


The Corpus Callosum

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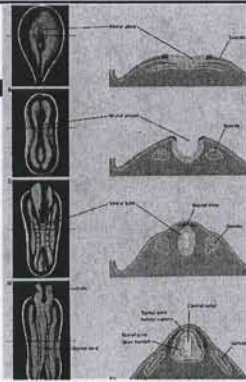
Major Events in Embryogenesis of the Brain

- Dorsal Induction
- Ventral Induction
- Proliferation
- Migration
- Organization
- Myelination

Dorsal Induction-Neurulation

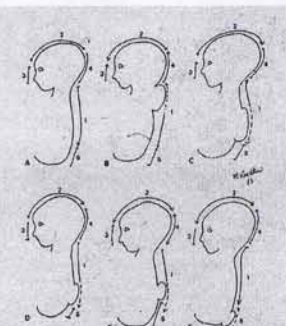
- Time: 3-4 weeks
- Major events:
 - Neural tube formation
 - Anterior neuropore closure
 - Posterior neuropore closure
- Disorders:
 - Craniorachischisis totalis
 - Anencephaly / encephalocele
 - Myeloschisis / meningocele

Neurulation




- Neural Placode
- Neural groove
- Neural Tube
- Spinal cord/brain

Multi Gene Closure of the Neural Tube

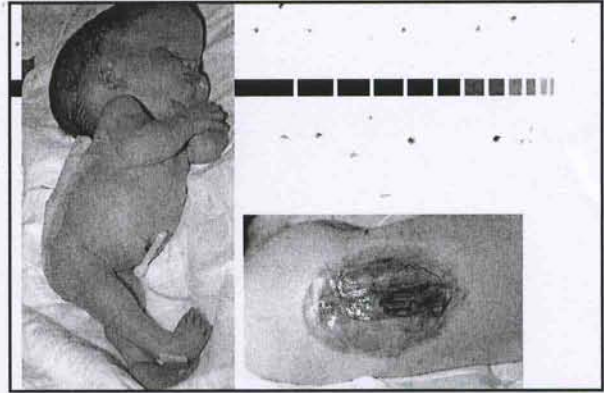


- At least 5 genes identified
- Most lesions at junction of two gene domains
- Three of the genes utilize folate as a cofactor in their function
- Molecular genetics of the genes is obscure

Anencephaly




- Defects of Gene 2 and 4 of neural tube closure
- Incompatible with prolonged survival
- ?donor tissue?



Ventral Induction

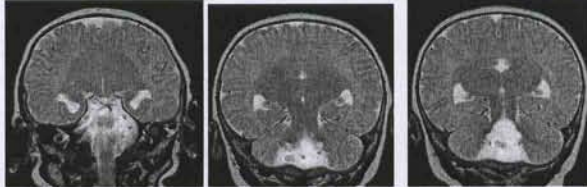
- Time:
 - 5-6 weeks
- Major events:
 - Forebrain / mesoderm interaction (Face)
- Disorders:
 - Holoprosencephalies, single cerebral ventricles with microcephaly

10 Month-old Female



- Hypotelorism
- Microcephaly
- ?large ears?
- Marked developmental delay
- Seizures
- Brain malformation?

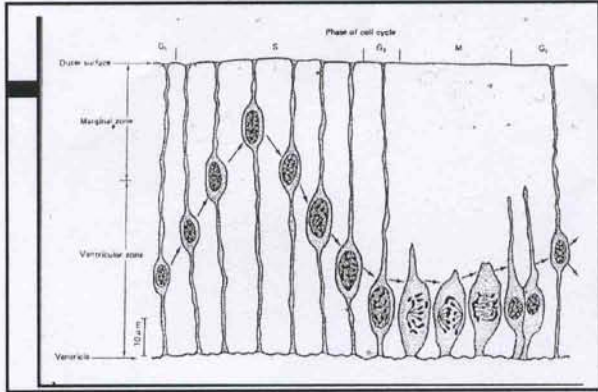
E. M. Coronal T-2



Fused thalami, absent inferior vermis, separate temporal horns

Proliferation

- Time:
 - 2-4 months
- Major events:
 - Neuronal and glial proliferation in periventricular zone
- Disorders:
 - Microcephaly vera
 - Apparently well formed, small brain
 - Megalencephaly
 - Apparently well formed large brain.



Macrocephaly



- Brain larger than normal but not functionally organized* normally due to overgrowth, lack of apoptosis etc.

Microcephaly Vera

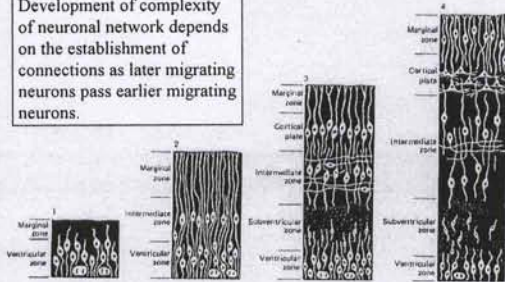


- Normal morphologically, the brain is smaller than usual with fewer neurons and/or fewer neuronal columns

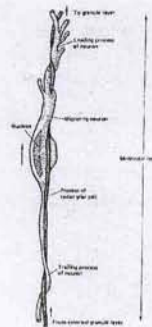
Migration Phase

- Time:
 - 3-5 months
- Major events:
 - Migration of glial then neural elements from periventricular zone to cortex
 - Formation of grey matter cortex and corpus callosum
- Disorders:
 - Schizencephaly
 - Lissencephaly
 - Pachygyria, polymicrogyria, heterotopia
 - Agenesis and hypoplasia of the Corpus Callosum?

Development of complexity of neuronal network depends on the establishment of connections as later migrating neurons pass earlier migrating neurons.

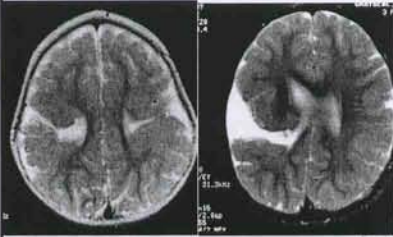


Migration of Neurons

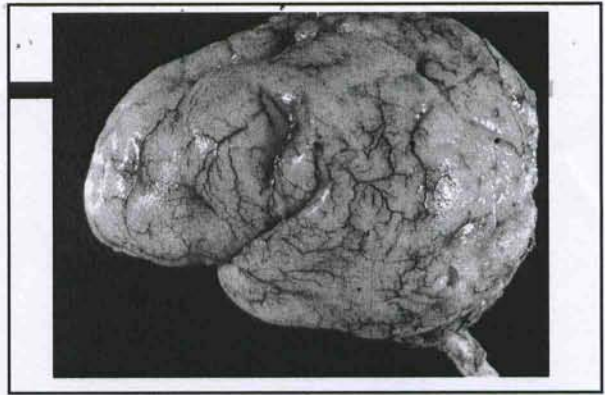


- Glial guides critical for normal neuronal migration
- Glial cells migrate first
- Many more cells migrate than will reside finally in cortex
- Neurons establish connections as they migrate through the superficial layers


Schizencephaly



Open lipped-
schizencephaly
And closed lipped
schizencephaly
depending on degree
of gray matter cover
over the cleft.



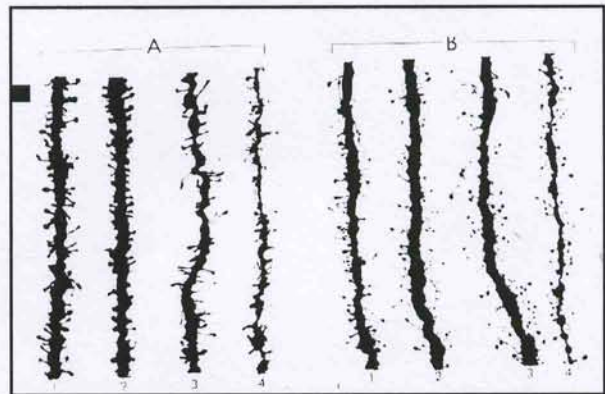
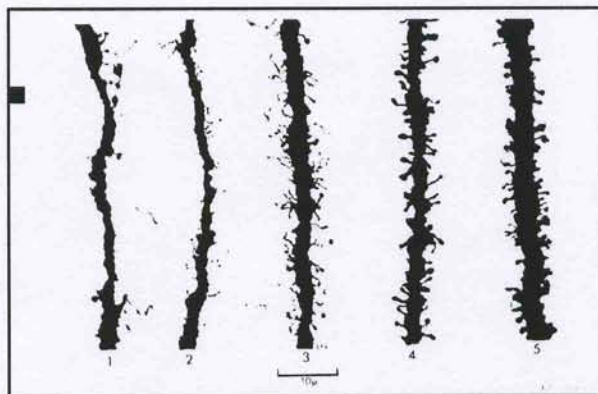
Polymicrogyria

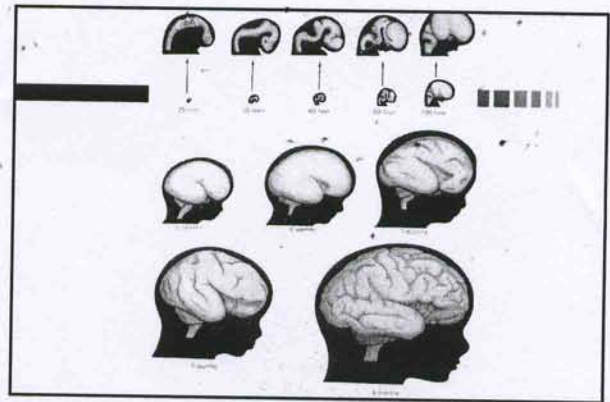
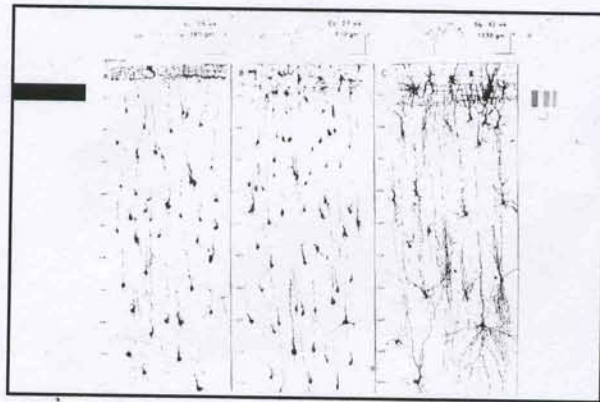


- Most frequently at lip of the Sylvian fissure
- Many causes but prenatal in origin most commonly

Organization

- Time:
 - 6 months gestation to 6-8 months of life
- Major events:
 - Dendritic, Synaptic and Axonal arborization
 - Selective cell death and glial proliferation
- Disorders:
 - Learning /processing difficulties
 - Mental retardation with normal gross brain structure





Development of the Brain

- Prosencephalic formation
- Concurrently with ventral induction beginning at about 6 weeks of gestation and proceeding from there.

Prosencephalic (Forebrain)formation

- Prosencephalic cleavage
 - Horizontal – Optic and Olfactory tracts
 - Transverse – Telencephalon / Diencephalon
 - Saggital – cerebral hemispheres, basal ganglia, ventricles
- Midline Prosencephalic development
 - Corpus callosum
 - Septum pellucidum
 - Optic chiasm
 - Hypothalamus

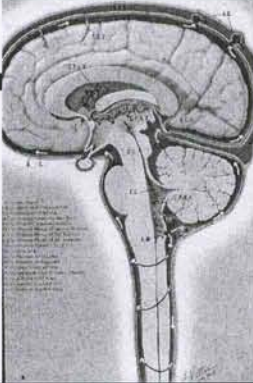
Disorders of Prosencephalic Development

- Prosencephalic formation
 - Aprosencephaly / Atelencephaly (anencephaly)
- Prosencephalic cleavage
 - Holoprosencephaly / Holotelencephaly
- Midline prosencephalic development
 - Agenesis of the corpus callosum
 - Absent septum pellucidum / cavum septum pellucidum?
 - Optic nerve / chiasm defects

Disorders of Midline Prosencephalic Development

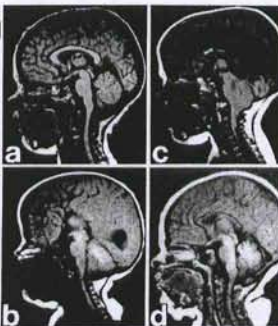
- Commissural plate
 - Corpus callosum
 - Septum pellucidum
- Chiasmatic plate
 - Optic chiasm, Septo-optic dysplasia
- Hypothalamic primordium
 - Septo-optic dysplasia with hypothalamic dysfunction
 - Growth failure, abnormal maturation, salt and water etc.

Anatomy of the Corpus Callosum



- Major structure containing fiber tracts from one hemisphere to the other
- Narrow variation in size relative to size of the brain
- Thickens in size between 11 and 15 years, then constant in size relative to brain

Anomalies of the CC

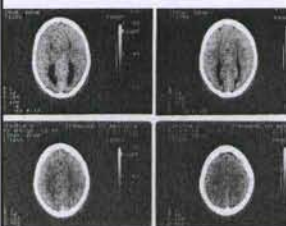


- A. Normal CC
- B. Absent CC (agenesis)
- C. Partial absence of CC, Also has Chiari II malformation of brain
- D. Hypoplastic CC, Thinner than normal due to decreased numbers of crossing fibers

Anomalies of the CC

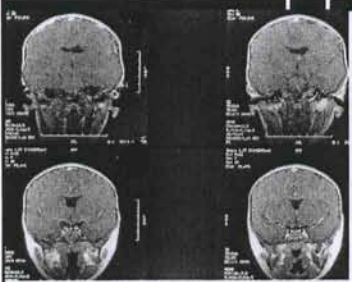
- Absence of CC
 - May occur as an isolated event (Defect of lamina terminalis)
 - Remainder of CNS may have developed normally
 - May occur as a part of more widespread midline developmental disturbance
- Partial absence of CC
 - Usually the result of disturbance of development in "mid stream"
 - The adverse influence may and usually does affect other areas of the brain also
- Hypoplastic CC
 - Decreased numbers of crossing fibers resulting in thin CC
 - Can be the result of extensive white matter destruction
 - More likely the result of global developmental disturbance

Colpocephaly in ACC



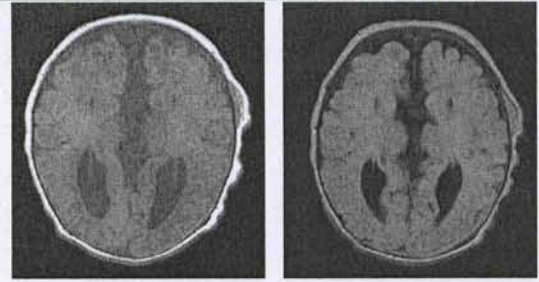
- Disproportionate dilatation of the posterior horns of the lateral ventricles
- Preservation of the fetal configuration of the lateral ventricles (Yakovlev 1940)
- Deficient development of the posterior cerebral white matter

Absence of the Septum Pellucidum




- Septo-Optic dysplasia
- Visual function often impaired
- Endocrine function often impaired
- Cognitive function often impaired
- Seizures frequent
- Salt and water regulation frequently impaired

Agenesis of the CC With Colpocephaly




Infantile Seizures



- Delay in development
- Hypotonia
- Poor head control
- No specific facial features

Microphthalmia With Coloboma




- These features constitute the features of a disease known as Aicardi syndrome.
- Midline defects of brain including cerebrum and cerebellum and optic nerves

Aicardi Syndrome


- Most common presentation is with Infantile Spasms
- Females affected
- Xp22
- X-linked dominant
- Lethal in males
- Gene not yet identified
- All cases represent new mutations
- Influence of paternal age

Chiari II Malformation




- Abnormal "kink" of mesencephalon
- Beaked quadrigeminal plate
- Cerebellar tonsils herniated to the cervical spinal canal
- Syrinx
- Associated with MM (dorsal induction defect)

Syrngomyelia




- Chiari I
- Chiari II
- Other malformations of the cord

7 Year-old female



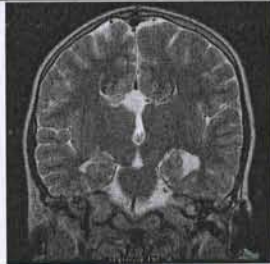
- Hypertelorism, Apparent and real
- Broad bridge of nose
- Low hair line
- Short neck
- Low-set malformed ears

Dysmorphic features




- Flat nose
- ?receding jaw
- Low set ears
- Low hair line
 - Particularly posterior

Agensis of the Corpus callosum



- Median Facial Cleft syndrome
- Also seen with other midline malformation syndromes
 - CATCH 22 syndromes
 - Oleft lip and palate
 - Many others

10 Year-old with Heart lesions and developmental delay

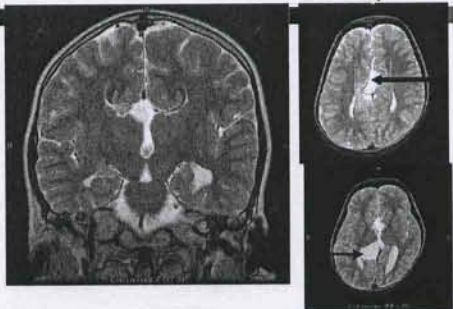


- Narrow face
- Prominent bridge of nose
- ASD, VSD, Conotruncal heart lesion
- High narrow palate
- Growth failure

CATCH 22 Spectrum

- Shprintzens syndrome
- DiGeorge, ACF etc.


MRI of a Child With Developmental Delay



Shprintzen's Syndrome

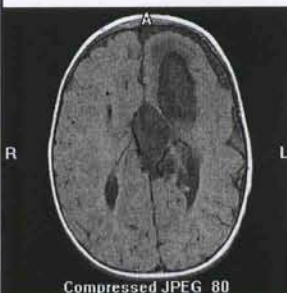
- Brain anomalies
 - Colpocephaly
 - Heterotopias
 - Hypoplastic CC
 - Agensis of CC
 - Hypothalamic anomalies
 - Chiasmatic anomalies
 - Atrophy
 - Small Posterior fossa

A-CC with Midline Cyst



- Lipoma and cyst formation common with interruption of the CC development
- May develop in conjunction with the CC or may develop instead of the CC or may be the result of tissue loss or injury during the development of the CC

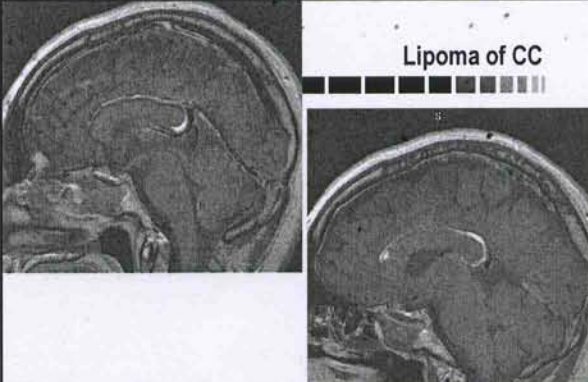
A-CC



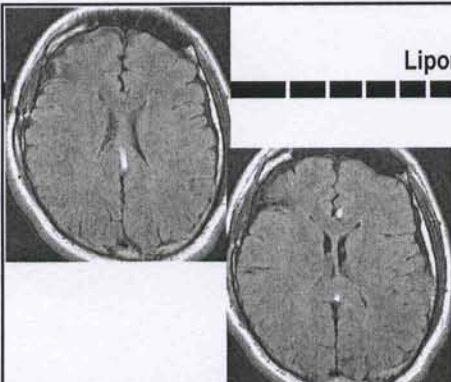
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- Agenesis of the corpus callosum with
- Midline arachnoid cyst formation and
- Entrapment of the left lateral ventricle and unilateral hydrocephalus
- Note migrational abnormality of left frontal lobe gray matter

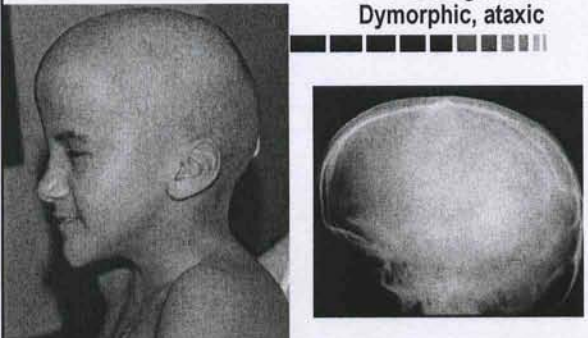
Lipoma of CC



Lipoma of CC



**9 Y-O Large head
Dymorphic, ataxic**



Dandy-Walker



- Agenesis of the Corpus Callosum
- Cystic dilatation of the 4th ventricle
- Absence of the cerebellar vermis (midline cerebellum)

8 Year Old Girl



- In regular class
- LD teacher also
- School picture