



# Radiology of Multiple Sclerosis

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# Our Patient

- 40 y.o. woman with baseline diplopia, weakness, ataxia, and dysarthria
- Now presents with titubation head tremor
- Past neurologic history...

Multiple sclerosis



# What makes this patient typical?

- She is between 20 & 40 years old (symptoms usually start by age 55). Peak age of onset is 24.
- Women are affected 2x more than men.
- She lives north of the 40<sup>th</sup> parallel.
- Common initial symptoms: sensory changes, weakness, ataxia, blurry or double vision.
- FYI: About 400,000 people have MS in the US.



# Tests

- CSF shows oligoclonal bands of IgG in 90% of MS patients.
- Other conditions with similar CSF: HIV, Lyme disease, neurosarcoidosis, syphilis, subacute sclerosing panencephalitis (SSPE), chronic meningitis.
- **Evoked Potentials** can suggest demyelination of certain areas by measuring speed of nerve conduction within the brain.



# Imaging Studies

- CT is *not* sensitive for MS plaques.
- They may occasionally be seen as low attenuation areas on CT but are often not detected.
- **MRI** more often demonstrates areas of recent and old demyelination.
- The MRI lesions may not, however correlate with clinical symptoms.
- Patients can have asymptomatic MRI lesions and focal neurologic findings without a corresponding MRI lesion.



# Diagnostic Criteria for Multiple Sclerosis

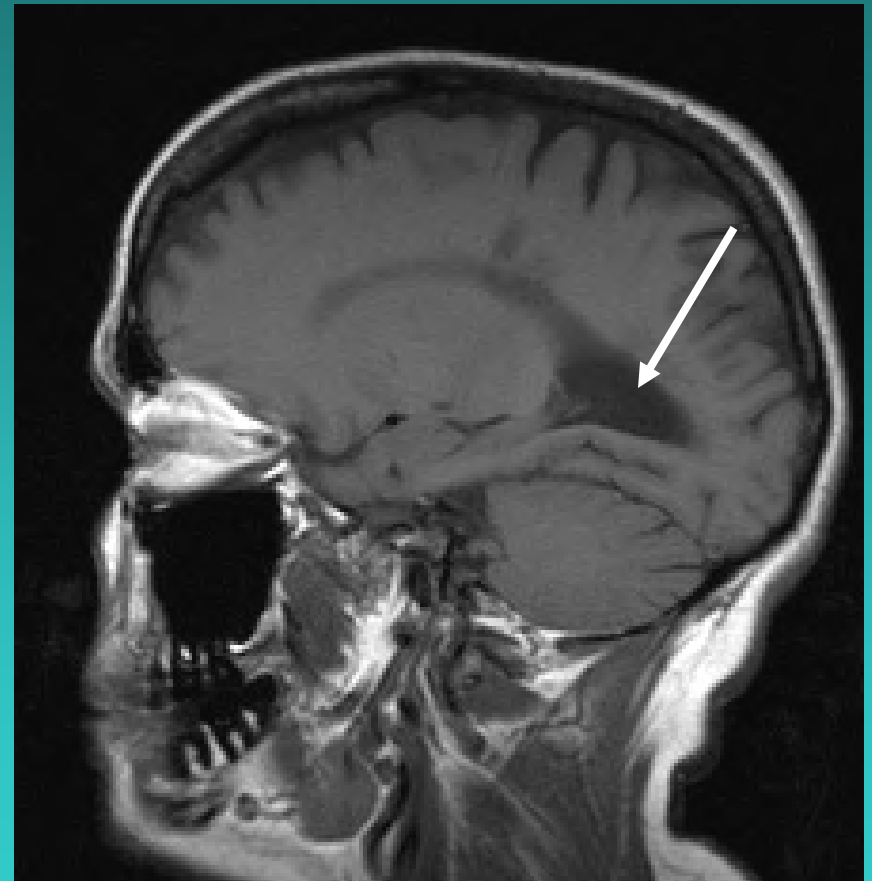
- “White-matter lesions disseminated over time and space”
- Clinically definite MS:
  - 2 episodes of symptoms
  - evidence of 2 white-matter lesions (imaging or clinical)
- Laboratory-supported definite MS:
  - 2 episodes of symptoms
  - evidence of 1 white-matter lesion
  - oligoclonal bands in CSF
- Probable:
  - 2 episodes and either 1 lesion or oligoclonal bands.



# Typical appearance of MS on MRI

## T1-weighted image

- CSF is ...
- Dark
- On T1, demyelinated areas are isointense or hypointense.



T1 MRI



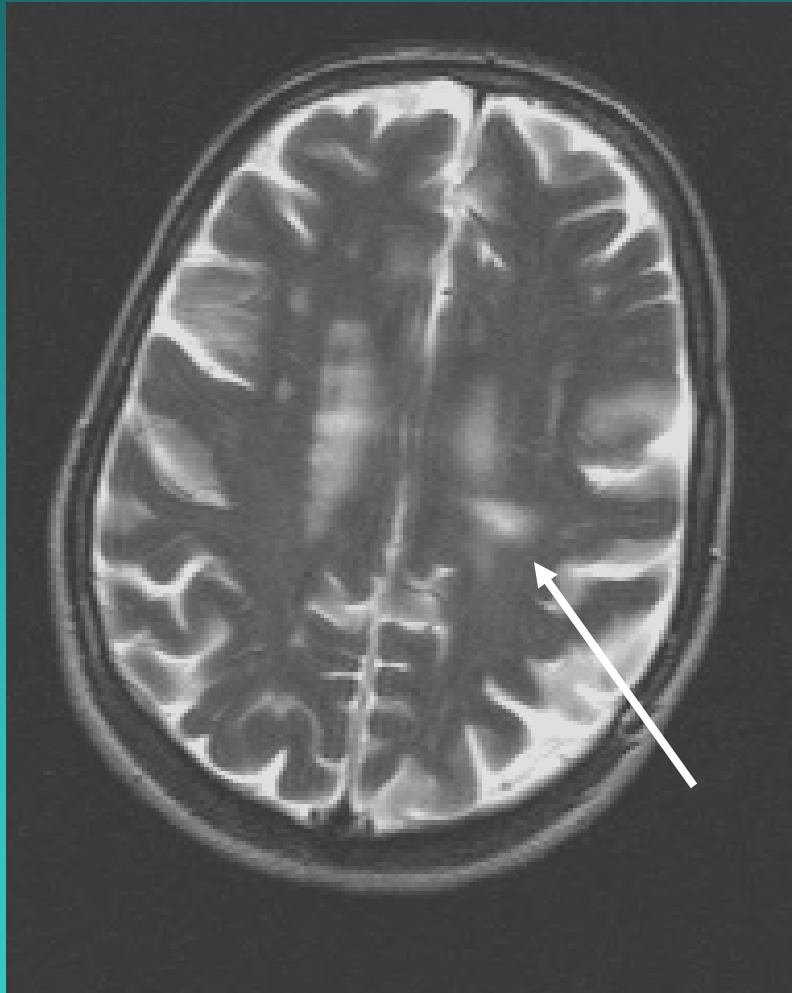
# Differential Diagnosis of Dark Areas on T1

- Fairly nonspecific sign of tissue loss
- Ischemic or infarcted areas
- Areas of edema or acute hemorrhage
- Malignant tumors
- Meningiomas





# Typical appearance of MS on MRI



**T2 weighted images**

CSF is ...

Bright

On T2, demyelinated areas  
are bright



# Differential Diagnosis of bright areas on T2

- **“Normal Variants”**
- **Multiple sclerosis**
- **Lyme** disease
- **AIDS** and/or PML
- Neurosarcoidosis
- Vasculitides (Primary CNS, Behçet’s, syphilis, lupus)
- Diffuse axonal injury/Post-anoxic encephalopathy
- Malignant hypertension → cerebral edema



# Differential Diagnosis of bright areas on T2, cont.

- **Ischemic areas**
- Migraine
- **Acute Disseminated Encephalomyelitis**
- Subacute Sclerosing Panencephalitis (SSPE)
- Osmotic Demyelination
- **Alcoholism**
- Drugs: cyclosporine, chemotherapeutic agents
- Radiation



# “Normal” Variants

- Up to age 40, terminal areas of myelination may remain bright on T2, as seen here.

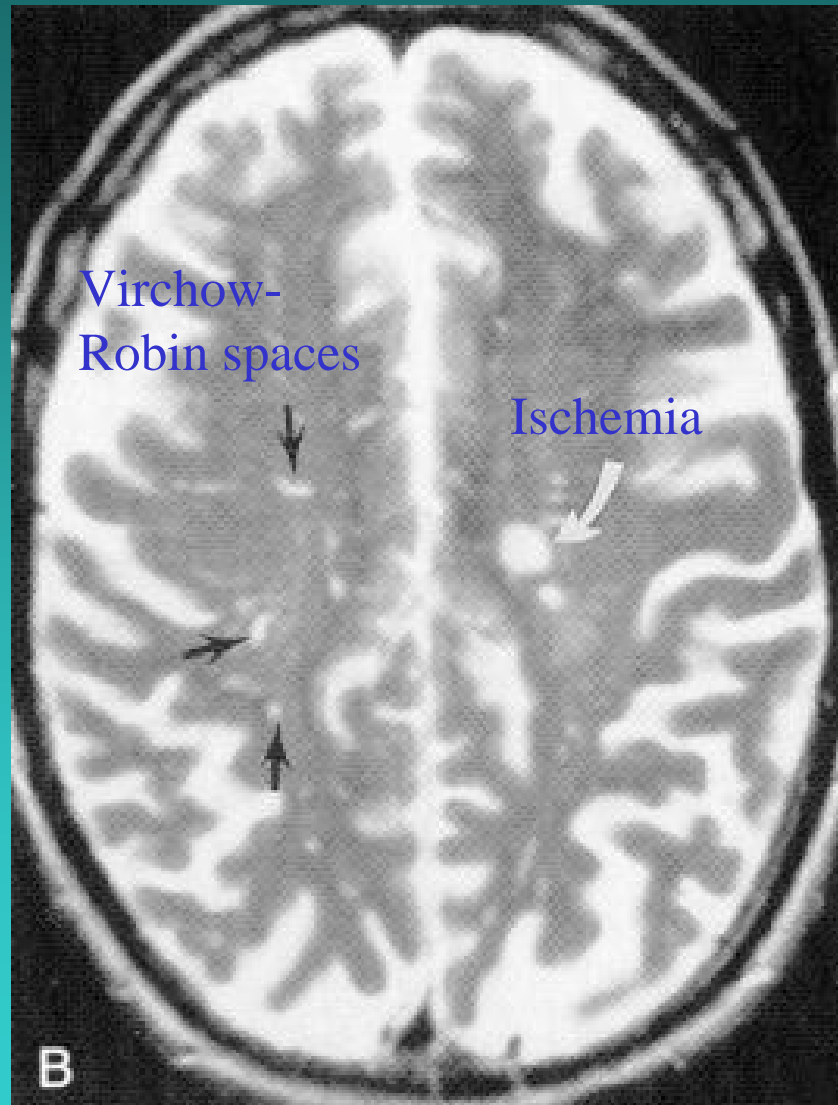




# “Normal” Variants Aging Brain

- UBOs or unidentified bright objects are seen in 30% of the normal elderly.
- Causes include:
- Virchow-Robin spaces, which are perivascular. Black arrows.

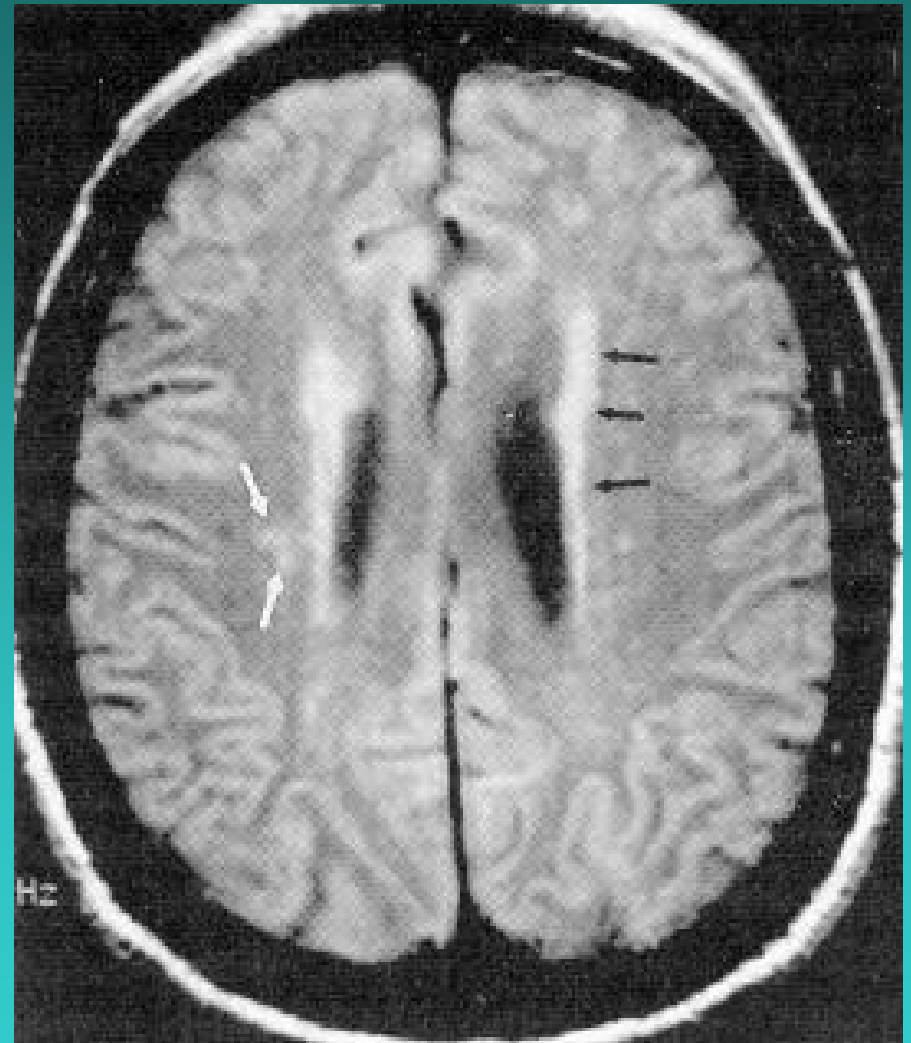
AND . . .





# Normal Aging Brain

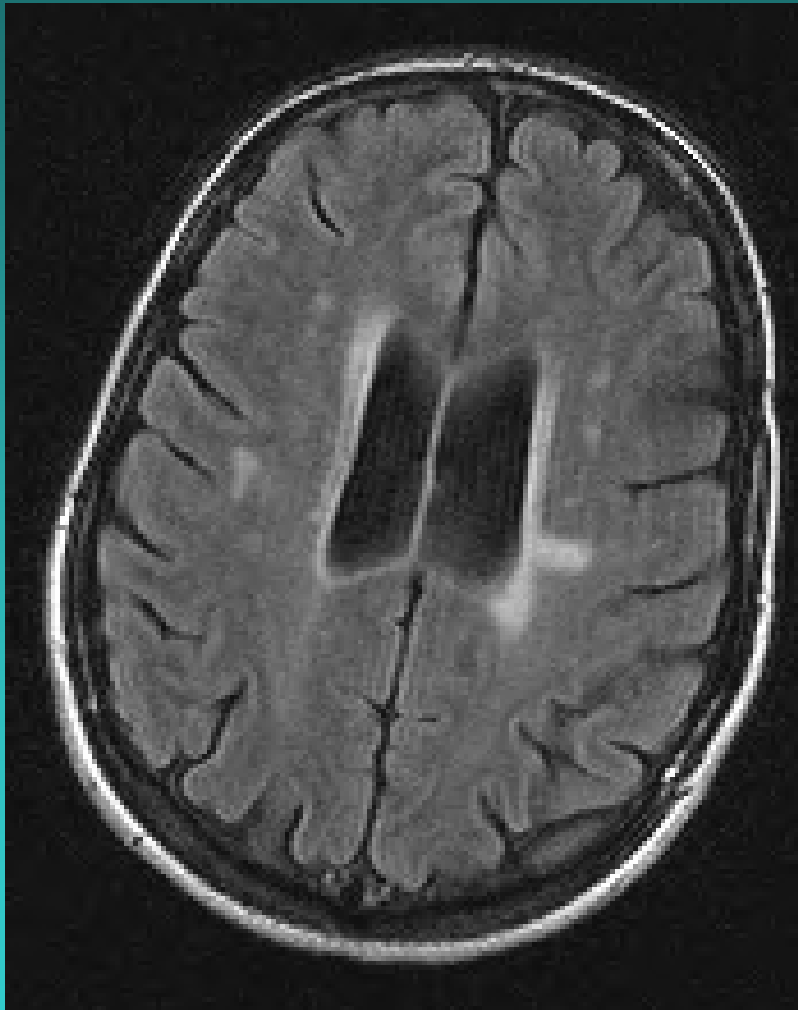
- Periventricular hyperintensities (black arrows).
- Deep white matter hyperintensities (white arrows).



Ketonen, LM. 1998. *Neurologic Clinics*. Vol. 16, no. 3, p. 585.



# Typical location of MS Plaques



- Periventricular Region
- “Dawson’s fingers”



# Typical location of MS Plaques

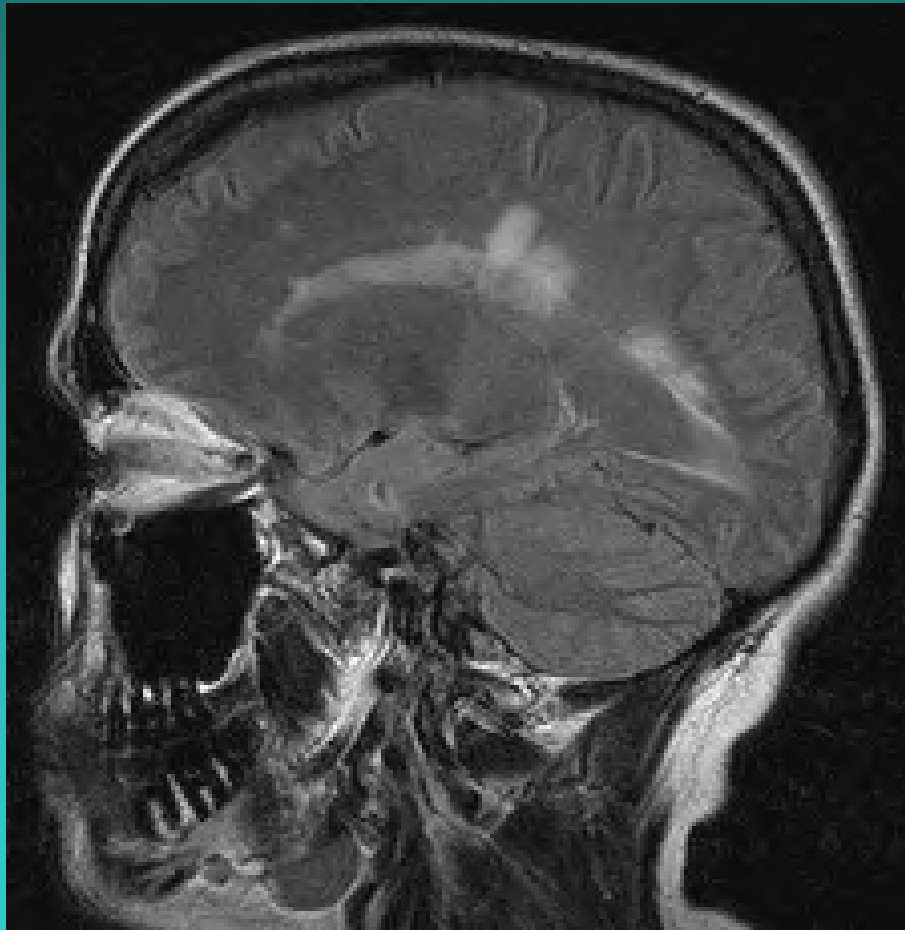


- Periventricular Region
- “Dawson’s fingers” represent lymphocytic infiltration along periventricular medullary veins.





# Typical location of MS Plaques



- Periventricular Region
- “Dawson’s fingers”
- Corpus callosum

Other locations include:

- Visual Pathways
- Posterior fossa
- Cervical spine

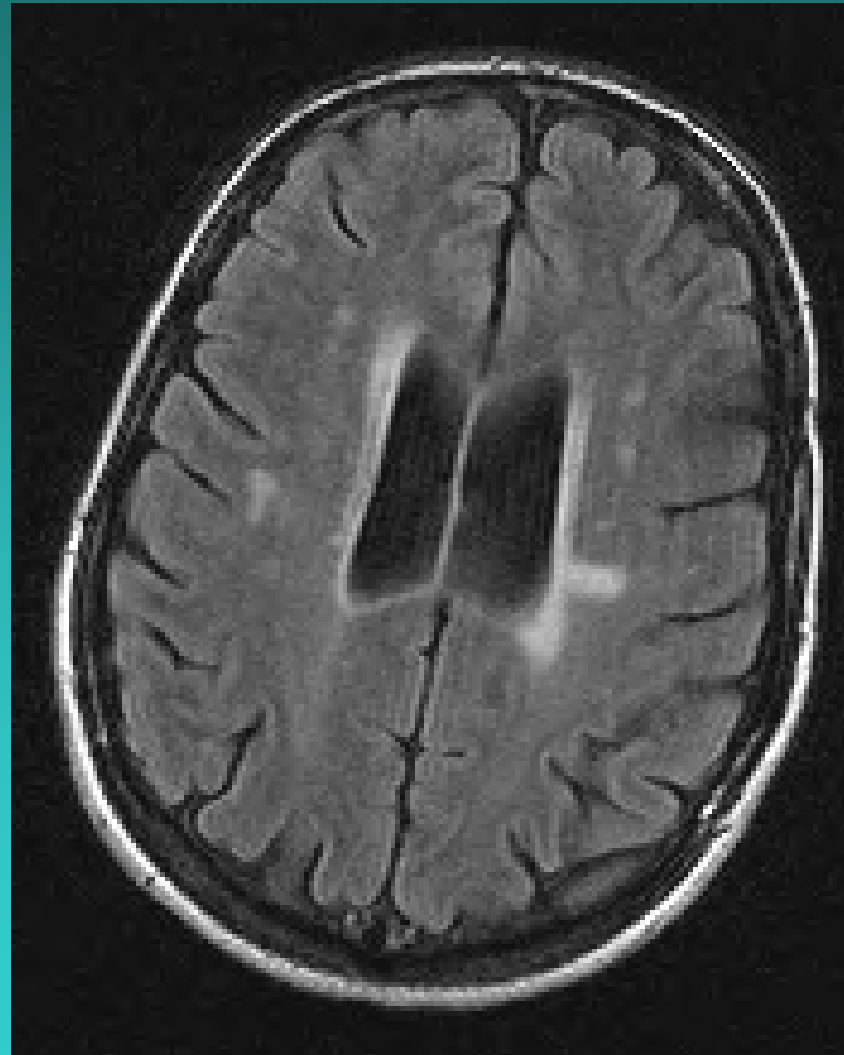


- Specialized MRI techniques aid detection of old and new MS plaques



# Fluid-attenuation inversion recovery(FLAIR) MRI

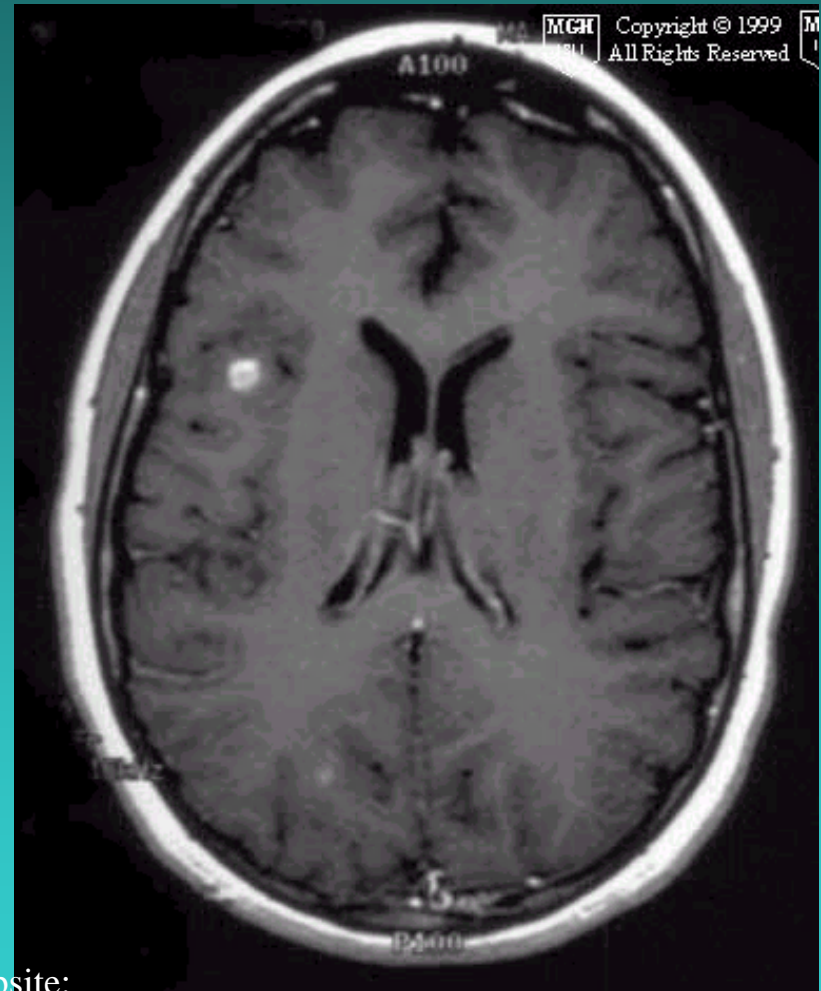
Shows lesions the  
same way T2 does, but  
CSF is dark. So ...  
easier to see abnormal  
areas.





# Gadolinium Enhanced MRI

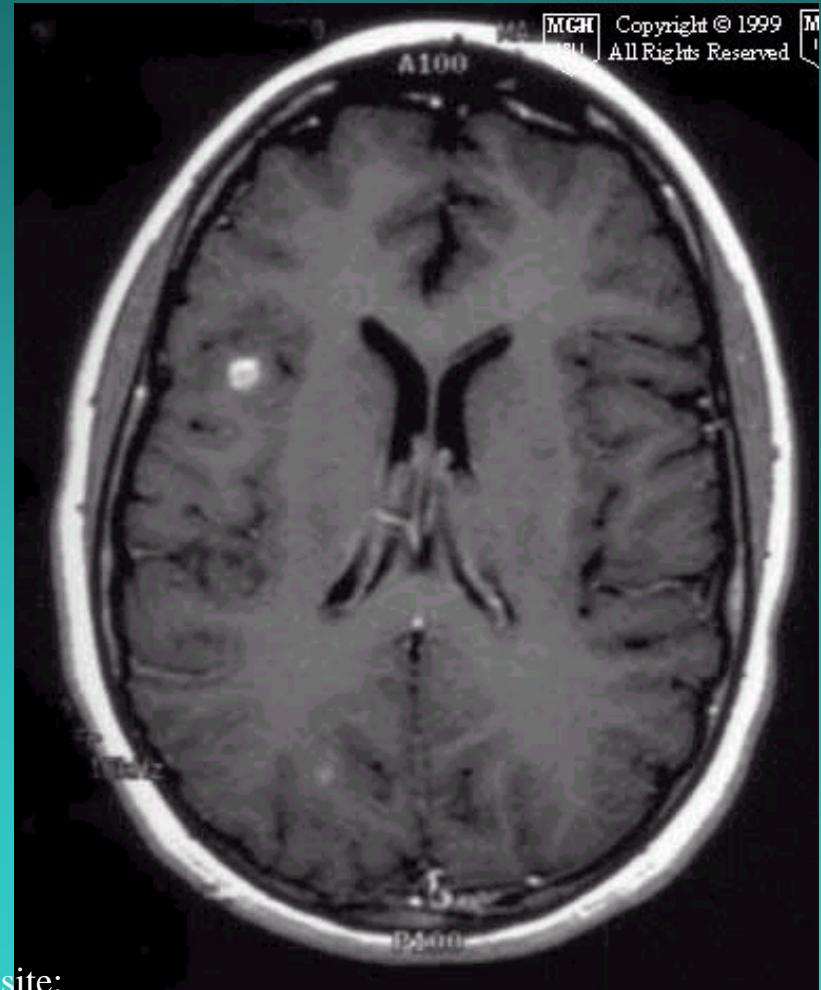
New “active” MS plaques enhance with contrast (gadolinium) on MRI because inflammation makes the blood-brain barrier leaky.





# Gadolinium Enhanced MRI

- Thus, new and old lesions can be distinguished on MRI.
- This can help fulfill the diagnostic criteria of demyelination episodes occurring at distant times.



From Aunt Minnie Radiology-Pathology Compendium Website:

<http://education.auntminnie.com/AuntMinnie/AMRadPath/QMachine.ASP?UID=9Q152KNJ&SESS=471756655>



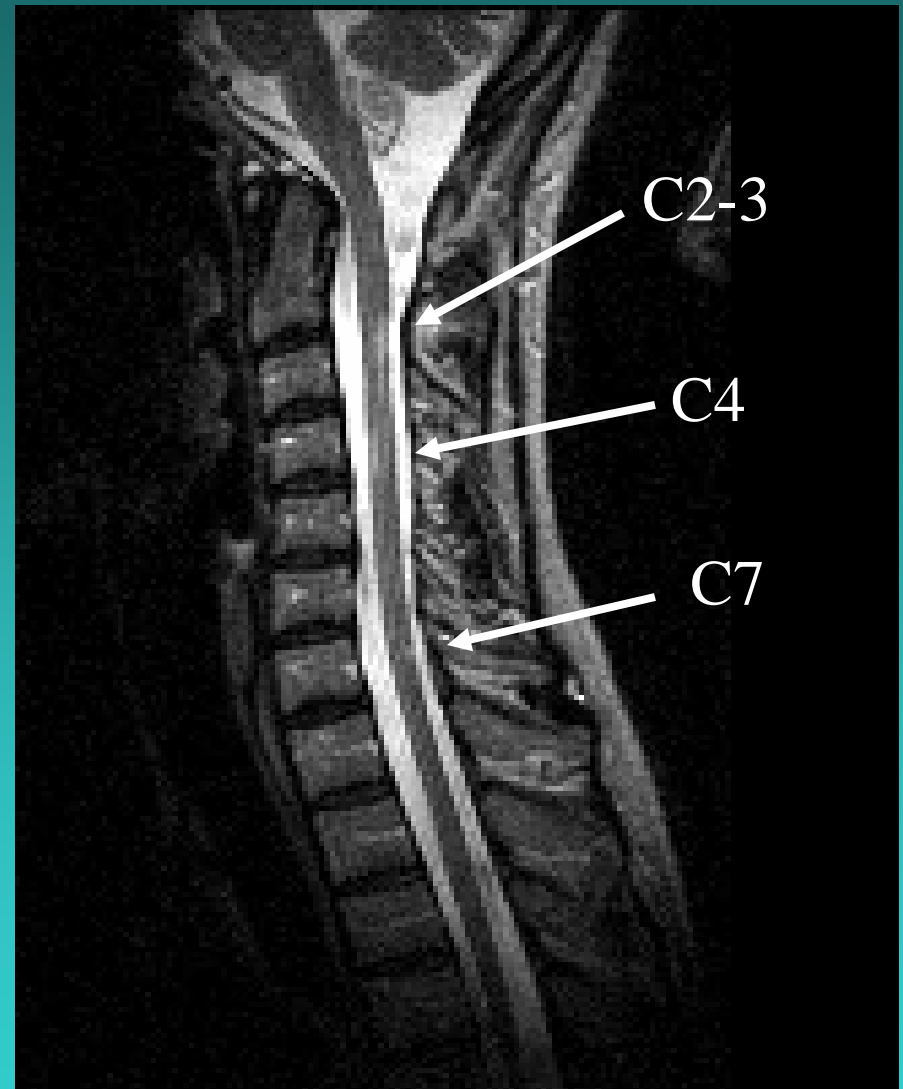
# Our patient had lesions in the cervical spinal cord



# OUR PATIENT: C-spine MRI, T2 Sagittal view

## Film Findings:

- Abnormal bright areas at C2-3, C4, and C7



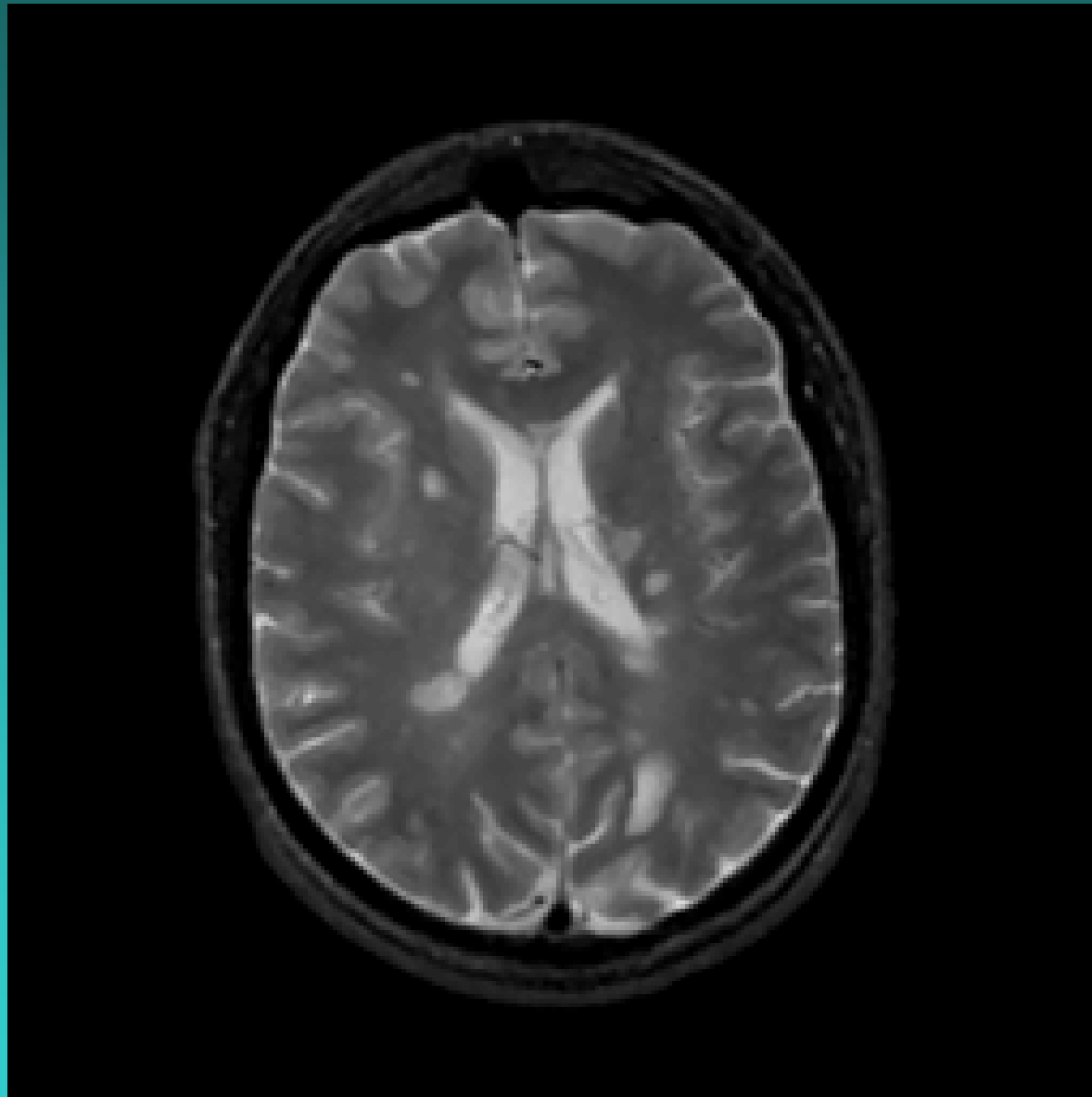


Click Here for a videoclip of a  
classic patient with MS



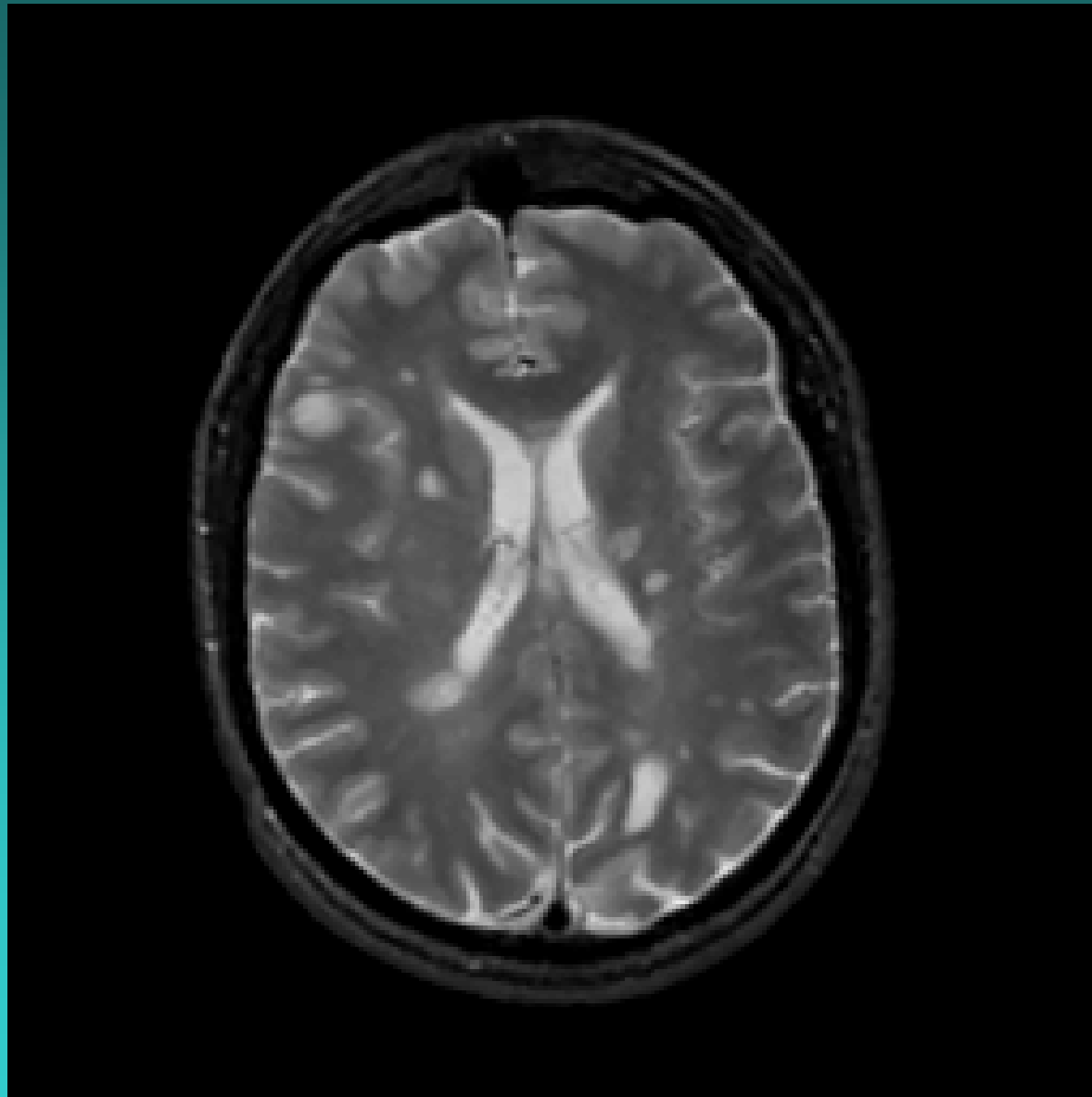


# MS Movie



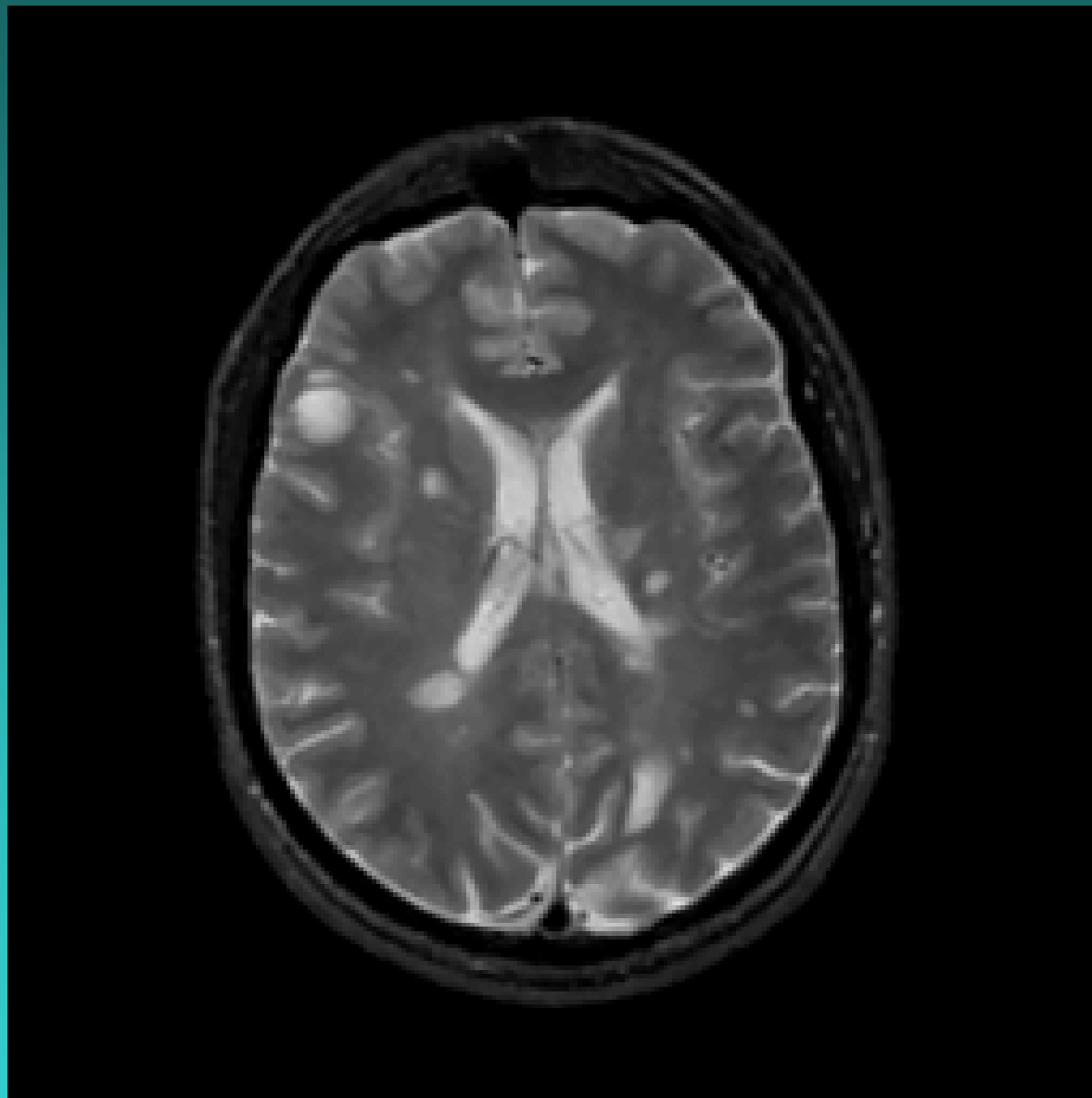


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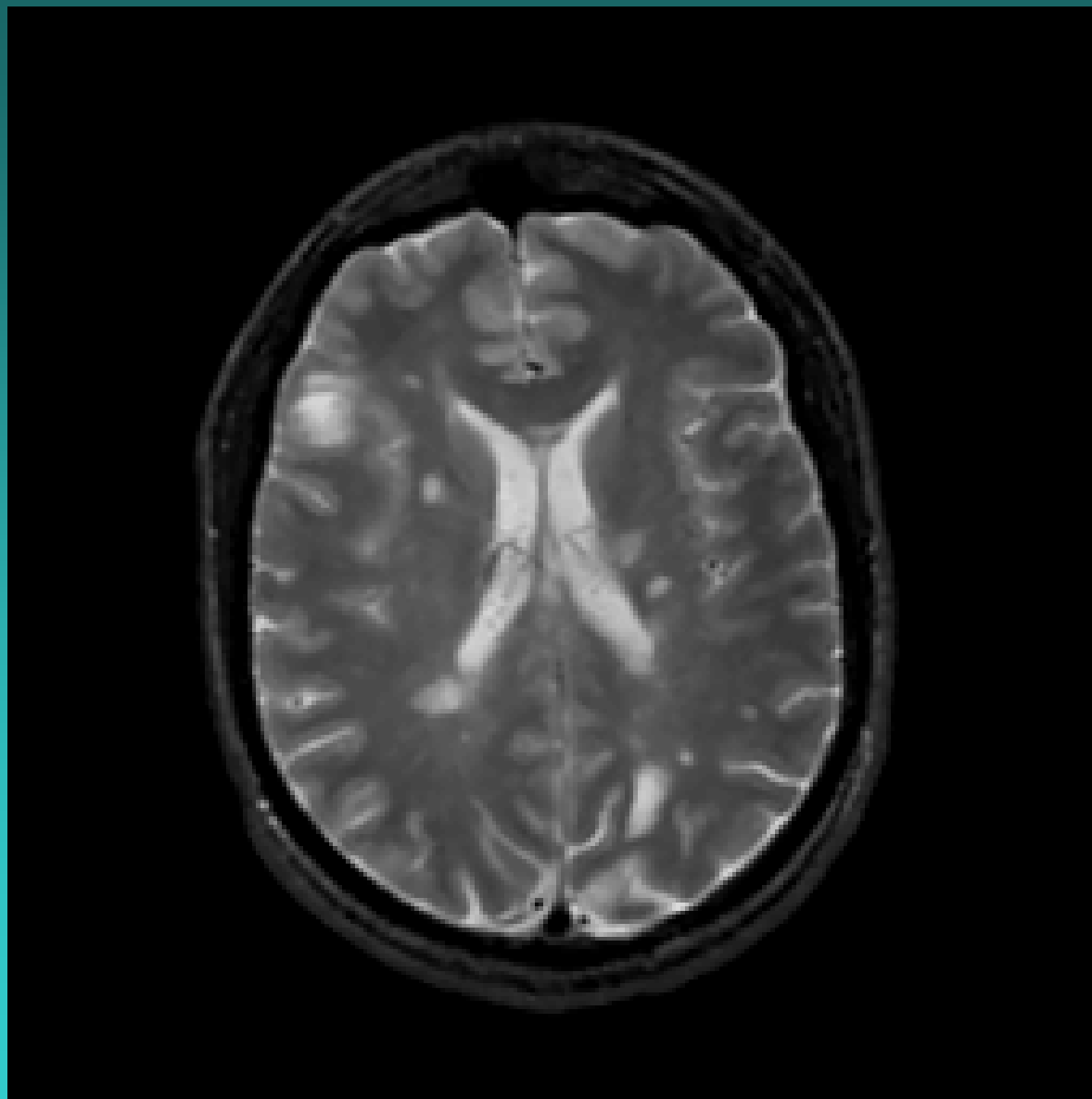


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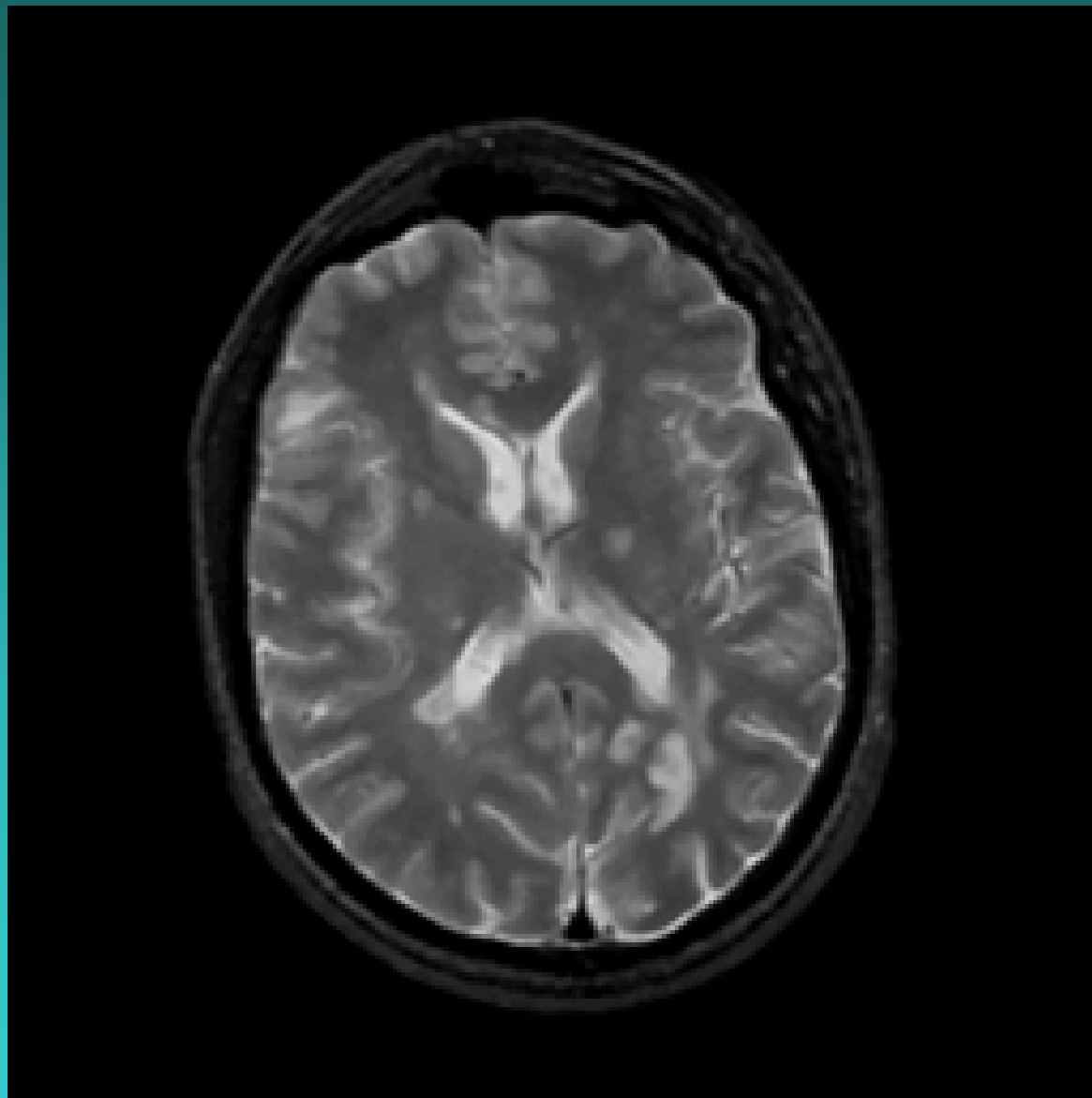


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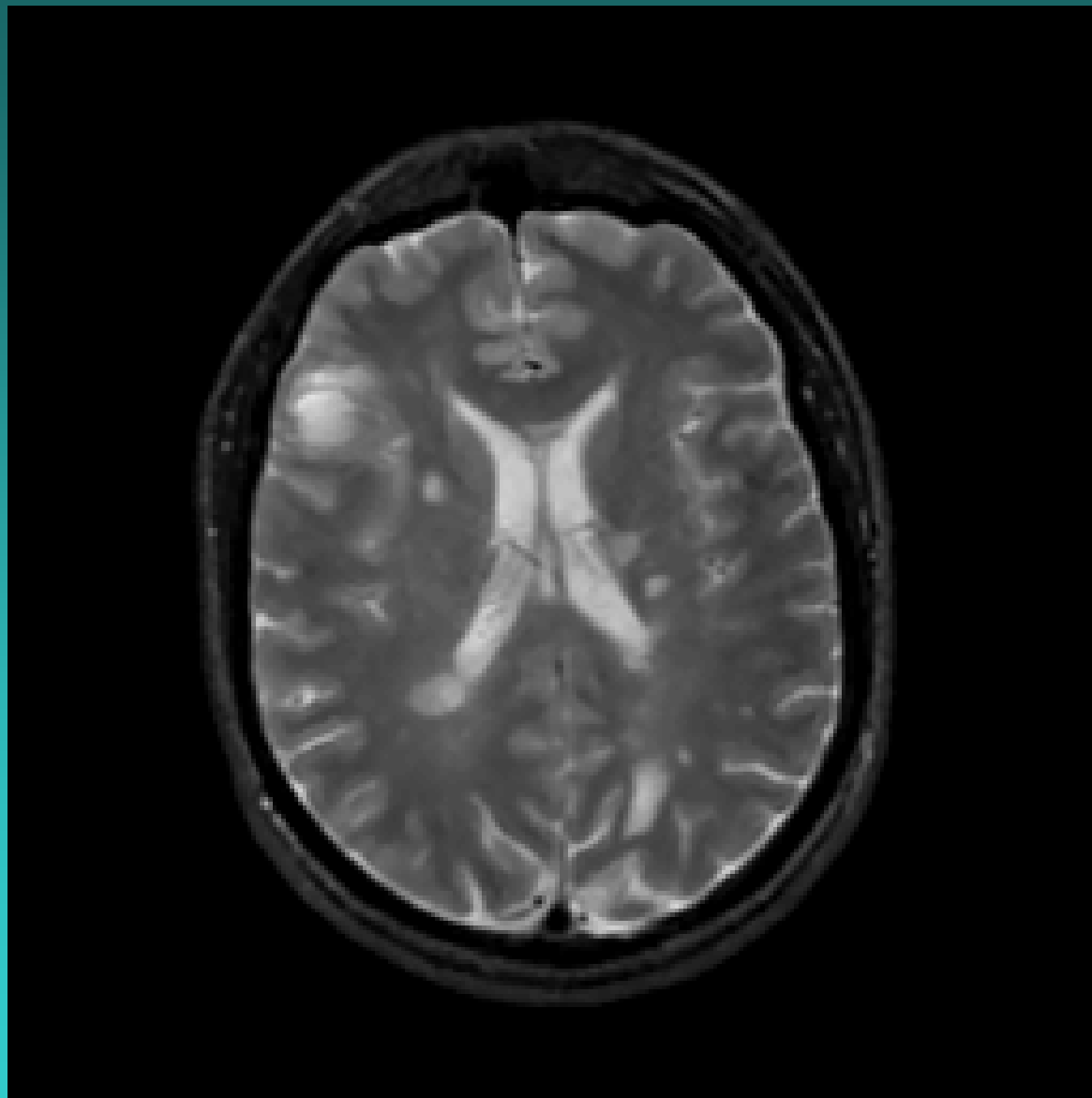


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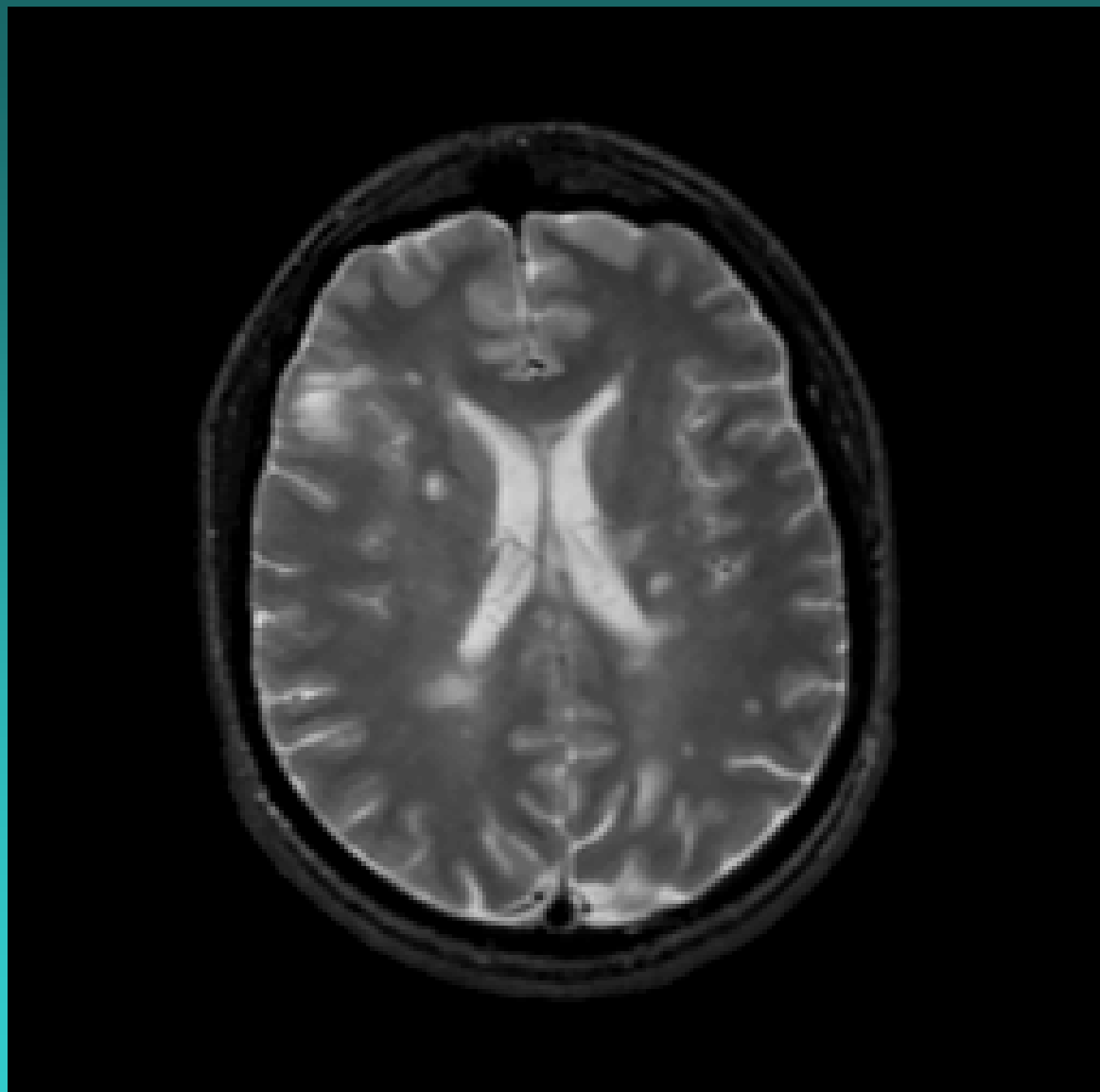


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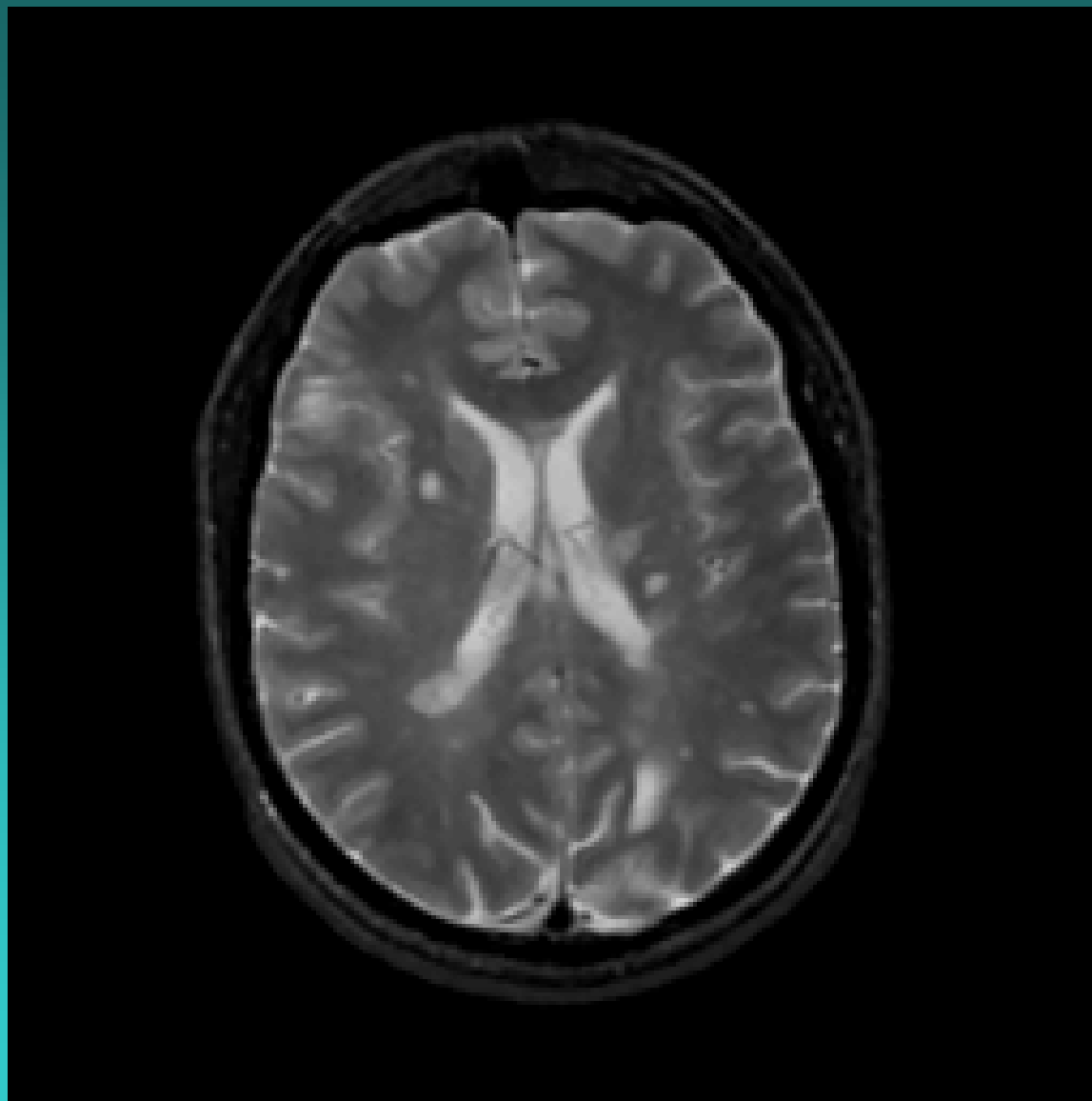


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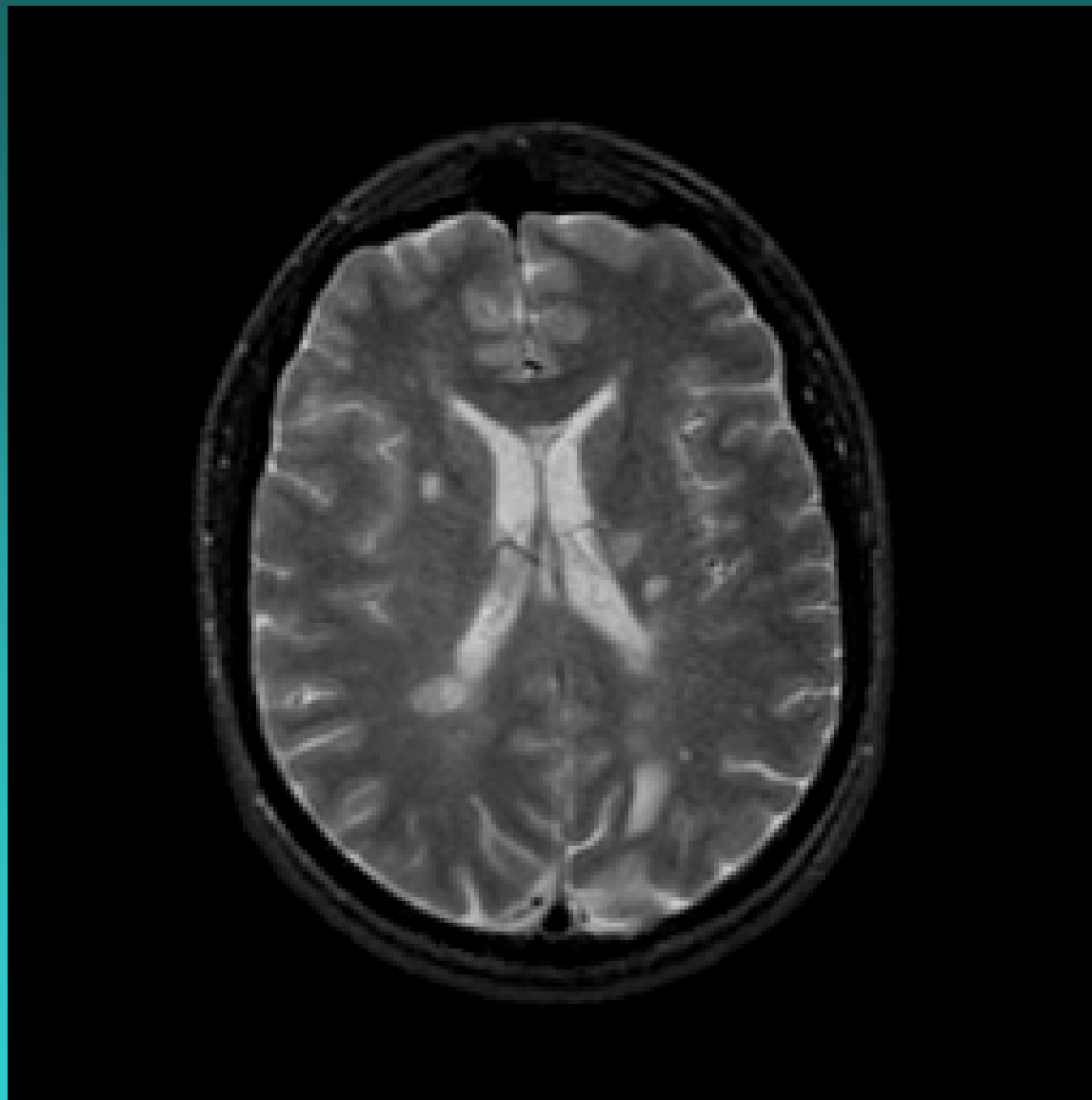
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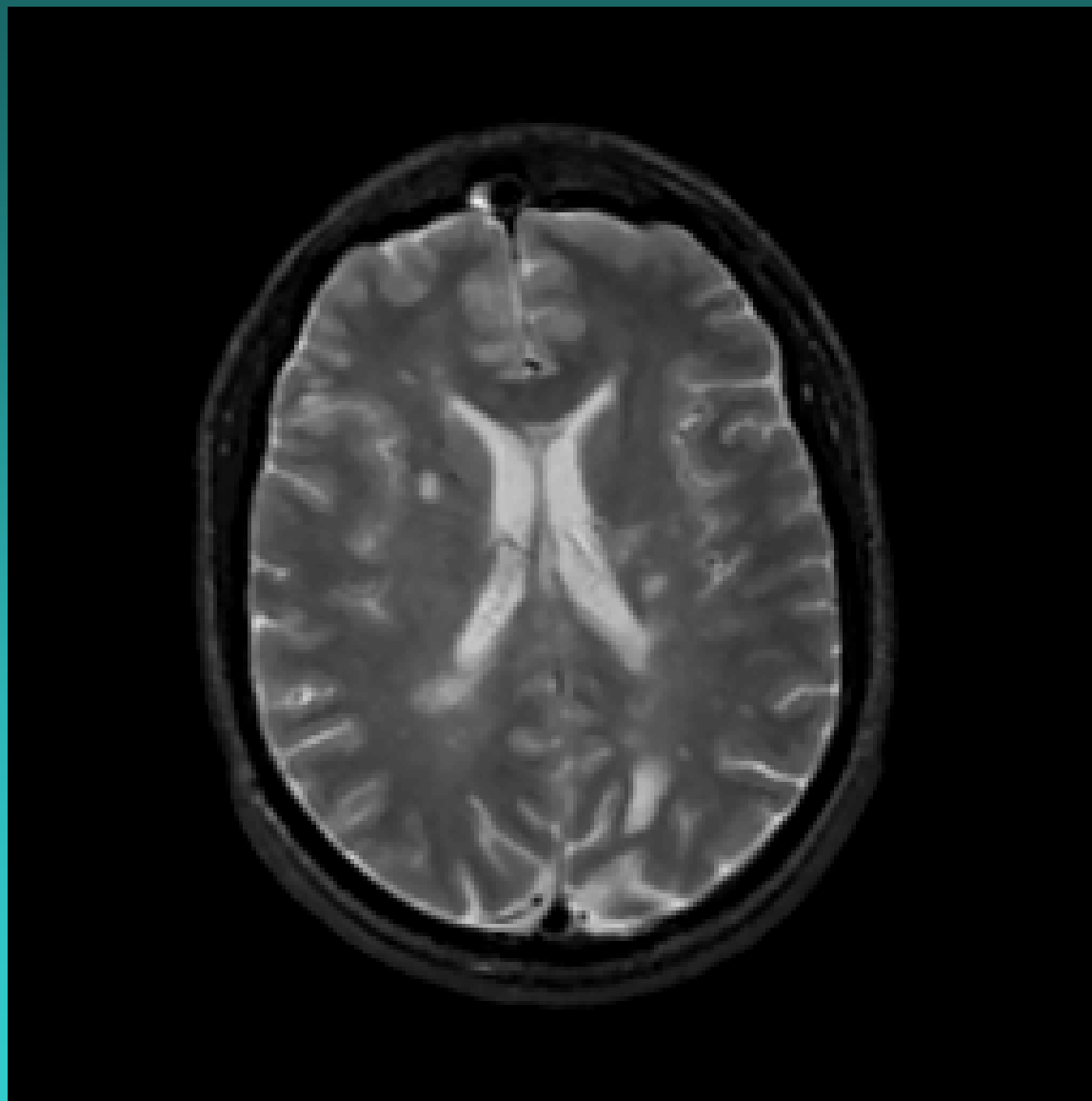


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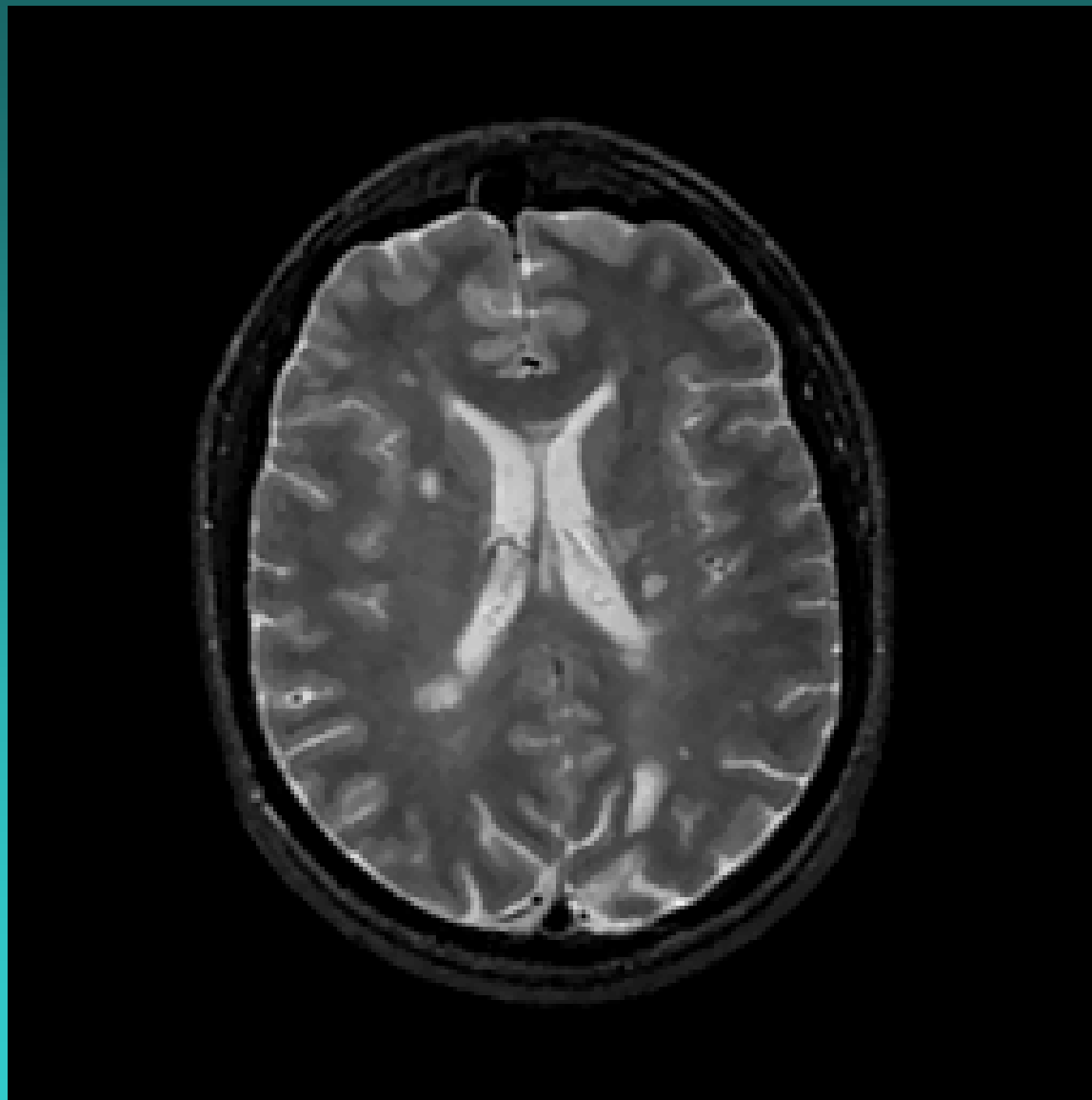


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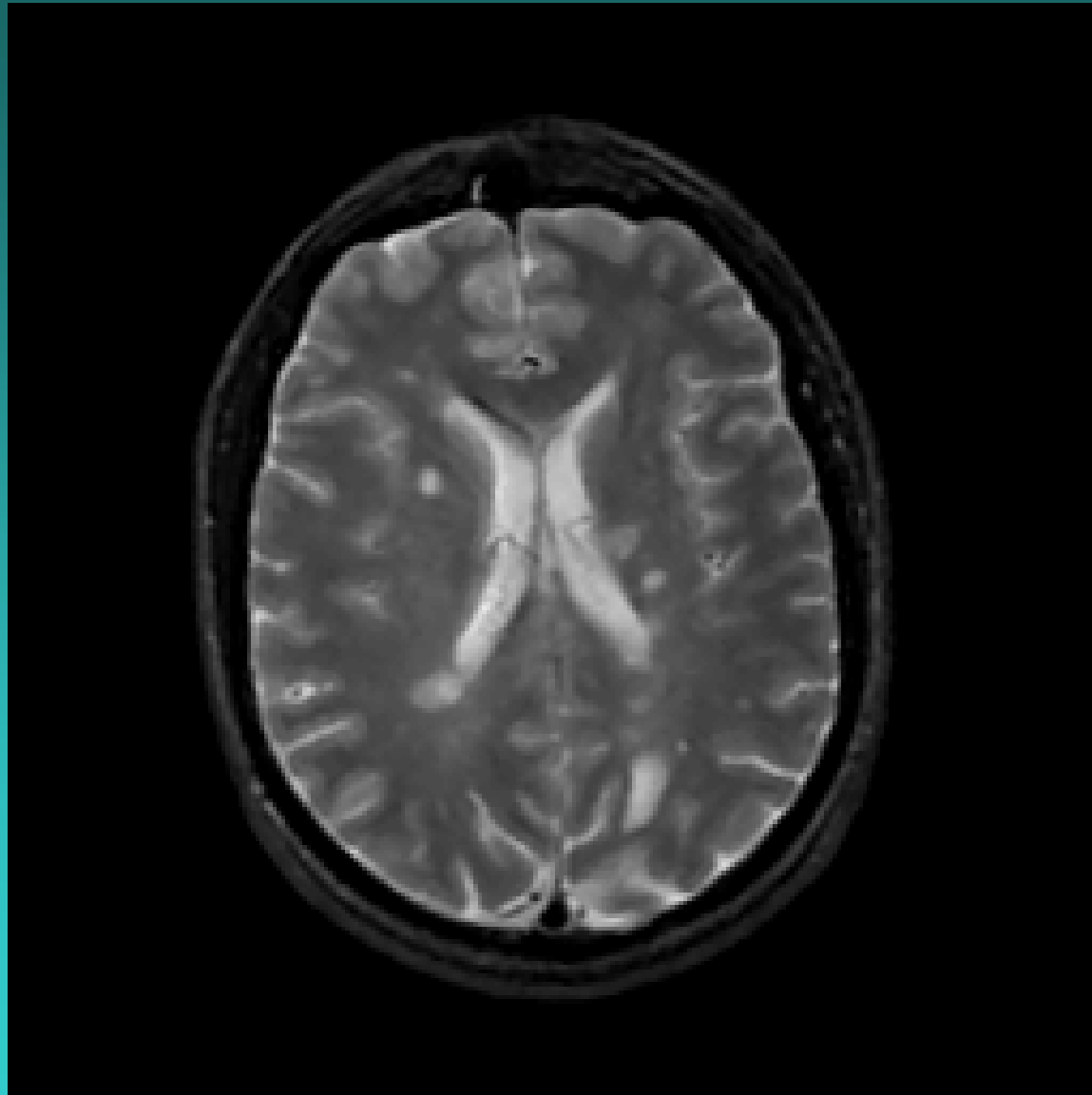


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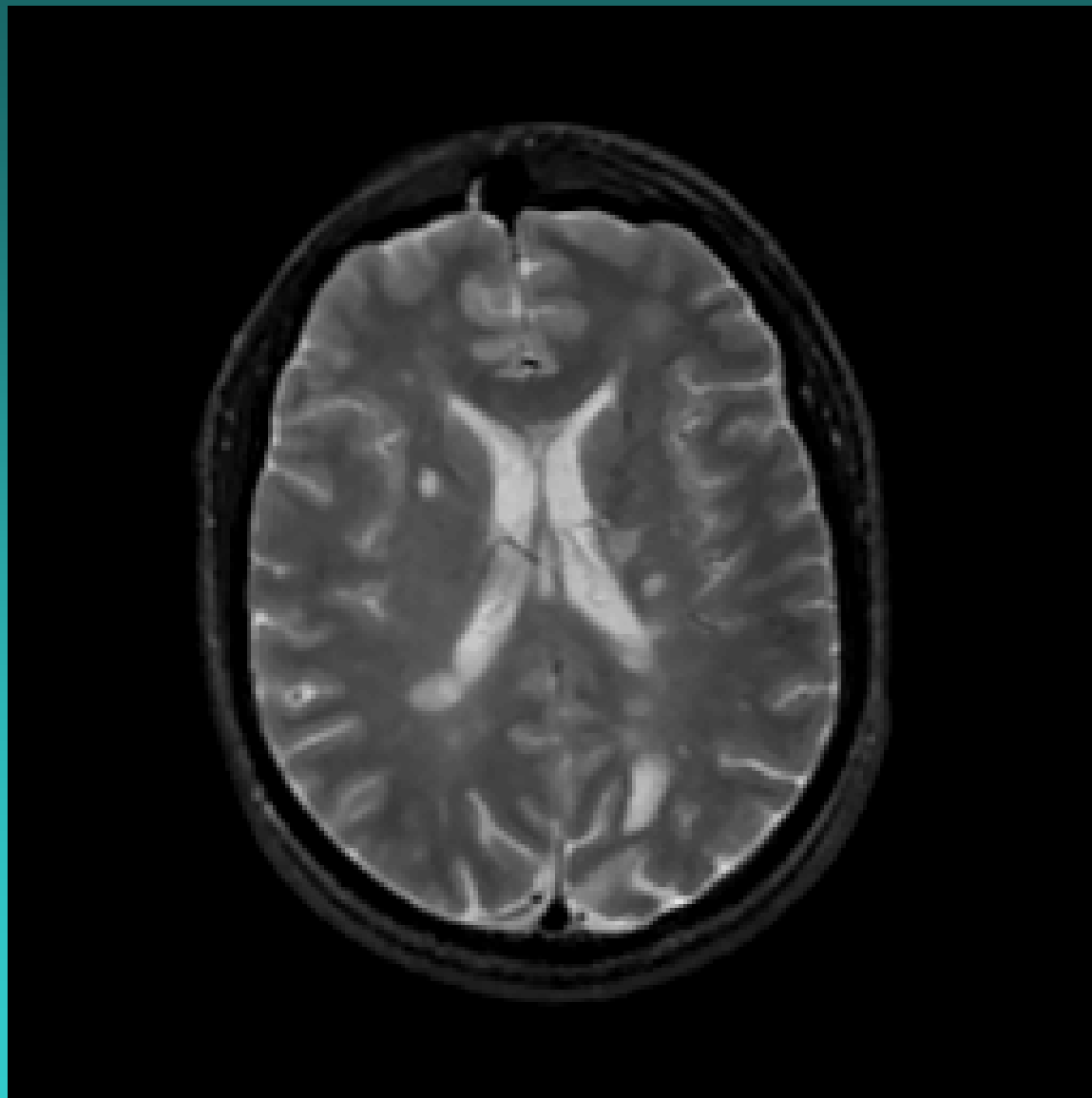


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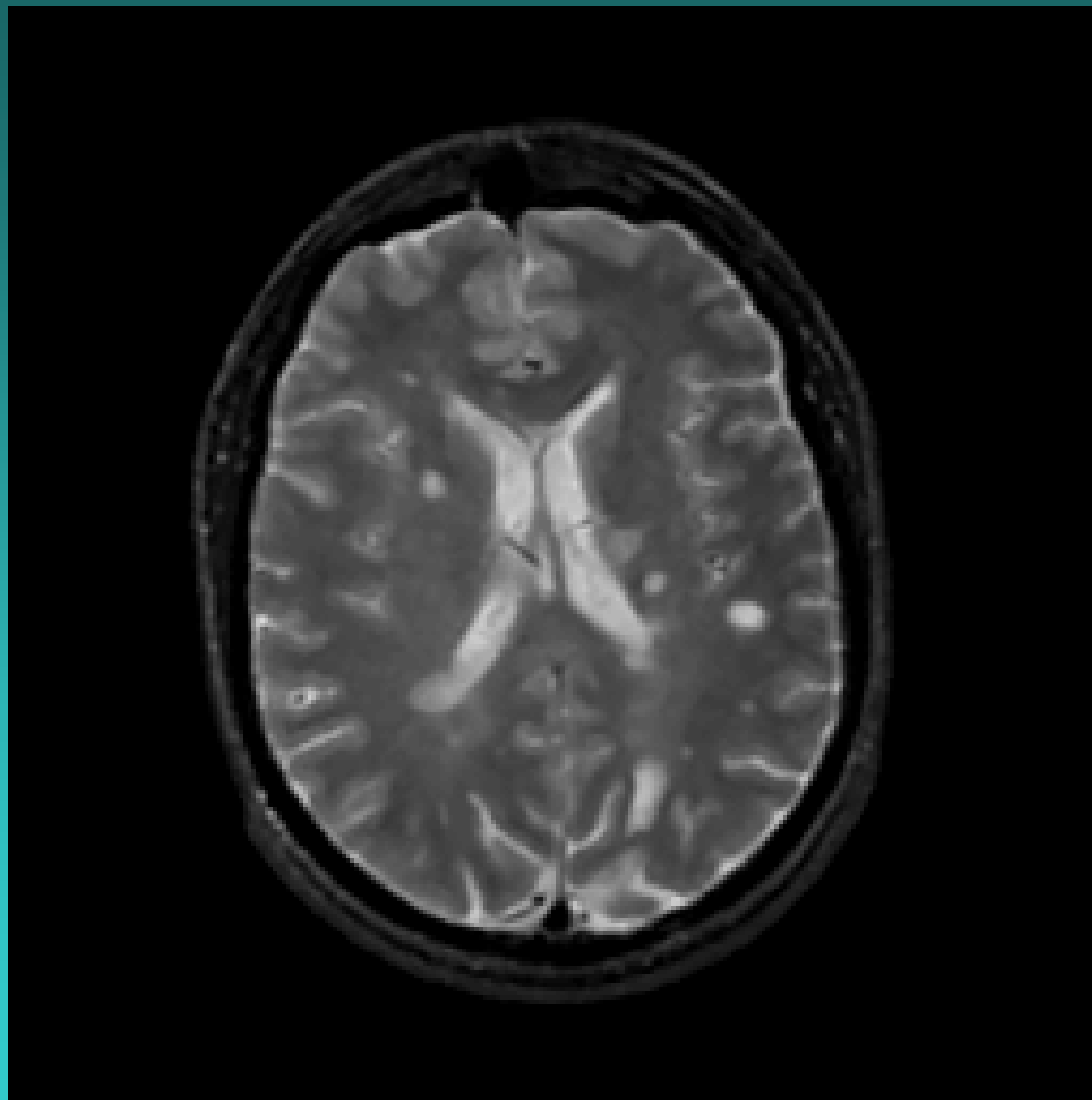


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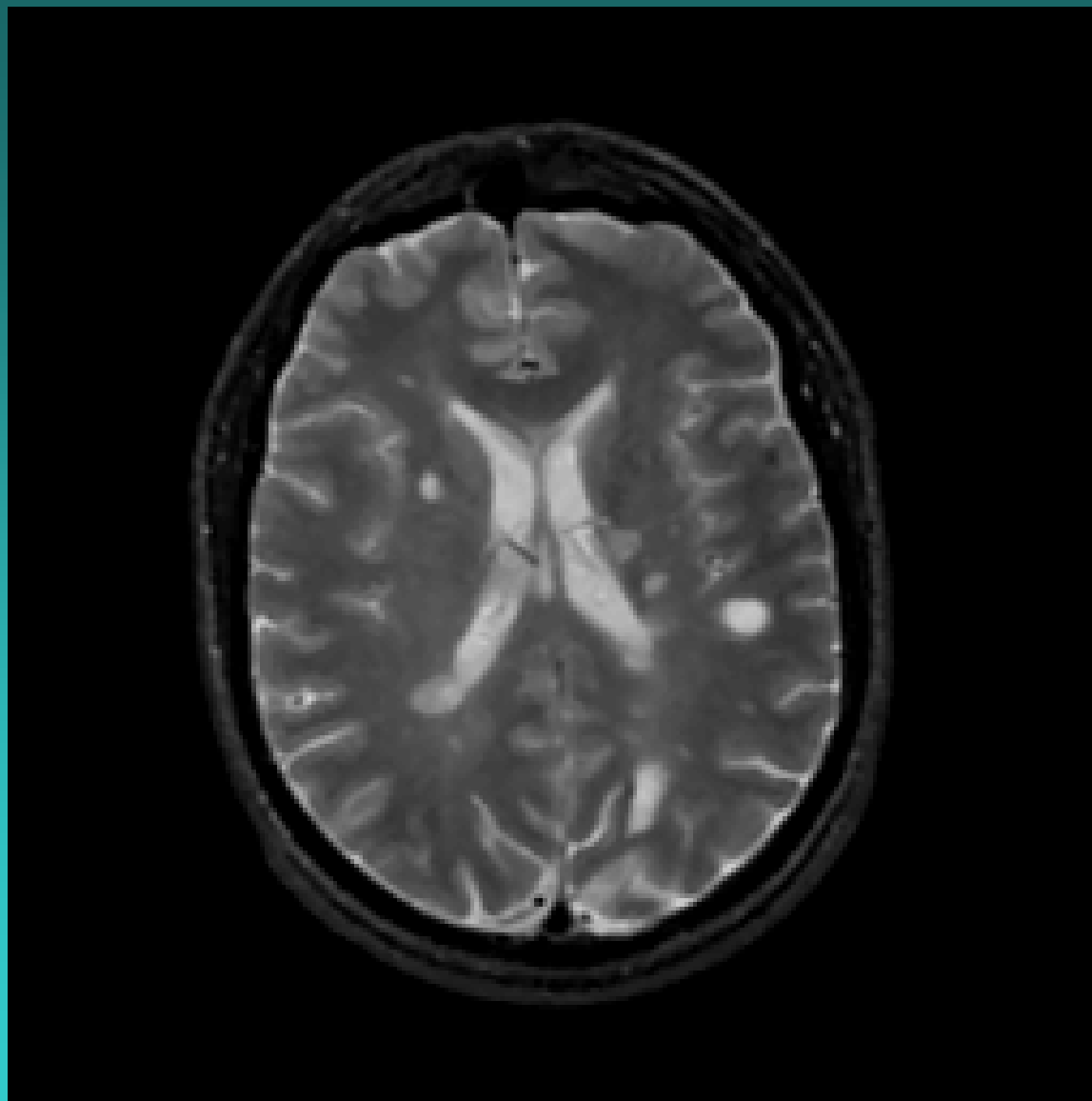


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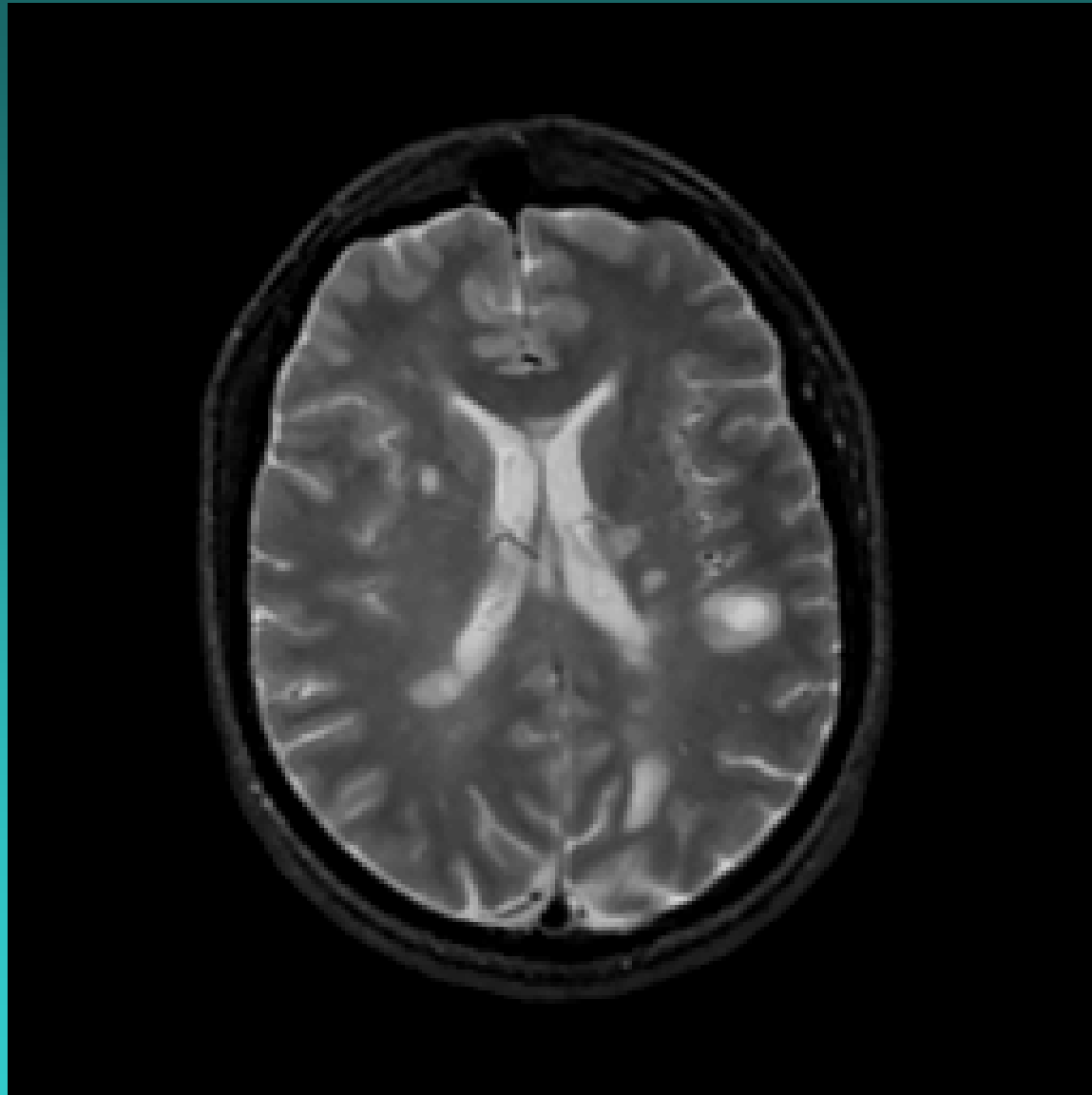


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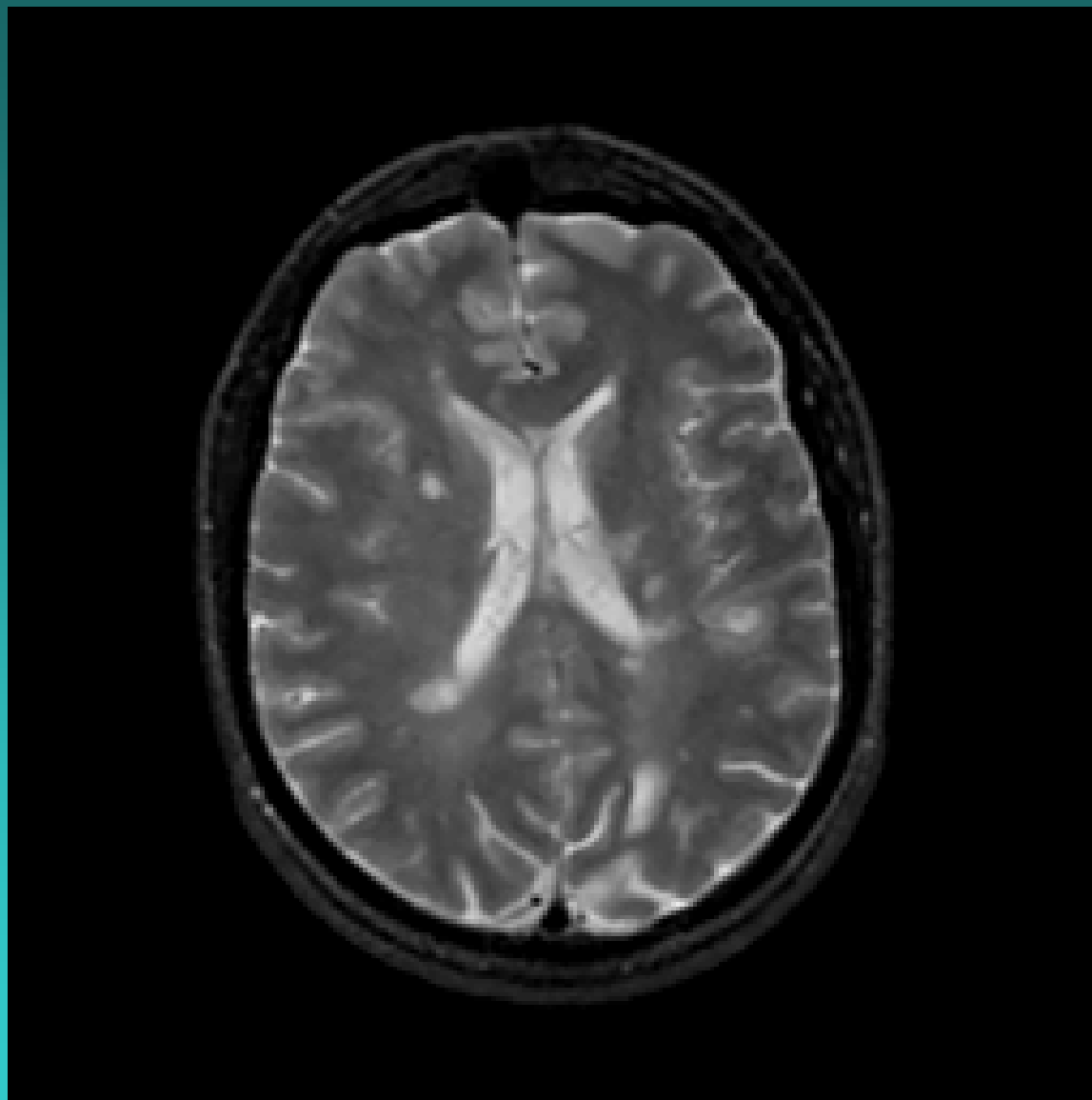
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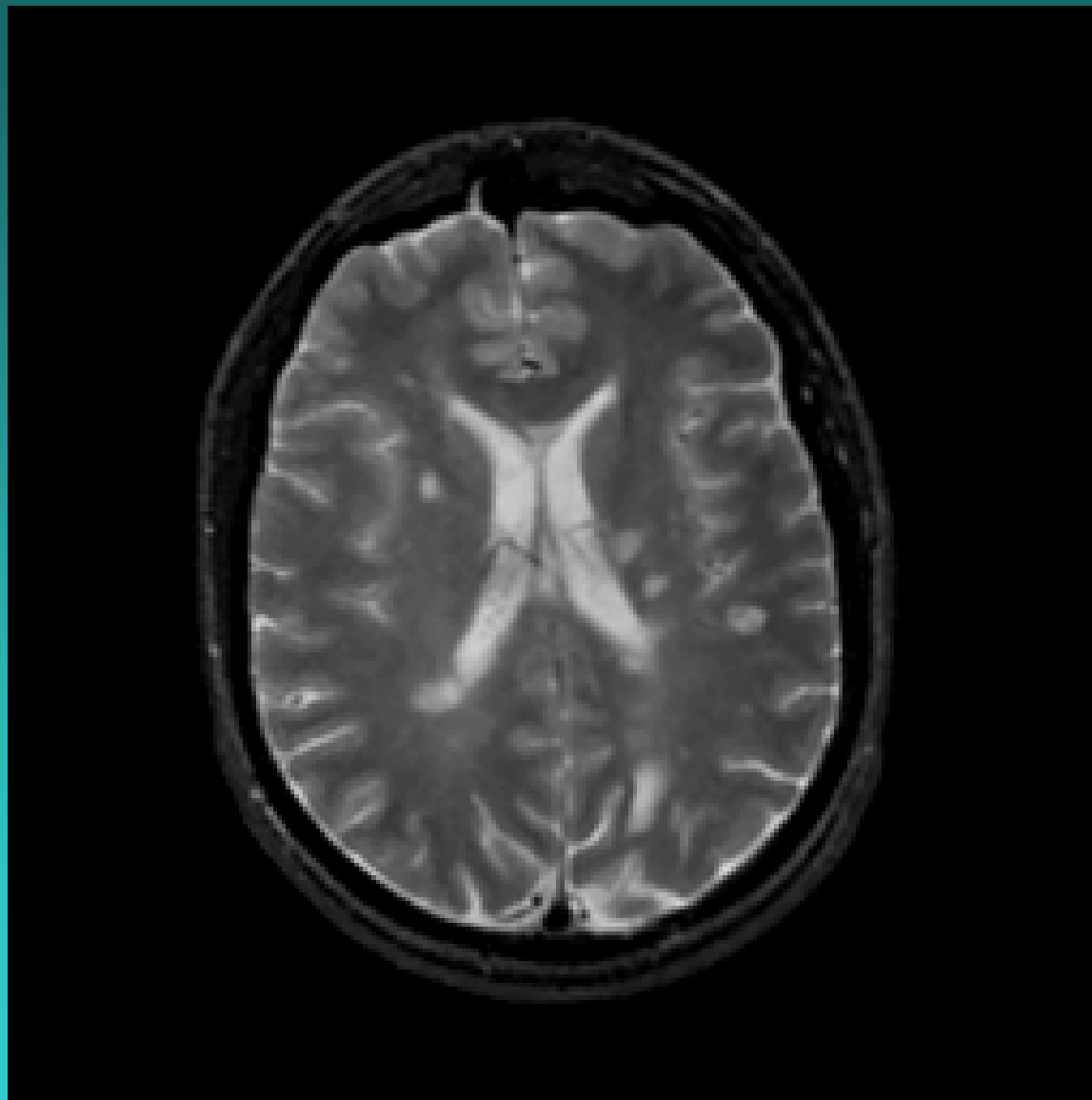


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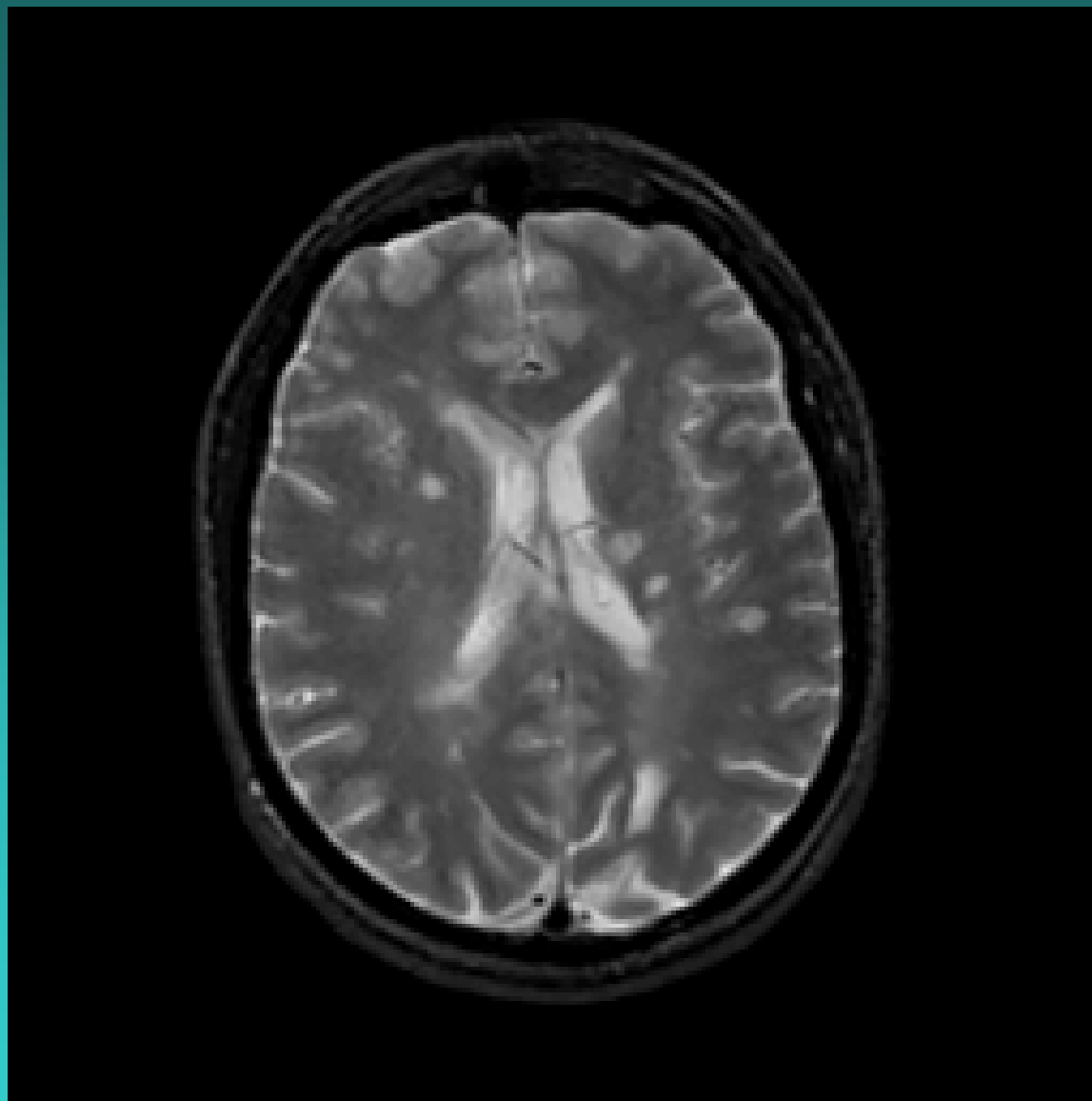


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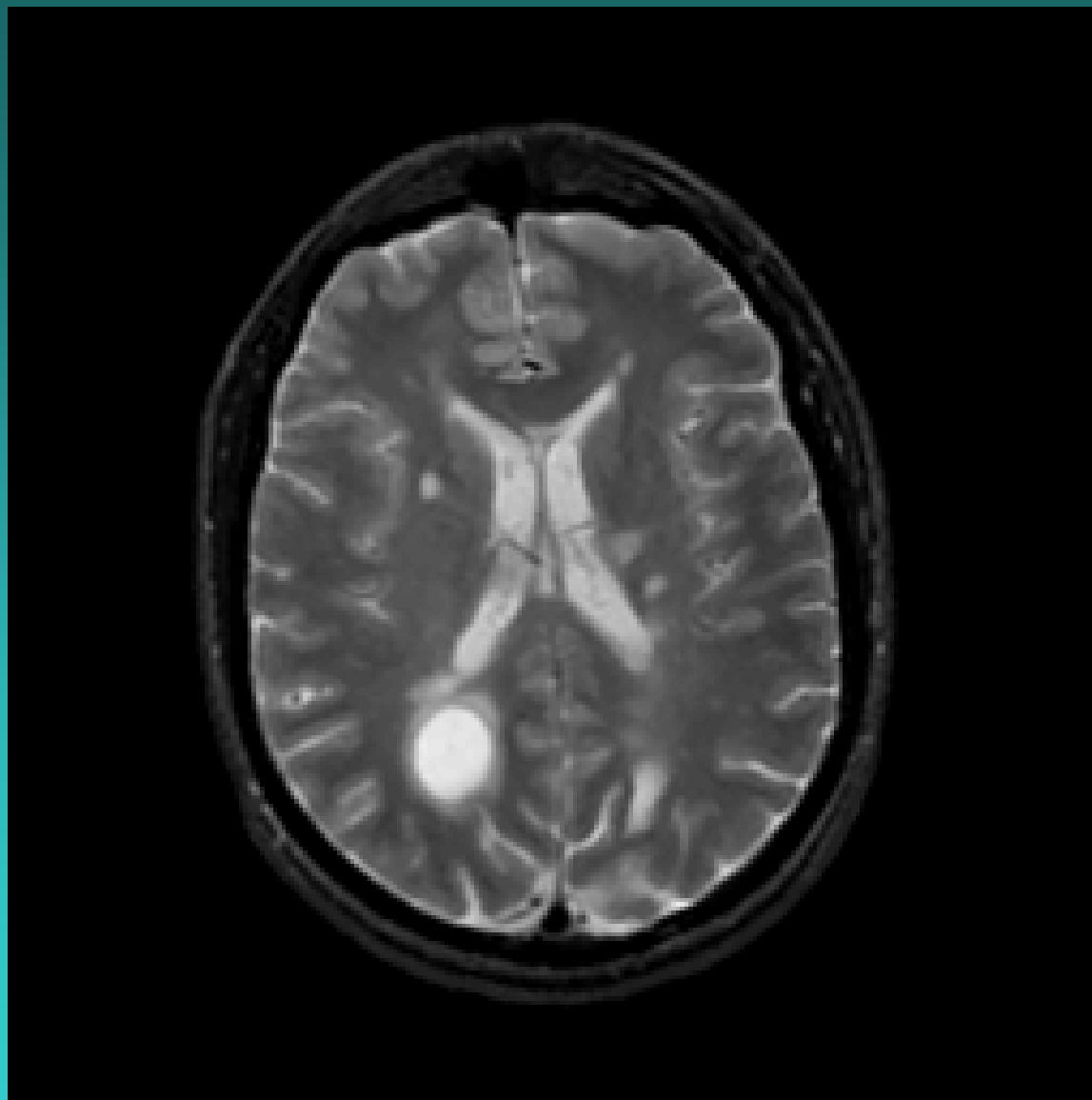


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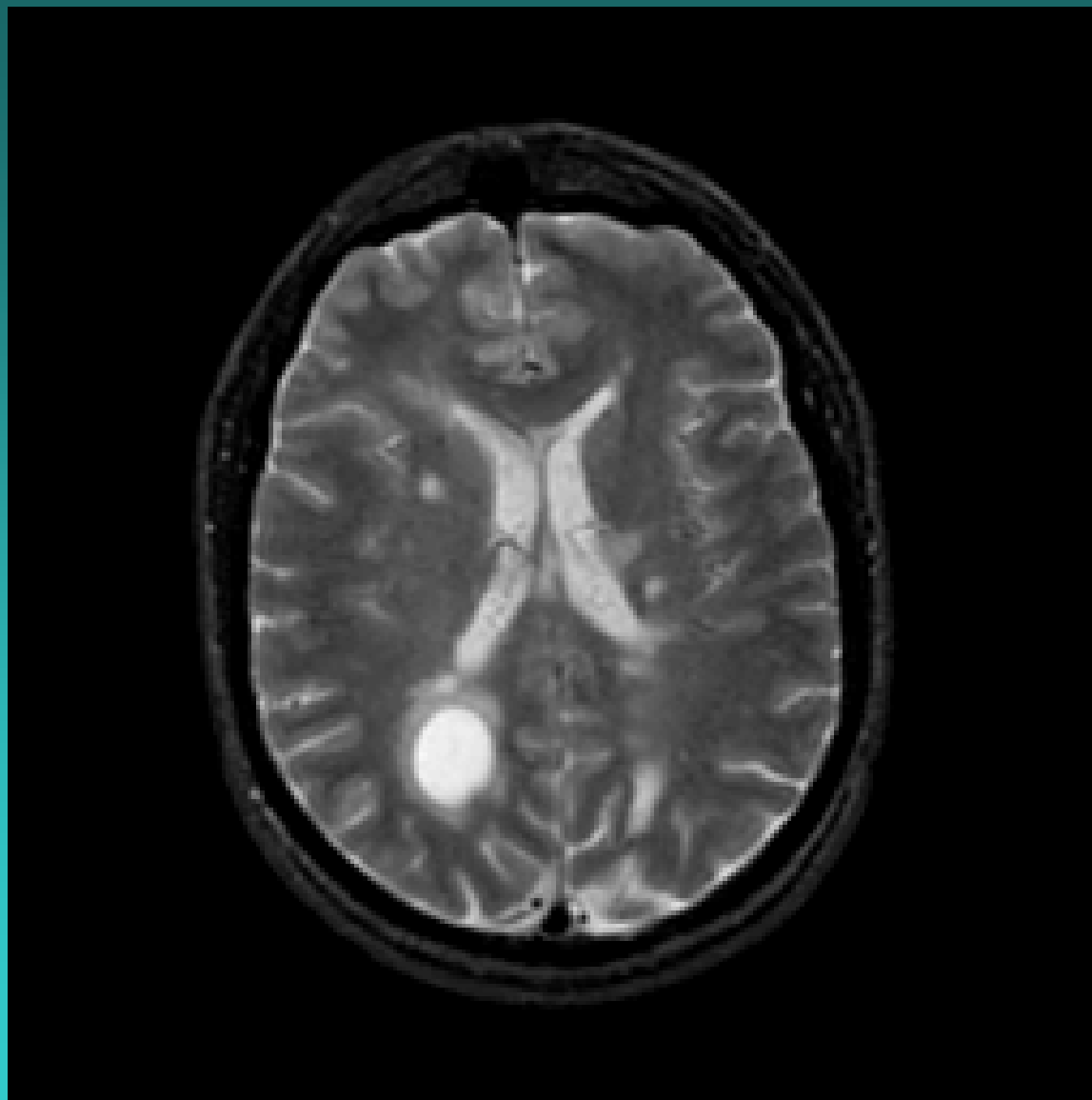


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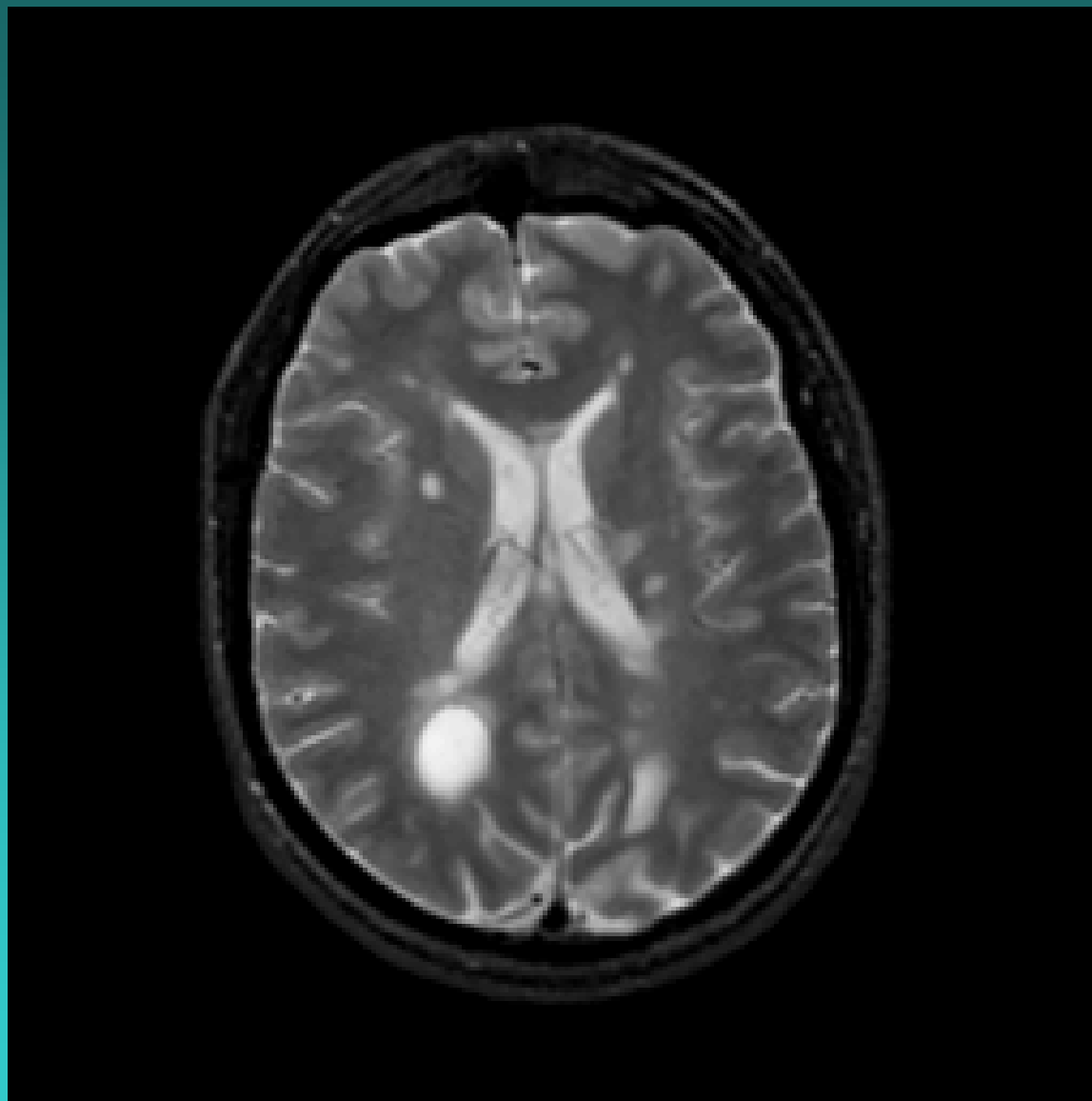


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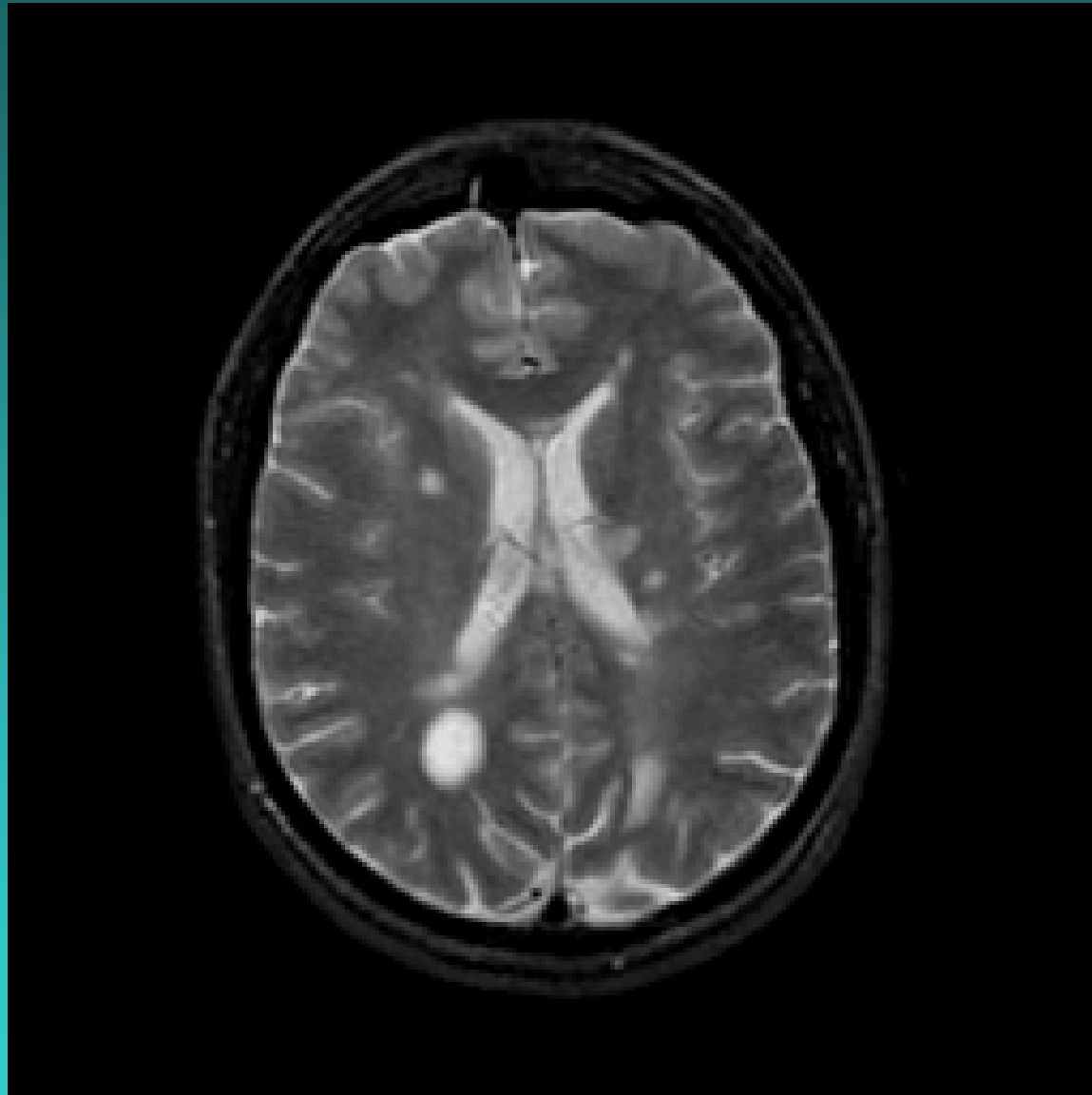


# MS Movie





# MS Movie





# Discussion: Multiple Sclerosis

- **Etiology:** probably autoimmune; related to environmental factors, genetic predisposition, and viral infection.
- **Pathology:** Plaques of demyelination, at first associated with lymphocyte and macrophage infiltration, then with astrocyte proliferation and gliosis. The oligodendrocytes are destroyed. These plaques often begin around venules and grow along the vessels.





# Discussion: Multiple Sclerosis

- **Course:** relapsing-remitting vs. progressive.
  - R-r often becomes secondary progressive: 50% of patients at 10 years.
- **Prognosis:** After 15 years, 50% walk with cane, 10% need wheelchair, 2% have died.
- **Treatment:** For exacerbations, corticosteroids are used. For slowing progression/reducing relapses, immunomodulatory drugs are used: interferon- $\beta$ 1a and - $\beta$ 1b, copolymer1 (mimics myelin basic protein), cyclophosphamide, methotrexate, azathioprine, cyclosporine.



# Patient Follow Up

- Her first episode of symptoms occurred at age 16 (diplopia), and she was diagnosed with relapsing-remitting MS at age 29. Around the time of our presentation, at age 40, she converted to secondary progressive type MS.
- 5 months later, her diplopia and weakness had worsened greatly and she required a wheelchair. She had also experienced a cognitive decline.
- After 3 days of IV steroids, she was not improved. She was discharged for 2 more days of IV steroids and then a taper.



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- Movie Reference

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