



1

Compartmental organization of the brain with related axonal pathways.

- Deep (periventricular) compartment**
- Corpus callosum – (segment I)
 - Fronto-occipital fascicle (FOF) – (segment I)
 - Cortico-striatal fibers (Muratoff's fascicle) – (segment I)
 - Fronto-pontine pathways – (segment I)
- Intermediate compartment**
- Crossroads of projection pathways – (segment II) Ila
 - Thalamocortical fibers
 - Cortico-fugal fibers
 - Callosal radiation
 - Associative sagittal fibers
 - Sagittal axonal strata – (segment II) IIb
 - Thalamocortical pathways
 - Basal forebrain cholinergic afferents
 - Cortico-cortical associative fiber system
 - Centrum semiovale – (segment III)
 - Long associative fiber system
 - Projection fibers
- Superficial compartment**
- Gyral white matter – (segment IV)
 - Short cortico-cortical fibers
 - U-fibers
- Subplate/subplate remnant
- Growing front of all afferent pathways
 - Short cortico-cortical fibers
- Intracortical fibers – (segment V)

大腦白質の発達の区分

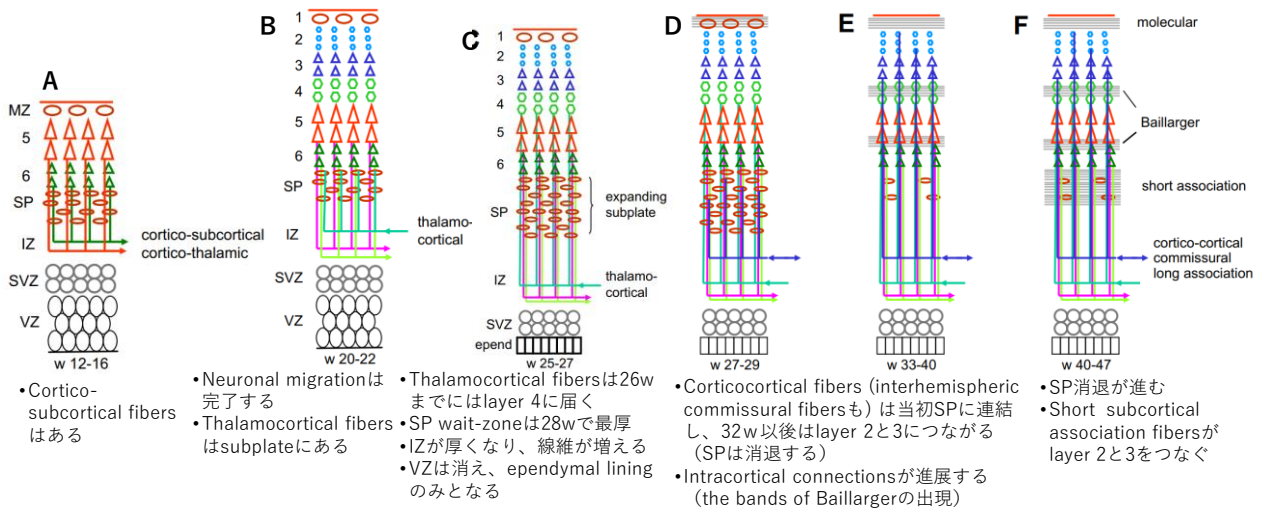
Kostović I et al. Developmental dynamics of radial vulnerability in the cerebral compartments in preterm infants and neonates. Front Neurol . 2014;5:139.

Von Monakowのsegment Crossroads Sagittal strata Subplate

	Deep periventricular	Intermediate		Distal (superficial)
Compartments (where?)	Segment I (periventricular pathway)	Segment II (crossroads and sagittal strata)	Segment III (centrum semiovale)	Segment IV and V (gyral white matter and cortical white matter) Subplate
Axonal pathways classes (what?)	Callosal, associative (FOF) and motor (corticostriatal and corticopontine)	Sensory (thalamocortical) Motor (pyramidal)	Long associative (FLS, FA, FLI, etc.) Sensory	Short cortico-cortical (U fibers) Intracortical
Schematic representation of pathways (connectivity)				

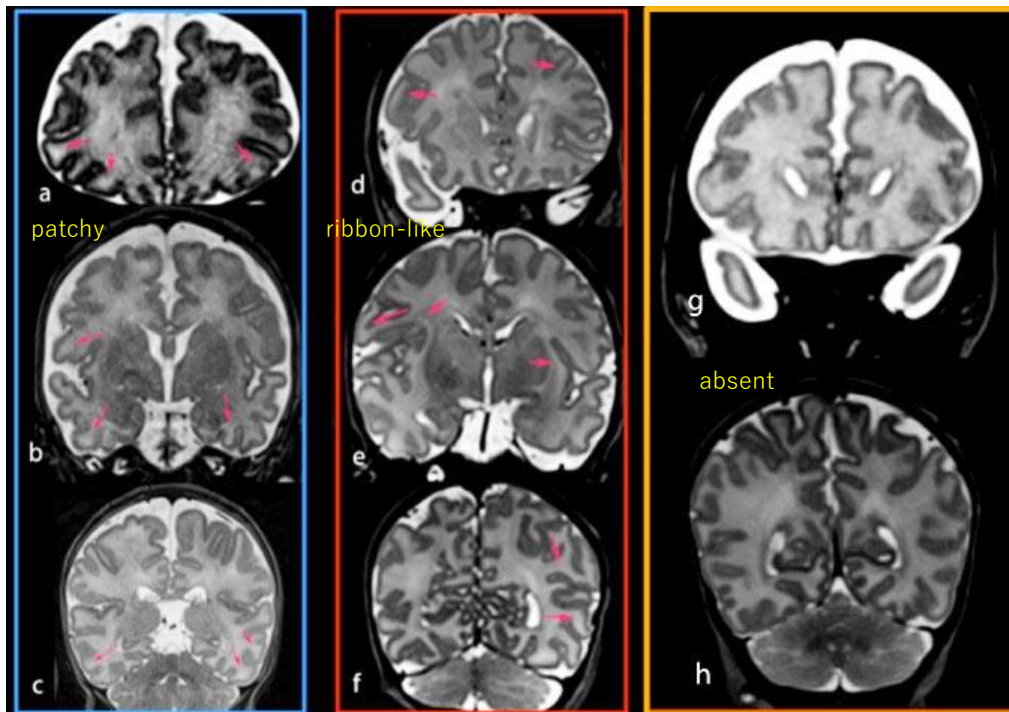
2

Development of the connectivity



Raybaud C, Widjaja E. Development and dysgenesis of the cerebral cortex: malformations of cortical development. Neuroimaging Clin N Am 2011;21:483-543.

5



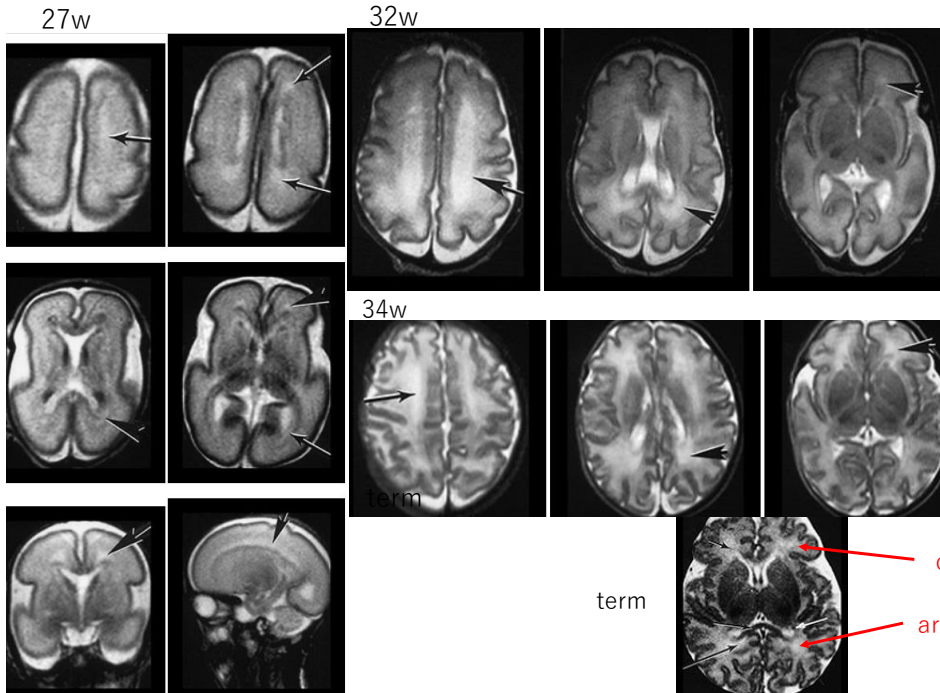
Subplate

Segment IIIとcortical plateの間
3-12mまであり
34wからpatchy
リボン型T2高信号
・36wから中心部
・2mで後頭部
・12mで前頭部

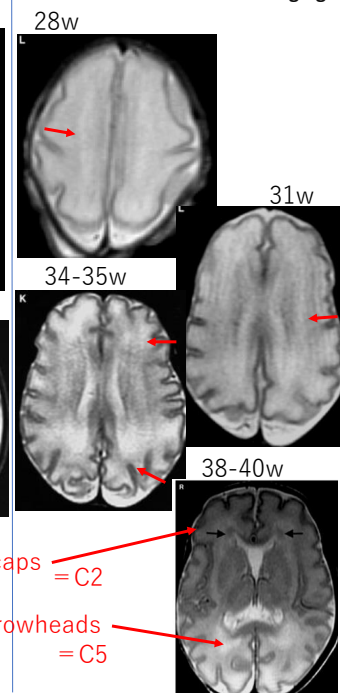
Marie P Pittet, Lana Vasung, Petra S Huppi, Laura Merlini. Newborns and preterm infants at term equivalent age: A semi-quantitative assessment of cerebral maturity. Neuroimage Clin 2019;24:102014.

6

Rutherford: MRI of the Neonatal Brain



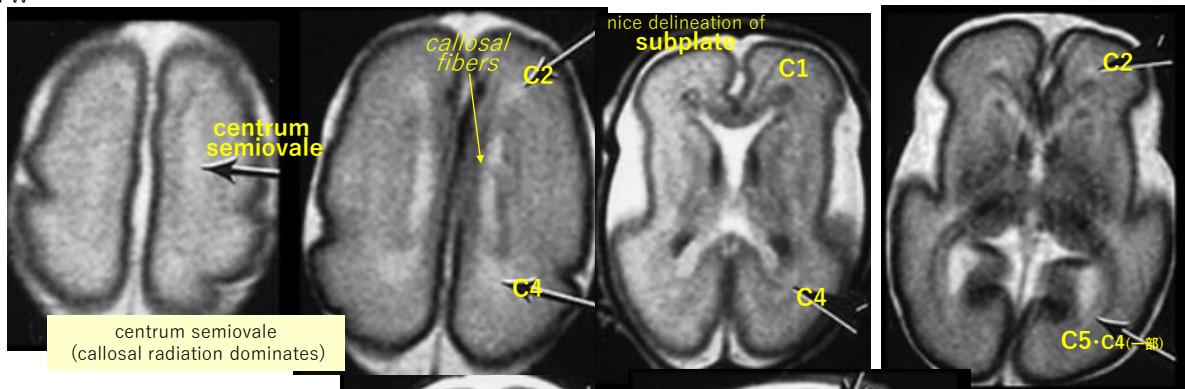
Barkovich: Pediatric Neuroimaging



7

KostovicのMRI解釈 (Rutherford: MRI of the Neonatal Brain)

27w

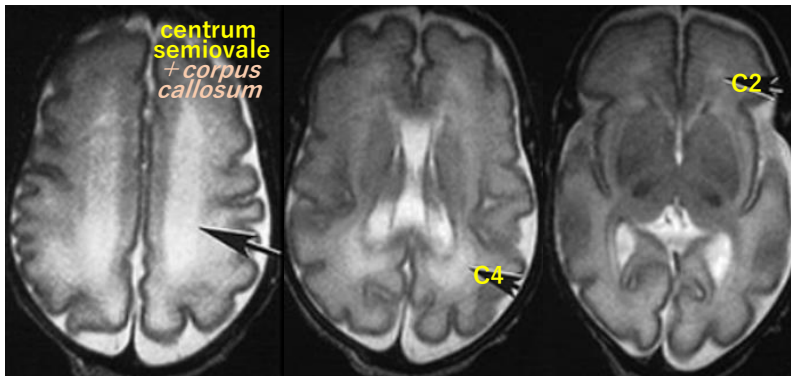


- 32wまでのsubplateは
- ・ water-rich fetal cortexであり、large bundle of fibersは存在しない
 - ・ extracellular matrix, plexus of fine axons, dendrites, synapsesに富み、low cell densityである
 - ・ cell dense cortical plateと fiber-rich sagittal strata and centrum semiovale の間にある
 - ・ 大脳皮質第6層の下にあり、脳回ができたら消退していく

narrowing of subplate in places of sulcal formation.

8

32w



(Rutherford: MRI of the Neonatal Brain)

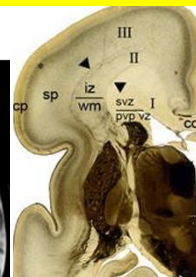
32wを過ぎると *subplate remnant* が主体となる

以下のT2高信号部がvulnerable

- ・ crossroads (特にC2・C4)
- ・ centrum semiovale - corpus callosum

28w

crossroads (white matter segment II)



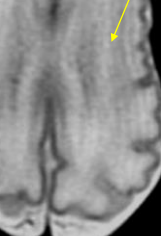
centrum semiovale (white matter segment III)

28w (Barkovichのテキスト) 31w
centrum semiovale - corpus callosum

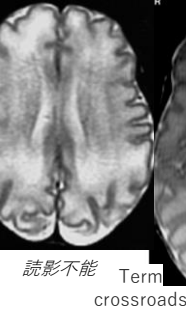


very good quality, maximal subplate

31w
centrum semiovale + corpus callosum

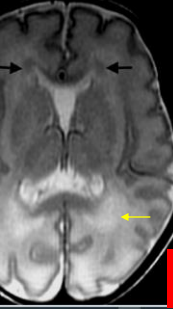


34-35w



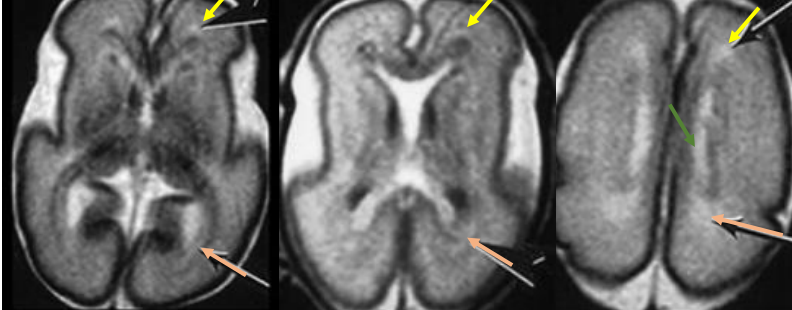
読影不能 Term crossroads

38-40w



9

27w



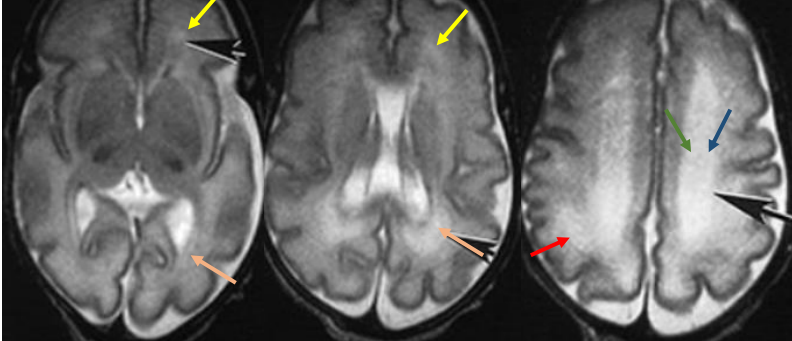
caps: crossroads (C2+C1)

arrowheads: crossroads (C5+C4)

いわゆるPVL 好発部

→ いわゆるPVLはこの後側方に広がる

32w

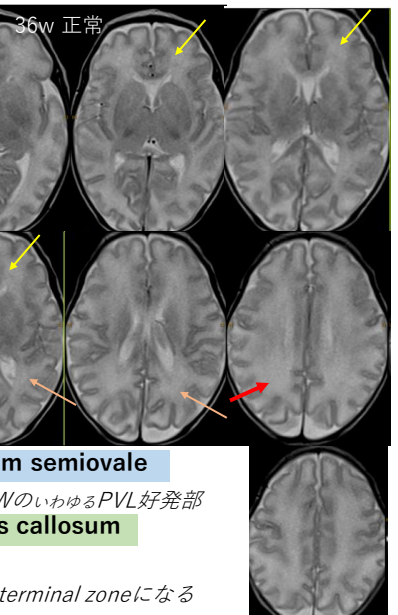


centrum semiovale

27-28WのいわゆるPVL好発部

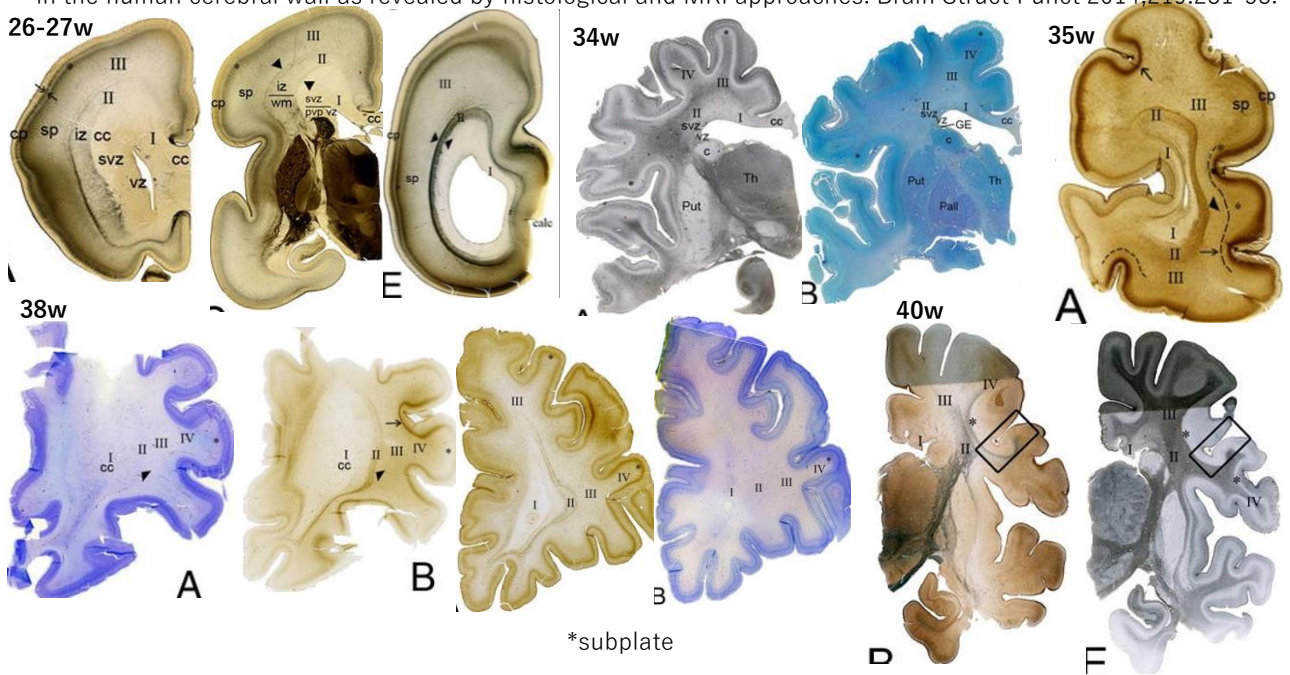
corpus callosum

→ terminal zoneになる



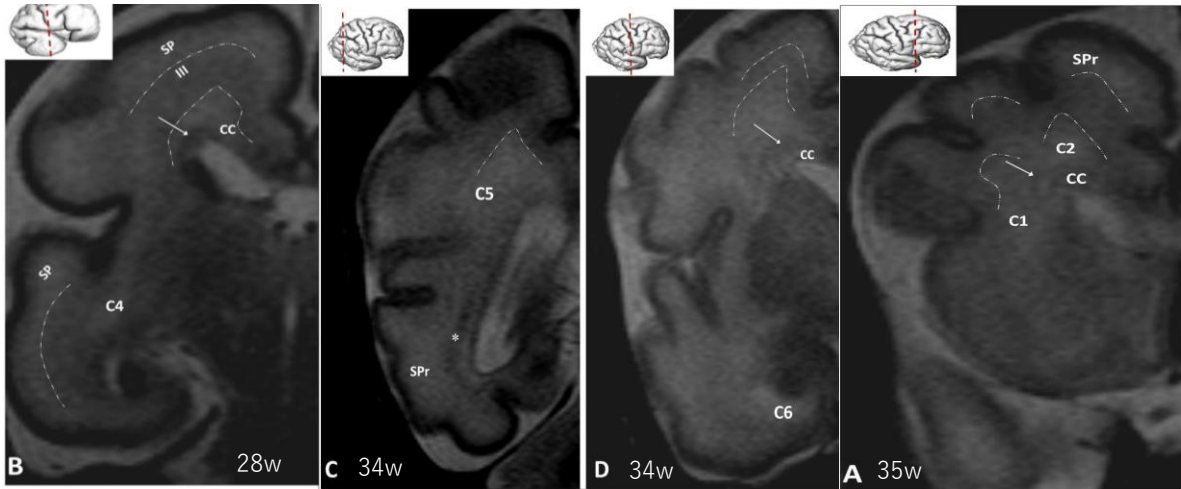
10

Kostović I et al. Perinatal and early postnatal reorganization of the subplate and related cellular compartments in the human cerebral wall as revealed by histological and MRI approaches. *Brain Struct Funct* 2014;219:231-53.



11

Ana Katušić A, et al. Transient structural MRI patterns correlate with the motor functions in preterm infants. *Brain & Development* 2021; 43:363-371.



CrossroadsはC1, C2, C4, C5, C6 (C3は見えないのでやめ)

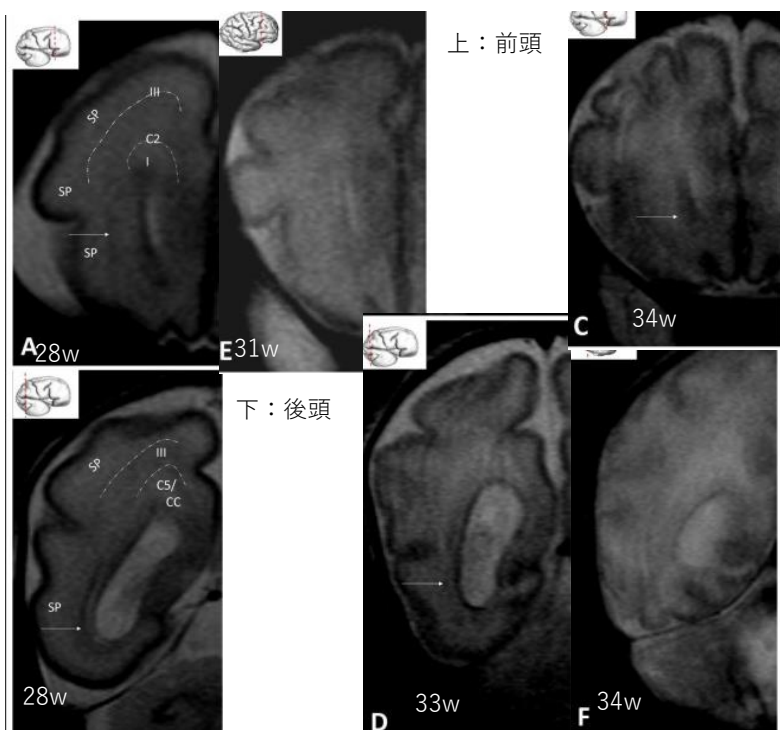
* occipital sagittal strata, これはC5につながる, white matter segment IIにある

A,B,Dのarrowsは脳梁(CC)の上に乗るcellular cluster

Broken lines: Von Monakow segment

SPr: a subplate remnant

12



Arrows: sagittal strata (segment II of white matter)

A,B: visible

C,D: poorly visible

E,F: non-visible

AとBでは、Von Monakow segments of white matterの境界が見える

Segment IIはcorpus callosumが主体

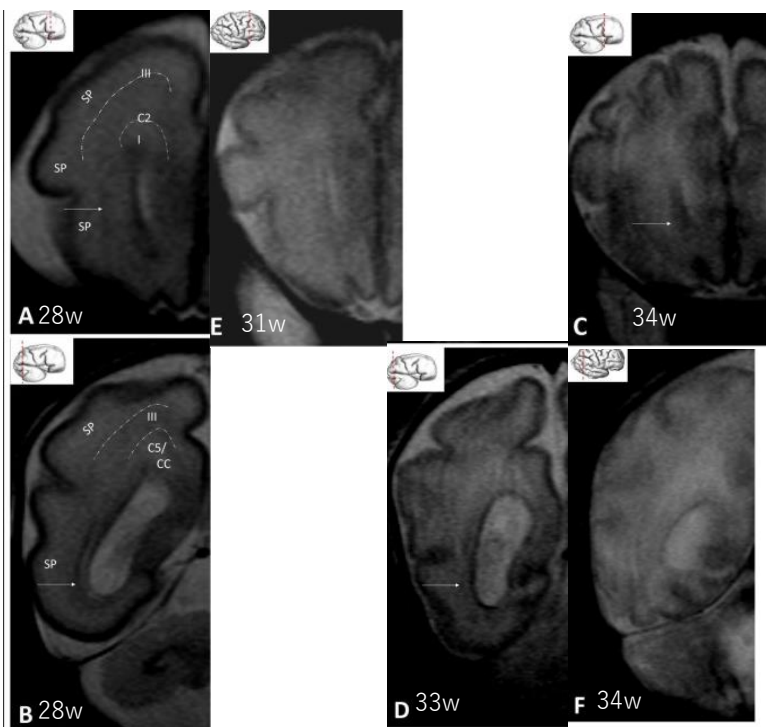
Segment IIIはdeveloping centrum semiovale

SPはsubplate component, これはsegment IVに合体する

Corpus callosum (CC)とperiventricular crossroad C5は合体する

CCはC5の主成分

13



上：前頭 下：後頭

Arrows: Sagittal strata (segment II of white matter)

A, B: visible C, D: poorly visible

AとBでは、Von Monakow segments of white matterの境界が見える

Segment IIはcorpus callosumが主体

Segment IIIはdeveloping centrum semiovale

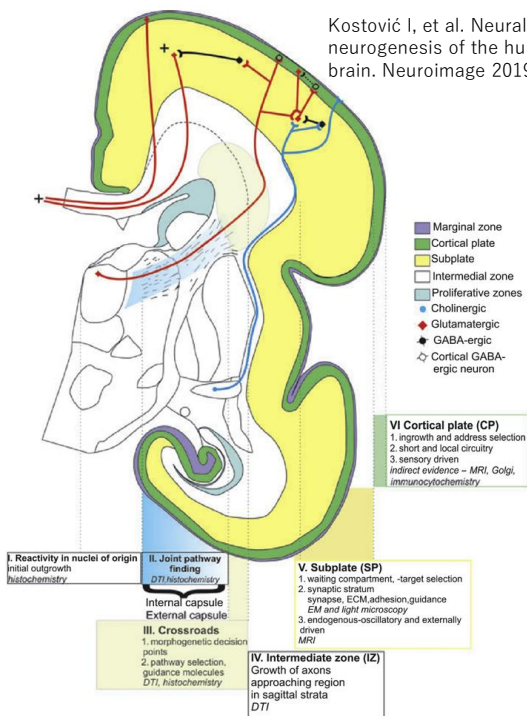
SPはsubplate component, これはsegment IVに合体する

Corpus callosum (CC)とperiventricular crossroad C5は合体する

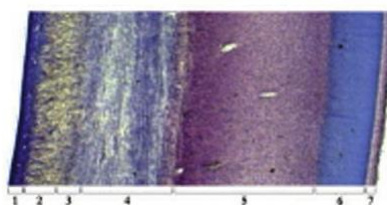
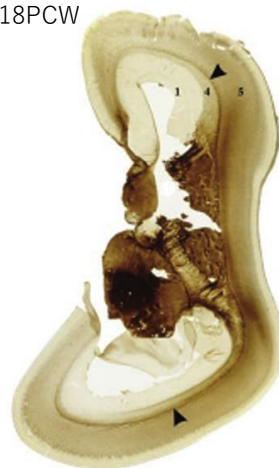
CCはC5の主成分

14

Kostović I, et al. Neural histology and neurogenesis of the human fetal and infant brain. *Neuroimage* 2019;188:743-773.



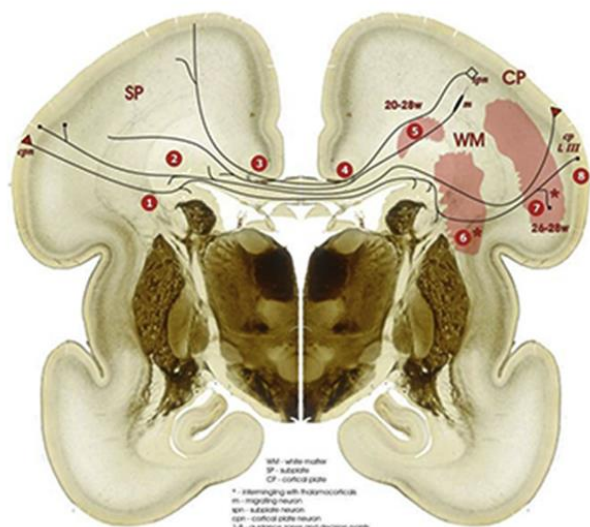
18PCW



- 1 = Ventricular zone (germinal matrix)
- 2 = Periventricular fibre rich zone
- 3 = Subventricular cellular zone
- 4 = Intermediate zone (fetal "white" matter)
- 5 = Subplate zone
- 6 = Cortical plate
- 7 = Marginal zone

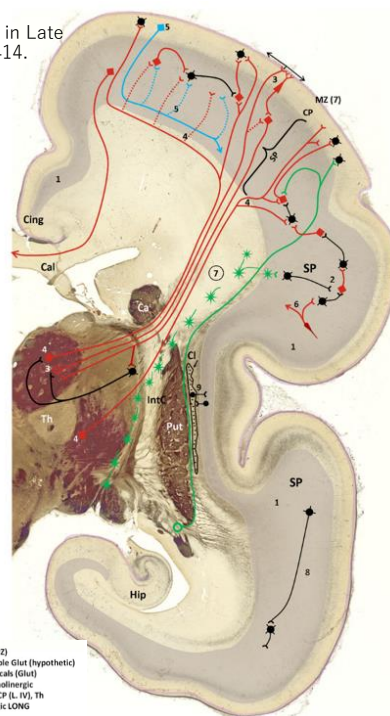
15

Kostović I, et al. Fundamentals of the Development of Connectivity in the Human Fetal Brain in Late Gestation: From 24 Weeks Gestational Age to Term. *J Neuropathol Exp Neurol* 2021;80:393-414.



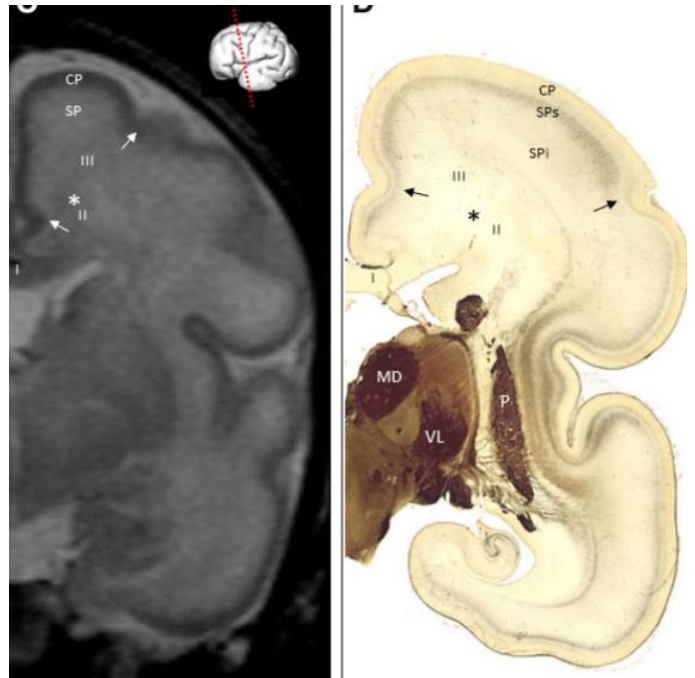
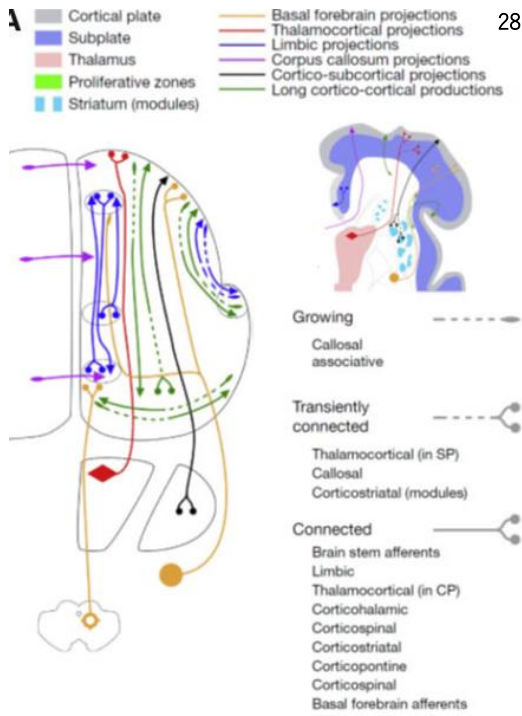
Growth of corpus callosum fibers in the human fetal brain. Callosal axons pass through 8 growth zones which produce axonal guidance and repellent molecules. Asterisks mark area of intermingling with thalamocortical fibers.

- Glutamatergic SPN, Th-SPN/CP, SPN-Th
- Maternal neurons
- Th multiple Glut (hypothetic)
- Pyramid CP
- Migratory side projection
- Isodendritic C. neurons
- Subplate zone (SPZ)
- Associative multiple Glut (hypothetic)
- Long cortico-cortical (Glut)
- Basal forebrain cholinergic
- GABAergic SPN, CP (L, VI), Th
- GABAergic LONG

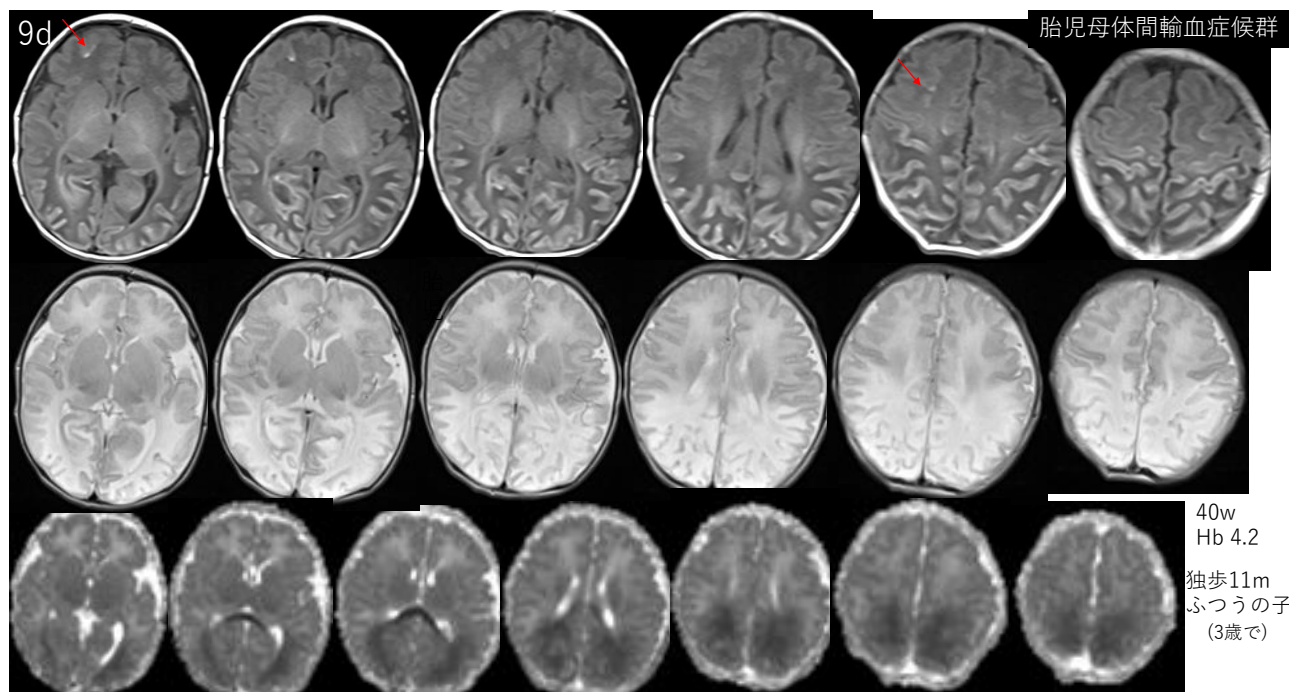


16

28-31WG (26-29PCW)

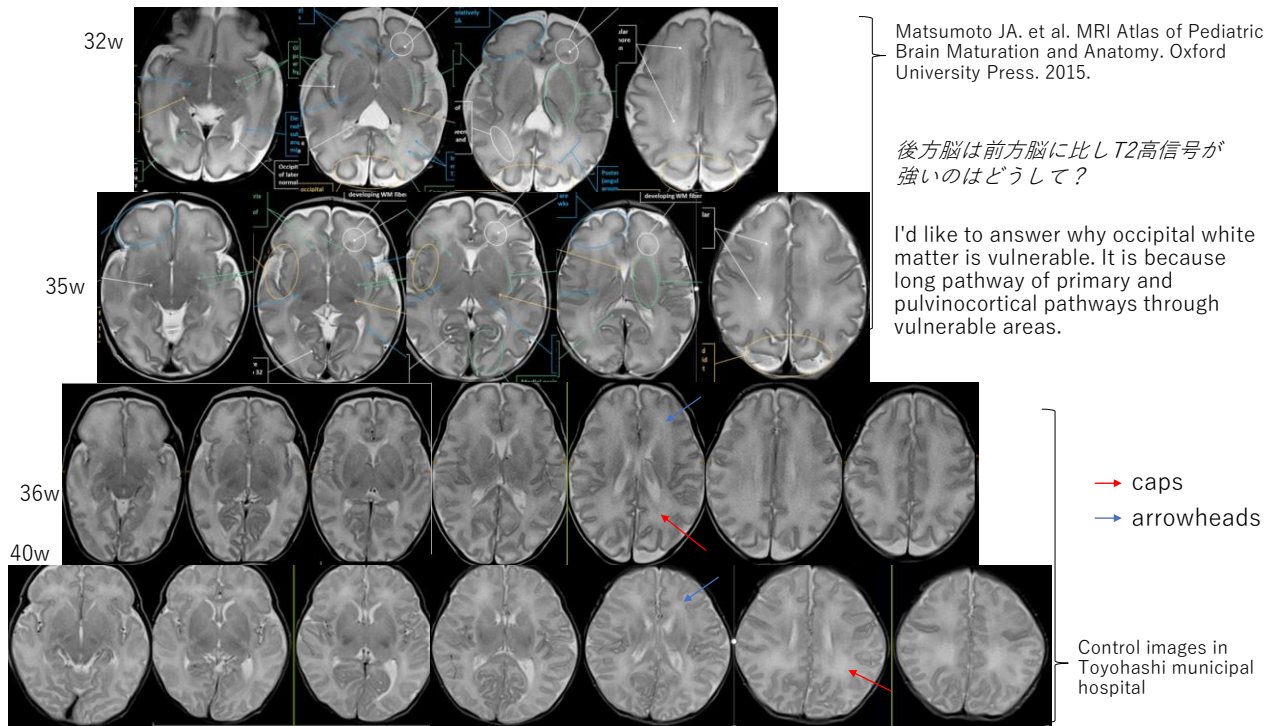


17

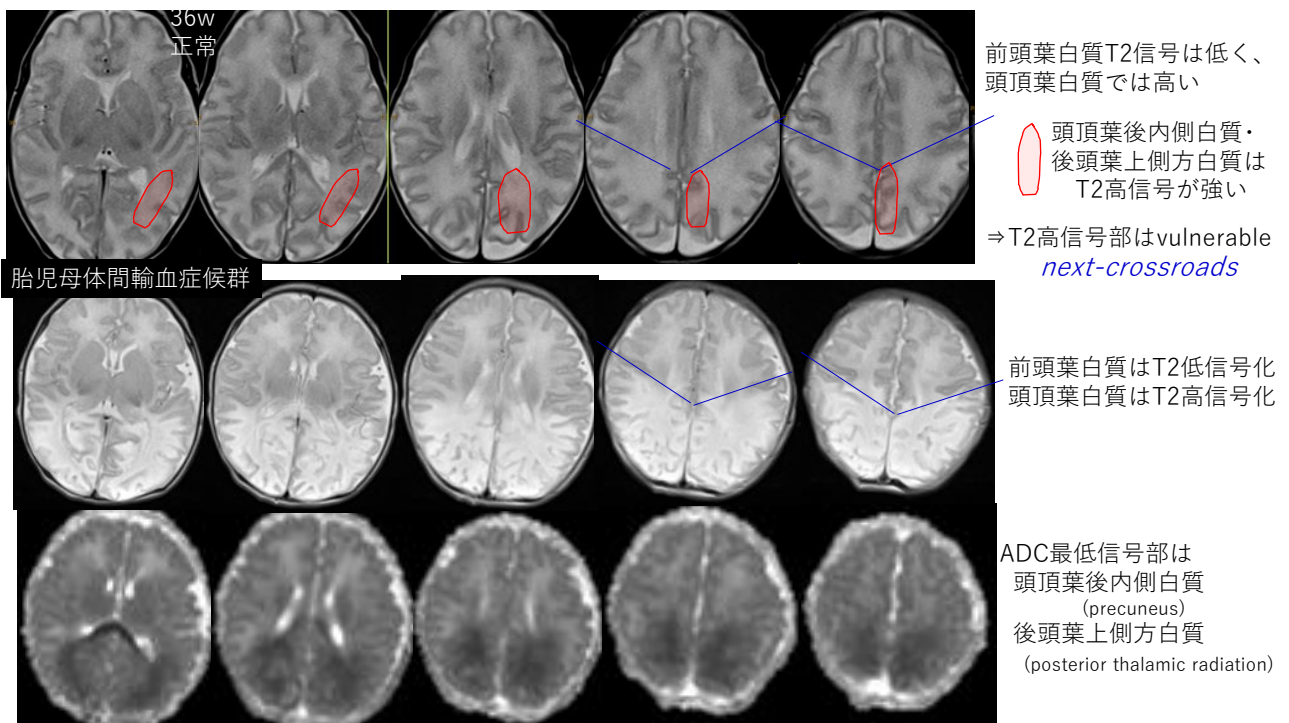


・ 右前頭部皮質谷部・sagittal strataがT1高信号・T2高信号 ・ PCA領域・ PCA・MCA境界域・ MCA領域後方・ ACA・PCA境界域が低血流 ・ 視床病変あり

18



19



20