ECHOGRAPHIE ET AUTRES IMAGERIES DU SYSTÈME NERVEUX CENTRAL

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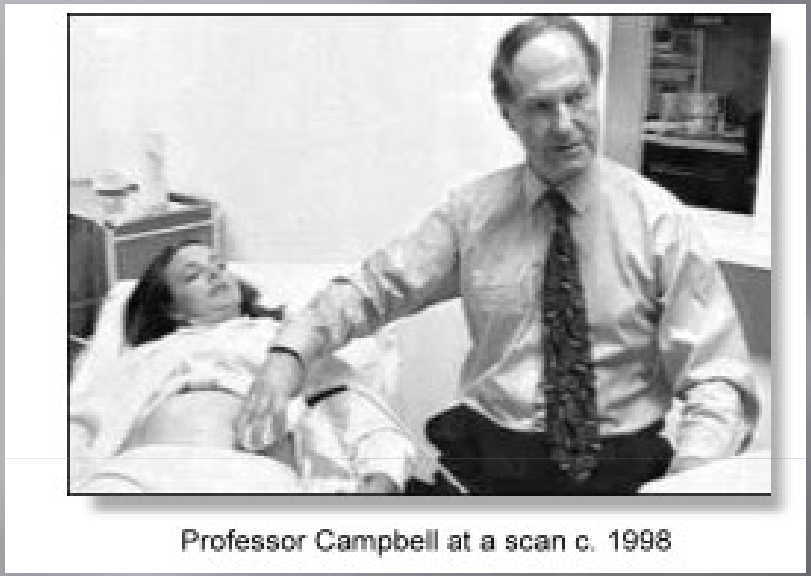
Possibilités de l'échographie

- Historique
- Techniques
- La croissance cérébrale
- L'analyse du cervelet
- Les ventricules cérébraux
- L'espace inter- et péri hémisphérique
- Le Doppler
- Les principales lésions
- Un l'IRM

Historique et technique

- **Historique**:
  - Un héritage de l'obstétrique: St Campbell
  - La sémiologie anatomique normale
  - La sémiologie des lésions hémorragiques
  - La sémiologie des lésions ischémiques
- **Techniques**
  - l'évolution des sondes
  - L'arrivée du couplage écho-Doppler

Figures de proues



Professor Campbell at a scan c. 1998

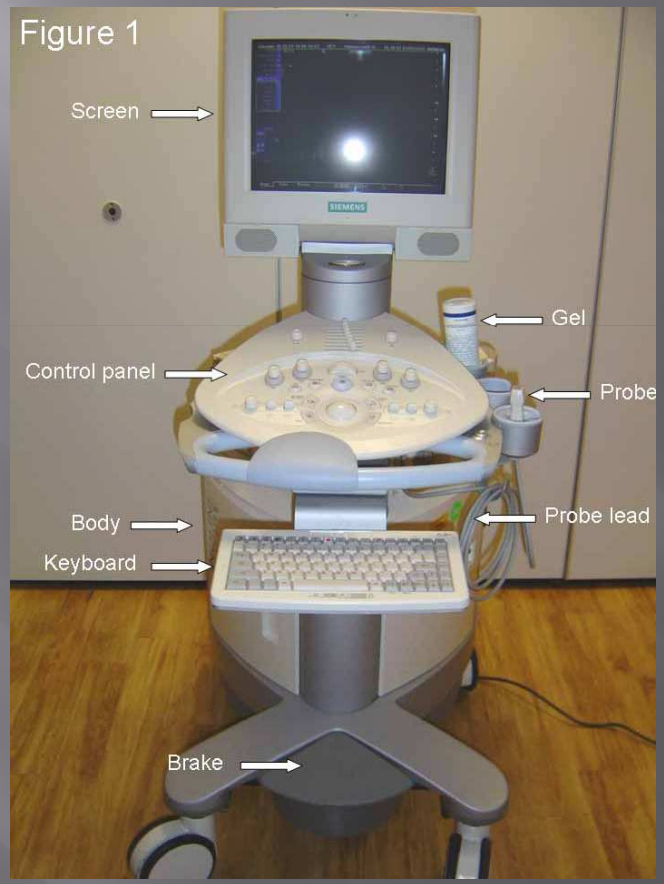
Professor Wigglesworth

Kypros Nicolaides

Ces auteurs ont décrit
Les fondements de
L'écho-Doppler du
Fœtus et
du nouveau-né

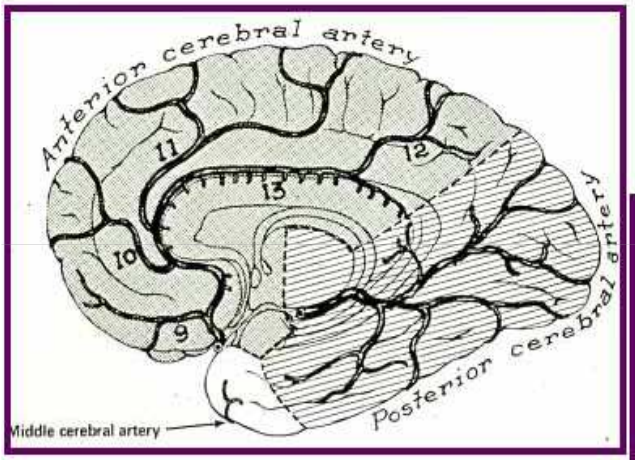
Professor Malcolm Levene

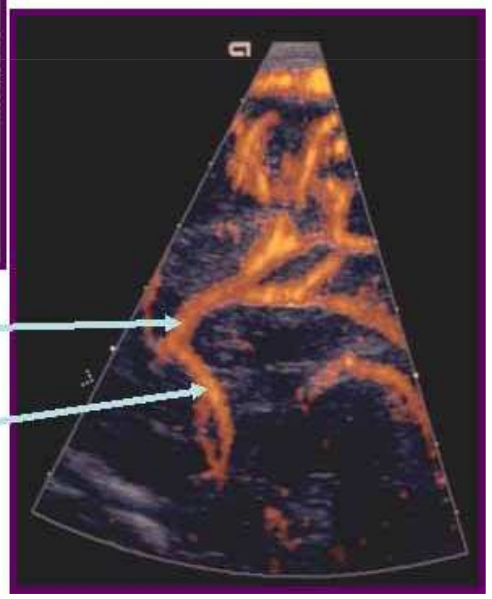
L'écho-Doppler: une extension indispensable à l'examen clinique



La technique de l'echo-Doppler

Figure 3

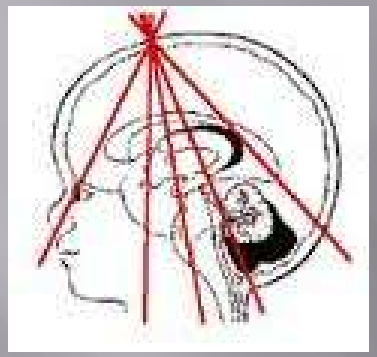


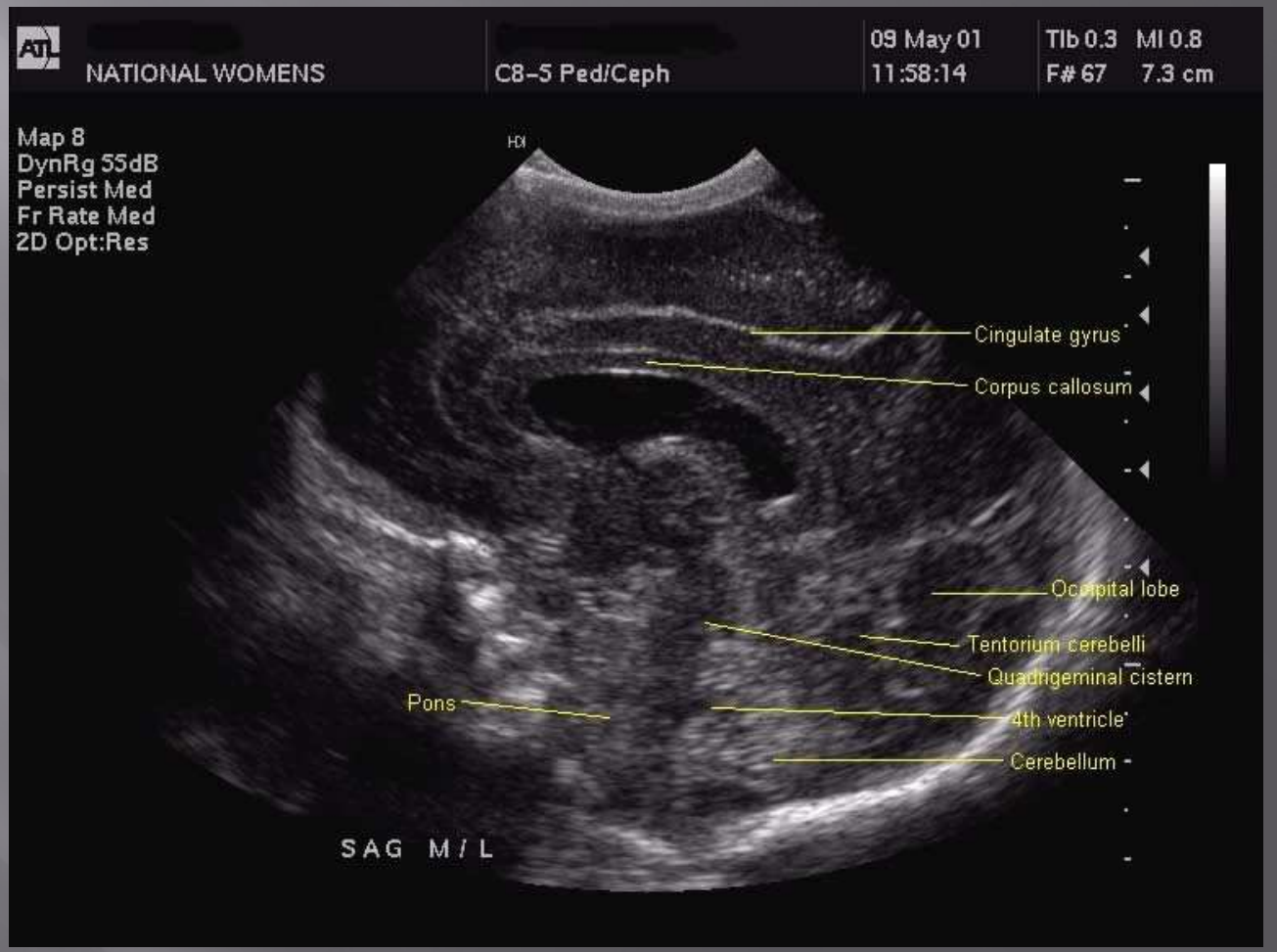


Pericallosal artery

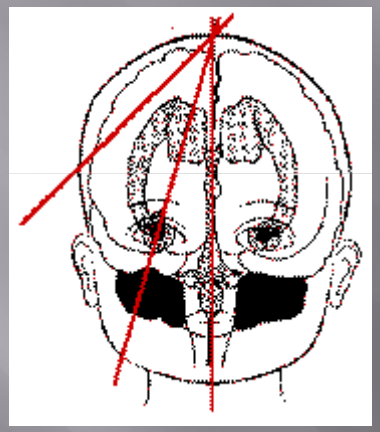
Anterior cerebral artery

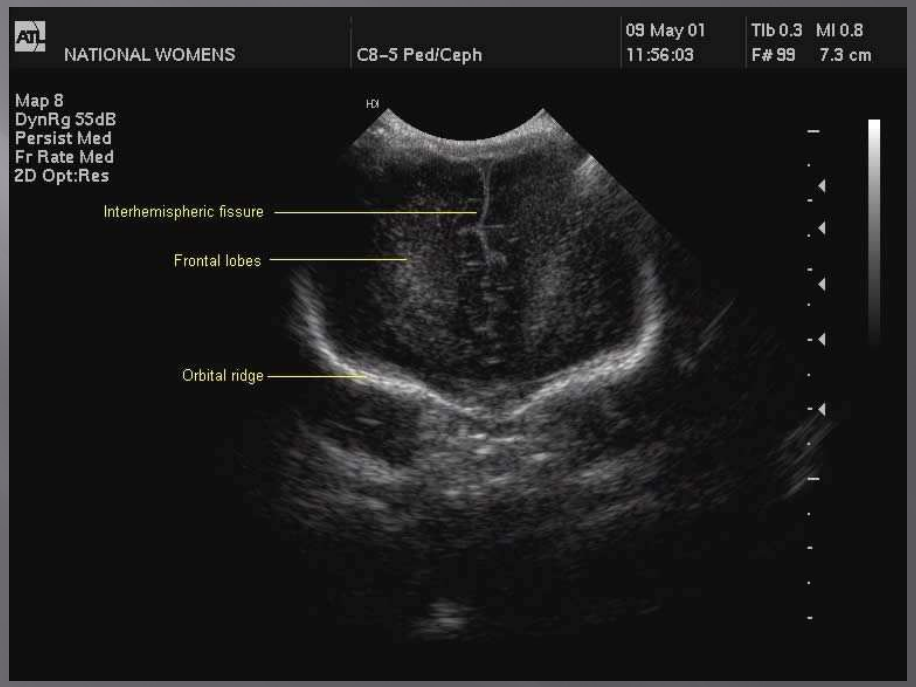
Coupes sagittales





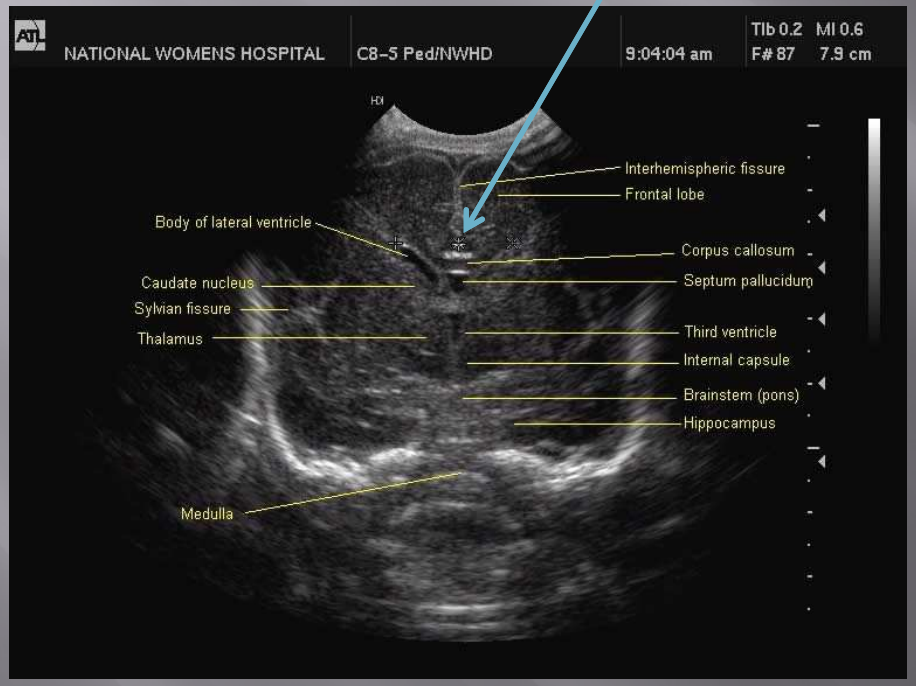
Coupes frontales

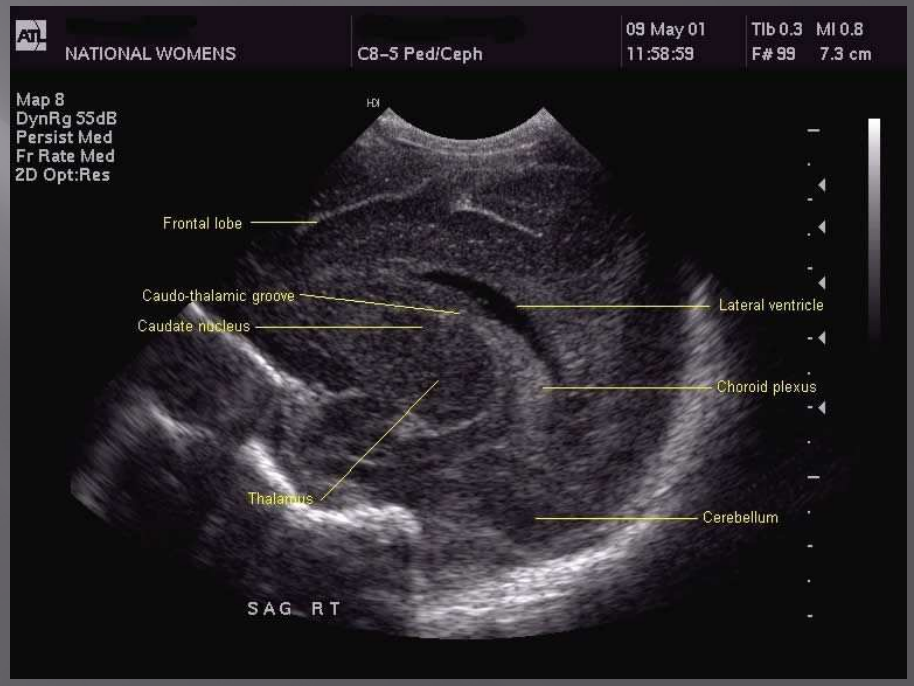




Coupes frontale et parasagittale

La mesure de la hauteur du lobe frontal





Le Doppler

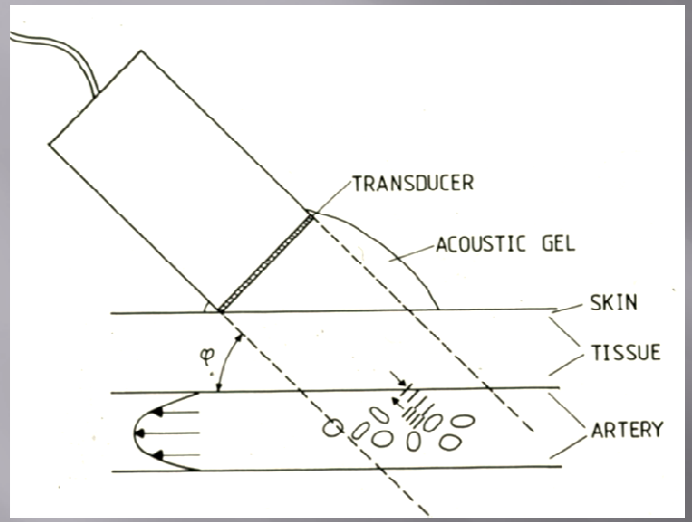
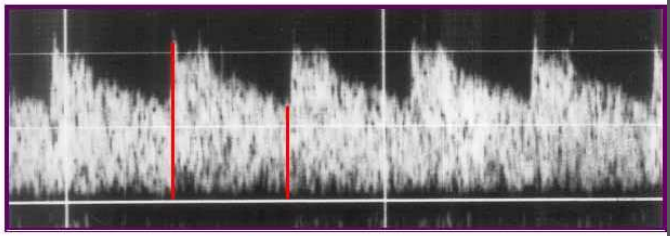
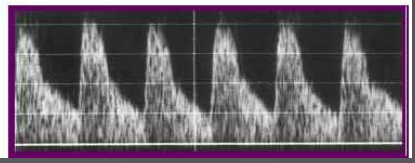


Figure 2

High end-diastolic velocity giving low pulsatility ratio indicating loss of normal vasomotor tone

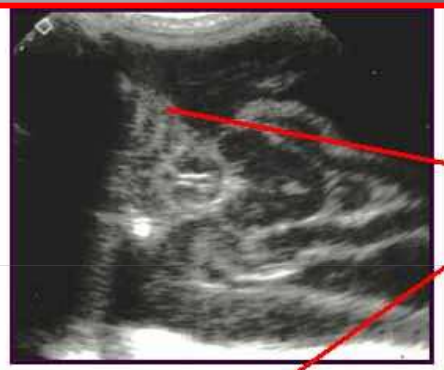


Normal

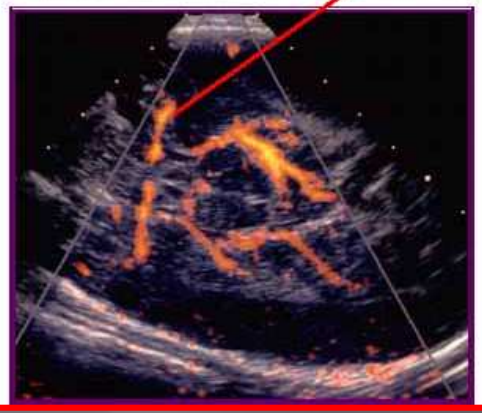


L'abord de l'écho-Doppler

Figure 4



Line of insonation for the **middle cerebral artery** from the temporal window



Utilités de l'écho-Doppler

Predictive value of blood velocity and PI measurements for adverse outcome in HIE(Levene 1989)

Abnormal CBFV*		***Low PI < 0.55***	
Sensitivity	**57%**	**60%**	
Specificity	**88%**	**63%**	
PPV	**94%**	**83%**	

 # 2 - 4 days after birth
< 2SD or > 3 SD

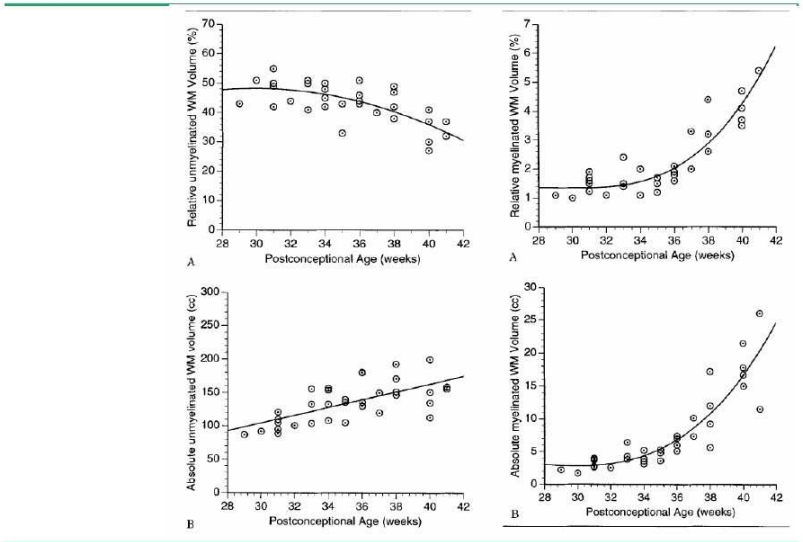
Early (< 6 hours) bedside assessment in term HIE (Eken 1995)

Sensitivity		***Specificity***	
Ultrasound	**42.1%**	**60%**	
Doppler	**23.5%**	**100%**	
SSEP	**94.7%**	**73.3%**	
VEP	**89.5%**	**66.7%**	
CFM	**94.1%**	**78.6%**	

L'analyse Doppler du cerveau: « listening to the brain »

Le cerveau périnatal des cellules, qui bougent…

Études de Huppi en IRM



Les travaux sur l'IRM du cerveau périnatal et néonatal:
- Boston
-Londres

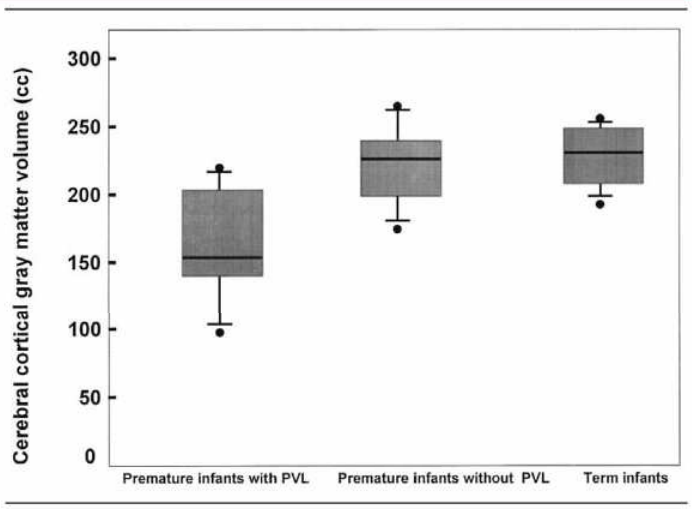
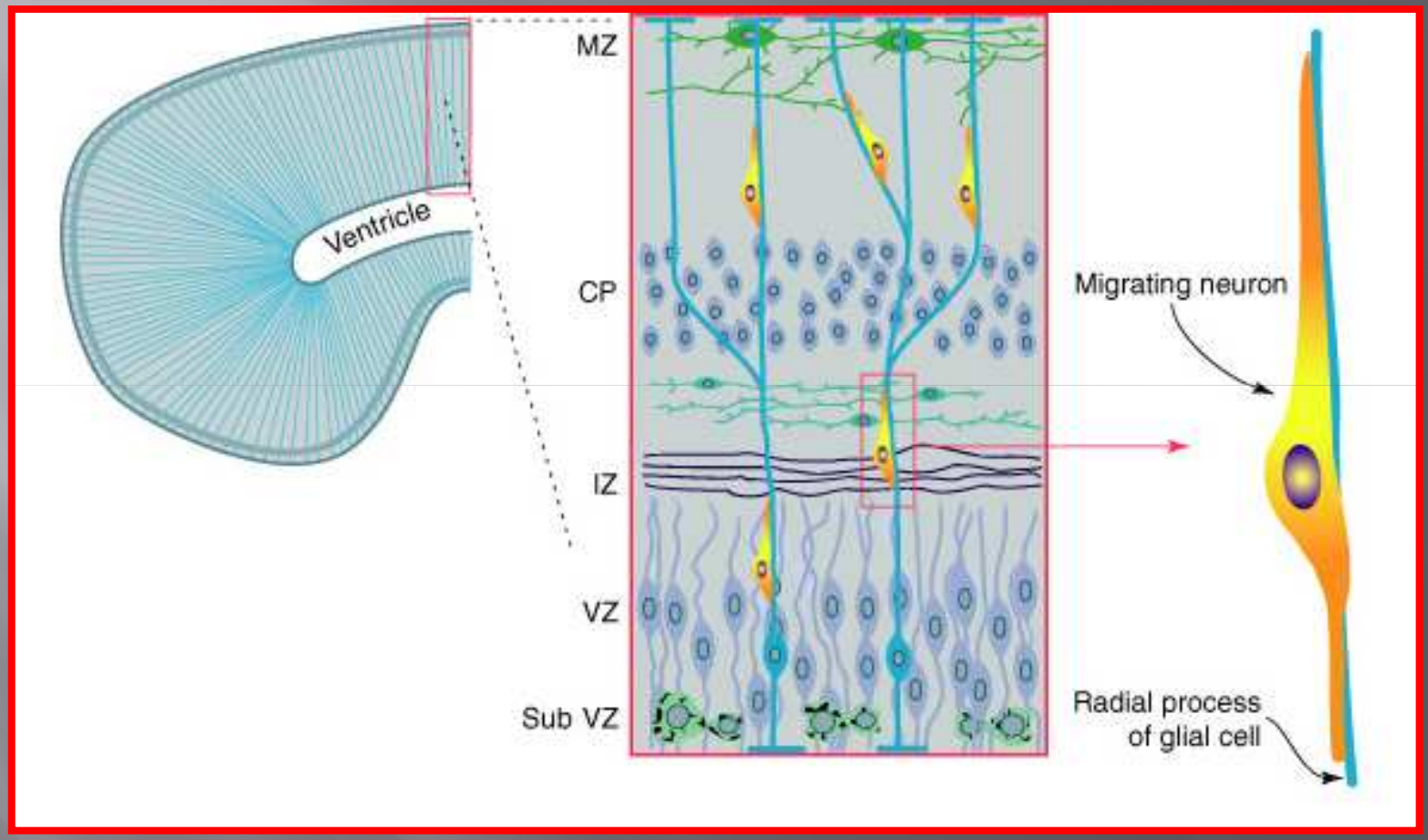


Fig 1. Cerebral cortical gray matter volumes at term in premature infants with (n = 10) and without (n = 10) evidence of periventricular leukomalacia (PVL) and in normal term infants (n = 14) (expressed as medians, with 25th/75th centile box, 10th/90th centile error bars, and outliers).

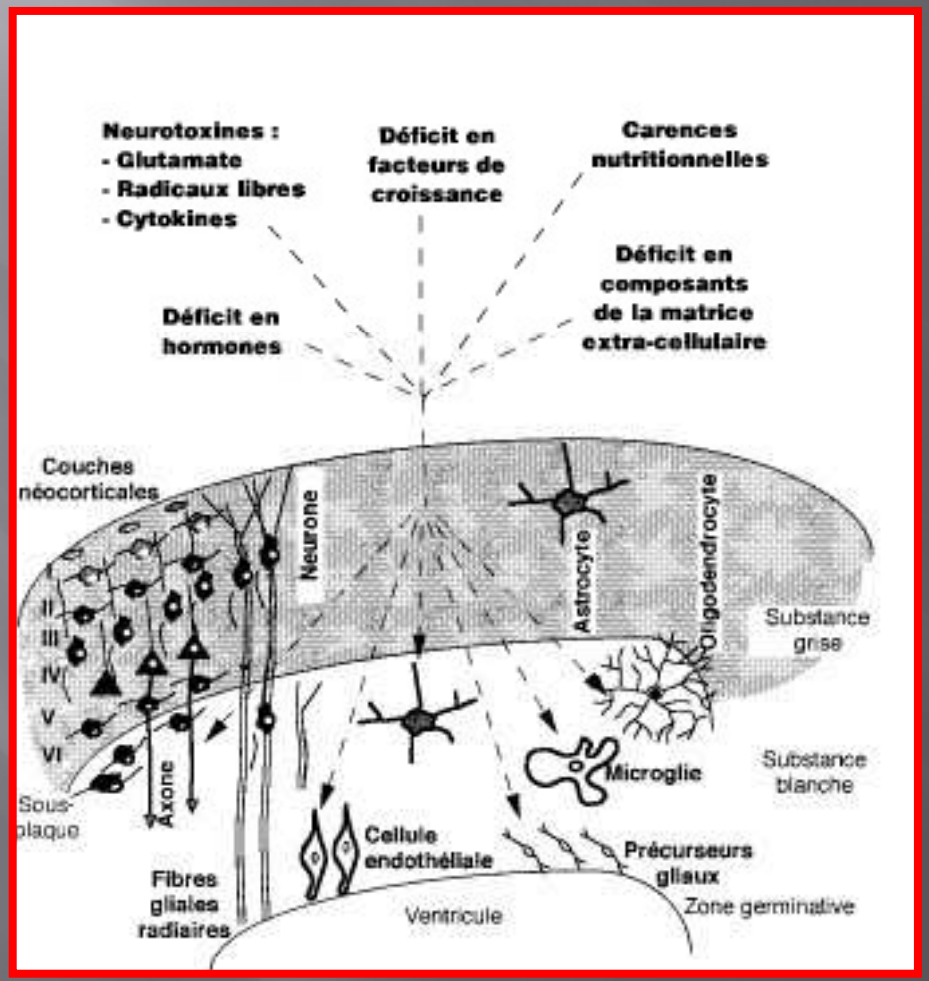
Réduction de la masse corticale
Réduction de la masse blanche
Troubles de la formation des tractus et fibres de projection

La croissance cérébrale:

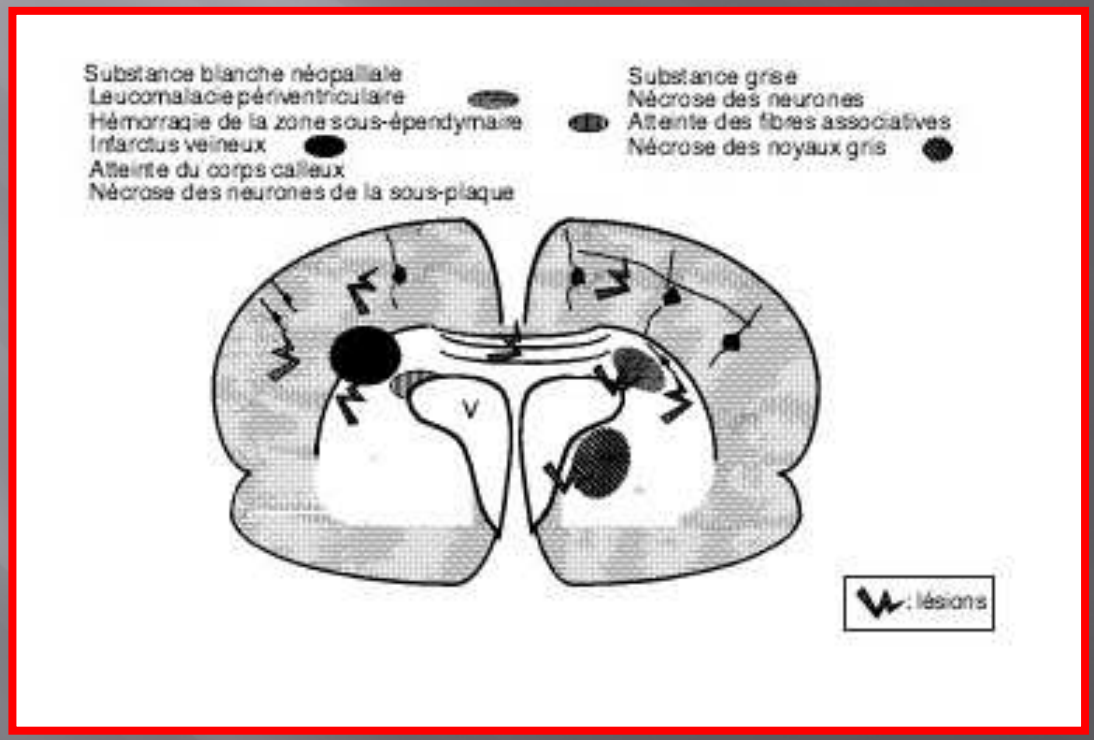
toute l'importance de la migration neuronale tardive



Structure cellulaire (2)

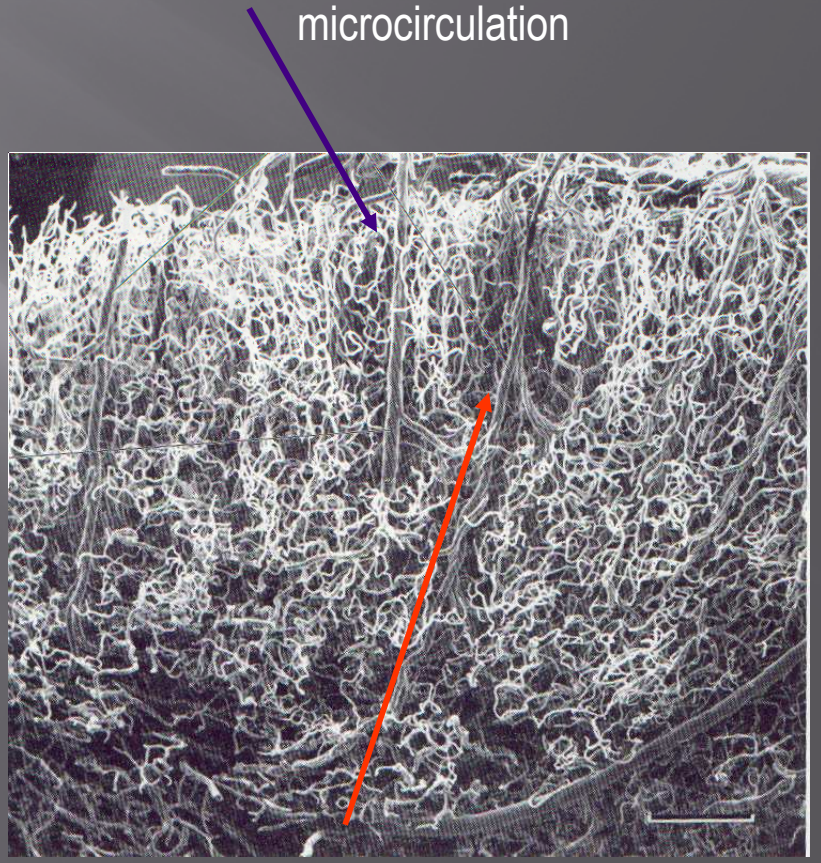


Structure cellulaire



Fetal and neonatal Brain development: histology and biochemistry

- Early neuronal migration (Rakic)
- Late neuronal migration (Sarnat)
- Cerebral blood flow (Lou)
- Autoregulation of CBF (Lou, Greisen)
- Cerebral metabolism (Volpe)
- Autoregulation of CM
- Focus on neurons
- Focus on glial cells
- Clinical aspects



40 % glial cells , 4 % neurons, 4 % blood,
10 % CSF, 35 % ECF, 10 % variance

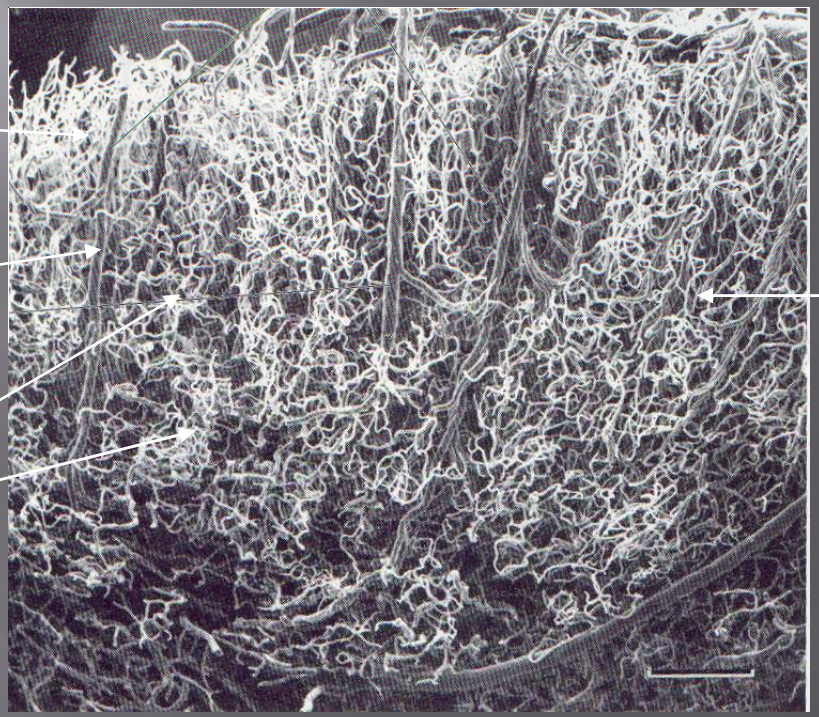
The concept of neurone-glial cells association

Les cellules sont en place à l'âge de 4 mois après le terme

Oligodendrocytes:
Perineuronal;

Astrocytes:
perivascular,
in White and grey matter

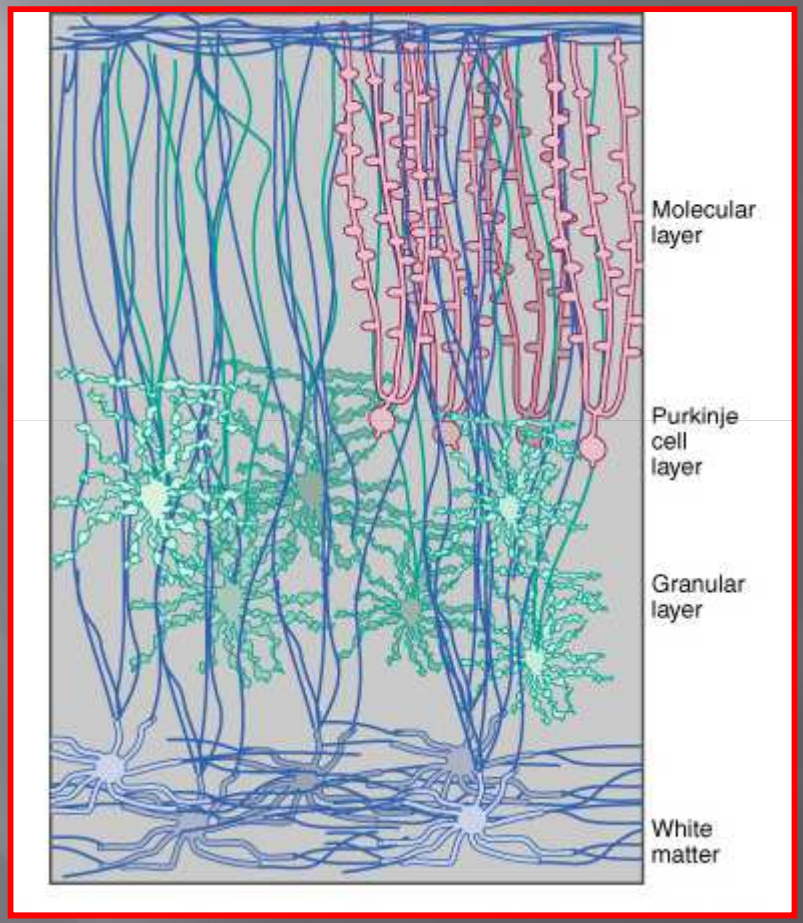
Microcytes:
travellers



Radial cells

Layers 1, 2 and 3 for intra-cortical associative relationships
1, 4, 5 , 6 for projective intra-cortical and subcortical relationships

L'analyse du cervelet



Les cellules sont en place à l'âge de 12 mois après le terme

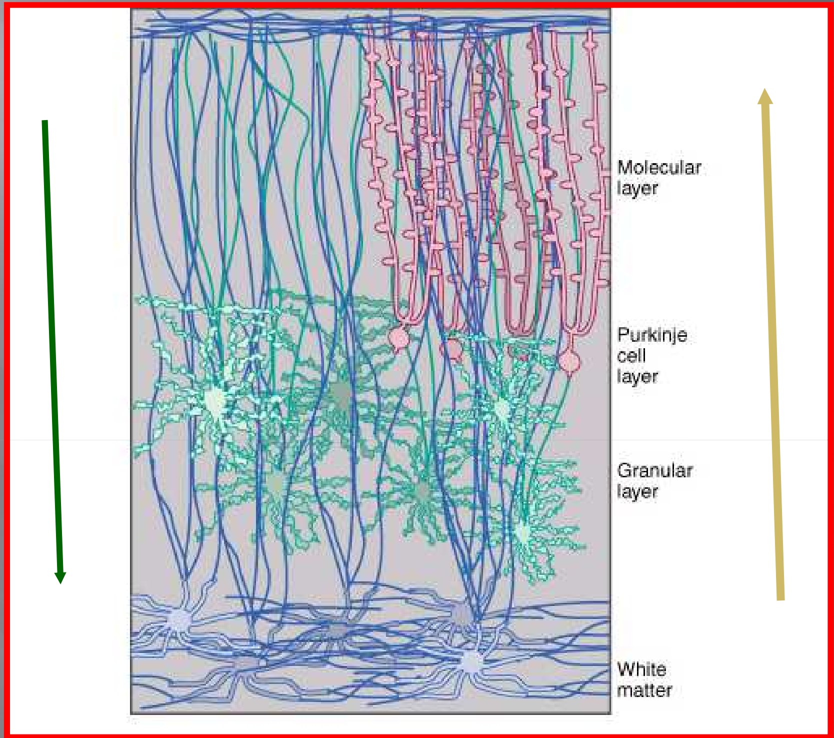
Specific aspects of neuronal migration, fibers and synapses construction, myelination

cortex

« white matter » zone

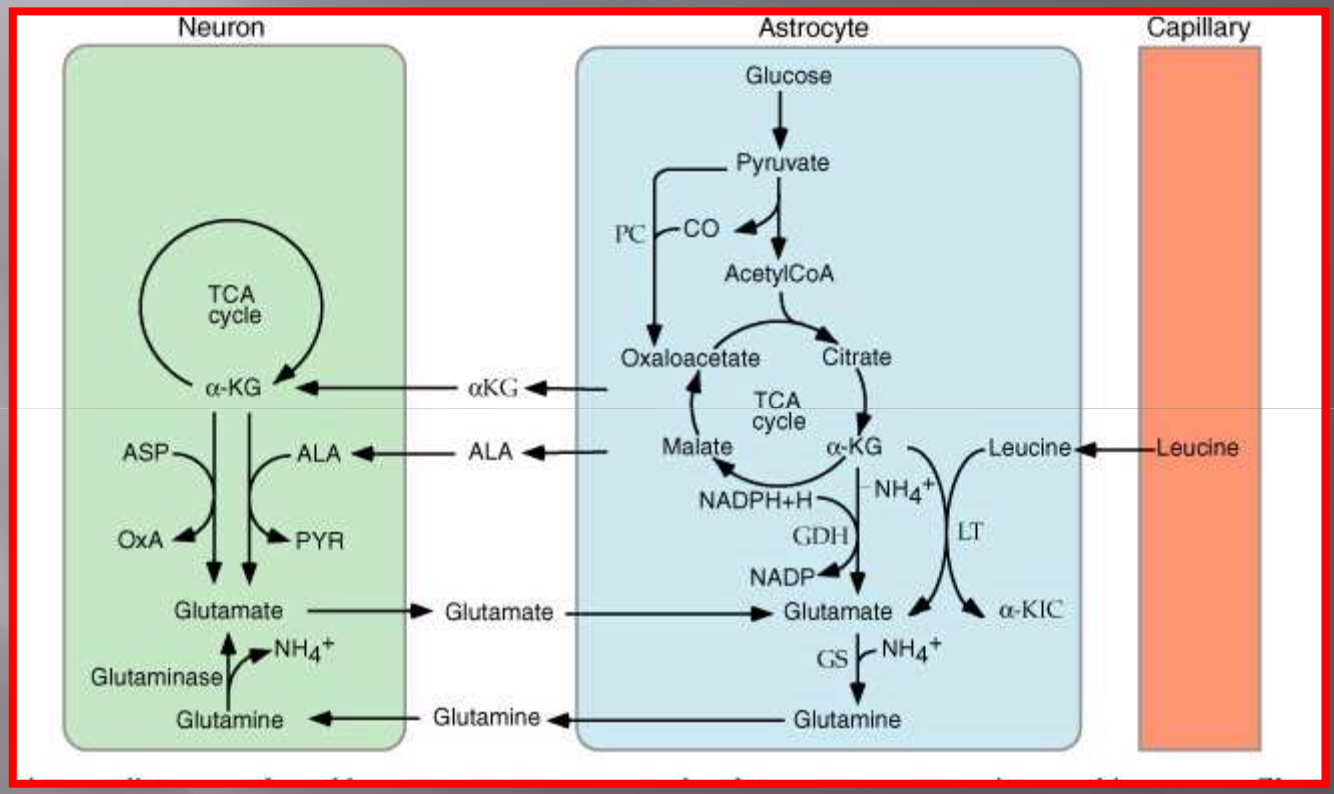
Germinal zone

From ependyma

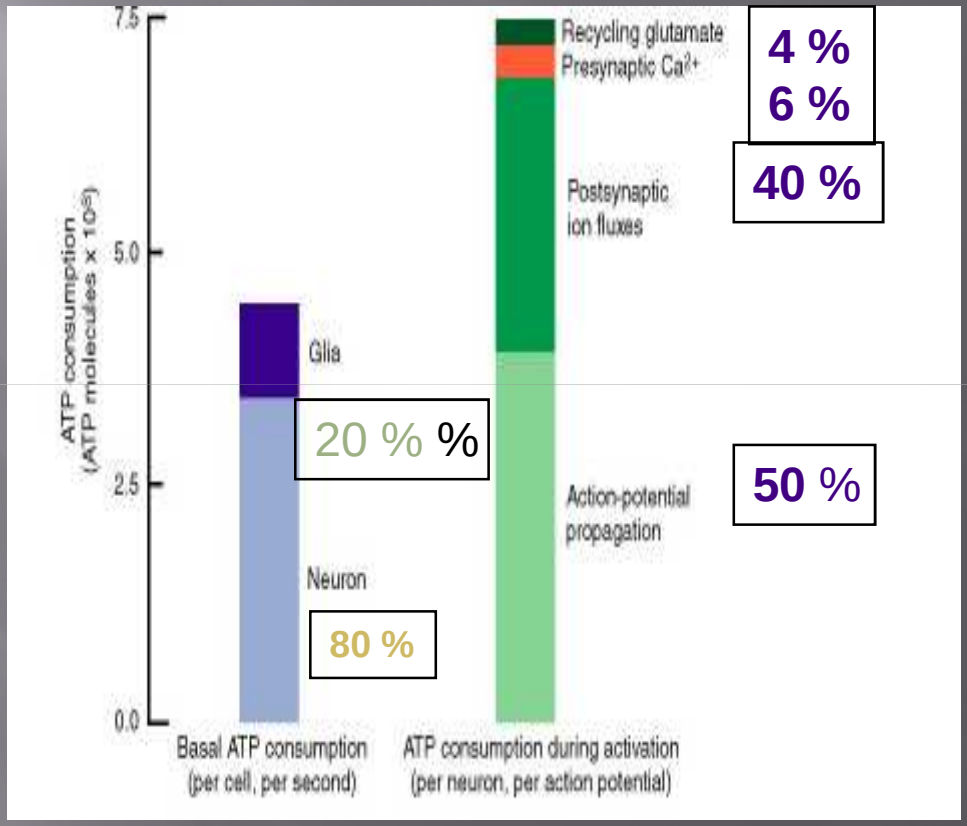


7-10 glial cells per neuro

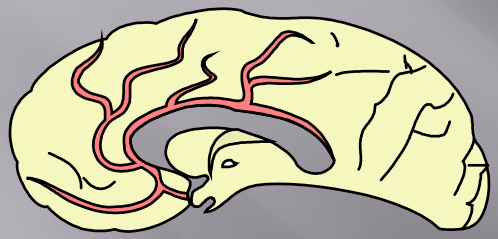
Importance de l'association biochimique

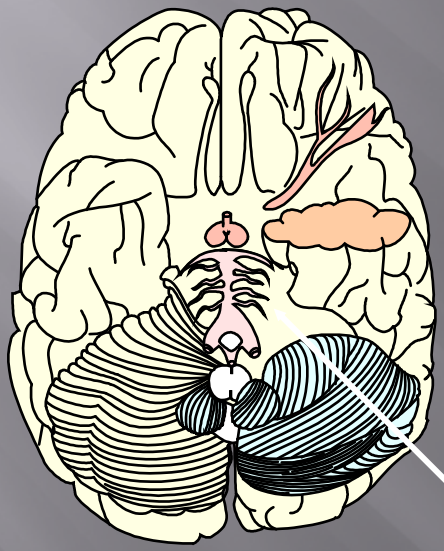


Toute l'importance de la biochimie



Cerebral blood flow and metabolic autoregulation loss or absence





- **CBF absent if:**
  - respiratory distress;
  - circulatory distress;
  - hypoglycemia;
  - CNS infection;
  - brain trauma;
- **Loosing the independence**
- 1° Systolic blood pressure;

  2 °CO2 pressure (attention to pCO2 < 27 for >= 1hr or > 65 for > 6 hrs);

  3° O2 content;

Glucose (mg/dL) and O2 (ml/dL) requirements in the distressed brain

Hemoglobin from present blood stores O2 for 60 sec

	Cbf ml/100g/m	[aG] ->I	[aG]-> W	[aO2]->I	[aO2]-> W
term	20	21	36	10	22
Preterm « good »	15	30	50	13	29#
Preterm sick	10	40	72	19	44#
	2	82	143	28#	62#

Hb 12 g/dL

target

Hb 15 g/dL

Glycogen stores are enough for 30-60 minutes...

L'analyse des ventricules cérébraux

- Comment apprécier la dimension: la hauteur standard, l'index ventriculaire selon Levene, l'indice selon Evans
- Bien regarder le pourtour et son intégrité
- Bien regarder les plexus choroïdes
- Bien regarder la région de la couche germinative
- Bien regarder la région périventriculaire

Il faut « couper » le cerveau par différents abords et faire des mesures rapportées aux valeurs normatives.

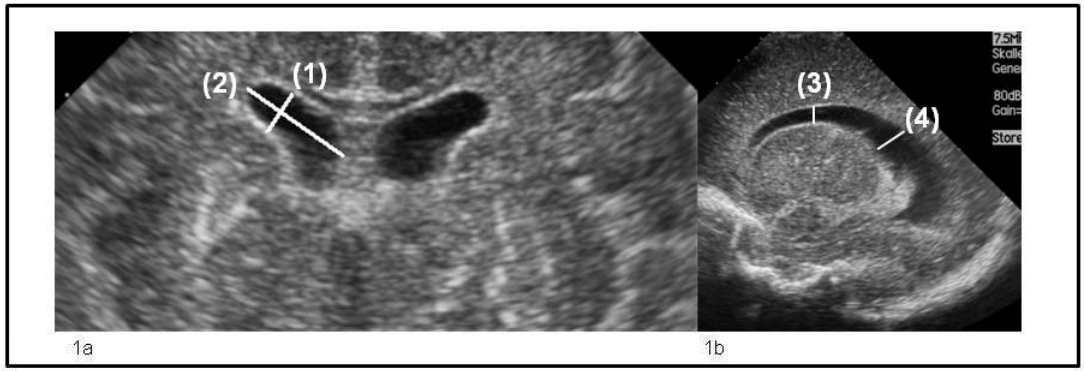
Indice standard (Allan, 1987)

Ventricular index (Levene,1988)

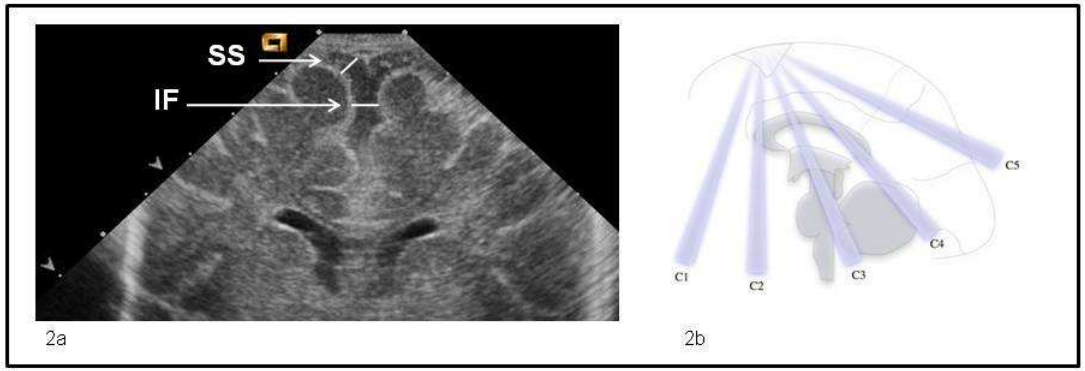
Hauteur du lobe frontal (Battisti, 1986)

-cranio-cortical width: < 4 mm
-Sino-cortical width < 3 mm
-Interhemispheric width < 6 mm

Les indices (2)

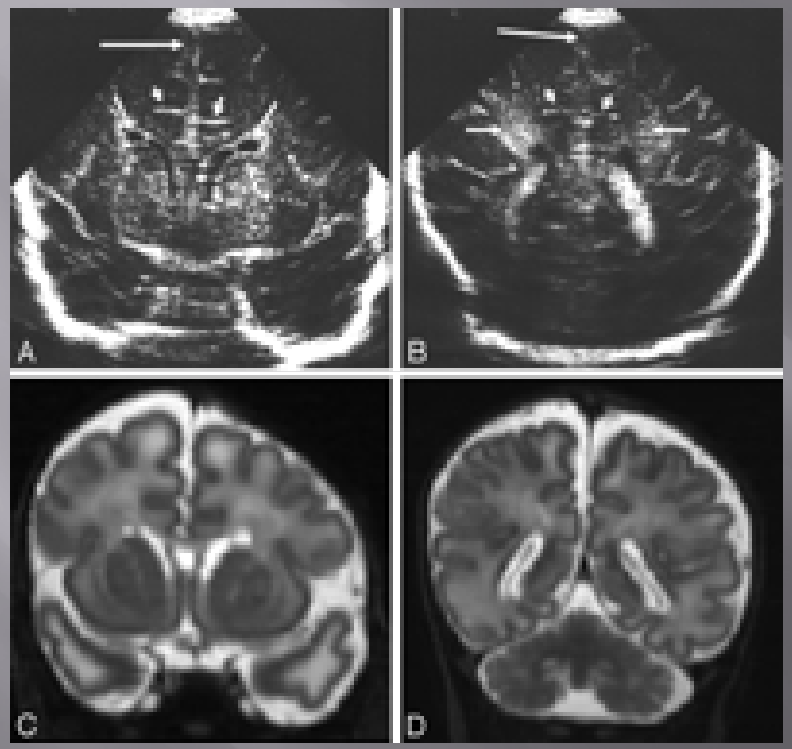


Appendix Figure 1a+b



Appendix Figure 2a+b

L'espace inter- et péri-hémisphérique



Les lésions

- Les lésions malformatives
- Les lésions hémorragiques
- Les lésions inflammatoires
- Les lésions dites kystiques
- L'œdème cérébral
- La dilatation du système ventriculaire

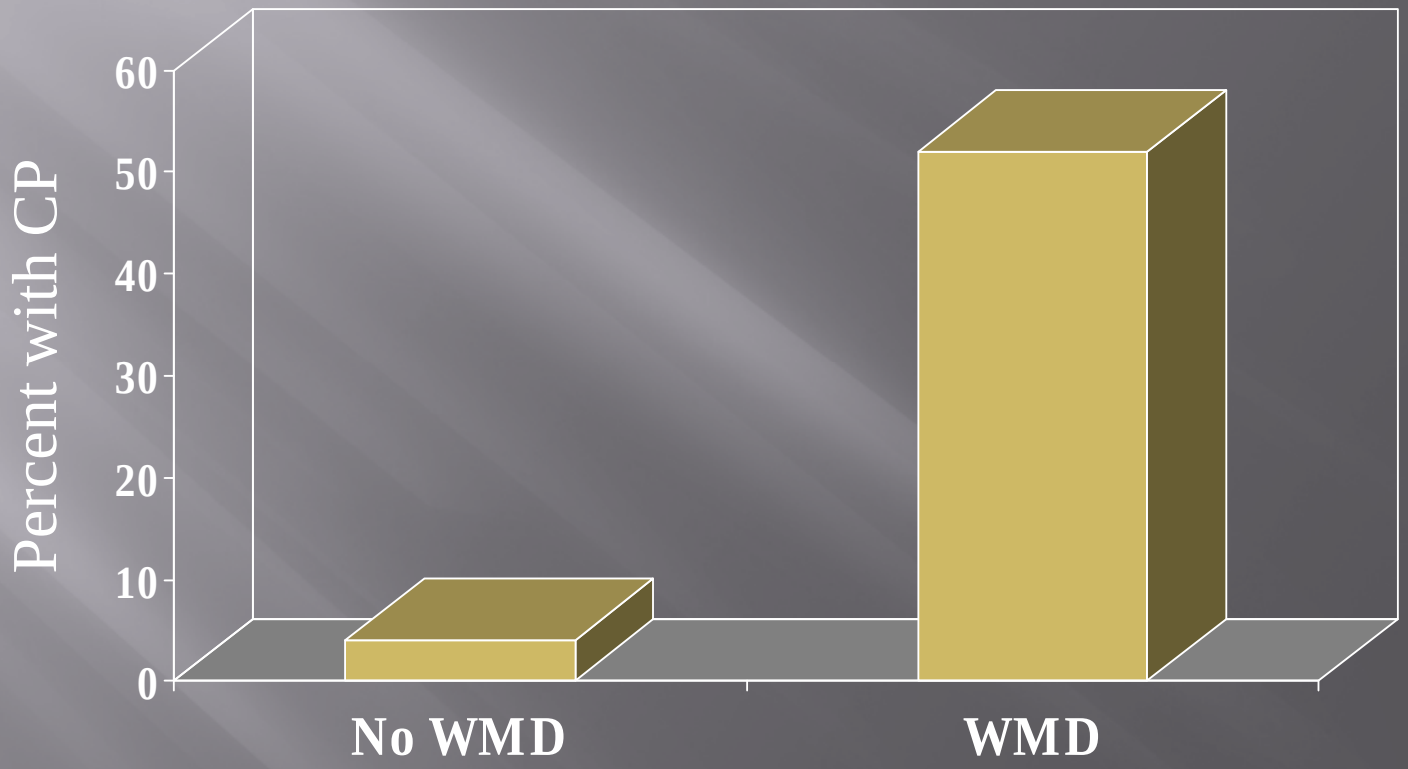
FACTOR ANALYSIS PRODUCES FOUR CLUSTERS OF HISTOLOGIC ABNORMALITIES

DEN - Gilles et al J Neuropathol Exp Pathol 1998; 57:1026

1. NON-HEMORRHAGIC LESIONS
   - Small, dense, asymmetrical lesions: hypertrophic astrocytes, macrophages, coagulative necrosis in white and gray matter
   - Large, diffuse symmetrical lesions: hypertrophic astrocytes and amphophilic globules

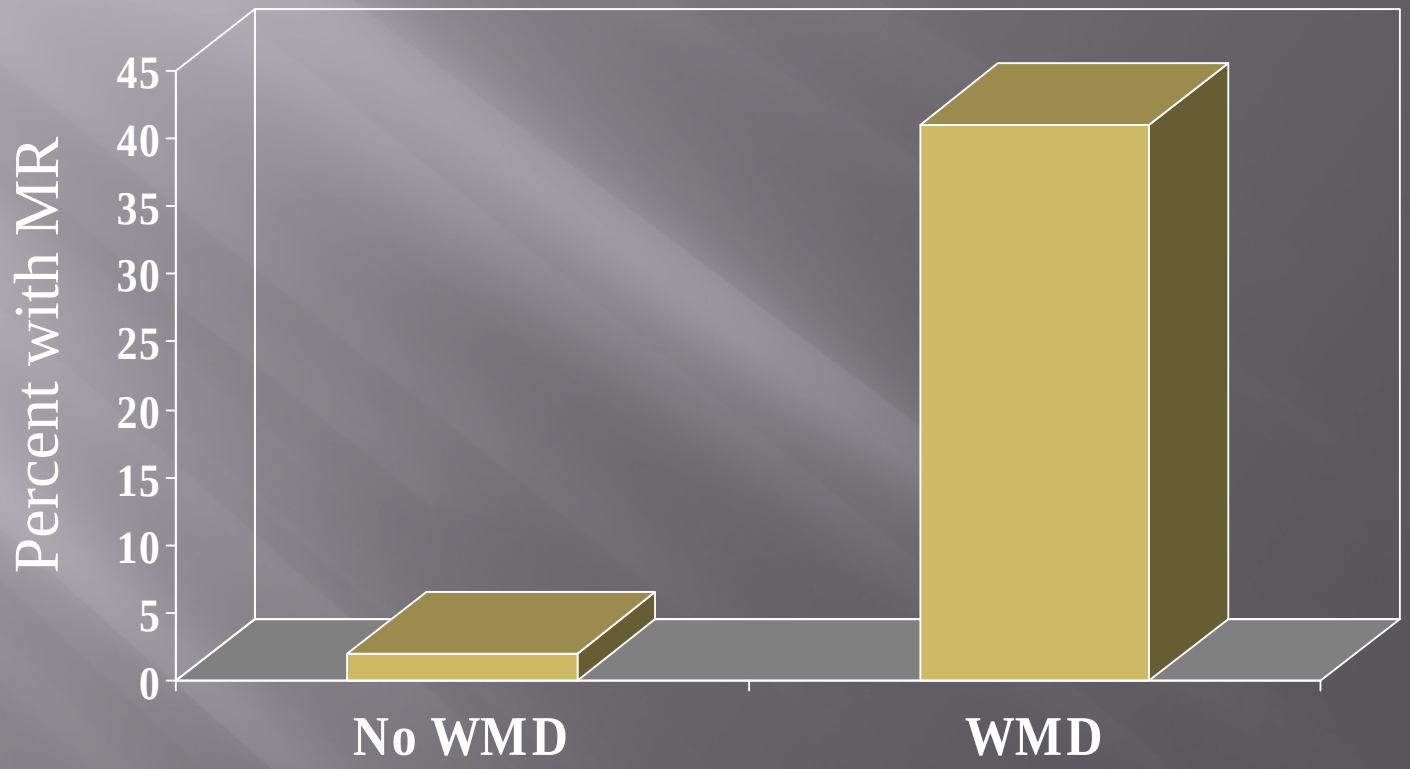
2. HEMORRHAGIC LESIONS
   - Intraventricular, subarachnoid and parenchymal hemorrhage
   - Hemorrhagic necrosis

White Matter Damage and Cerebral Palsy



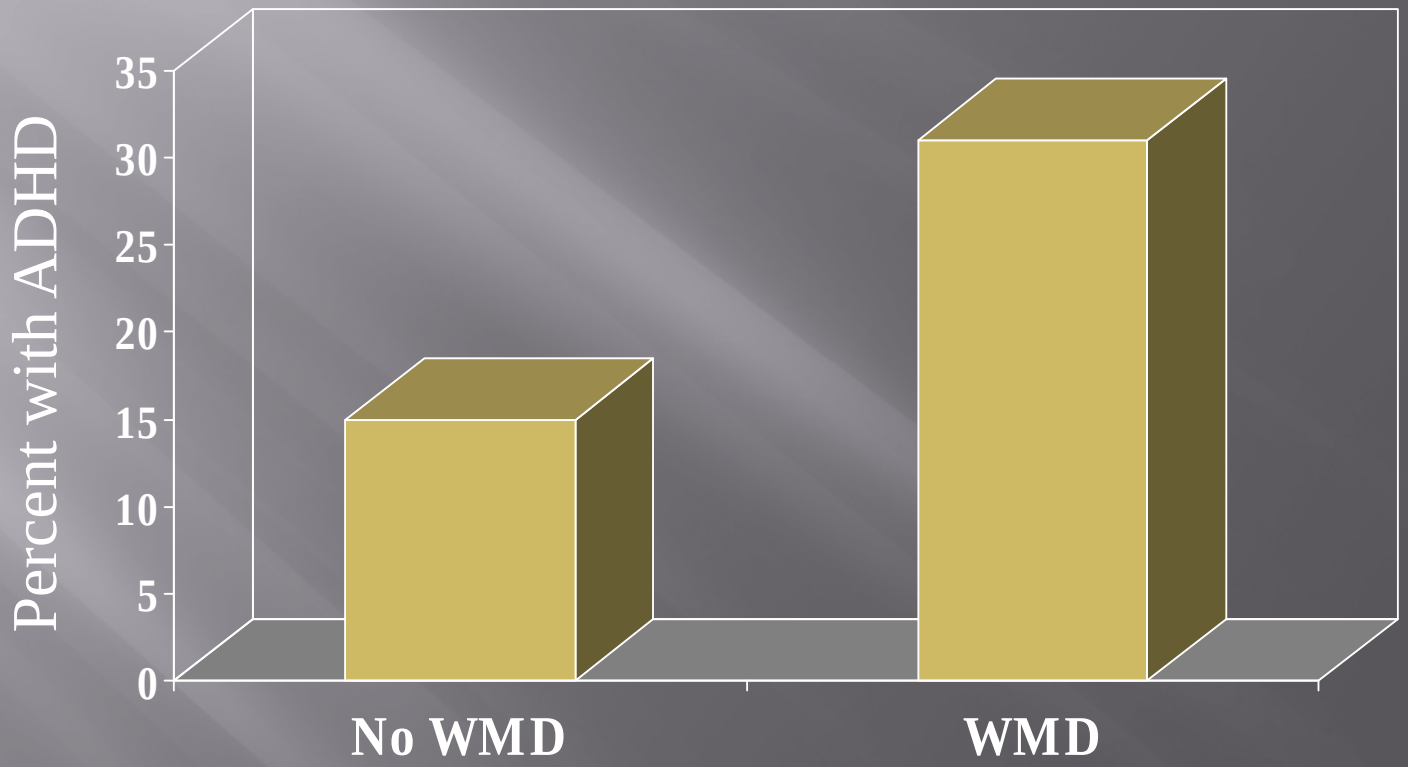
Pinto-Martin et al. Pediatrics 1995; 95:249

White Matter Damage and Mental Retardation



Whitaker et al. Pediatrics 1996; 98:719.

White Matter Damage and Attention Deficit Hyperactivity Disorder



Whitaker et al. Arch Gen Psychiatry 1997; 54:847

Les lésions malformatives

- Agénésie du corps calleux
- Trouble de la gyrie
- Malformation vasculaire
- Hydranencéphalie, porencépahlie
- Tumeur du plexus choroïde
- …

Les lésions hémorragiques

Elles sont devenues beaucoup moins fréquents

CLASSIFYING BRAIN DAMAGE

Paneth N: J Pediatrics 1999;134:527-9.

PAPILE CLASSIFICATION

Grade I – GMH alone

Grade II – uncomplicated GMH/IVH

Grade III – IVH with ventricular enlargement

Grade IV – IVH with parenchymal extension

NBH/DEN CLASSIFICATION

1. **No lesion**
2. **GMH or IVH without ventricular enlargement (VE)**
3. **Parenchymal echodensity or lucency or ventricular enlargement (greater than mild)**

(DEN prioritized looking at EL)

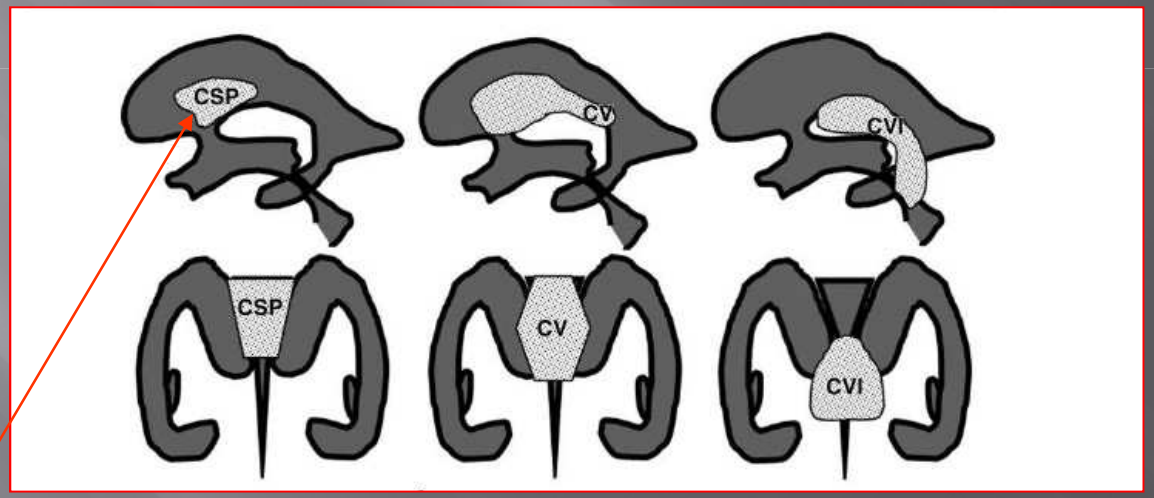
Hémorragie « stade 4 »

Les lésions pseudo-cystiques

Elles sont les lésions les plus fréquentes

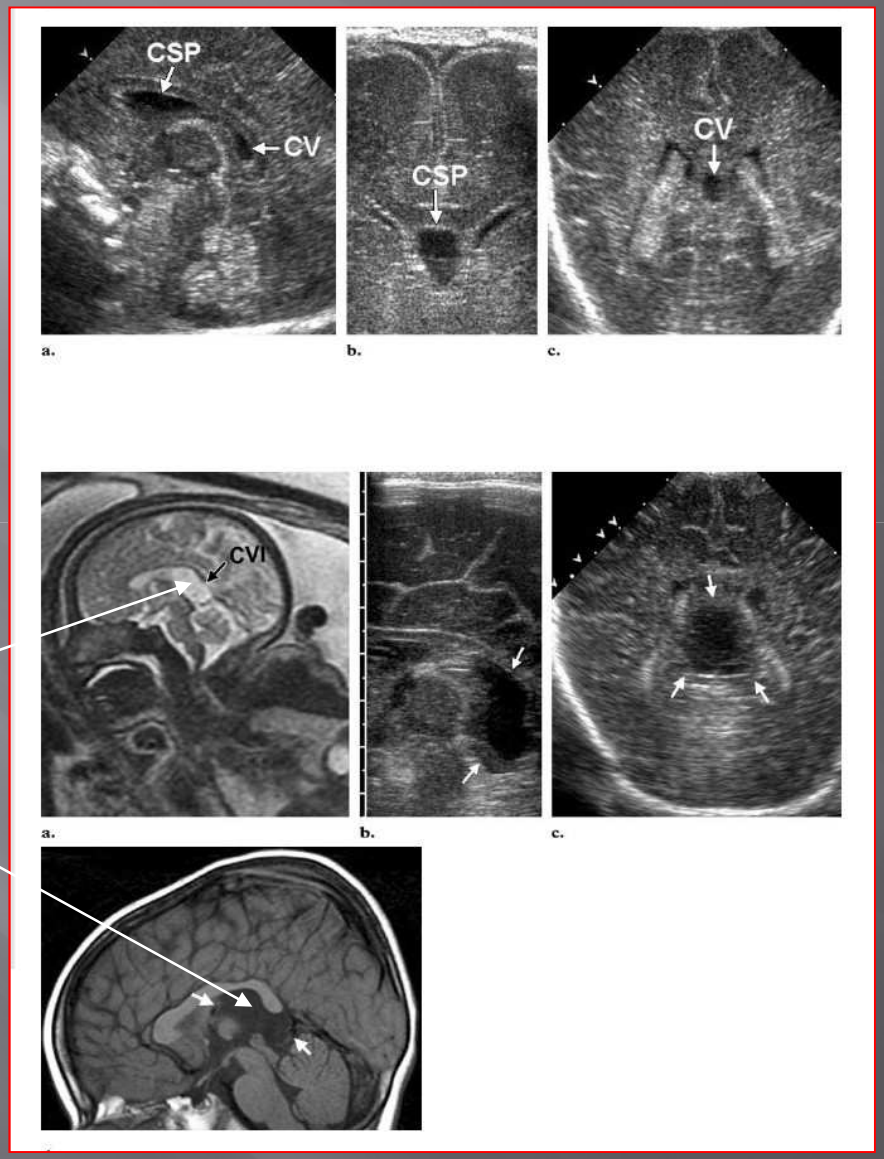
- **Elles peuvent rester permanentes**
- **elle peuvent sembler disparaître et laisser place à une gliose.**

Les structures médianes:
-csp: cavum septi pellucidum
-Cv: cavum vergae
-Cvi: cavum veli interpositi

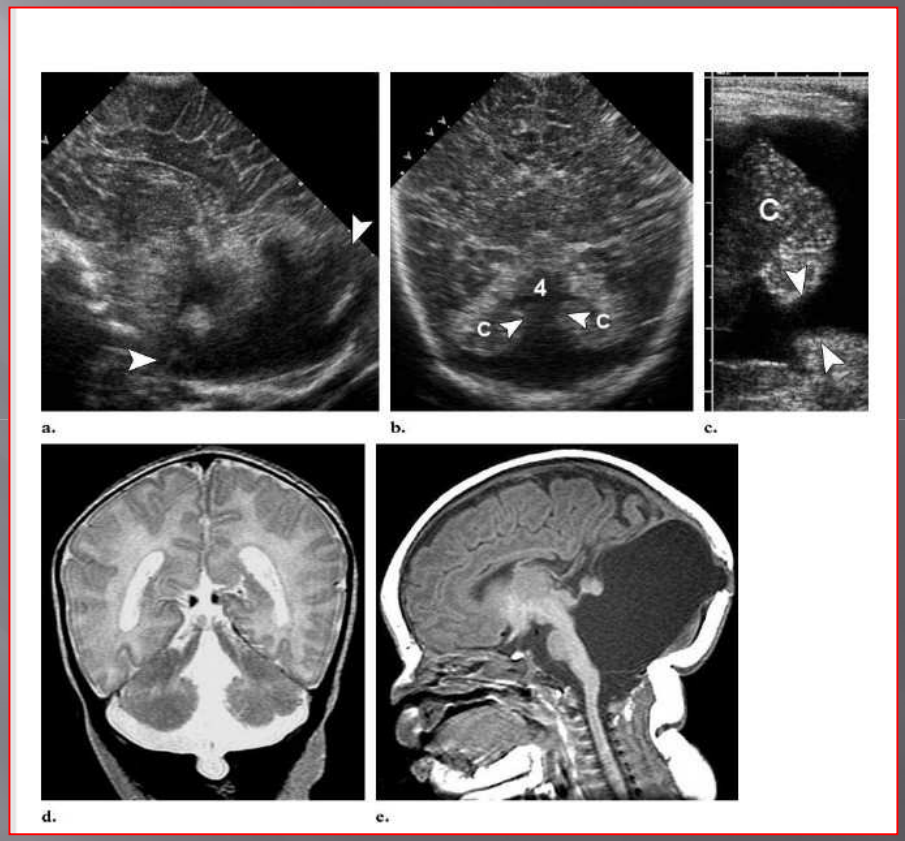


< système limbique

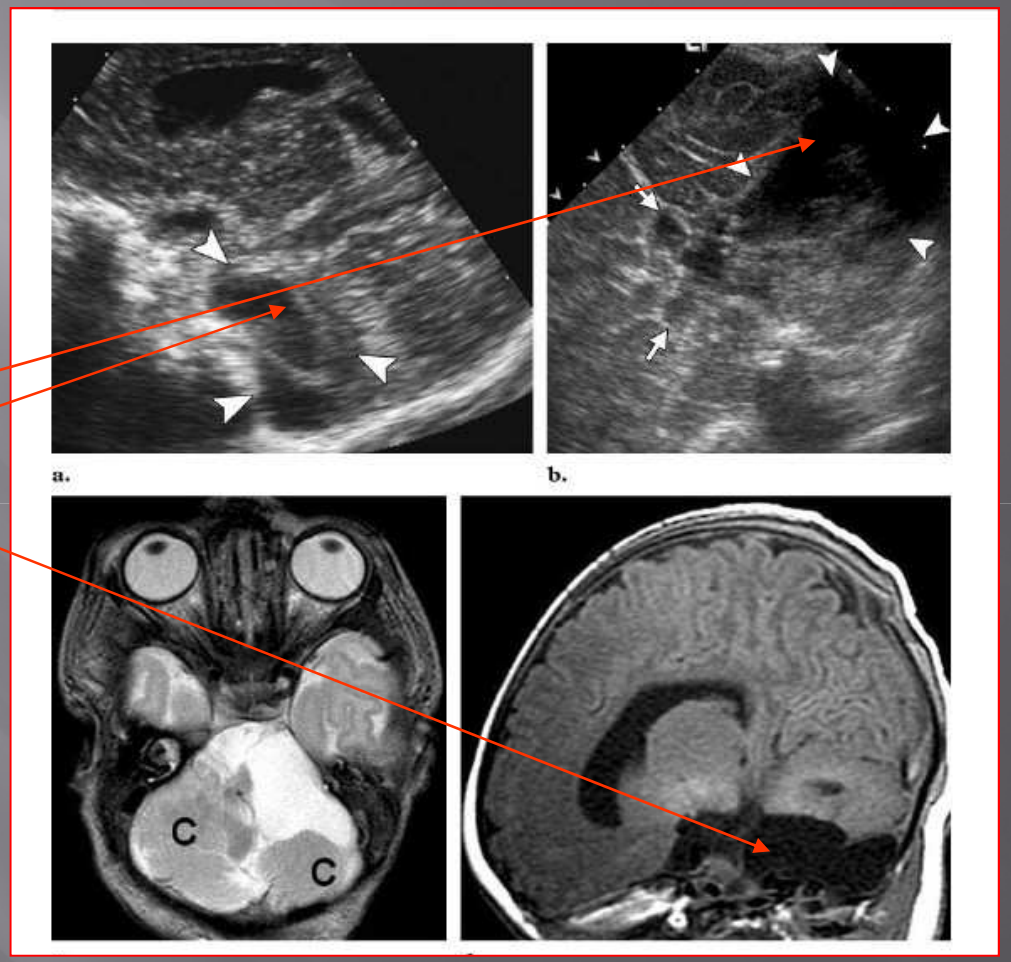
CVI on MRI



Mega cysterna magna < infarction, inflammation (CMV)

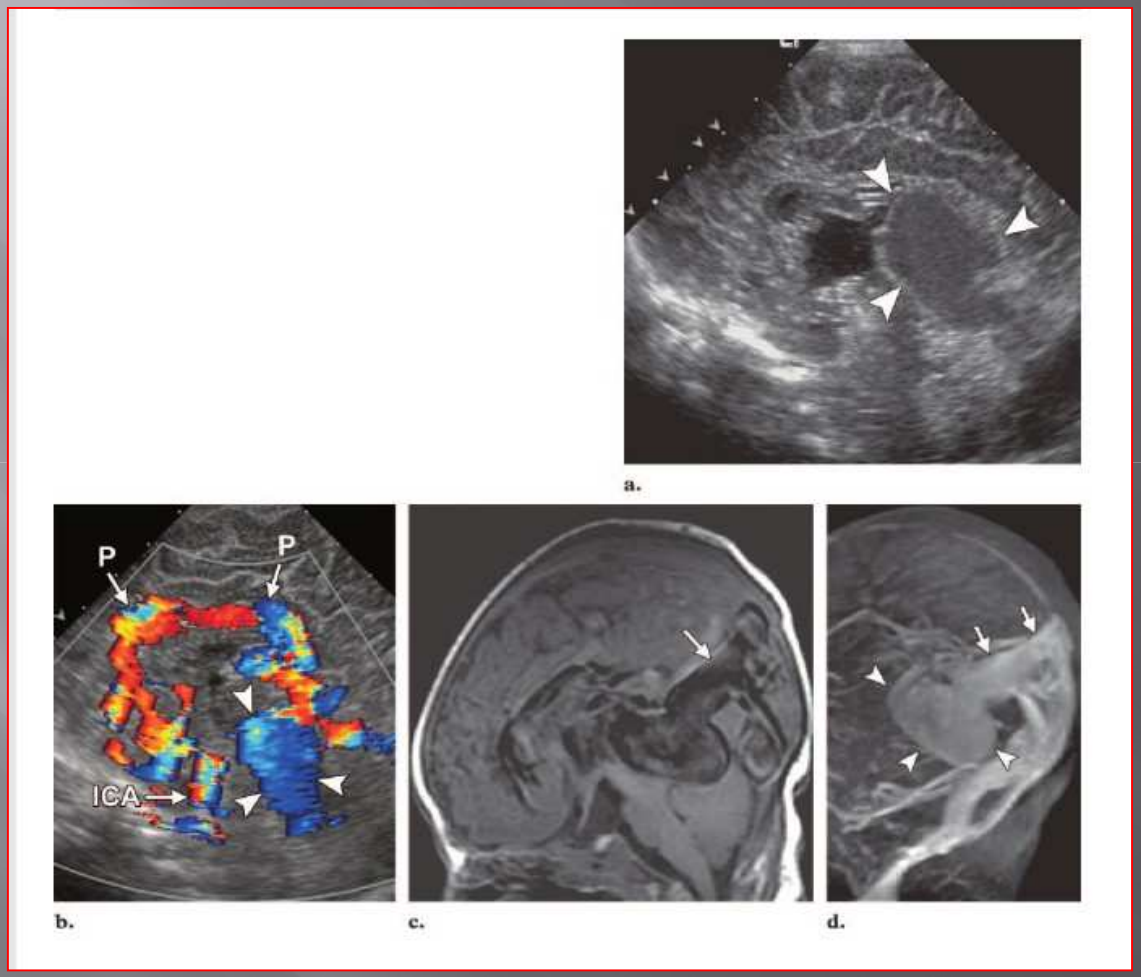


CSF collection

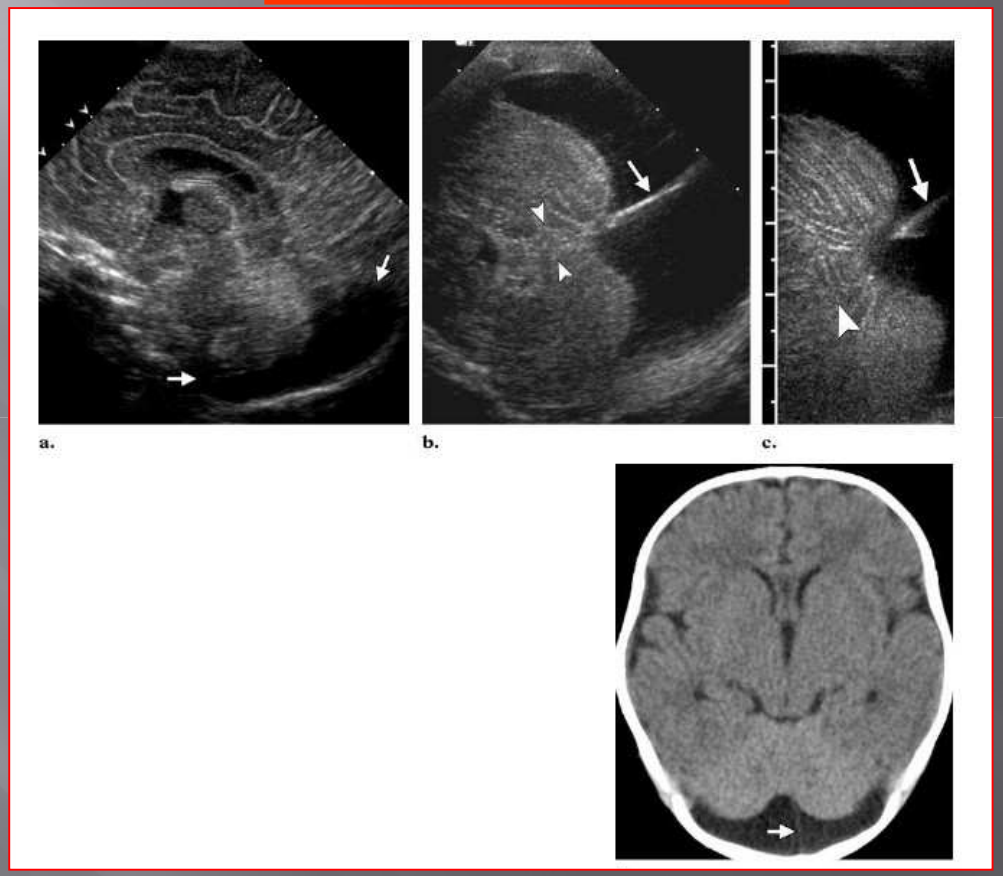


Arachnoid cyst

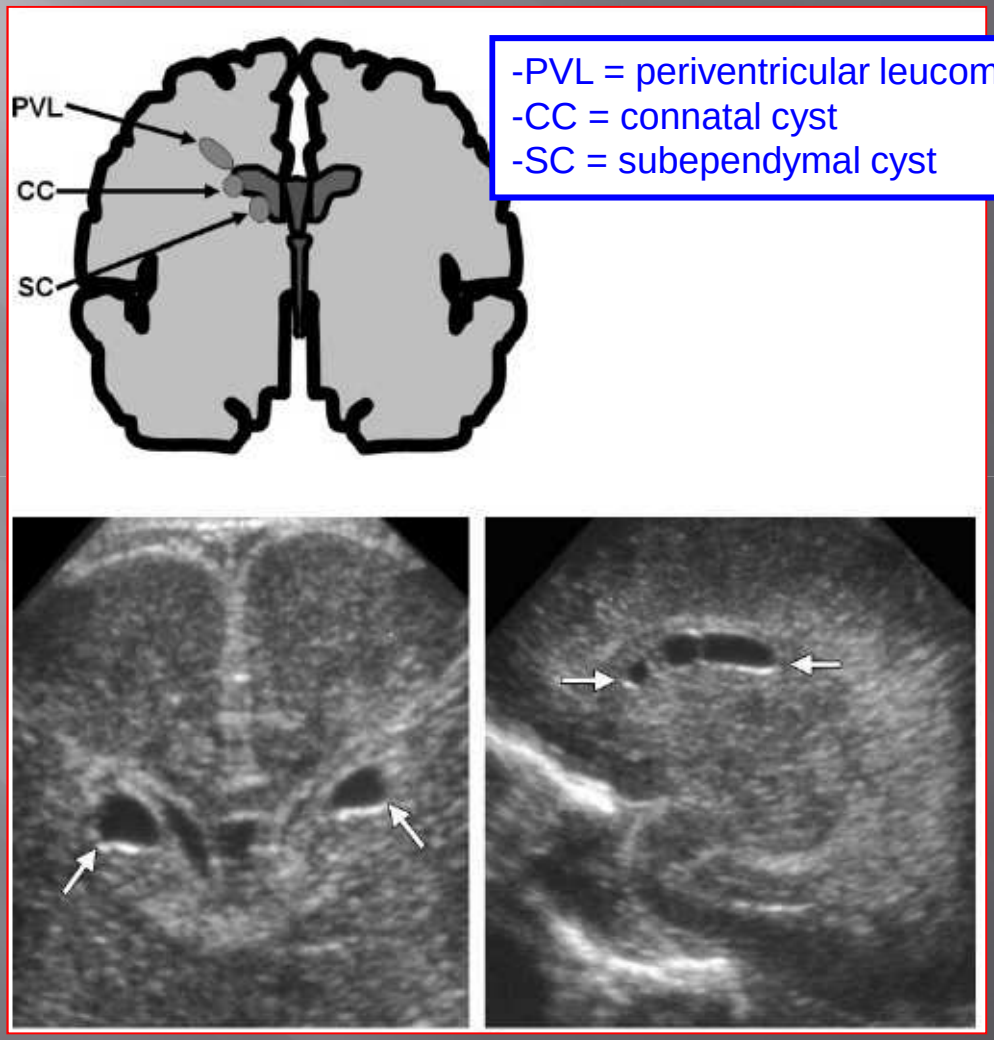
Vein of Galien malformation



Mega cysterna magna



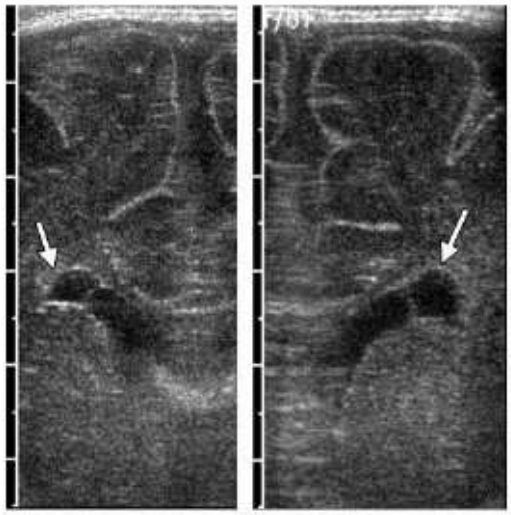
Differents forms of periventricular cysts

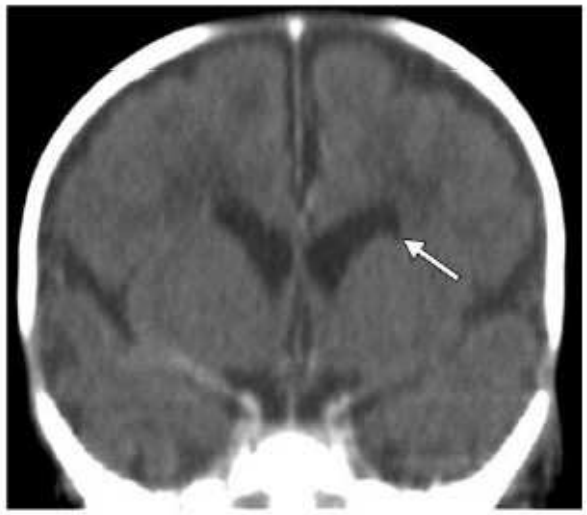


-PVL = periventricular leucomalacia
-CC = connatal cyst
-SC = subependymal cyst

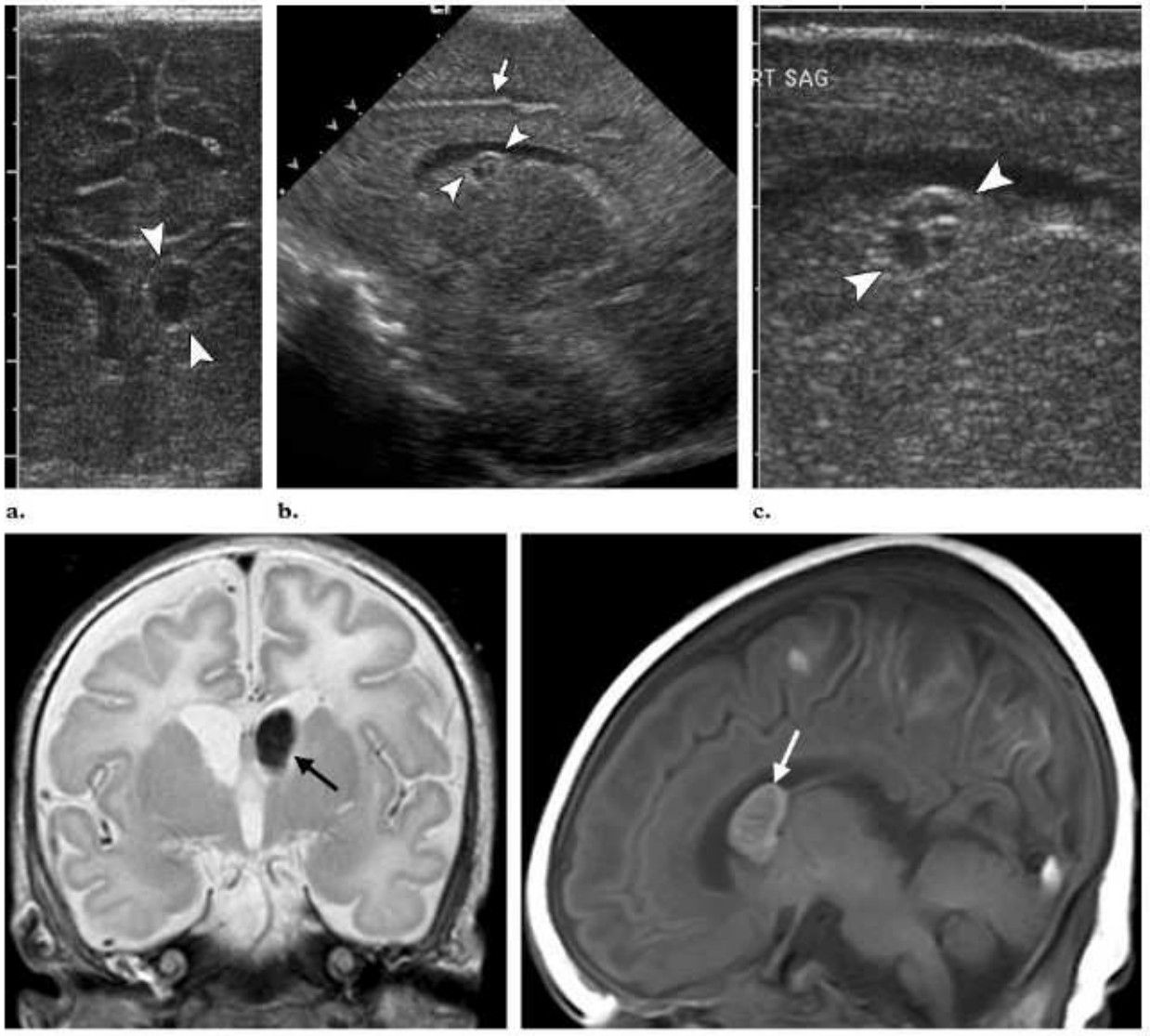
Connatal cyst:
They are bilateral

a.

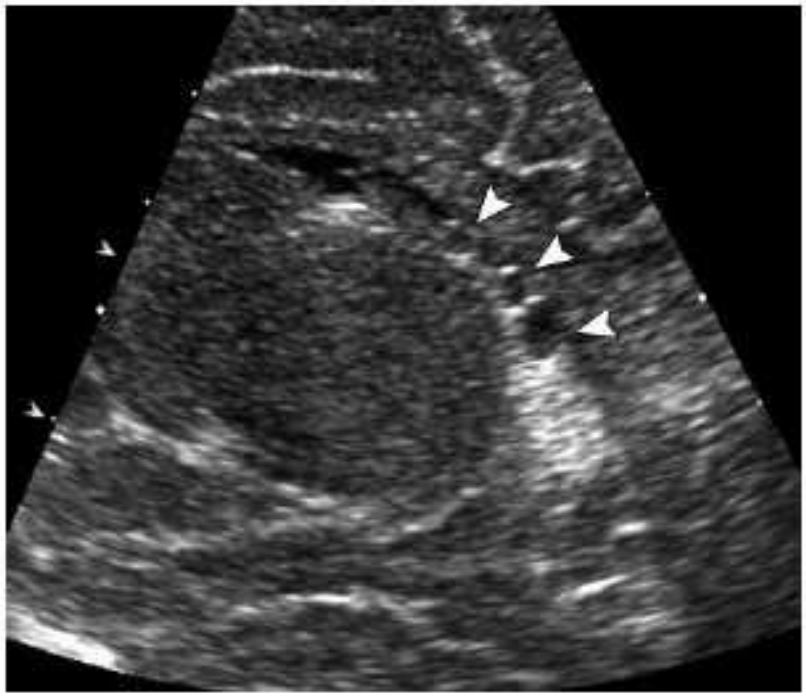


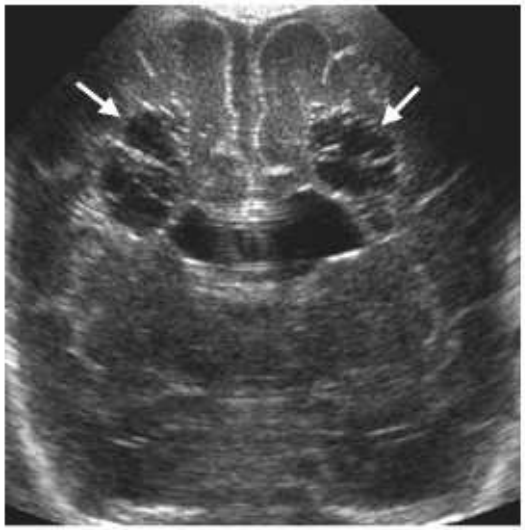


Subependymal cyst after hemorrage

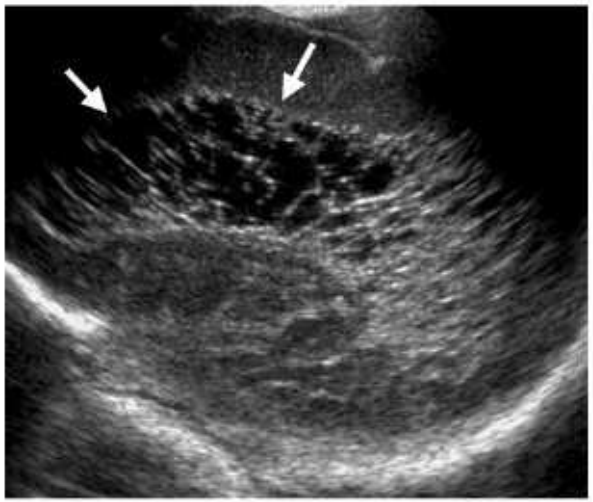


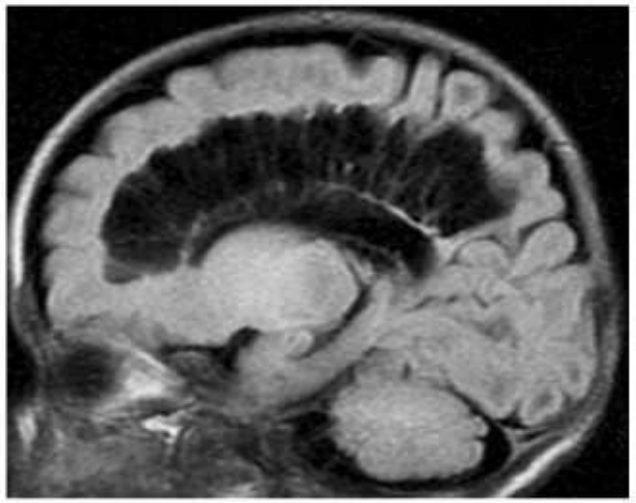
Small choroid pseudocysts





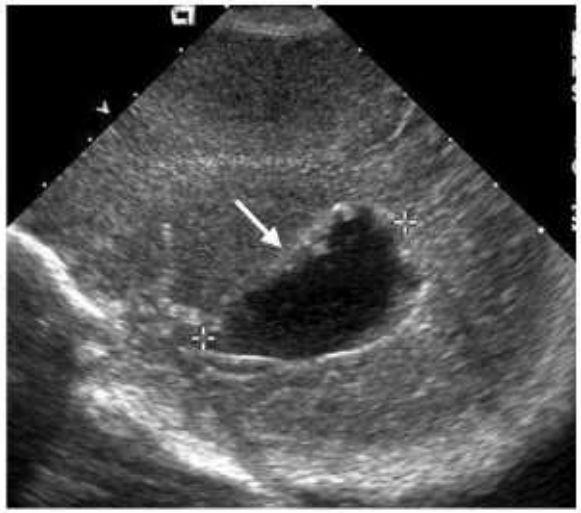
a.



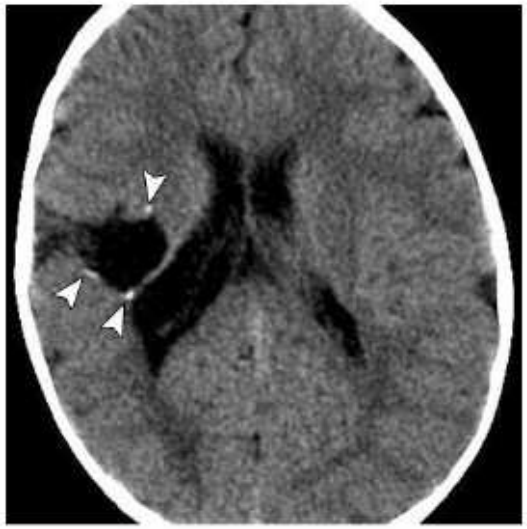


Periventricluar leukomalacia: Extended form

a.

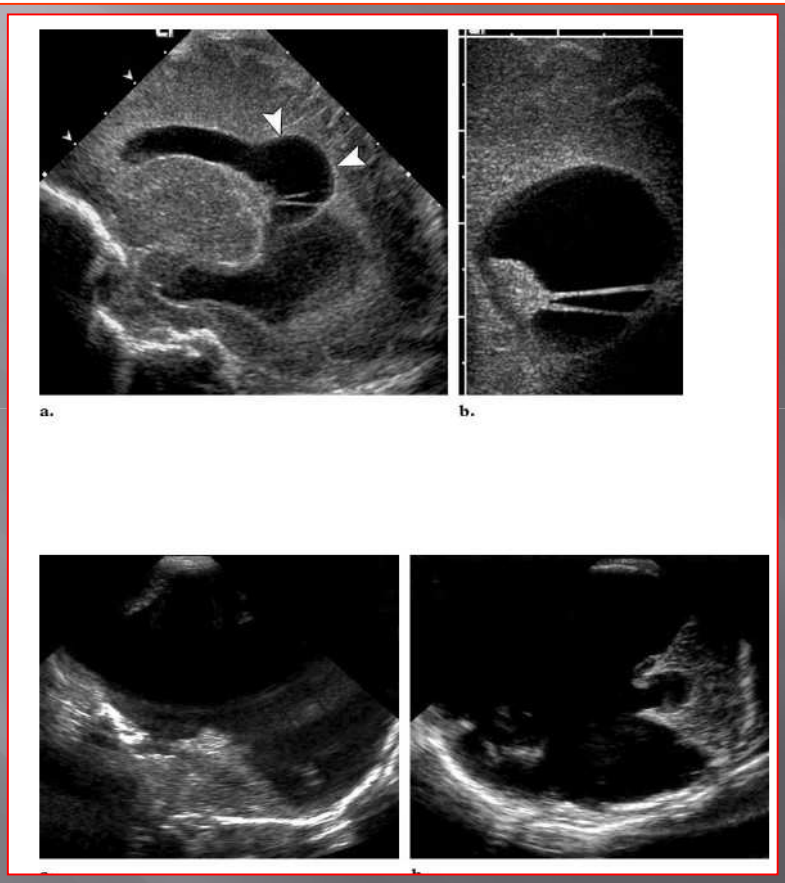


b.



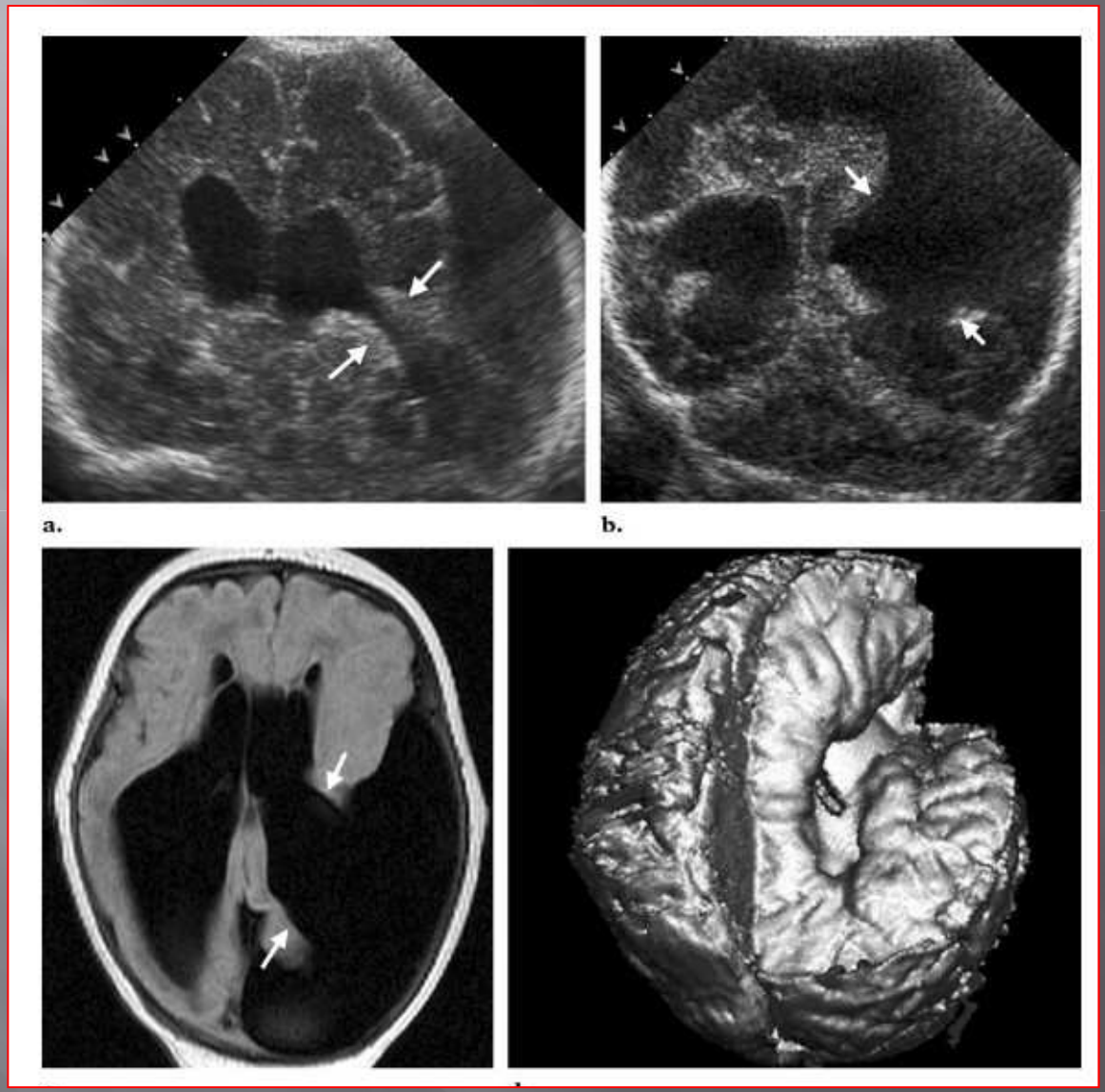
Porencaphaly:
Non communicating

Porencephaly (communicating form

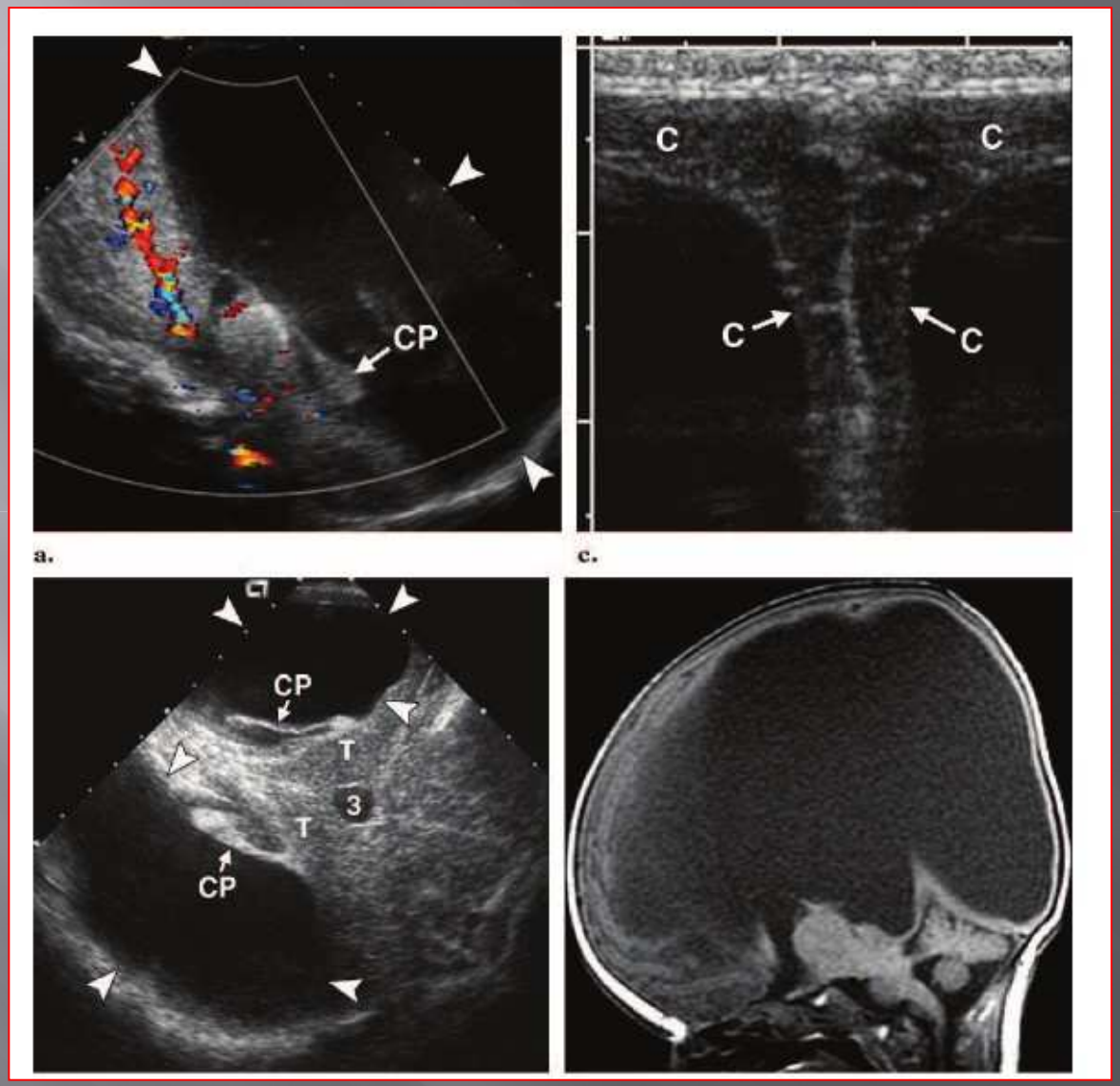


hydranencephaly

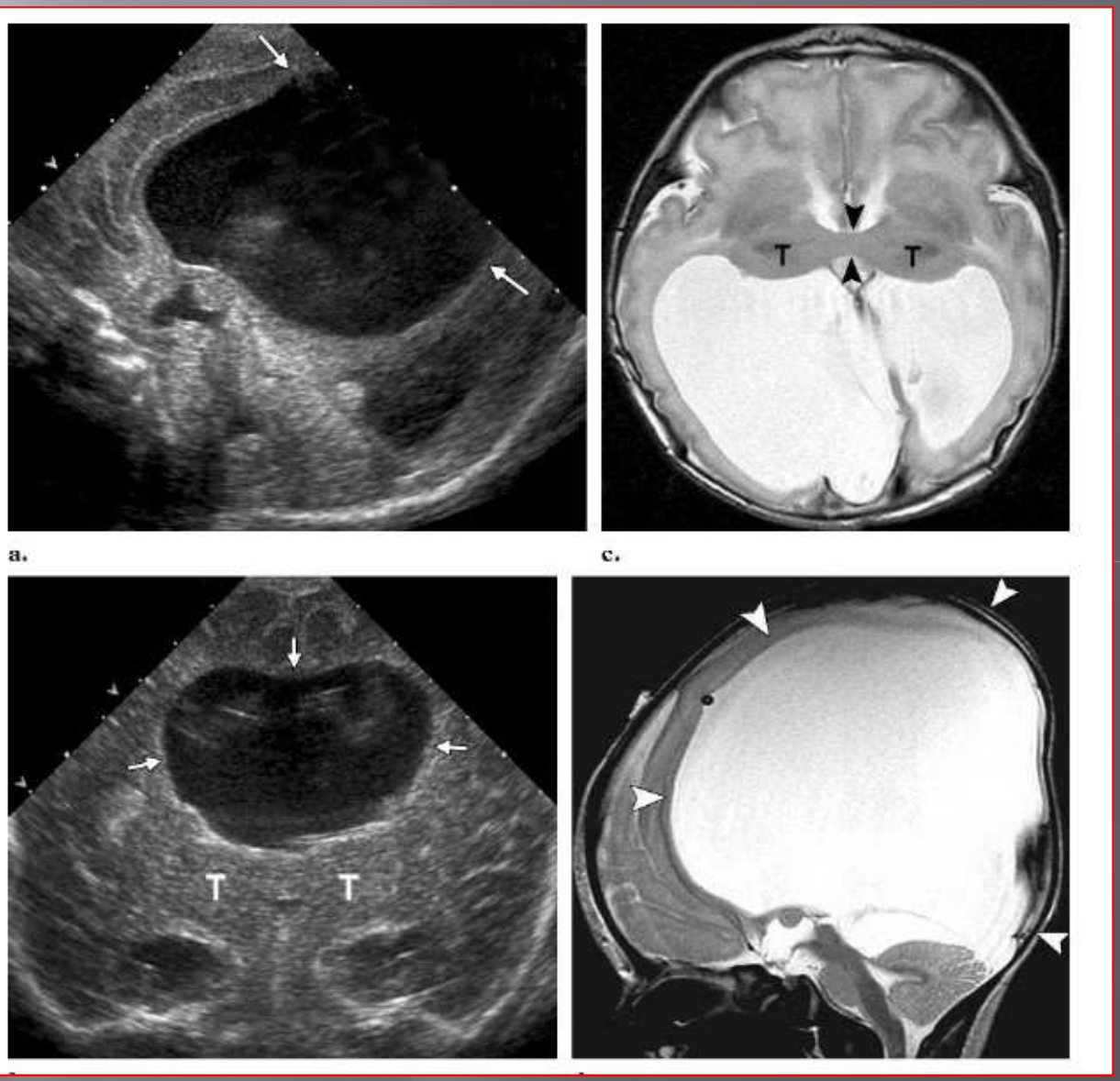
Schizenphaly: ultrasounds and MRI

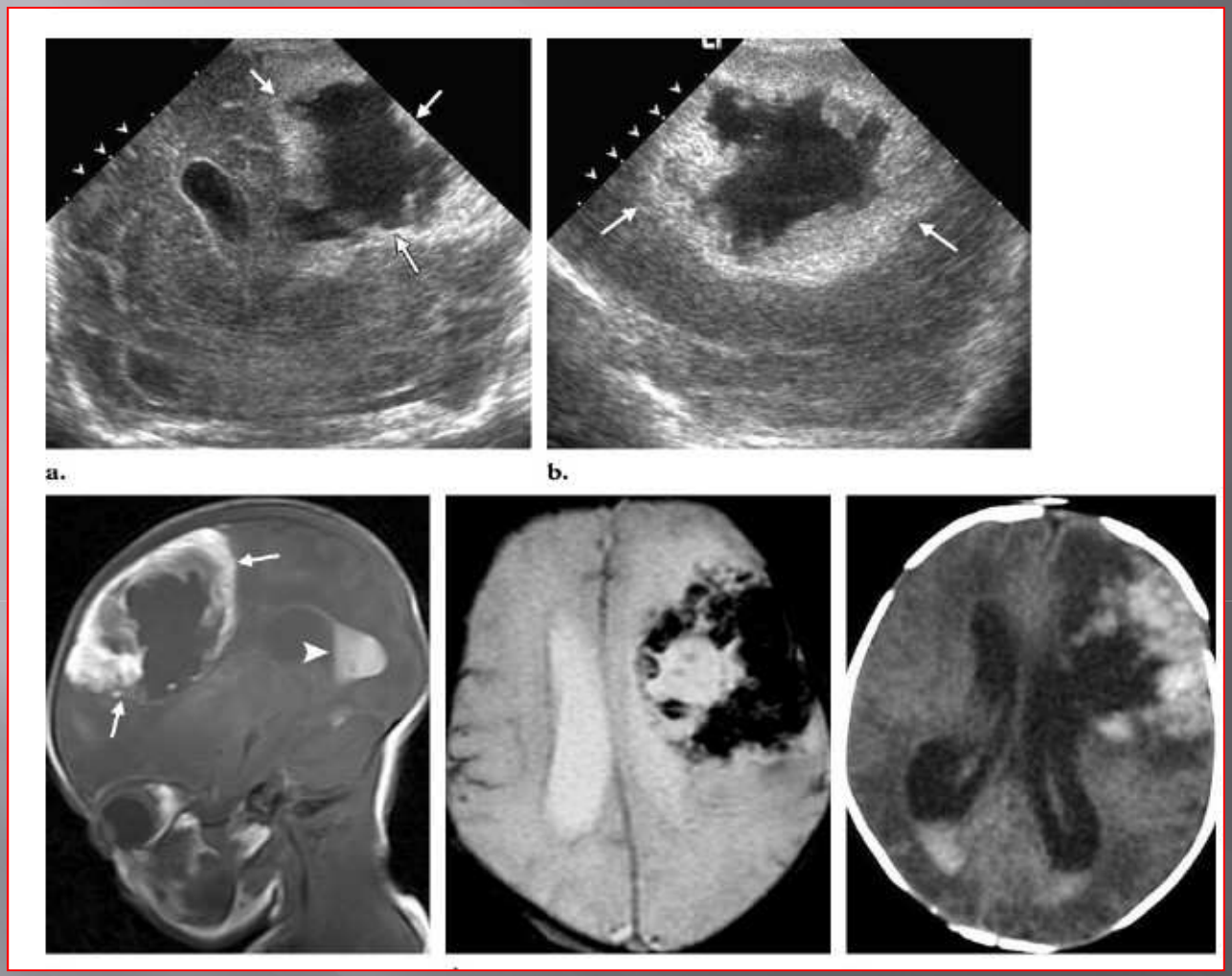


Sever obstructive hydrocephalus



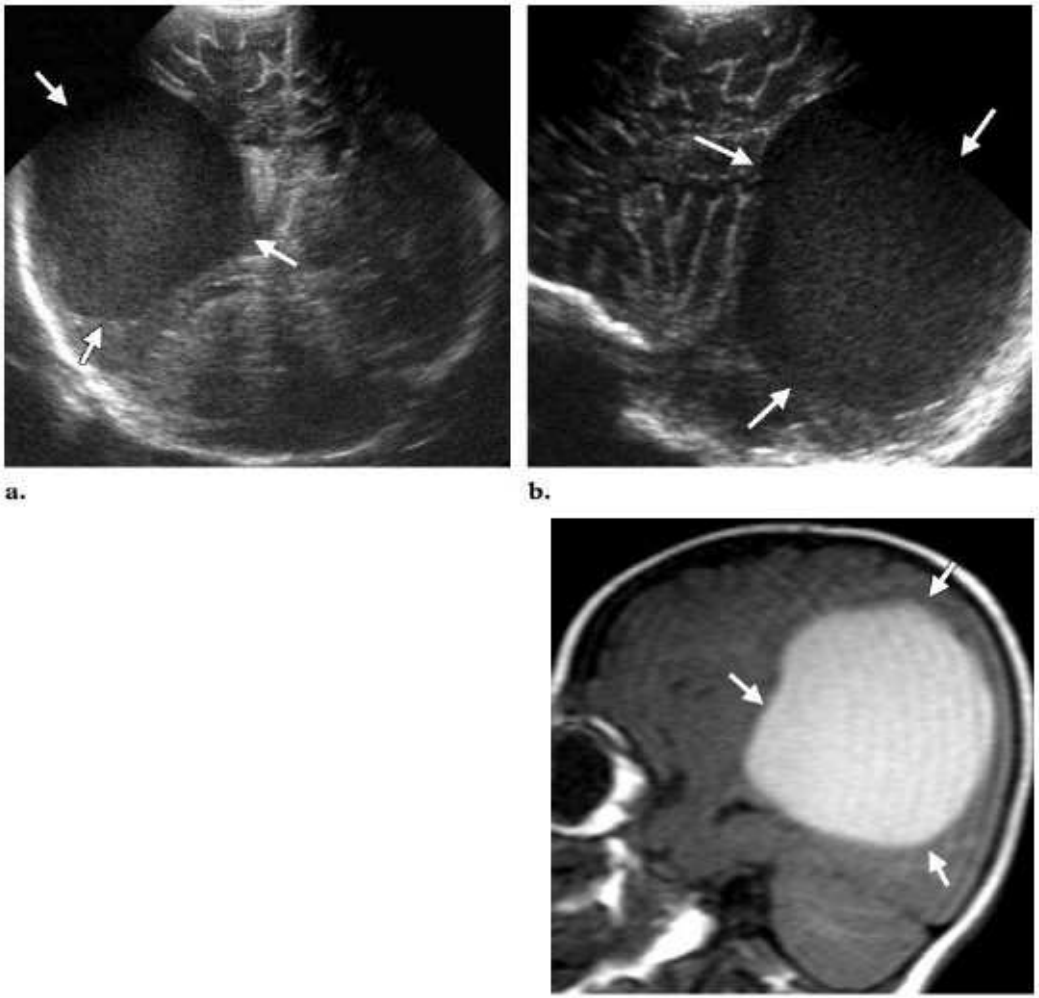
holoprosencephaly



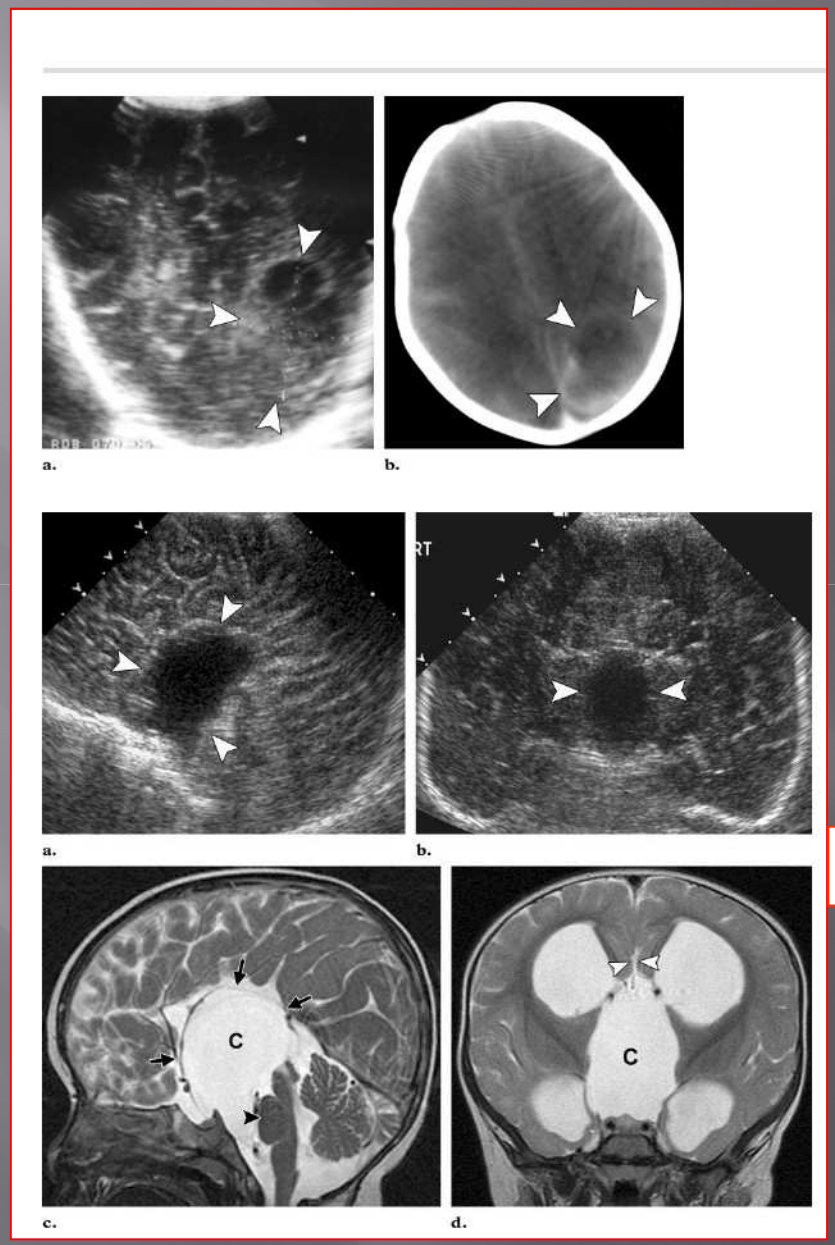


Parietal hematoma

Intraparietal hematoma

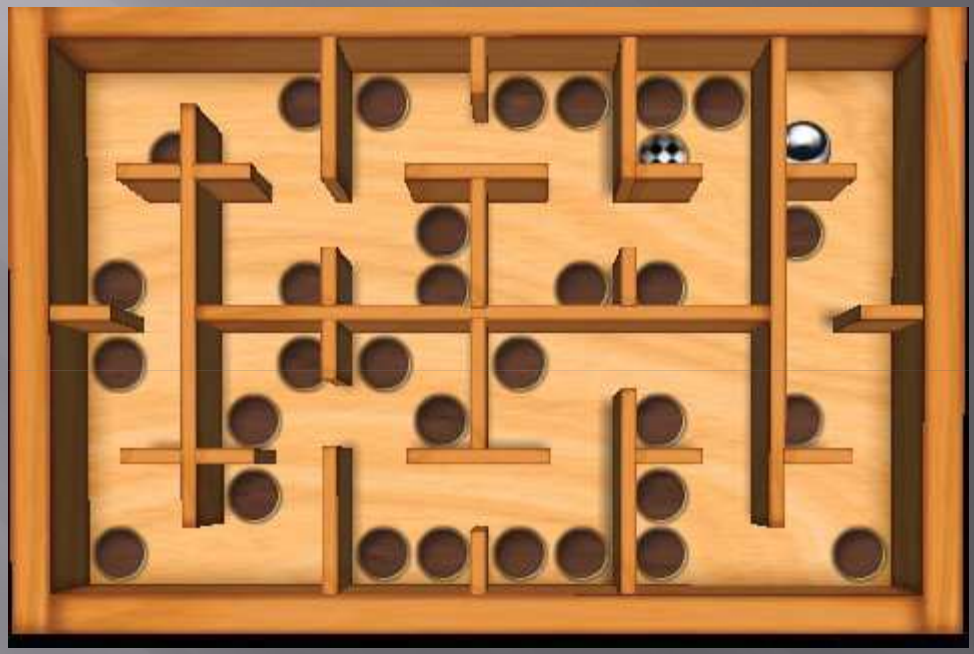


Brain abcess



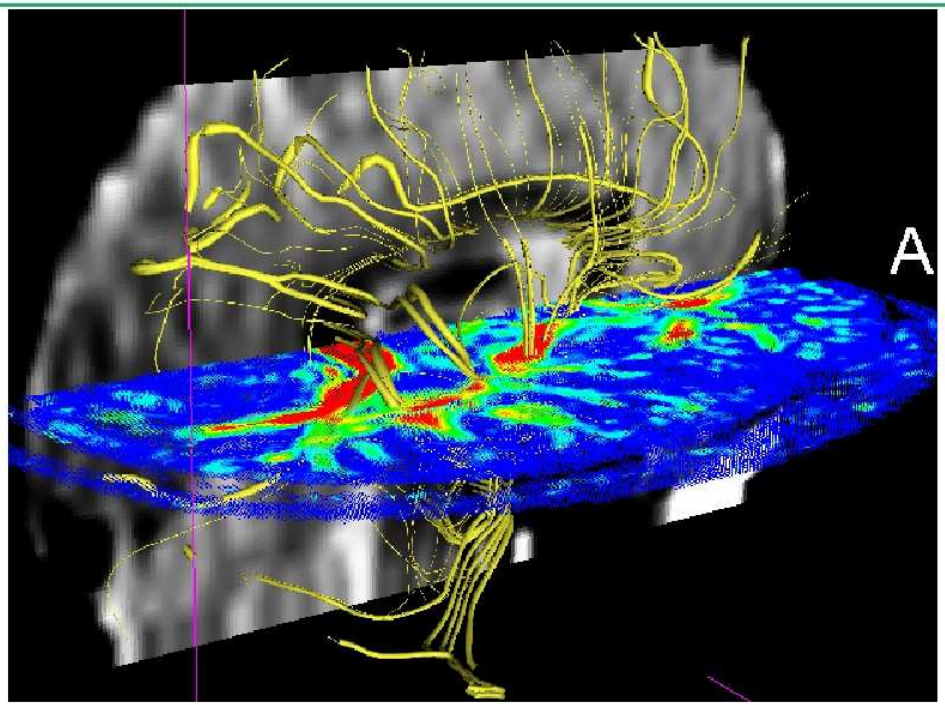
Suprasellar arachnoid cyst

MRI and tension diffusion



Moving water molecules are « followed » in their movements
and the fiber tracts interline these movements, in the descending or ascending sense.

Les tractus sont « traqués »



Les tractus sont « traqués » (2)