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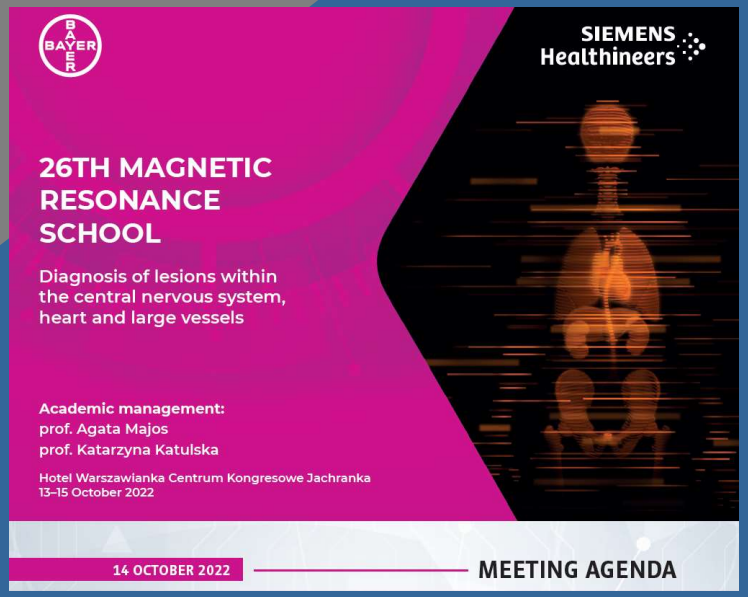
Città della Salute e della Scienza di Torino

Imaging of pediatric non-traumatic neuroemergencies



PP-GAD-ALL-0290-1 November 2021

DISCLOSURES

- Financial support from Bayer
- Financial support from Merck Serono
- Financial support from AIM Group International

Images Source from

REGINA MARGHERITA CHILDREN'S HOSPITAL, TURIN

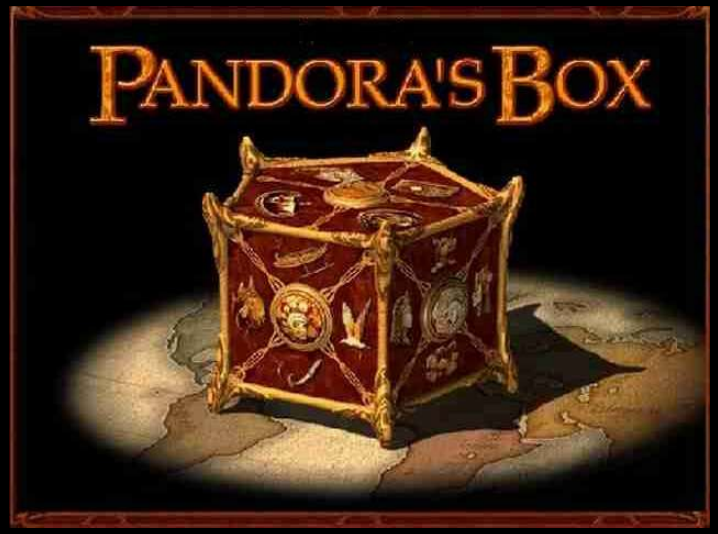
CLINICAL PRACTICE

GASLINI CHILDREN'S HOSPITAL, GENOA

LITERATURE REVIEW, AS REPORTED

Presentation outline

Accurate clinical assessment in combination with appropriate imaging is essential for the characterization of non-traumatic neurological emergencies, which may represent a complex diagnostic challenge



- Spinal emergencies
- Stroke
- Encephalitis
- Medication neurotoxicity
- Seizure/status epilepticus

Different imaging modalities may be chosen based on the institutional availability and clinical status of the patient

US

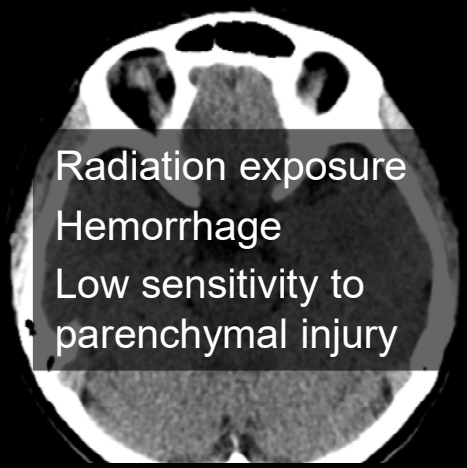
First hand examination in neonates & small infants

CT

Radiation exposure

Hemorrhage

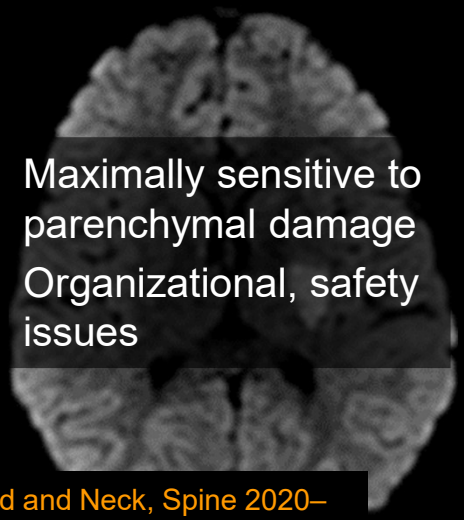
Low sensitivity to parenchymal injury



MRI

Maximally sensitive to parenchymal damage

Organizational, safety issues



In: Hodler J, Kubik-Huch RA, von Schulthess GK, editors. Diseases of the Brain, Head and Neck, Spine 2020–2023: Diagnostic Imaging. Cham (CH): Springer; 2020. Chapter 14 and Speaker's own opinion

NON-TRAUMATIC SPINAL EMERGENCIES

Suspected spinal cord injury

- ✓ Pain
- ✓ Paresthesias
- ✓ Leg weakness
- ✓ Sphincterial dysfunction

Magn Reson Imaging Clin N Am 24 (2016) 621–644

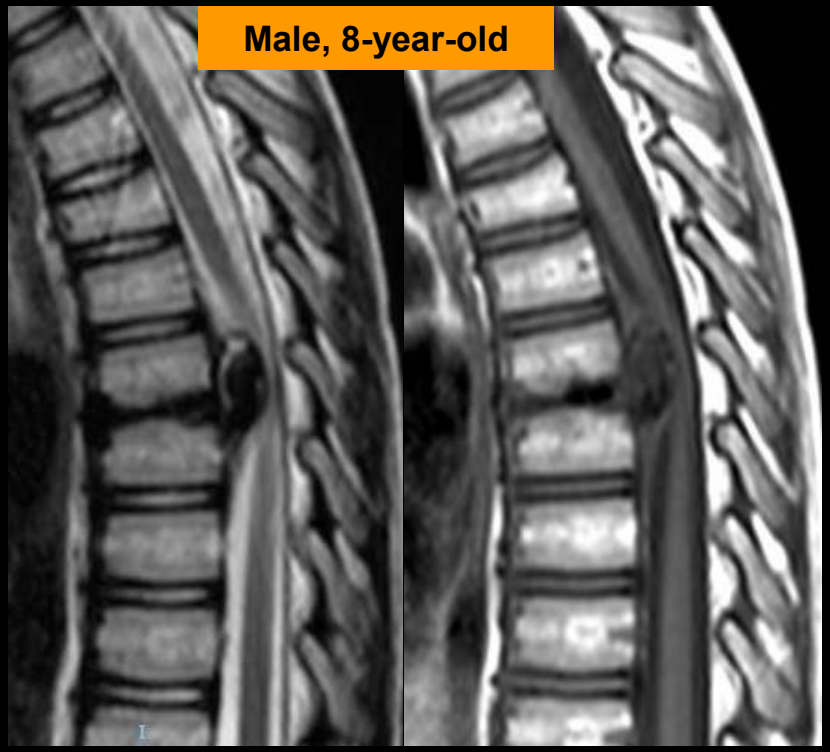
Diagnostic Approach to Pediatric Spine Disorders

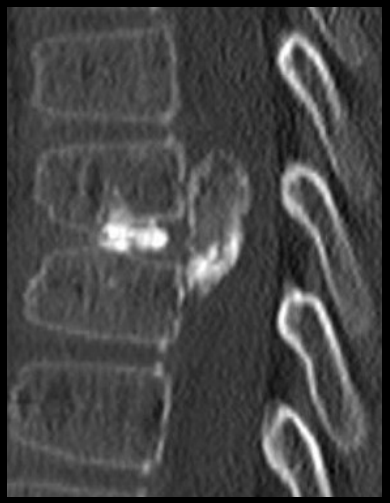
Andrea Rossi, MD*, Carola Martinetti, MD, Giovanni Morana, MD, PhD, Mariasavina Severino, MD, Domenico Tortora, MD

Non-compressive myelopathy

Compressive myelopathy

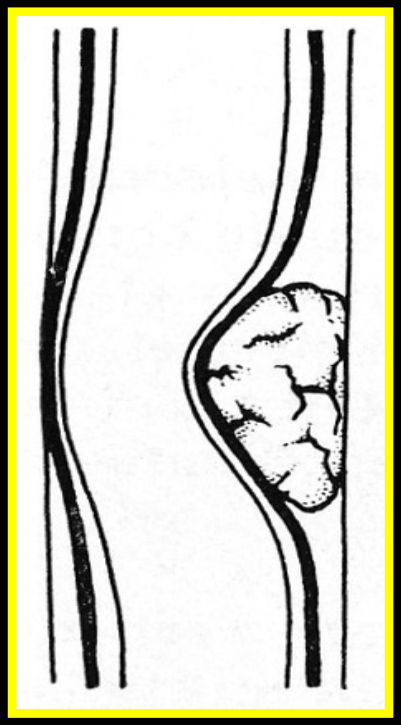
Pediatric calcified intervertebral disc herniation





- benign, self-limiting condition with unknown etiology (inflammatory or post-traumatic etiologies have been suggested)
- complete recovery occurs on conservative management (within 3 months)
- a high index of suspicion and awareness of this condition is a must to obviate unnecessary surgical intervention

Spinal cord compression can occur acutely in children with cancer



Intraspinal metastases can also cause cord or nerve root compression

Neuroimaging Clin N Am. 2007 Feb;17(1):17-35

Tumors of the Spine in Children

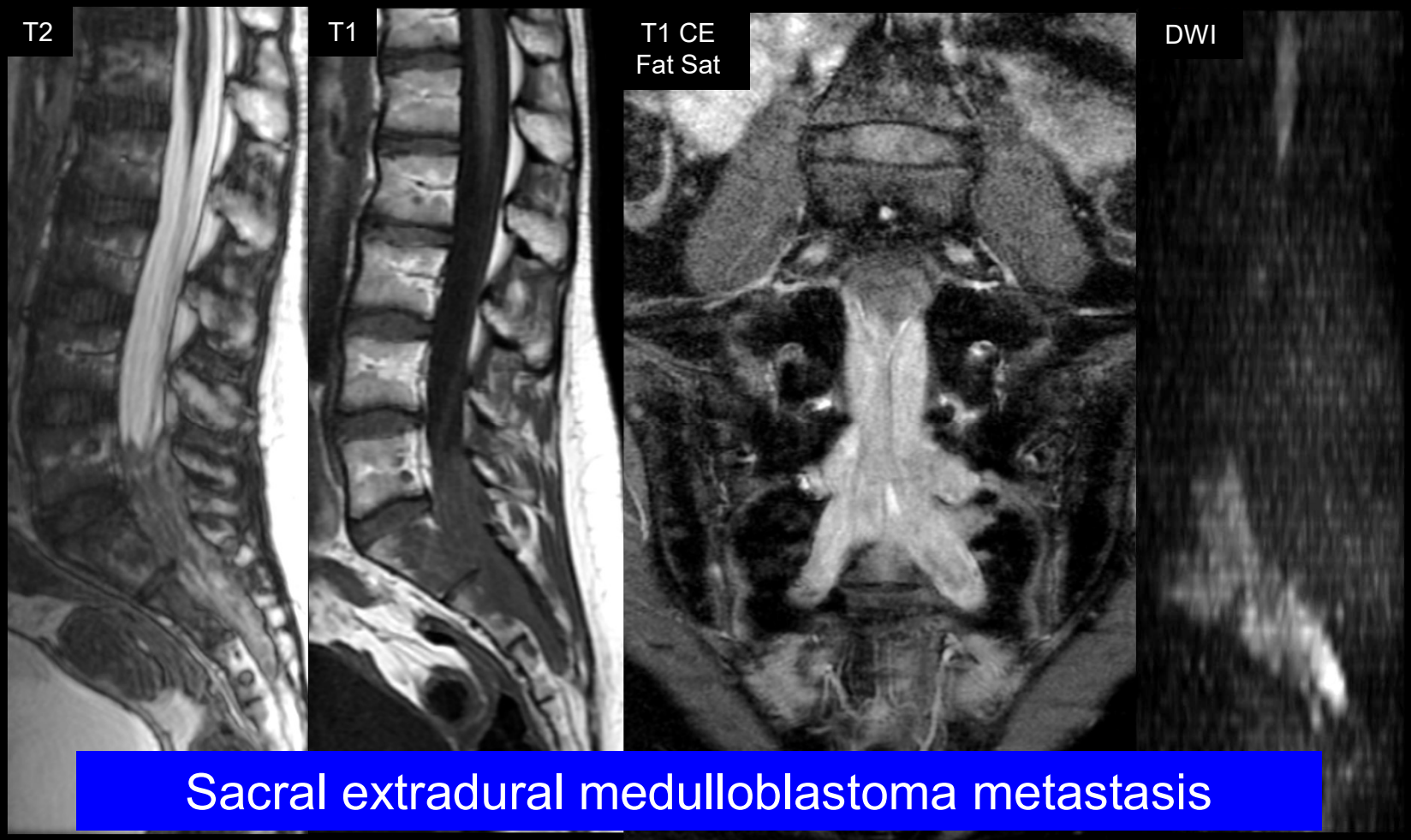
Andrea Rossi, MD*, Carlo Gandolfo, MD,
Giovanni Morana, MD, Paolo Tortori-Donati, MD

Extradural tumors account for about two thirds of all spinal tumors in the pediatric age group and may be grouped into:

- tumors of the epidural space
- bone tumors
- extraspinal tumors invading the spine

Female, 15 years

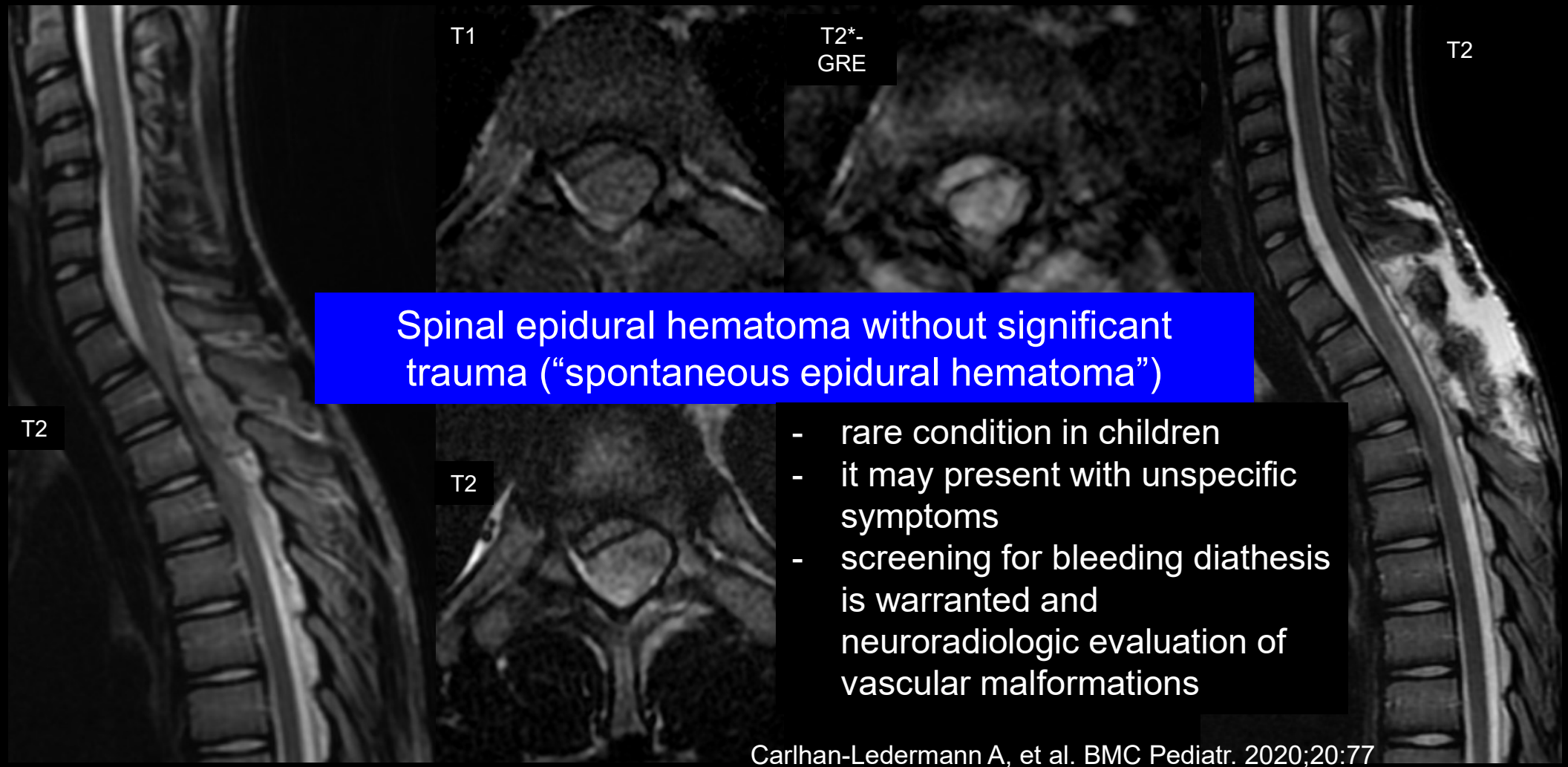
Back pain and urinary incontinence. Prior medulloblastoma (off therapy since 5 years)



Sacral extradural medulloblastoma metastasis

Male, 12-year-old

Sudden onset of acute back pain

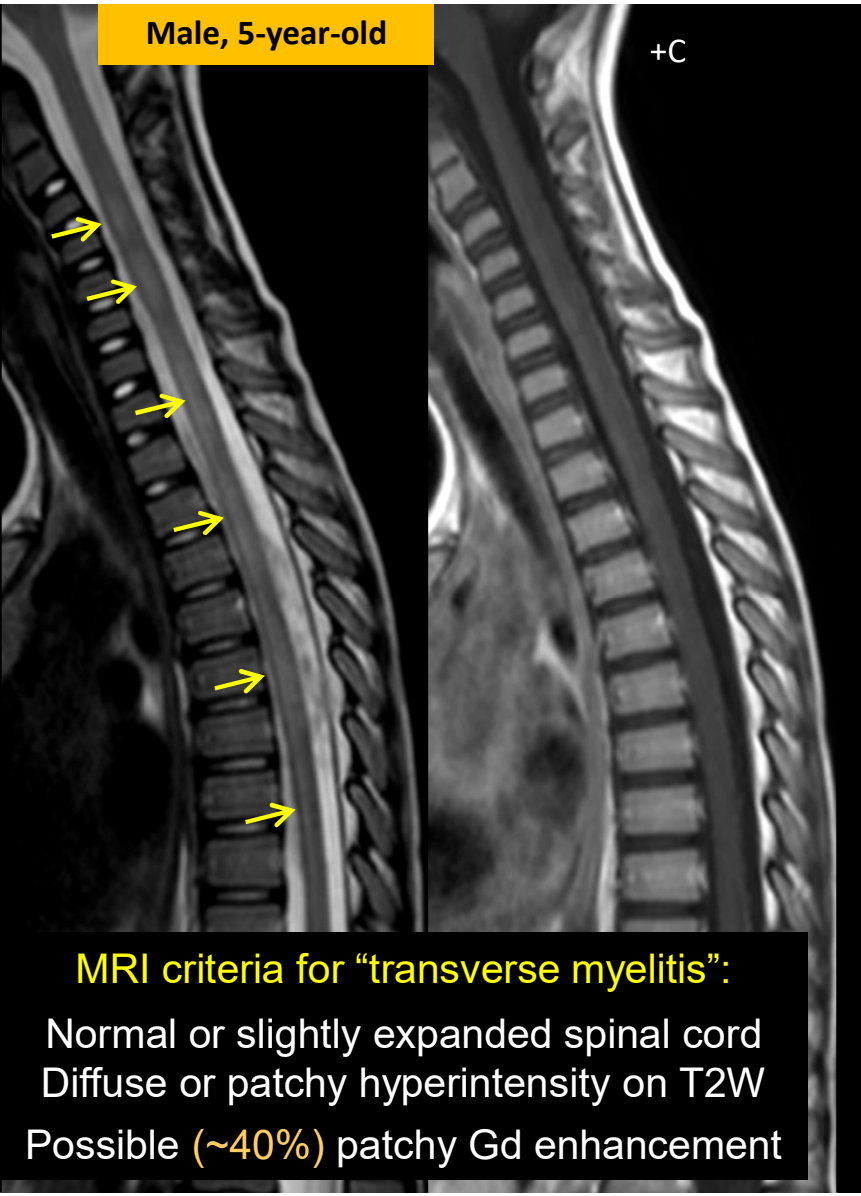


Spinal epidural hematoma without significant trauma (“spontaneous epidural hematoma”)

- rare condition in children
- it may present with unspecific symptoms
- screening for bleeding diathesis is warranted and neuroradiologic evaluation of vascular malformations

Carlhan-Ledermann A, et al. BMC Pediatr. 2020;20:77

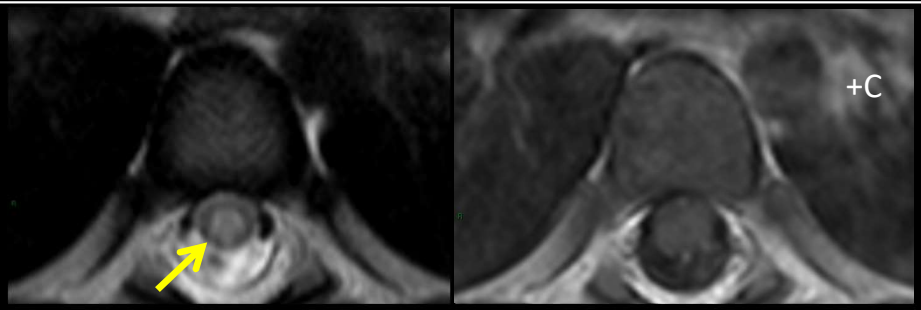
ADEM: myelitis presentation



MRI criteria for “transverse myelitis”:

Normal or slightly expanded spinal cord
Diffuse or patchy hyperintensity on T2W

Possible (~40%) patchy Gd enhancement



Look at the brain!

Spinal Cord Abnormalities in ADEM

- Multiple areas of T2 high signal intensities
- Long segment or skip lesions
- No enhancement
- Holocord involvement is possible

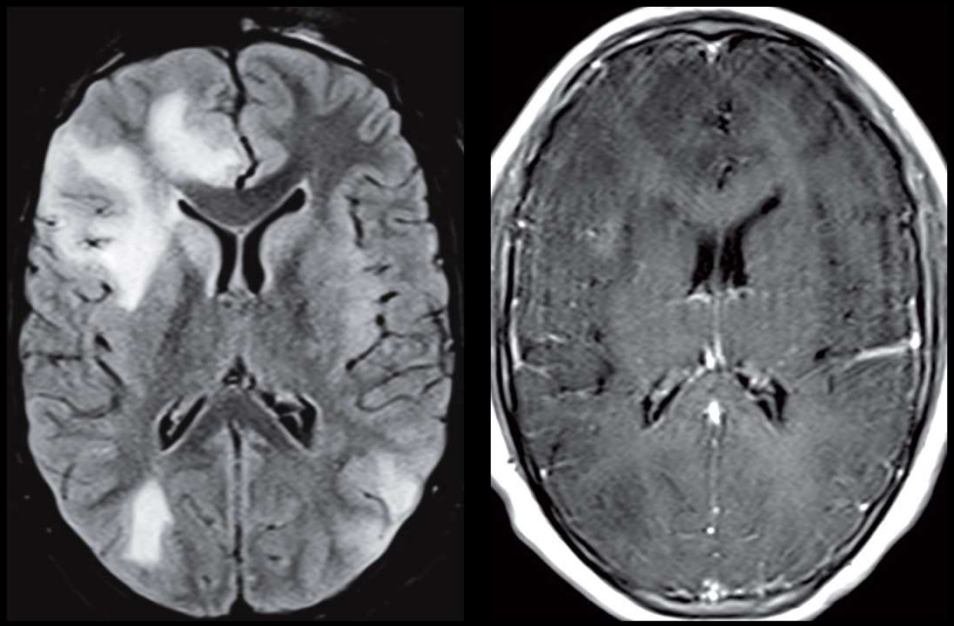
Rossi A. Imaging in acute disseminated encephalomyelitis. *Neuroimag Clin N Am* 2008

Neuroimaging manifestations in children with SARS-CoV-2 infection: a multinational, multicentre collaborative study

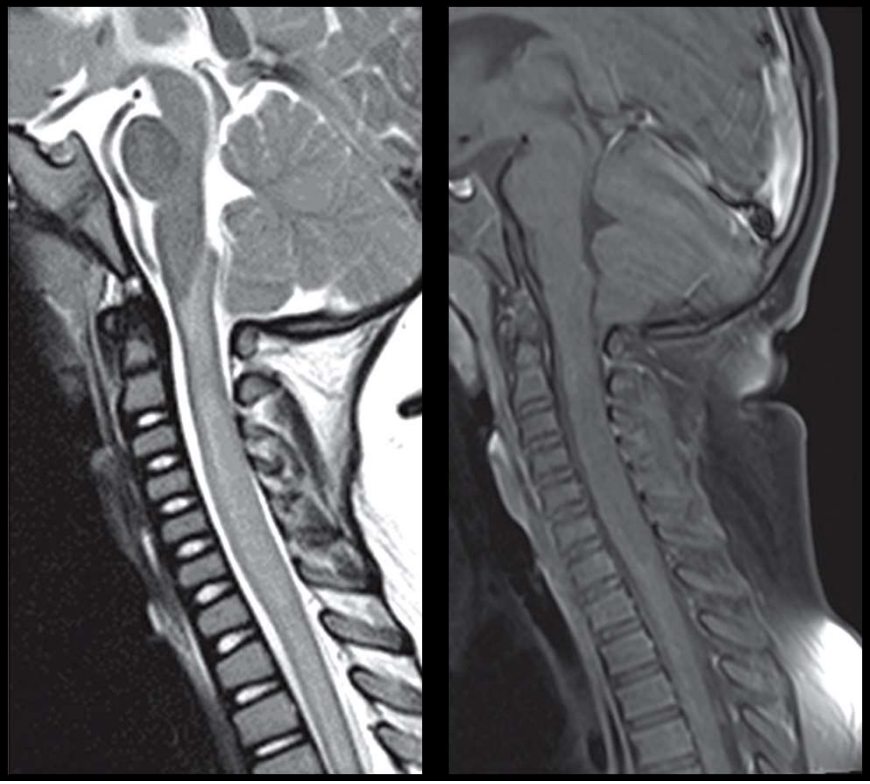
Lancet Child Adolesc Health 2020

Camilla E Lindan, Kshitij Mankad, Dipak Ram, Larry K Kociolek, V Michelle Silvera, Nathalie Boddaert, Stavros Michael Stivaros, Susan Palasis*, on behalf of the ASPNR PECOBIG Collaborator Group†*

ADEM-like brain changes

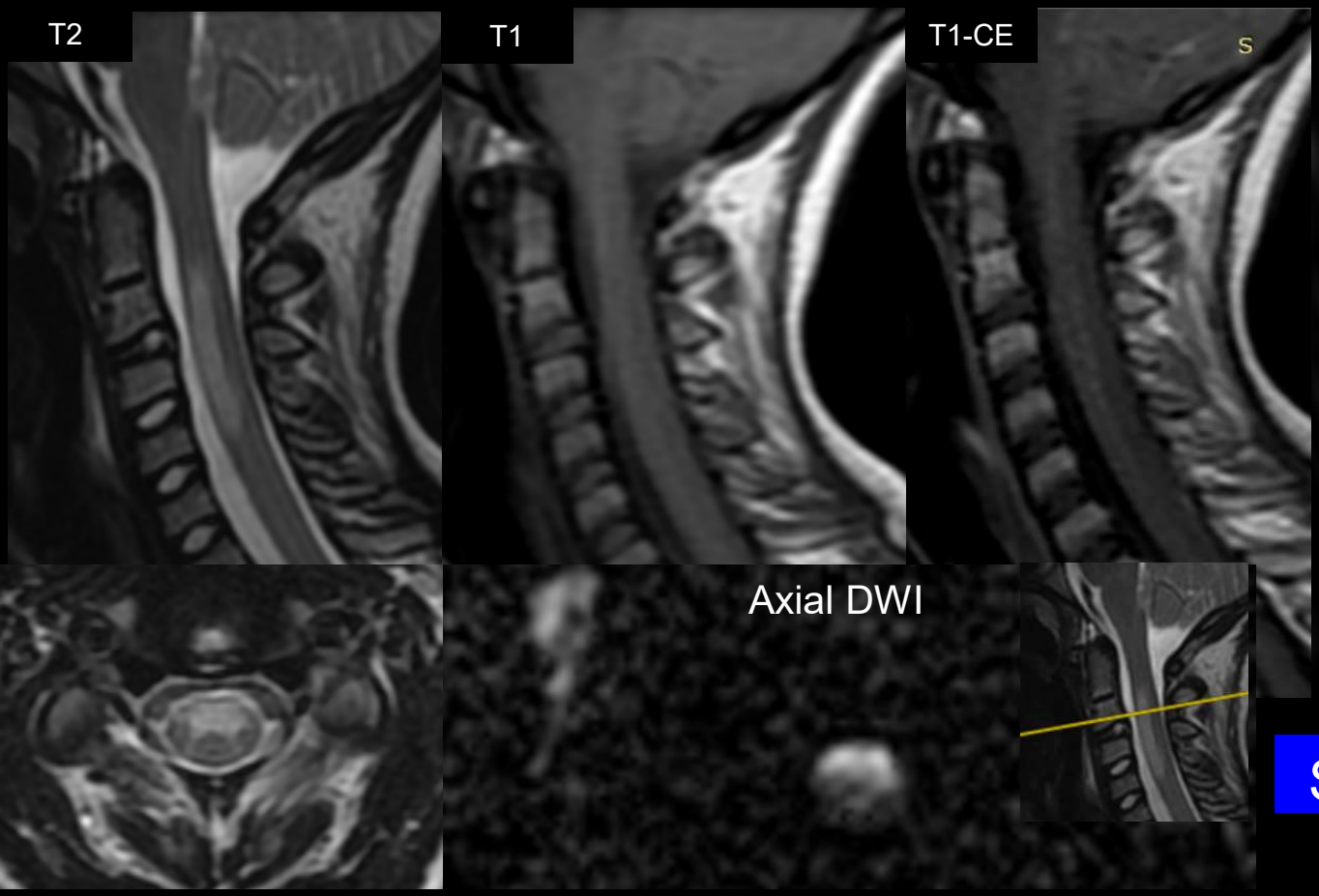


Longitudinally extensive transverse myelitis



Female, 10-year-old

Neck pain, paresthesias and numbness in her hands



Spinal cord ischemia

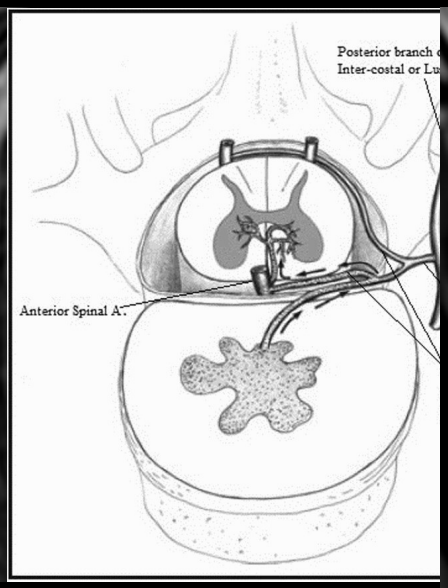
- Diffusion imaging is recommended in all acute myelopathies of the spinal cord
- In the acute stage, there is no enhancement in ischemia, which is generally present in inflammatory, tumoral, and infectious pathologies (Vargas MI et al. AJNR Am J Neuroradiol. 2015;36:825-30).

1 week later

T2

T1-CE

FLAIR



6 months later

DWI

J Neurosurg Pediatrics 11:445–450, 2013

Spinal cord infarction following minor trauma in children: fibrocartilaginous embolism as a putative cause

Report of 3 cases

ANDREW REISNER, M.D.,[1,2] MATTHEW F. GARY, M.D.,[1] JOSHUA J. CHERN, M.D., PH.D.,[1] AND J. DAMIEN GRATTAN-SMITH, M.B.B.S.[3]

- Presumed cause: embolization of disc material to the spinal microcirculation
- The mechanism of FCE includes the migration of nucleus pulposus material into vessels supplying the spinal cord

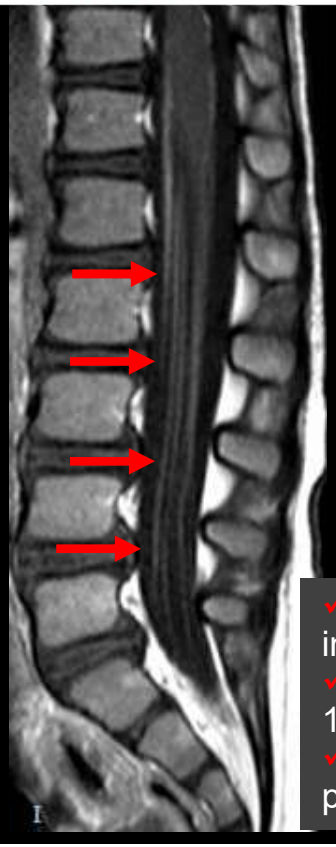
Guillain Barrè Sd (acute demyelinating polyradiculoneuritis)

- Pre-contrast studies are inconclusive
- Gad compounds must be administered!

Pediatric Spinal Infection and Inflammation

Andrea Rossi, MD

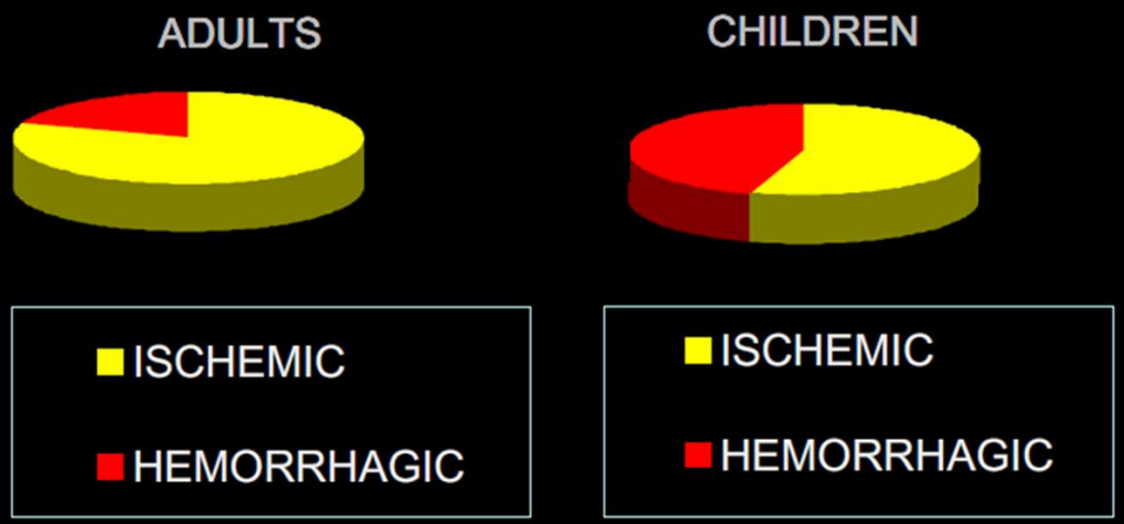
Neuroimag Clin N Am 25 (2015) 173–191



✓ Sensory disturbances (pain, paresthesia) in 40% of cases
✓ Patients usually are between ages 4 and 12 years
✓ Acute onset of lower extremity weakness progressing to flaccid paralysis

Pediatric stroke

- Stroke in children is at least as frequent as brain tumors
- It is among the top ten causes of death in childhood
- Variable clinical presentation



Murphy SL. Deaths: final data for 1998. Natl Vital Stat Rep 2000;48:1–105

Pediatric stroke

"Stroke is under-recognized in children and there can be marked delays in diagnosis"

Quant Imaging Med Surg. 2018 Nov; 8(10): 984–991.
doi: 10.21037/qims.2018.11.09
PMCID: PMC6288056
PMID: 30598876

Pediatric stroke: current diagnostic and management challenges

Nikil K. Rajani,[1] Kirsten Pearce,[2] Tom Campion,[2] Vincenzo Salpietro,[3] Mariana Planells,[4] Winston Chong,[5] Tufail Patankar,[6] and Kshitij Mankad[2]

"Twenty percent to over half of children presenting urgently with stroke-like symptoms will have stroke mimics; therefore, more than in adults, the first question in children is whether the cause of the child's symptoms is a stroke or stroke mimic"

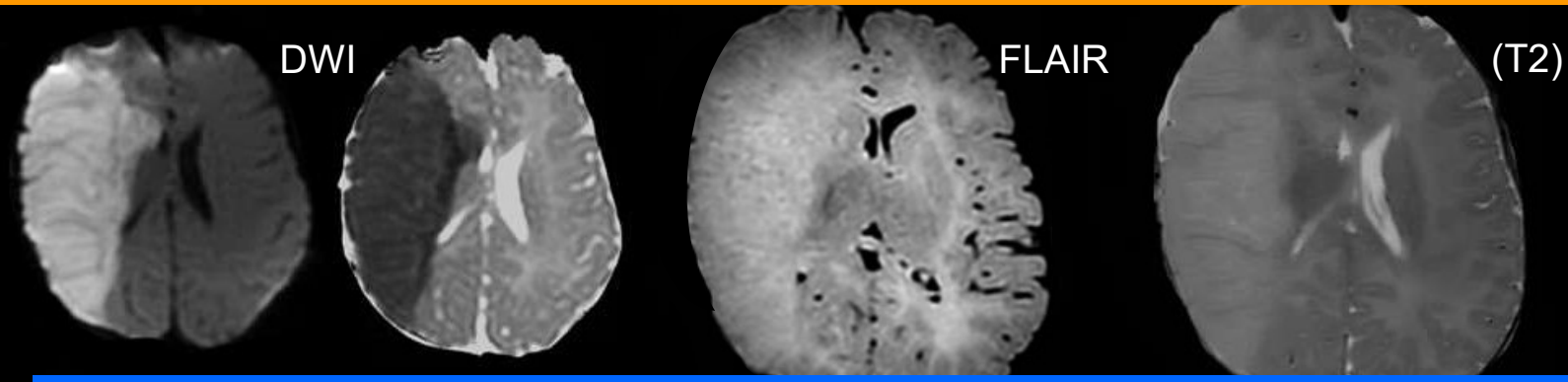
Review > Pediatr Neurol. 2017 Apr;69:11-23. doi: 10.1016/j.pediatrneurol.2016.12.004. Epub 2017 Jan 25.

Pathways for Neuroimaging of Childhood Stroke

David M Mirsky [1], Lauren A Beslow [2], Catherine Amlie-Lefond [3], Pradeep Krishnan [4], Suzanne Laughlin [4], Sarah Lee [5], Laura Lehman [6], Mubeen Rafay [7], Dennis Shaw [8], Michael J Rivkin [9], Max Wintermark [10],
International Paediatric Stroke Study Neuroimaging Consortium and the Paediatric Stroke Neuroimaging Consortium

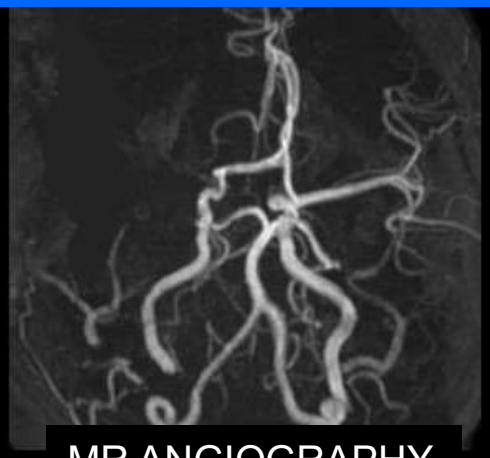
"Non-contrast head computed tomography (CT), is often the initial study in a child presenting with possible stroke and can rule out intracranial hemorrhage. However, CT has limited sensitivity for the detection of acute childhood AIS and stroke mimics. CT scan misses the diagnoses in over 40% of children"

“Considering this limited sensitivity, the concerns for radiation, and the likelihood of needing MRI to confirm diagnosis, many centers have developed rapid brain or hyperacute MRI protocols for stroke”



15-20 minutes!

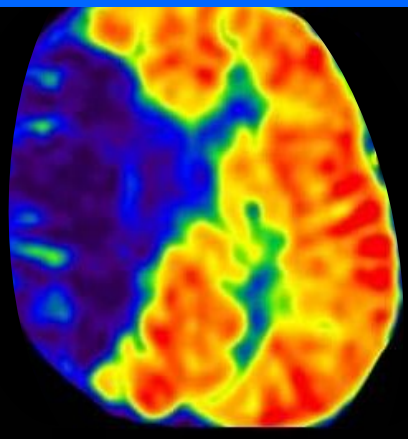
“In a child who is medically unstable, in whom a contraindication to MRI is present, who presents to a center without MRI capabilities, or in whom sedation will delay MRI, CT with CT angiogram (CTA) of the head and neck may be preferable”



MR ANGIOGRAPHY

BRUSH SIGN

SWI or T2* GRE



ASL (optional)

Mirsky DM,et al. Pediatr Neurol. 2017;69:11-23

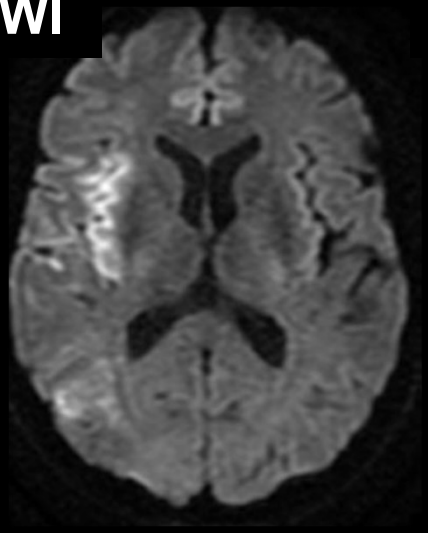
ISCHEMIC STROKE…BRUSH SIGN

- During acute ischemia, the local oxygen deprivation secondary to arterial occlusion is seen as a hypointense zone in the cortical and deep veins called the brush sign, as multiple hypointense vessels, or as prominent vessel.

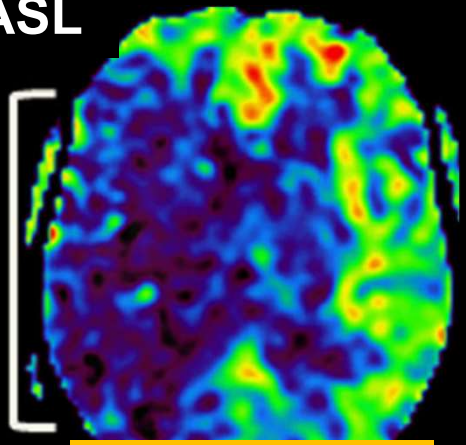
- **The brush sign, reflecting cerebral hypoperfusion, would be correlated with penumbra volume**

DWI-PWI-SWI mismatch (penumbra)

DWI

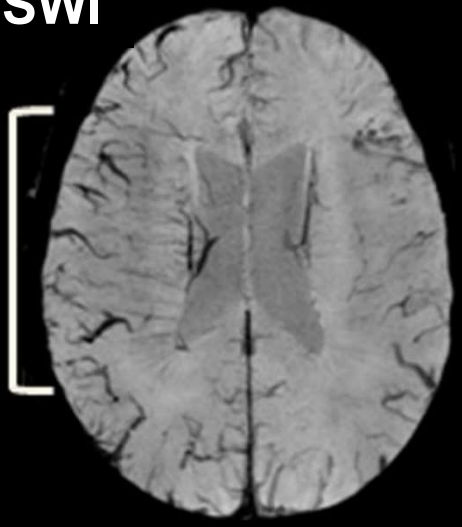


ASL



Hypoperfusion of the ischemic region / penumbra

SWI



Prominence of perimedullary and cortical veins

Increased amount of deoxygenated blood

Insights Imaging (2017) 8:91–100

Pediatric ischemic stroke

Potential risk factors/etiology

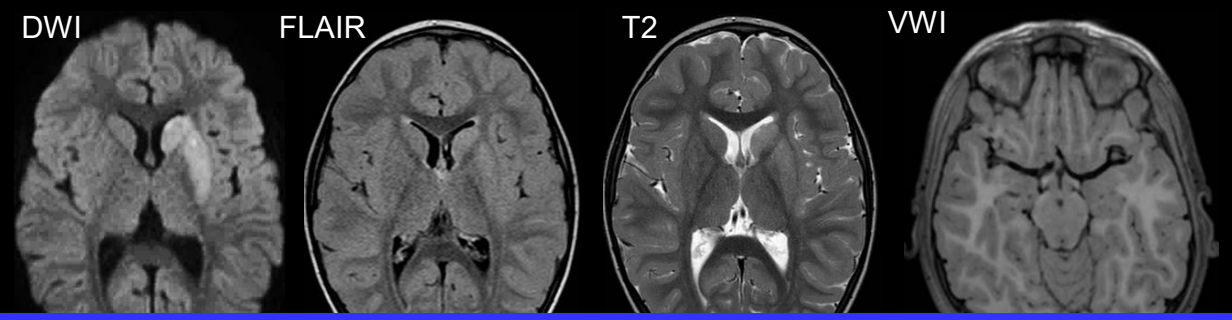
Artheriopathies	Arterial fibromuscular dysplasia, arteriovenous malformation, arterial dissection, Moyamoya disease, transient cerebral arteriopathy of childhood, primary central nervous system vasculitis, cranial radiotherapy
Vasculitis	Meningitis, postinfectious systemic lupus erythematosus, polyarteritis nodosa, granulomatous angiitis, Takayasu's arteritis, rheumatoid arthritis, dermatomyositis, inflammatory bowel disease, hemolytic-uremic syndrome, drug abuse
Hematologic disorders and coagulopathies	Hemoglobinopathies (sickle cell anemia, sickle cell-hemoglobin C, sickle-thalassemia), purpura, thrombocytosis, polycythemia, disseminated intravascular coagulation, leukemia or other neoplasms, congenital coagulation defects, oral contraceptive use, liver dysfunction with coagulation defect, vitamin K deficiency, Lupus anticoagulant, anticardiolipin antibodies
Metabolic disorders	Mitochondrial disorders (MELAS syndrome), urea matabolic disorders, homocystinuria, aminoaciduria, glutaric acidemia type I, lysosomal disorders, Fabry's disease
Heart diseases	Congenital malformations (ventricular/atrial septal defect, patent ductus arteriosus, aortic/mitral stenosis, coarctation, complex congenital heart defects);
	Acquired (Rheumatic heart disease, endocarditis, myocarditis, arrhythmia)
Traumatic	Child abuse, post-traumatic arterial dissection, blunt cervical arterial trauma, arteriography, post-traumatic carotid cavernous fistula, penetrating intracranial trauma

Arteriopathy appears to be the predominant underlying mechanism, causing 53% of pediatric ischemic strokes

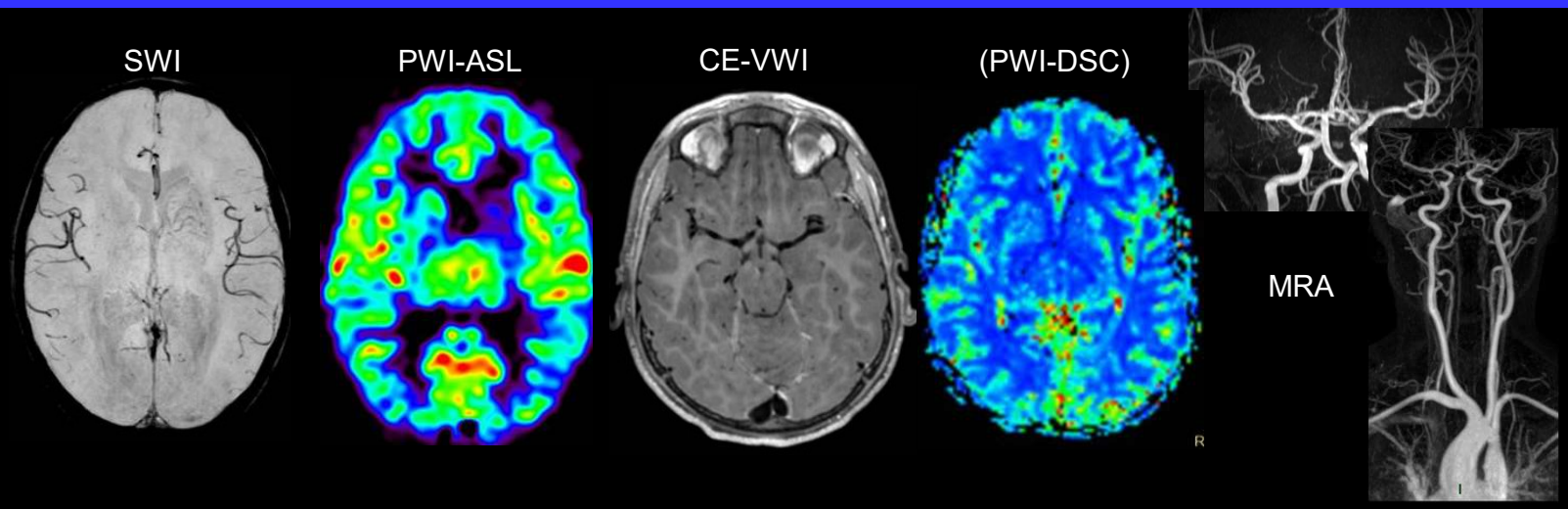
Tolani et al. Pediatric Neurology 2015
Fullerton et al. Stroke 2016
Rosa M, et al. Ital J Pediatr. 2015

Pediatric ischemic stroke

Non-Hyperacute phase

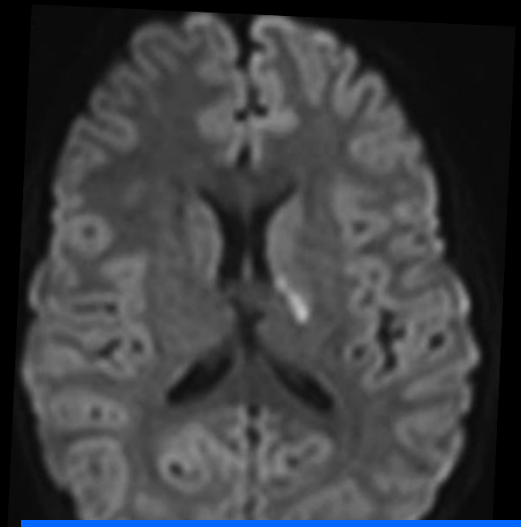


To obtain diagnostic information that could be useful in the etiological definition of stroke

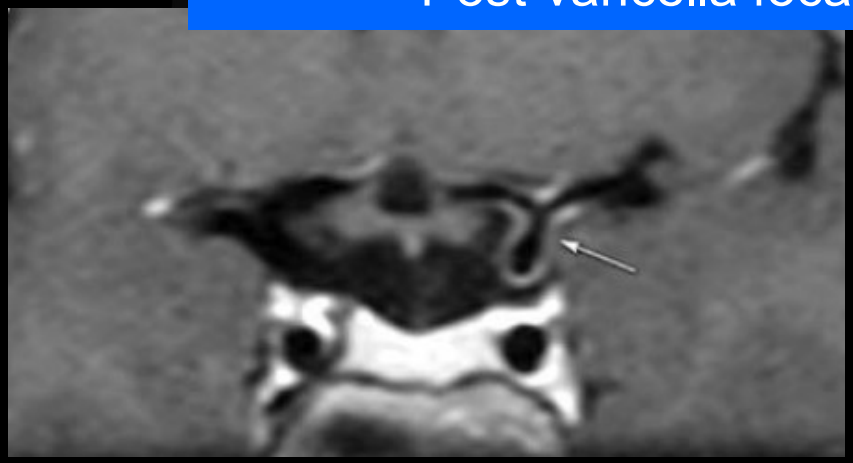


Mirsky DM, et al. Pathways for Neuroimaging of Childhood Stroke. Pediatr Neurol. 2017;69:11-23

Vessel Wall Imaging may improve diagnosis and characterization of arteriopathies



Post-varicella focal cerebral arteriopathy



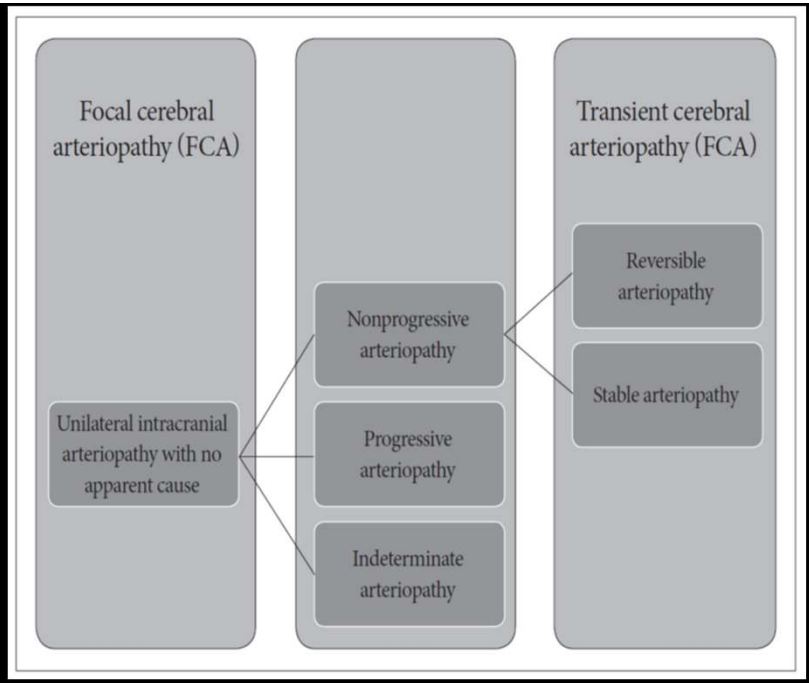
Stroke. 2018;49:891-898.

Arterial Wall Imaging in Pediatric Stroke

Nomazulu Dlamini, MD, MSc, PhD; Ivanna Yau, MN, NP; Prakash Muthusami, MD; David J. Mikulis, MD, BSc; Jorina Elbers, MD, MS; Mahmoud Slim, PharmD, PhD; Rand Askalan, MD, PhD; Daune MacGregor, MD; Gabrielle deVeber, MD; Manohar Shroff, MD, DABR; Mahendranath Moharir, MD, MSc

Focal cerebral arteriopathy

The most common established arteriopathy in paediatric stroke is an acquired unilateral intracranial arteriopathy (FCA) associated with basal ganglia stroke



J Korean Neurosurg Soc. 2015 Jun; 57(6): 401–407

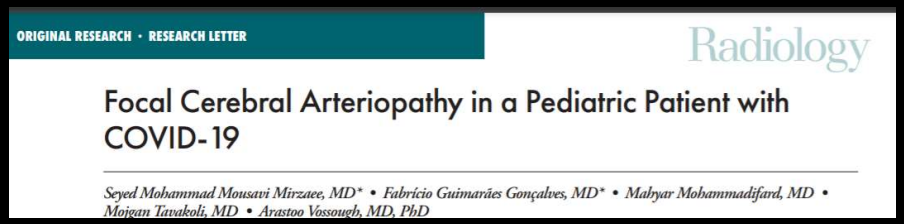
FCA is a provisional diagnosis that does not imply an underlying mechanism

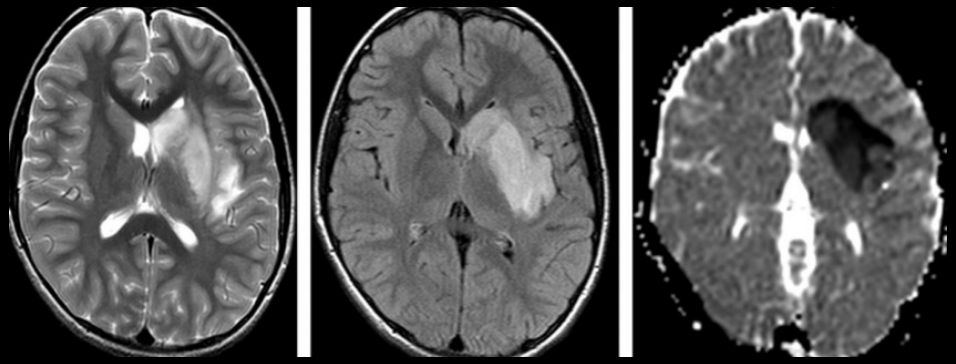
It may represent the end result of a variety of underlying pathophysiological mechanisms producing the same angiographic appearance

Most cases are presumed to be inflammatory (infectious or postinfectious)

Focal cerebral arteriopathy [FCA]

Varicella-zoster virus vasculopathy is a well-known cause of FCA. Other infectious agents less commonly associated with FCA include other herpesviruses, human immunodeficiency virus, parvovirus B19, influenza A, enteroviruses, and *Mycoplasma pneumoniae*



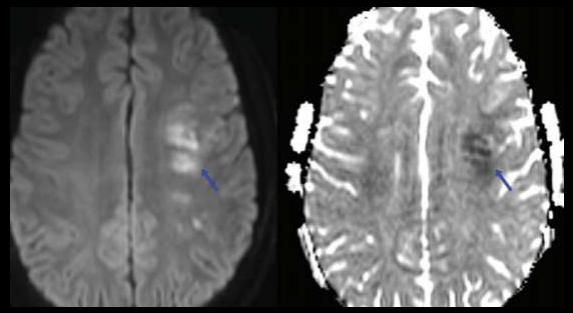


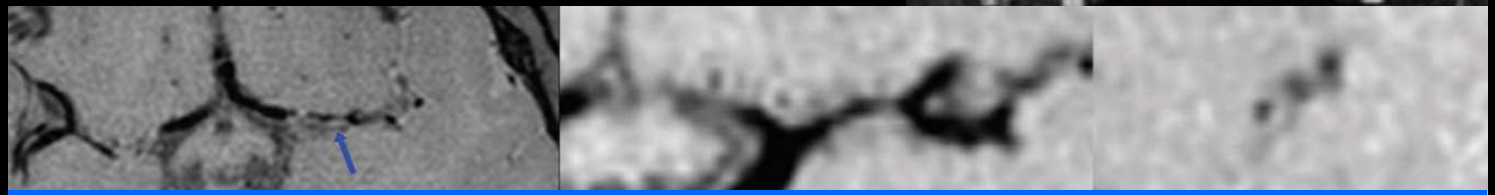
AJNR 2020

BRIEF/TECHNICAL REPORT
PEDIATRICS

Vessel Wall Enhancement and Focal Cerebral Arteriopathy in a Pediatric Patient with Acute Infarct and COVID-19 Infection

E. Gulko, P. Overby, S. Ali, H. Mehta, F. Al-Mufti, and W. Gomes

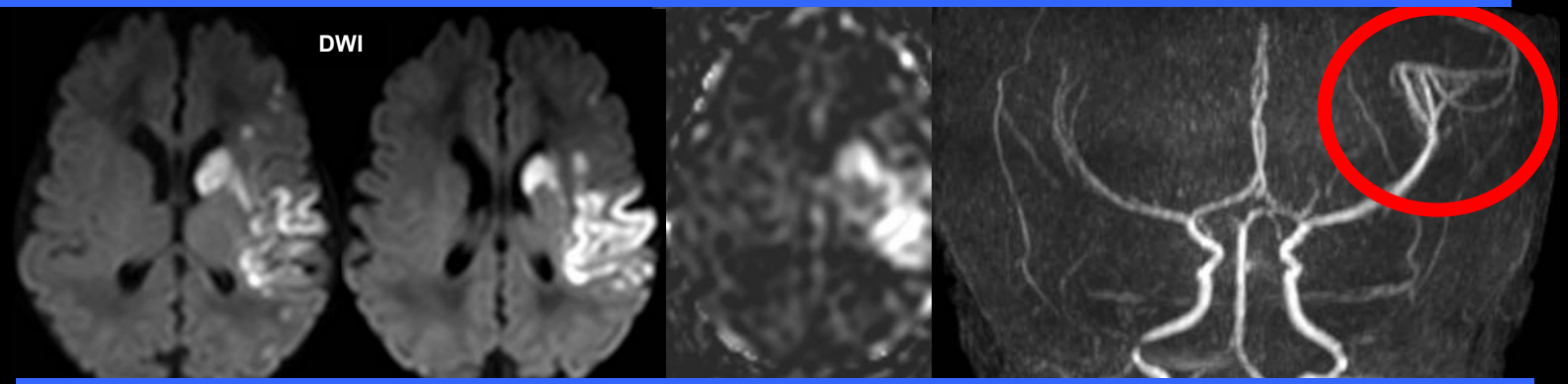




- Focal cerebral arteriopathy of childhood-inflammatory type
- Can be diagnosed by marked concentric vessel wall enhancement on VWI

Acute ischemic stroke in full term newborns

Full term newborn, sudden onset of neonatal convulsions involving right superior and inferior limbs



Follow-up 2 weeks later

- It is most likely to be caused by thromboembolism passing from the placenta through the patent neonatal foramen ovale (maternal and placental factors)
- Recurrence risk extremely low

Gunny RS, Lin D. Imaging of perinatal stroke. Magn Reson Imaging Clin N Am. 2012 Feb;20:1-33

Stroke. 2016;

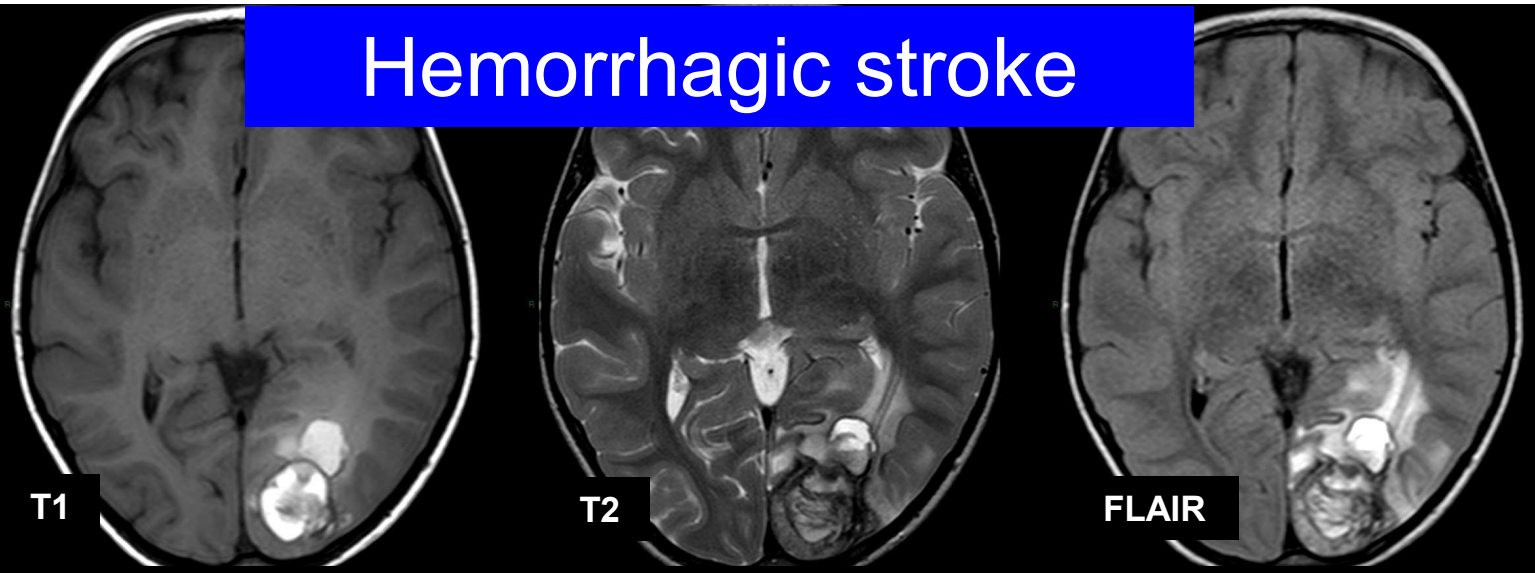
Arterial Spin Labeling Perfusion Magnetic Resonance Imaging Performed in Acute Perinatal Stroke Reveals Hyperperfusion Associated With Ischemic Injury

Christopher G. Watson, ScB; Mathieu Dehaes, PhD; Borjan A. Gagoski, PhD;

Hyperperfusion found on ASL:

- **Reflection of seizure-related increase in cerebral blood flow**
- Alternatively, could arise from **acquisition during the reperfusion phase** of acute stroke following vessel recanalization.

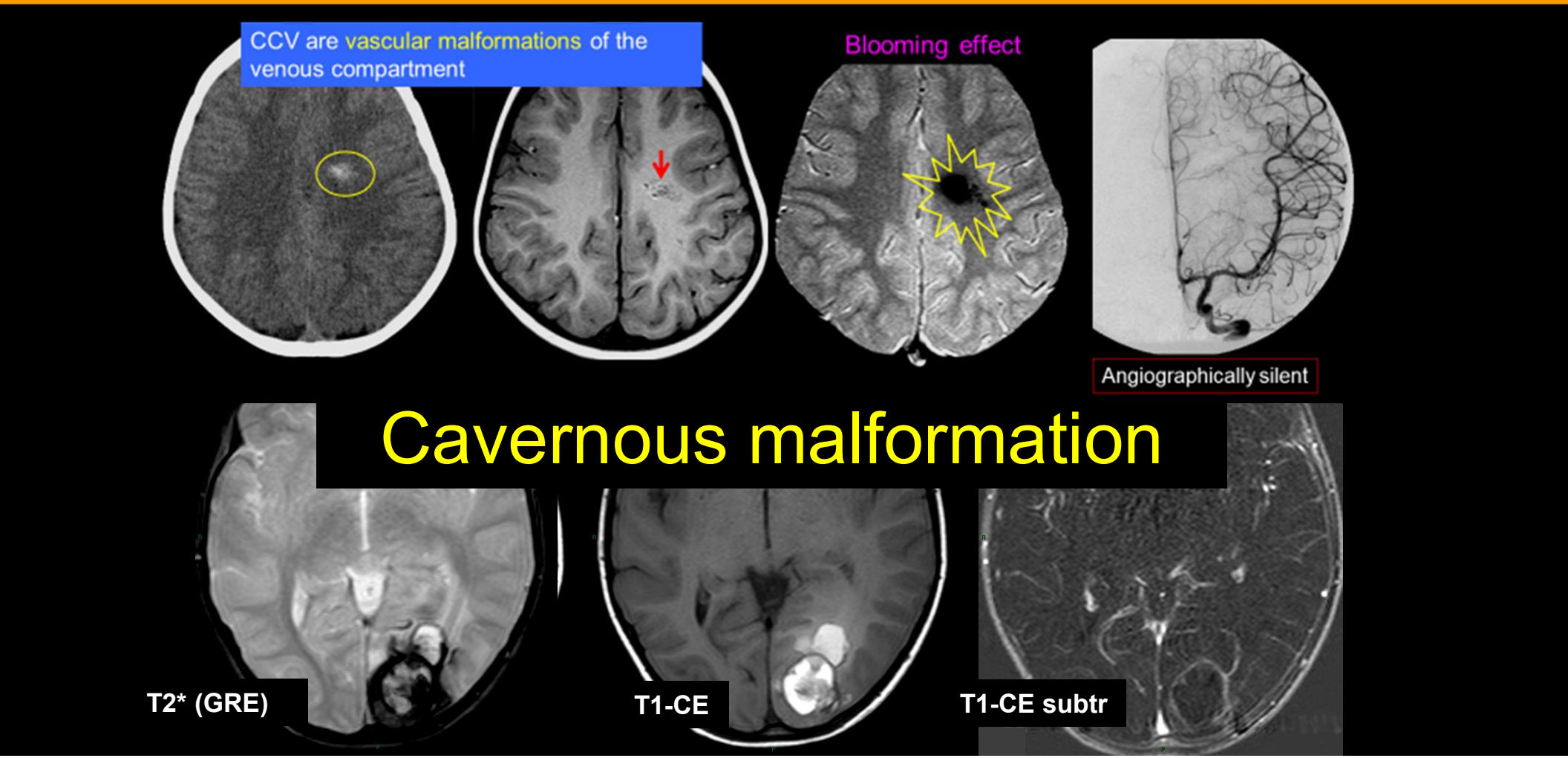
Hemorrhagic stroke

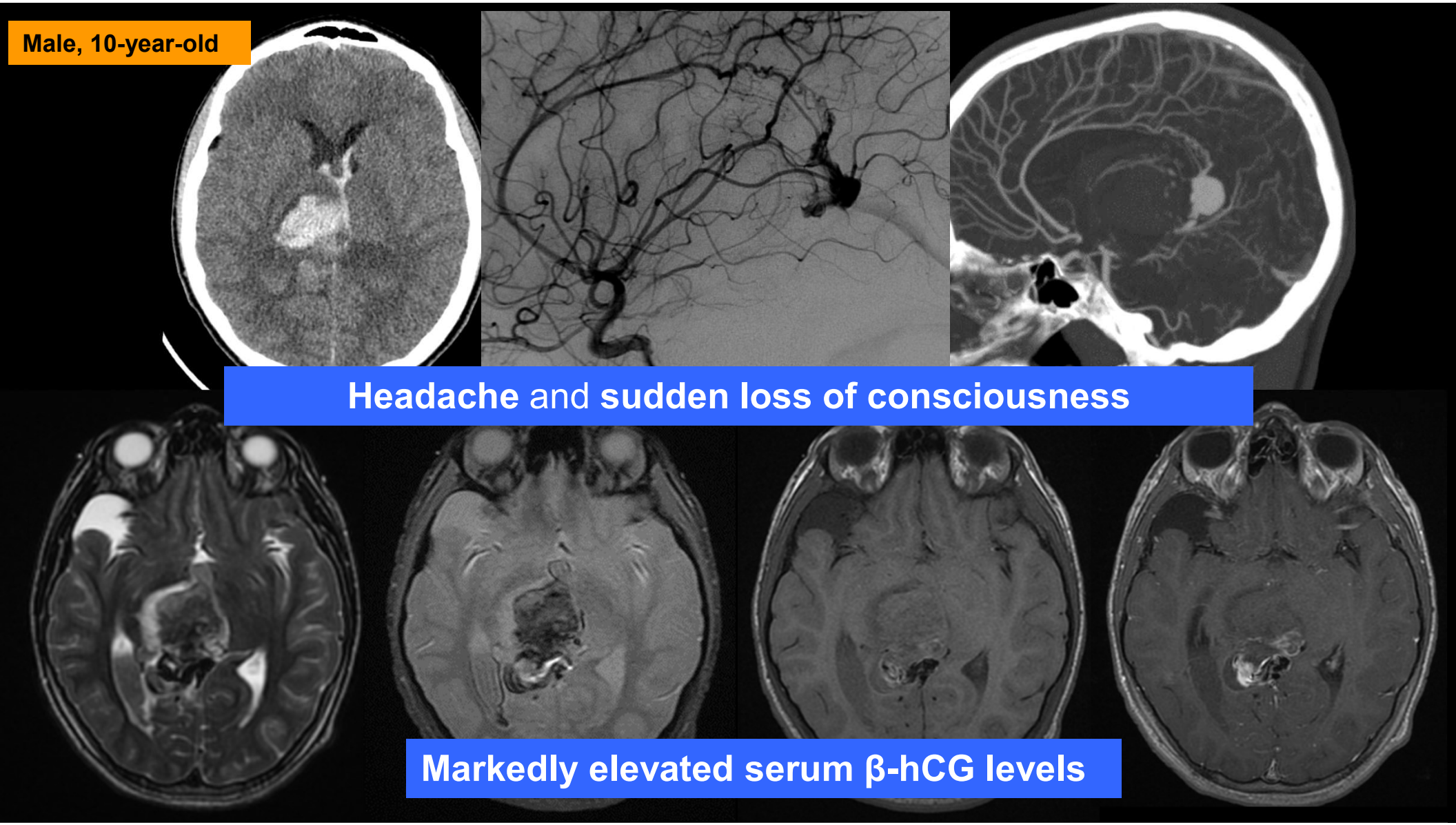


May result from a variety of causes: vascular malformations, aneurysms, hematological disorders, bleeding diathesis, anticoagulation treatment, intracranial neoplasms, dural sinus thrombosis and complications from infections

(Huisman TA. Cancer Imaging. 2009;9 Spec No A(Special issue A):S10-3)

RT predisposes to the delayed development of cerebral cavernous malformations, which may cause brain haemorrhage

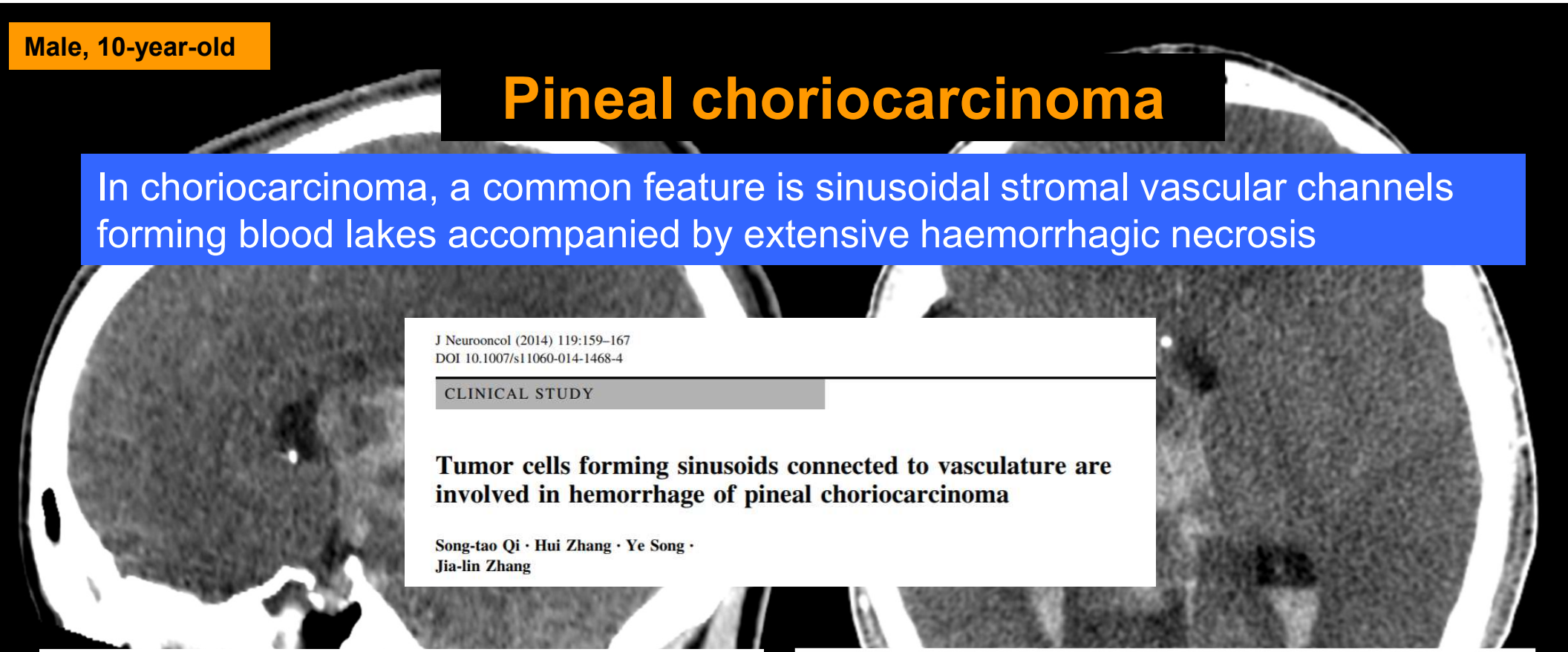



Male, 10-year-old
Headache and sudden loss of consciousness
Markedly elevated serum β-hCG levels

Male, 10-year-old

Pineal choriocarcinoma

In choriocarcinoma, a common feature is sinusoidal stromal vascular channels forming blood lakes accompanied by extensive haemorrhagic necrosis



J Neurooncol (2014) 119:159–167
DOI 10.1007/s11060-014-1468-4

CLINICAL STUDY

Tumor cells forming sinusoids connected to vasculature are involved in hemorrhage of pineal choriocarcinoma

Song-tao Qi · Hui Zhang · Ye Song · Jia-lin Zhang

Radiology. 1973 Jul;108(1):67-70. doi: 10.1148/108.1.67.

Angiographic demonstration of arteriovenous shunts in pulmonary metastatic choriocarcinoma

J D Green, T S Carden Jr, C B Hammond, I S Johnsrude

PMID: 4736189 DOI: 10.1148/108.1.67

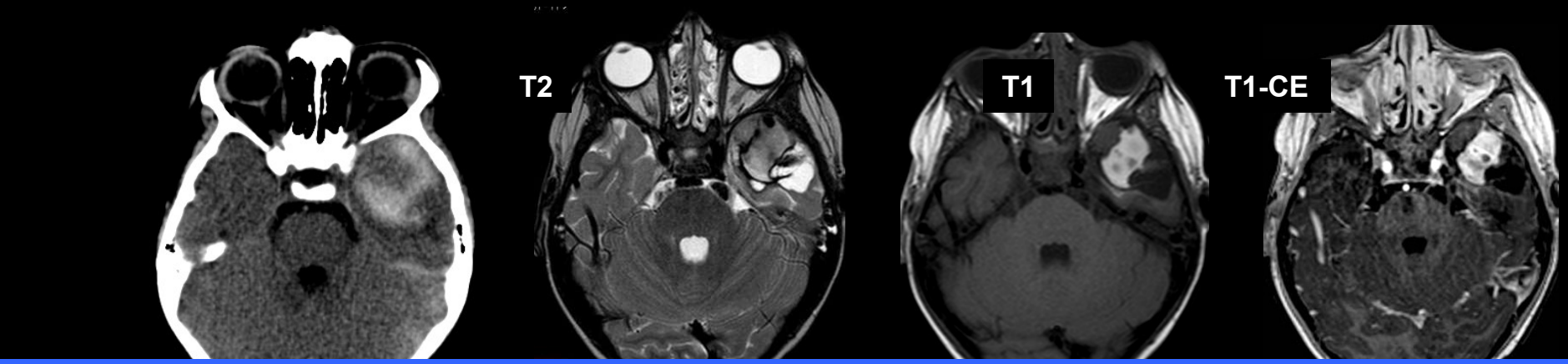
Journal of Computer Assisted Tomography
12(2):317–319, March/April

Case Report

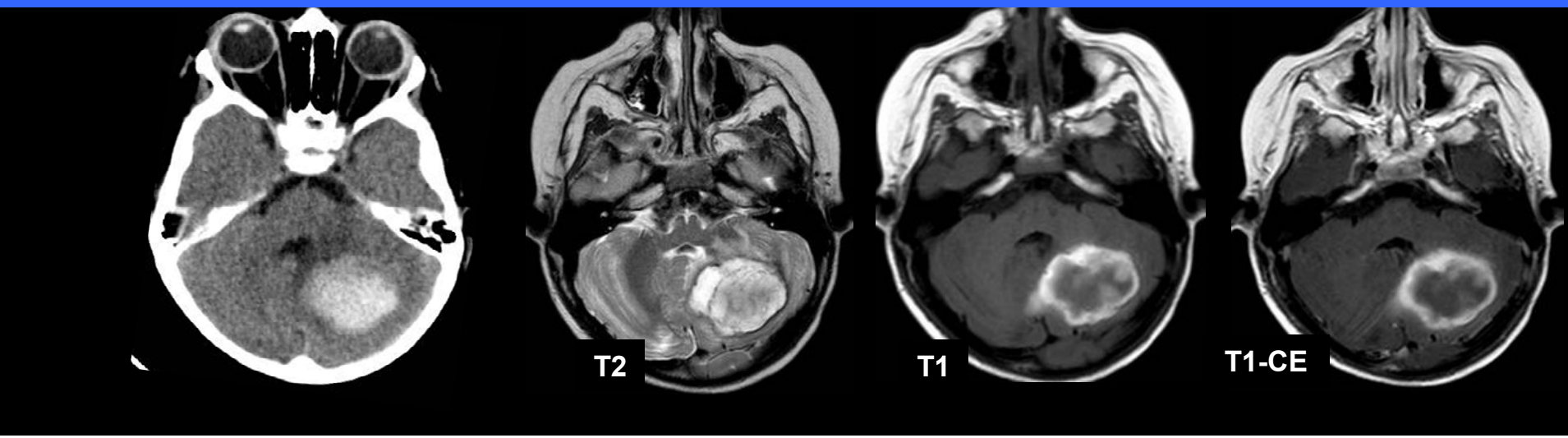
Metastatic Choriocarcinoma Simulating an Arteriovenous Malformation on Chest Radiography and Dynamic CT

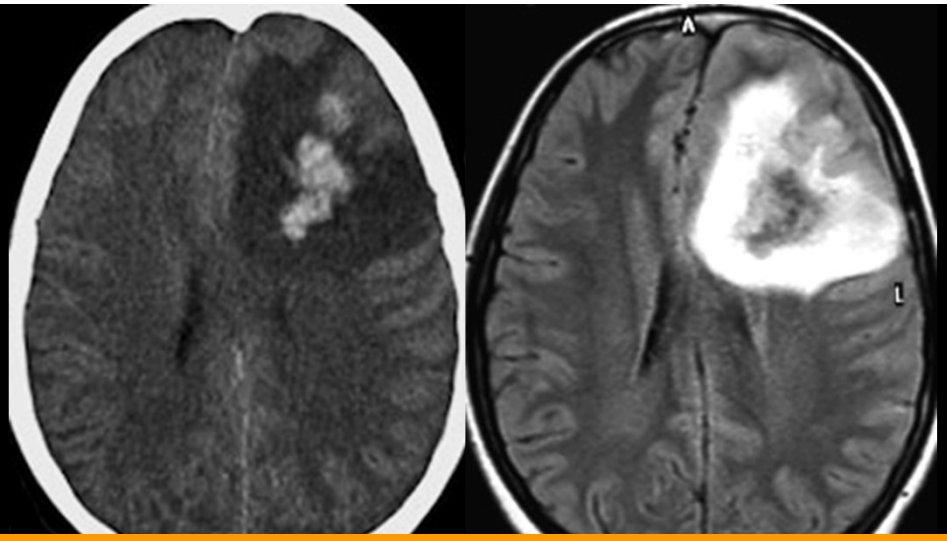
Kenneth M. Cirimelli, Patrick M. Colletti, and Sjoerd Beck

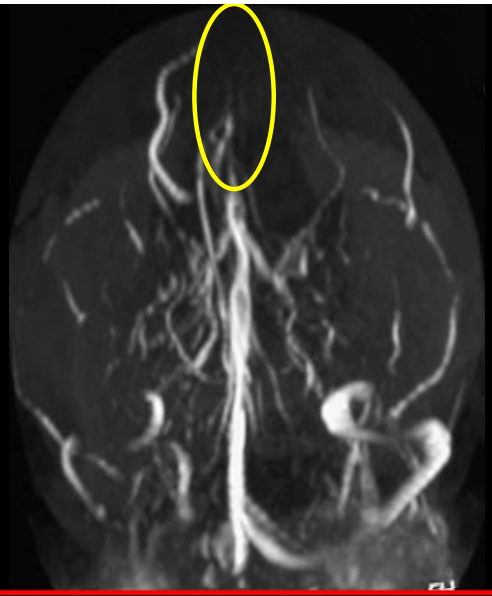
Haemorrhage is an inherent feature of NB metastasis



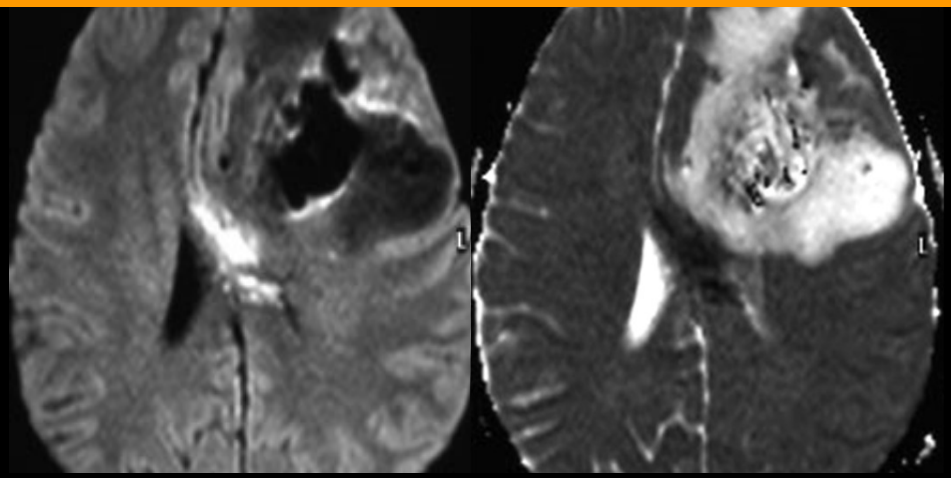
All foci of haemorrhage in the brain should be considered suspicious for metastatic disease in neuroblastoma patients (Nabavizadeh SA, Acad Radiol. 2014;21:329-37)







Male, 9-year-old, Acute Lymphoblastic leukemia, L-asp induction 48 h, headache, convulsions



Rossi A, Morana G, Gandolfo C, Severino M. Neuroradiol J. 2010;23:183-90

L-asparaginase

Depletion of plasmatic coagulation and fibrinolysis factors resulting in either hypercoagulable states or bleeding diathesis

ALL cells unable to synthetize asparagine

asparagine → L-asp → aspartate

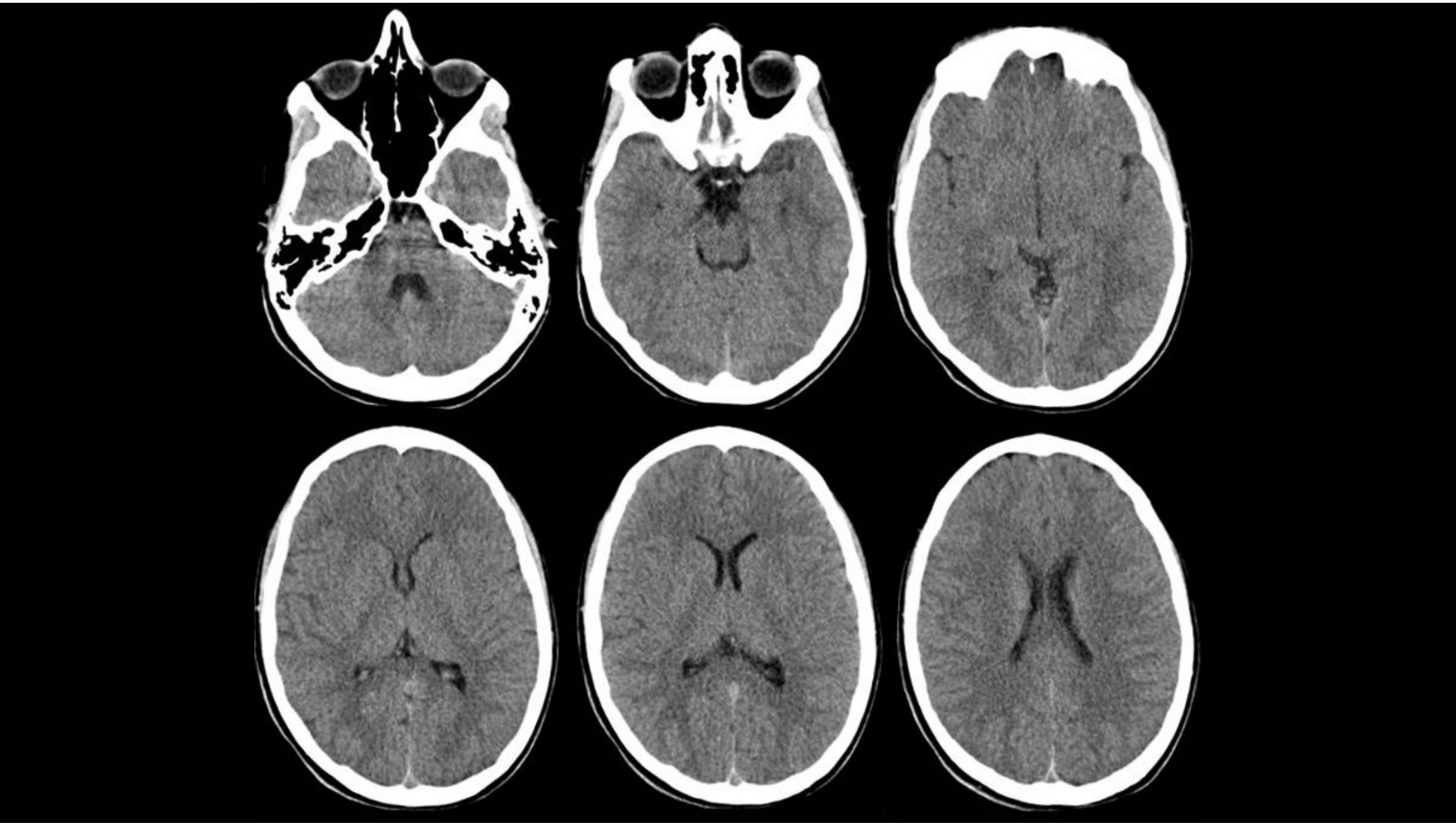
- ✓ Cortical infarcts
- ✓ Brain hemorrhage
- ✓ Hemorrhagic infarcts
- ✓ Sinovenous thrombosis

Toxicity generally presents within one day of administration

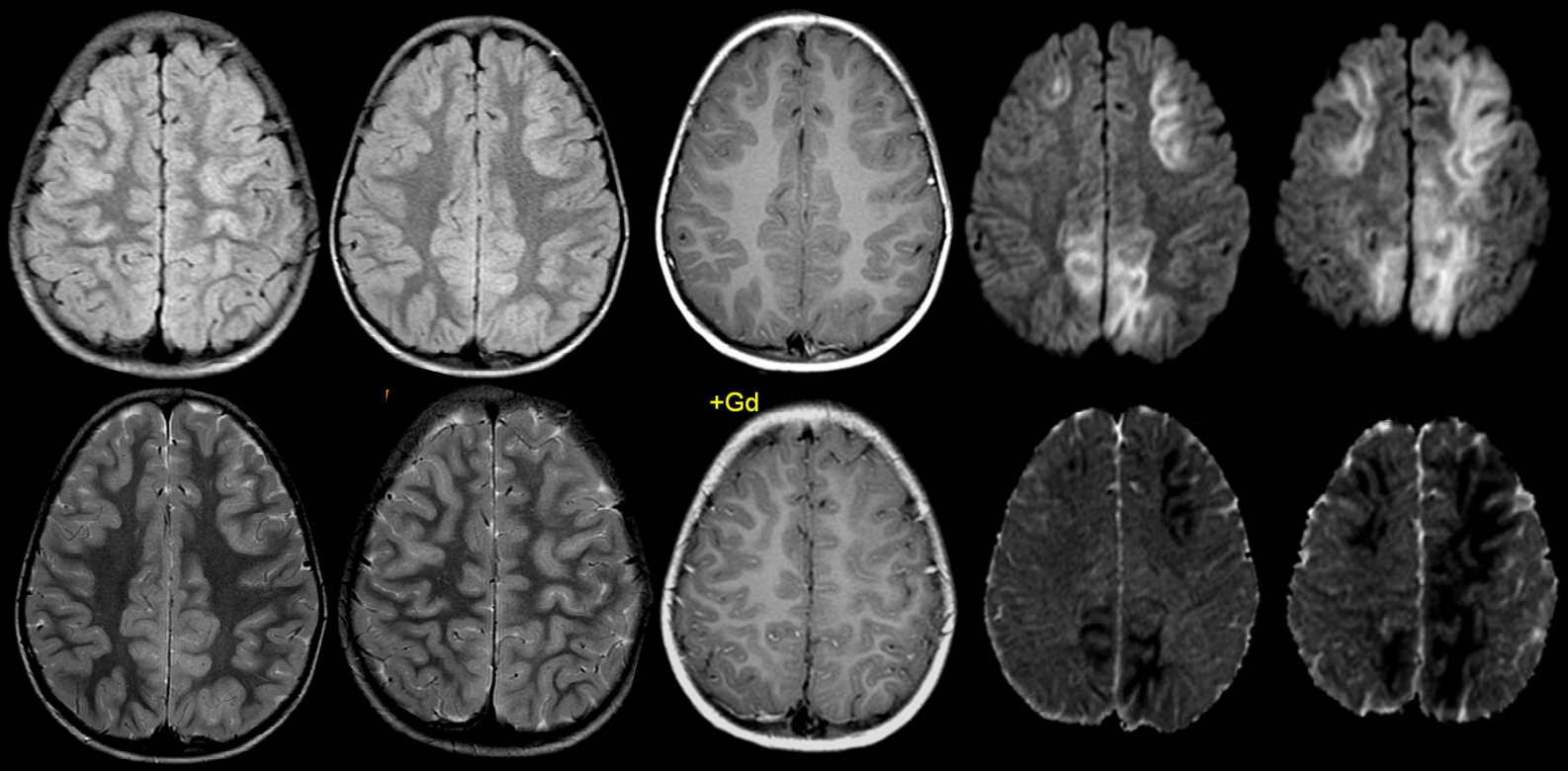
Pediatric Encephalitis

- One of the most challenging illness in medicine
- There are more than 100 different etiologies that can lead to encephalitis in children (infectious vs autoimmune)
- The majority of patients lack an identified etiology
- Few specific diagnostic tests:
  - EEG
  - CSF
  - PCR & serology
  - Neuroimaging

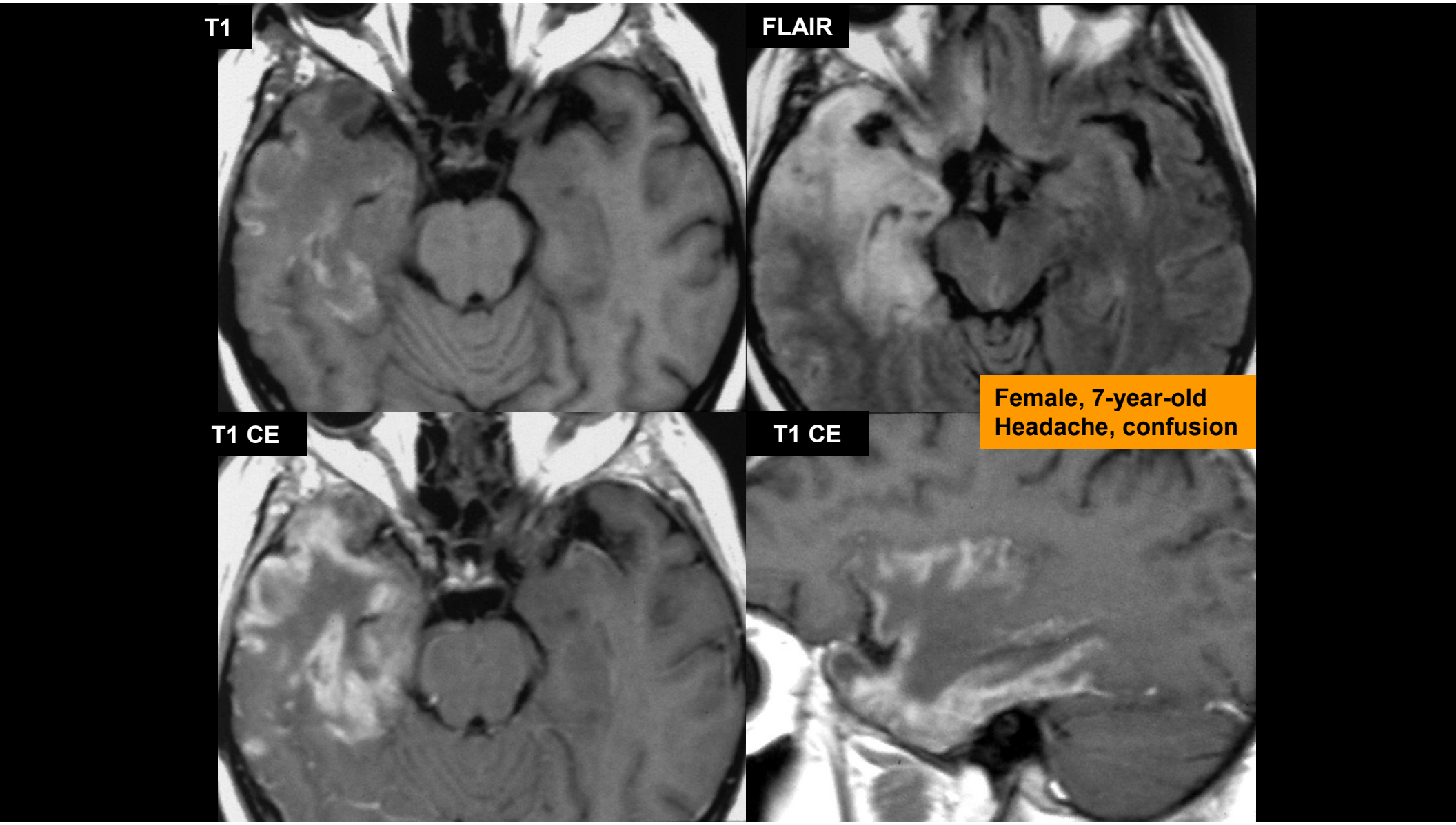
Erickson TA, et al. Infectious and Autoimmune Causes of Encephalitis in Children. Pediatrics. 2020;145:e20192543

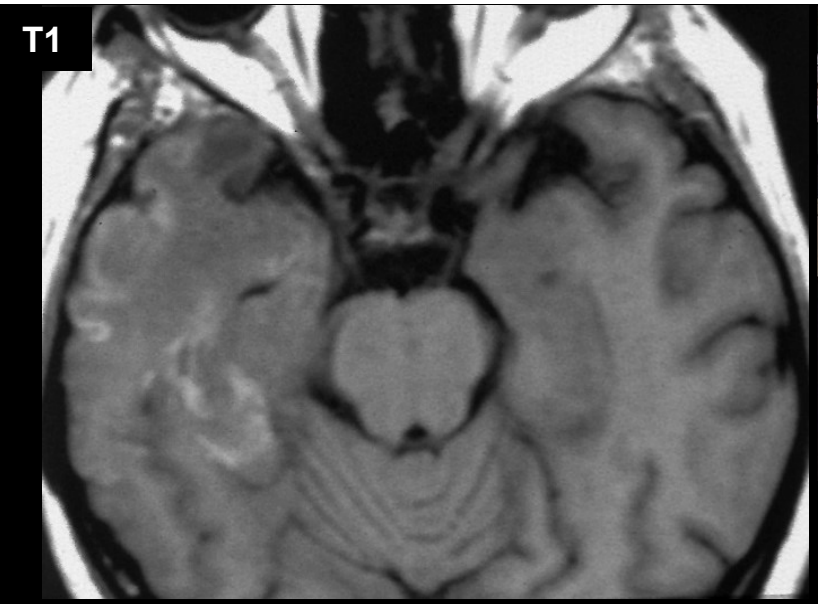


MRI in pediatric encephalitis



Asymmetric involvement of the cerebral cortex
DWI is more conspicuous in the early stages of the disease

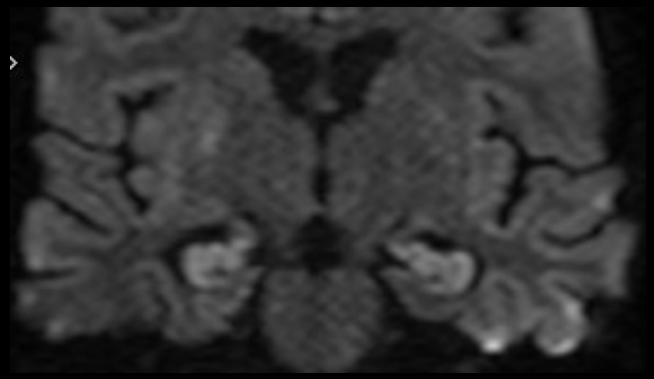

T1
FLAIR
T1 CE
T1 CE
Female, 7-year-old
Headache, confusion

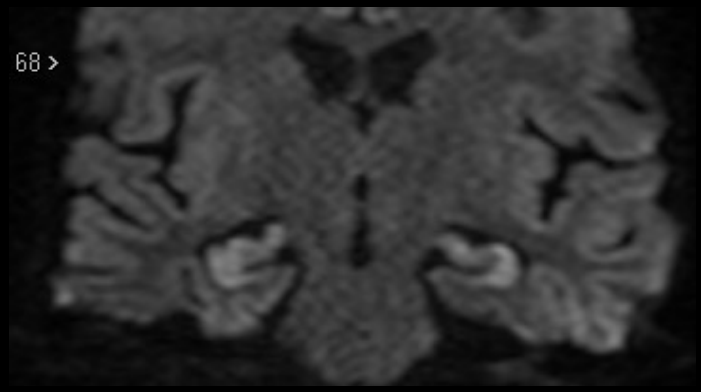


HSV-1 encephalitis

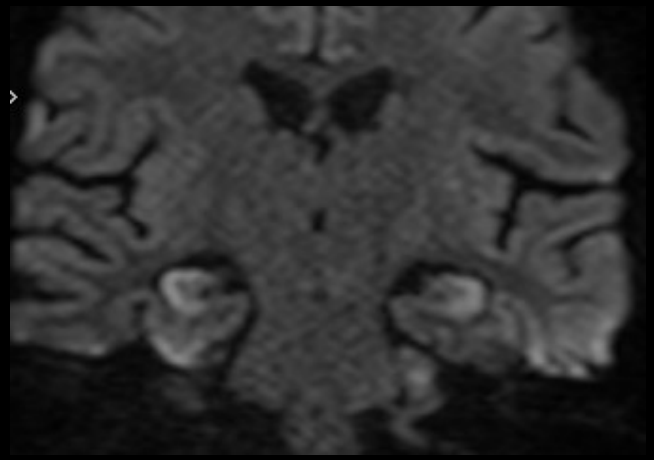
- Usually presents with nonspecific symptoms
- MR imaging usually shows a hemorrhagic process, which often involves the medial temporal lobes, inferior frontal lobes, and insula
- Imaging often displays unilateral findings, but the disease can spread to the contralateral side

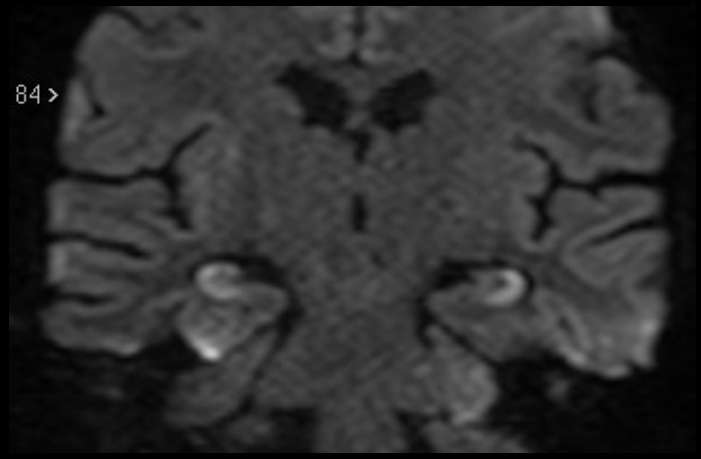
Leonard JR, et al. AJR Am J Roentgenol. 2000;174:1651-5

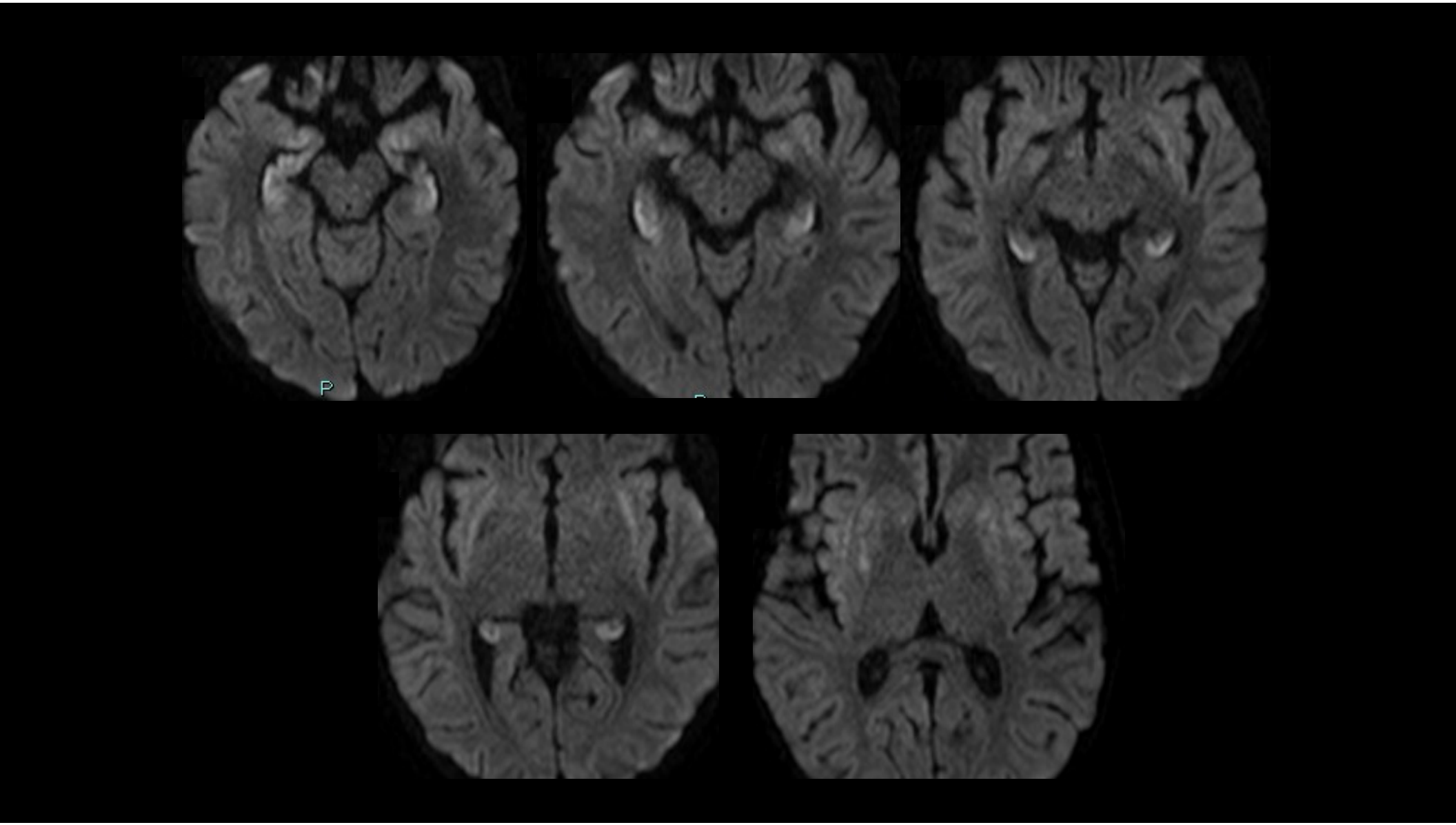




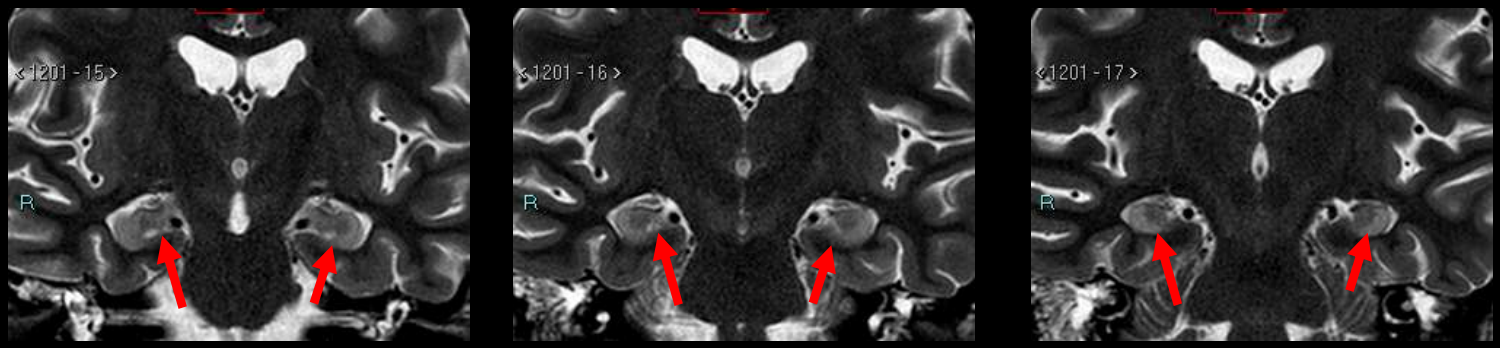
Female, 13-year-old, aplastic anemia/bone marrow transplantation, acute clinical onset, confusion ➡ status epilepticus



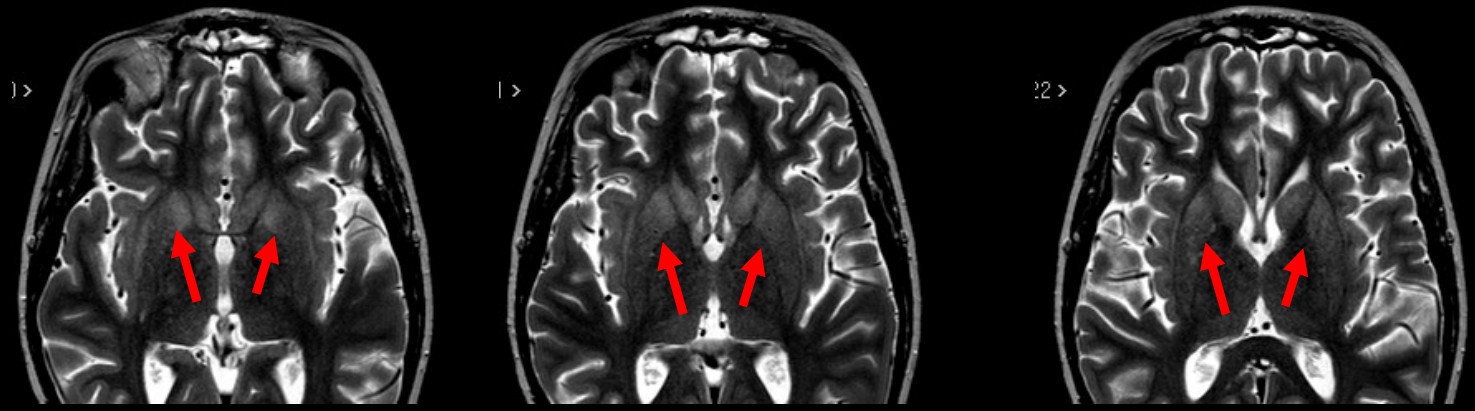



P

Post-transplant HHV6 limbic encephalitis



MRI typically shows bilateral signal abnormalities in the limbic system …" This complication is considered to represent acute encephalitis caused by direct virally induced damage to the central nervous system, but our understanding of the etiologies and pathogenesis is still limited." (Bone Marrow Transplant. 2015 Aug;50:1030-6)



Acute Disseminated Encephalomyelitis

1) First polyfocal, clinical CNS event with presumed inflammatory demyelinating cause
2) Accompanied by **encephalopathy** (defined as altered behavior or consciousness) that cannot be explained by fever
3) Brain MRI is abnormal during the acute (3-month) phase
4) Typically on brain MRI:
   - Diffuse, poorly demarcated, large (>1–2 cm) lesions involving predominantly the cerebral white matter
   - T1 hypointense lesions in the white matter are rare
   - Deep gray matter lesions (e.g. thalamus or basal ganglia) can be present
5) No new clinical and MRI findings emerge three months or more after the onset

International Pediatric Multiple Sclerosis Study Group criteria for pediatric multiple sclerosis and immune-mediated central nervous system demyelinating disorders: revisions to the 2007 definitions

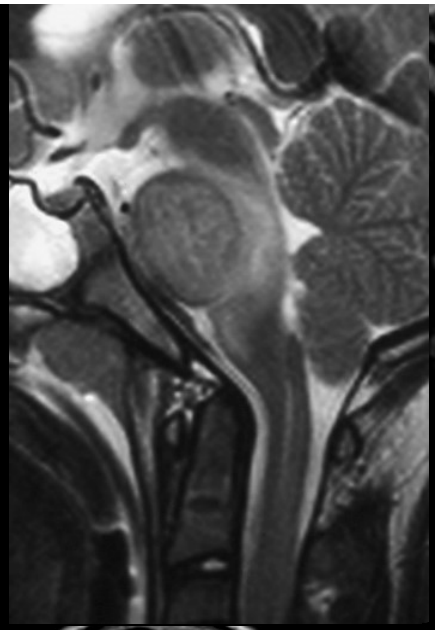
Multiple Sclerosis Journal
19(10) 1261–1267

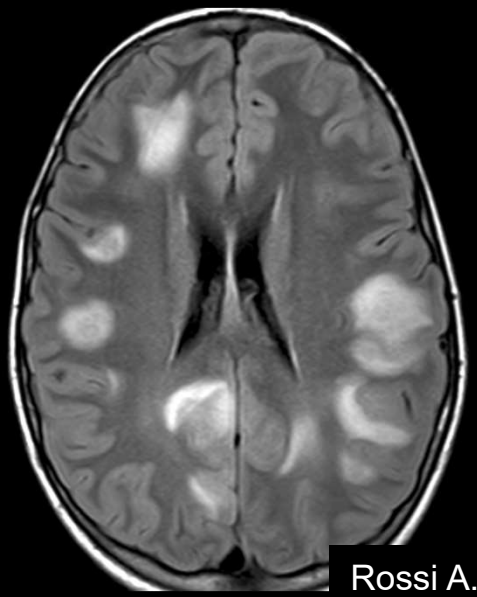
DOI: 10.1177/1352458513484547
msj.sagepub.com
SAGE

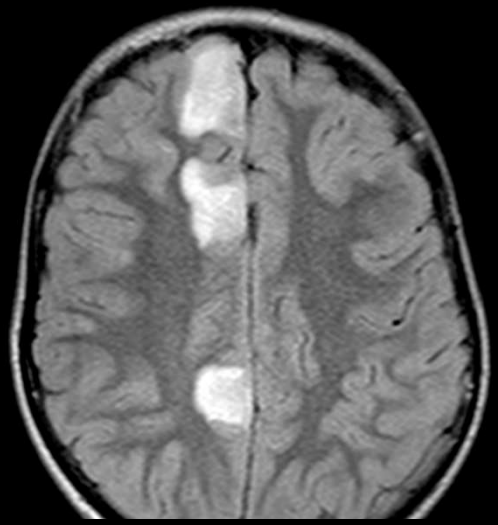
Lauren B Krupp[1*], Marc Tardieu[2*], Maria Pia Amato[3], Brenda Banwell[4], Tanuja Chitnis[5], Russell C Dale[6], Angelo Ghezzi[7], Rogier Hintzen[8], Andrew Kornberg[9], Daniela Pohl[10], Kevin Rostasy[11], Silvia Tenembaum[12] and Evangeline Wassmer[13] for the International Pediatric Multiple Sclerosis Study Group

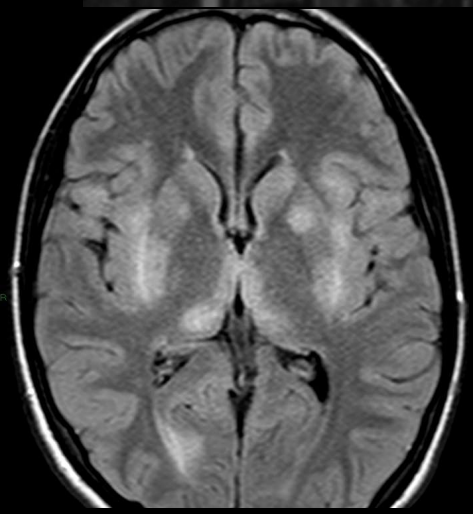
ADEM: imaging patterns

- Prevailing white matter
- Cortico/juxtacortical
- Deep gray matter nuclei *often symmetric*
- Posterior fossa *tumefactive brainstem lesions*
- Spinal cord *40% of cases*

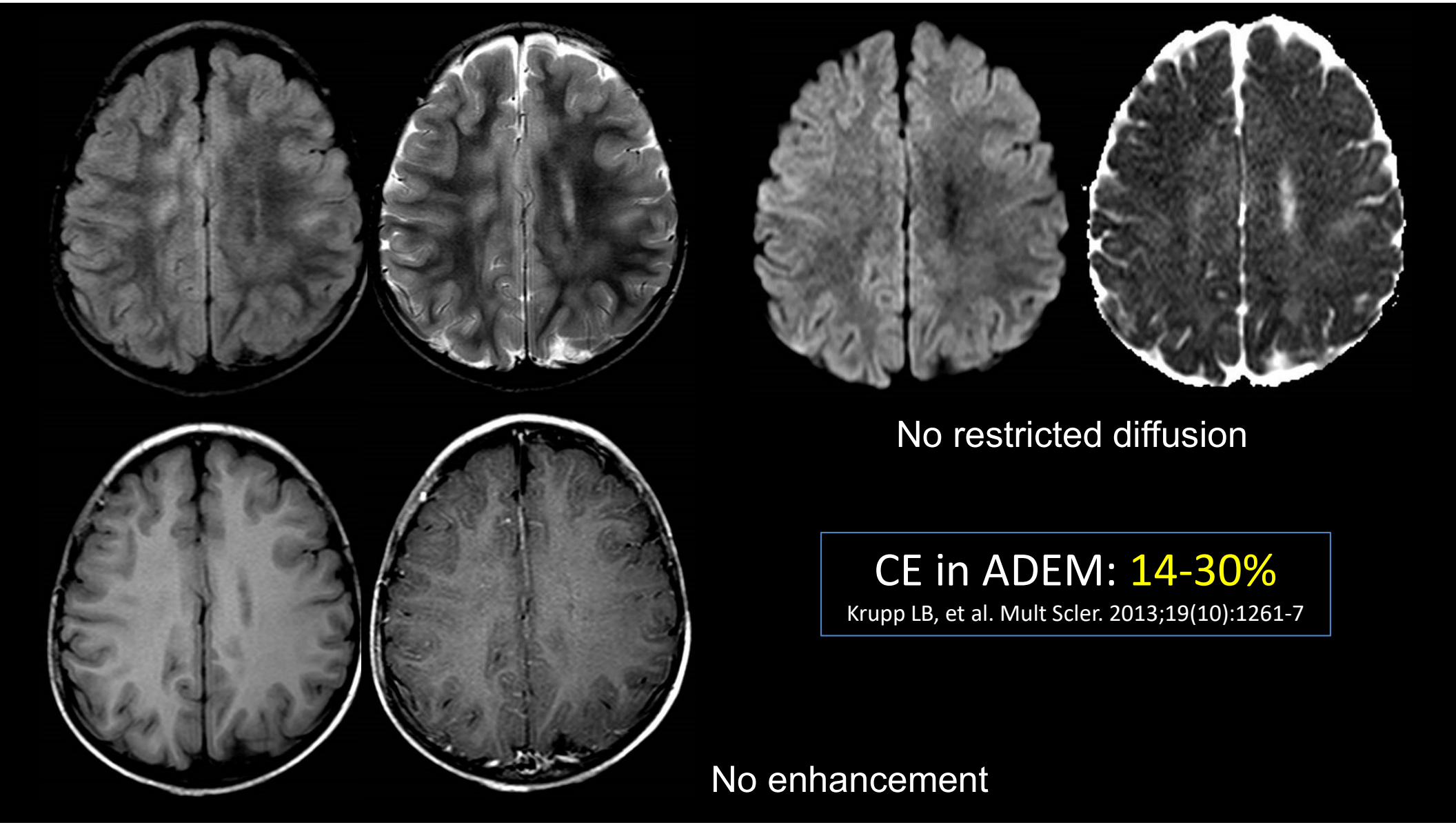


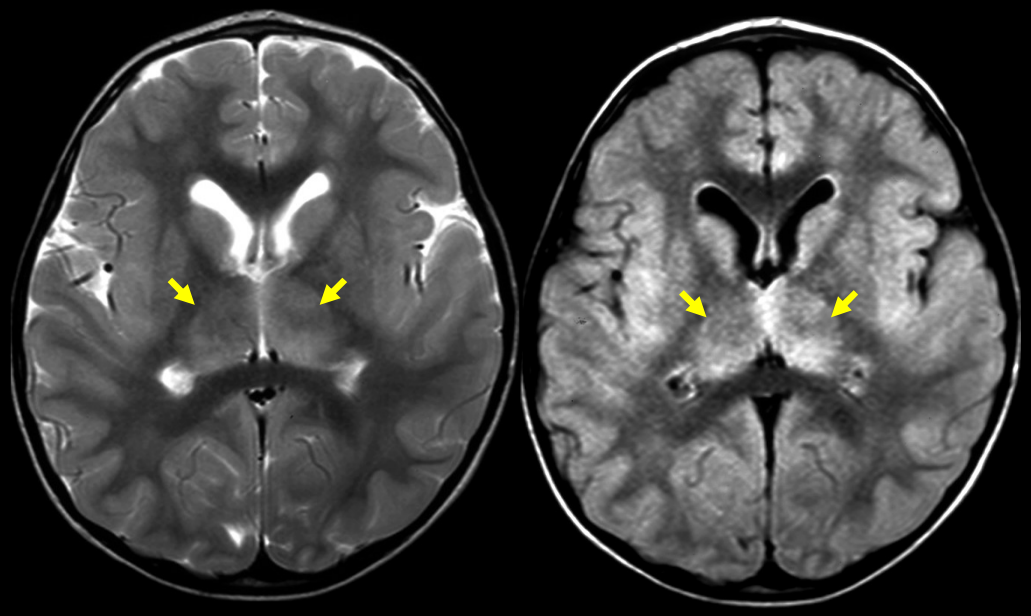






Rossi A. Imaging of acute disseminated encephalomyelitis. Neuroimaging Clin N Am. 2008 Feb;18(1):149-61

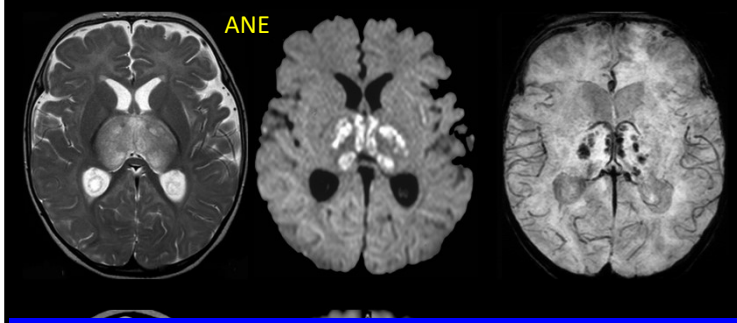

No restricted diffusion
CE in ADEM: 14-30%
Krupp LB, et al. Mult Scler. 2013;19(10):1261-7
No enhancement



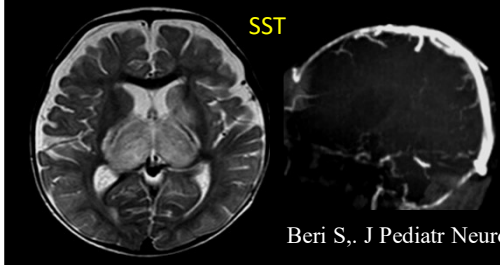
“Bithalamic ADEM”

12% of ADEM cases

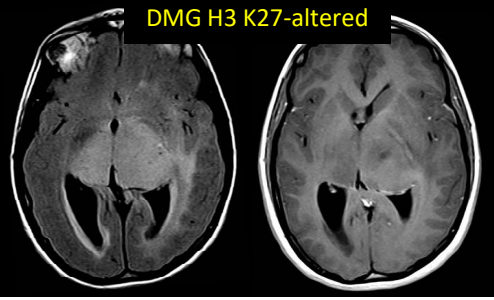
Tenembaum S,et al. Acute disseminated encephalomyelitis: a long-term follow-up study of 84 pediatric patients. Neurology. 2002;59:1224-31



Rapidly progressing encephalopathy triggered by acute febrile diseases, mostly viral infection/ Intracranial “cytokine storm”



Beri S,. J Pediatr Neurosci. 2012;7:30-2

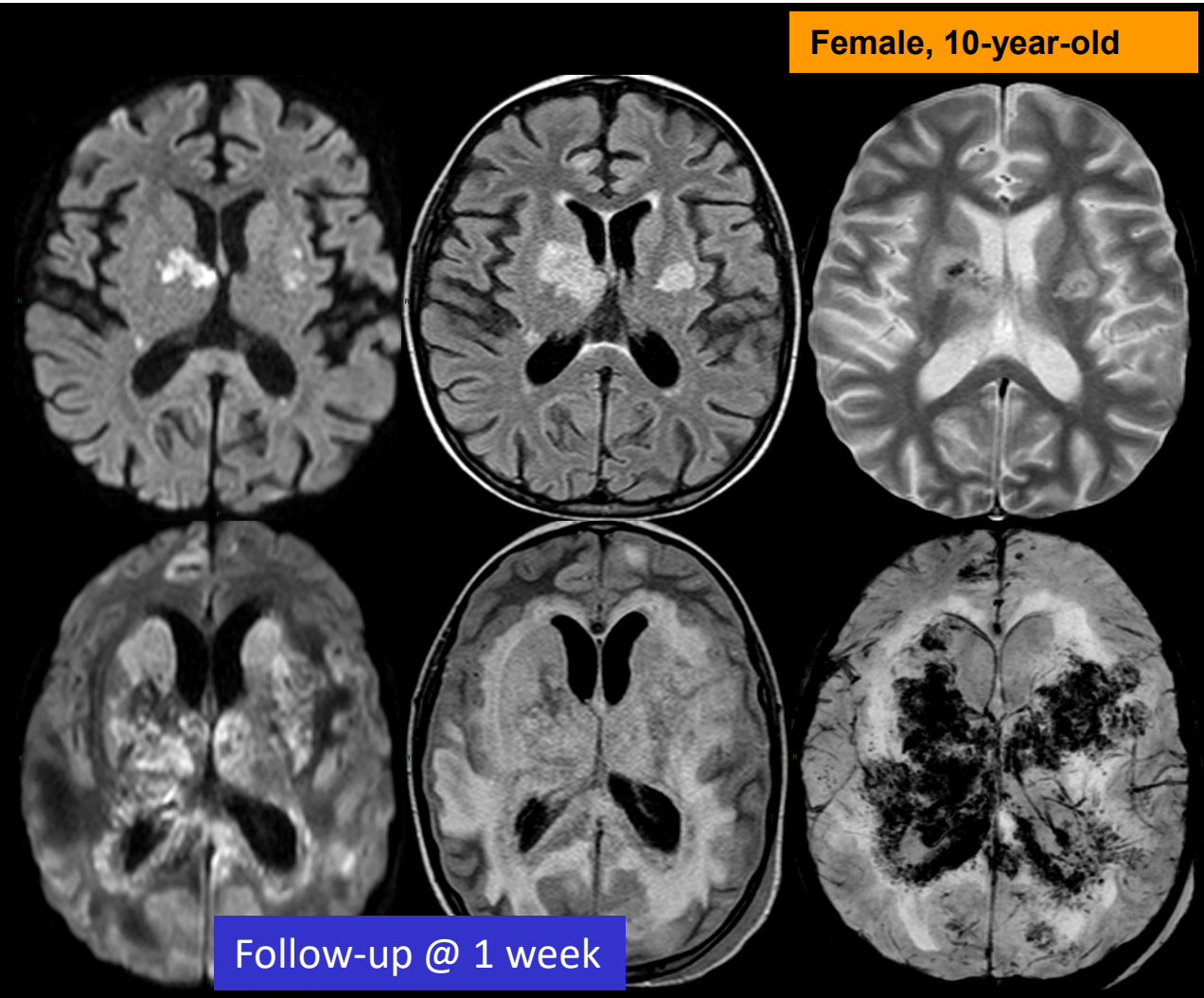


AHLE

Acute hemorrhagic leukoencephalitis
(Hurst encephalitis)

Rare, fulminant and fatal demyelinating disease, considered to be a rapidly progressive form of ADEM

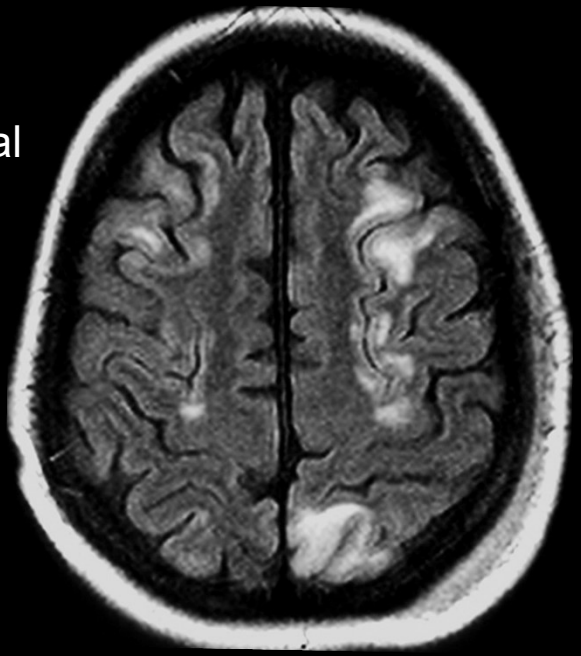
(Nabi S, et al. BMJ Case Rep.2016;2016:bcr2016217215)



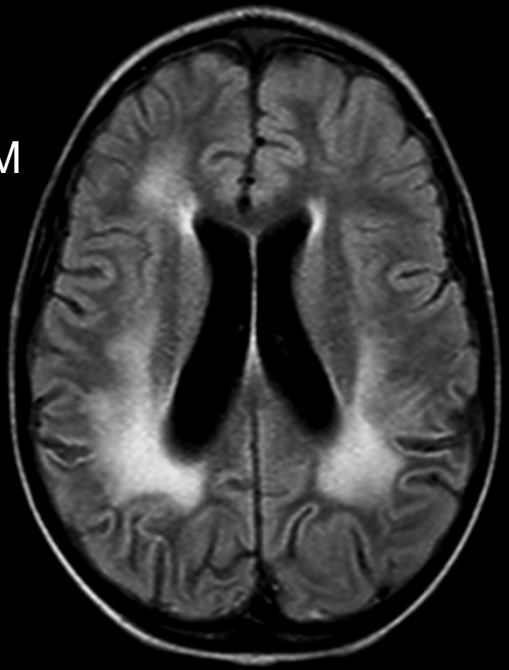
Drug induced encephalopathy

Can be determined by a wide and heterogeneous group of medications

Peripheral pattern
PRES

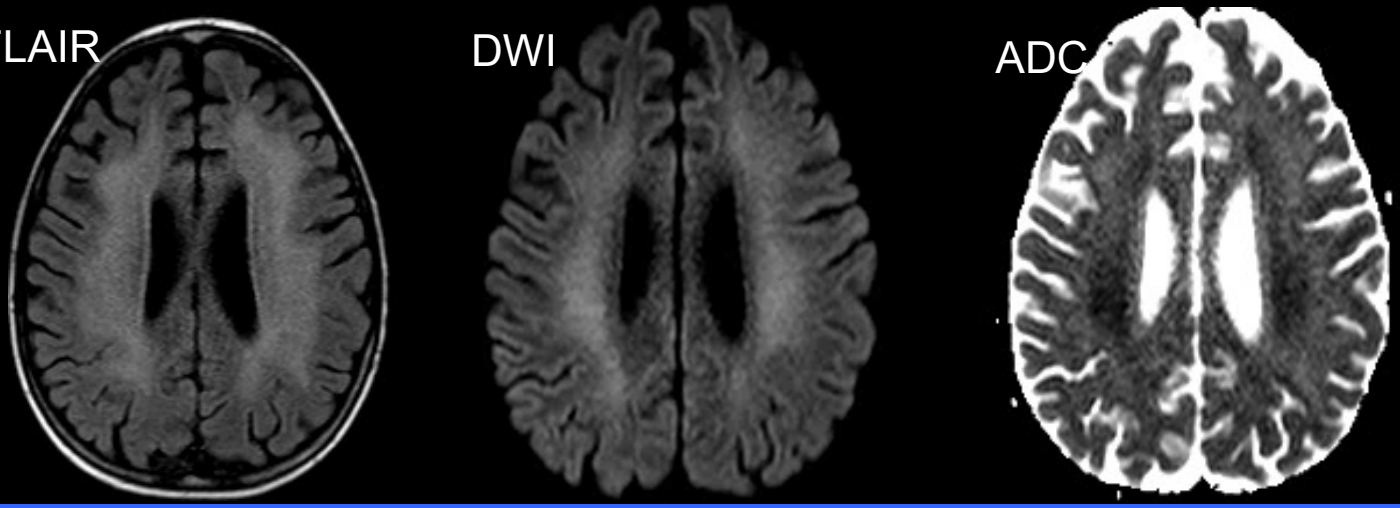


Central WM pattern
ATL



Acute toxic leukoencephalopathy

Central WM pattern



- Secondary to chemotherapy (MTX, fludarabine, doxorubicin, etc) and immunosuppresive agents (cyclosporine, tacrolimus, etc)
- Acute confusion, somnolence, generalized seizures, headache, vision impairment
- Good clinical and radiological outcome after drug withdrawal

The cause of restricted diffusion in ATL may arise from intramyelinic edema, cytotoxicity from capillary endothelial injury or direct toxic demyelination

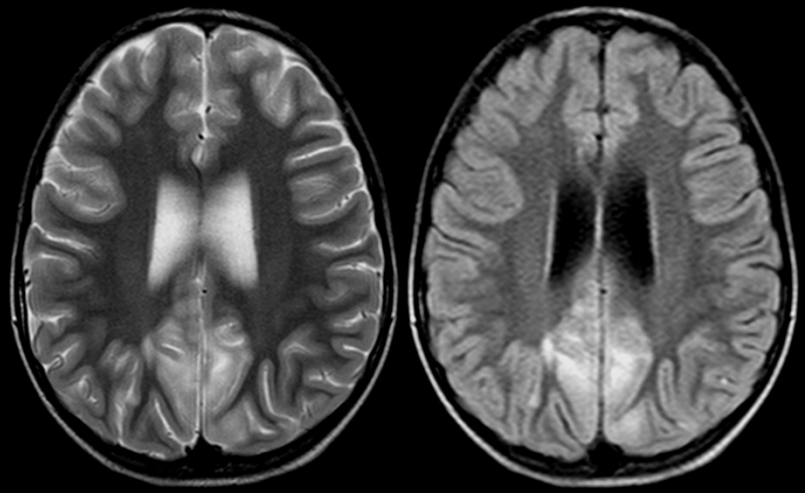
Iyer RS, et al. Medication neurotoxicity in children. Pediatr Radiol. 2011;41:1455-64

PRES: a clinico-neuroradiological syndrome

Peripheral pattern

- ✓ Headache
- ✓ Seizures (status epilepticus)
- ✓ Visual disturbances (cortical blindness)
- ✓ Confusion (coma)
- ✓ Latency: hours-months from drug administration

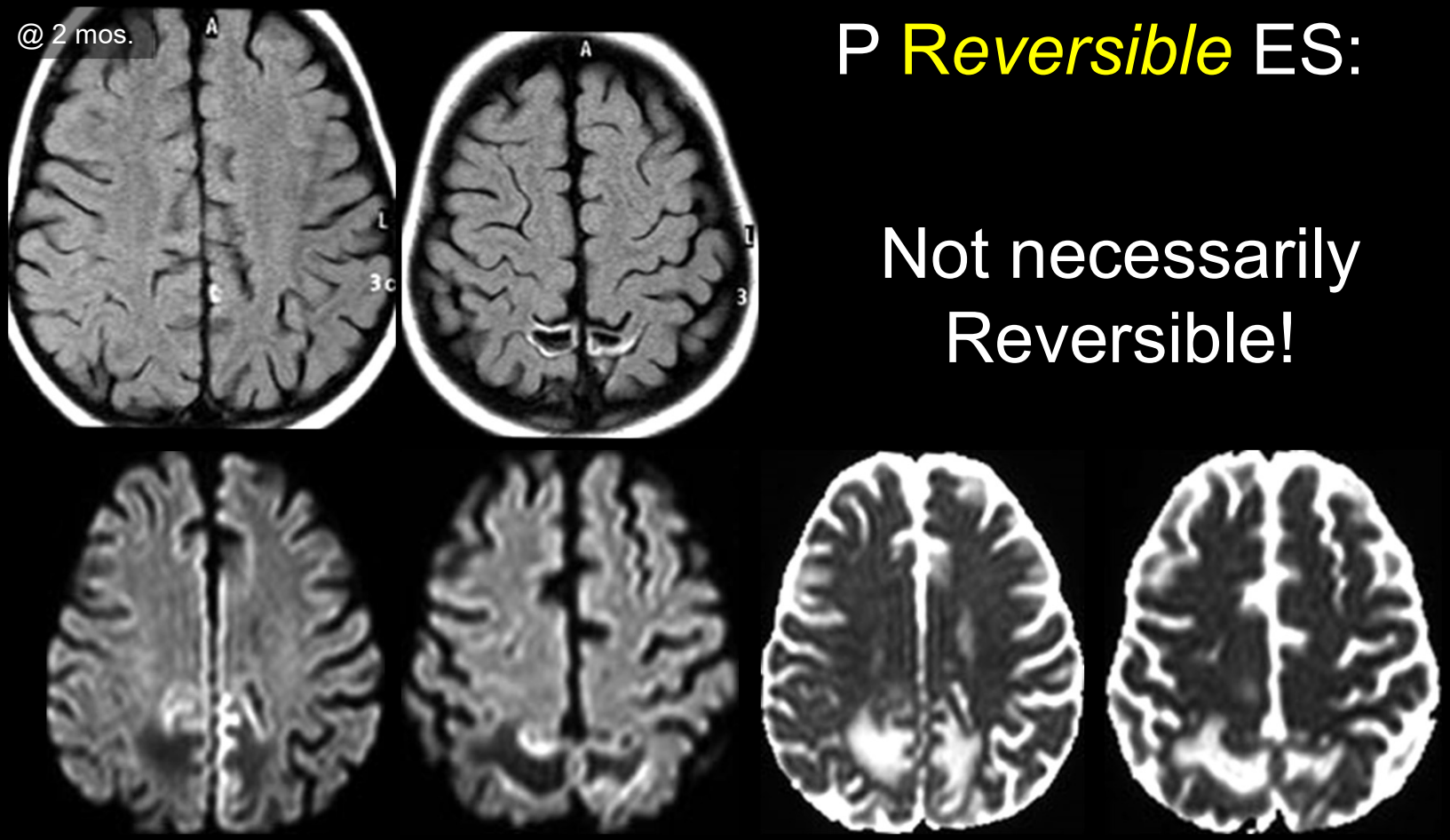
Typical MRI: predominant involvement of the posterior portions of the cerebral hemispheres, consistent with vasogenic edema



Reversibility of both clinical and MRI manifestations

Anderson RC, et al. Posterior Reversible Encephalopathy Syndrome (PRES): Pathophysiology and Neuro-Imaging. Front Neurol. 2020;11:463

PRES: “less typical” neuroradiological findings



P *Reversible* ES:

Not necessarily Reversible!

PRES: "less typical" neuroradiological findings

Haemorrhagic PRES

3 types of haemorrhage: minute, focal haematoma and subarachnoid

9-15% of patients with PRES had foci of intracranial hemorrhage

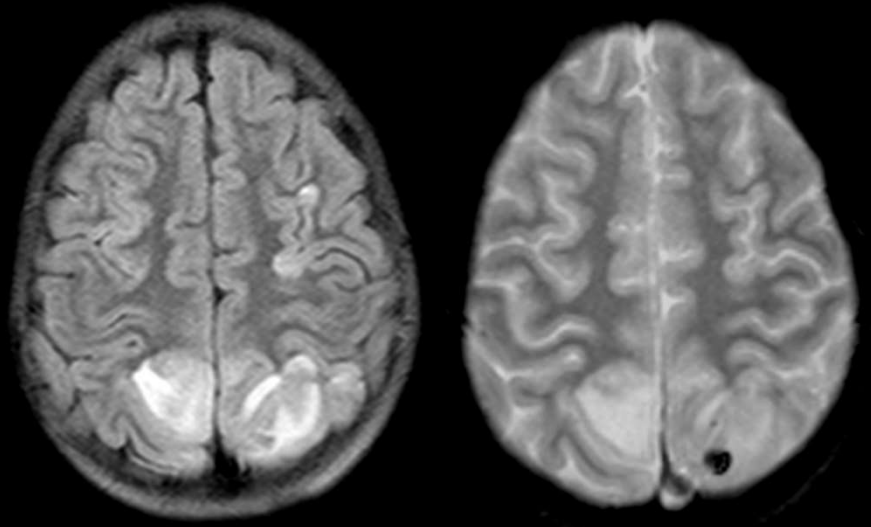
Covarrubias et al., *AJNR* 2002

Hefzy et al., *AJNR* 2009

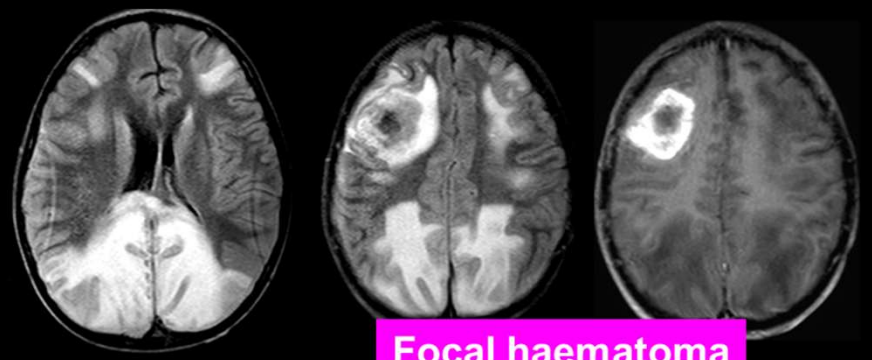
Endothelial damage

Fluid leakage

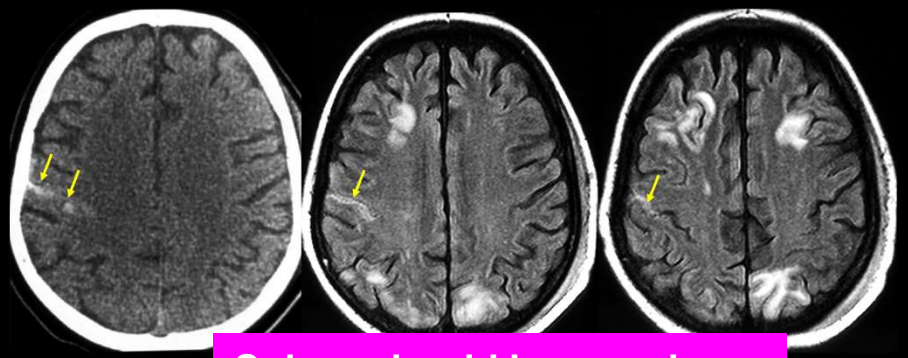
Blood leakage



Minute haemorrhage

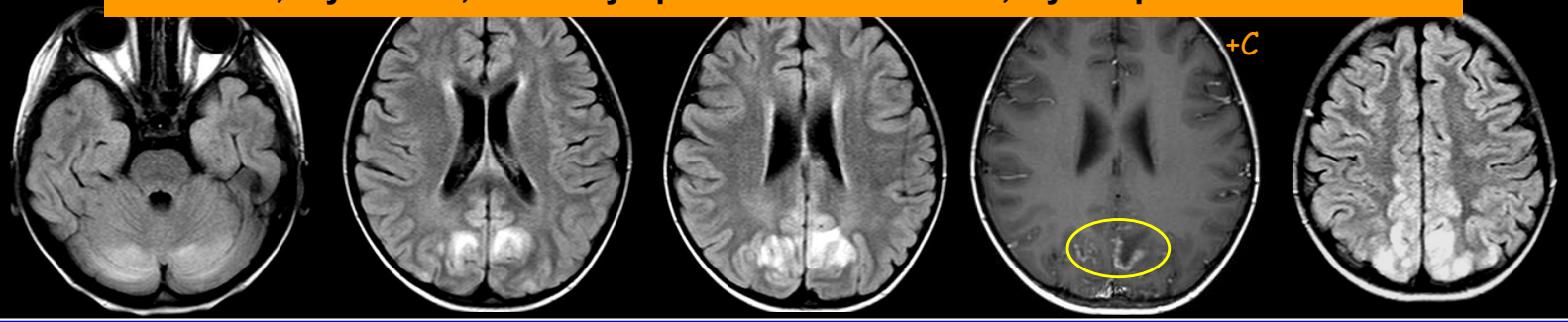


Focal haematoma



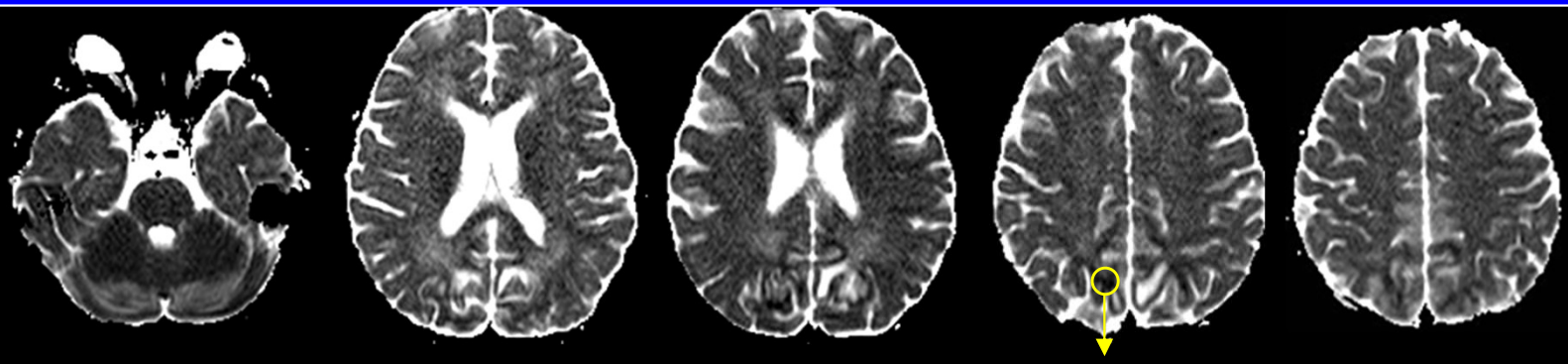
Subarachnoid haemorrhage

Female, 7-year-old, Acute Lymphoblastic Leukemia, Cyclosporine treatment

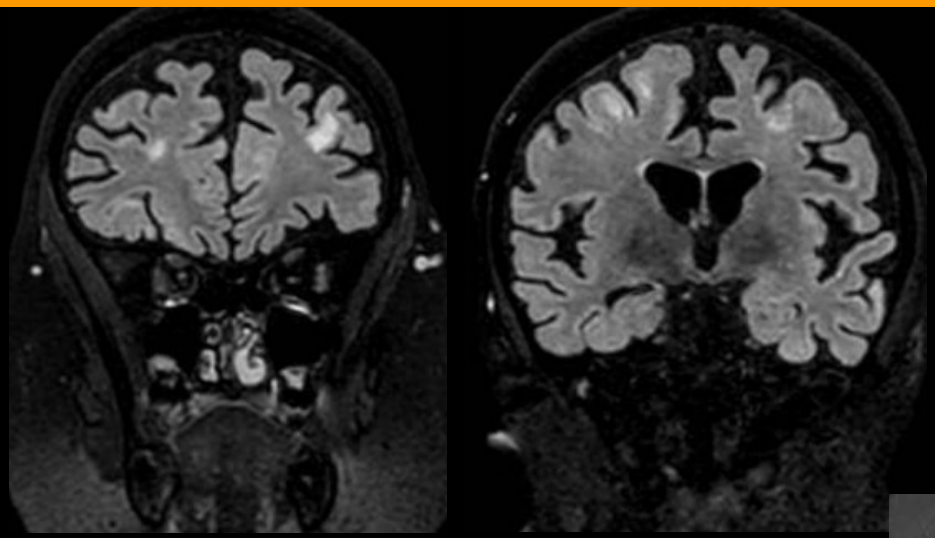


- Contrast-Enhancement (37-43%): cortical, leptomeningeal, parenchymal or pachymeningeal
- Restricted diffusion (17-22%)

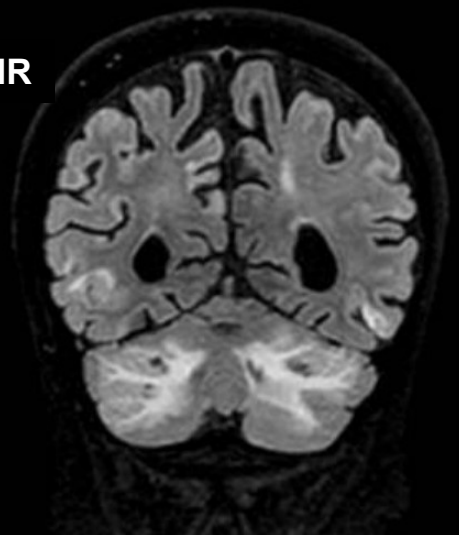
Saad AF, et al. Imaging of Atypical and Complicated Posterior Reversible Encephalopathy Syndrome. Front Neurol. 2019 Sep 4;10:964

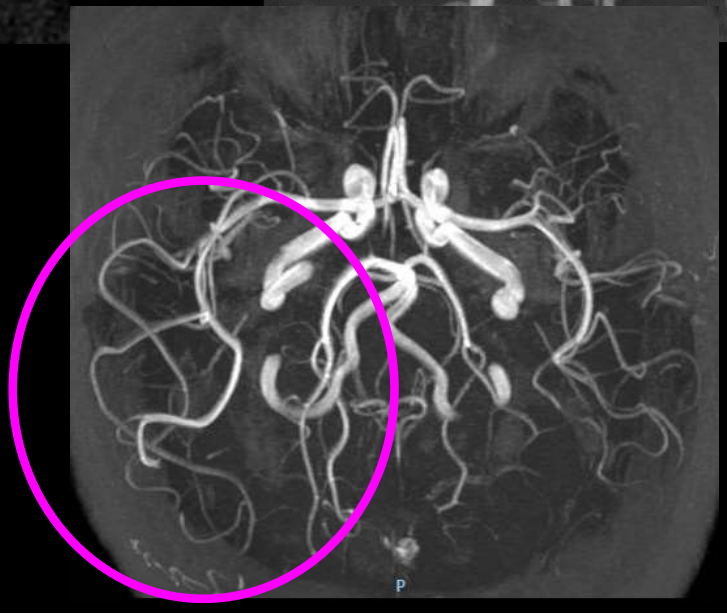


Female, 9-year-old, Acute Lymphoblastic Leukemia, impairment of consciousness, seizures, CsA treatment

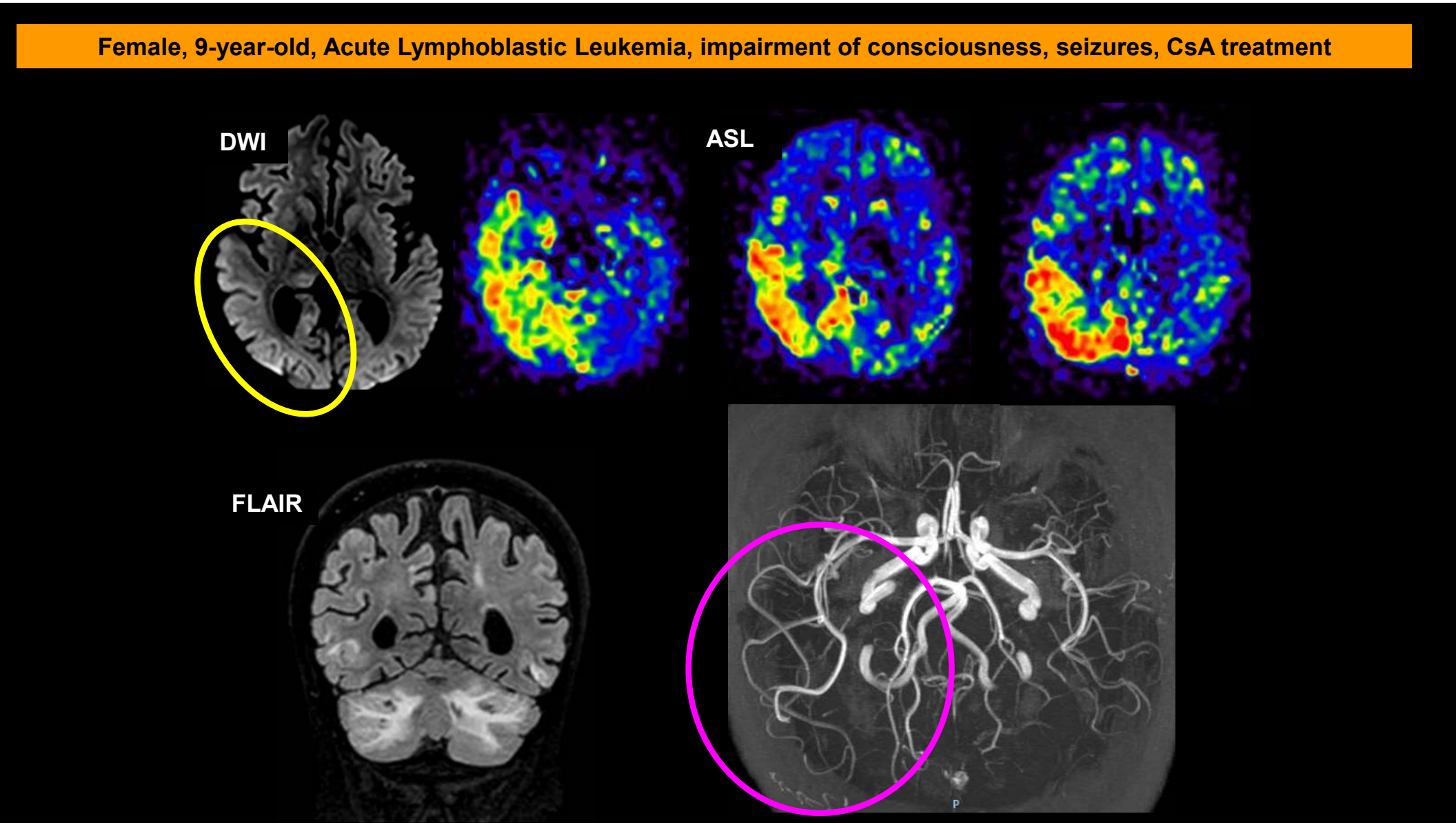


FLAIR





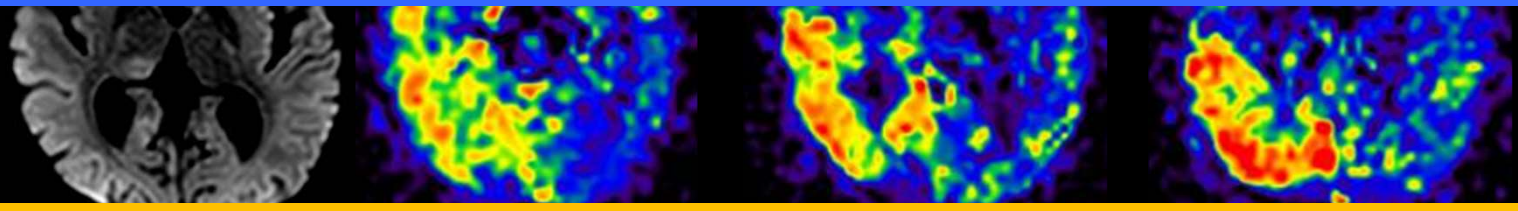
Female, 9-year-old, Acute Lymphoblastic Leukemia, impairment of consciousness, seizures, CsA treatment



PRES and seizure-induced changes

Coexisting thalamic abnormalities in seizure patients are likely the result of excessive activity in the thalamic nuclei having reciprocal connections with the affected cerebral cortex

Kim NY et al. Investigative Magnetic Resonance Imaging 2017;21:82-90



uncoupling between metabolism and circulation

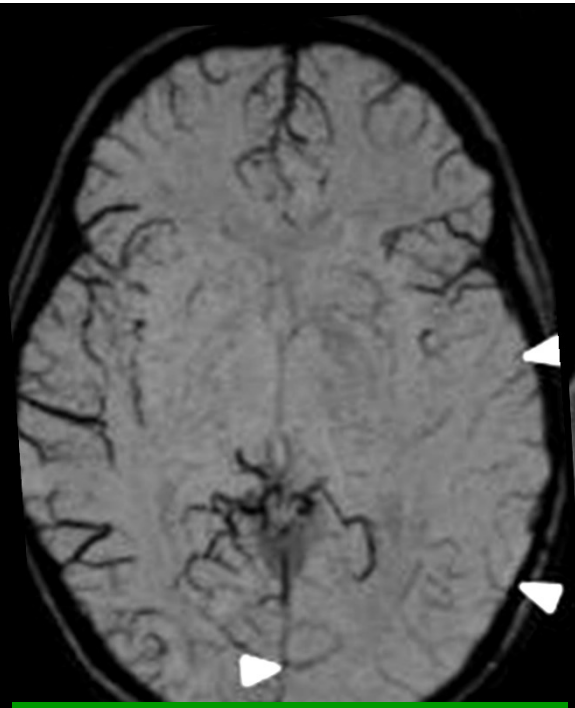
- During ictal period the activated cortex exhibits increased glucose and oxygen usage, thereby causing compensatory regional hyperperfusion.
- When this hyperperfusion is no longer sufficient to supply the hyperactive cortical area with the induction of glutamate excitotoxity, pathophysiological changes leading to cytotoxic edema in epileptic cortical neurons can occur [uncoupling between metabolism and circulation].
- Such “ictal” MRI findings on ASL/DWI can persist during peri-ictal period

eNeurologicalSci. 2018 Jun 26;12:5-18. doi: 10.1016/j.ensci.2018.06.001. eCollection 2018 Sep.

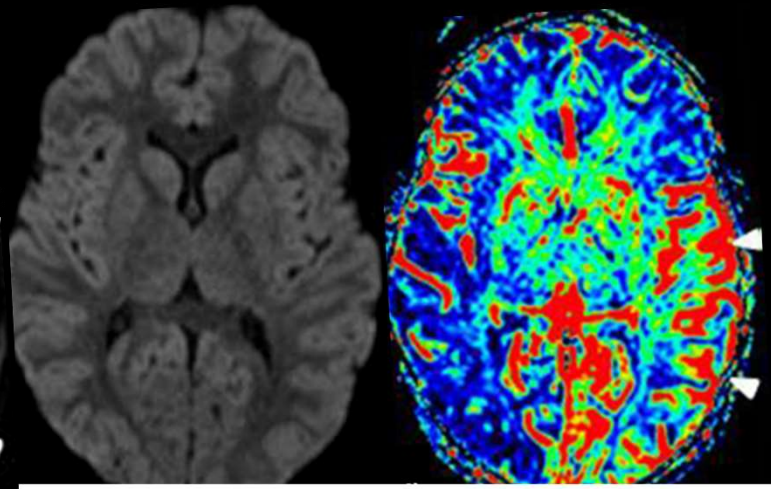
Hemodynamic state of periictal hyperperfusion revealed by arterial spin-labeling perfusion MR images with dual postlabeling delay.

Takahara K[1,2], Morioka T[1,3], Shimogawa T[1,2,3], Haga S[1], Kameda K[1], Arihiro S[4], Sakata A[5], Mukae N[2], Iihara K[2].

PERI-ICTAL CHANGES….THE OPPOSITE OF BRUSH SIGN



Pseudo-narrowed or pseudo-diminished cortical veins due to higher levels of oxygenated haemoglobin



Eur Radiol (2014) 24:2980–2988
DOI 10.1007/s00330-014-3284-9

MAGNETIC RESONANCE

Focal hemodynamic patterns of status epilepticus detected by susceptibility weighted imaging (SWI)

Jerome Aellen · Eugenio Abela · Sarah E. Buerki · Raimund Kottke · Elisabeth Springer ·

4-year-old girl with fever seizure and clinical status epilepticus

When the epileptic activity does not have enough intensity to induce the uncoupling, cortical hyperintensity is not found on DWI whereas ictal hyperperfusion is solely obtained

(Takahara K, et al. eNeurologicalSci. 2018;12:5-18)

“The SWI findings can be explained by a decreased amount of deoxygenated blood and therefore lowered paramagnetic properties due to hyperperfusion of the ictal region”

REGINA MARGHERITA CHILDREN'S HOSPITAL - TURIN

Acute Disseminated Encephalomyelitis

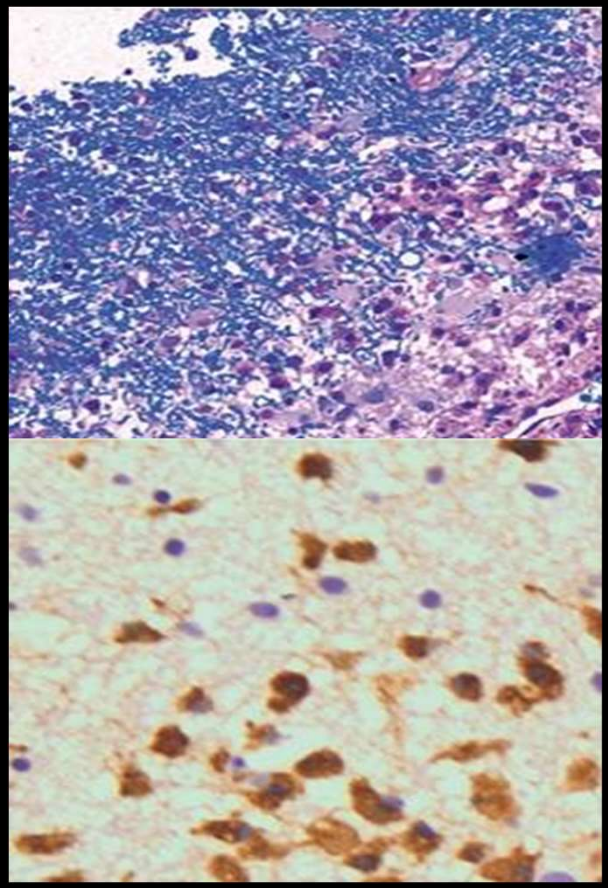
Immunomediate response (1-3 weeks latency) to:
Exanthematic diseases (measles, chickenpox)
Upper airway infections
Vaccination

Acute, monophasic, reversible (complete recovery in 70-90%)

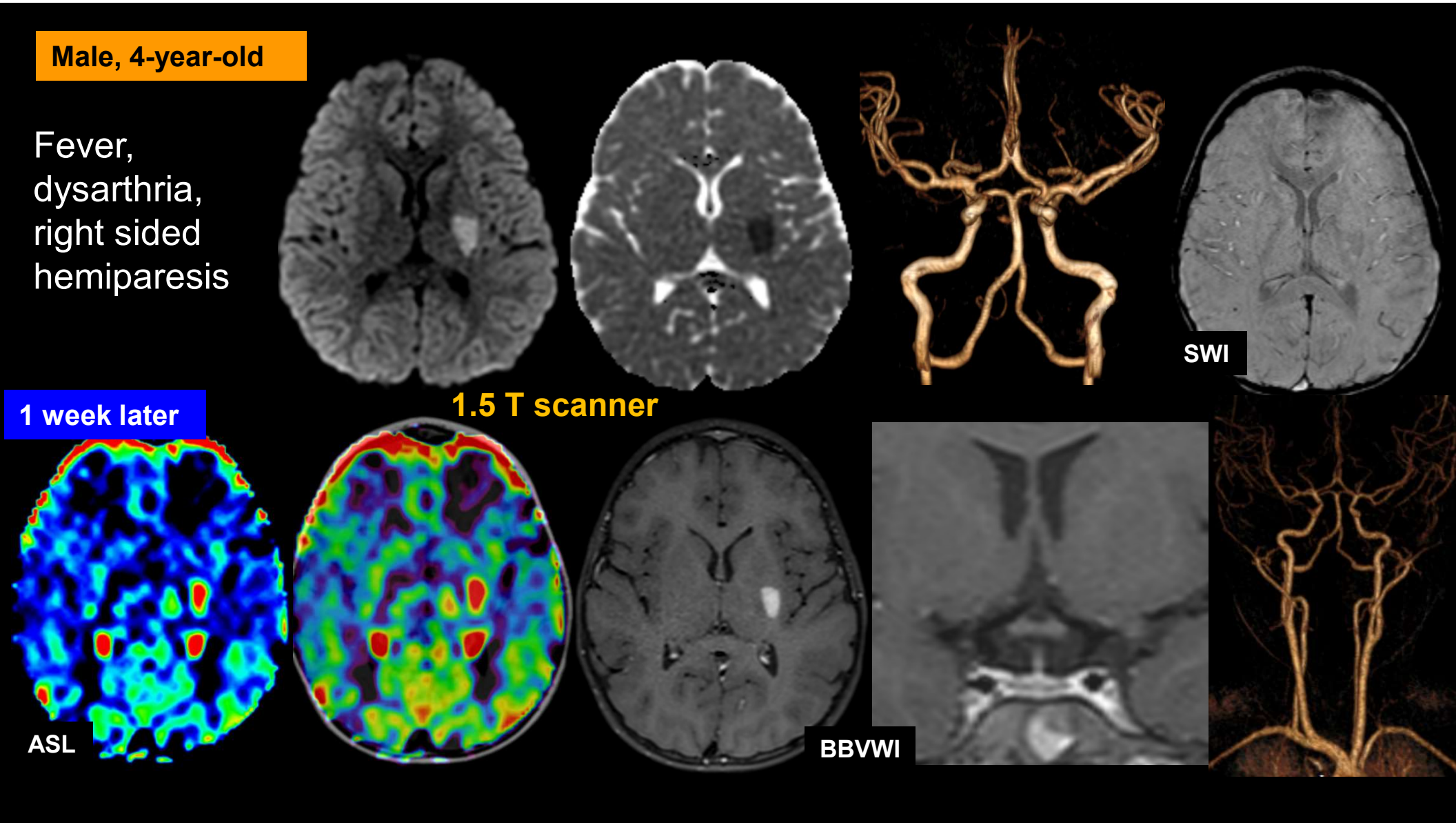
More common in pts < 10 yrs

Pathology: multifocal (ie, brain and spinal cord) perivenular demyelination and macrophage infiltration

- Tenembaum S, Chitnis T, Ness J, Hahn JS; International Pediatric MS Study Group. Acute disseminated encephalomyelitis. Neurology. 2007;68(16 Suppl 2):S23-36
- Rossi A. Imaging of acute disseminated encephalomyelitis. Neuroimaging Clin N Am. 2008;18:149-61



© Kuhlmann T et al, *Acta Neuropathol* 2008


Male, 4-year-old
Fever, dysarthria, right sided hemiparesis
1.5 T scanner
SWI
1 week later
ASL
BBVWI