

Imagerie cérébrale du prématuré et du nouveau-né

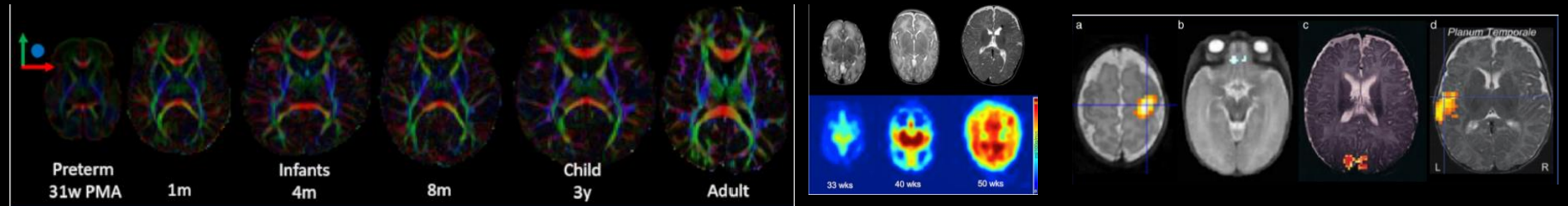
C Durand

2021

Introduction

- **Moyens d'exploration**

- ETF +++
- TDM : non sauf urgences neuro-chirurgicales
- IRM +++
 - IRM conventionnelle
 - Techniques avancées : protocoles de recherche
- EEG

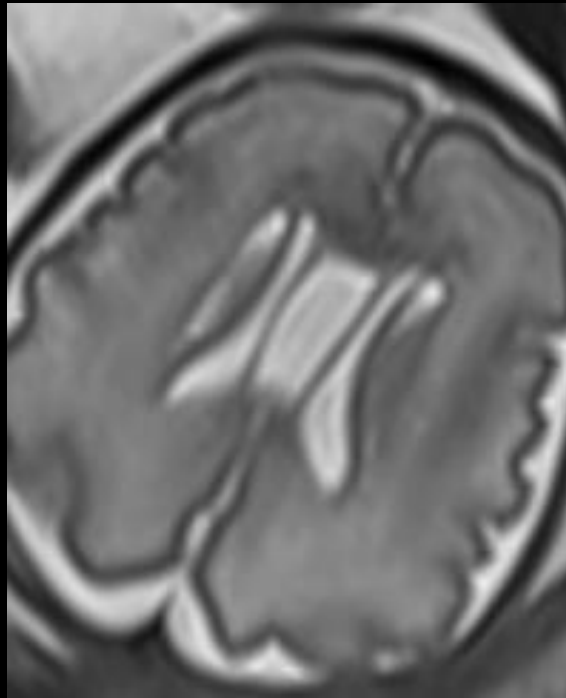


Introduction

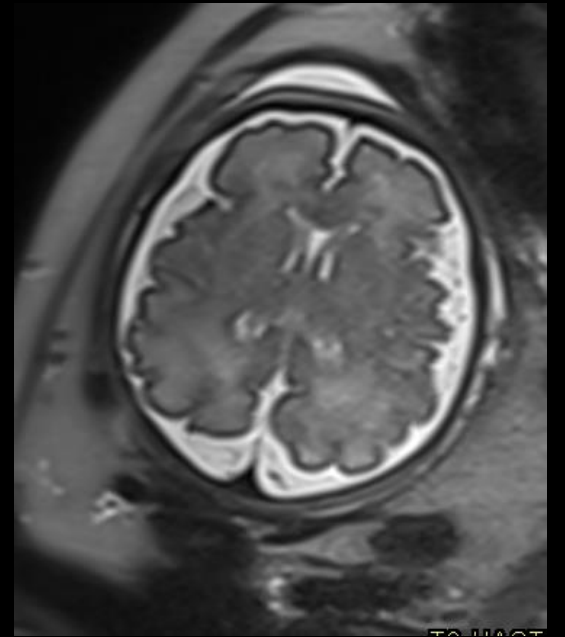
- Que nous a appris l'IRM fœtale



26 SA



30 SA



33 SA

Introduction

- Interprétation du bilan lésionnel radiologique nécessite pour être pertinent
 - Données cliniques +++++
 - Evolution temporelle : toutes les données d'imagerie dans le temps
 - Multidisciplinarité avec les néonatalogues

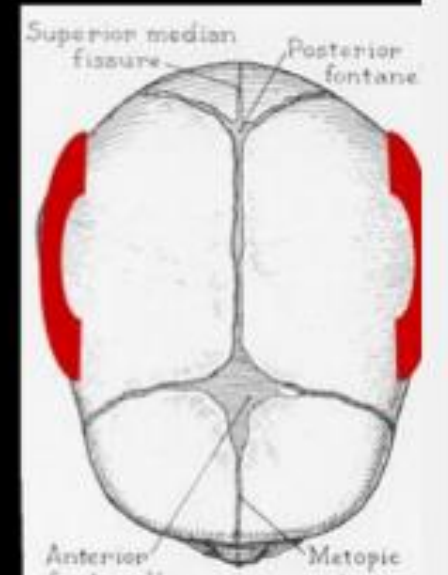
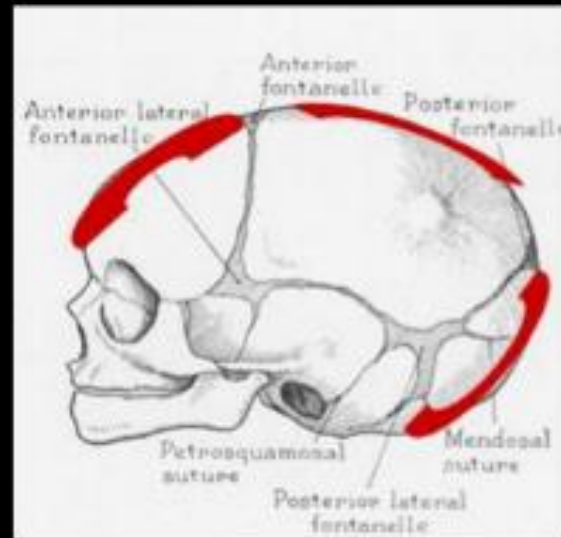
ETF

- Technique non irradiante, accessible, réalisable au lit
 - Intérêt +++ chez prématuré
- Technique qui peut être répétée
- Performante pour étude des hémorragies intra-ventriculaires, des lésions kystiques, pour le suivi des dilatations
- Limites
 - Nécessite une expérience
 - Zones d'ombre

Zones d'ombre en ETF

Zones d'ombre

- topographie :
 - convexité cérébrale
 - fosse postérieure ++



Cervelet et US

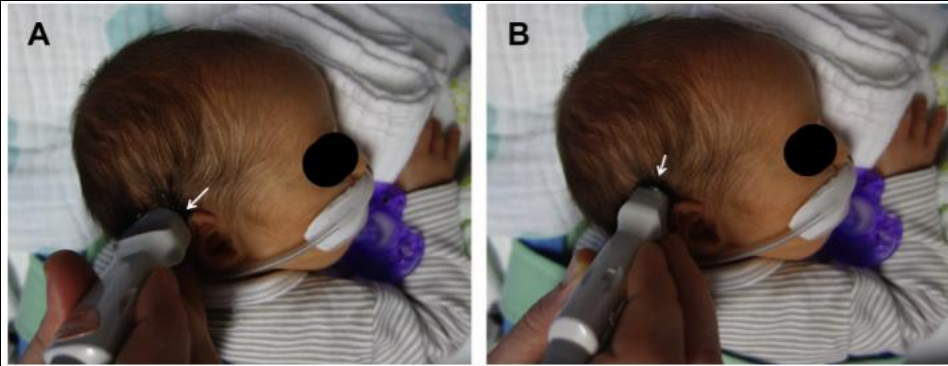
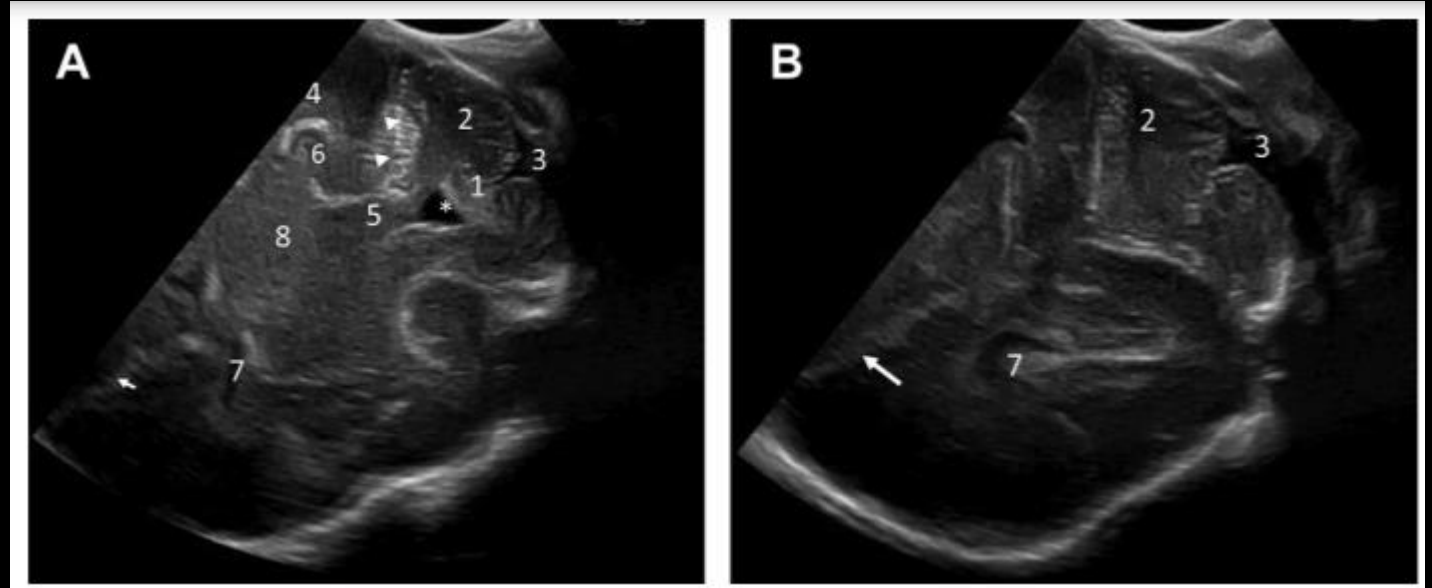
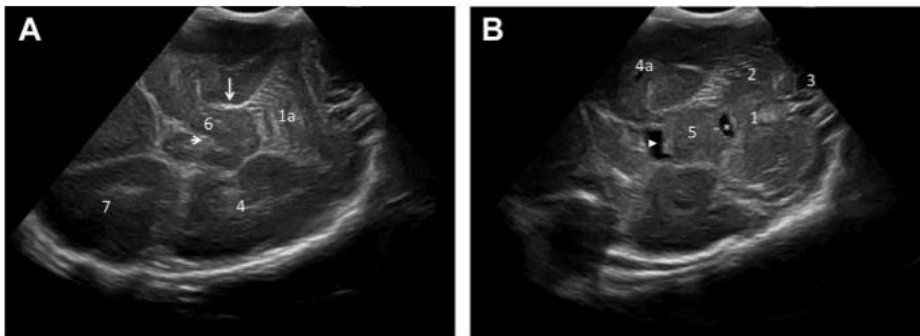


Fig. 3. Probe positioning for mastoid fontanel cranial ultrasonography, axial (A) and coronal (B) view.

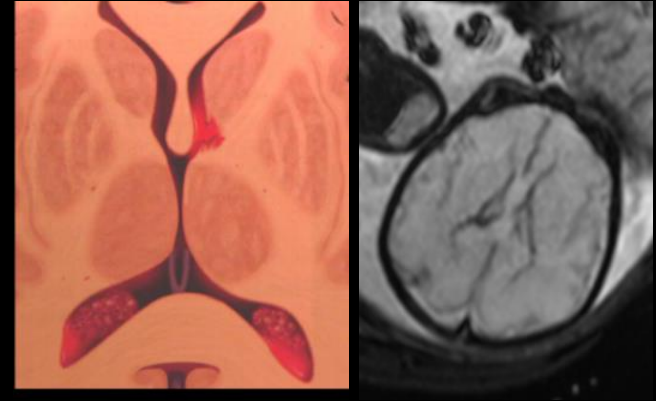


Coronales

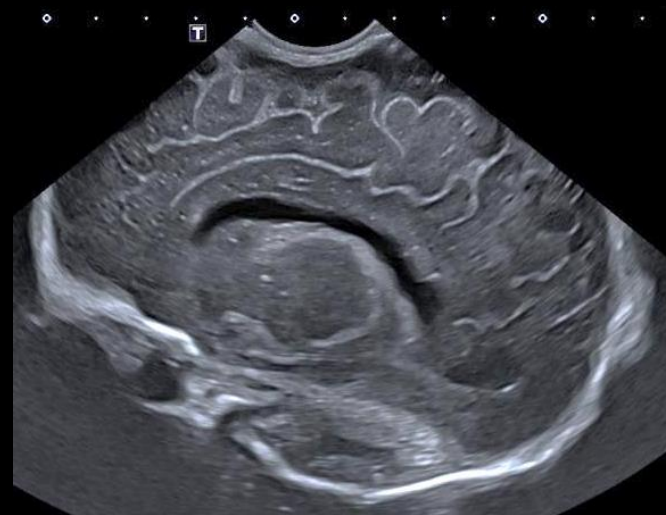
Pathologies du Prématuré

- Hémorragies ventriculaires et ses complications
 - Infarctus hémorragiques
 - Hydrocéphalie
- Lésions de la SB
- Infections
- Malformations : DAN de plus en plus

Hémorragies intraventriculaires



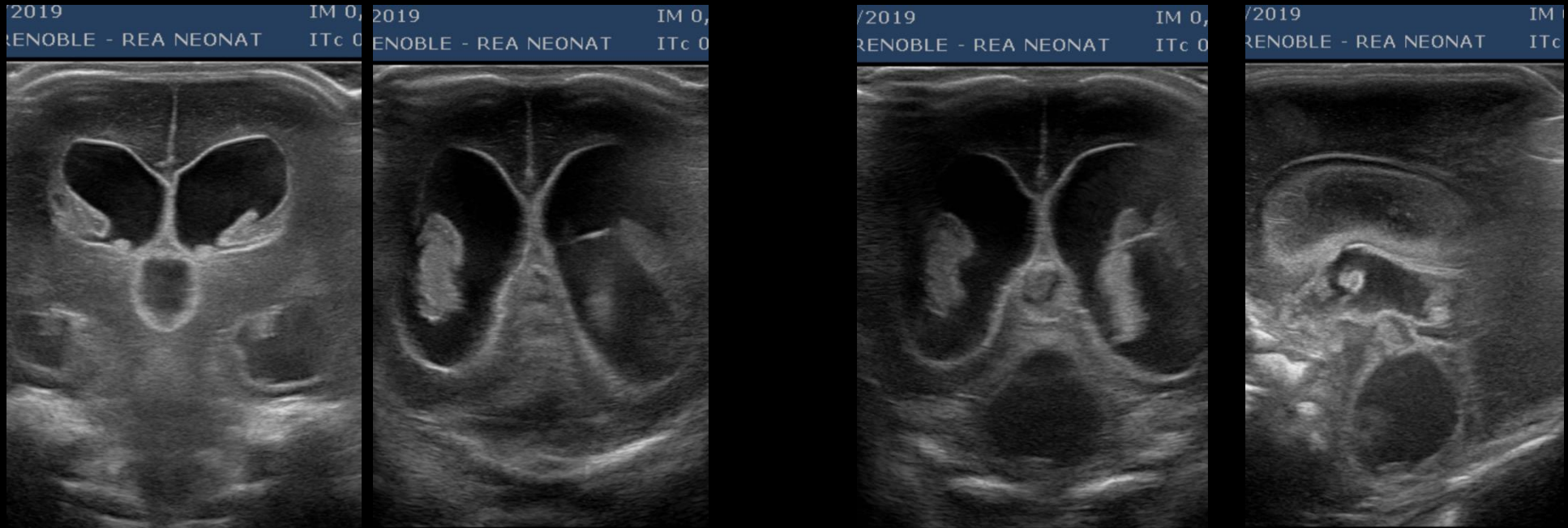
- Physio-pathologie
 - Fragilité de la matrice germinale
 - Fluctuations du débit sanguin cérébral pendant une période d'instabilité physiologique et d'autorégulation cérébrale limitée chez le prématuré
- Classification de Papile (1978) décrite en TDM
 - Grade 1 : HSE dans le sillon thalamo-caudé
 - Grade 2 : HIV sans dilatation ventriculaire
 - Grade 3 : HIV avec dilatation ventriculaire
 - Grade 4 : HIV avec atteinte parenchymateuse (infarctus hémorragique)
- Limites : stade 4 et absence de description des autres lésions hémorragiques dont cervelet, TC, NGC



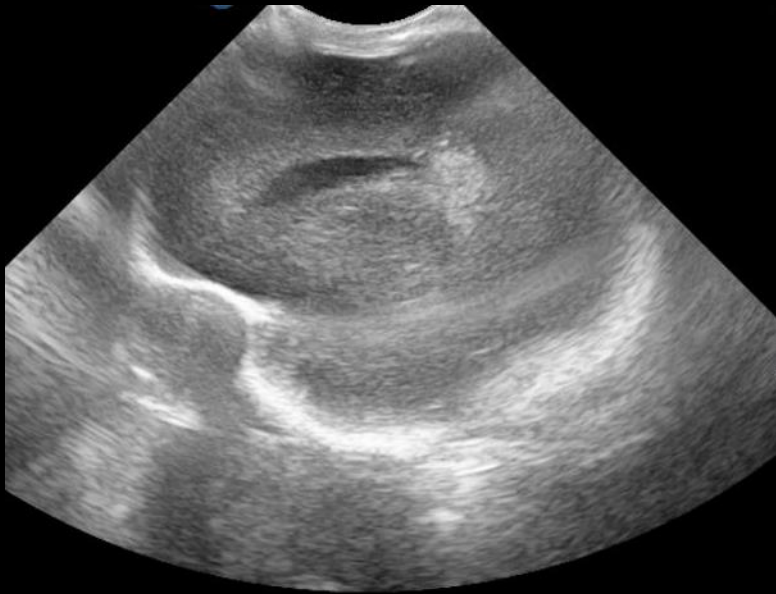
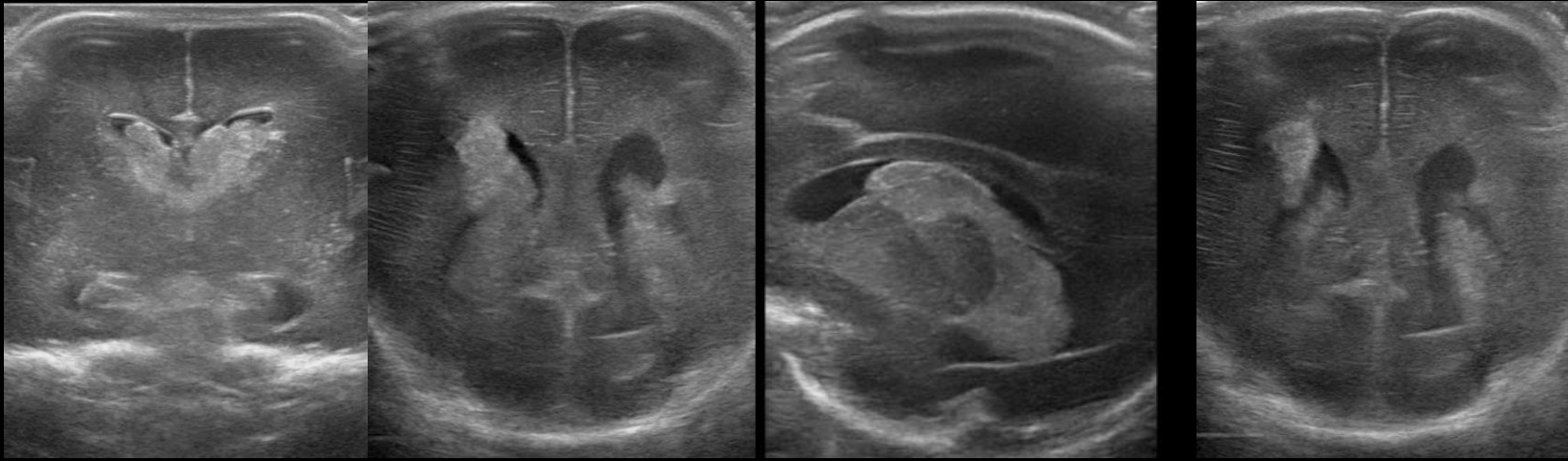
24 SA et 3 jours – J7



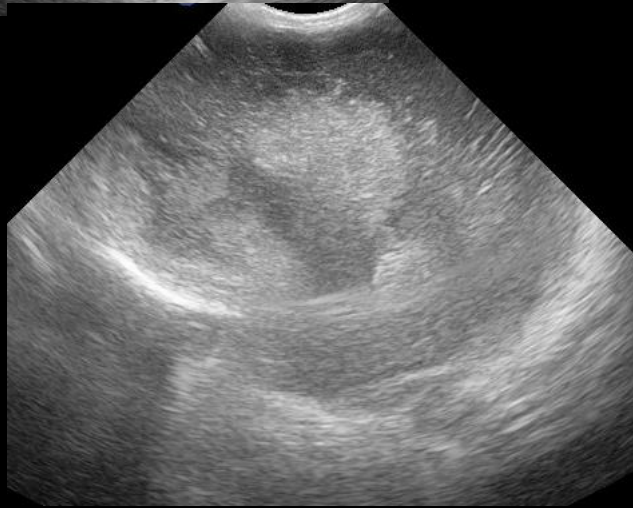
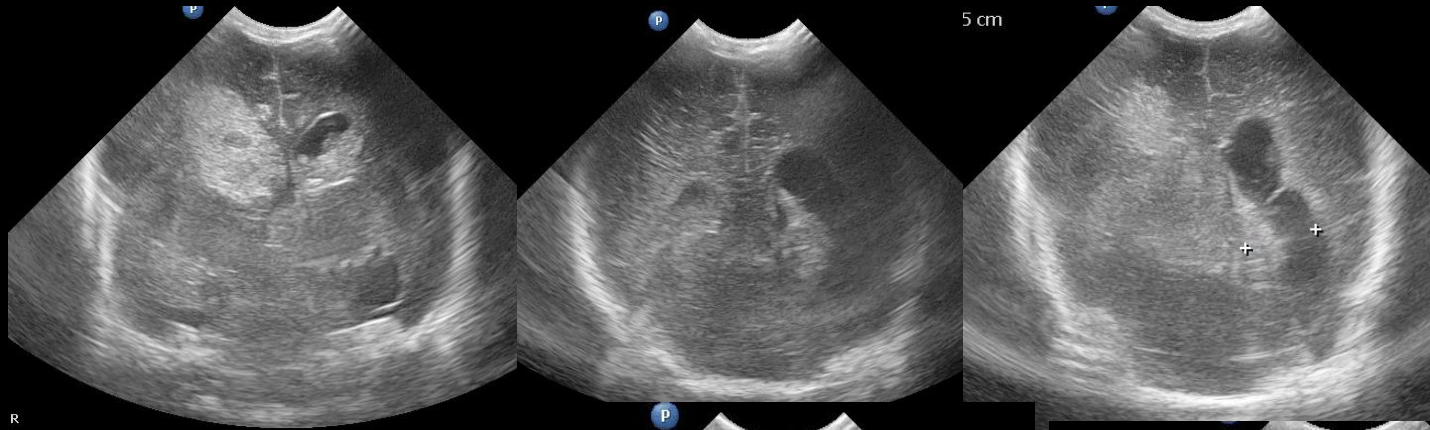
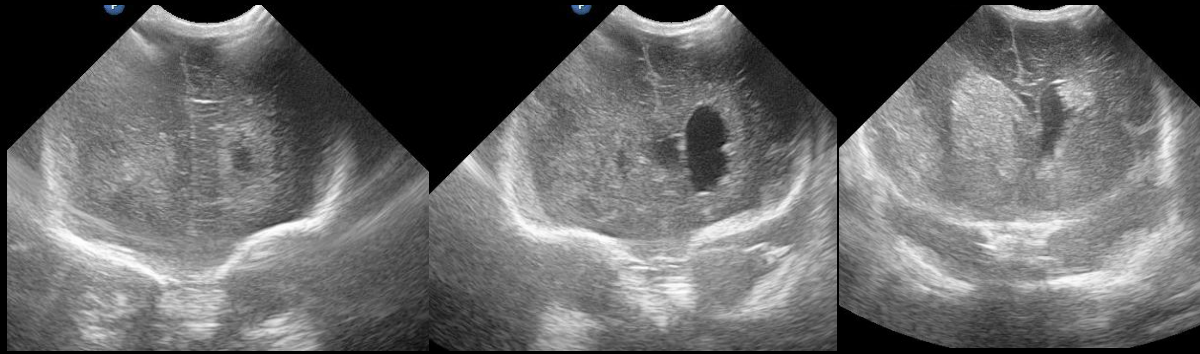
24 SA et 3 jours – J11



24 SA



Stade 4 ?



Hémorragies intraventriculaires

- Classification de Bassan (2006) pour les stades 4
 - Territoire hyperéchogène péri-ventriculaire mesurant au moins 5mm de grand axe
 - Grade 1 : 1 territoire atteint
 - Grade 2 : > ou égal à 2 territoires
 - Grade 3 : déviation de la ligne médiane
- Les auteurs montrent que ces lésions sont très précocement visibles dans les 4 premiers jours

Ultrasonographic Features and Severity Scoring of Periventricular Hemorrhagic Infarction in Relation to Risk Factors and Outcome

Haim Bassan, MD*, Carol B. Benson, MD*, Catherine Limperopoulos, PhD*, Henry A. Feldman, PhD*, Steven A. Ringer, MD, PhD*, Elaine Veracruz*, Jane E. Stewart, MD*, Janet S. Soul, MD*, Donald N. DiSalvo, MD*, Joseph J. Volpe, MD*, Adré J. du Plessis, MBChB, MPH*

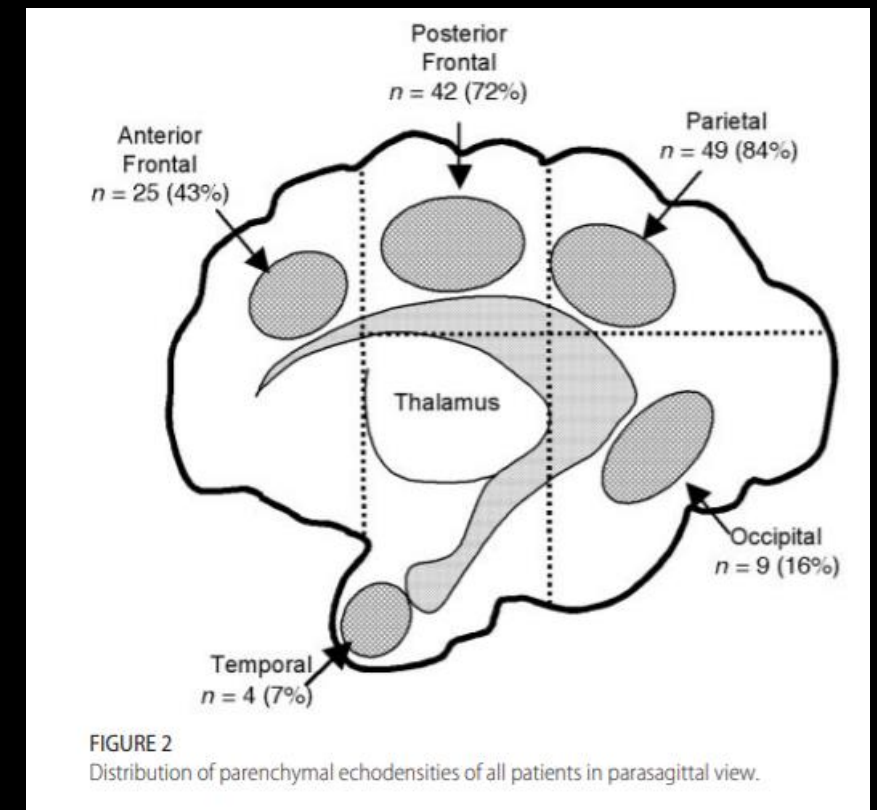


TABLE 3 PVHI Severity Scoring as Predictor of Outcome

Outcome	PVHI Severity Score, n/N (%)				<i>P</i> ^a	OR (95% CI)
	0	1	2	3		
Death (<i>n</i> = 58)	3/17 (18)	3/11 (27)	9/20 (45)	8/10 (80)	.0017	2.46 (1.34–4.52)
Early seizures <5 d (<i>n</i> = 58)	0/17 (0)	0/11 (0)	3/20 (15)	2/10 (20)	.03	3.41 (1.18–9.84)
Seizures in NICU stay (<i>n</i> = 58)	2/17 (12)	2/11 (18)	3/20 (15)	4/10 (40)	.17	1.59 (0.82–3.11)
VP shunt (<i>n</i> = 35)	4/14 (28)	3/8 (37)	5/11 (45)	1/2 (50)	.23	0.88 (0.50–1.56)
Abnormal neuromotor examination (<i>n</i> = 31)	4/12 (33)	4/7 (57)	9/10 (90)	2/2 (100)	.0042	4.11 (1.42–11.9)
Microcephaly (<i>n</i> = 30)	1/11 (9)	1/7 (14)	3/10 (30)	1/2 (50)	.17	2.18 (0.75–6.29)

The PVHI severity score is derived from the CUS study with the maximum PVHI size and is based on the presence (score of 0) or absence (score of 1) of 3 items: (1) lesion extends \geq 2 territories (for bilateral cases, extent of lesion is scored on the basis of the worse side); (2) bilateral PVHI; and (3) midline shift. A CUS study with none of these features scores 0, whereas a study with all 3 features scores 3. OR indicates odds ratio; CI, confidence interval.

^a *P* value tests for significant trend in exact Cochran-Armitage trend test.

Evolution des infarctus hémorragiques

3 types d'évolution


- Liquéfaction avec macrokystes, communiquant ou non avec le ventricule
- Association de micro et macrokystes : le plus fréquent
- Aspect microkystique : association avec des lésions ischémiques de la SB de type artérielle probable
 - Diagnostic différentiel avec LMPV ++++

Autres lésions hémorragiques

- Parenchyme
 - NGC
 - Fosse cérébrale postérieure : cervelet +++
 - Hémorragie cérébelleuse : la plus fréquente
- Fragilité de la matrice germinale , de la couche granulaire externe et matrice germinale sous épendymaire du V4
- Unilatérale, hémisphérique
 - Bilatérale, plus rarement atteinte du vermis

Seminars in Fetal & Neonatal Medicine xxx (2016) 1–10

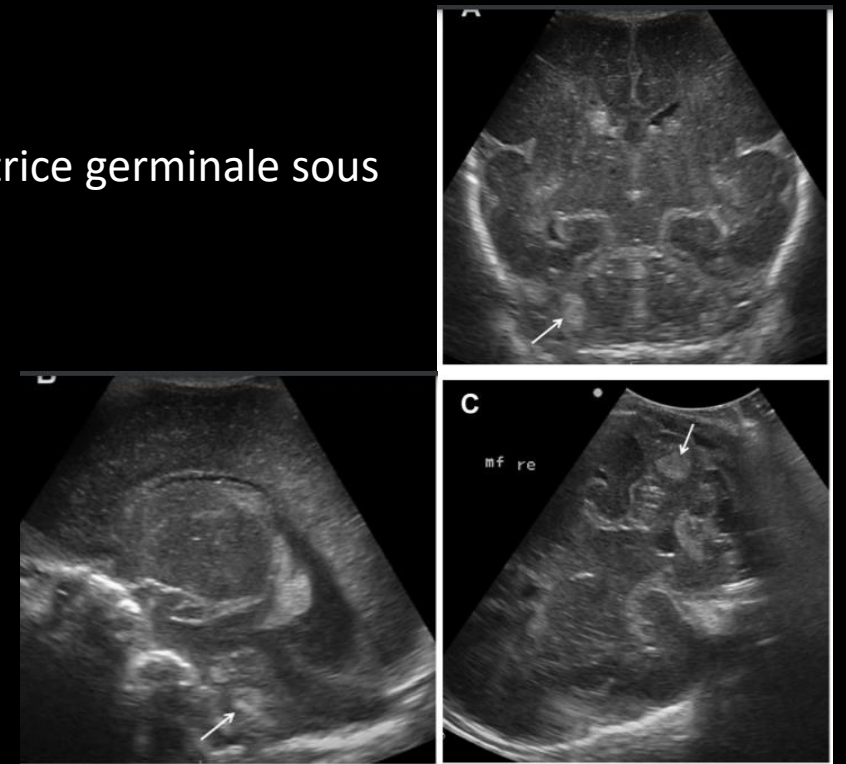
Contents lists available at [ScienceDirect](#)

 Seminars in Fetal & Neonatal Medicine

Cranial ultrasonography of the immature cerebellum: Role and limitations

S.J. Steggerda ^{a, *}, G. van Wezel-Meijler ^b

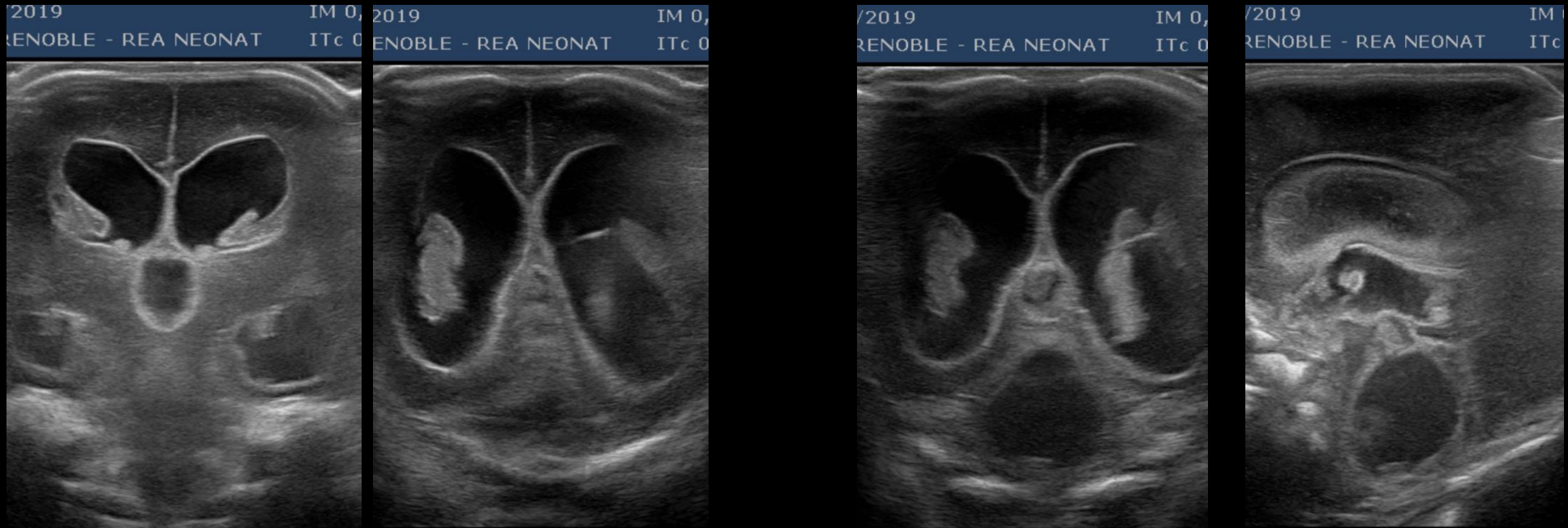
^a Department of Neonatology, Leiden University Medical Center, Leiden, The Netherlands
^b Isala Woman-Child Center, Isala Hospital, Zwolle, The Netherlands

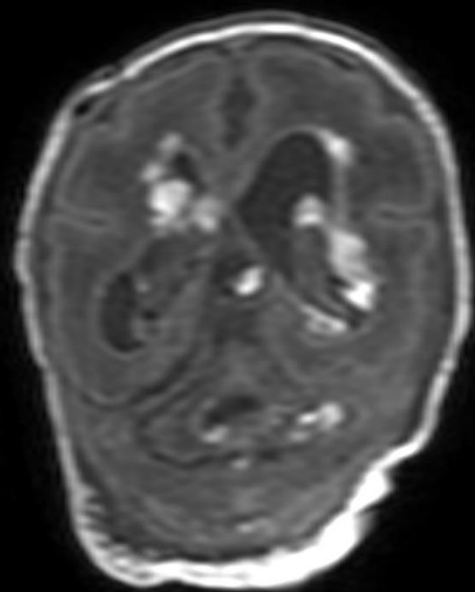
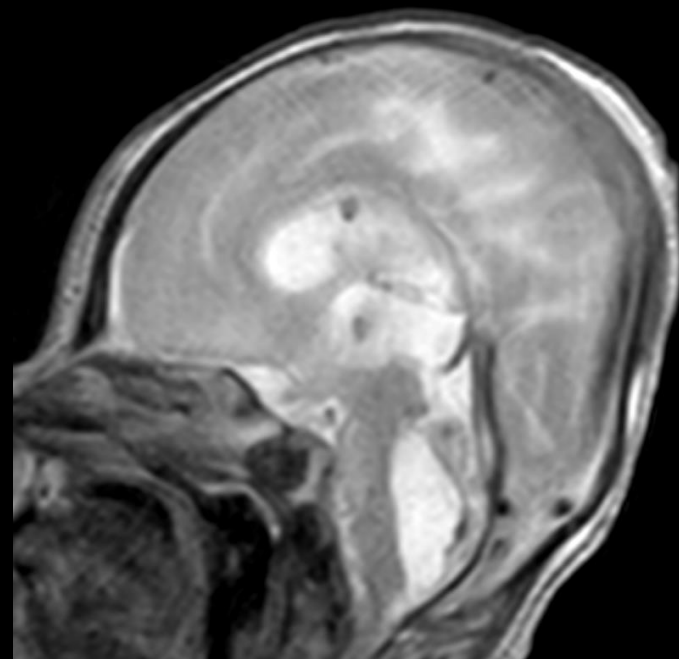
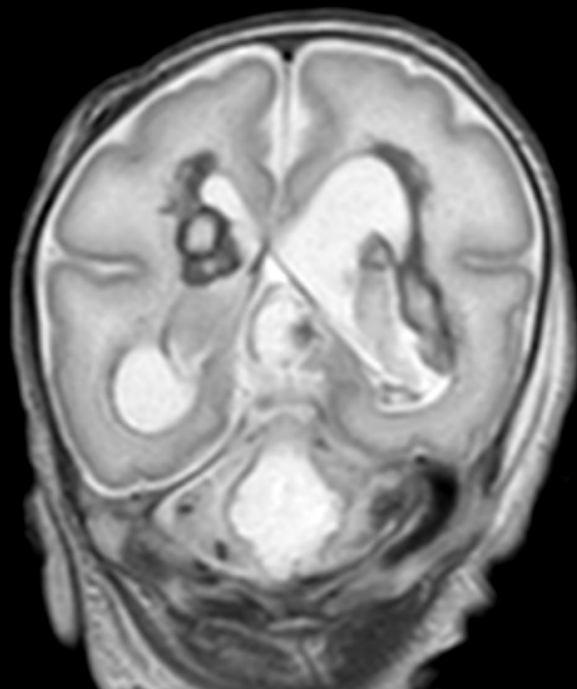
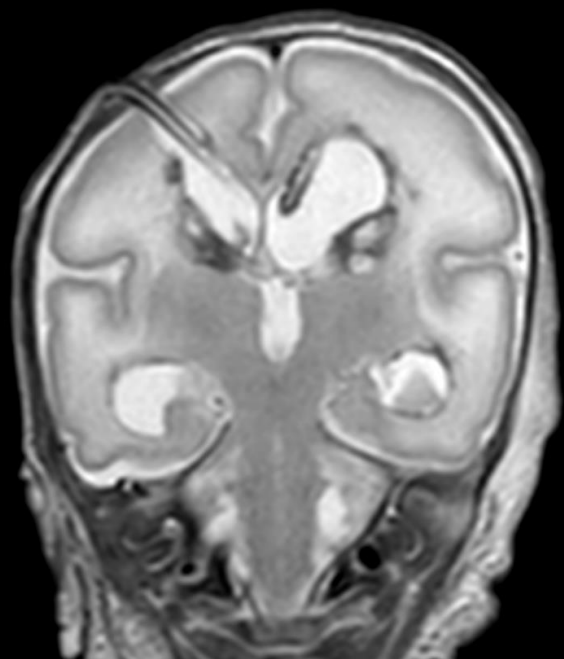


24 SA et 3 jours – J7



24 SA et 3 jours – J11





Lésions hémorragiques du cervelet

The CHOPIn Study: a Multicenter Study on Cerebellar Hemorrhage and Outcome in Preterm Infants

updates

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V. Boswinkel¹  · S. J. Steggerda² · M. Fumagalli^{3,4} · A. Parodi⁵ · L. A. Ramenghi⁵ · F. Groenendaal⁶ · J. Dudink^{6,7} · M. N. Benders⁶ · R. Knol⁷ · L. S. de Vries⁶ · G. van Wezel-Meijler¹

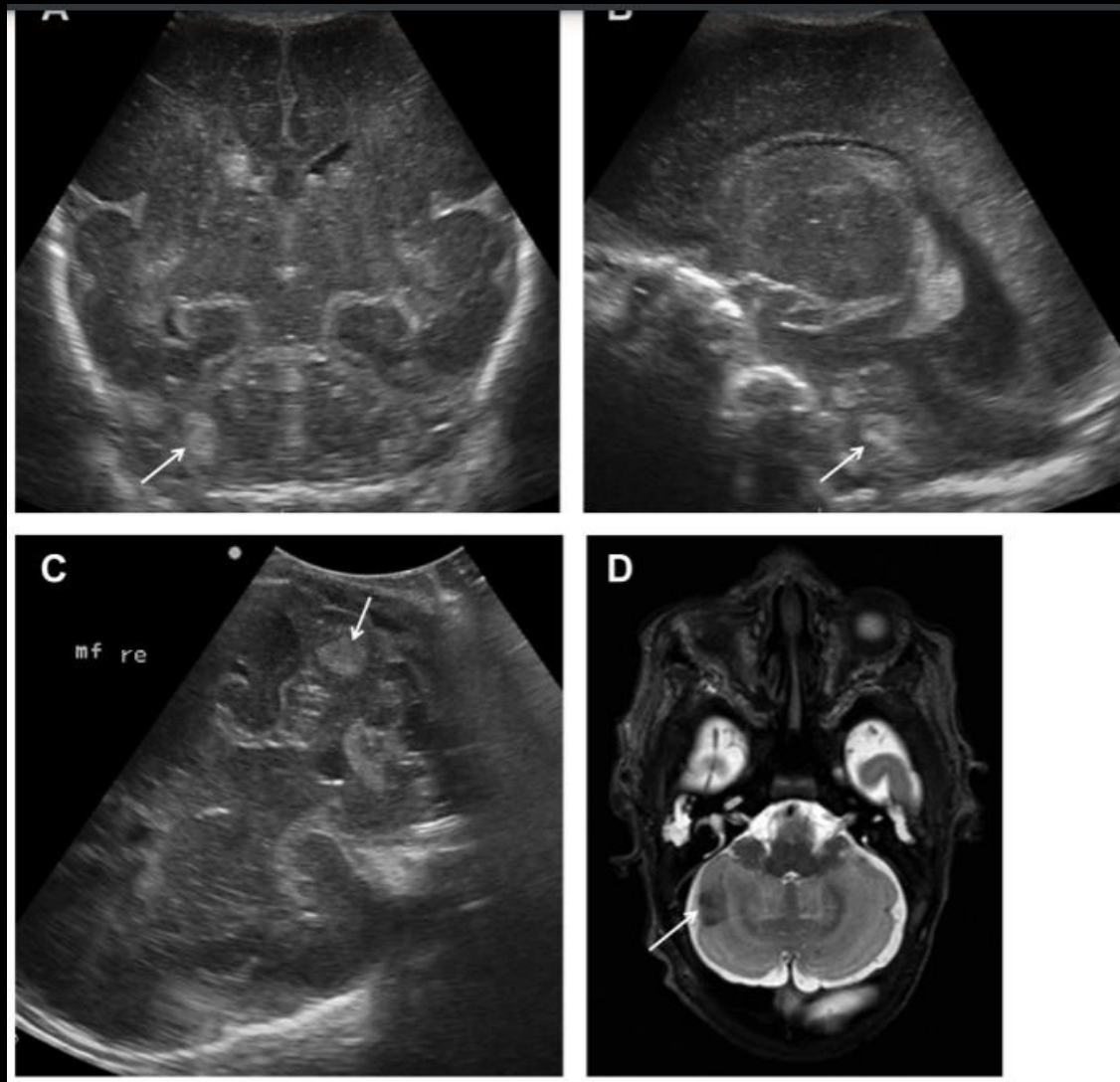
• Classification IRM

- Stade 1 a : lésions ponctuées (<5mm) , nombre < 6
- Stade 1b : lésions ponctuées (<5mm) , nombre > 6
- Stade 2 : lésion > 4mm et intéressant moins d'un 1/3 de l'hémisphère cérébelleux
- Stade 3 : lésion intéressant plus d'un 1/3 de l'hémisphère cérébelleux

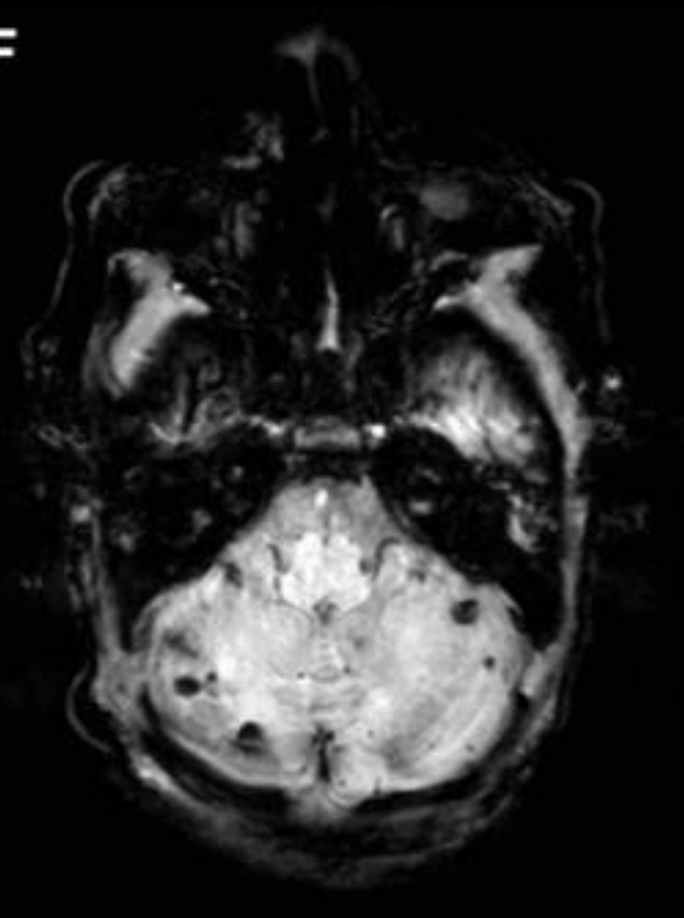
Pattern of CBH The classification was modified from the CUS classification by Meijler and Steggerda [18] and previous work by others [13, 24] (Fig. 1).

1. Punctate CBH: one or more lesions ≤ 4 mm;
Infants with punctate CBH were subdivided into two groups: ≤ 6 lesions or > 6 lesions.
2. Limited CBH: the lesion(s) being > 4 mm, but involving $< 1/3$ of the cerebellar hemisphere;
3. Massive CBH: the lesion involving $\geq 1/3$ of the cerebellar hemisphere.

Intérêt du T2* ou SWI

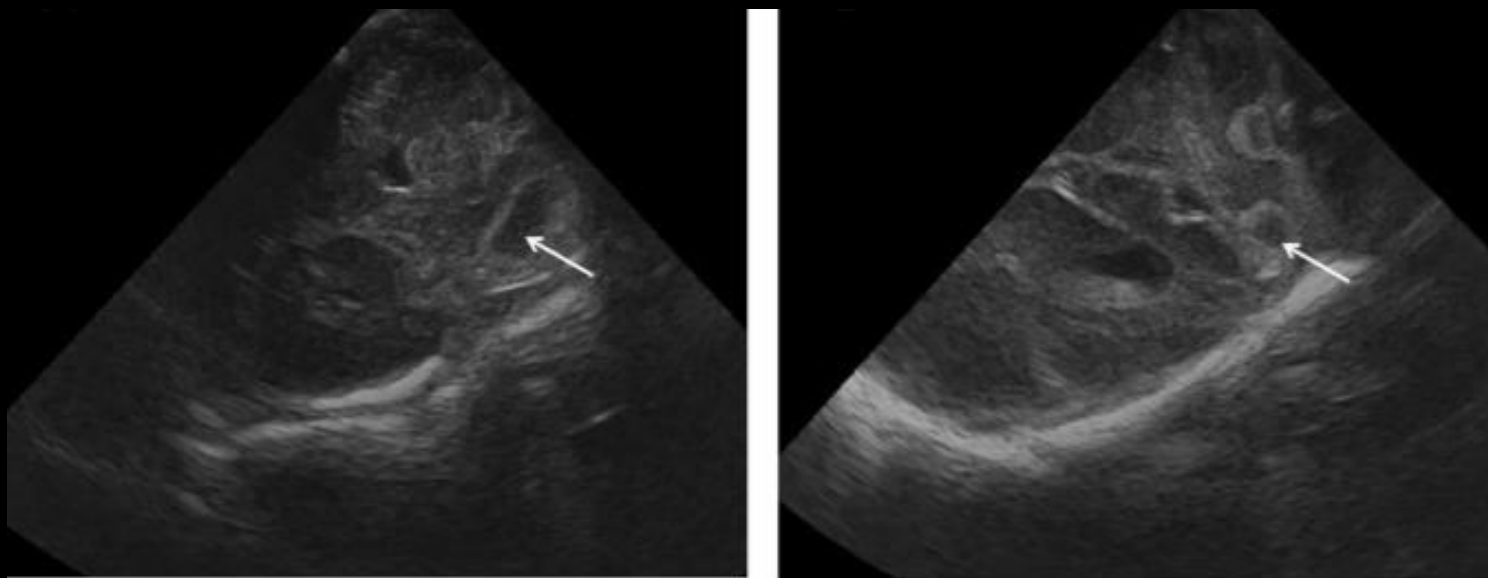
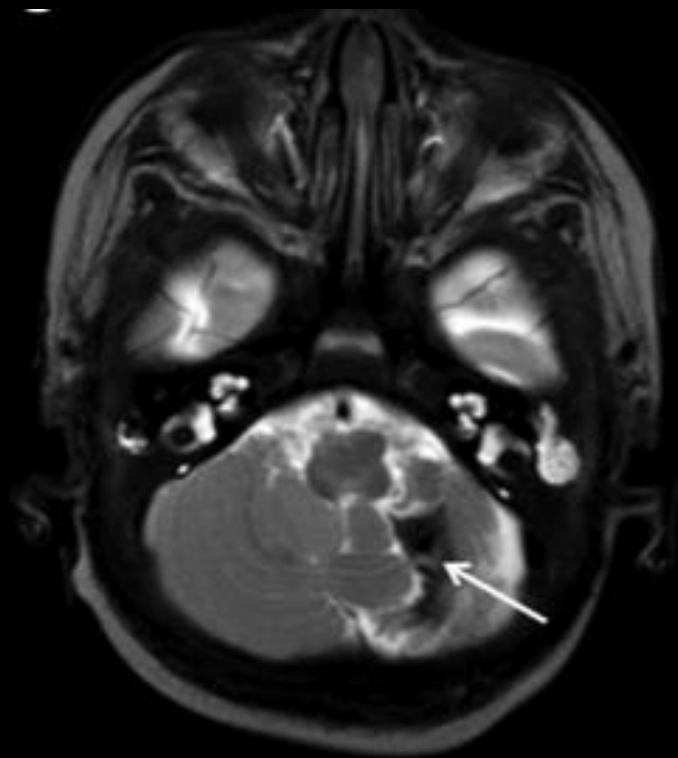


F



Evolution temporelle Echo- IRM complémentaire

Qu'en pensez-vous ?



Lésions de la Substance Blanche (SB)

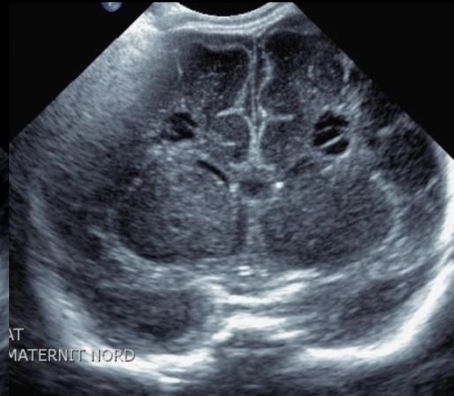
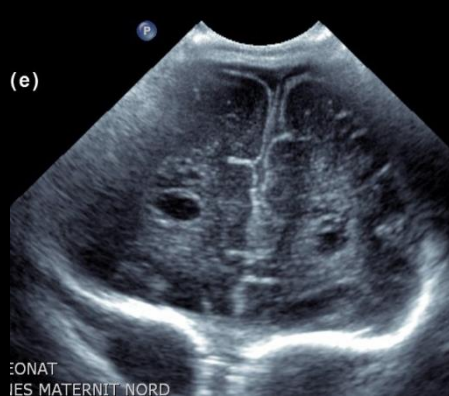
- White matter injuries
- **Classification US (de Vries LS)**
 - Stade 1 : Hyperéchogénicité transitoire de la SB périventriculaire pendant au moins 7 jours
 - Homogène
 - Inhomogène
 - Stade 2 : petits kystes fronto-pariétaux localisés
 - Stade 3 : kystes périventriculaires étendus
 - Stade 4 : hyperéchogénicité diffuse de la SB évoluant en lésions kystiques périventriculaires et sous corticales

Lésions de la SB

31 SA



Evolution à J20



Lésions de la Substance Blanche (SB)

AJNR, Am J Neuroradiol 34:2208-14 Nov 2013 www.ajnr.org

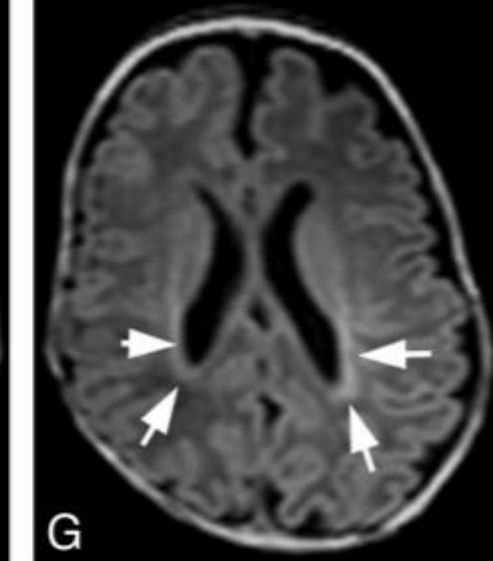
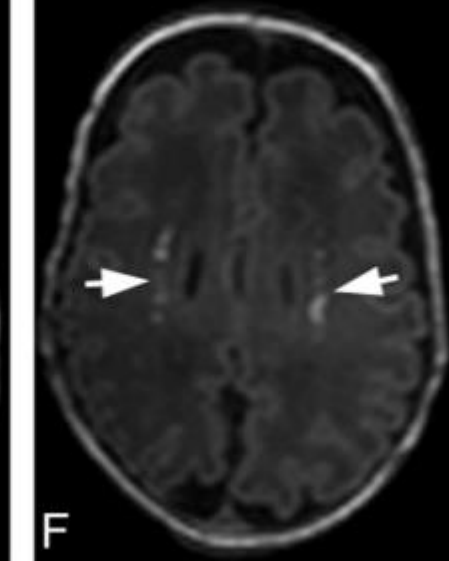
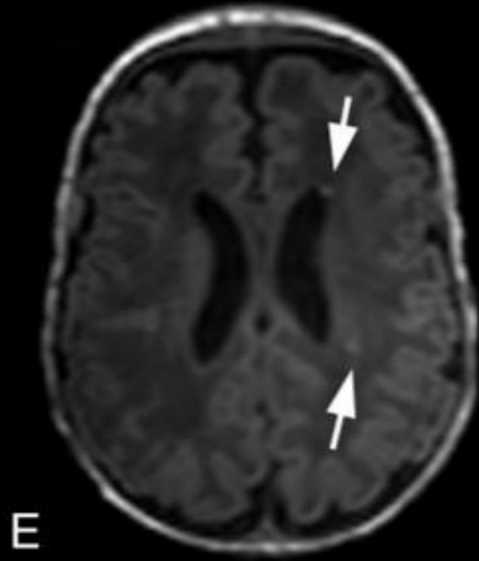
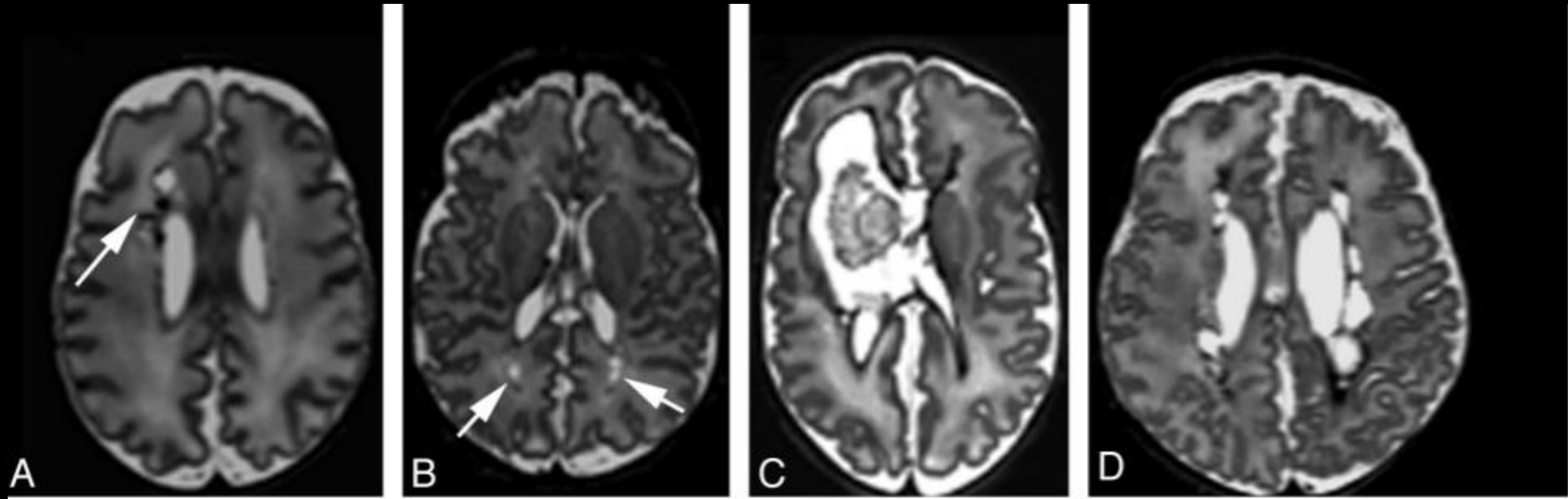
New MR Imaging Assessment Tool to Define Brain Abnormalities in Very Preterm Infants at Term

H. Kidokoro, J.J. Neil, and T.E. Inder

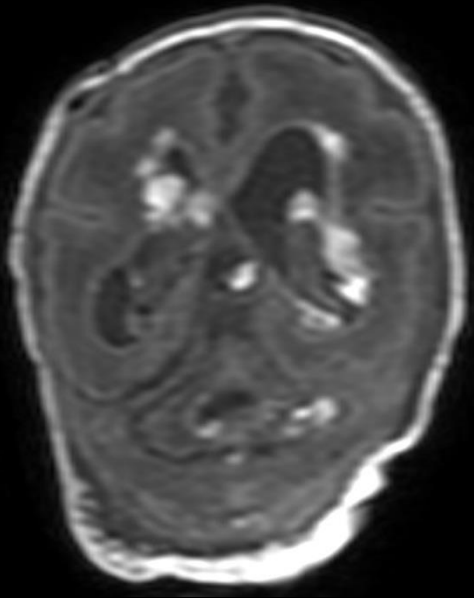
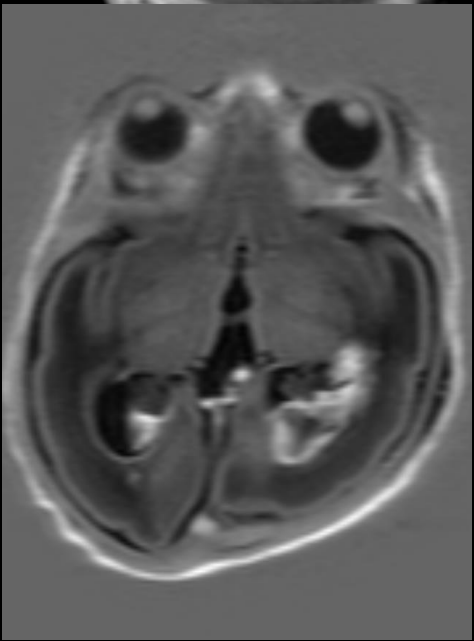
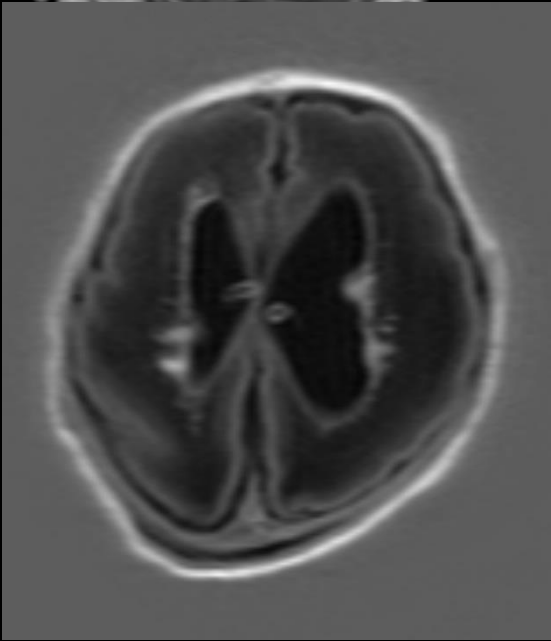
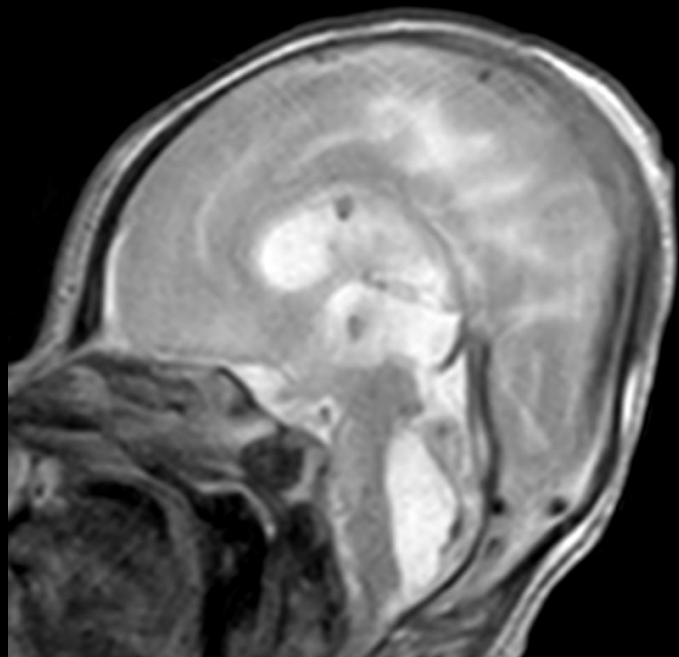
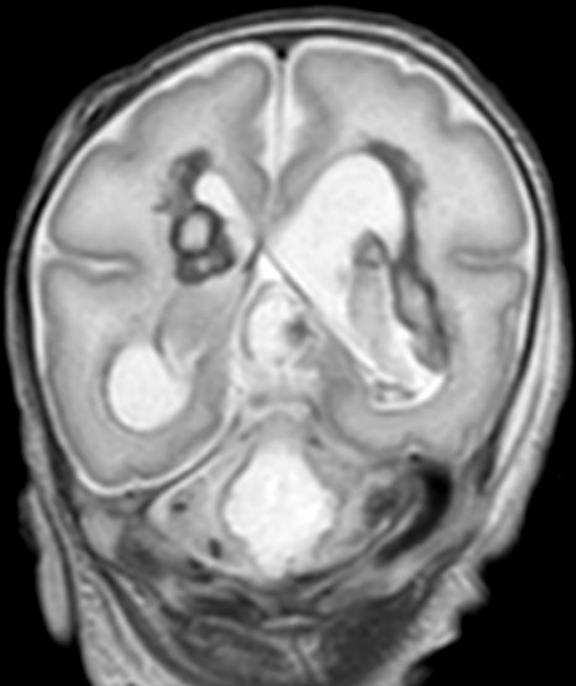
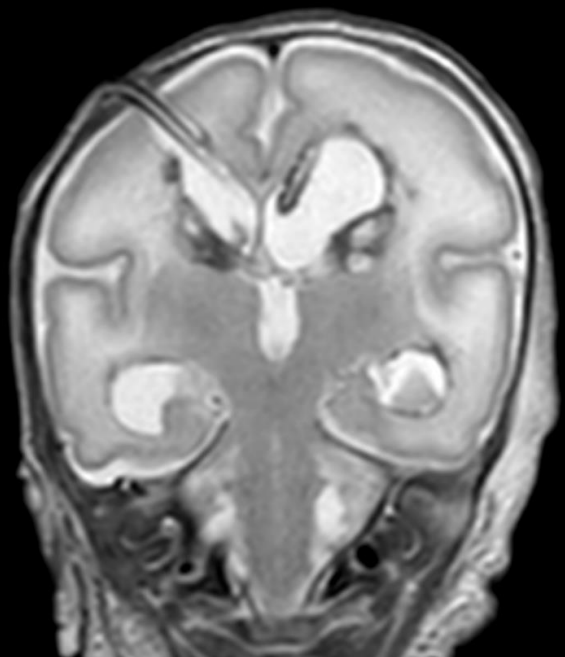
- **Classification IRM (IRM à terme)**

- Grade 1 : lésions ponctuelles < 3mm périventriculaires uni ou bilatérales
- Grade 2 : lésions ponctuelles dans les faisceaux cortico-spinaux bilatéraux ou > ou = 3 lésions par hémisphère
- Grade 3 : lésions extensives avec hypersignal T1 sur les parois ventriculaires
- Grade 4 : Lésions kystiques (LMPV kystique ou évolution d'un IH)
 - Focale unilatérale
 - Focale bilatérale
 - Extensive unilatérale
 - Extensive bilatérale

- Dilatation ventriculaire 7.5mm si bilatérale ou > 10 si unilatérale



Non accessible à l'échographie



Lésions de la Substance Blanche (SB)

- Classification IRM : A quel terme ?

MRI Based Preterm White Matter Injury
Classification: The Importance of Sequential
Imaging in Determining Severity of Injury

Miriam Martinez-Biarge¹ Floris Groenendaal² Karina J. Kerschbaum² Manon J. N.
L. Benders², PLOS ONE | DOI:10.1371/journal.pone.0156245 June 3, 2016

Table 2. MRI classification for preterm white matter injury. BGT: Basal-ganglia thalami, DWI: Diffusion weighed imaging, PLIC: Posterior limb of the internal capsule, PWMLs: Periventricular white matter lesions, SI: Signal intensity, TEA: Term equivalent age, VM: Ventriculomegaly.

Diffusion	First 2 wks after birth/insult	2-6 wks after birth/insult	TEA	T1- T2
Grade Ia	<6 focal PWMLs and focal DWI abnormalities	<6 PWMLs	PWML<6. Focal increased SI of the WM on T1. Symmetrical age appropriate or nearly age appropriate myelination of the PLIC	
Grade Ib	≥6 focal PWMLs and focal DWI abnormalities	≥6 PWMLs	≥6 PWMLs. Same as above	
Grade II	≥6 PWMLs; focal and some confluent DWI abnormalities	≥6 PWMLs / focal periventricular cysts	Focal periventricular cysts and/or at least 2 of the following: mild VM measured at the atrium (7.5-10mm); irregularly shaped ventricles; few focal increased SI WM lesions on T1; (sparse) myelination of the PLIC	
Grade III	Extensive (confluent) DWI abnormalities	Extensive periventricular cysts	Extensive periventricular cysts, and/or at least 2 of the following: decreased WM volume and mild-moderate VM (>10mm); irregularly shaped ventricles; extensive increased SI WM lesions on T1; sparse or no myelination of the PLIC	
Grade IV	Extensive (confluent) DWI abnormalities extending into the subcortical white matter	Extensive periventricular and subcortical cysts	Extensive periventricular and subcortical cysts, and/or at least 2 of the following: moderate-severe VM (>14mm); severe complete loss of WM; BGT involvement; extensive increased SI WM lesions on T1; no myelination of the PLIC	

Lésions de la Substance Blanche (SB)

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Classification: The Importance of Sequential
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	First 2 wks after birth/insult	2–6 wks after birth/insult	TEA
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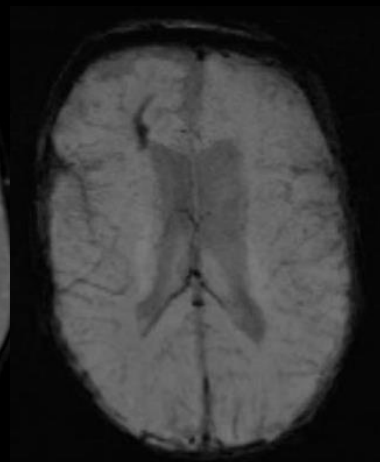
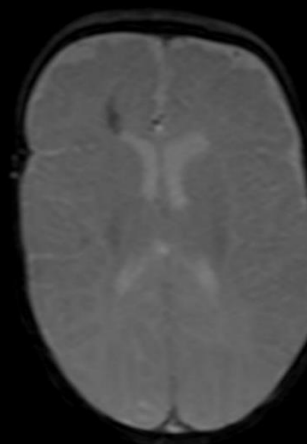
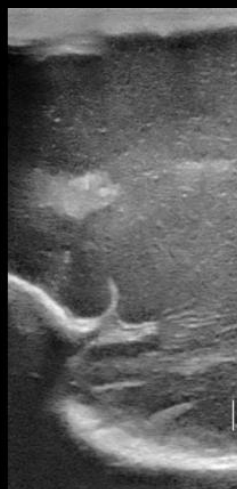
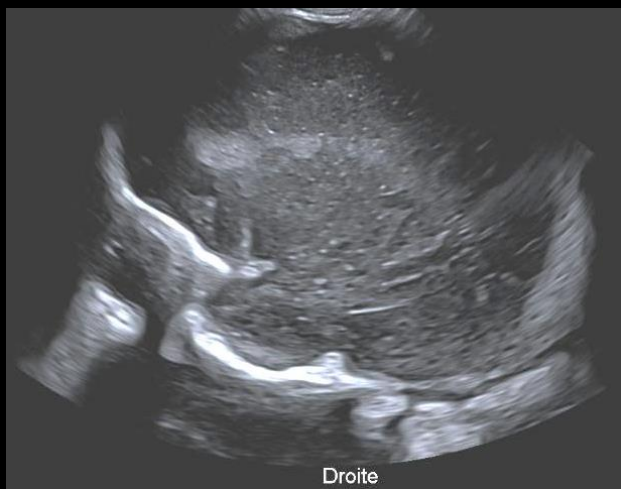
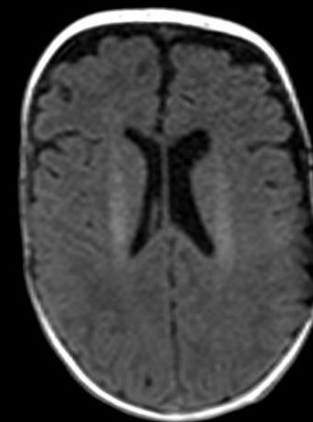
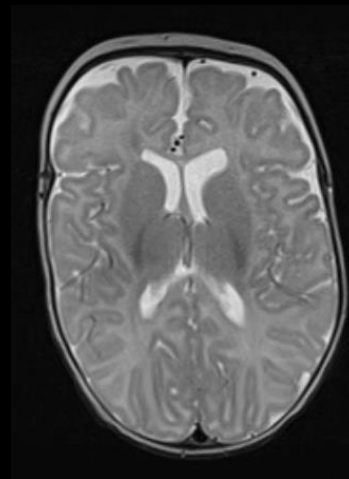
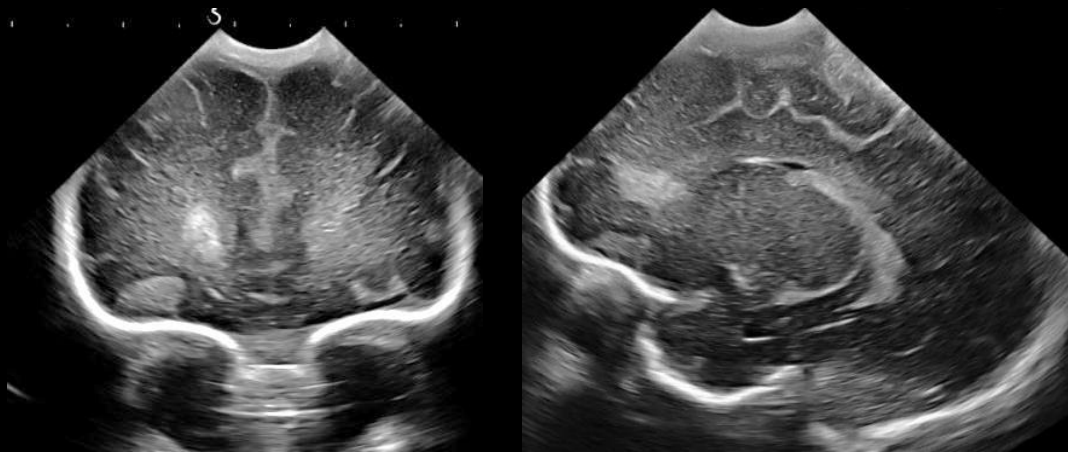
Lésions de la Substance Blanche (SB) et IRM

- Bilan exhaustif des lésions (IRM >Echo)
- Doit être interpréter en fonction
 - Du terme à laquelle elle est réalisée
 - Aspect et évolution des lésions en échographie
 - Données cliniques

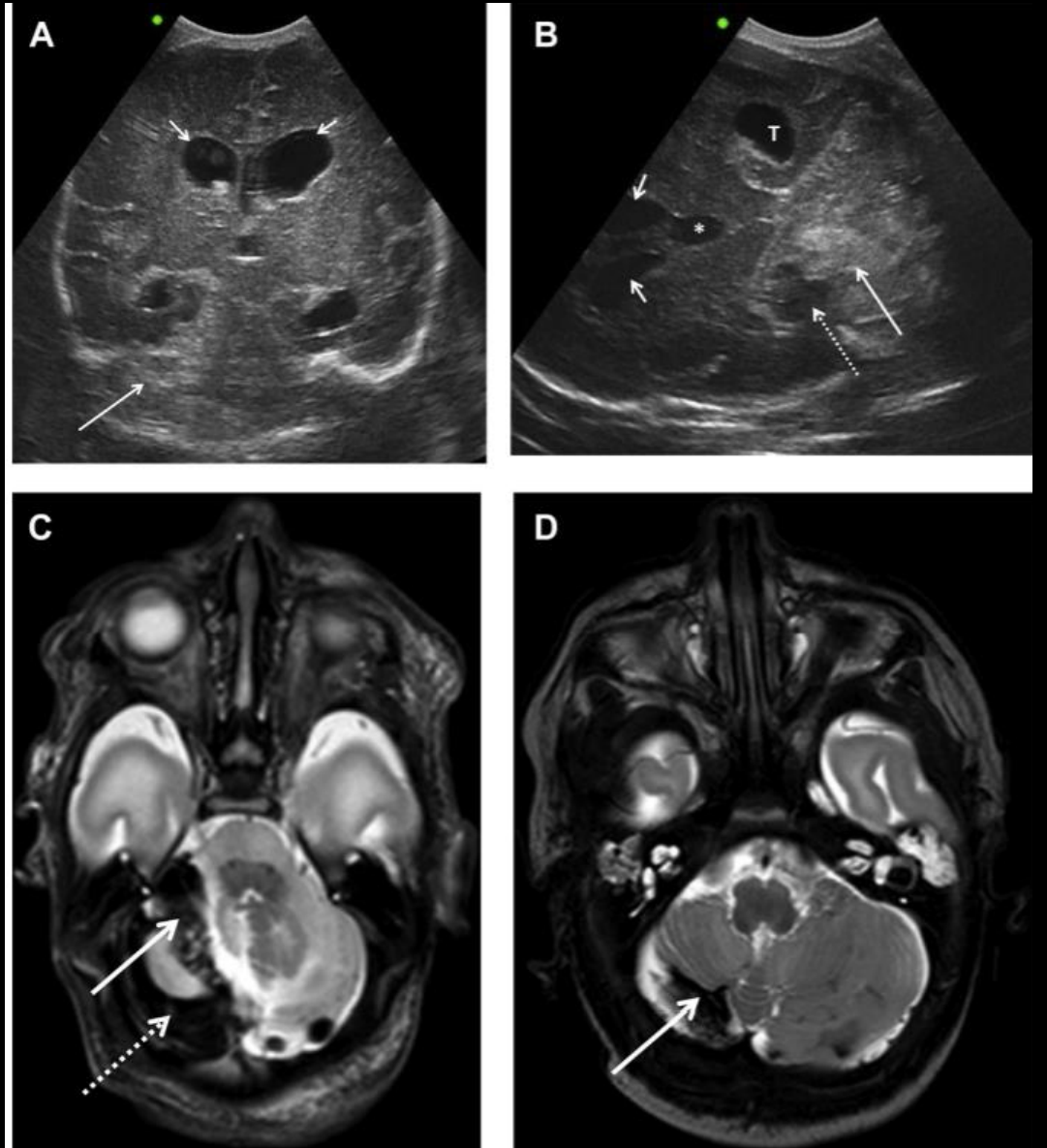
Autres lésions

- NGC, parenchyme
 - Ischémie versus hémorragie
- FCP
 - HSD
 - Ischémie cérébelleuse
 - Atteinte souvent bilatérale des hémisphères dans leur partie inférieure (territoire des artères cérébelleuses inférieures), associée à des lésions de la SB sus tentorielle
- Infections, malformations

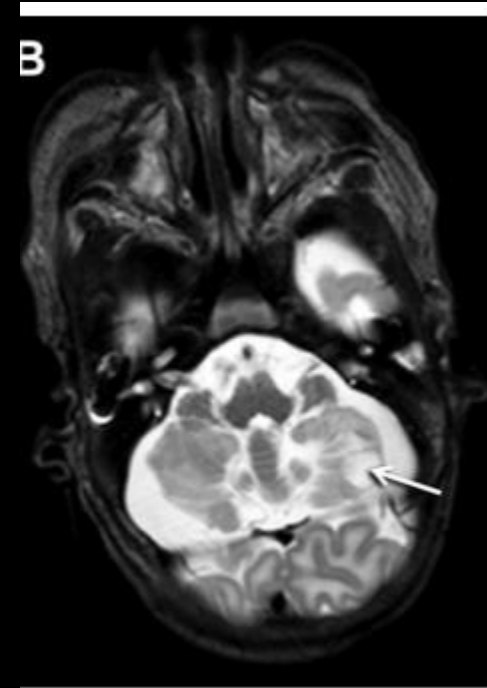
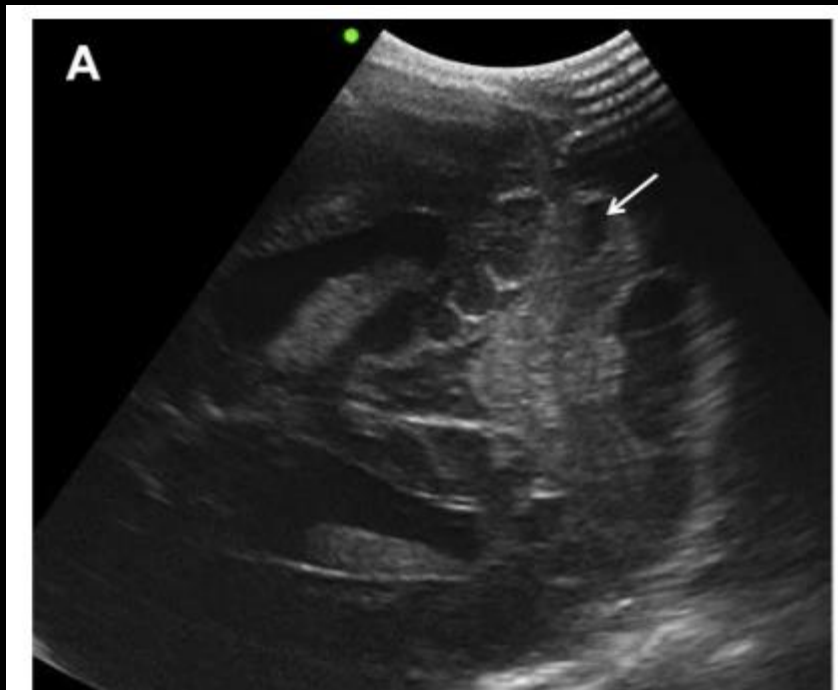
Grossesse gémellaire, 34 SA



- Hémorragie cérébelleuse et ischémie
- HSD



Ischémie à la phase tardive



Biométries en imagerie (BIP, DFO, DTC)

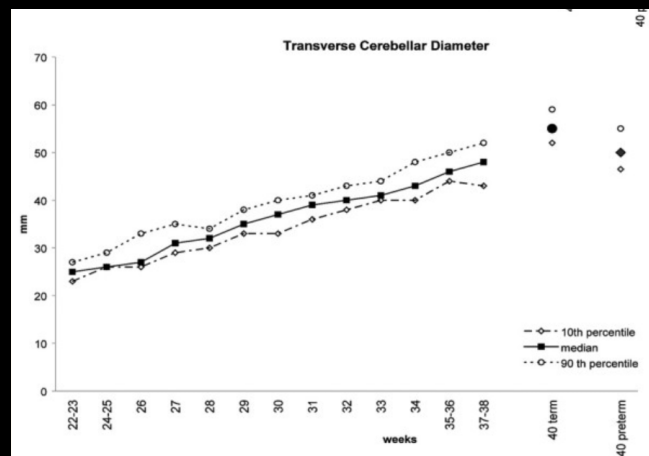
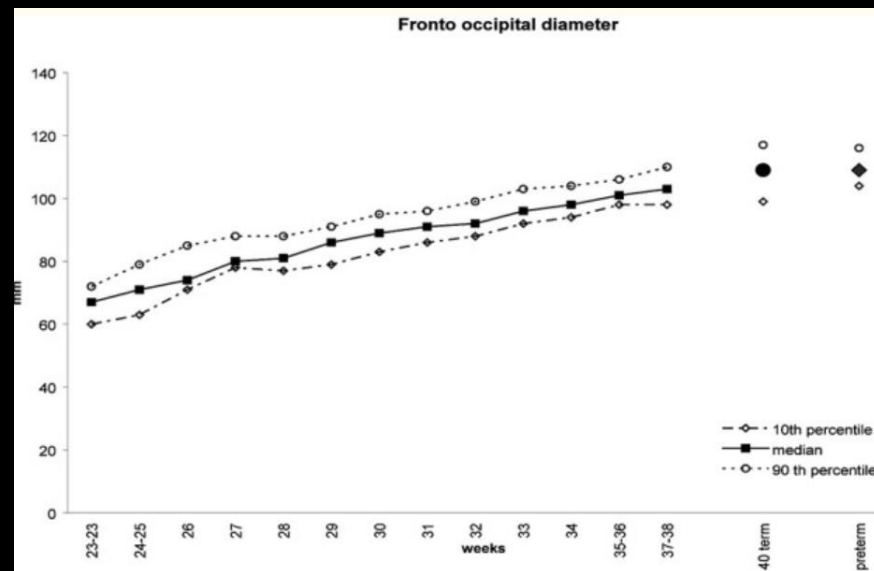
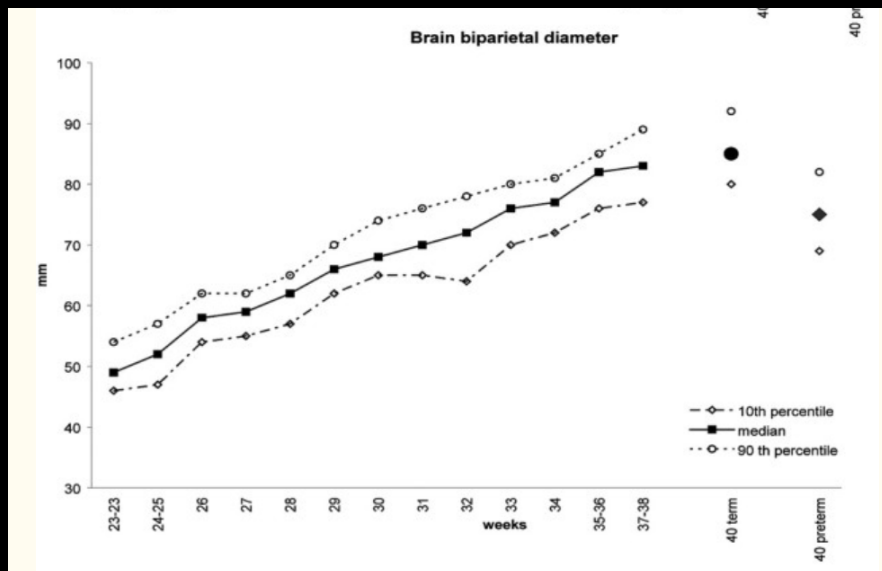


Table 1: Prevalence of infants with each item in cerebral WM score (VPT infants/term infants)

Variables	WM Score				
	Score 0	Score 1	Score 2	Score 3	Score 4
Cerebral WM					
Cystic lesions	None (90/22)	Focal unilateral (3/0)	Focal bilateral (1/0)	Extensive unilateral (2/0)	Extensive bilateral (1/0)
Focal signal abnormality	None (77/20)	Focal punctate (13/2)	Extensive punctate (5/0)	Linear (2/0)	
Myelination delay	PLIC & corona radiata (65/22)	Only PLIC (26/0)	Minimal—no PLIC (6/0)		
Thinning of the corpus callosum	None (40/18)	Partial (genu/body < 1.3 mm or splenium < 2.0 mm) (53/4)	Global (genu/body < 1.3 mm and splenium < 2.0 mm) (4/0)		
Dilated lateral ventricles	Both sides VD < 7.5 mm (26/17)	One side 7.5 mm ≤ VD < 10 mm (19/4)	Both sides 7.5 mm ≤ VD < 10 mm or one side VD ≥ 10 mm (42/1)	Both sides VD ≥ 10 mm (10/0)	
Volume reduction	cBPW ≥ 77 mm (21/19)	77 mm > cBPW ≥ 72 mm (30/2)	72 mm > cBPW ≥ 67 mm (40/1)	67 mm > cBPW (6/0)	

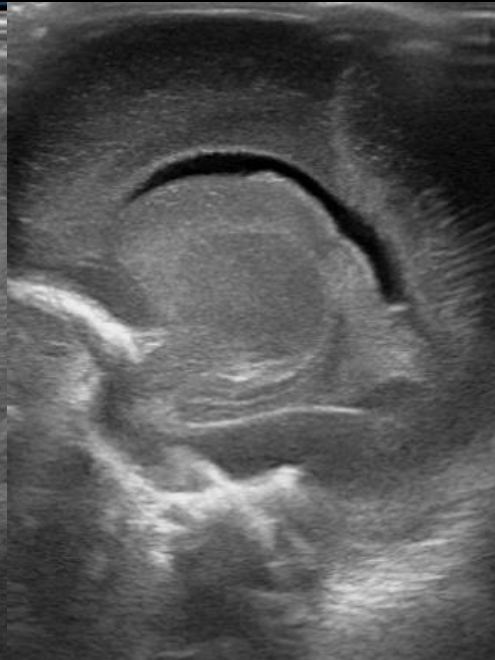
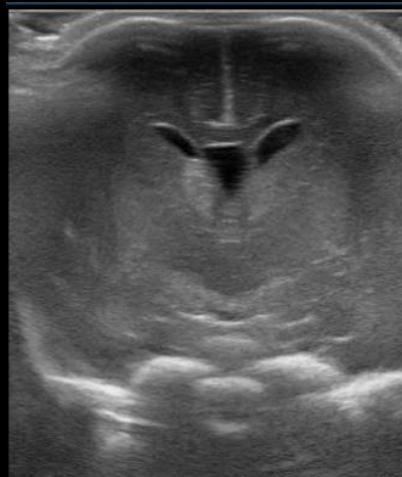
Table 3: Effect of WM injury or intraventricular hemorrhage on deep GM or cerebellum in VPT infants

		Deep GM		Cerebellum	
		Signal Abnormality <i>n</i> (%)	Corrected Deep GM Area Mean (SD)	Signal Abnormality <i>n</i> (%)	Corrected Transcerebellar Diameter Mean (SD)
WM injury ^c	Yes (<i>n</i> = 23)	4 (17) ^a	9.4 (1.2) ^b	7 (30)	49.0 (2.8)
	No (<i>n</i> = 74)	1 (1.4)	9.9 (0.9)	16 (22)	49.3 (3.4)
Intraventricular hemorrhage	Yes (<i>n</i> = 31)	3 (9.7)	9.4 (0.9) ^b	12 (39) ^b	48.2 (3.5) ^b
	No (<i>n</i> = 66)	2 (3)	9.9 (1.0)	11 (17)	49.7 (3.0)

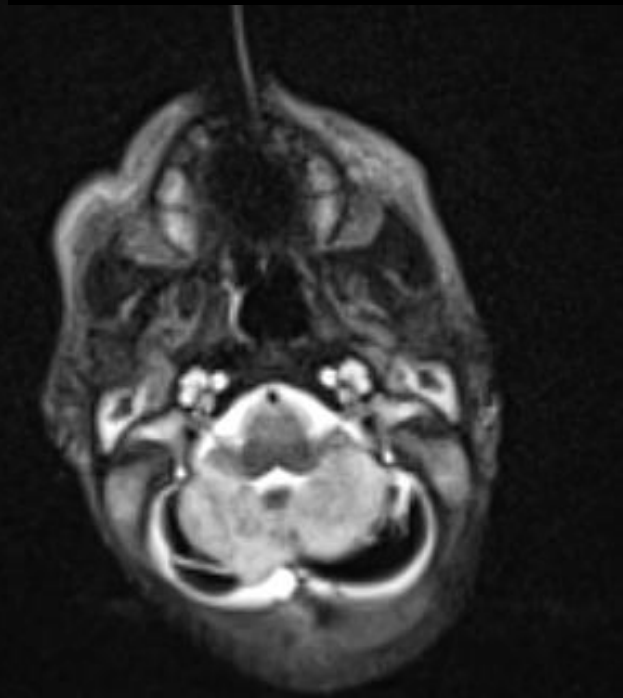
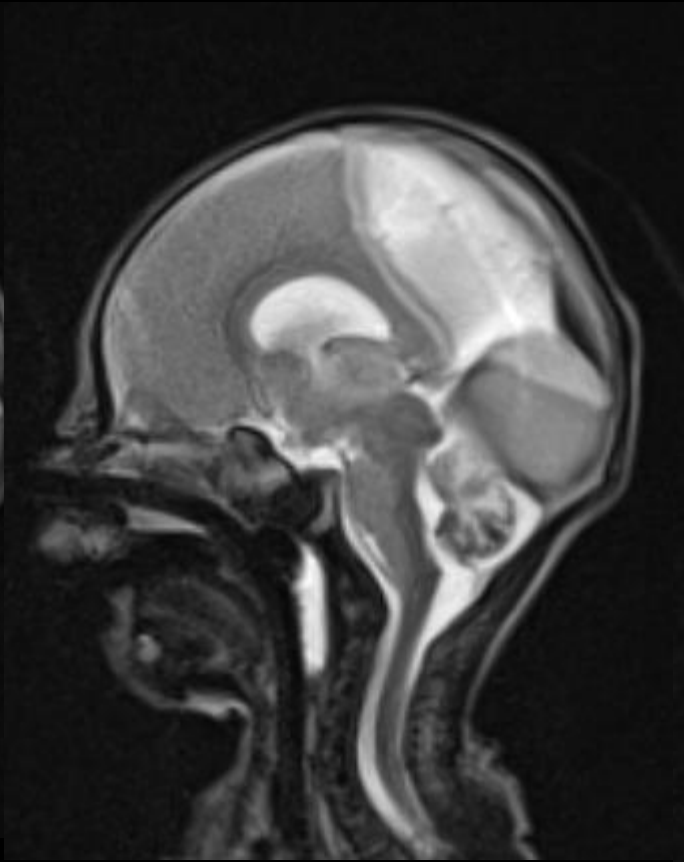
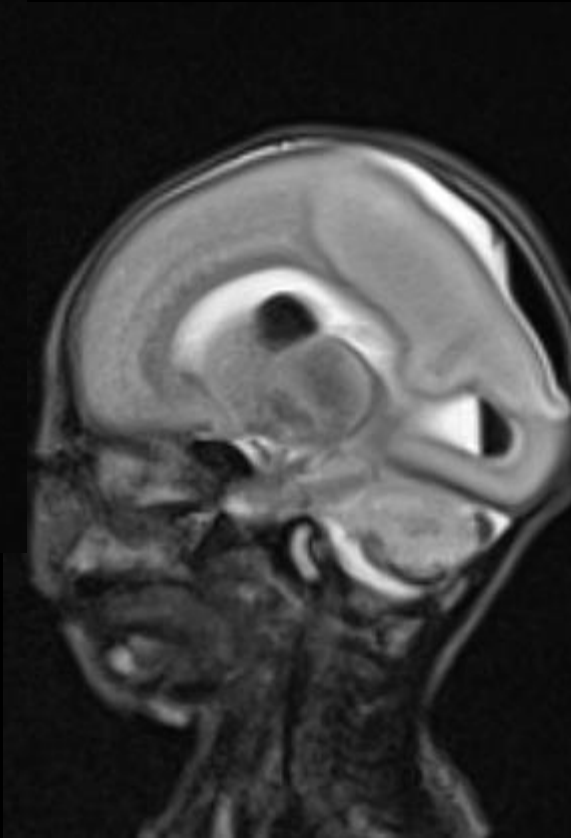
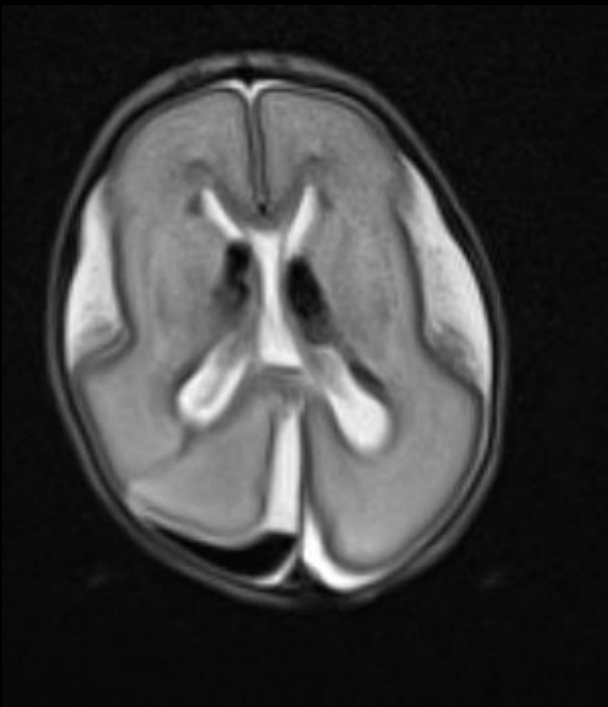
Cas clinique 1



24 SA, J3



J3, perforation digestive US : J11



J12

Hémorragie sous piale

Entité lésionnelle peu connue, caractérisée par

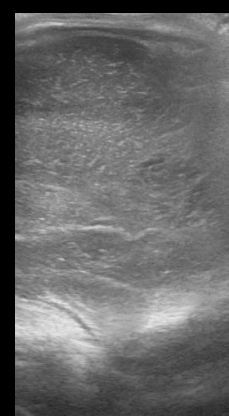
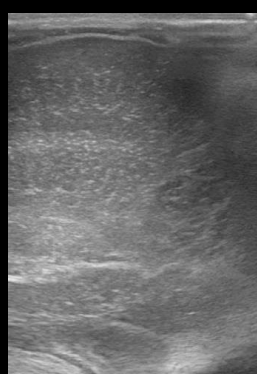
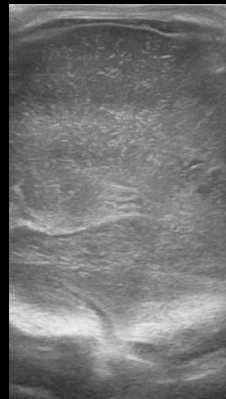
- Collection hémorragique sous piale
- Atteinte ischémique corticale, associée ou non à une lésion ischémohémorragique de la substance blanche sous jacente.

Physiopathologie

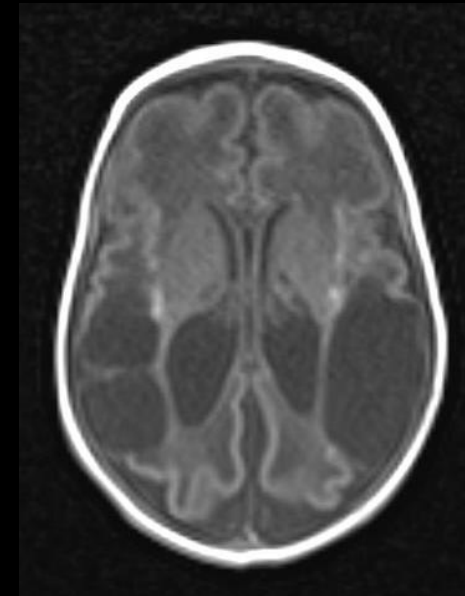
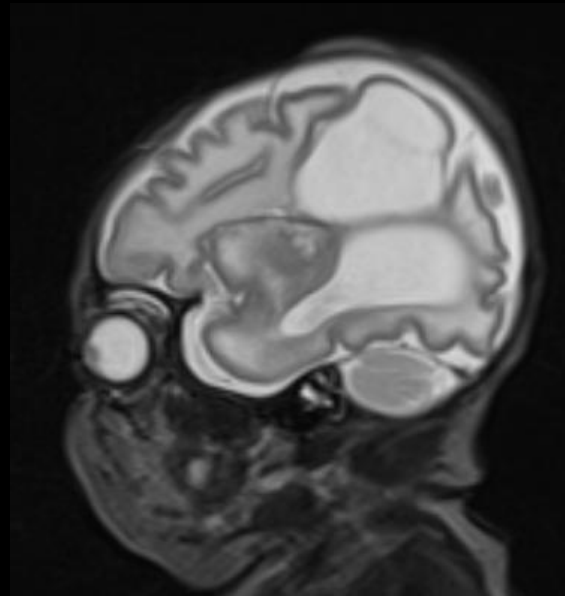
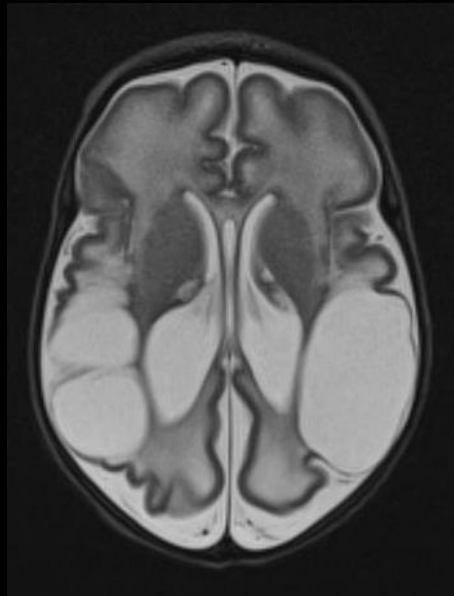
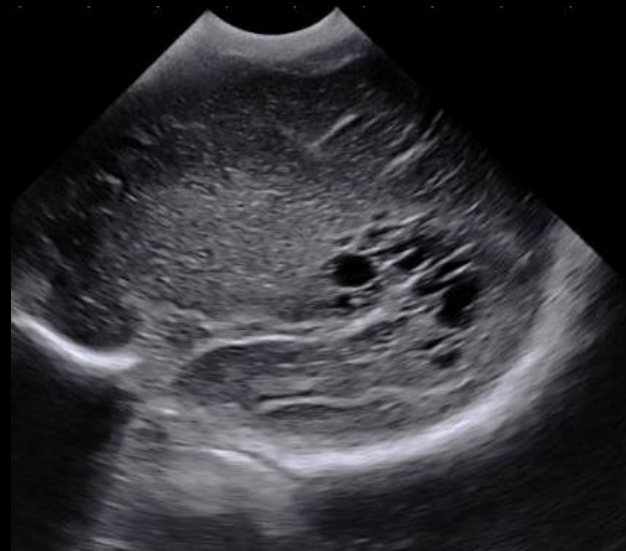
- Possibilité d'un clivage entre les prolongements des cellules gliales astrocytaires superficielles lorsque survient un gonflement du tissu glial. L'œdème cortical entraîne un gonflement de la couche superficielle du cortex, et donc un étirement puis une rupture du réseau capillaro-veineux en son sein.
- L'hémorragie prendrait son origine dans la couche 1 du cortex, puis diffuserait dans l'espace sous pial compte tenu de l'imperméabilité de la pie mère.

Cas clinique 2

30 SA, rupture des membranes à 28 SA

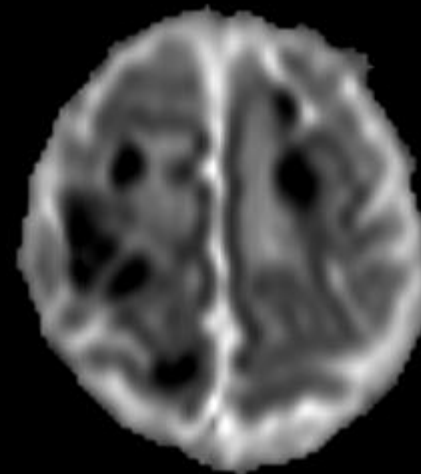
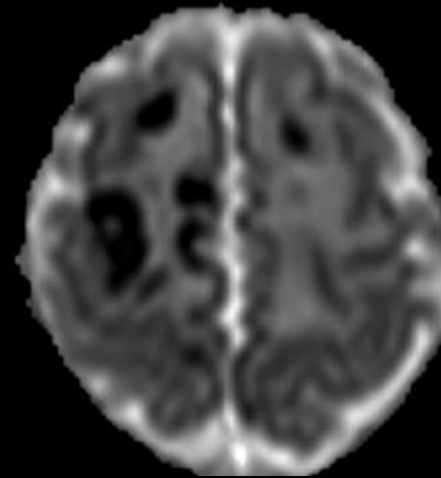
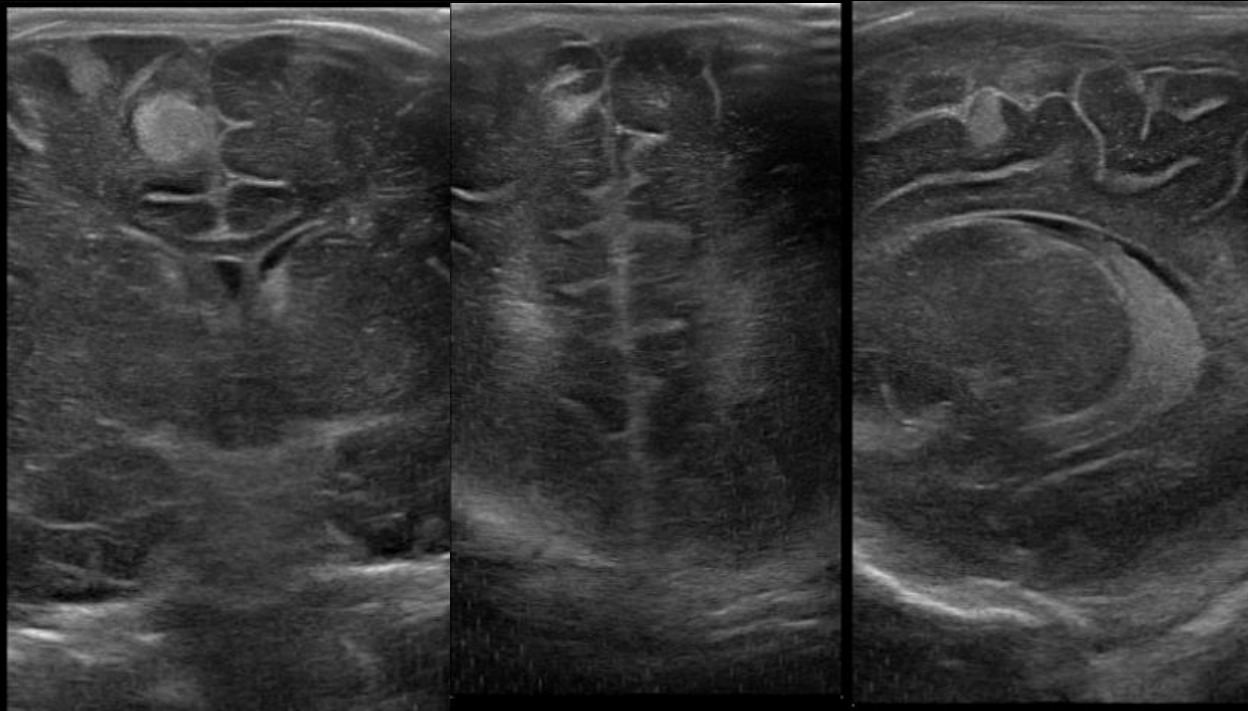


J+5



Cas clinique 3

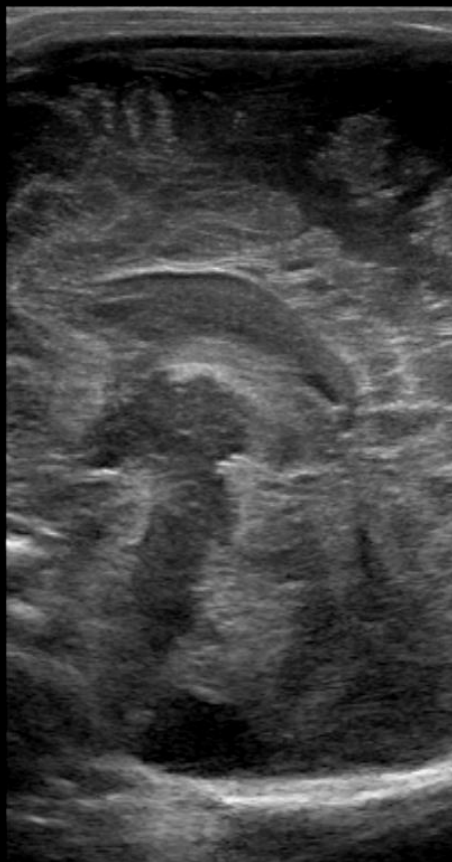
34 SA, contexte infectieux



Cas clinique 4

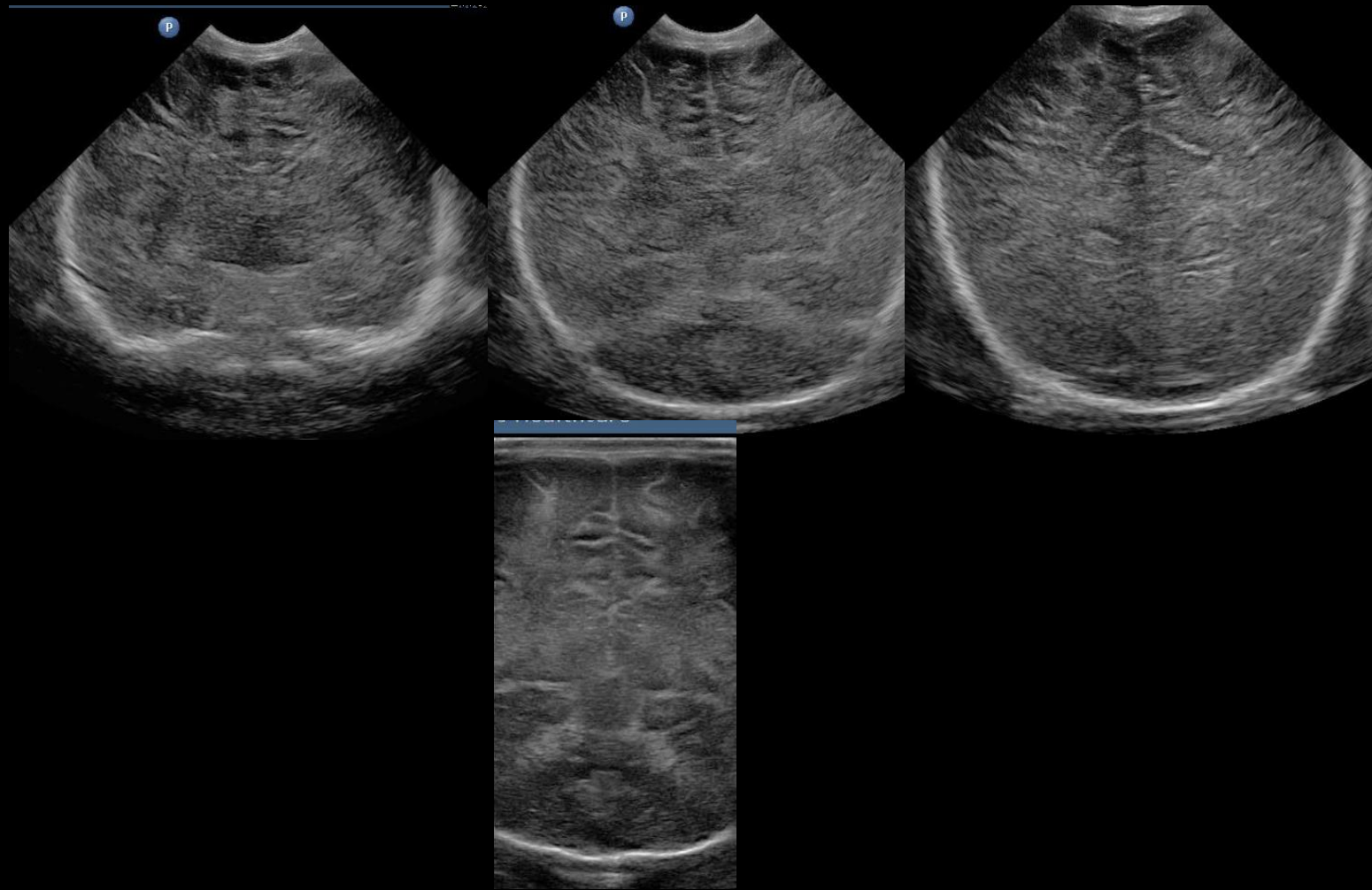


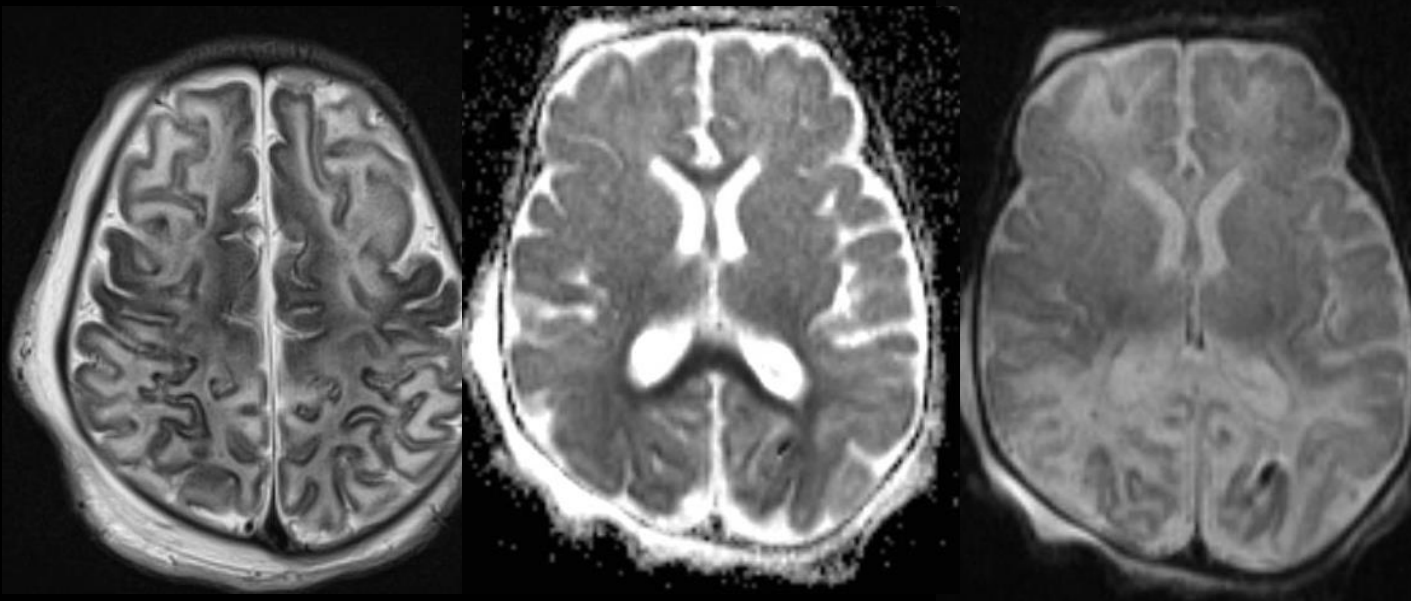
25 SA



Et le nouveau-né à terme

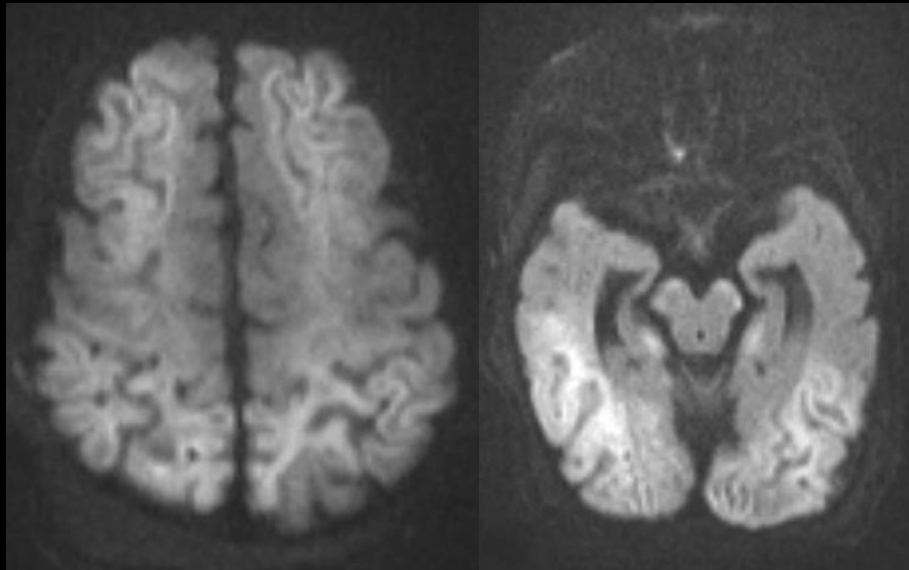
NN à terme, SF, césarienne, convulsions





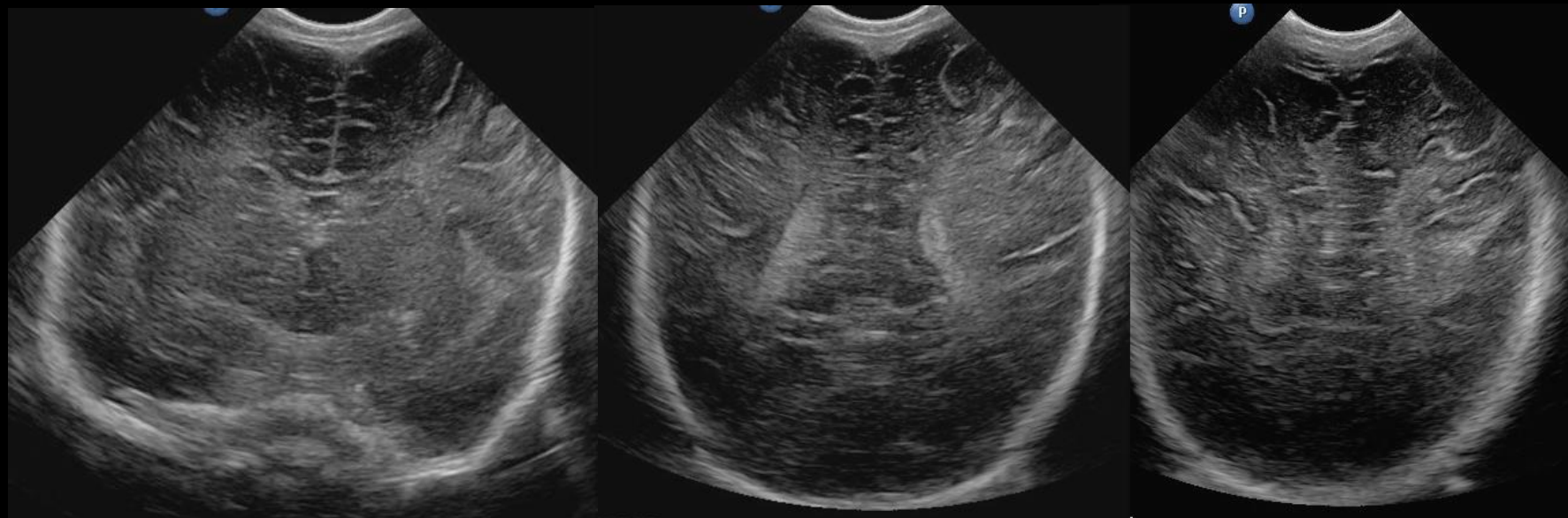
Intérêt de la diffusion de J2 à J5-J6

Phase aiguë : faux négatif
Normalisation vers J6-J7

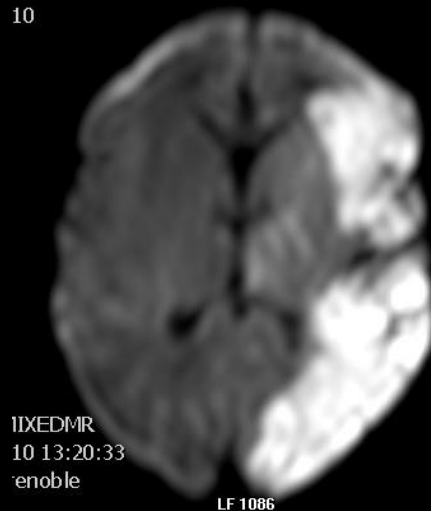


Phase subaiguë : T1 – T2

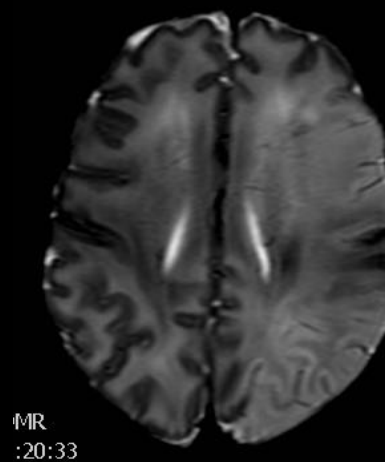
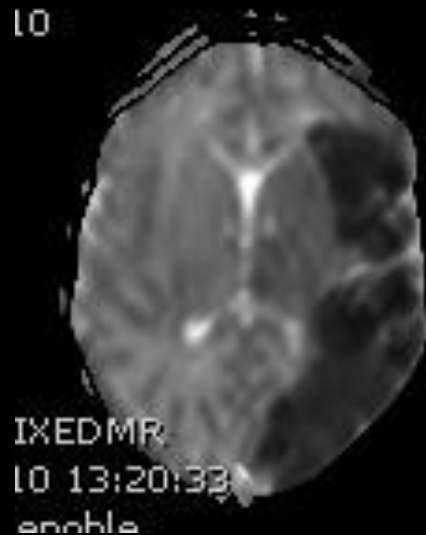
NN à terme, convulsions droites



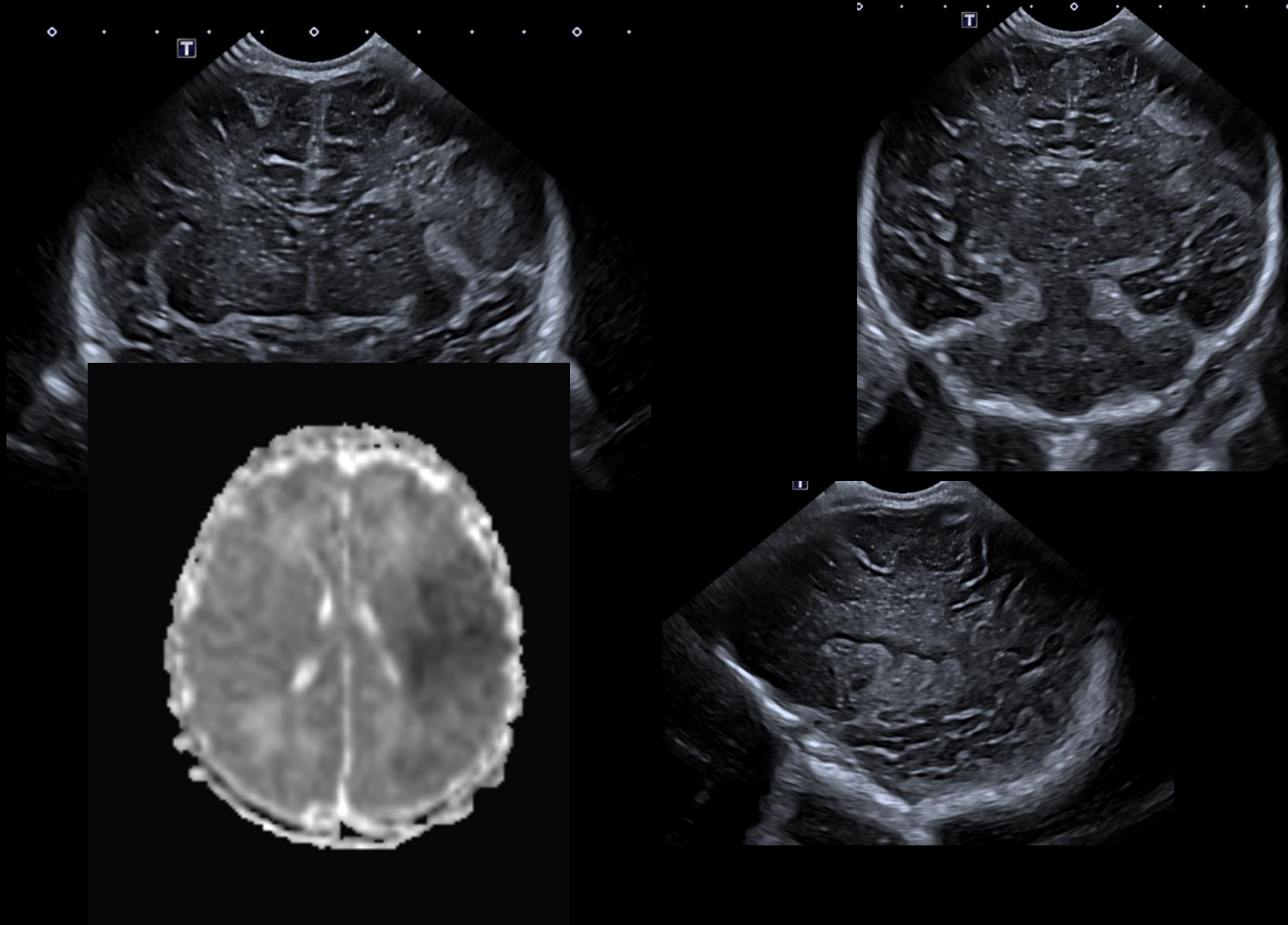
10



10



Crises convulsives à J1 droites, à terme



Conclusion

- Prématuré et pathologies
 - HIV et les autres lésions hémorragiques
 - Lésions de la SB
 - Infection, malformations,
- Prématuré et imagerie
 - Toujours échographie
 - IRM > échographie pour l'étude de la FCP, de la convexité, les lésions de la SB non kystiques
- NN à terme
 - IRM > échographie pour les deux pathologies principales : EHI, AVC