



Lisa McLeod HMS III

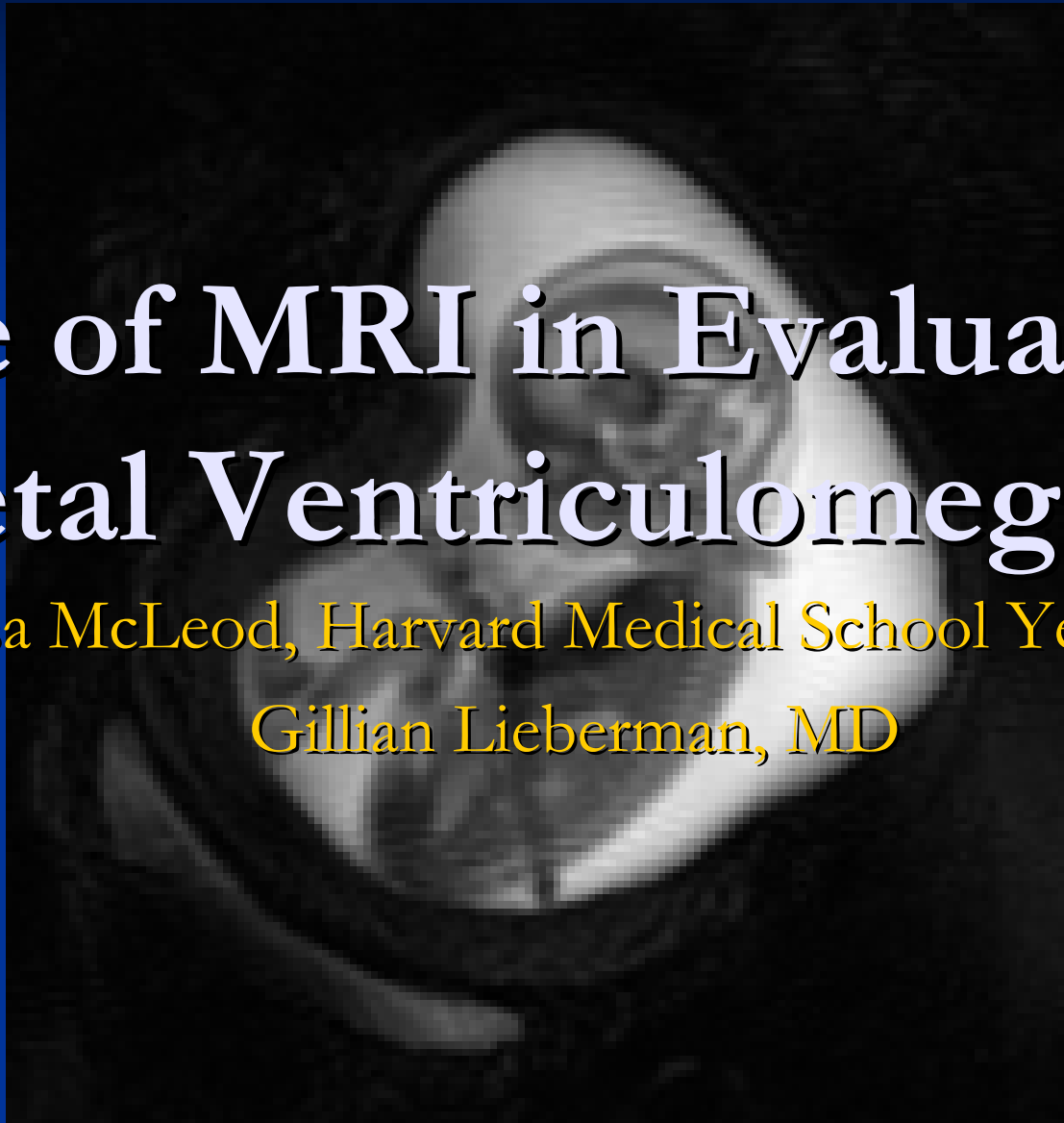
Gillian Lieberman, MD

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Use of MRI in Evaluating Fetal Ventriculomegaly

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Objectives:

- Review *basic* fetal CNS development and neuroanatomy
- Discuss DDx of ventriculomegaly documented on fetal ultrasound
- Illustrate the use of fetal MRI in differentiating these diagnoses and its impact on management
- Identify pros and cons of Ultrasound and MRI for fetal survey
- Future directions of use of fetal MRI in diagnosis of etiology of ventriculomegaly



Landmarks of fetal brain development visible by MRI

■ Glial Cell Migration

- Visible @ 22 weeks GA
- Cells migrate from ventricular periphery toward cortical ribbon
- T2 Hypointense

■ Sulcation/Ventricles

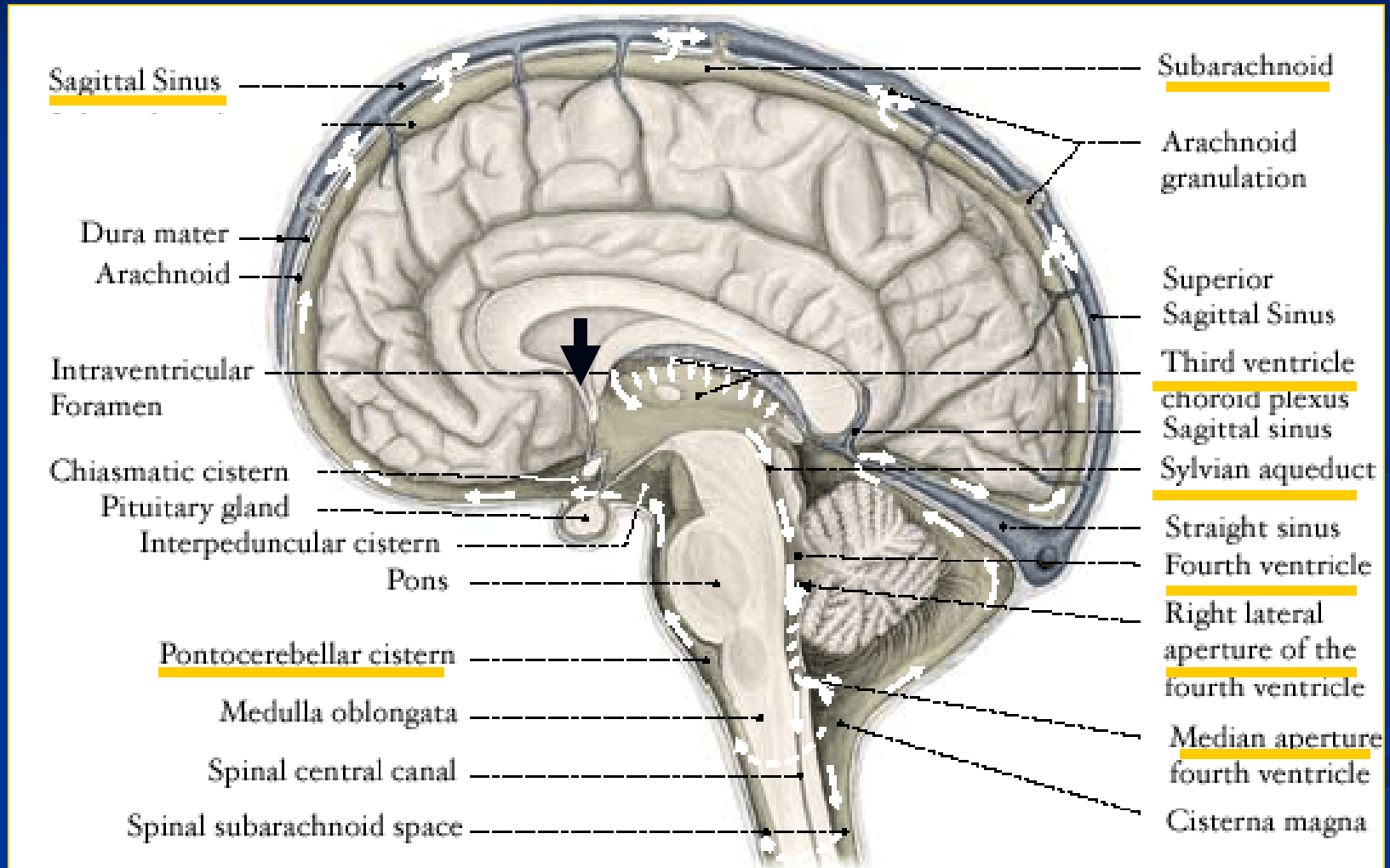
- Agyric (exc. Sylvian) until 24 weeks
- Physio Hydrocephalus resolves from 14 weeks
- Both T2 Hyperintense

■ Axonal Maturation/Myelination

- Caudal-cephalic/Dorsal-ventral
- T2 Hypointense



Ventricular CSF Circulation





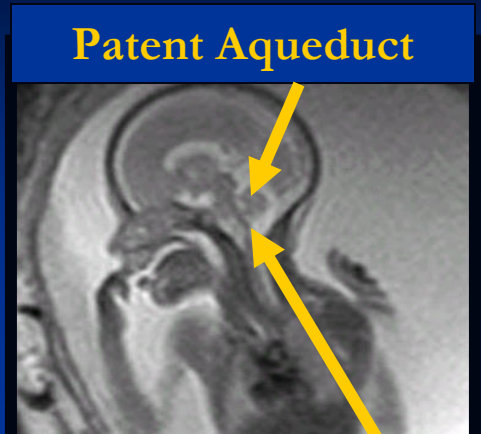
17 weeks to 23 weeks GA

- ❖ Increase sulcation (calcarine, parieto-occipital)
- ❖ Cell migration creates Intermediate layer between germinal matrix and cortical ribbon
- ❖ Reduced Ventricle size
 - ❖ Megendi & Lushka form allowing CSF flow to subarachnoid
 - ❖ Midline structures further reduce ventricle size (i.e. Corpus Call, Sept. Pallucidum)



Corpus callosum

BIDMC



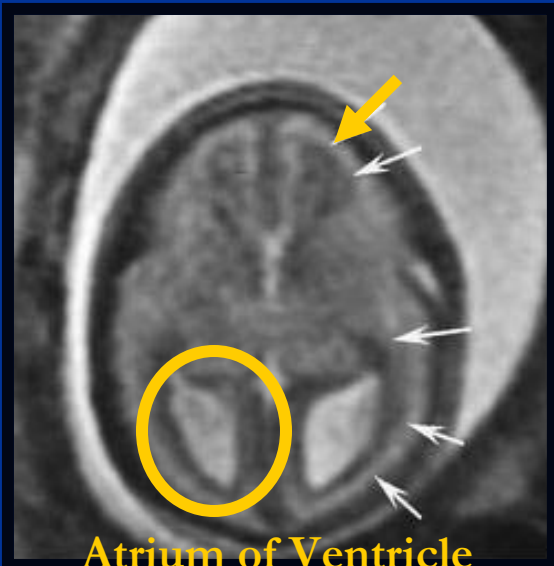
Patent Aqueduct

Brainstem Myelination

BIDMC

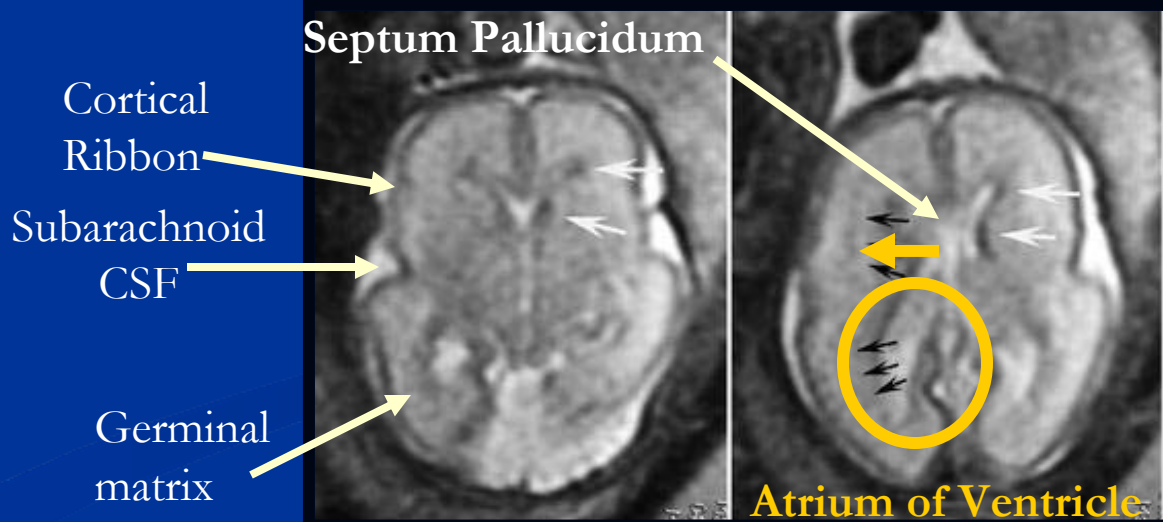
- ❖ Lower Brainstem Myelination

NL 17 Wk Fetus



Atrium of Ventricle

NL 23 Wk Fetus

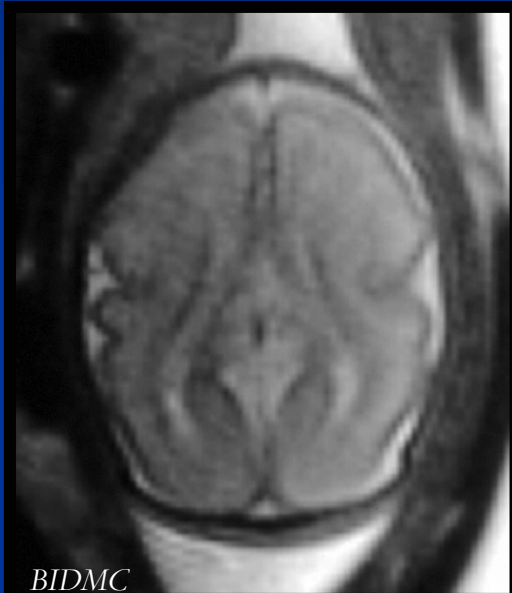


Lower images from <http://www.radnet.ucla.edu/residents/chief/residentrounds1.htm>



28 Weeks to 33 Weeks GA

NL 28Wk Fetus



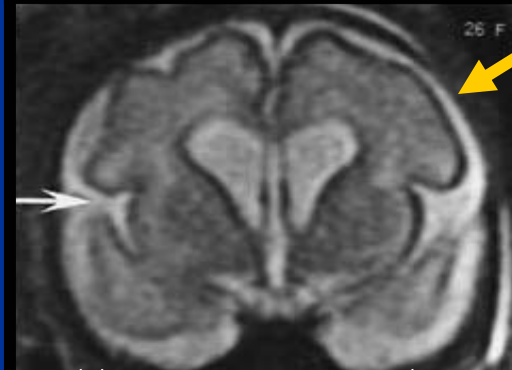
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❖ Increased Axonal Myelination of Basal Ganglia

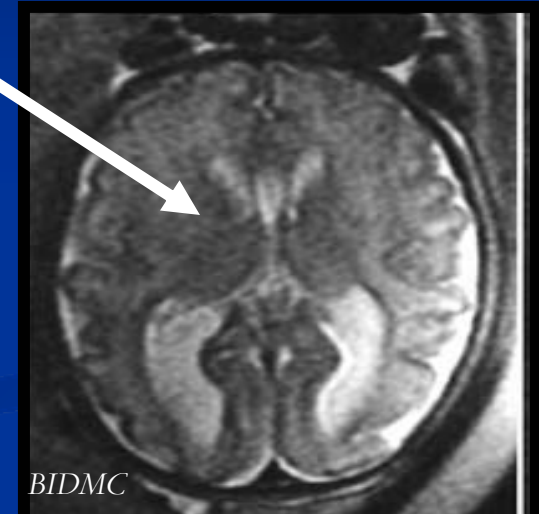
❖ Increased Sulcation (precentral gyrus, postcentral gyrus, Temporal Sulci)

❖ Maturation of Arachnoid Granulations (less subarachnoid fluid)

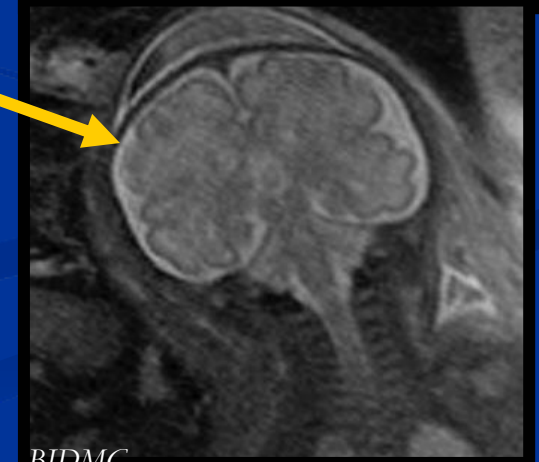
❖ Increased Contrast between white and grey matter



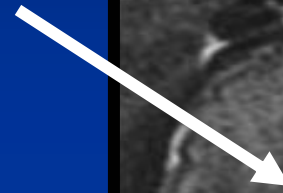
NL 33Wk Fetus



BIDMC



BIDMC





Patient K.A.:

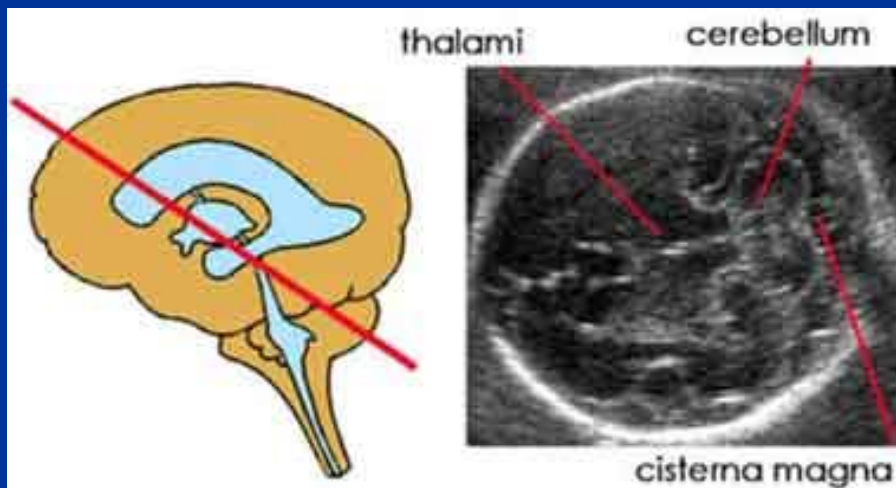
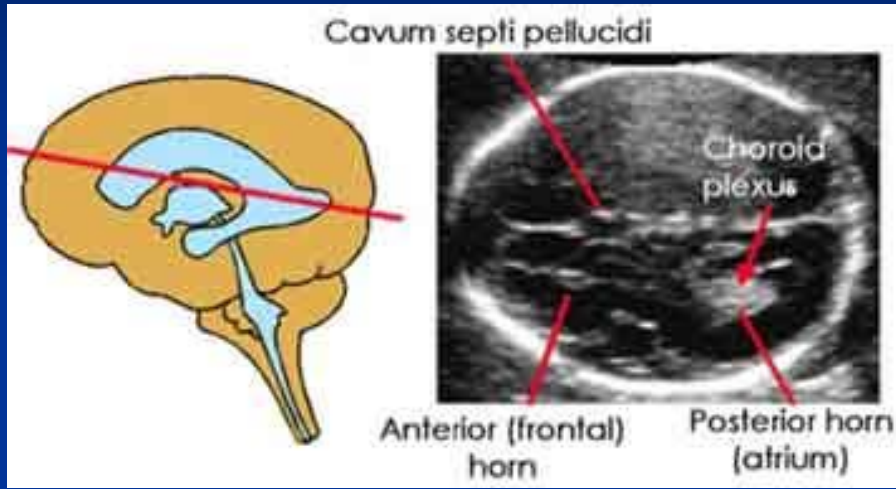
33yo F at 18 weeks GA presents for high risk ultrasound of fetus with h/o choroid plexus cysts at first trimester exam.

➤ Findings this exam:

- Persistence of abnormal choroid plexus
- Mild Borderline Ventriculomegaly (9mm prominent lateral ventricles)
- 7mm Cyst in the Posterior Fossa
- Ventricular Septal Defect

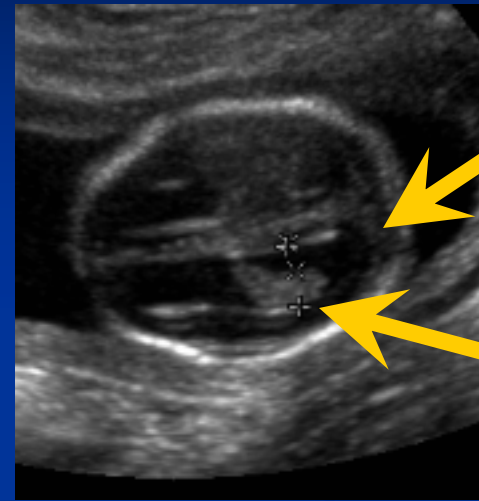


NL Patient 18 weeks



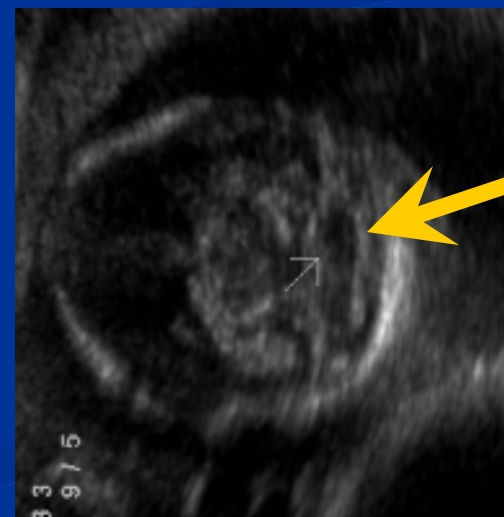
Above from <http://www.centrus.com.br>

Patient K.A. 18 weeks



Prominent ventricular atrium (cursor on medial reflection)

Dangling choroid plexus (>3mm from medial reflection)



Cyst in posterior fossa

Images from BIDMC



■ Ventriculomegaly:

- Defined as enlargement of the ventricles to greater than 10mm without an associated macrocephaly
- Frequency 0.5-2/1000 live births
- Natural History Reversible (29%), Stable (57%), or lead to Hydrocephalus (14%)*
- Prognosis – Highly dependant on etiology
 - Good when no associated malformations present. BUT Ultrasound has a 20-60% false negative rate in diagnosis of associated abnl's.
 - Bad if associated malformations, male gender, severe enlargement (>15mm), extension to 3rd/4th ventricles, or appears early in gestation.

* Values difficult to interpret given number of terminations for this finding.



Etiologies of Ventriculomegaly

- Primary causes:
 - 20% Aqueductal stenosis (*isolated ~18%*)*
 - Myelomeningocele with Chiari malformation
 - Agenesis of the Corpus Callosum (10%)
 - Dandy-Walker malformation (*prognosis variant dep.*) *
 - Holoprosencephaly*
 - Hydranencephaly
 - Lissencephaly
- Secondary causes:
 - Intraventricular hemorrhage
 - Cerebral ischemia
 - Infections (CMV, HSV, Toxo, Varicella)
 - Tumors

**often associated with chromosomal abnl's*

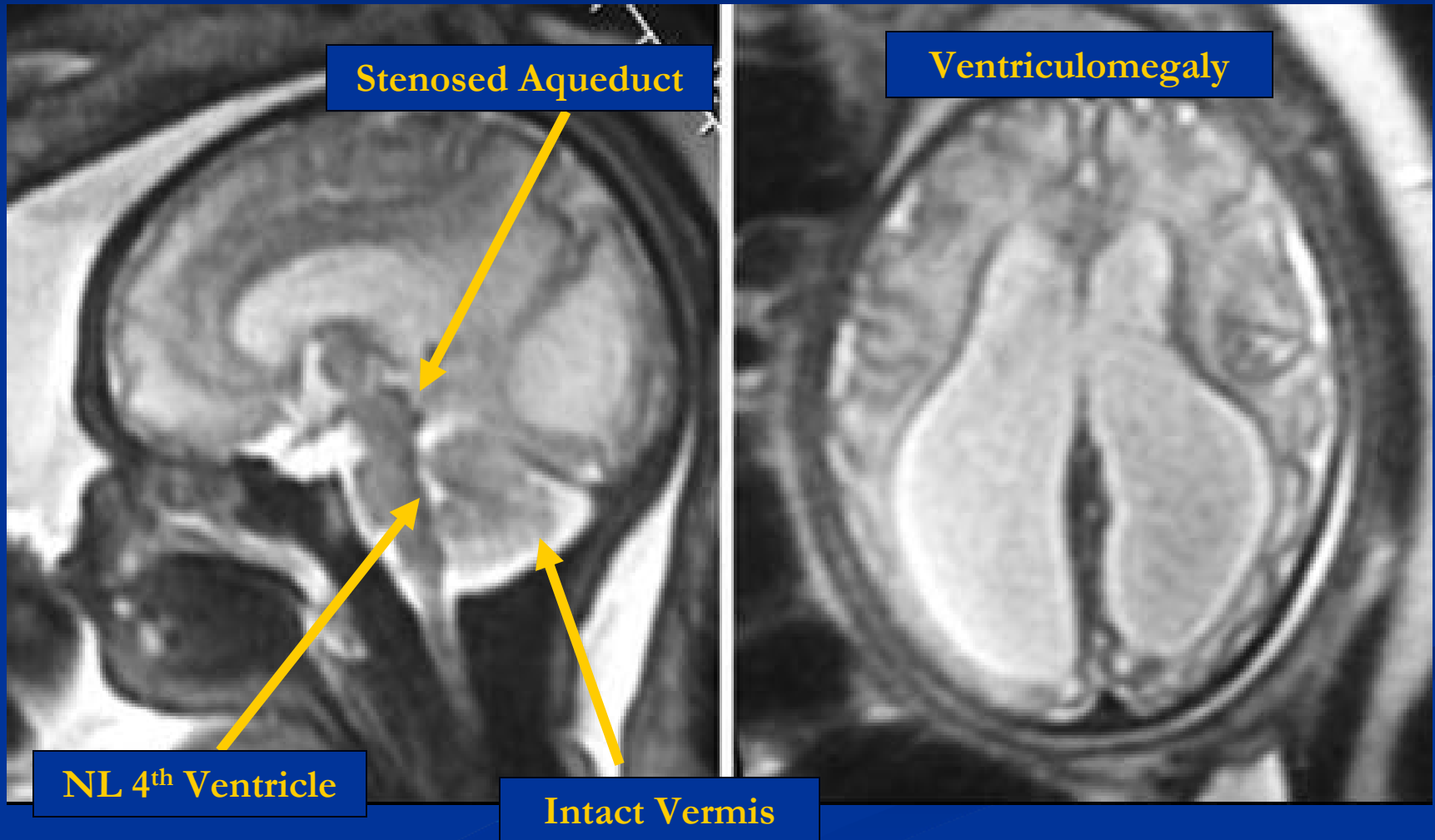


Patient work-up for Ventriculomegaly

- Maternal Blood Tests (Rubella, Parvo, HIV, Torch, anti-platelet abs)
- Karyotype of fetus
- Fetal echocardiogram
- Fetal MRI
 - CNS: Symmetry & Distribution, Cell layers, Choroid, Posterior Fossa, Aqueduct patency,
 - Extracranial: Other signs of aneuploidy

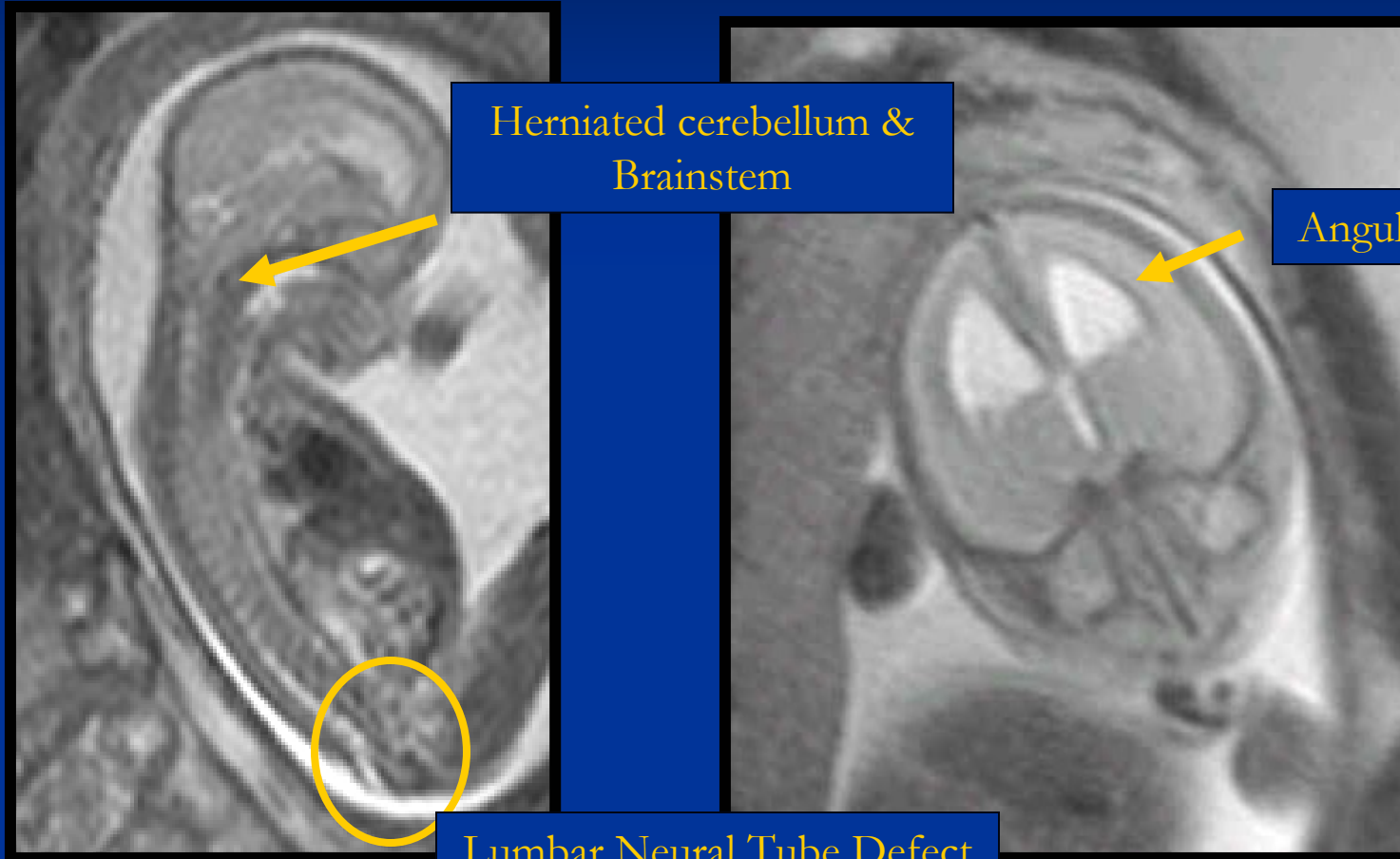


Isolated Aqueductal Stenosis in 32 Week Fetus





Myelomeningocele with Chiari Malformation in 23 week Fetus



Herniated cerebellum & Brainstem

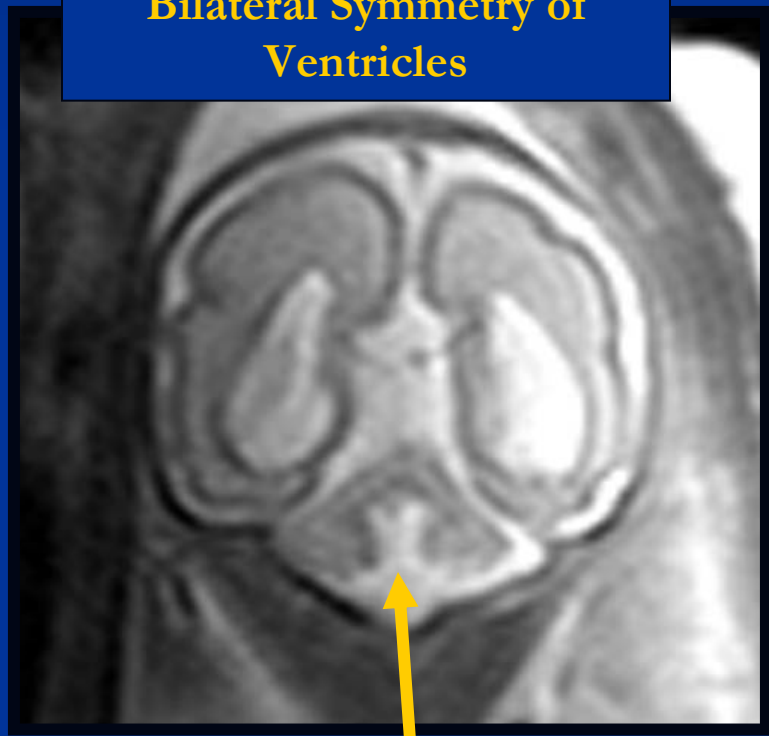
Angular Ventricles

Lumbar Neural Tube Defect
Causing Tethered Cord



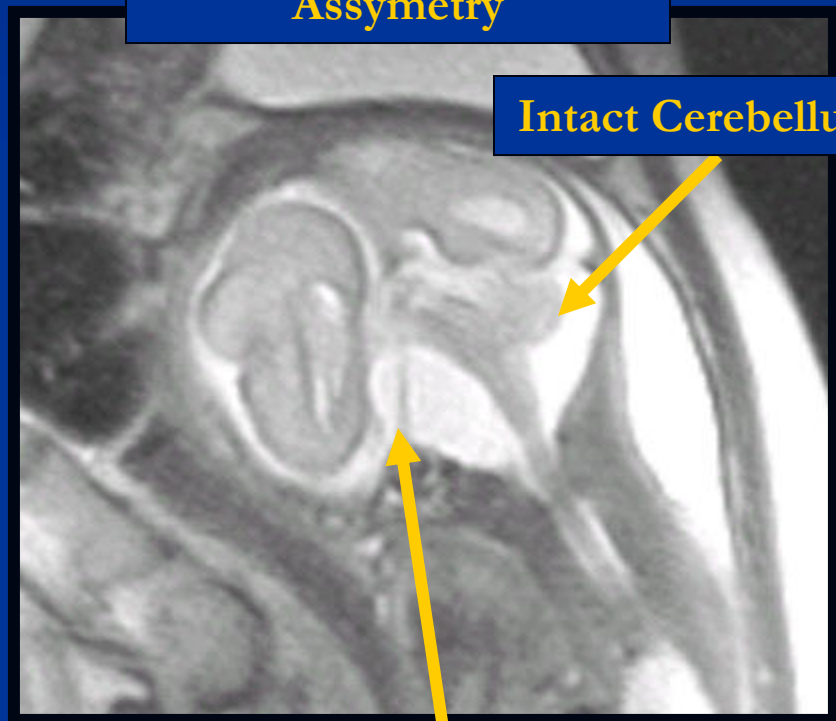
Dandy Walker Variant Vs. Arachnoid Cyst in 26 Week Fetuses

Bilateral Symmetry of Ventricles



Agenesis/Dysgenesis of Cerebellar Vermis

Assymetry

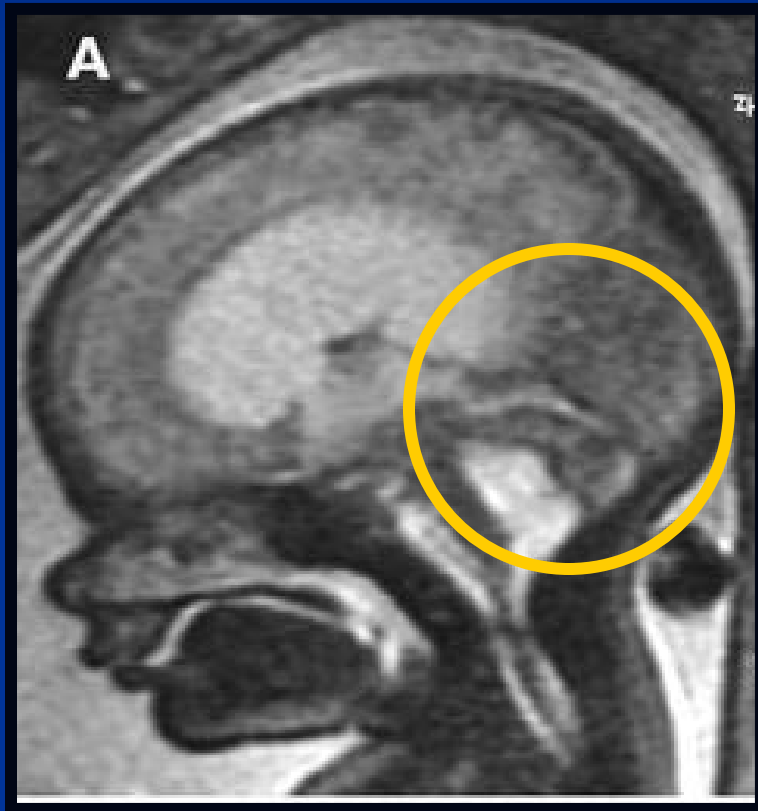


Intact Cerebellum

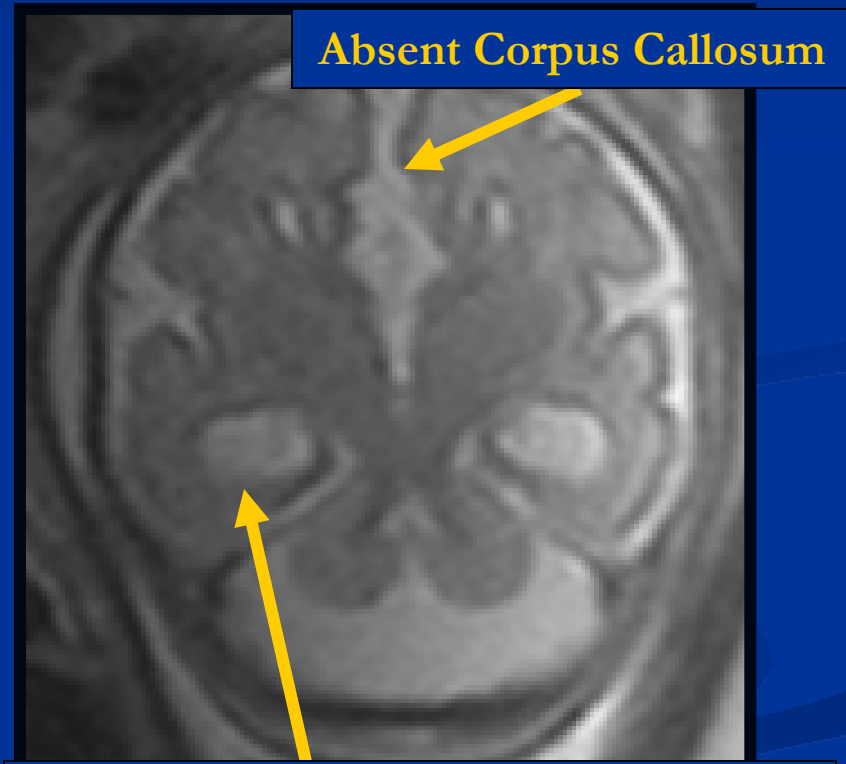
Septation and Mass effect on Adjacent tissues



Hemorrhage Vs. Agenesis of Corpus Callosum in 26 Week Fetuses



Hypointense Parenchyma = Hemorrhage/clot blocking outflow tract



Absent Corpus Callosum

Colpocephaly: Prominent Occipital Horns

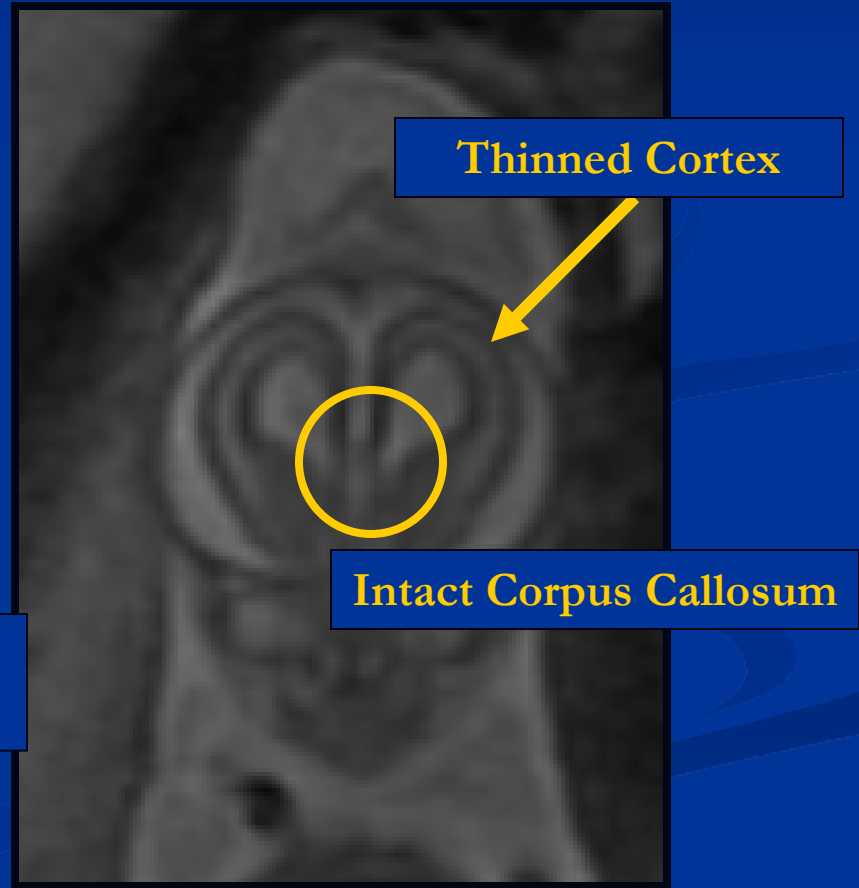
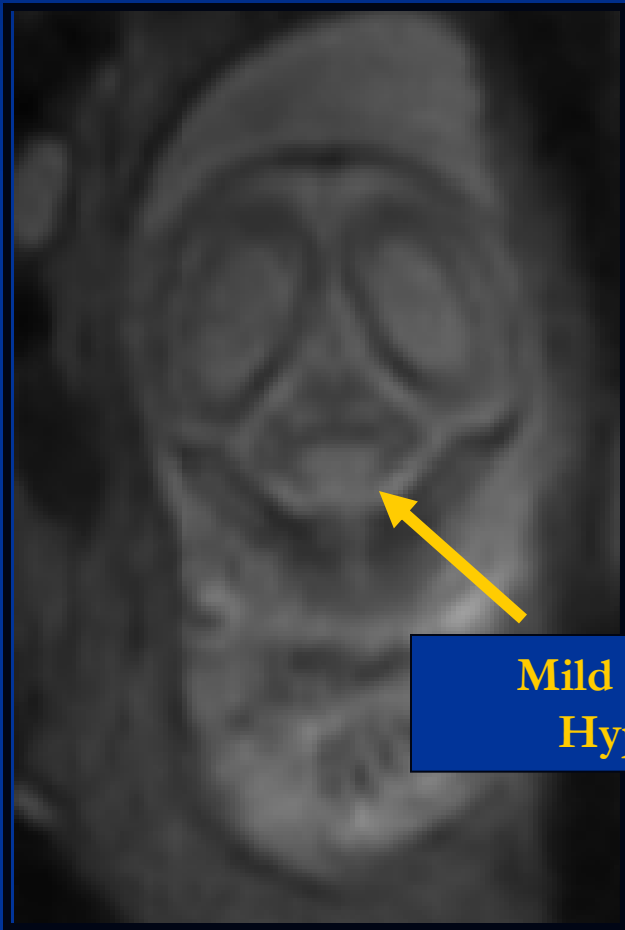


Back to Patient K.A.....

- Posterior fossa difficult to conclusively assess
- What is the origin of the posterior cyst?
- Why are the ventricles so prominent?
- What is this child's prognosis?
- Since ultrasound could not conclusively dx, same day fetal MRI ordered.



Fetal Findings Were: Dandy Walker Variant with Cortical Atrophy





How Should K.A. Be Counseled?

- Depending on mother's wishes, amniocentesis should be recommended
- Dandy Walker variant can have mild prognosis
- Cortical thinning implies perturbed brain development
- Given ventricular prominence plus associated malformations (VSD) prognosis is poor



■ When to use MRI:

- Obese mothers
- Low position of head
- Calcification of cranium
- CNS anomalies not diagnosable by US
- When HASTE ultra fast spin echo MRI available

■ When NOT to use MRI:

- Too much fetal movement
- Suspected cardiac anomalies
- Early gestational age (too many incidental findings)
- Absolute contraindications (claustrophobia, metal)



Future Uses of Fetal CNS MRI:

- Help Guide Patient Counseling When Abnormalities are Found
- New outlook into patient selection for in utero interventions:
 - High probability of good outcome for cases of isolated ventriculomegaly/hydrocephalus
- Useful correlations between Ventricle morphology and underlying soft tissue defects:
 - Colpocephalus → Agenesis of Corpus Call.
 - Angular Anterior Horns → Meningomyelocele
 - Fused Anterior Horns → Absence of Septum pellucidum



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Suggested Reading

SD Brown, Children's Hospital and Massachusetts General Hospital, Boston, MA; JA Estroff and CE Barnewalt, Children's Hospital, Boston, MA. Fetal MRI. *Applied Radiology* 2004; 33(2) 9-25.



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