Neuronal Migration Disorders

Neuronal Migration Disorders

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Stage 3: Migration and Histogenesis

- Cellular differentiation (Months 2-5).
- Neuronal migration from germinal matrix to the cortex.

Neuronal migration disorders (NMD)

- refers to a heterogenous group of disorders that, it is supposed, share the same etiopathological mechanism: a variable degree of disruption in the migration of neuroblasts during neurogenesis.

- The neuronal migration disorders are cerebral dysgenesis,

Neuronal migration disorders (NMD)

I. Corpus callosum agenesis.

II. Lissencephaly.

III. Polymicrogyria

IV. Heterotopias.

V. Schizencephaly

VI. Focal cortical dysplasias.

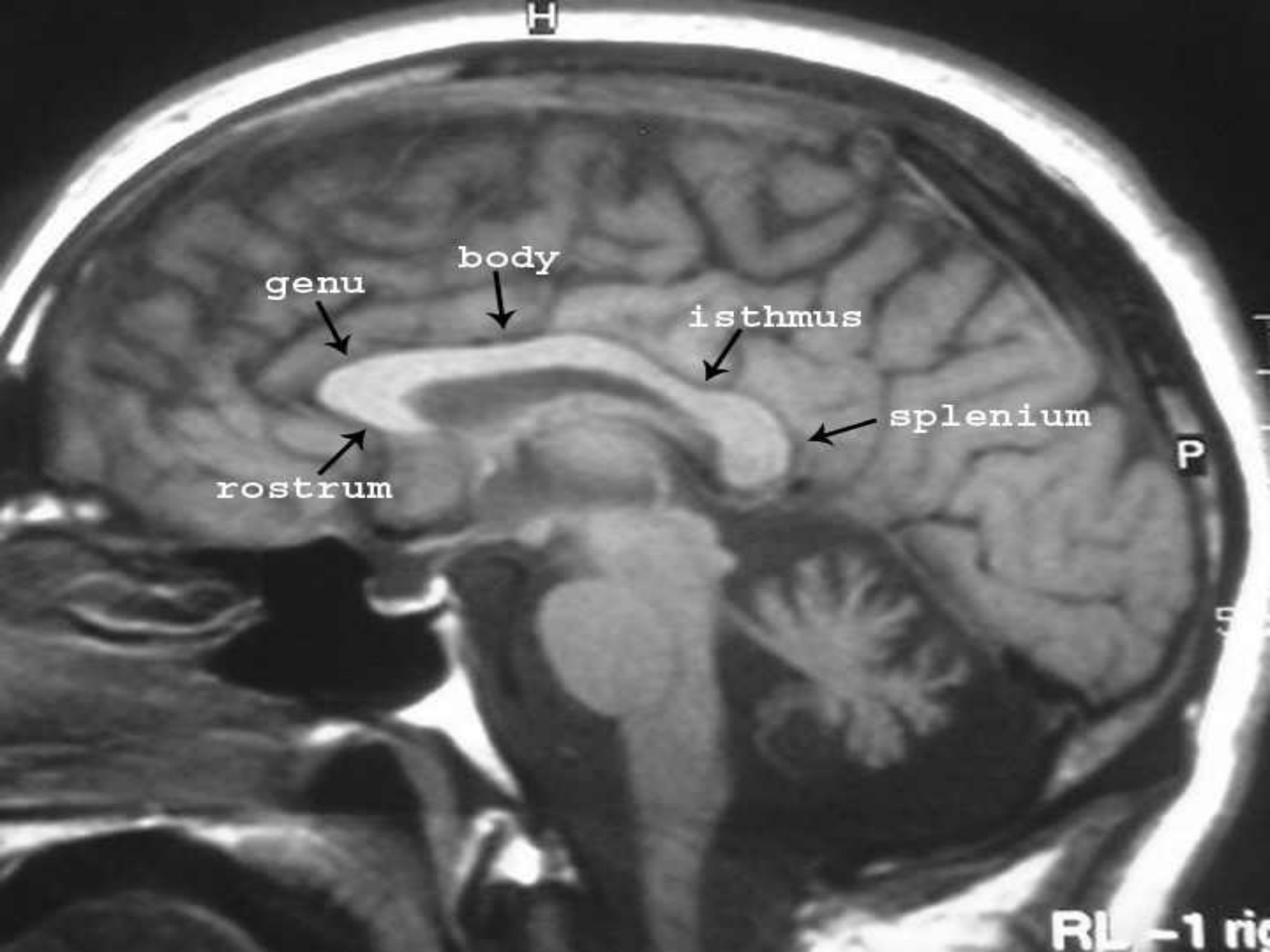
I. Agenesis of the Corpus Callosum

- Growth anterior to posterior starting at the genu.
- Myelination from posterior to anterior.
- Association with Chiari II, Dandy Walker, Holoprosencephaly and lipomas.
- Splaying of the anterior horns (Bulls horn appearance) High third ventricle.
- Absent cingulate sulcus.

Agenesis of the Corpus Callosum

May be:

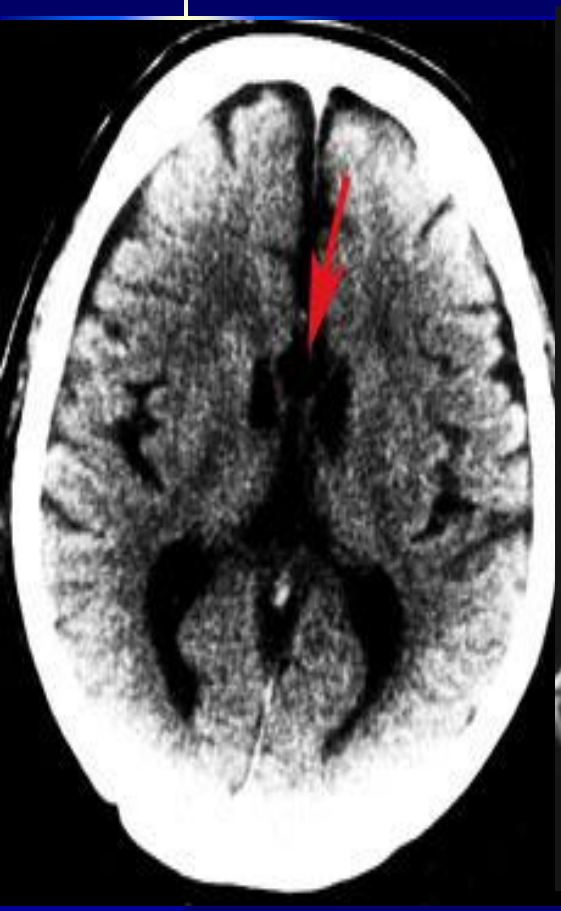
- Complete
- Partial (splenium and rostrum always missing)

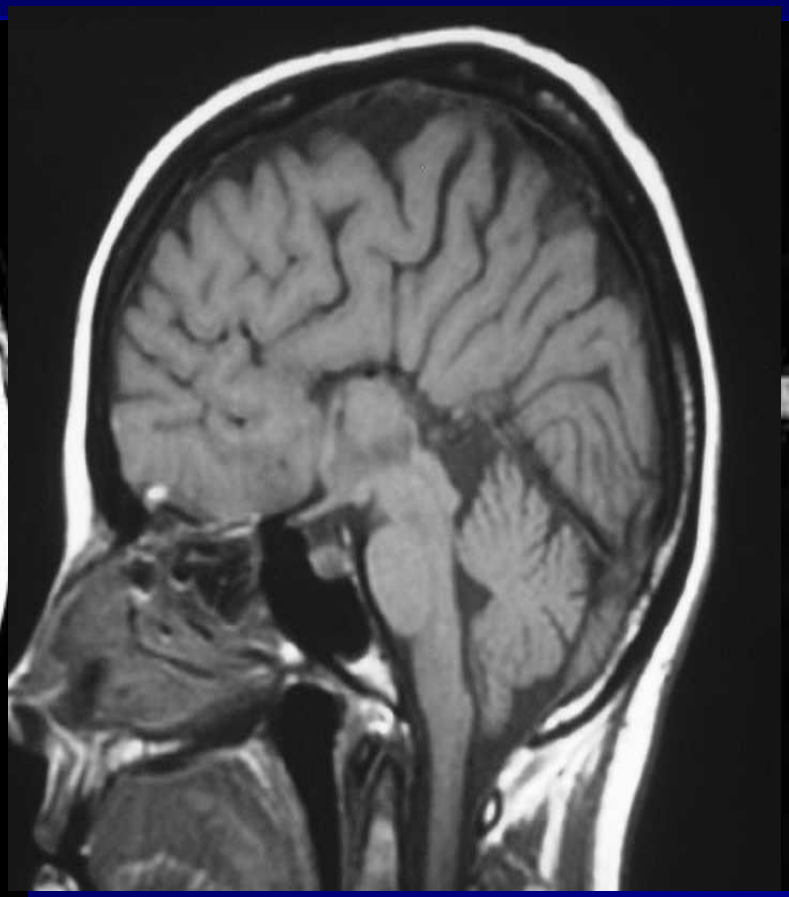

H
genu
body
isthmus
splenium
rostrum
P

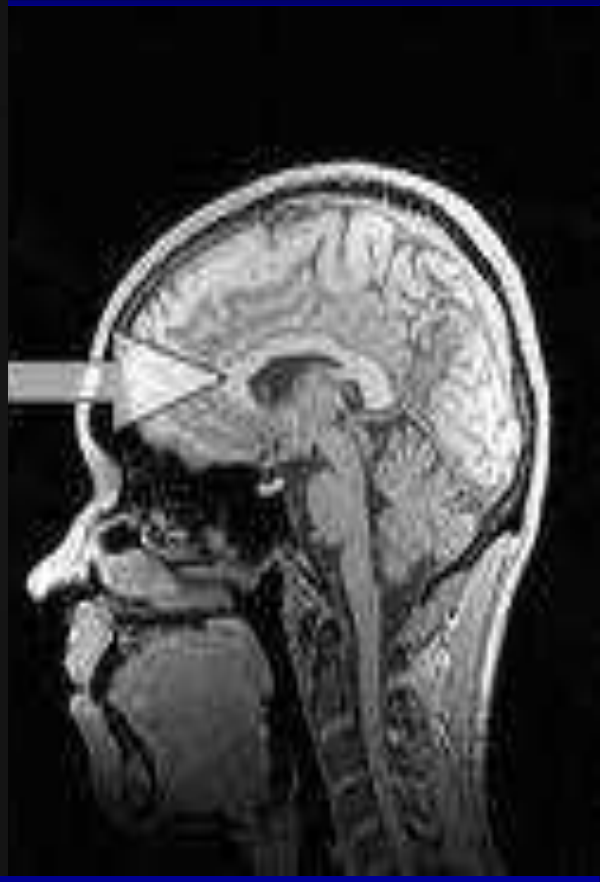
Agenesis of the Corpus Callosum

- ventricles
  - ventricles run parallel rather than the normal "bow-tie" configuration giving a racing car appearance on axial imaging
  - colpocephaly (dilatation of the trigones and occipital horns) gives a characteristic "longhorn"/moose head/viking helmet appearance on coronal imaging
  - dilated high-riding 3rd ventricle communicating with the interhemispheric cistern or projecting superiorly as a dorsal cyst
- cortex
  - bundles of Probst
  - radial gyri (absent cingulate gyrus)
  - everted cingulate gyrus [10]
- limbic system [4]
  - hypoplastic fornices
  - hypoplastic hippocampi

Corpus Callosum Agenesis

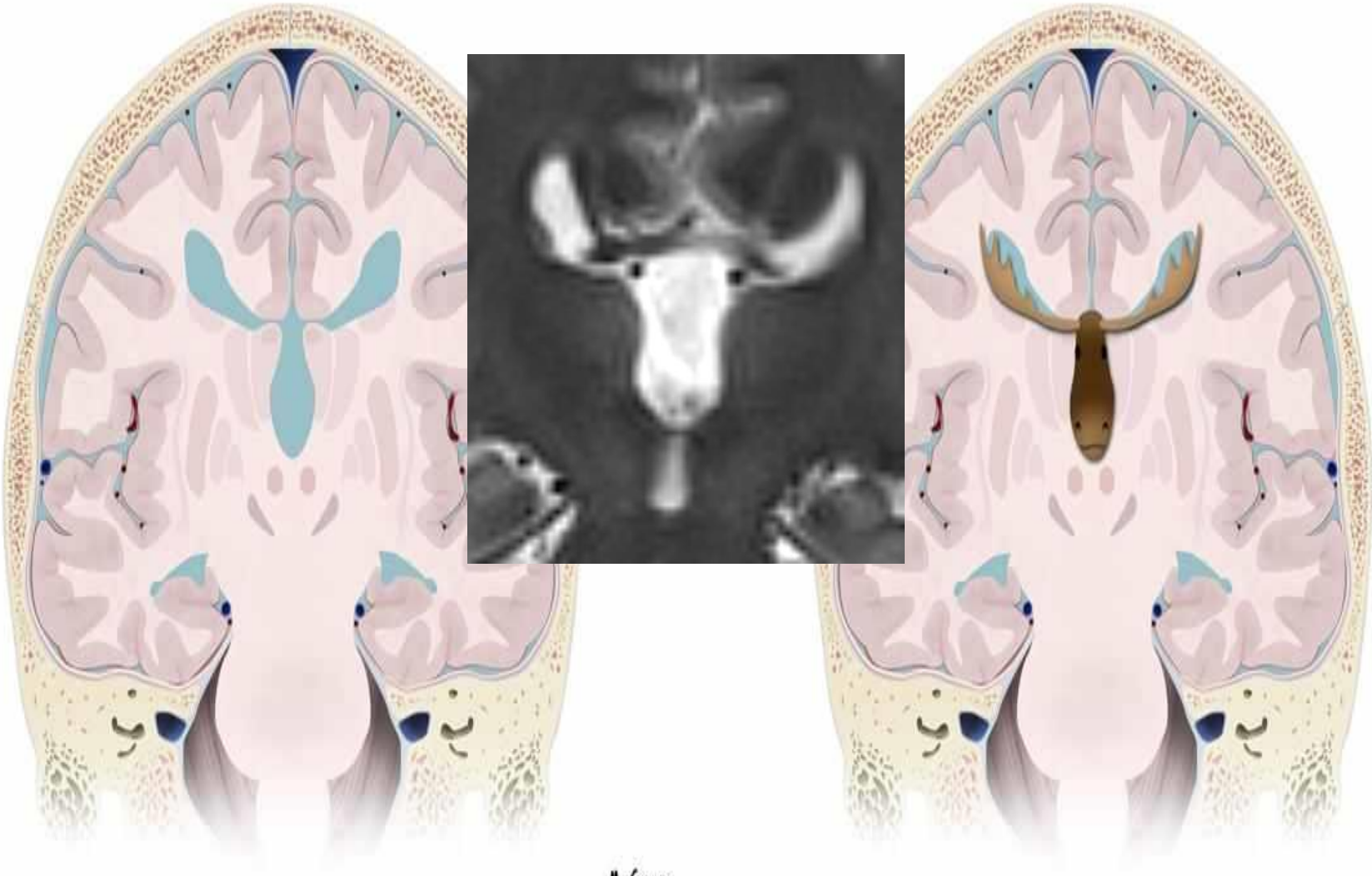






Moose head appearance

of corpus callosum agenesis



Moose head appearance

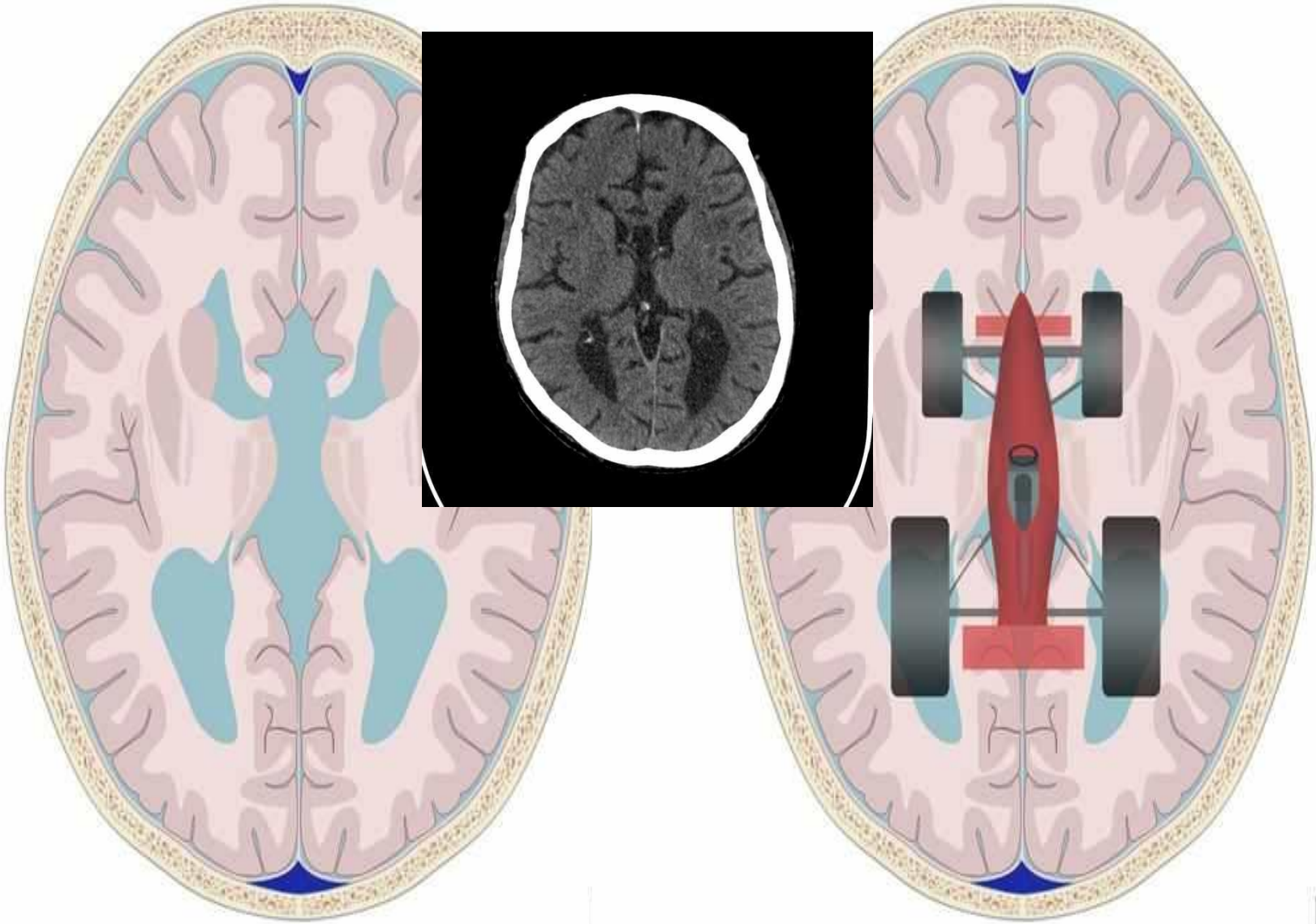
of corpus callosum agenesis

Racing car sign

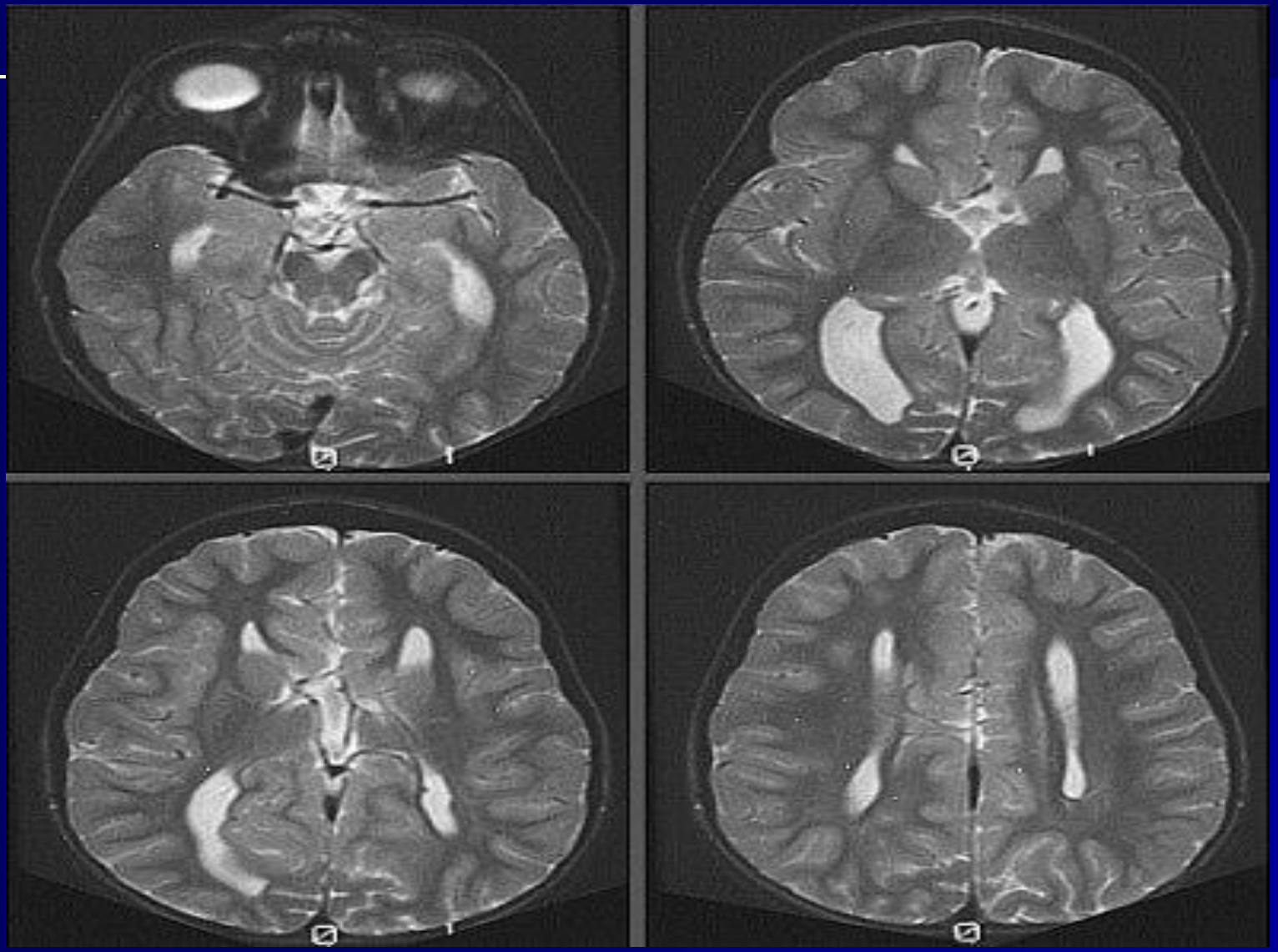
of corpus callosum agenesis

Racing car sign

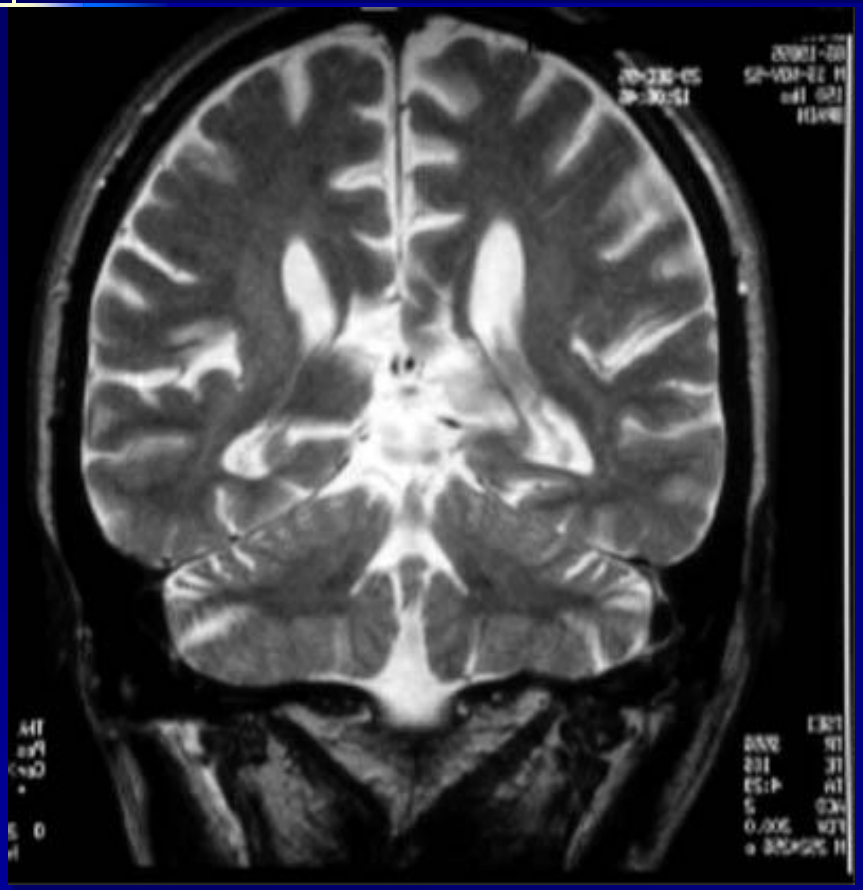
of corpus callosum agenesis

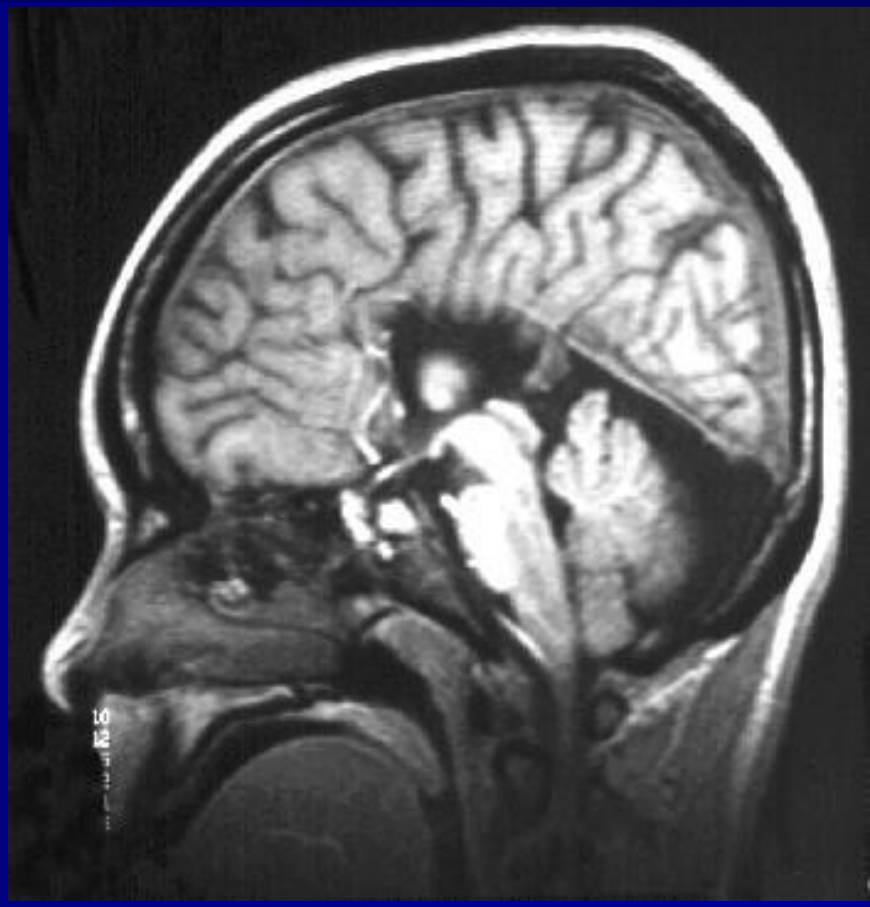


Corpus Callosum Agenesis



Corpus Callosum Agenesis





Agenesis of the Corpus Callosum

Associated anomalies can be frequent and broad which includes:

- **aneupliodic syndromic**
  - trisomy 18
  - trisomy 13
  - trisomy 8 [9]
- **non-aneuploidic syndromic**
  - Aicardi syndrome
  - Apert syndrome
  - Bickers Adams Edwards syndrome
  - Coffin-Siris syndrome
  - fetal alcohol syndrome
  - Fryns syndrome
  - Gorlin syndrome
  - hydrolethalus syndrome
  - Lowe syndrome
  - Zellweger syndrome
- **other CNS associations**: often multiple present
  - Chiari II malformation (7%)
  - Dandy-Walker spectrum (11%)
  - grey matter heterotopia
  - holoprosencephaly
  - hydrocephalus (30%): particularly the trigones and posterior horns of lateral ventricles = colpocephaly
  - interhemispheric cysts
  - intracranial lipoma (10%)
  - polymicrogyria
  - porencephaly
- **inborn errors of metabolism** [6]
  - non-ketotic hyperglycaemia
  - pyruvate metabolism disorders
  - congenital lactic acidosis (due to mitochondrial respiratory chain defects)
  - Mucopolysaccharidoses AND mucolipidoses

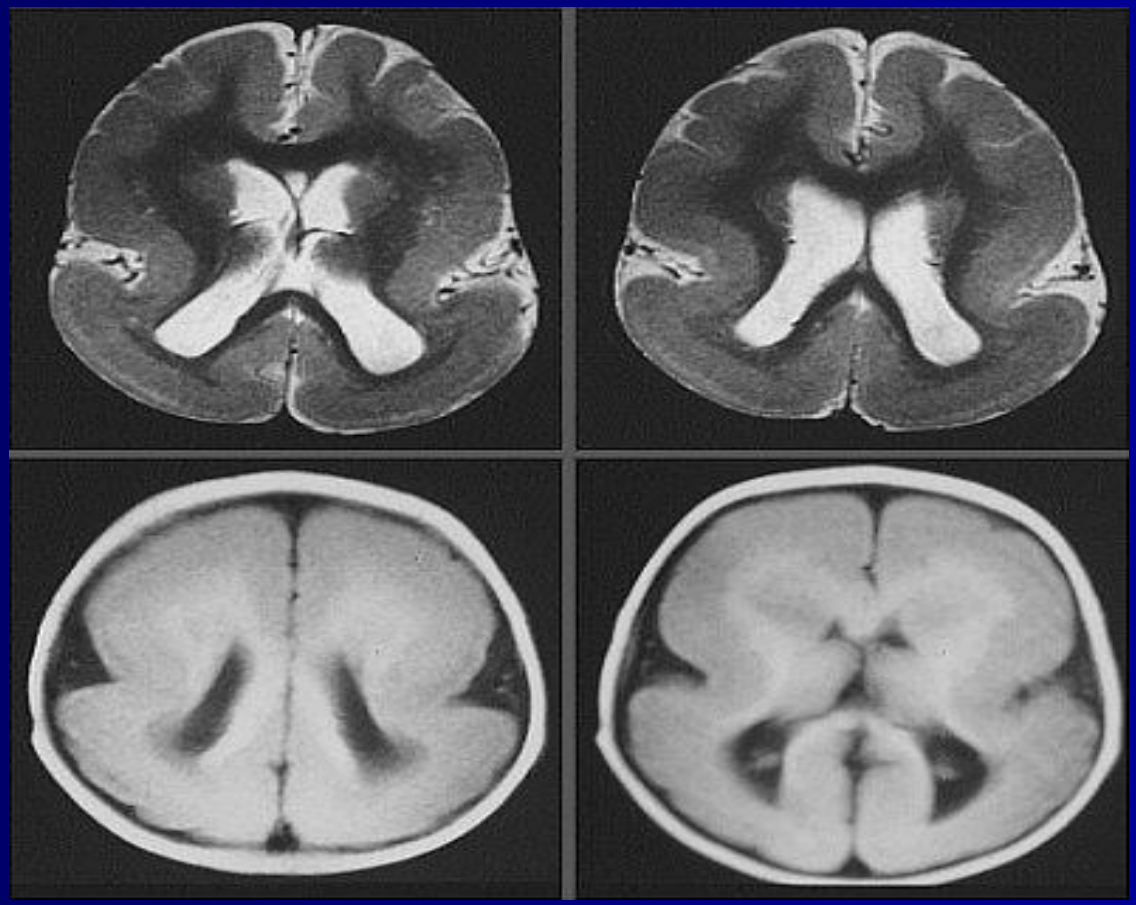
II.Lissencephaly (Agyria-Pachygyria):

- Most severe form of neuronal migrational anomalies. Patients often have small brains, mental retardation, spasticity, seizures.

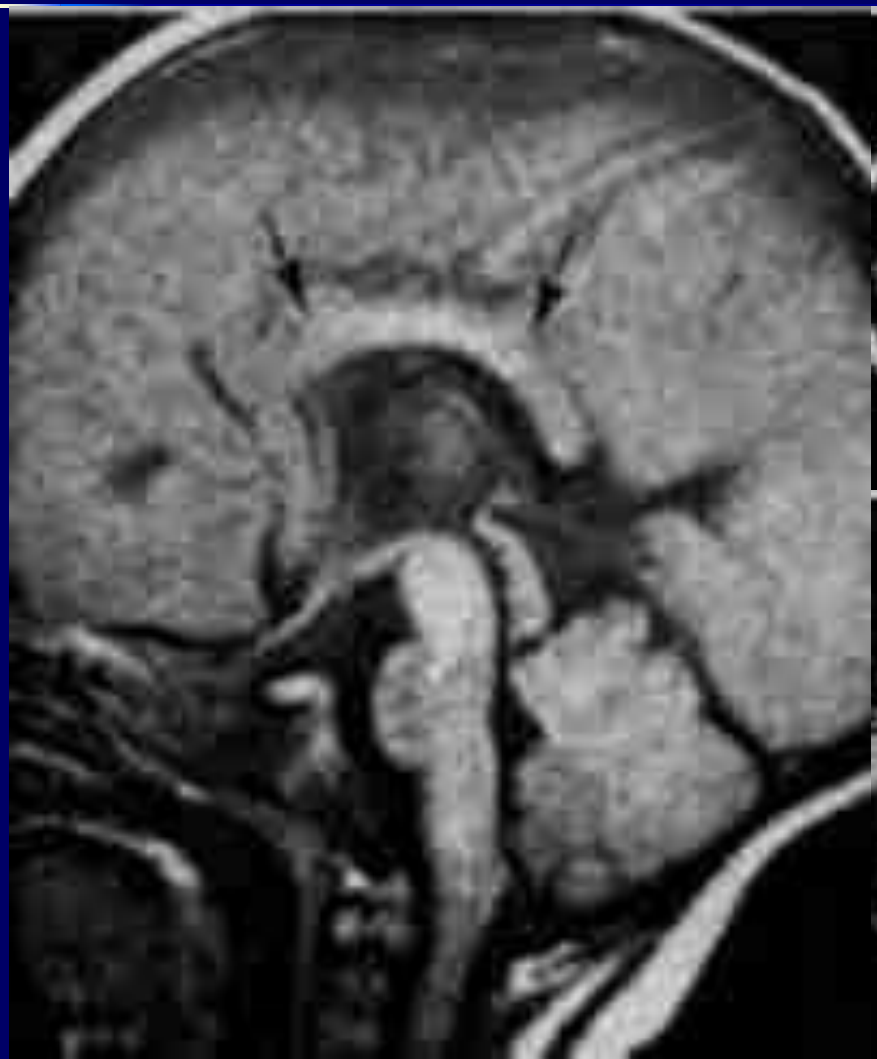
Agyria (complete lissencephaly)

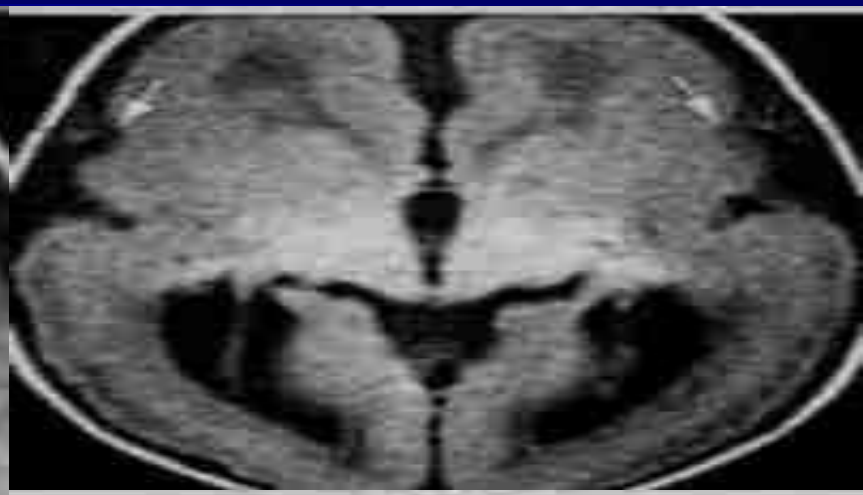
- Smooth brain
- Figure eight configuration with clefts extending to the sylvian fissures.
- abnormally thick cortex with four abnormal layers,
- Widespread neuronal heterotopia,
- Enlarged ventricles,
- Often agenesis or malformation of the corpus callosum

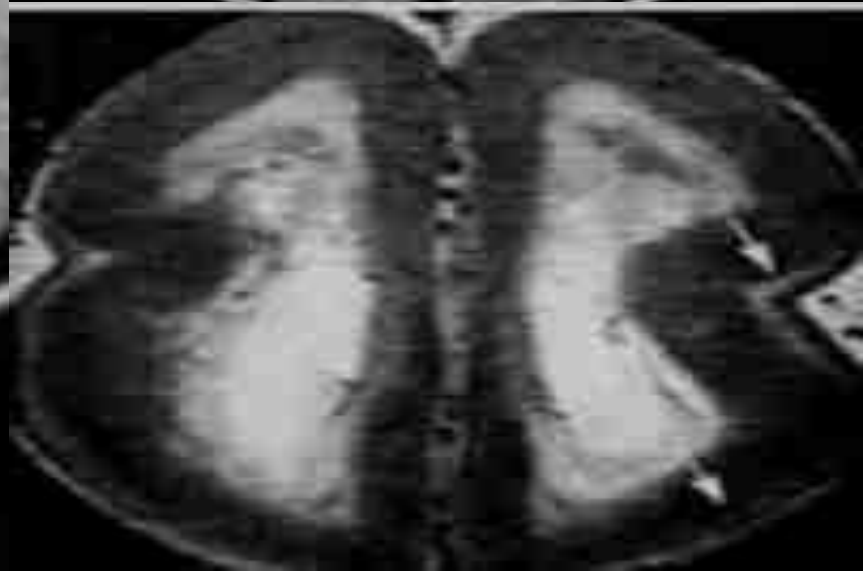
Agyria



Agyria

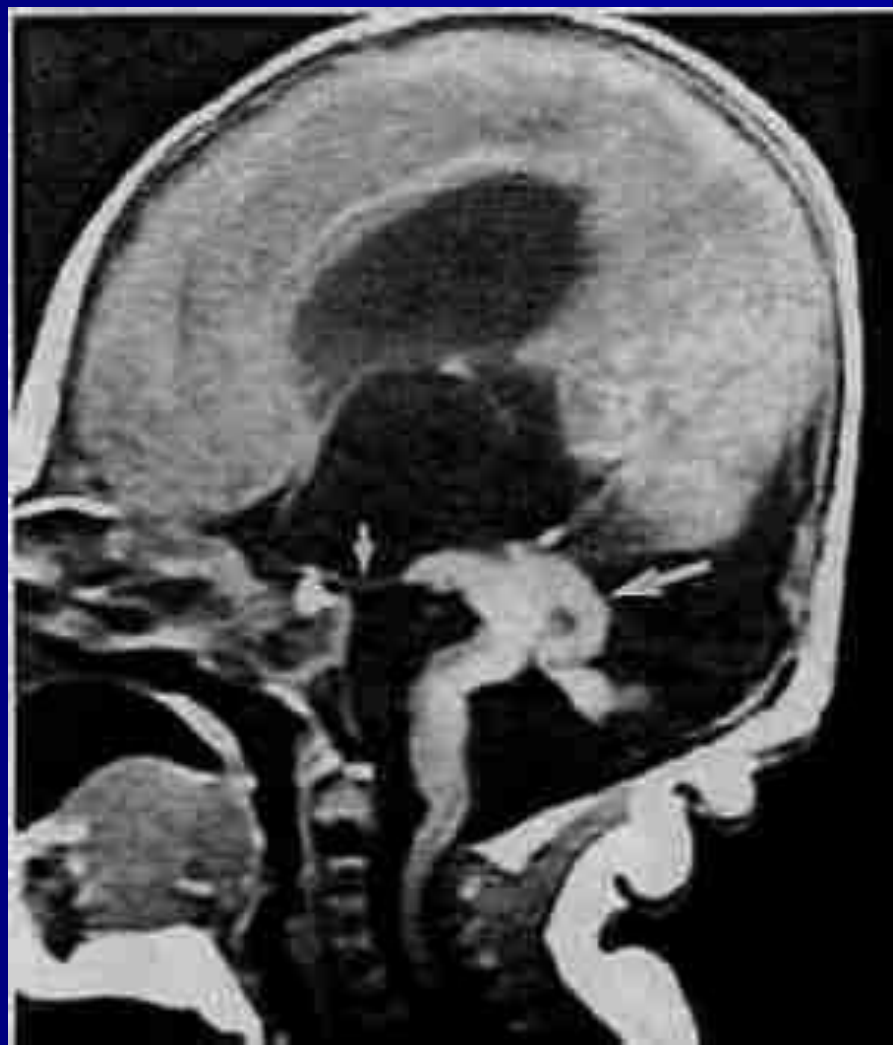






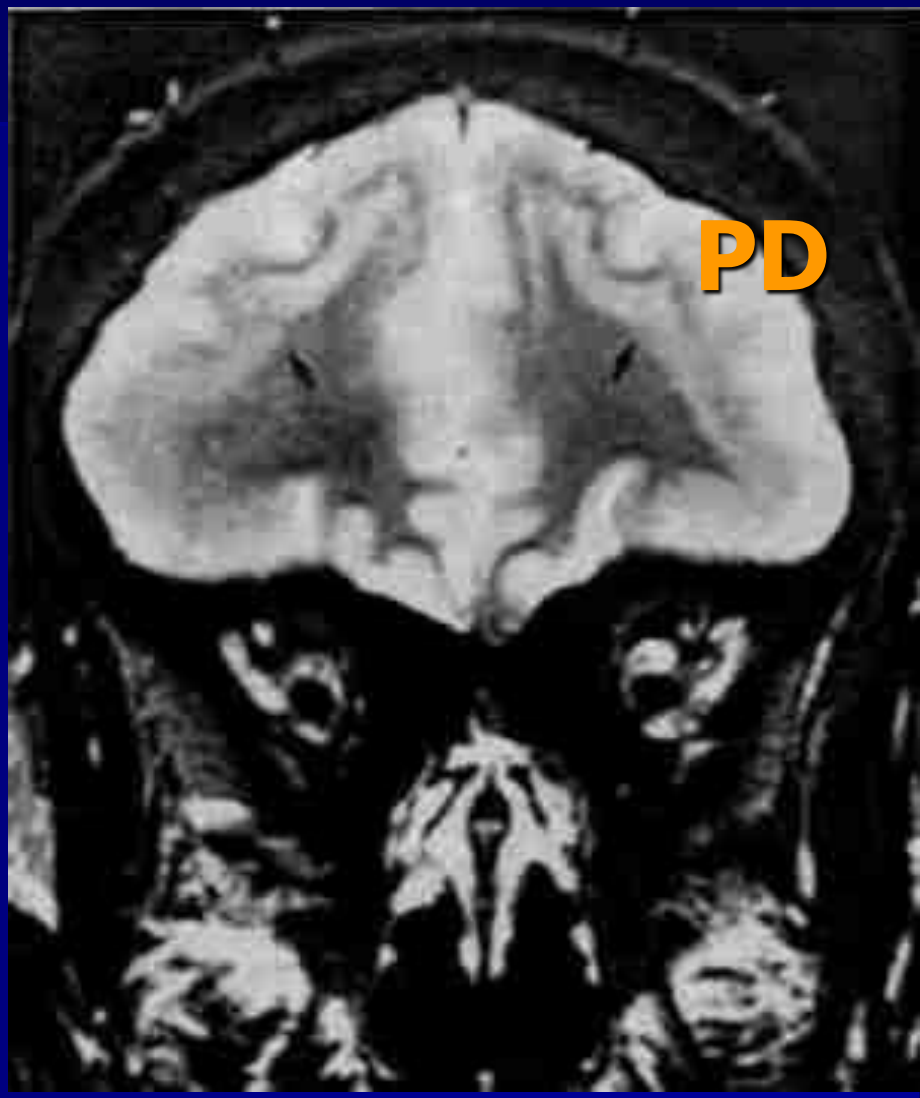
Cobblestone lissencephaly (in Walker-Warburg syndrome)

- Hydrocephalic distension of the third ventricle with downward bulging of the ventricular floor (short arrow).
- The brainstem is severely hypoplastic with unusual kinking of the pontomesencephalic junction.
- The tectum (long arrow) appears massive relative to normal, which probably reflects an early arrest of development.



Pachygyria

- Pachygyria
- bilateral undulating bands of abnormal gray matter (arrows) in the subcortical region



III. Polymicrogyria:

- Neurons reach the cortex but are abnormally distributed into multiple small gyri like dimples on the surface of a basketball.
- Clinically less severe than lissencephaly. Seizures, developmental delays.
- Focal polymicrogyria may be seen with an anomalous draining vein and gliosis.
- May be associated with Chiari II, schizencephaly,

Polymicrogyria:

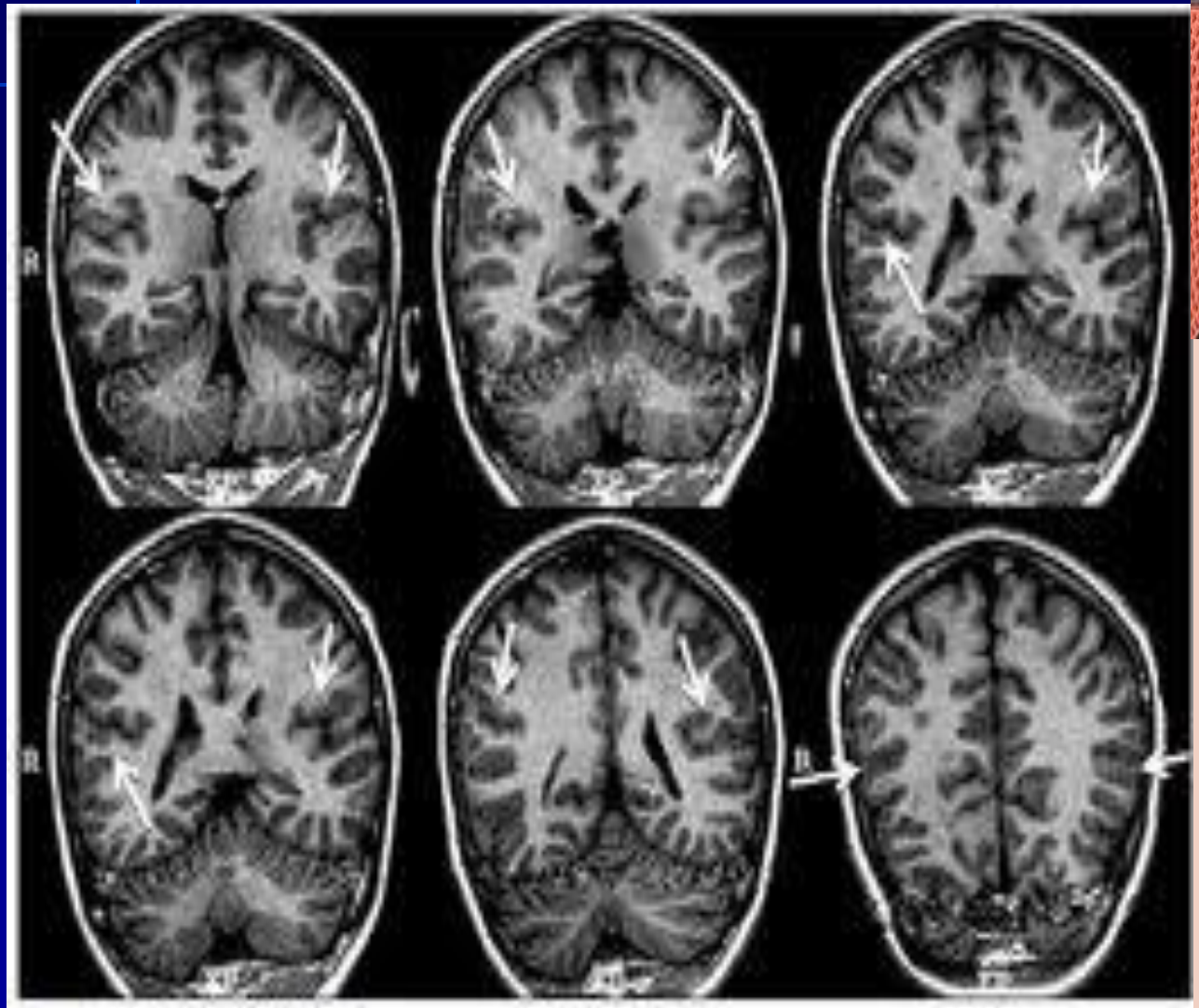
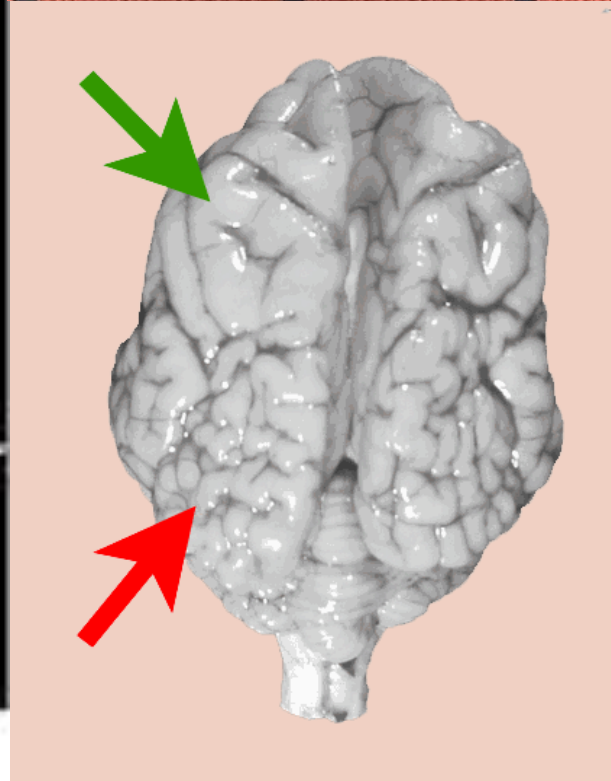


Fig 1. T1 image. MRI study of first twin with bilateral posterior parietal polymicrogyria.



Polymicrogyria:

Bilateral frontal
Bilateral perisylvian
Bilateral parietal
Bilateral posterior
Polymicrogyria (other)

IV.Heterotopia

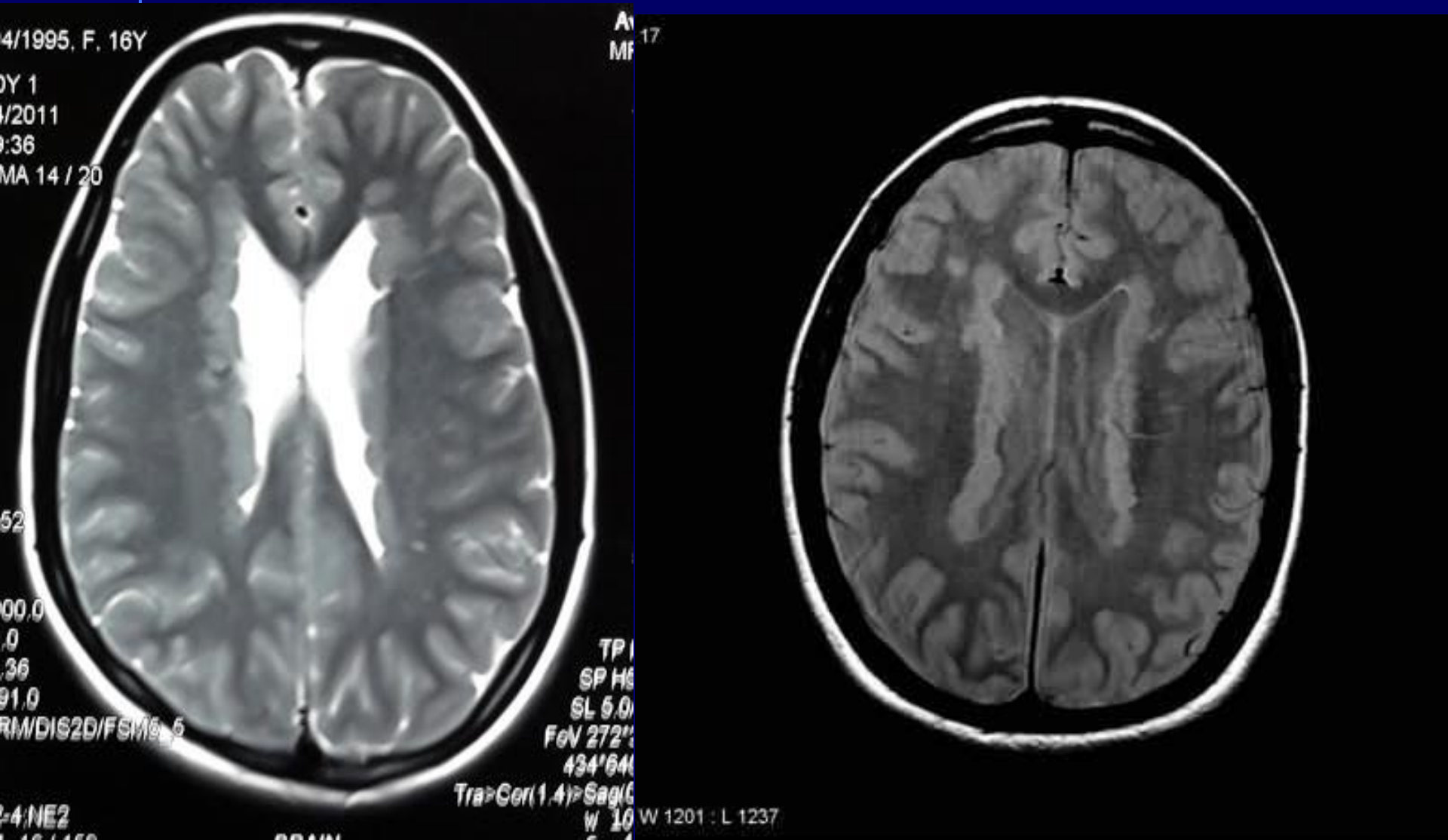
Interruption of normal migration of neural blast from the general matrix to the cortex.

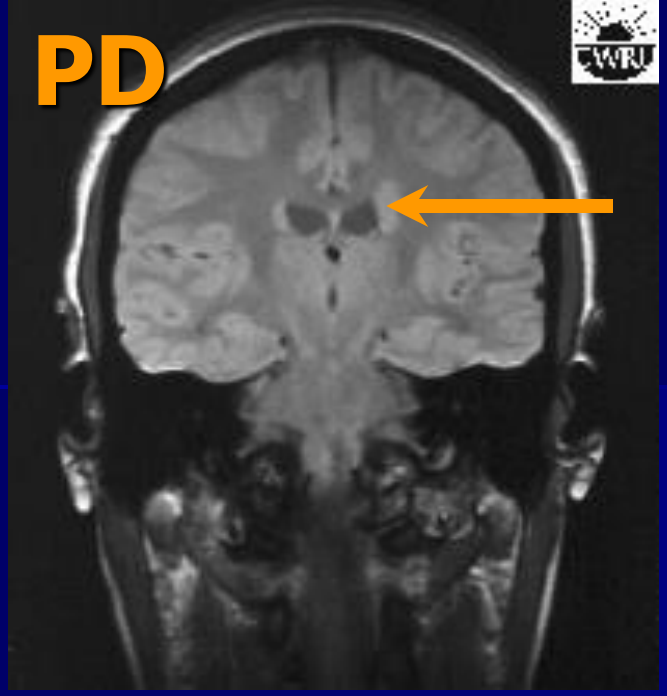
- Diffuse heterotopia
- Focal heterotopia
  - **Subcortical**
  - **Subependymal**
  - **Both subcortical and subependymal**

IV.Heterotopia

- Seizures, mental retardation.
- Association with corpus callosum agenesis, Chiari malformations, Tuberous Sclerosis, septooptic dysplasia.

IV.Heterotopia

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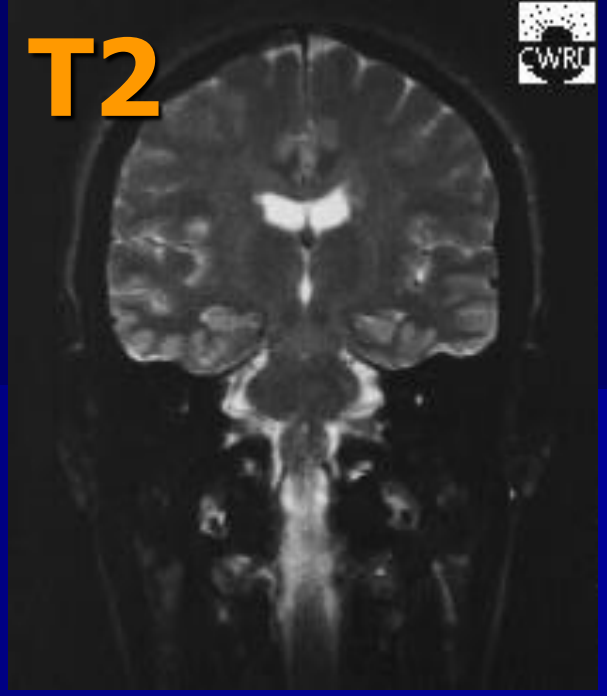
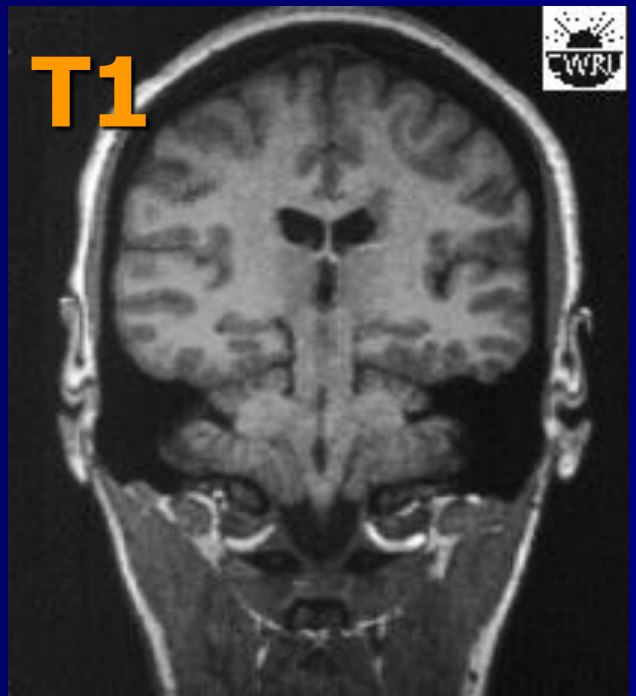
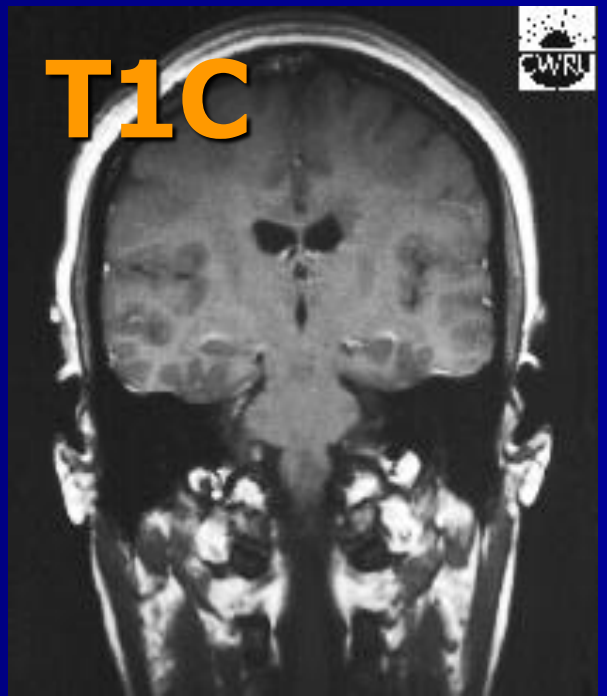
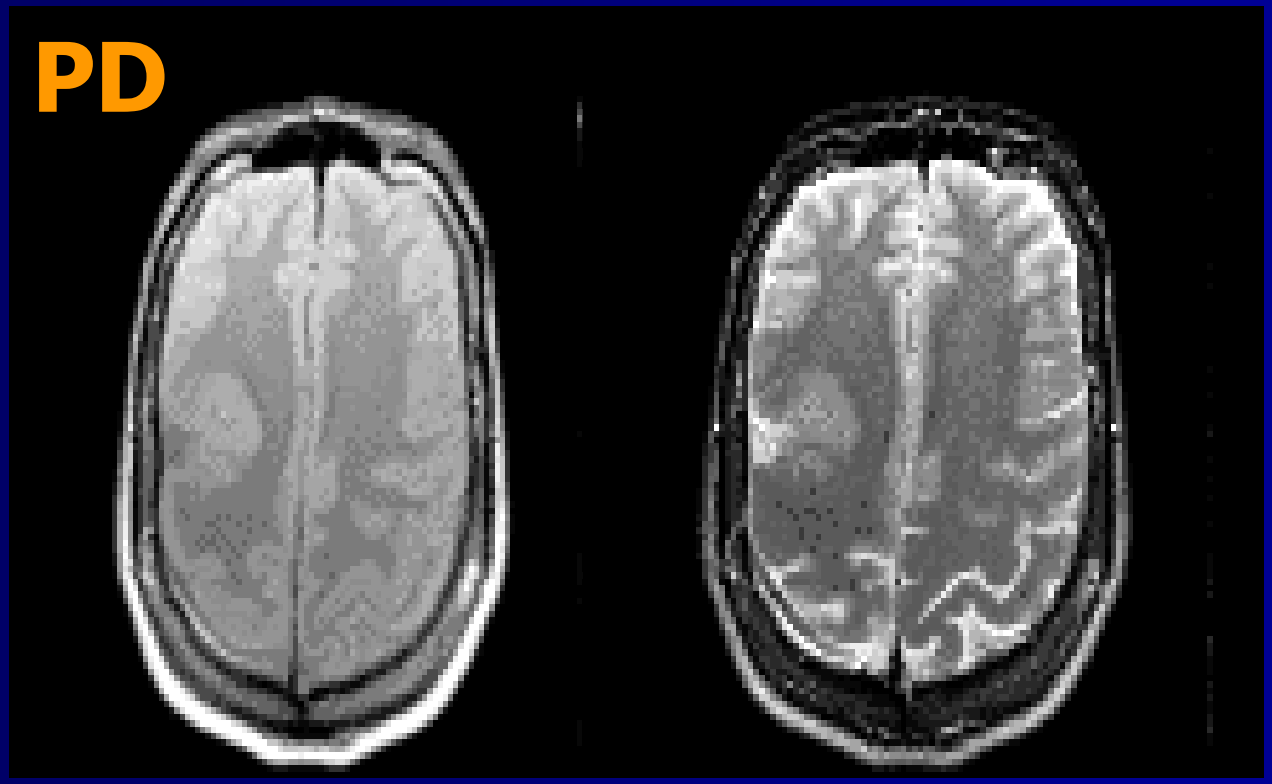
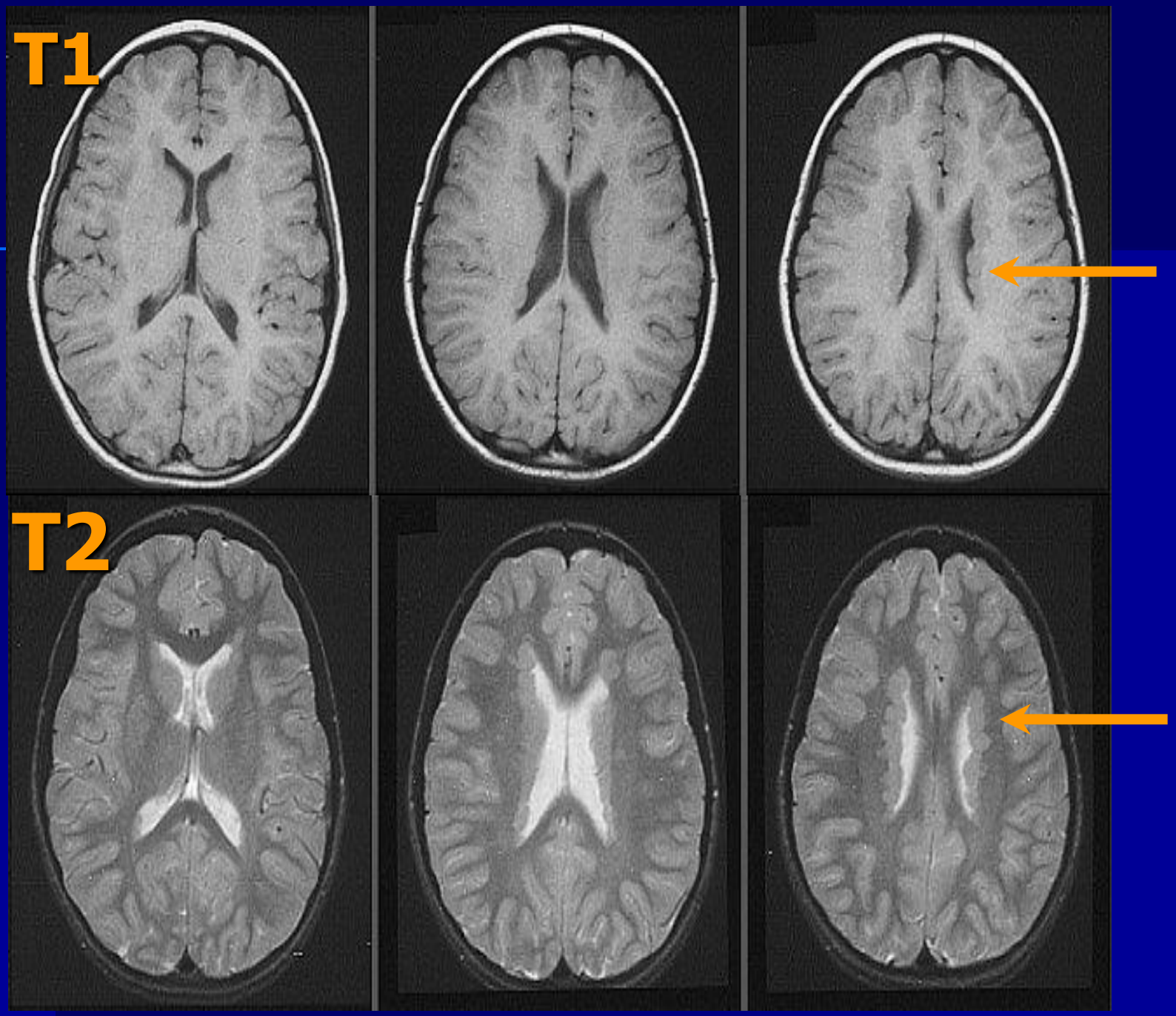

T2


T1


T1C

Heterotopic grey matter and abnormal sulcation




T1
T2

V. Schizencephaly:

- Gray matter extension from the ventricle to the cortex.
- Two types: closed lip (mild, no CSF within) and open lip (contains CSF, severe with cortical defects and large ventricles).
- Association with septooptic dysplasia and optic atrophy.

V. Schizencephaly:

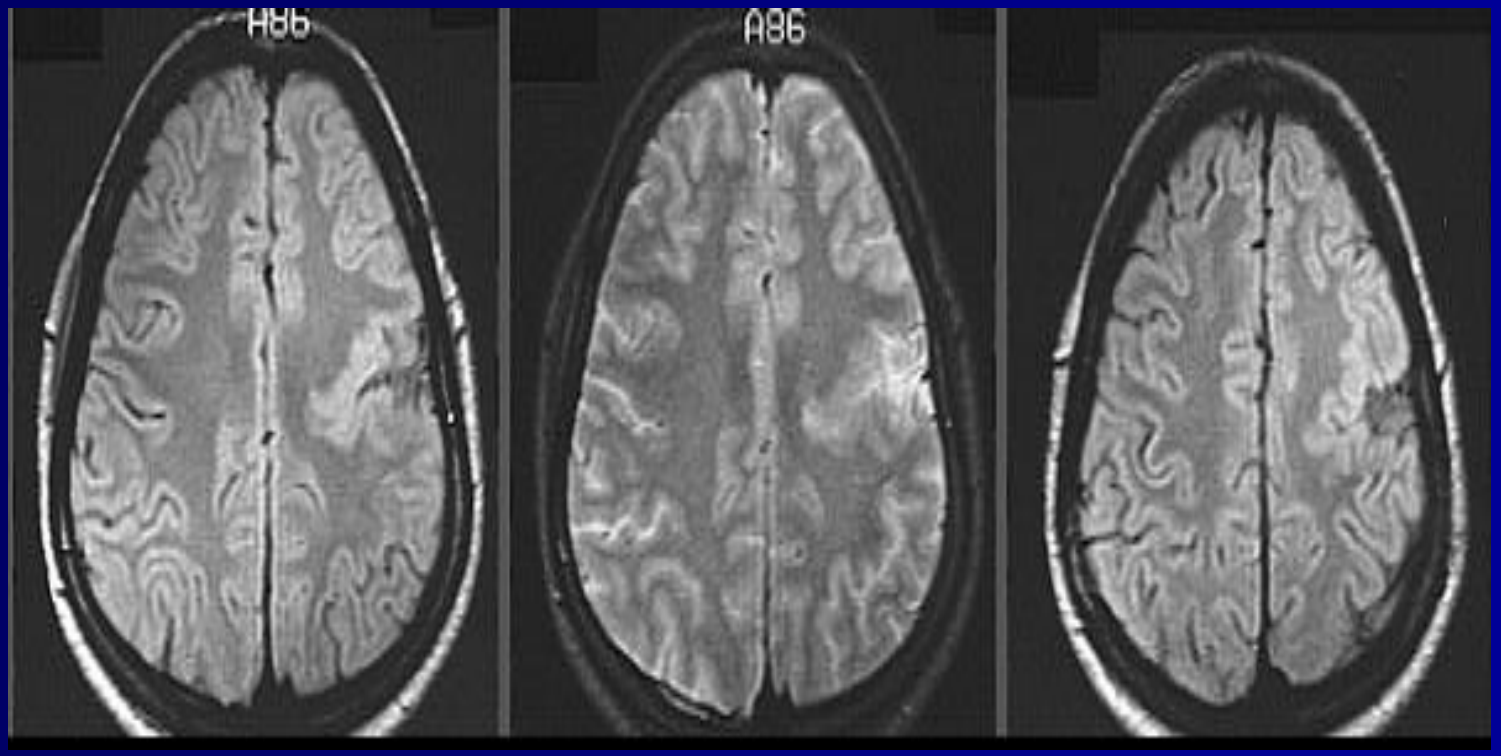
- **MRI**
  - Closed lip (type I): seen as nipple-like out-pouching at the ependymal surface.
  - open lip (type II): heterotopic gray matter lined CSF cleft seen extending from ventricular to cortical surface

V. Schizencephaly:

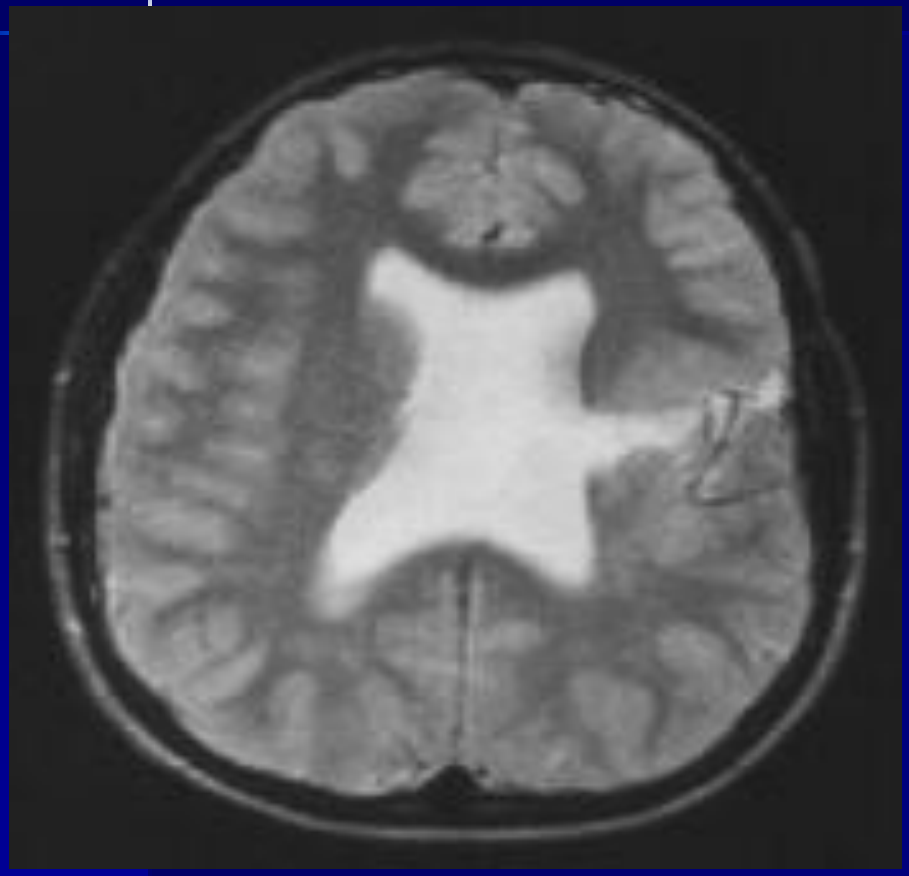
Differential diagnosis

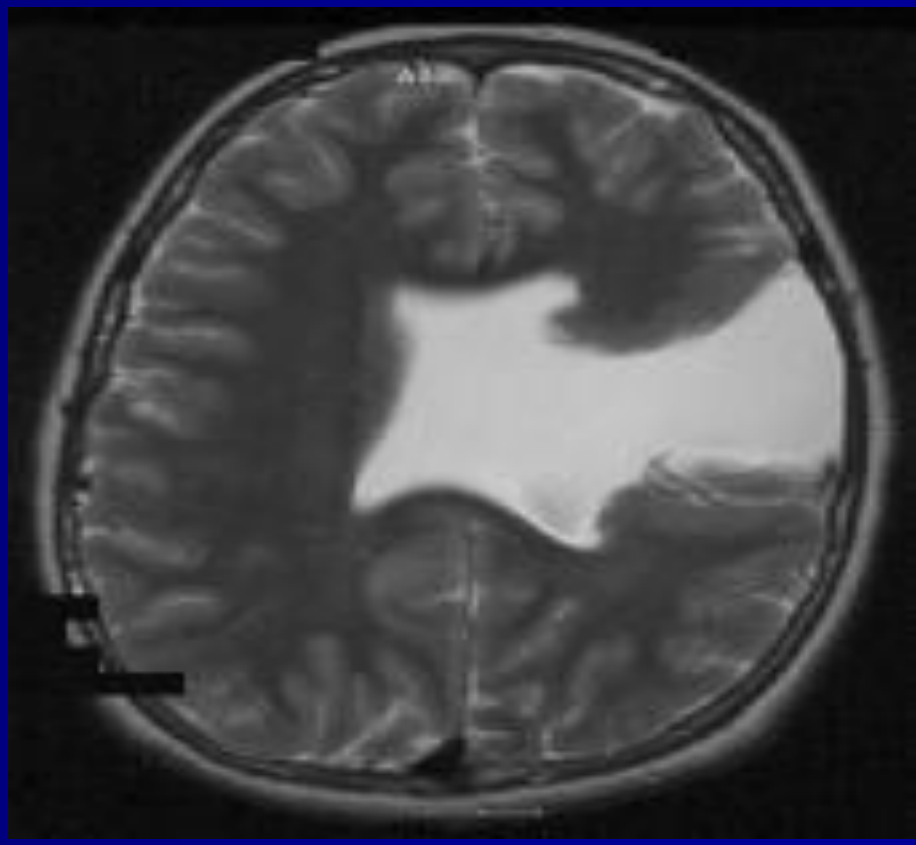
- focal cortical dysplasia
  - sometimes may have a cleft on the cortical surface that does not extend completely to the ventricular surface
- heterotopic grey matter
  - closed lip schizencephaly can mimic a band of grey matter heterotopia. Assessing the ventricular outline will often demonstrate a slight cleft whereas periventricular grey matter will usually bulge into the ventricle.
- porencephaly
  - a zone of encephalomalacia that extends from the cortical surface to the ventricular surface but is lined by gliotic white matter, not grey matter
  - it is worth noting that some authors would refer to schizencephaly as 'true porencephaly'

Schizencephaly:

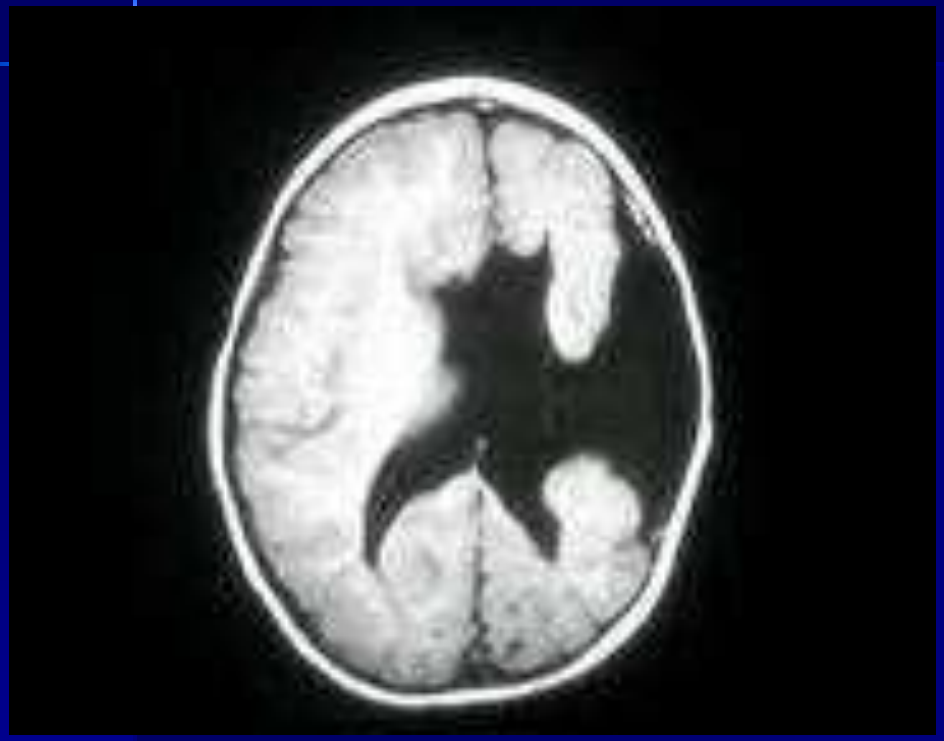


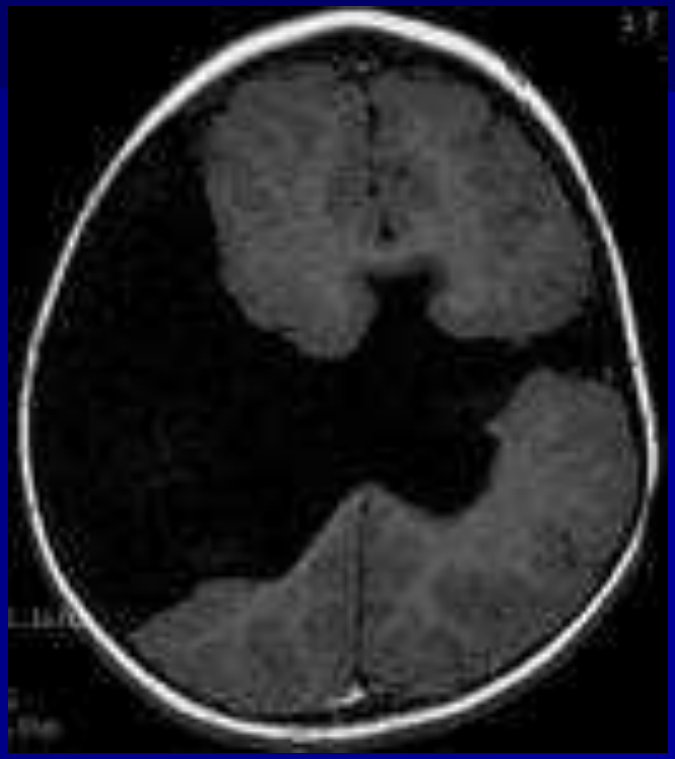
Schizencephaly:





Schizencephaly:





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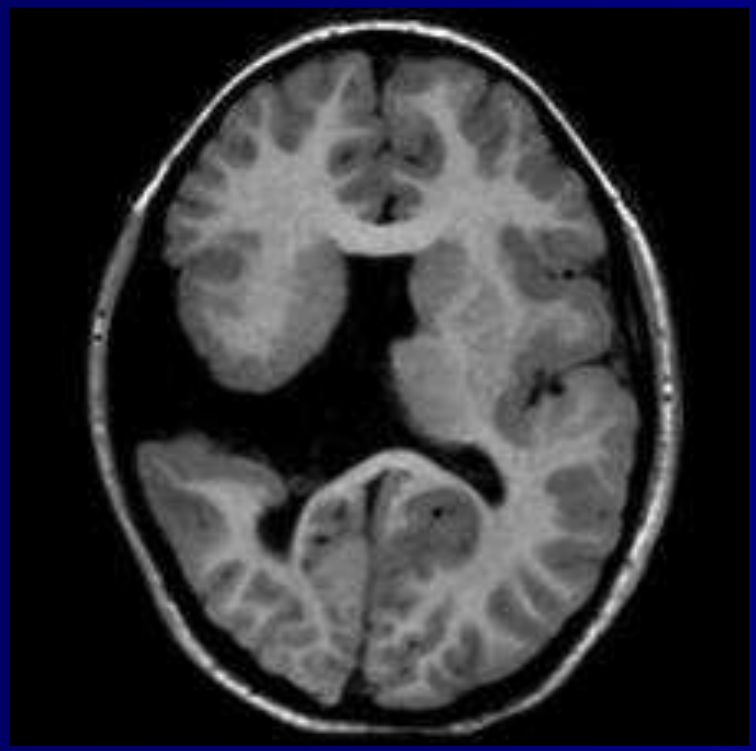
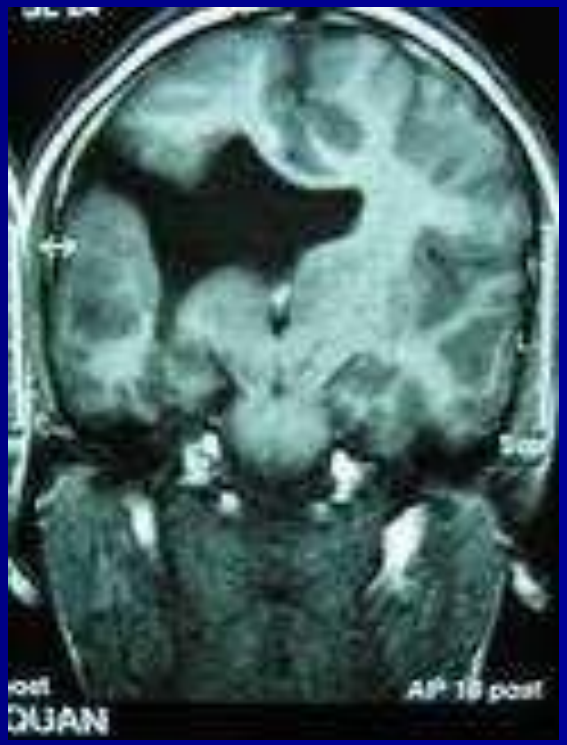
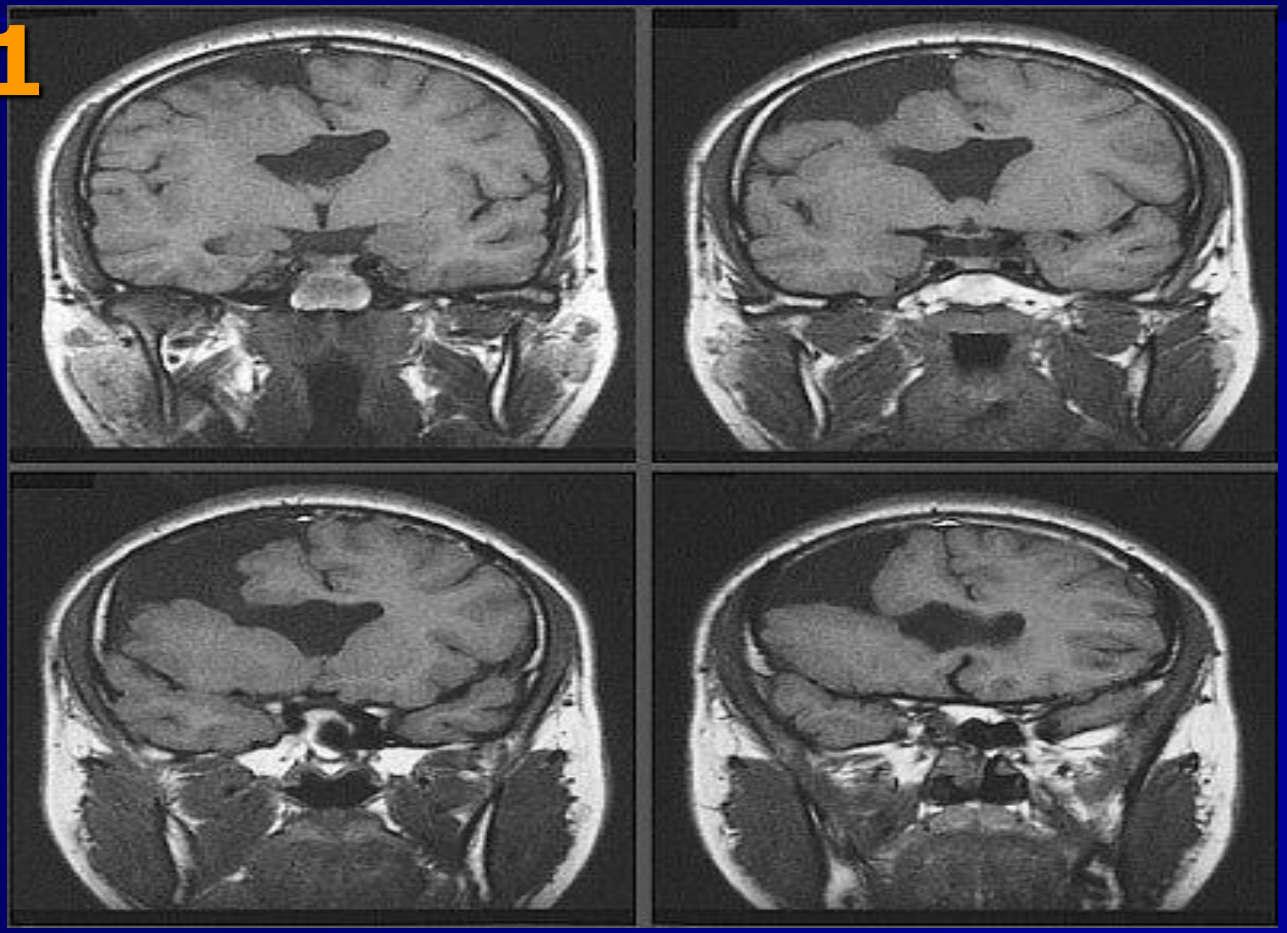




Schizencephaly:

T1



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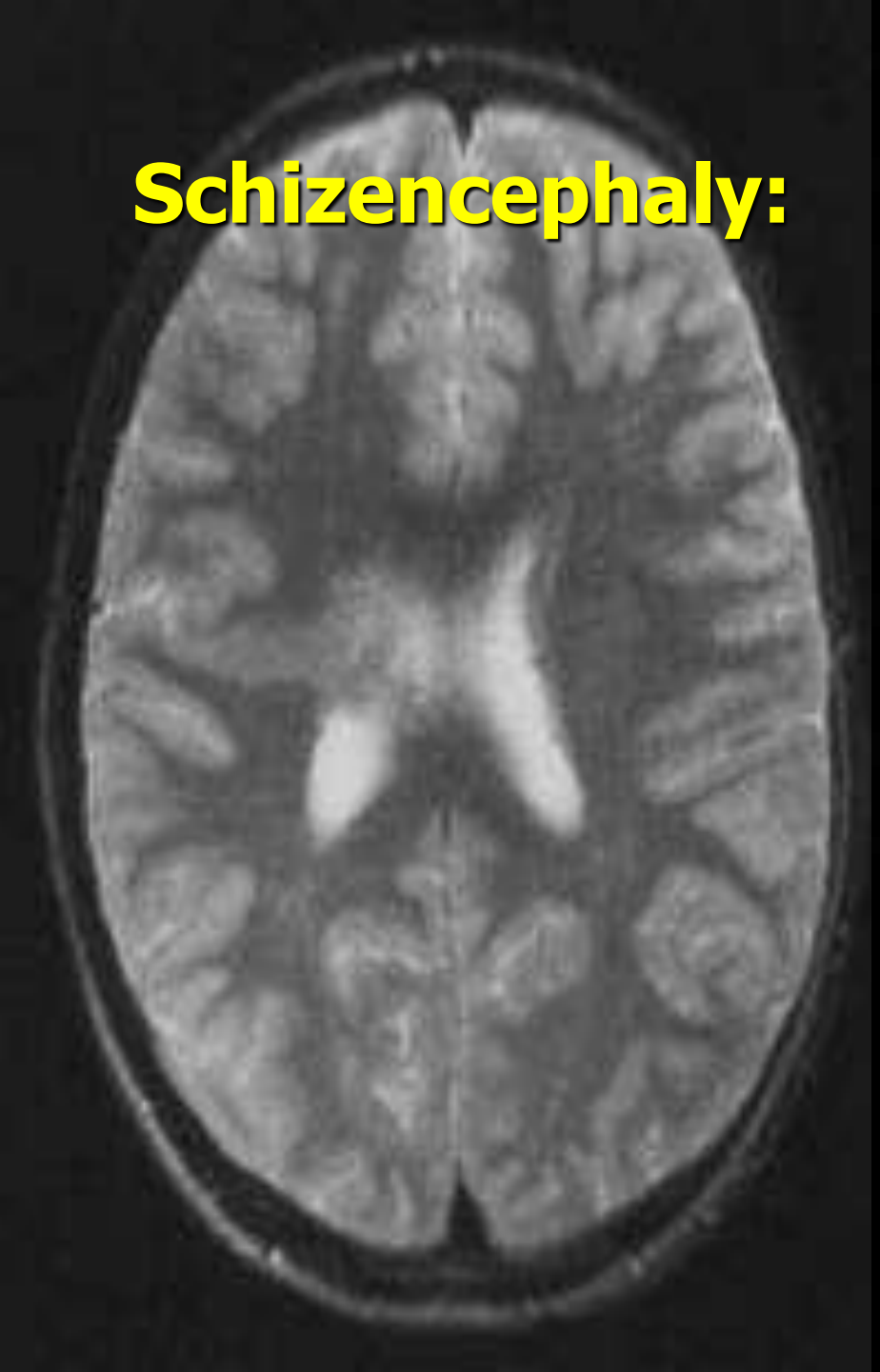
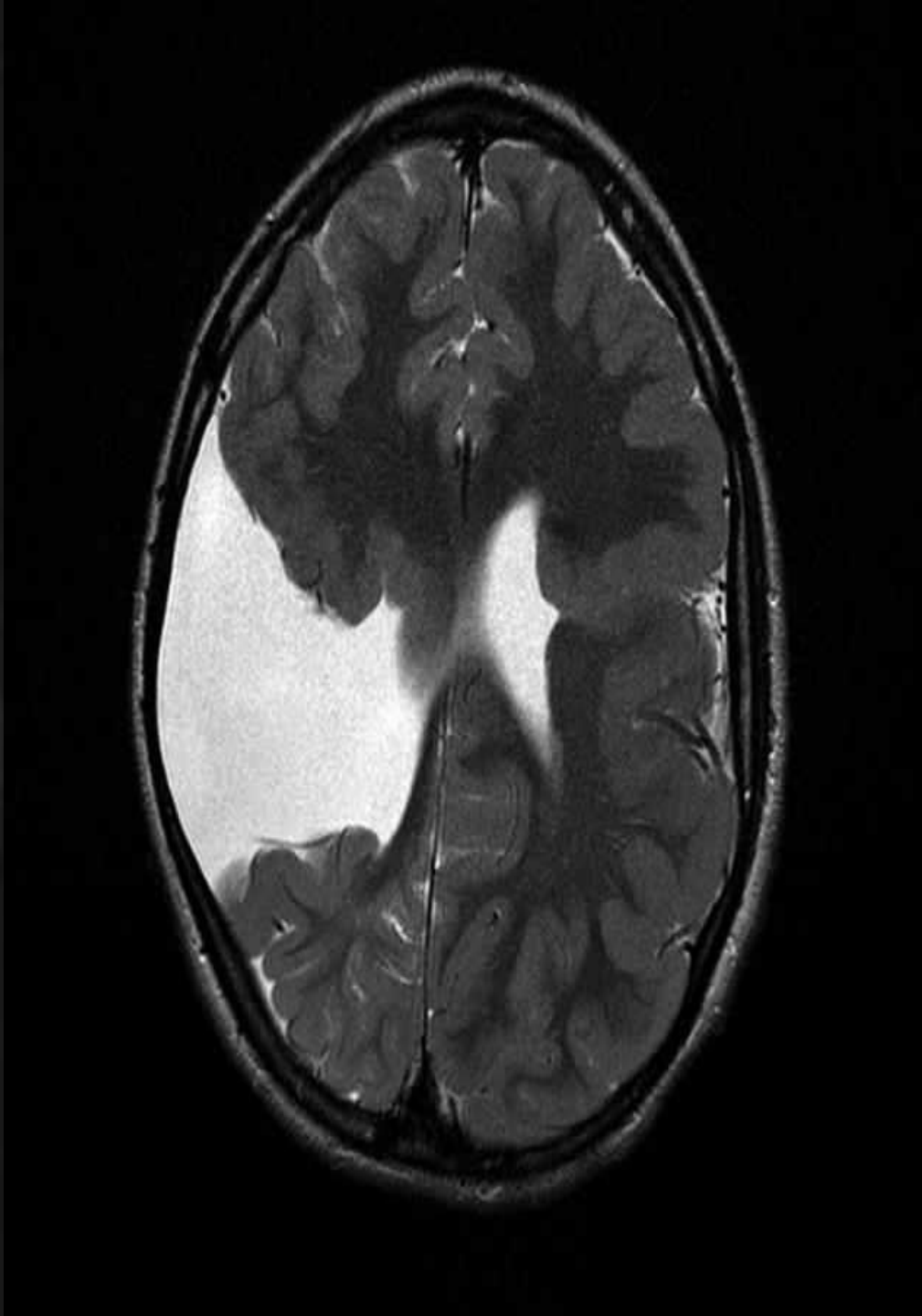




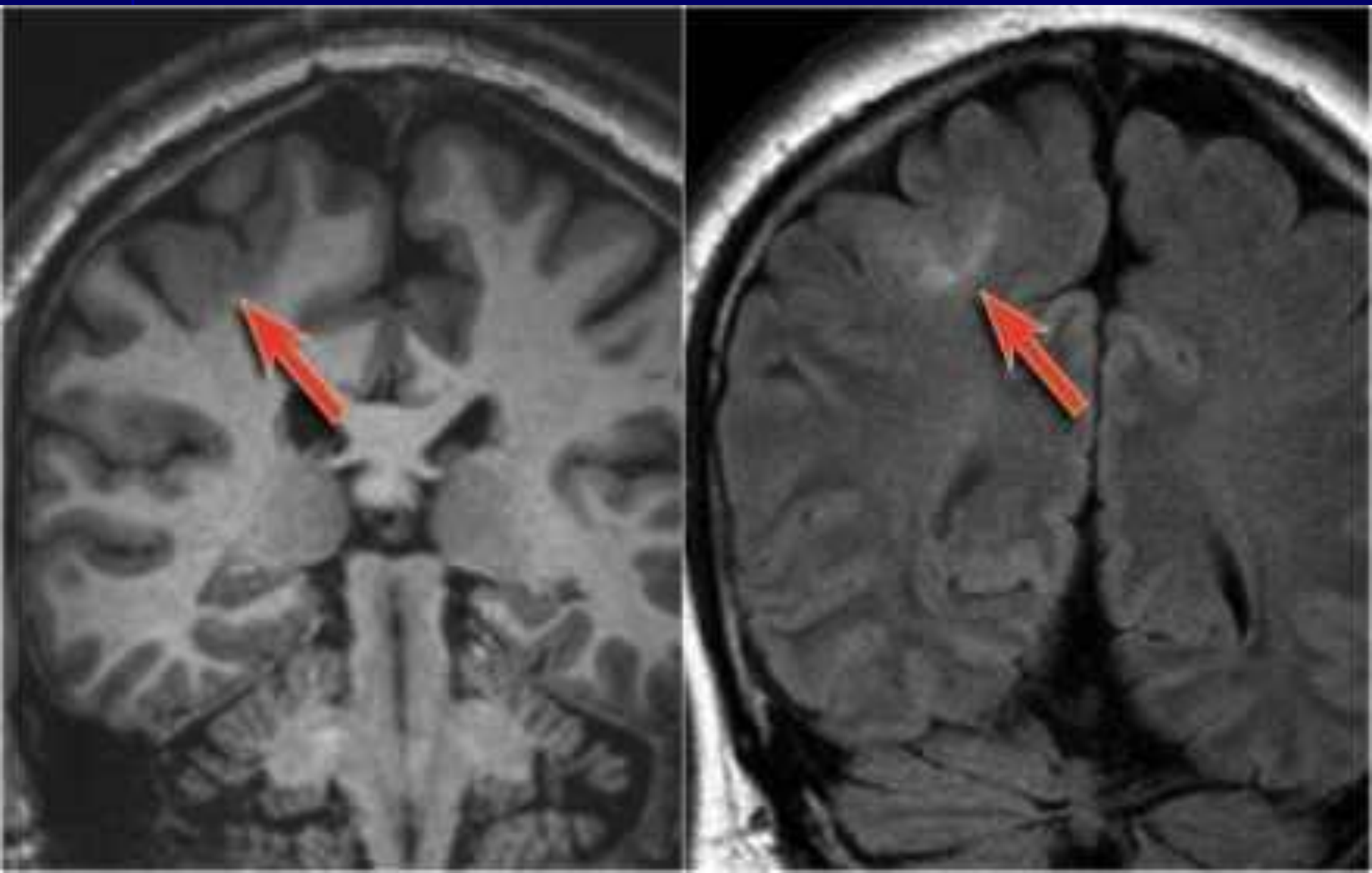
VI. Focal cortical dysplasia

- Focal cortical dysplasia is a congenital abnormality where the neurons fail to migrate in the proper formation in utero.
- MRI findings may be very subtle or may even be negative, therefore a high index of suspicion is mandatory!
- The most common findings are cortical or subcortical hyperintensities especially seen on FLAIR-images. These are often found at the bottom of a deep sulcus.
- Another finding is a blurred interface between grey and white matter, because the white matter looks a little bit like gray matter because it contains neurons that did not reach the cortex.

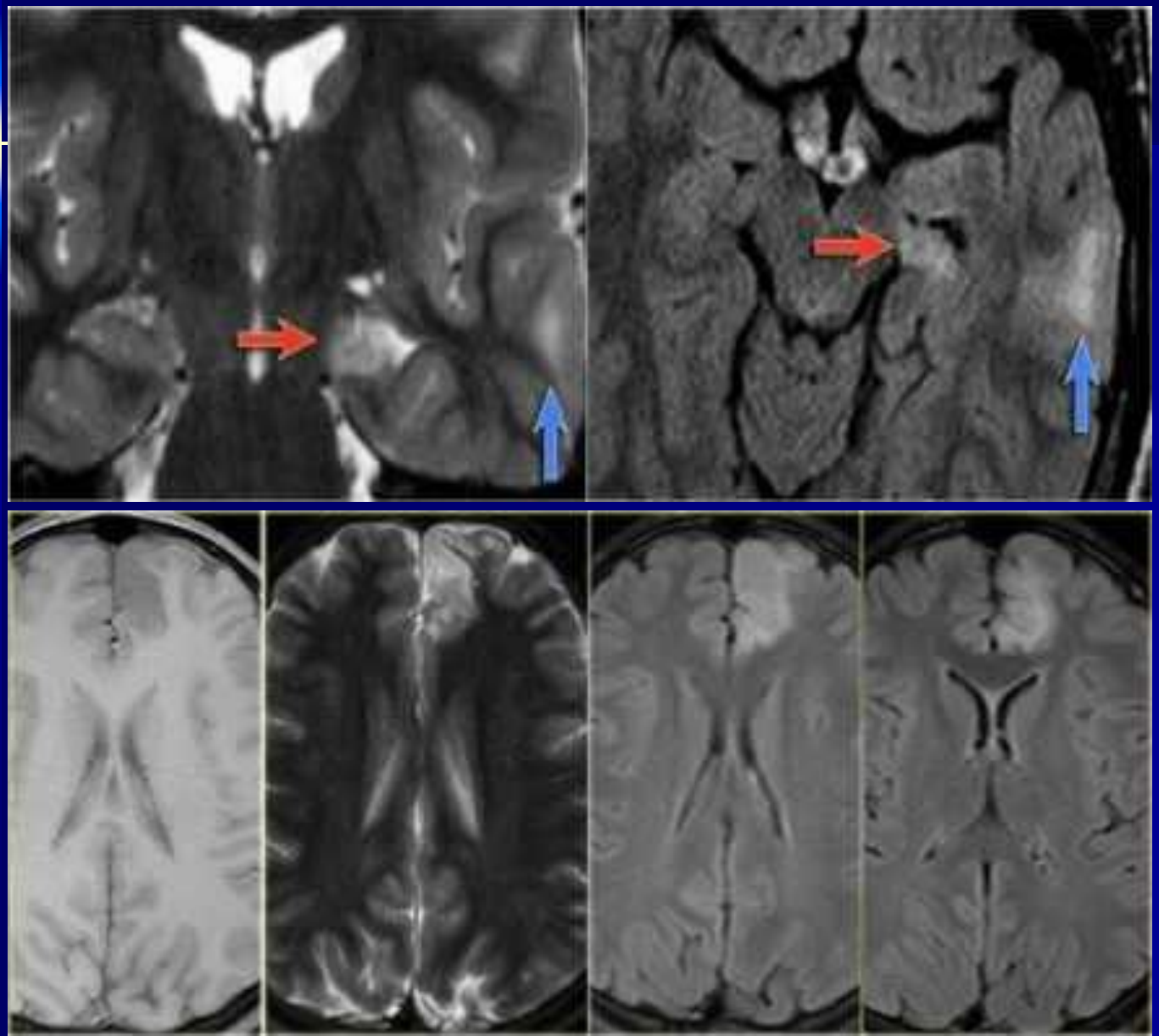
Focal Cortical Dysplasia - FCD

- Malformation of cortical development
- 5-25% of focal epilepsy
- Most common cause of refractory extratemporal epilepsy, especially in children
- MR-findings:
  - Subtle cortical/subcortical high signal
  - Often located at bottom of a deep sulcus
  - Blurred grey/white interface
  - Focal cortical thickening
  - Transmantle sign

VI. Focal cortical dysplasia



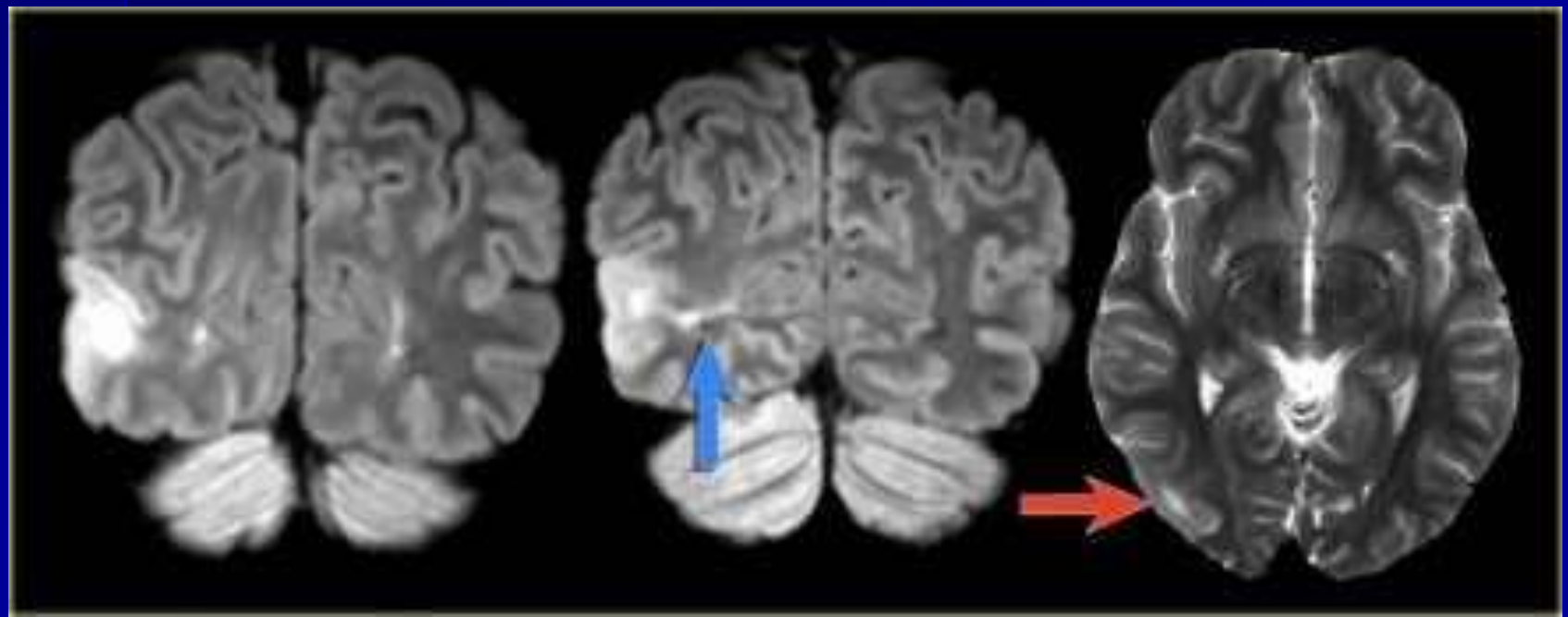
VI. Focal cortical dysplasia



VI. Focal cortical dysplasia

Transmantle sign

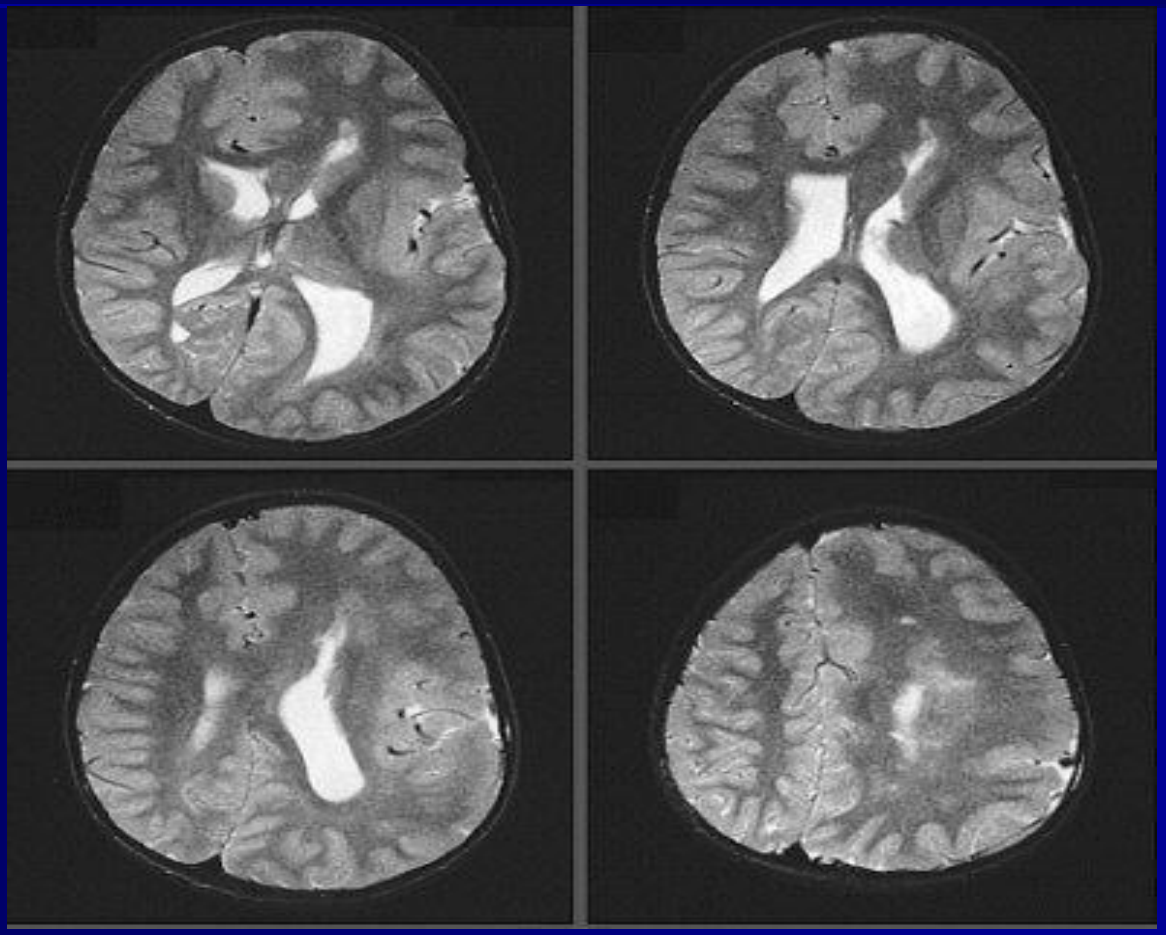
- Sometimes the hyperintensity is seen extending from the subcortical area to the margin of the ventricle. This is called the *transmantle sign*. This finding represents the arrested neuronal migration.



- **Unilateral Megalencephaly:**

  Hamartomatous overgrowth of a cerebral hemisphere with associated migrational anomalies

Hemimegalencephaly

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