CASE PRESENTATION

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(JR 3 DEPT OF RADIO-DIAGNOSIS GMC,NAGPUR)

CLINICAL COMPLAINTS

- 8-year-old child was brought to the casualty the chief complaints of giddiness and lethargy since last 15 days , bilateral painful proptosis associated with redness in the eyes since last 3 months and bilateral swelling in inguinal and axillary region.

Consent was taken from patient's parents for the image

EXAMINATION

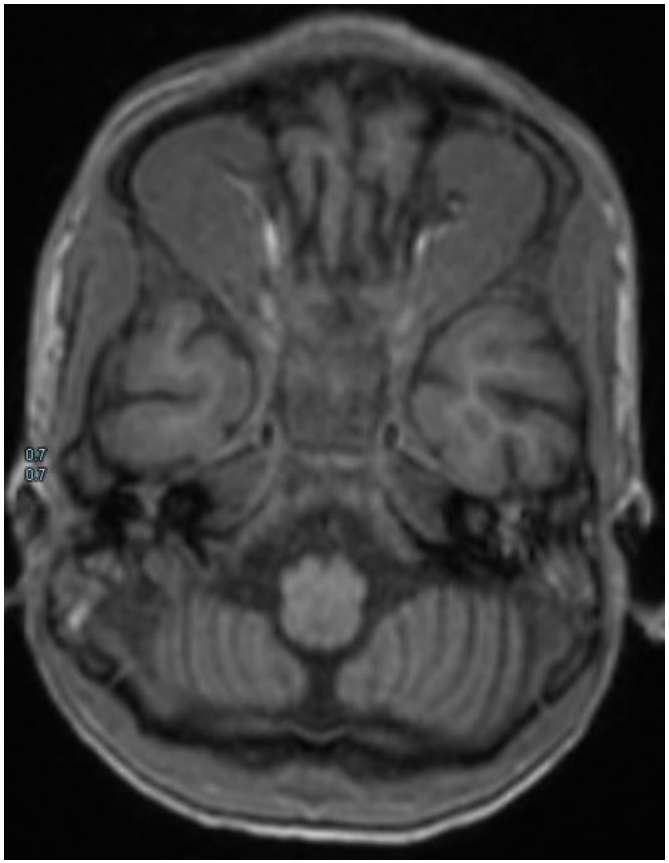
On ocular examination:

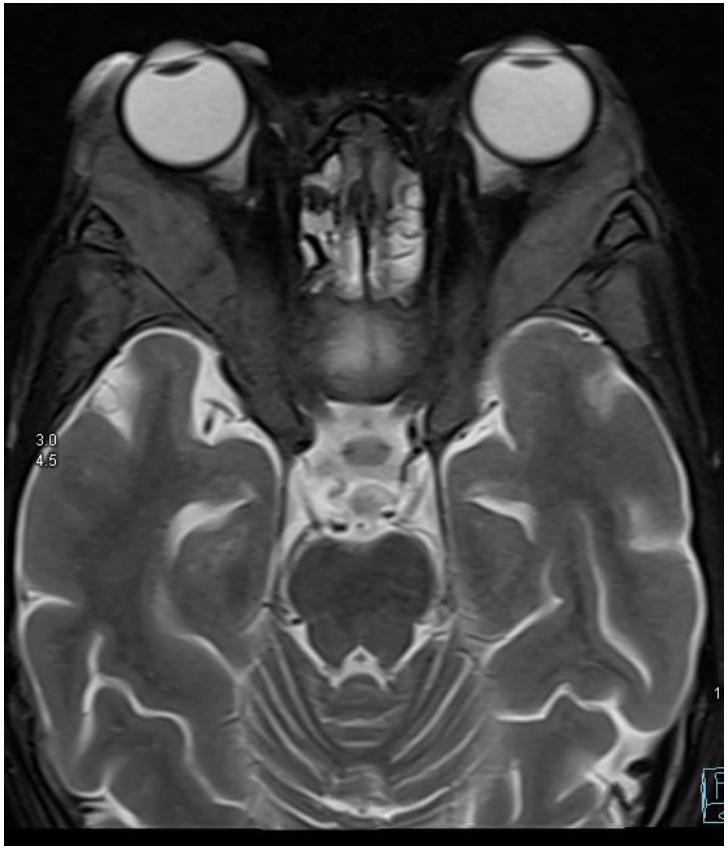
- There was overlying chemosis which severe exposure keratopathy , axial proptosis along with Lagophthalmos and restricted ocular mobility

Haematological examination:

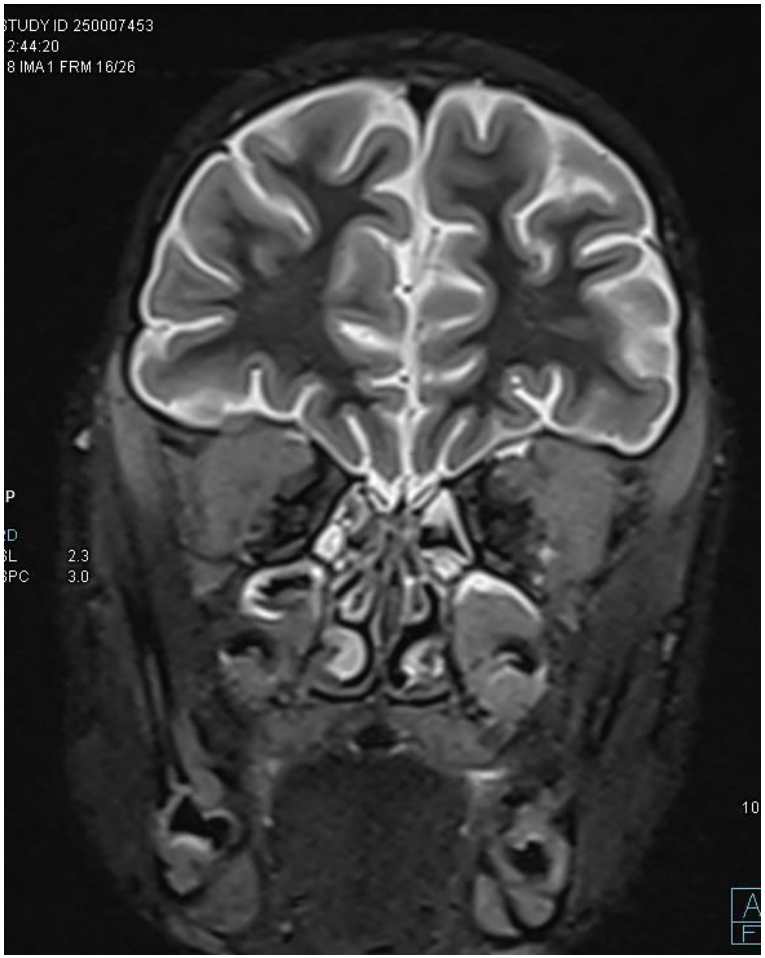
- WBC count of 10,500, RBC-4400 , Platelets-2.5lakhs
- Presence of microcytic hypochromic anaemia with anisopoikilocytosis ,pencil cells and polychromasia.

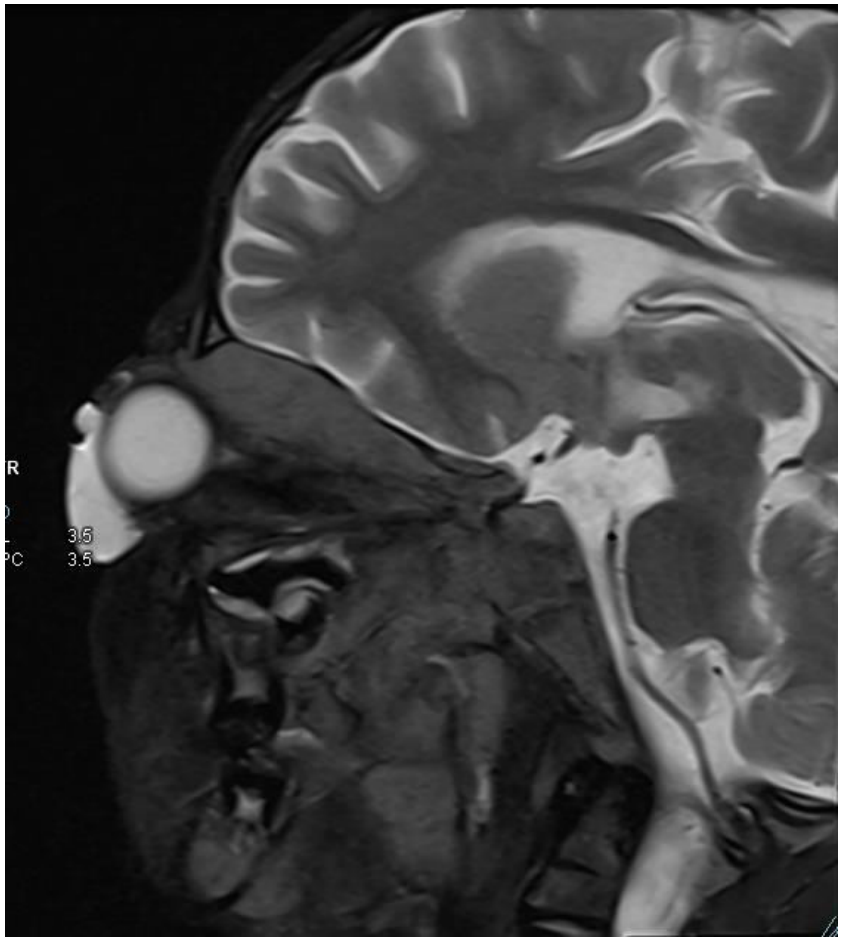
MRI ORBIT- T1 AND T2



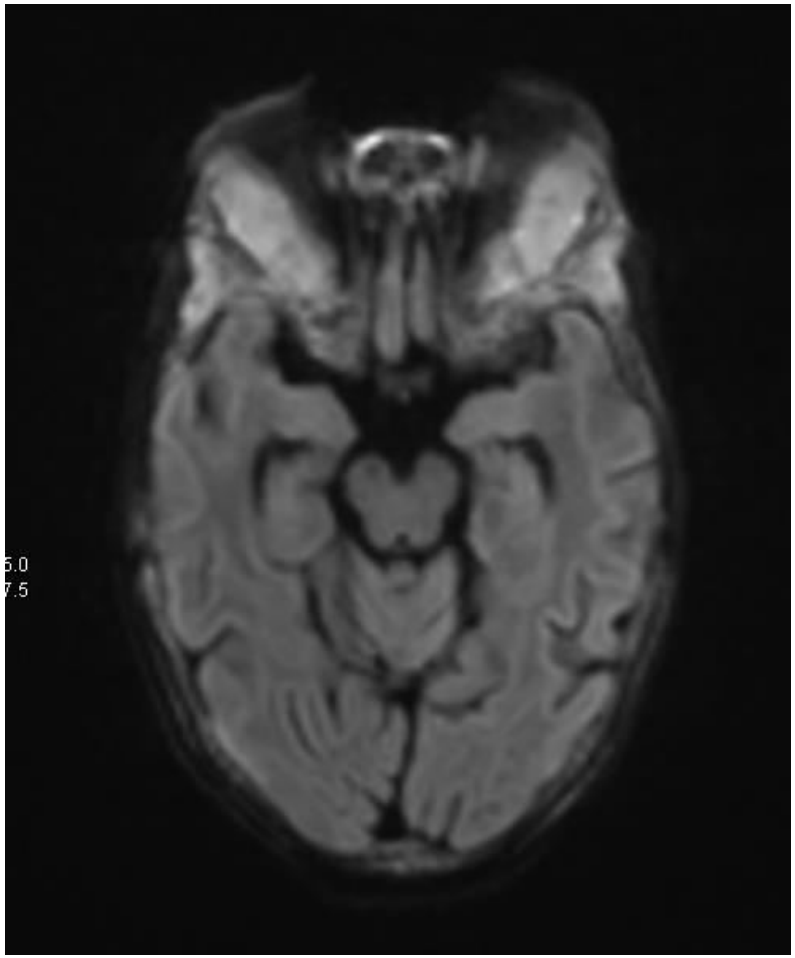


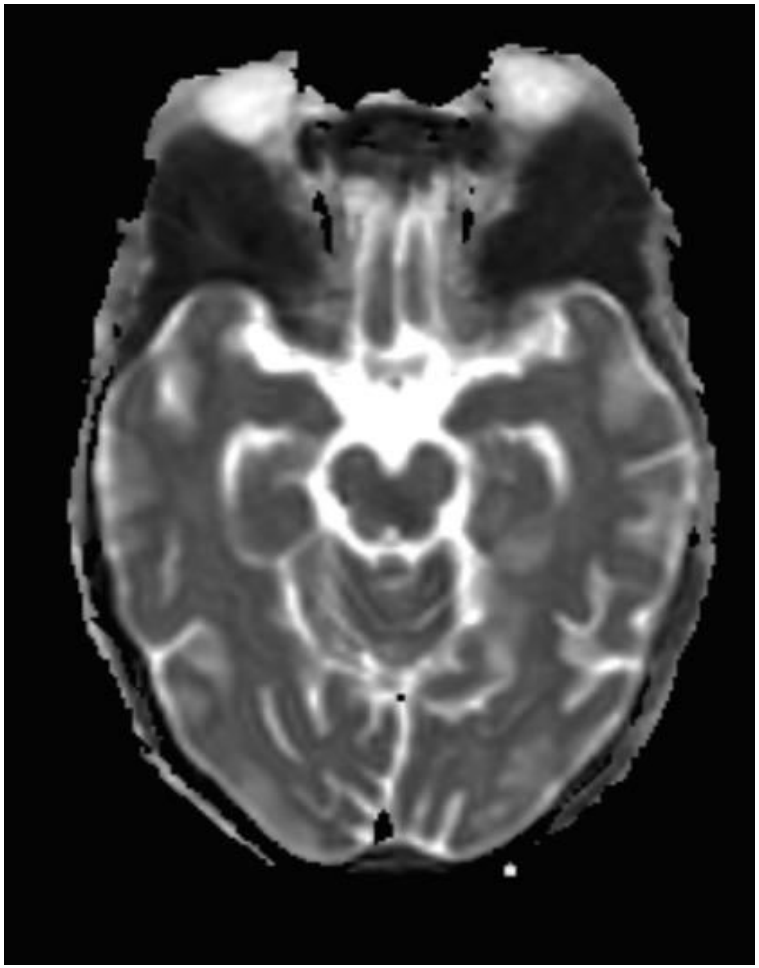
MRI ORBIT-T2



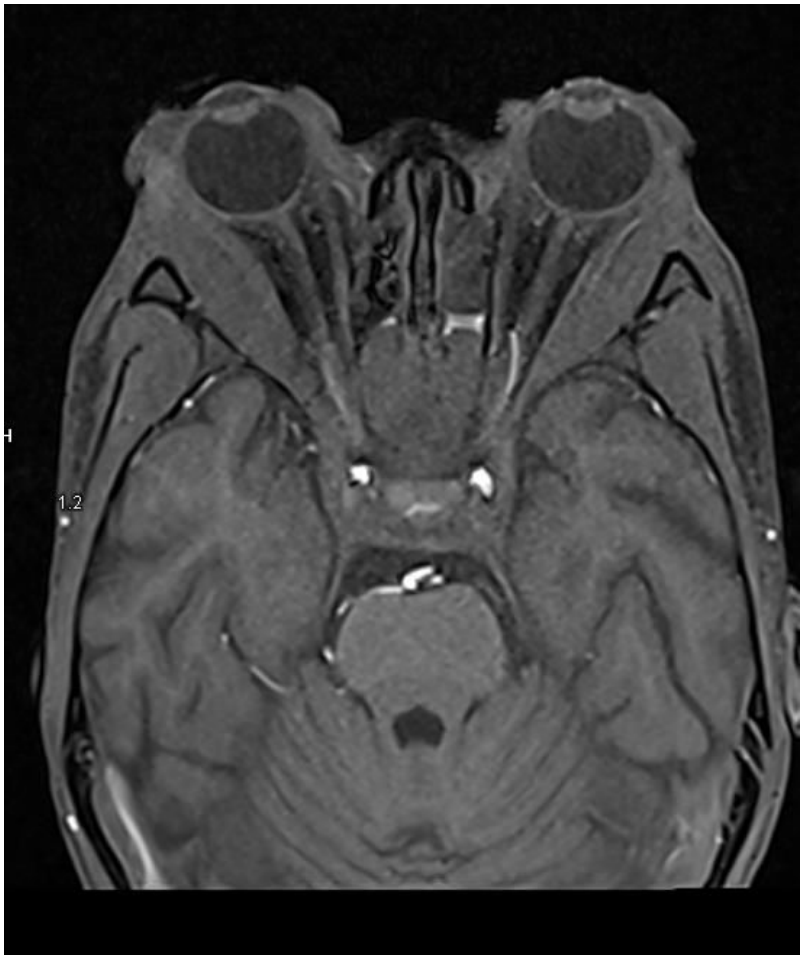


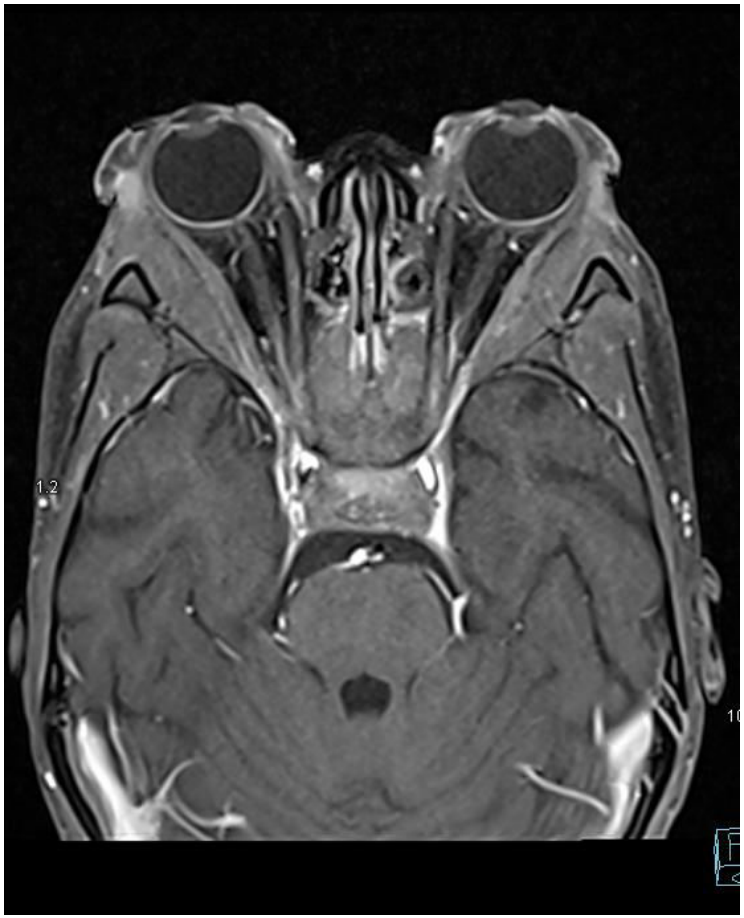
MRI ORBIT-DWI AND ADC



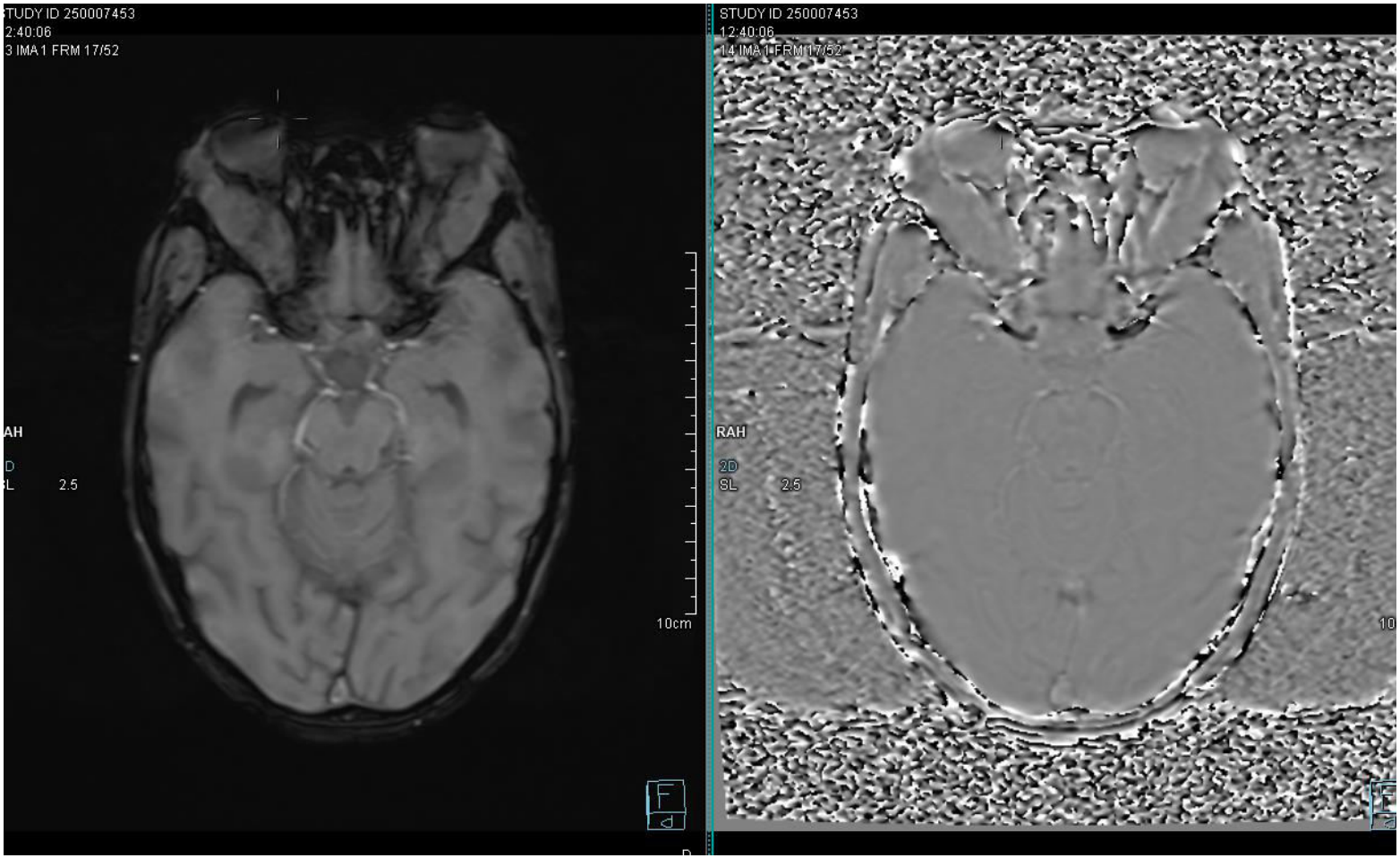


MRI ORBIT-PR AND POST CONTRAST





MRI ORBIT–SWI AND PHASE



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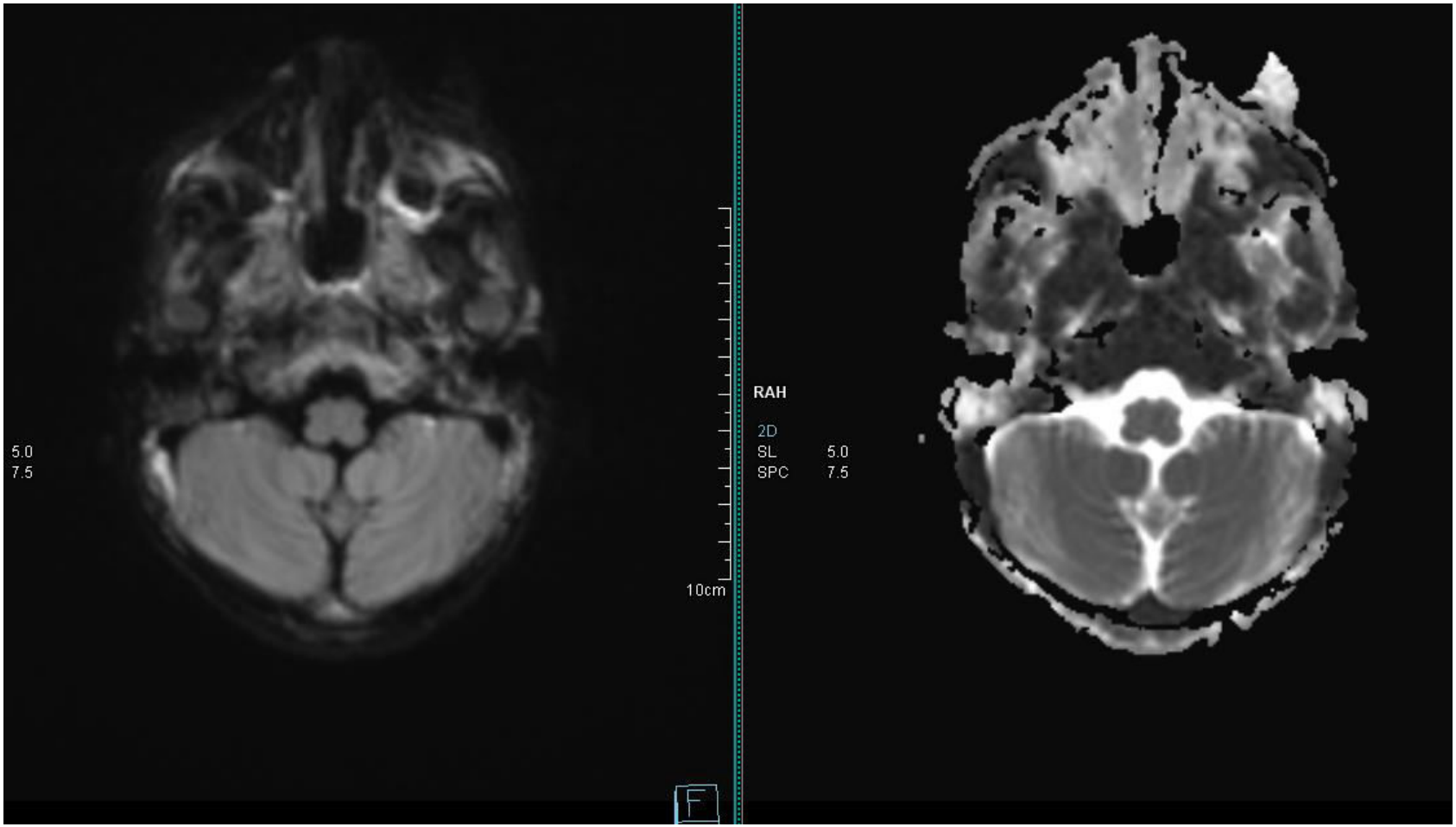
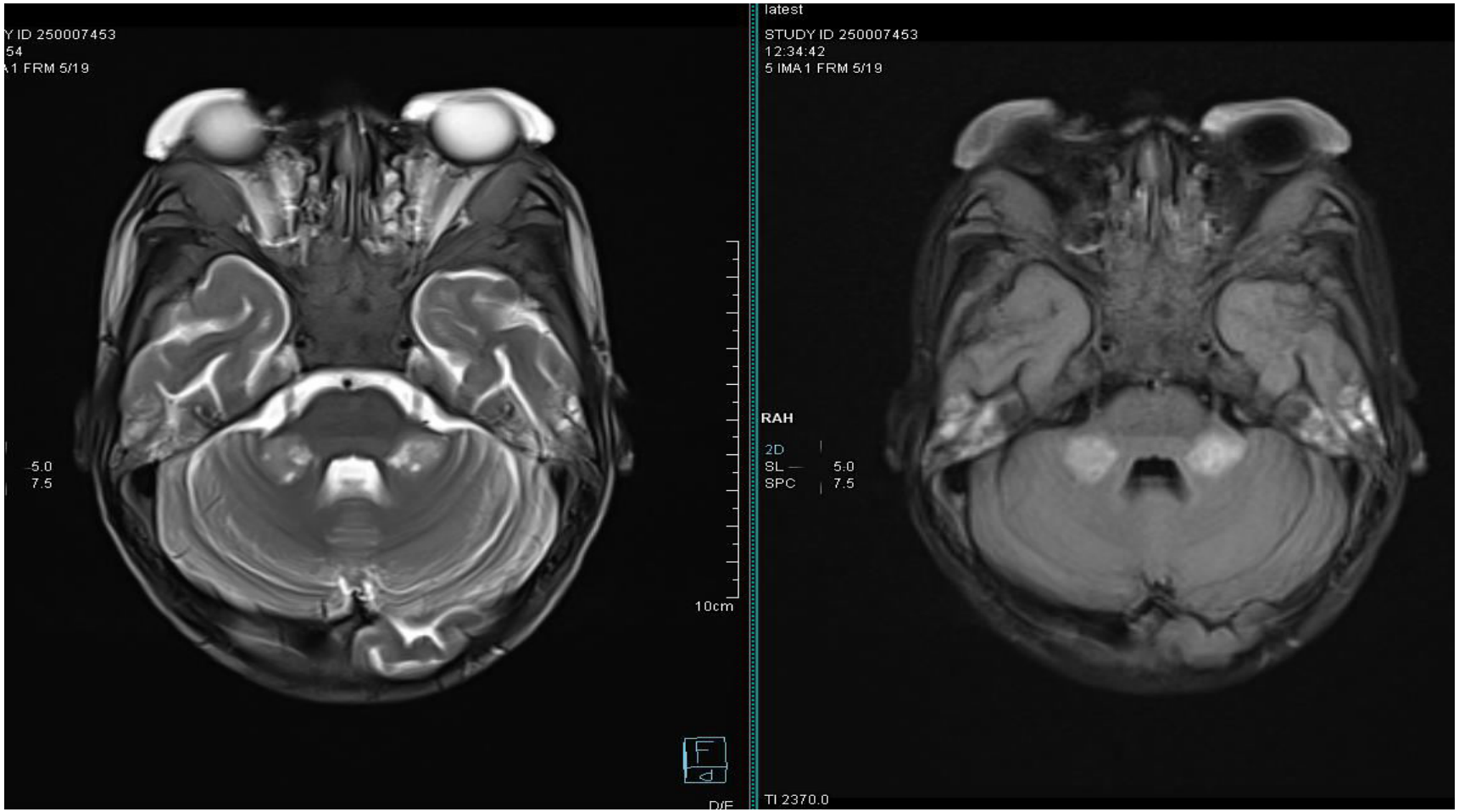
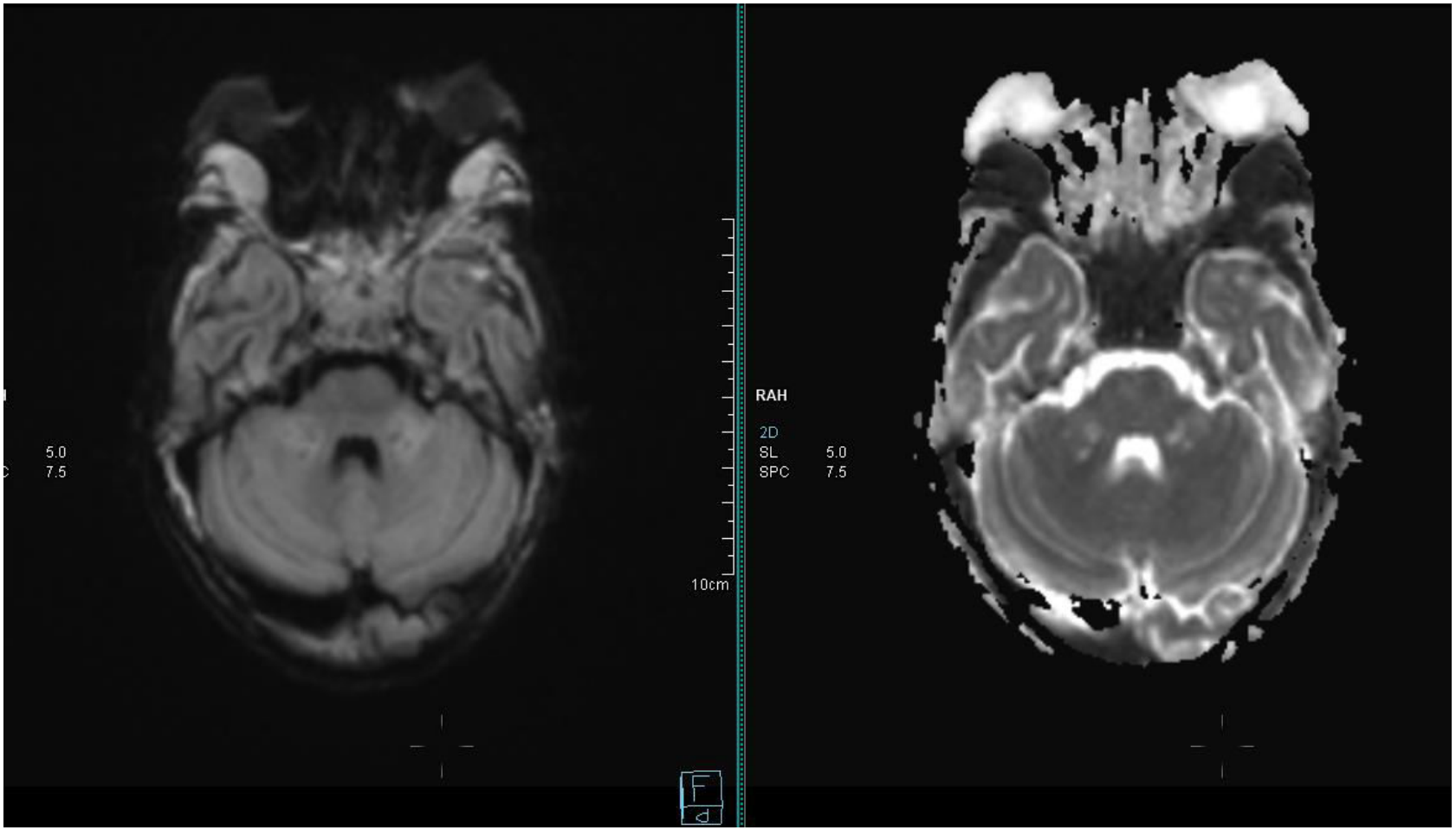


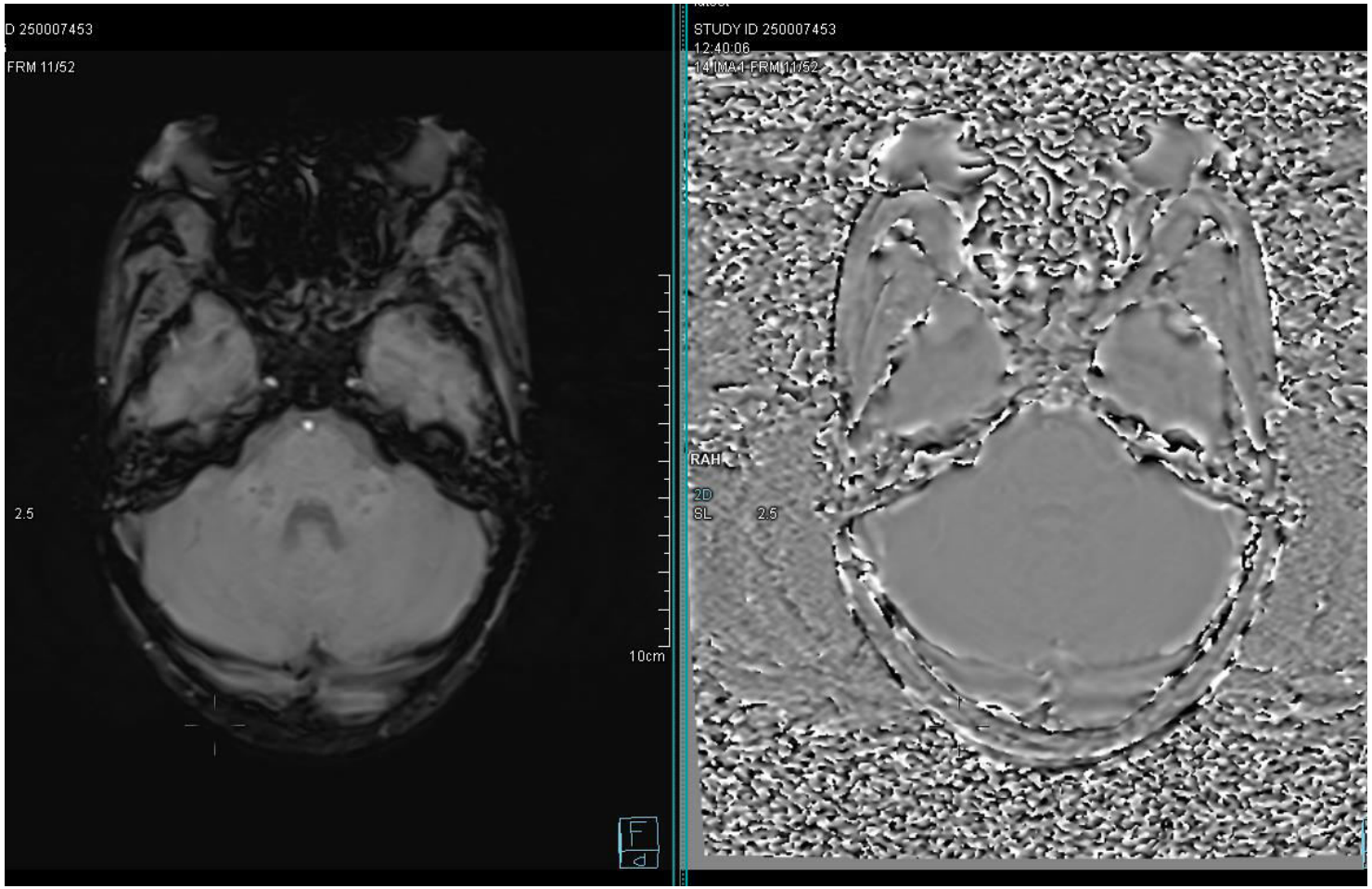
MRI BRAIN -T2 AND FLAIR



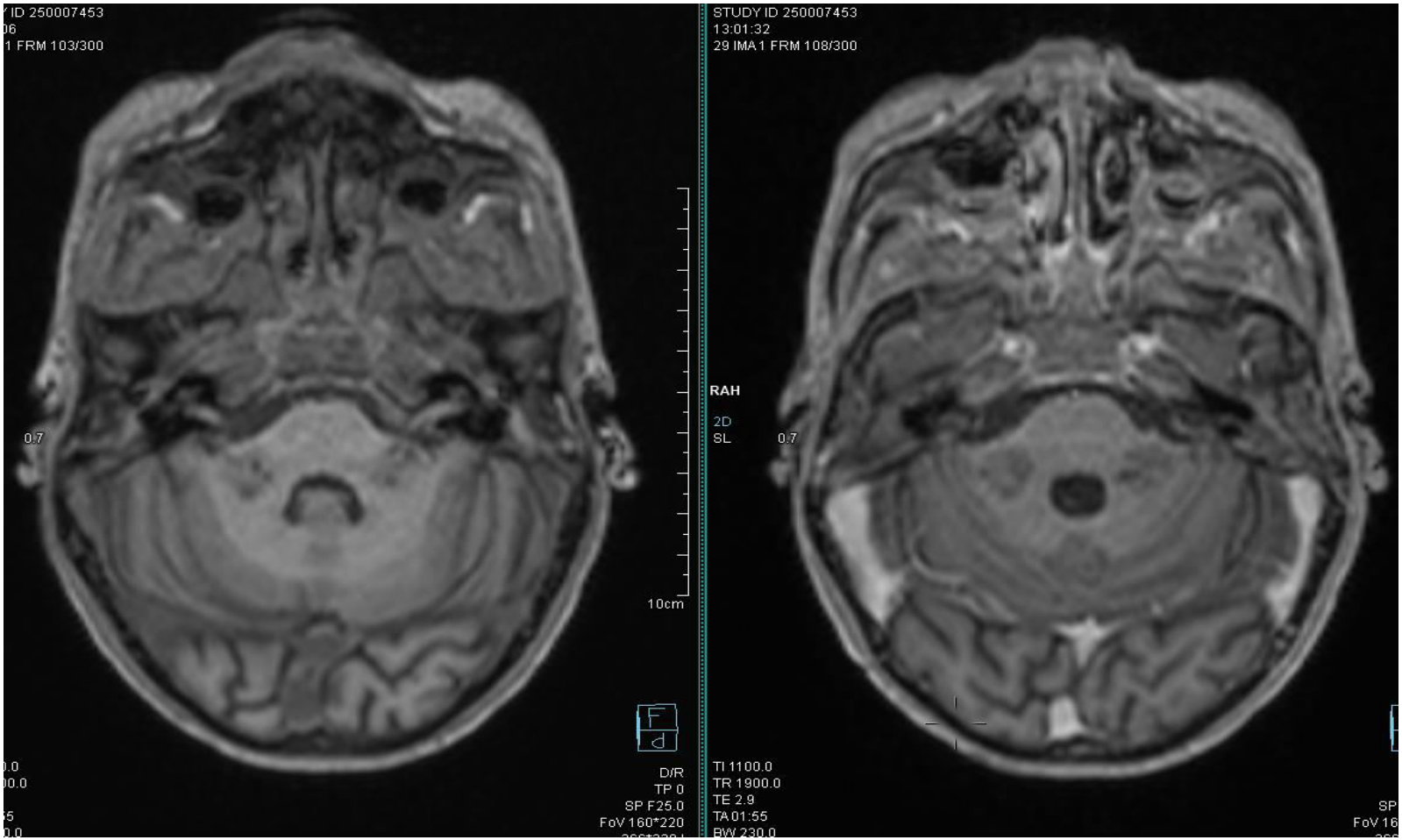
MRI BRAIN-DWI AND ADC



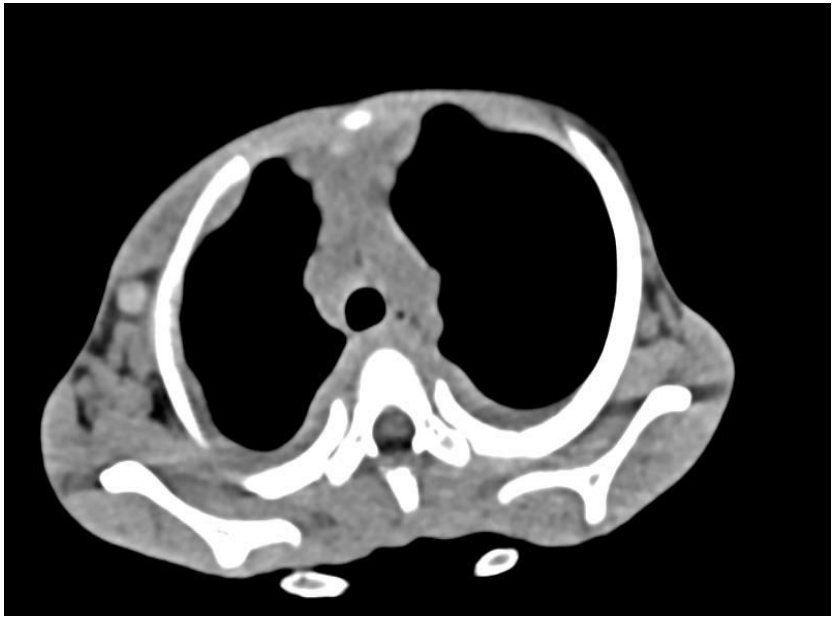
MRI BRAIN–SWI AND PHASE

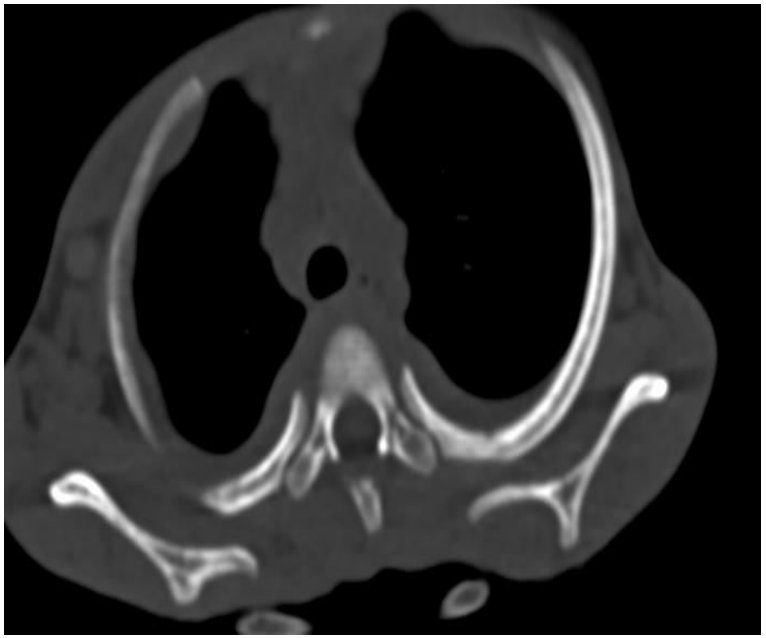


MRI BRAIN PRE AND POST CONTRAST

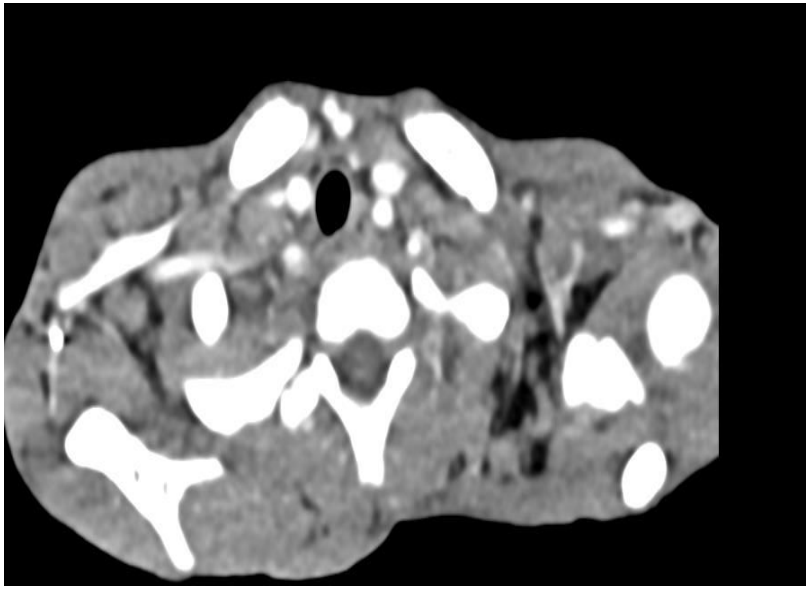


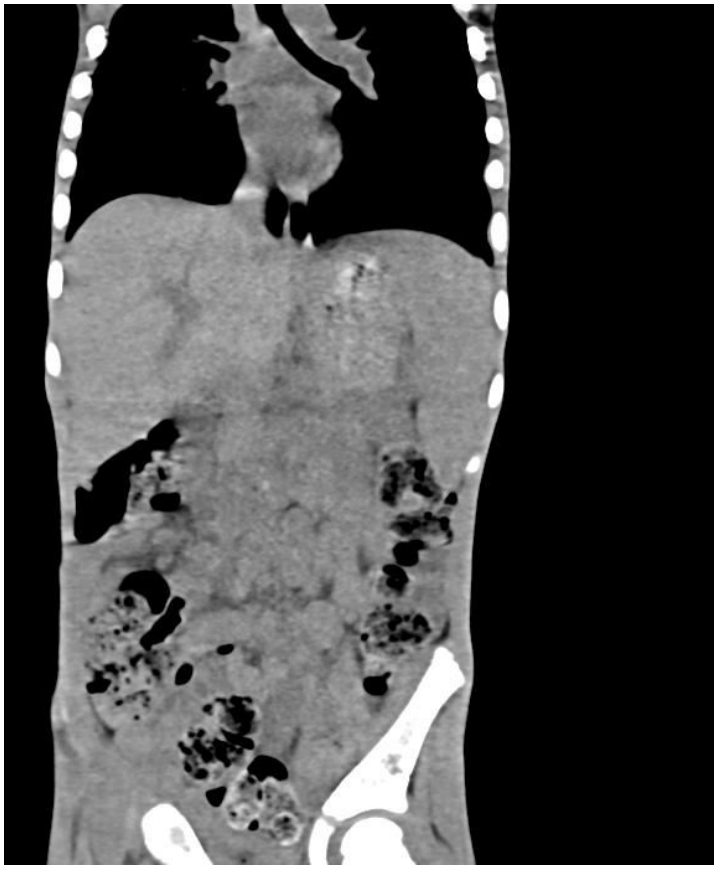
HRCT THORAX



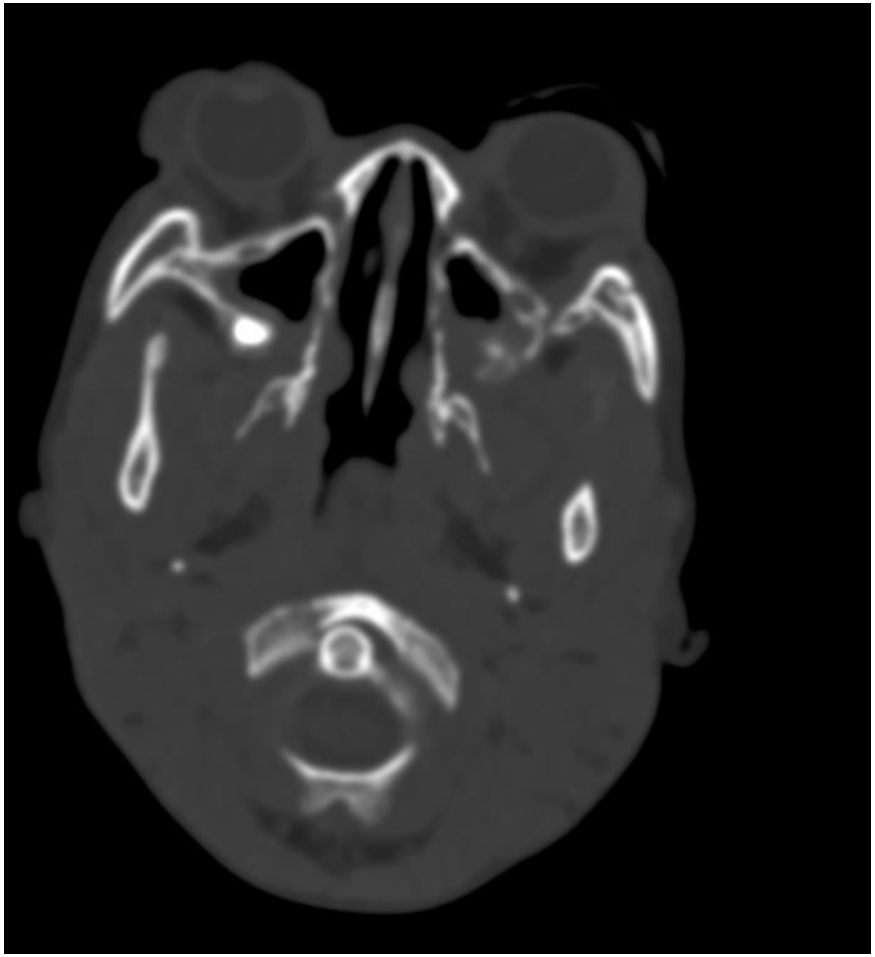


CONTRAST ABDOMEN





NCCT HEAD



Bone marrow examination

- Hypercellular bone marrow with more than 90% blast cells with negative strain for MPO.

FINAL DIAGNOSIS

- These imaging features in a known case of acute lymphoblastic leukaemia may suggest diffuse extra medullary haematopoiesis involving orbital, sino-nasal and mandibular bones. Other possibility of bilateral or vital and skeletal leukemic infiltration appears less likely.
- Non enhancingT2/FLAIR hyperintensities in the bilateral cerebellar peduncle in a known case of acute lymphoblastic leukaemia may suggest possibility of paraneoplastic demyelinating lesions more over leukemic infiltrate

Anatomical Involvement

- **Extraconal and intraconal compartments**: Most frequent sites.
- **Lacrimal gland**: May appear enlarged with abnormal signal and enhancement.
- **Optic nerve/sheath complex**: Can cause compression, edema, or enhancement.
- **Orbital bones**: Marrow replacement or erosion may be seen, especially in aggressive disease.
- **Extraocular muscles**: May be infiltrated but typically retain their shape (vs. orbital pseudotumor, which causes muscle enlargement including tendinous insertions).

Distinguishing EMH vs. Leukemic Infiltration on Imaging

MRI Feature	EMH	Leukemic Infiltrate
Location	Extraconal or near orbital bones	Can be intraconal or diffuse
T1 signal	Iso- to mildly hyperintense (fatty elements)	Iso- to hypointense
T2 signal	Variable; may be hyperintense or heterogeneous	Generally hyperintense
Enhancement	Mild to moderate	Often **homogeneous, intense** enhancement
Symmetry	Often **bilateral** and smooth	May be **unilateral**, asymmetric, or infiltrative
Bony changes	May be associated with bone expansion	Bone erosion is more typical in aggressive leukemic masses

Pathological Differentiation (Gold Standard)

Feature	Extramedullary Hematopoiesis (EMH)	Leukemic Infiltration
Cellularity	Normal **tri-lineage** hematopoiesis (RBC, WBC, megakaryocytes)	Monomorphic **lymphoblasts** (usually B- or T-lineage in ALL)
Organization	Structured, marrow-like architecture	Sheets of immature, undifferentiated cells
Mitotic activity	Low to moderate	High (due to blast proliferation)
Functionality	Produces blood cells	Non-functional neoplastic tissue
Immunohistochemistry	Negative for markers of blasts (TdT, CD10, CD34)	Positive for lymphoblast markers (TdT, CD34, CD10, CD19/CD3)

Stage-wise Pathophysiology of Orbital Infiltrates in Acute Lymphoblastic Leukaemia (ALL)

Stage	Pathophysiological Events	Orbital Involvement	Clinical Features
Stage 1: Hematologic Leukemia Initiation	Leukemic cells (immature lymphoblasts) proliferate uncontrollably in the **bone marrow** and enter the **bloodstream**. No extramedullary involvement yet.	No orbital involvement at this stage. Leukemic cells confined to **bone marrow** and **blood**.	**Fatigue**, **pallor**, **fever**, **easy bruising**, **bone pain**, and **lymphadenopathy**.
Stage 2: Extramedullary Spread	Leukemic cells migrate to **extramedullary sites** via the bloodstream, such as the **liver**, **spleen**, **lymph nodes**, and **orbit**	**Orbital infiltration** begins, often involving **orbital fat**, **lacrimal glands**, and **extraocular muscles**.	**Proptosis** (eye bulging), **periorbital swelling**, **eye pain**, **diplopia** (double vision), and **visual disturbances**.
Stage 3: Orbital Infiltration	Leukemic cells infiltrate **orbital soft tissues**, including **fat**, **extraocular muscles**, and **optic nerve sheath**. **Angiogenesis**occurs to support growing tumor	**Orbital masses** form in **extraconal** and **intraconal spaces**. The **optic nerve** may be compressed.	**Painful proptosis**, **restricted eye movement**, **visual impairment**, **diplopia**, **ocular discomfort**, and **headache**.
Stage 4: Advanced Leukemia & Systemic Spread	Leukemia becomes more aggressive with widespread systemic involvement, including the orbit. **Bilateral orbital involvement** may occur. **Orbital bone marrow** may also be affected.	**Bilateral orbital infiltration** and **mass effect**. **Orbital bone marrow infiltration** leads to **bone erosion**	**Bilateral proptosis**, **severe visual disturbances**, **pain**, **swelling**, **visual impairment**, and systemic symptoms like **fever**, **weight loss**, and **splenomegaly**.
Stage 5: Myeloid Sarcoma (Chloroma) Formation	Development of **solid tumors** made of immature myeloid cells (**chloromas**) in extramedullary sites. These can infiltrate the orbit. **Increased angiogenesis** and **necrosis** occur.	Formation of **orbital chloromas** (solid masses) leads to **severe proptosis** and **mass effect**. **Optic nerve compression**may occur.	**Severe proptosis**, **pain**, **visual loss** from **optic nerve compression**, **headache**, and **orbital mass** palpable on exam.

MRI Findings in a Case of ALL in the Cerebellar Peduncles and Dentate Nucleus

MRI Finding	Reason for the Finding
T2/FLAIR	Bilateral **hyperintense signal** (may be symmetric or slightly asymmetric)
T1	Usually isointense or hypointense
DWI/ADC	May show **restricted diffusion** in acute stages if inflammation is high
Post-contrast	Typically **no enhancement** (if immune-mediated), or mild patchy enhancement
No mass effect or edema	Helps differentiate from infiltrative tumors or CNS leukemia

Mechanisms:

1. Immune Cross-Reactivity (Molecular Mimicry)

The immune system attacks leukemic cells **and accidentally targets myelin or neurons** that share similar antigens.

No leukemic cells in CNS, but **inflammatory demyelination** occurs.

2. Paraneoplastic Autoantibodies

Antibodies or T-cells may attack **oligodendrocytes or cerebellar neurons**.

3. Cytokine Storm / Inflammatory State

ALL can trigger **massive cytokine release** → BBB disruption → CNS inflammation and demyelination.

MRI Comparison: Paraneoplastic Demyelination vs. Leukemic Infiltration

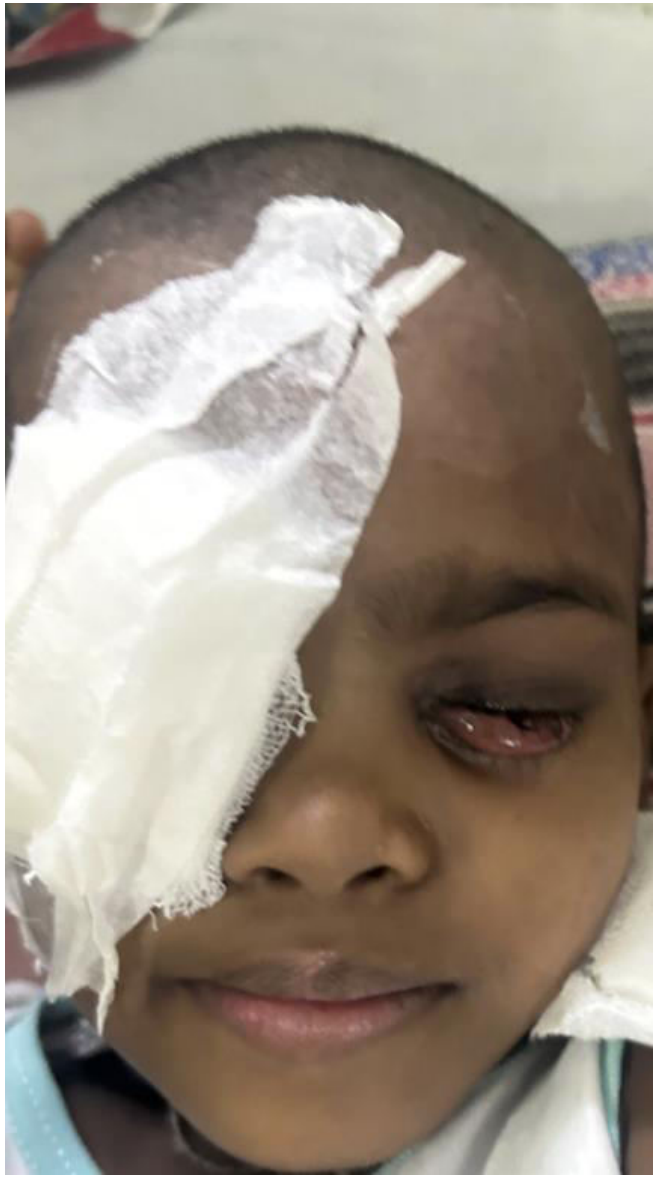
MRI Feature	Paraneoplastic Demyelination	Leukemic Infiltration
Location	**Bilateral**, symmetric involvement of dentate nuclei	Can be **unilateral or asymmetric**, may extend beyond cerebellum
T2/FLAIR	Hyperintense signal in dentate nuclei (symmetric), often no mass effect	Hyperintense but more likely with **adjacent edema** and mass effect
T1	Iso- to hypointense	Iso- to hypointense
DWI/ADC	Mild **restricted diffusion** (if acute inflammation) or none	**Marked restricted diffusion** due to high cellularity of blasts
Contrast enhancement	Usually **none or minimal**, non-nodular	**Nodular, patchy**, or **leptomeningeal enhancement** common
Mass effect	Absent	**Present** if large infiltrate or tumor-like mass

Differential Diagnosis

Entity	Key MRI Clues	Clinical Clues
Orbital lymphoma	Homogeneous, T1 isointense, mild T2 hyperintense, strong enhancement	Older patients, painless, no systemic leukemia
Rhabdomyosarcoma	Rapidly growing, heterogeneous, T2 hyperintense, variable enhancement	Children, painful, very aggressive
Orbital pseudotumor (idiopathic orbital inflammation)	T2 hypointense (fibrosis), muscle tendon involvement	Painful, acute, often unilateral
Neuroblastoma metastases	Bony involvement, calcifications	Pediatric tumor with systemic features
Optic nerve glioma	Fusiform nerve thickening, T2 hyperintense, no diffusion restriction	Slow-growing, often NF1-related

AFTER COMMENCEMENT OF TREATMENT

- Treatment was commenced with methotrexate, vincristine and daunorubicin.
- There was clinical and hematological resolution of the symptoms with decrease in proptosis and orbital swelling.



Consent was taken from patient's parents for the image

Why MRI Orbit Matters in ALL

Detects orbital leukemic infiltration

- Common in relapse or initial presentation
- Appears as soft tissue masses, muscle involvement, optic nerve thickening

Assesses optic nerve involvement

- Helps diagnose CNS spread via optic pathways
- Identifies optic neuritis, sheath enhancement

Guides differential diagnosis

Monitors treatment response

- Tracks resolution or progression of orbital disease
- Useful after chemotherapy, intrathecal therapy, or radiation

Prevents vision loss

- Early detection allows timely therapy (e.g. corticosteroids, CNS chemo)

Supports CNS staging

- Helps in identifying subtle CNS involvement in high-risk patients

Non-invasive, high-resolution

- Preferred imaging modality for soft tissue, nerve, and marrow assessment in orbit

CASE ACKNOWLEDGEMENT

1. DR.RAVI RAJDEO SIR: Associate professor in the department of radio-diagnosis GMC ,Nagpur.
2. DR.POOJA RAUT MAM: Lecturer in the department of radio-diagnosis GMC ,Nagpur.

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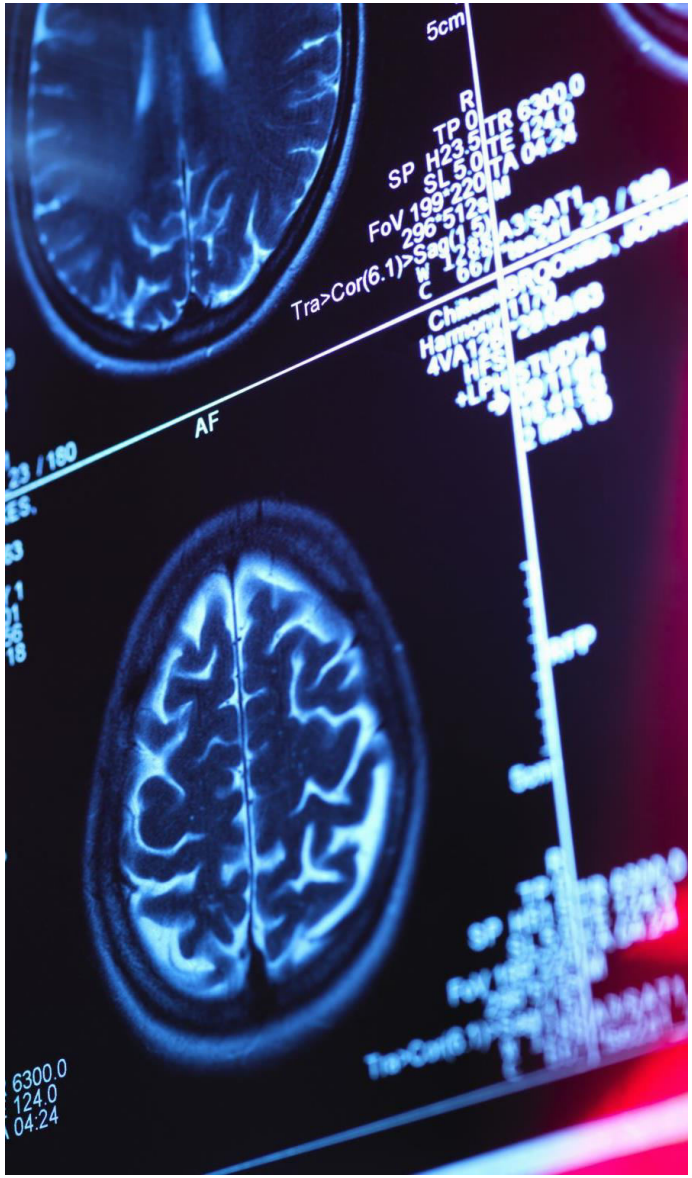

Thank you!