Cortical Dysplasia

Gregor Kasprian

Universitätsklinik für Radiologie und Nuklearmedizin
www.meduniwien.ac.at/radnuk
Definition

“Cortical dysplasia“

• Disorder of cortical development
• Cortical dysgenesis
• Neuronal migration disorder
• Malformation of cortical development
Classification


- **Group 1:**
  abnormal neuronal and glial proliferation

- **Group 2:**
  abnormal neuronal migration

- **Group 3:**
  abnormal postmigratory development

http://www.rsna.org/A_James_Barkovich_MD.aspx
Prenatal Concept

“Poliakov-Sidman-Rakic-Kostovic classification”

Poliakov GI (1949) Structural organization of the human cerebral cortex during its ontogenetic development. Medgiz, Moscow, pp 33–91
Prenatal Origin

“protomap hypothesis“
“cells know their destiny before they have arrived“


https://en.wikipedia.org/wiki/Pasko_Rakic#/

A

CF  CP  LV  VZ

B

https://en.wikipedia.org/wiki/Pasko_Rakic#/
Prenatal Concept or "when to look where for "cortical" dysplasia"

Search in the Right place at the Right time!

(Peri)ventricular

Lamination!

Cortical

developmental stage

0-16 GW
16-24 GW
24 GW - postnatal

bRGC: Basal (SVZ) radial glial cell
CP: Cortical plate
IPC: Intermediate progenitor cell
MZ: Marginal zone
NPC: Neuroepithelial progenitor cell
SP: Subplate
SVZ: Subventricular zone
VZ: Ventricular zone

Order of birthdate and lamination
Intracerebral projections
Subcerebral projections

Migrating interneuron
Origin

Neuronal Migration

Fetal Brain MRI
excellent tissue contrast

20 GW

3 Tesla postmortem MRI

Histology

1.5 Tesla In vivo MRI
Compartments of the Fetal Brain

20 GW

Fetal MRI of Normal Brain Development.
Compartments of the Fetal Brain

20 GW

(Sub-)Ventricular Zone and Ganglionic Eminence
Ganglionic Eminence

GW 21

postmortem

3D segmentation
Ventricular Zone

Irregular lining/borders

subependymal heterotopia

22GW

26GW

24GW

2nd pregnancy

2nd pregnancy/FU
Ventricular Zone

Irregular lining/borders

FLNA Mutation:
c6078dupC frame shift mutation

2nd pregnancy

2nd pregnancy/FU

maternal MRI
Ganglionic Eminence
Thickening

23 GW

arrested migration
Search in the Right place at the Right time!

Isolated CCA?

20+4

Thickening

Ganglionic Eminence

Thickening

Hemimegalencephaly

Unilateral Enlargment „too much“ Proliferation
Fetal DTI – GE “fibers”

Vimentin

et al. NeuroImage, 2006;15;33:27
Fetal DTI – GE “fibers”

GW 29+4

Walker Warburg
Ganglionic Eminence

Persistence

GW 26

GW 29
Ganglionic Eminence
Thickening and destruction

Pyruvate dehydrogenase deficiency

GW 20 GW 21, postmortem MRI
Compartments of the Fetal Brain

(Sub-)Ventricular Zone and Ganglionic Eminence
Compartments of the Fetal Brain

Intermediate Zone
Intermediate Zone
Abnormal axon guidance

34GW  
Frontal Polymicrogyria

25GW  
Heterotopia.
Abnormal Gyration

28GW  
Heterotopia,
Dysplasia
Intermediate Zone
Abnormal axon guidance

- trisomic for 1q32.2,
- monosomic for 1q44

Aicardi Syndrome
- Frontal Polymicrogyria
- Heterotopia. Abnormal Gyration
- Heterotopia, Dysplasia
Compartments of the Fetal Brain

Intermediate Zone
Compartments of the Fetal Brain

Cortical Plate + Subplate
Absence of subplate

T2w bright!

normal 22GW

DWI dark!

Lissencephaly Type 1

22GW

Search in the Right place at the Right time!

Top Magn Reson Imaging 2010;21; 387-394.
Cortical plate

FGF2R downregulation affects migration at late stages!

Apert Syndrome

Acrocephalosyndactyly

abnormal head shape
Cortical plate

Apert syndrome

Brain involvement?

“52% of patients with Apert's syndrome had an IQ below 70.”


“hippocampal anomaly is a primary abnormality related to maldevelopment of the limbic system.”

Cortical plate

FGF3R Mutations, thanatophoric dysplasia

#1 (GW 16+5)  #3 (GW 19+5)  #6 (GW 20+0)  #4 (GW 21+6)  #5 (GW 22+2)
Search in the Right place at the Right time!