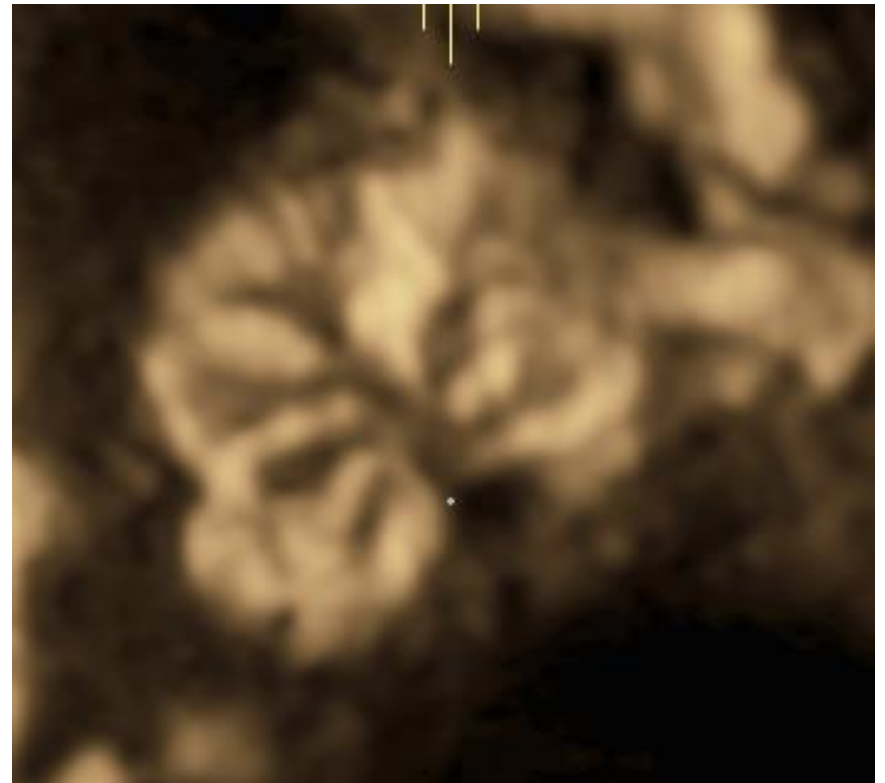


# PB 27+0 SSW

Fall PB



Kontrolle 27+3 SSW



3D: TCD unter p5, Vermishöhe an p10, Vermisfläche weit unter p5

# PB Genetik

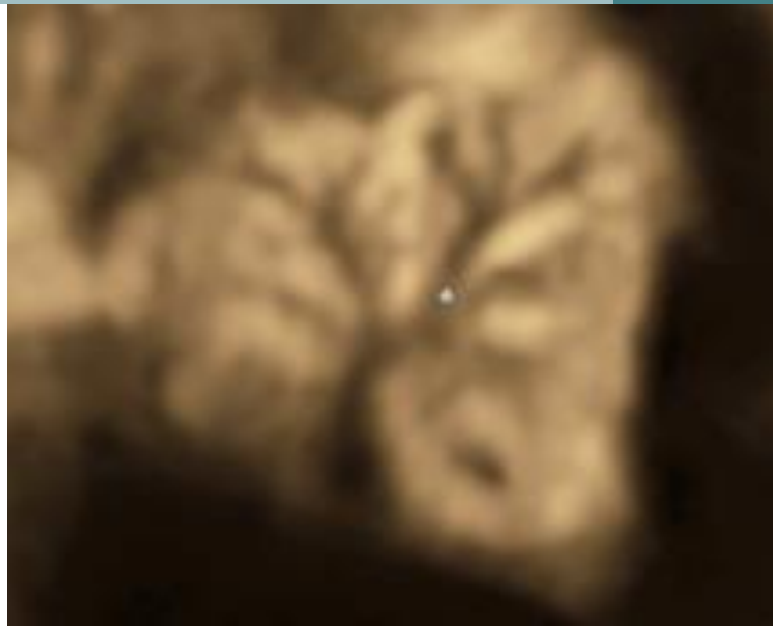
## Amniozentese

- Deletion 5p15.33-p14.1 (25,5Mb):  
Cri du chat Syndrom
- Deletion 21p11.2-q21.2 (14Mb): pathogen mit Entwicklungsverzögerungen und intellektueller Beeinträchtigung

## Zou, 2017: CNVs bei fetaler zerebellärer Hypoplasie

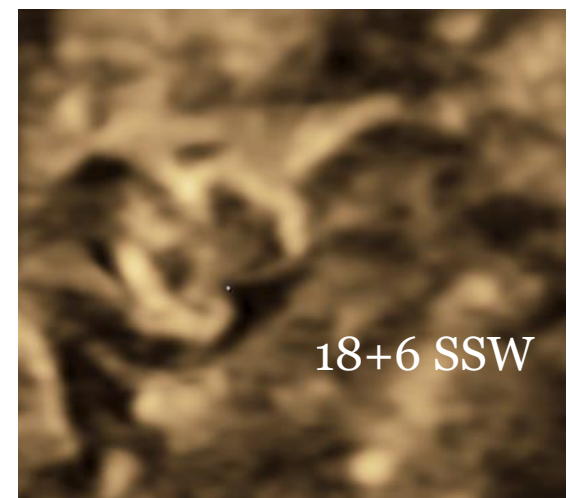
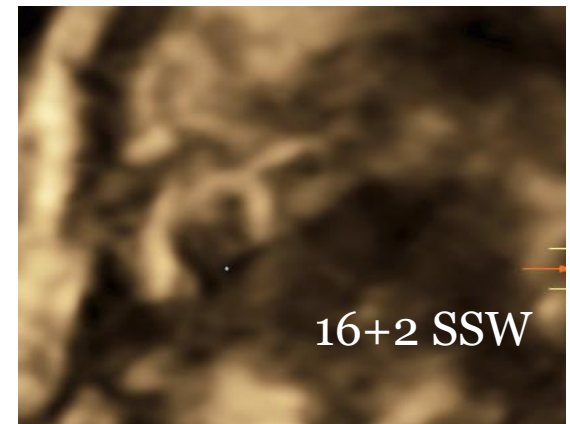
- Vermishypoplasie: 33%
- Zerebelläre Hypoplasie: 54%
- Dandy Walker: 25%
- Häufigste CNVs: deletion 5p15.33 (cri-du-chat), 6q terminal deletion und X chromosomale Aberrationen

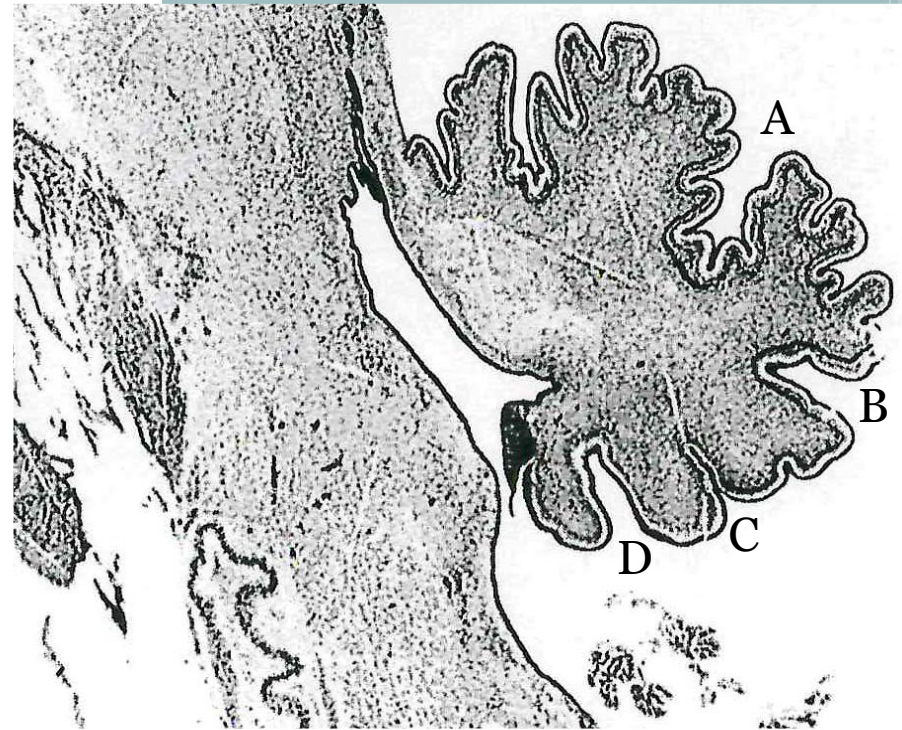
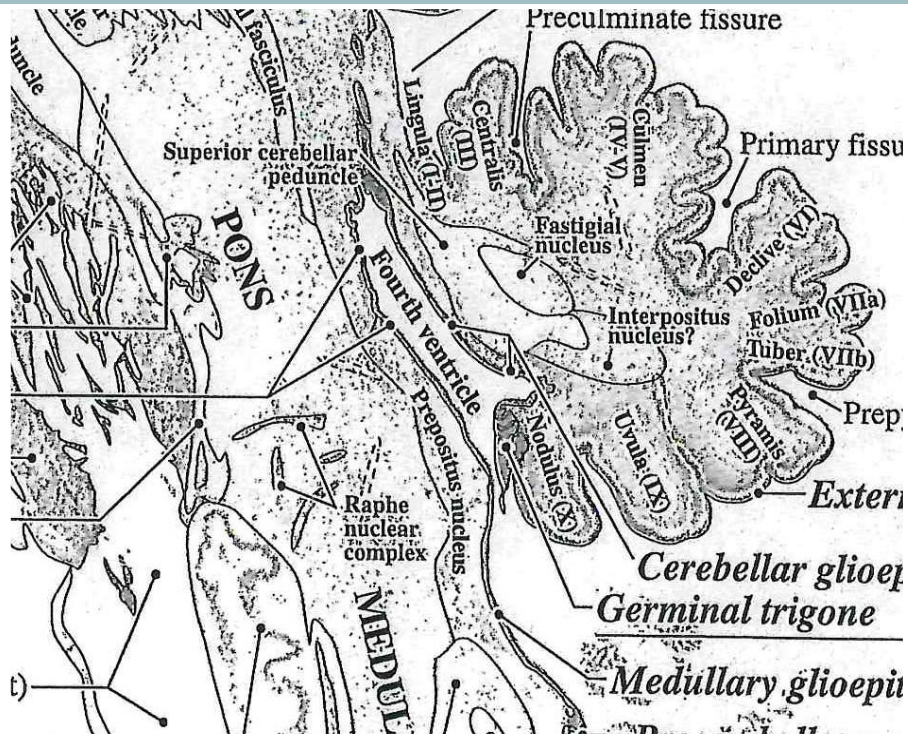
# Beurteilung der Vermisstruktur



# Zerebellum

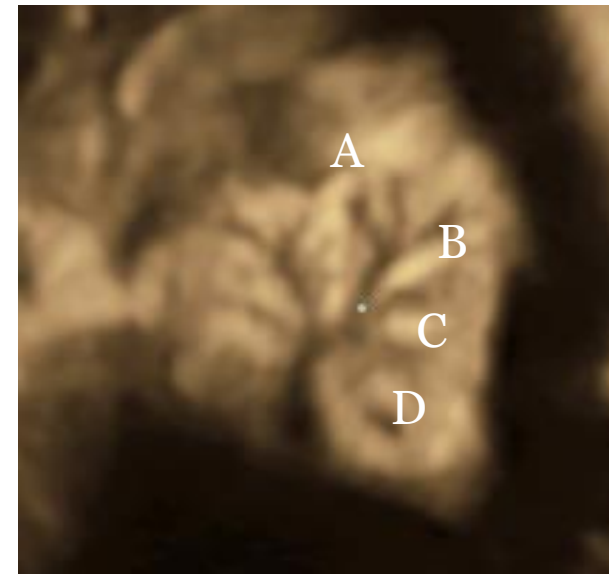
- Ab 14+0 SSW Unterteilung des Zerebellums durch Fissuren
  - **Fissuren unterteilen Lobuli im Vermis**
- Fissuren lassen sich am besten am Vermis darstellen
- Zeitspanne zwischen histologischem Erscheinen und Bildgebung ca 8 bis 9 Wochen?
- Ultraschall: Fissura prima darstellbar ab 14+0/15+0 SSW (Birnbbaum 2022)





- A Fissura prima (Culmen – Declive)
- B Präpyramidale Fissur (Tuber – Pyramis)
- C Fissura secunda (Pyramis – Uvula)
- D Posterolaterale Fissur (Uvula – Nodulus)

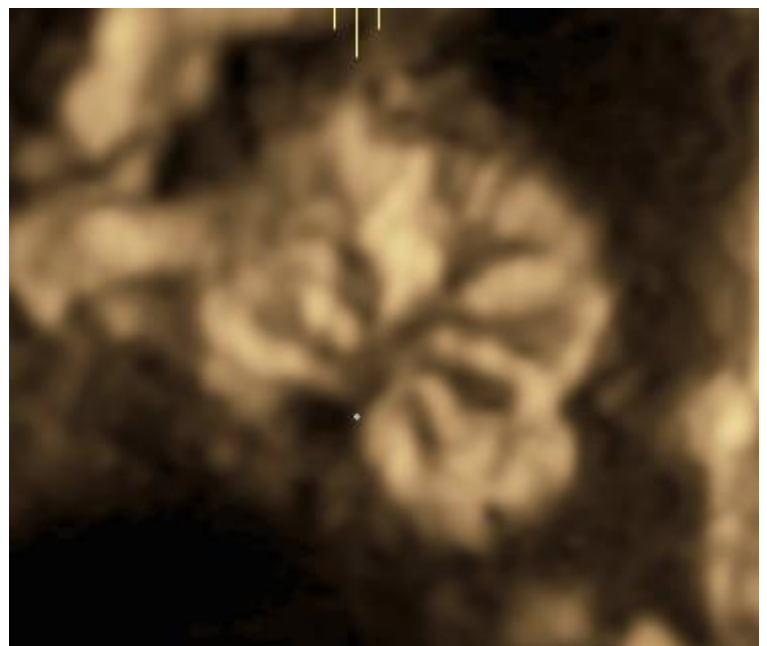
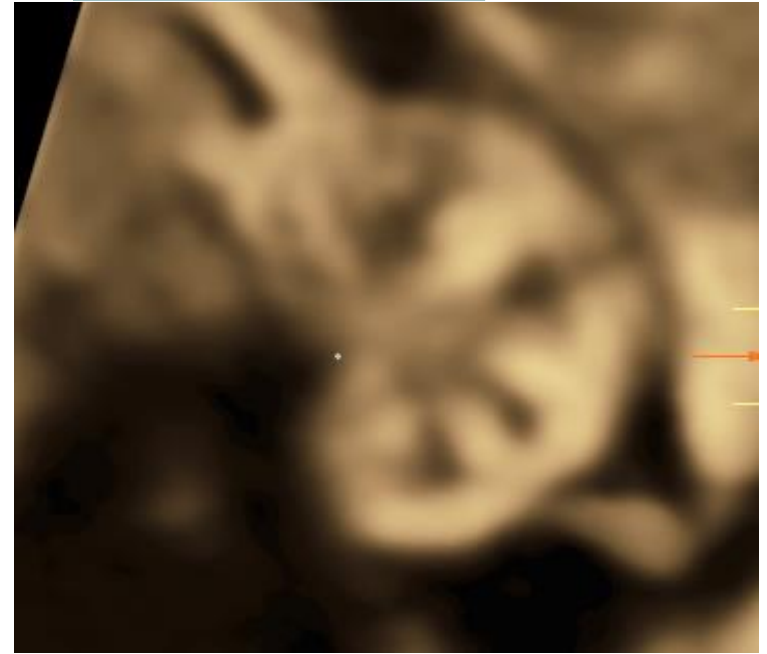
Fissuren zwischen den Lobuli sind hyperechogen,  
und das intralobuläre Parenchym hypoechogen





## Derzeitige Studie

- >200 Fälle
- 22+0 bis 38+1 SSW
- In vielen Fällen ist es möglich 5-6 Lobuli und 4 Fissuren zu unterscheiden
- Bei optimaler Bildqualität sind 7 (-9) der 9 Lobuli darstellbar



# Take Home Message

## Exakte Durchführung der Basisuntersuchung

- Head shape
- Lateral ventricles
- Cavum septi pellucidi
- Thalami
- Cerebellum
- Cisterna magna
- Spine

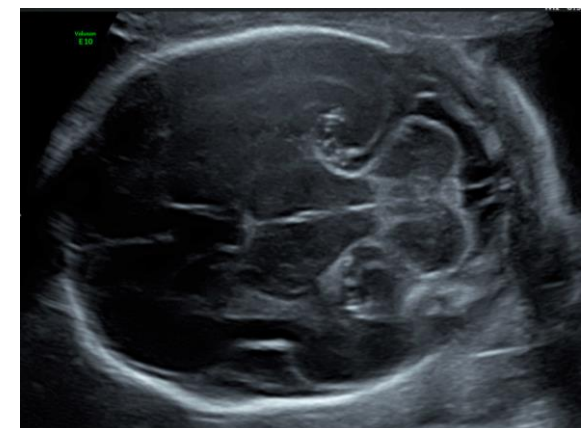
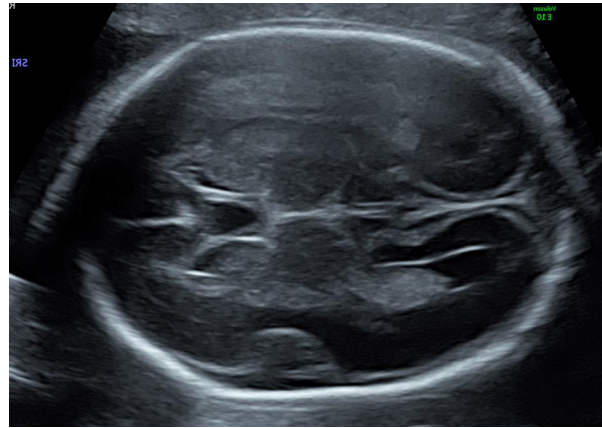
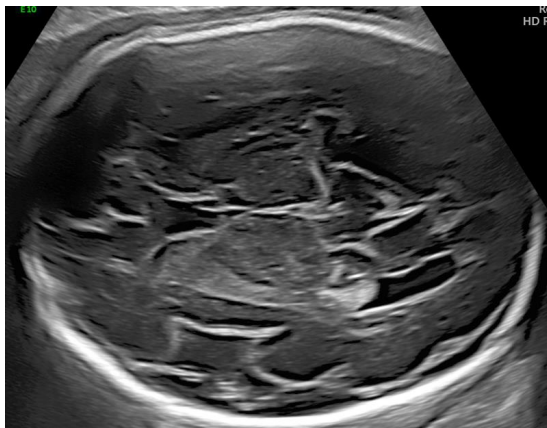
Ultrasound Obstet Gynecol 2020; 56: 476–484  
Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/uog.22145



**GUIDELINES**

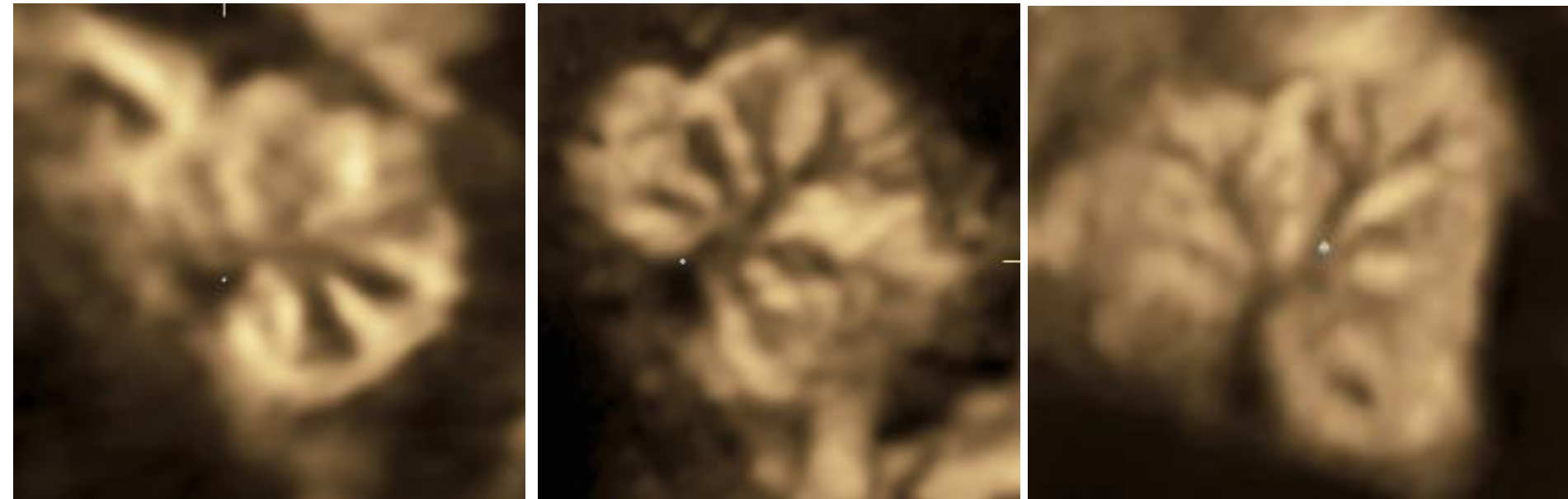
### Sylvische Fissur

(dated): sonographic examination of the fetal central nervous system. Part 1: performance of screening examination and indications for targeted neurosonography

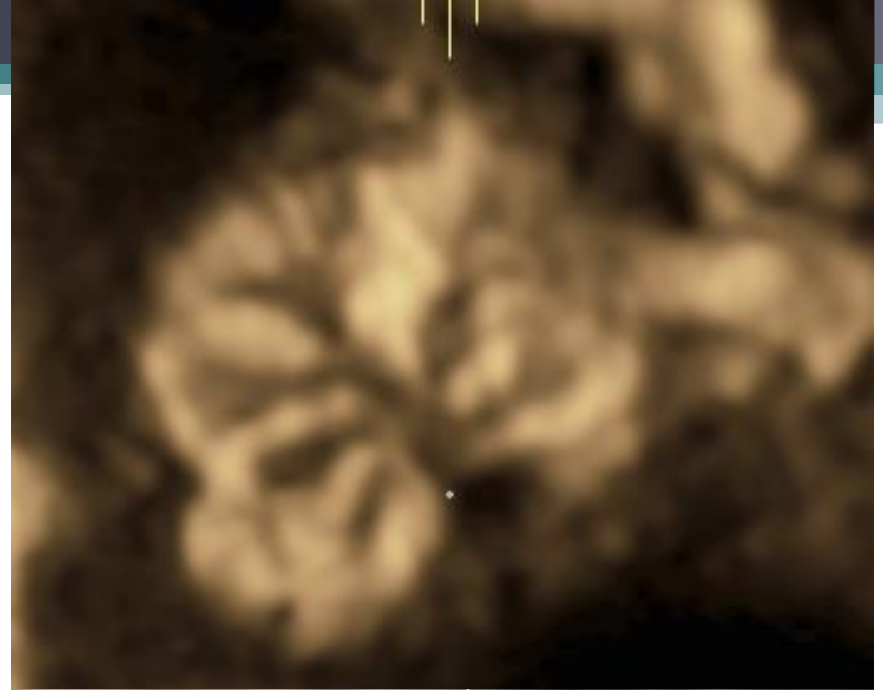
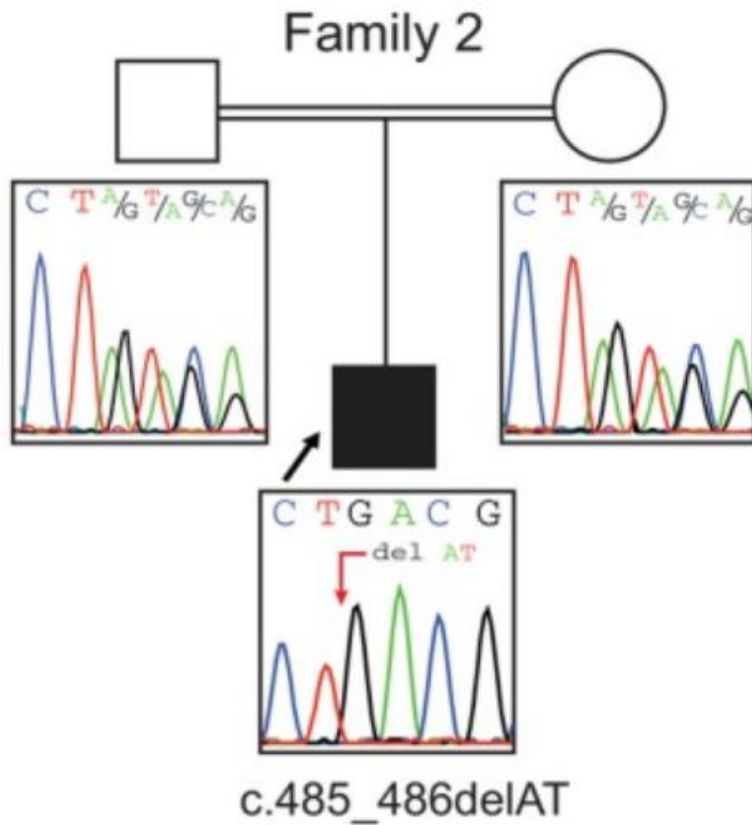


# 3D Ultraschall

- 3D ist für die Neurosonographie sehr hilfreich



# Zukunft Morphologie-Genetik



# Danke für Ihre Aufmerksamkeit!

