*MR Imaging in Epilepsy

From Anatomical to Functional Imaging

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*Role of MR Imaging

*Identify underlying structural abnormalities that require specific treatments.

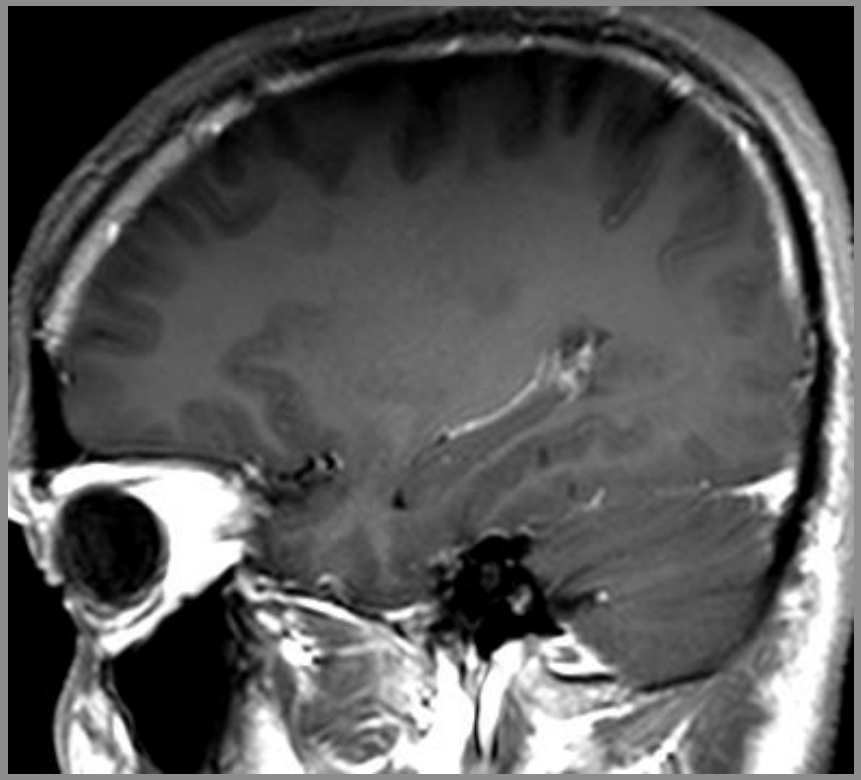
*Preoperative evaluation in epilepsy surgery.

*Epileptogenic substrates

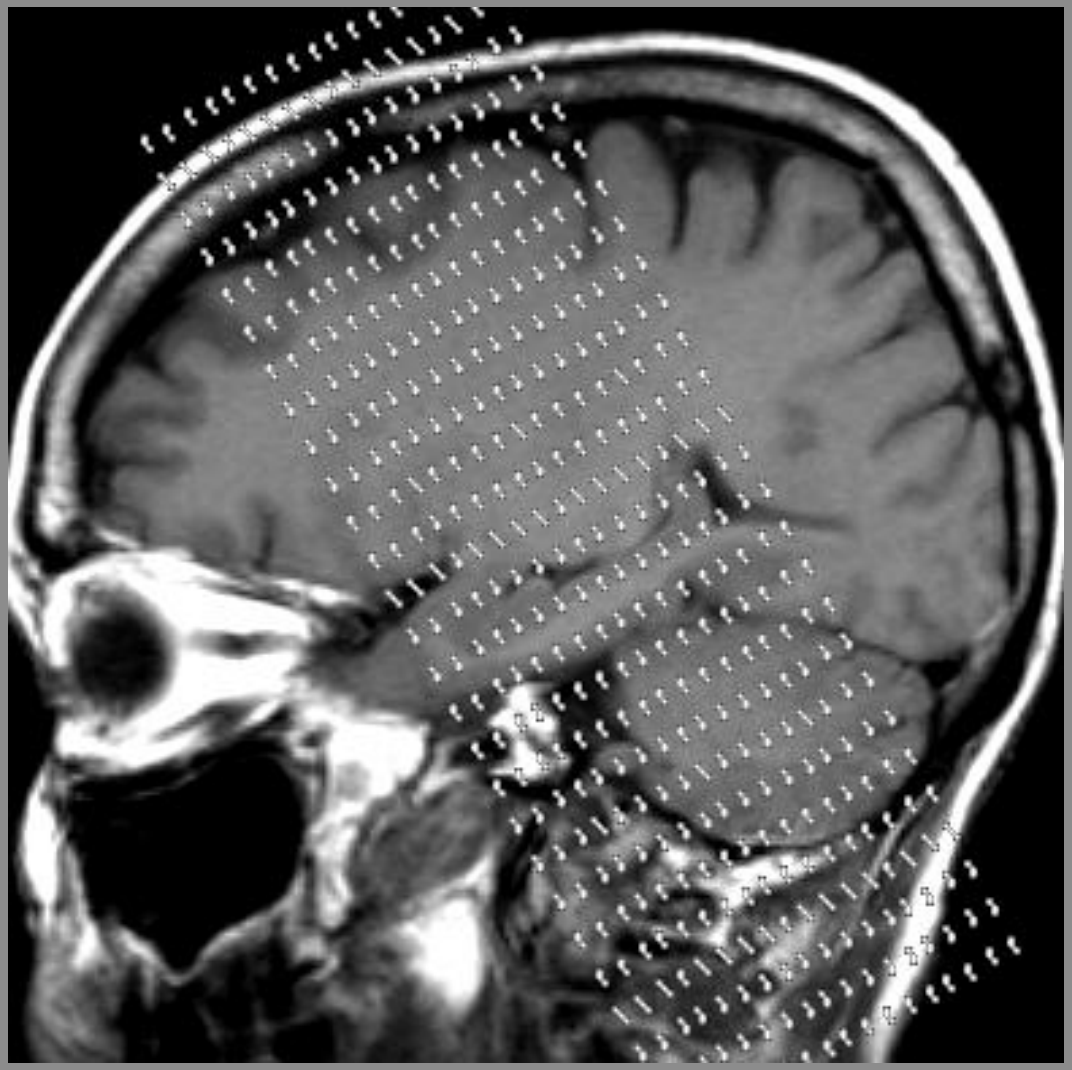
*Hippocampal sclerosis
*Malformation of cortical development
*Neoplasm
*Vascular malformation
*Gliosis and miscellaneous abnormalities

*Hippocampal Sclerosis

*Hippocampus

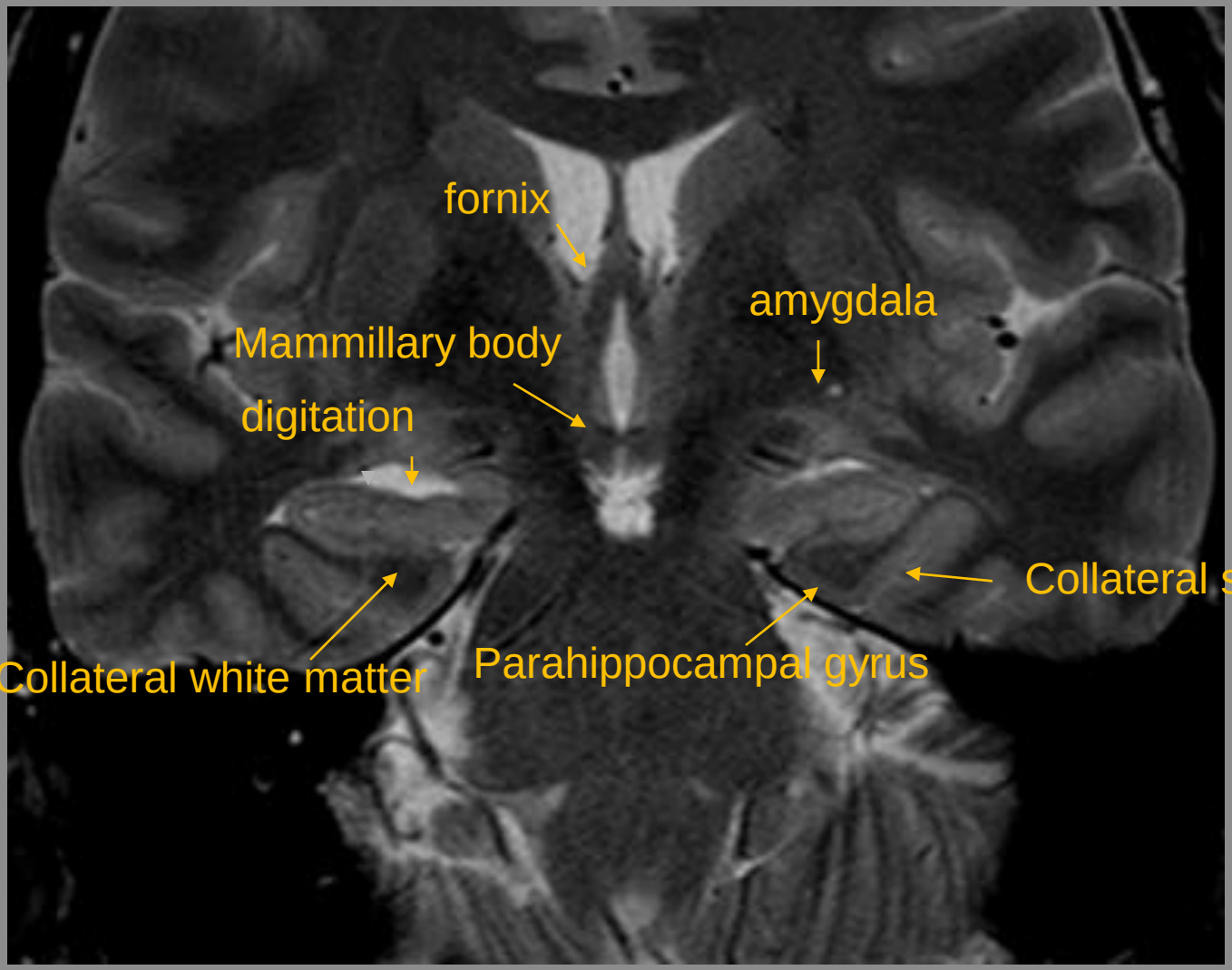


*Hippocampus



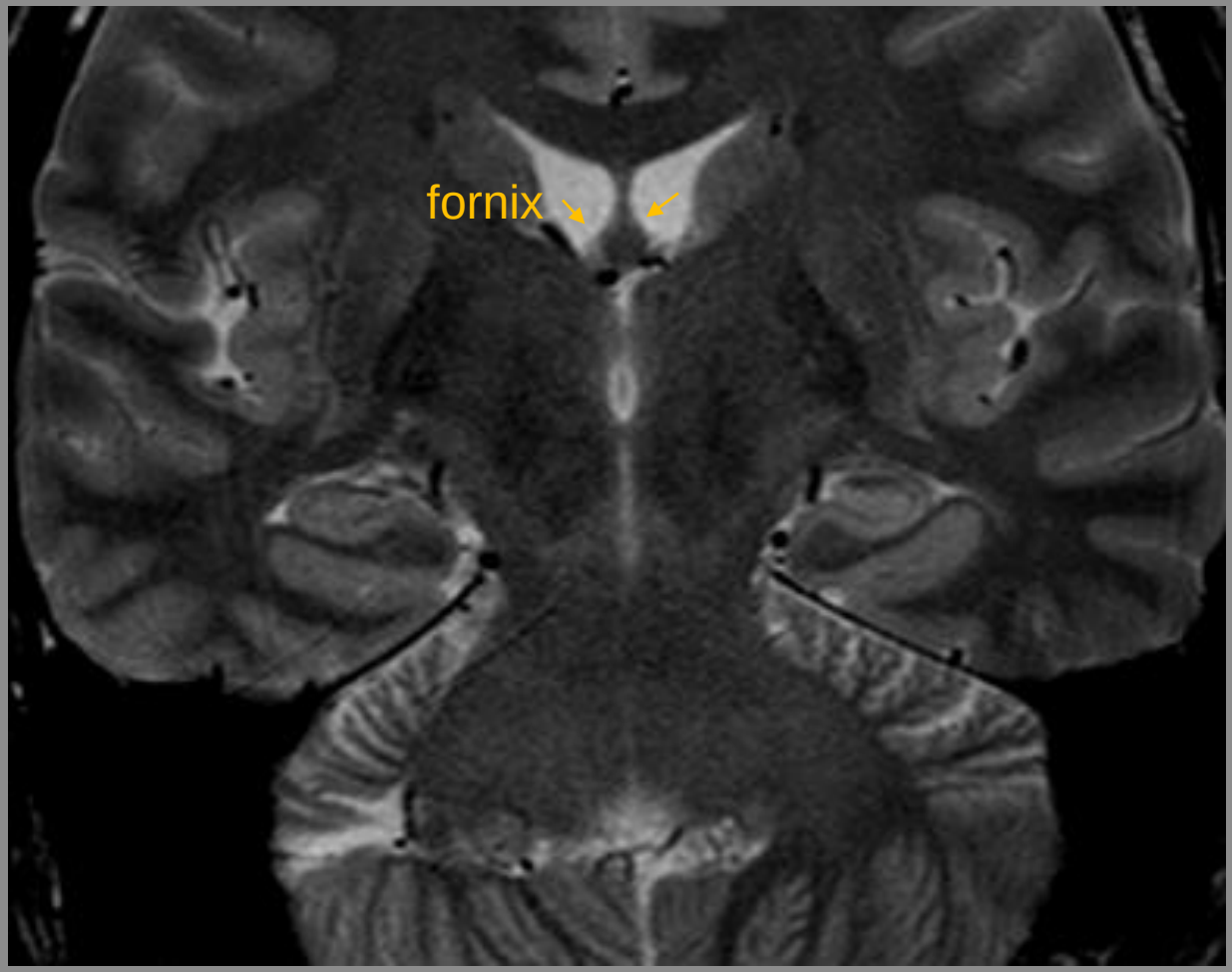
*Hippocampus

The head is not covered by choroid plexus and has digitations.



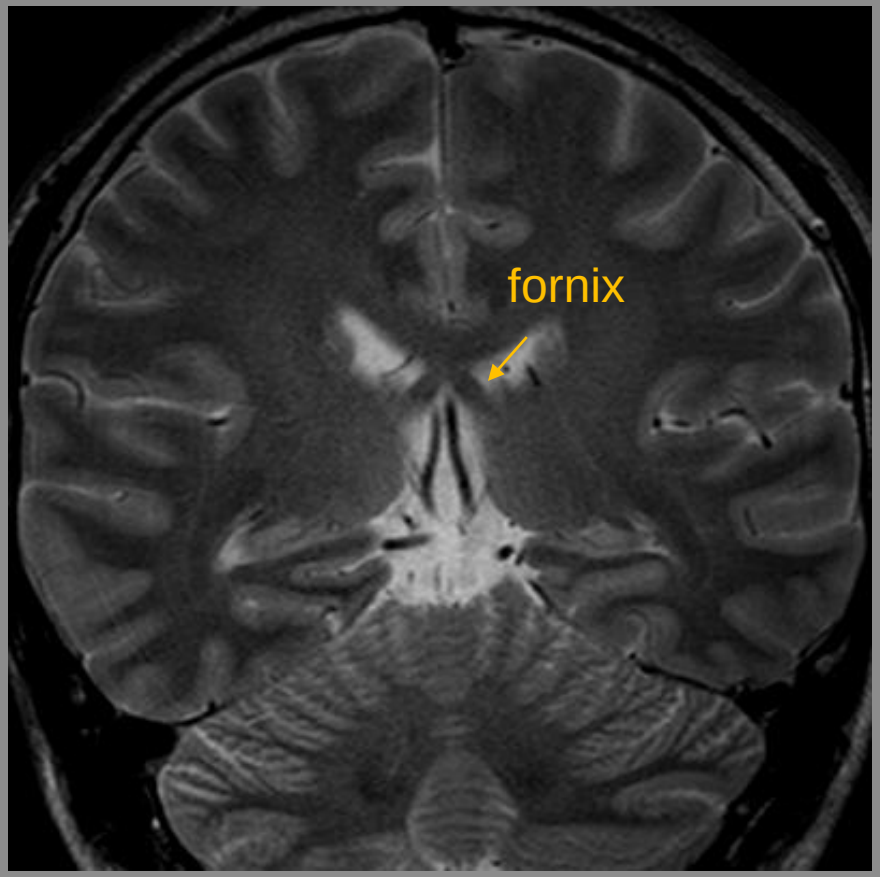
*Hippocampus

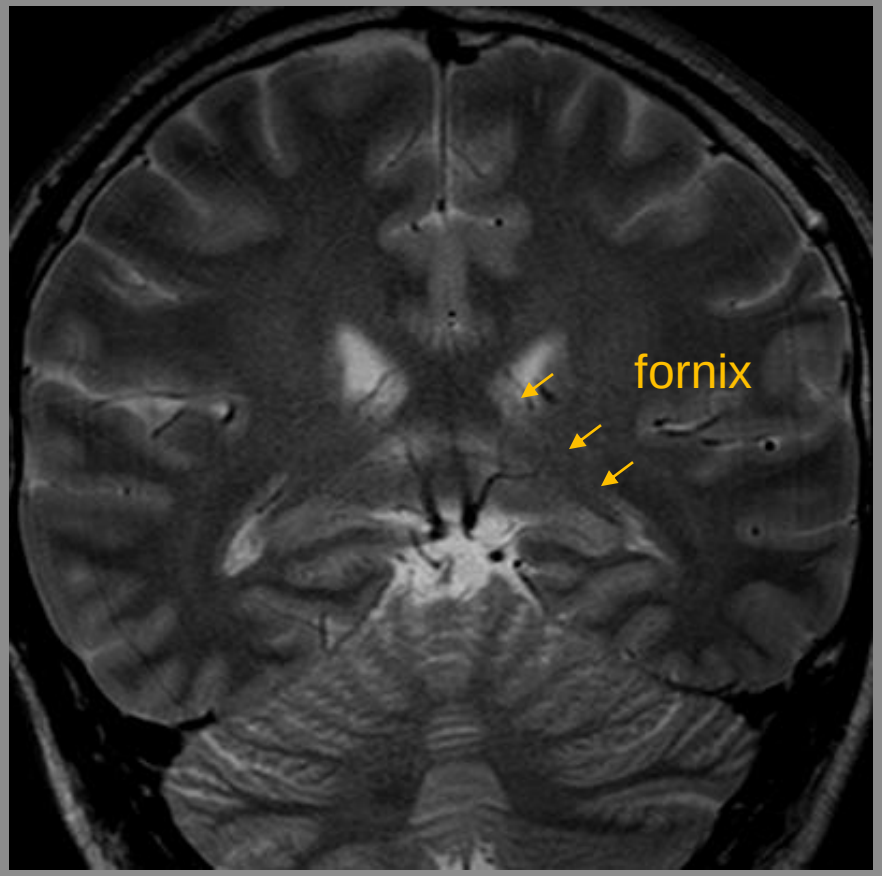
The body can be seen at the level of the anterior brain stem.



*Hippocampus

The tail can be seen at the level of the cerebellum.





*Hippocampal Sclerosis

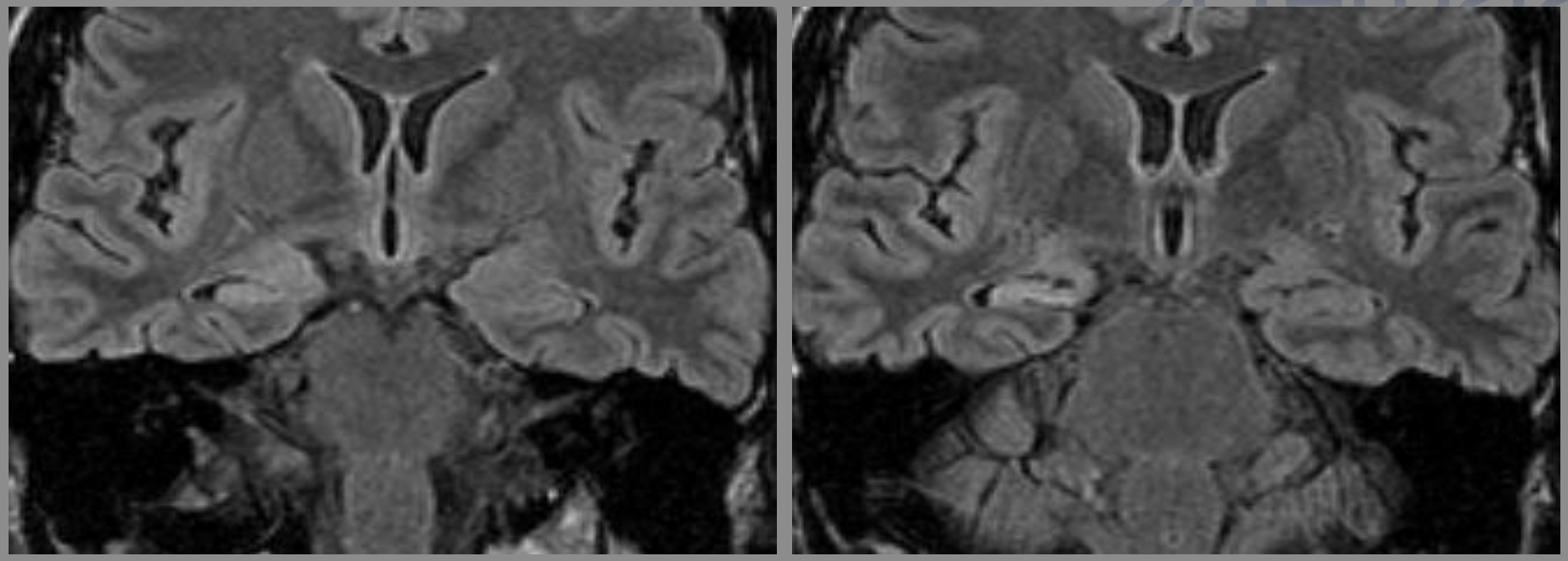
*Hippocampal sclerosis refers to neuronal loss in CA1-4 and the dentate gyrus.

*Mesial temporal sclerosis implies more extended sclerosis of extrahippocampal tissue, such as the amygdala and parahippocampal gyrus

*Hippocampal Sclerosis: MRI findings

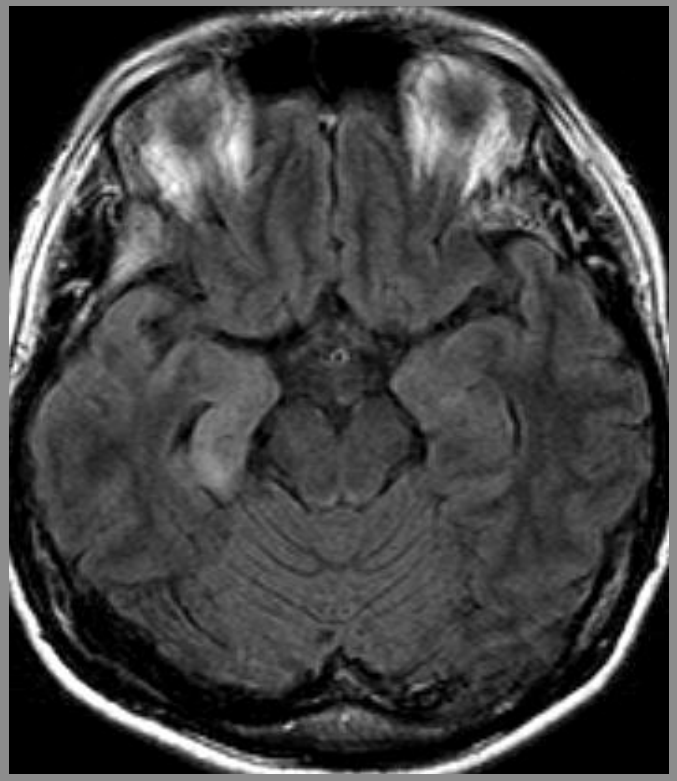
- Loss of internal architecture
- Loss of hippocampal head interdigitations
- Abnormal hypersignal T2 change of hippocampus
- Hippocampal atrophy
- Atrophy of the ipsilateral fornix
- Atrophy of the ipsilateral mammillary body
- Atrophy of the ipsilateral collateral white matter
- Dilatation of the ipsilateral temporal horn

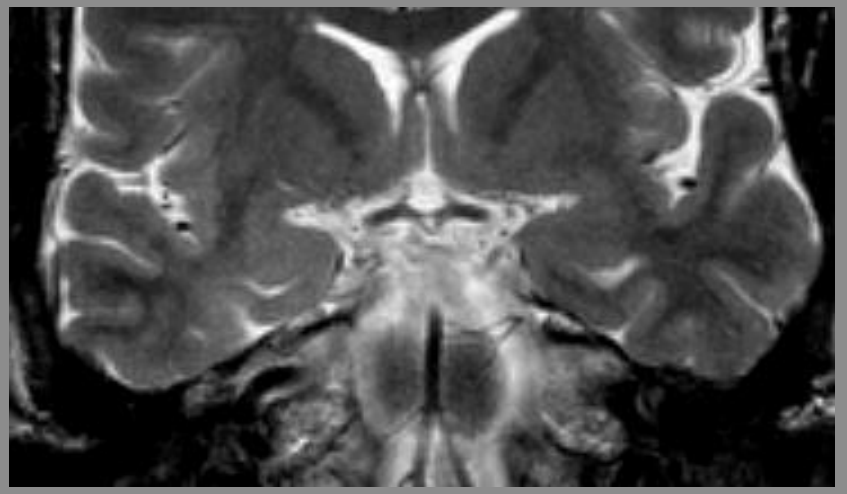
*Right Mesial Temporal Sclerosis

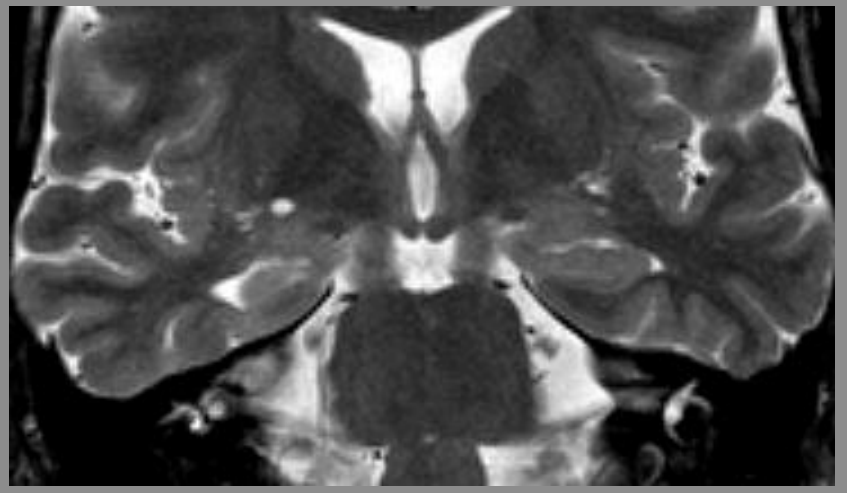


* Right Mesial Temporal Sclerosis

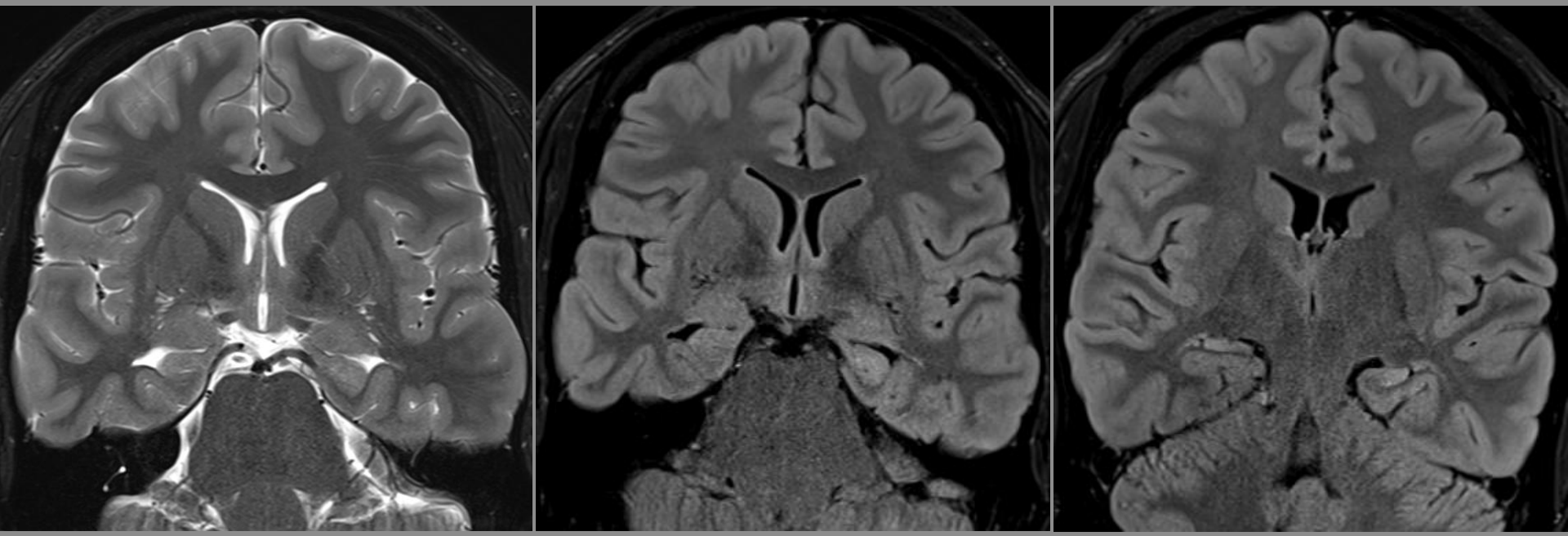
A 37 year-old female epilepsy since 2 years of age with visual aura.

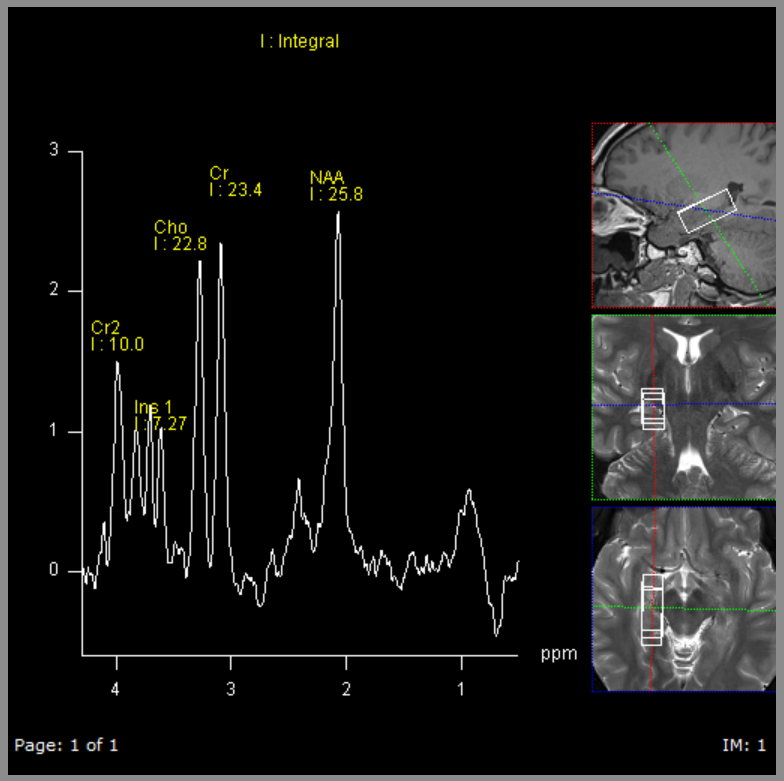


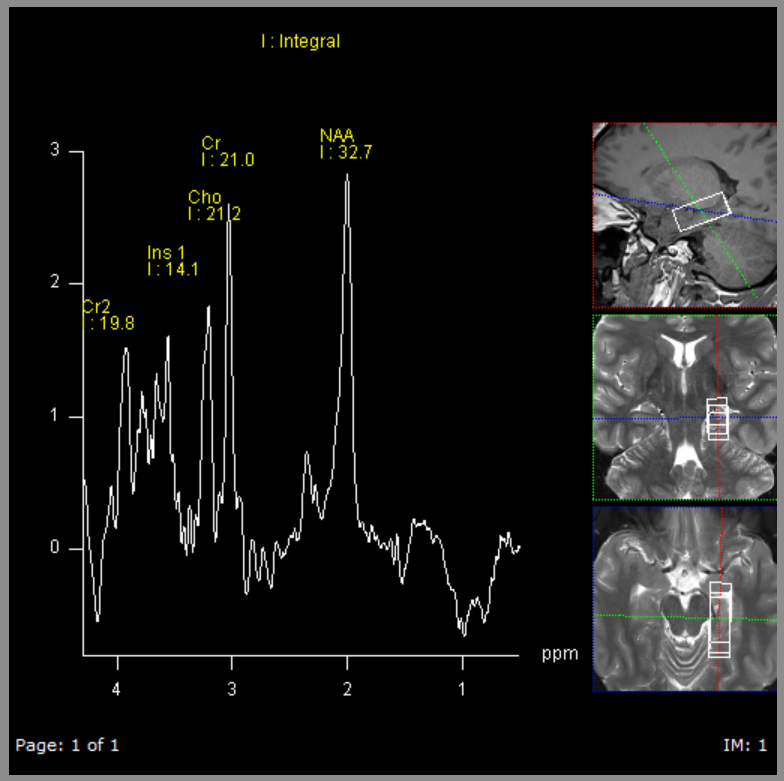




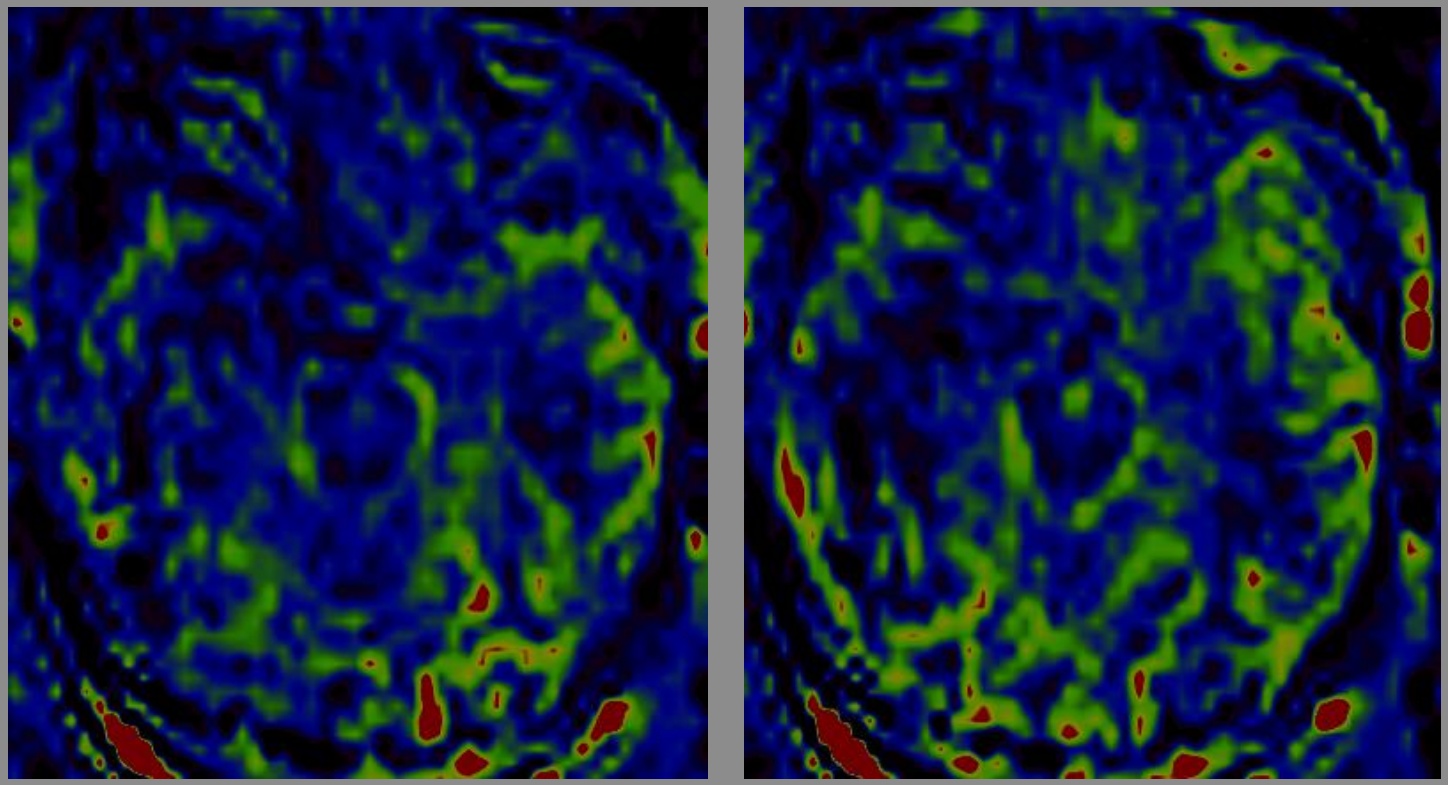
*Mesial Hippocampal Sclerosis







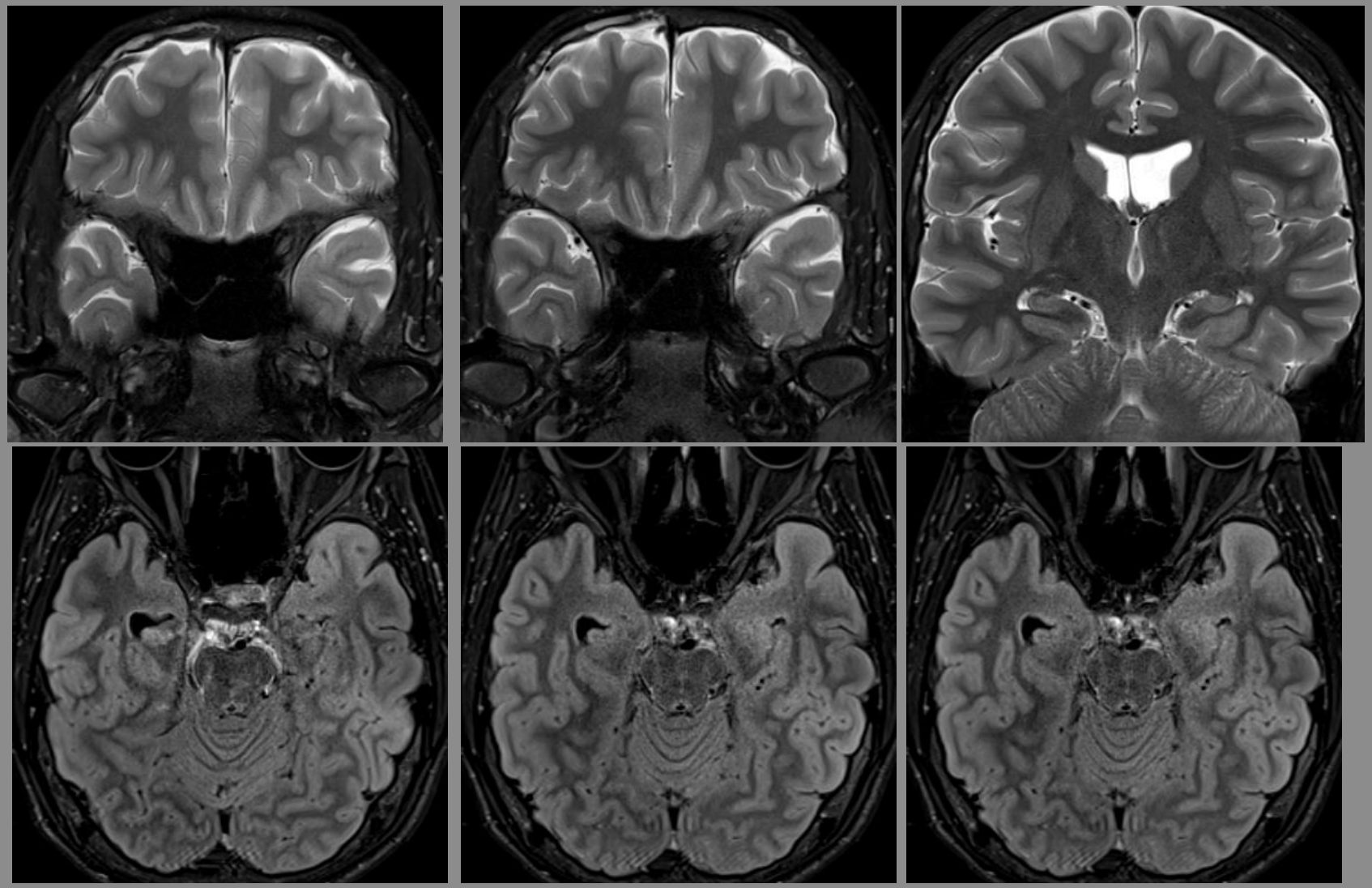
*Mesial Hippocampal Sclerosis

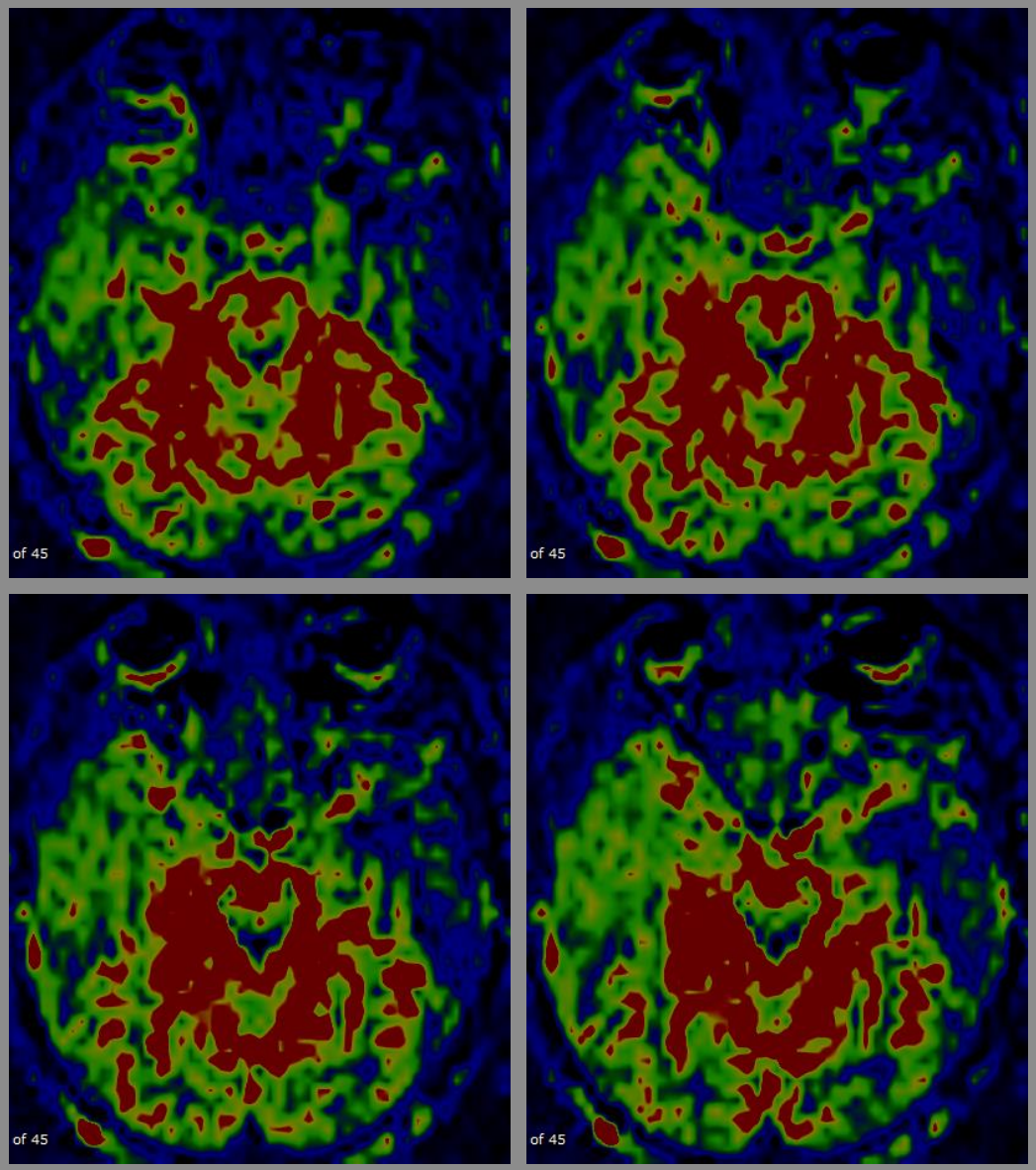


Perfusion Study with 3D ASL

* Mesial Hippocampal Sclerosis

A 14 year-old male had seizure and abnormal EEG at the left temporal region.



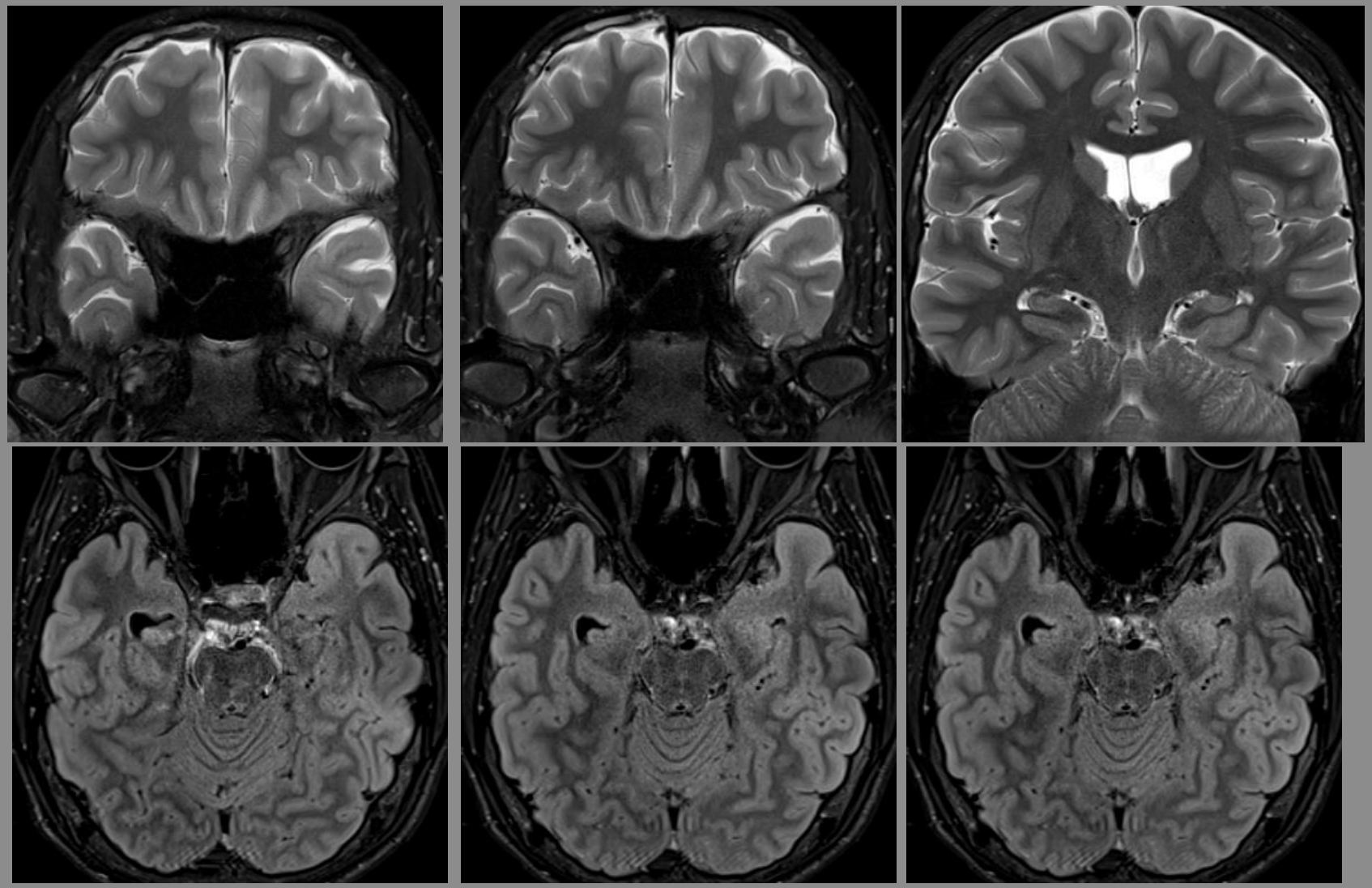


Left Mesial Temporal Sclerosis

A 14 year-old boy had abnormal EEG at the left temporal region

Perfusion Study with 3D ASL

A 14 year-old male had seizure and abnormal EEG at the left temporal region.



*Malformation of cortical development

*Malformation of cortical development

*MCD is characterized by an abnormal structure of the cerebral cortex.

*Malformation Secondary to Abnormal Neuronal and Glial Proliferation or Apoptosis, Malformation Due to Abnormal Neuronal Migration, and Malformation Secondary to Abnormal Postmigration Development.

*MCD is an important cause of developmental delay and epilepsy.

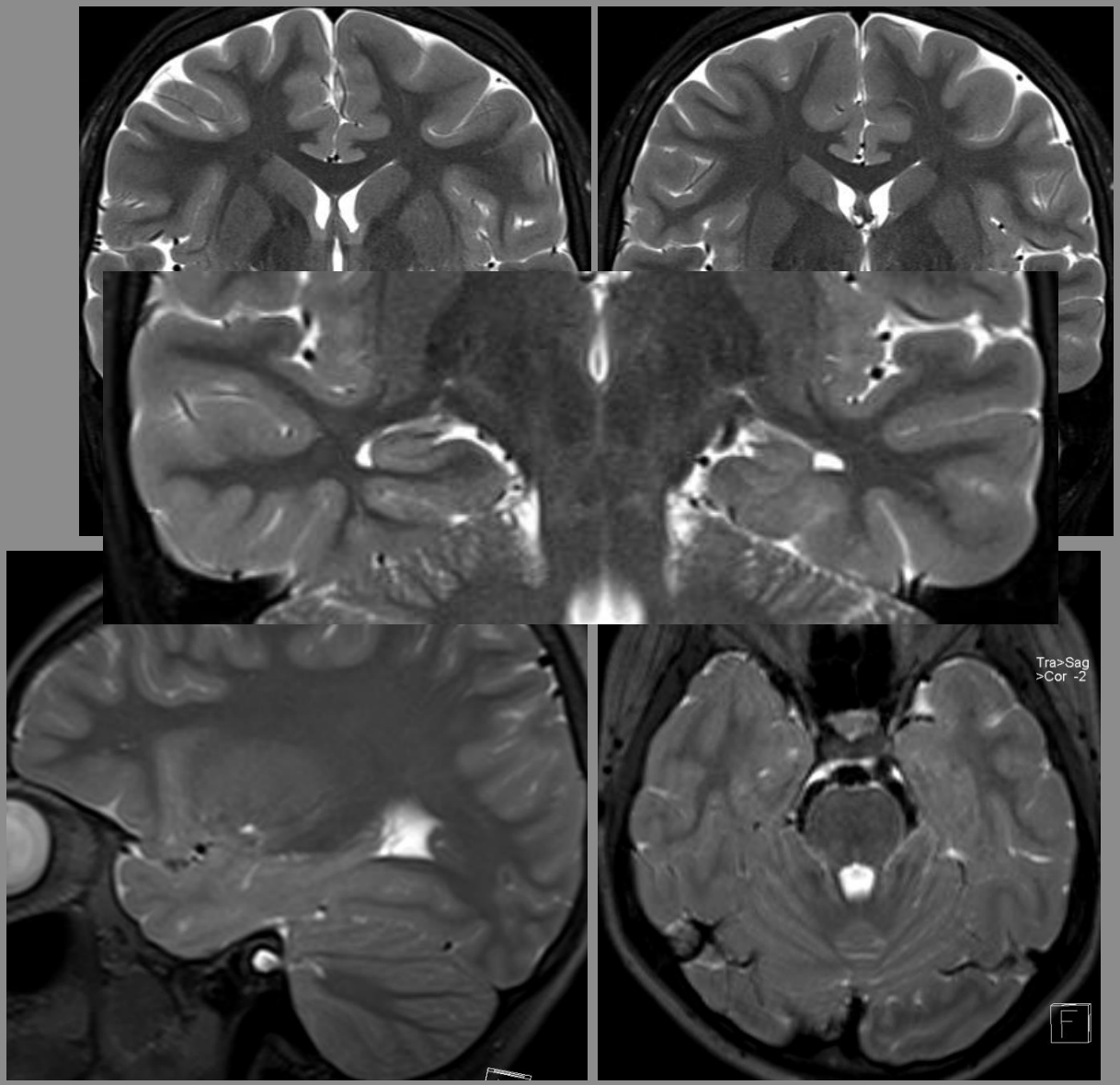
*Focal Cortical Dysplasia (FCD): Imaging Findings

- *Cortical thickening
- *Abnormal gyration
- *Blurring of gray-white junction
- *T2 prolongation in the cortex or subjacent white matter
- *Decreased white matter volume
- *Heterotopic gray matter
- *CSF cleft
- *Cortical dimple

Table 2. New classification system of focal cortical dysplasia by Blumcke et al. 2011.

Type	Characteristic features
I	a – focal cortical dysplasia with abnormal radial cortical lamination b – focal cortical dysplasia with abnormal tangential 6-layer cortical lamination c – focal cortical dysplasia with abnormal radial and tangential cortical lamination
II	a – focal cortical dysplasia with dysmorphic neurons b – focal cortical dysplasia with dysmorphic neurons and balloon cells
III	a – architectural distortion of cortical layer in temporal lobe with hippocampal atrophy b – architectural distortion of cortical layer adjacent to glial or glioneuronal tumor c – architectural distortion of cortical layer adjacent to vascular malformation d – architectural distortion of cortical layer adjacent to other lesions acquired in early childhood such as trauma, ischemic event, encephalitis

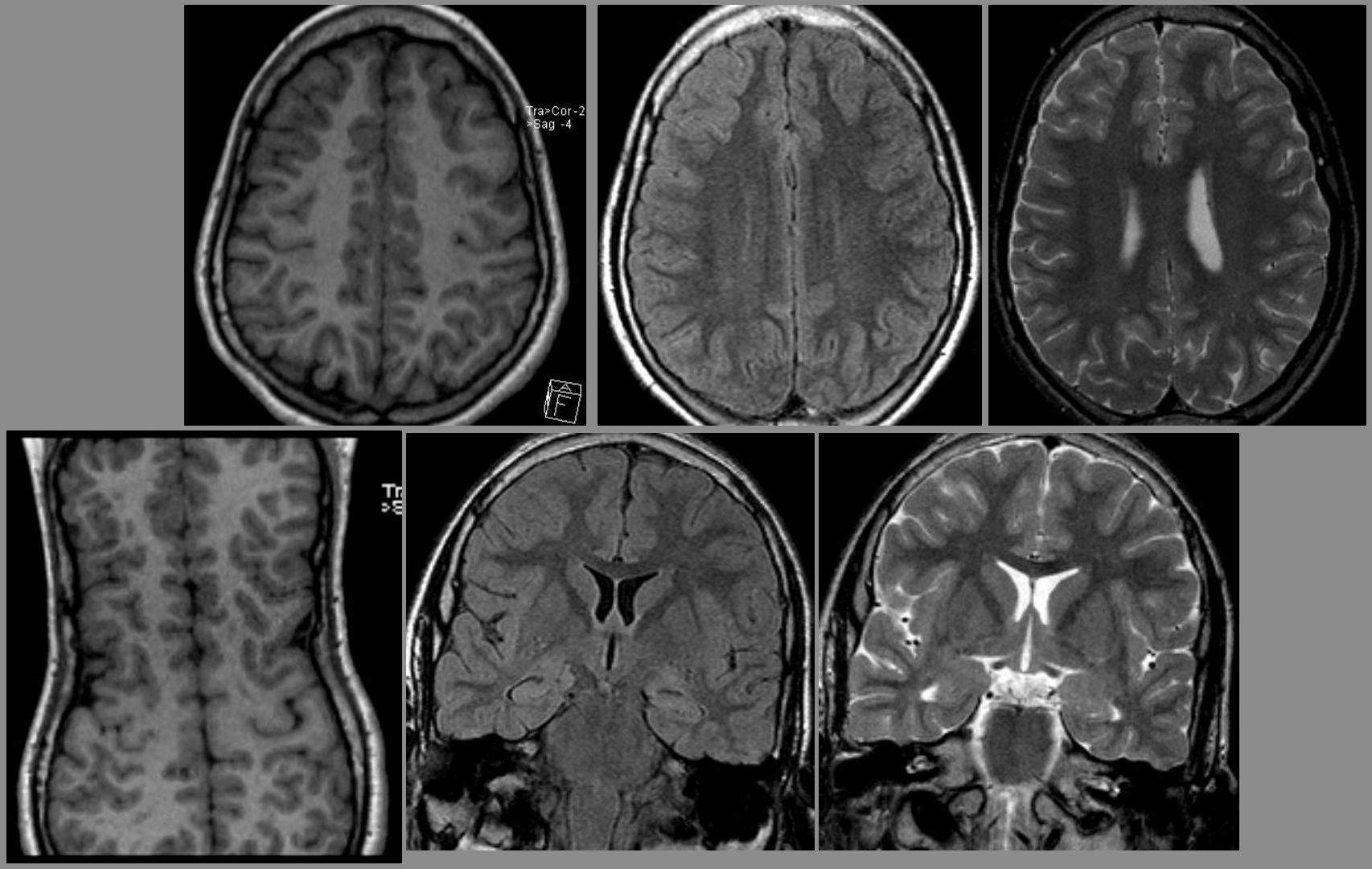
* FCD type I



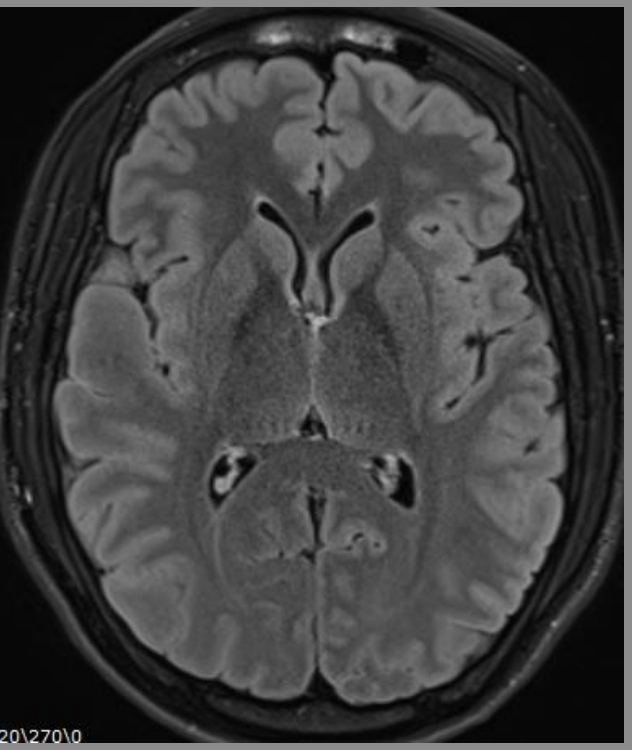
* FCD type Ia

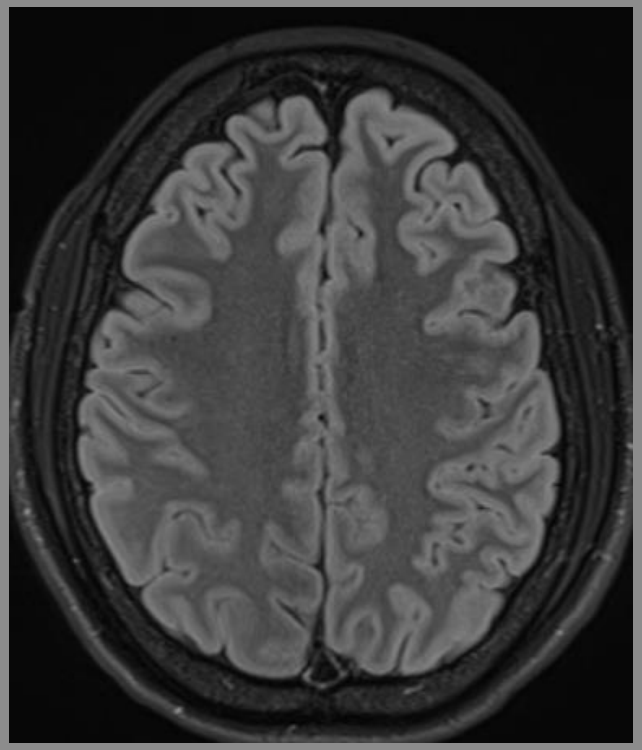
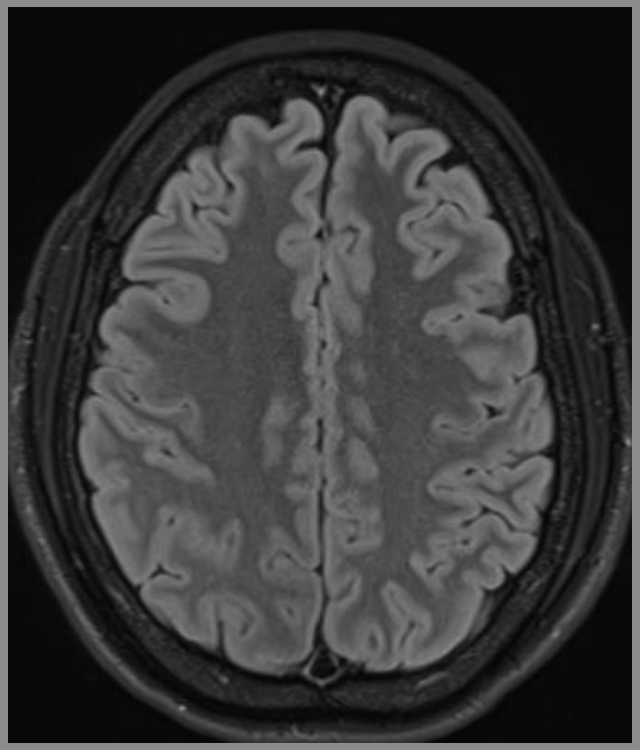
A 13 year-old boy had seizure since 3 years of age.

EEG – Bisynchronous sharp-slow activity over bilateral frontal regions with right predominance.

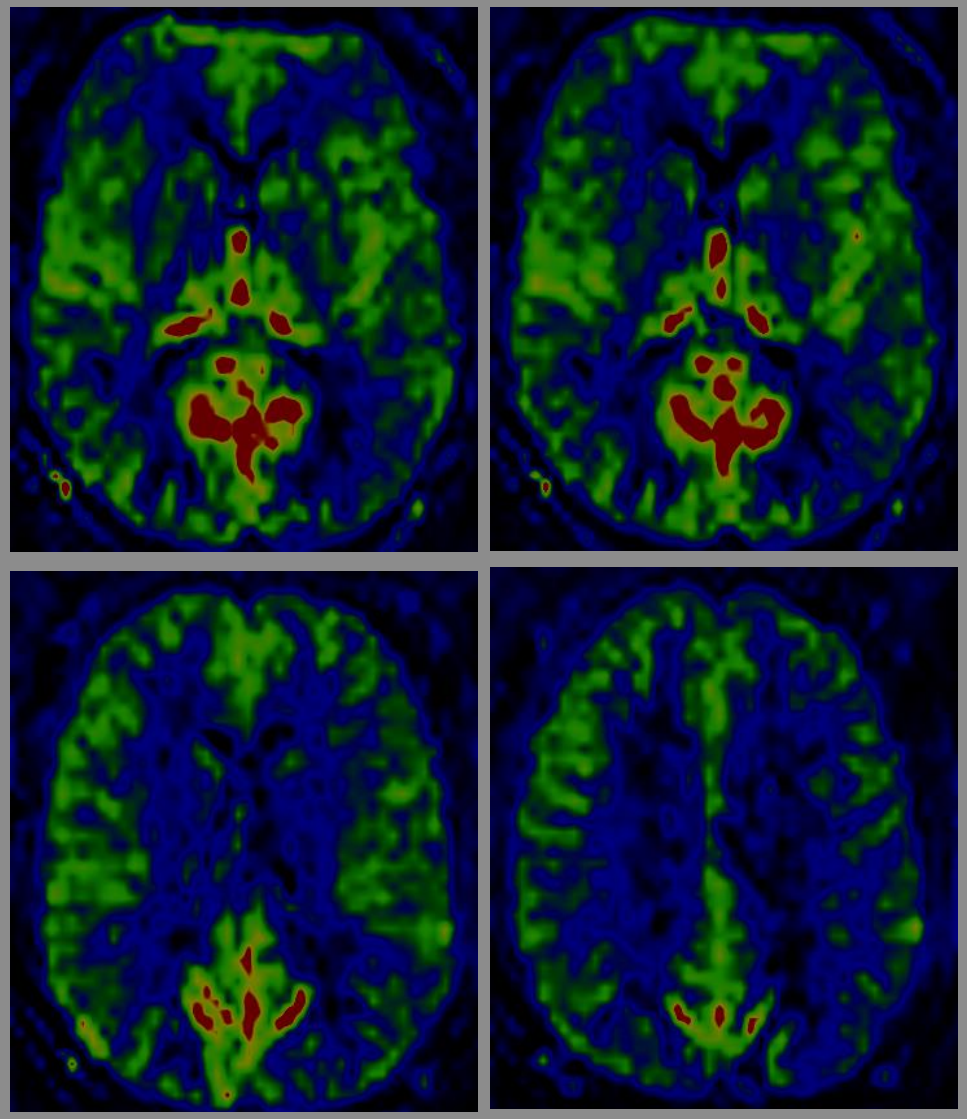


A 20 year-old female had seizure since 9 years of age. Seizure Started from feeling of palpitation,followed by loss of awareness and whole body stiffening/jerking.



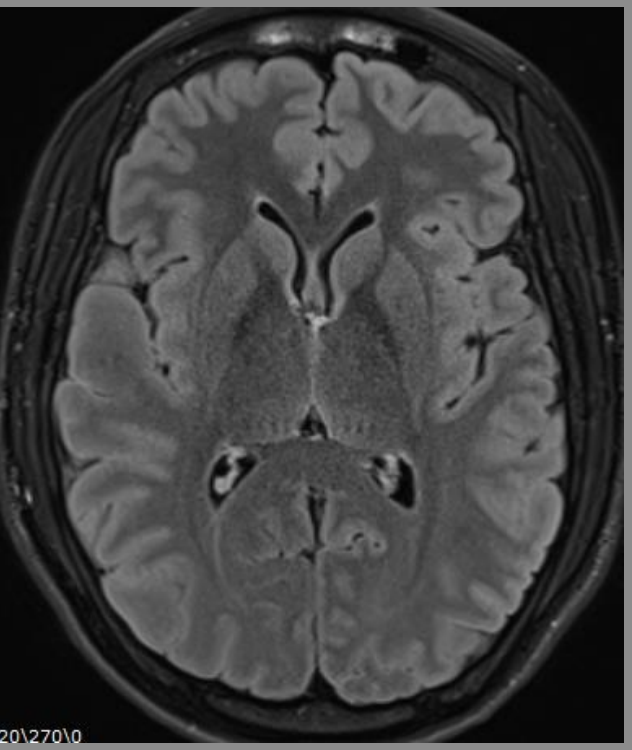



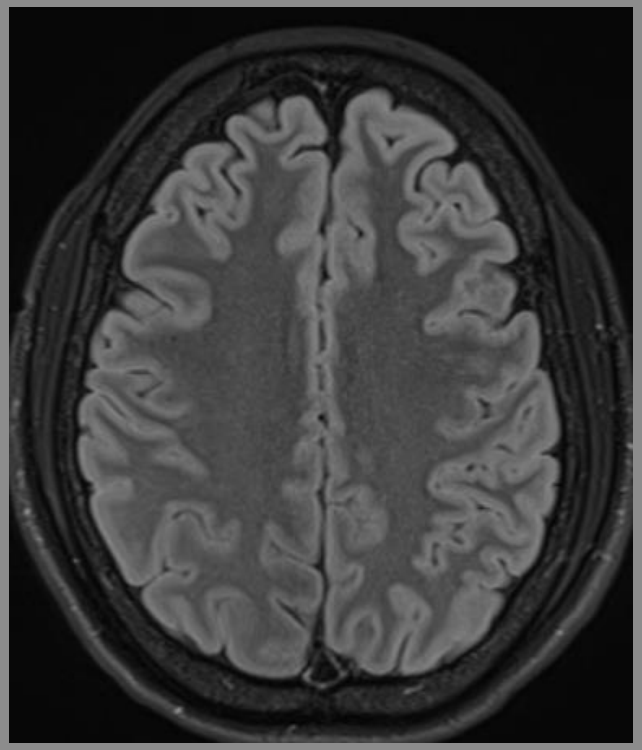
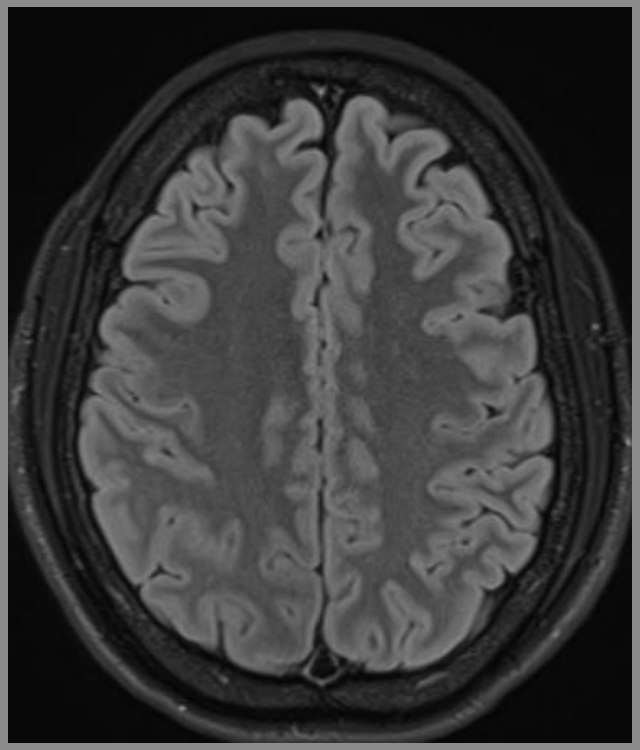
*Microdysgenesis



Perfusion Study
with 3D ASL

A 20 year-old female had seizure since 9 years of age. Seizure Started from feeling of palpitation,followed by loss of awareness and whole body stiffening/jerking.

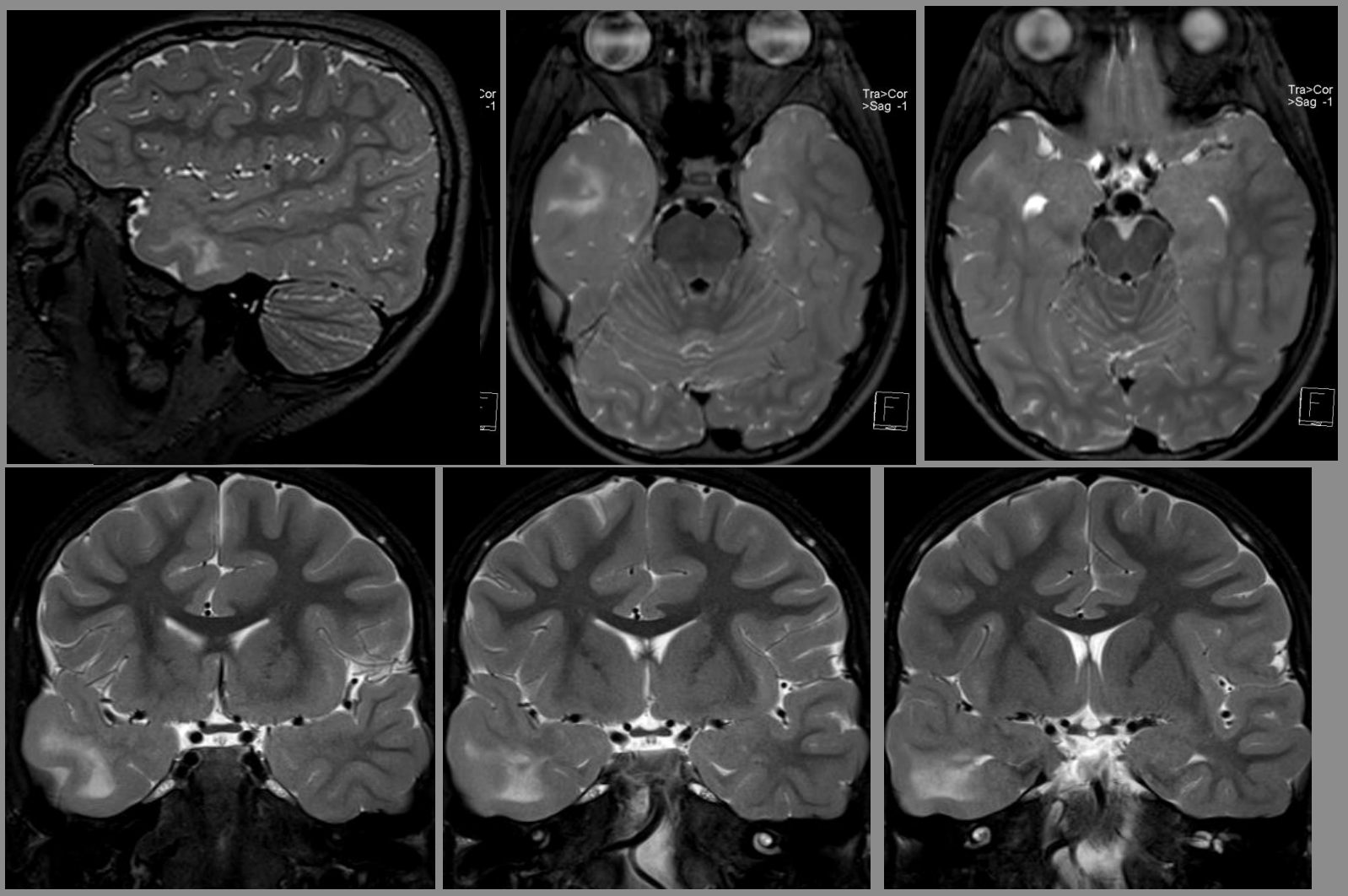


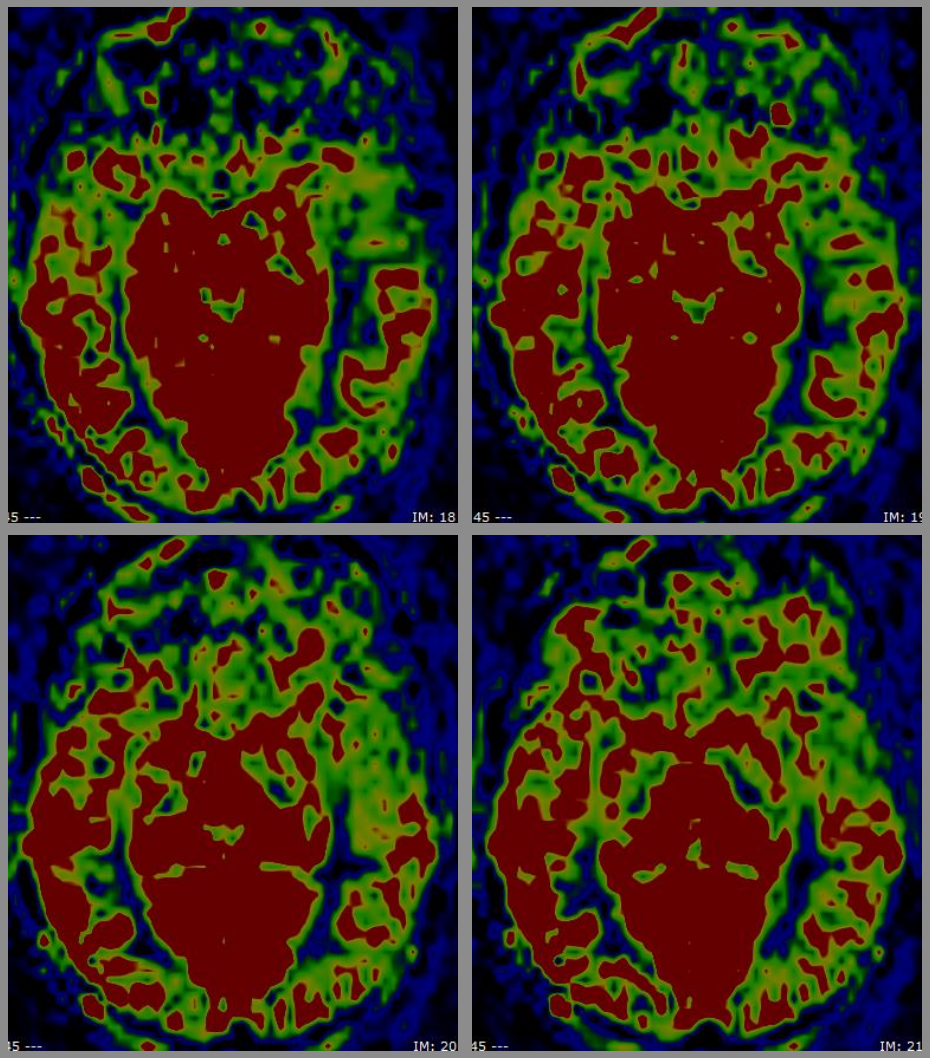
*Microdysgenesis

*FCD type IIa

A 9 year-old boy, right handedness, had seizure since 2 ½ years of age and had intractable seizure.



*FCD type IIa

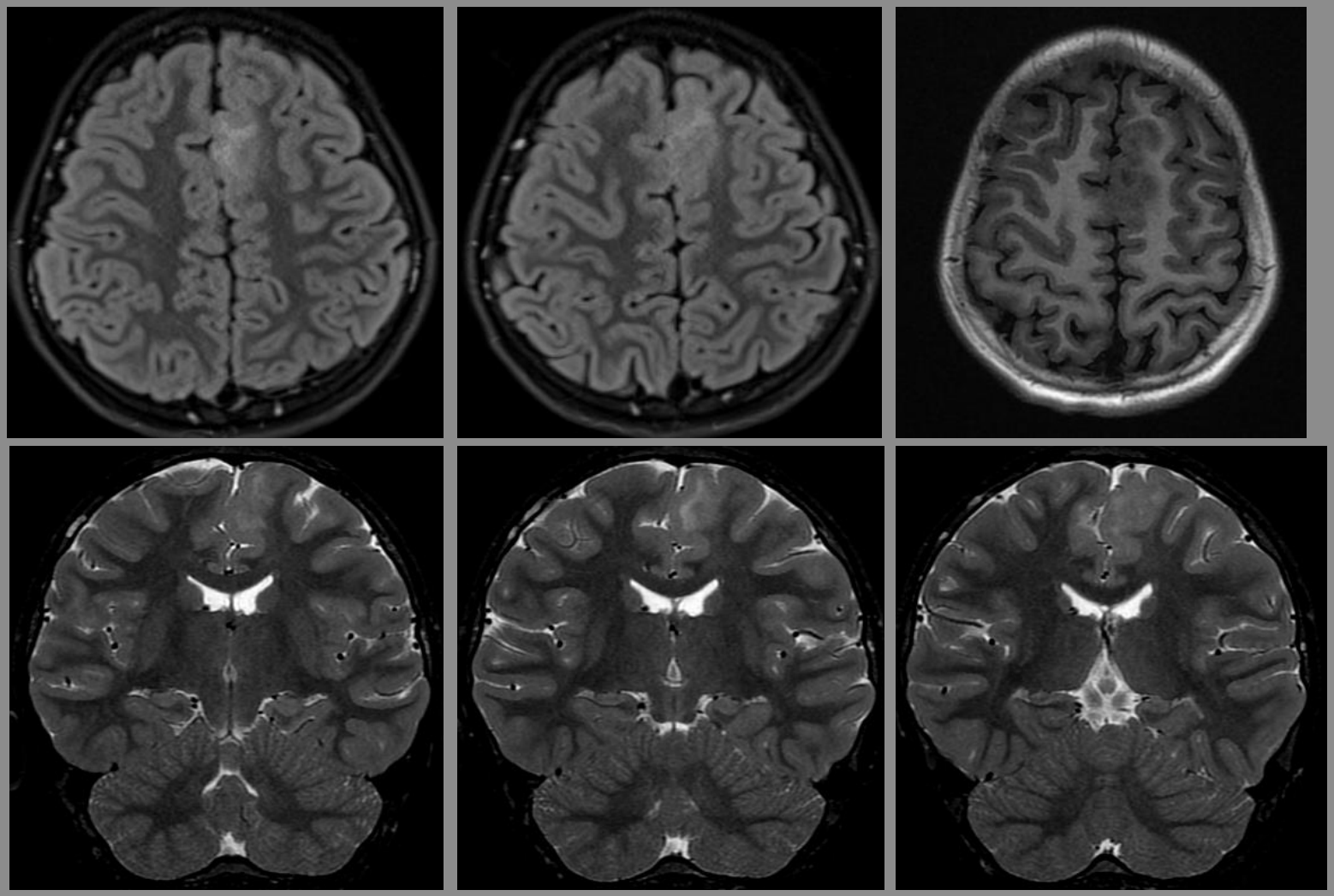


A 9 year-old boy, right handedness, had seizure since 2 ½ years of age
and had intractable seizure.

Perfusion Study
with 3D ASL

*FCD type IIb

A 7 year-old boy had seizure since 3 years of age. He had seizure starting from chewing and turning to the right side, followed By generalized seizure.



Tuberous Sclerosis Complex: Imaging Findings

*Cortical/subcortical tubers

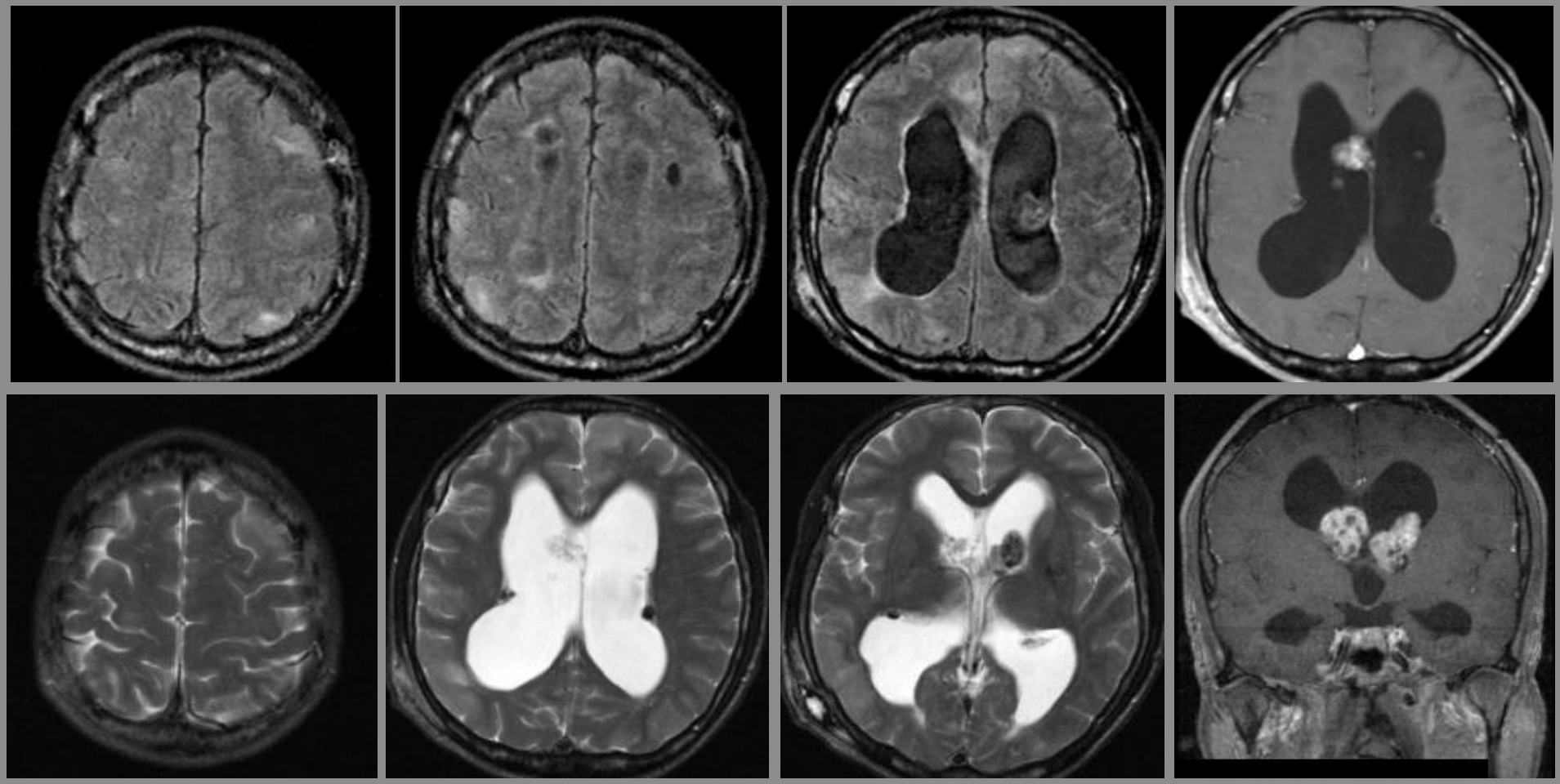
*Calcified subependymal nodule (hamartoma)

*Subependymal giant cell astrocytoma

*White matter lesions along lines of neuronal migration

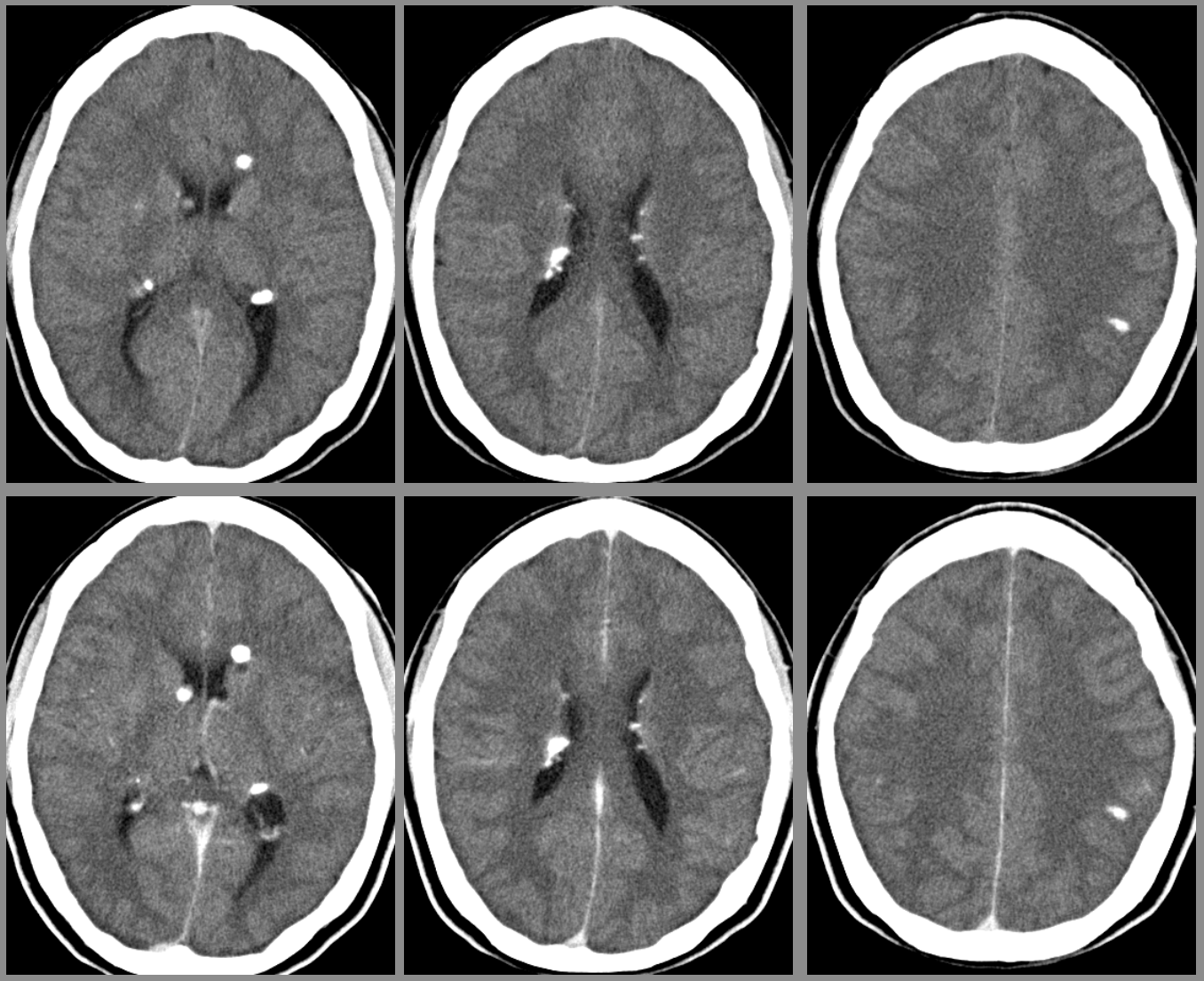
* Diagnostic Imaging: Pediatric Neuroradiology by Barkovich

*Tuberous Sclerosis Complex

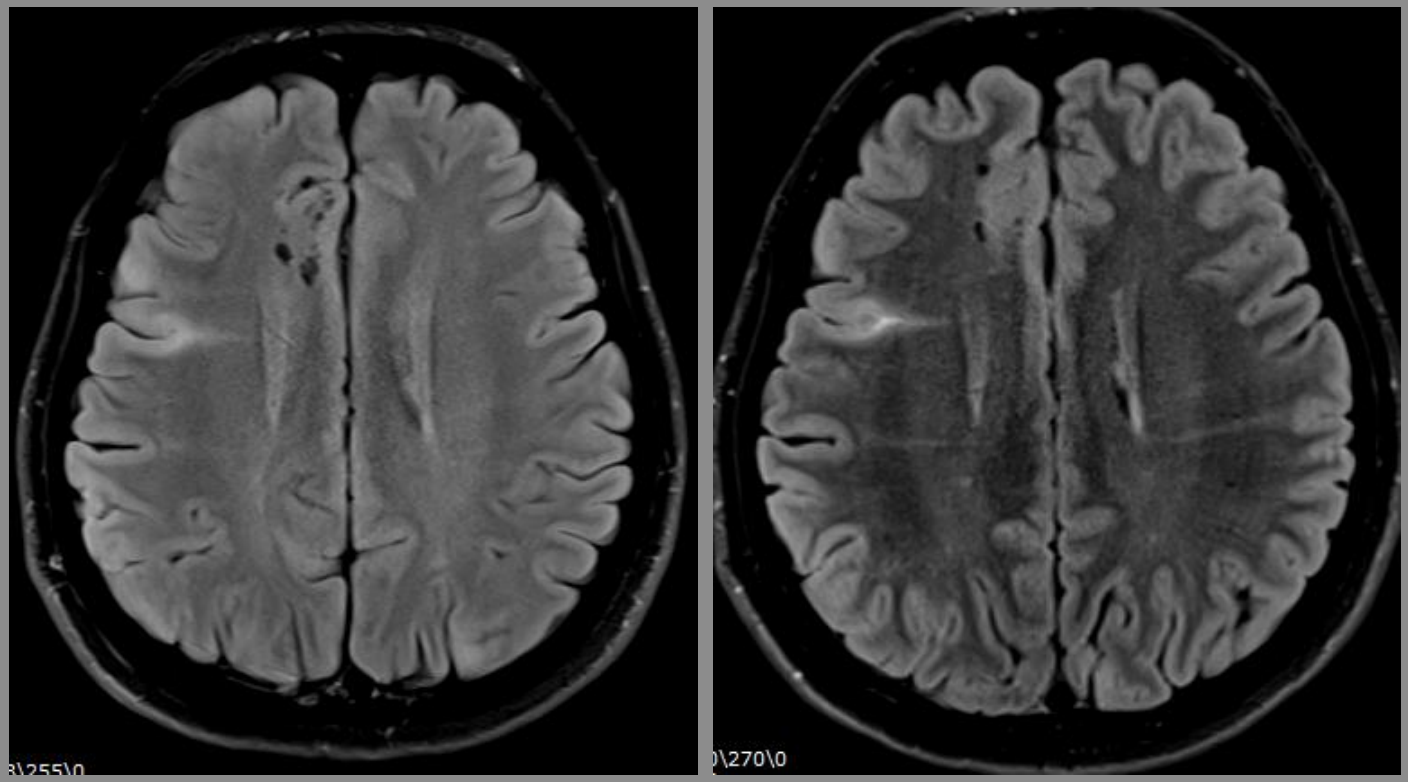


* Tuberous Sclerosis Complex

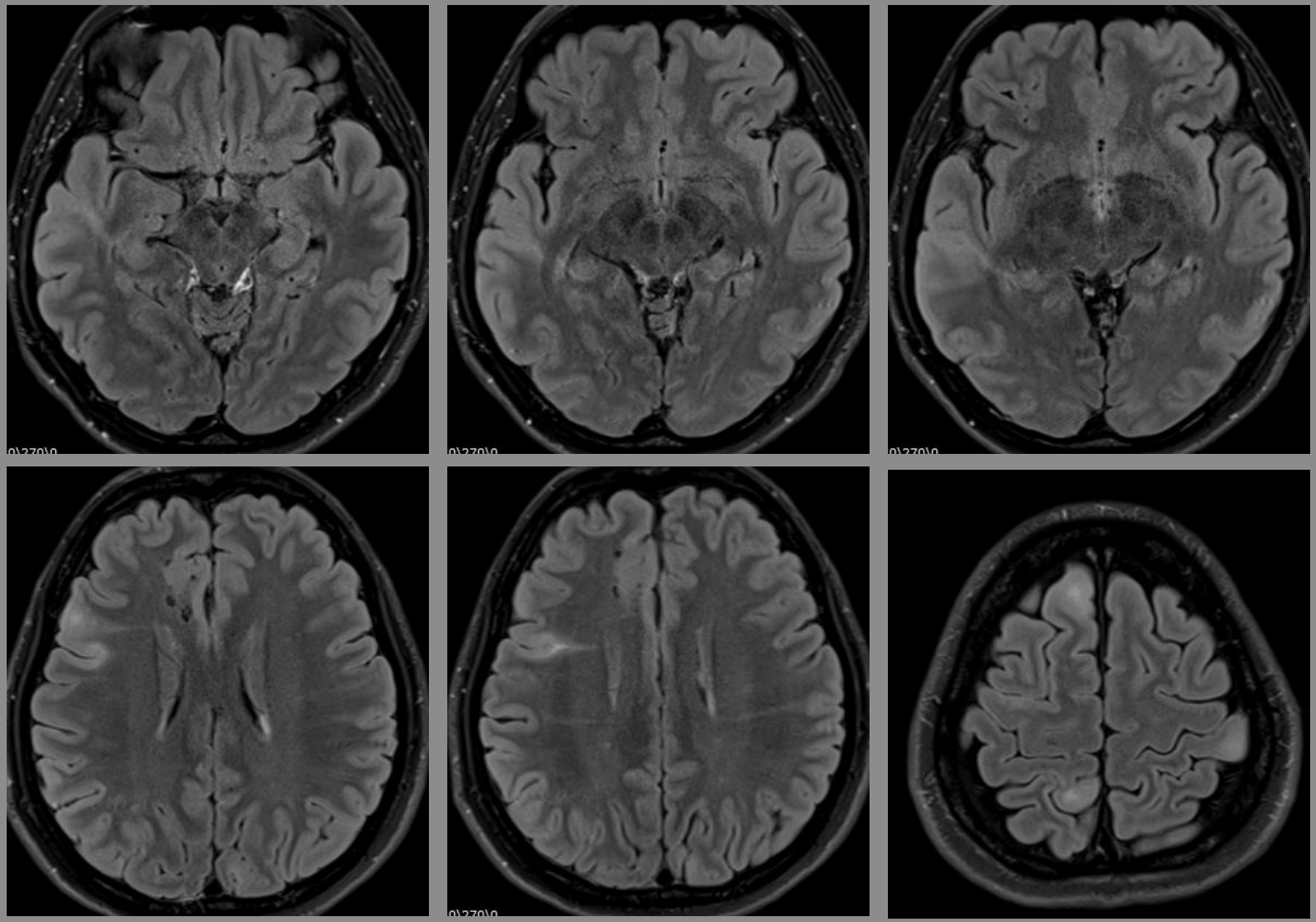
A 10 year-old girl had complex partial seizure.



*Tuberous Sclerosis

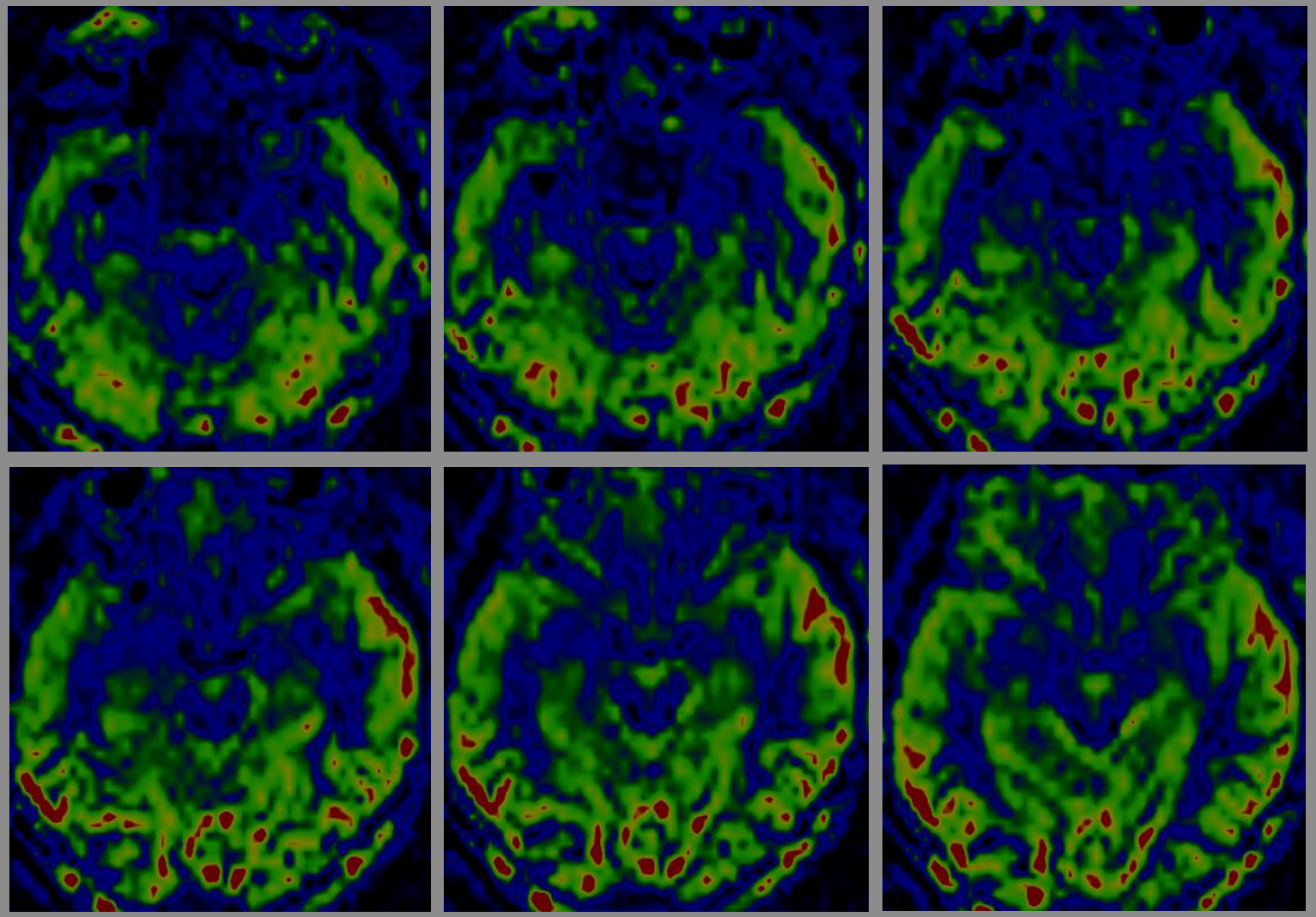


*Tuberous Sclerosis



*Tuberous Sclerosis

Perfusion Study
with 3D ASL



*Heterotopia represents collections of normal neurons situated in abnormal locations.

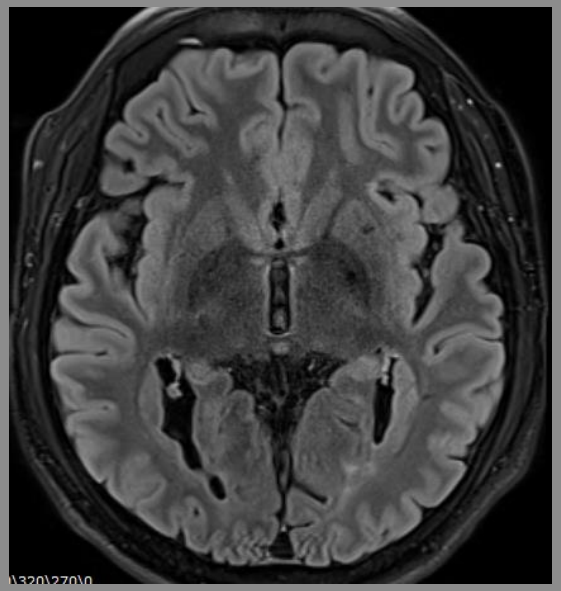
*Heterotopia is isointensity to GM in all MRI sequences and reveals no contrast enhancement.

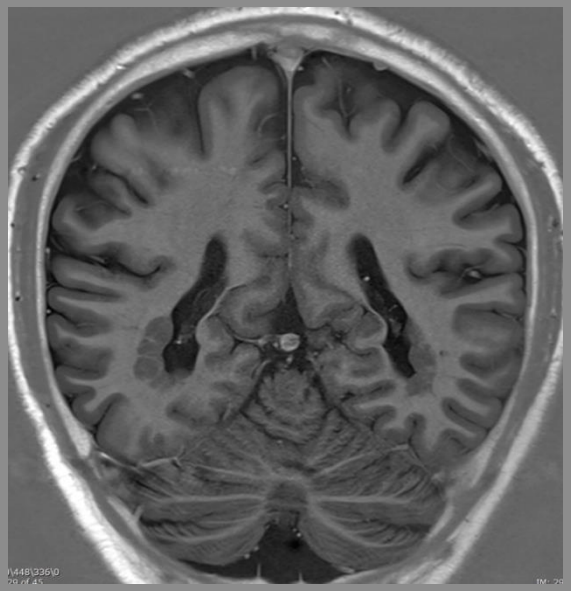
*Heterotopia

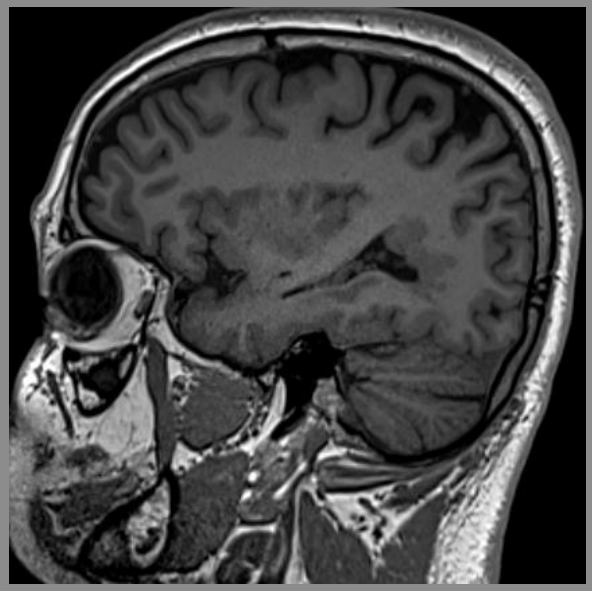
*Heterotopia

*Subependymal heterotopia
*Band (laminar) heterotopia
*Subcortical heterotopia

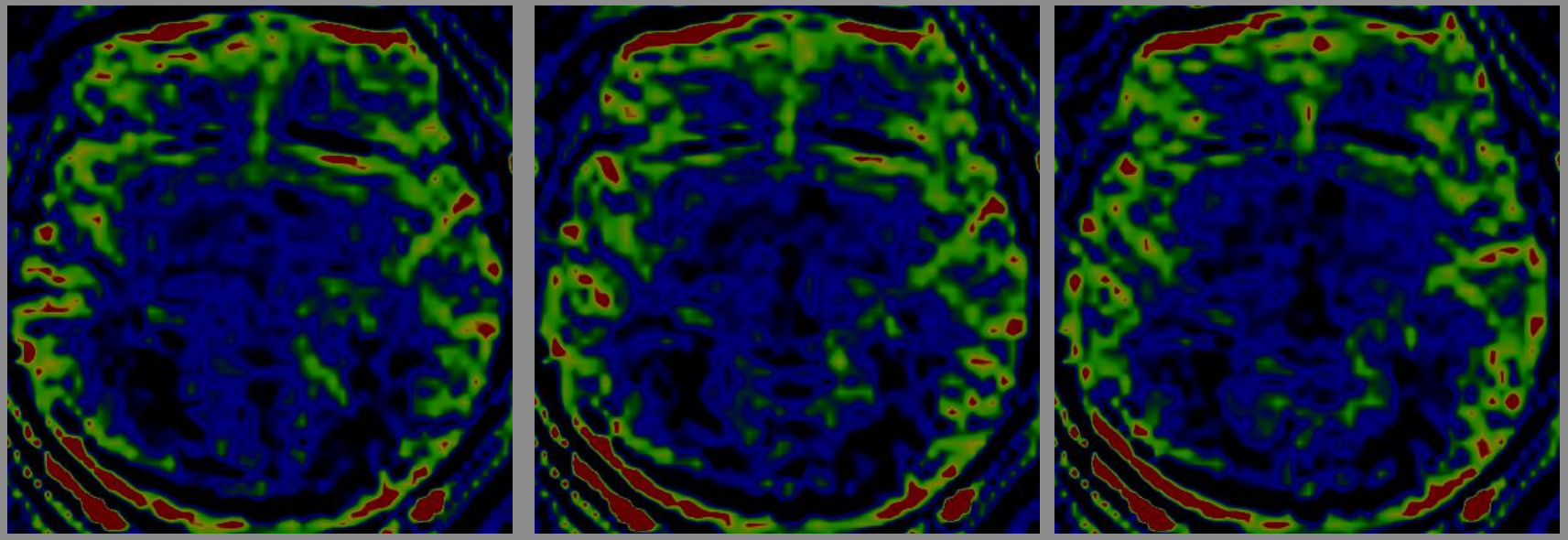
* Subependymal Heterotopia







*SubependymalHeterotopia



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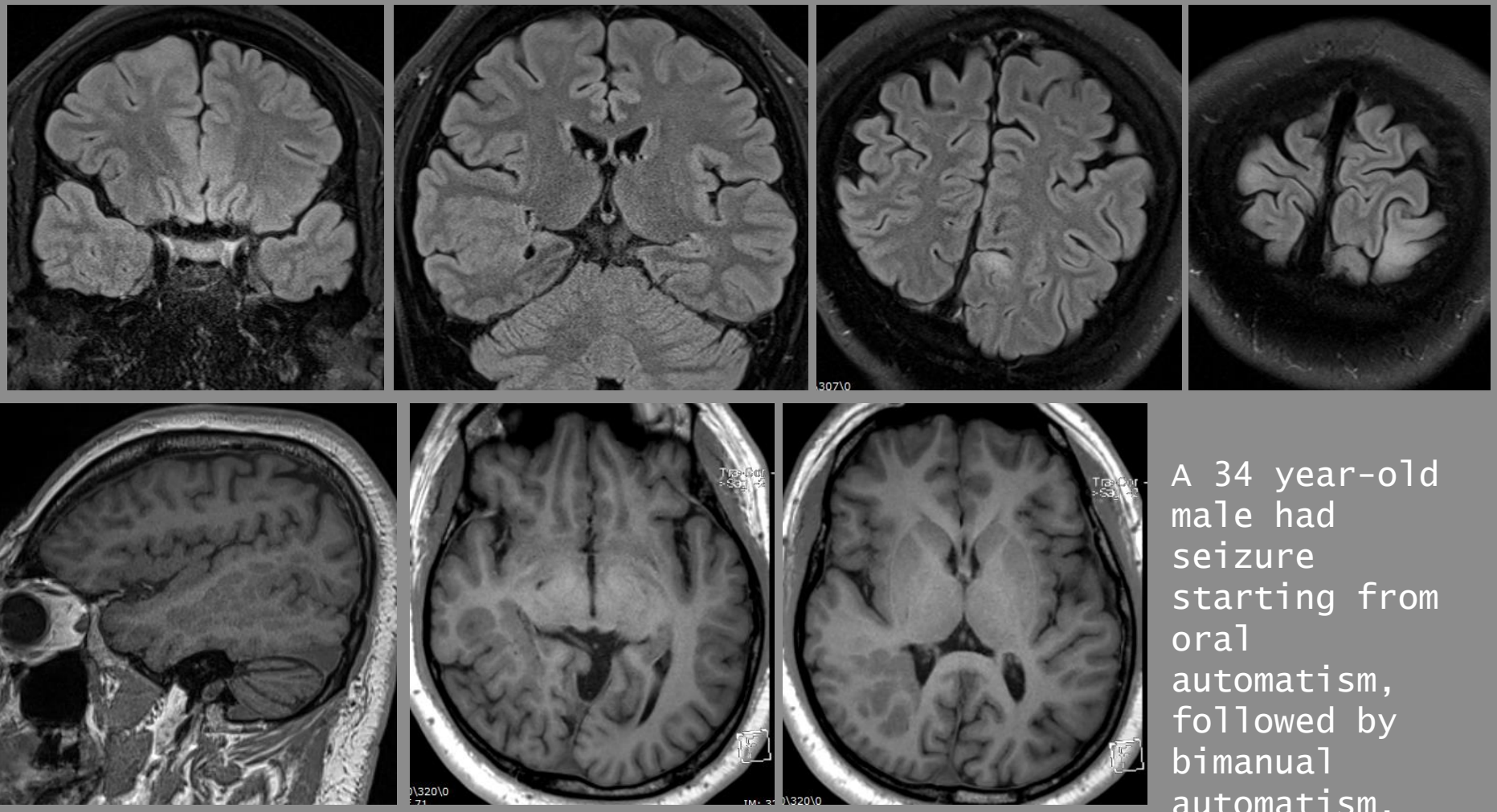
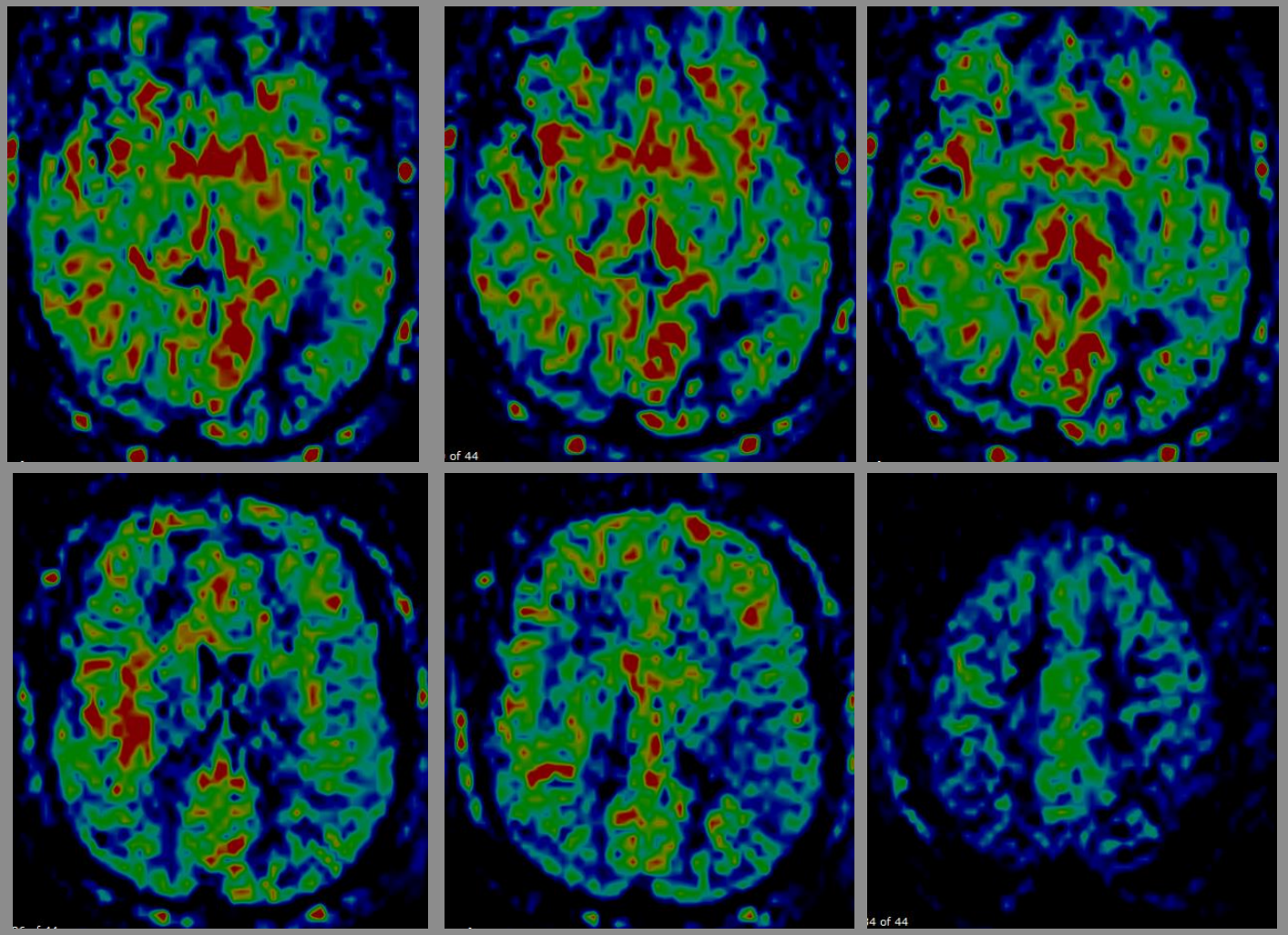
*Subcortical Heterotopia



A 34 year-old male had seizure starting from oral automatism, followed by bimanual automatism.

*Subcortical Heterotopia

He had seizure 15-20 minutes before MRI.



Perfusion Study
with 3D ASL

*Malformation Secondary to Abnormal Postmigration Development

*Polymicrogyria (PMG)

*Schizencephaly

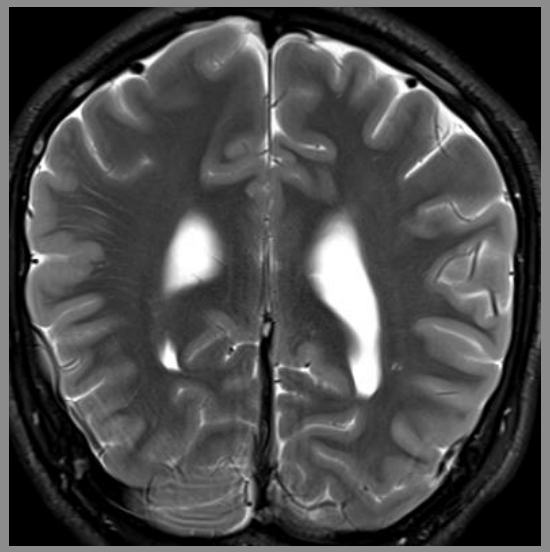
*Polymicrogyria (PMG)

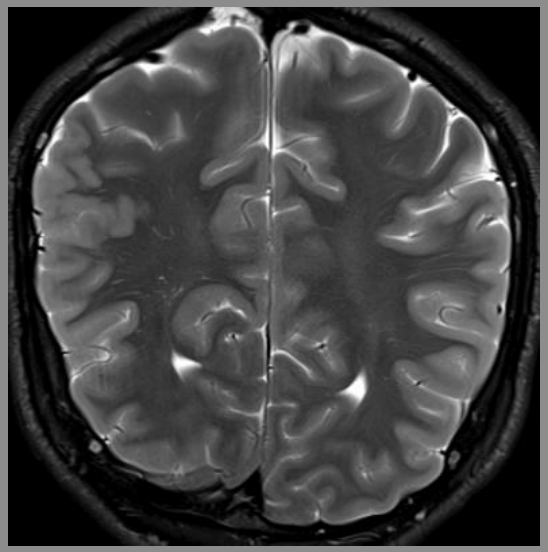
*Causes of PMG include prenatal infection, prenatal ischemia or exposure to toxins and chromosomal abnormalities.

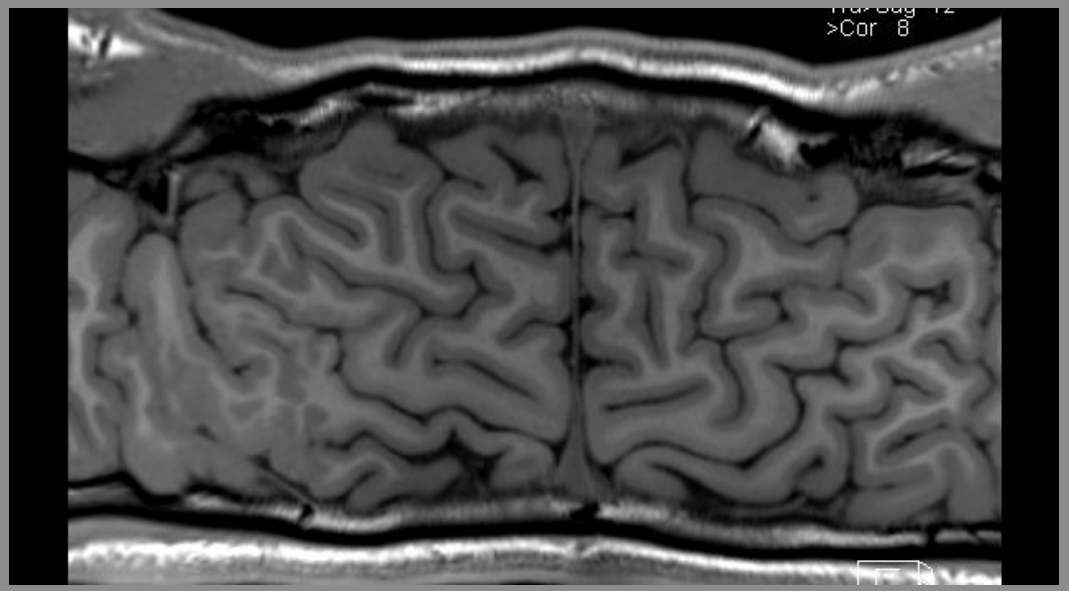
*PMG is commonly located in perisylvian regions.

*Polymicrogyria (PMG)

- Imaging findings
  - PMG may has a smooth surface, or multiple deep infoldings of the cortex with irregular G-W junction.
  - Reduced WM volume is the affected region.



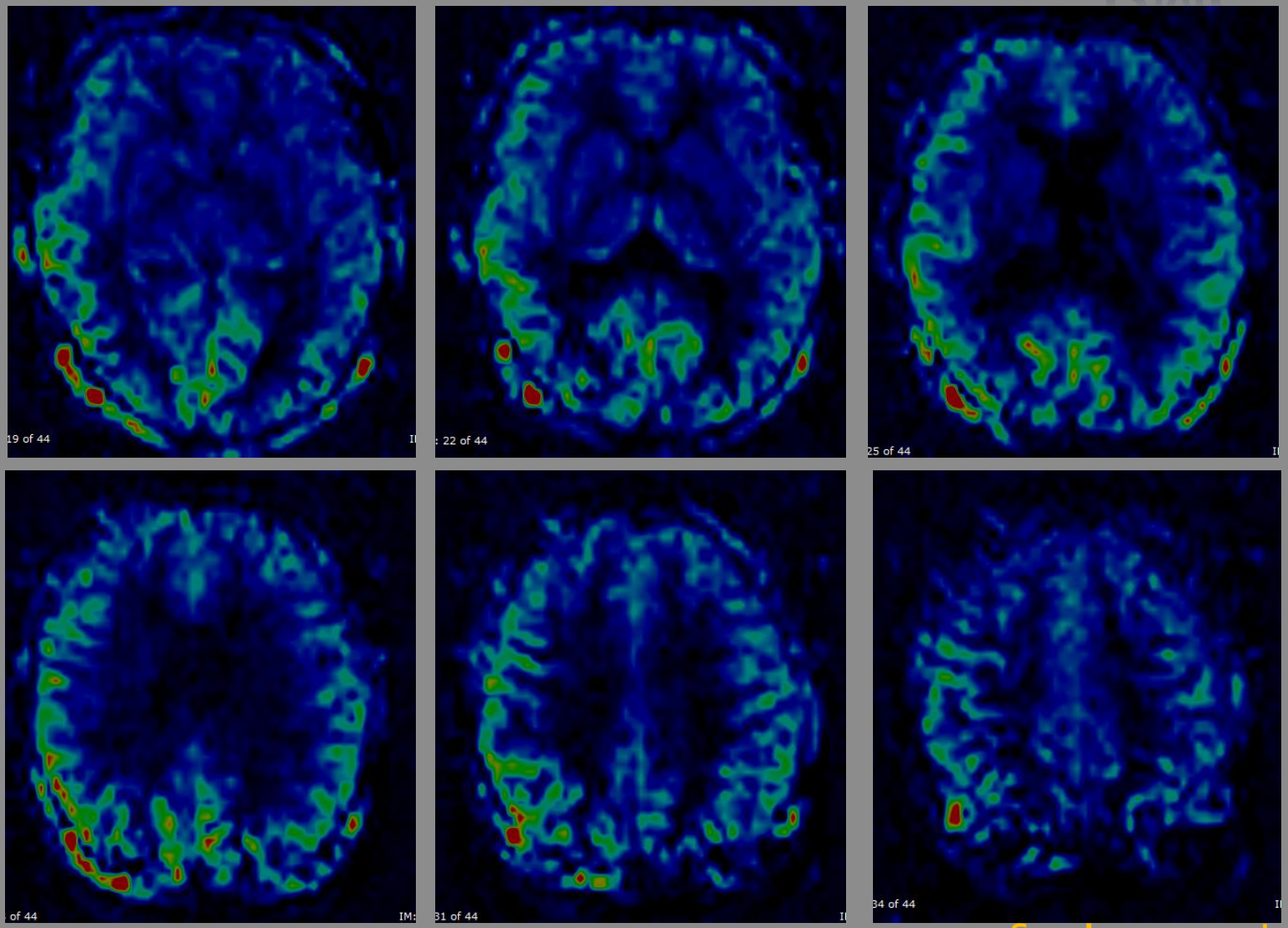




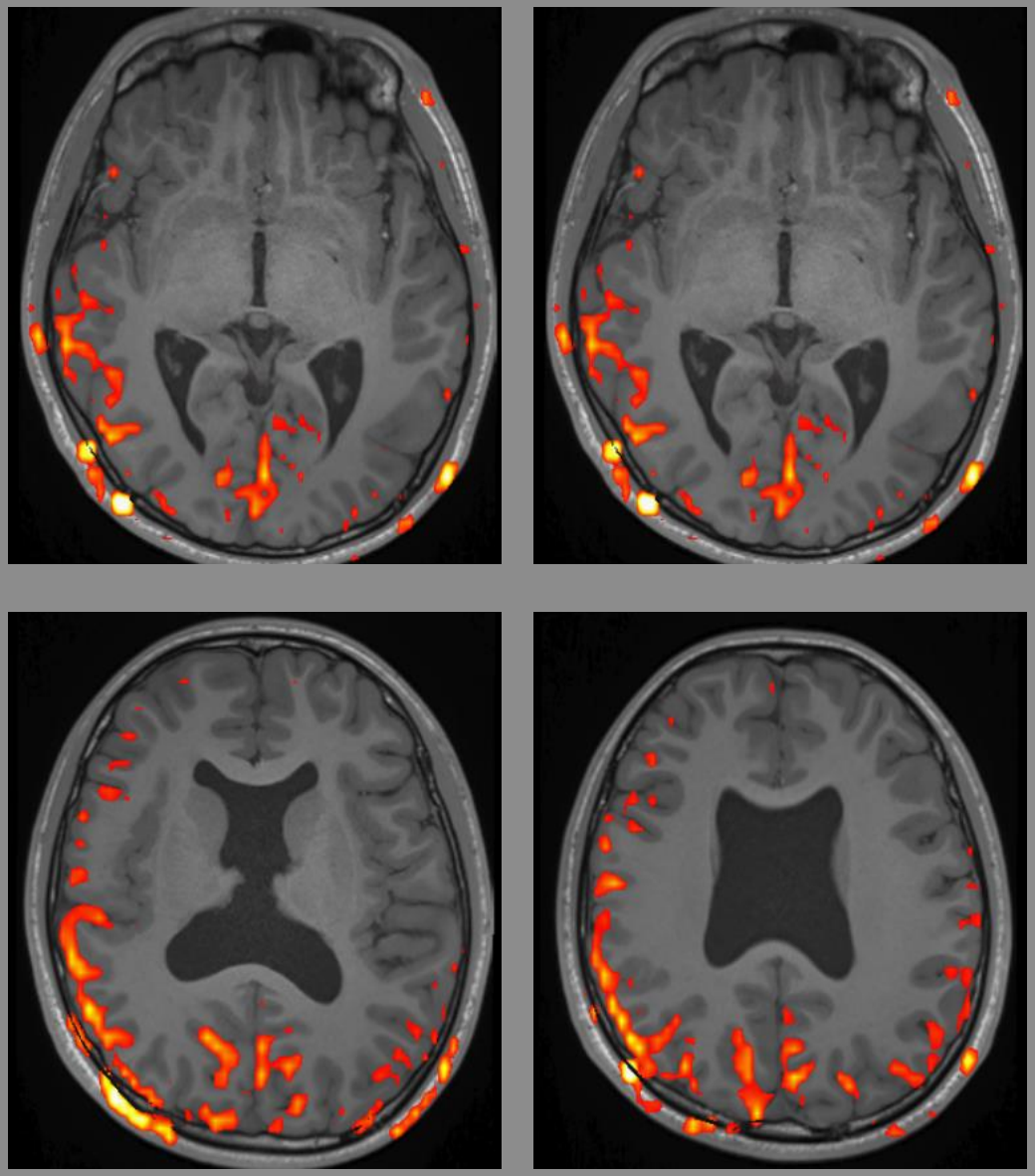
*PMG

A 14 year-old boy, case of epilepsy, had epileptical discharge from bilateral centrotemporal regions and VF defect and decreased VA right eye.

*PMG



Perfusion Study
with 3D ASL



Perfusion Study
with 3D ASL

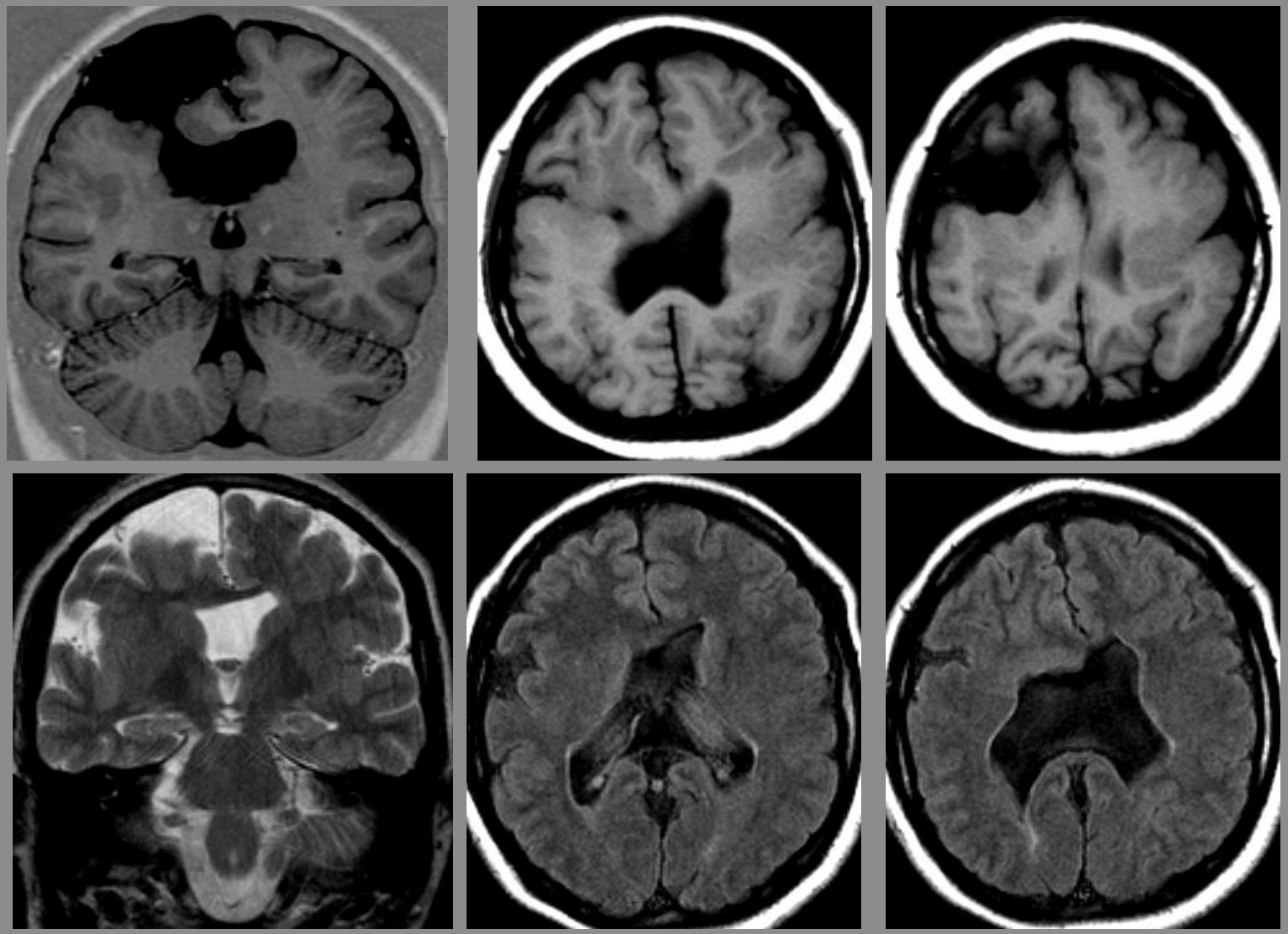
*Schizencephaly

*Schizencephaly is a cleft lined with GM and connecting subarachnoid space with the ventricular system.

*The wall of the cleft is lined by dysmorphic GM.

*Schizencephaly is divided into open-lip or closed-lip type.

*Open lip Schizencephaly

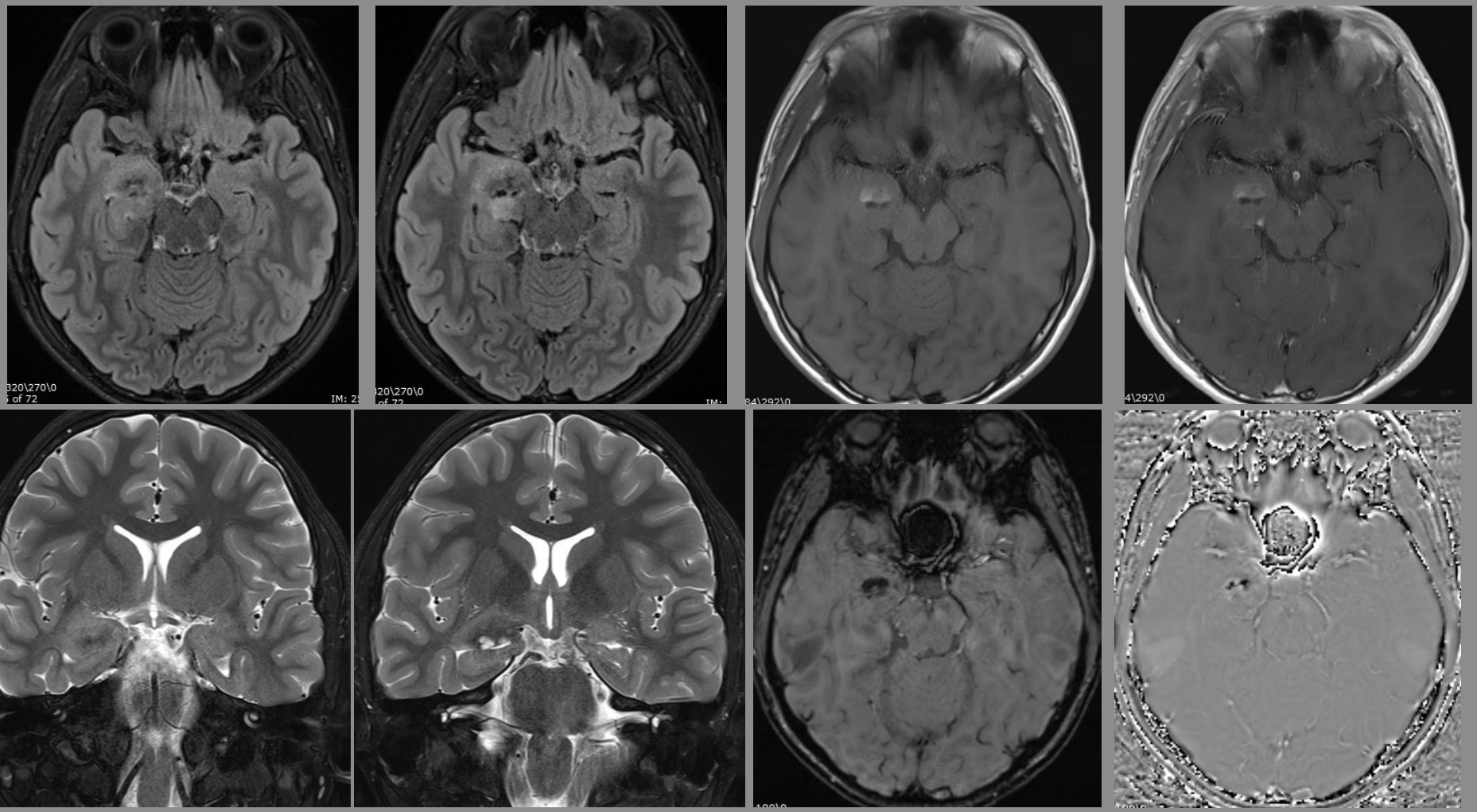


A 22 year-old female seizure since childhood, slow speech and poor development.

*Tumour

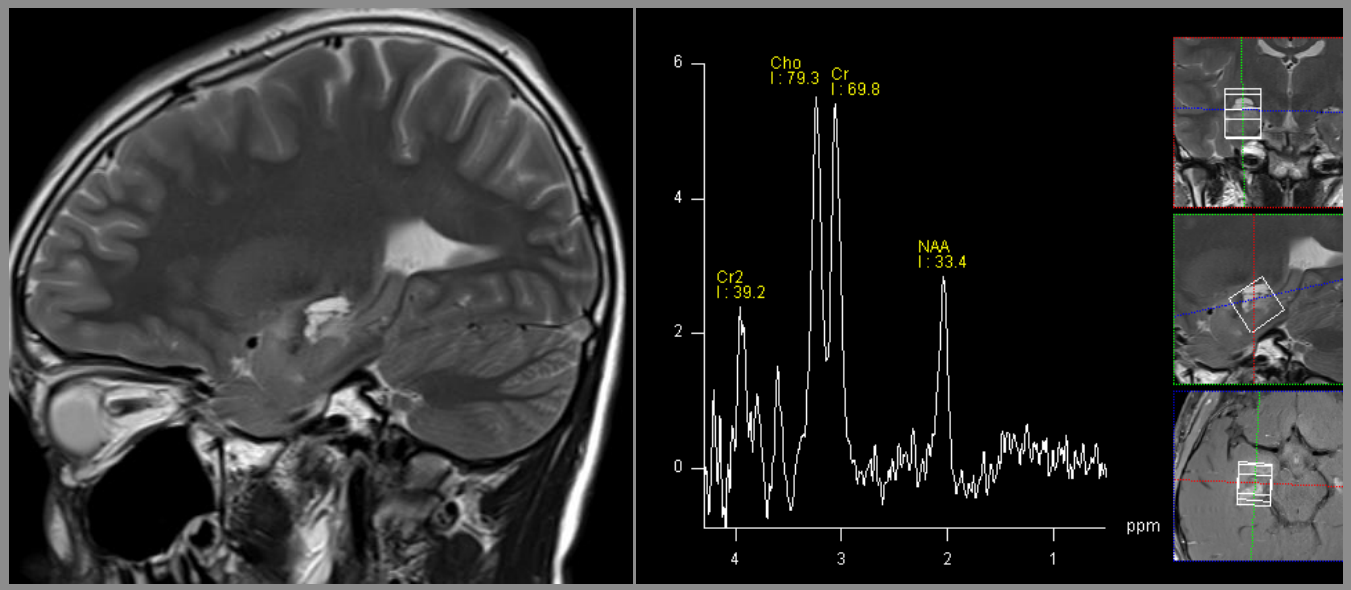
*DNET

A 13 year-old boy had complex partial seizure during sleep.



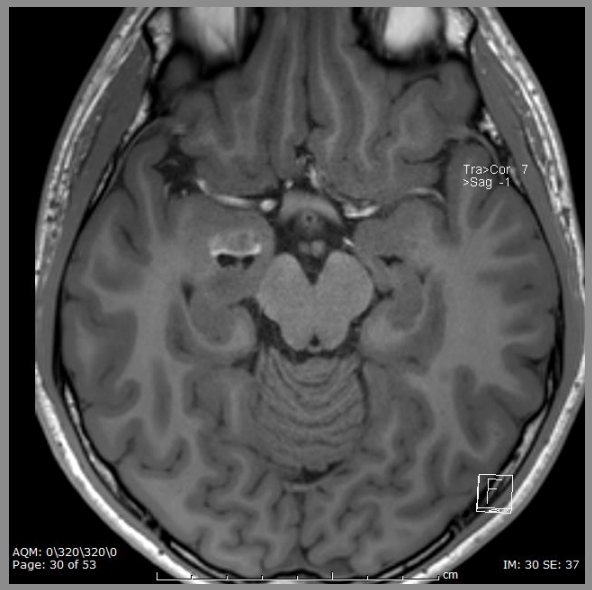
SWI-SOURCE IMAGE

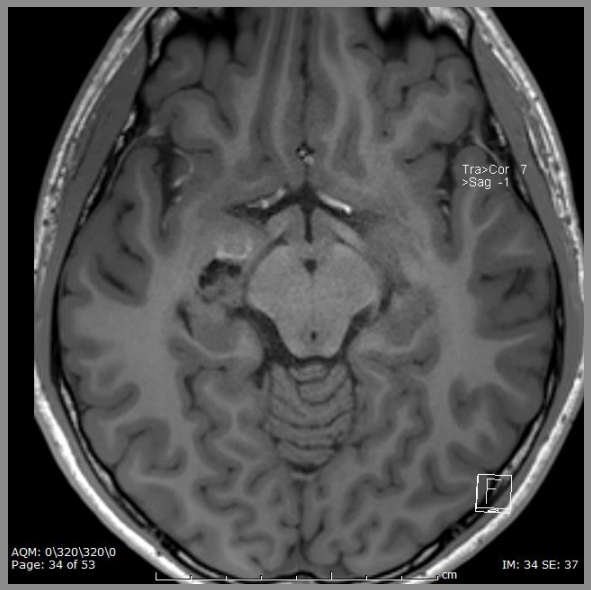
SWI-PHASE IMAGE



*DNET

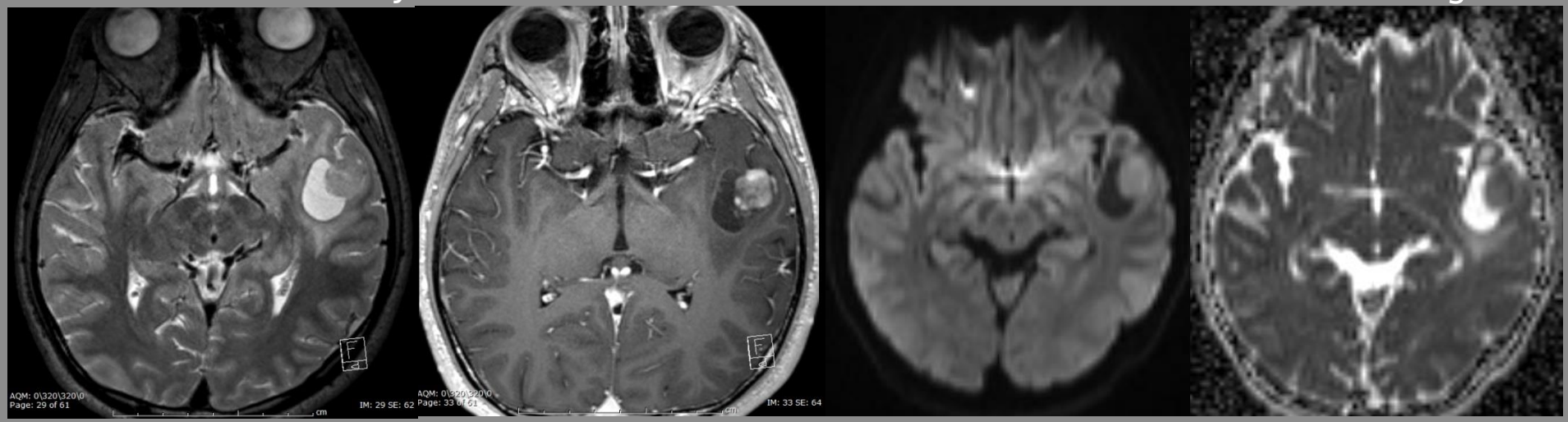
A 13 year-old boy had complex partial seizure during sleep.

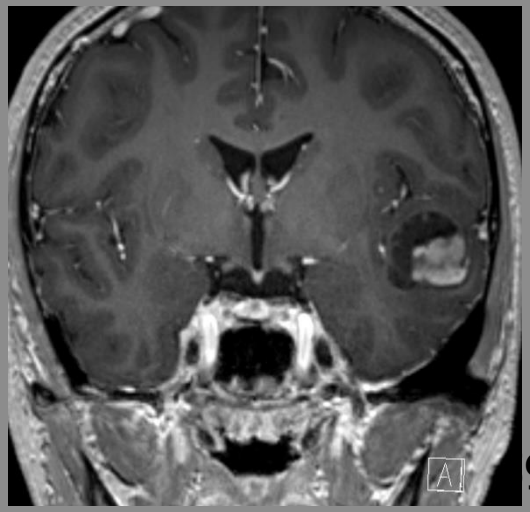


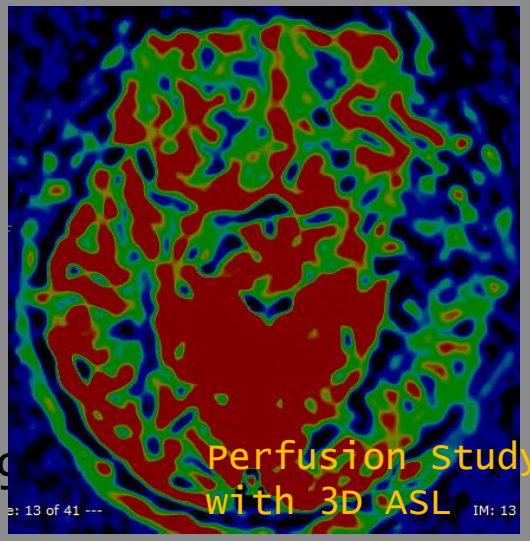


* Pleomorphic xanthoastrocytoma

A 16 year-old male had first seizure attack 10 months ago.

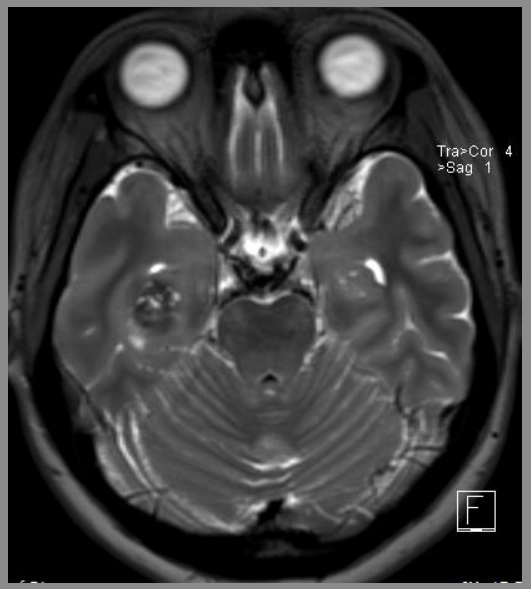


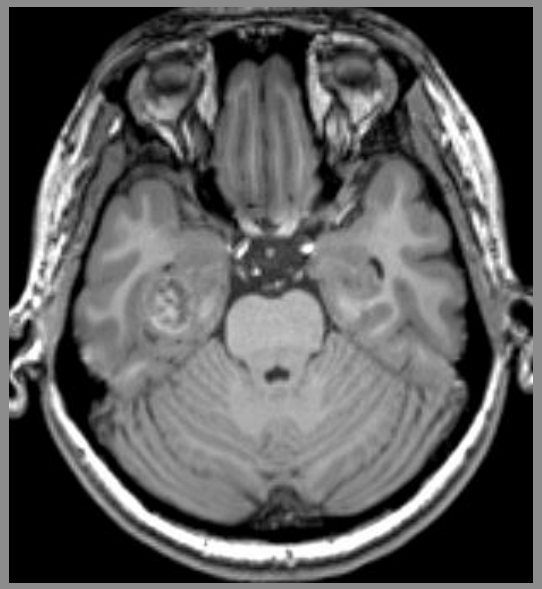


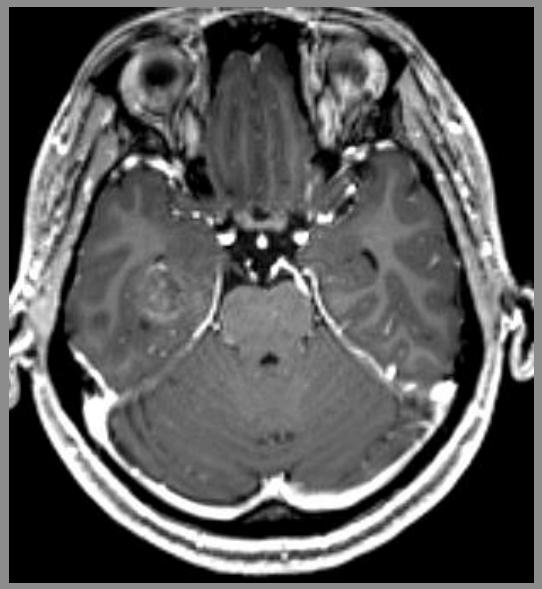


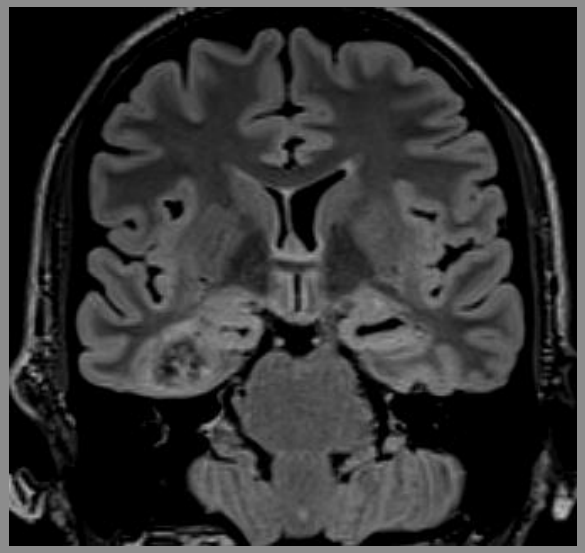
*Oligodendroglioma

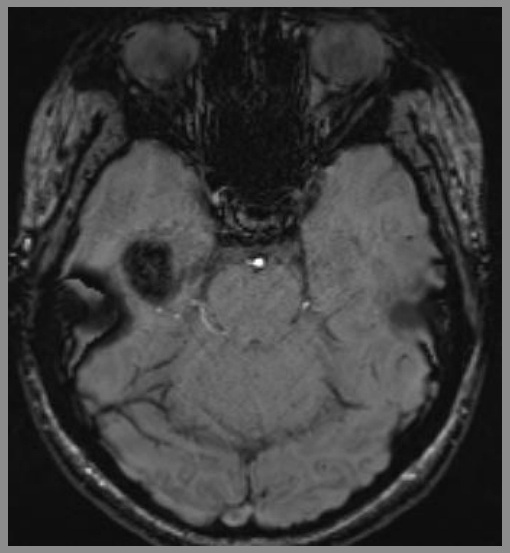
A 26 year-old female had seizure for 9 months.



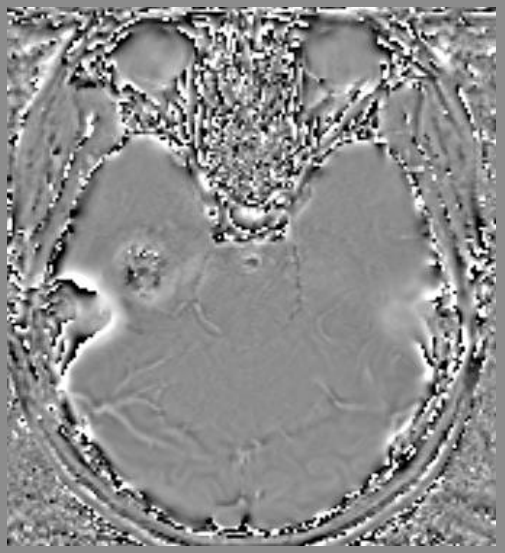








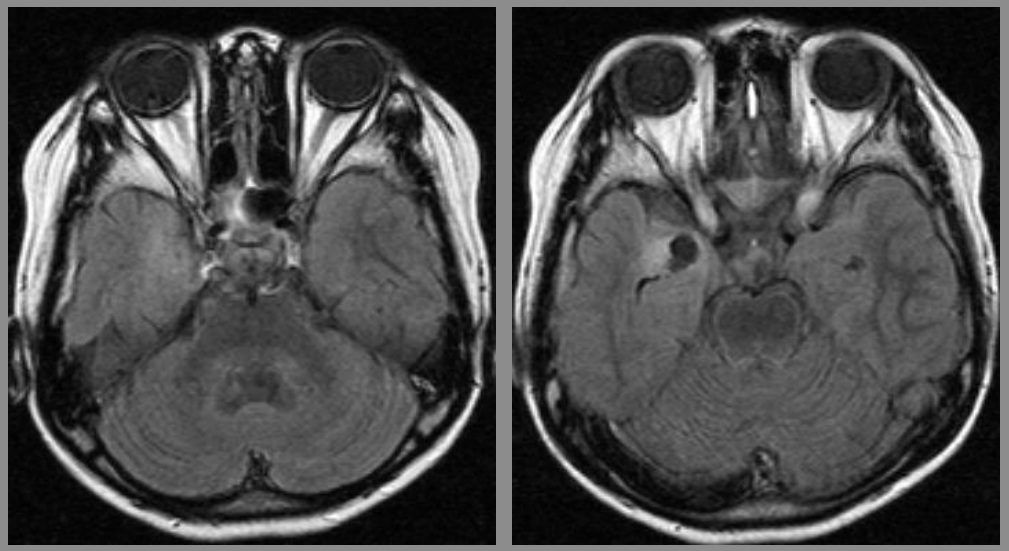
SWI-SOURCE IMAGE

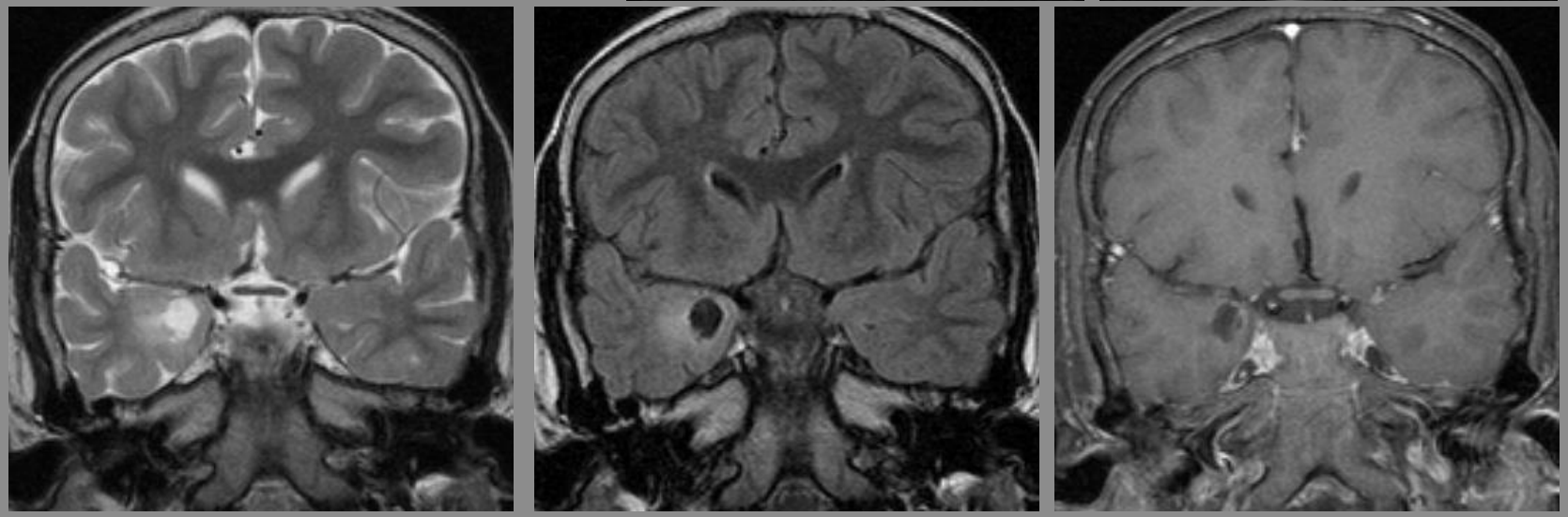


SWI-PHASE IMAGE

* Ganglioglioma

- Benign mixed solid&cystic cortically based lesion, often calcification, variable enhancement, common location, temporal lobe.

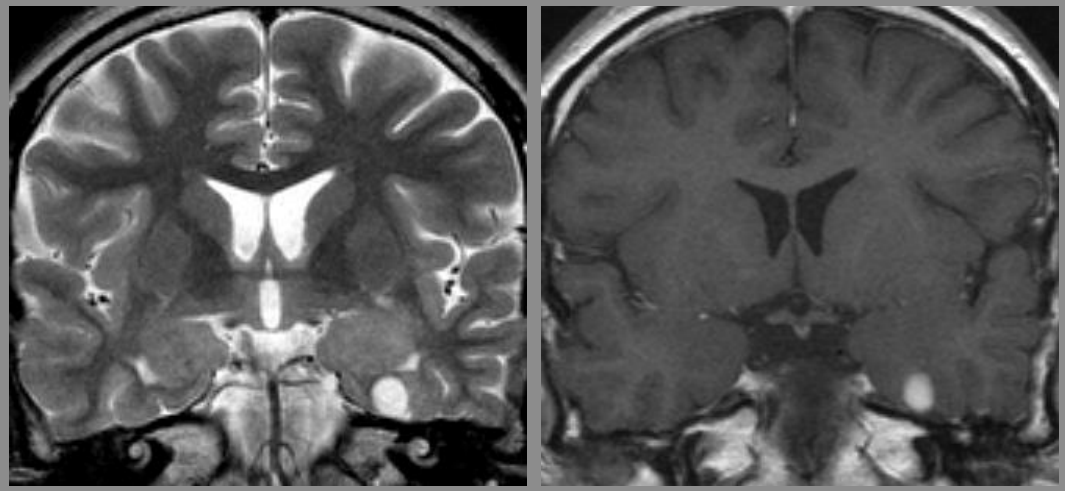


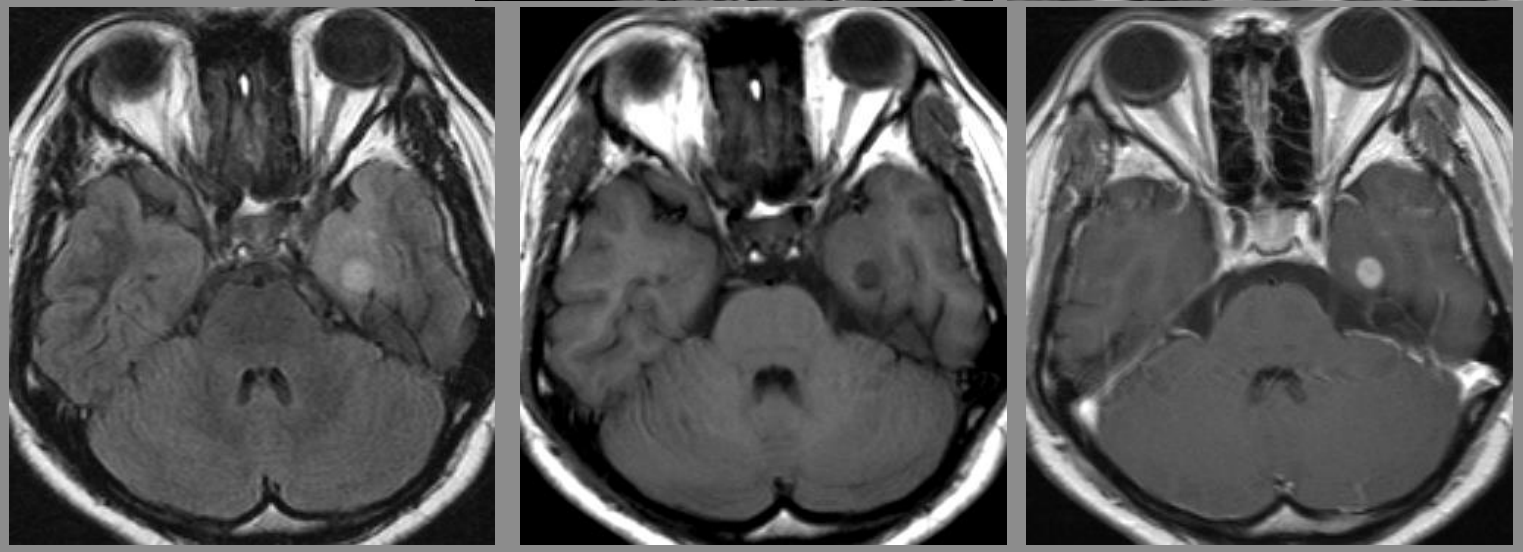


A 8 year-old girl intractable seizure for 3 years.

* Pilocytic Astrocytoma

- Age of onset : 8-13 years
- The mesial temporal lobe is classical location.
- Imaging: A cyst with an enhancing nodule. Variable enhancement of cyst wall.

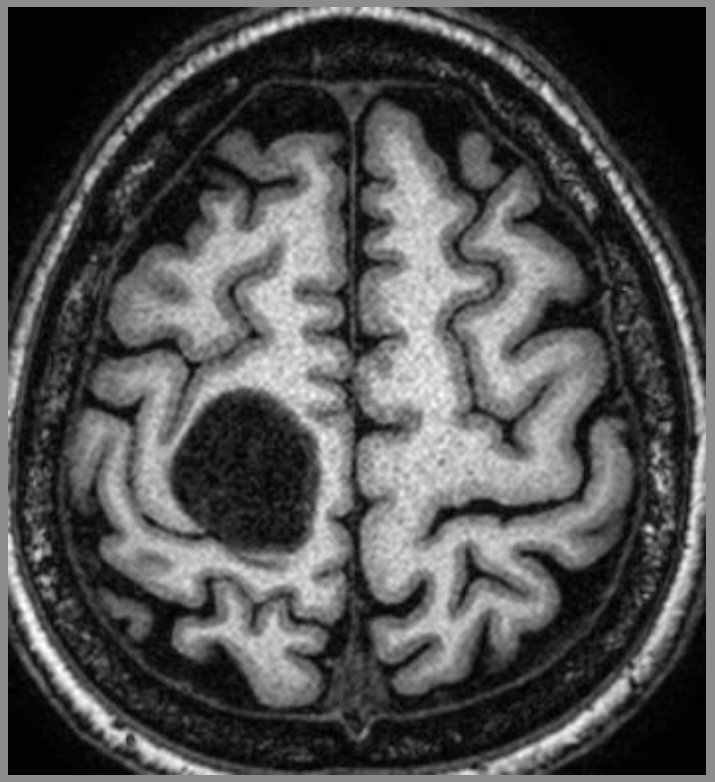


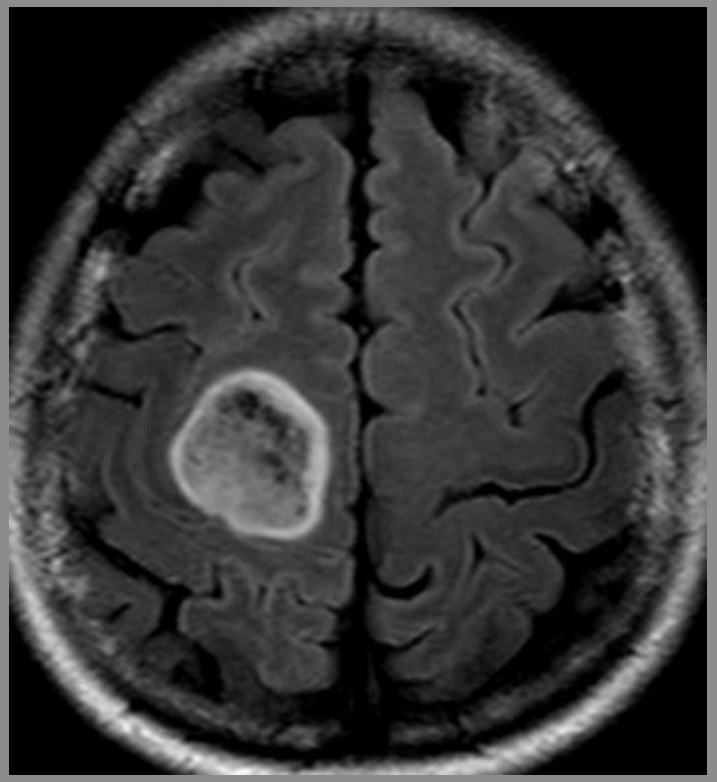


A 17 year-old female complex partial seizure for 5 years.

*Presurgical Evaluation

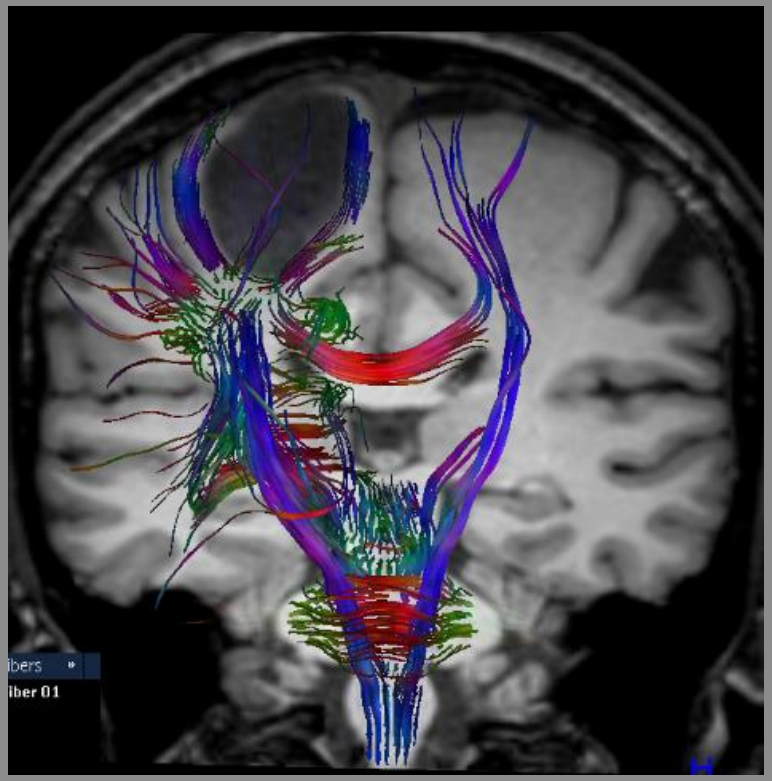
*Astrocytoma

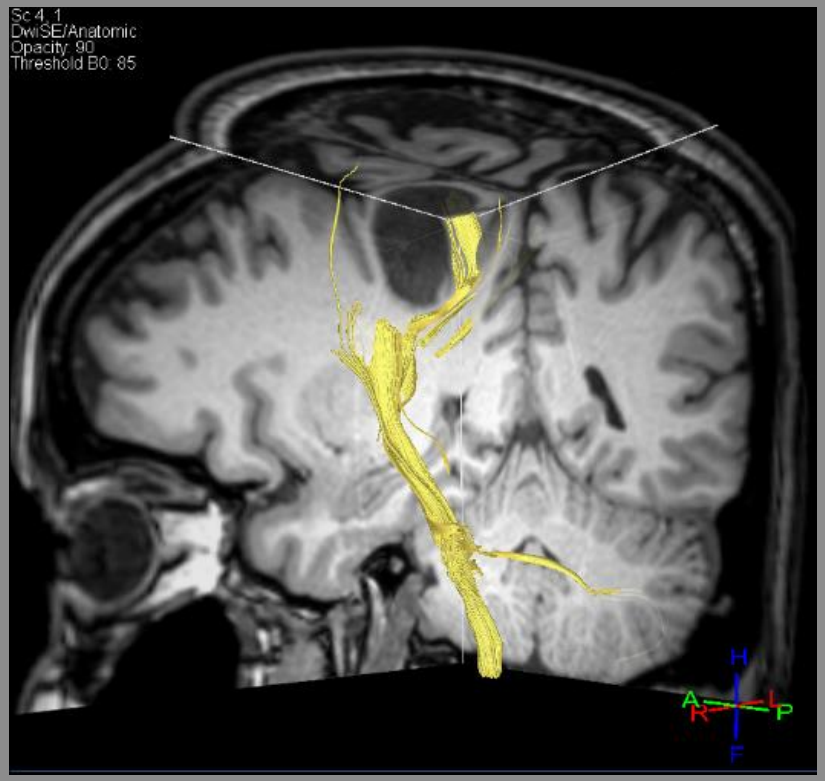




A 40 year-old female focal seizure of left upper limb for ½ year.

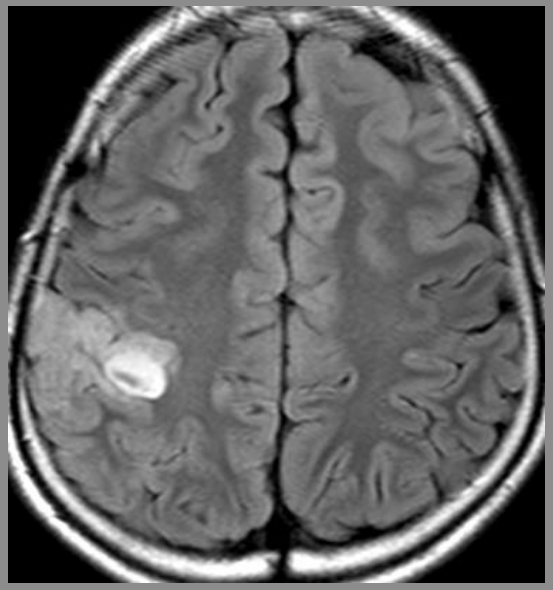
*Astrocytoma

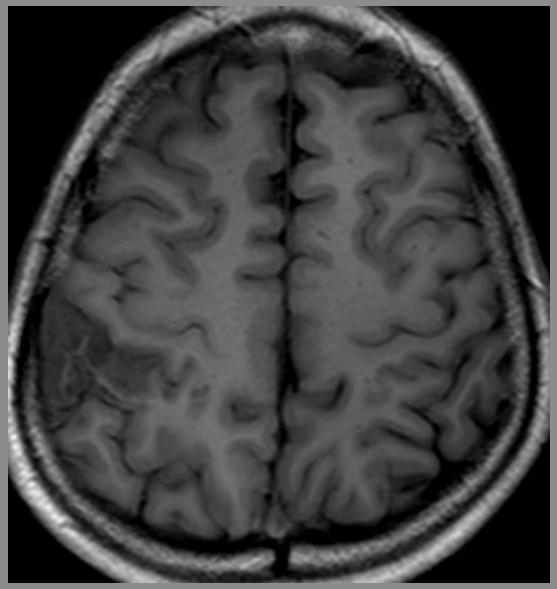


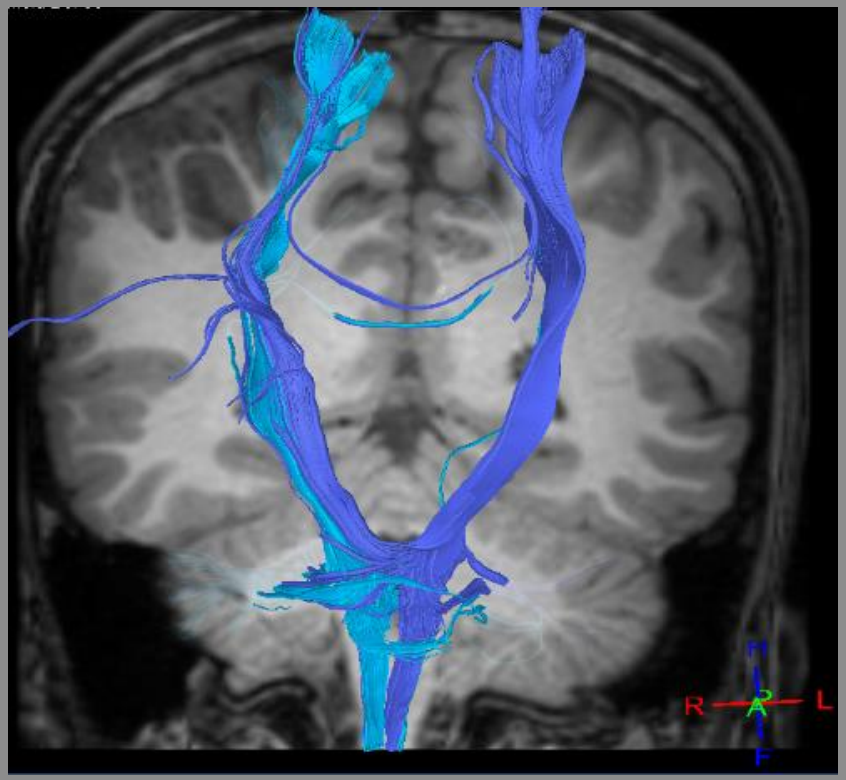


A 40 year-old female focal seizure of left upper limb for ½ year.

*DNET

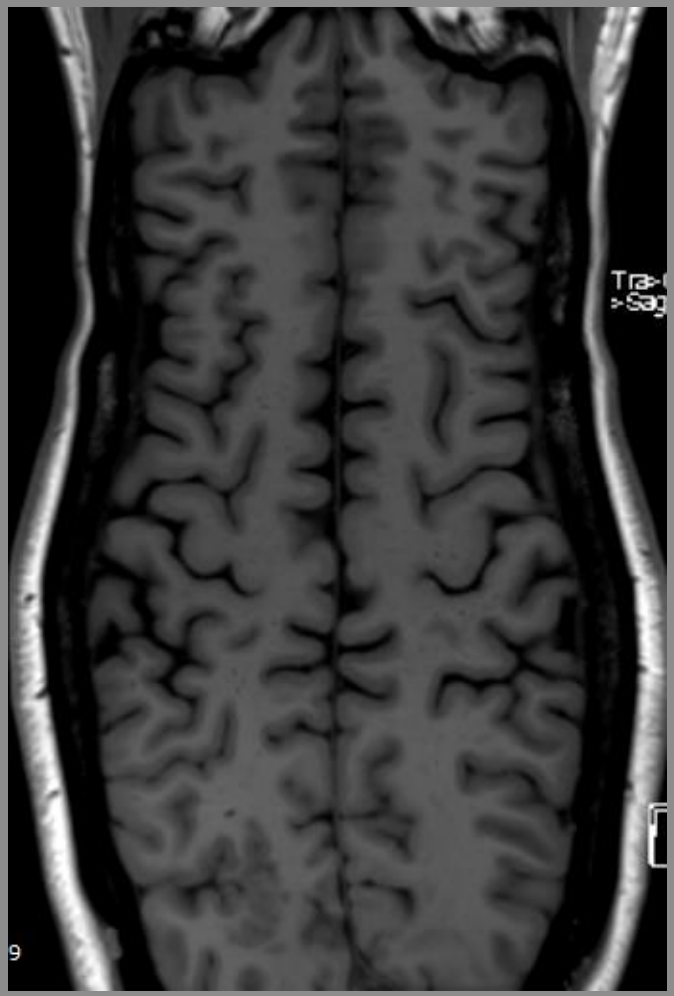


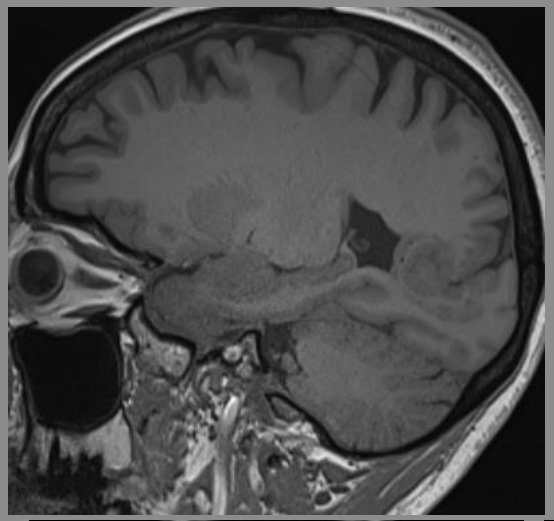


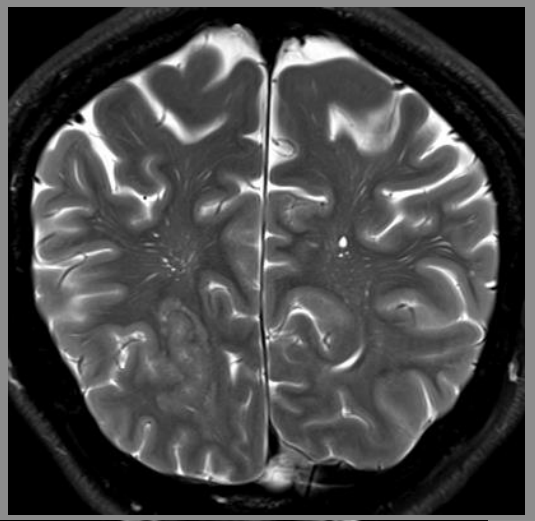


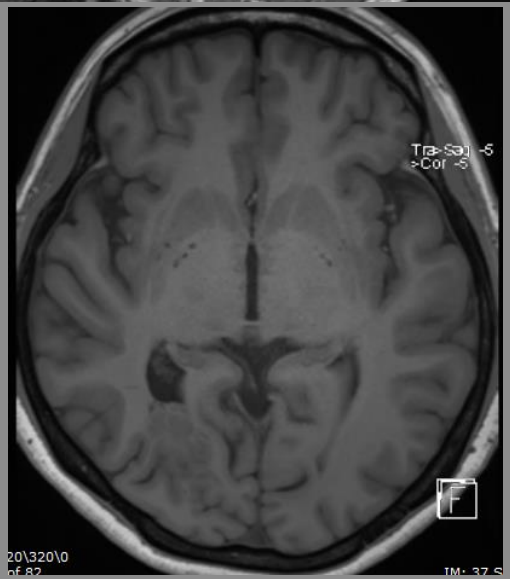
A 13 year-old boy left-sided prior to generalized epilepsy.

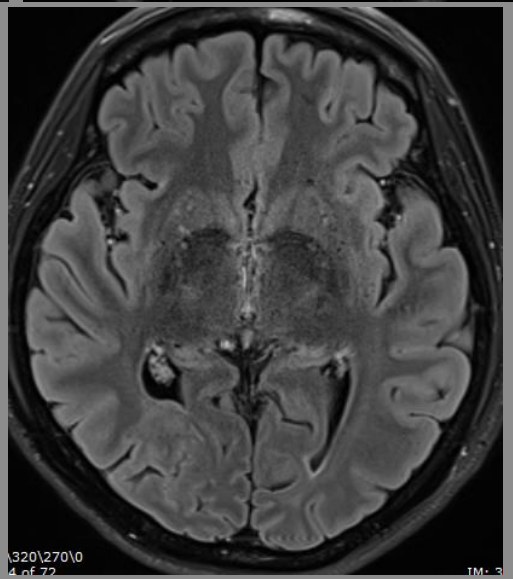
* Subcortical heterotopia at the right occipital lobe



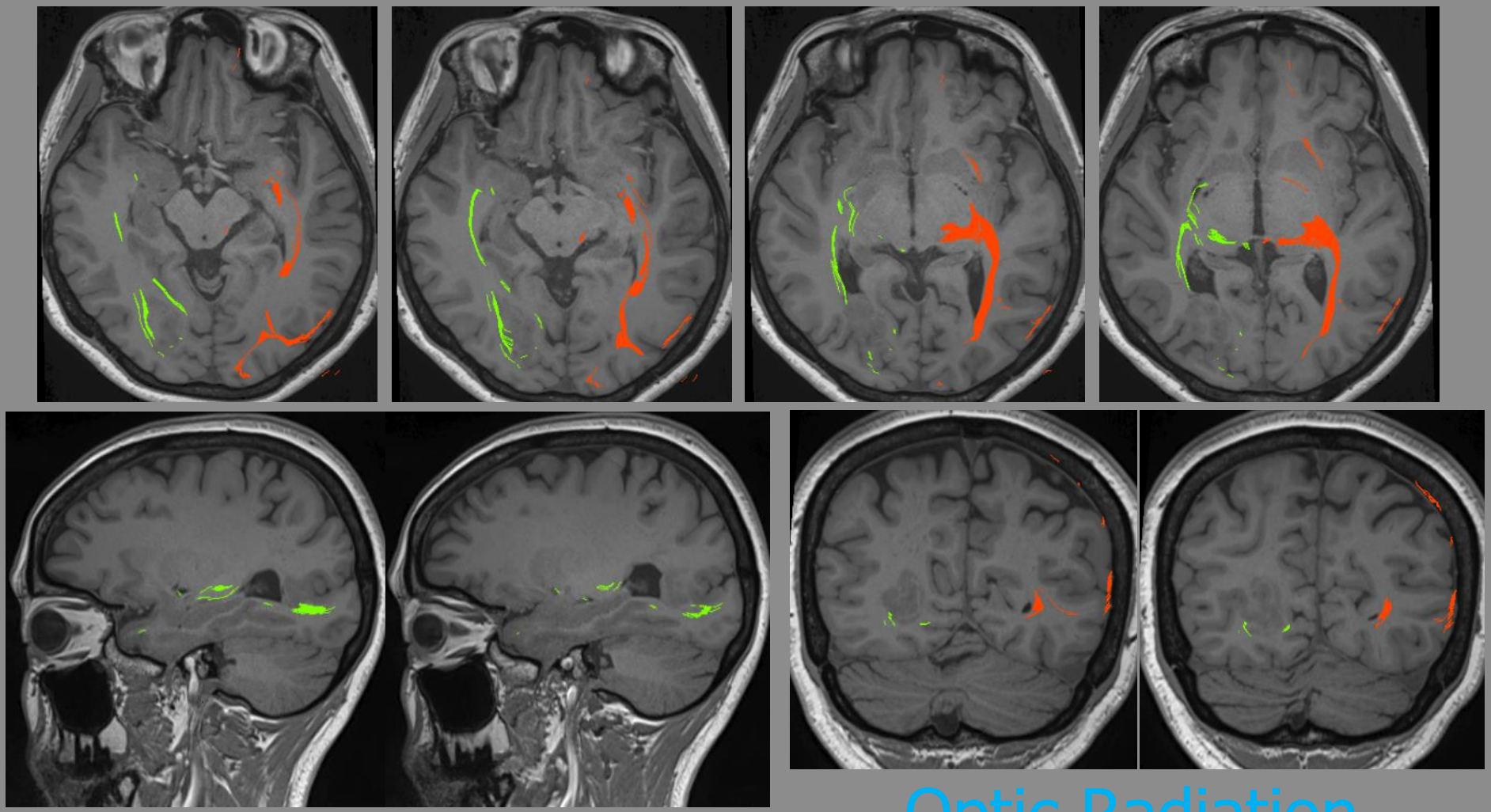








* Subcortical heterotopia at the right occipital lobe

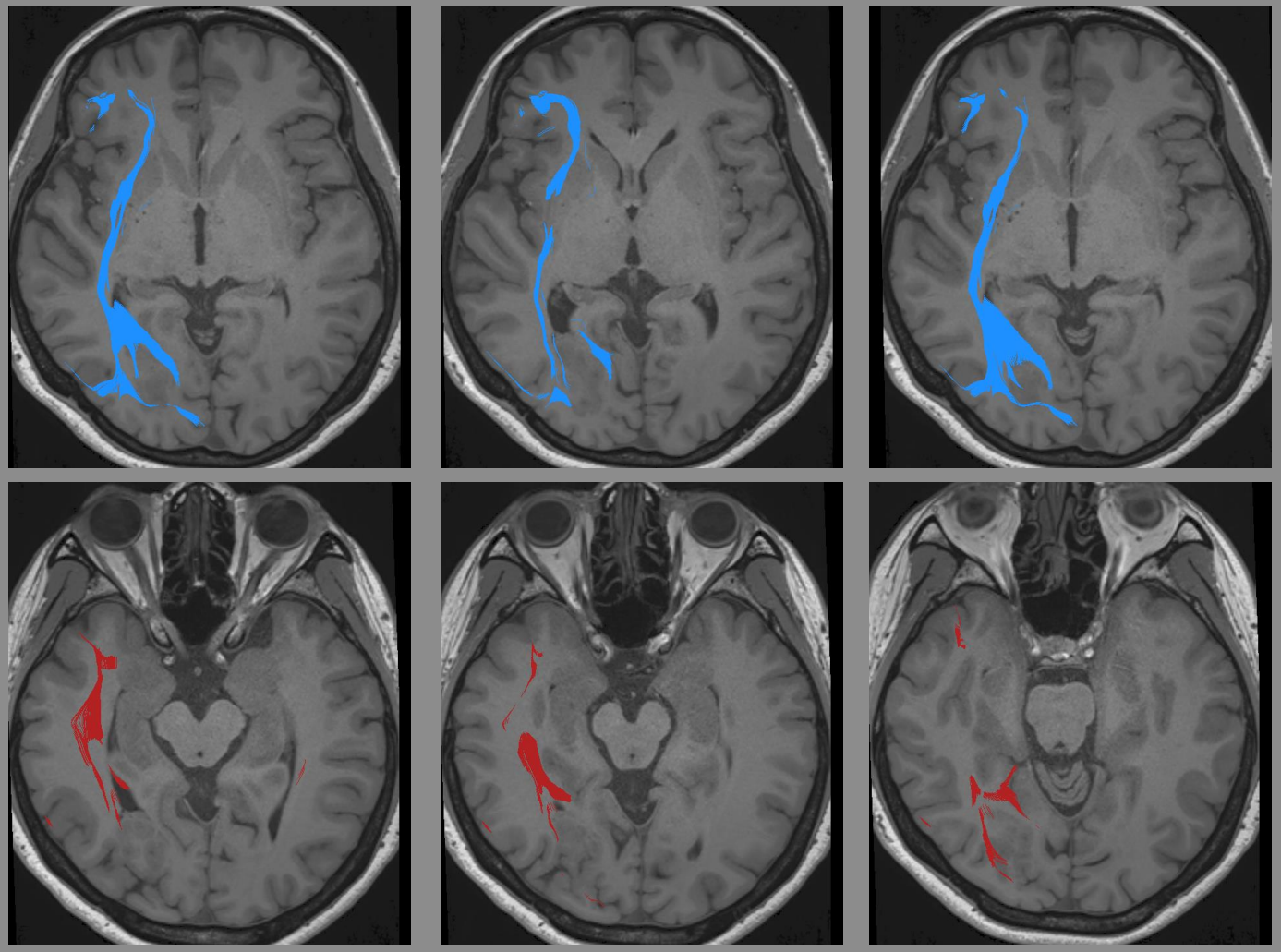


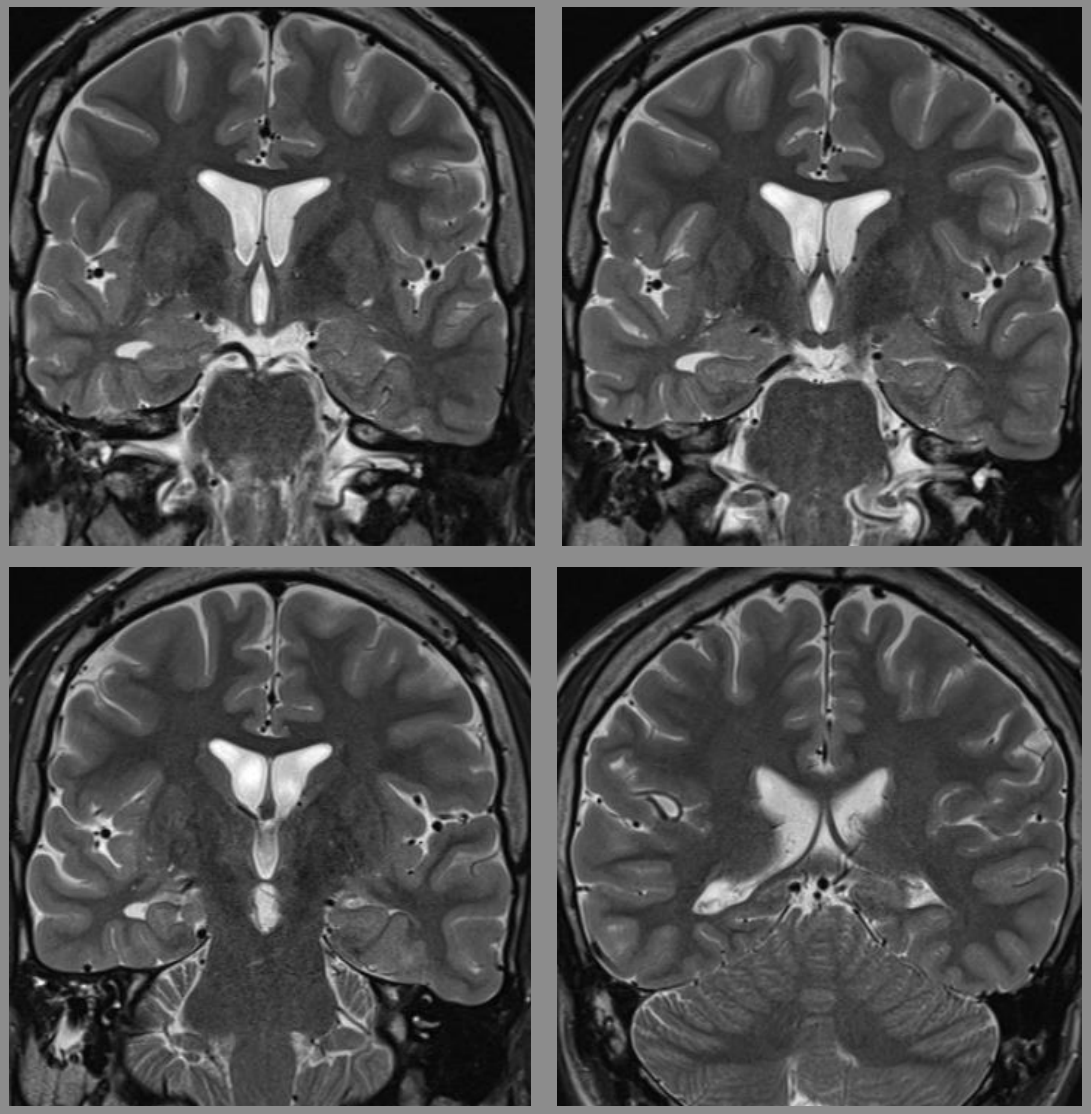
Optic Radiation

* Subcortical heterotopia at the right occipital lobe

IFOF

ILF





* M 22 years, left handedness, had right mesial temporal sclerosis

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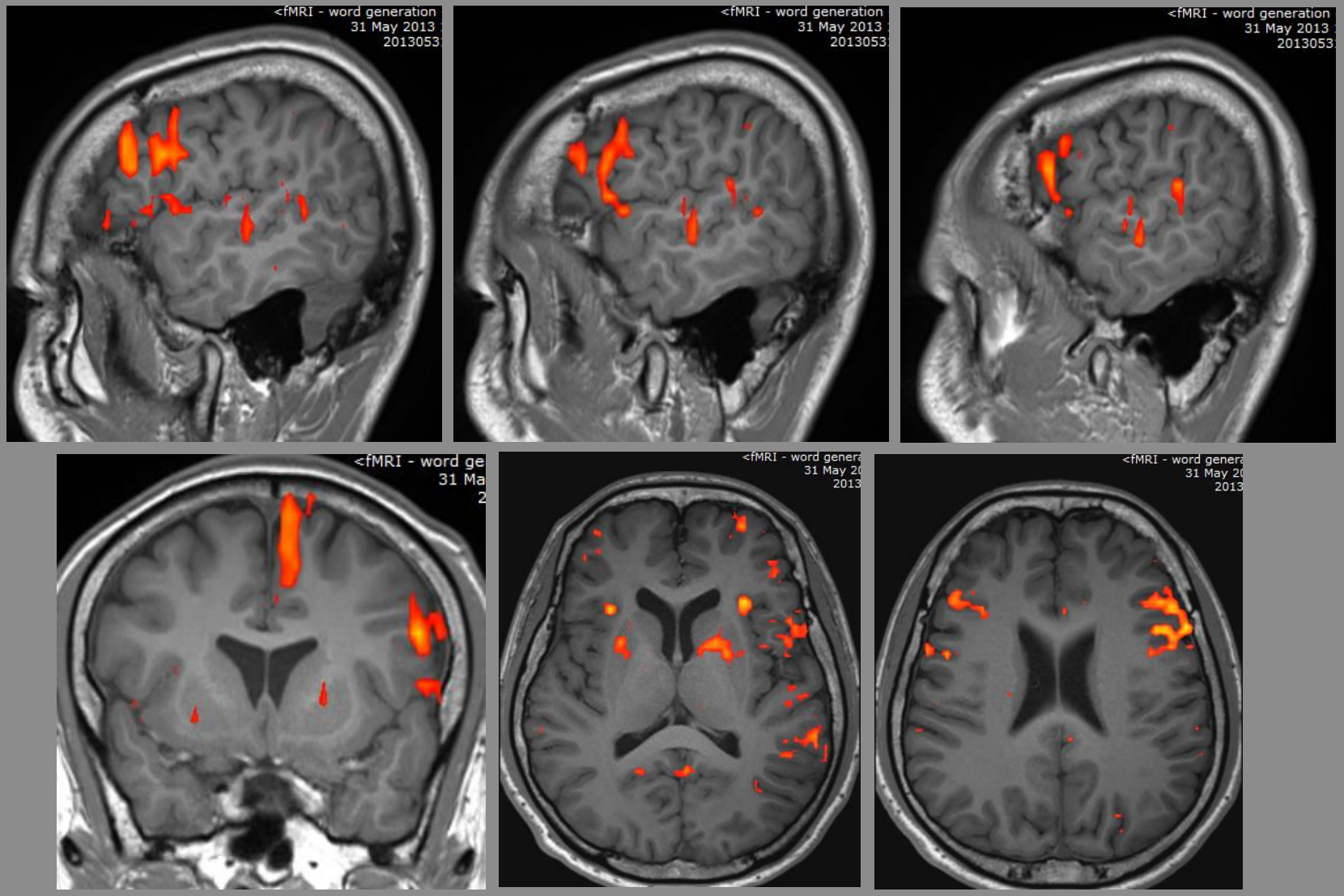
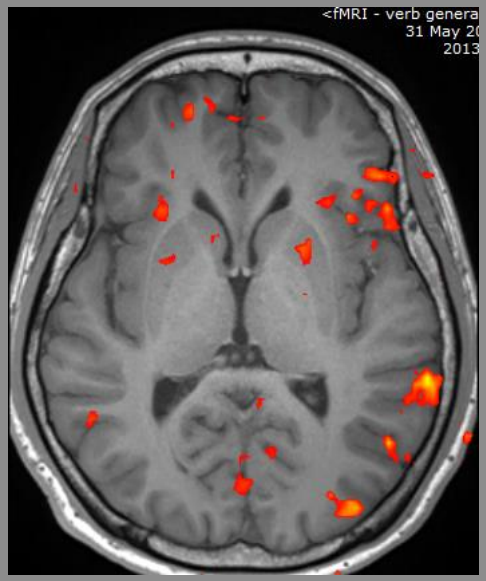
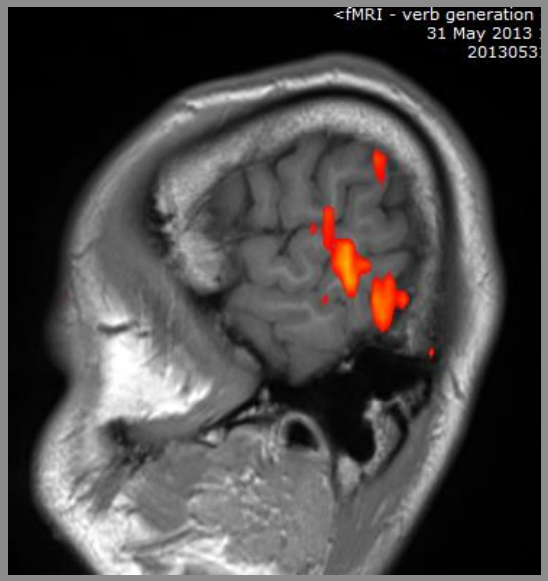
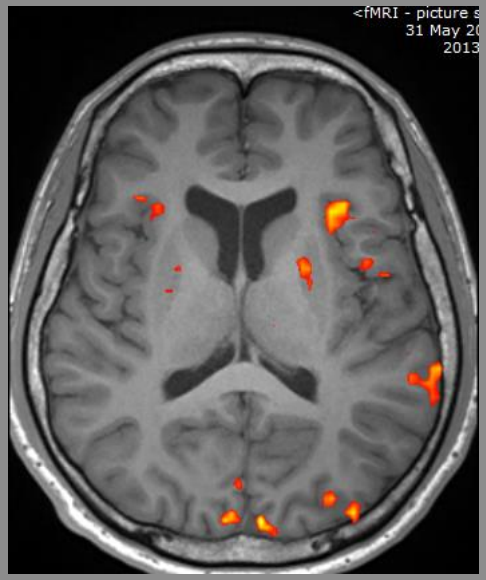
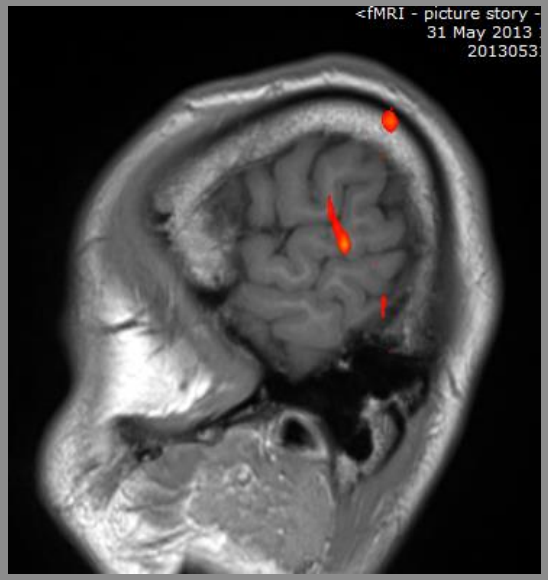


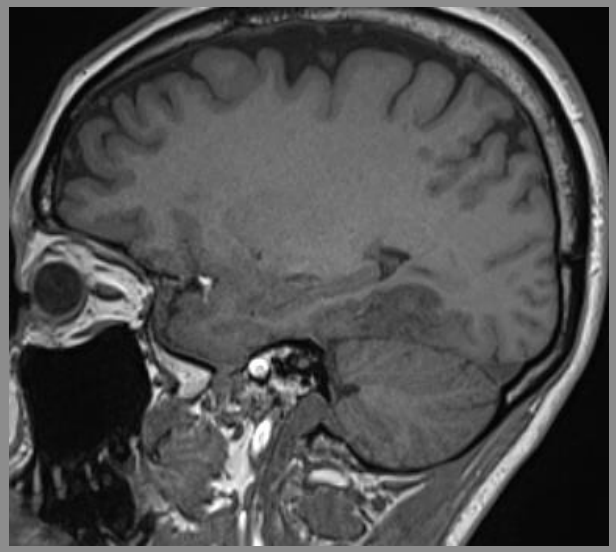
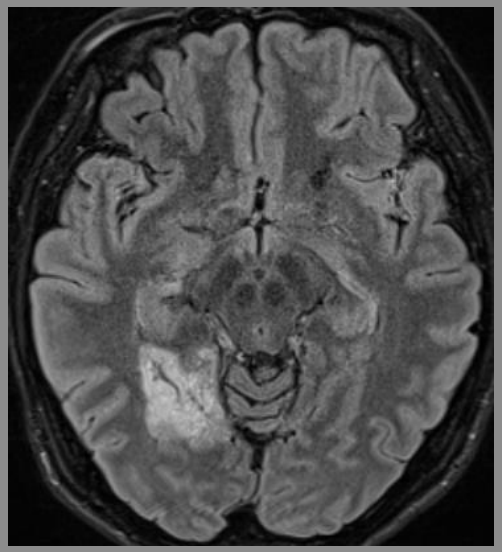
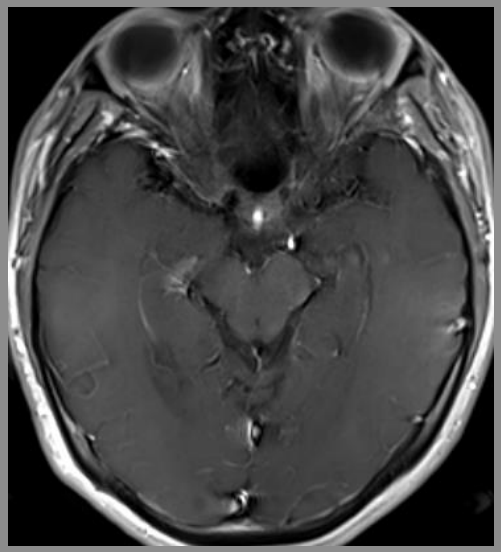
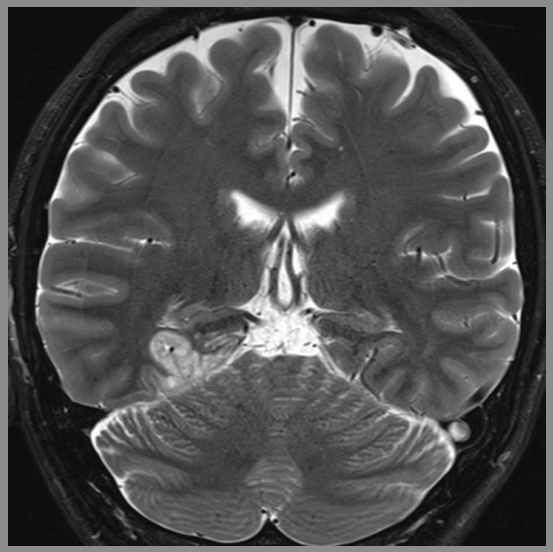
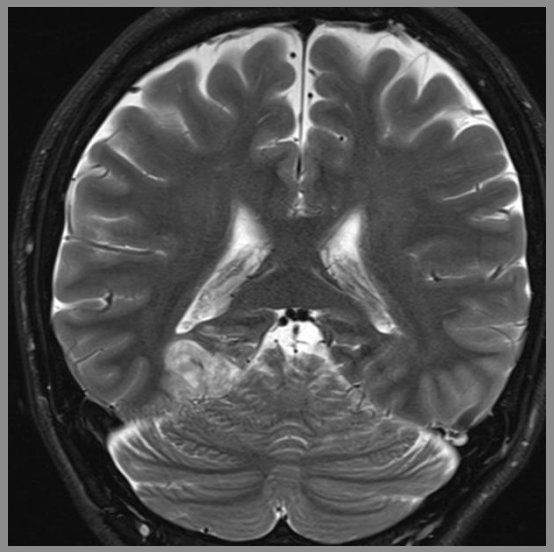








* M 22 years, left handedness, had right mesial temporal sclerosis

* A 28 year-old female, left handedness, had seizure with palpitation and chewing.

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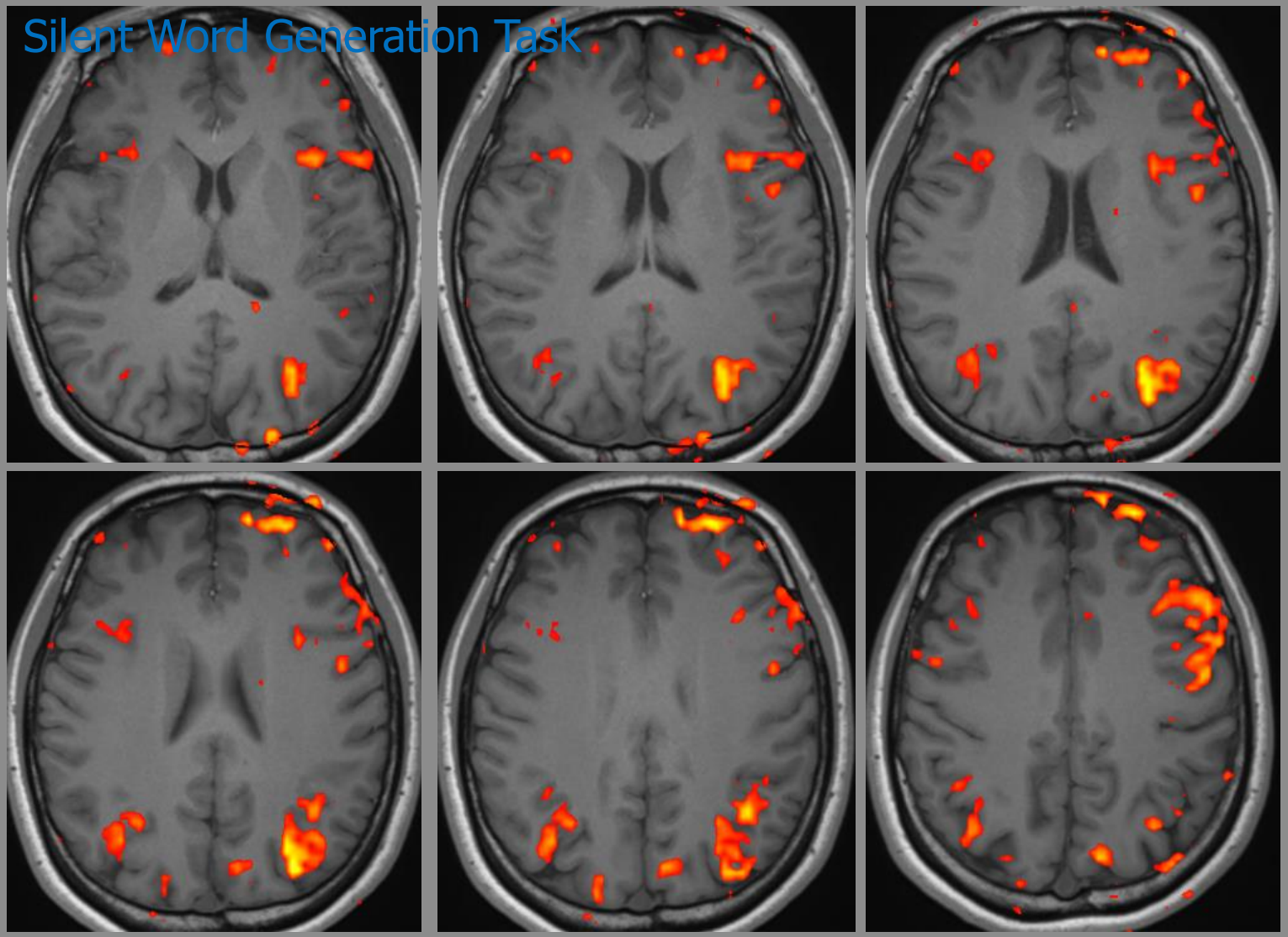
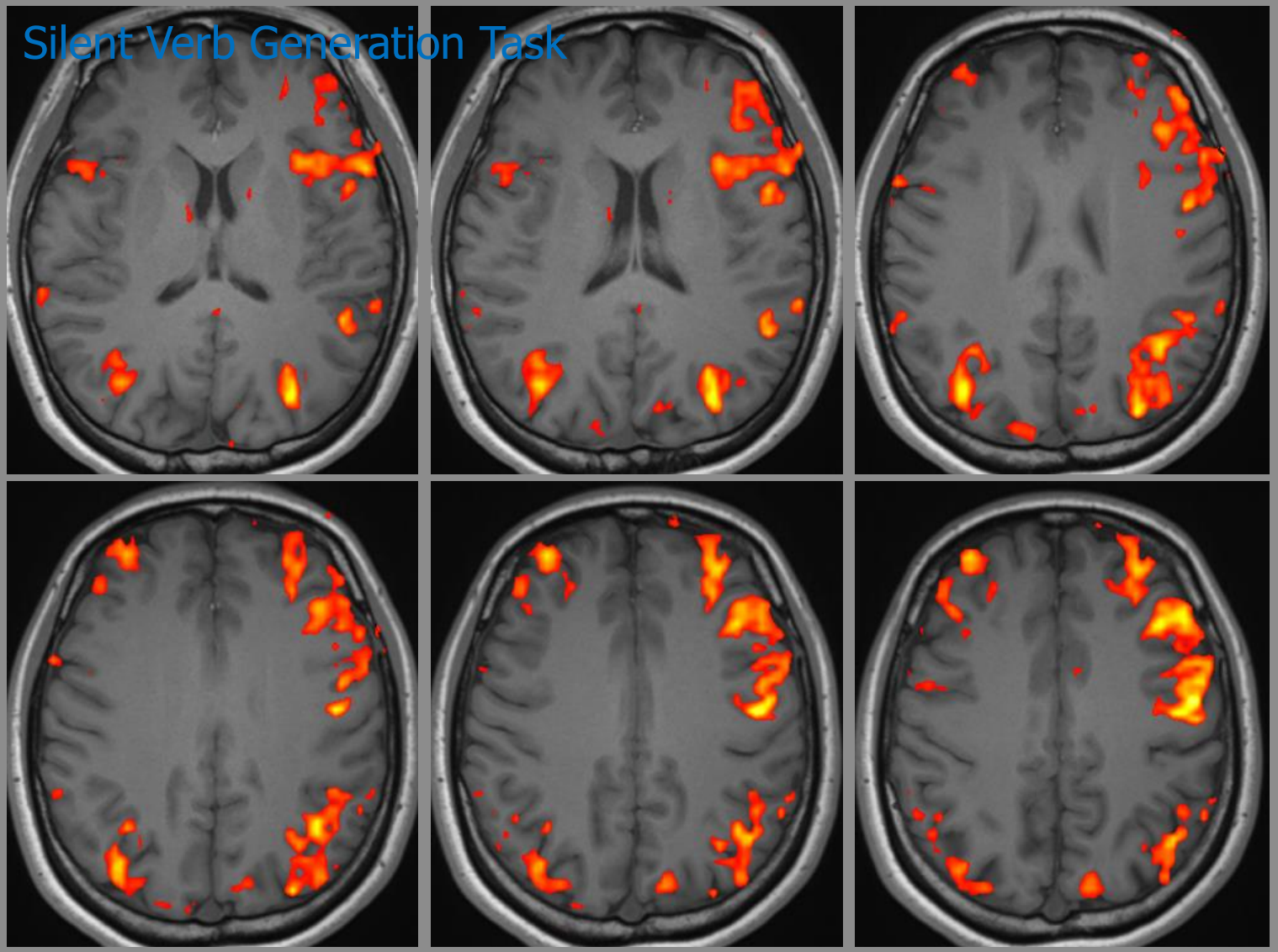
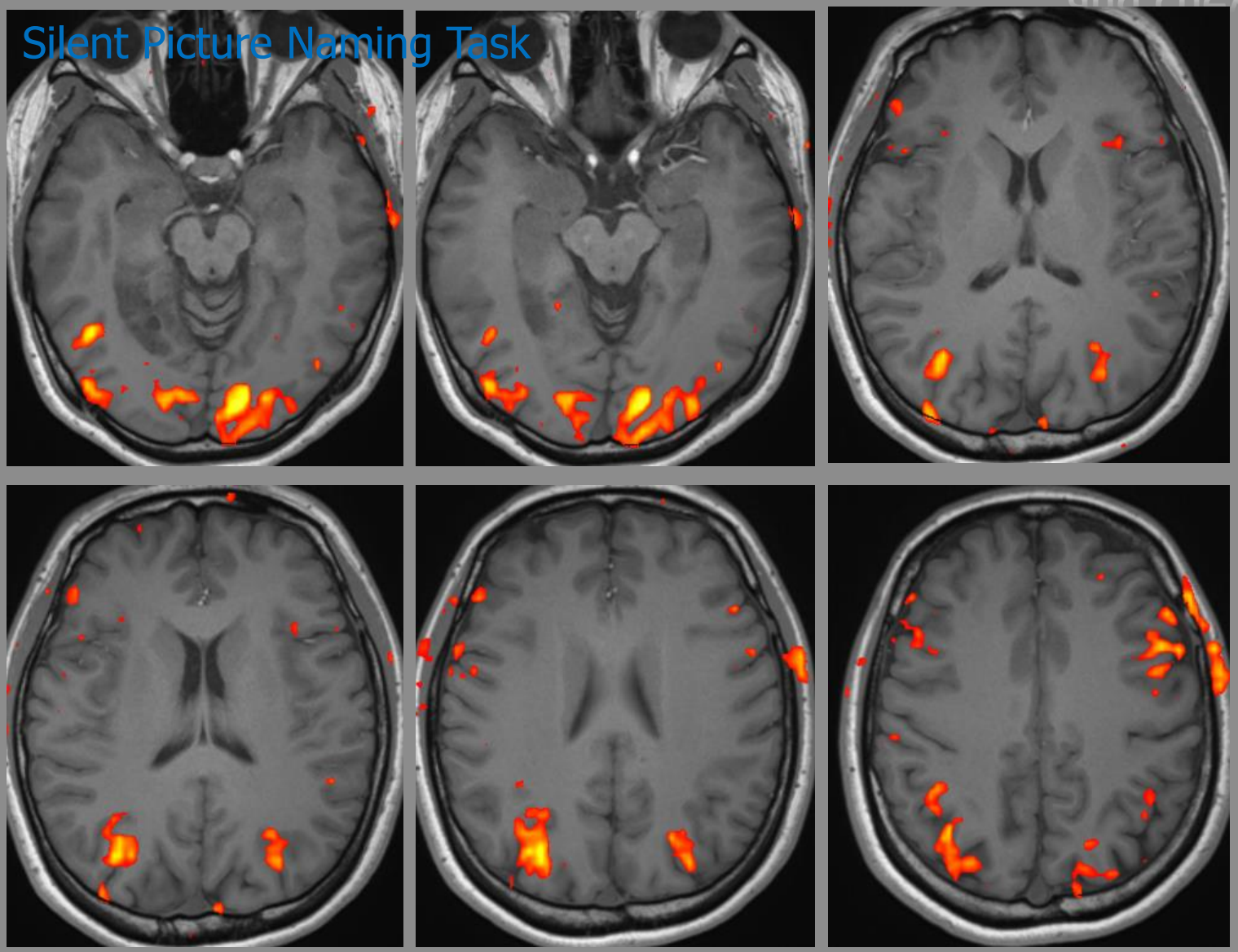


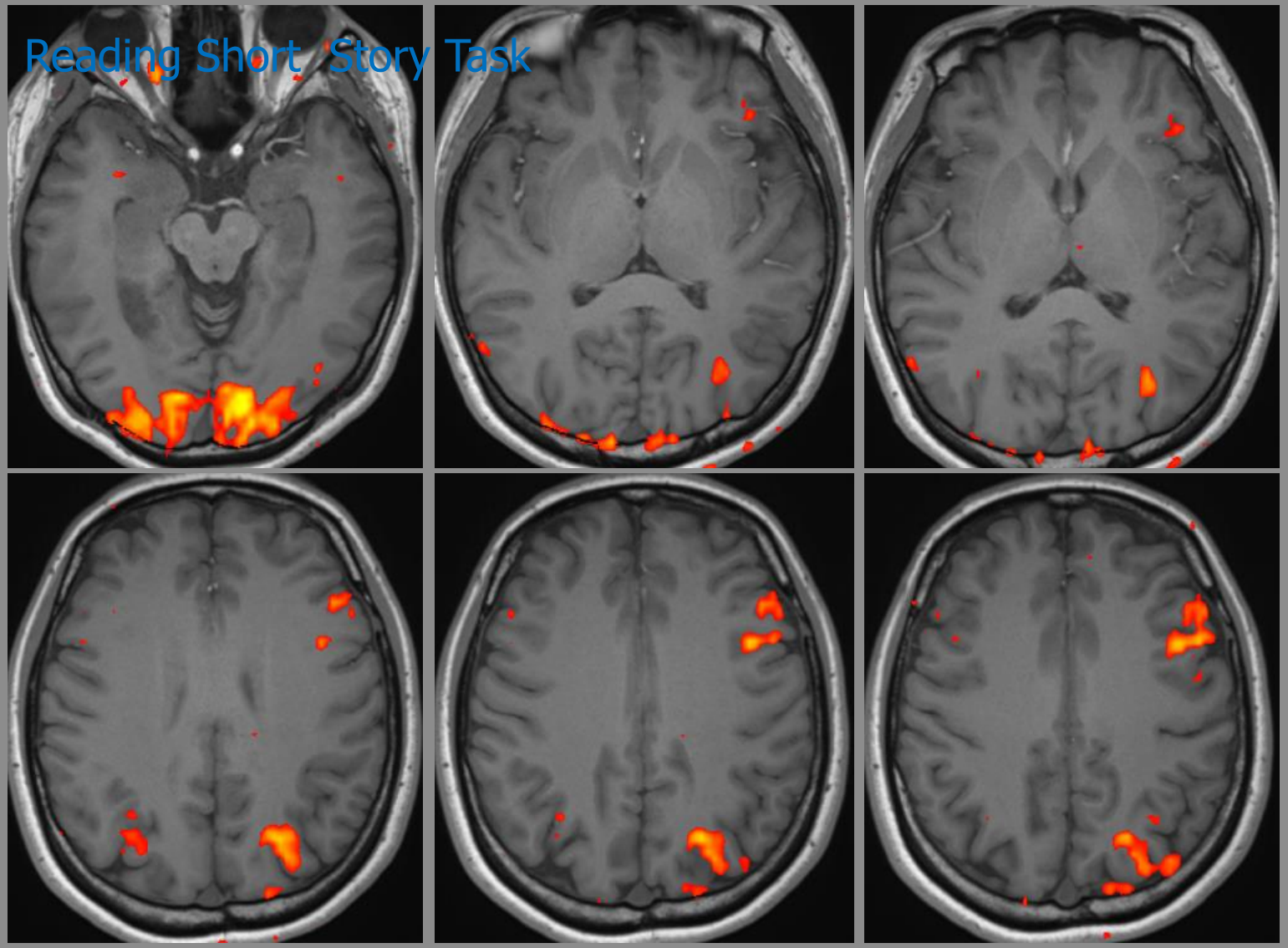
* A 28 year-old female, left handedness, had seizure with palpitation and chewing.

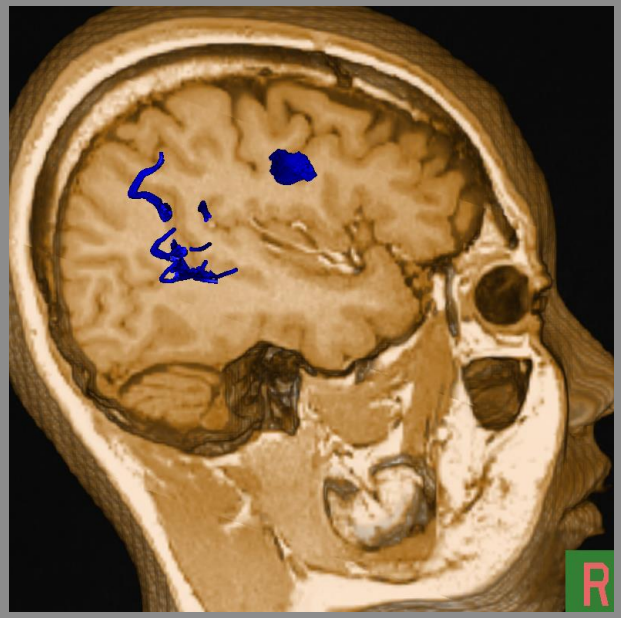


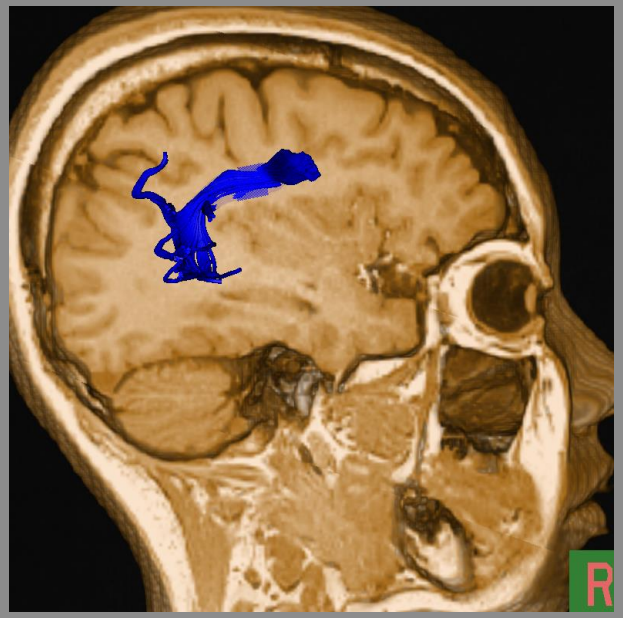
* A 28 year-old female, left handedness, had seizure with palpitation and chewing.

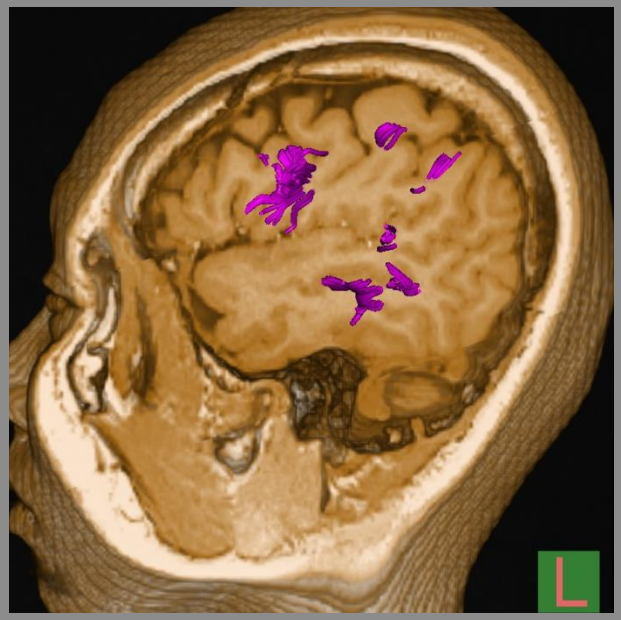


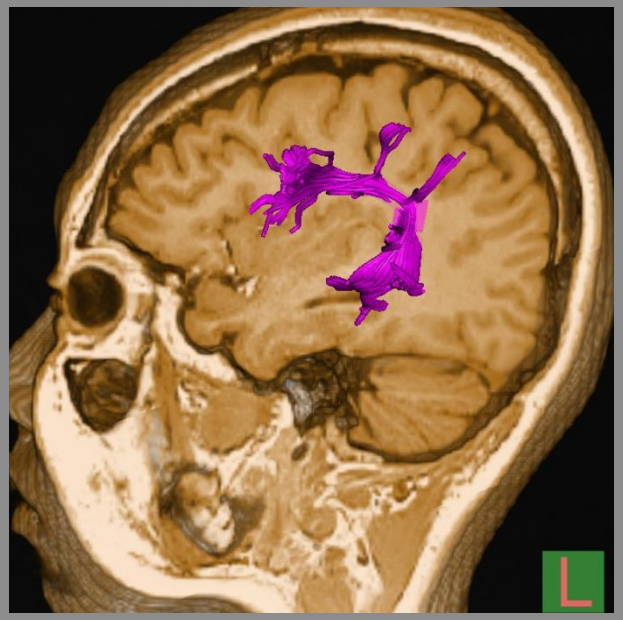
* A 28 year-old female, left handedness, had seizure with palpitation and chewing.



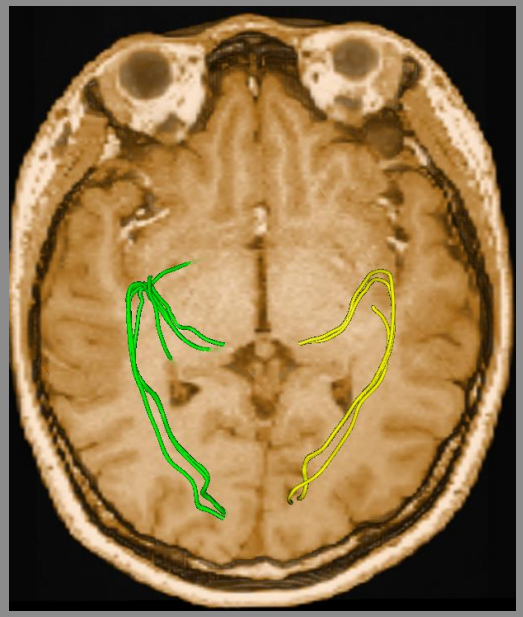


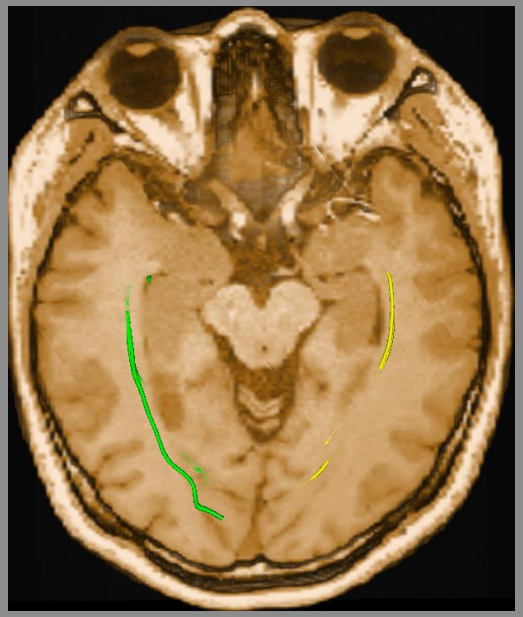


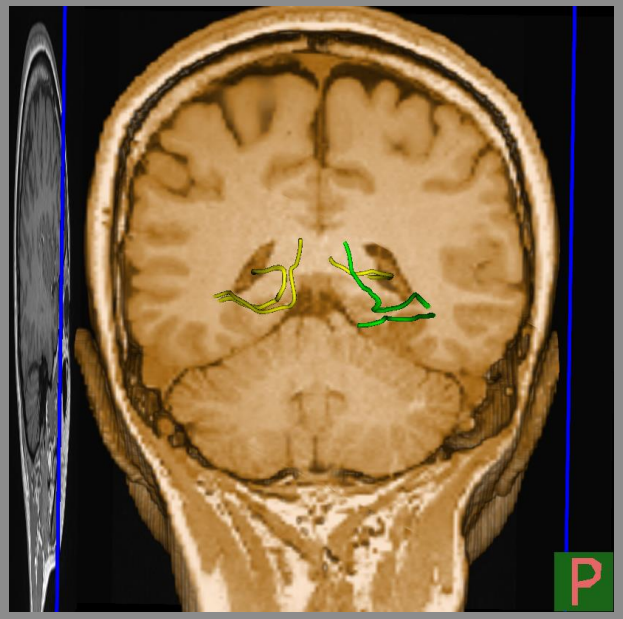


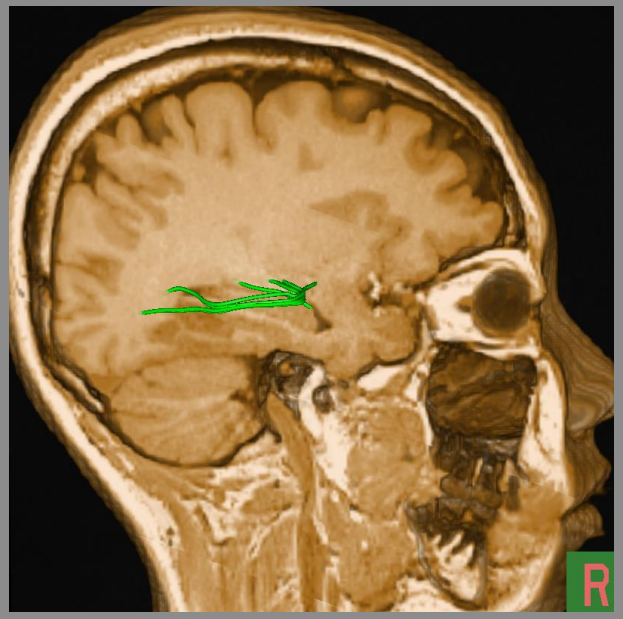


* A 28 year-old female, left handedness, had seizure with palpitation and chewing.



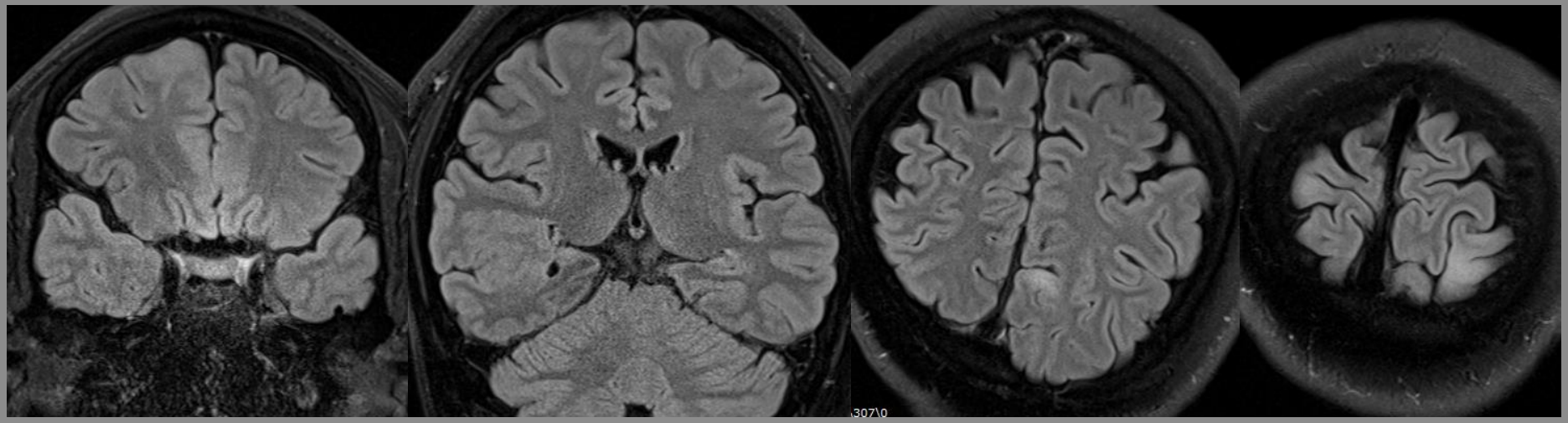


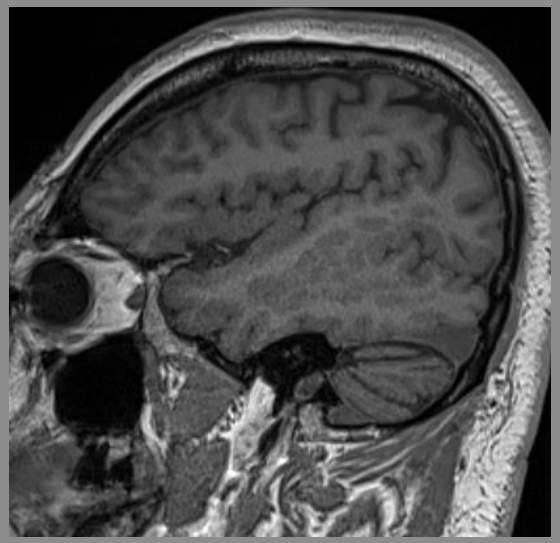


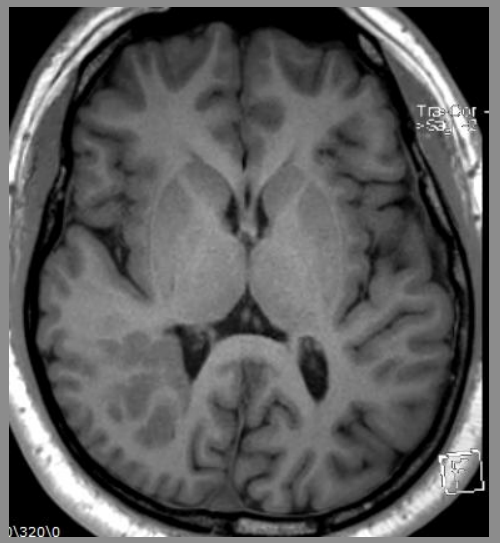


* A 28 year-old female, left handedness, had seizure with palpitation and chewing.

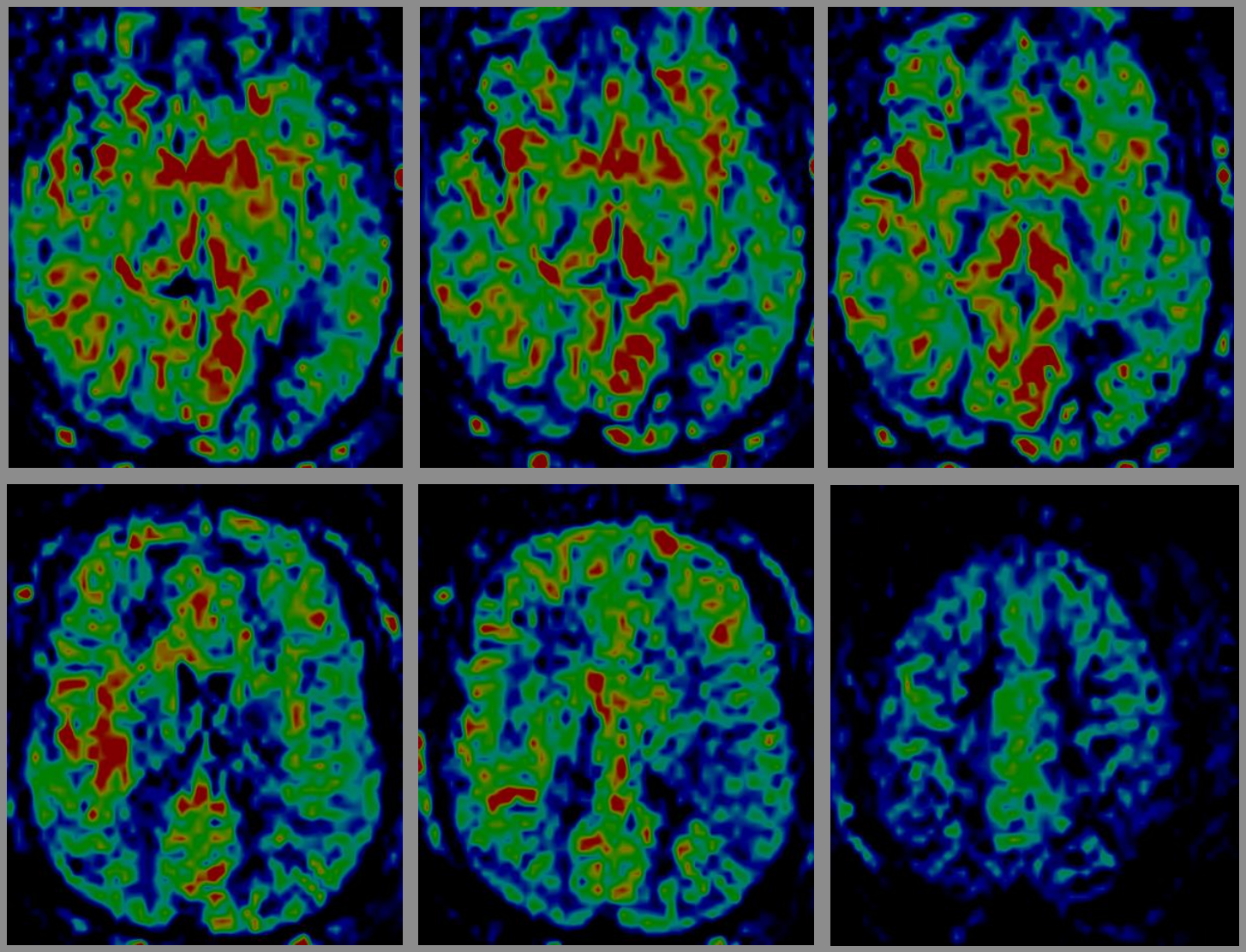
* A 34 year-old male had seizure starting from oral automatism, followed by bimanual automatism.

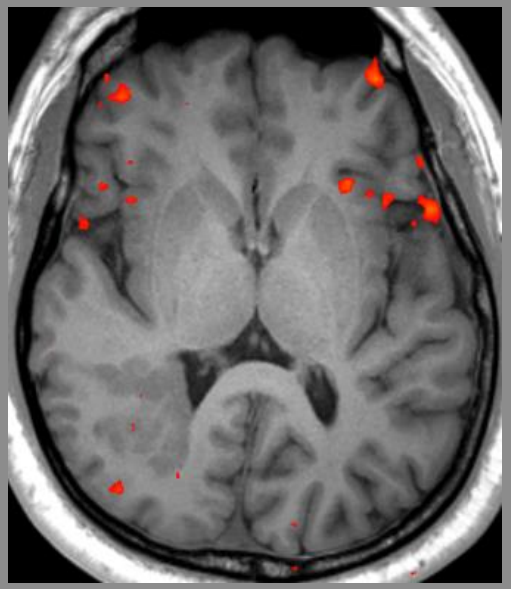
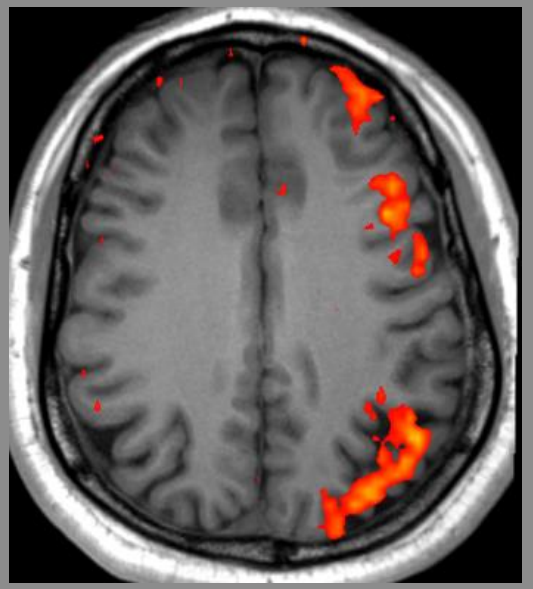
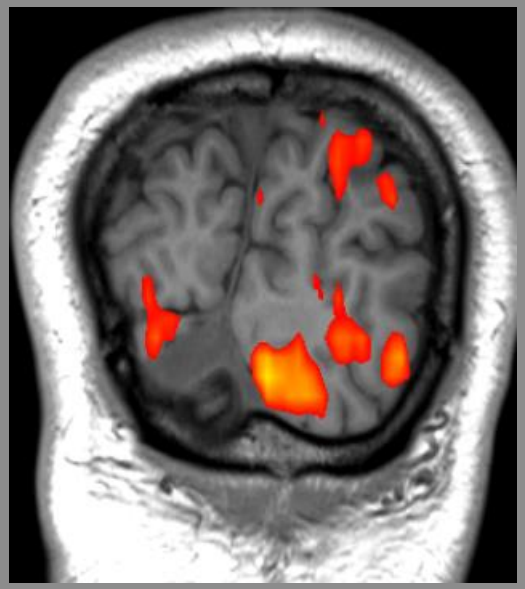
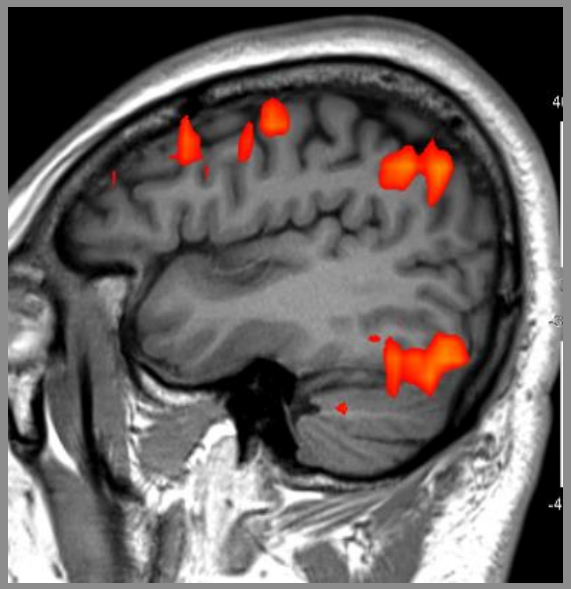




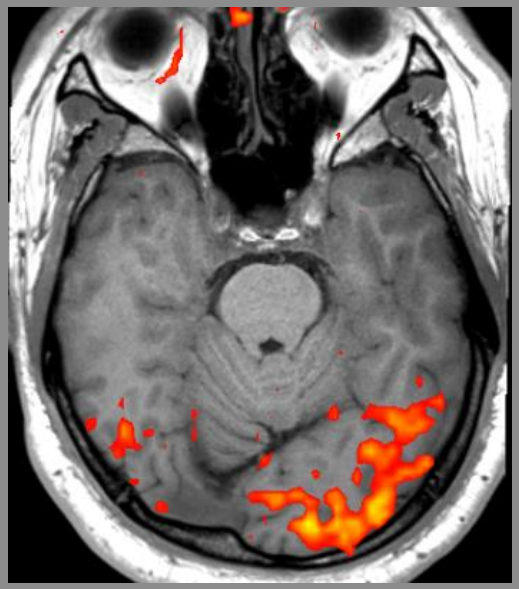
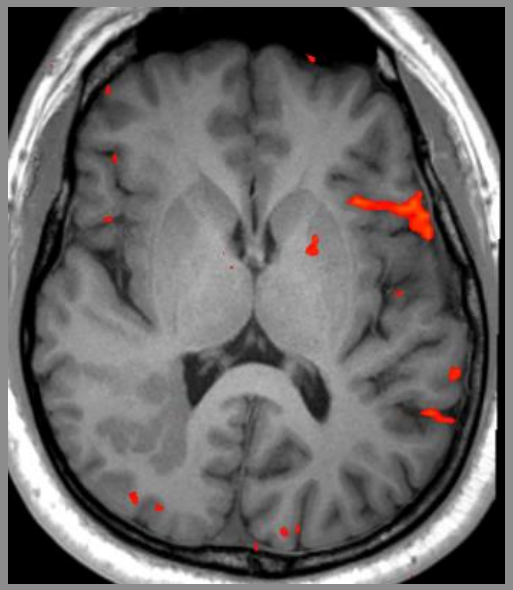
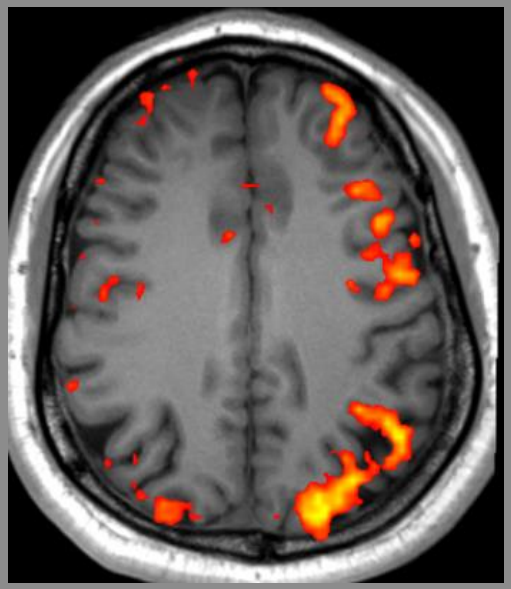
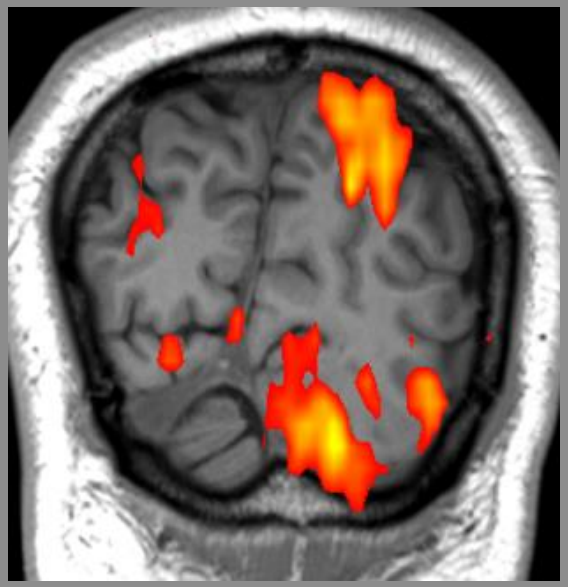
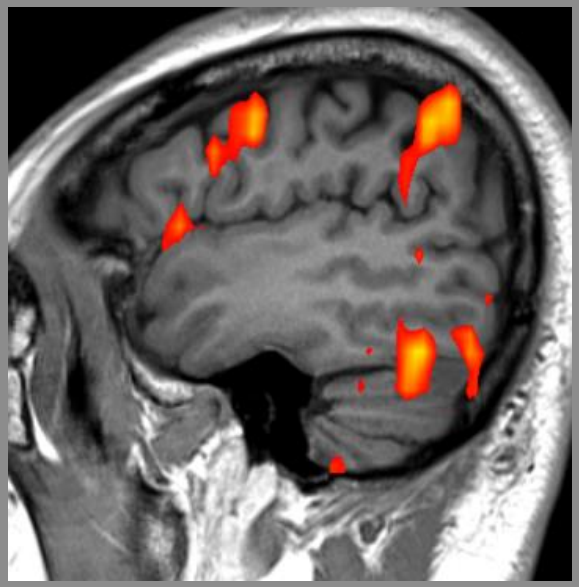


* He had seizure 15-20 minutes before MRI.

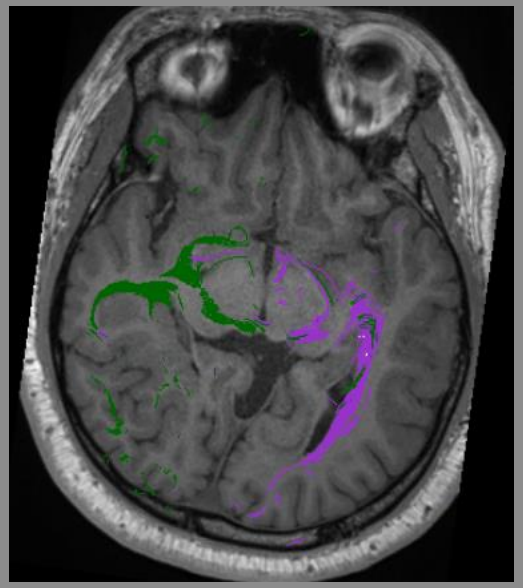


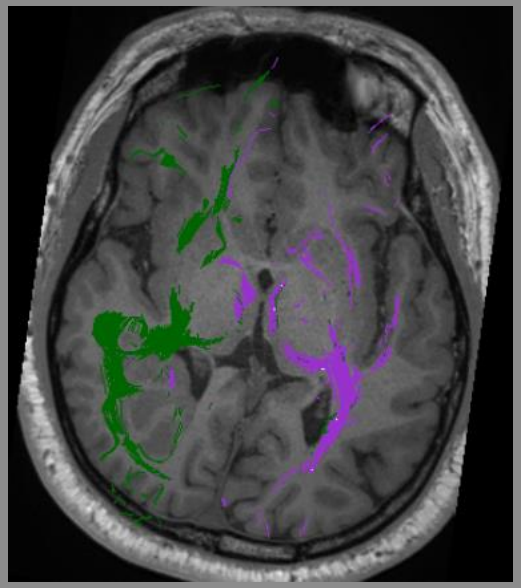






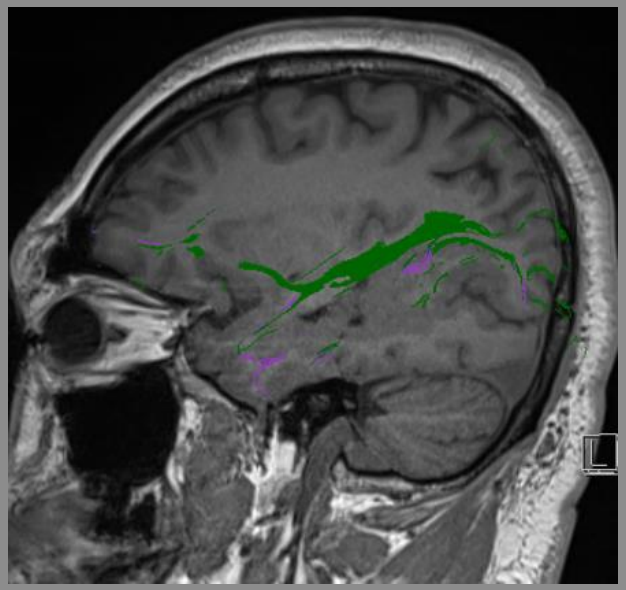
* FMRI- Picture naming

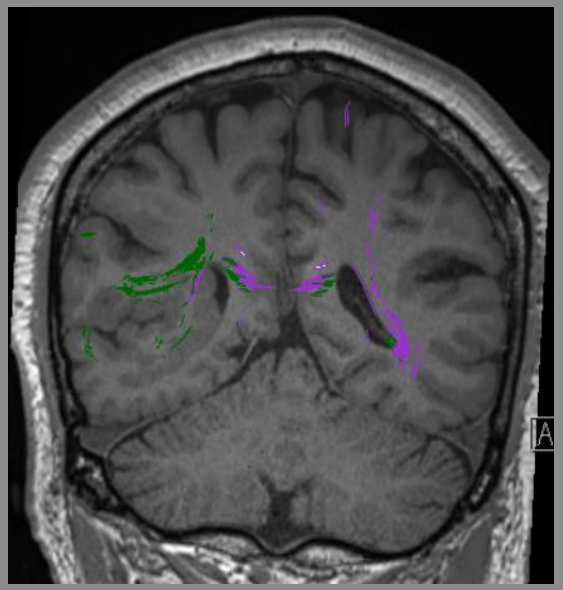






* FMRI-Verb generation

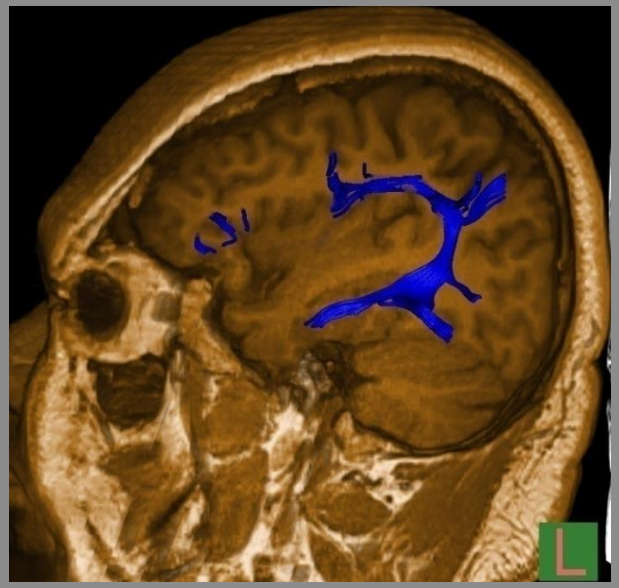


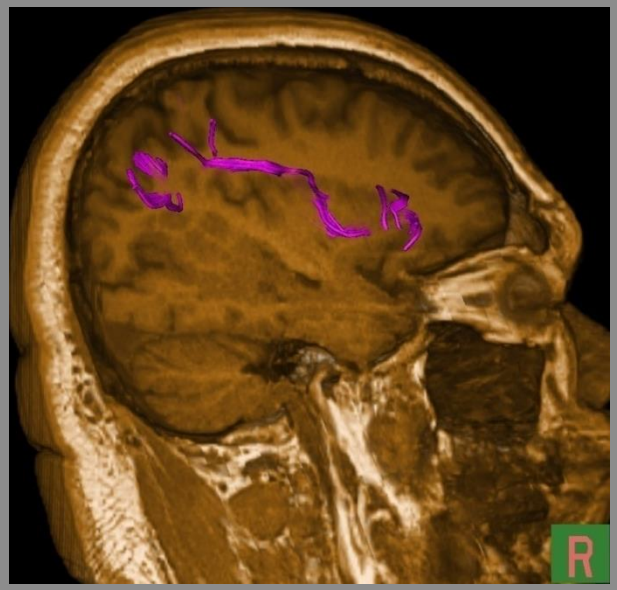


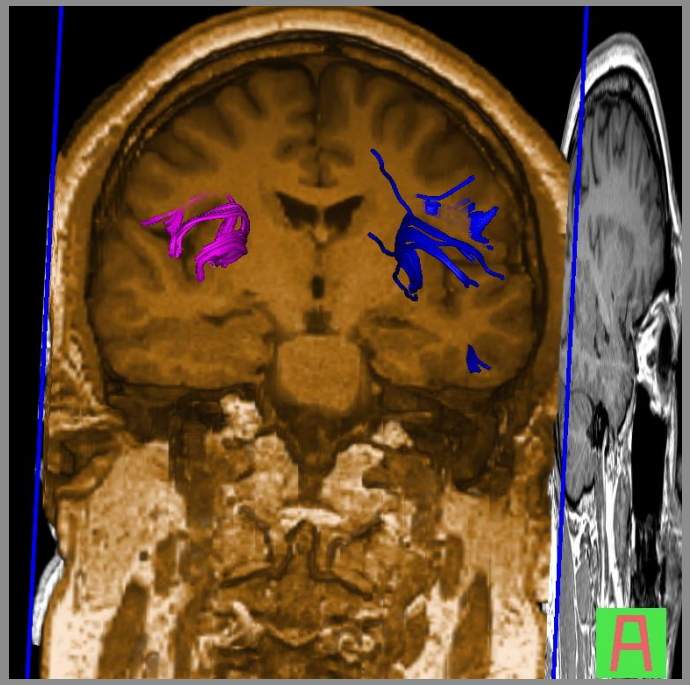




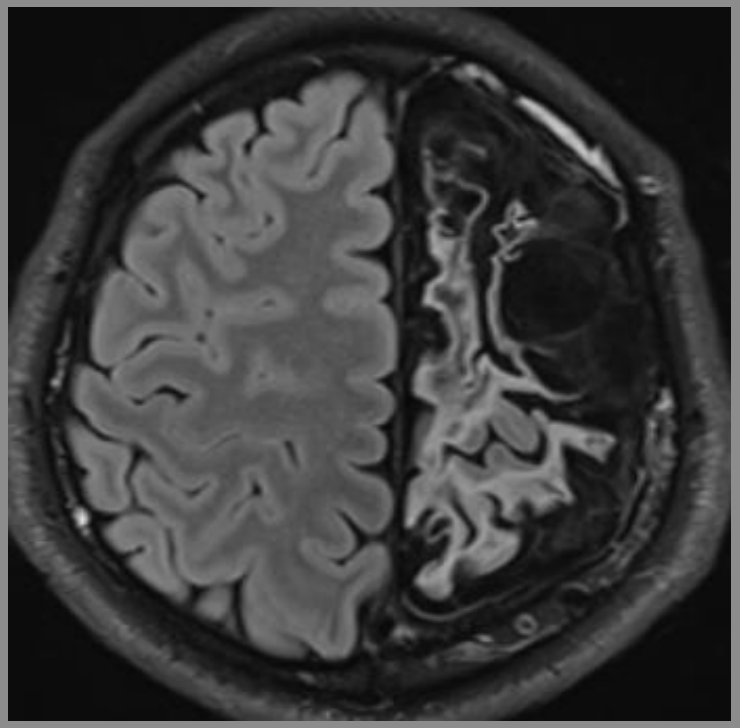
* MR Tractography
Optic Radiation

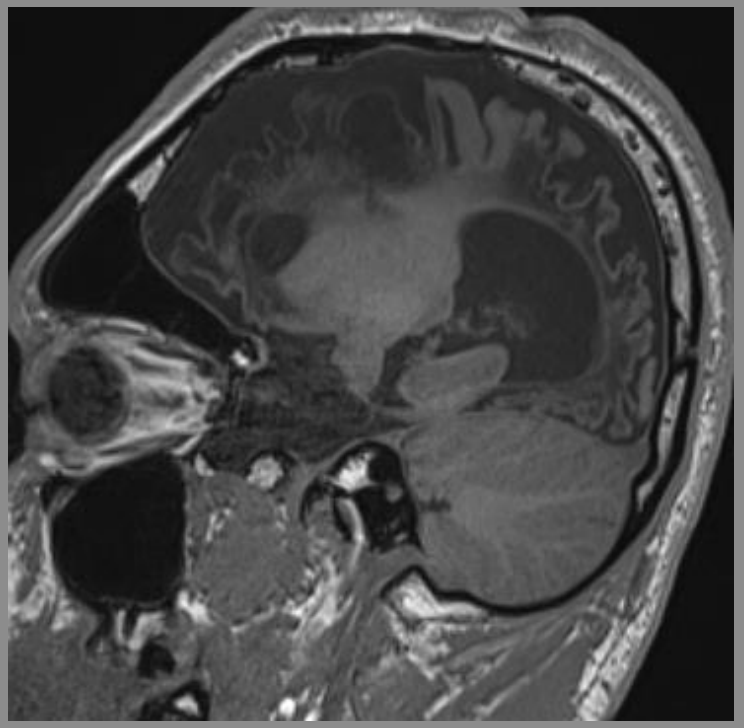




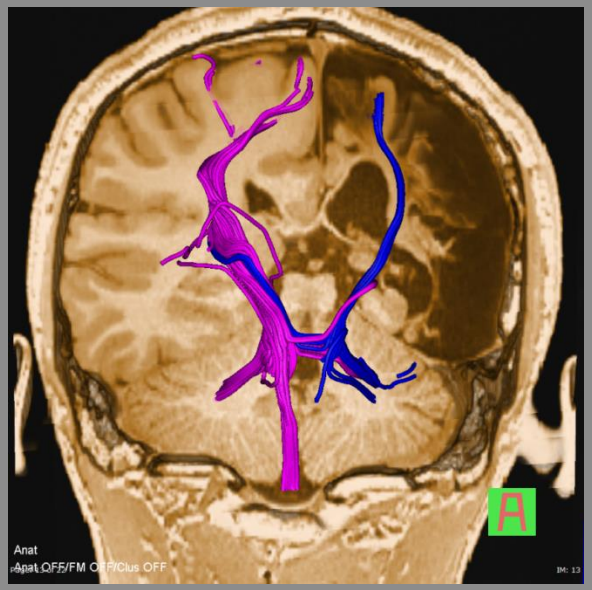


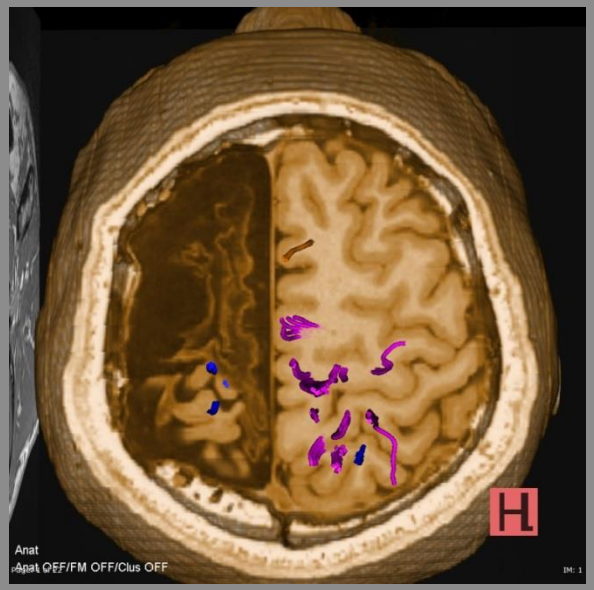
* MR Tractography
Arcuate Fasiculus



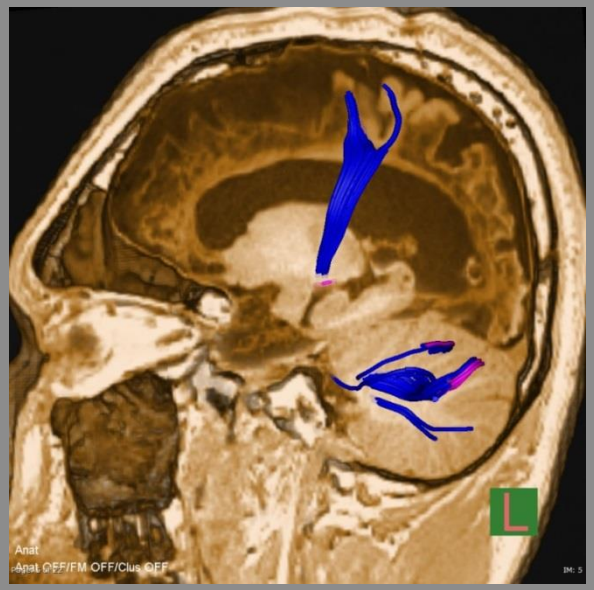


*Encephalomalacia
Left Cerebral Hemisphere

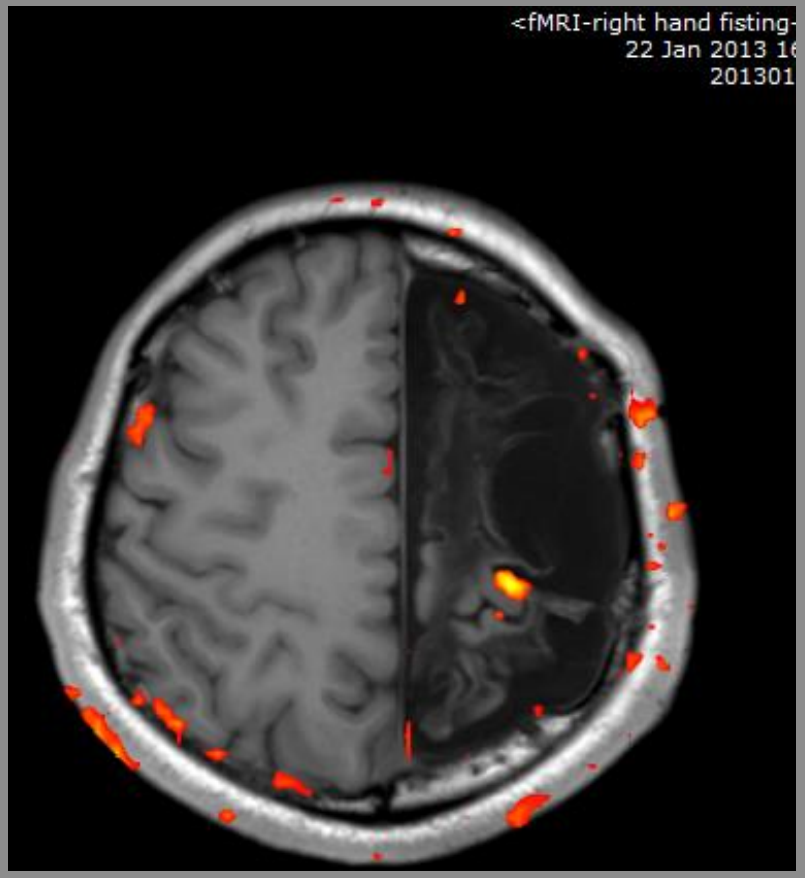




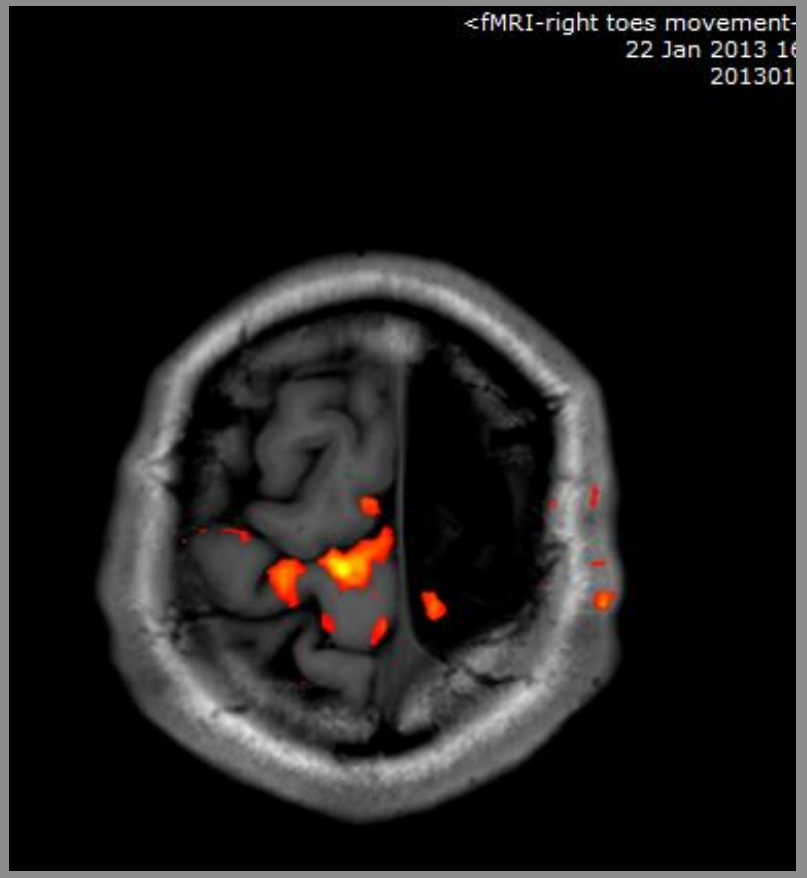
* Encephalomalacia Left Cerebral Hemisphere



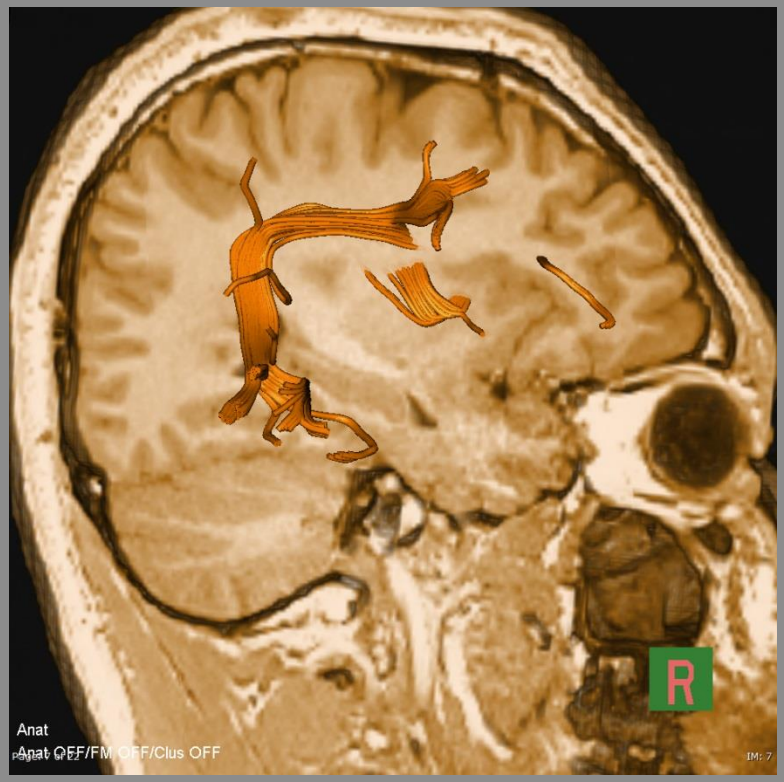
*Encephalomalacia Left Cerebral Hemisphere

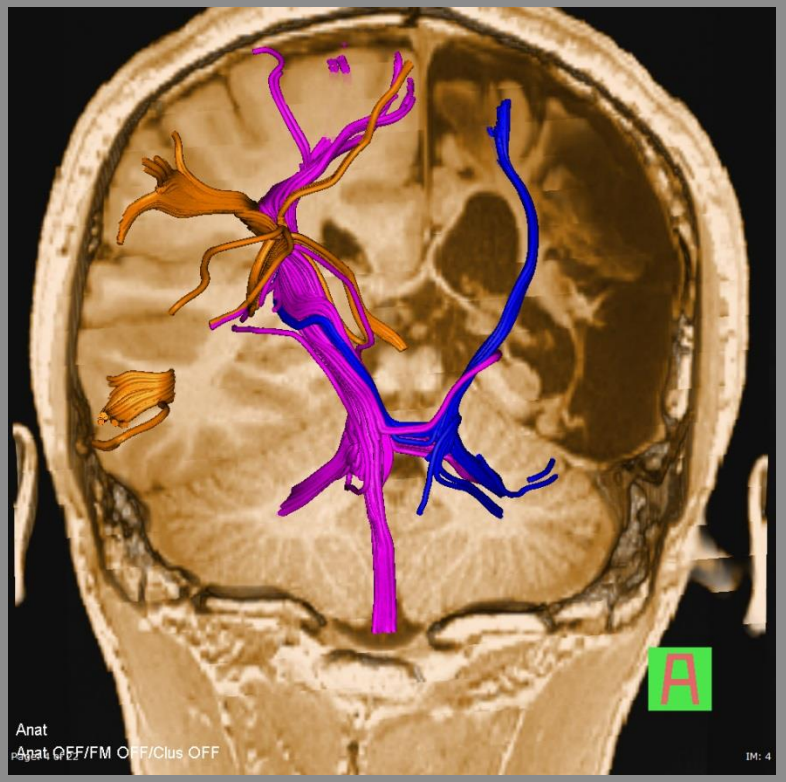


Right Hand Fisting

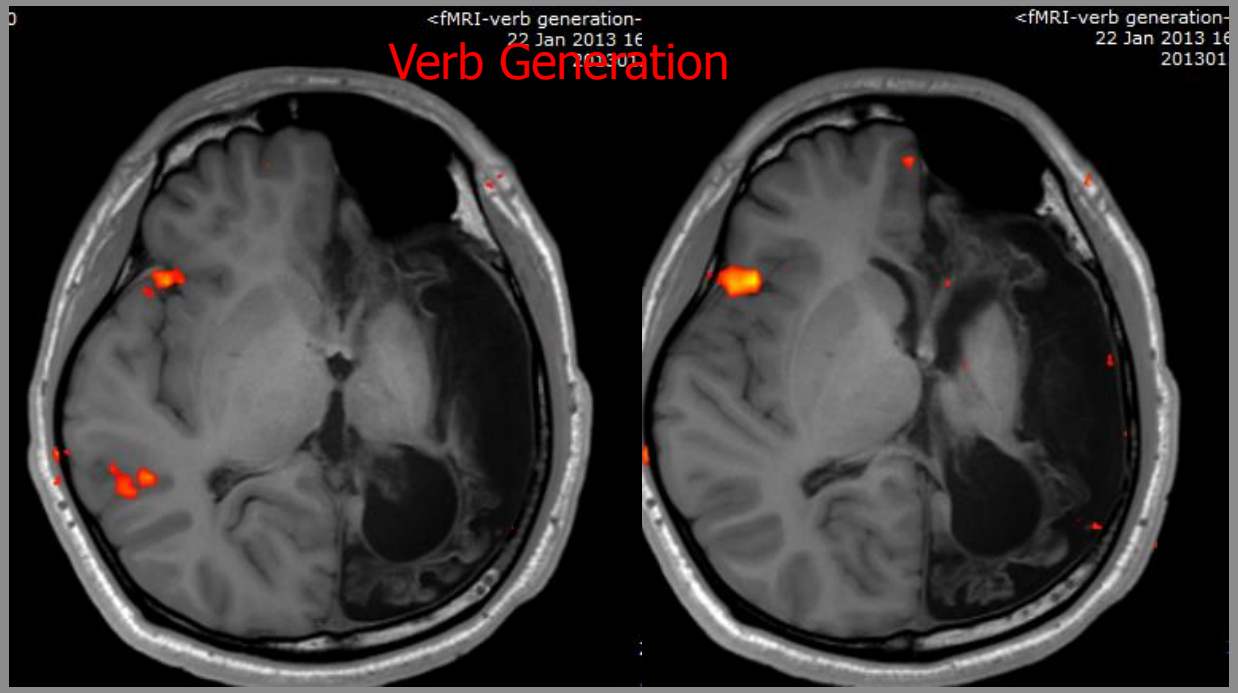


Right Toes Movement



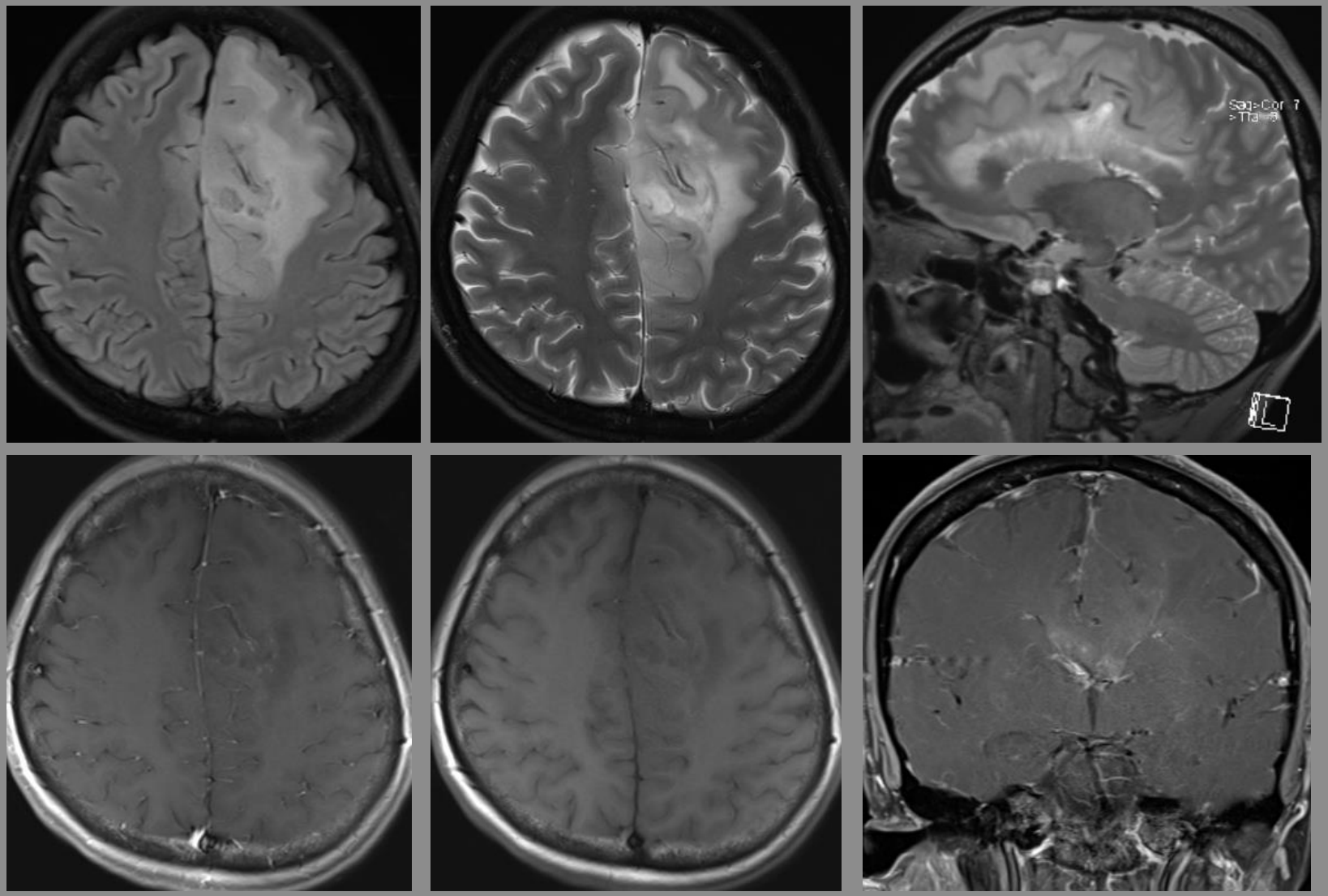


*Encephalomalacia Left Cerebral Hemisphere

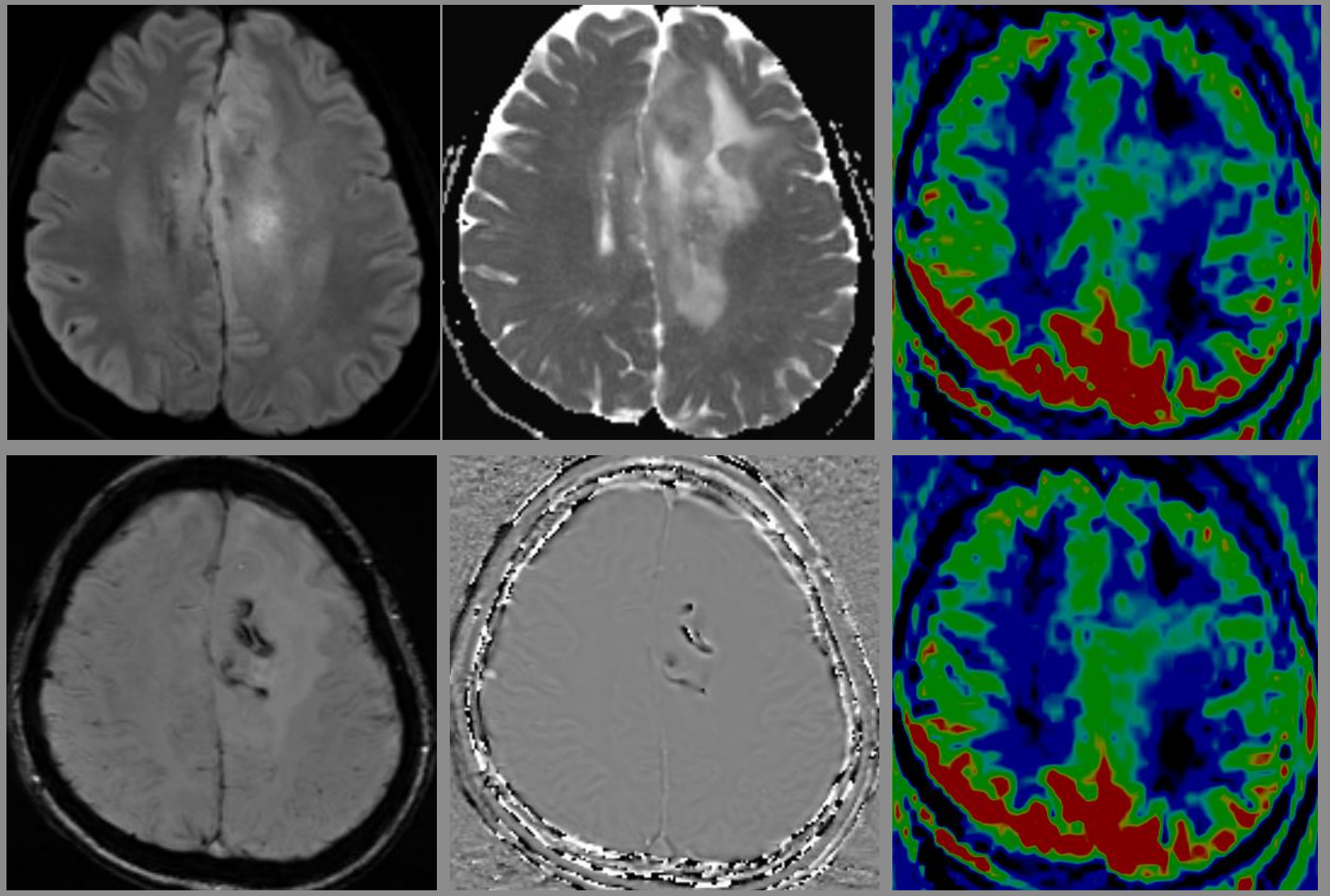


* Encephalomalacia Left Cerebral Hemisphere

* A 43 year-old female had focal seizure starting from right arm to right leg for 3-4 months.

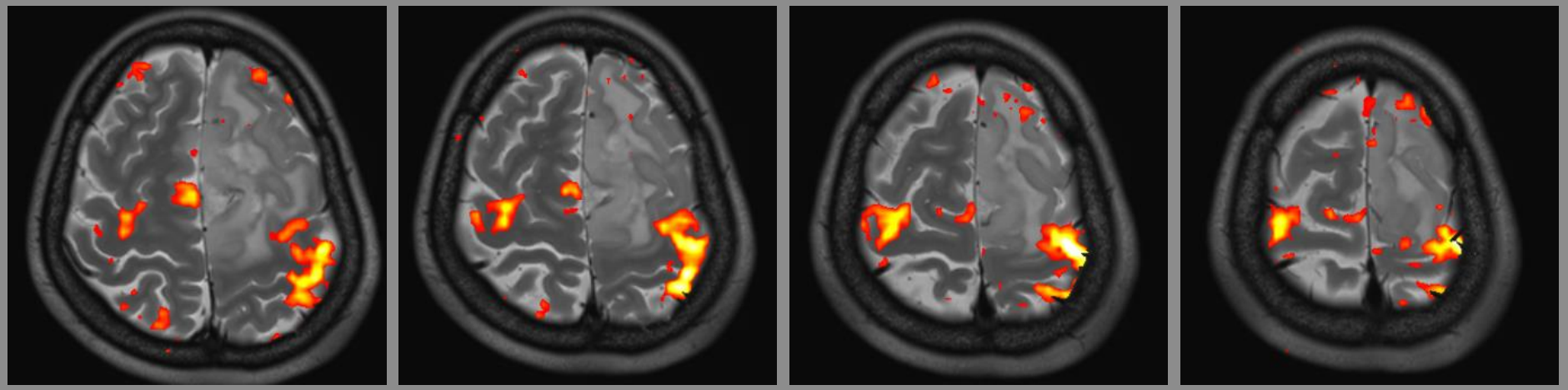


* A 43 year-old female had numbness and jerking right side for 1 week.

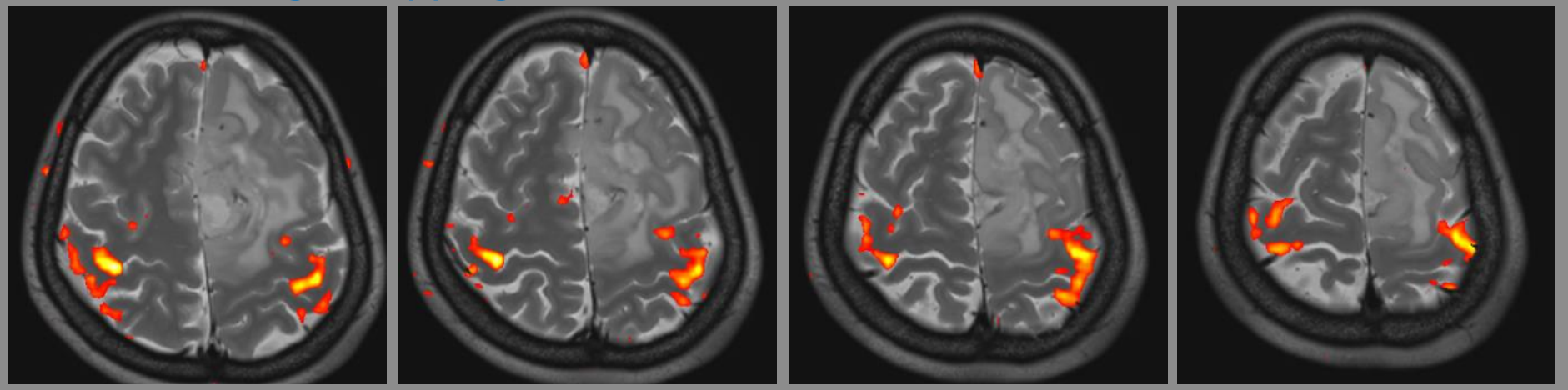


* A 43 year-old female had numbness and jerking right side for 1 week.

Right Finger Tappings

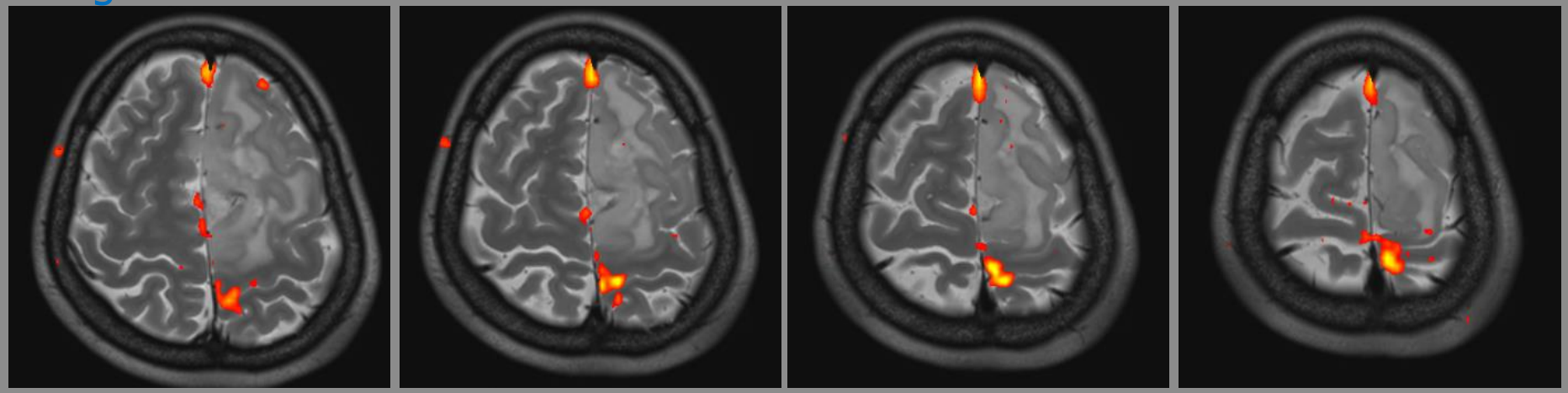


Bilateral Finger Tappings

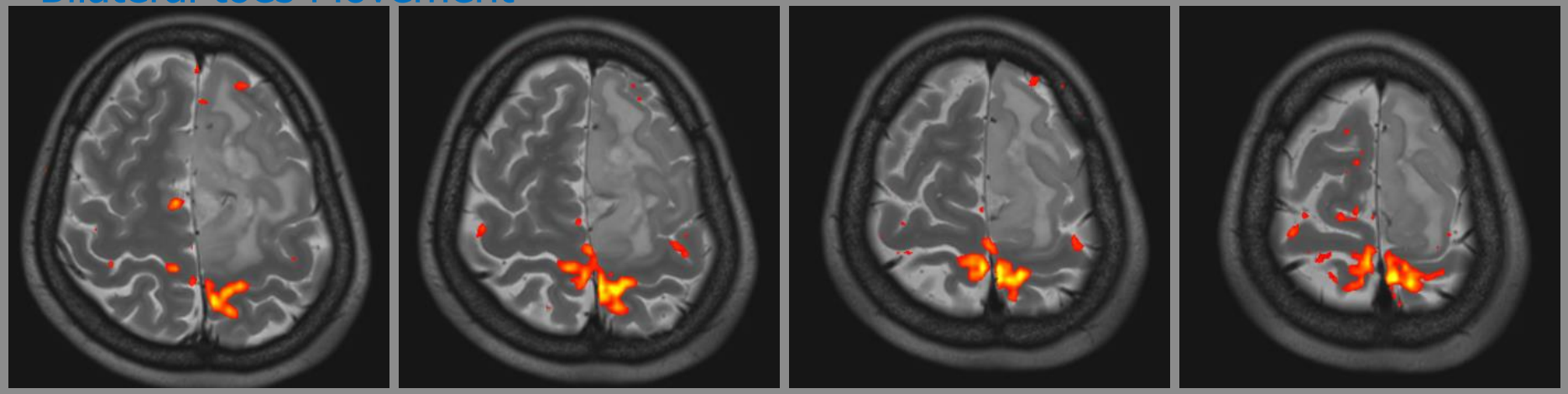


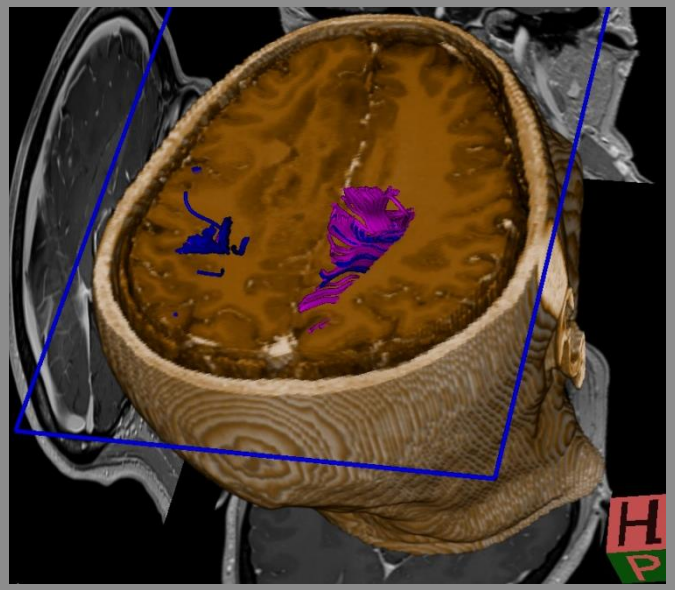
* A 43 year-old female had numbness and jerking right side for 1 week.

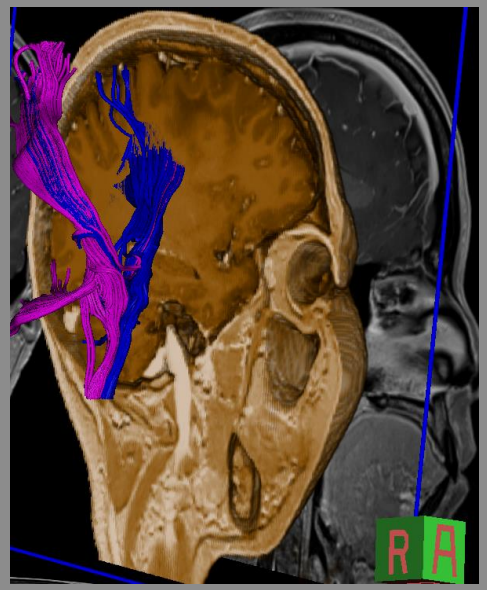
Right toes Movement



Bilateral toes Movement

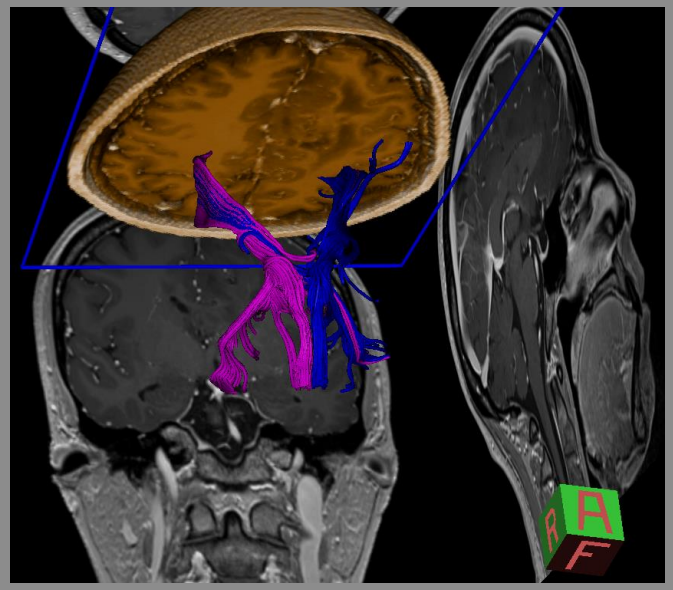






* A 43 year-old female had numbness and jerking right side for 1 week.

Oligodendroglioma



*Thank You