Neuroradiologic Findings in Tuberous Sclerosis Complex

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Focused patient history and workup

14-year-old female with past medical history of tuberous sclerosis, seizures on medication with Depakote, depression and anxiety presenting with breakthrough seizure

- Partial seizure favoring right side of the body
- Complex seizure [temporary loss of awareness]
- No history of recent illness
- Occasional convulsions

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Focused patient history and workup

Physical exam:

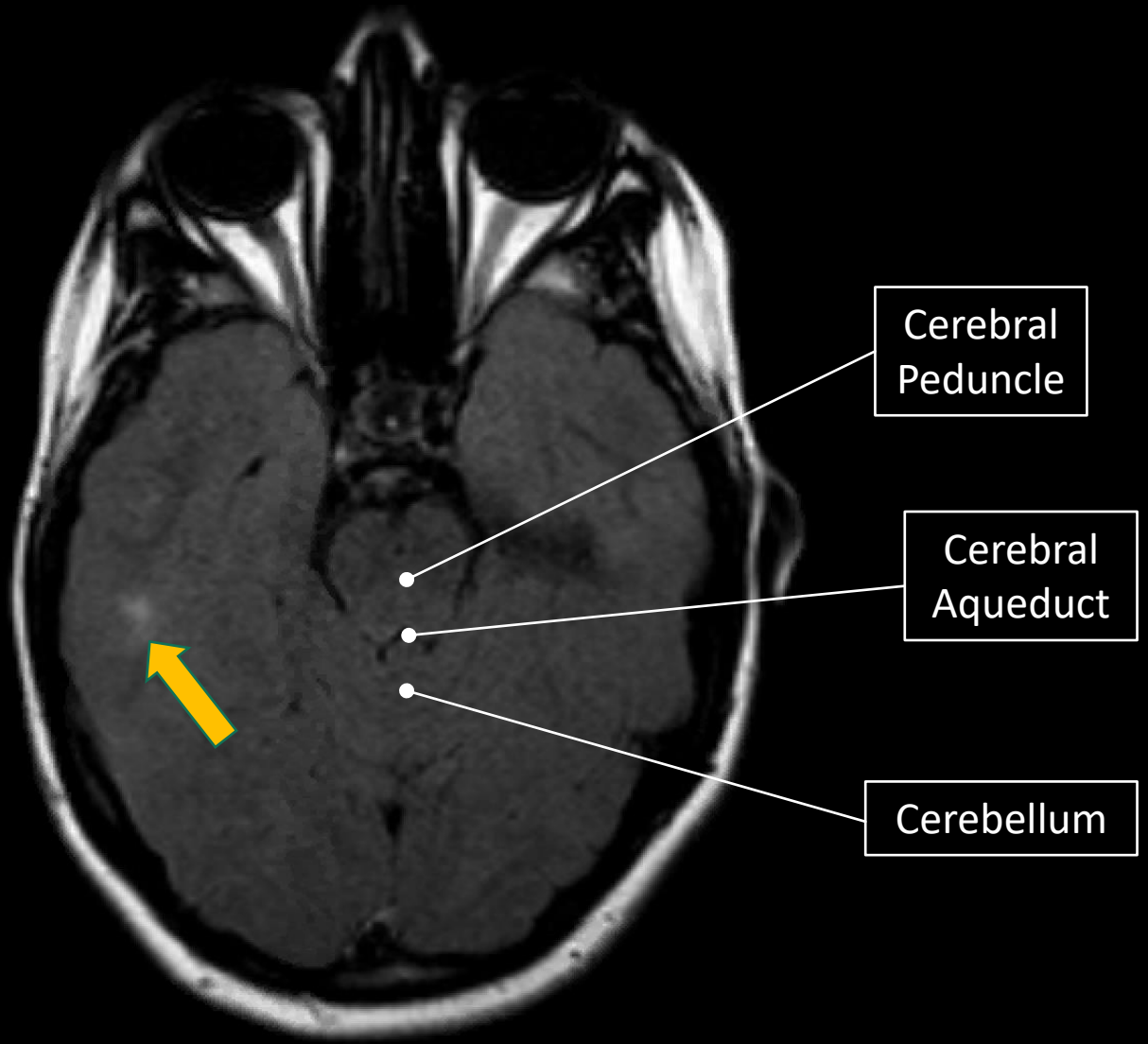
- Skin: hypopigmented macules are noted, there is a very small area of roughened skin on her right upper back
- Cranial nerves: pupils are normally active and symmetric, extraocular movements are full and conjugate with good tracking and without nystagmus, visual fields are full on confrontation testing.
- Neuro: Intact finger-to-nose coordination. Normal gait, appropriate heel to toe walk
- Motor: normal bulk and tone, no pronator drift is present. 5/5 strength in bilateral upper and lower extremities. Reflexes 1+ throughout.
- All other physical exam within normal limits.

Work-up: MRI brain with and without contrast

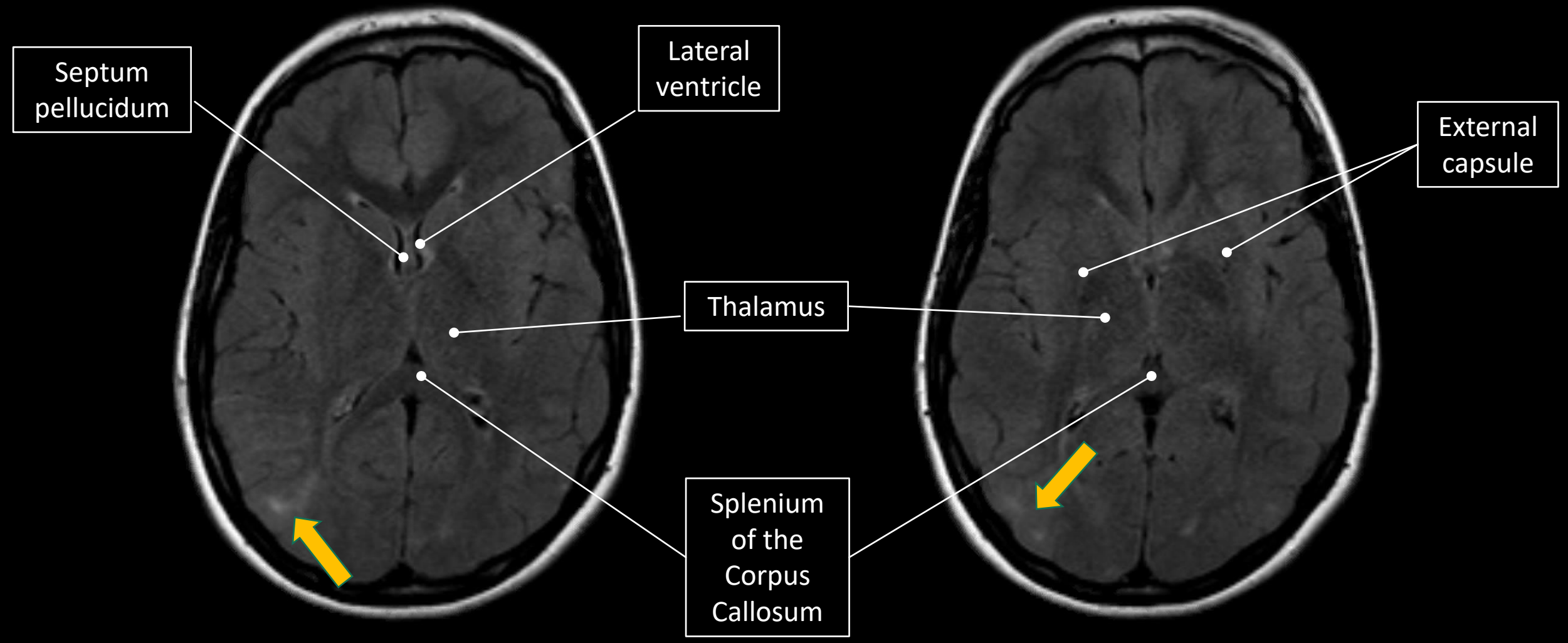
MRI T2 Flair Axial View

Finding 1: Tubers (orange arrow)

- Multiple subcortical foci of T2 FLAIR signal hyperintensity within the whit matter
- Scattered throughout the bilateral cerebral hemispheres
- Seen in multiple slices in the axial plan



MRI T2 Flair Axial View



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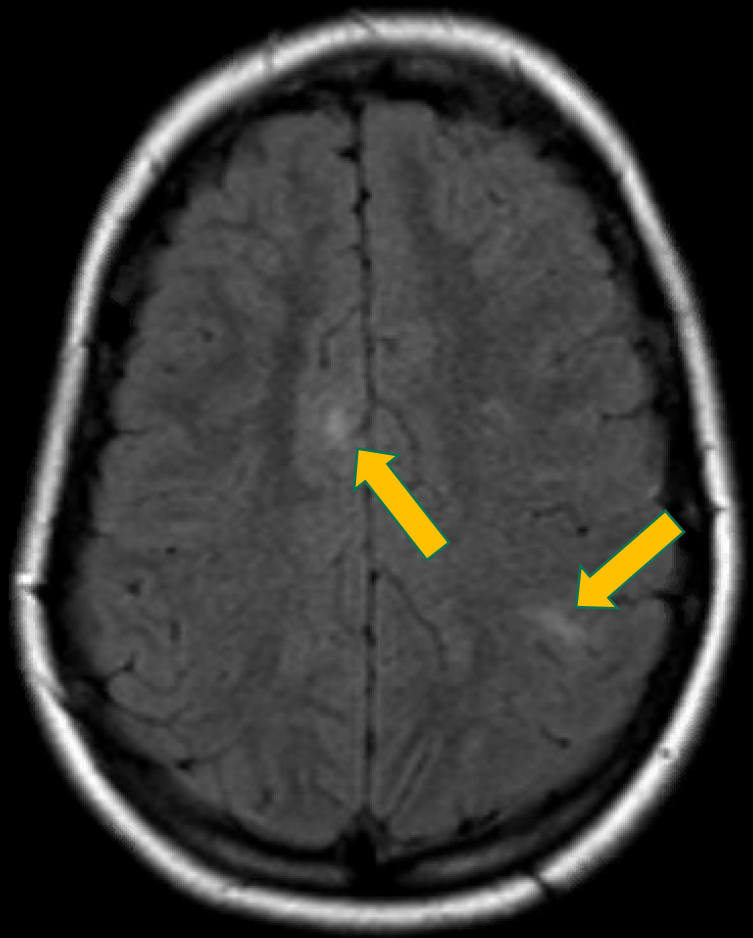
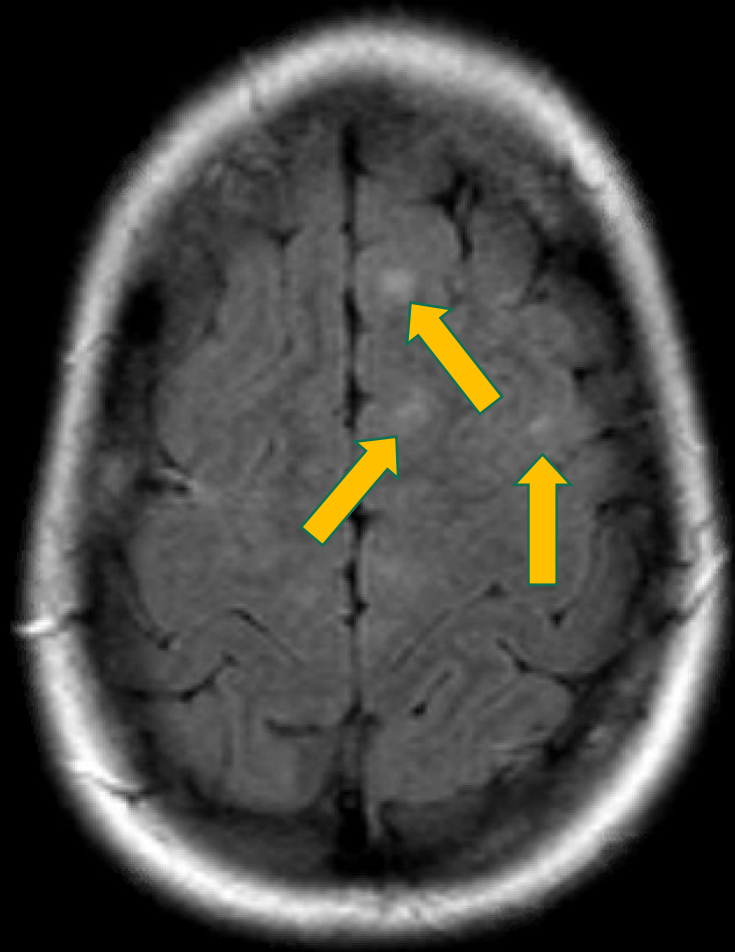
MRI T2 Flair Axial View

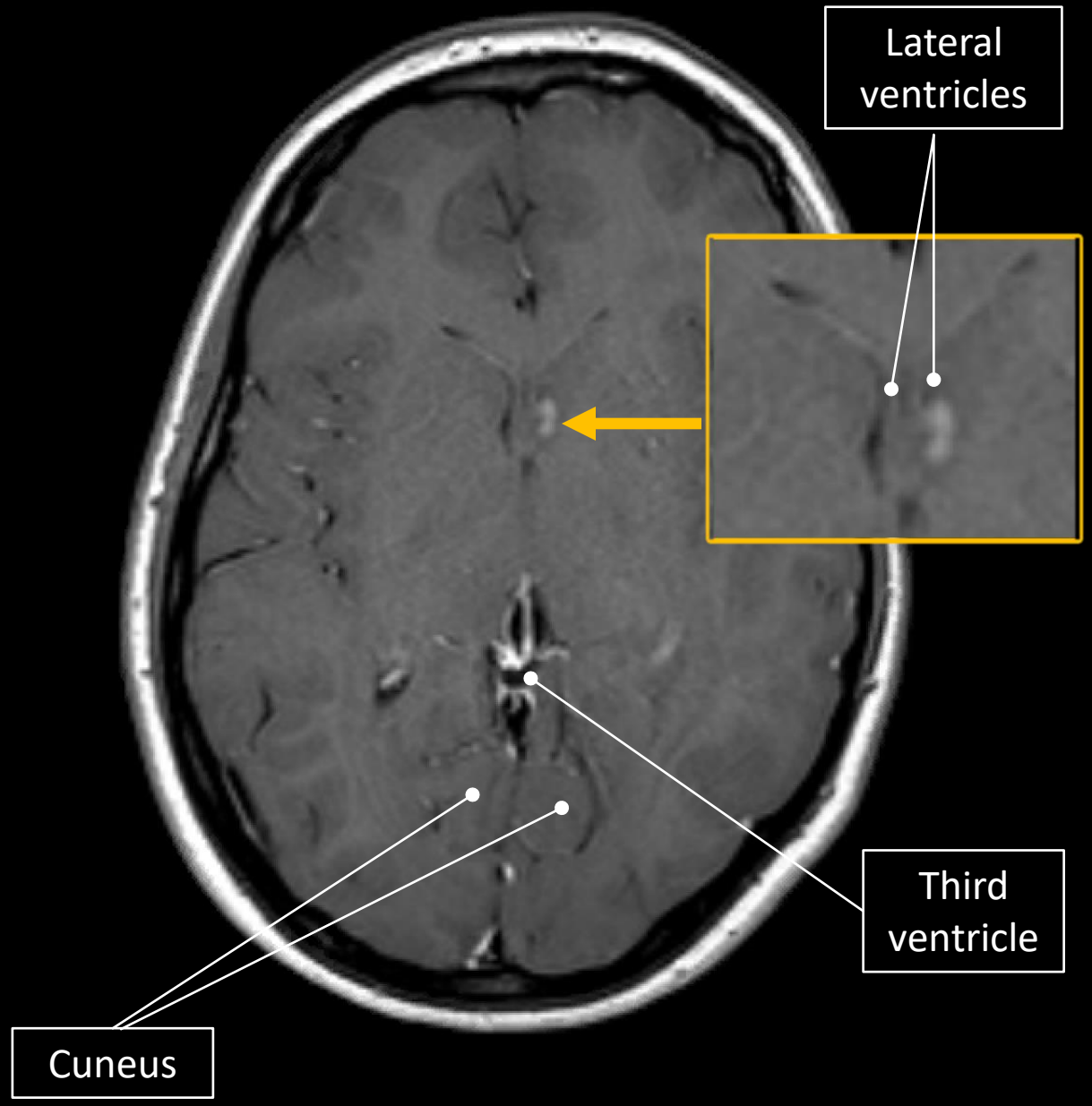




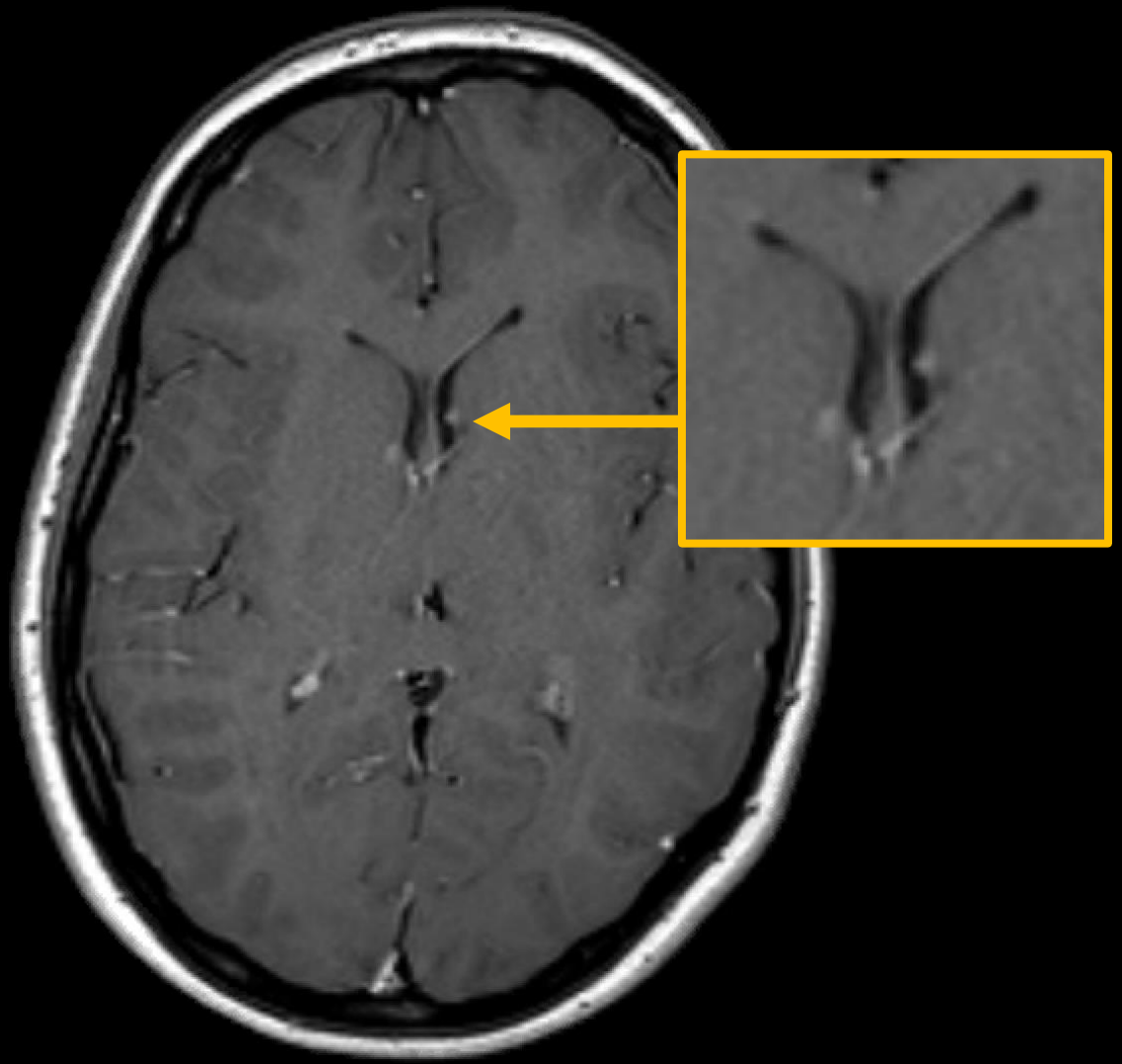
MRI T1 Gadolinium Axial View

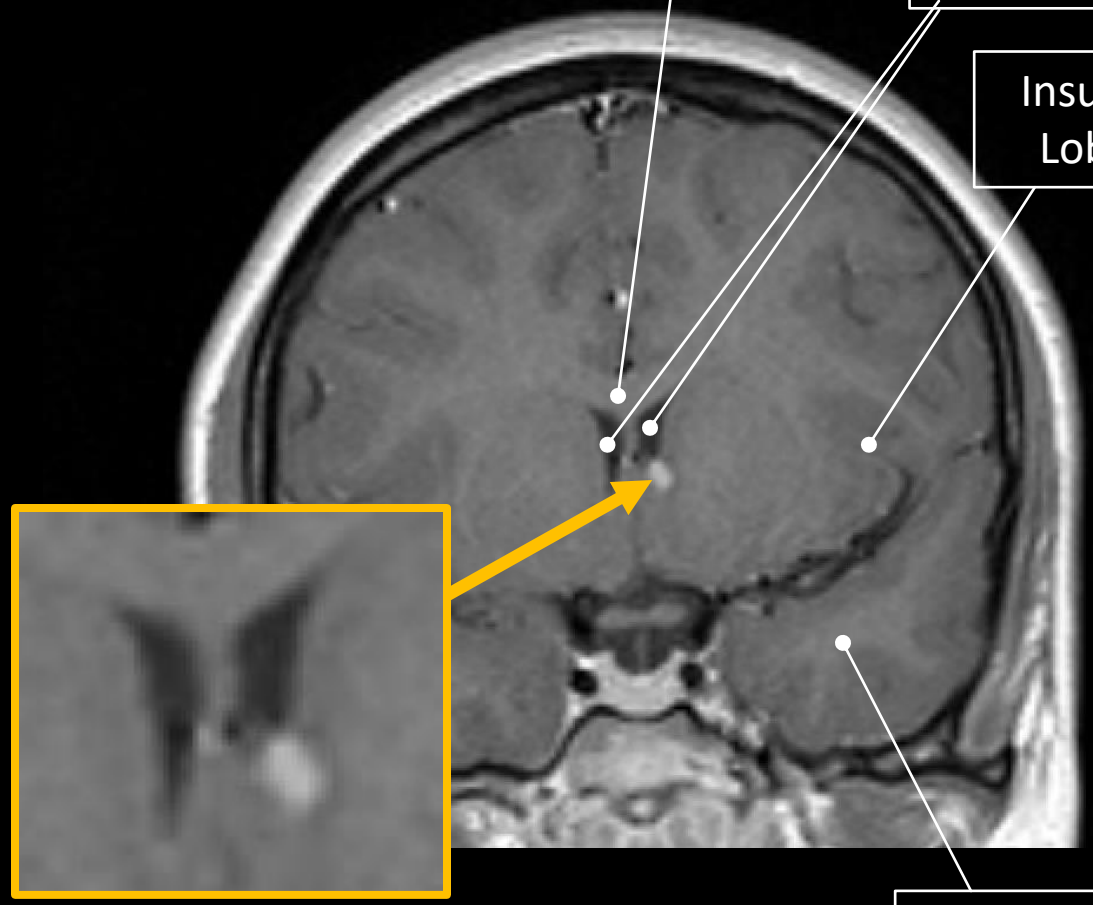
Finding 2: Subependymal nodules (orange arrow)

- Multiple nodular foci along ependyma surface of bilateral lateral ventricles
- Most prominent anterior to the left foramen of Monro
- Some nodules enhance with contrast



MRI T1 Gadolinium Axial and Coronal View





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Patient Outcome and Follow Up

Patient's home dose of Depakote was increased with improved control of breakthrough seizures

No evidence of subependymal giant cell astrocytoma requiring surgical resection.

Additionally, no evidence of mass-effect, midline shift, hydrocephalus, fluid collection, infarct, intracranial hemorrhage or abnormal enhancement identified.

Patient will continue to receive annual MRI.

Tuberous Sclerosis Complex (TSC)

Neurocutaneous disorder with multiple benign tumors arising from embryonic ectoderm

- Skin, eyes, central nervous system

Pathology: spontaneous mutation or autosomal dominant inheritance of TSC1 or TSC2 tumor suppressor genes

Clinical manifestation:

1. Seizures
2. Cognitive Impairment
3. Adenoma sebaceum

Most sensitive imaging modality for neurological findings: MRI

TSC Neurologic Findings

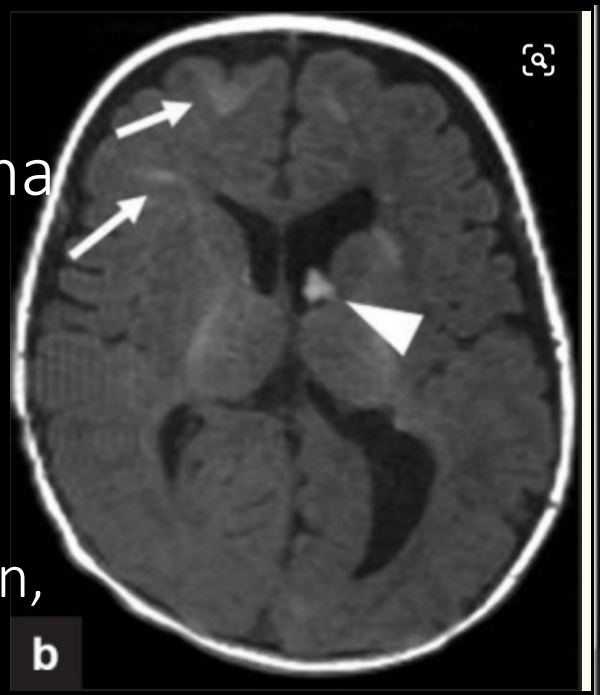
1. Cortical or Subcortical Tubers
   - Most commonly located in the frontal lobes
   - Imaging: hyperintense lesions on T2-weighted and Flair MRI
   - Usually occur in multiples
   - Clinical manifestation depends on location of tuber, often asymptomatic
   - Present in 95% of patients with TSC

2. Subependymal Nodules
   - Most commonly located in the walls of lateral ventricle, at caudothalamic groove
   - Consist of hypertrophic tissue, often calcified
   - Imaging: may appear contrast-enhanced
   - Can degenerate into subependymal giant cell astrocytoma (5-10% of cases)

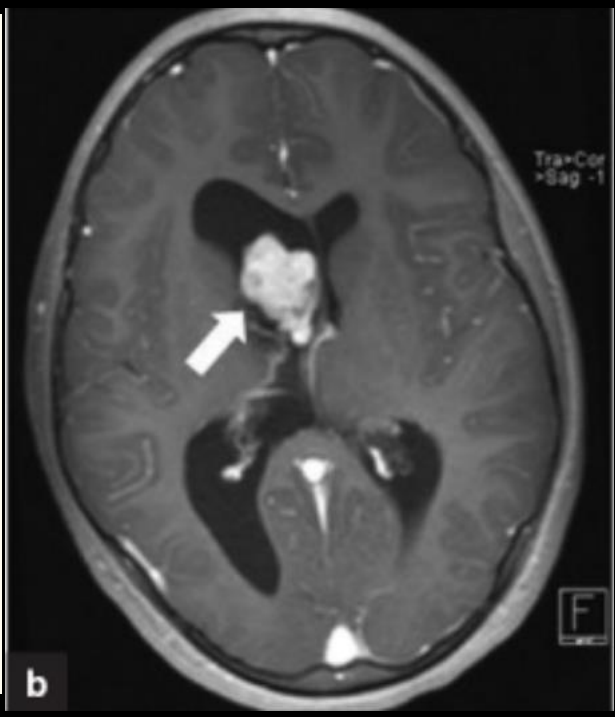
TSC Neurologic Findings

3. Subependymal Giant Cell Astrocytoma

- Enlarge from subependymal nodules and grow
- Eventually can cause ventricular obstruction -> hydrocephalus
- If causes significant clinical manifestation, can be surgically resected



Axial MRI T1: White matter lesions (arrows) and Subendymal nodule (arrowhead)



Axial MRI T1: Subendymal giant cell astrocytoma

4. White Matter Radial Migration Lines

- Heterotopic glia and neurons along expected path of neuronal migration
- Located in subcortical white matter

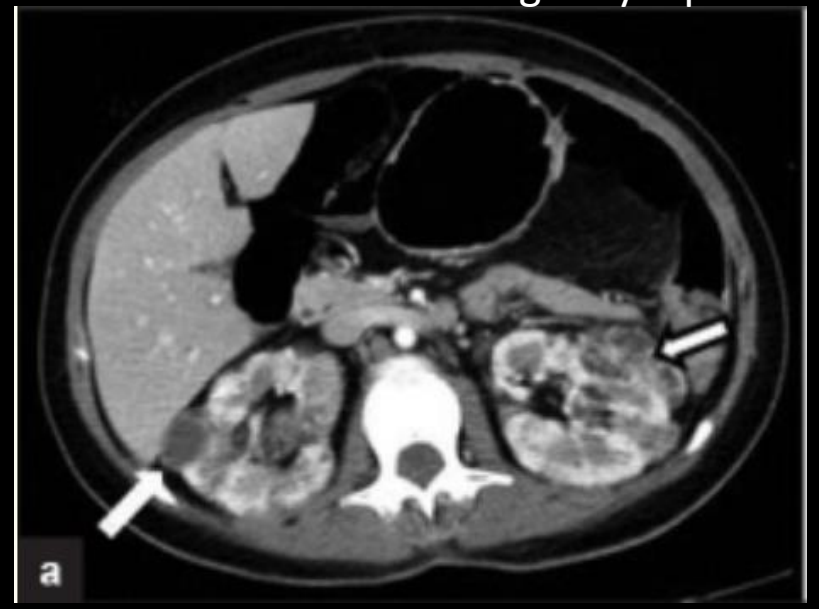
TSC Non-Neurologic Findings

1. Cardiac rhabdomyoma
   - Primary diagnostic tool is echocardiography

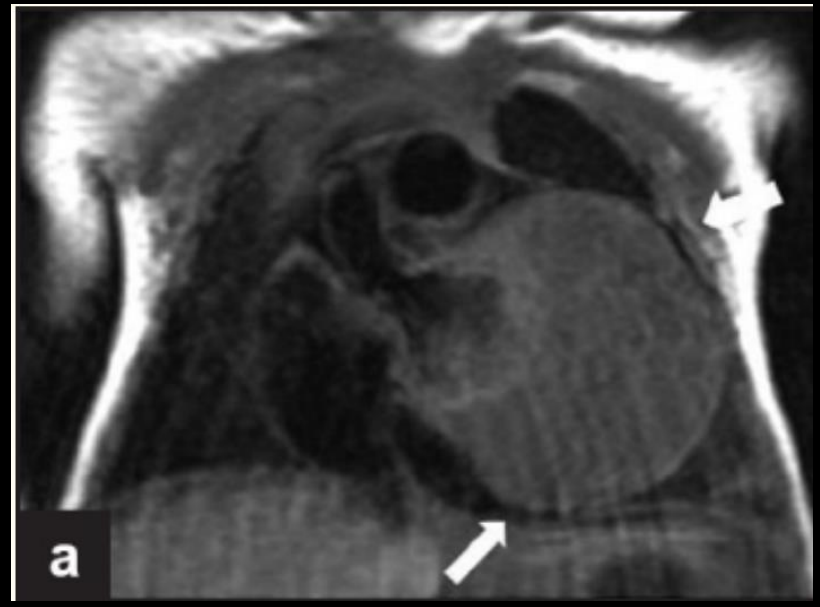
2. Renal: angiomyolipoma, renal cell carcinoma, renal cysts
   - Regular follow-up with Renal ultrasound and followed by Nephrology

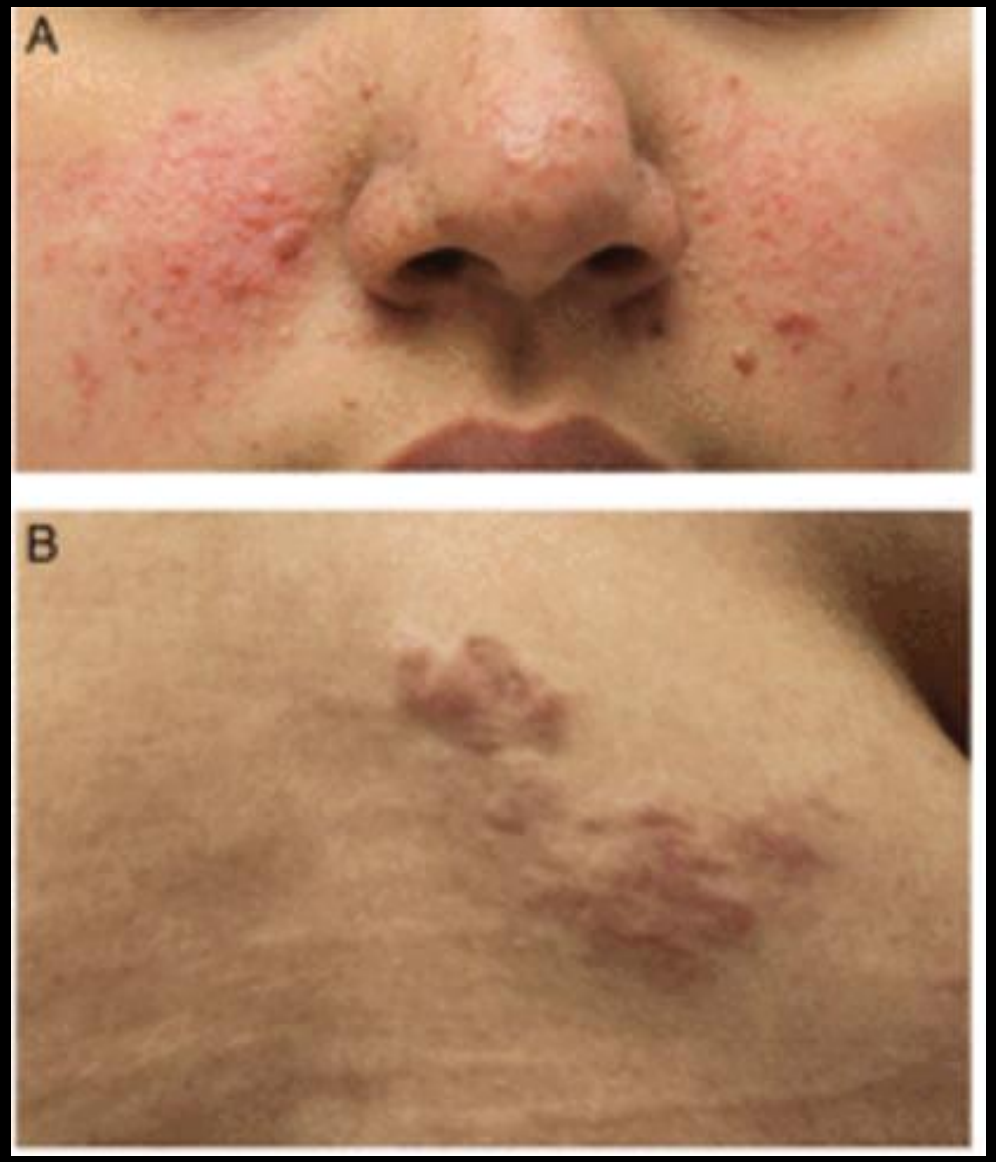
3. Cutaneous: hypopigmented macules, facial angiofibroma, Shagreen patches

Axial CT: Bilateral Renal Angiomyolipomas

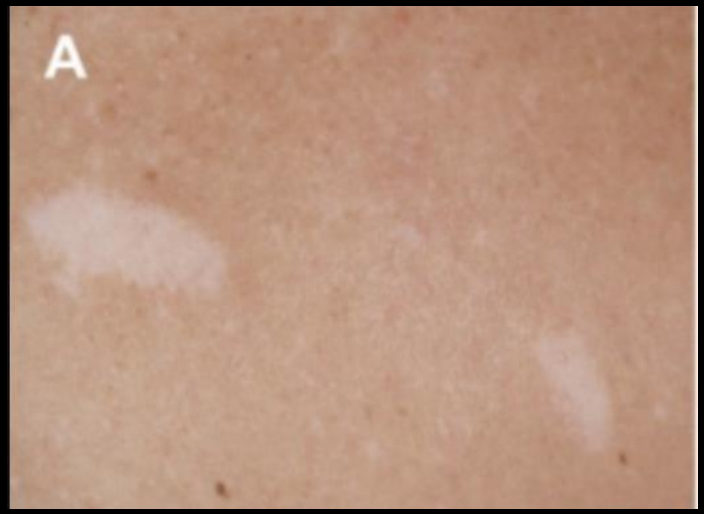


Coronal MRI T1: Cardiac rhabdomyoma





A) Facial angiofibromas B) Shagreen patches



A) Ash leaf patches

Study Appropriateness

Scenario	Procedure	Adult RRL	Peds RRL	Appropriateness Category	
Seizure disorder, change in clinical symptoms	MRI head without IV contrast	0 mSv O	0 mSv [ped] O	Usually appropriate	
	CT head without IV contrast	1-10 mSv	0.3-3 mSv [ped]	Usually appropriate	
	MRI head without and with IV contrast	0 mSv O	0 mSv [ped] O	Usually appropriate	
	FDG-PET/CT brain	1-10 mSv	3-10 mSv [ped]	May be appropriate	
	CT head without and with IV contrast	1-10 mSv	3-10 mSv [ped]	Usually not appropriate	
	HMPAO SPECT or SPECT/CT brain ictal and interictal	1-10 mSv	3-10 mSv [ped]	Usually not appropriate	
	MEG	0 mSv O	Null	Usually not appropriate	
	CT head with IV contrast	1-10 mSv	0.3-3 mSv [ped]	Usually not appropriate	
	MRI functional (fMRI) head without IV contrast	0 mSv O	0 mSv [ped] O	Usually not appropriate	

According to ACR Appropriateness Criteria

MRI in Seizure Disorders

MRI is preferred imaging modality in all seizure disorders

MRI Abnormalities are detected in:

- 80% of patients with diagnosed epilepsy
- 20% of patients with unprovoked seizure or epilepsy in remission

Advantages: Anatomical detail and low radiation exposure, especially in children requiring regular follow-up with Imaging

Disadvantages: Cost, Time required for scanning

UNC Top Three

1. MRI brain study is clinically appropriate for new-onset seizures or change in clinical status with an established seizure disorder.

2. Neuroradiologic findings are very likely to be seen in Tuberous Sclerosis Complex (TSC) and presence of intracranial findings can establish a clinical diagnosis of TSC.

3. In established TSC, routine cardiac echocardiography and renal ultrasound should be performed as screening for development of associated cardiac and renal tumors or cysts.

References

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