• Psychomotor development
• Mental retardation

Viktor Farkas M.D.
First Dept. of Pediatrics
Semmelweis University,
Budapest

1. Bulbus oculi
2. Cavum nasi
3. N. opticus
4. Sinus sphenoidalis
5. M. rectus med.
6. Lobus temporalis
7. Art. ophthalmica
8. Sella turcica
9. Pons
10. Ventriculus quartus
11. Vermis cerebelli
12. Lobus occipitalis

Csillag A, Atlas of Medical Imaging, Koenemann, Cologne, 1999

T1 súlyozott axiális MRI felvétel

Development of the Human Brain
Development of the Human Brain

- 9 months
- 7 months
- 5 months

Genes involved in neuronal migration

- FLNA: X-linked periventricular nodular heterotopia
- ARFGEF2: X-linked periventricular nodular heterotopia
- LIS1: isolated lissencephaly (lissencephaly type I)
- DCX: X-linked isolated lissencephaly (lissencephaly type II)
- ARX: X-linked lissencephaly with abnormal genitalia (XLAD)
- Reelin: lissencephaly with cerebellar hypoplasia (LCHb)
- VLDLR: simplified gyration with cerebellar hypoplasia
- POMT1: Walker-Warburg Syndrome (lissencephaly type II)
- POMT2: Walker-Warburg Syndrome (lissencephaly type II)
- POMGnT1: Muscle-Eye-Brain Disease (lissencephaly type II)
- Fukutin: Fukuyama Congenital Muscular Dystrophy (liss. type II)
- FKRP: congenital muscular dystrophy with cerebellar hypoplasia
- LARGE: congenital muscular dystrophy with cortical malformation
- GPR56: bilateral frontoparietal polymicrogyria

Key Processes

<table>
<thead>
<tr>
<th>Process</th>
<th>Age beginning</th>
<th>Greatest period of activity</th>
<th>Age of equilibrium</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axogenesis</td>
<td>first trimester</td>
<td>1 year</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Migration</td>
<td>first trimester</td>
<td>in utero through first year</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Differentiation</td>
<td>first trimester</td>
<td>throughout first year</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Apoptosis</td>
<td>third trimester</td>
<td>2-4 year</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Arborization</td>
<td>third trimester</td>
<td>fast year</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Synaptogenesis</td>
<td>third trimester</td>
<td>1-2 months</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Synaptic</td>
<td>birth</td>
<td>first few years</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Myelination</td>
<td>birth</td>
<td>first few years</td>
<td>N/A</td>
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</tr>
</tbody>
</table>
- subependymal / periventricular nodular heterotopia (PNH)
- lissencephaly type I (LIS I) / Double Cortex Syndrome (DCS)
- lissencephaly with abnormal genitalia (XLAG)
- lissencephaly with cerebellar hypoplasia (LCHb)
- lissencephaly type II (LIS II)
- bilateral frontoparietal polymicrogyria (BFPP)

Periventricular Nodular Heterotopia (PNH)
- associated with epilepsy
- up to 80%
- freq. begin after age 20
- mostly focal seizures
- cognitive impairment
- coagulopathy / vasculopathy (stroke / patent ductus art. Botalli)
- abortions

Periventricular heterotopia: a disorder at the start of migration
- Subsets of neurons fail to migrate from the periventricular region during corticogenesis
- PVNH due to mainly loss-of-function mutations in FLNA on Xq28
- FLNA is an actin-binding protein

Microlissencephalia

Autosomal recessive primary microcephaly
- Primary / true microcephaly is a subclass of microcephaly:
  - significant reductions in cerebral cortical size without displaying other gross abnormalities
- Affected individuals can have mild to moderate mental retardation and infrequently, epilepsy

<table>
<thead>
<tr>
<th>Condition</th>
<th>15 weeks</th>
<th>20 weeks</th>
<th>Birth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mature brain / cortex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pyramidal / associative</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Subplate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myelination</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Synaptogenesis, myelogenesis, 
  proliferative | | | |
| Sexual differentiation—gonadal | | | |

Figure 1: Rate of brain growth in model neurologic development in relation to timing of several landmark phases of development. Figure adapted from Rondal et al. (2000).
Development of locomotion

- Mothers are usually (but not always) right
- Social, cultural and ethnic factors
- Normal variations in development

Development of locomotion

- A, ventral suspension
- B, prone position
- C, sitting
- D, standing and walking
- E, manipulation (evolution of grasps)
- F, sphincter control

Development of locomotion

- Moro reflex
- Parachute reaction
- ........

Moro reflex:

Ventral position: Abnormal newborn

Ventral suspension

A, normal
B, pathological
Abnormal newborn

Development of locomotion

- Prone position

Development of locomotion

- Sitting

Sitting: normal newborn

Primitive Reflexes – Stepping

- Primitive Reflexes - Stepping
  With the baby held in vertical suspension and his feet touching the mat, he does not have the expected reciprocal flexion and extension of the legs. The stepping or walking reflex is absent in this baby.
Head Circumference

• Another very important part of assessing brain development is measuring the growth of the brain. This is accomplished by measuring the head circumference, which is an accurate reflection of brain size. The brain grows to 80% of its adult volume during the first 2 years of life so many neurological diseases that occur early in life will impact the growth of the brain. A small head (microcephaly) or a large head (macrocephaly or hydrocephalus) can be key findings in explaining the neurological abnormalities of a child.
• It is essential to plot head circumference on a standardized head growth chart such as the Nellhaus chart.

SPECIAL PROGRAMS
Neurodevelopment Assessment

• Attentional based disorders
• Dyslexia and language related learning difficulties
• Study and organizational problems
• Non-verbal learning disabilities
• Emotional/Behavioral problems
• Written Expression problems
Developmental Milestones

- The neurological examination of the pediatric patient must be couched in the context of neurodevelopmental milestones. The normal neurological findings one would expect for a newborn are certainly different than a 2, 6 or 12-month-old infant. Obtaining developmental milestones is an important reflection of the maturation of the child’s nervous system and assessing development is an essential part of the pediatric neurological examination. Delay in obtaining developmental milestones and abnormal patterns of development are important indicators of underlying neurological disease.

Diseases - Therapies

- Speech Therapy
- Occupational Therapy or Physical Therapy
- Vision Therapy
- Applied Behavioral Analysis Therapy
- Neurodevelopment Therapy
- Specific Educational Therapy
- ADD/ADHD
- The Ritalin-Free Child: Managing Hyperactivity Without Drugs by Diana Hunter (ISBN 0962833681
- Autism (also PDD)
- Asperger Syndrome
- Auditory Processing Dysfunction
- Dysgraphia
- Dyslexia
- Mental Retardation
- Sensory Processing Dysfunction
- Speech Disorders
- Vision Impaired

Cerebral Palsy

a persistent disorder of

- movement and
- posture

Risk factors for CP

- multifactorial
  - preterm birth
  - multiple gestation
  - intrauterine growth restriction
  - male sex
  - low Apgar scores
  - intrauterine infections
  - maternal thyroid abnormalities
  - prenatal strokes
  - birth asphyxia
  - maternal methyl mercury exposure
  - maternal iodine deficiency

Risk factors for CP

- prenatal factors result in 70-80% of cases of CP
- In most cases:
  the exact cause is unknown but is most likely multifactorial

Clinical course of CP

CP generally is considered to be

static encephalopathy or

nonprogressive in nature !!!!
Prevalence
• Worldwide incidence of CP is approximately 2 to 2.5 per 1000 live births.
• Each year about 10,000 babies born in the US develop CP.
• Data from the Northern Ireland Cerebral Palsy Registry revealed that ½ the children with CP were of low birth weight (i.e., less than 2500 grams).

Economic Impact
A California study (1992) of the extra economic costs associated with CP and 17 other congenital disorders (e.g., Down syndrome, spina bifida) showed that CP had the highest lifetime costs per new case, averaging $503,000 in 1992 dollars.

Rate of Cerebral Palsy
• Rate of cerebral palsy per 1000 live births across Europe by year and severity