Department of Radiology
School of Medicine, Queen's University

NEURORADIOLOGY
DIL part 1

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GOALS

- Upon completion of these modules, you will have reviewed some basic neuroanatomy, learned a standard approach to CT head interpretation, and reviewed some common intracranial pathologies including bleeds, strokes and tumors.

- I suggest getting through modules 1 and 2 during this 1 hour time allotment. Modules 3-5 can be used as references as the pathologies are discussed during this neuro session.

Overview

- Introduction to Neuroimaging - DIL part 1
- Basic Brain Anatomy - DIL part 1
- Standardized Approach to Image Interpretation - DIL part 2
- Common Pathology
  - Bleeds (Hemorrhages) - DIL part 3
  - Strokes (Infarcts) DIL part 4
  - Masses (Tumors) part 5

INTRODUCTION

- The primary imaging modalities for neuroradiology include computed tomography (CT) and magnetic resonance imaging (MRI).

INTRODUCTION

- CT (computed tomography)
  - Initial screening study for neurological pathology.
  - Can be performed without or with intravenous contrast.
  - Pros: easily accessible, relatively inexpensive, fast (great for emergency cases).
  - Cons: not very sensitive or specific for certain pathologies, radiation to patient.

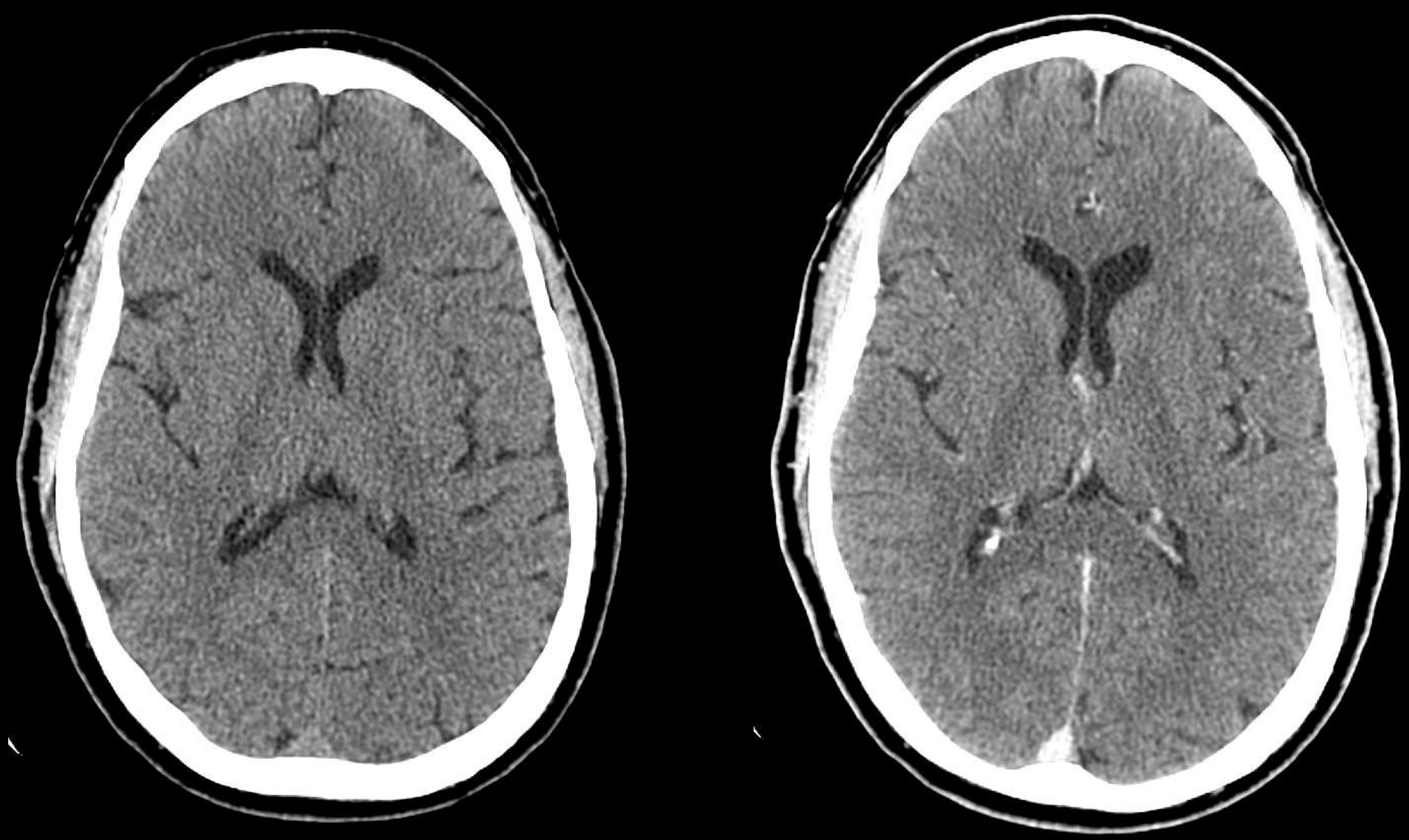
INTRODUCTION

- MRI
  - Often used to further evaluate findings made by CT.
  - Can also be performed without or with contrast.
  - Pros: More sensitive and more specific than CT for many pathologies, useful problem-solving tool, no radiation.
  - Cons: Certain metal implants are contraindications, claustraphobia, expensive, less available, time consuming, and also not senstive or specific for certain pathologies.

INTRODUCTION

- The following two slides will show you examples of a CT and an MRI, so you can start to recognize the type of study being performed. We have to start somewhere!

CT



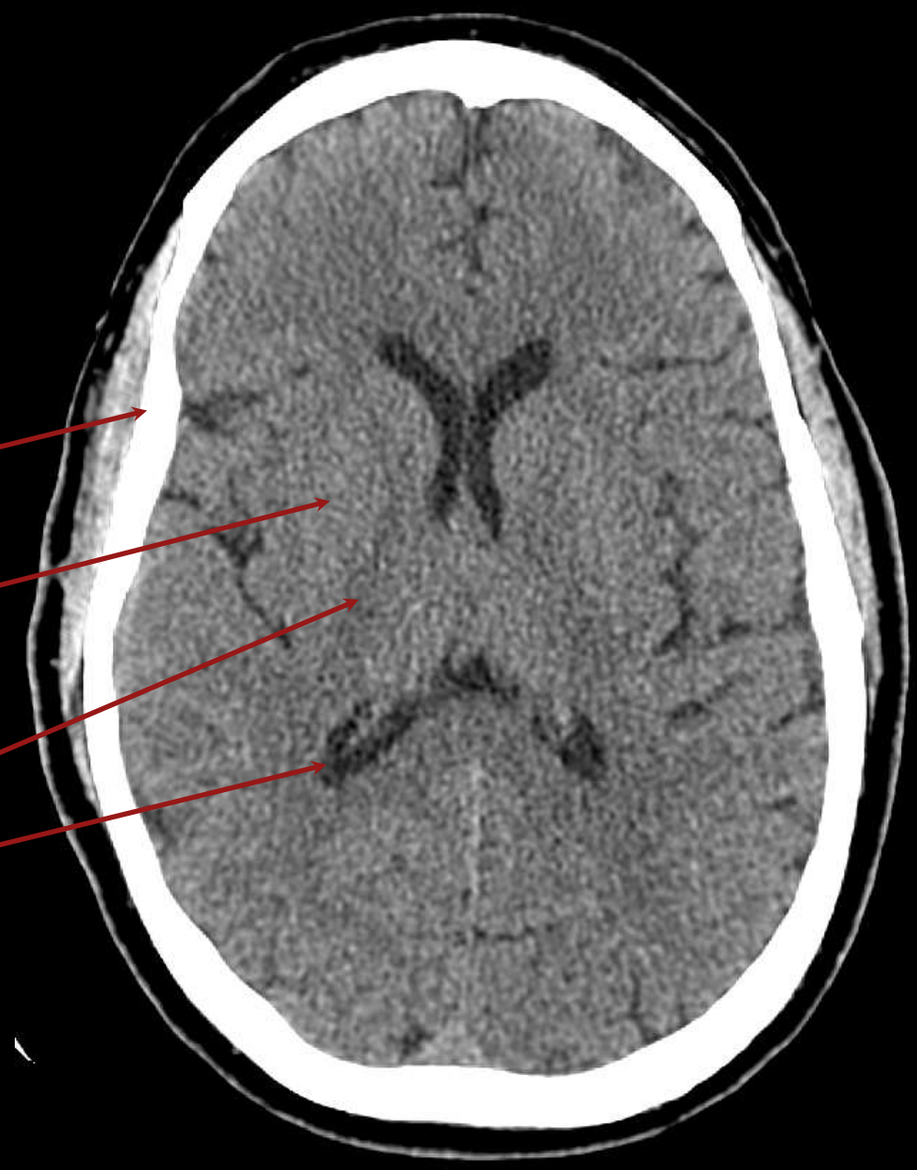
CT Without Contrast

CT With Contrast

Axial

CT

- Features of a CT:
  - Bones are white
  - Grey matter is lighter than white matter
  - CSF is black



Axial

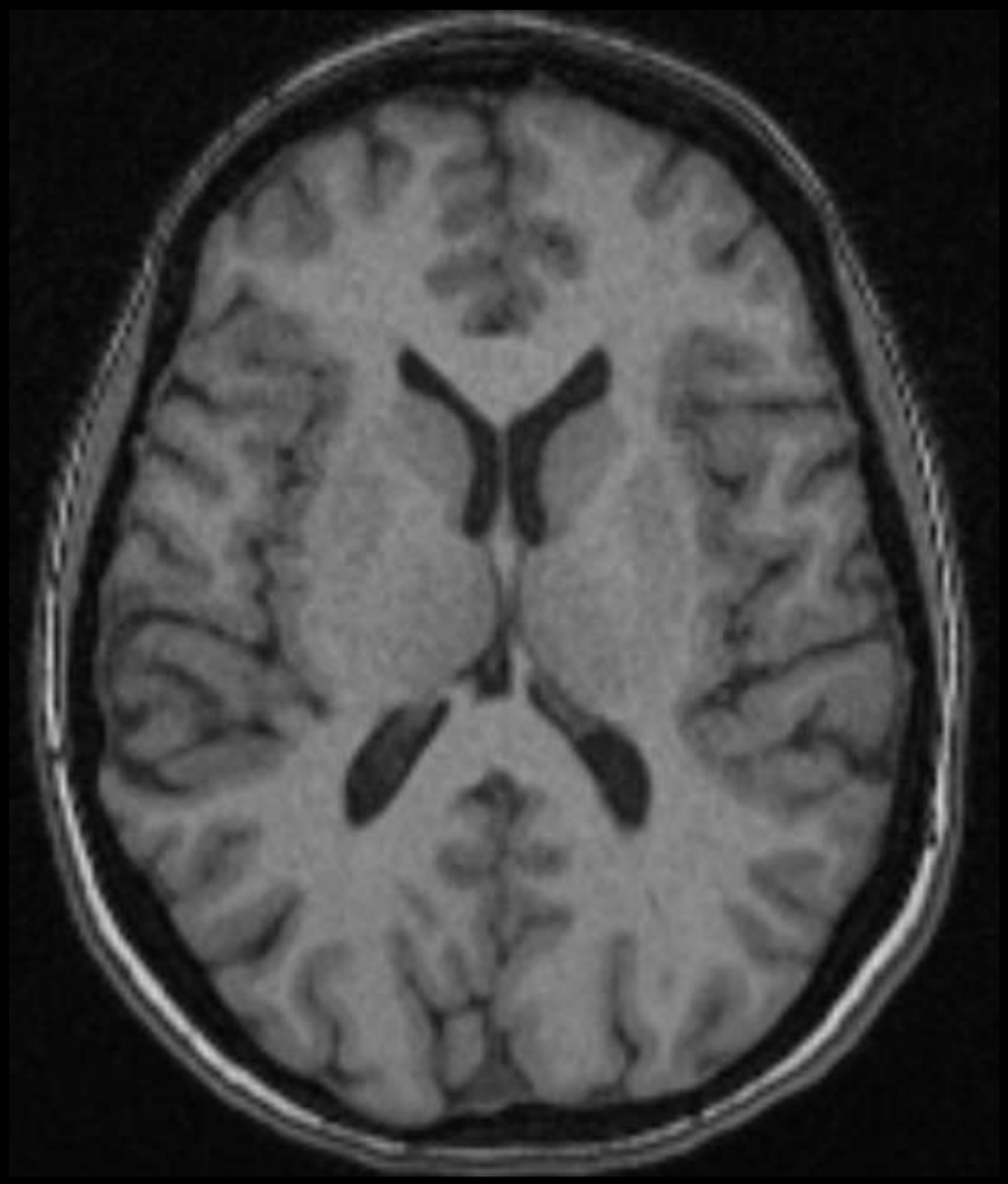
CT

- When you add IV contrast, notice a few things happen:
  - Choroid plexus enhances
  - The vessels are now bright

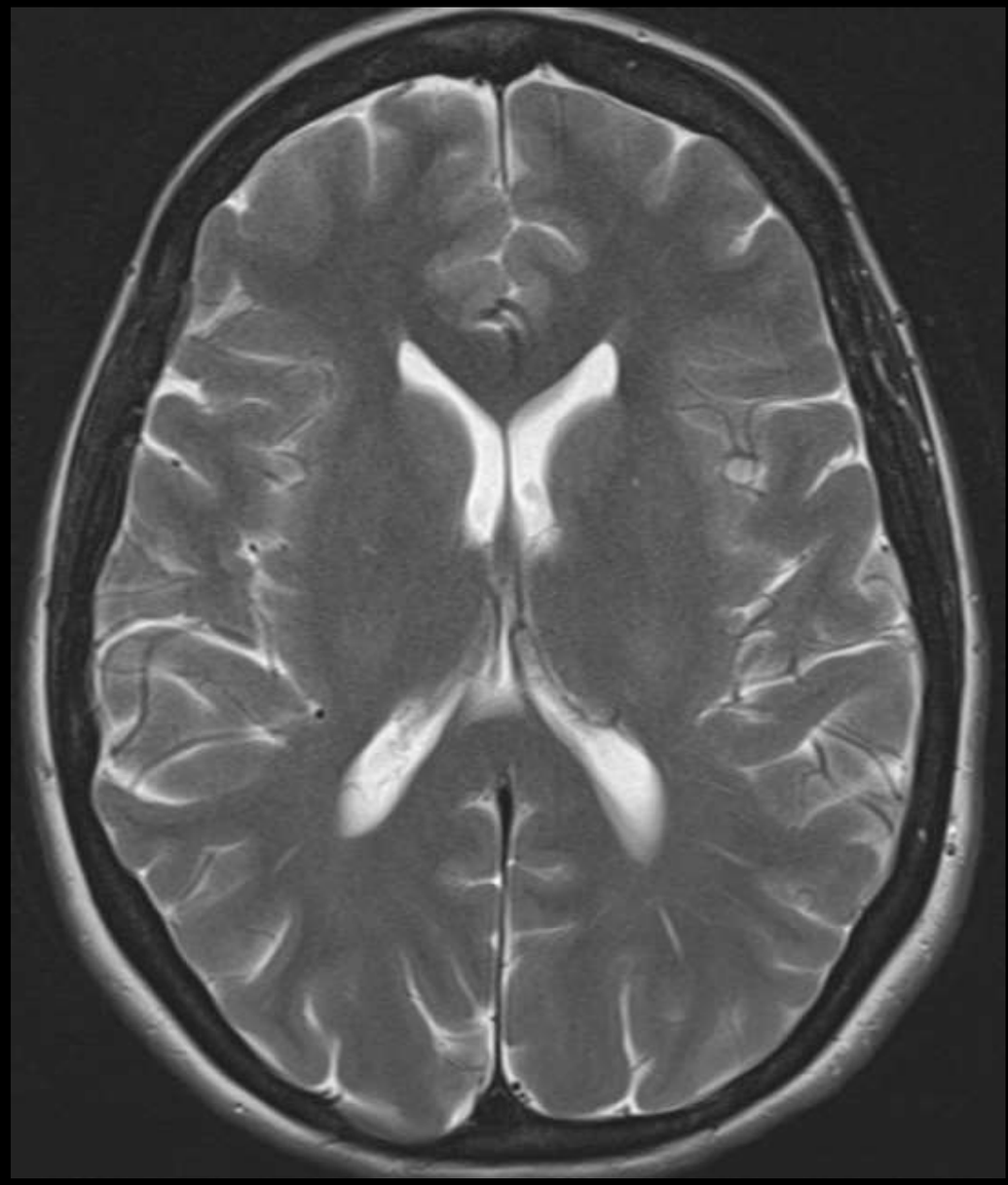
CT With Contrast

Axial

MRI



T1 MRI



T2 MRI

Axial

MRI

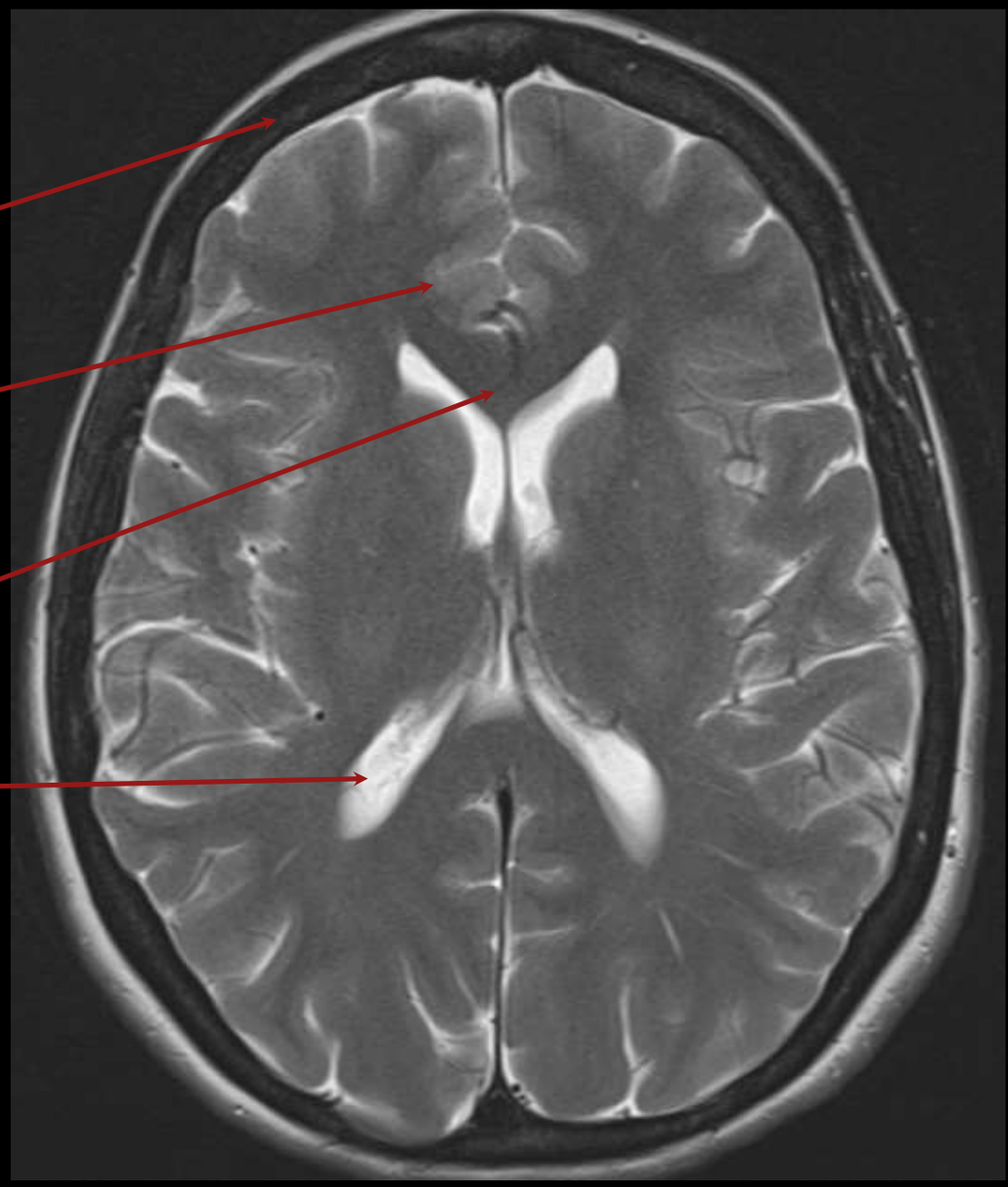
- Features of a T1 MRI:
  - Bones are black
  - Grey matter
    is darker than white matter
  - Grey-white differentiation is
    more distinct than on CT
  - CSF is black

T1 MRI

Axial

MRI

- Features of a T2 MRI
  - Bones are black
  - Grey matter is brighter than white matter
  - CSF is white
    - Maybe you can remember that water is white for T2's. Water white. WW. 2W's. T2.



T2 MRI

Axial

MRI

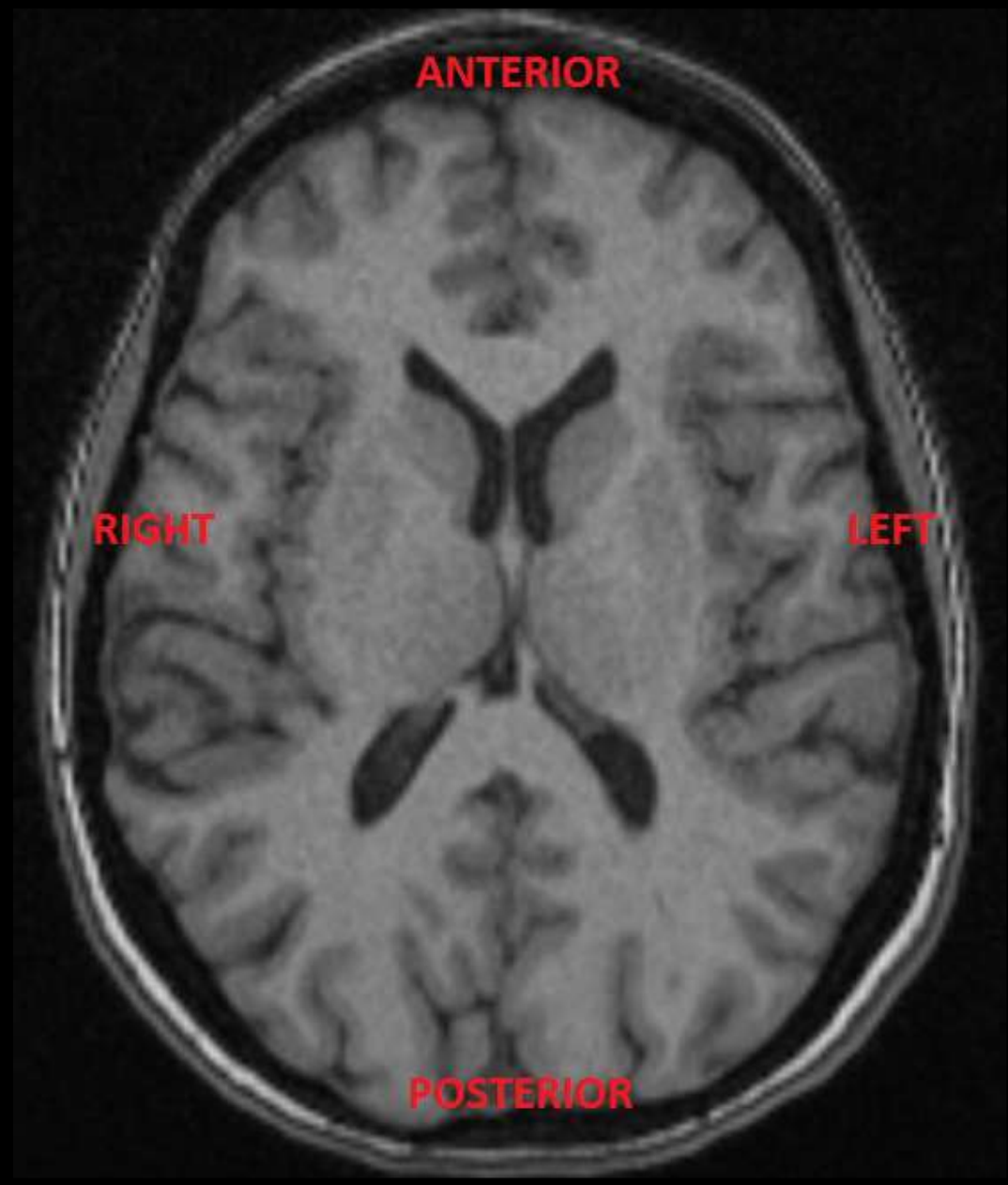
- In addition to T1 and T2, there are many other MRI sequences that are beyond the scope of this session.

CROSS SECTIONAL CONVENTIONS

- All CT's and MRI's are displayed in the same manner when you view them on a screen.
- The following slide will describe the standard convention.

CROSS SECTIONAL CONVENTIONS

- When you are looking at a transverse axial image, you should be familiar with the conventional orientation.
- Image right = patient's left
- Image left = patient's right
- Image top = patient's anterior
- Image bottom = patient's posterior



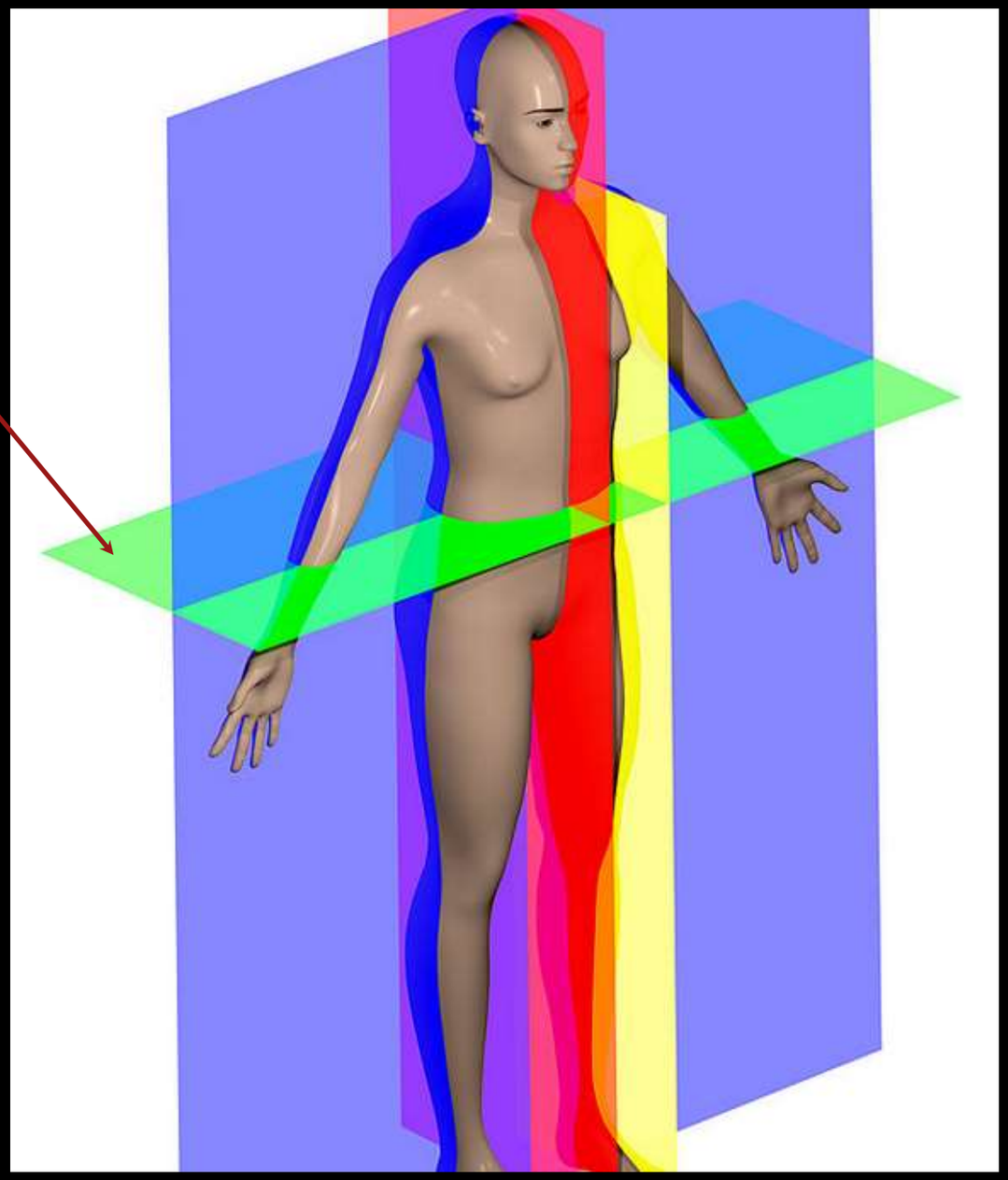
Axial

MULTIPLE PLANES

- Cross-sectional imaging is great because we can display it in different planes. This can be very helpful to localize a finding to a precise anatomic location.
- The common planes are TRANSVERSE AXIAL, CORONAL, and SAGITTAL.
- The next slide shows examples.

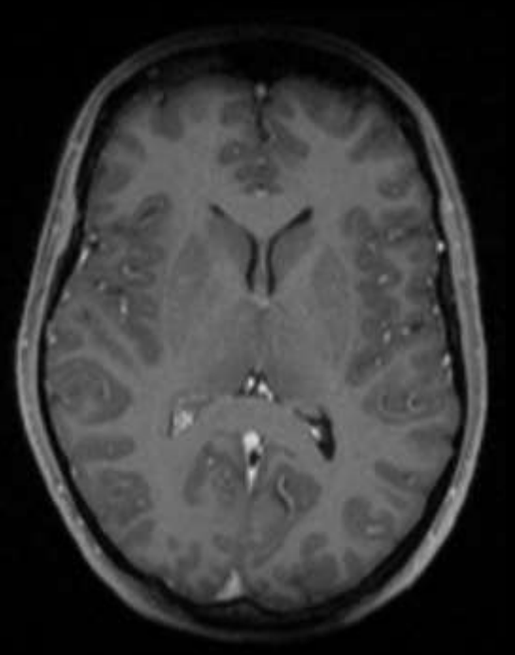
MULTIPLE PLANES

- The green slice cuts through the patient like a loaf of bread.



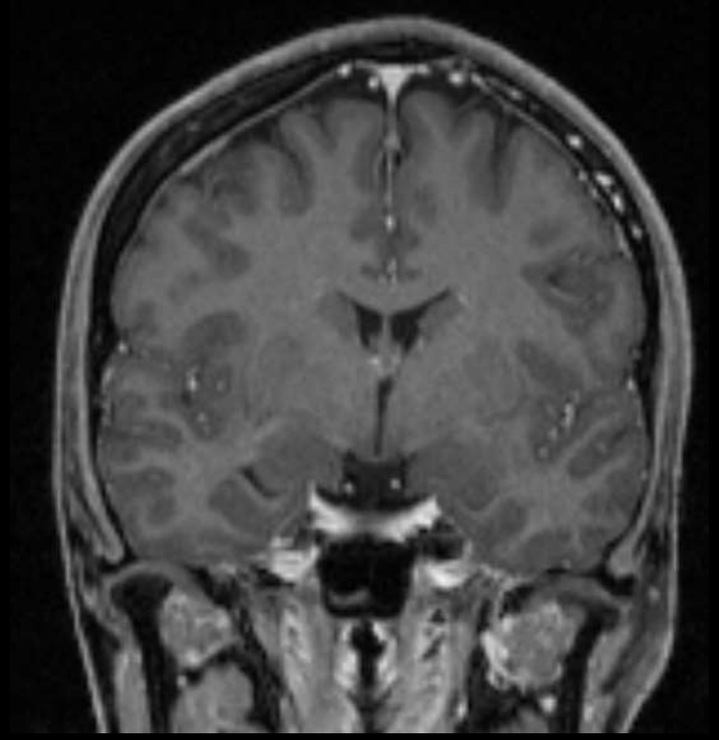
http://commons.wikimedia.org/wiki/File:Human_anatomy_planes.jpg

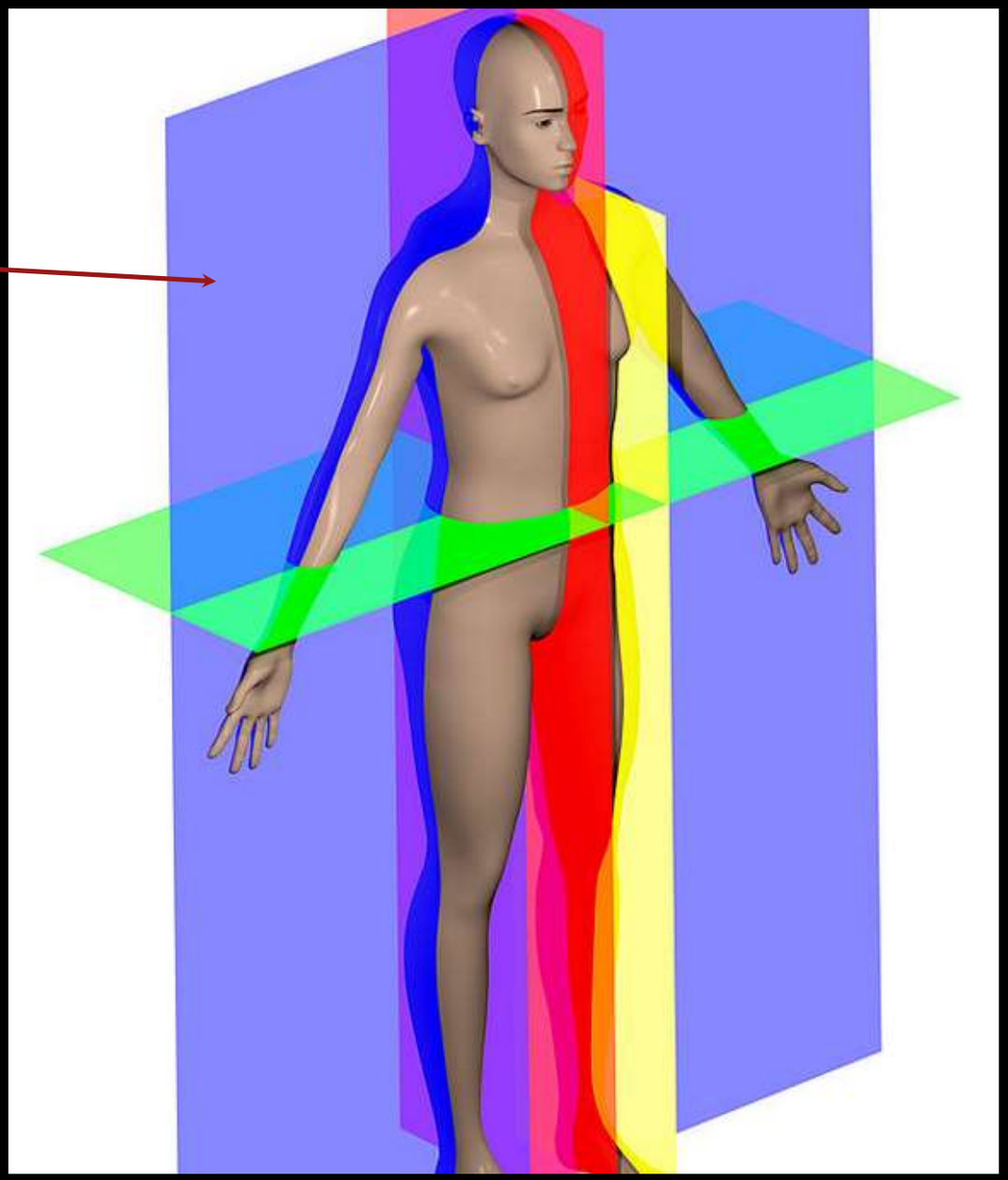
- This results in the transverse axial plane you're used to seeing.



MULTIPLE PLANES

- The blue slice produces the coronal plane.

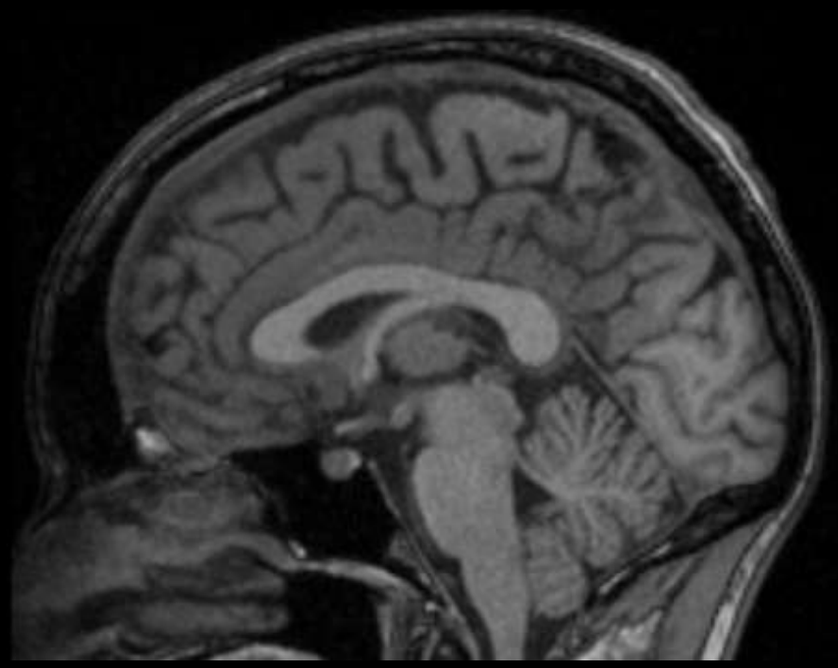


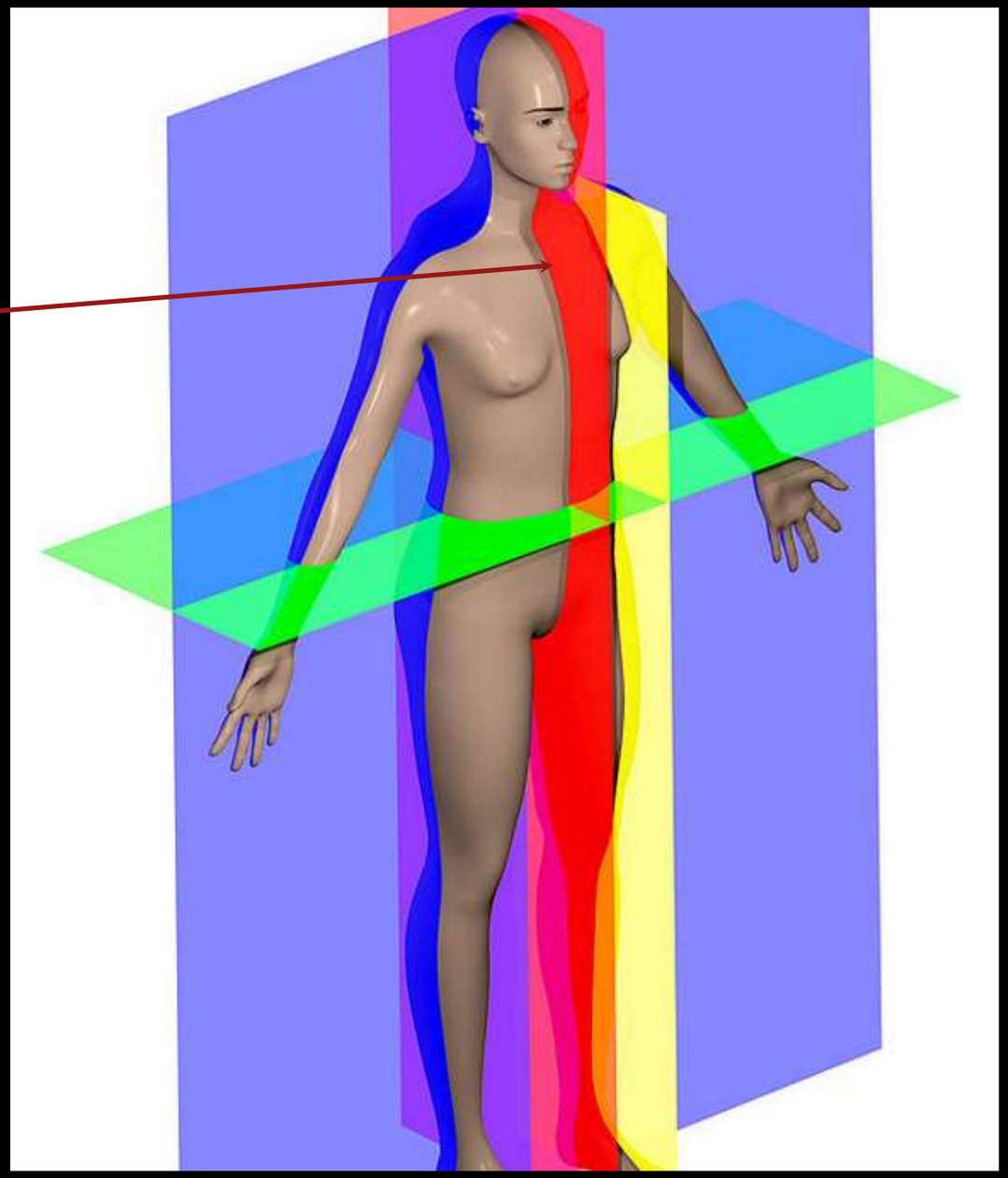


http://commons.wikimedia.org/wiki/File:Human_anatomy_planes.jpg

MULTIPLE PLANES

- The red slice cuts the patient down the midline and produces the sagittal plane.





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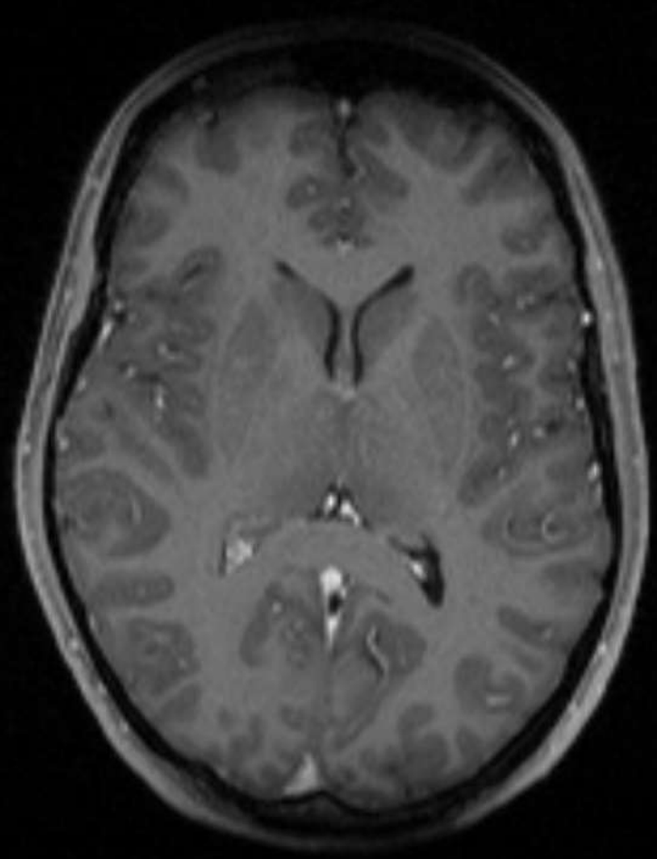
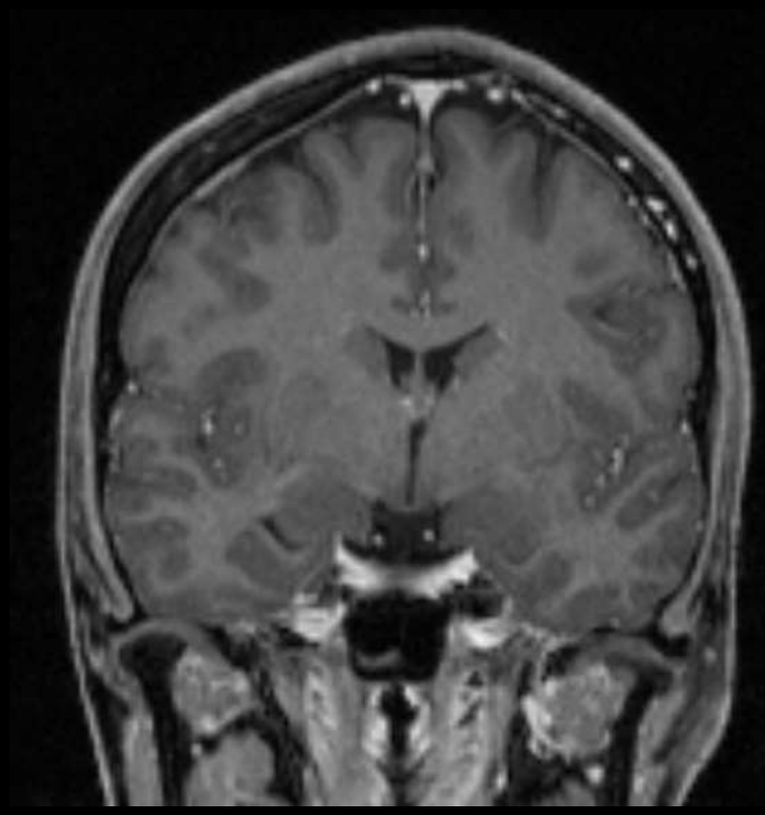
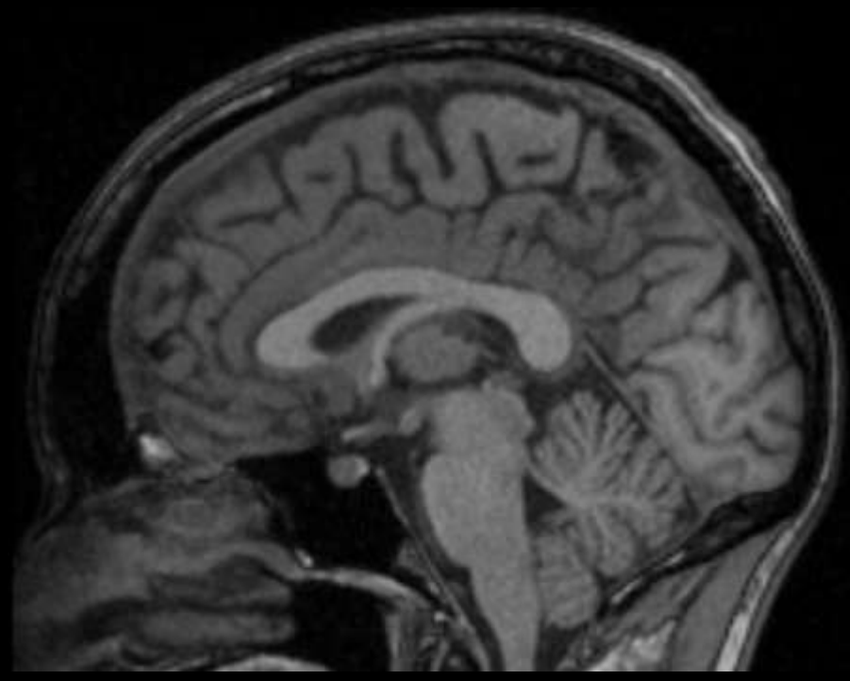
MULTIPLE PLANES



Transverse Axial



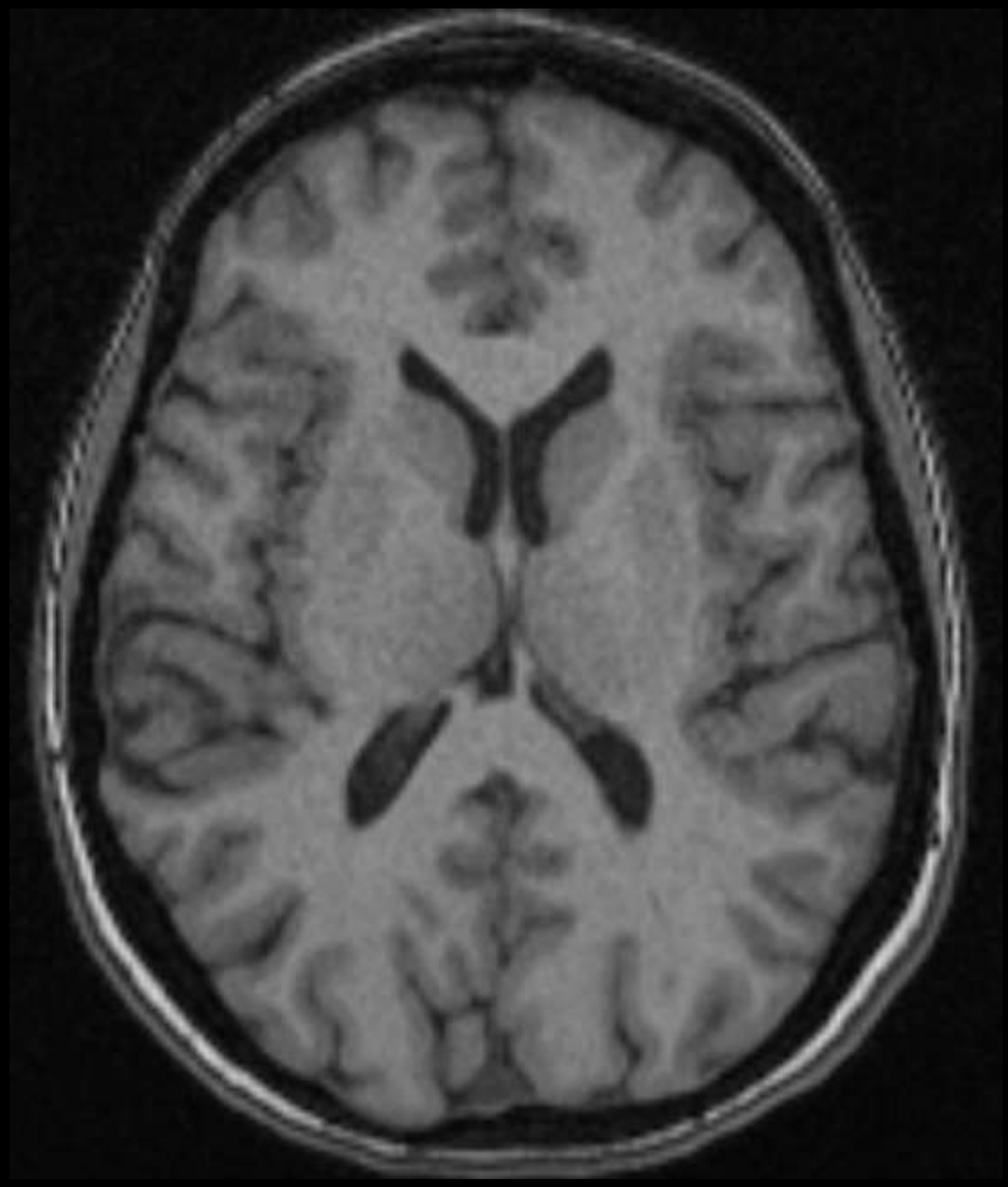
Coronal



Sagittal

MULTIPLE PLANES

- You've likely noticed that throughout this module, whenever there is a CT or MRI displayed, the plane of imaging will be written in the bottom right corner.
- This will help to orient you as you go through the cases.
- For example, this one is labelled "axial."



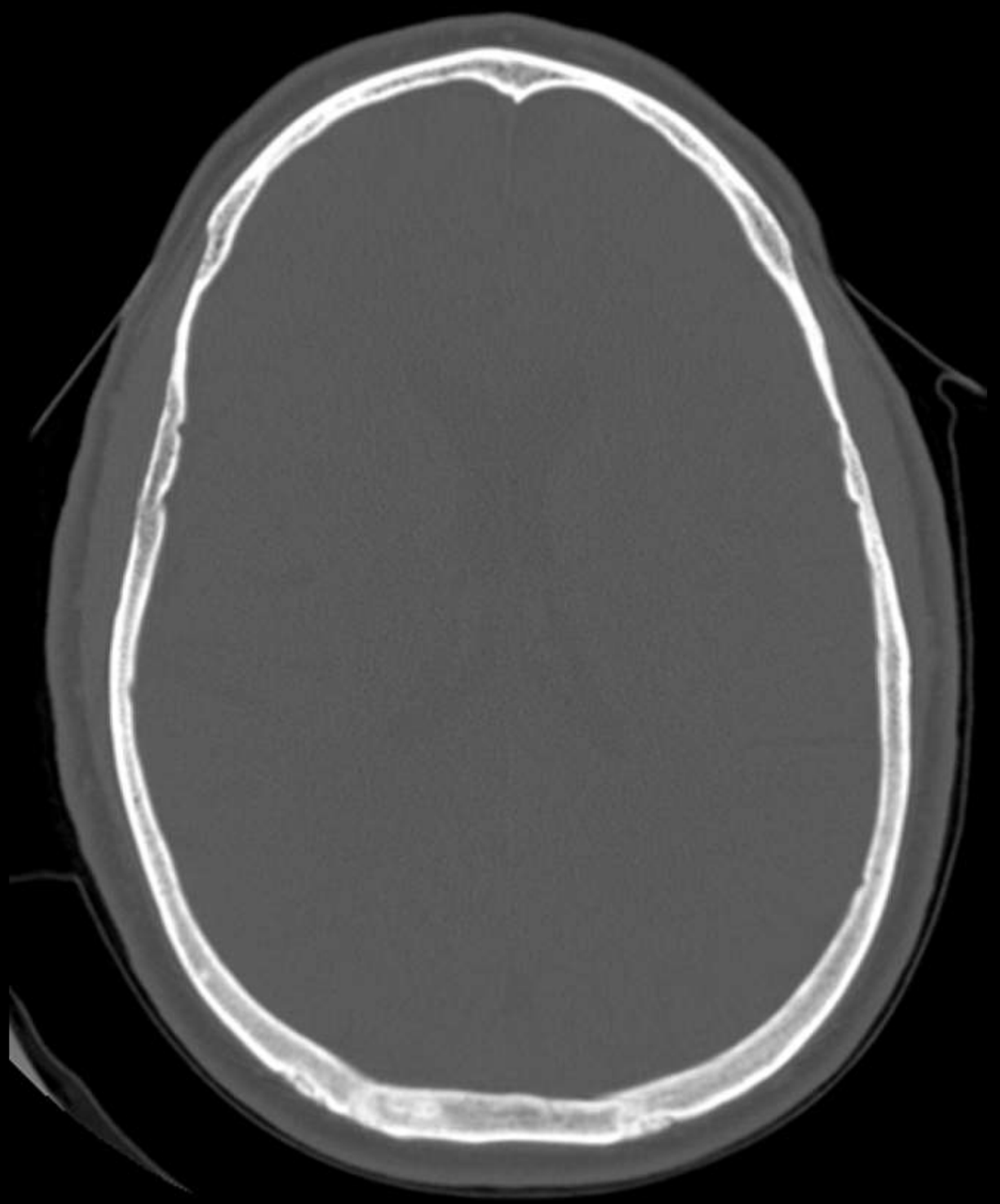
Axial

MULTIPLE WINDOWS

- Images can be acquired in a certain manner to better display certain structures. Once an image has been obtained, the radiologist can further modify these settings. Part of what is being altered is the "window."
- Look at this example of a CT with brain windows compared to the one beside it with bone windows.
- Notice how much better you can assess the brain on the left. Imagine trying to assess the brain on the right!

MULTIPLE WINDOWS

Brain Windows



Bone Windows

Axial

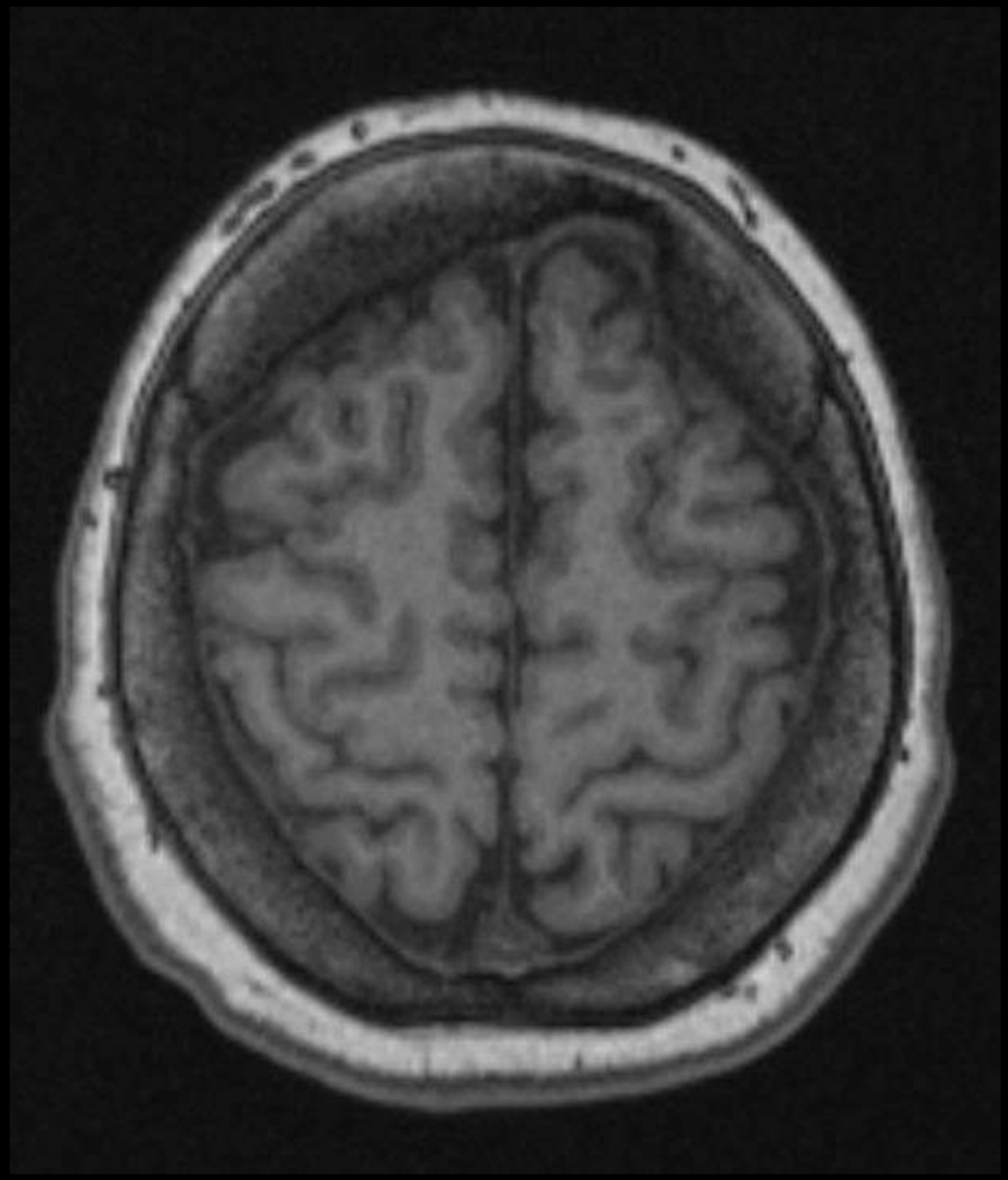
OVERVIEW

- Introduction to Neuroimaging
- **Basic Brain Anatomy**
- Standardized Approach to Image Interpretation
- Common Pathology
  - Bleeds (Hemorrhages)
  - Strokes (Infarcts)
  - Masses (Tumors)

ANATOMY

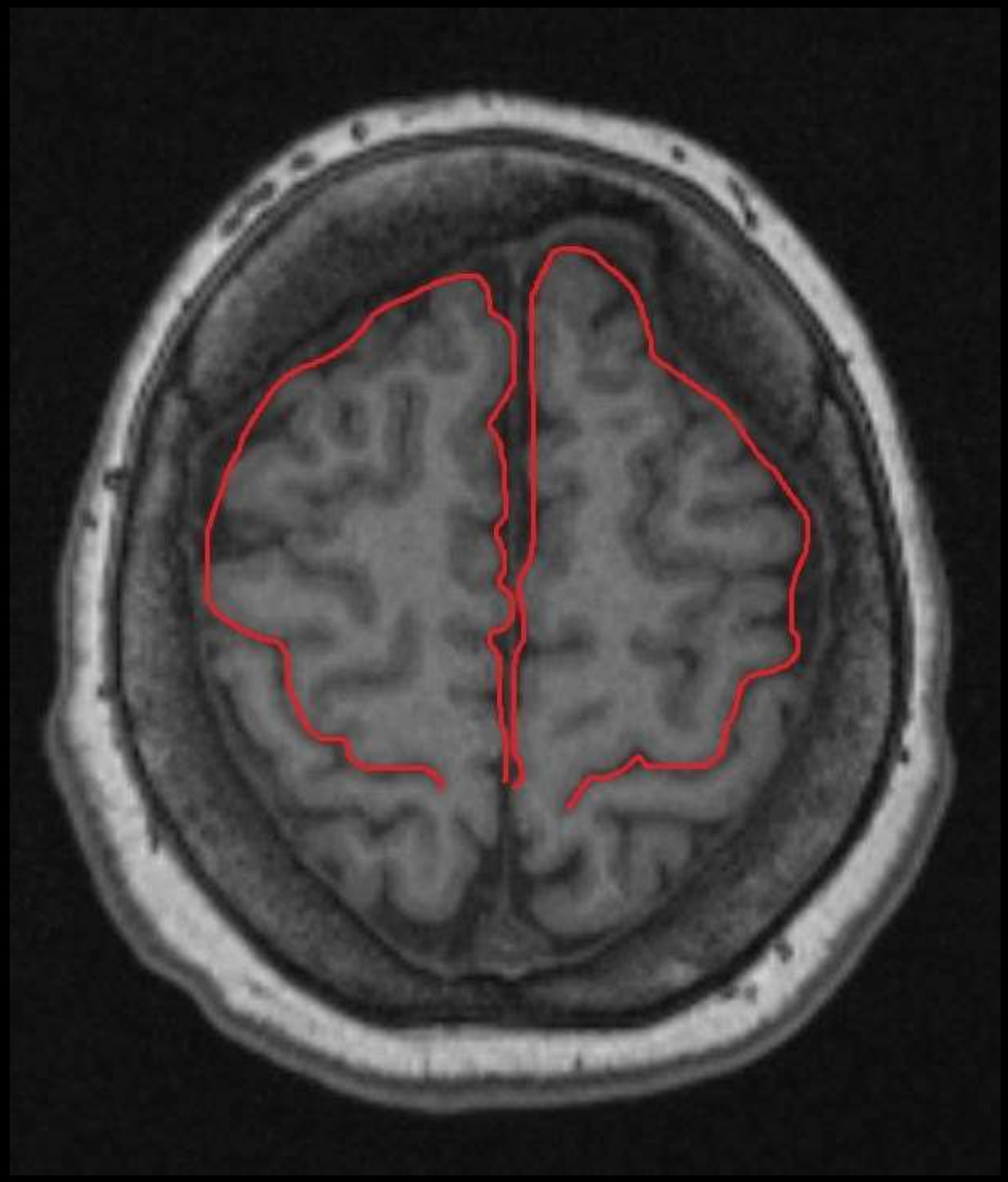
1. Lobar Anatomy
2. Major Fissures
3. Ventricular System
4. Basal Ganglia
5. White Matter Tracts (Corpus Callosum and Internal Capsule)
6. Brainstem
7. Cerebellum
8. Dural Folds (Falx and Tentorium)
9. Major Vessels (Circle of Willis)

FRONTAL LOBE



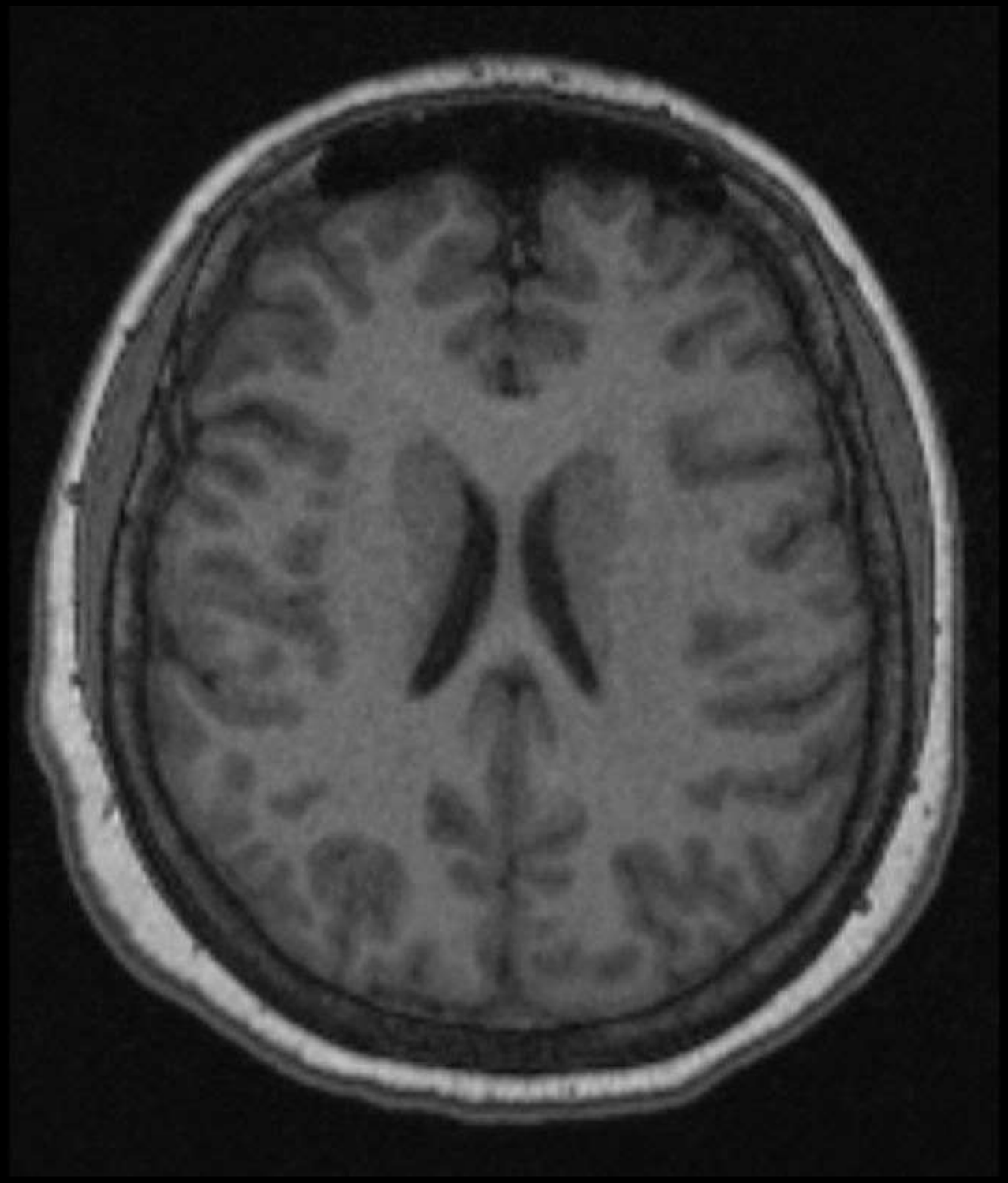
Axial

FRONTAL LOBE



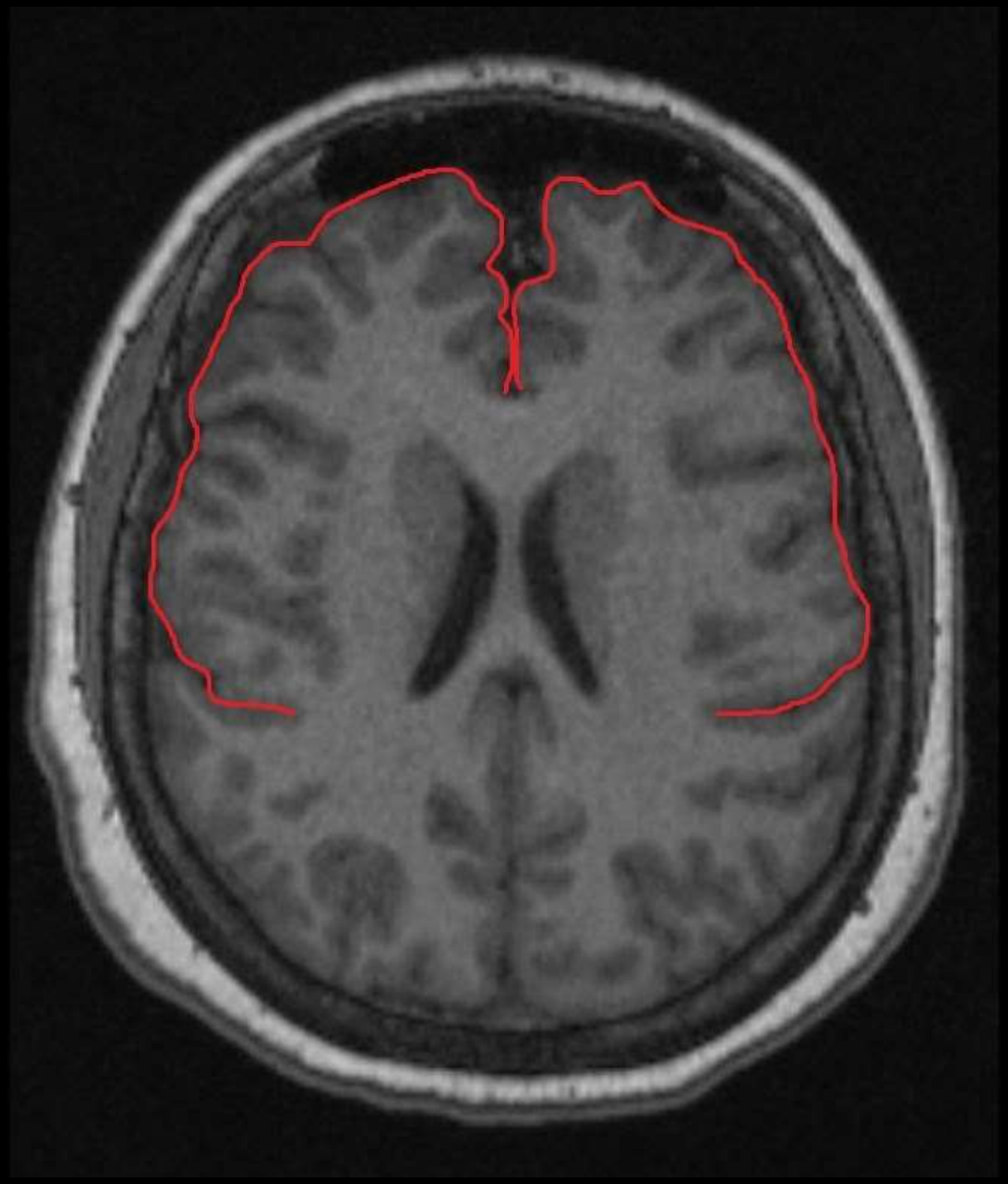
Axial

FRONTAL LOBE



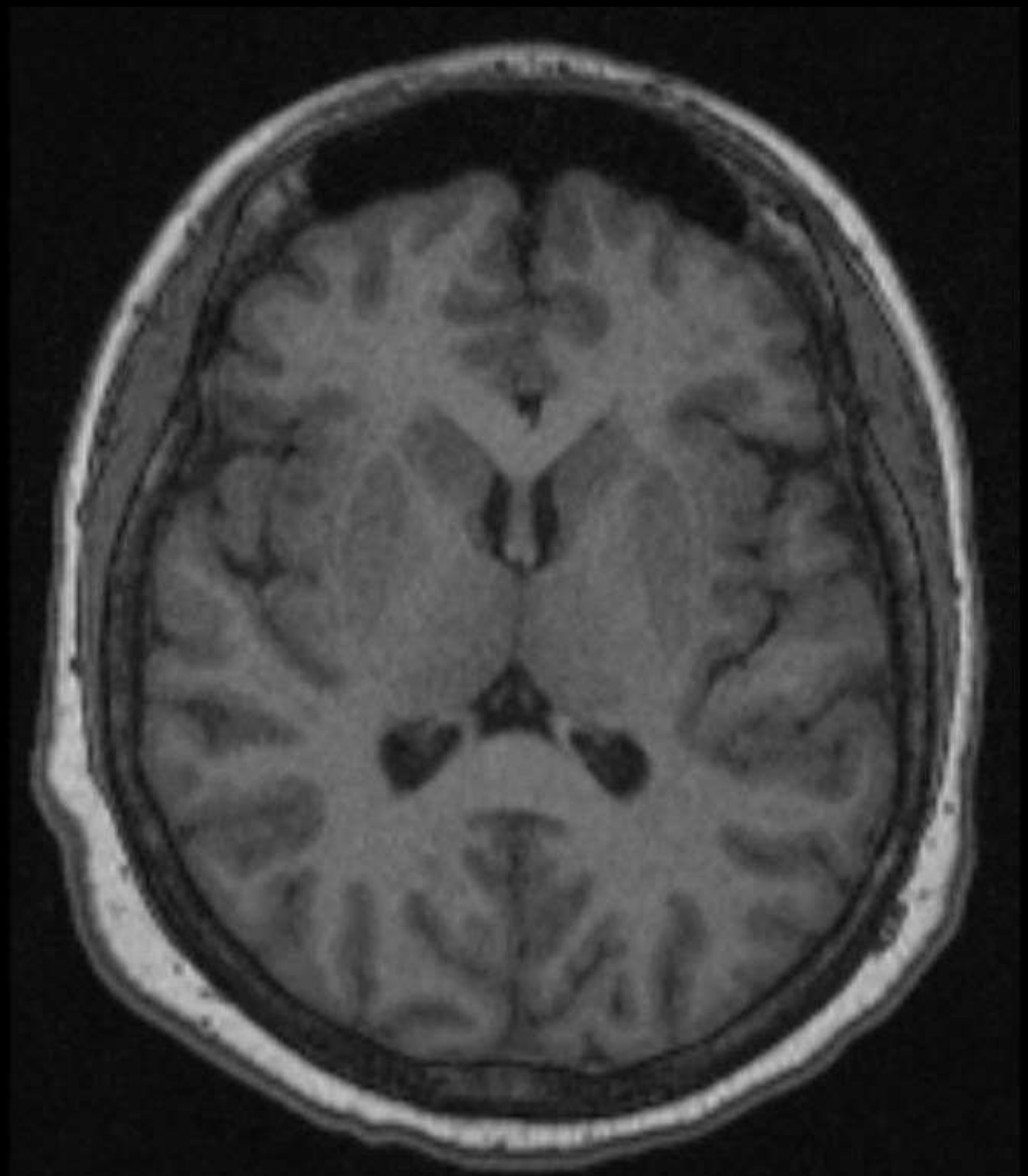
Axial

FRONTAL LOBE



Axial

FRONTAL LOBE



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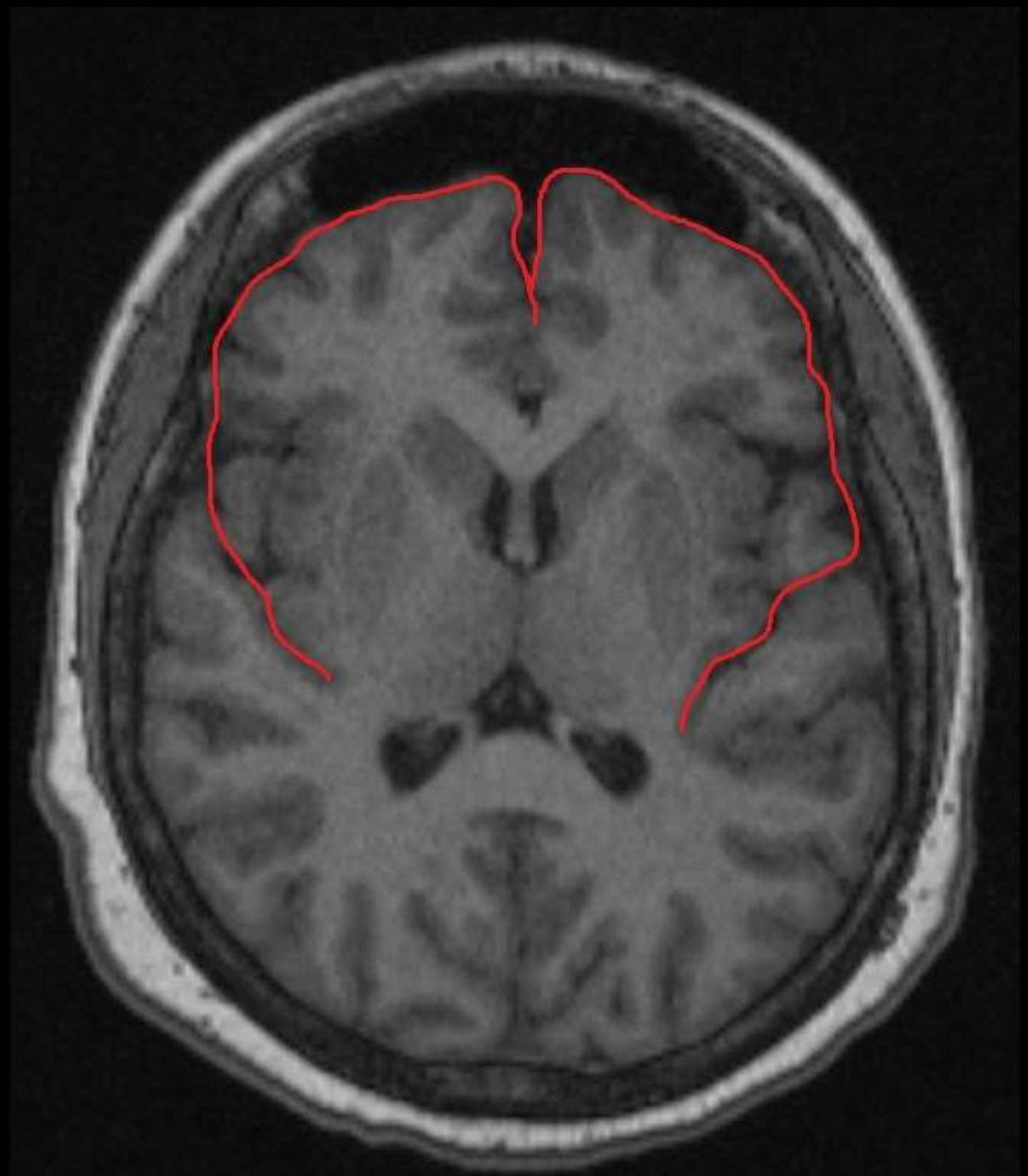

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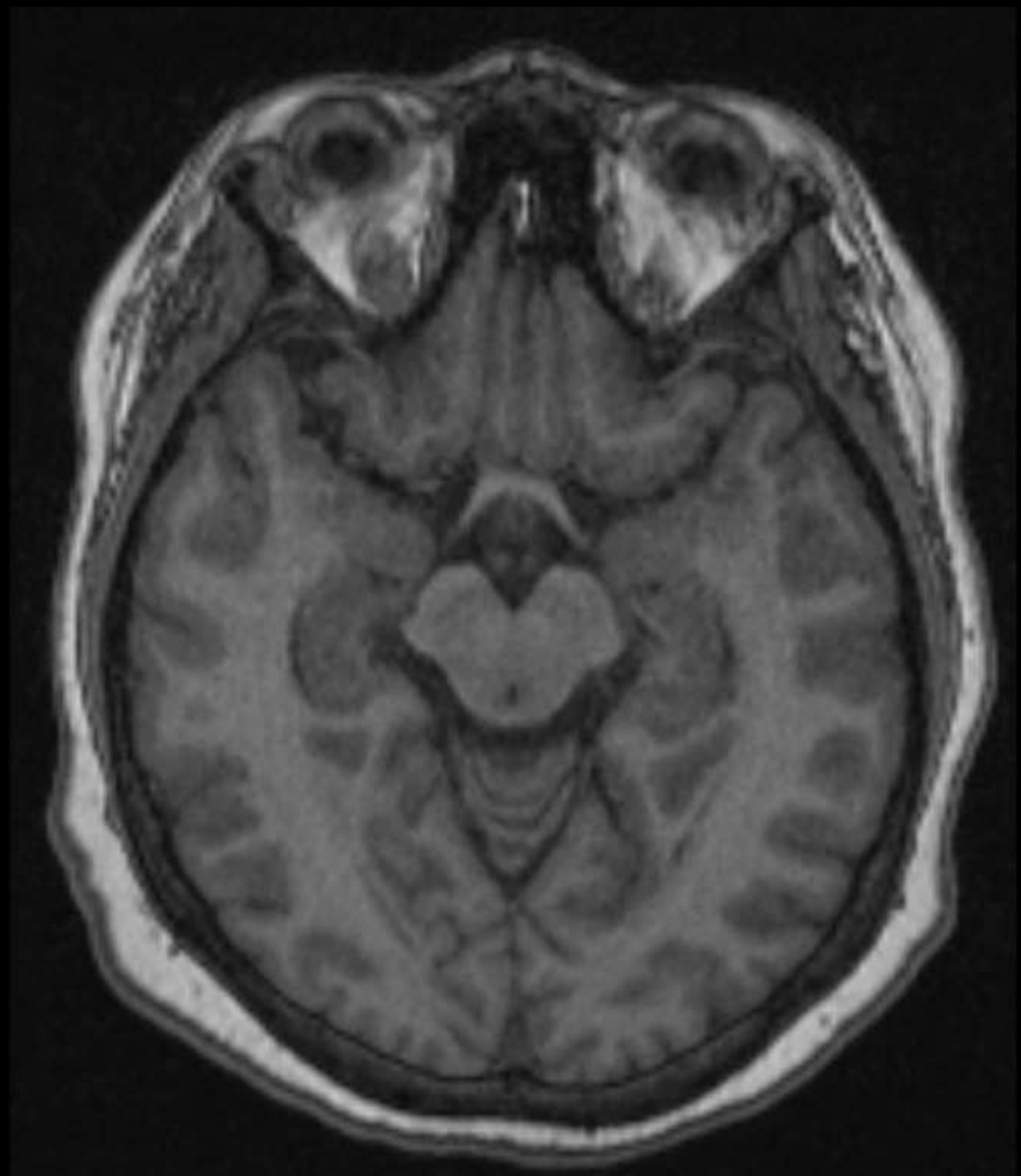

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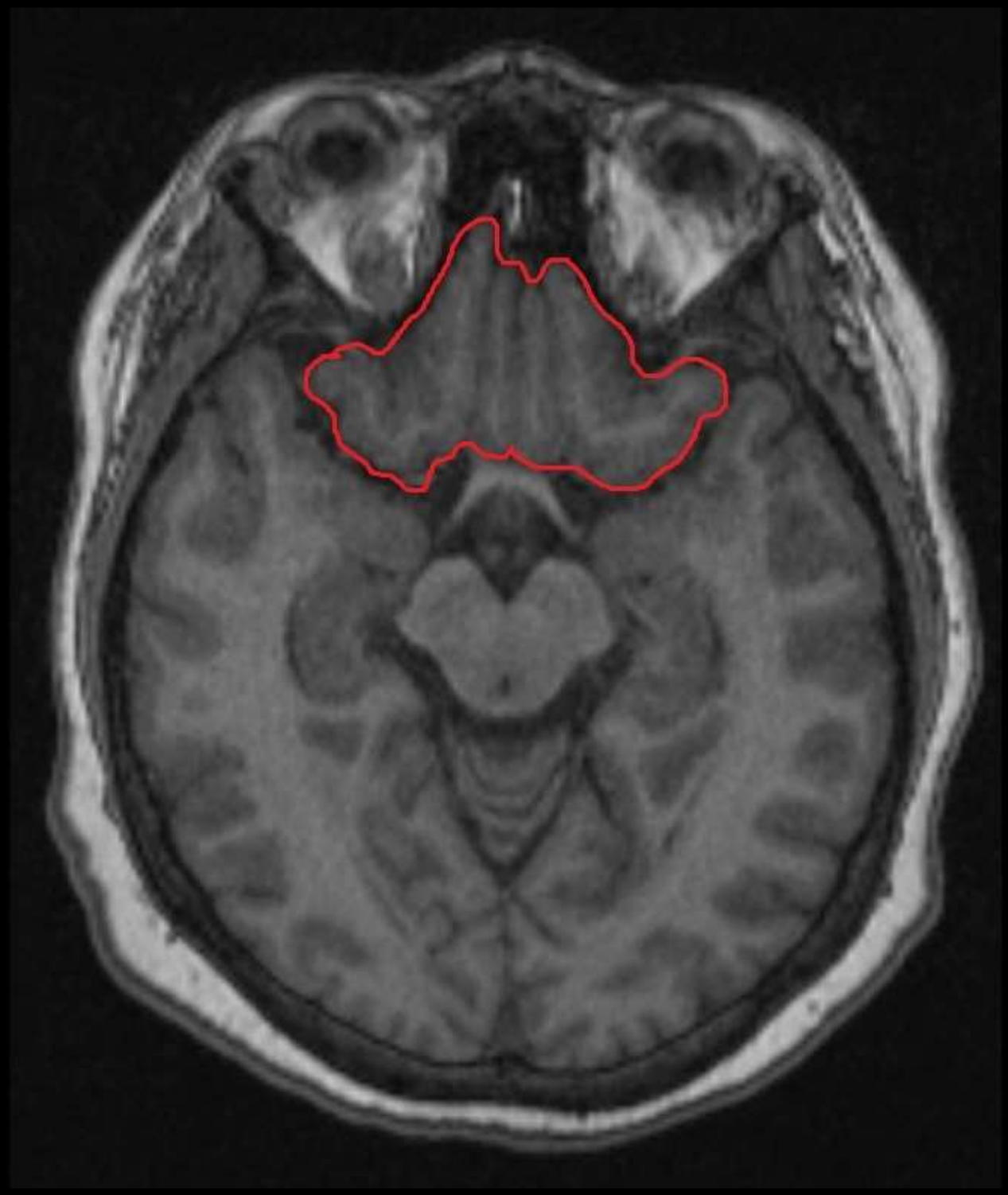
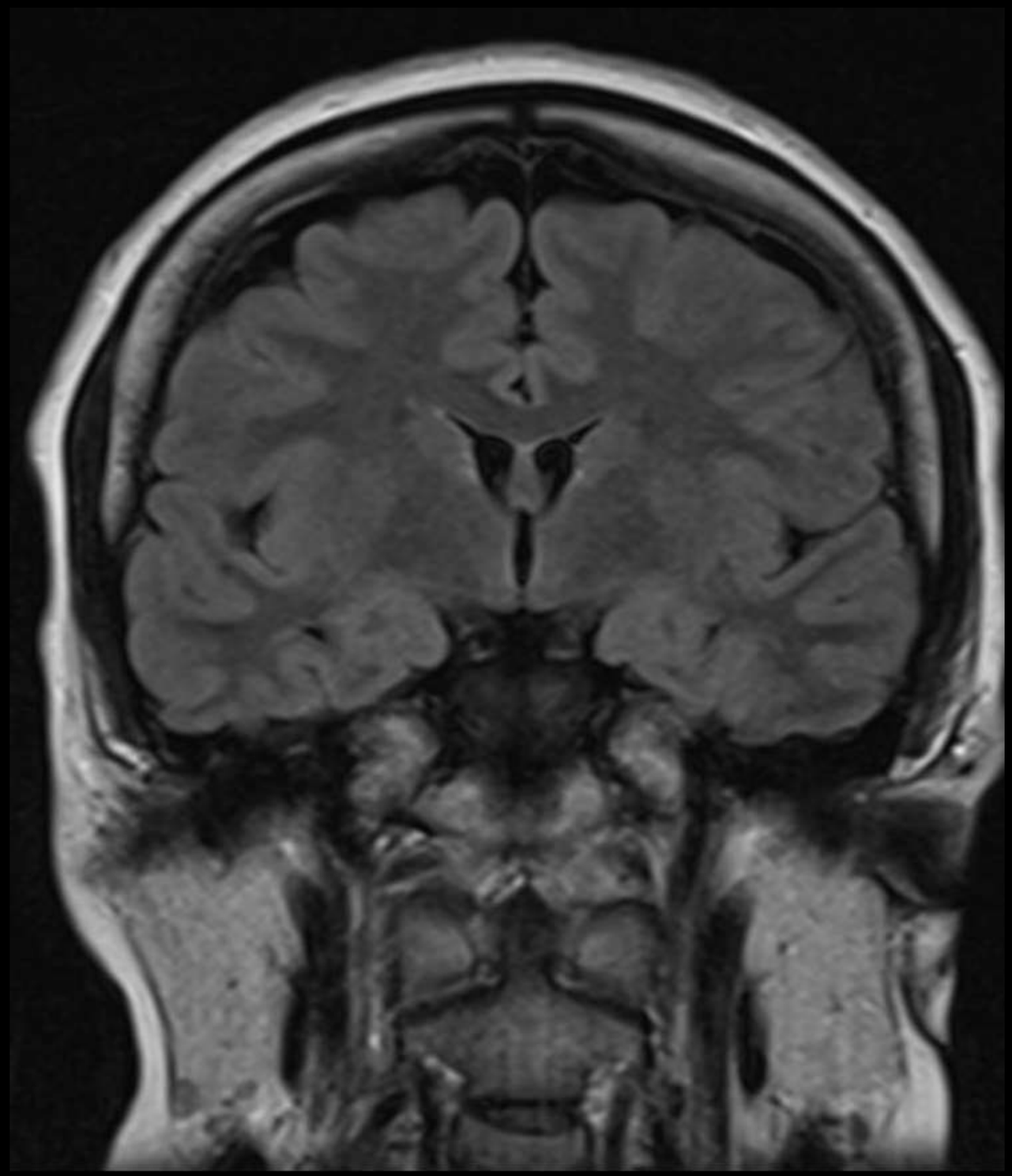


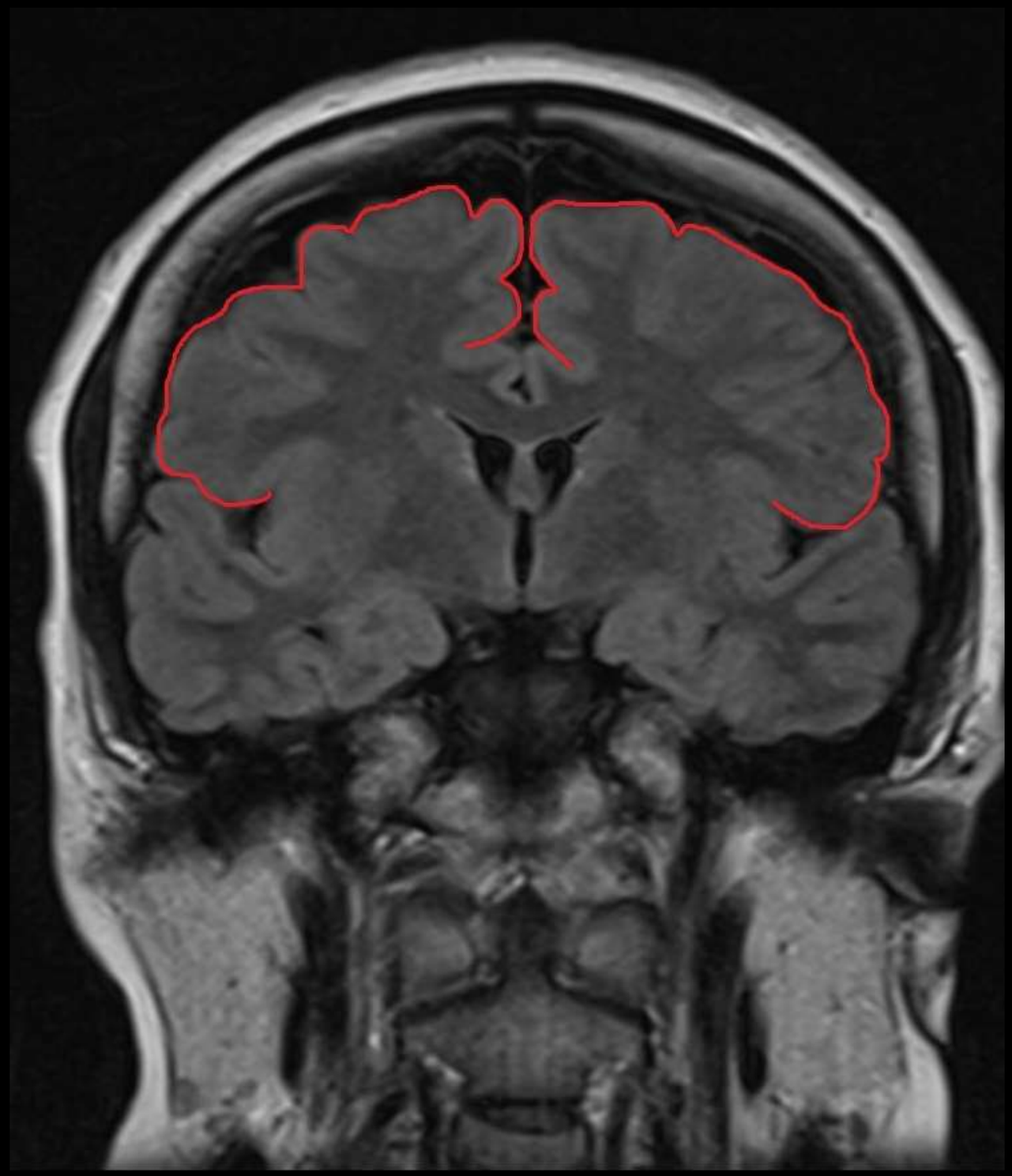
Axial

FRONTAL LOBE



Coronal

FRONTAL LOBE

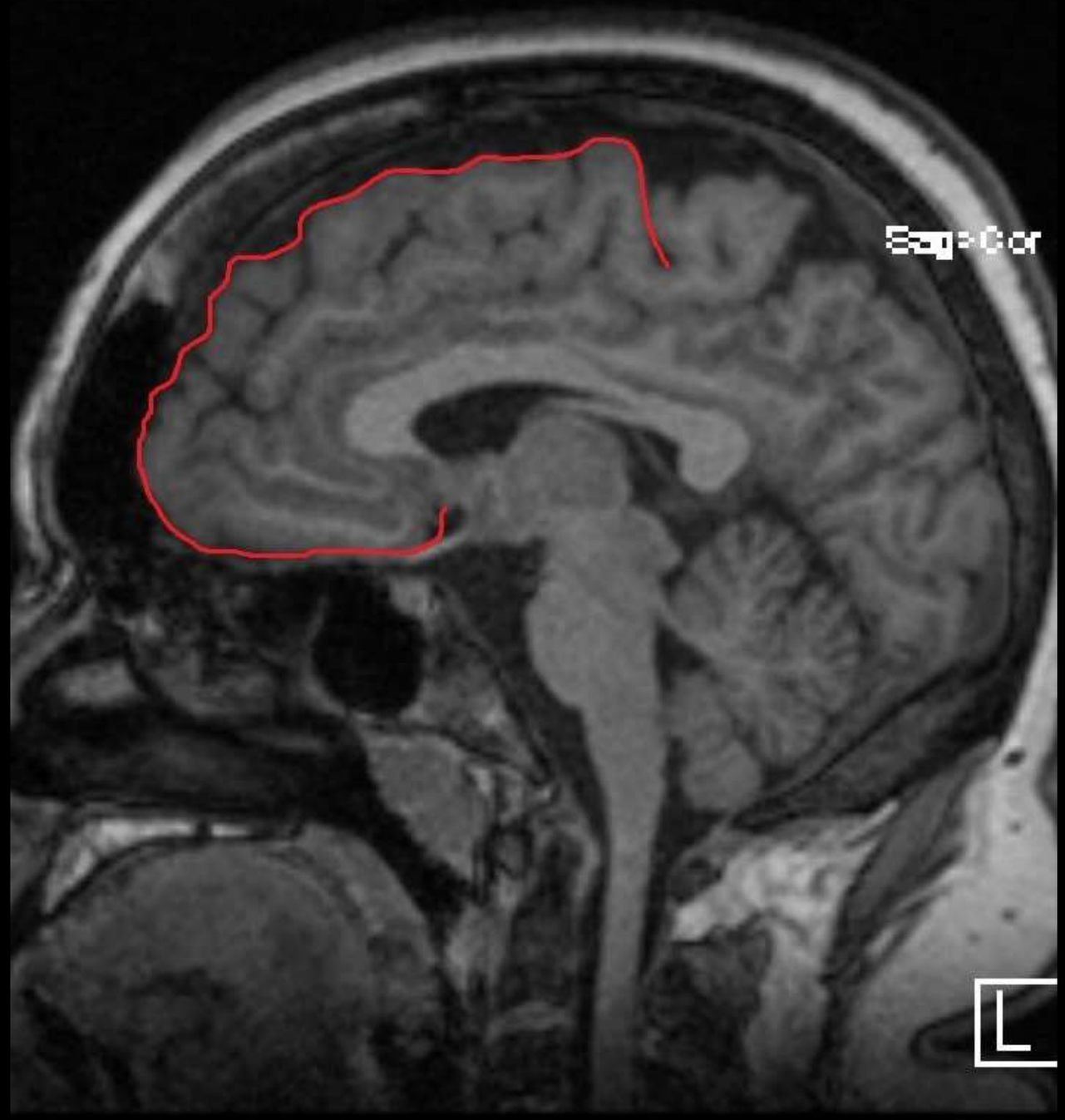


Coronal

FRONTAL LOBE

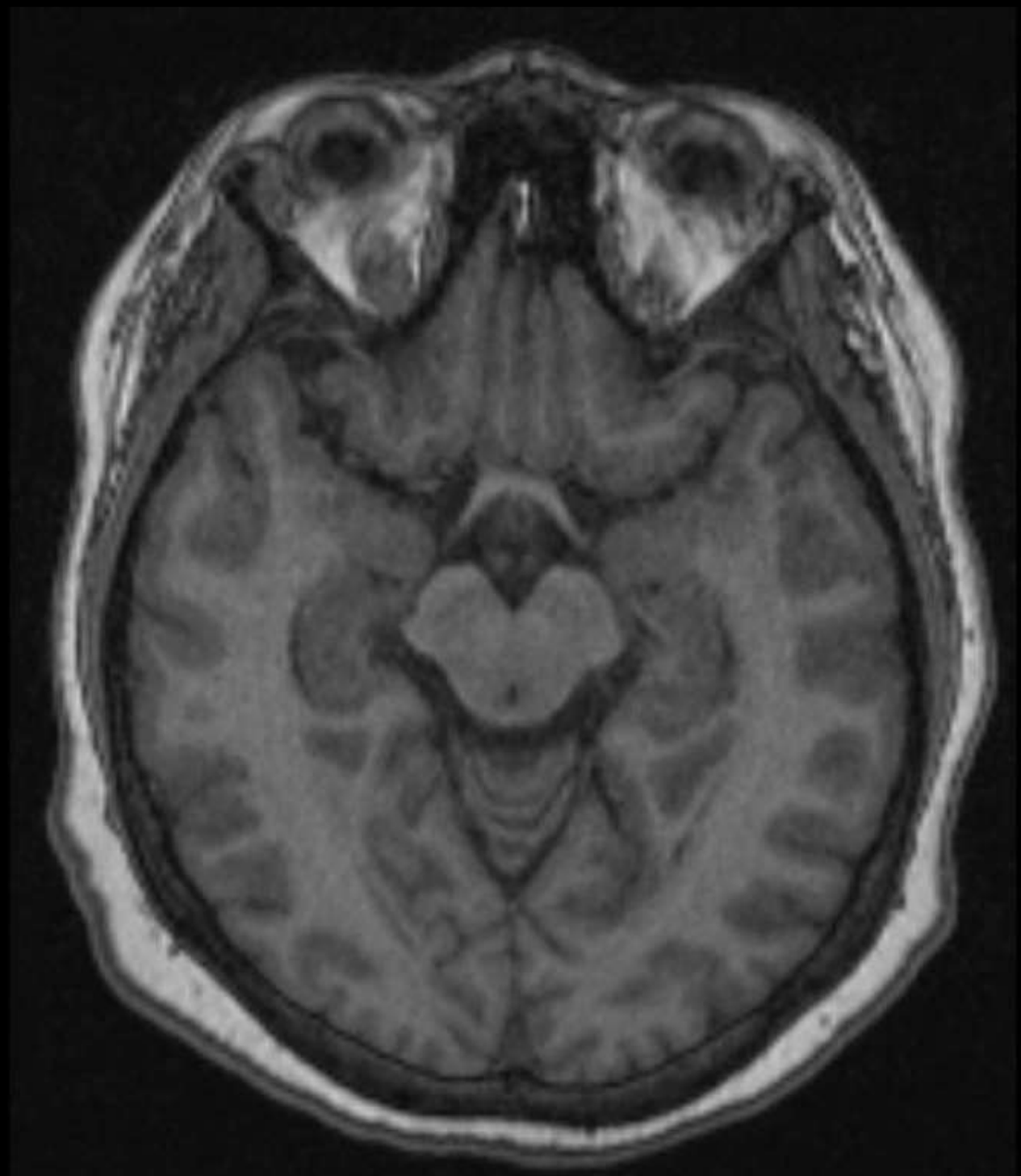
Sagittal

FRONTAL LOBE



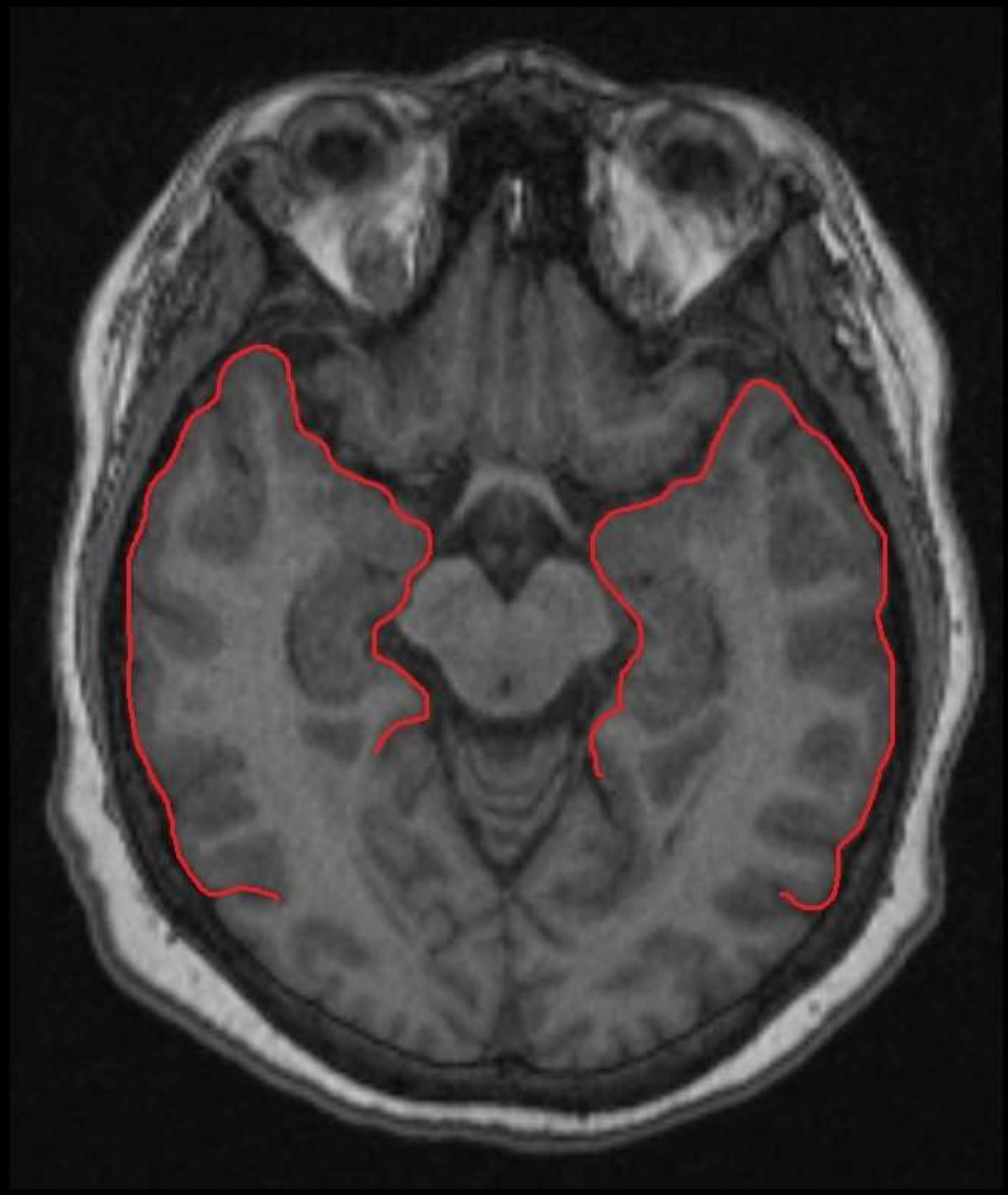
Sagittal

TEMPORAL LOBE



Axial

TEMPORAL LOBE



Axial

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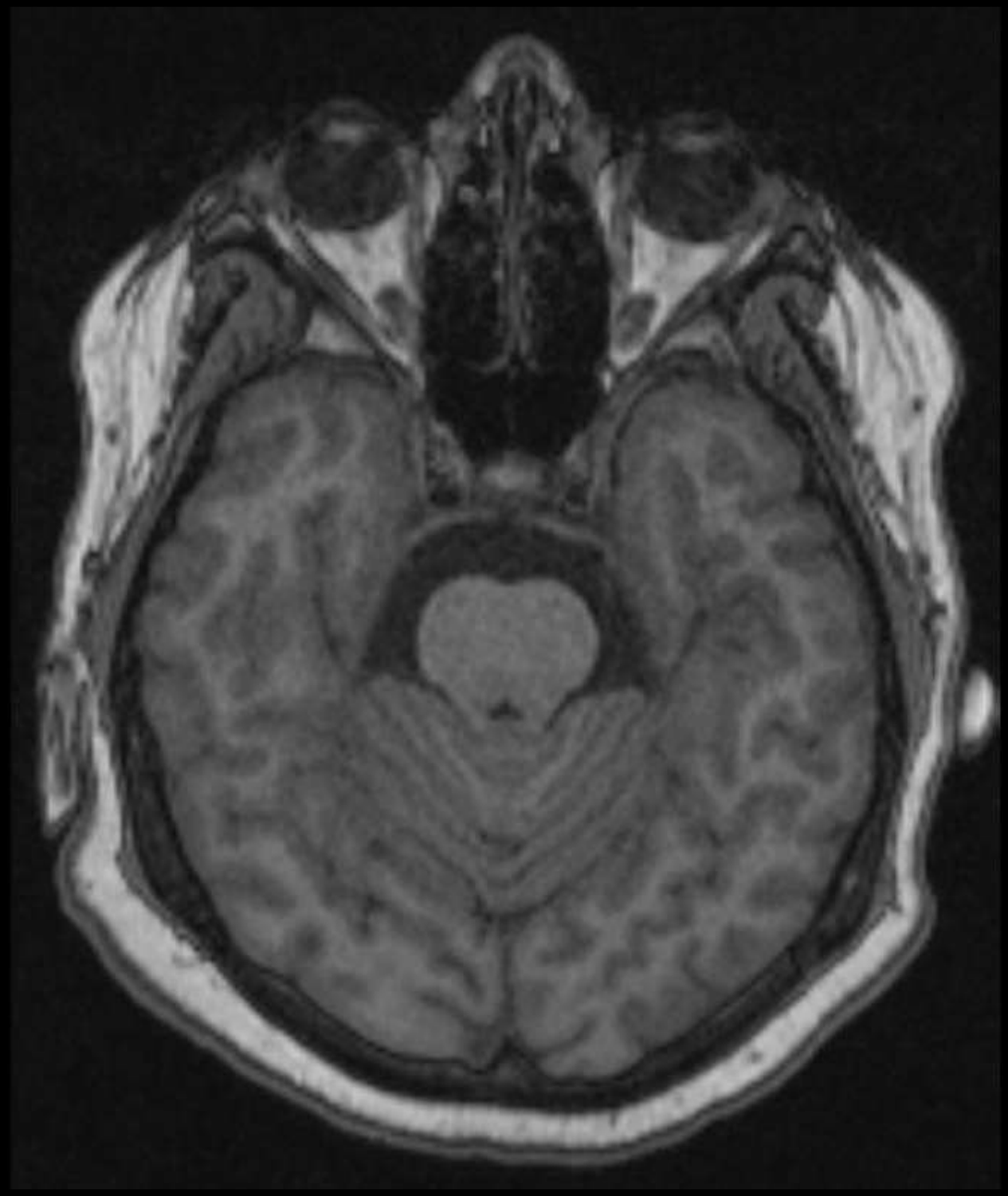
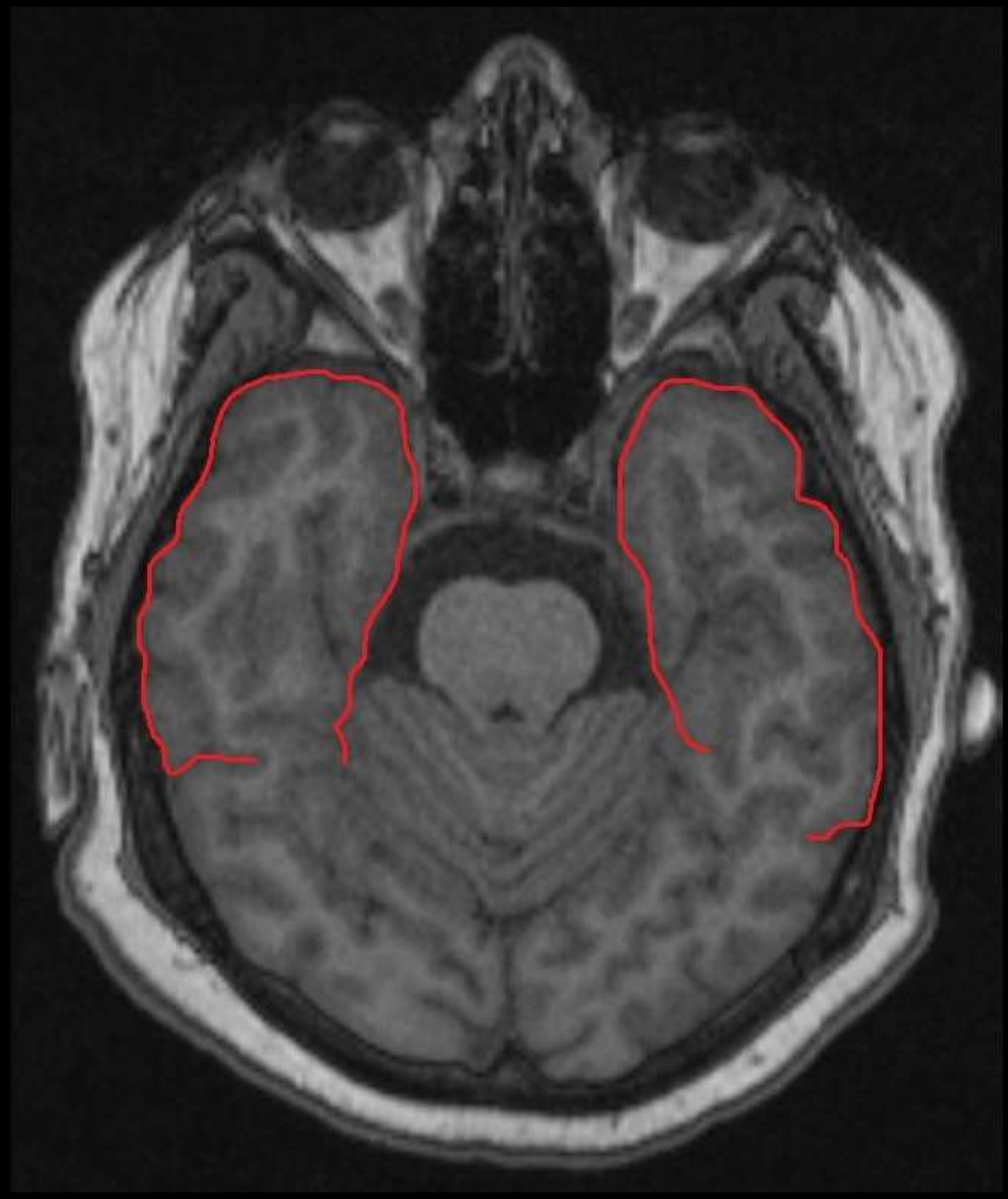


Axial

TEMPORAL LOBE



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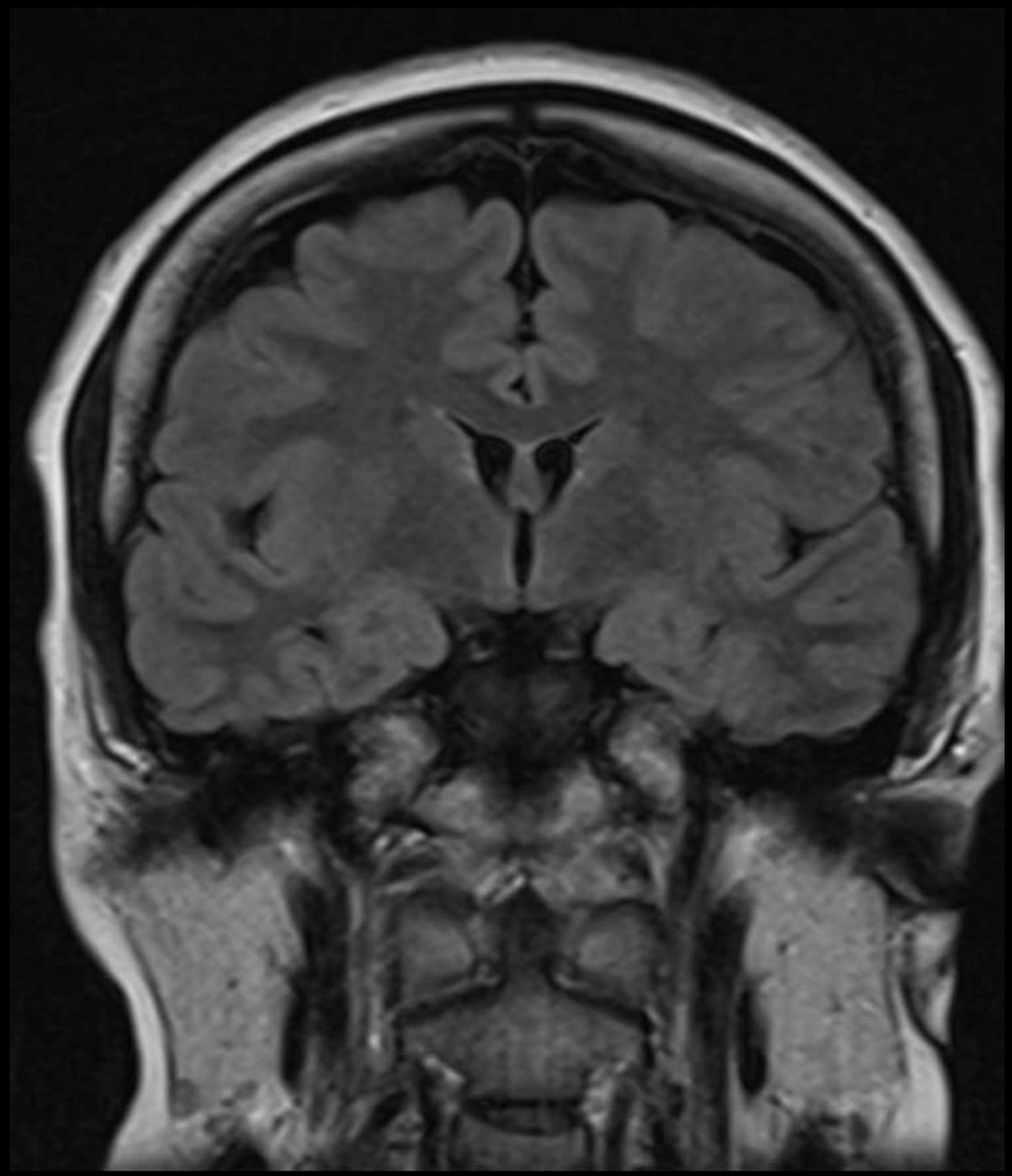

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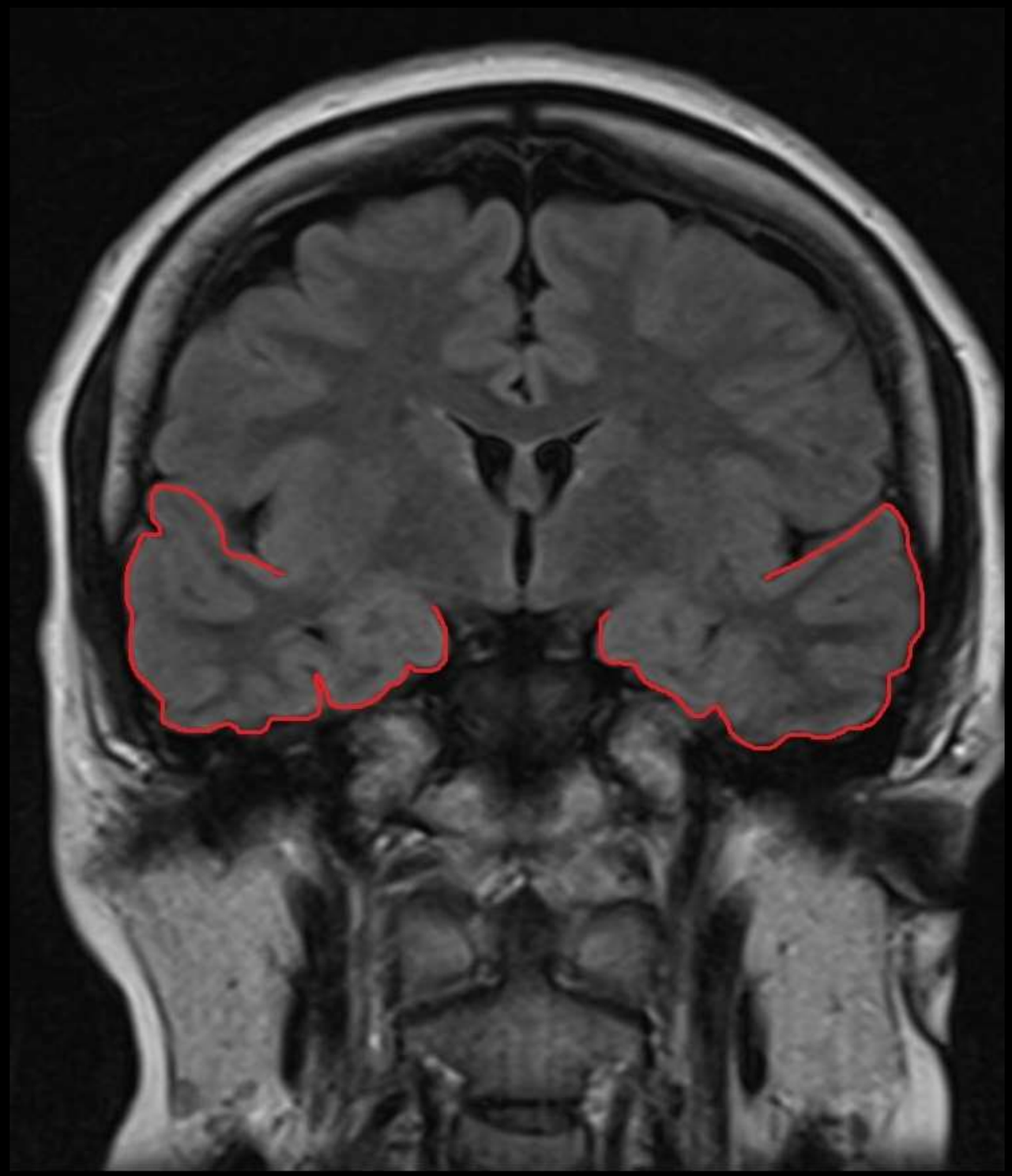
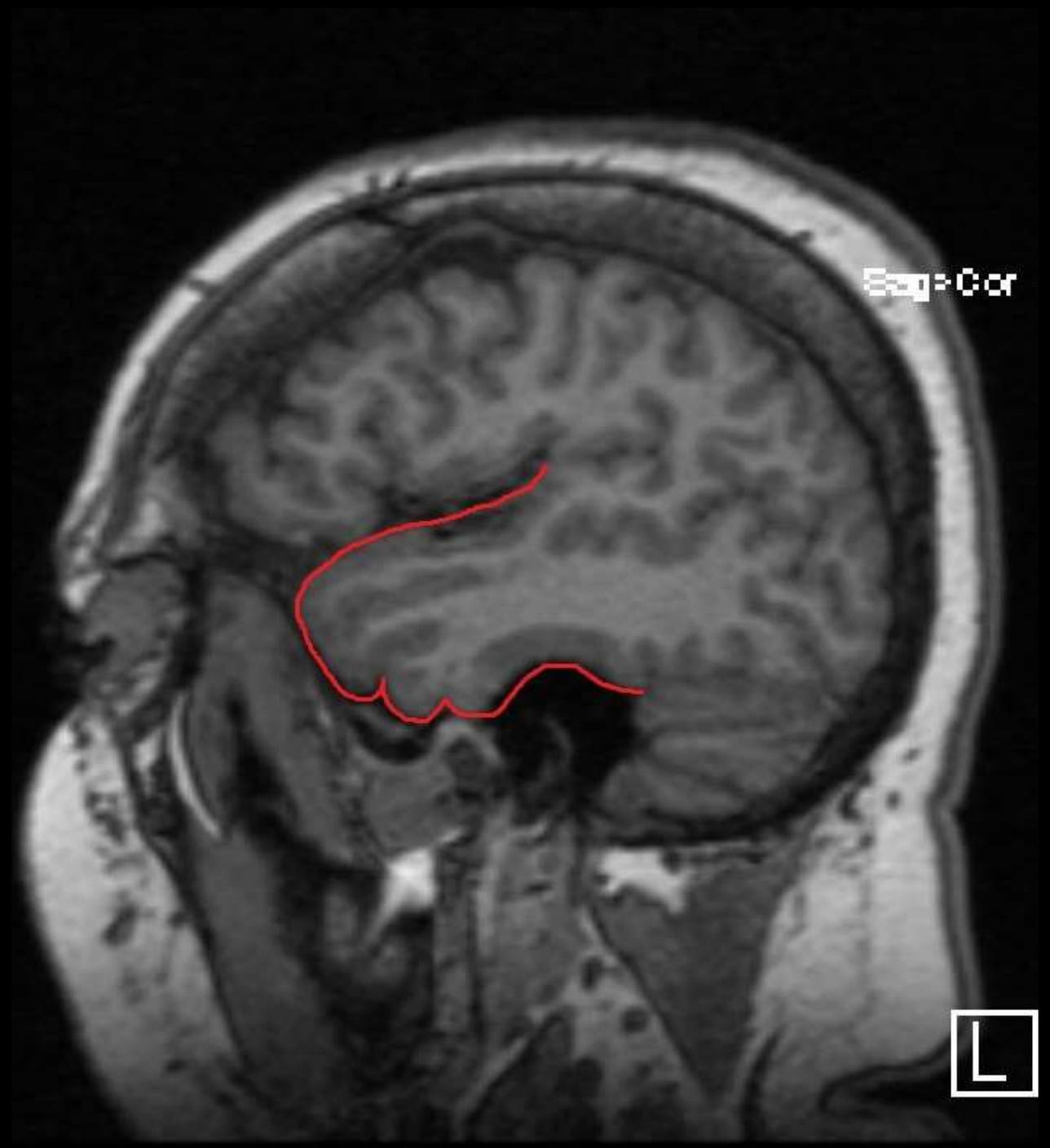


Coronal

TEMPORAL LOBE

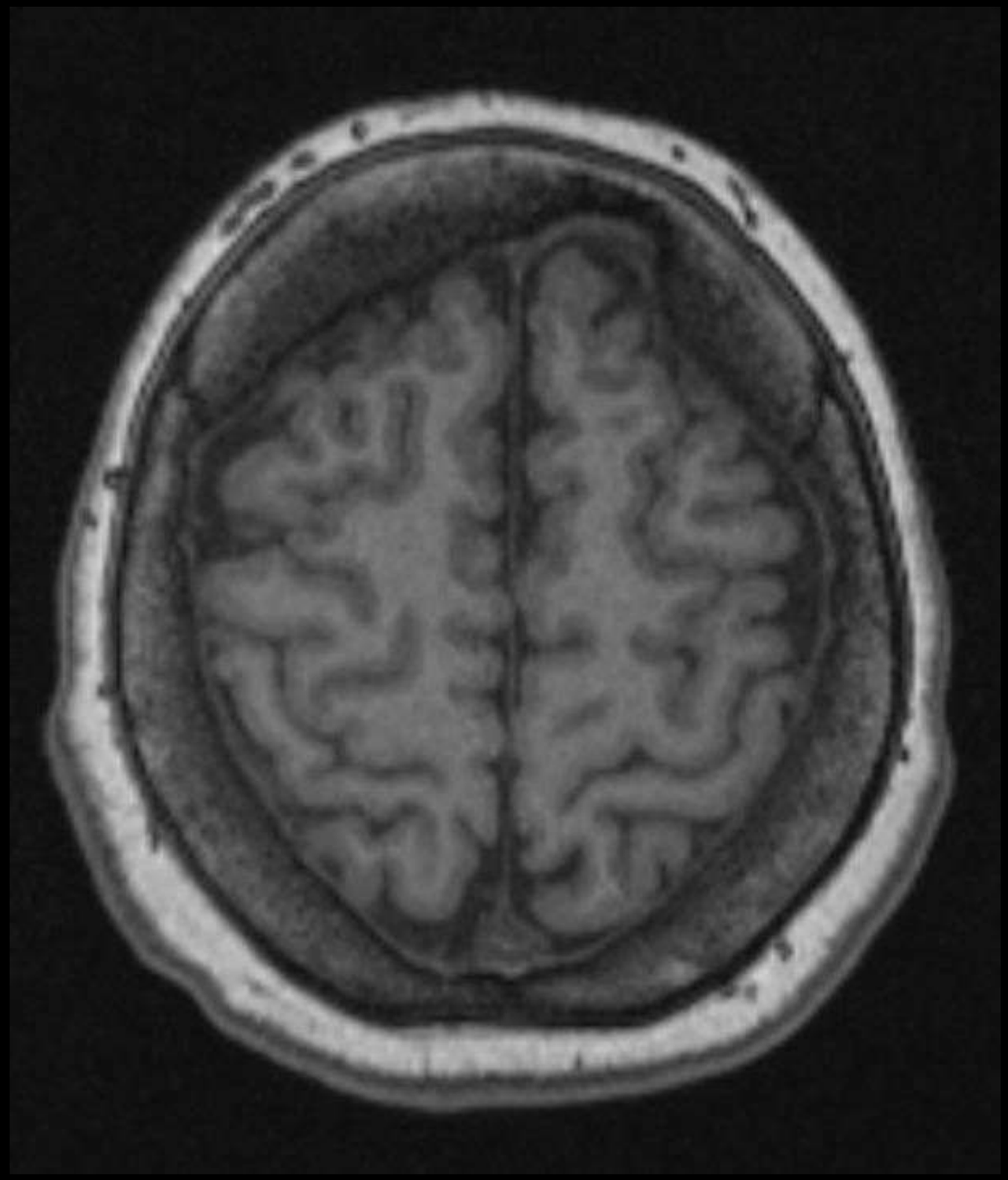
Sagittal

TEMPORAL LOBE



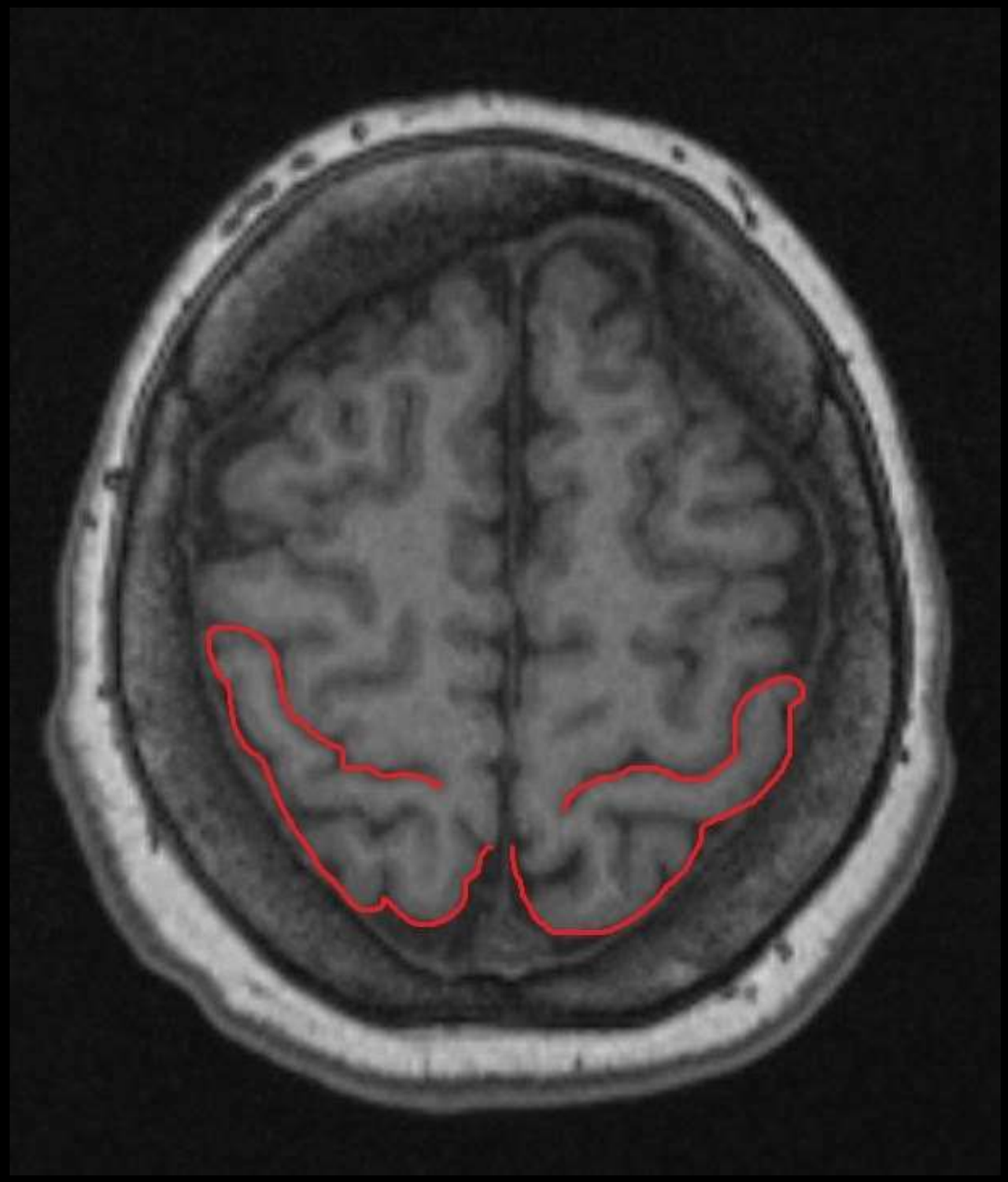
Sagittal

PARIETAL LOBE



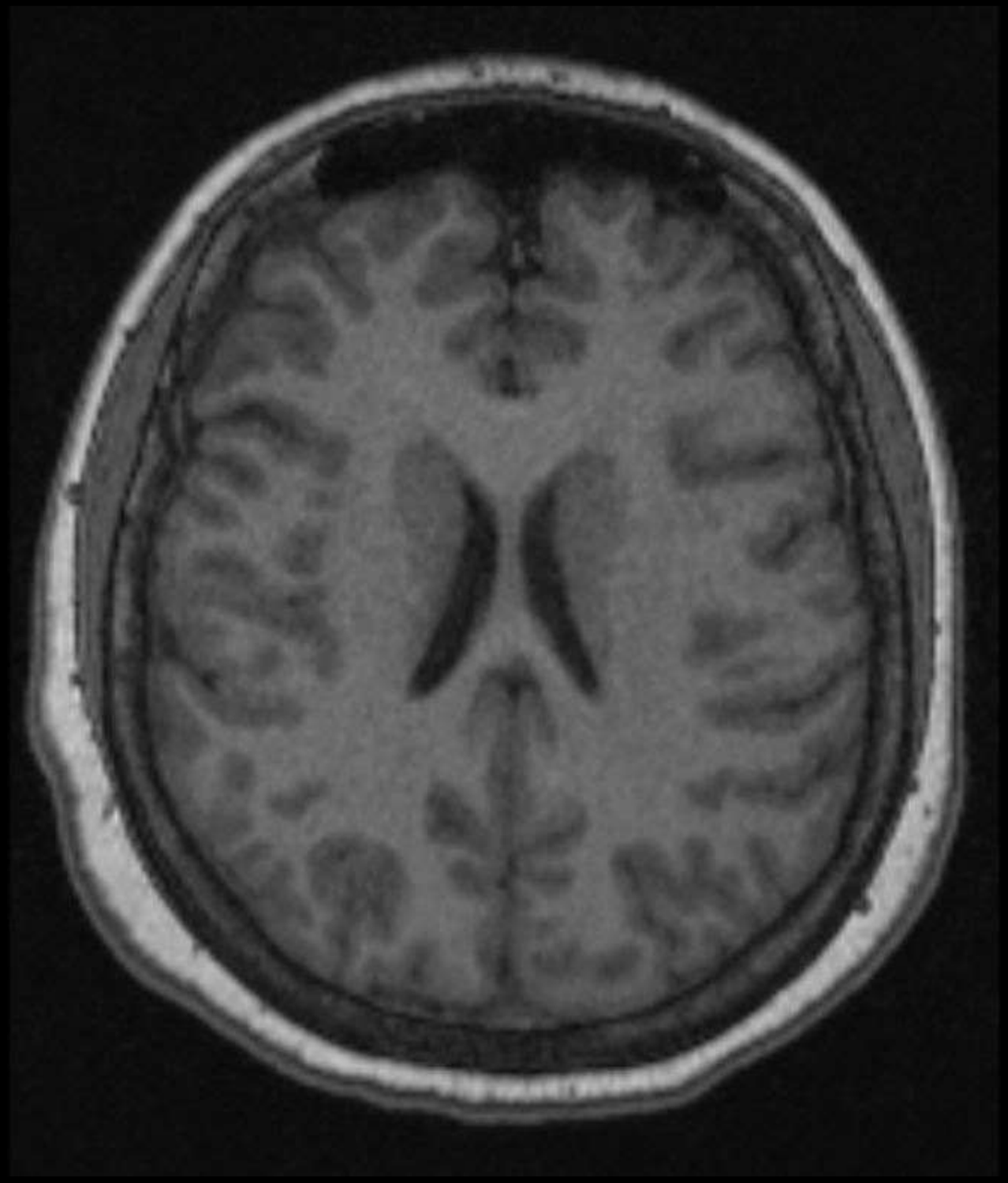
Axial

PARIETAL LOBE



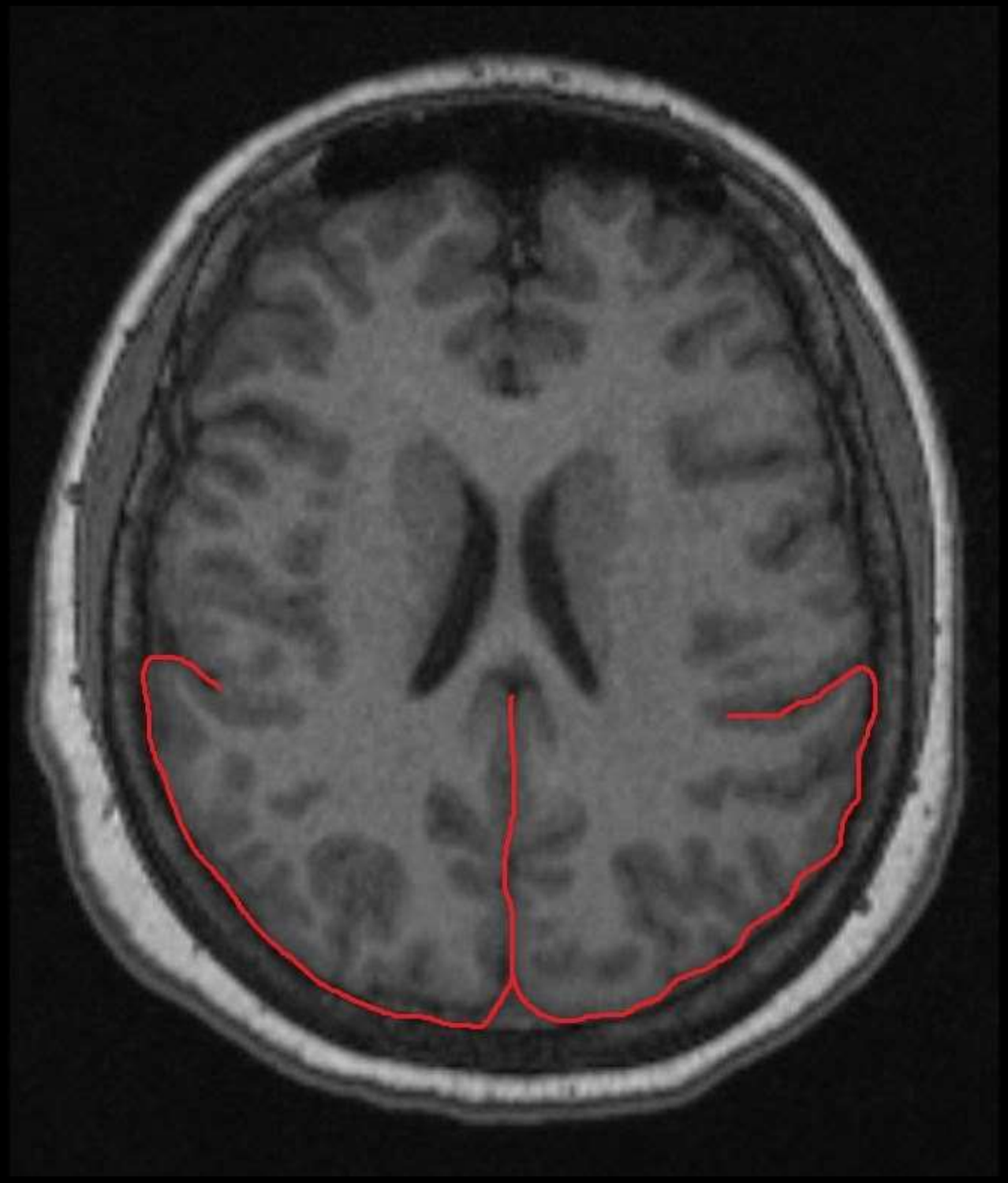
Axial

PARIETAL LOBE



Axial

PARIETAL LOBE

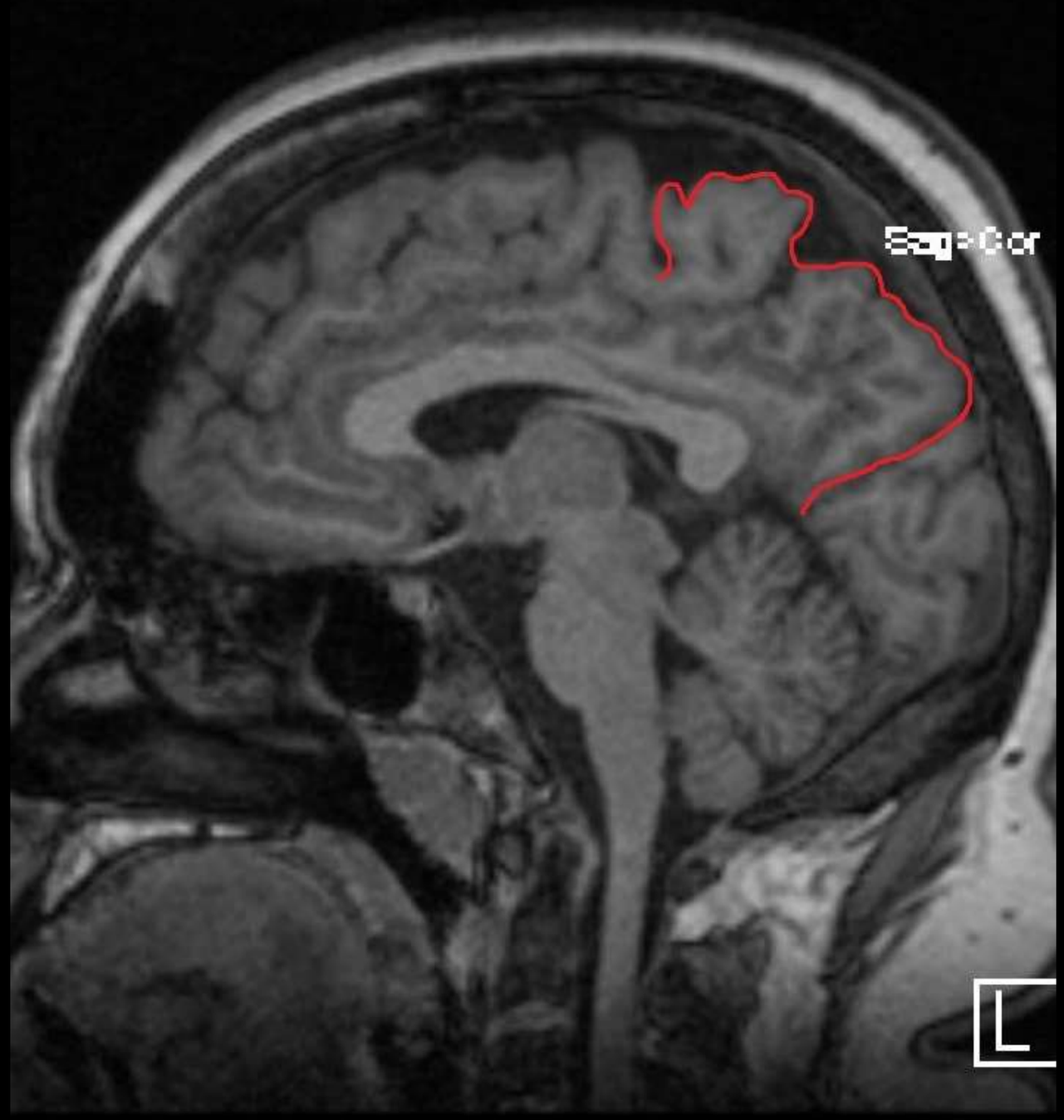


Axial

PARIETAL LOBE

Sagittal

PARIETAL LOBE

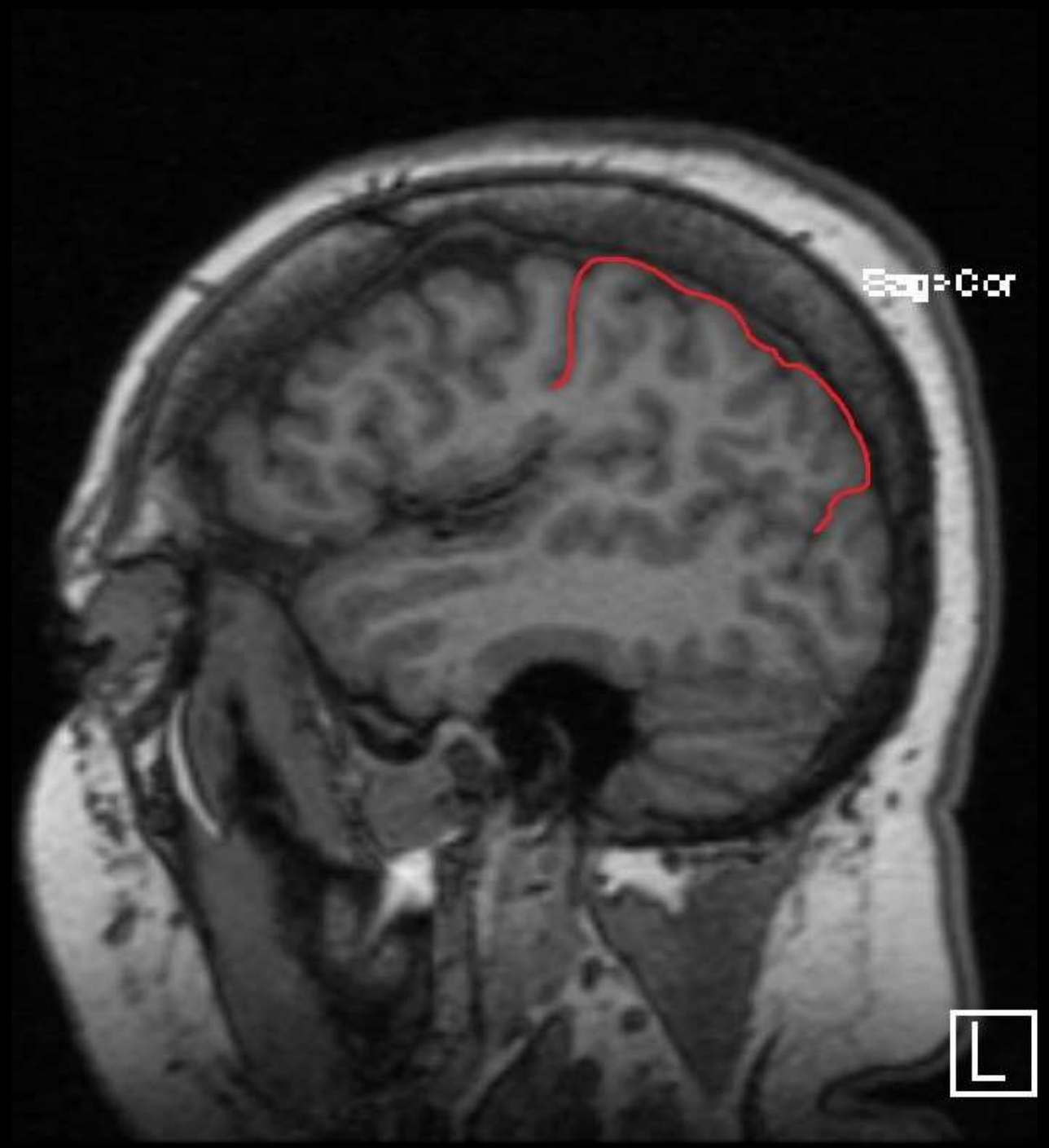


Sagittal

PARIETAL LOBE

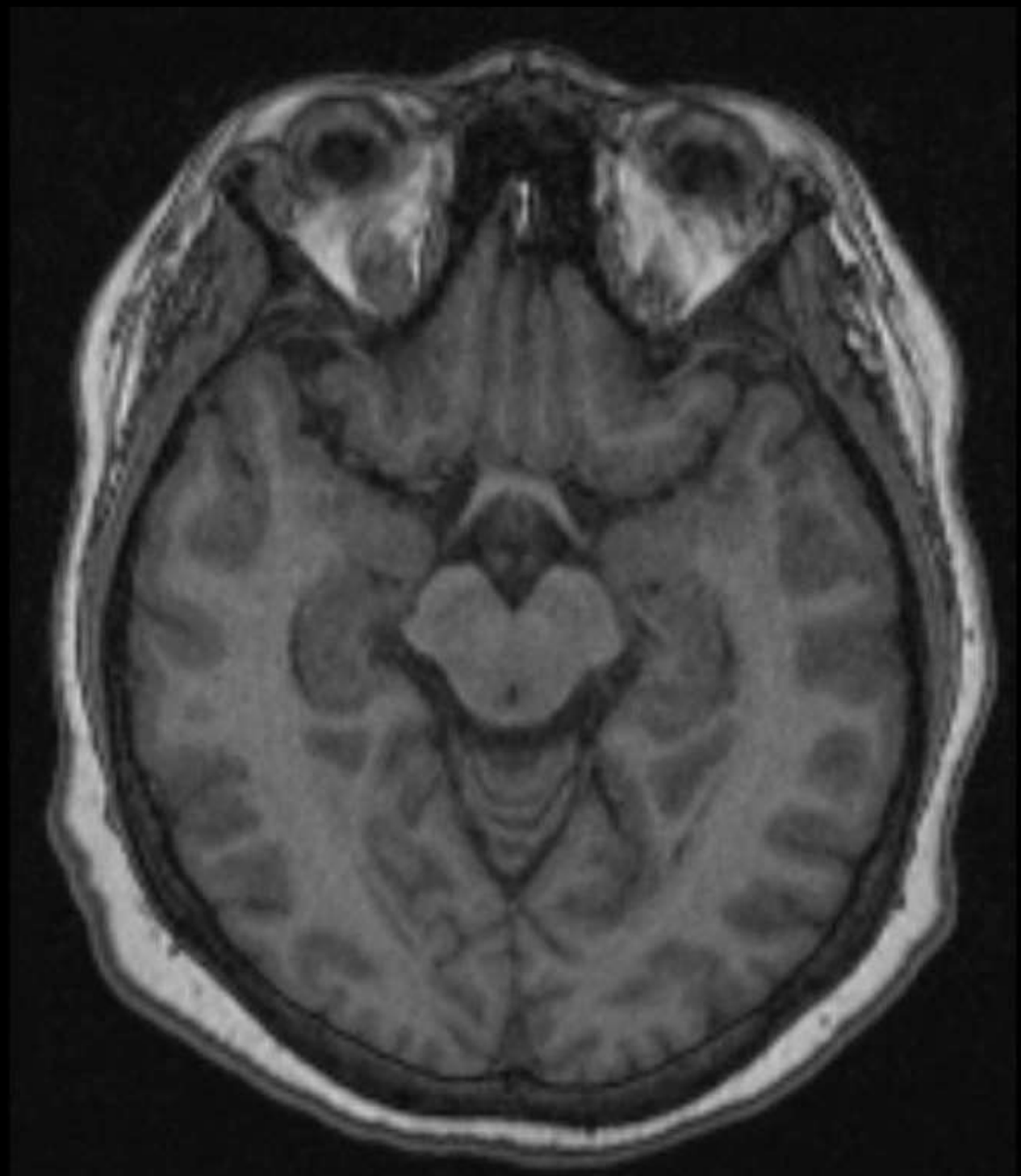
Sagittal

PARIETAL LOBE



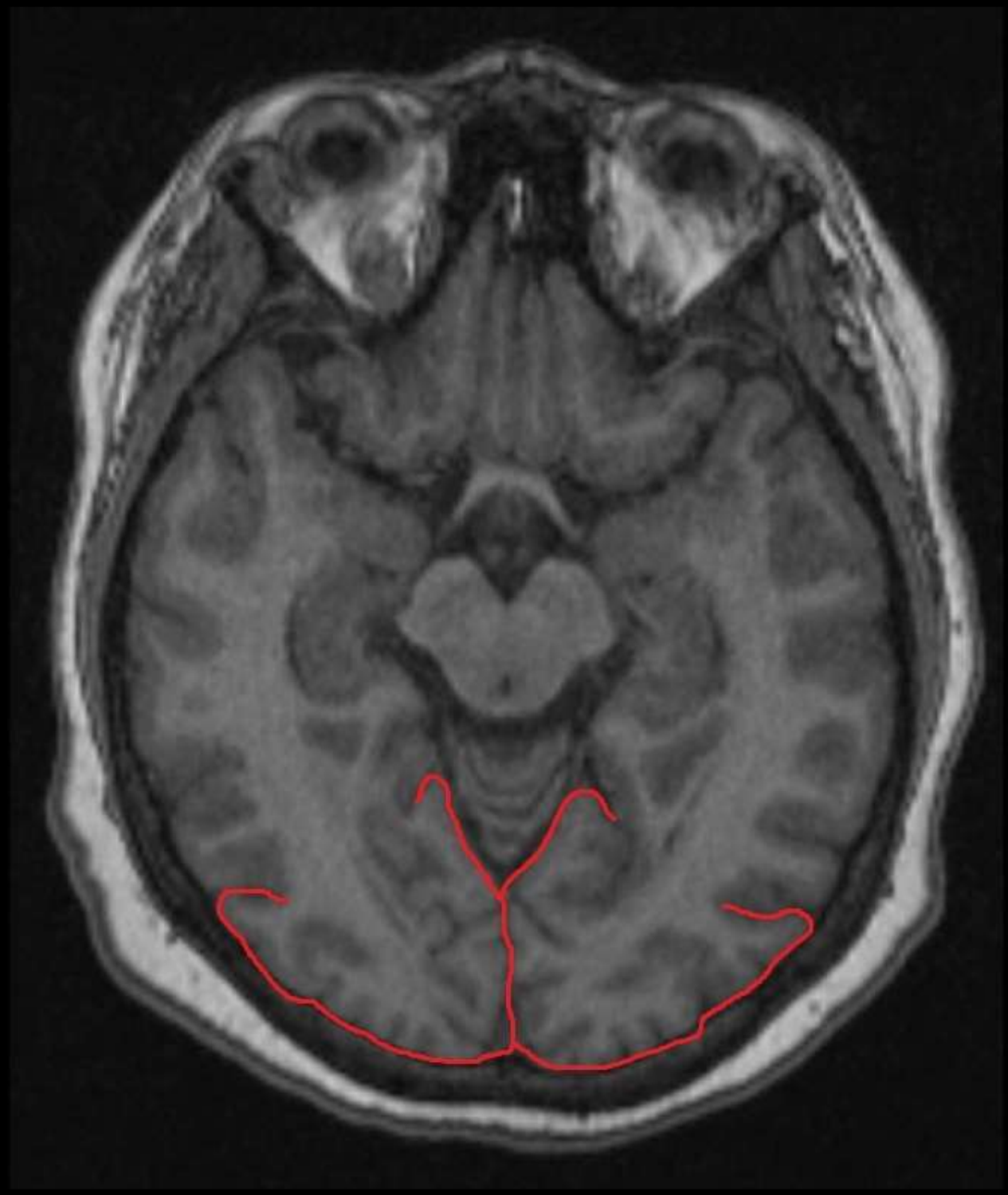
Sagittal

OCCIPITAL LOBE



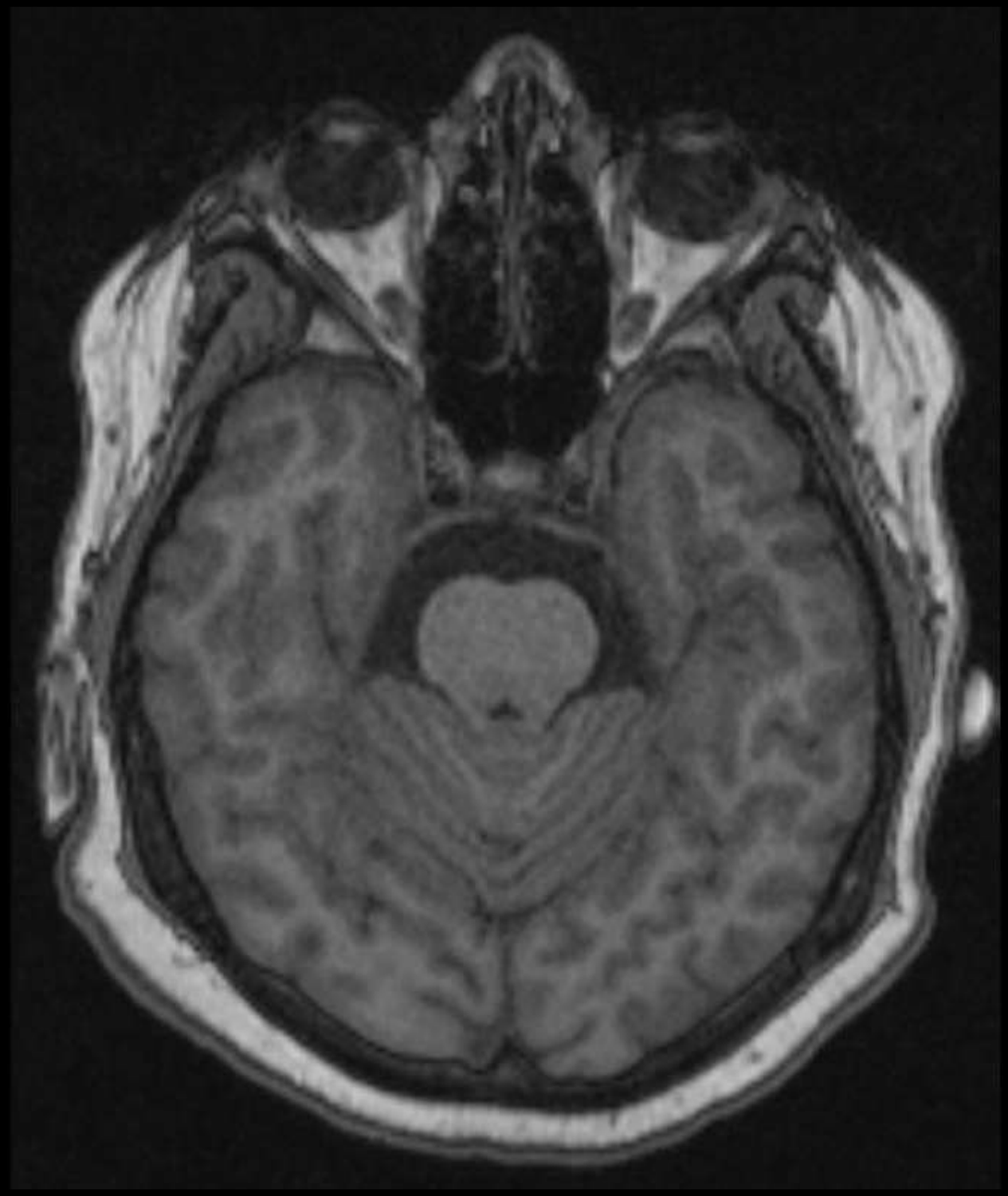
Axial

OCCIPITAL LOBE



Axial

OCCIPITAL LOBE



Axial

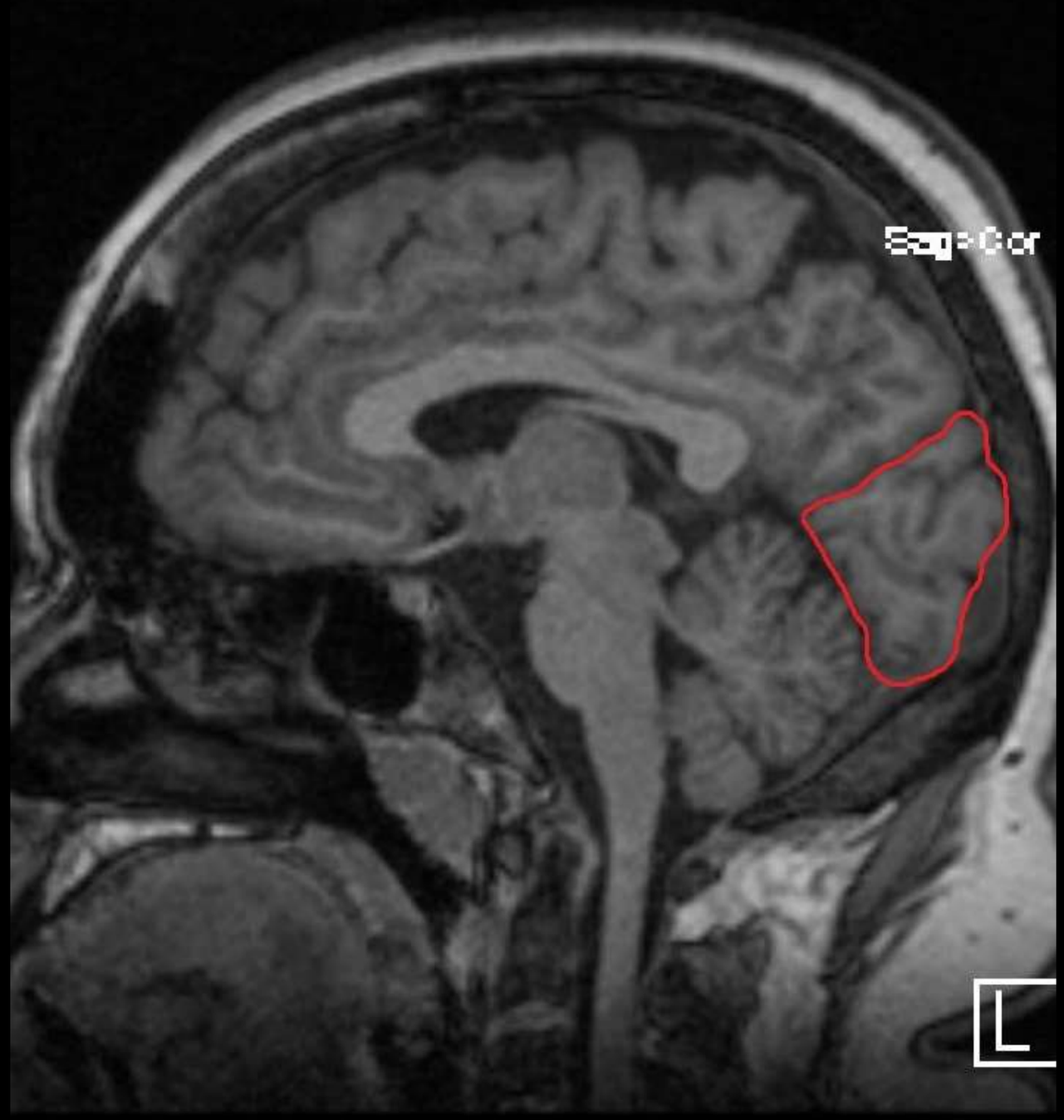
OCCIPITAL LOBE

Axial

OCCIPITAL LOBE

Sagittal

OCCIPITAL LOBE

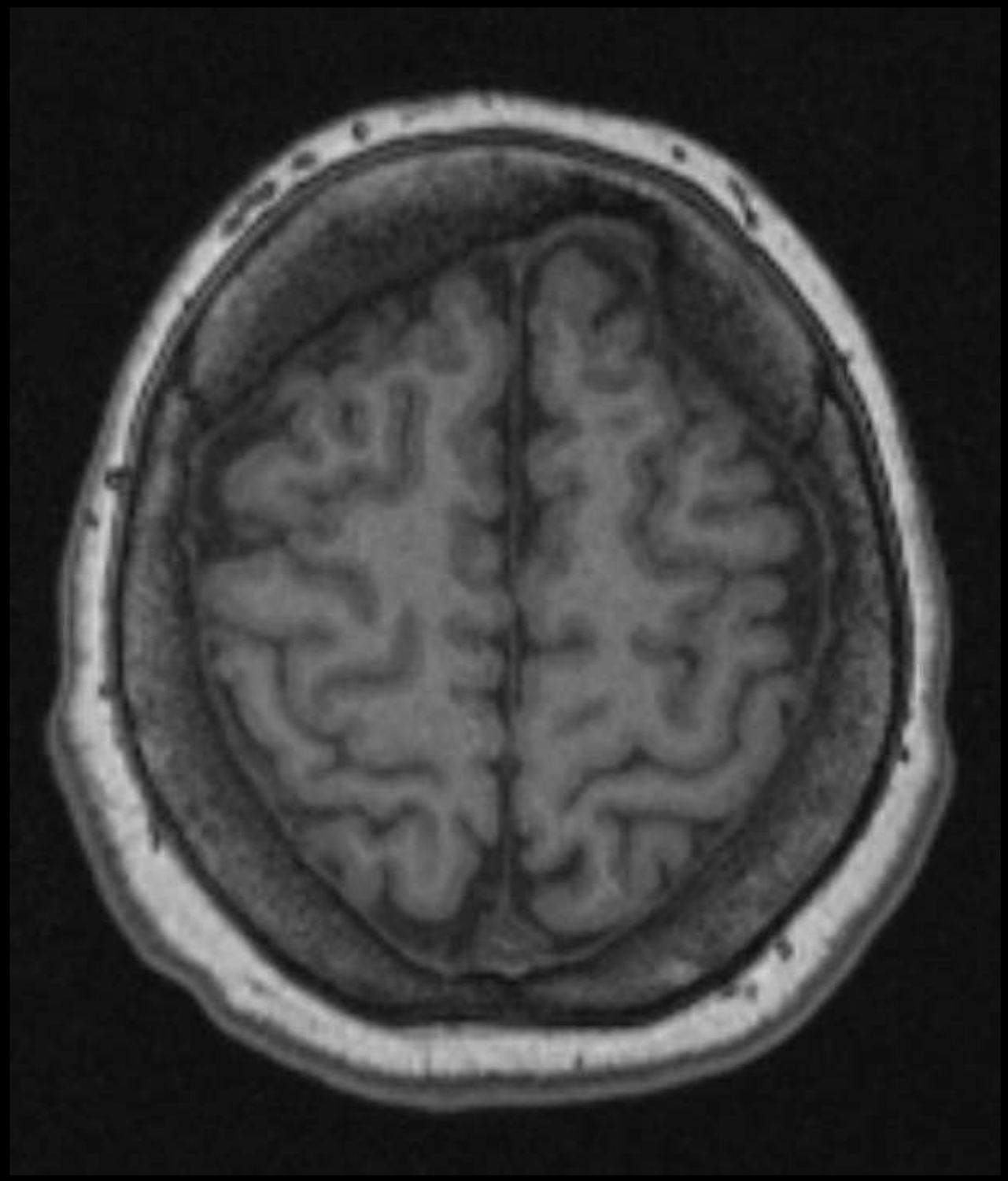


Sagittal

MAJOR FISSURES

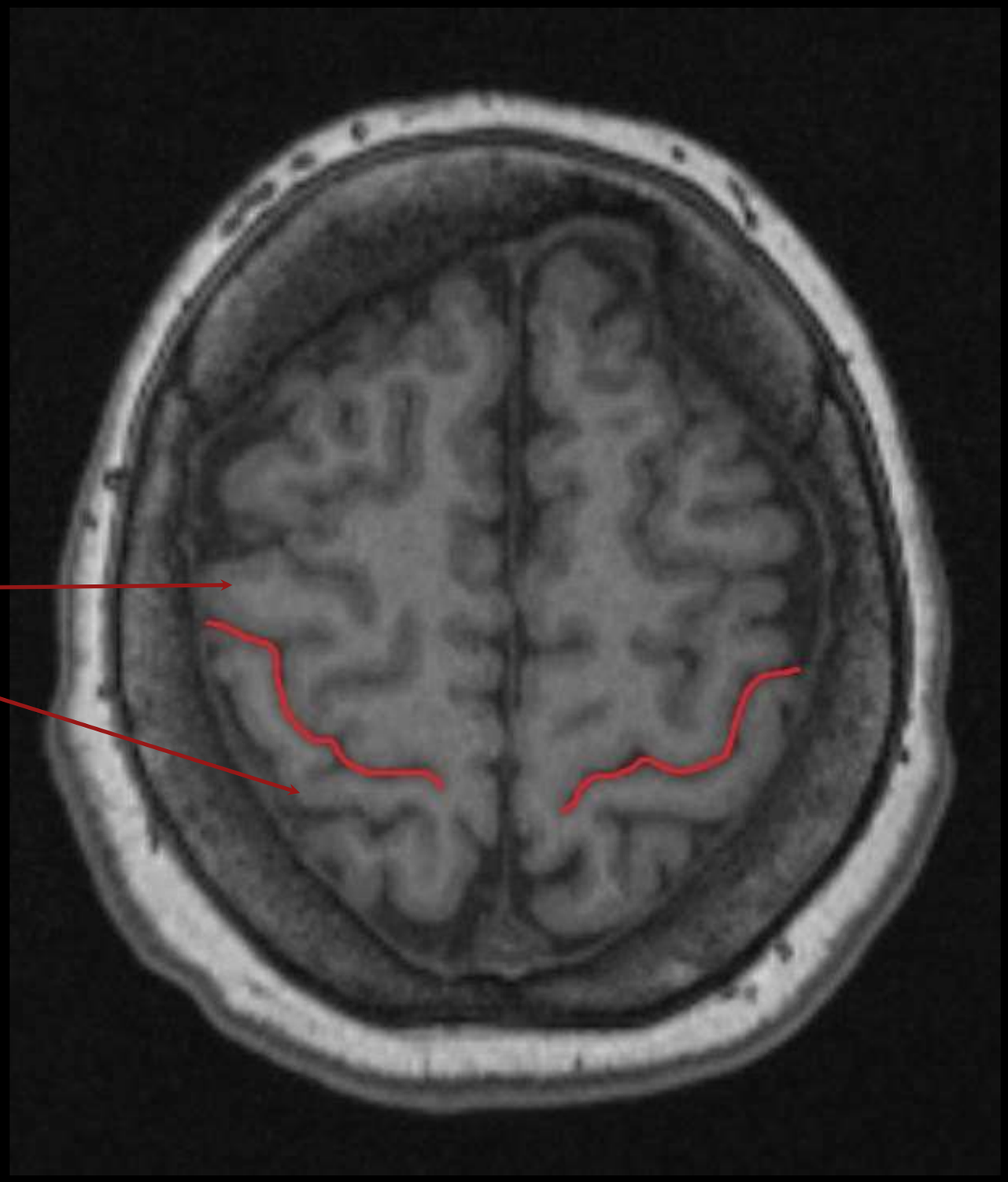
- Central Sulcus - separates frontal and parietal lobe.
- Parieto-occipital sulcus - separates parietal and occipital lobes.
- Lateral Sulcus (Sylvian fissure) - separates the frontal and parietal lobes from the temporal lobe.

CENTRAL SULCUS



Axial

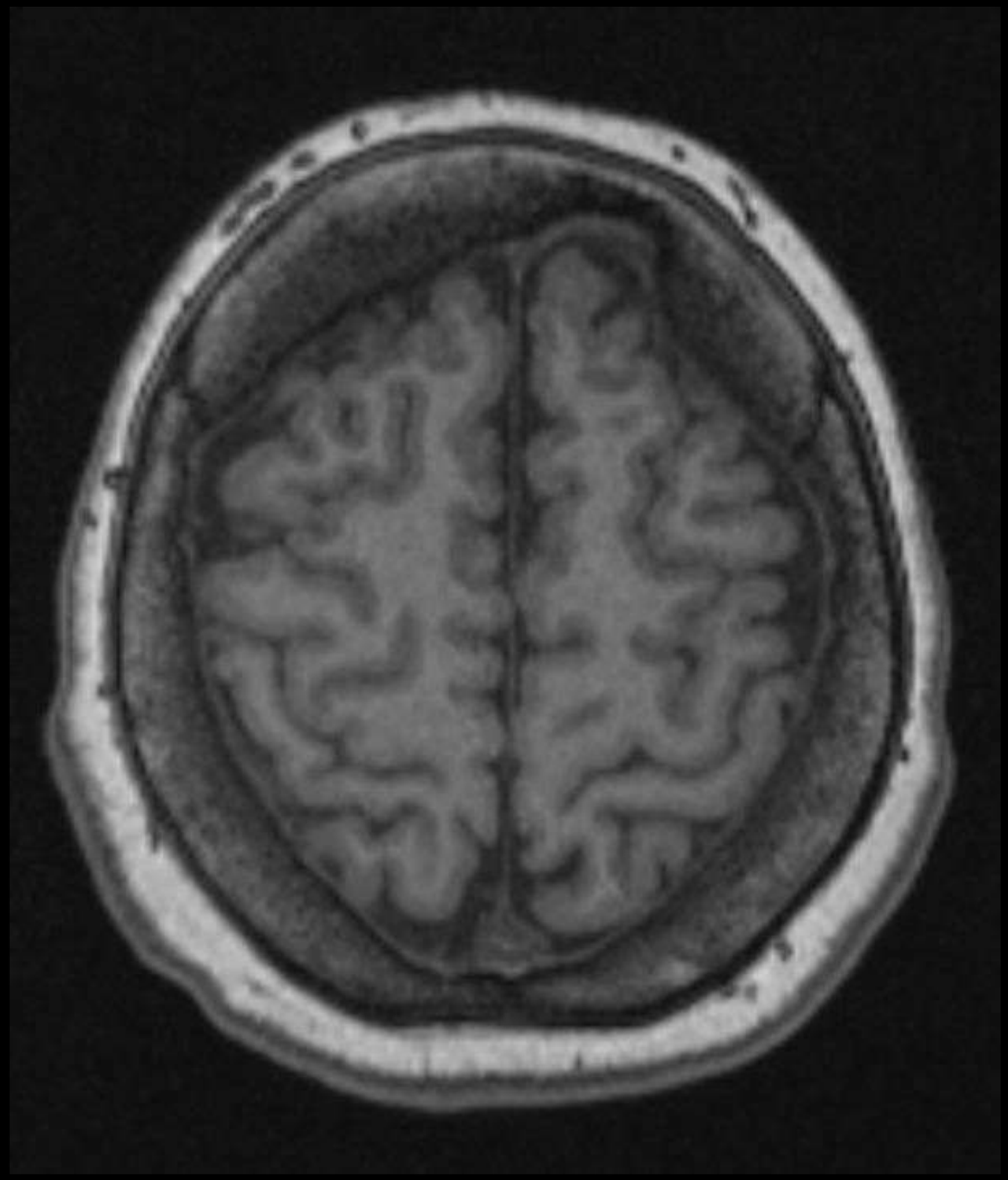
CENTRAL SULCUS



Separates the frontal and parietal lobes

Axial

PRECENTRAL GYRUS

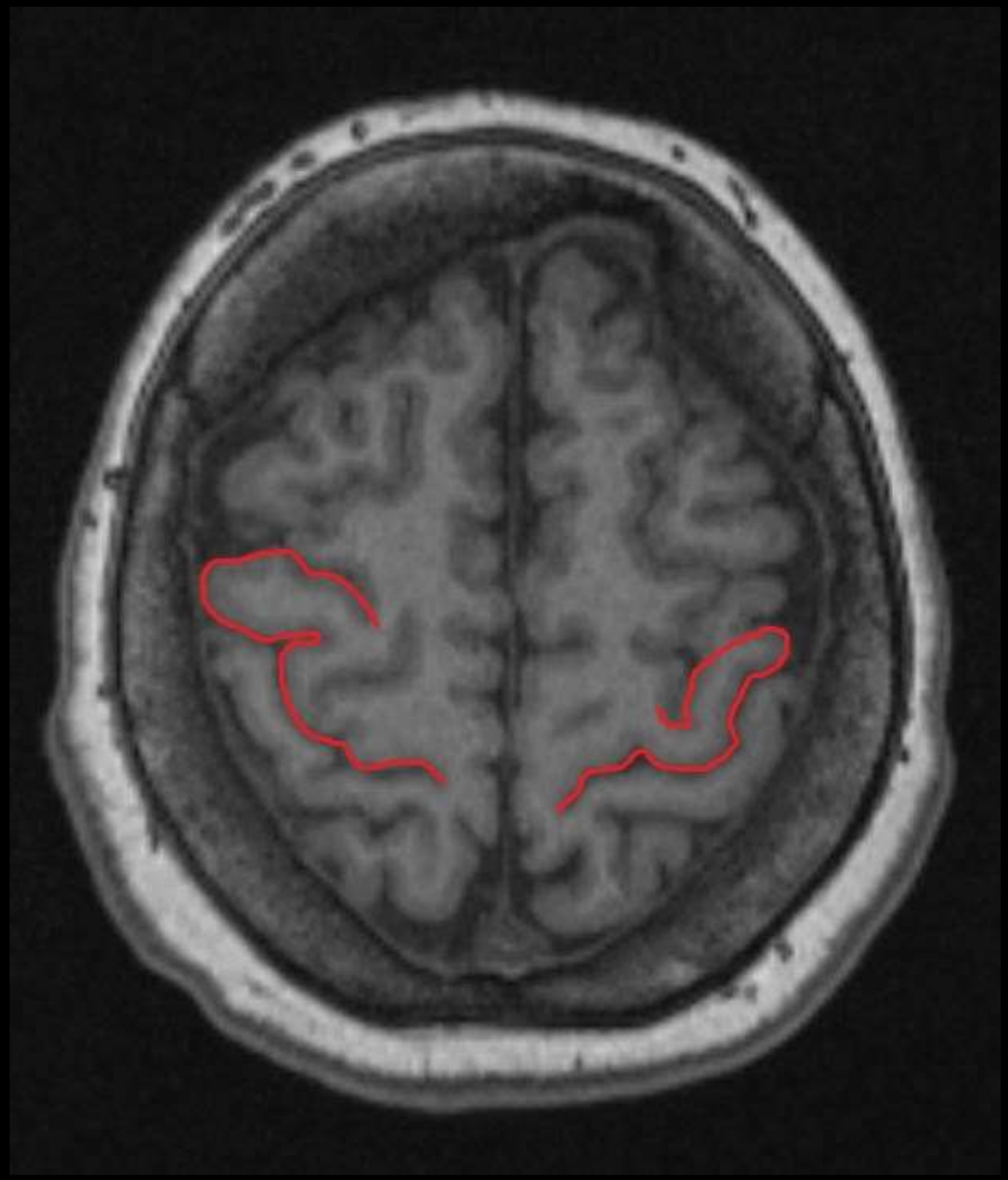


Axial

PRECENTRAL GYRUS

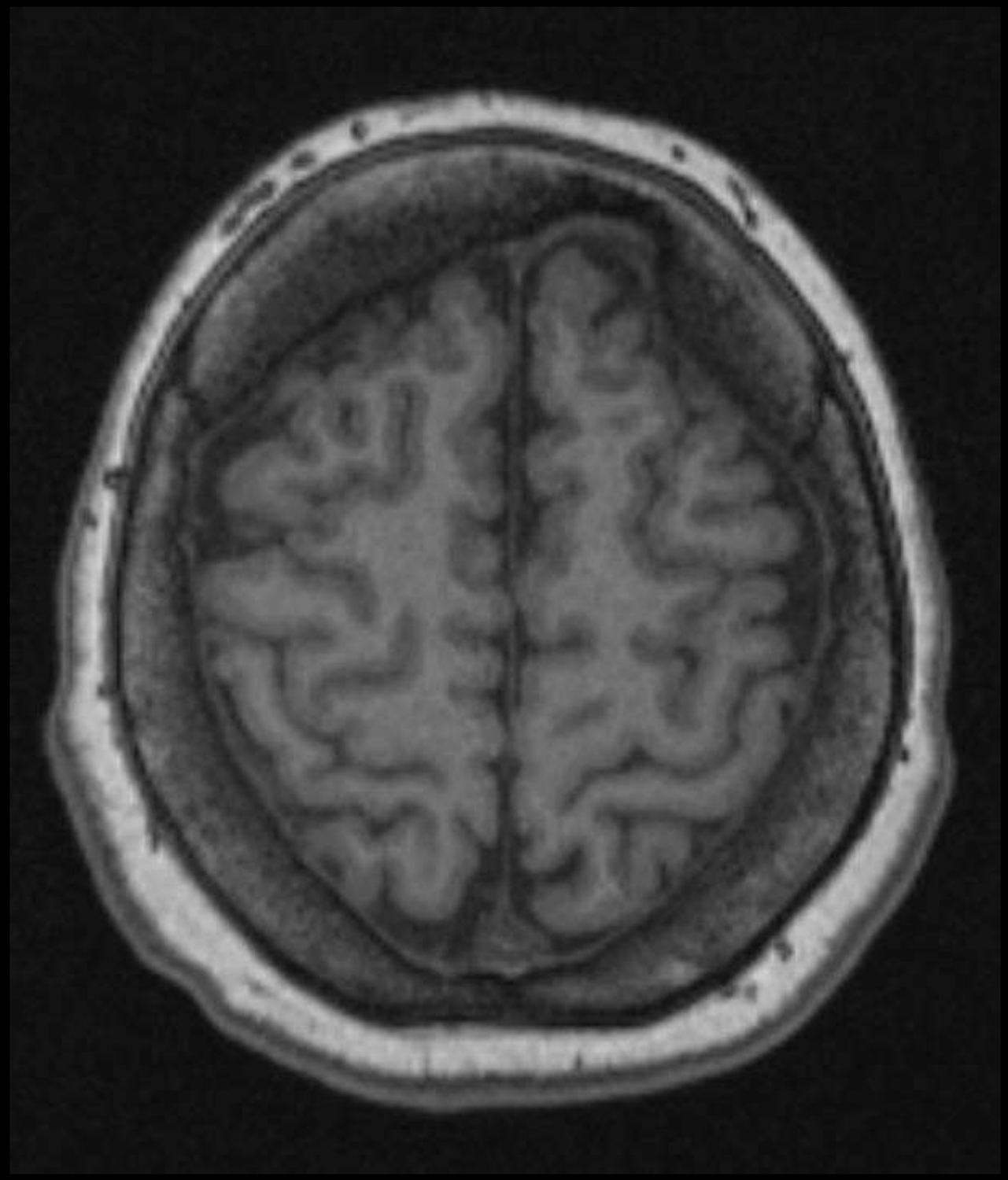
The part of the posterior frontal lobe that lies immediately anterior to the central sulcus.

This is the where the primary motor cortex resides.



Axial

POSTCENTRAL GYRUS

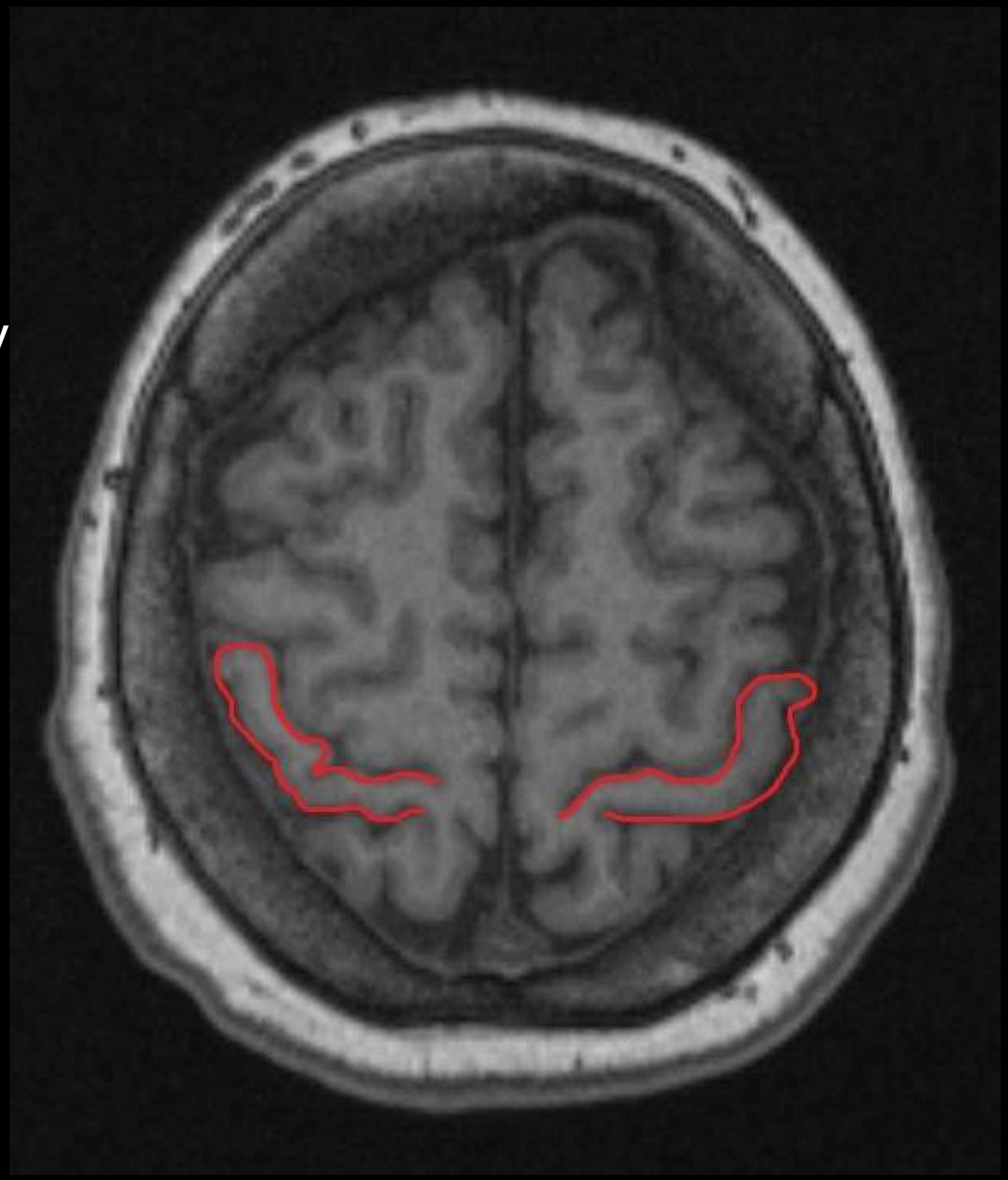


Axial

POSTCENTRAL GYRUS

The part of the anterior parietal lobe, immediately posterior to the central sulcus.

This is where the primary somatosensory cortex resides.

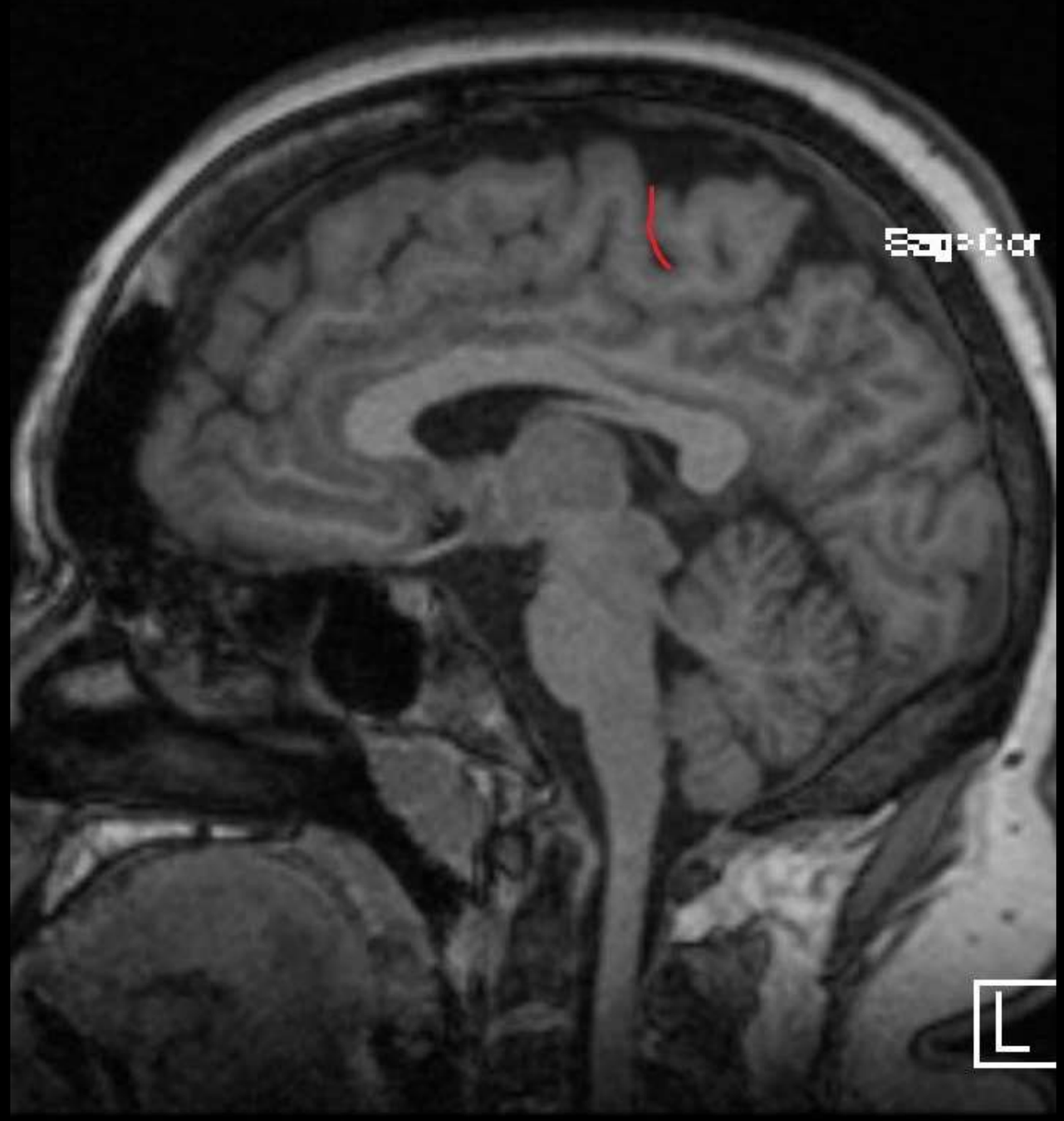


Axial

CENTRAL SULCUS

Sagittal

CENTRAL SULCUS

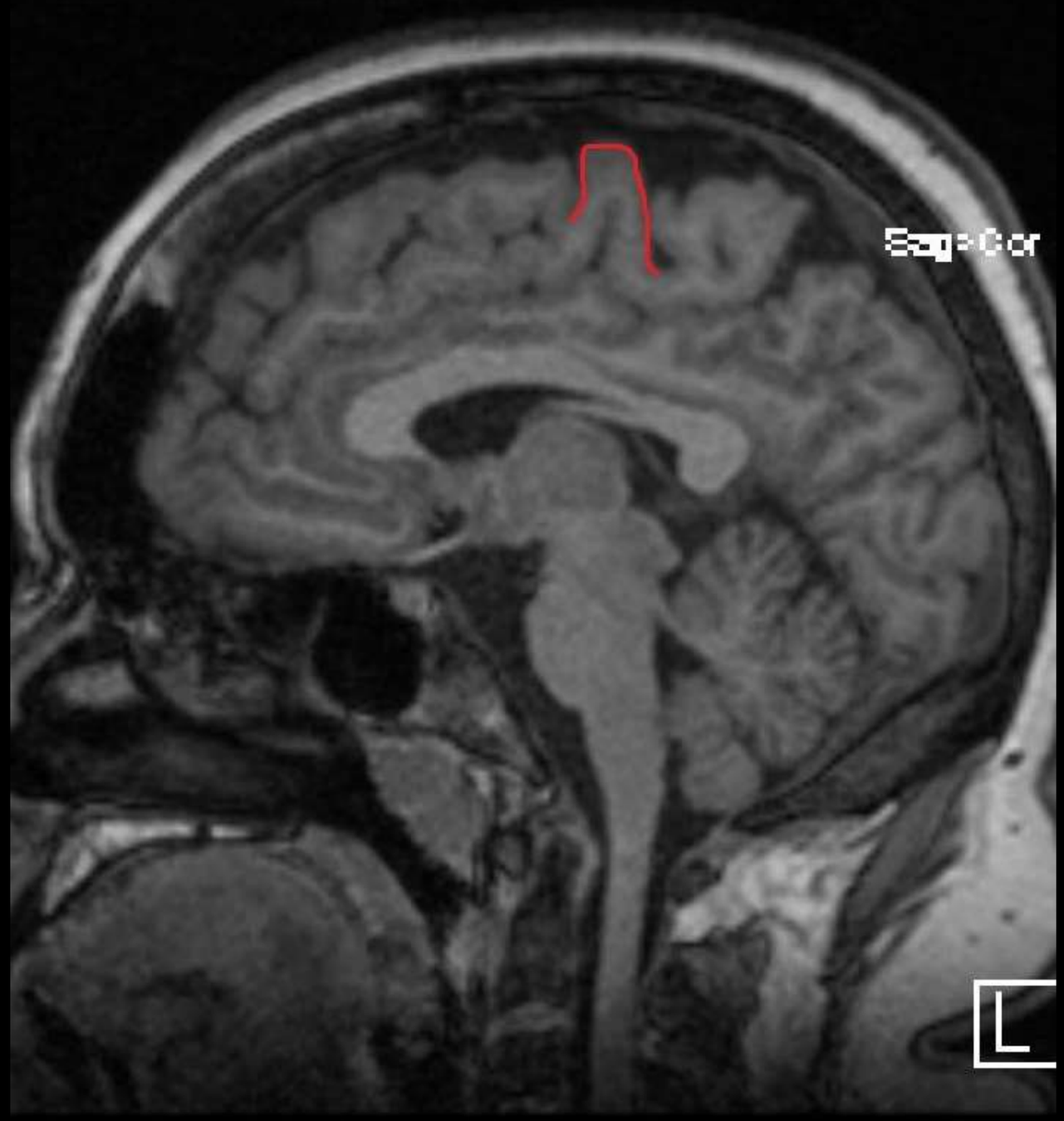


Sagittal

PRECENTRAL GYRUS

Sagittal

PRECENTRAL GYRUS

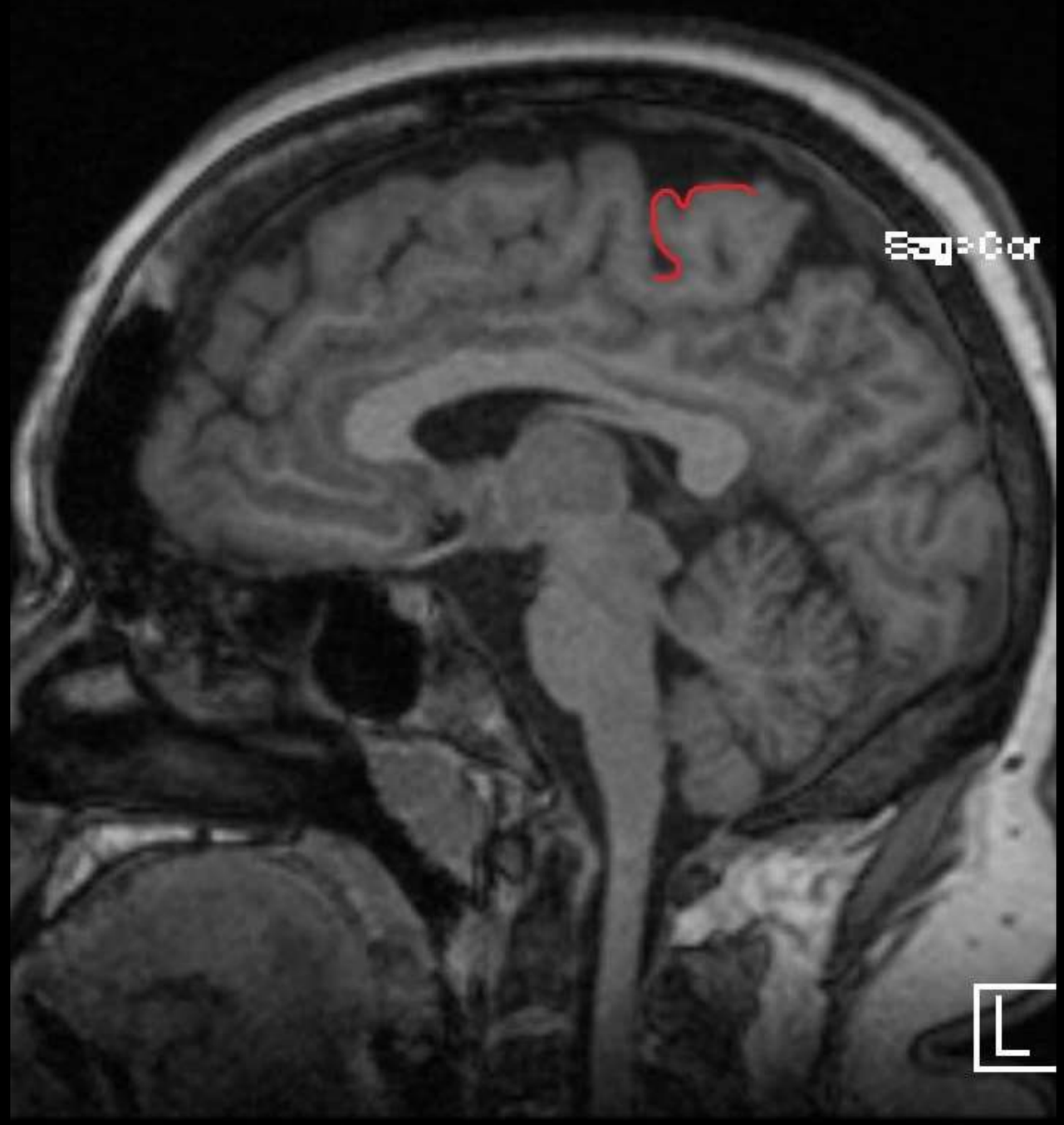


Sagittal

POSTCENTRAL GYRUS

Sagittal

POSTCENTRAL GYRUS

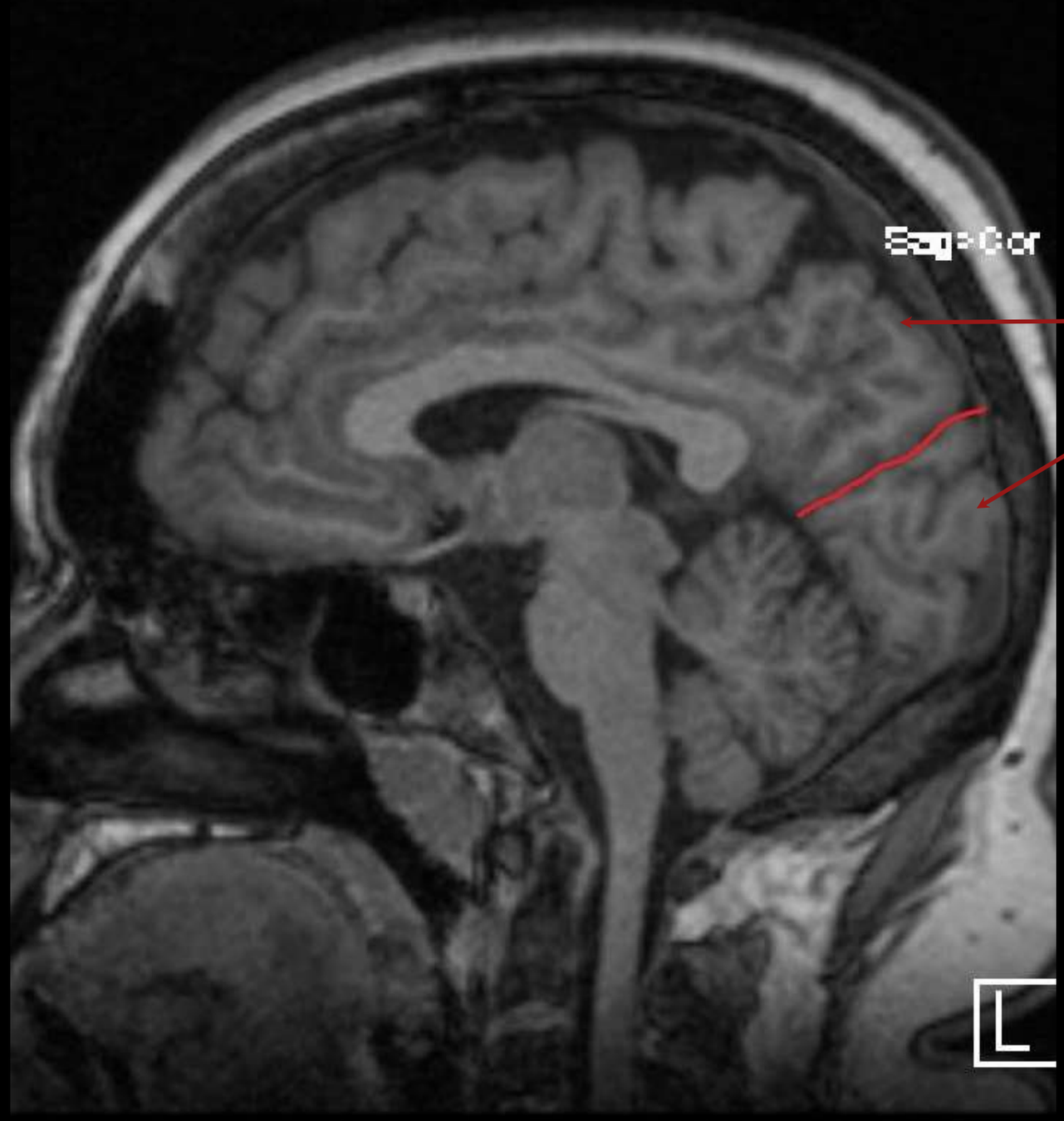


Sagittal

PARIETO-OCCIPITAL SULCUS

Sagittal

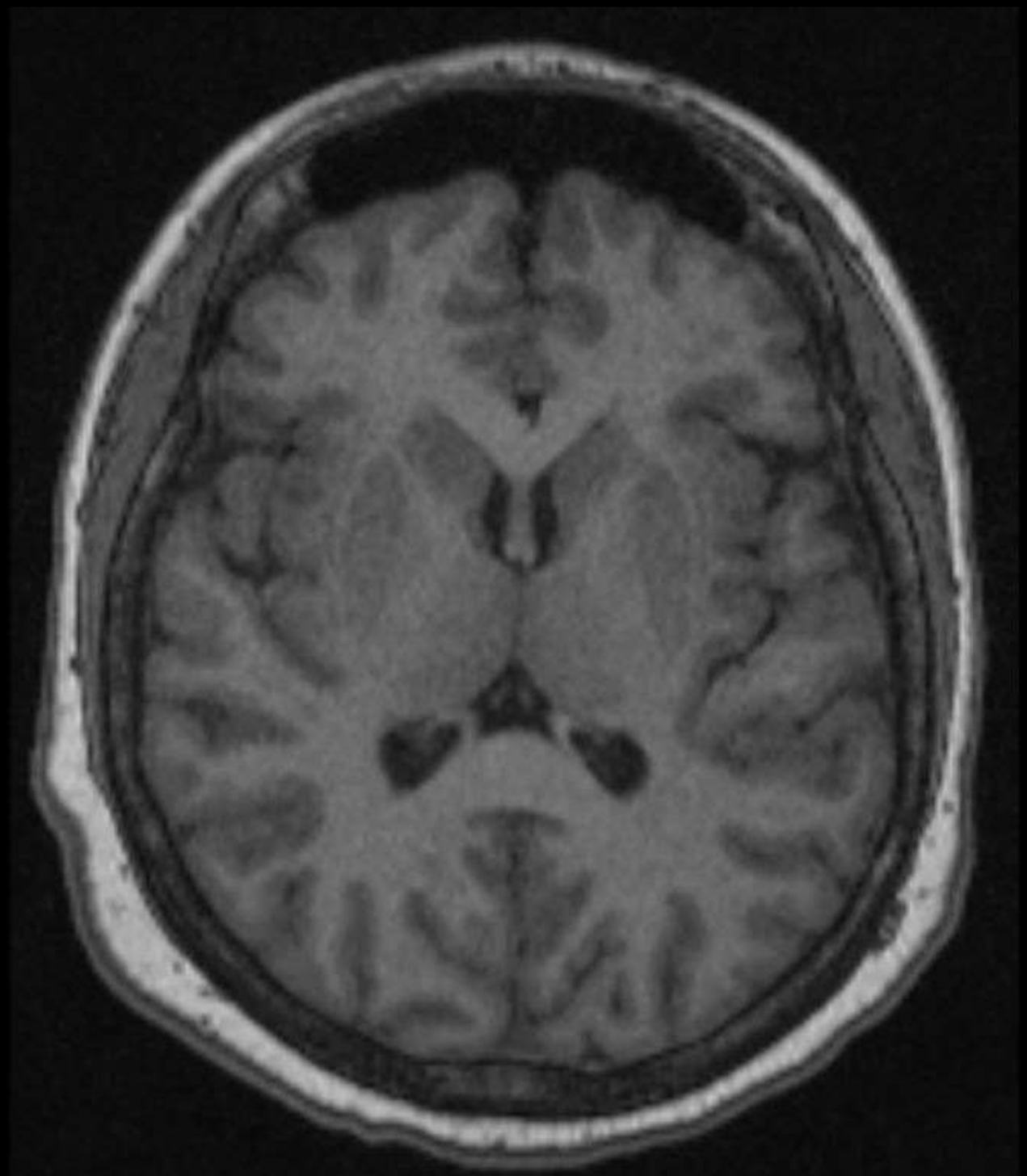
PARIETO-OCCIPITAL SULCUS



Separates the parietal and occipital lobes

Sagittal

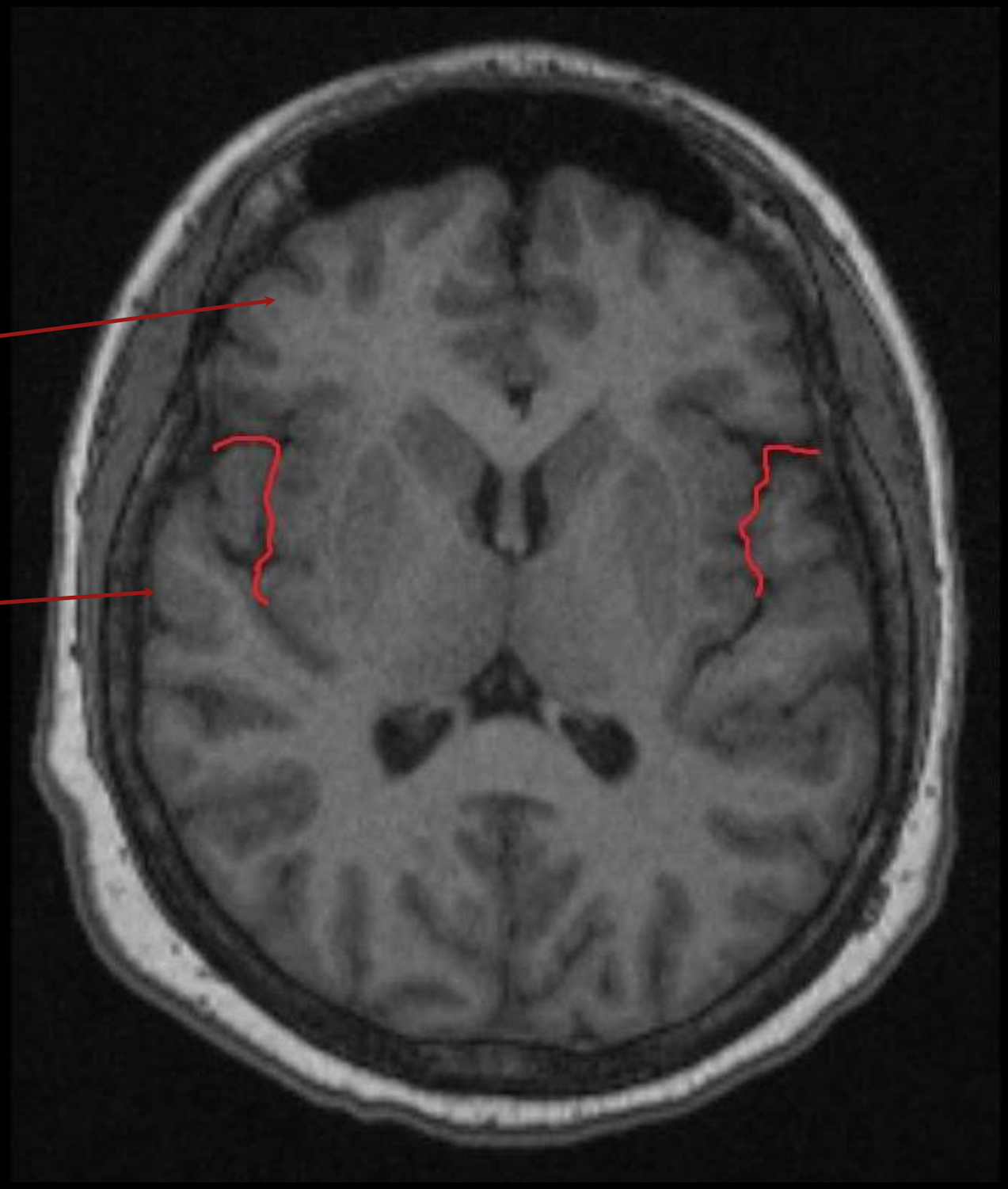
SYLVIAN FISSURE



Axial

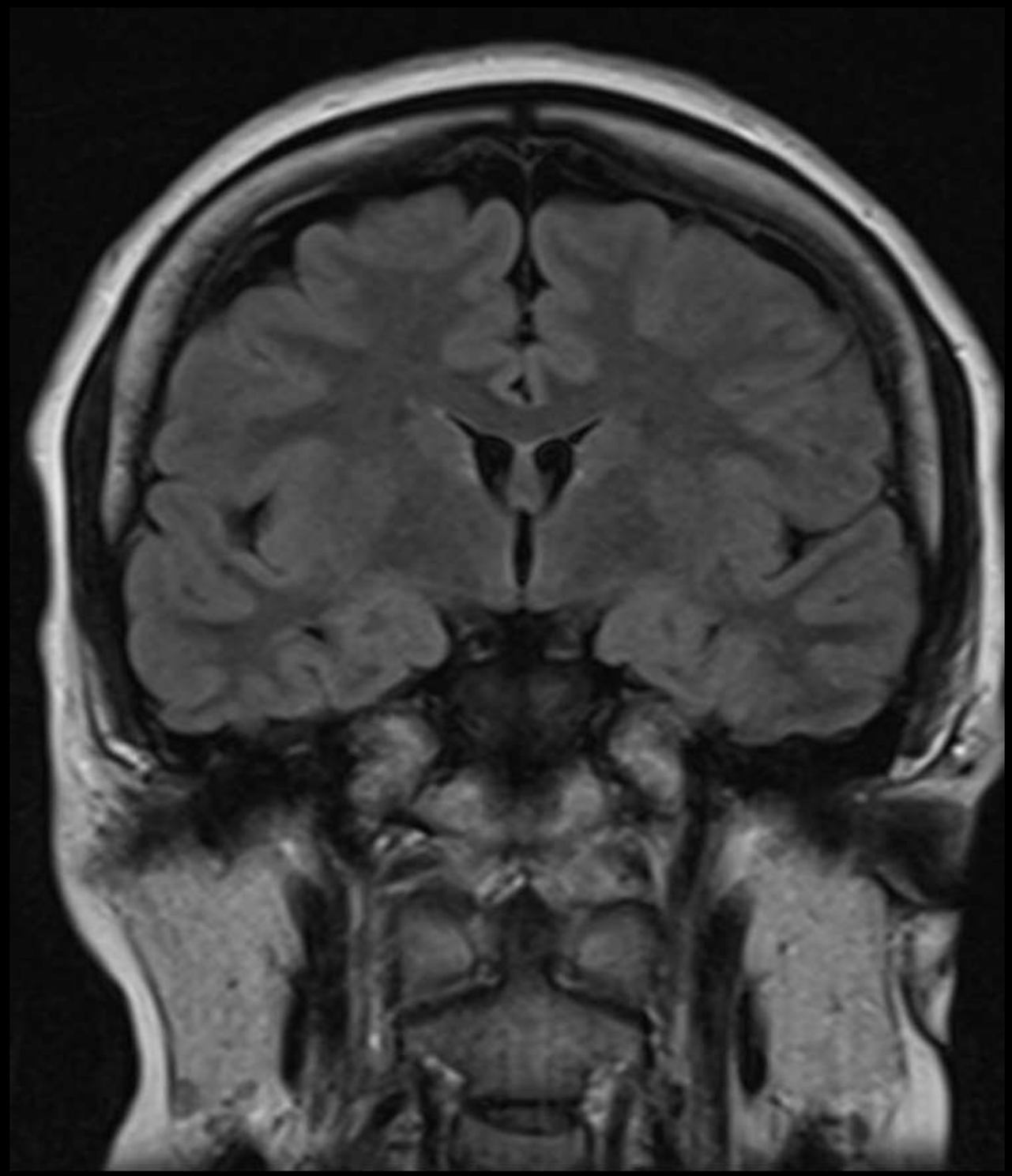
SYLVIAN FISSURE

Separates the frontal and parietal lobes from the temporal lobe



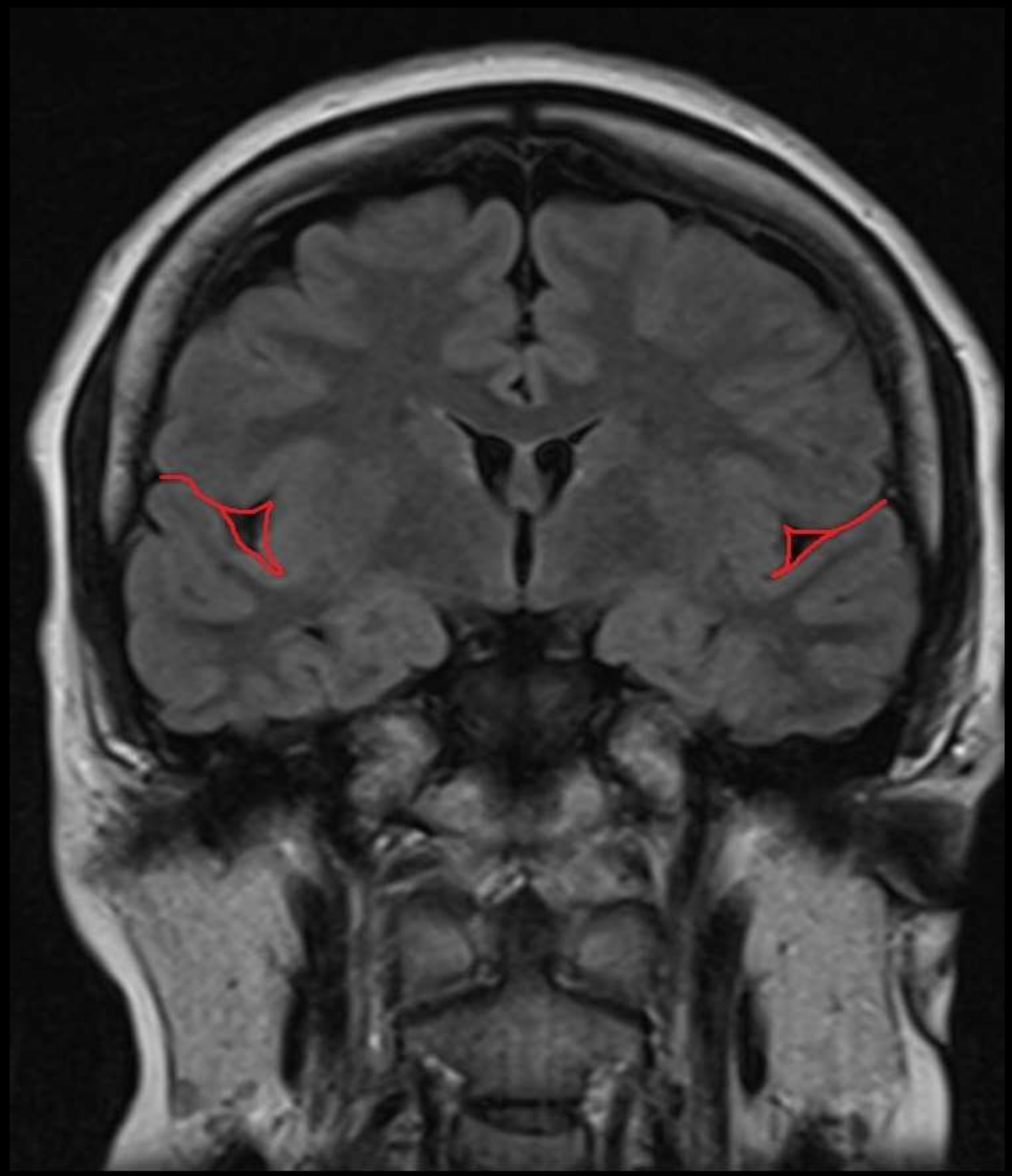
Axial

SYLVIAN FISSURE



Coronal

SYLVIAN FISSURE

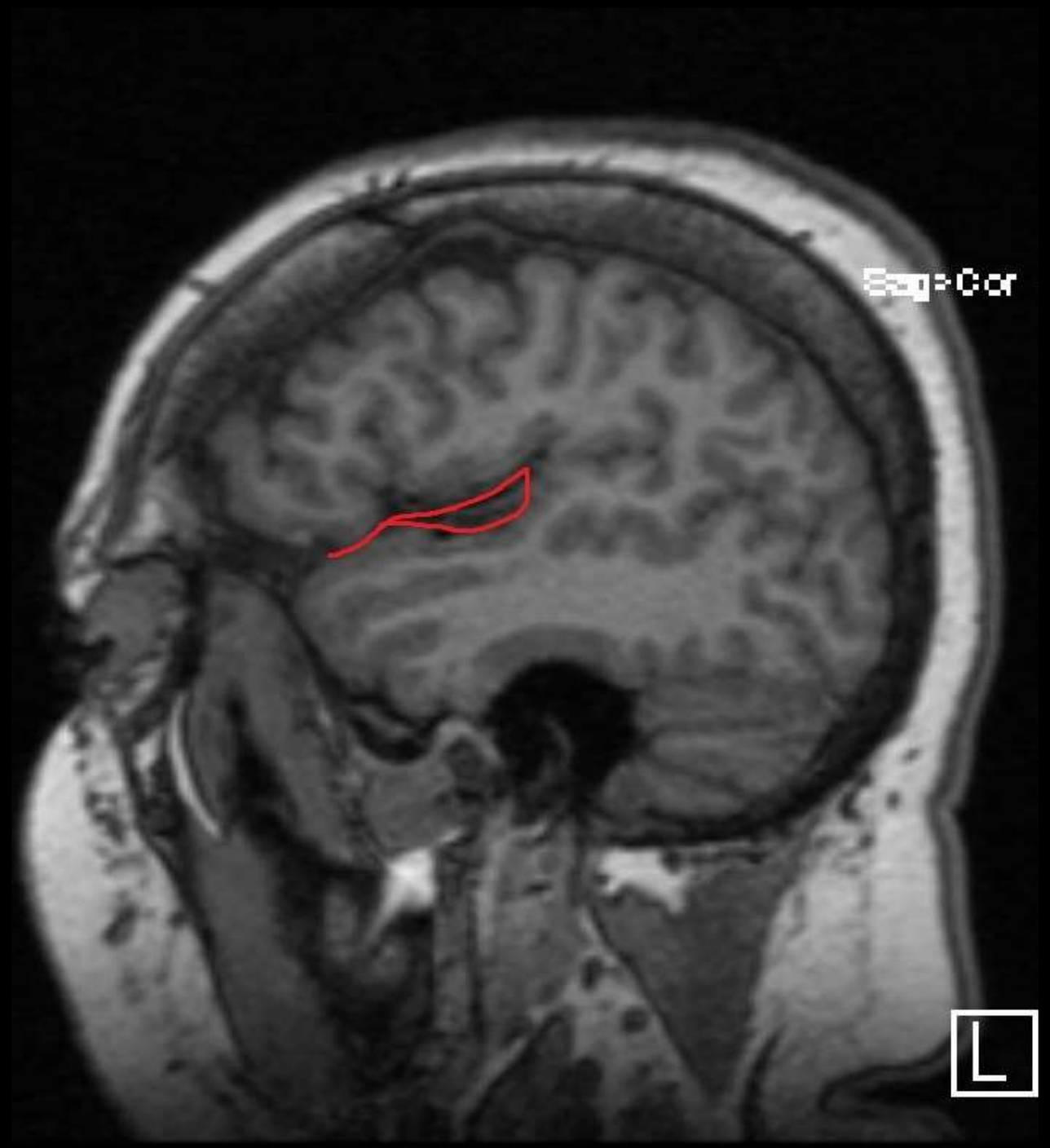


Coronal

SYLVIAN FISSURE

Sagittal

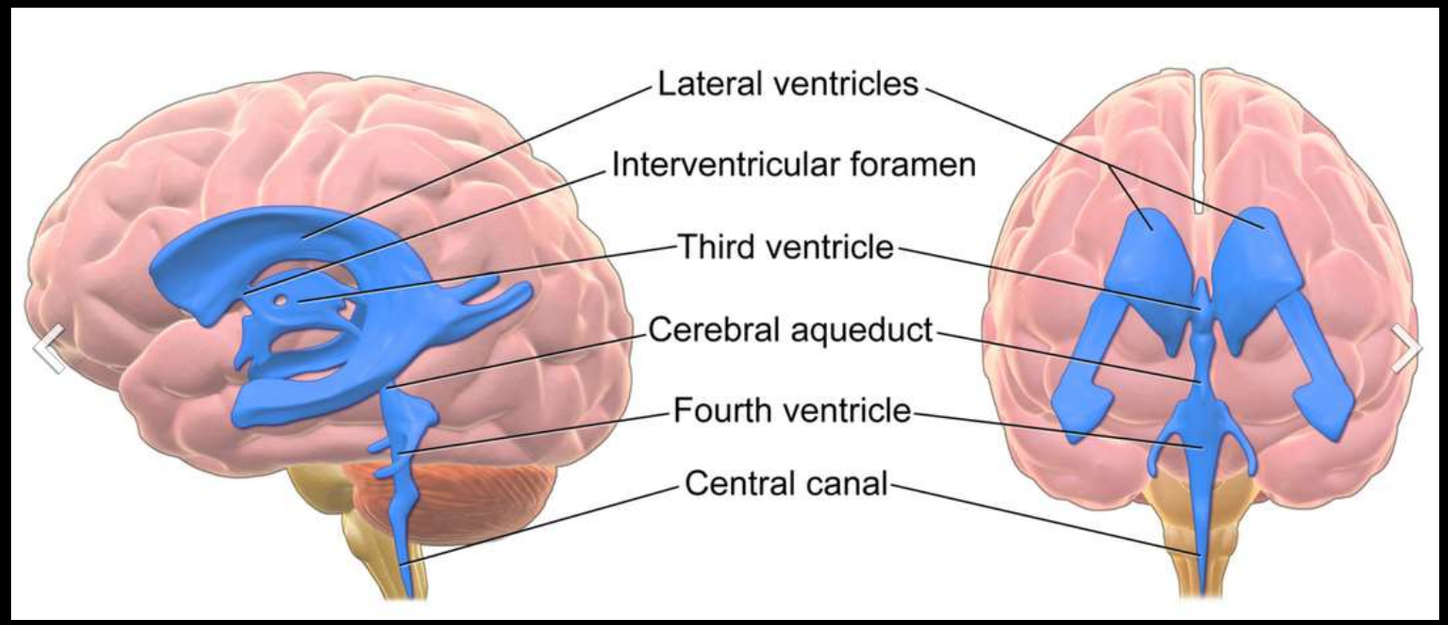
SYLVIAN FISSURE



Sagittal

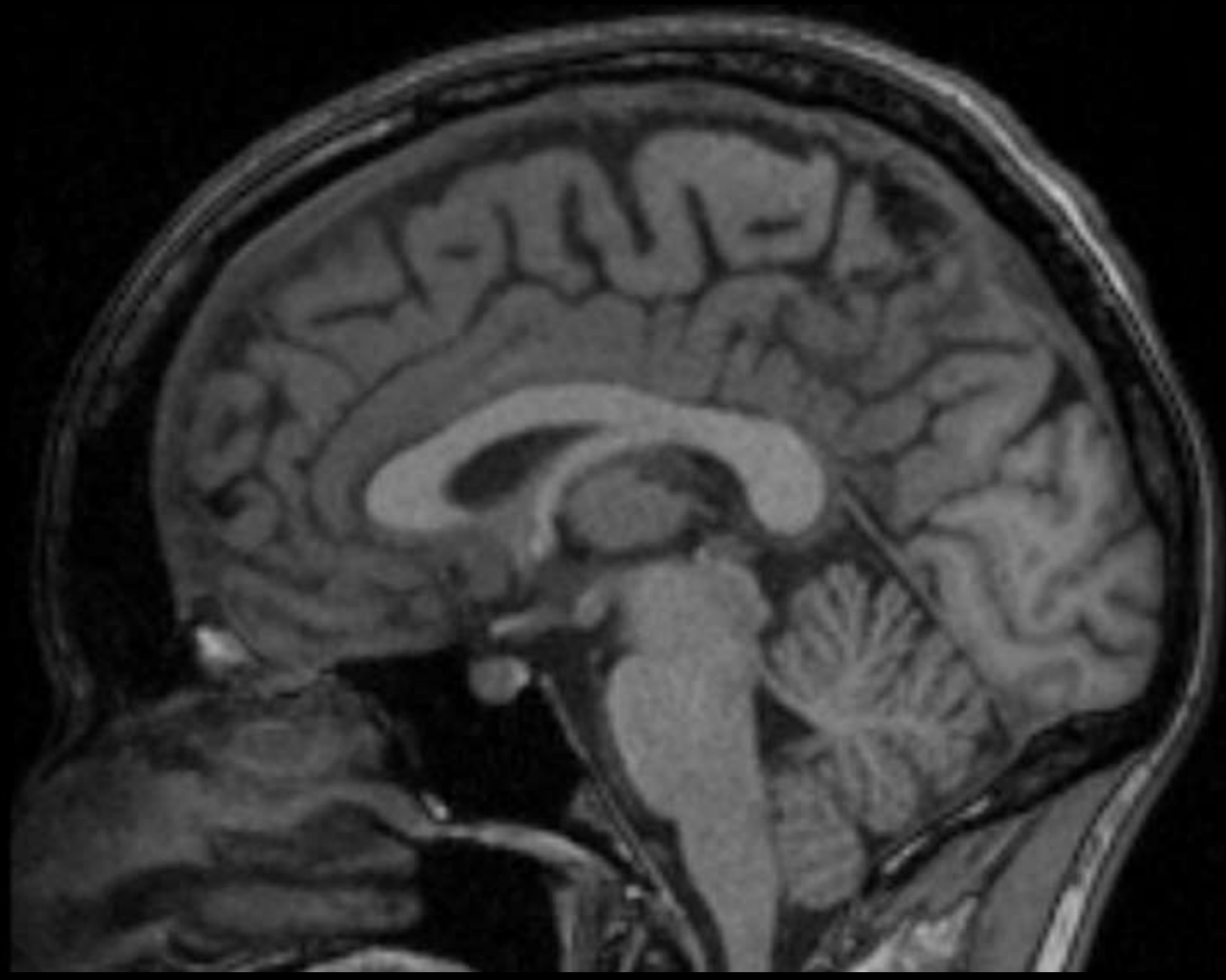
VENTRICULAR SYSTEM

- Ventricular System
  - Right and left lateral ventricles
  - Paired interventricular foramen
  - Third ventricle
  - Cerebral aquaduct
  - Fourth ventricle
  - Central canal



http://commons.wikimedia.org/wiki/File:Blausen_0896_Ventricles_Brain.png

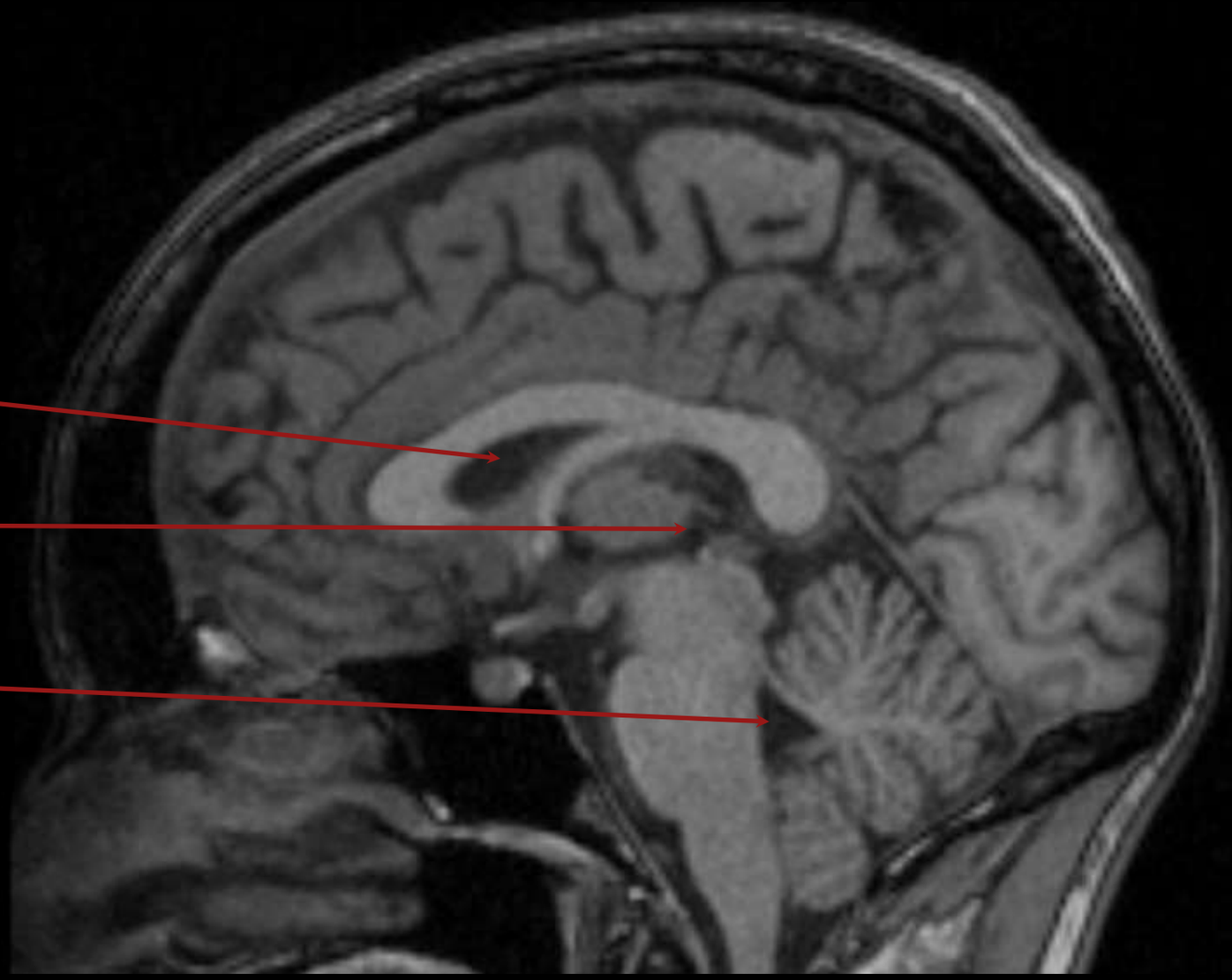
VENTRICULAR SYSTEM



Sagittal

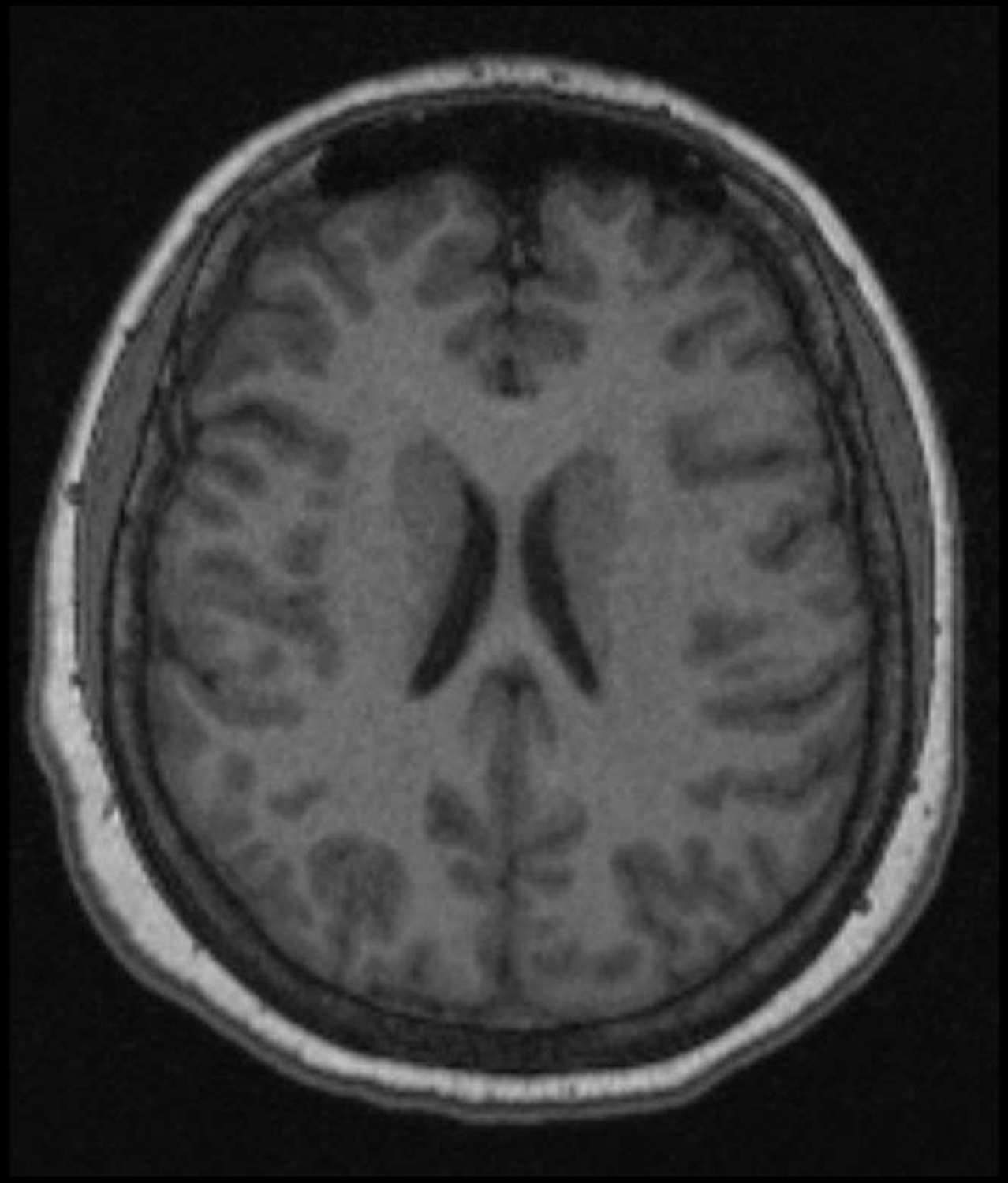
VENTRICULAR SYSTEM

- Lateral ventricle
- Third ventricle
- Fourth Ventricle



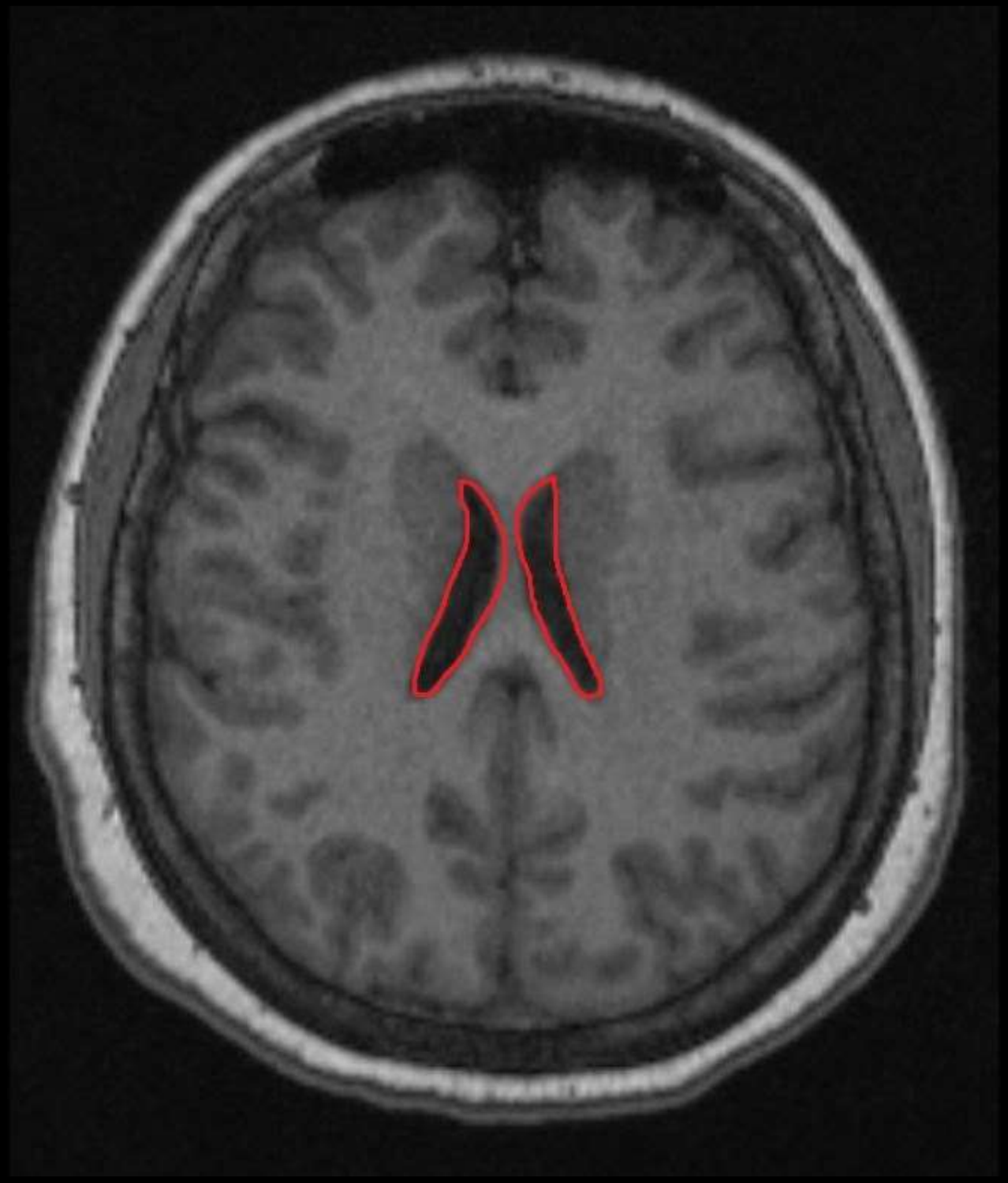
Sagittal

LATERAL VENTRICLES



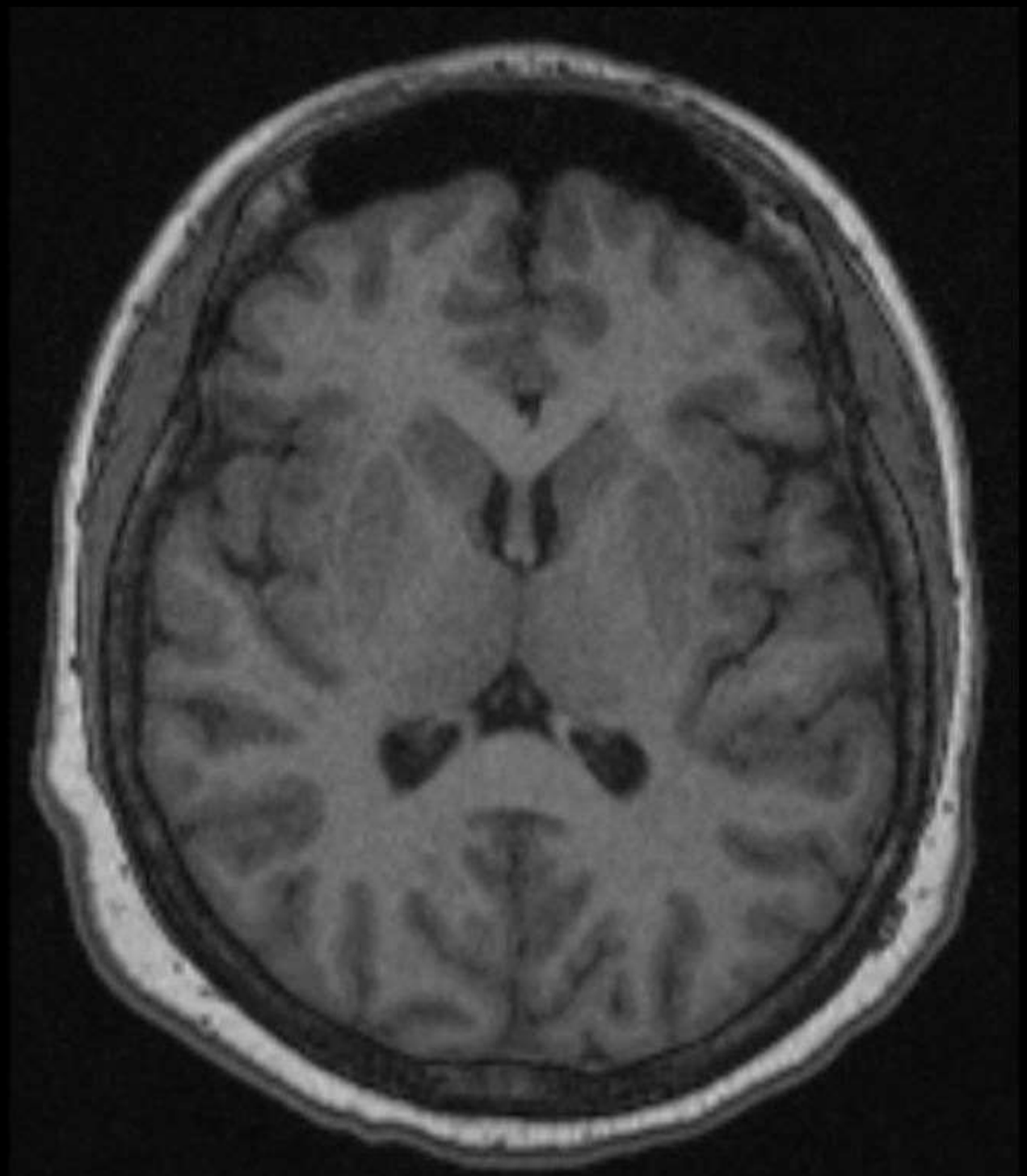
Axial

LATERAL VENTRICLES



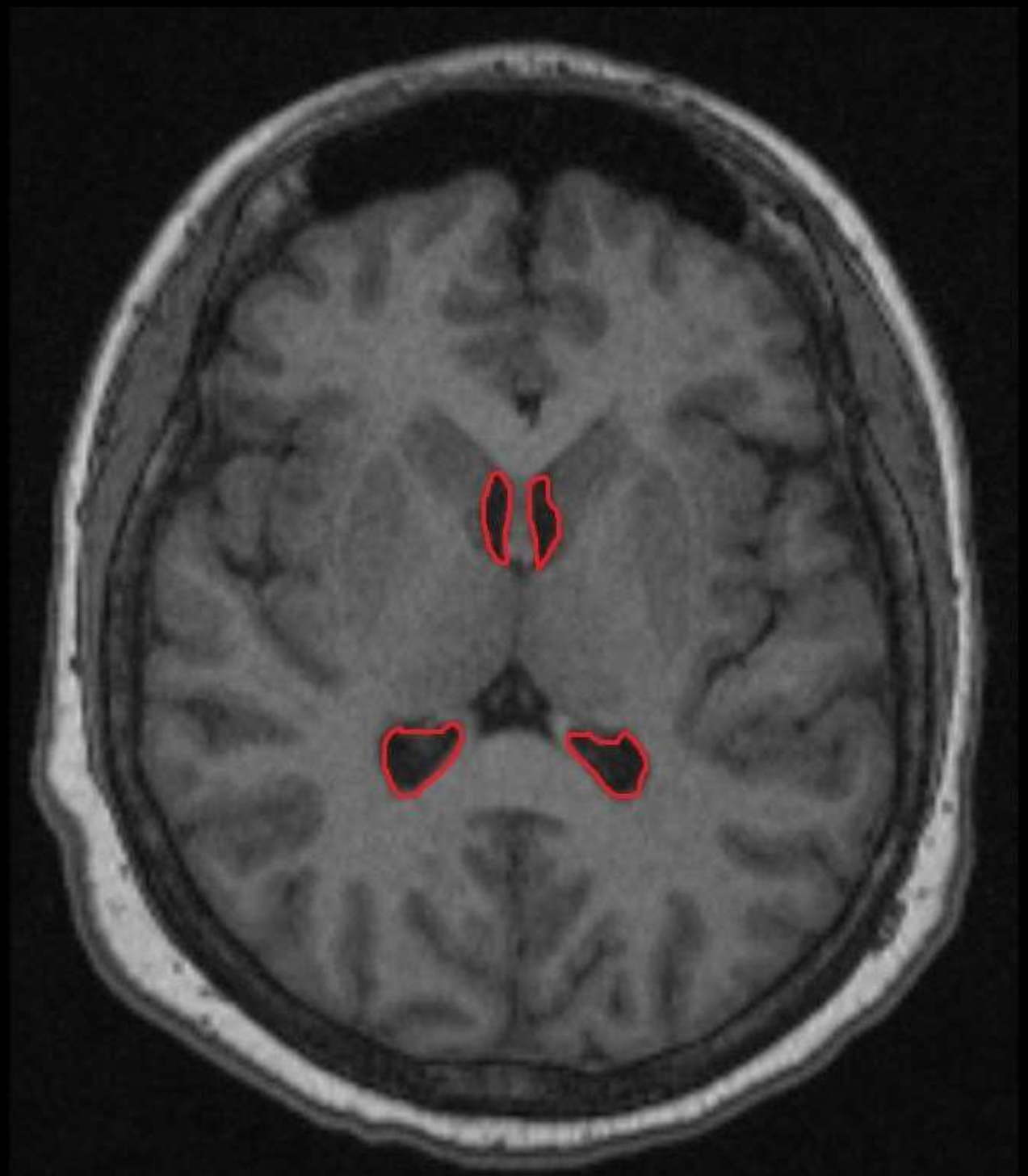
Axial

LATERAL VENTRICLES



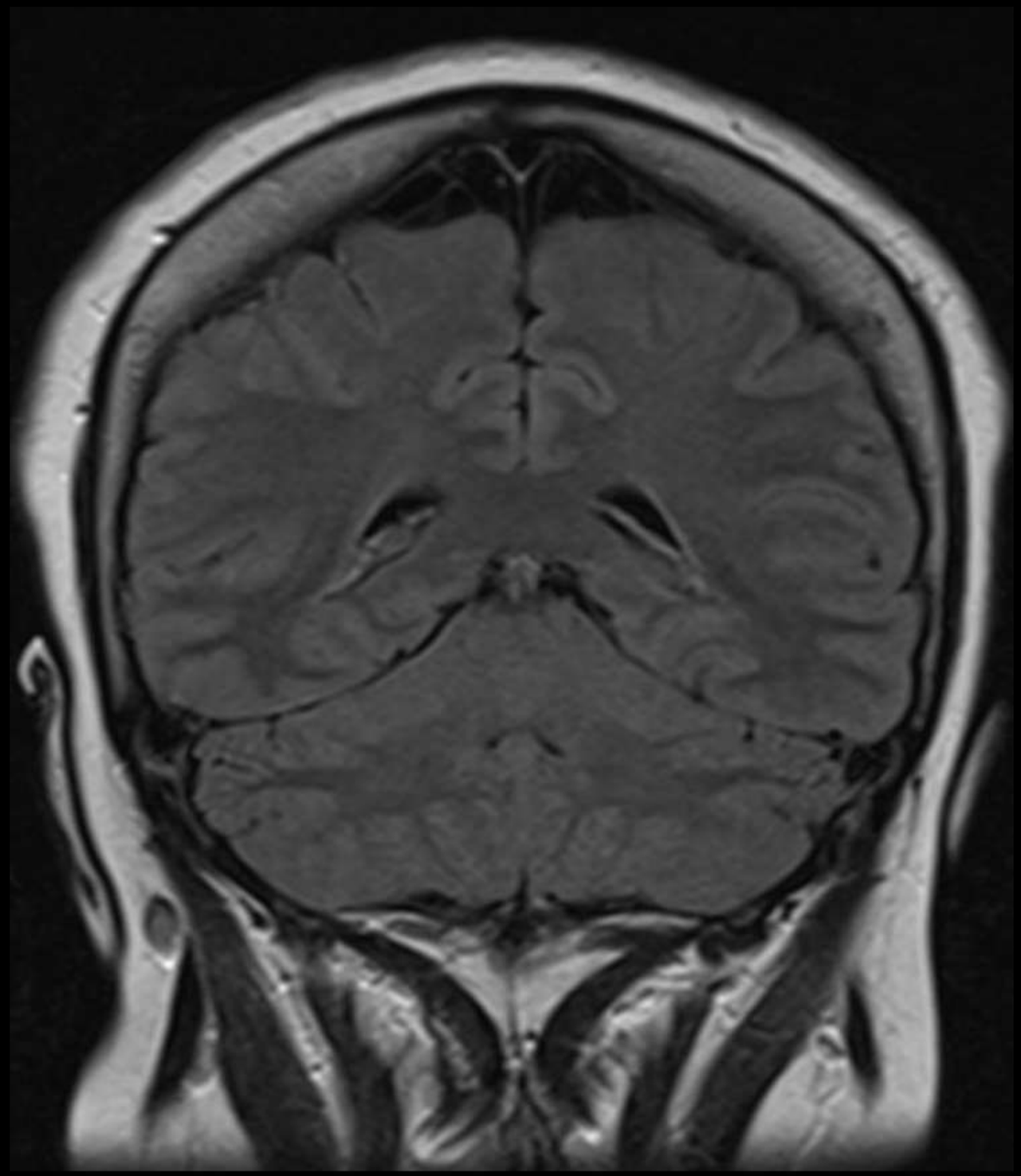
Axial

LATERAL VENTRICLES



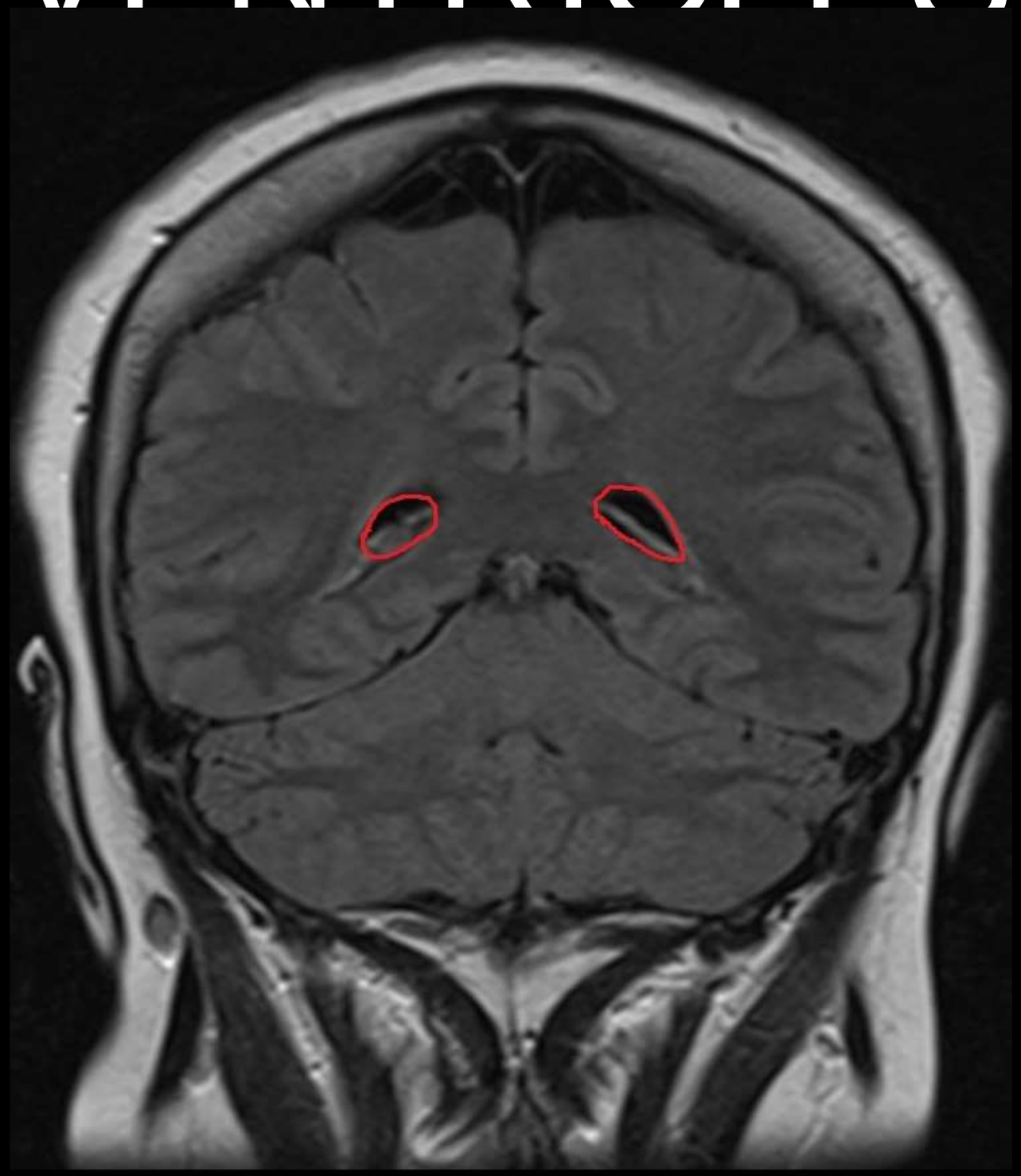
Axial

LATERAL VENTRICLES



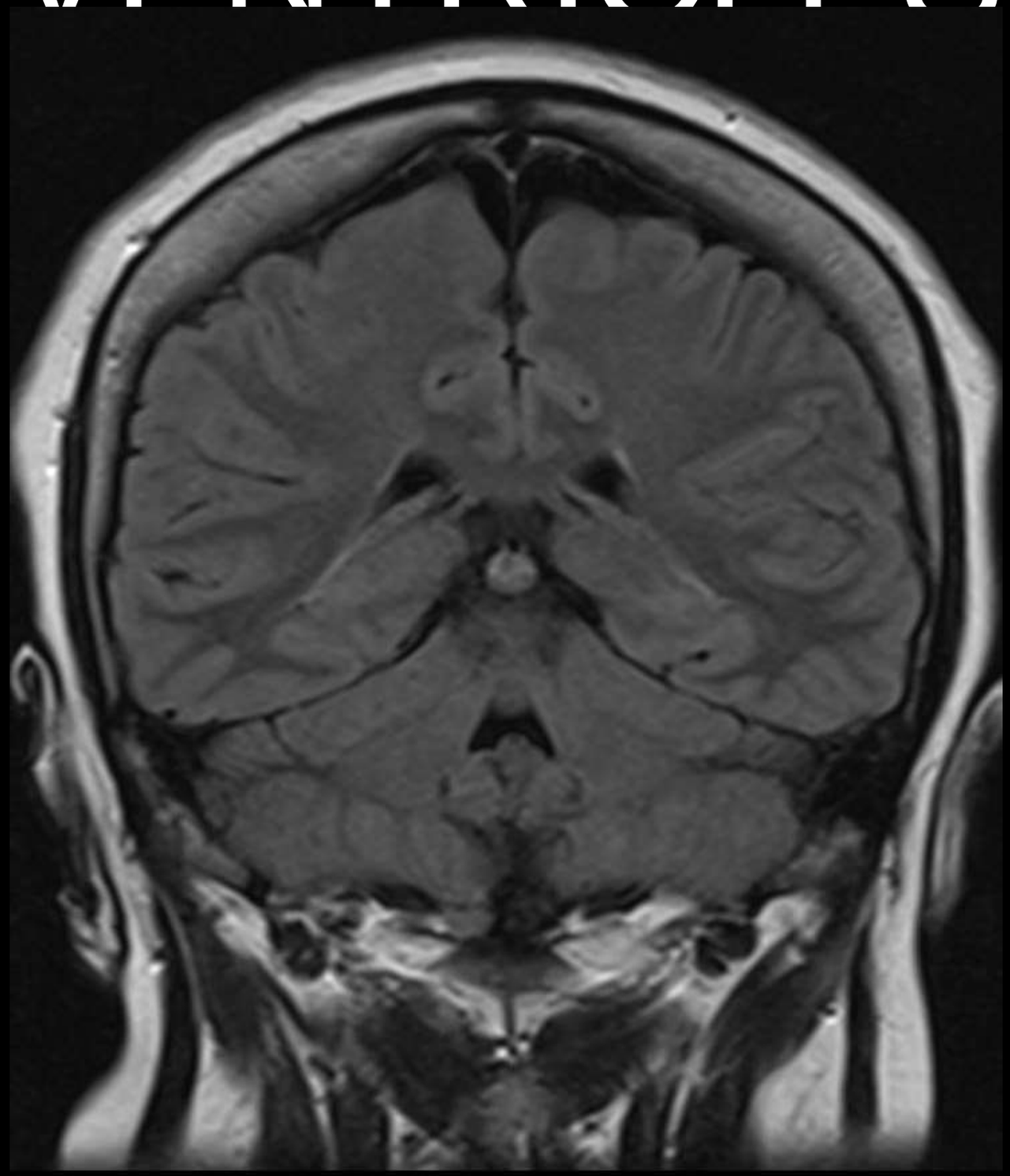
Coronal

LATERAL VENTRICLES



Coronal

LATERAL VENTRICLES

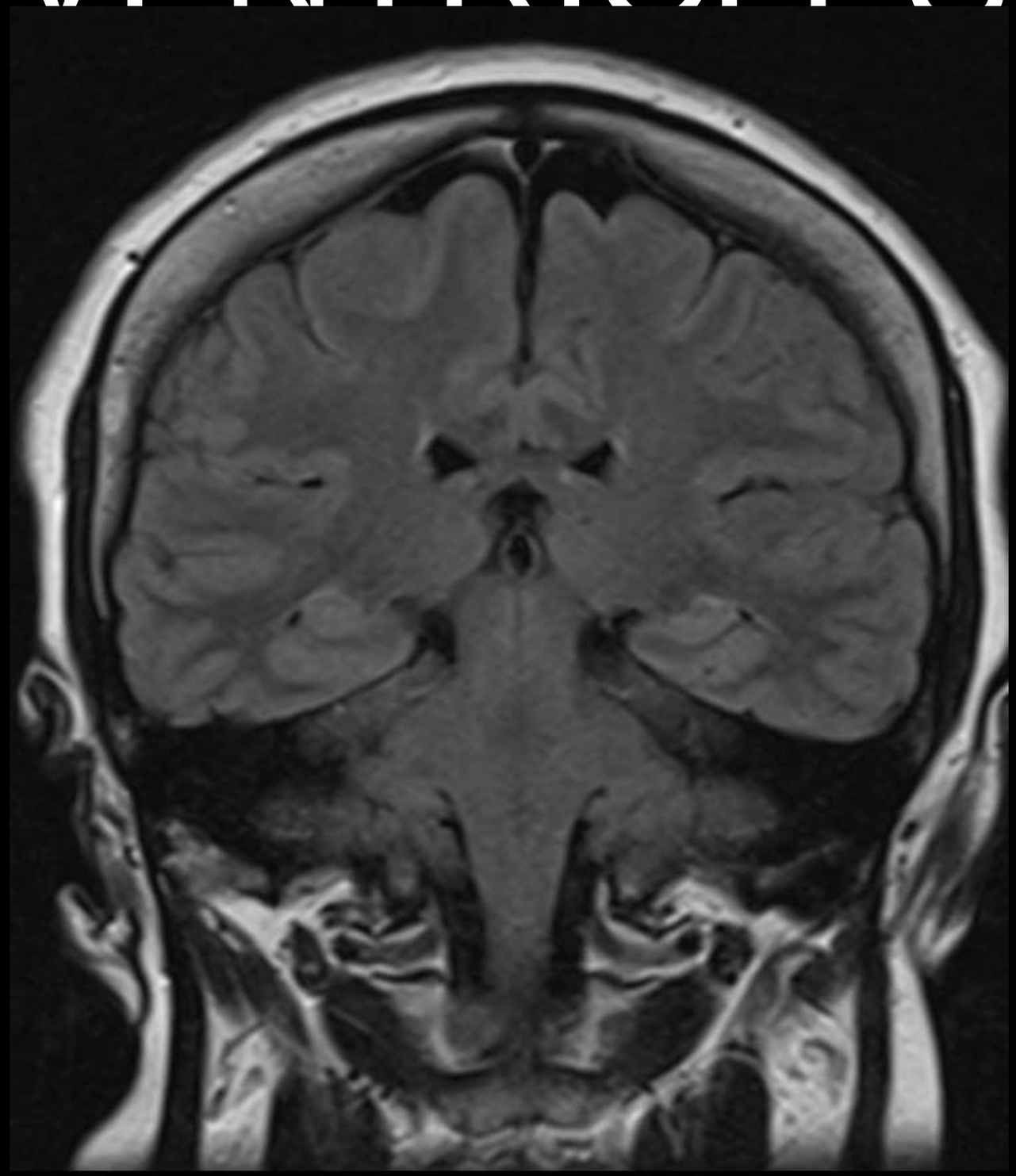


Coronal

LATERAL VENTRICLES

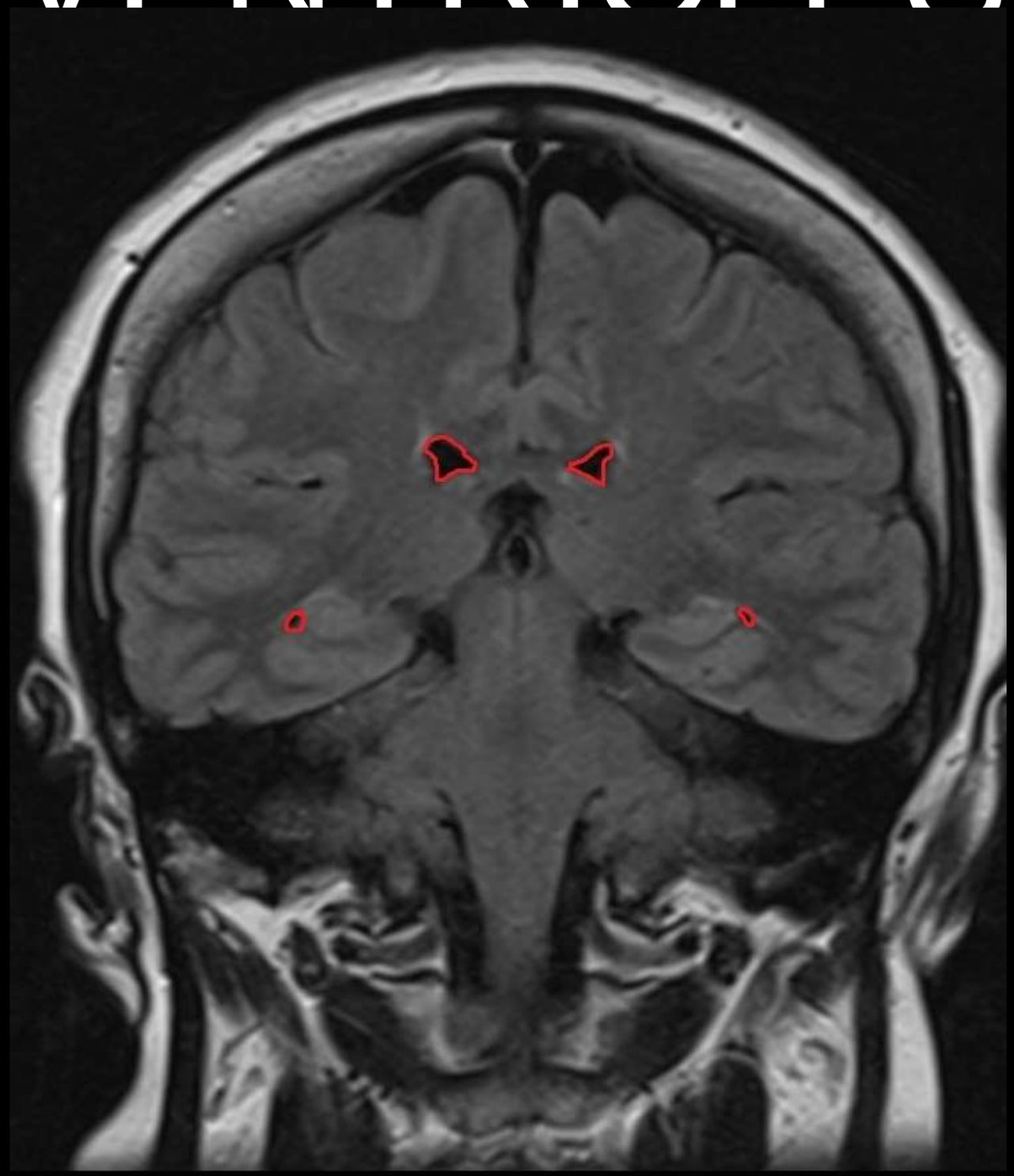
Coronal

LATERAL VENTRICLES



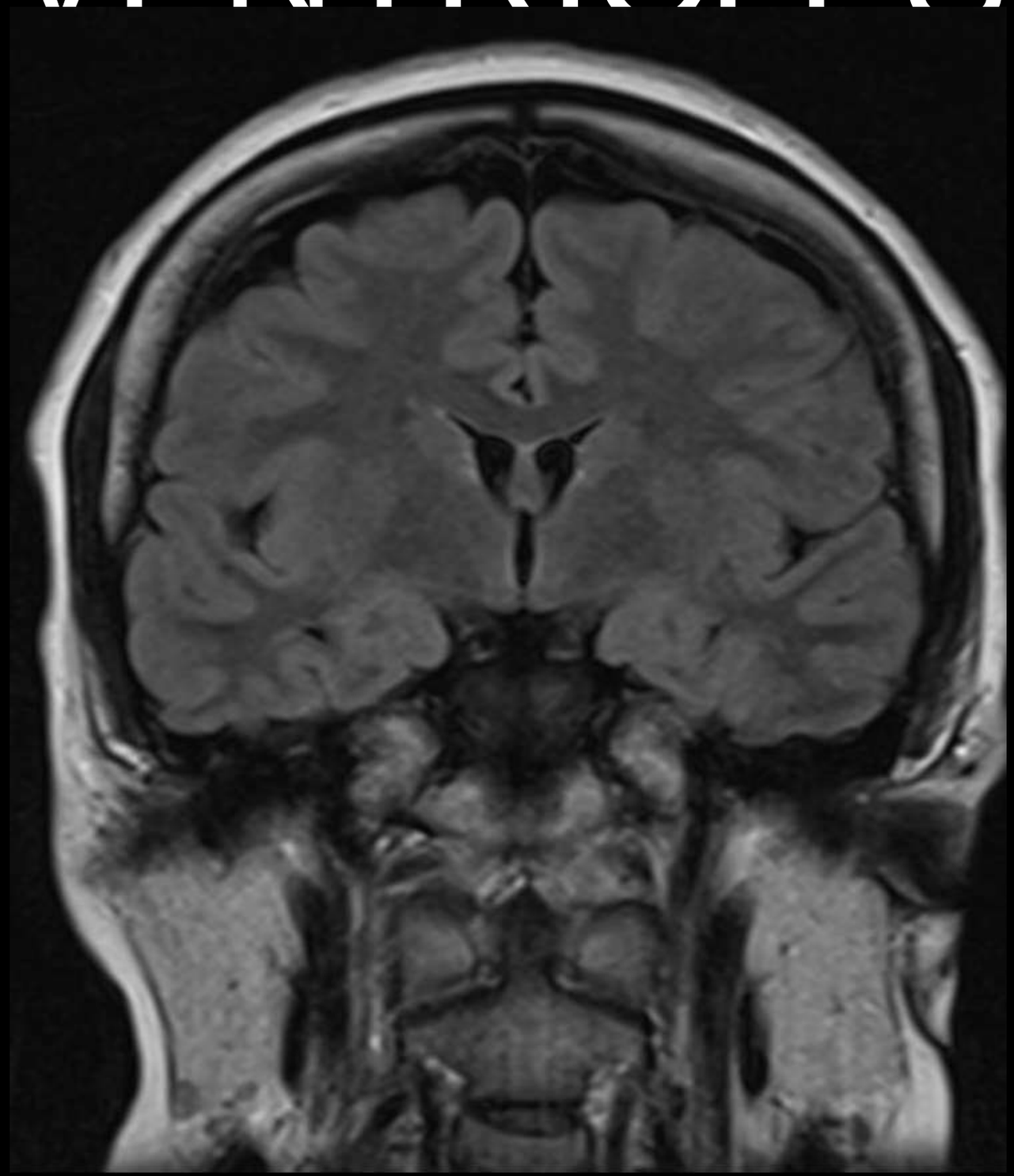
Coronal

LATERAL VENTRICLES



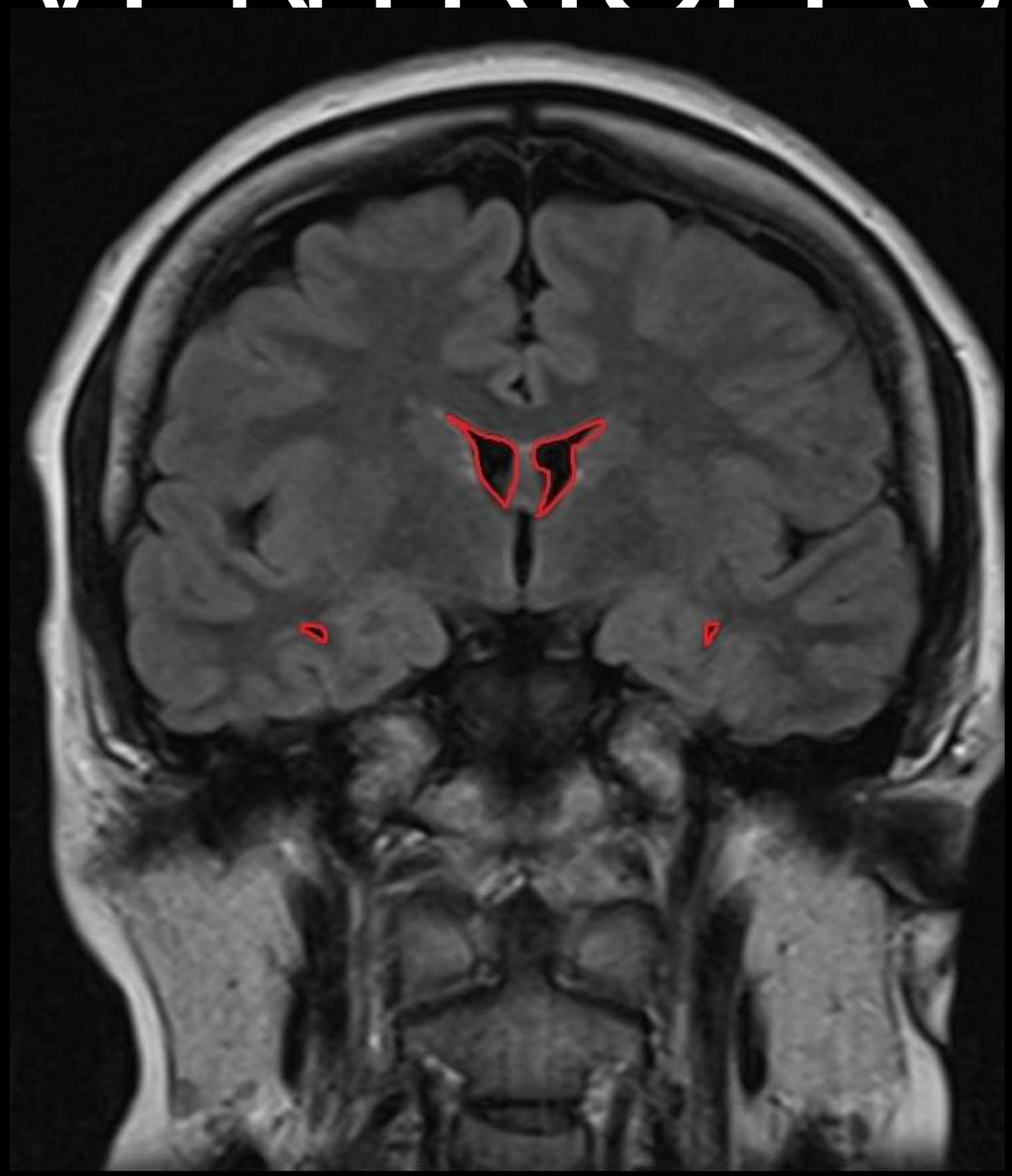
Coronal

LATERAL VENTRICLES



Coronal

LATERAL VENTRICLES

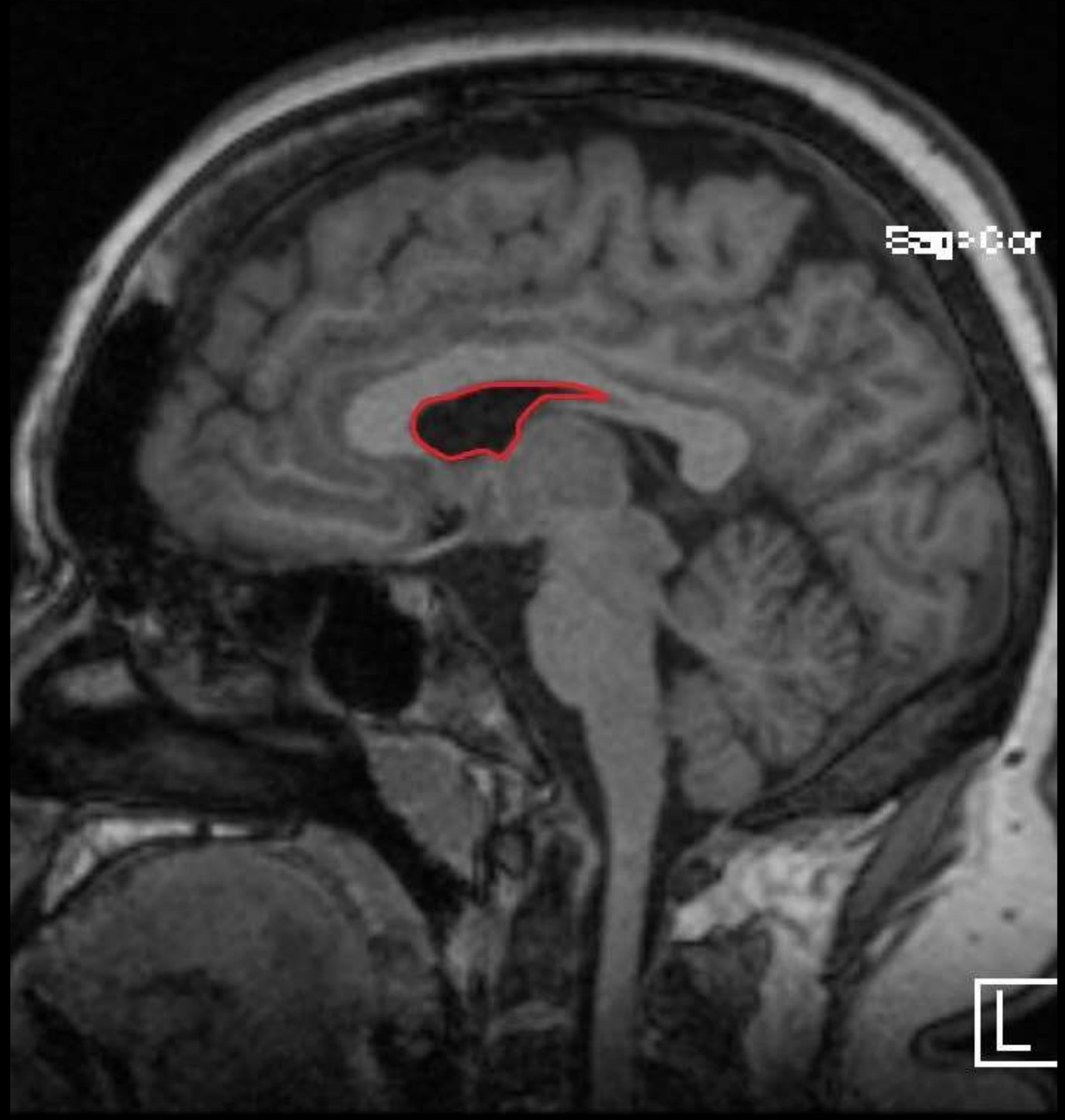


Coronal

LATERAL VENTRICLES

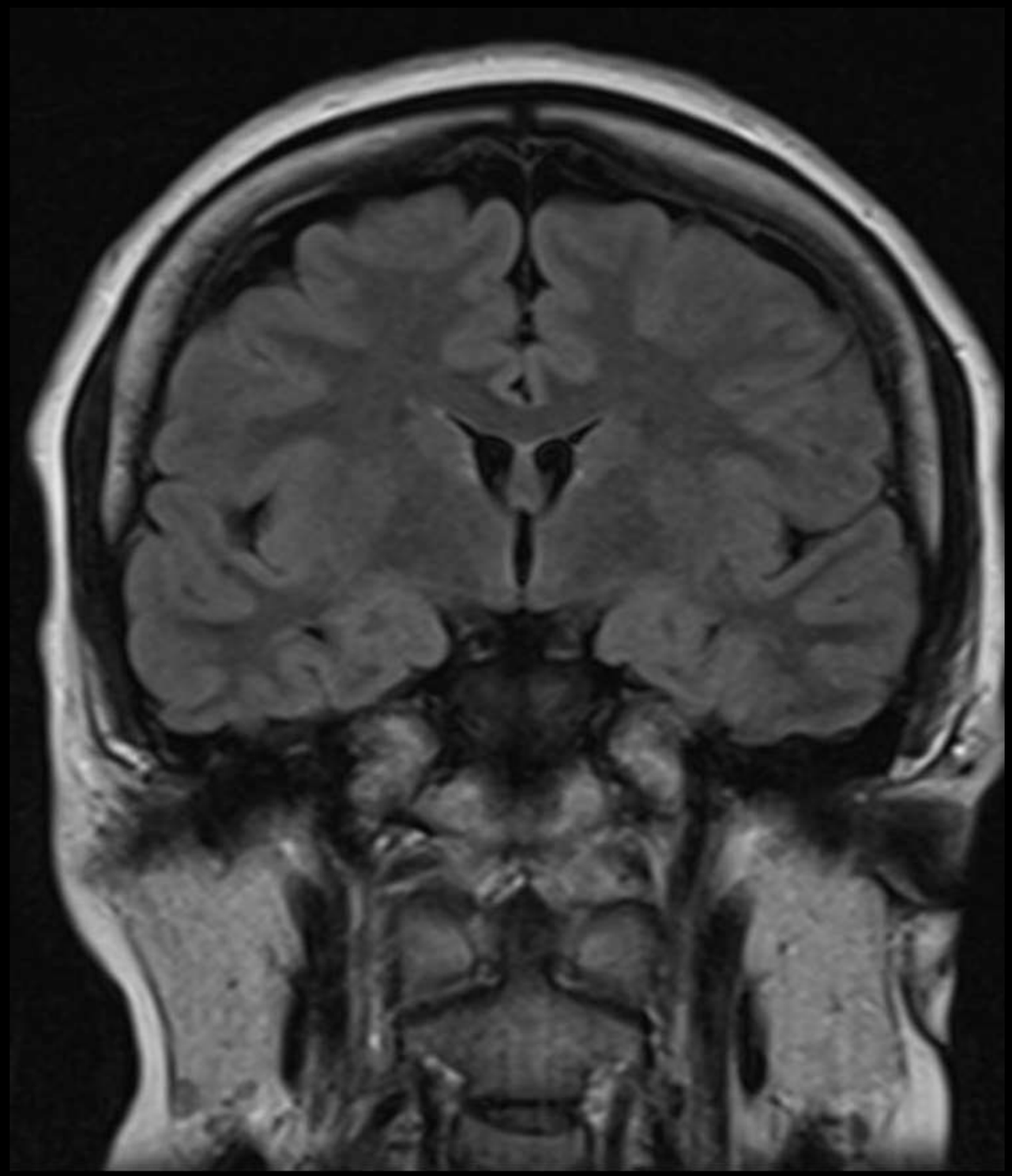
Sagittal

LATERAL VENTRICLES



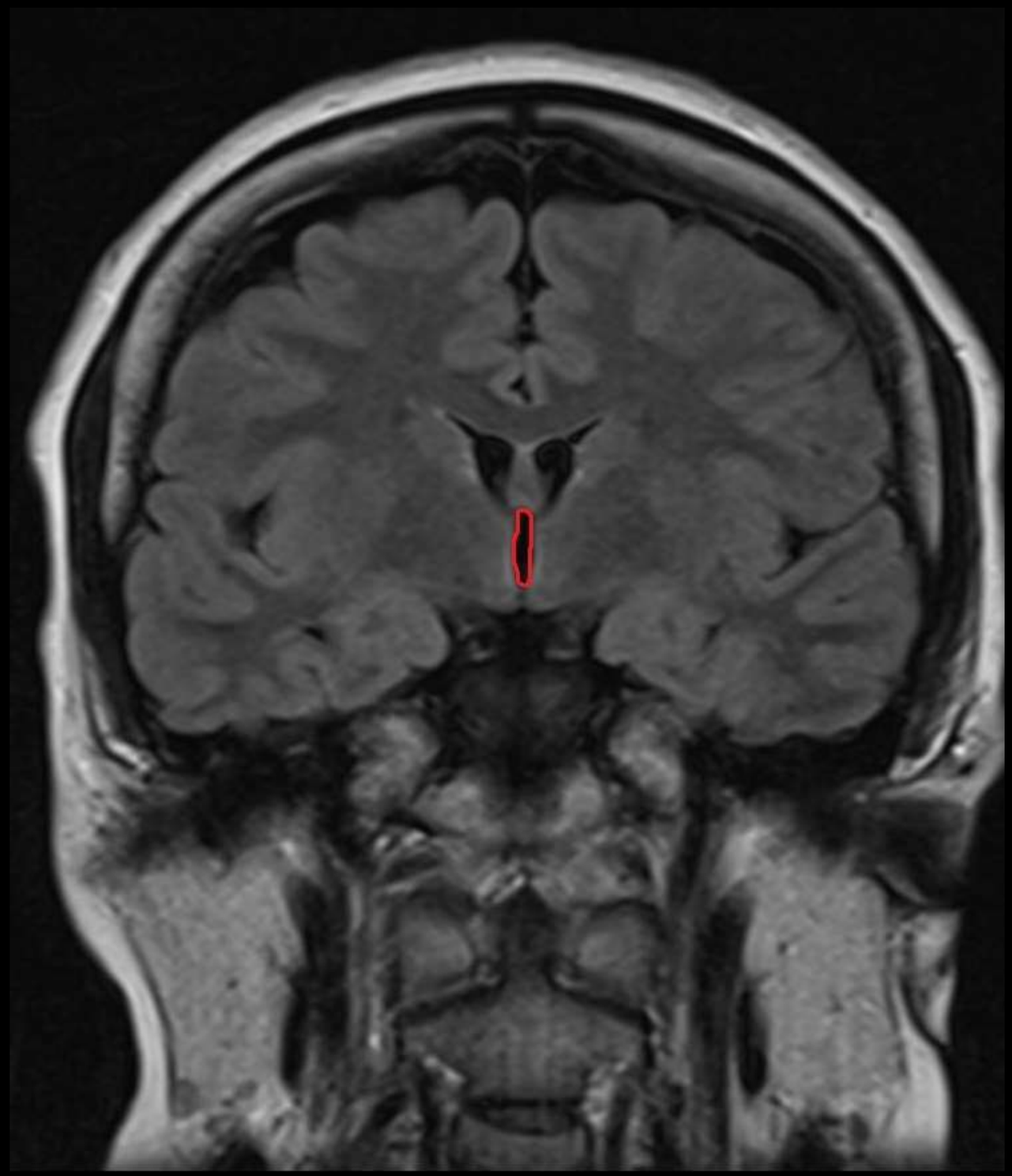
Sagittal

THIRD VENTRICLE



Coronal

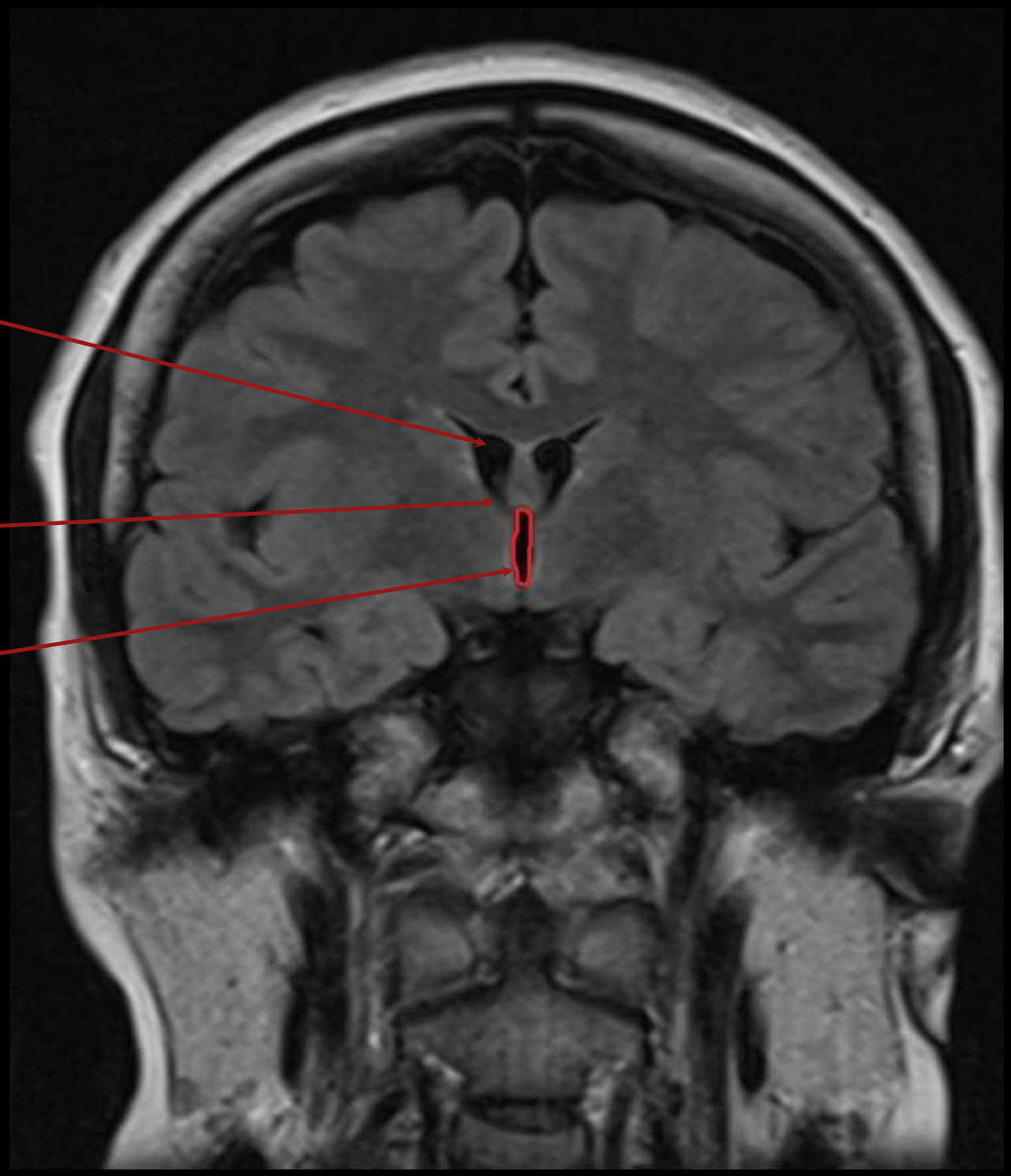
THIRD VENTRICLE



Coronal

THIRD VENTRICLE

Also note the lateral ventricles draining via the bilateral interventricular foramen into the third ventricle.

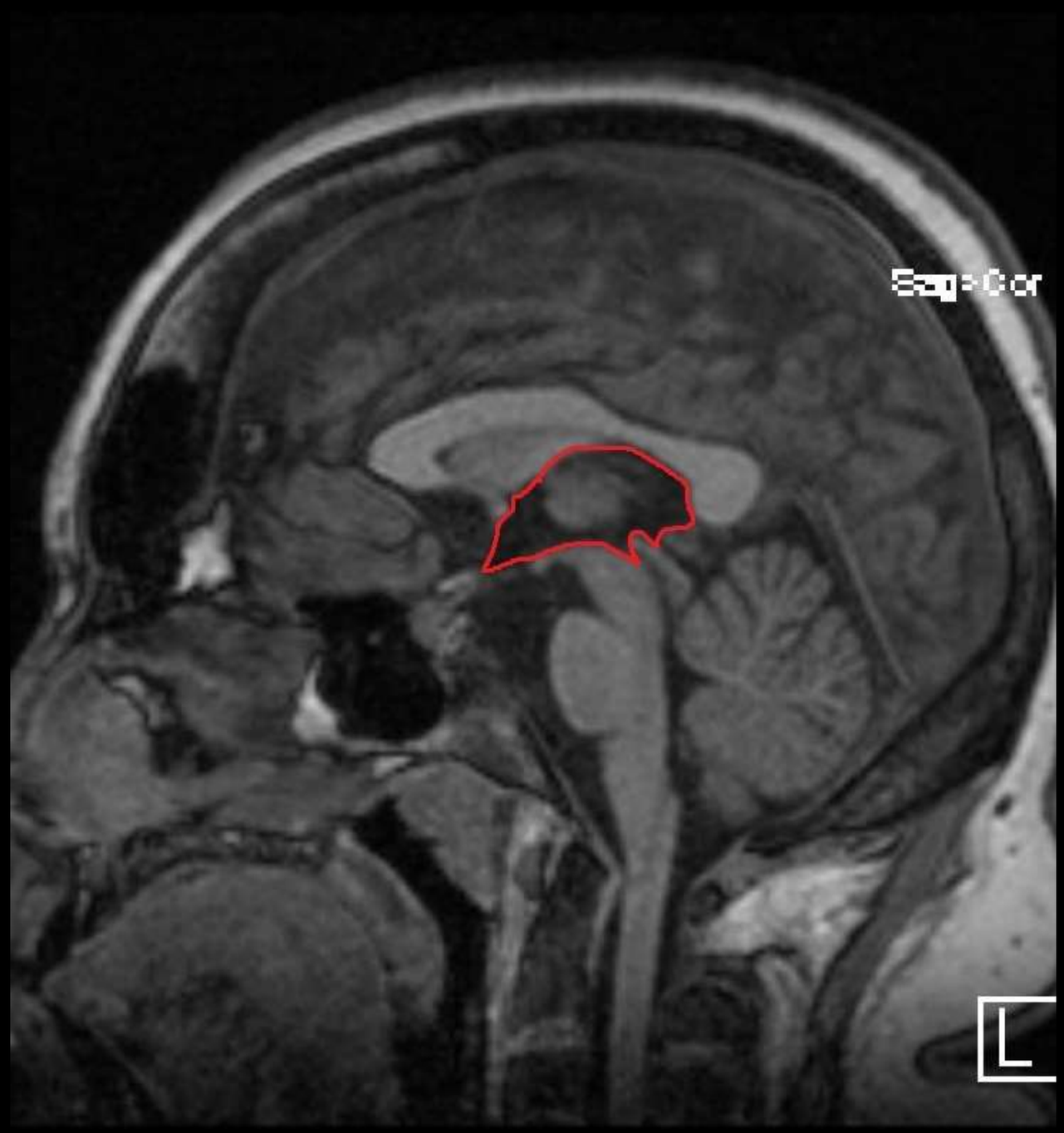


Coronal

THIRD VENTRICLE

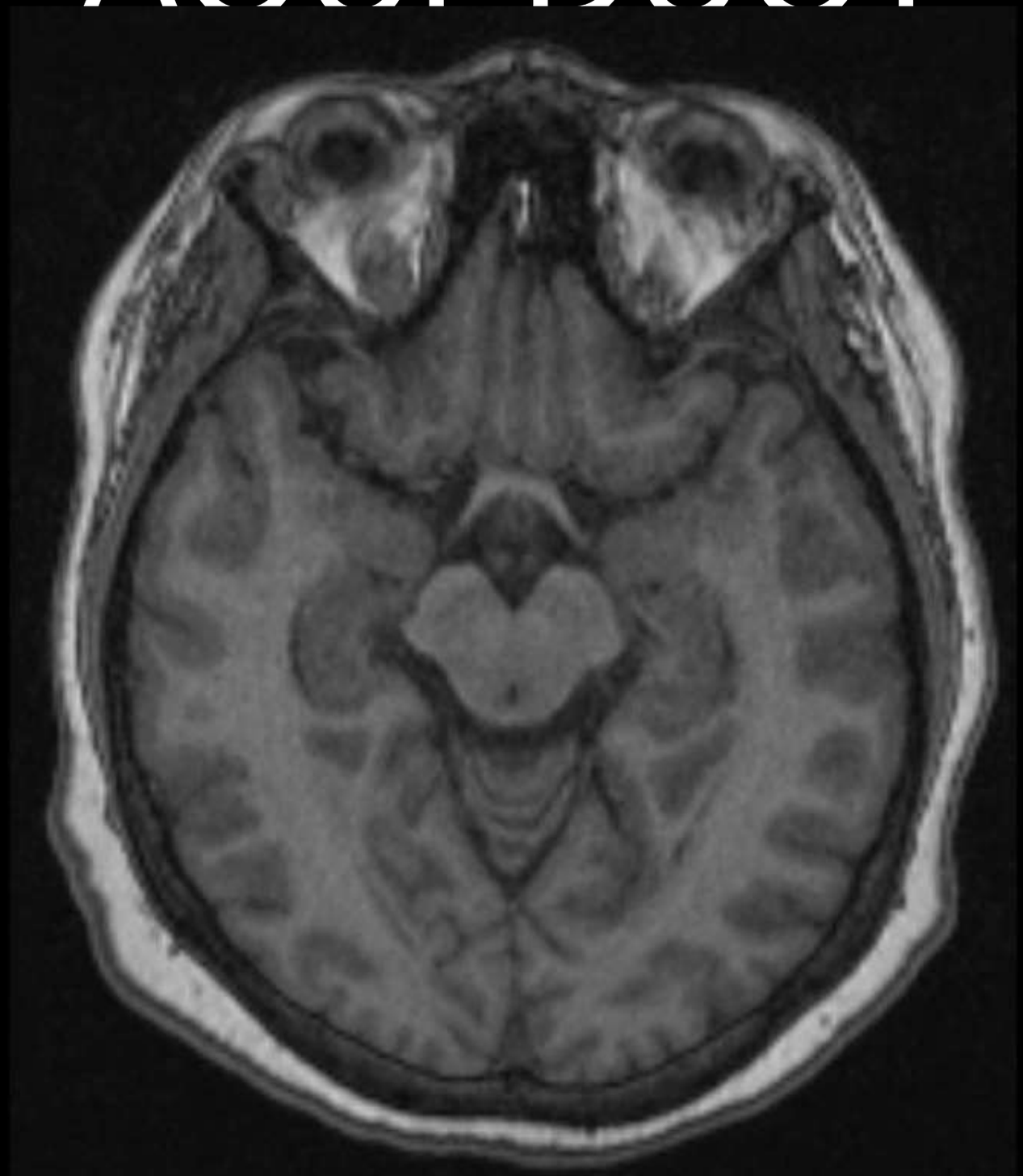
Sagittal

THIRD VENTRICLE



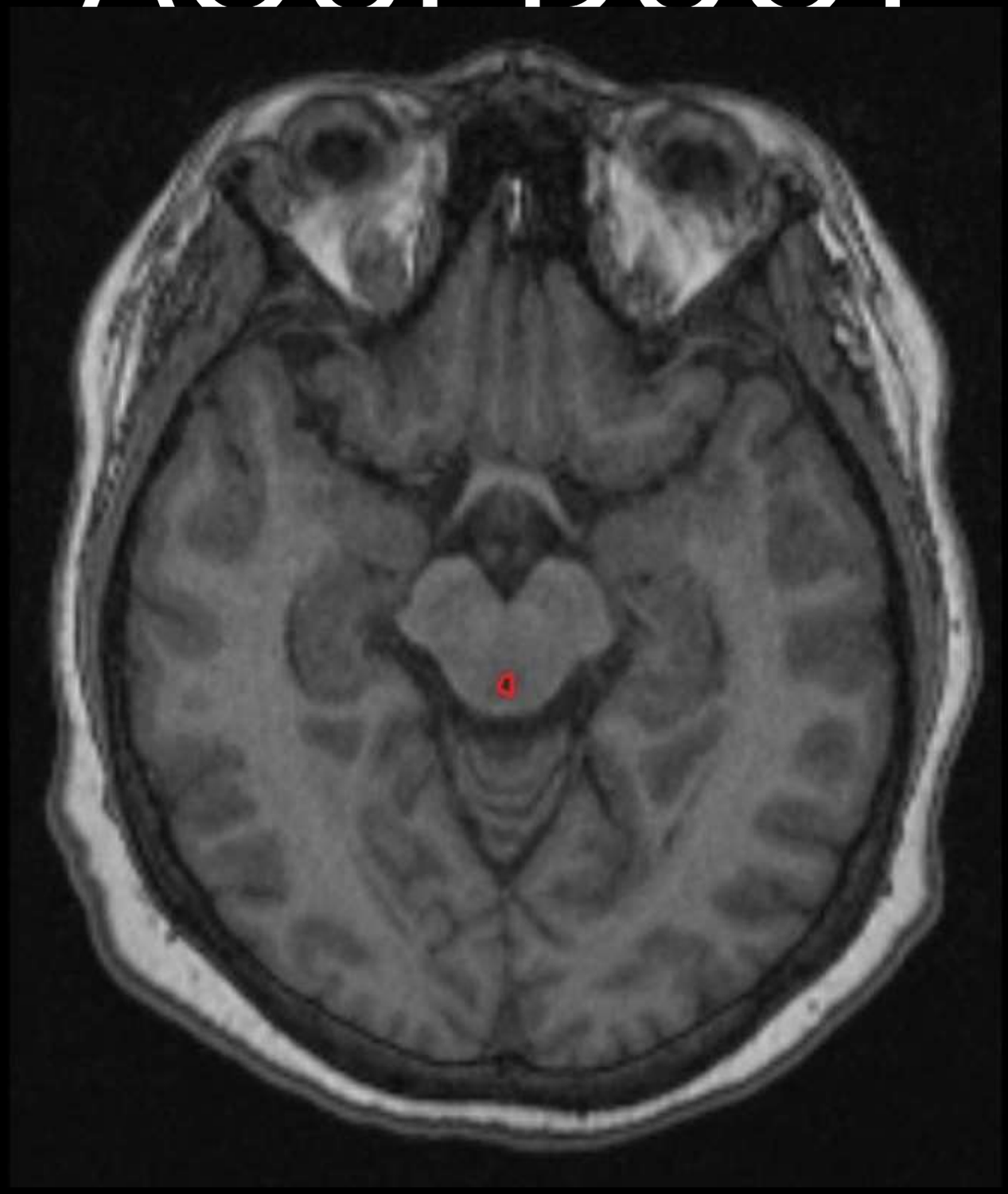
Sagittal

CEREBRAL AQUEDUCT



Axial

CEREBRAL AQUEDUCT

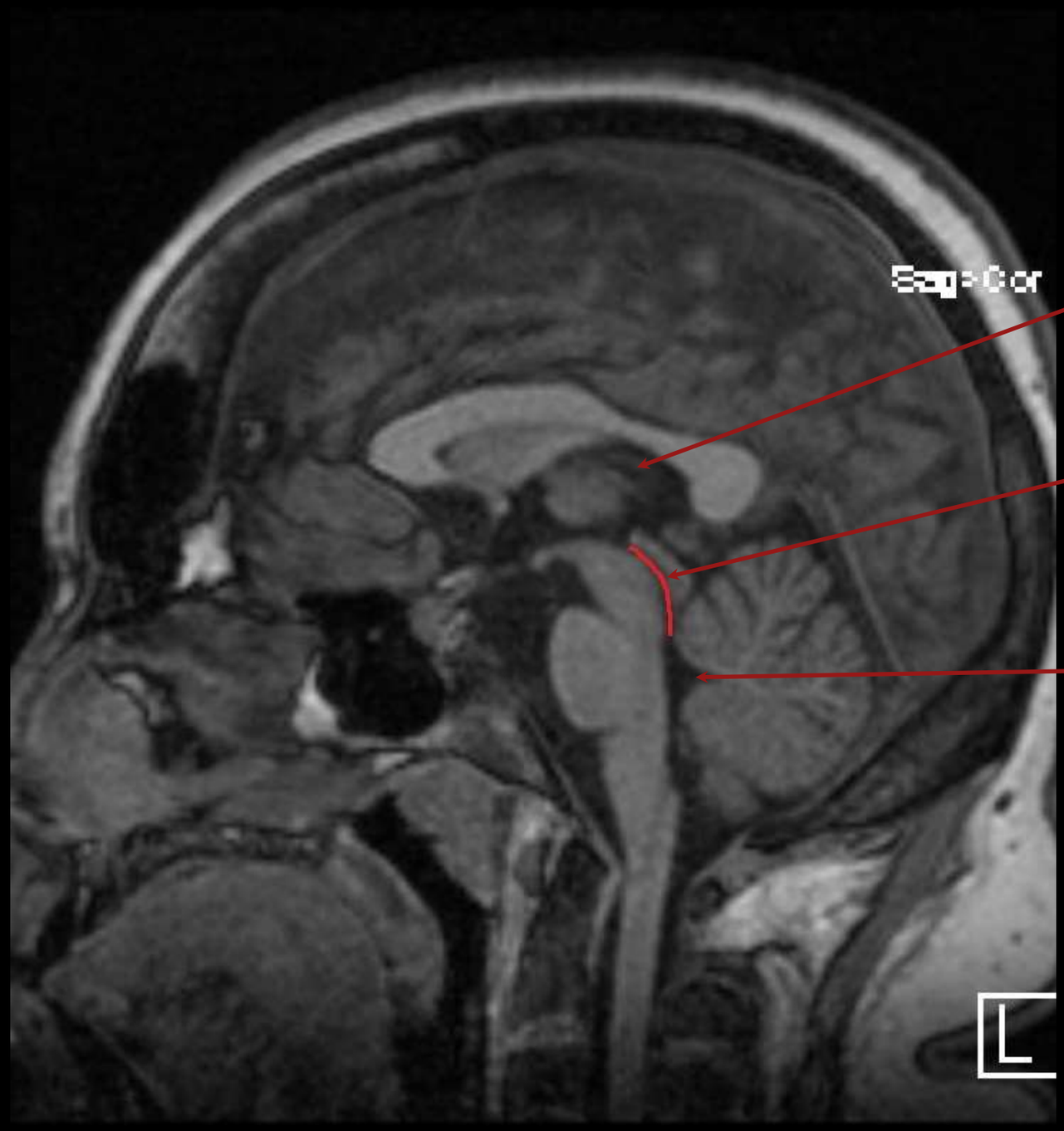


Axial

CEREBRAL AQUEDUCT

Sagittal

CEREBRAL AQUEDUCT



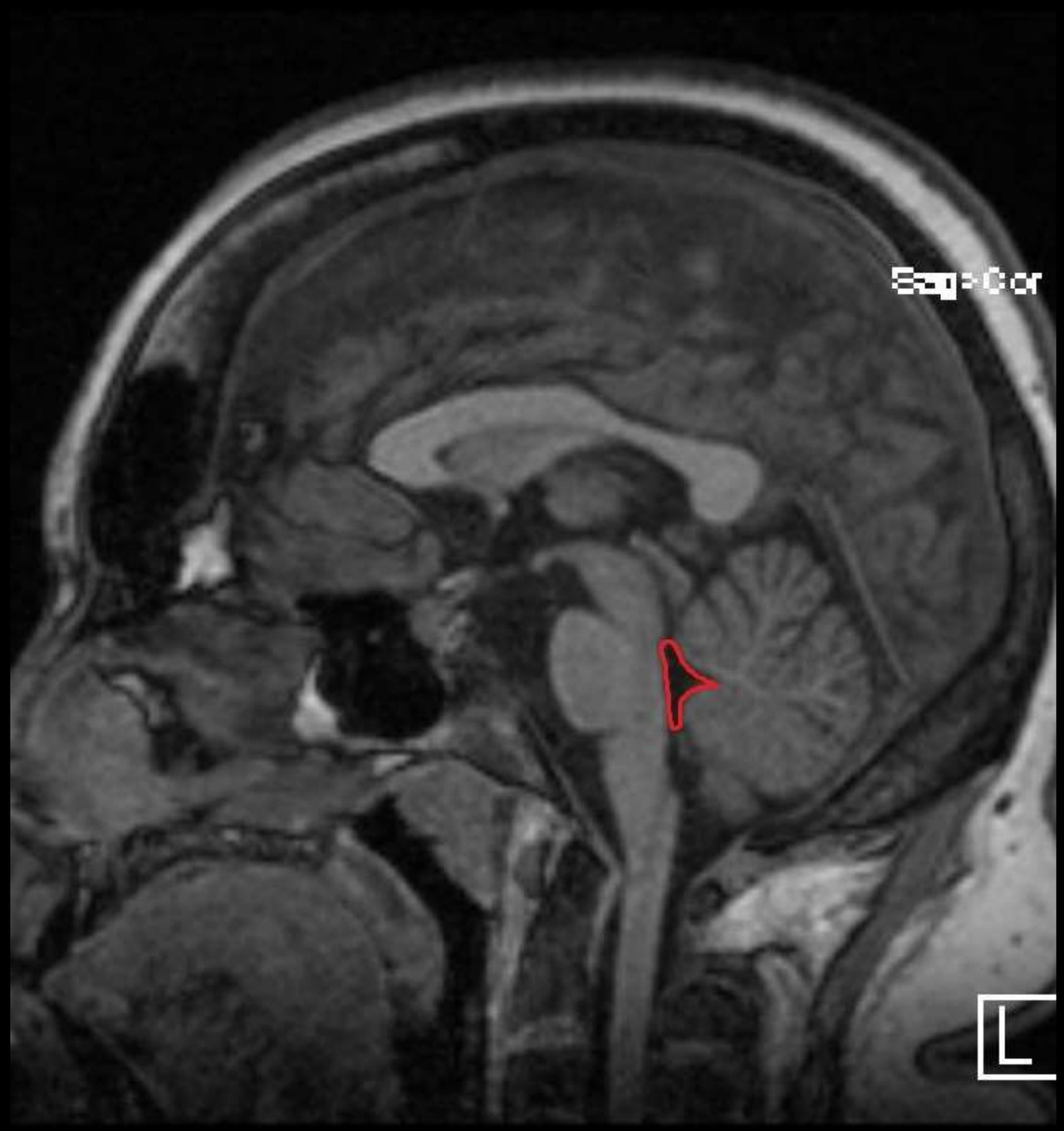
Recall that the third ventricle drains via the cerebral aqueduct into the fourth ventricle

Sagittal

FOURTH VENTRICLE

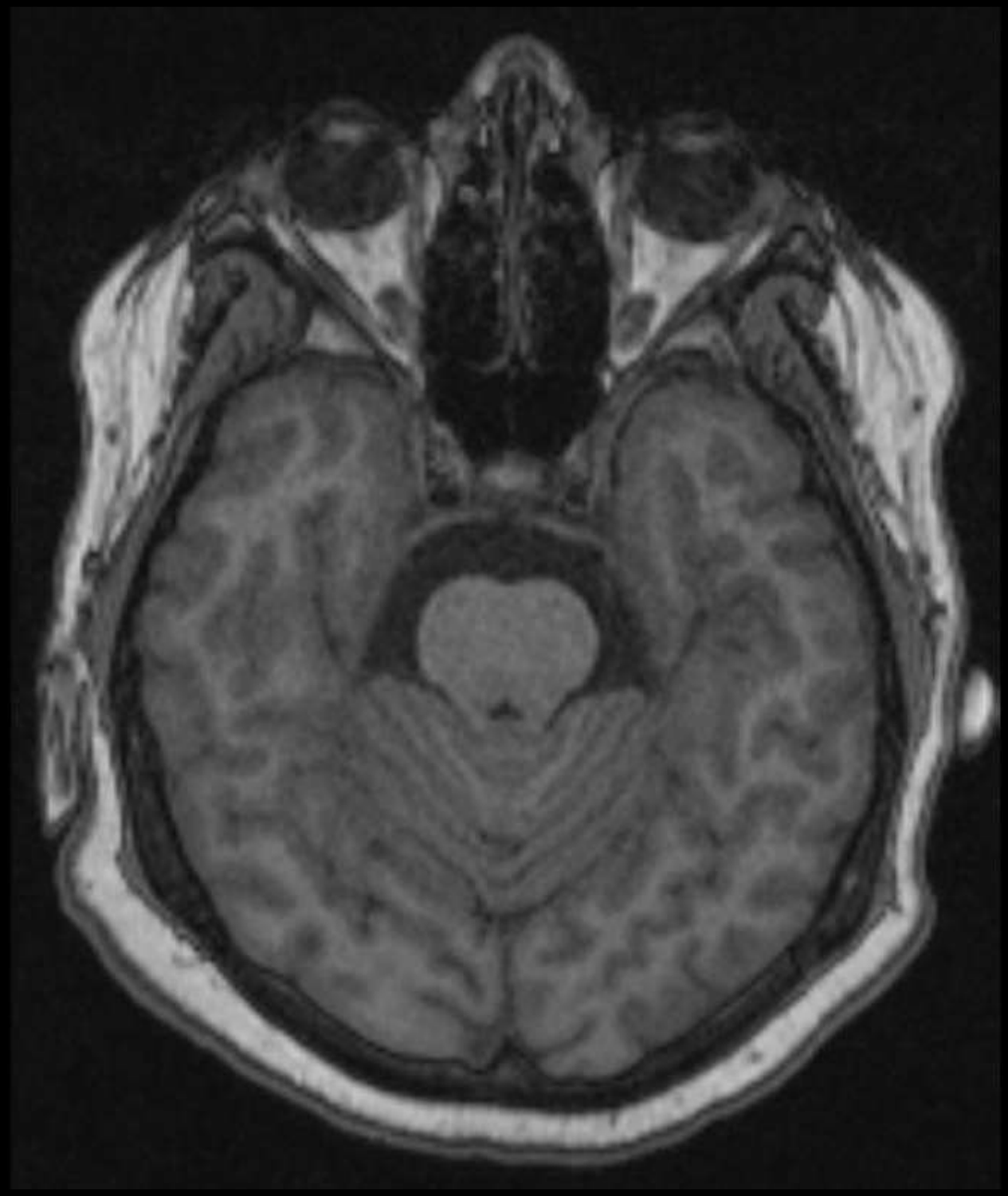
Sagittal

FOURTH VENTRICLE



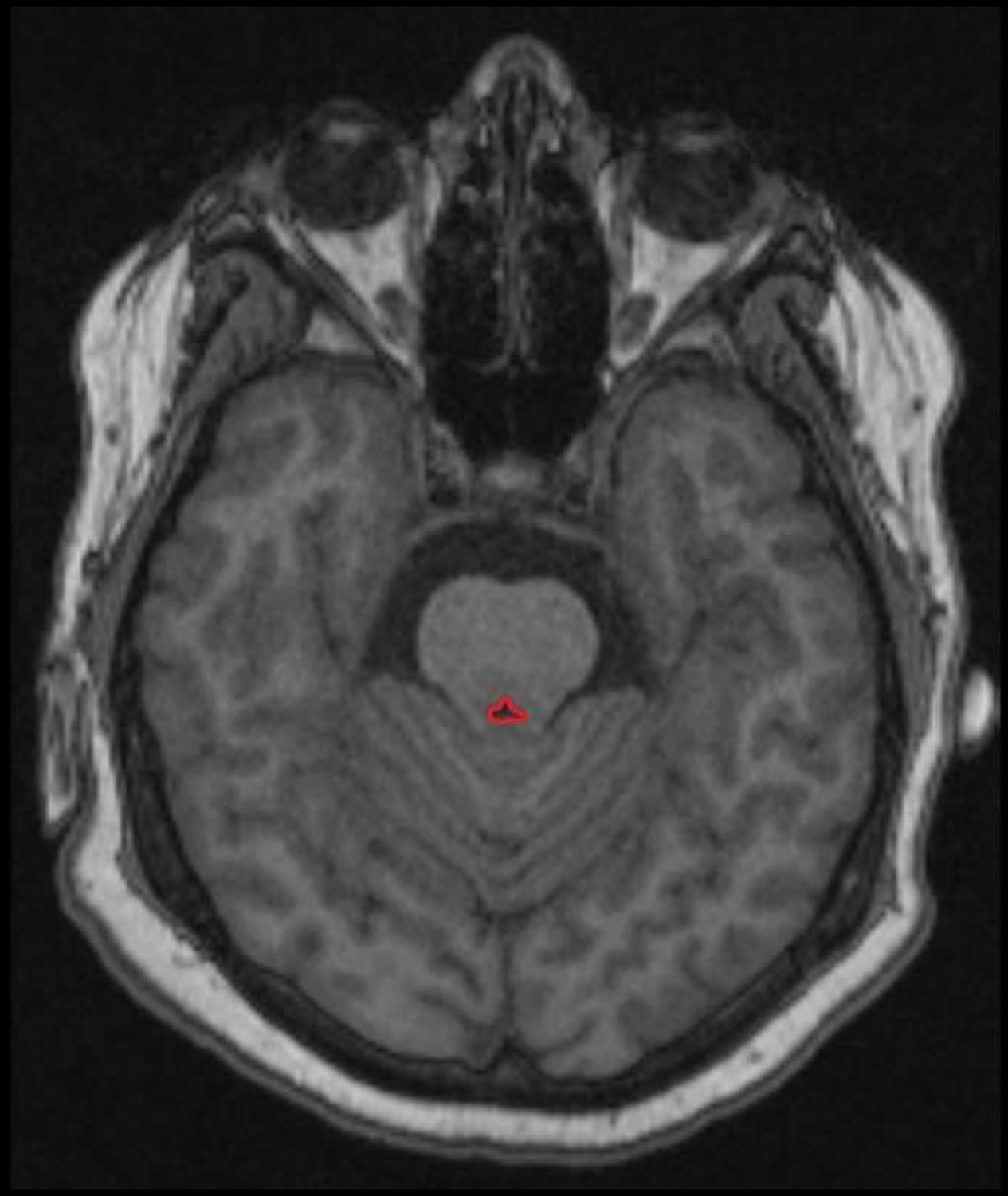
Sagittal

FOURTH VENTRICLE



Axial

FOURTH VENTRICLE

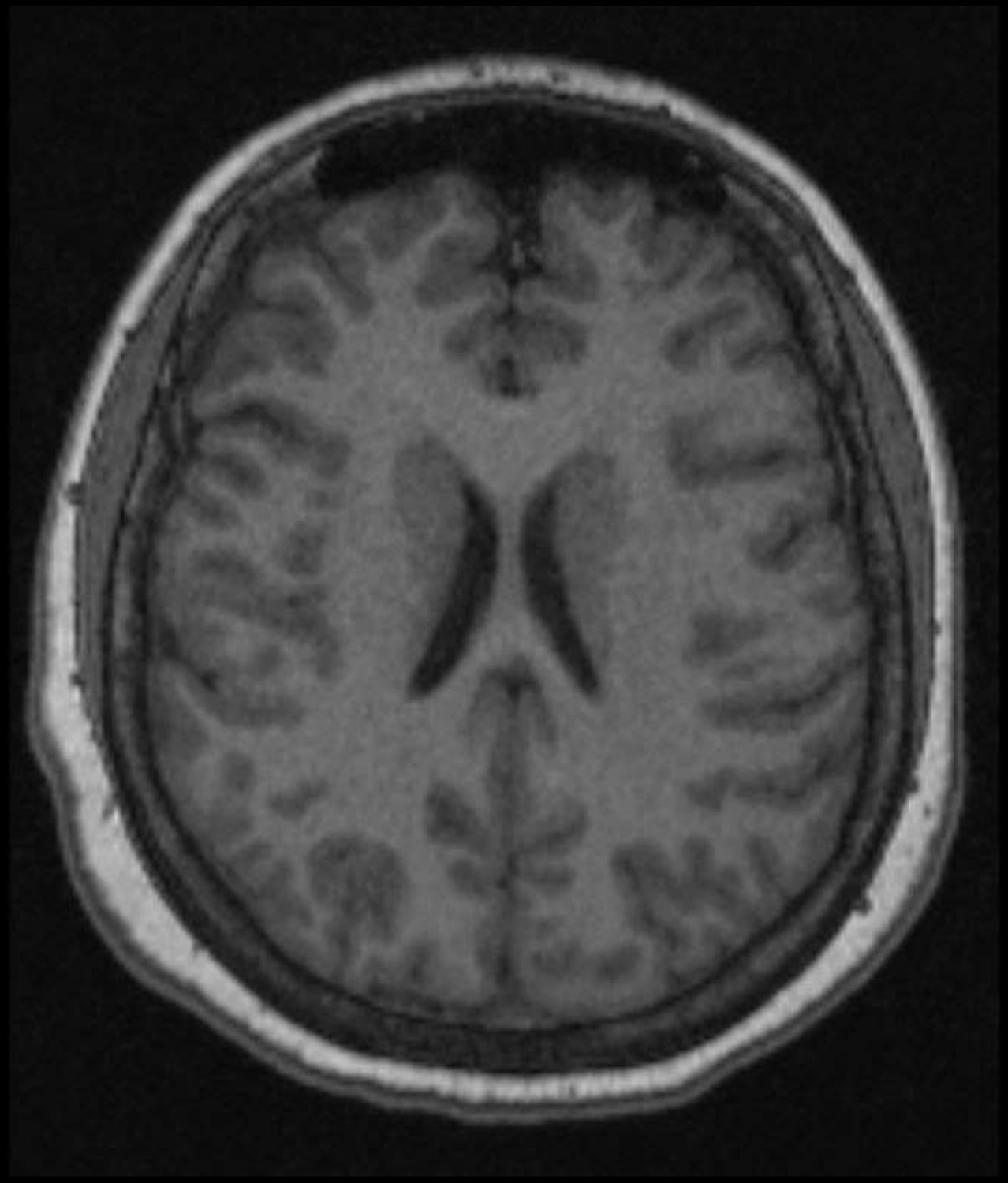


Axial

BASAL GANGLIA

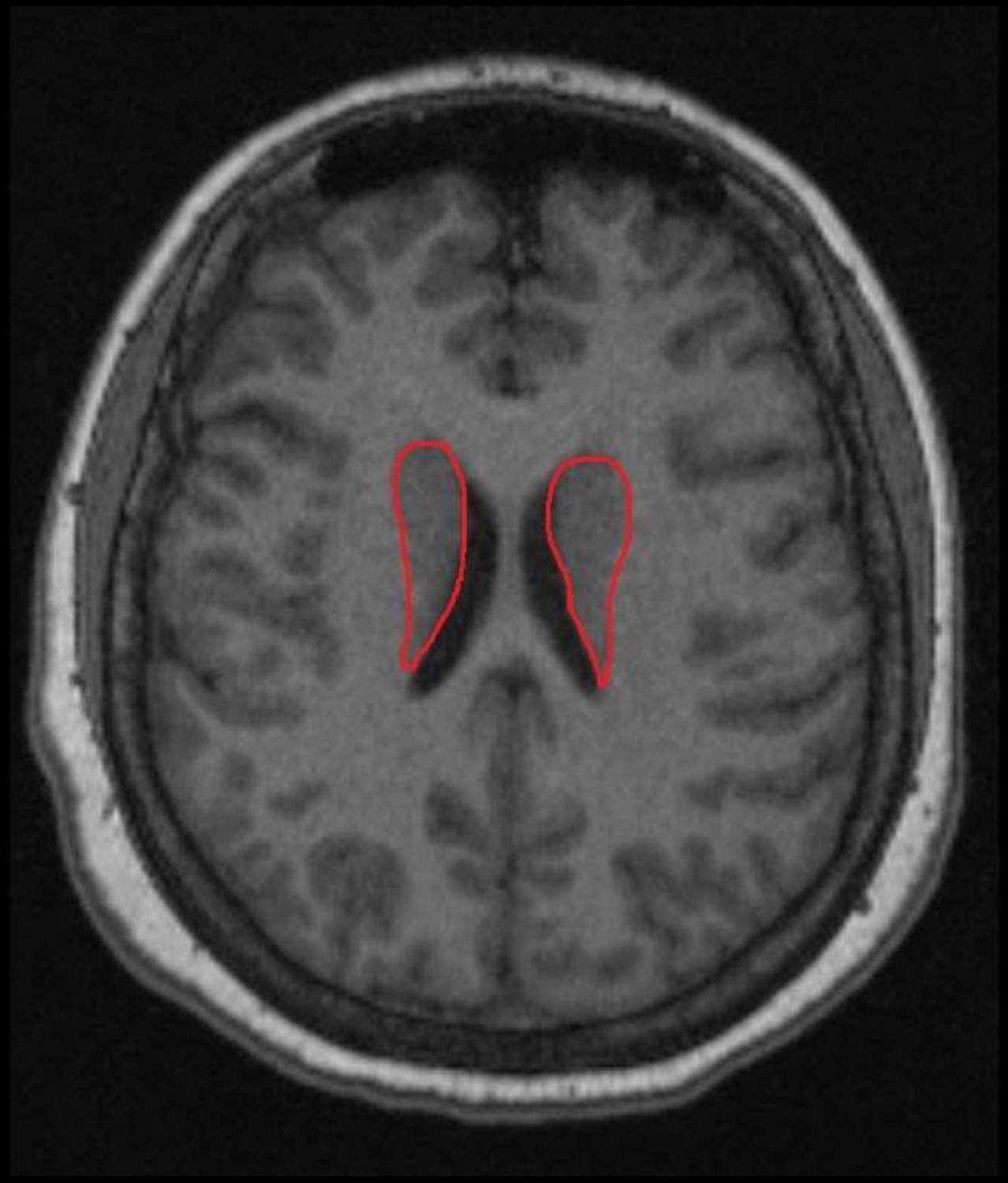
- Caudate Nucleus
- Lentiform nucleus = globus pallidus + putamen
- Thalamus
- There are other parts of the basal ganglia not covered, including: Substantia Nigra, Subthalamic Nucleus, Red Nucleus.

CAUDATE



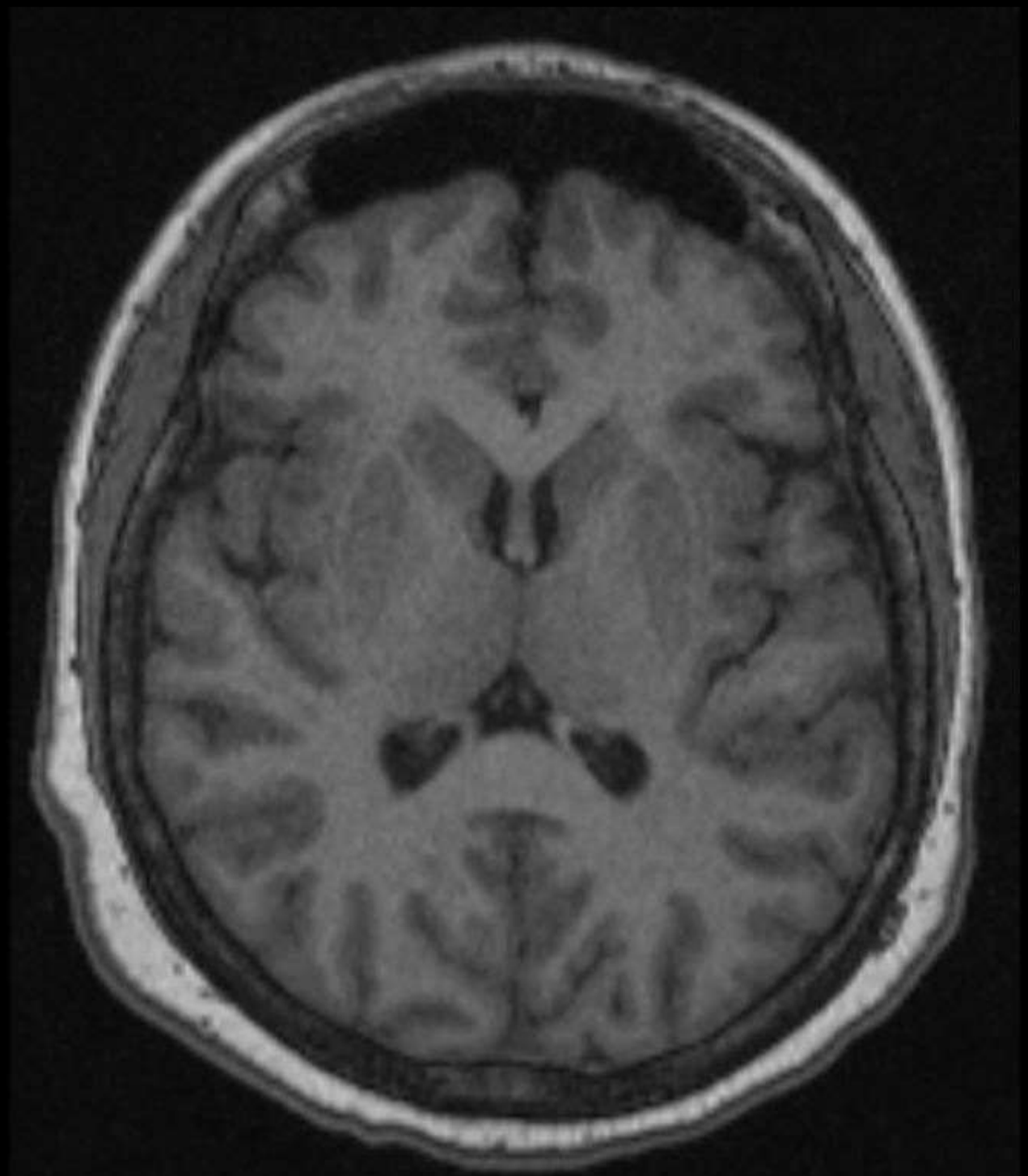
Axial

CAUDATE



Axial

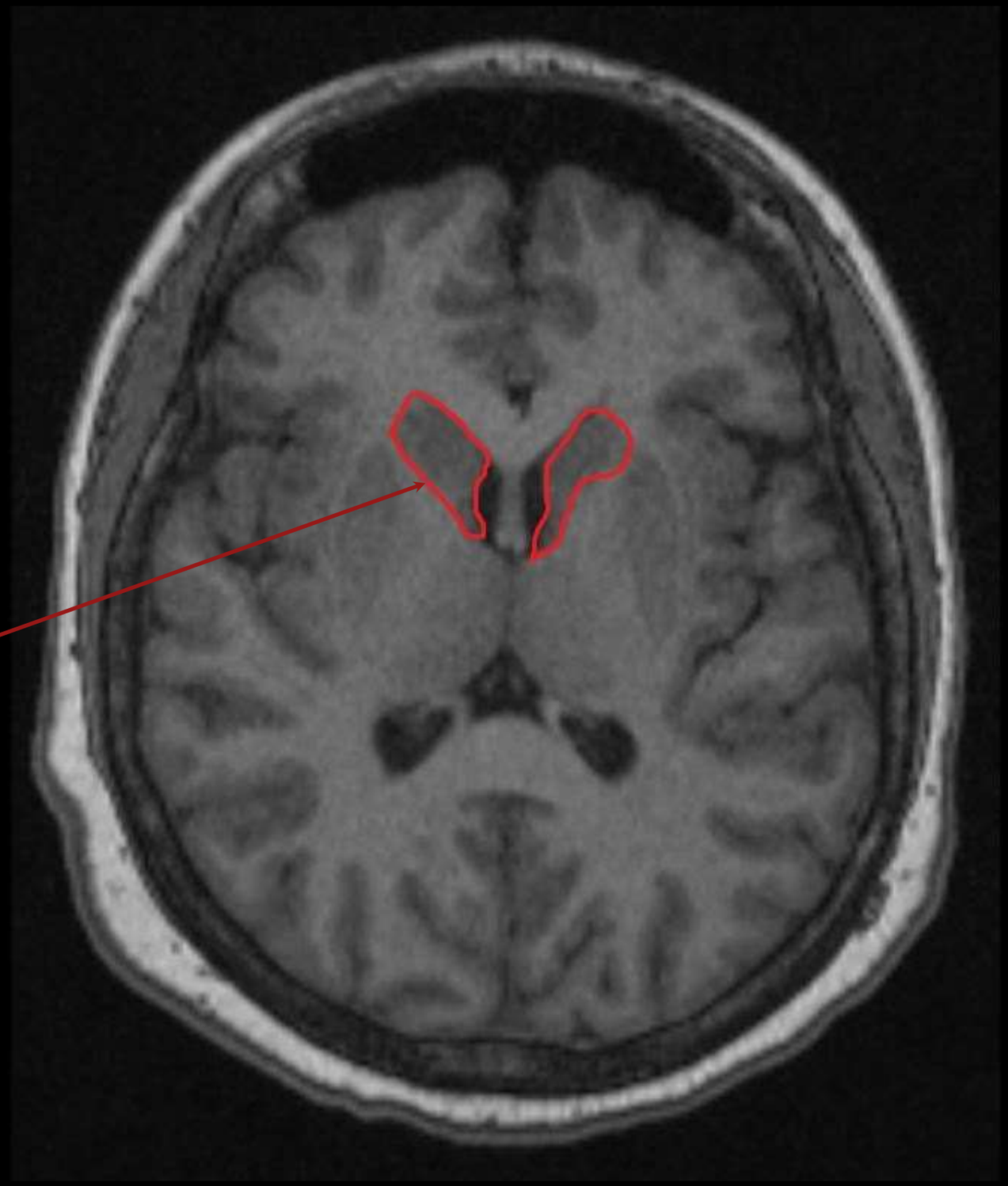
CAUDATE



Axial

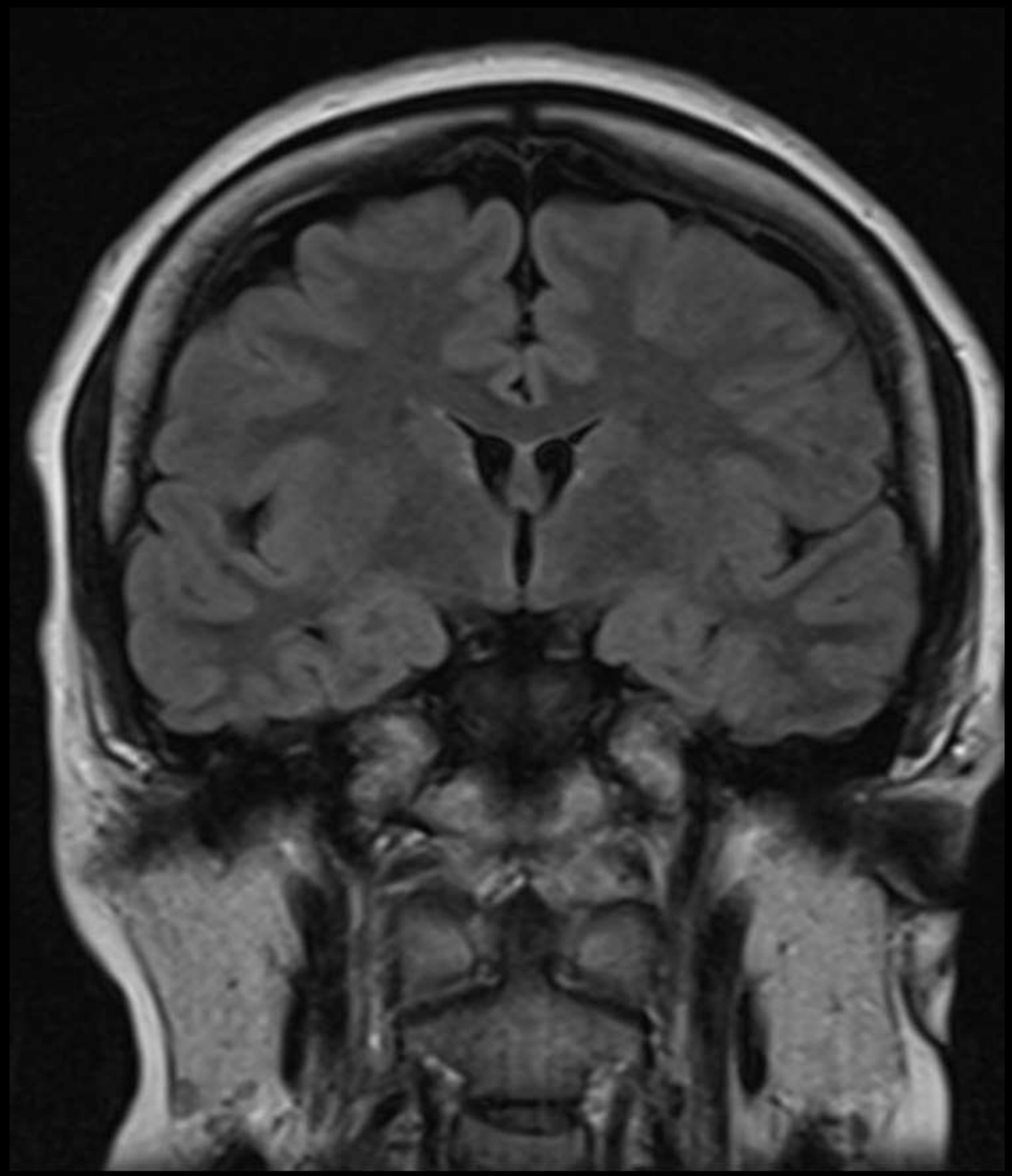
CAUDATE

Specifically, this is the part of the caudate nucleus called the "head."



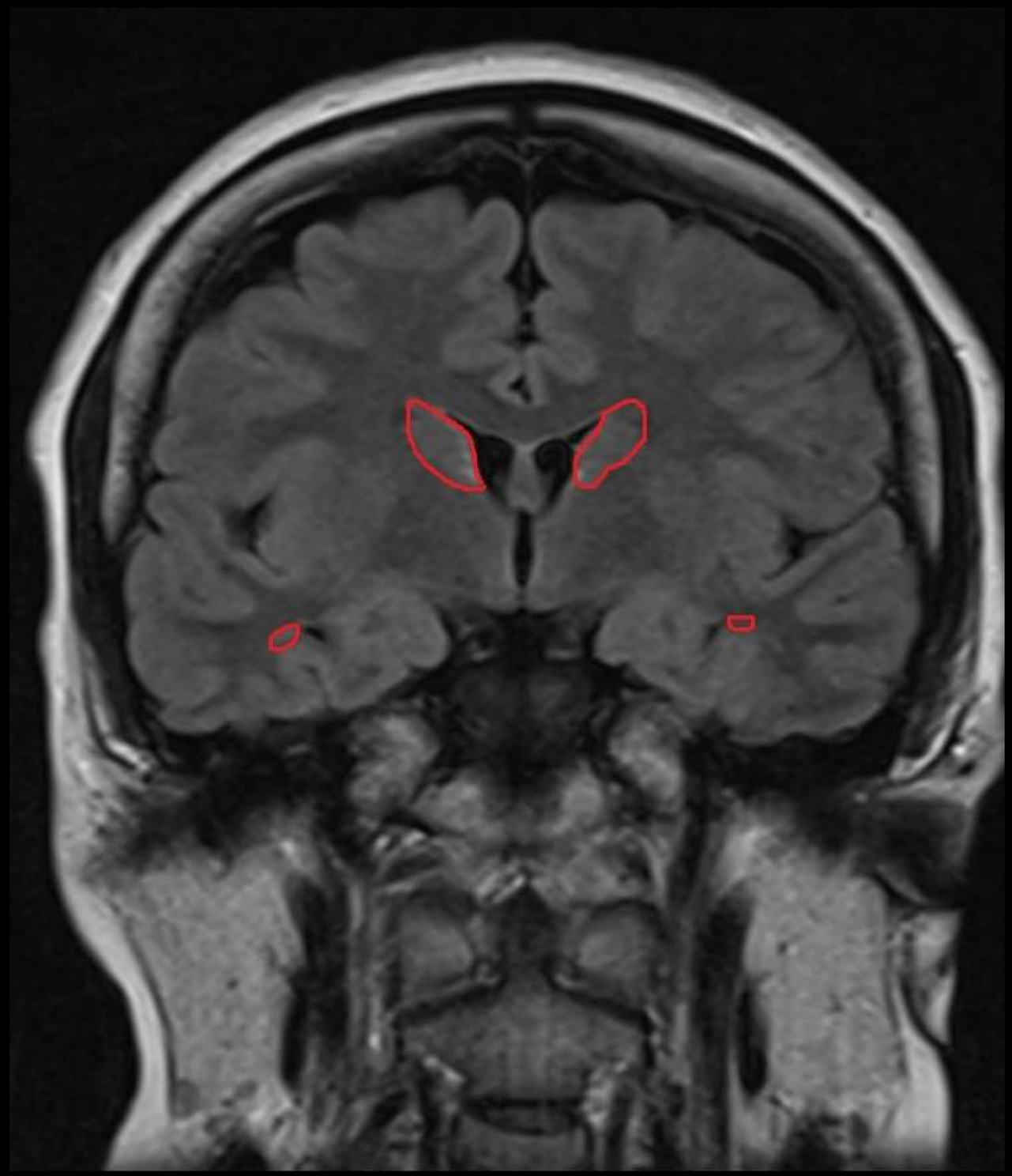
Axial

CAUDATE



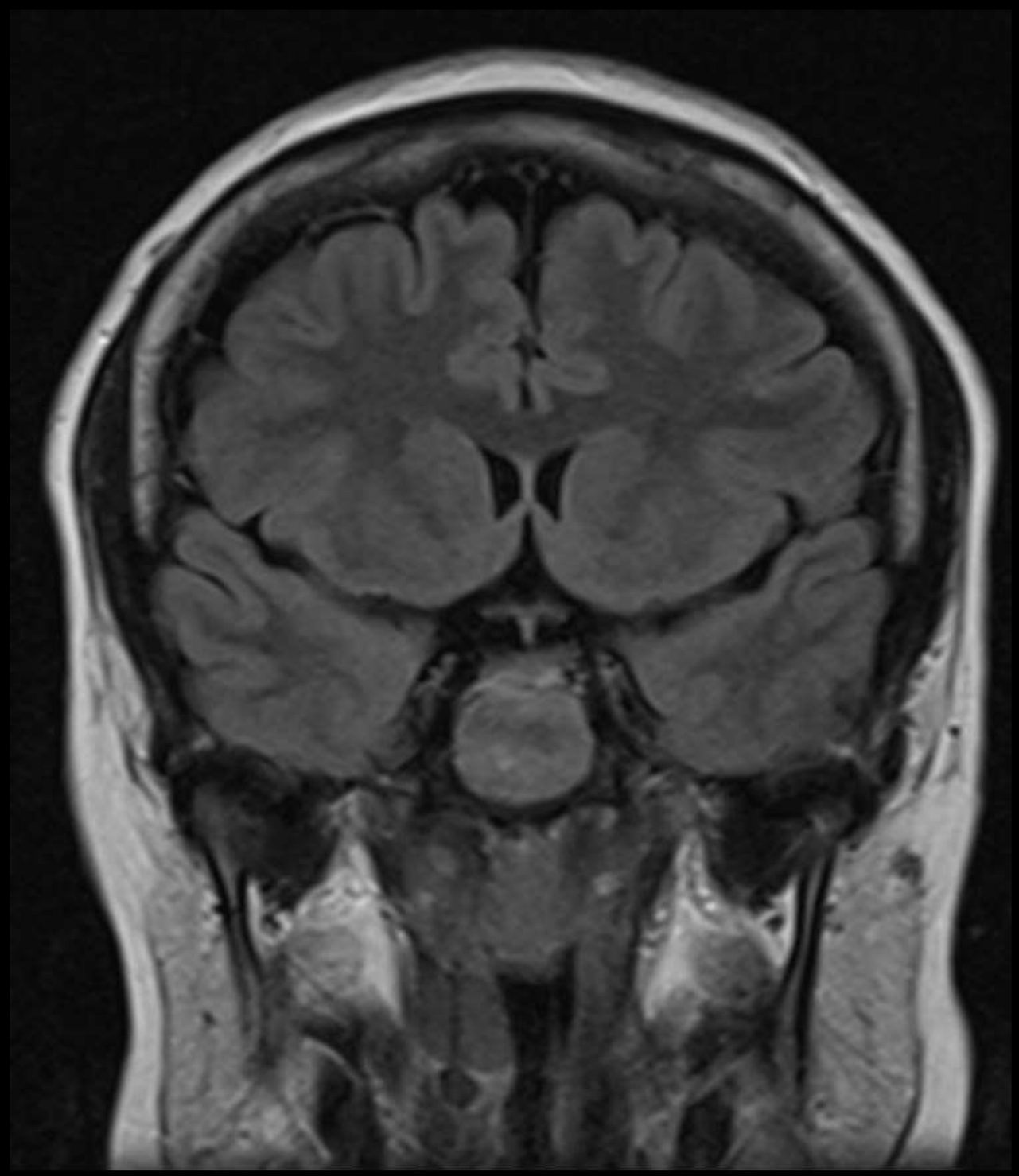
Coronal

CAUDATE



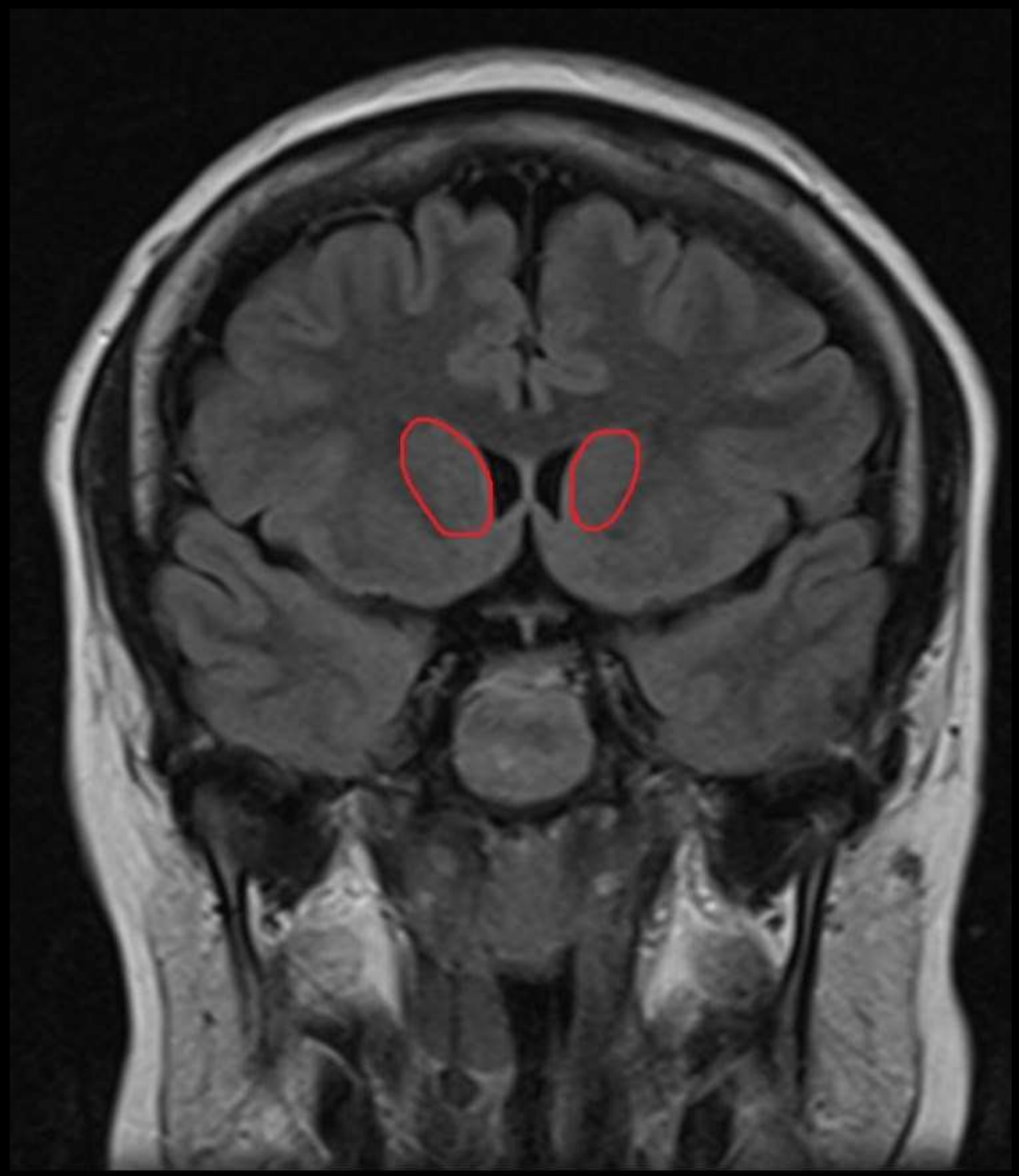
Coronal

CAUDATE



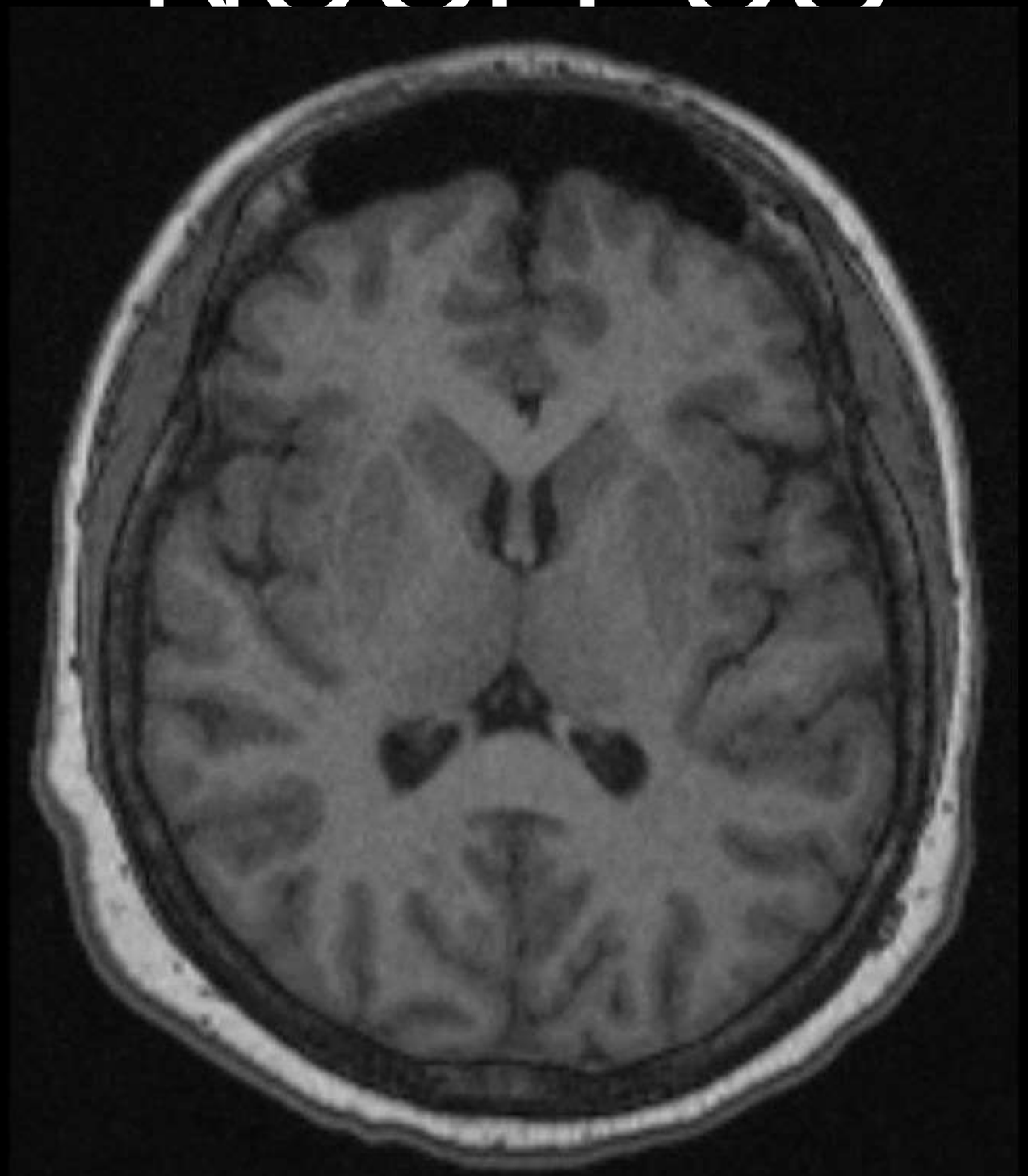
Coronal

CAUDATE



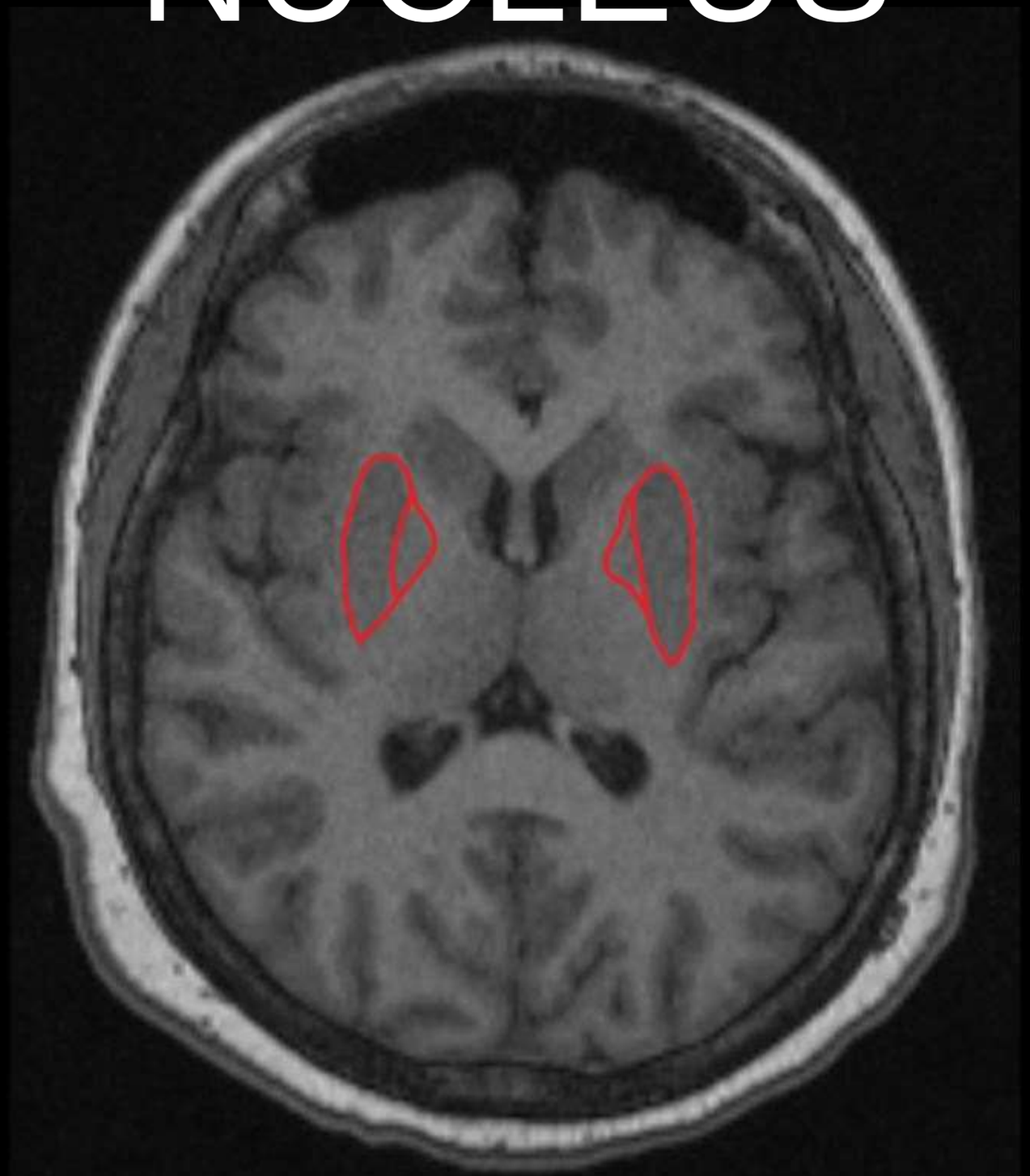
Coronal

LENTIFORM NUCLEUS



Axial

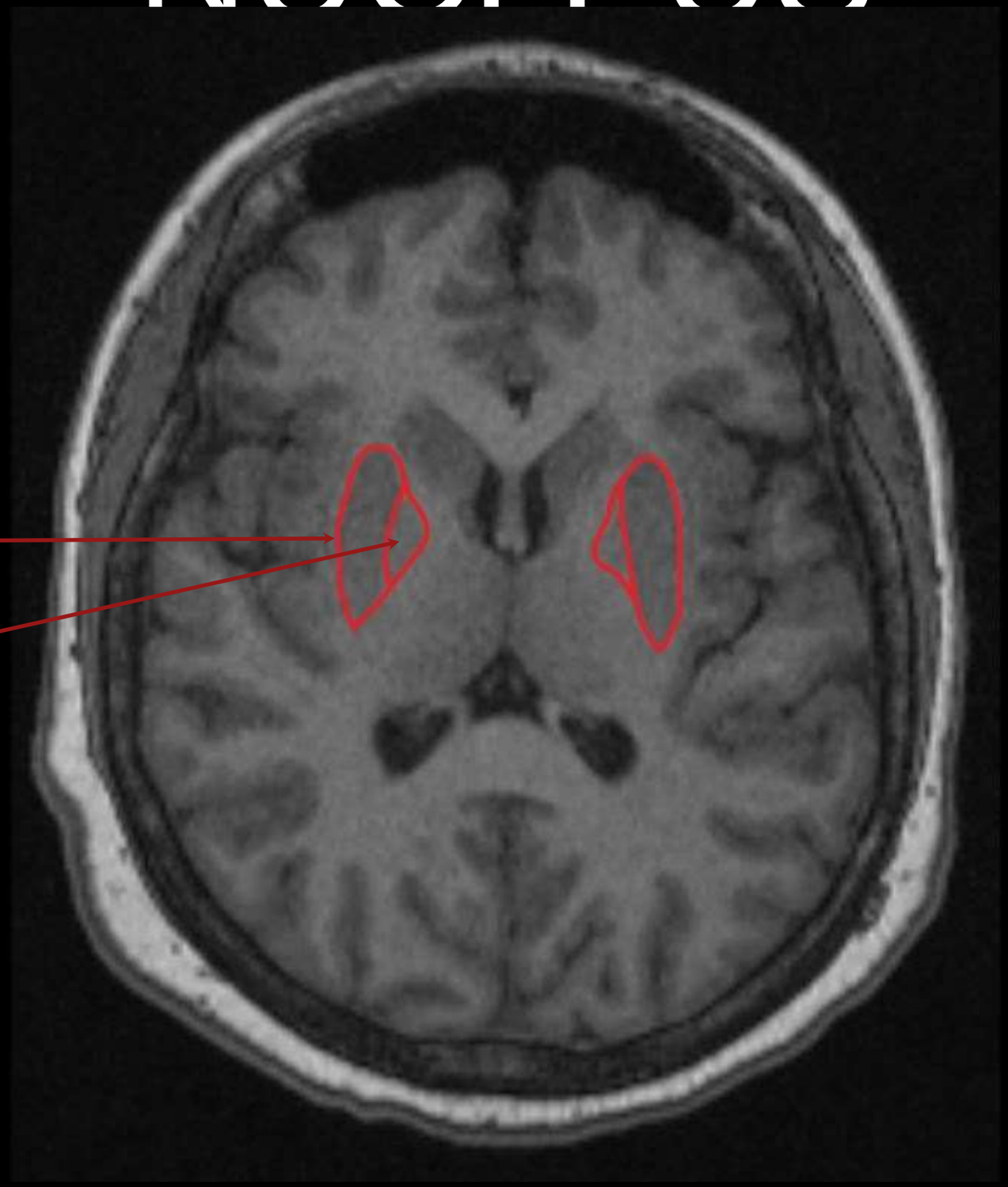
LENTIFORM NUCLEUS



Axial

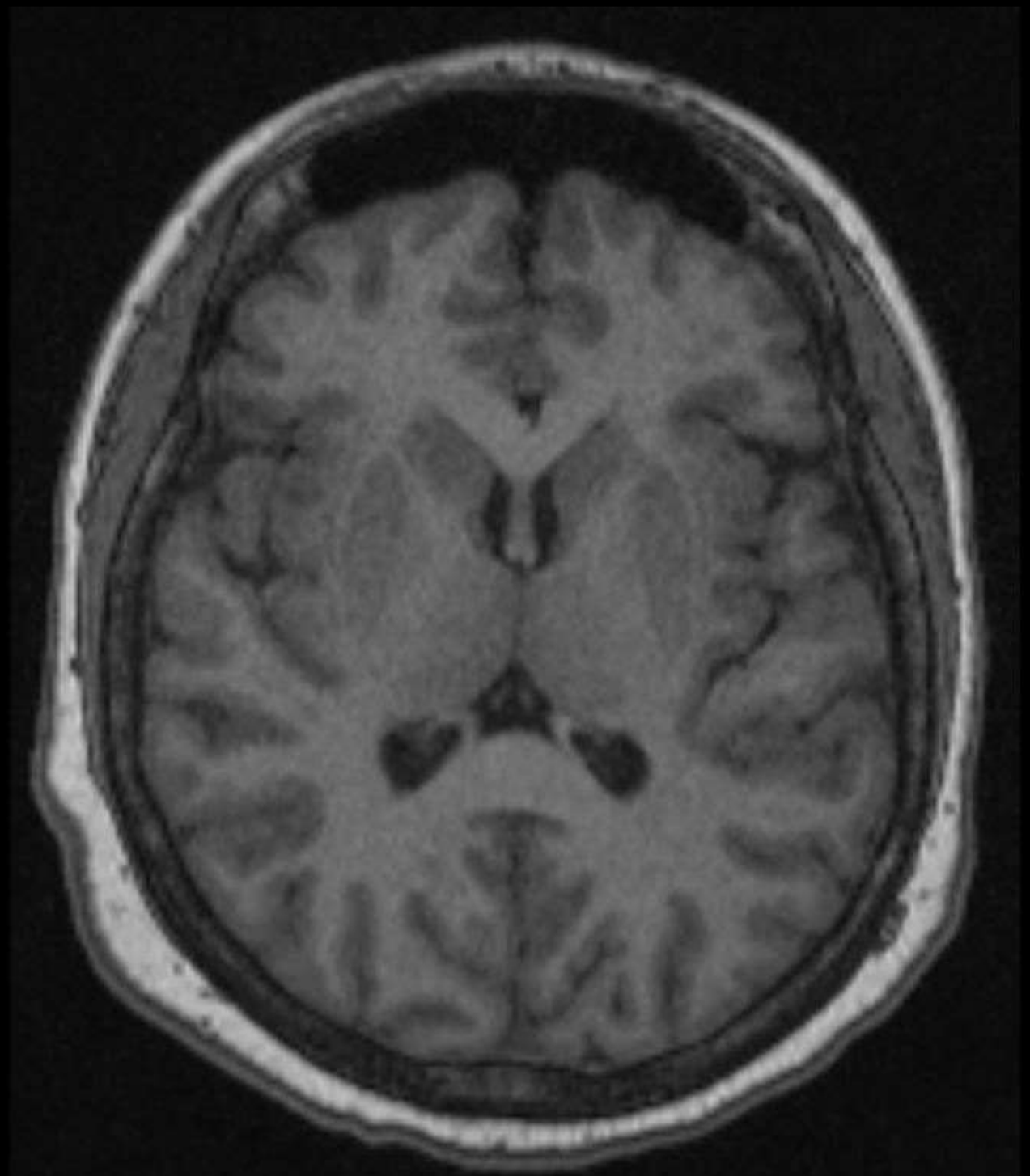
LENTIFORM NUCLEUS

Recall that the lentiform nucleus is comprised of the putamen and the globus pallidus



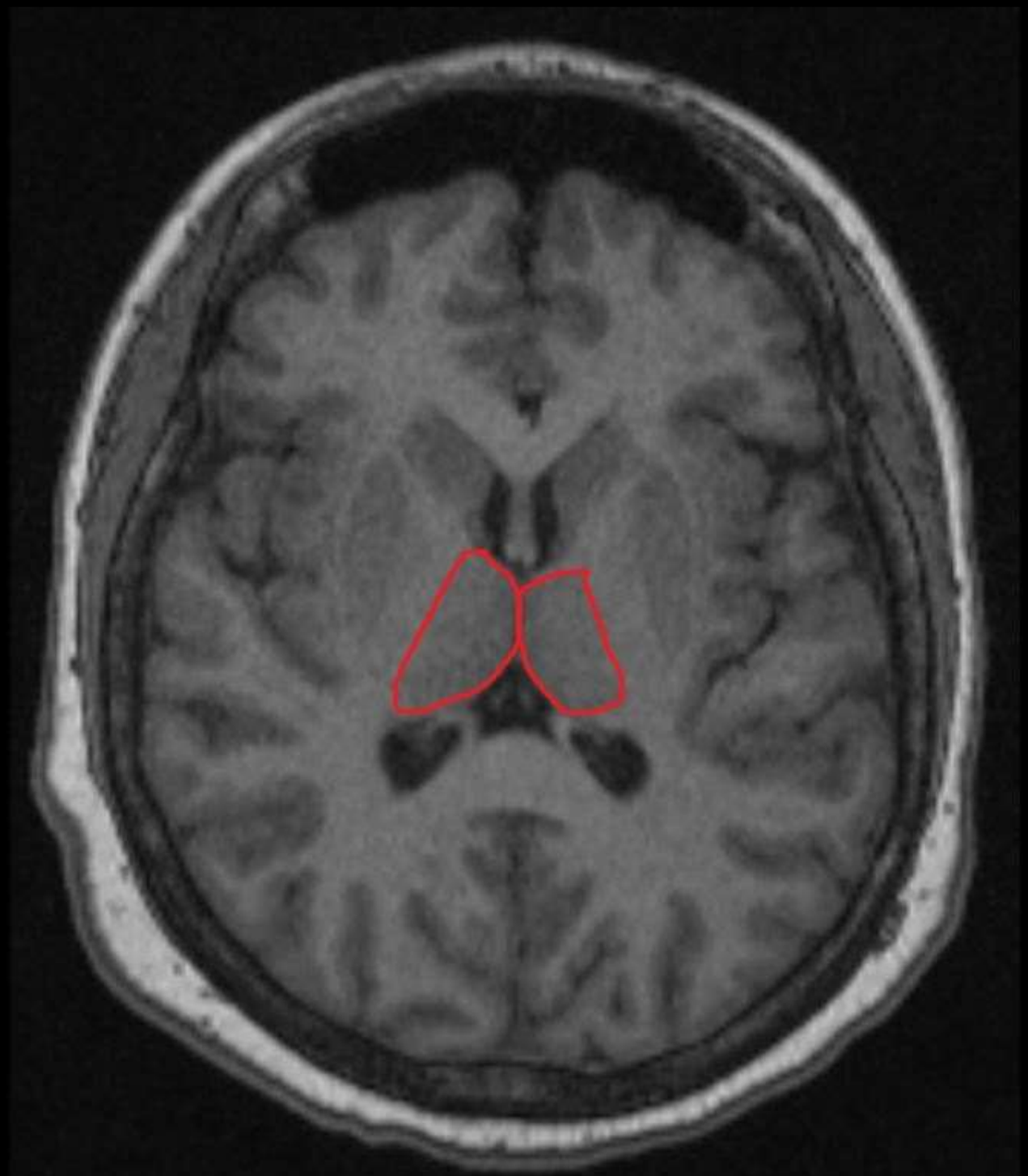
Axial

THALAMUS



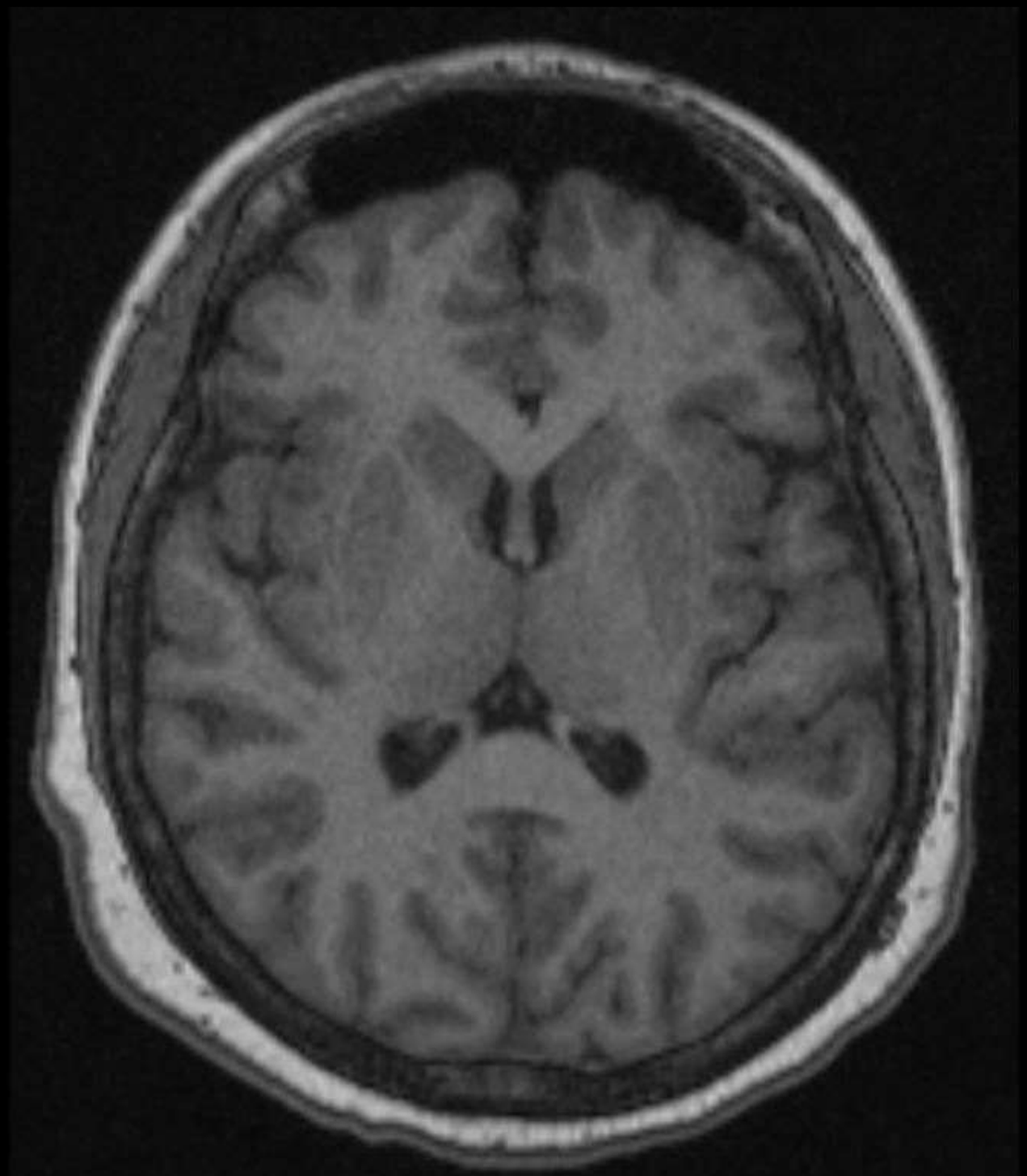
Axial

THALAMUS



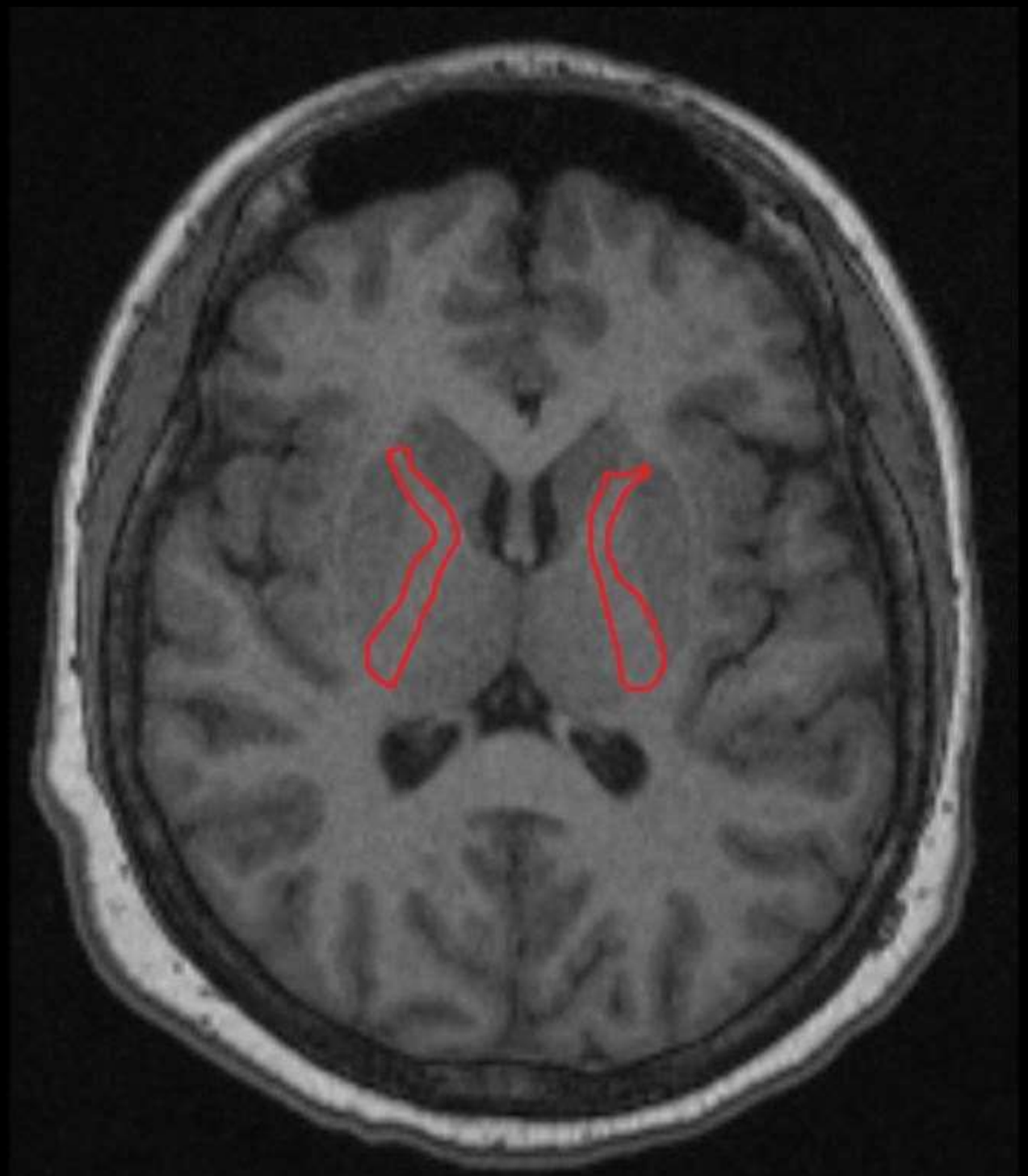
Axial

INTERNAL CAPSULE



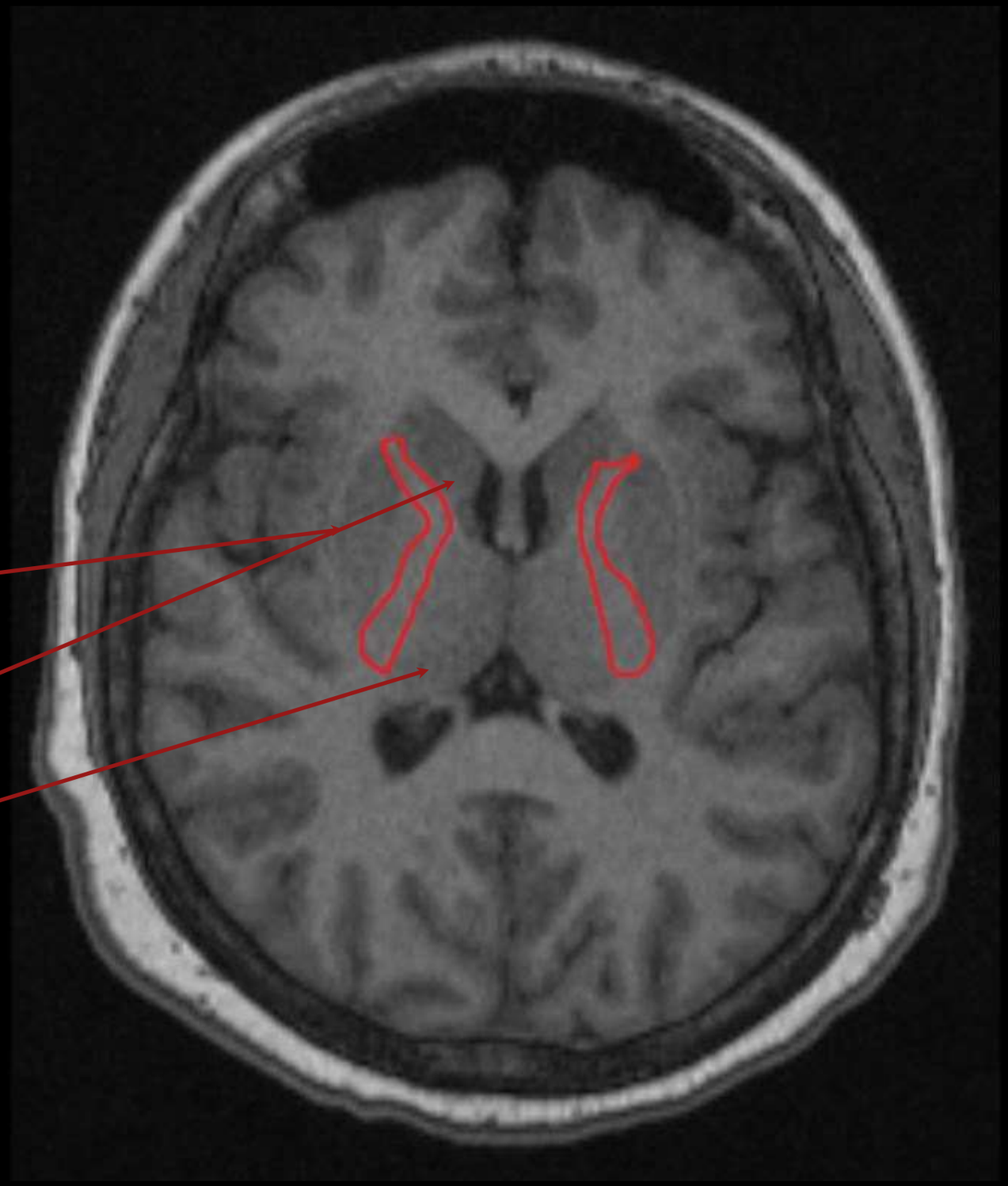
Axial

INTERNAL CAPSULE



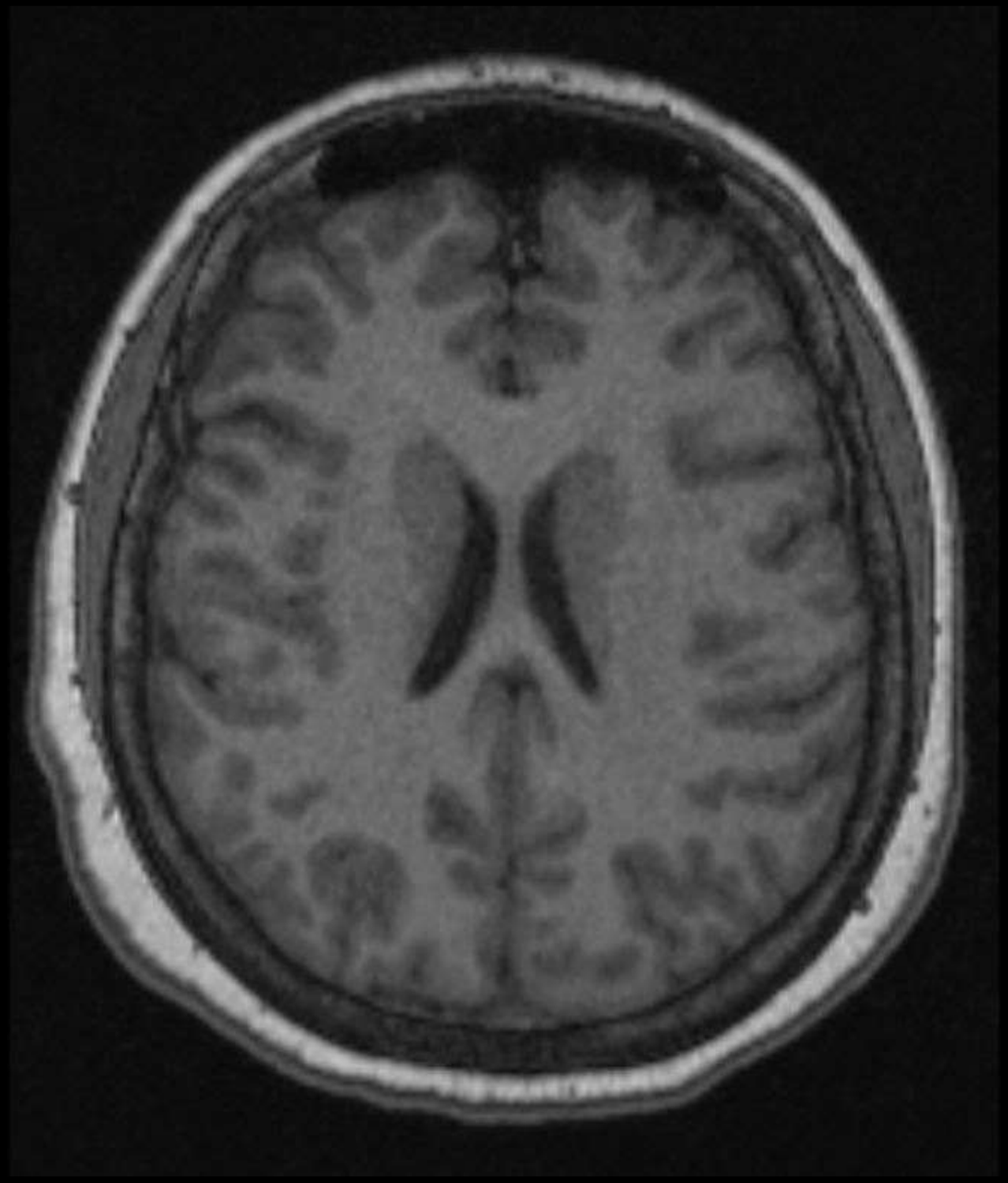
INTERNAL CAPSULE

The internal capsule is a white matter tract that separates the lentiform nucleus from the caudate nucleus and thalamus



Axial

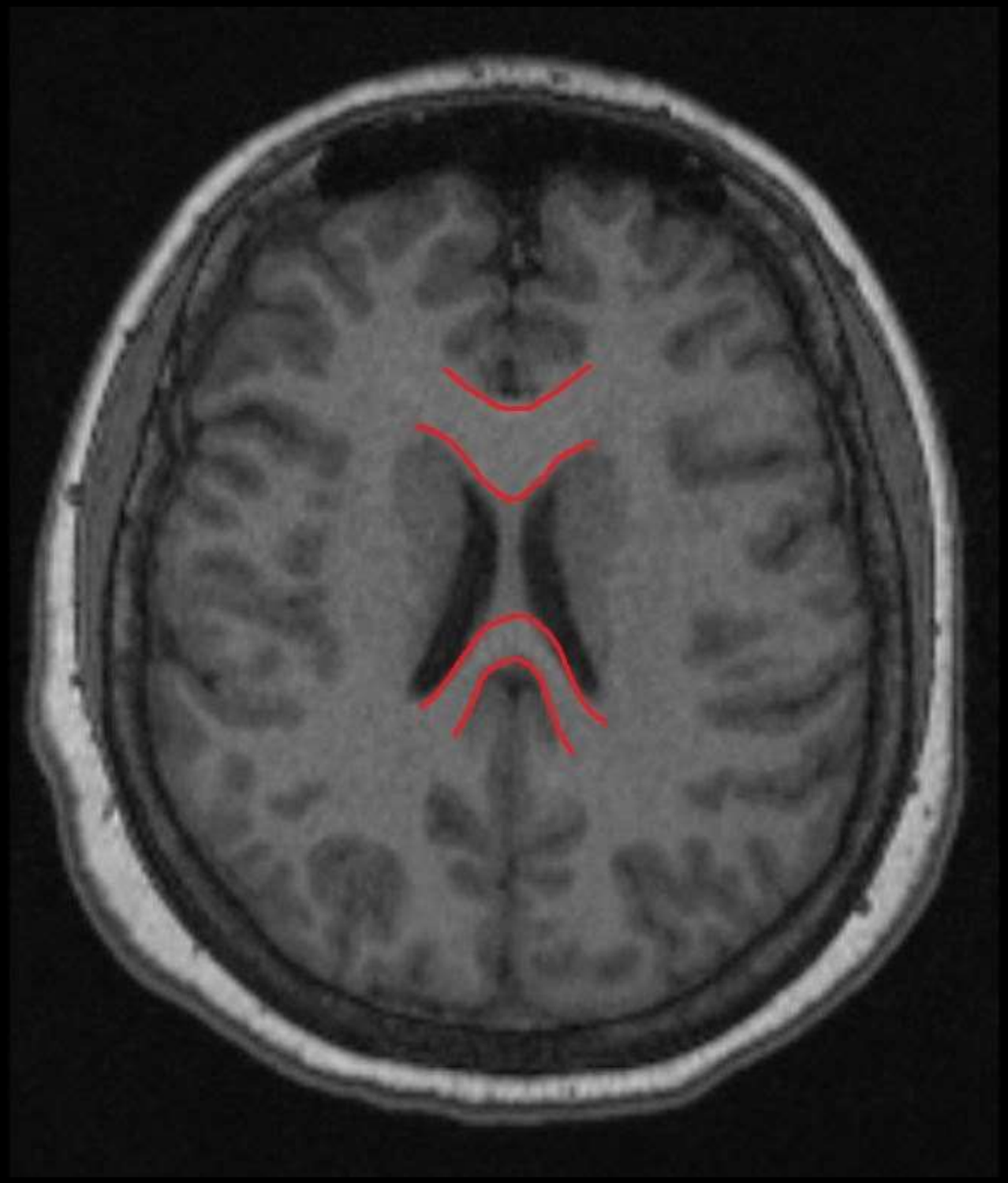
CORPUS CALLOSUM



Axial

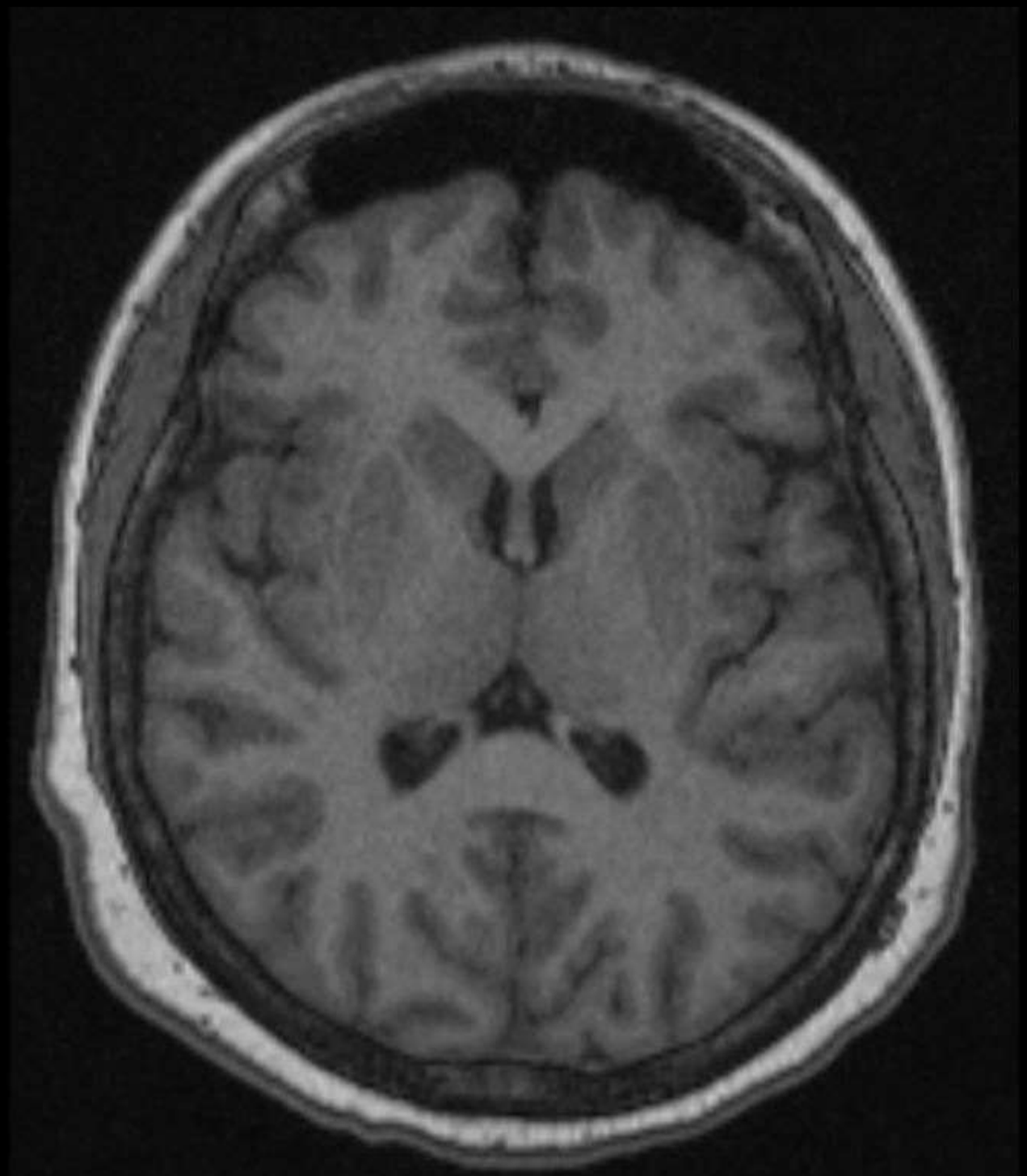
CORPUS CALLOSUM

White matter tract that connects the two cerebral hemispheres.



Axial

CORPUS CALLOSUM



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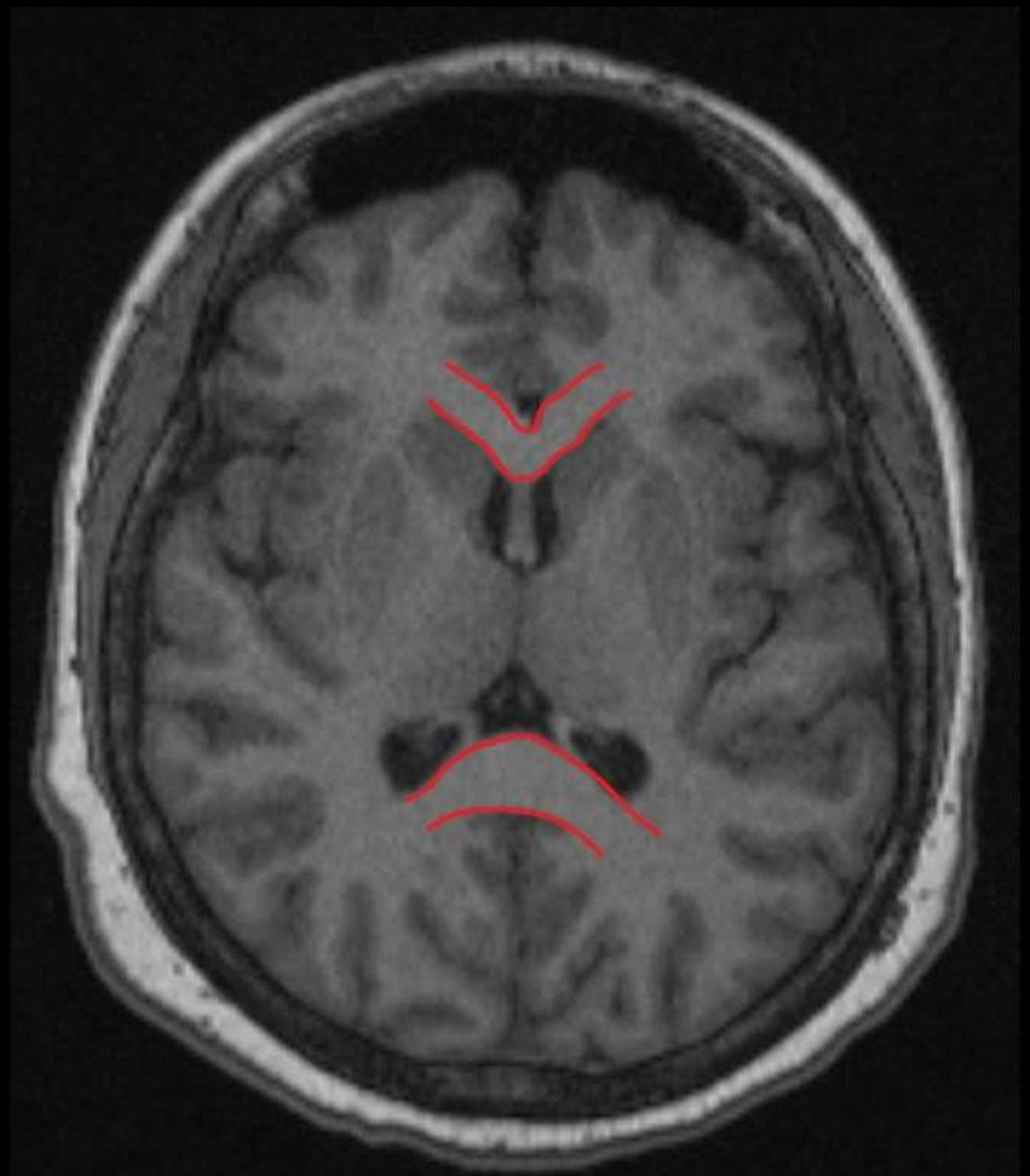
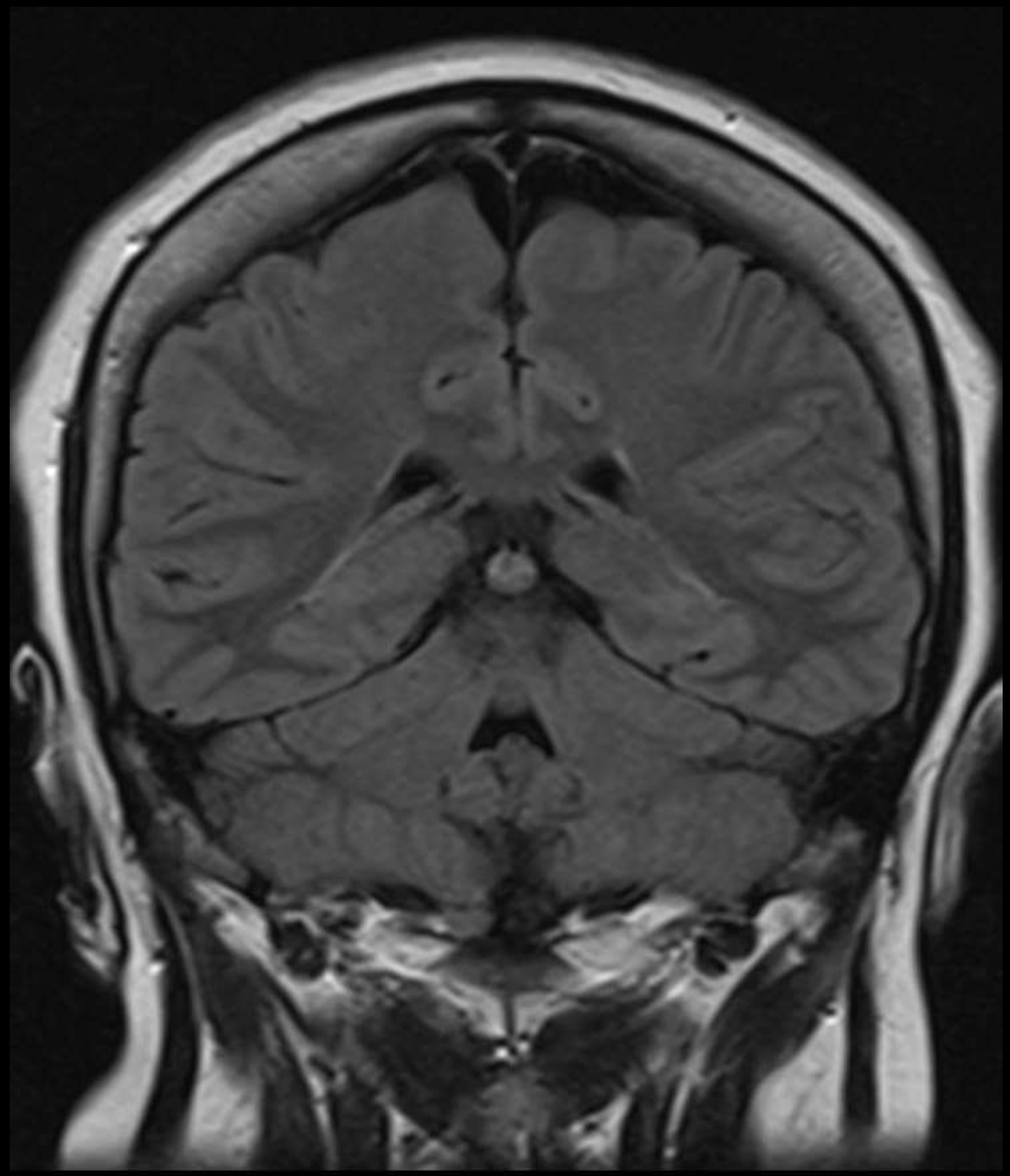
CORPUS CALLOSUM



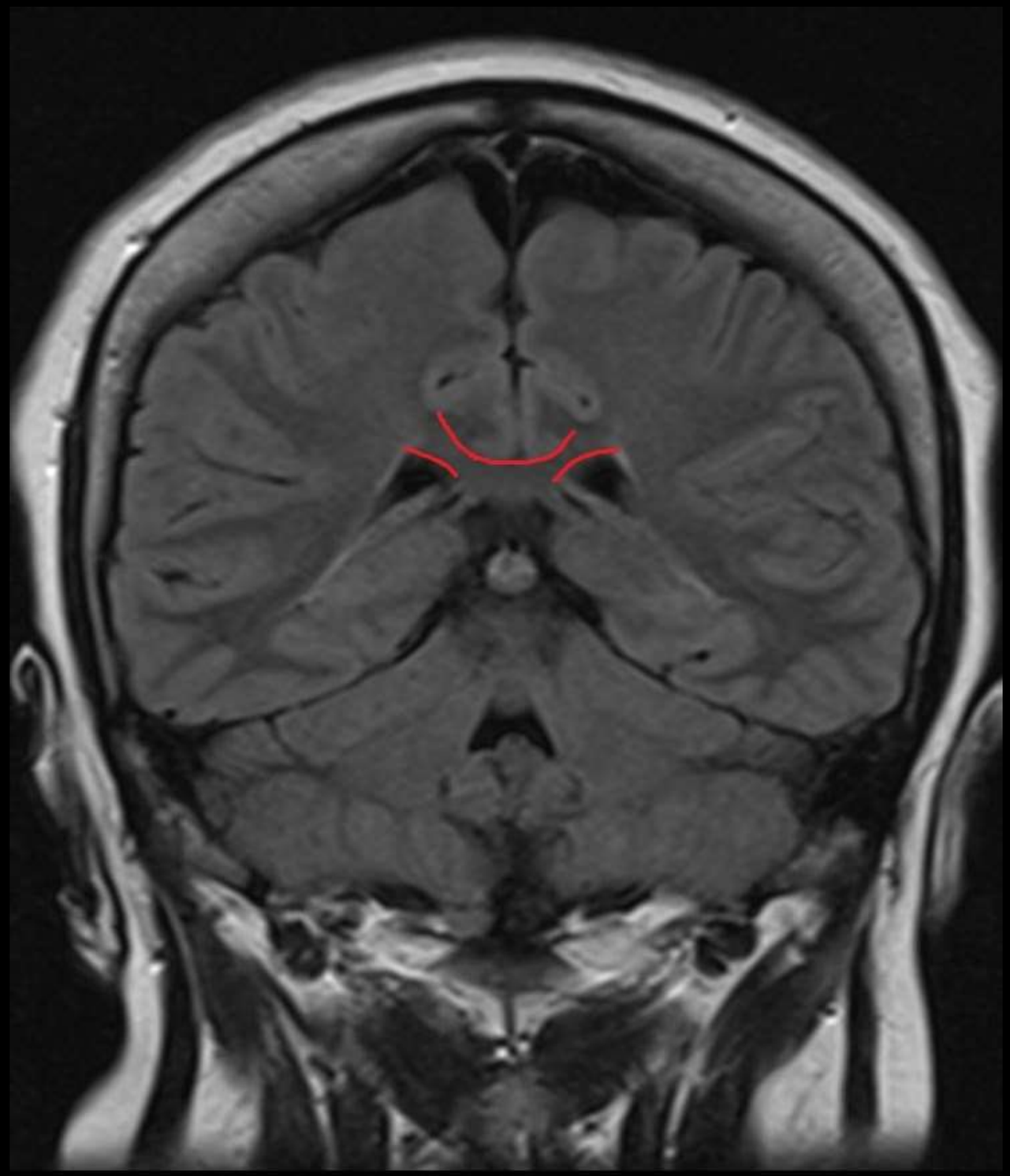
Axial

CORPUS CALLOSUM



Coronal

CORPUS CALLOSUM



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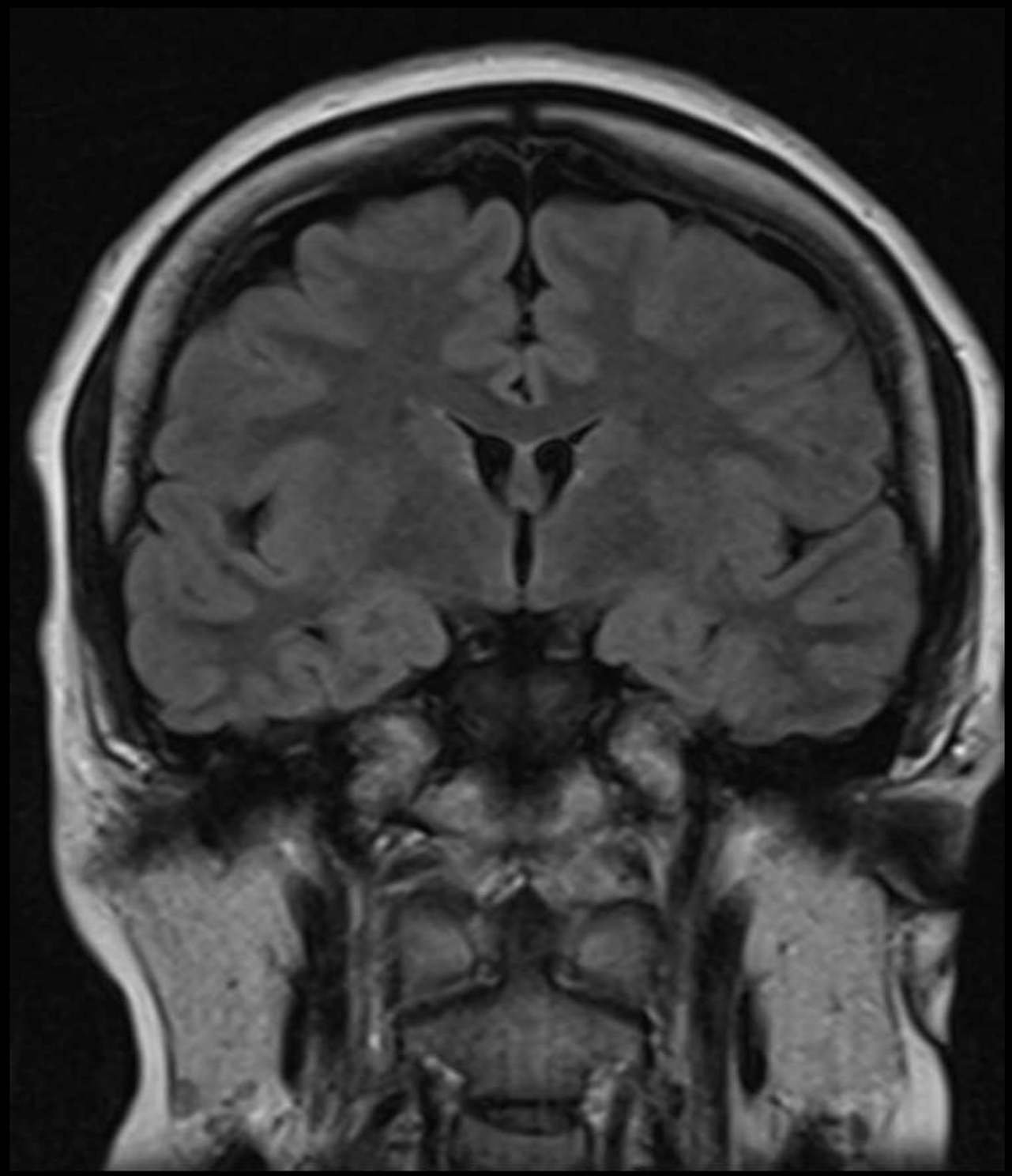

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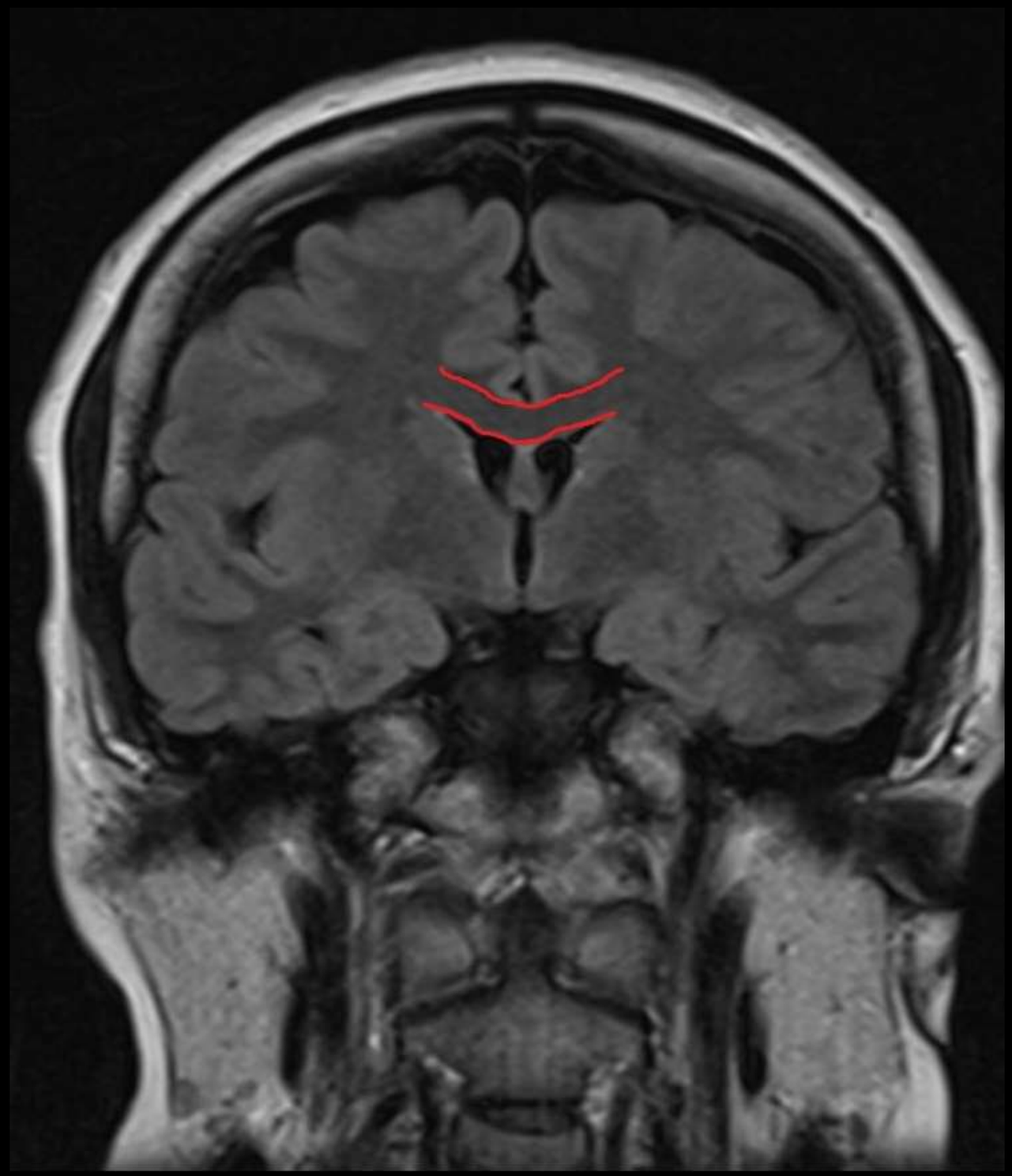


Coronal

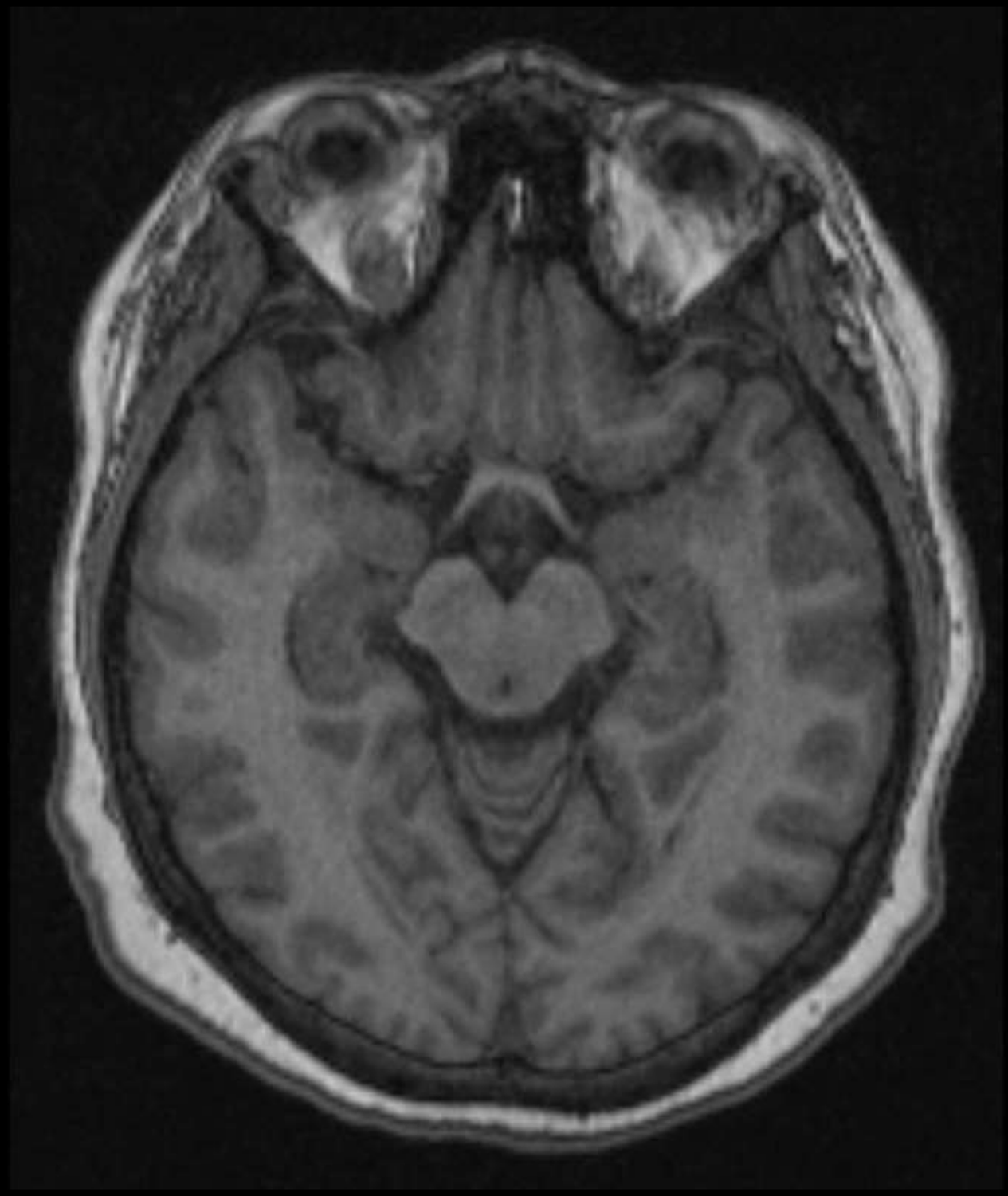
CORPUS CALLOSUM

Sagittal

CORPUS CALLOSUM

Sagittal

MIDBRAIN

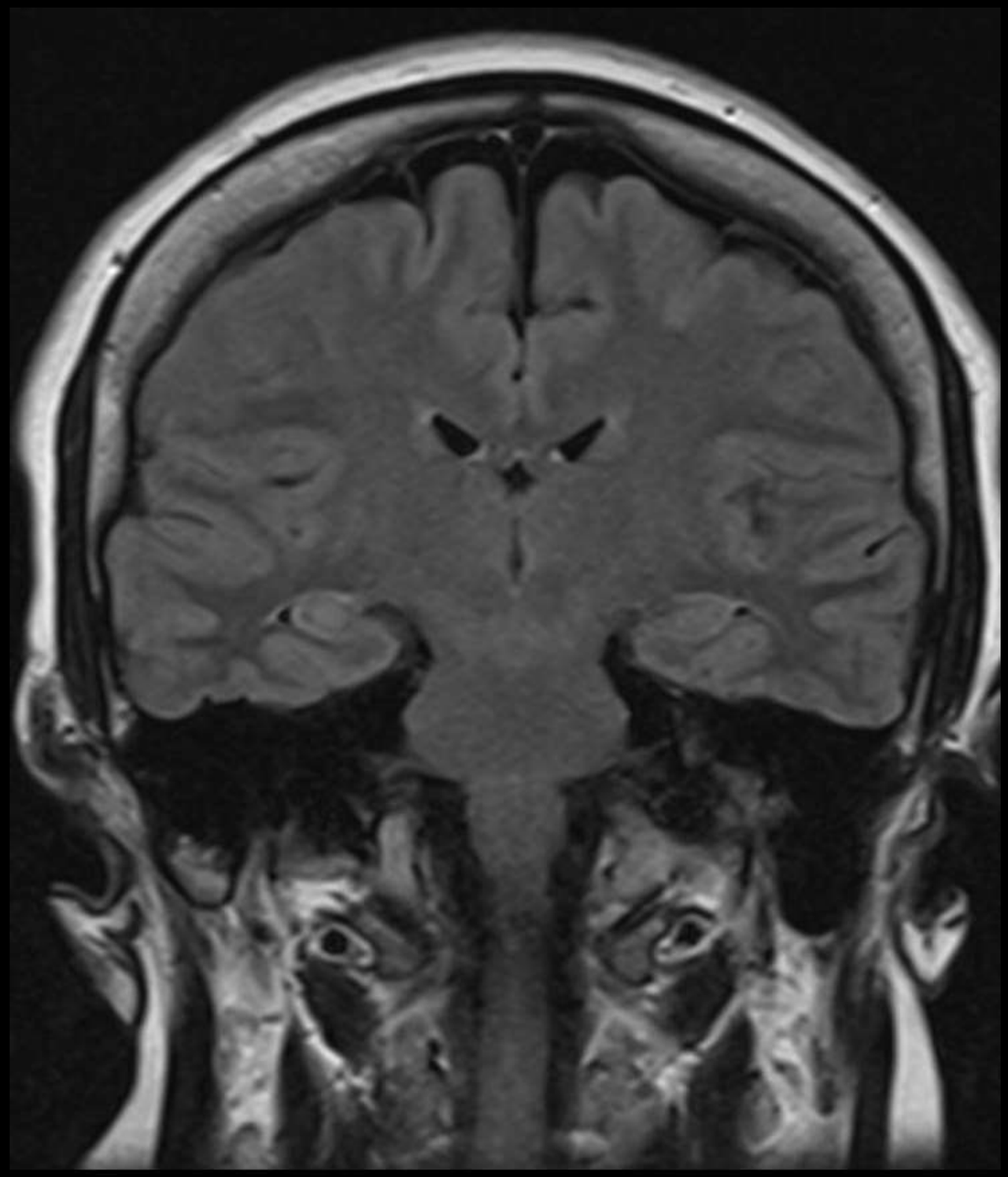


Axial

MIDBRAIN

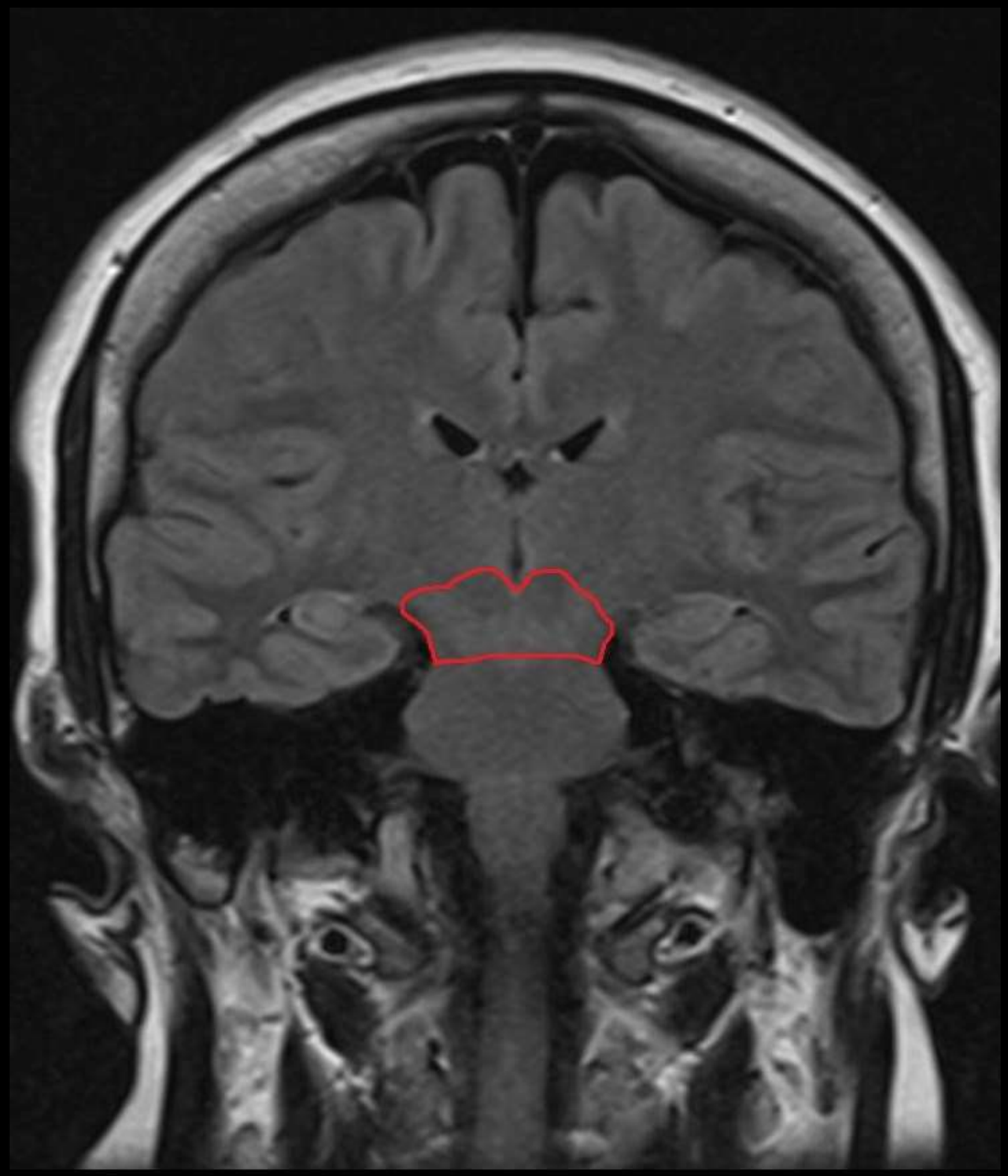
Axial

MIDBRAIN



Coronal

MIDBRAIN

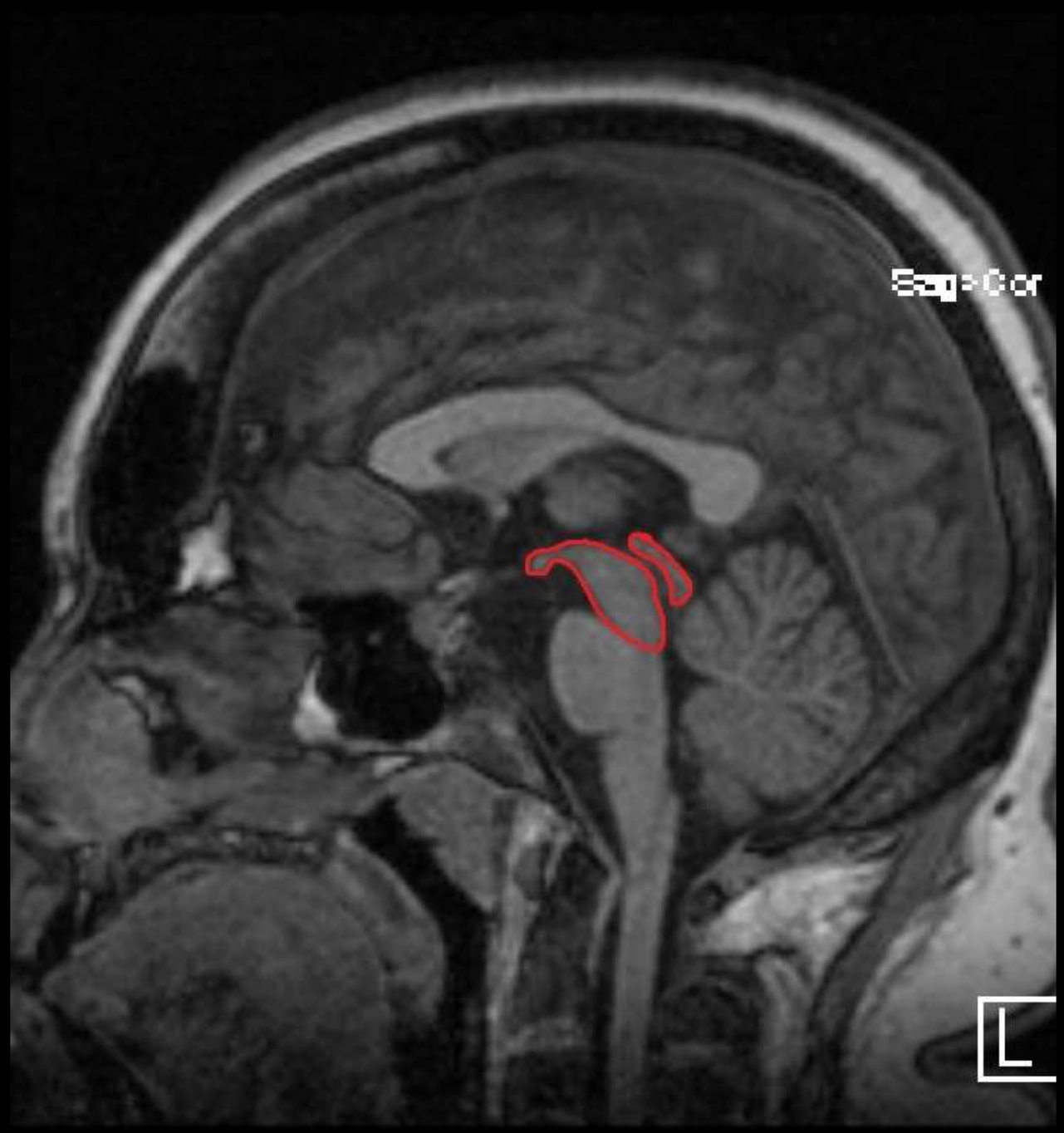


Coronal

MIDBRAIN

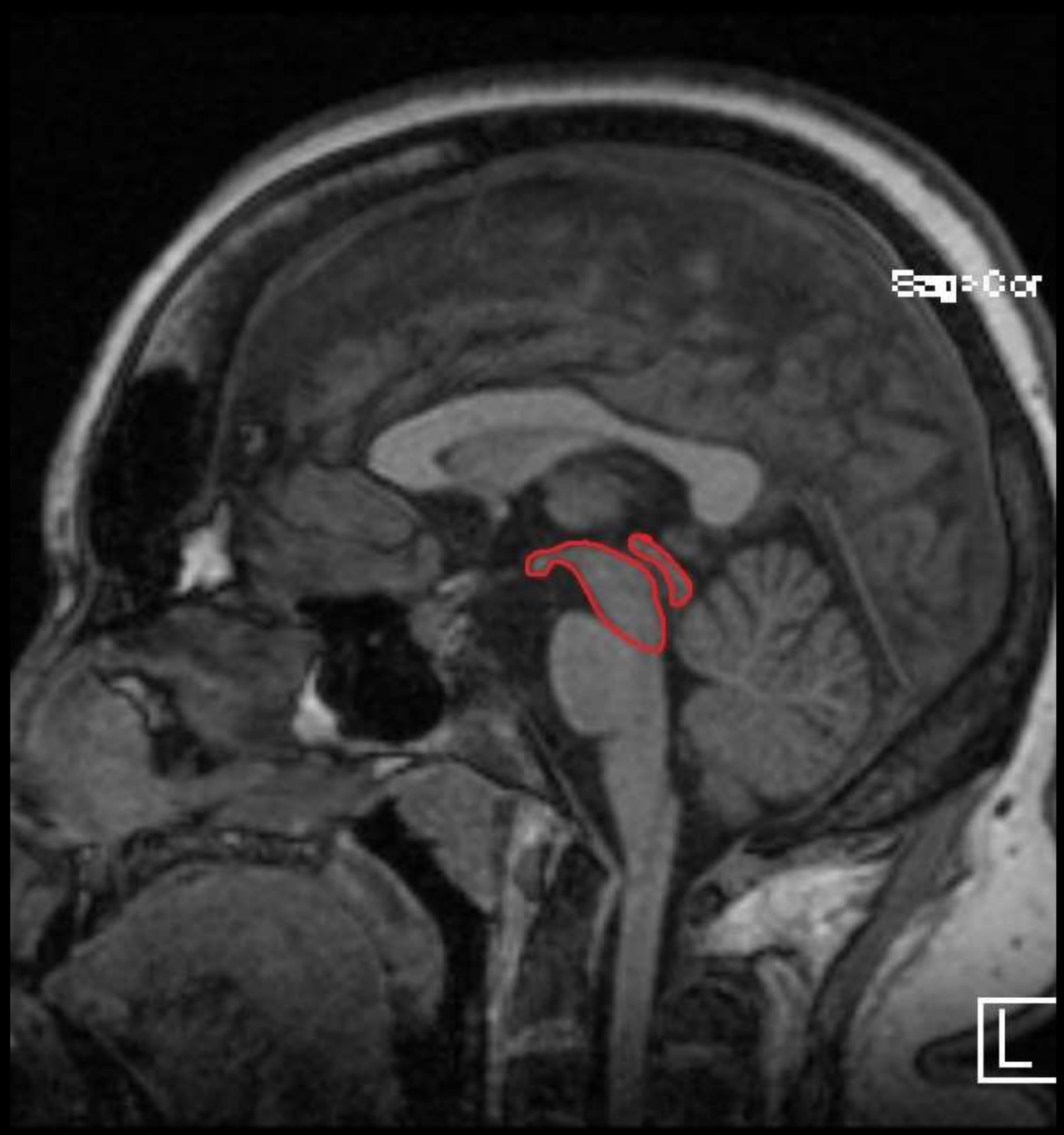
Sagittal

MIDBRAIN



Sagittal

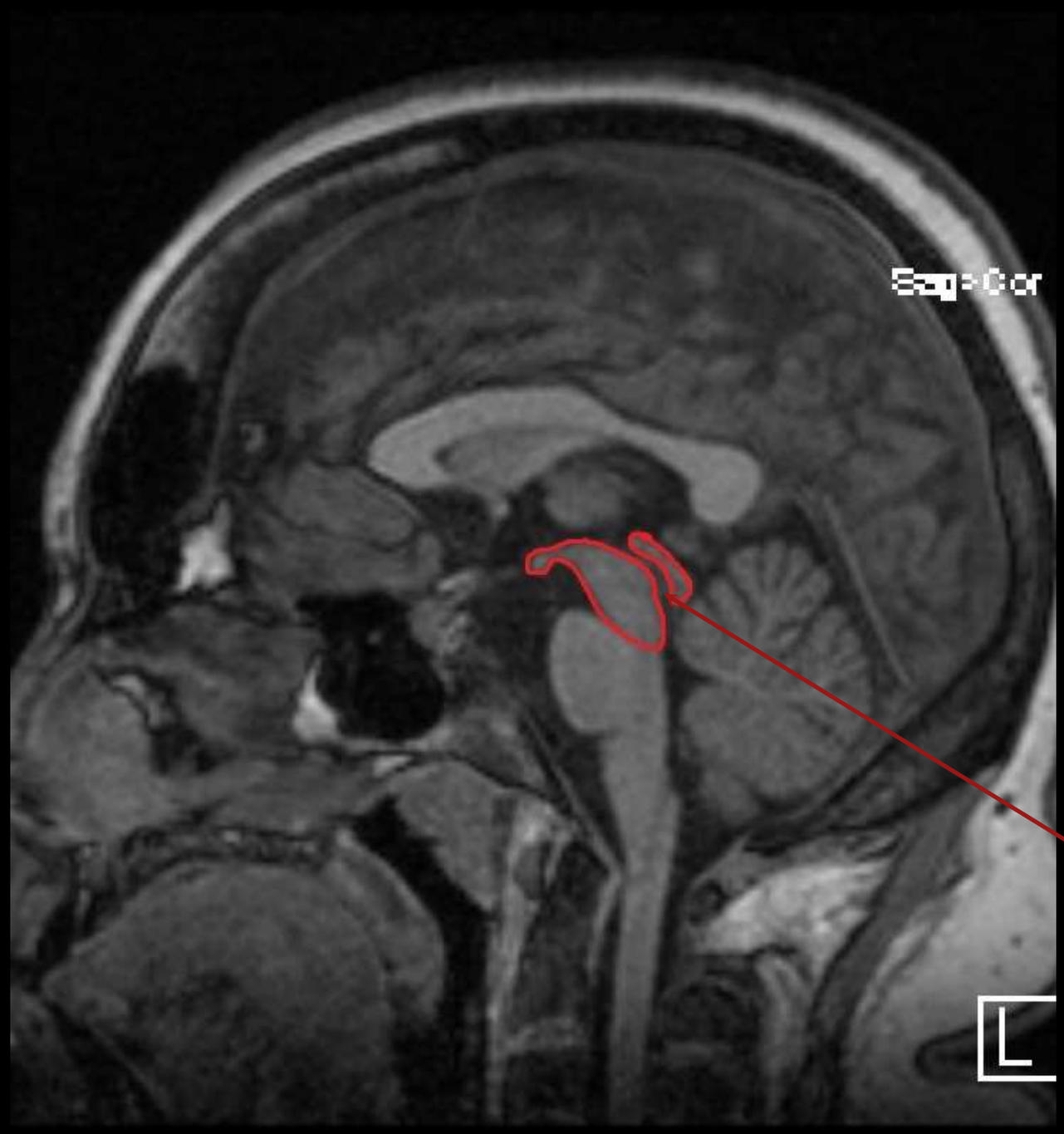
MIDBRAIN



Do you remember the name of the CSF tract that passes through the midbrain?

Sagittal

MIDBRAIN

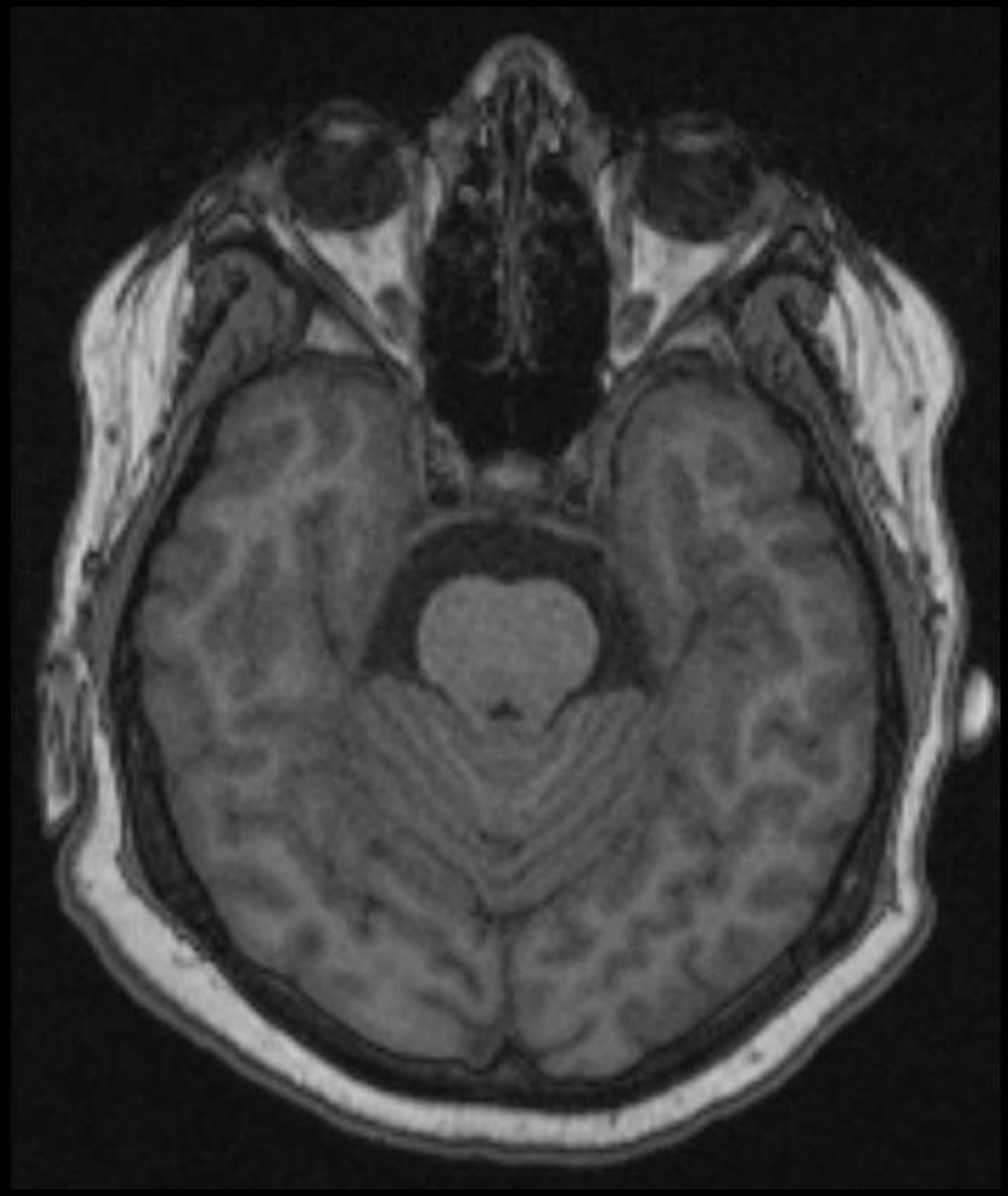


Do you remember the name of the CSF tract that passes through the midbrain?

It's the cerebral aqueduct!

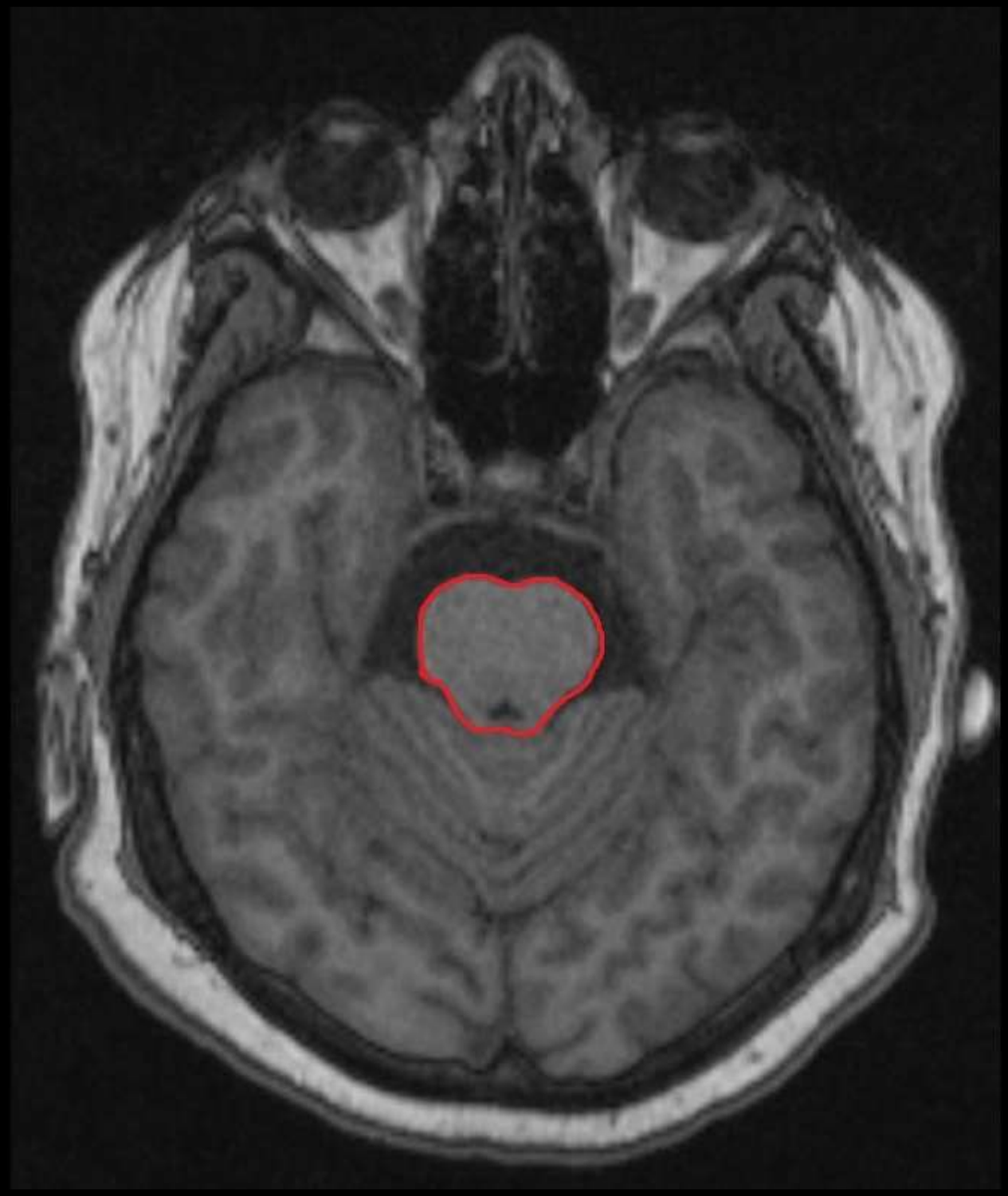
Sagittal

PONS



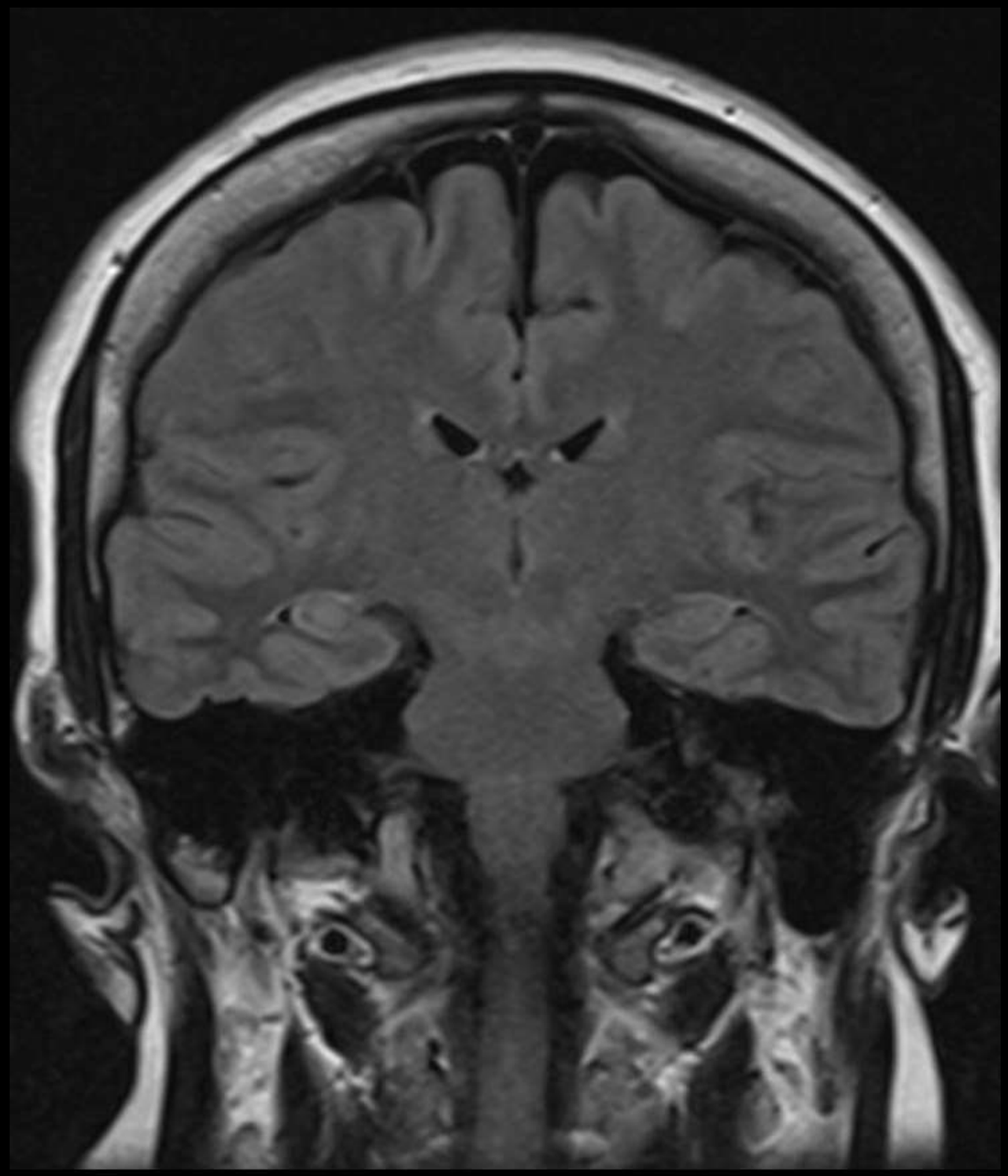
Axial

PONS



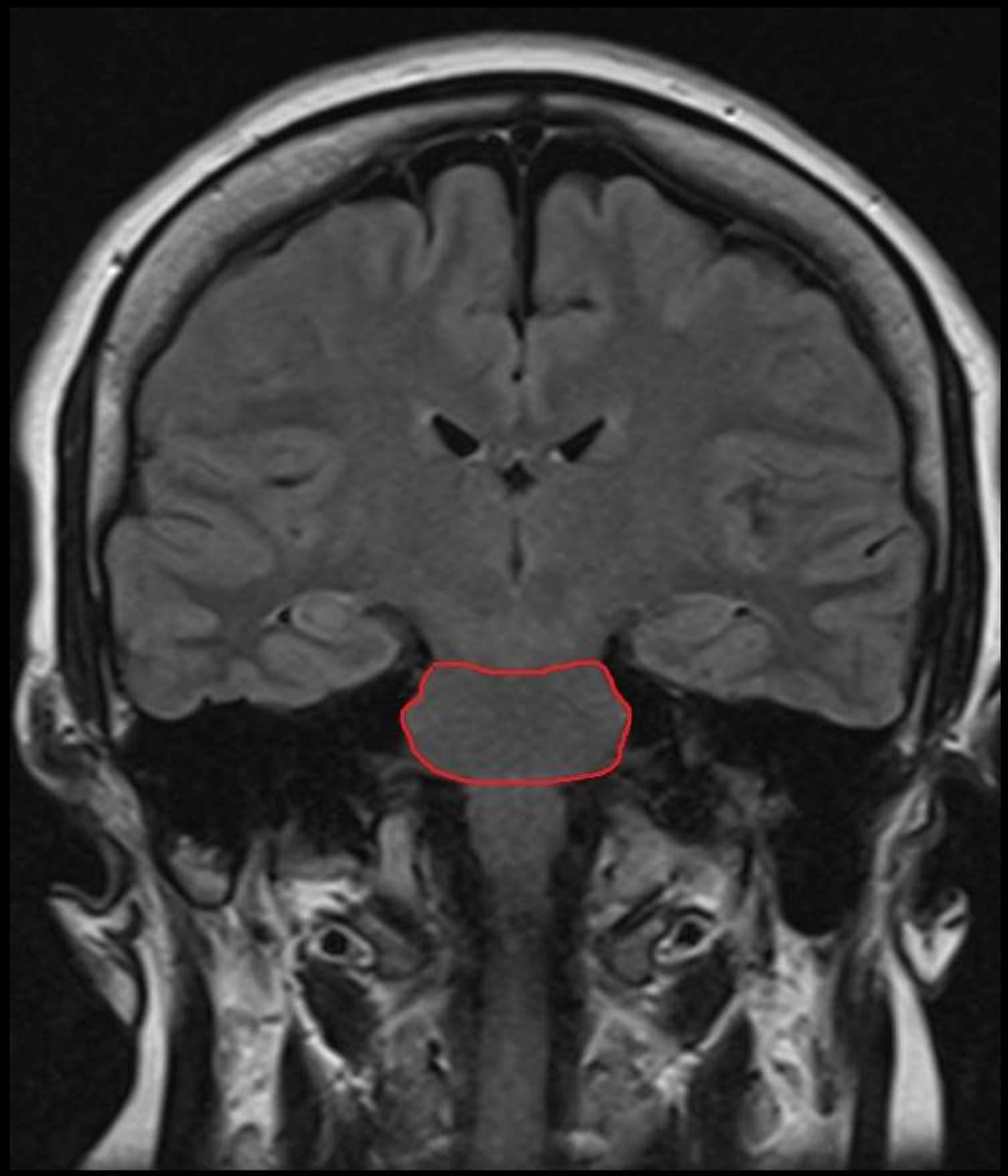
Axial

PONS



Coronal

PONS

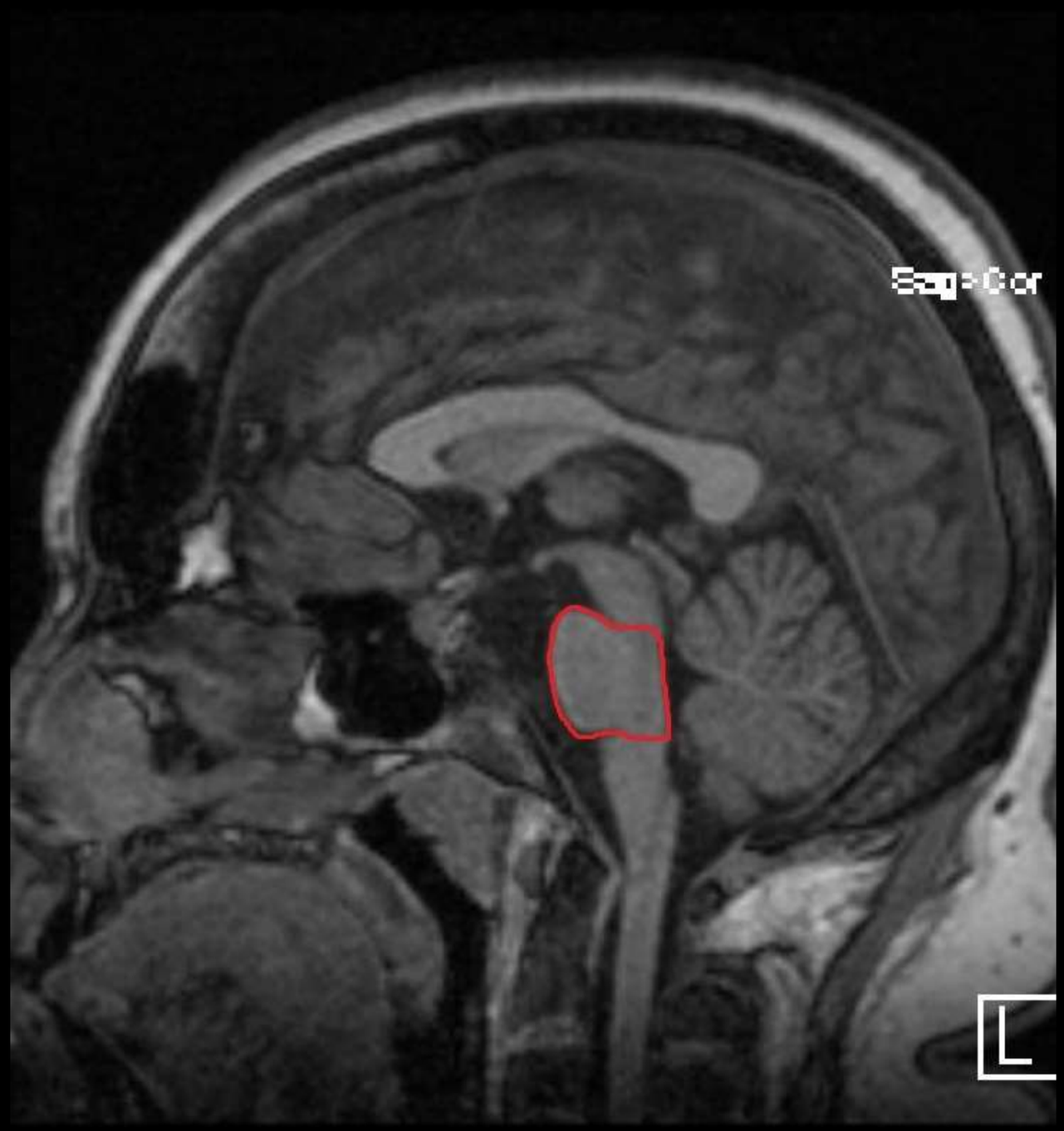


Coronal

PONS

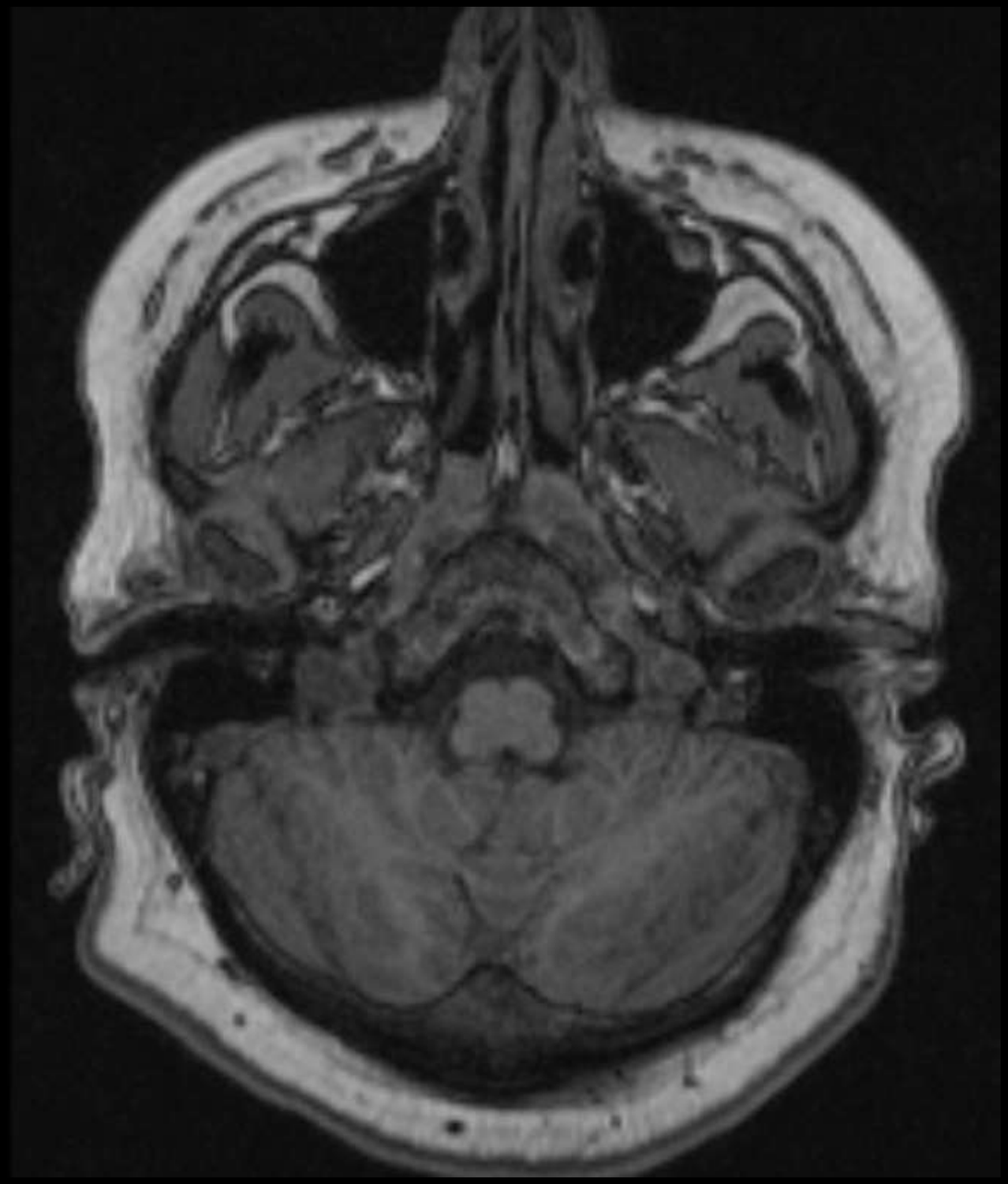
Sagittal

PONS



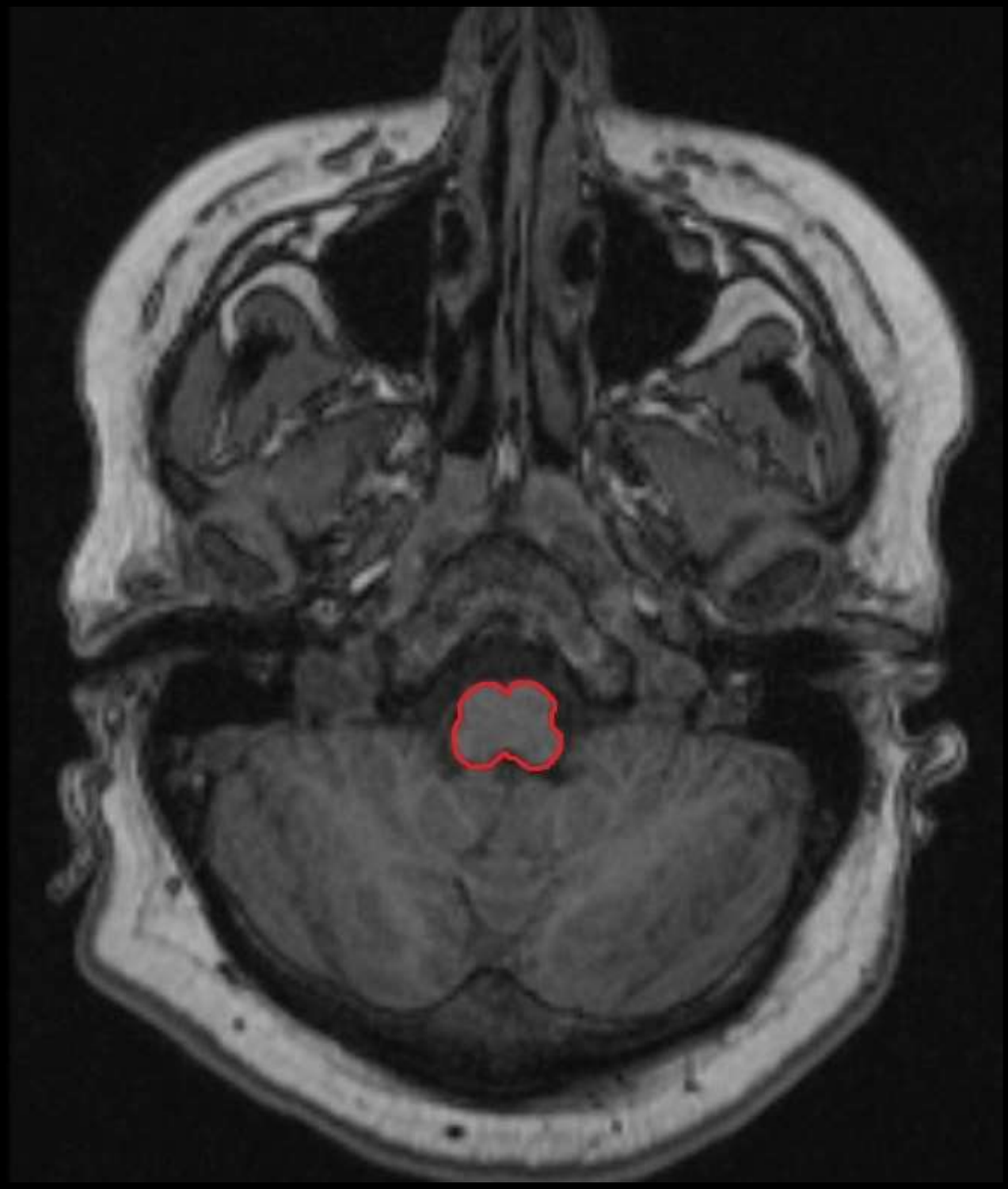
Sagittal

MEDULLA



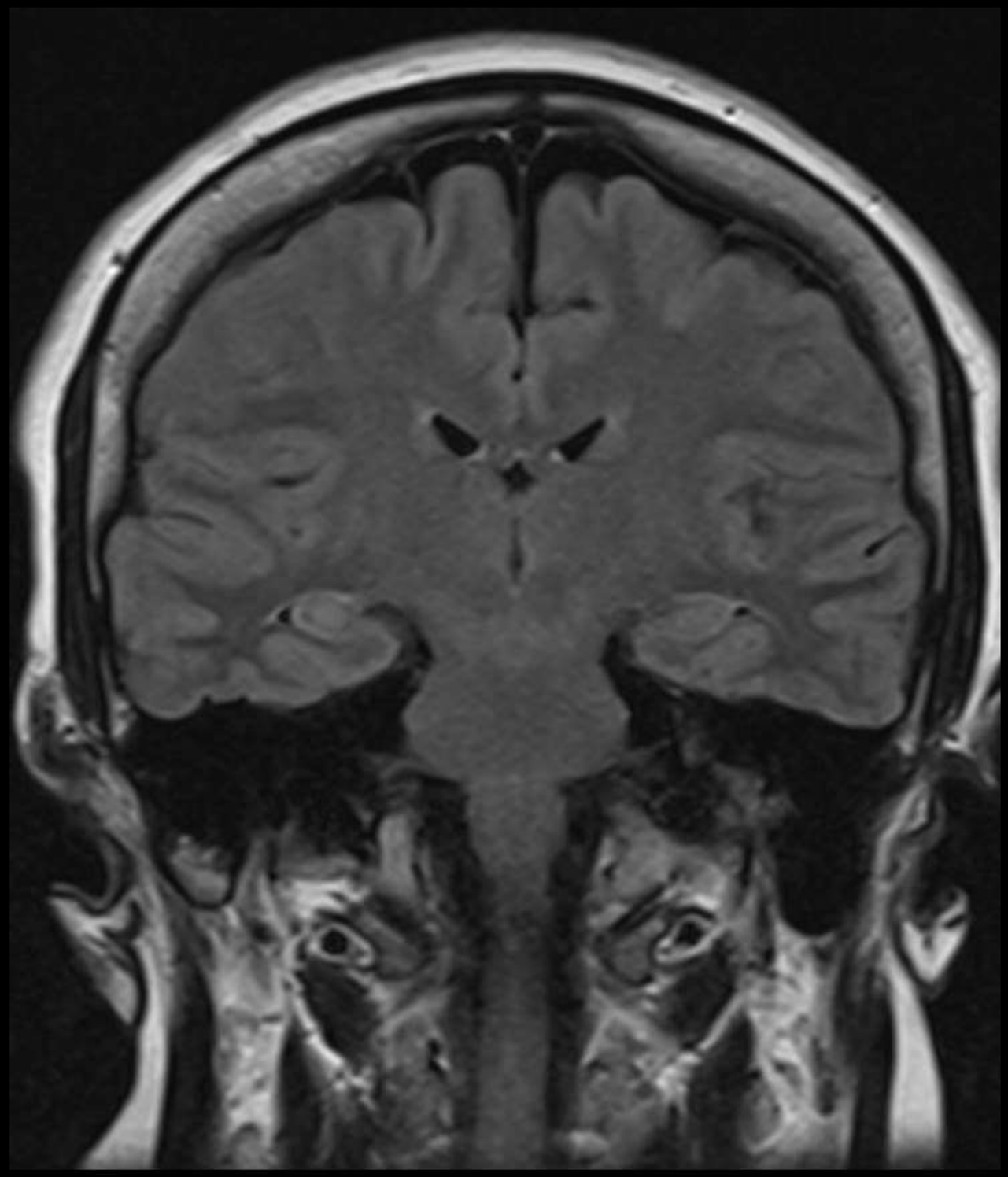
Axial

MEDULLA



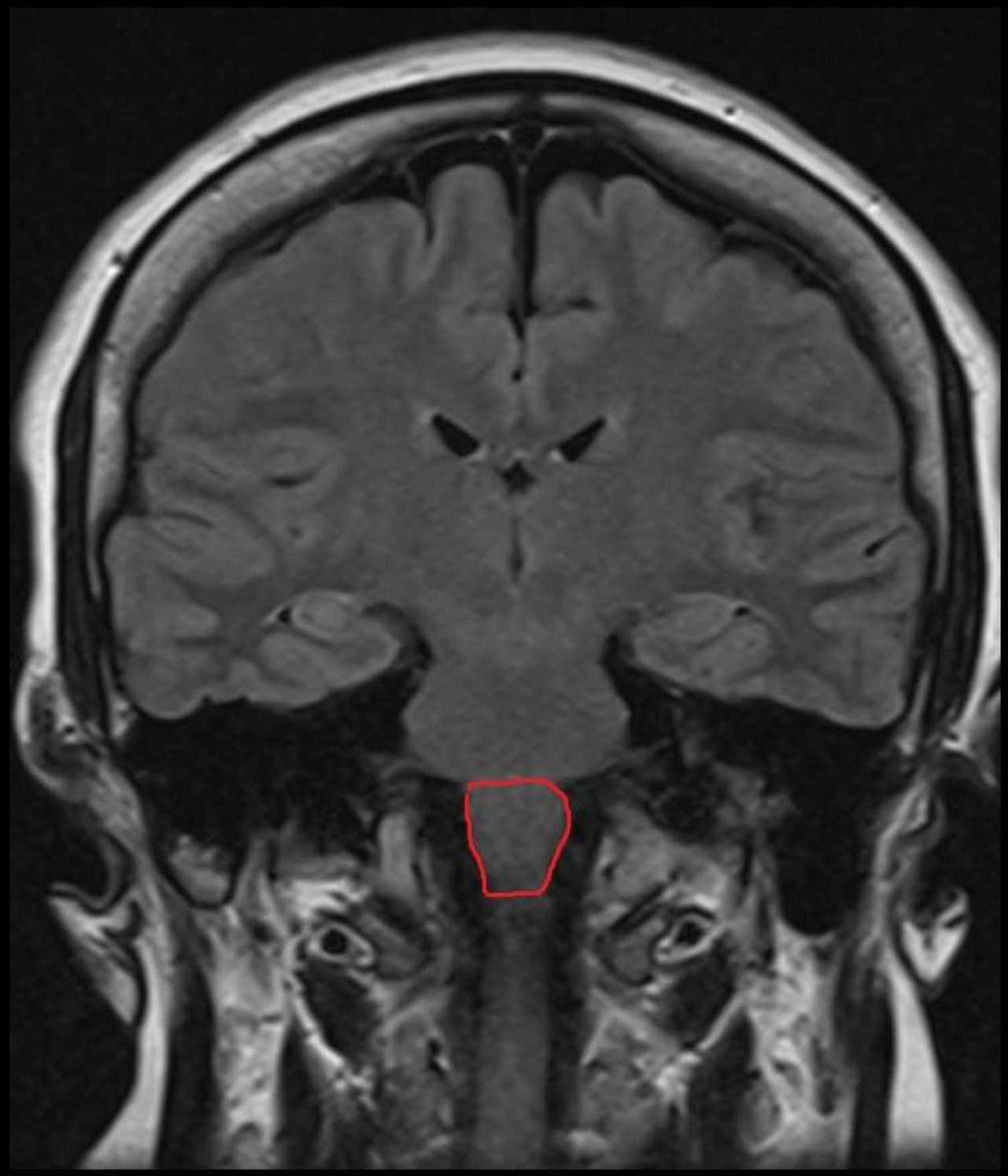
Axial

MEDULLA



Coronal

MEDULLA

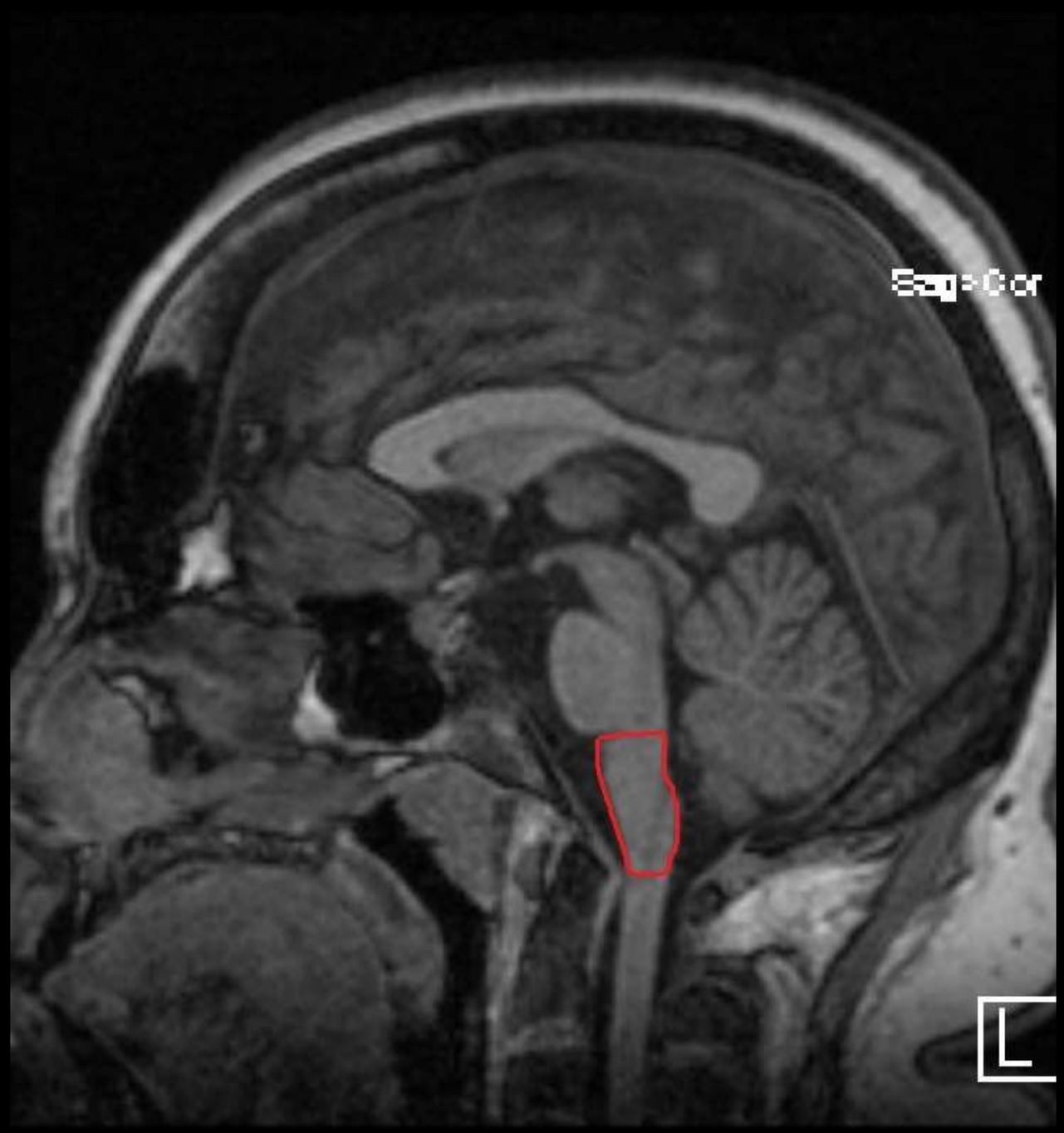


Coronal

MEDULLA

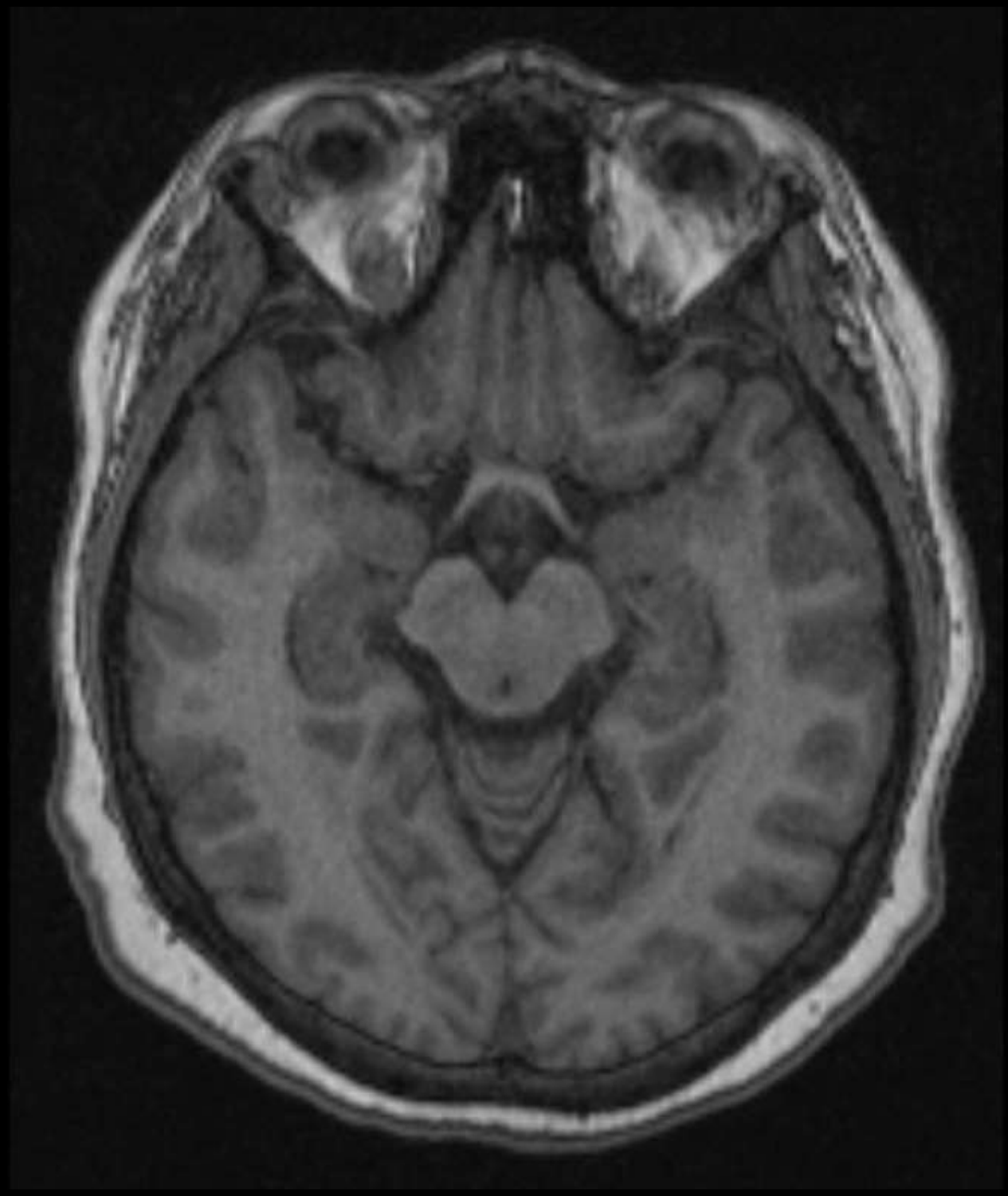
Sagittal

MEDULLA



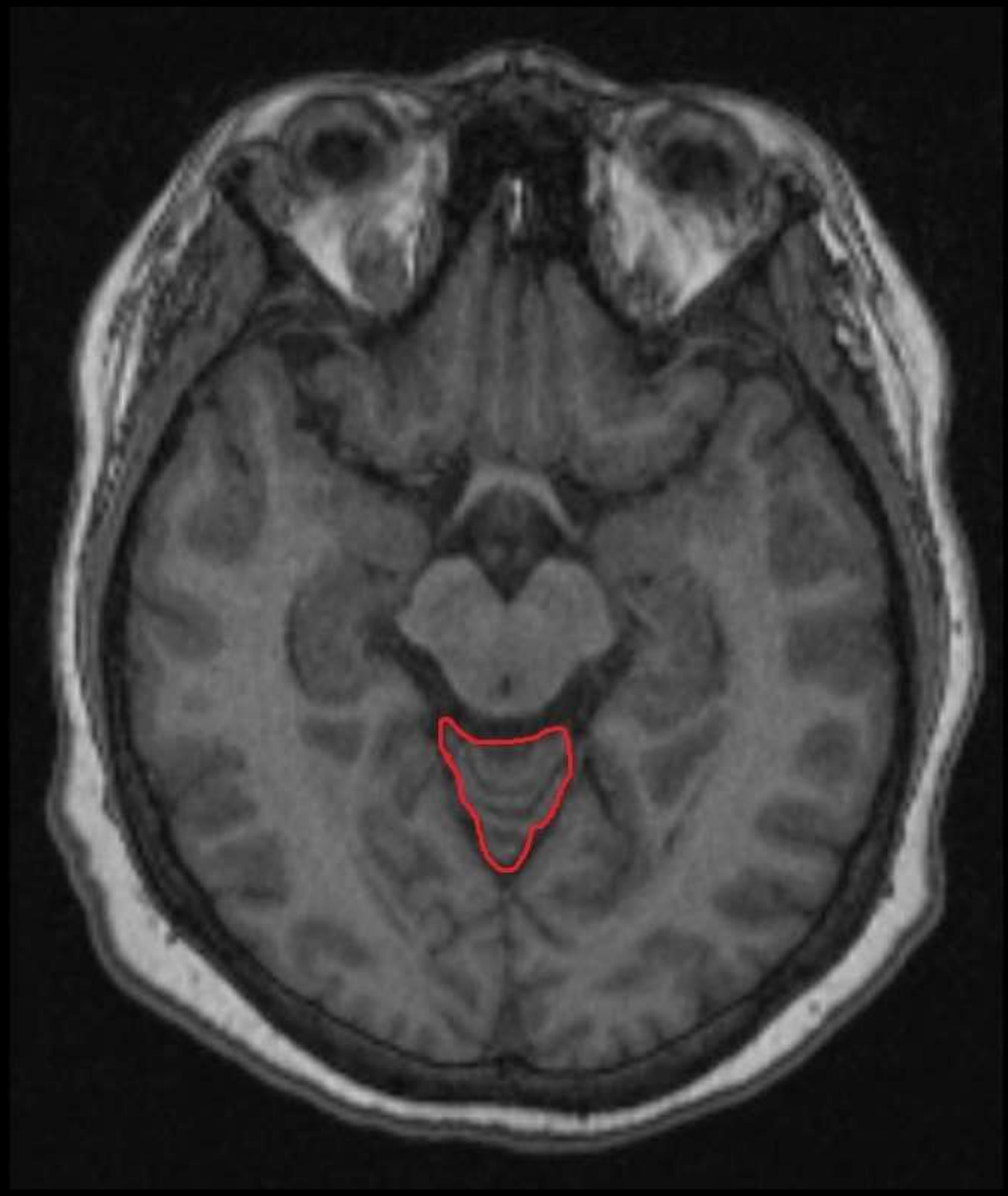
Sagittal

CEREBELLUM



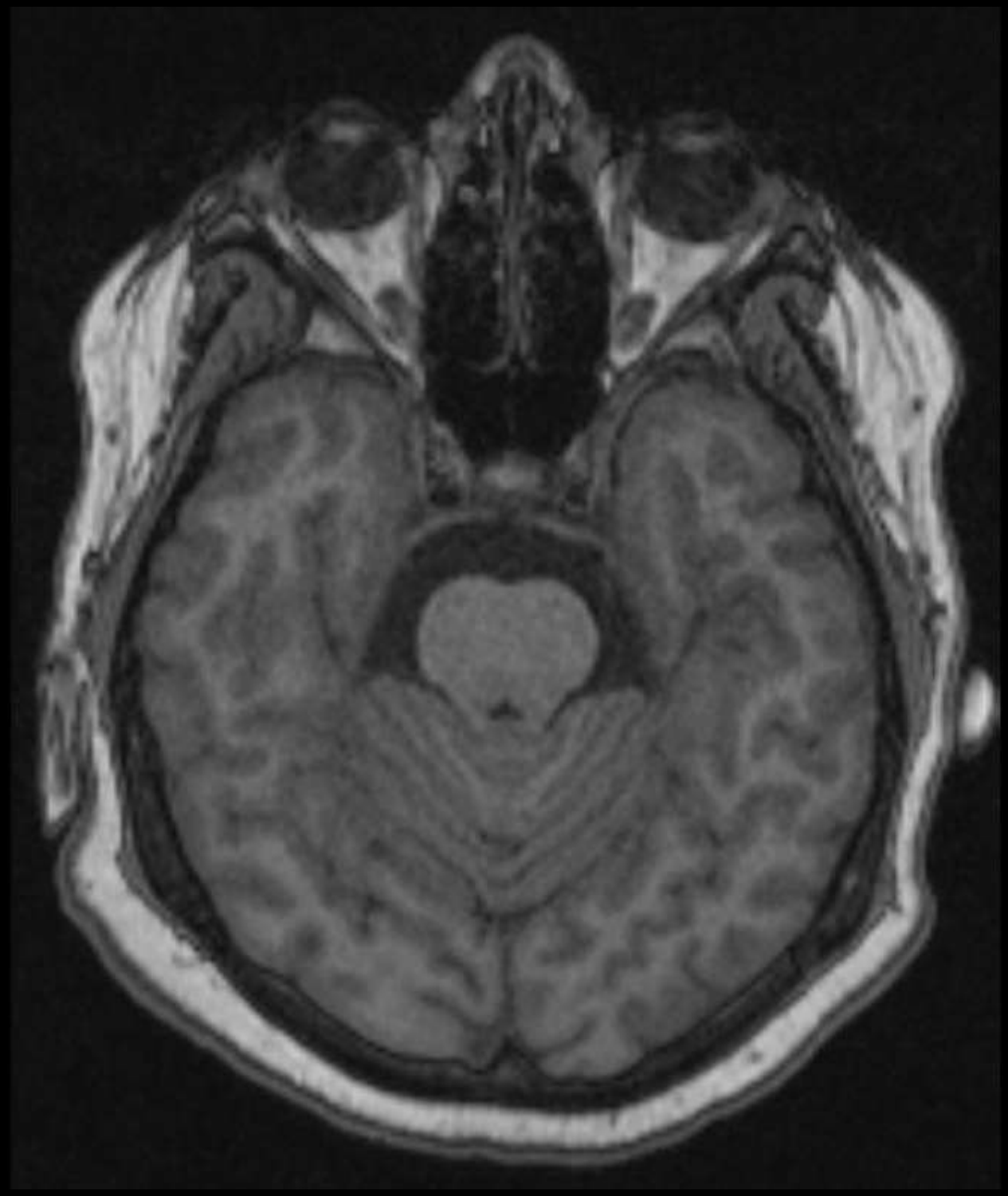
Axial

CEREBELLUM



Axial

CEREBELLUM

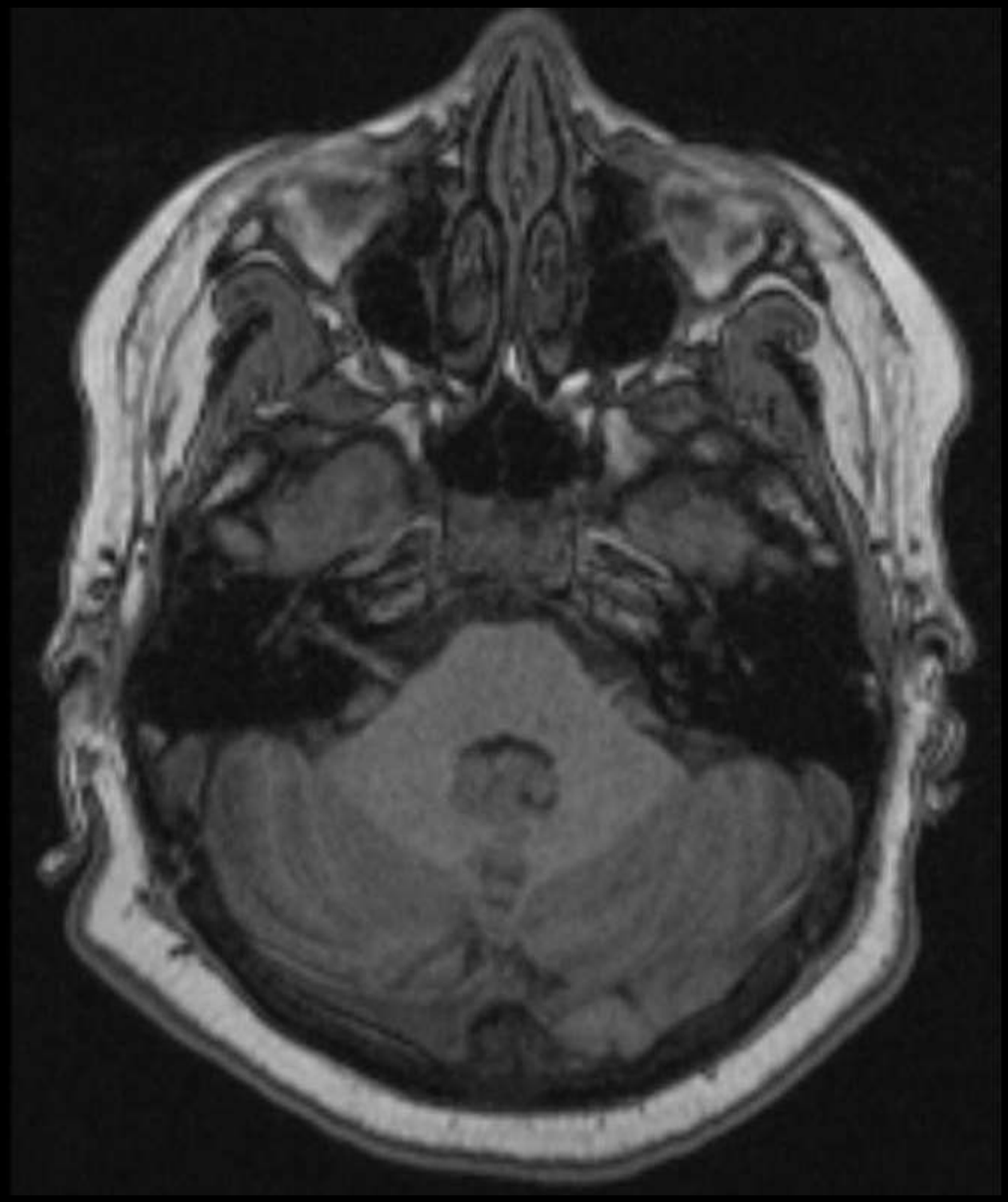


Axial

CEREBELLUM

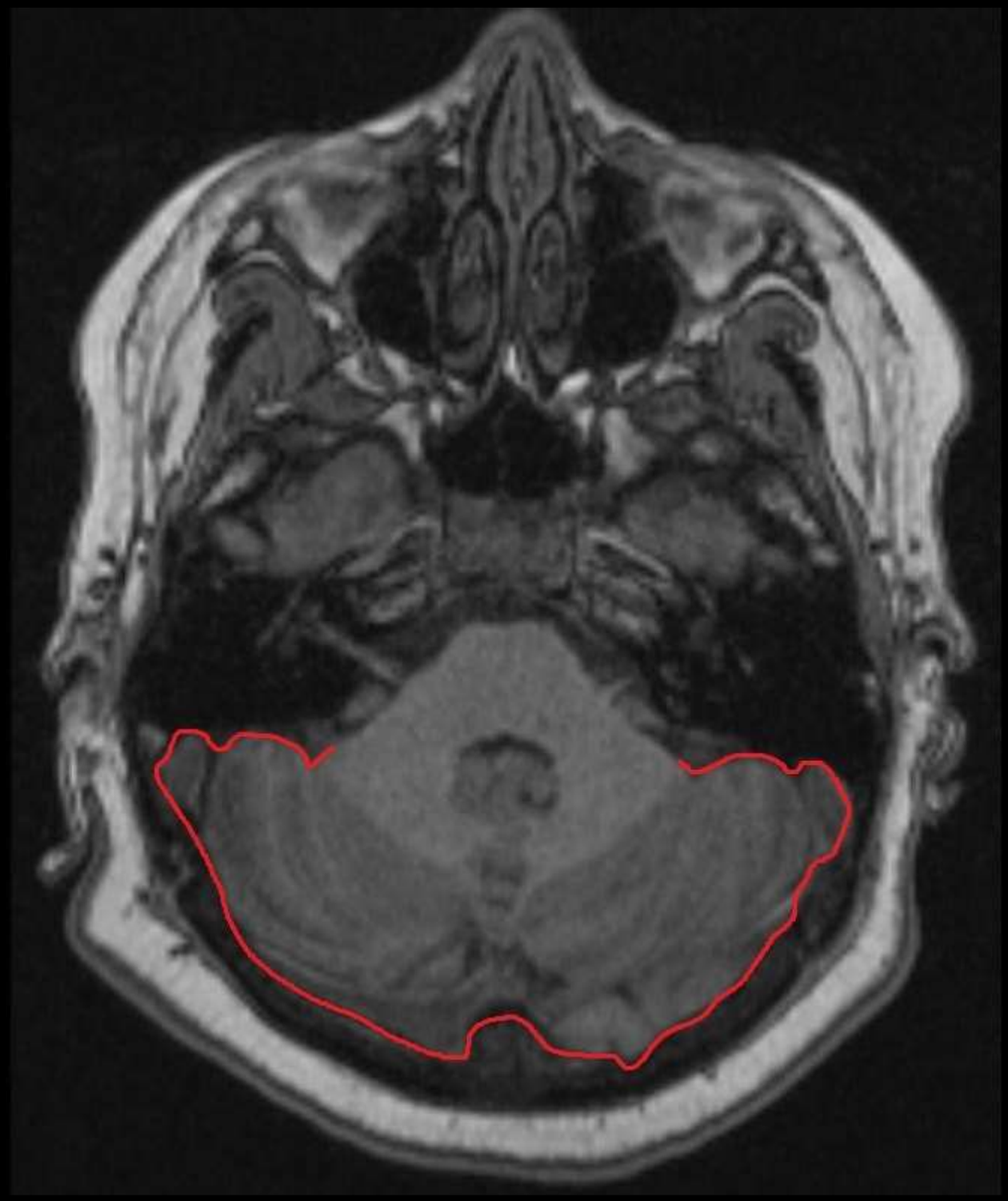
Axial

CEREBELLUM



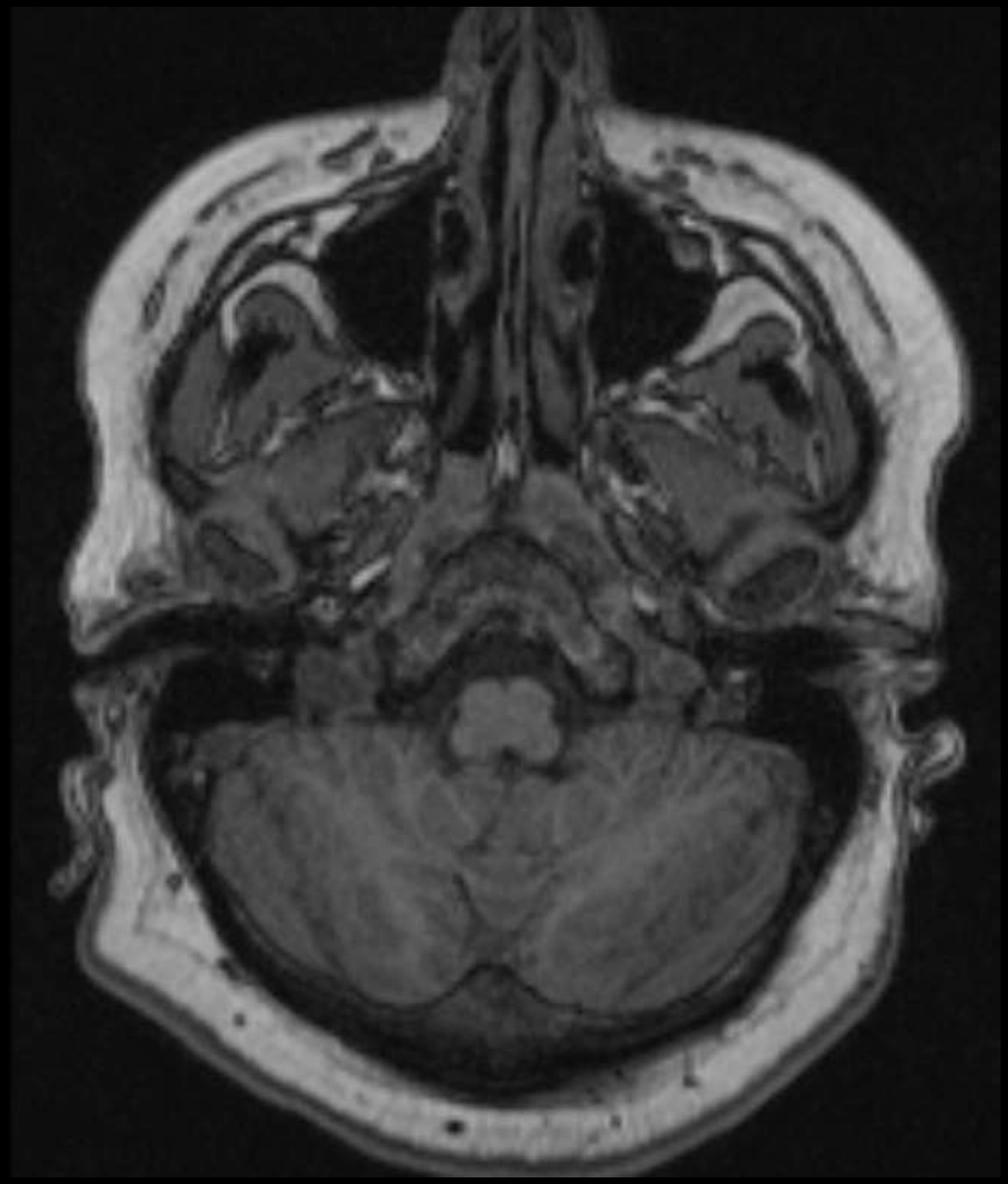
Axial

CEREBELLUM



Axial

CEREBELLUM

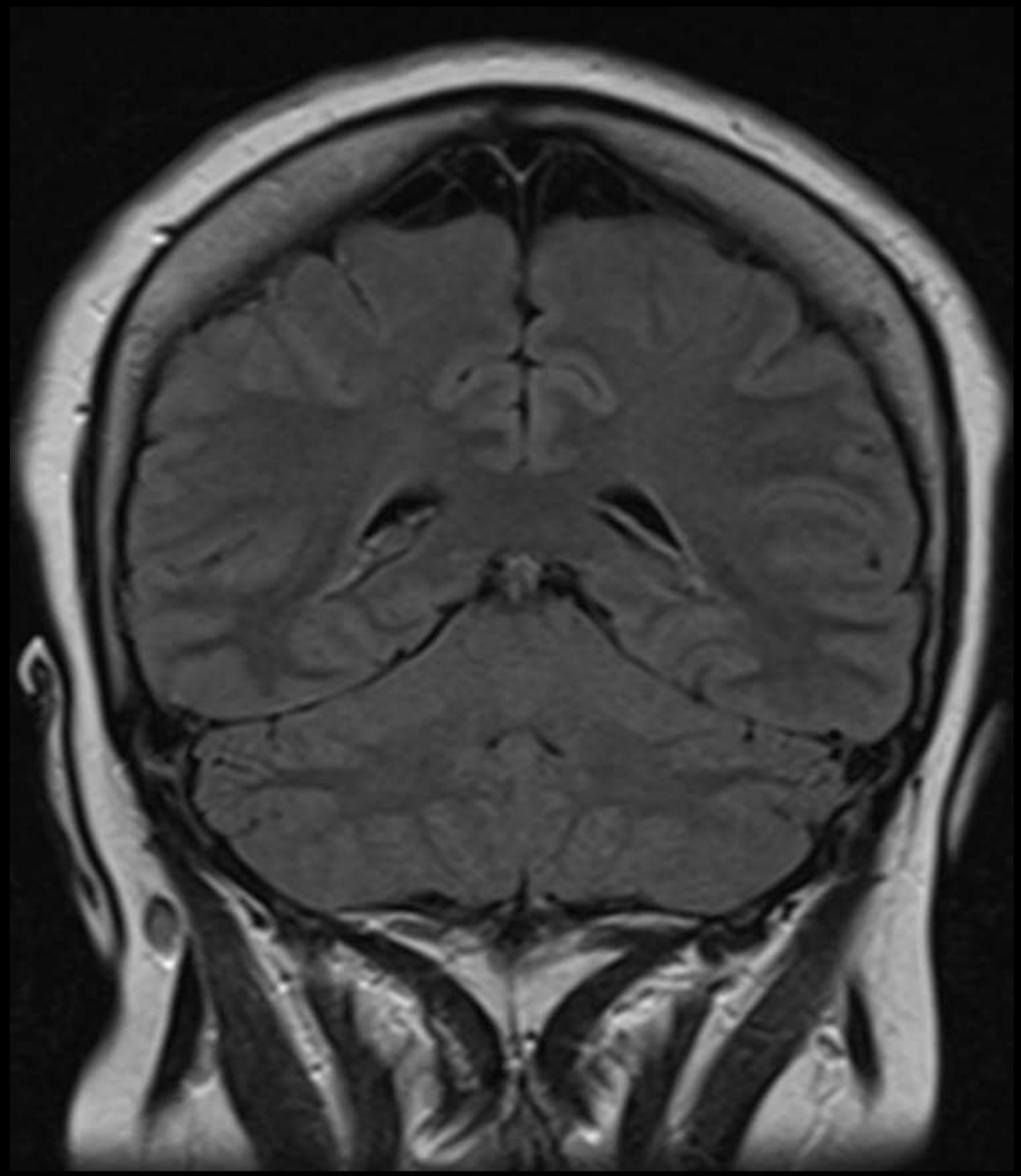


Axial

CEREBELLUM

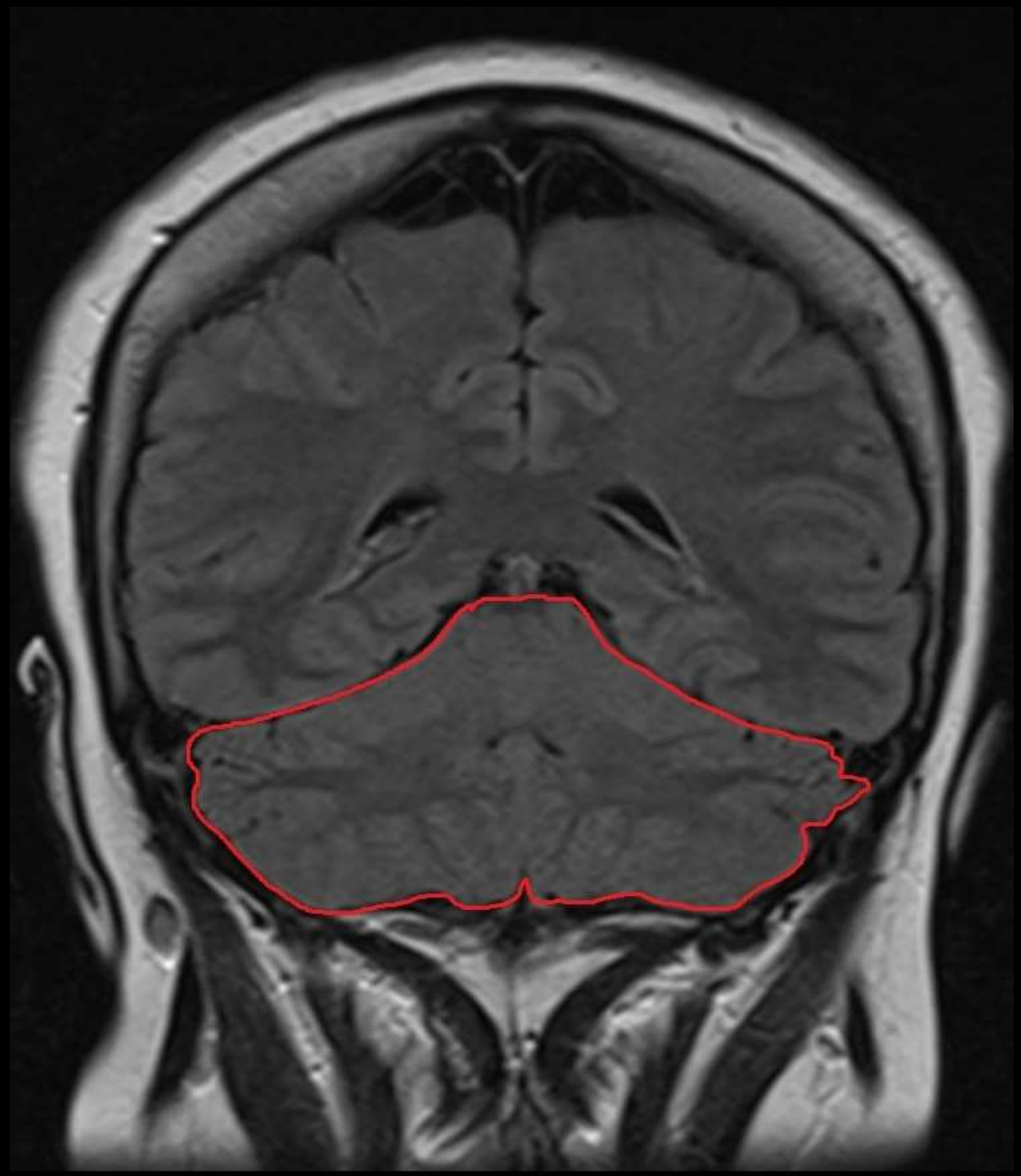
Axial

CEREBELLUM



Coronal

CEREBELLUM

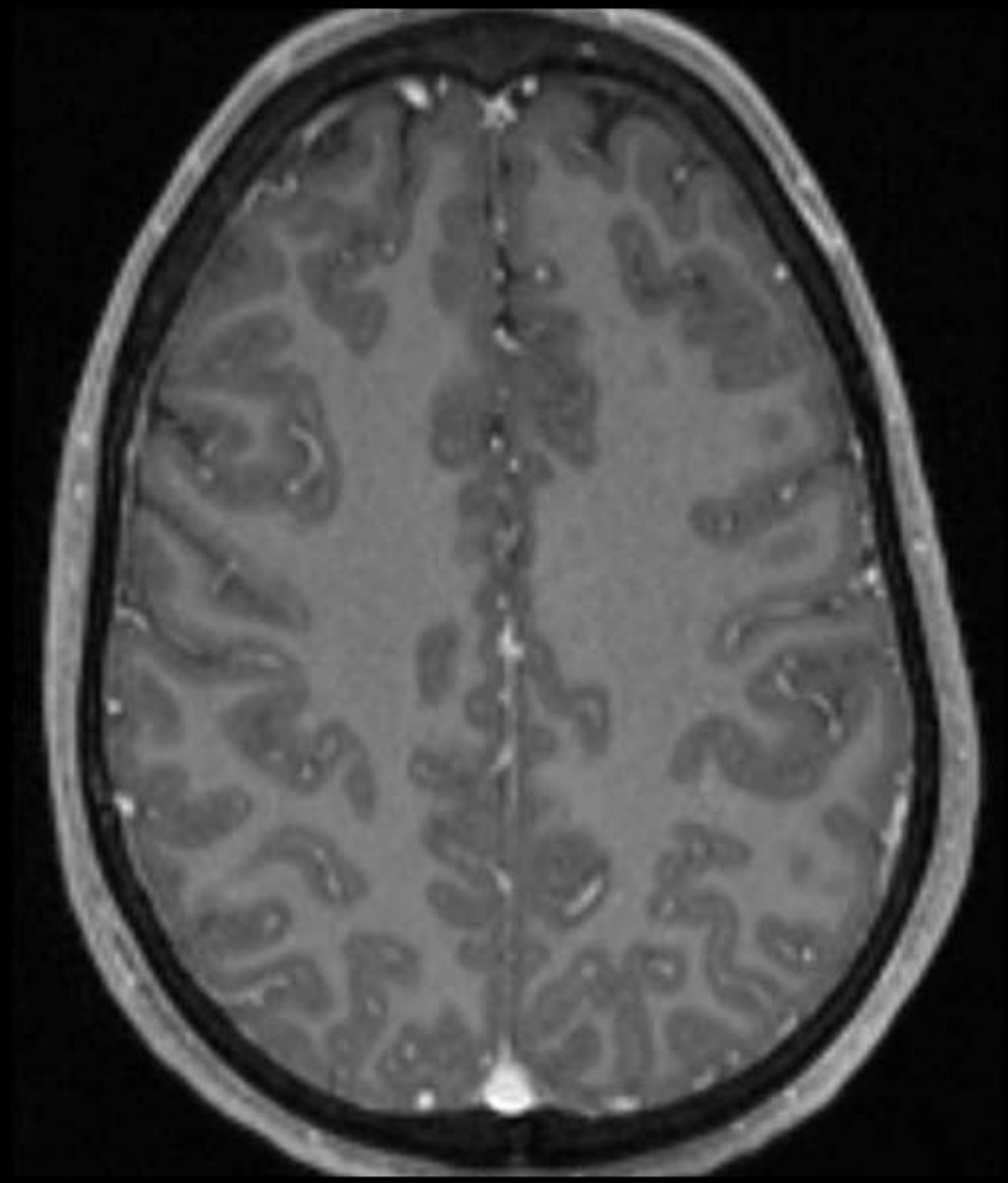


Coronal

CEREBELLUM

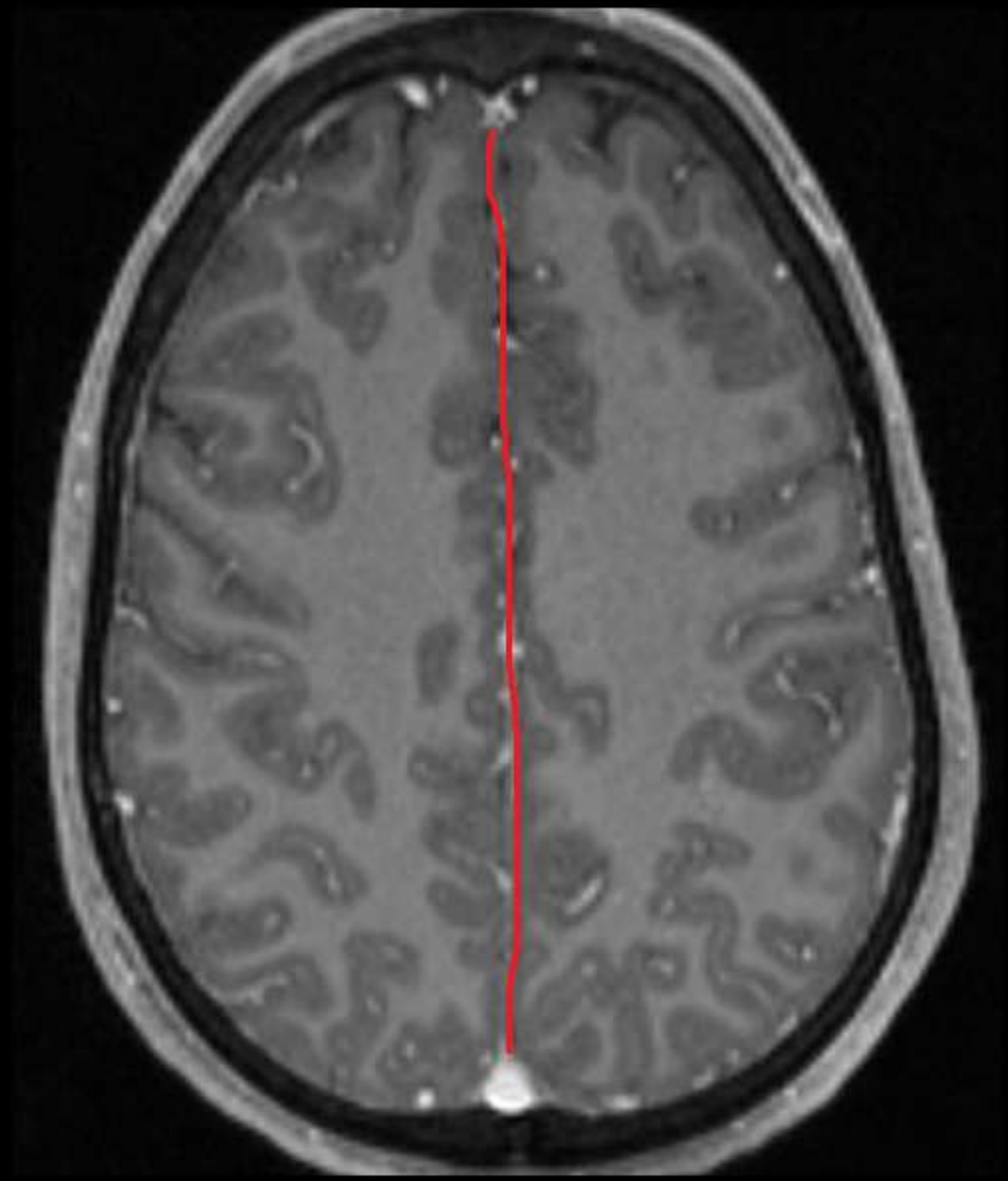
Sagittal

FALX CEREBRI



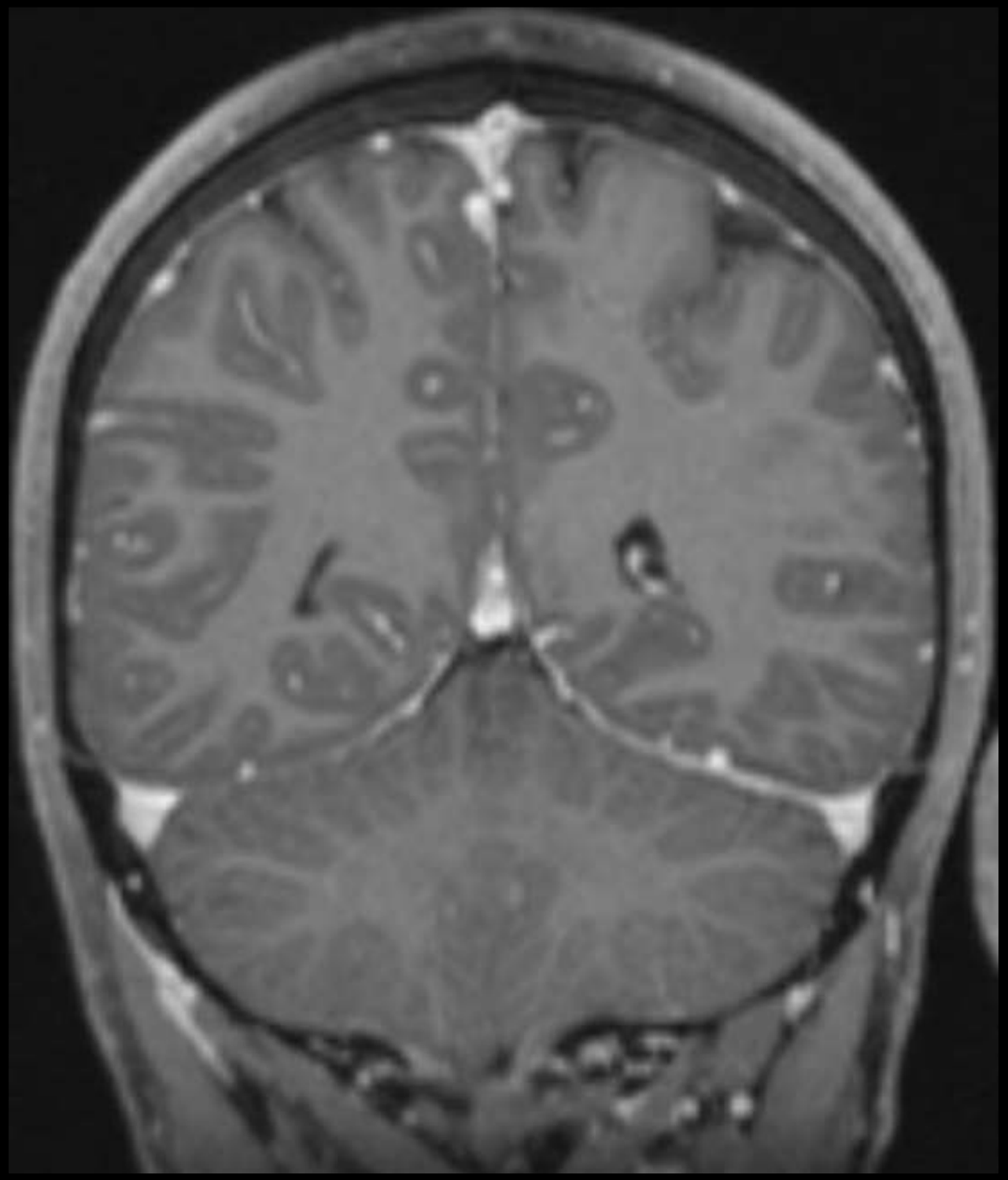
Axial

FALX CEREBRI



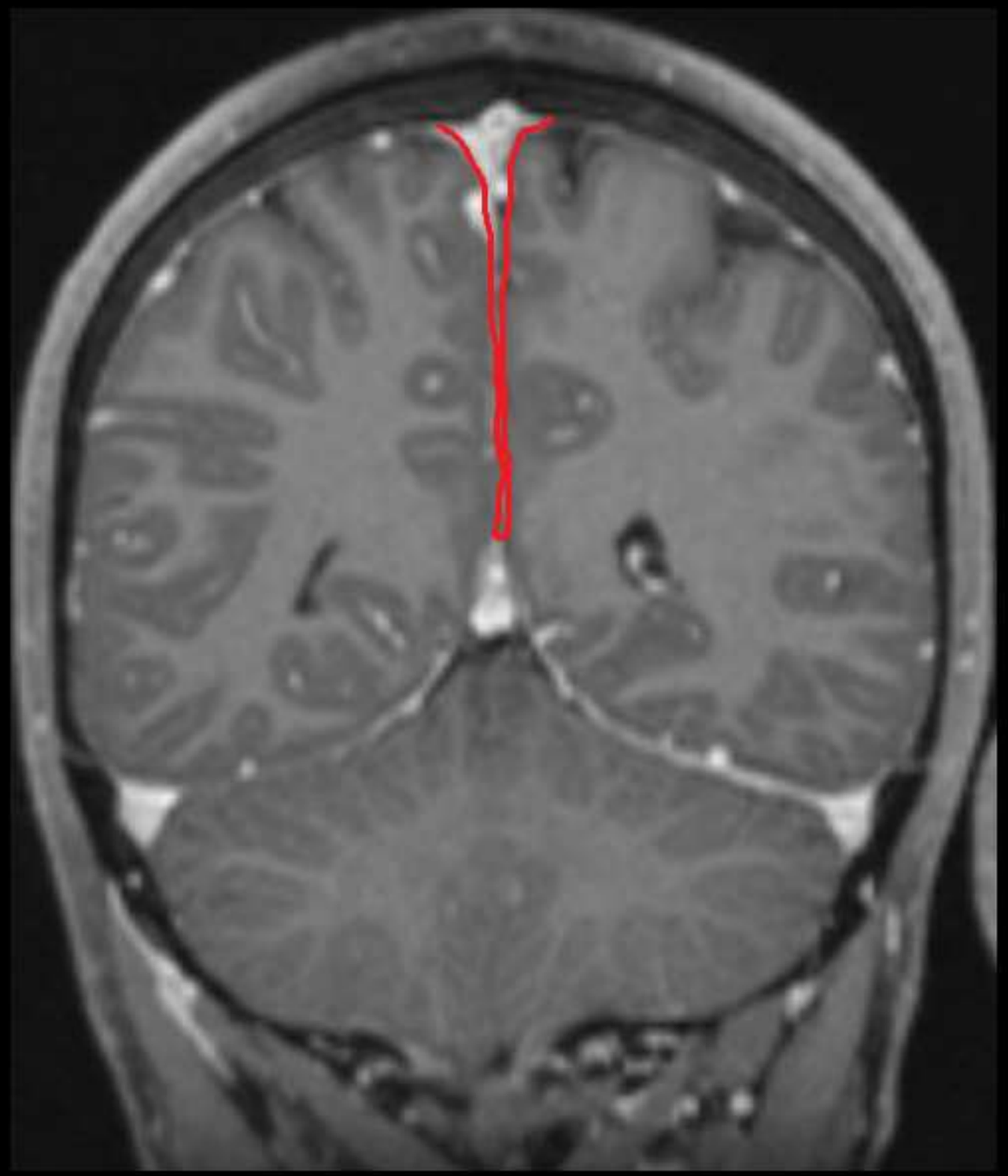
Axial

FALX CEREBRI



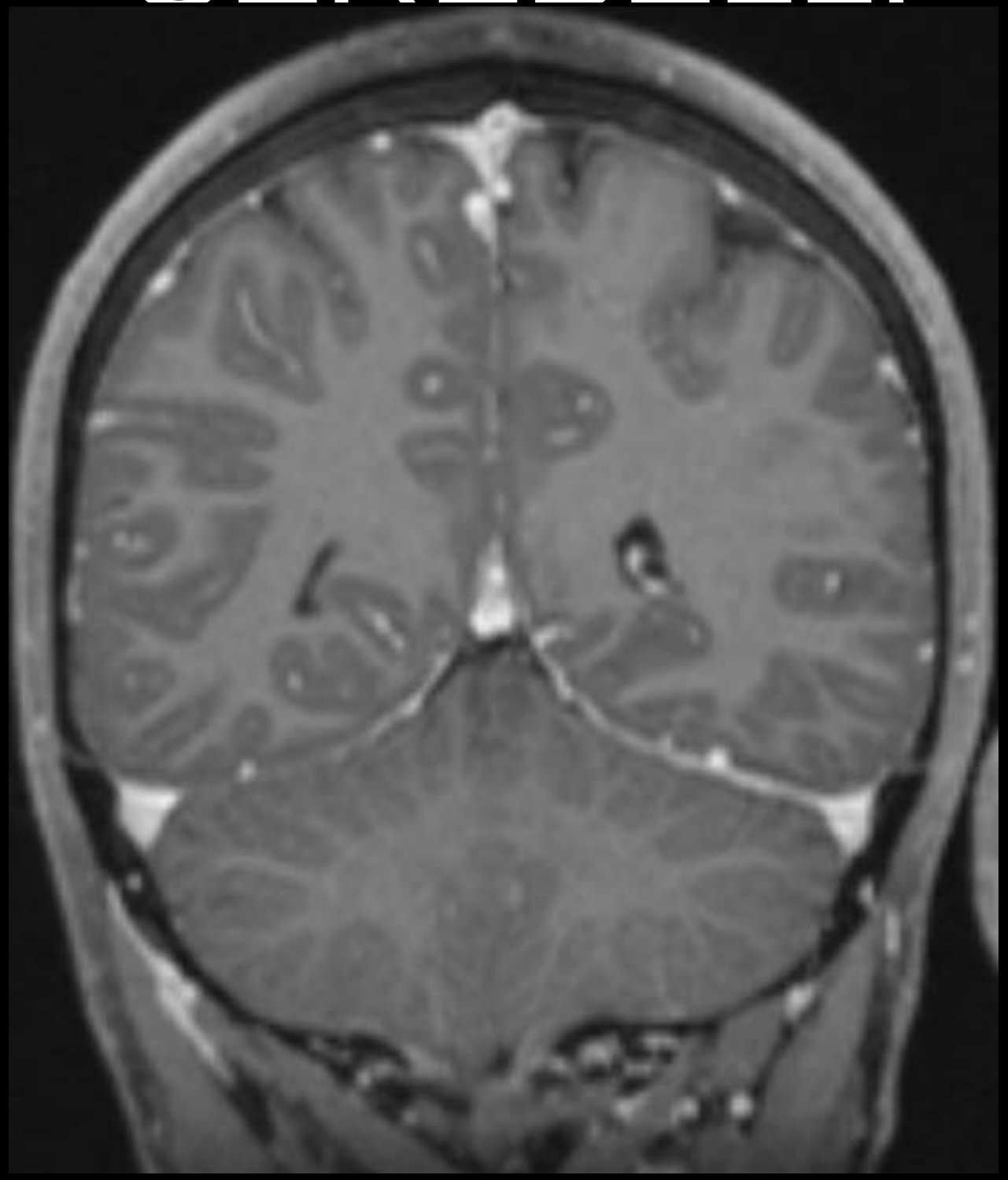
Axial

FALX CEREBRI



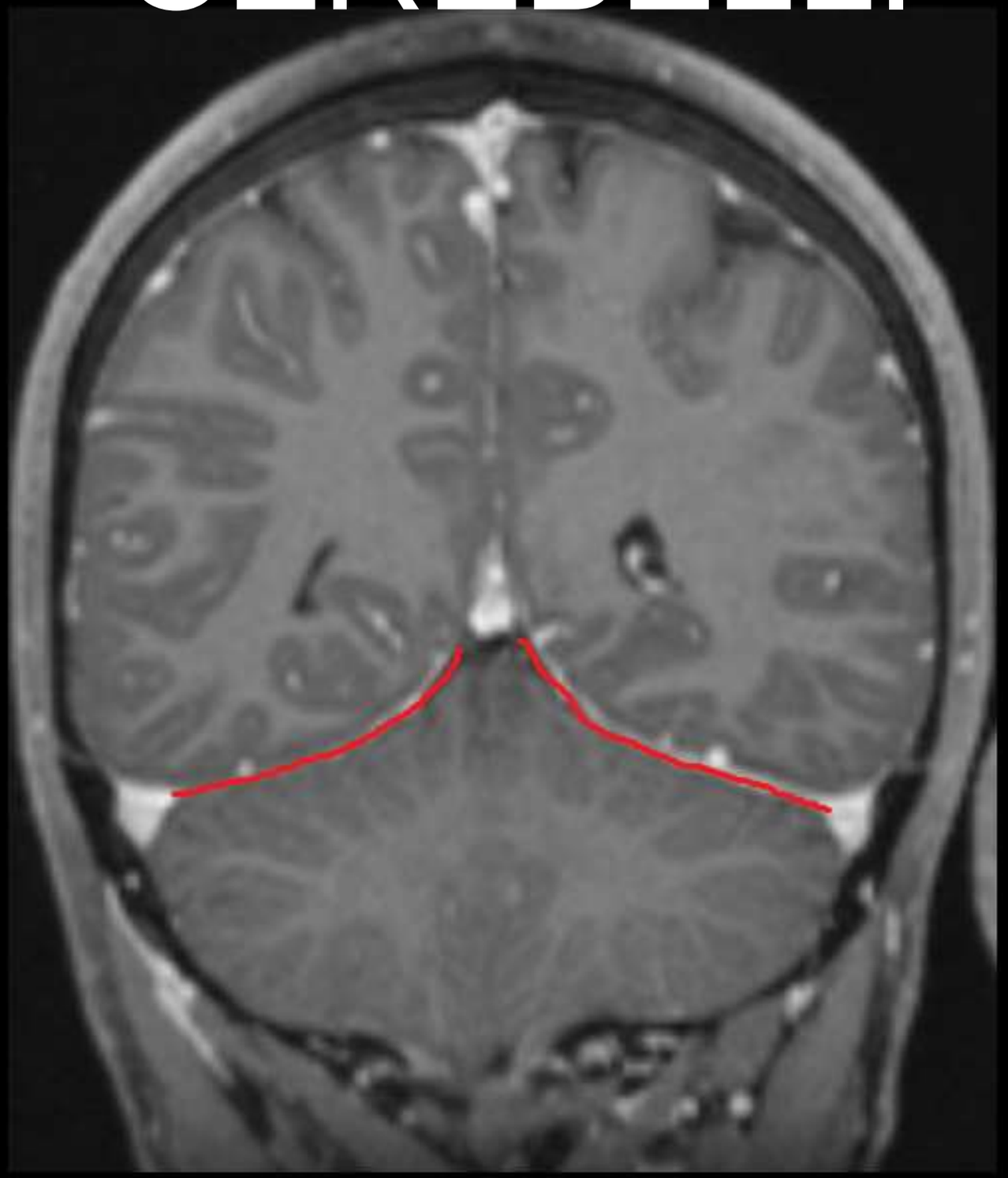
Coronal

TENTORIUM CEREBELLI



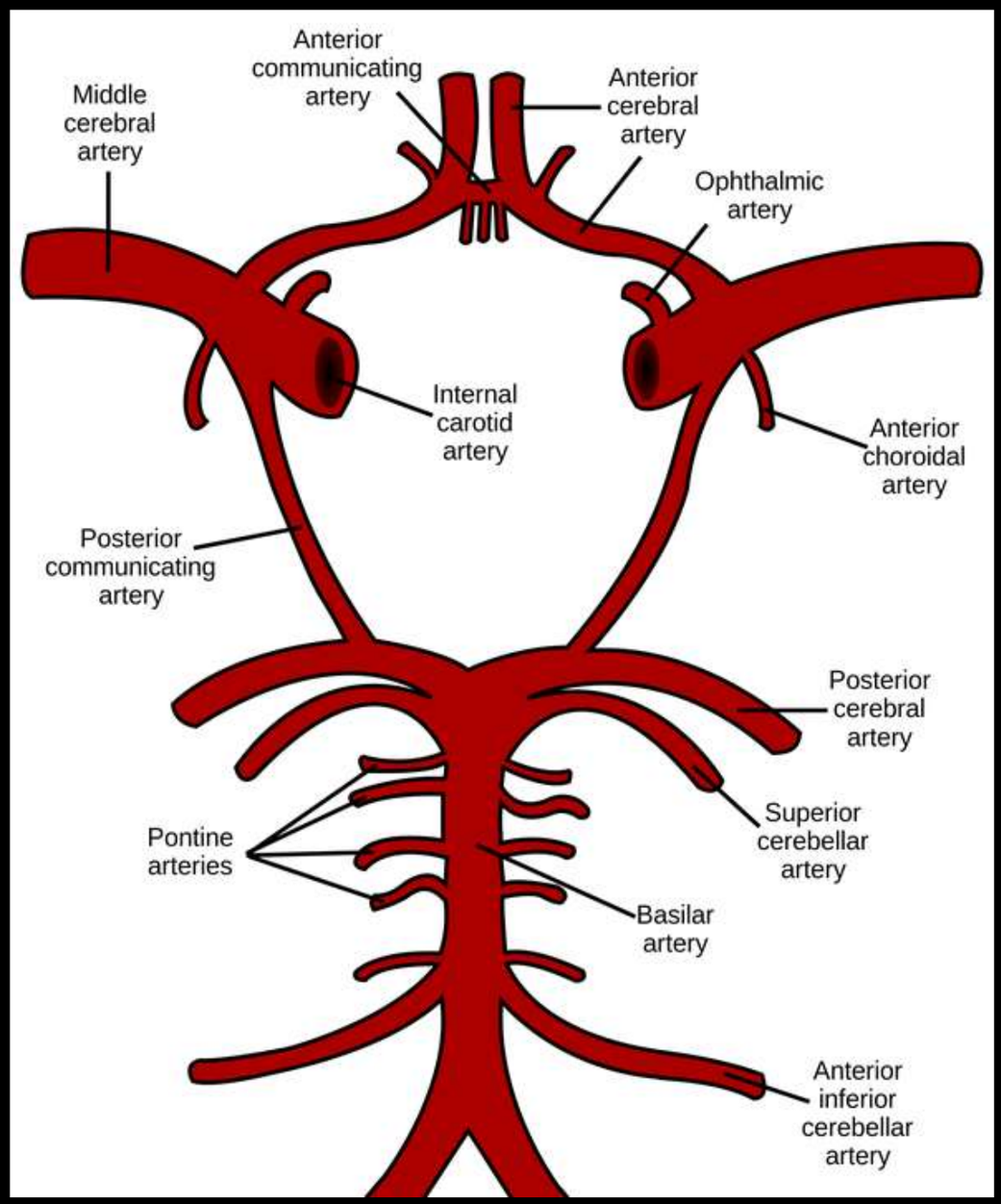
Coronal

TENTORIUM CEREBELLI



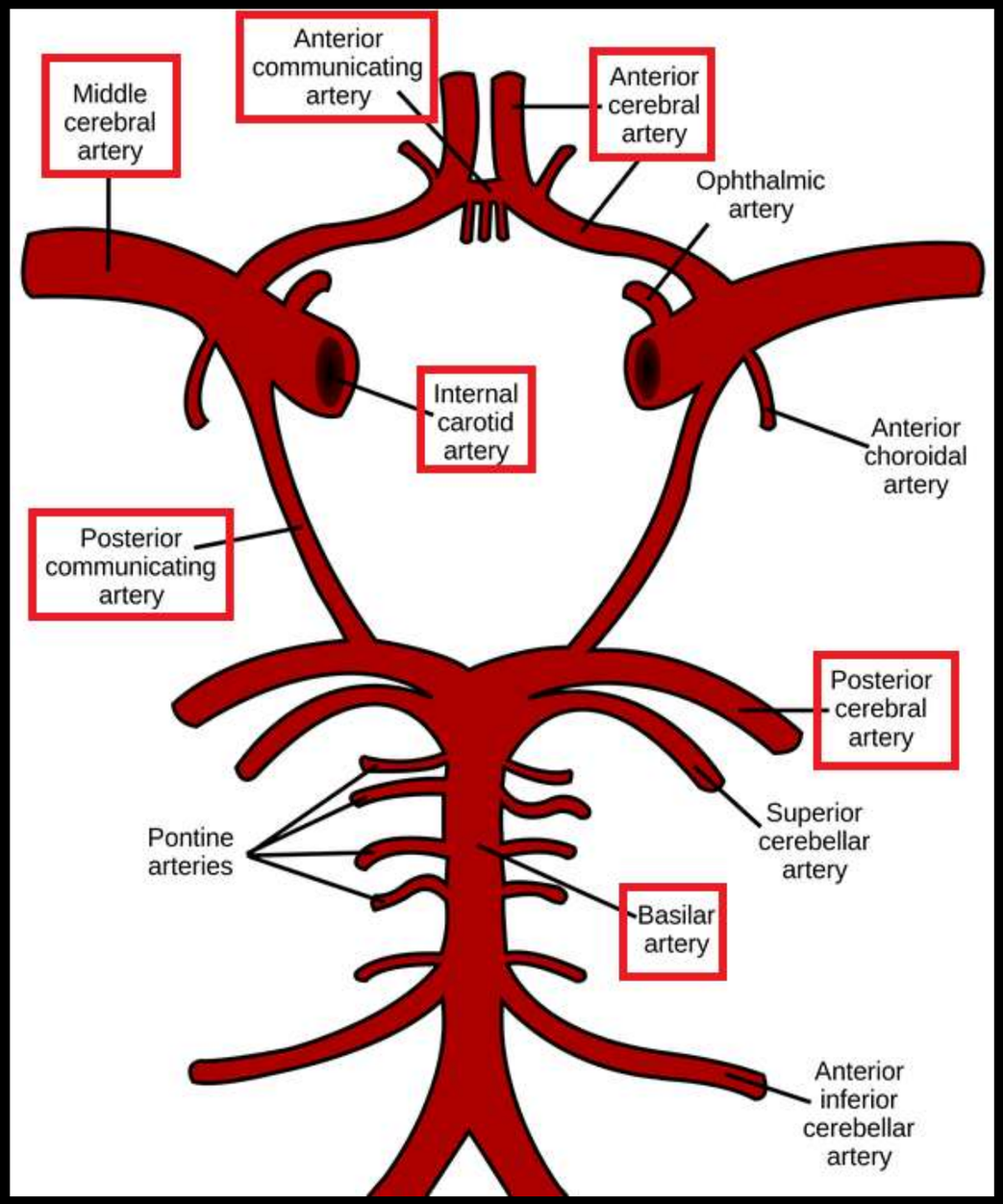
Coronal

MAJOR VESSELS



http://commons.wikimedia.org/wiki/File:Circle_of_Willis_en.svg

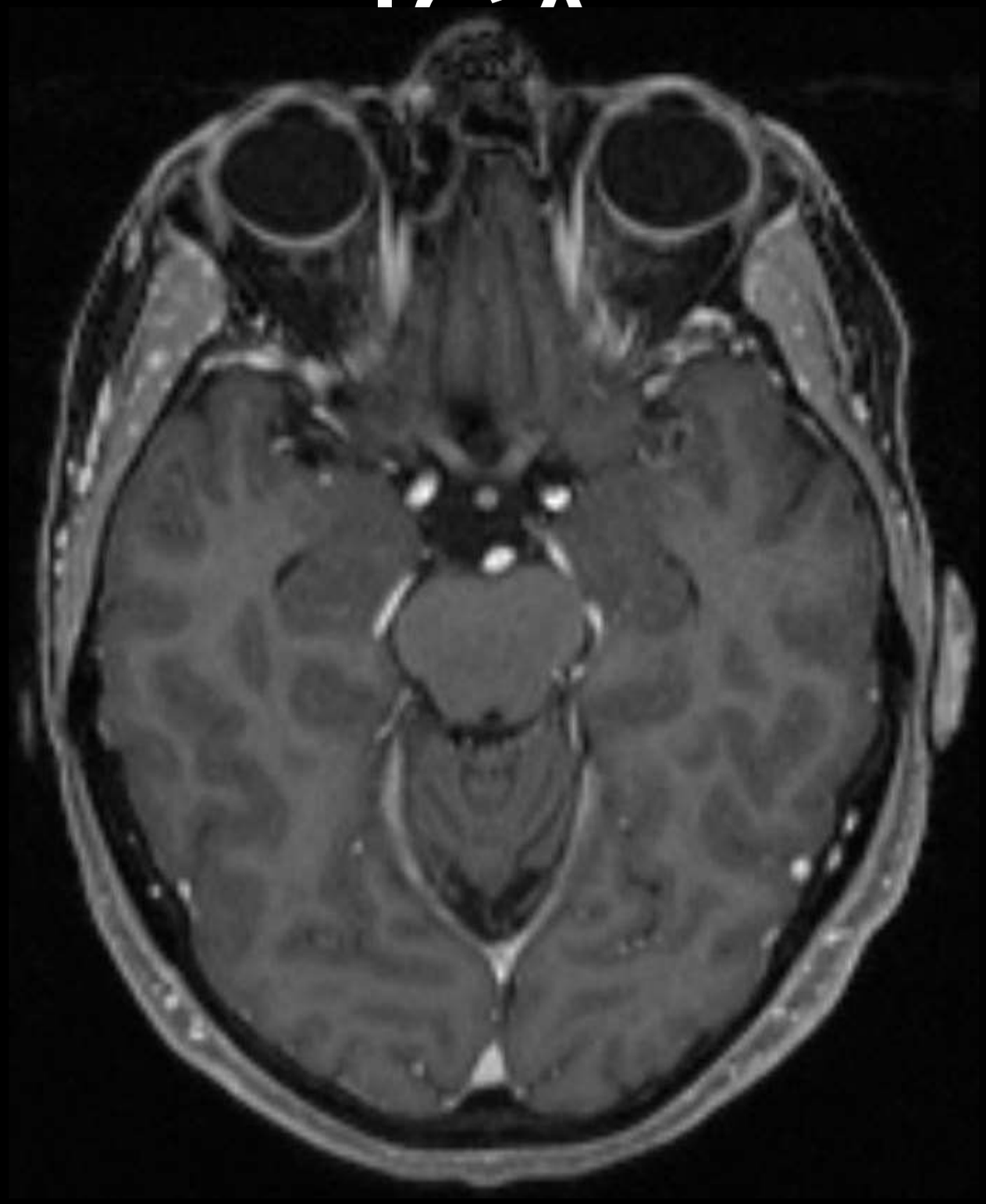
MAJOR VESSELS



http://commons.wikimedia.org/wiki/File:Circle_of_Willis_en.svg

The vessels we will review on imaging are the ones highlighted.

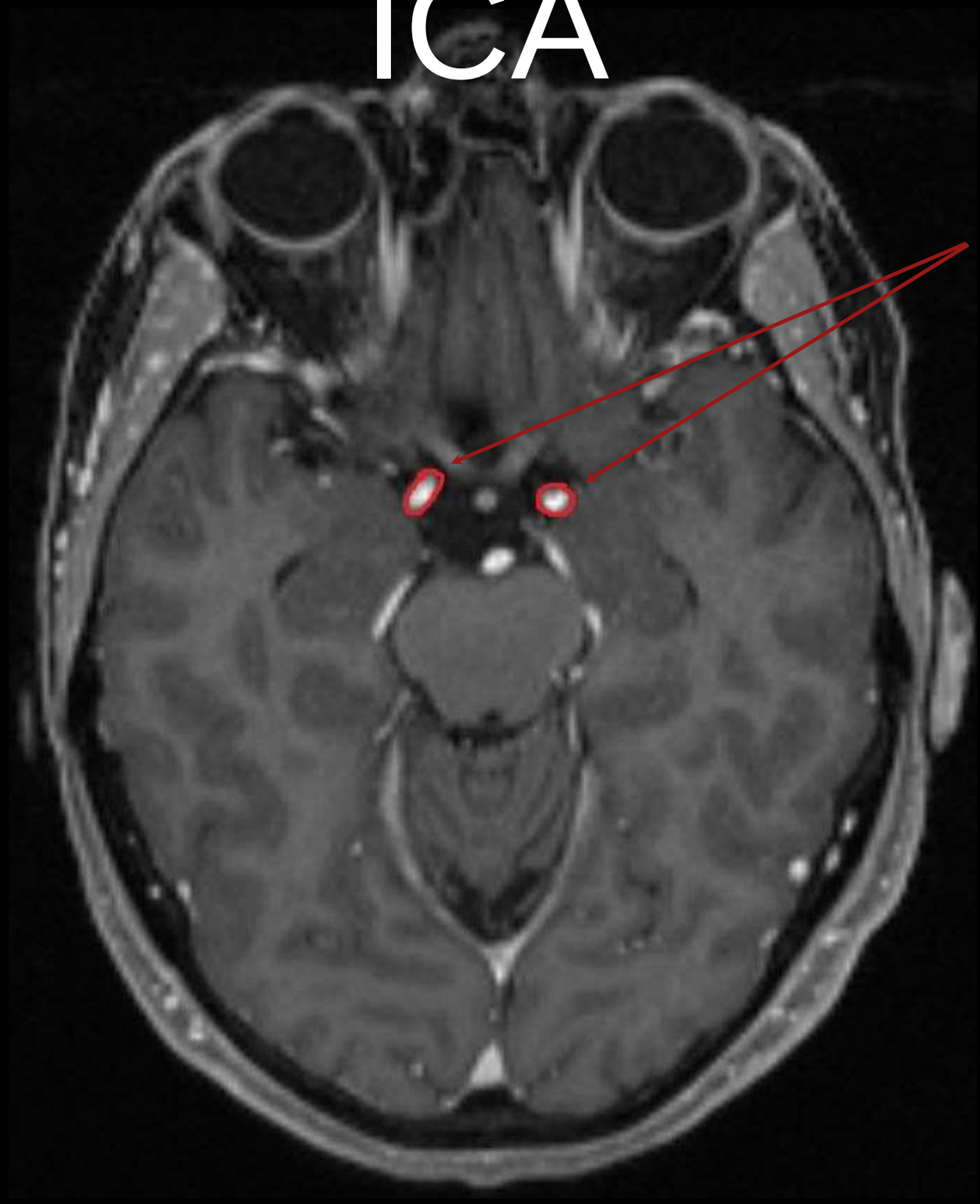
CIRCLE OF WILLIS - ICA



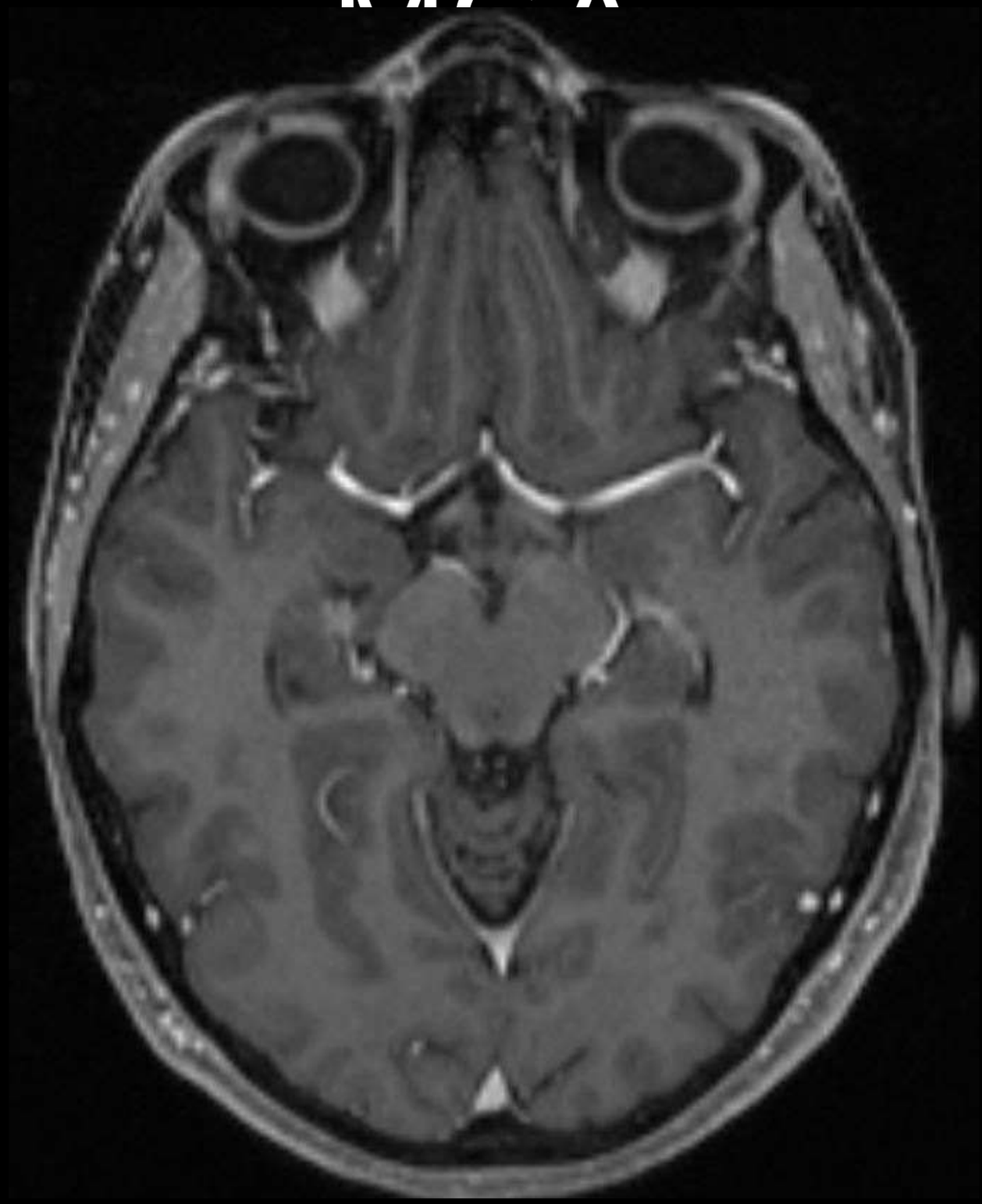
ICA = Internal Carotid Artery

Axial

CIRCLE OF WILLIS - ICA



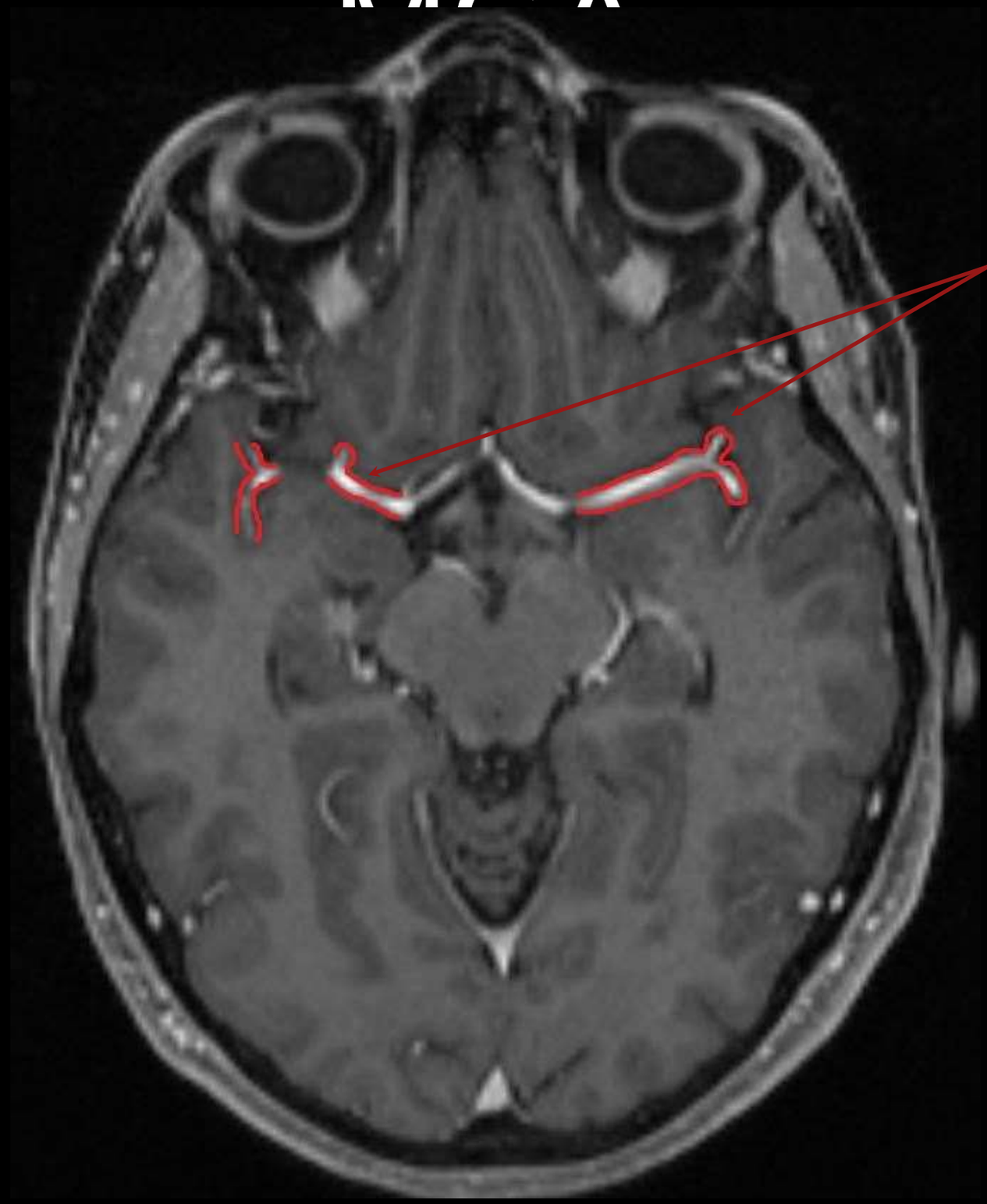
CIRCLE OF WILLIS - MCA



MCA = Middle Cerebral Artery

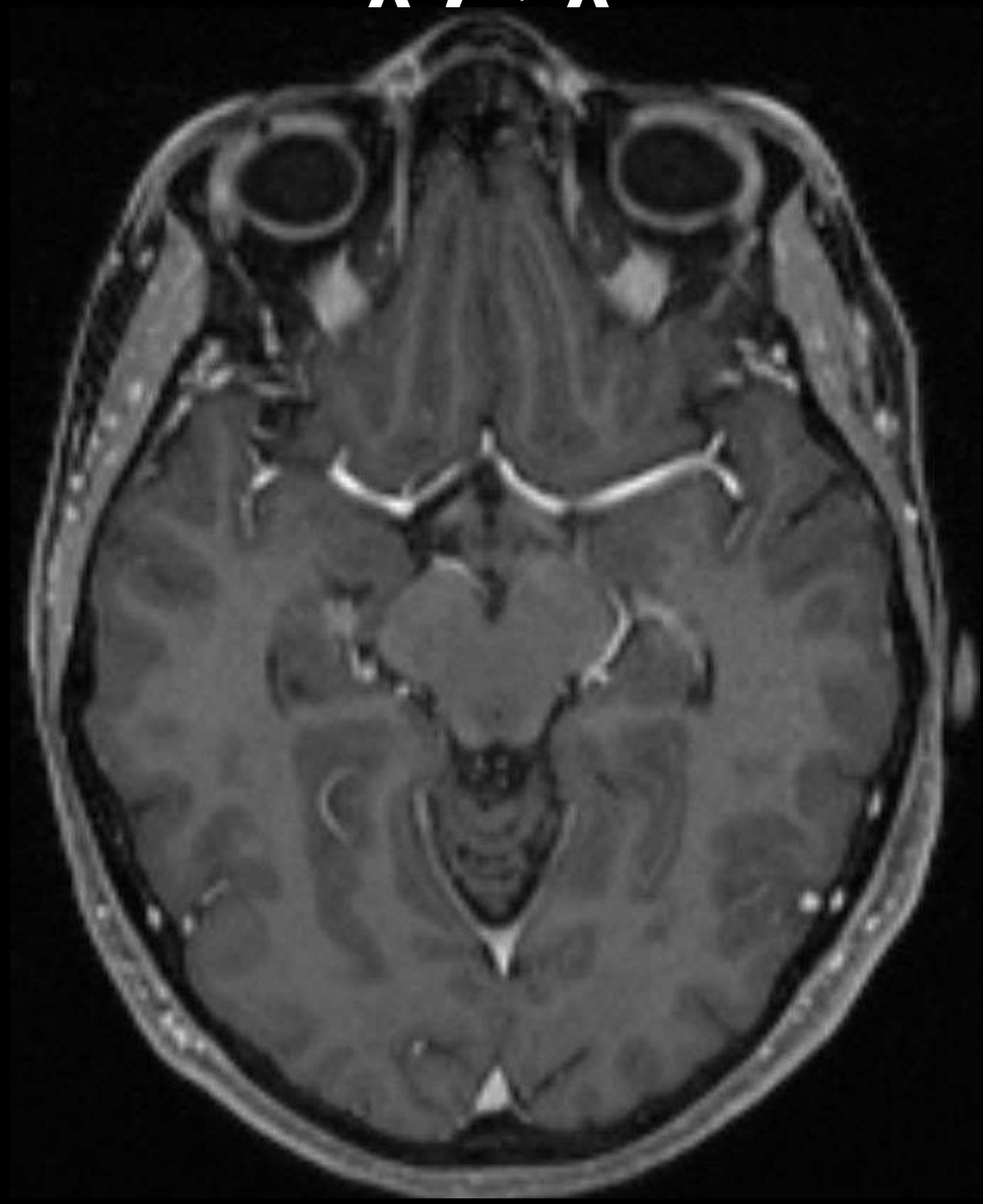
Axial

CIRCLE OF WILLIS - MCA



Axial

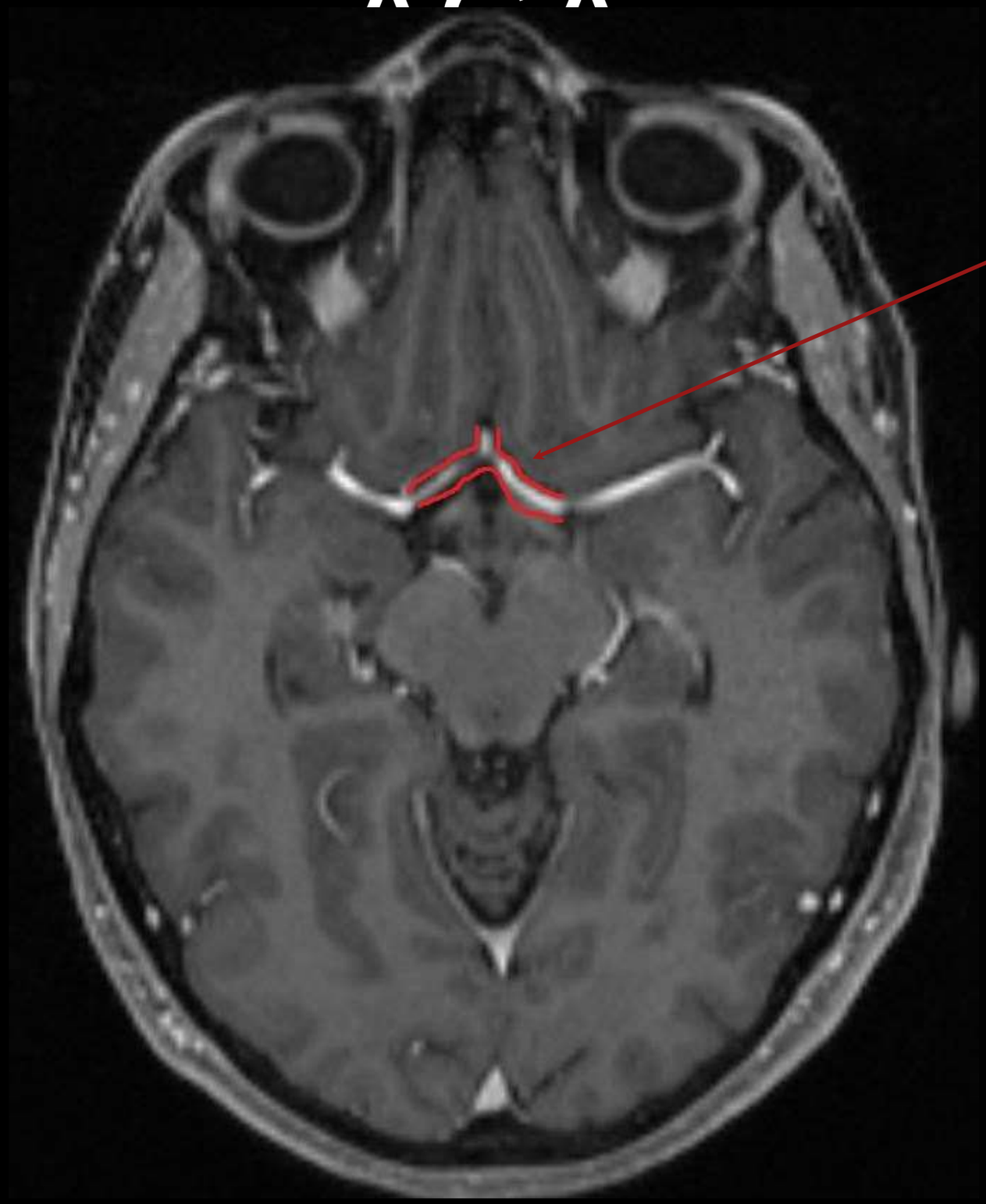
CIRCLE OF WILLIS - ACA



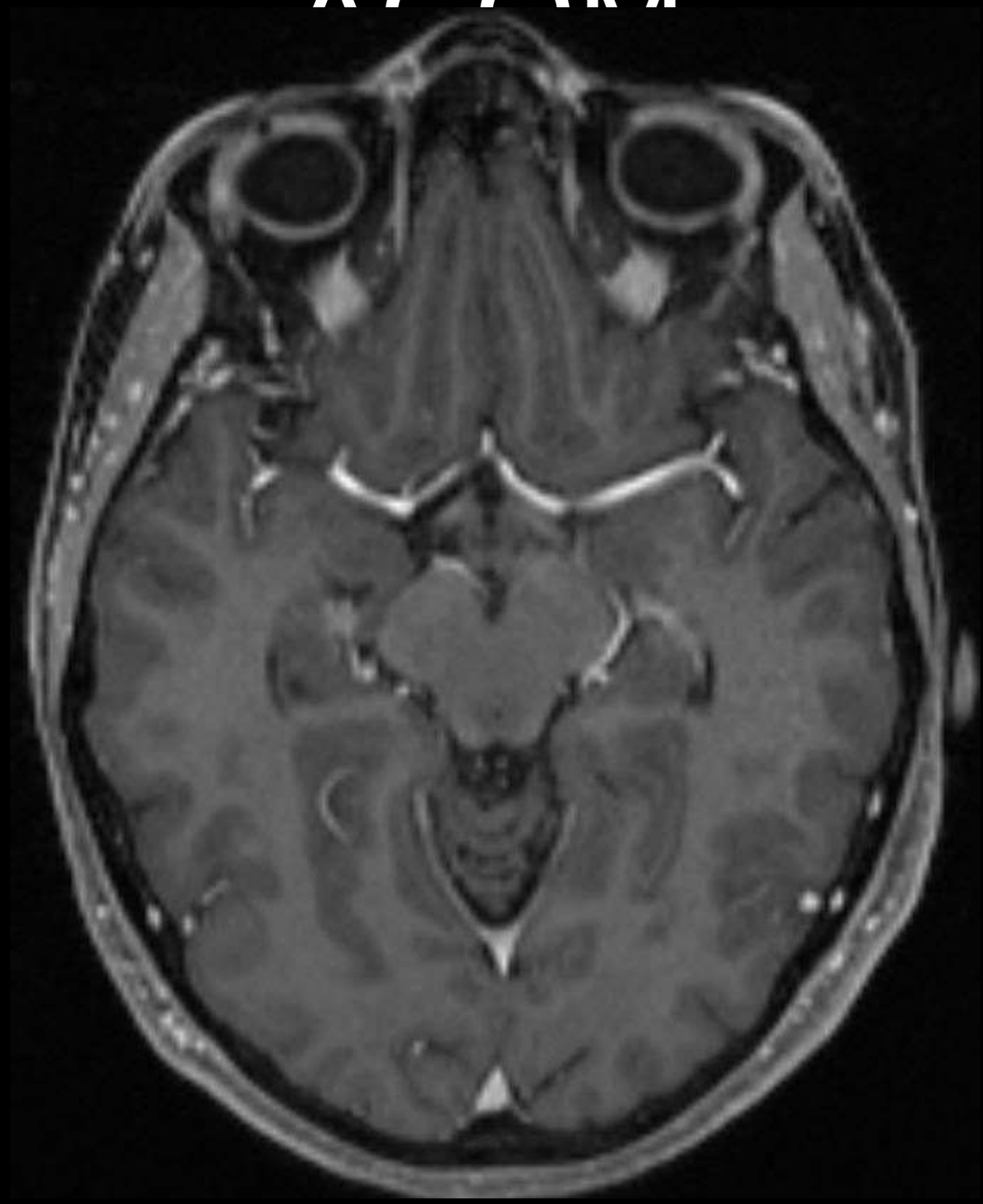
ACA = Anterior Cerebral Artery

Axial

CIRCLE OF WILLIS - ACA



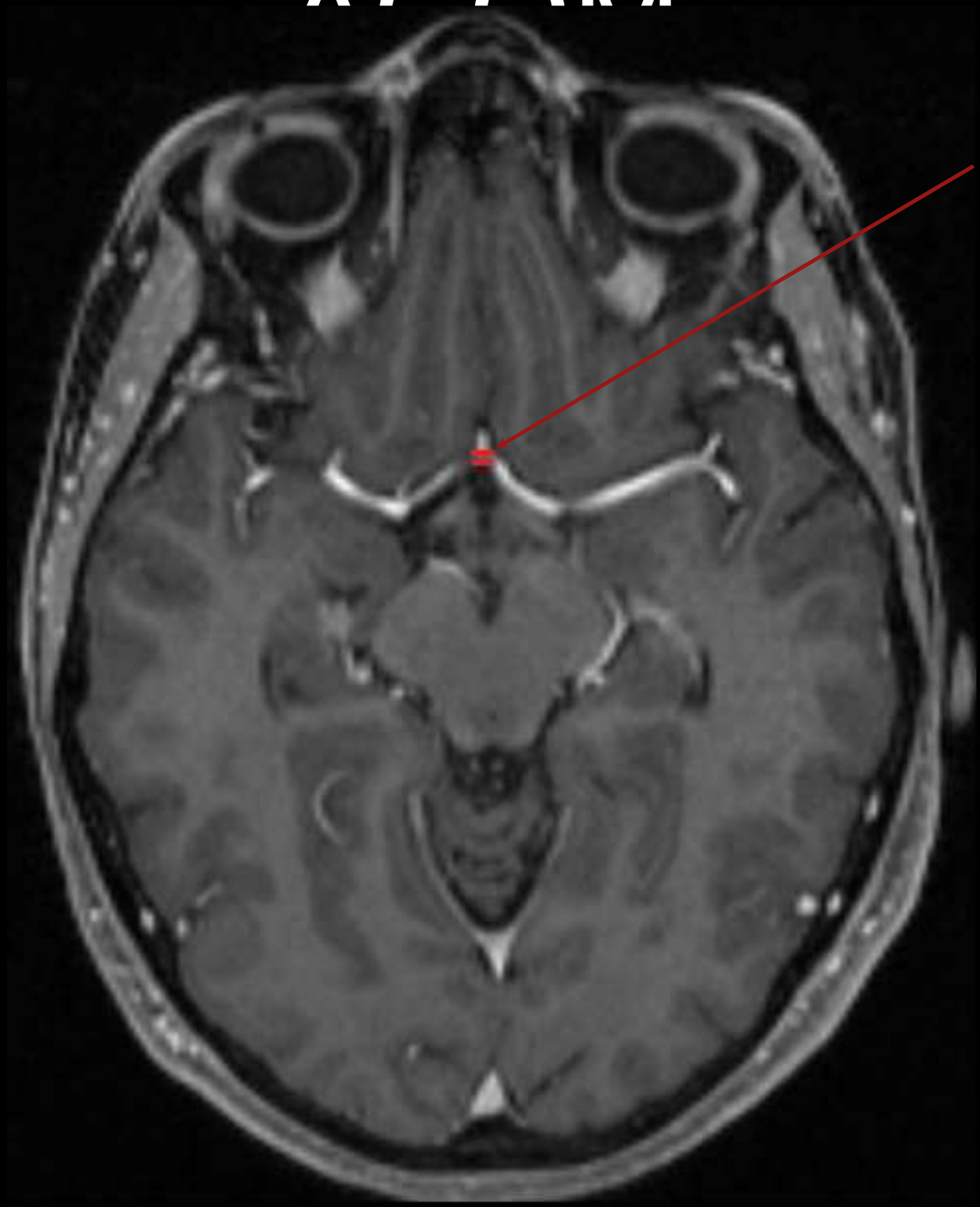
CIRCLE OF WILLIS - ACOM



ACOM = Anterior Communicating Artery

Axial

CIRCLE OF WILLIS - ACOM

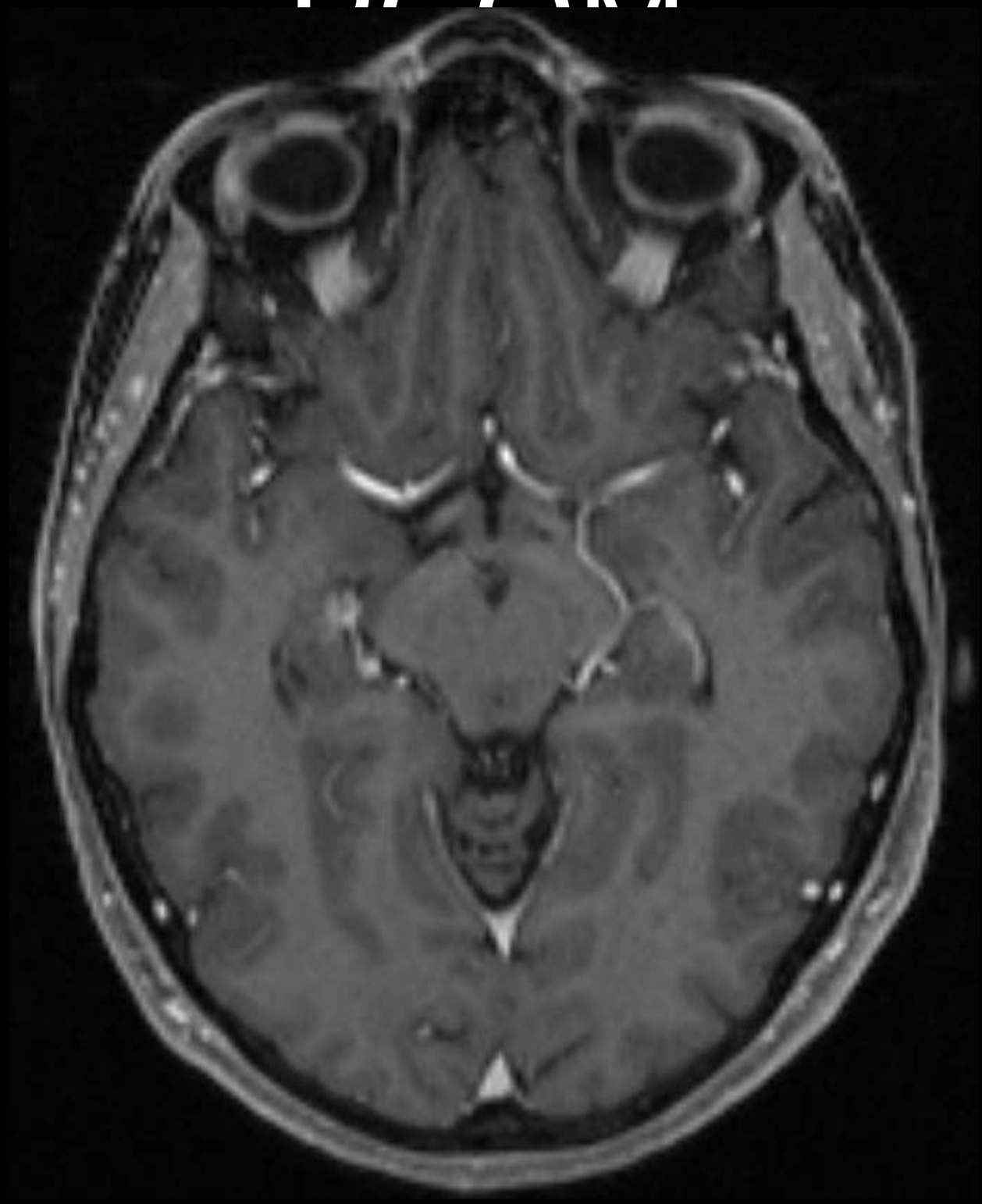


ACOM = Anterior Communicating Artery

The ACOM connects the left and right ACAs.

Axial

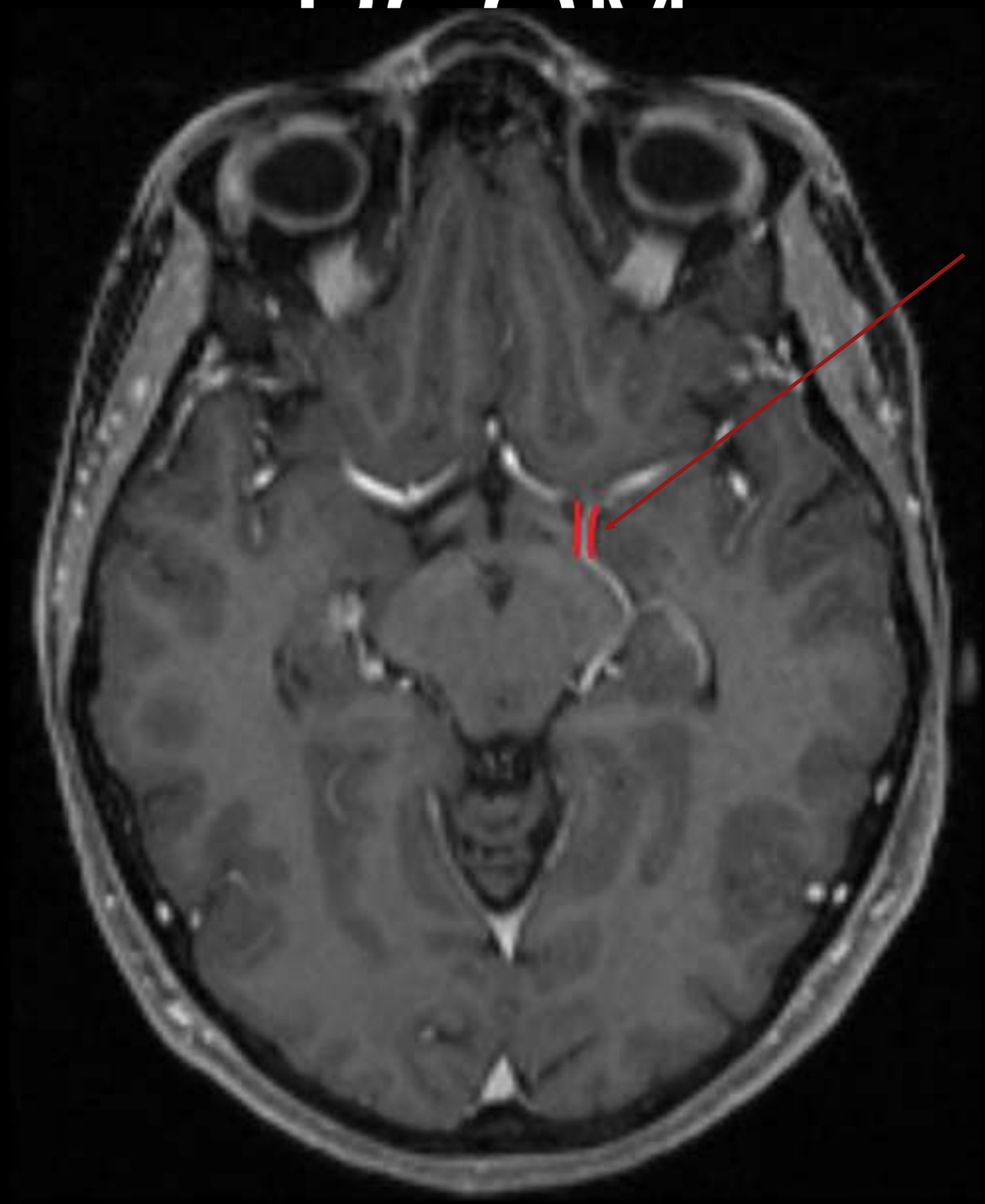
CIRCLE OF WILLIS - PCOM



PCOM = Posterior Communicating Artery

Axial

CIRCLE OF WILLIS - PCOM

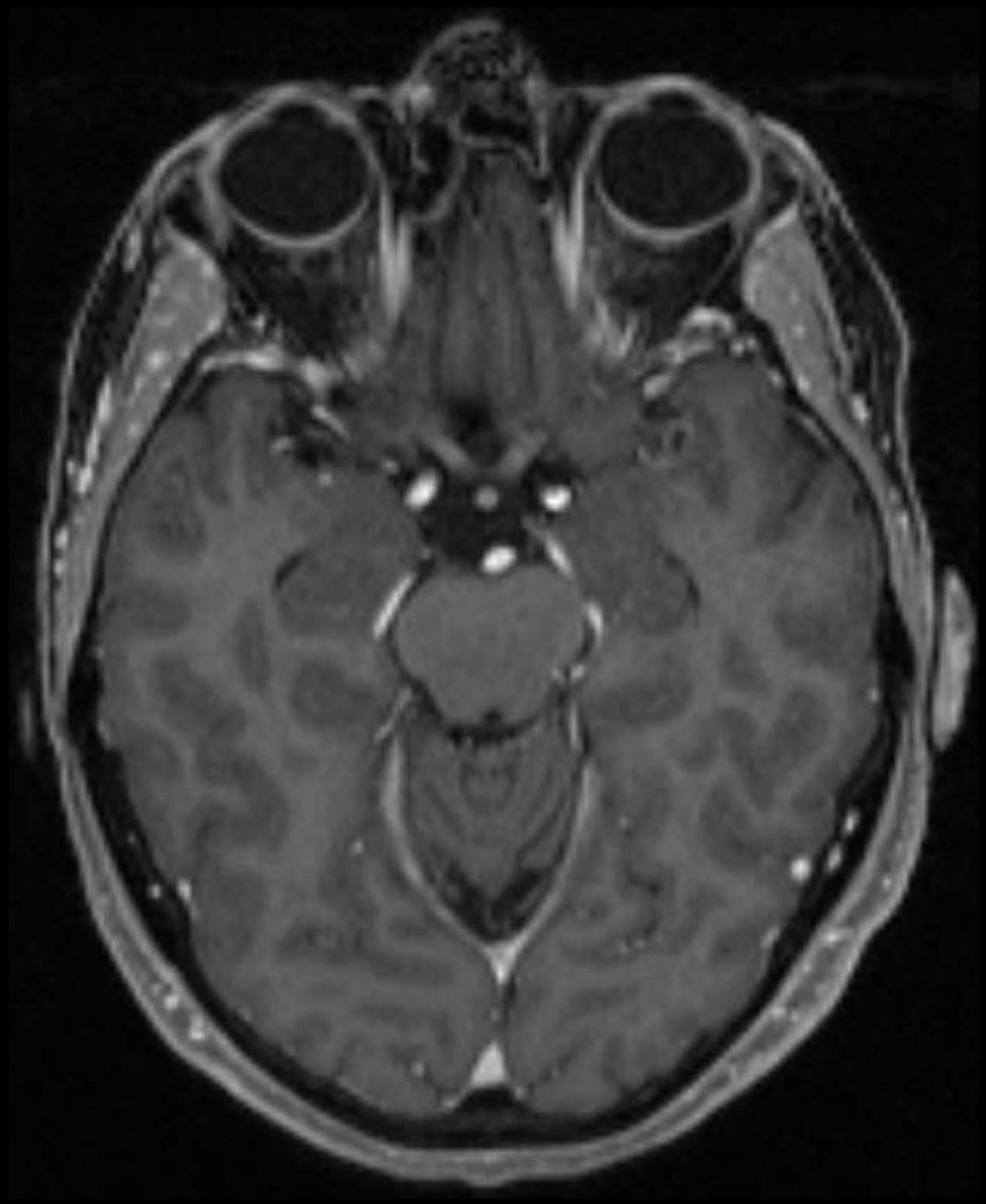


PCOM = Posterior Communicating Artery

PCOM connects the anterior and posterior circulation.

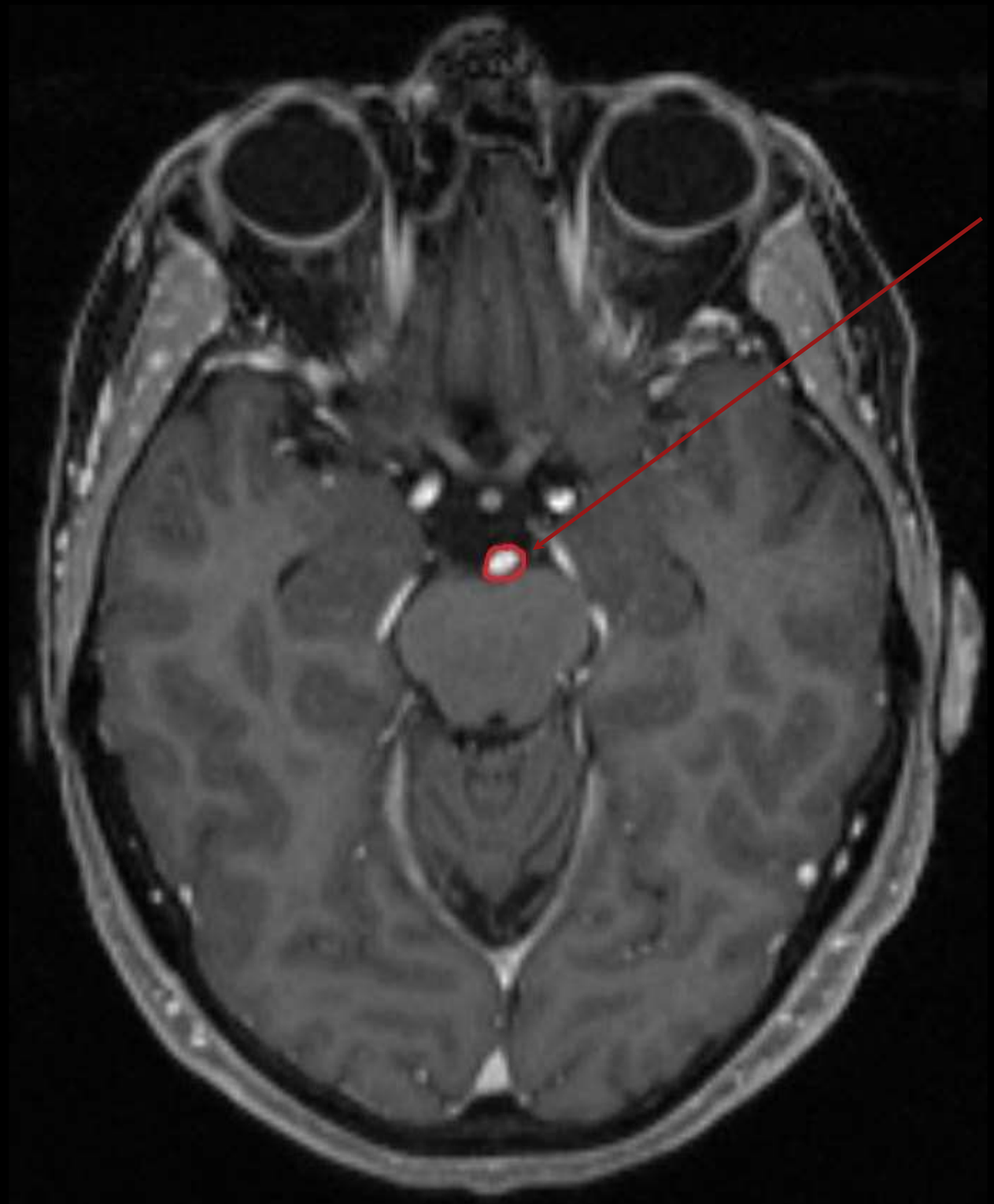
Axial

BASILAR ARTERY



Axial

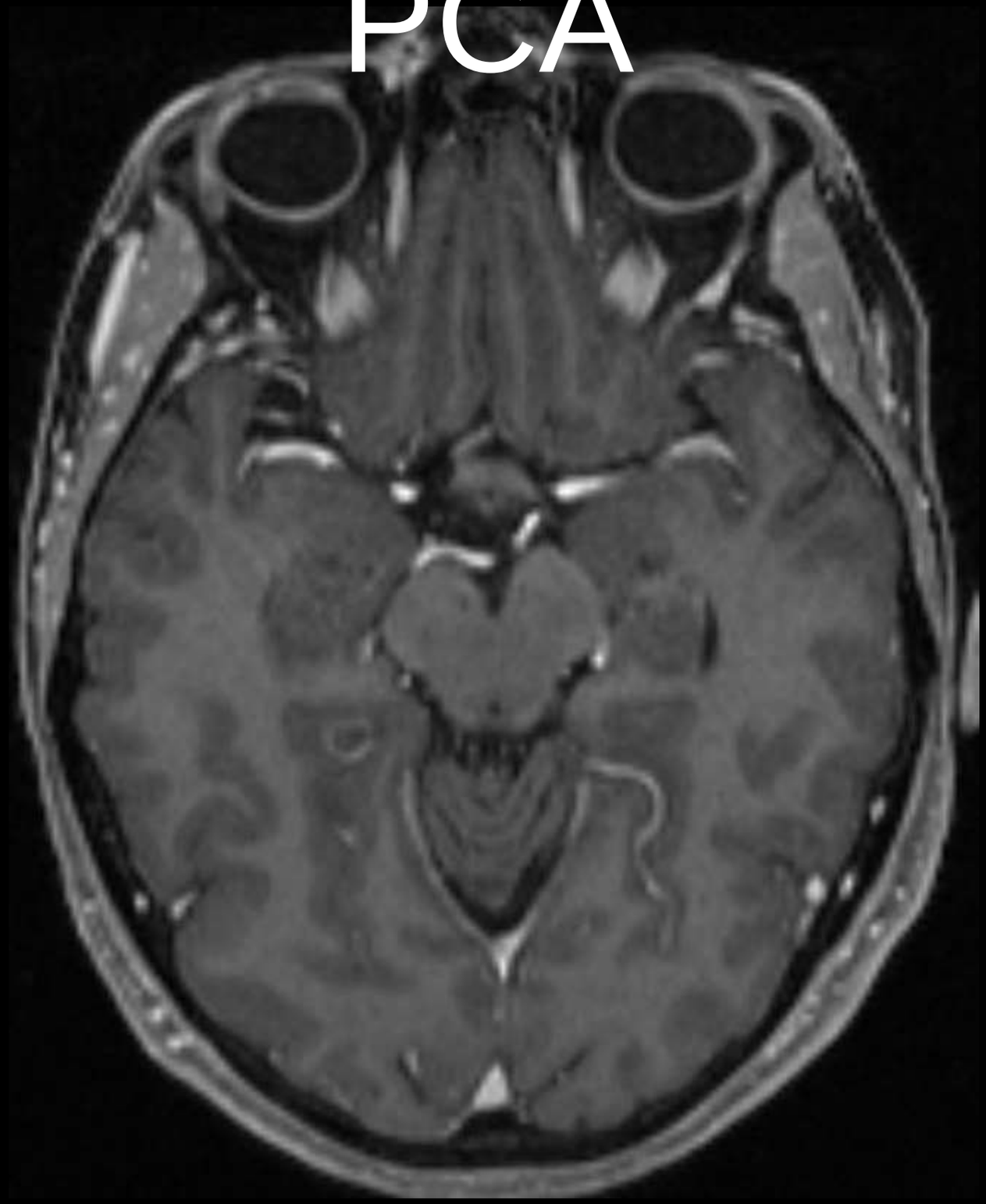
BASILAR ARTERY



The basilar artery is the distal continuation of the vertebral arteries, supplying the posterior circulation.

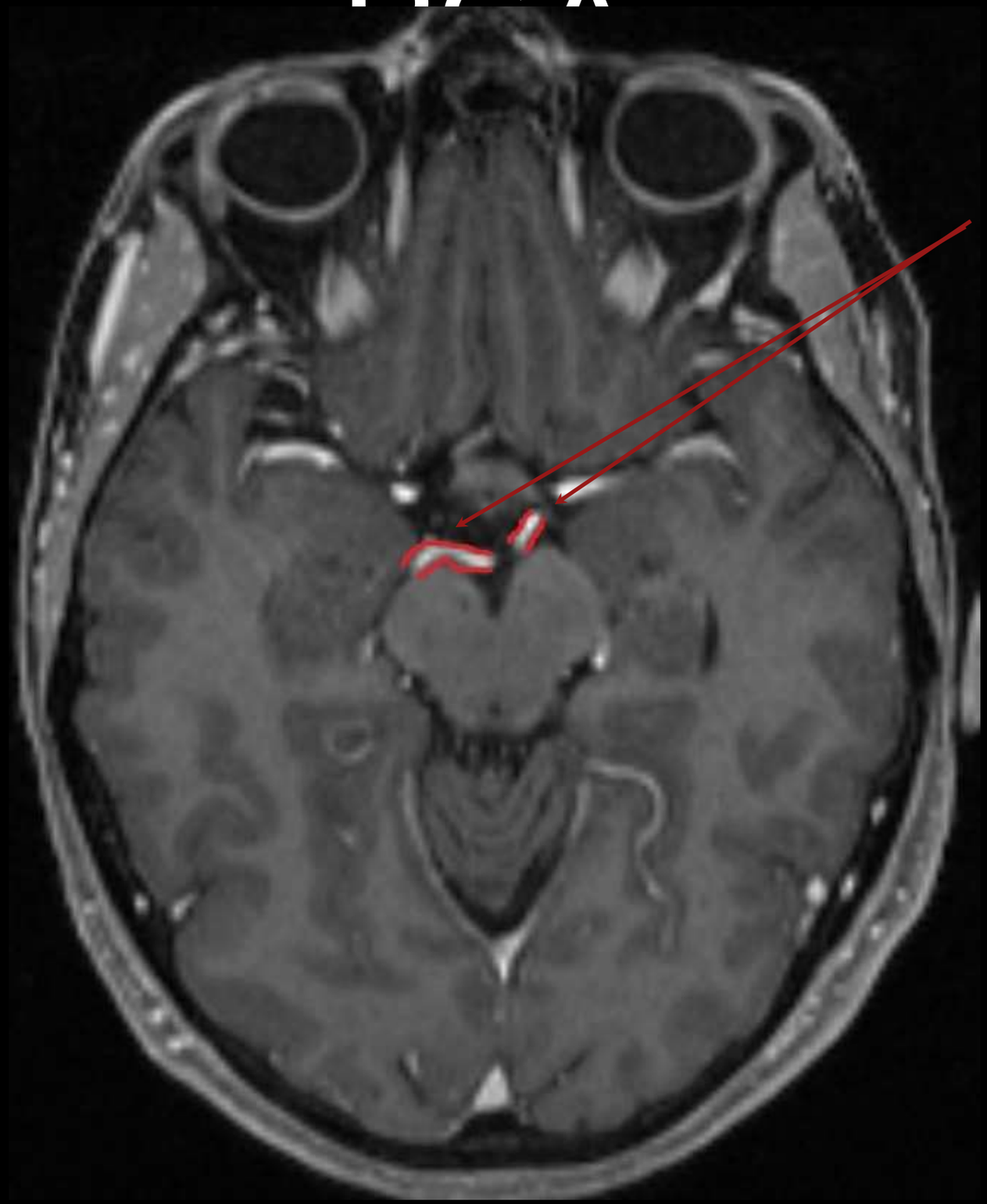
Axial

CIRCLE OF WILLIS - PCA



Axial

CIRCLE OF WILLIS - PCA

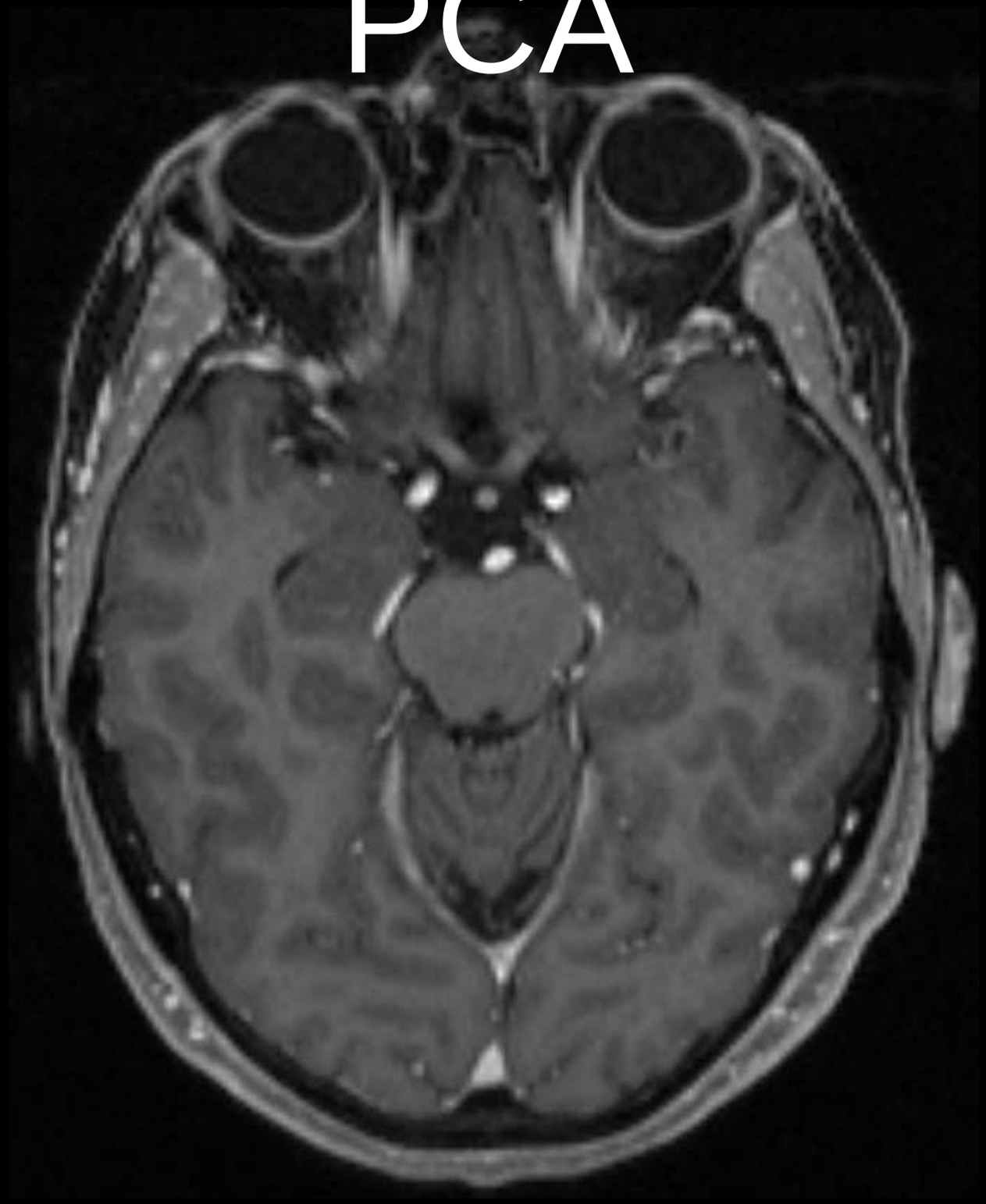


PCA = Posterior Cerebral Artery

The PCAs loop backwards around the midbrain.

Axial

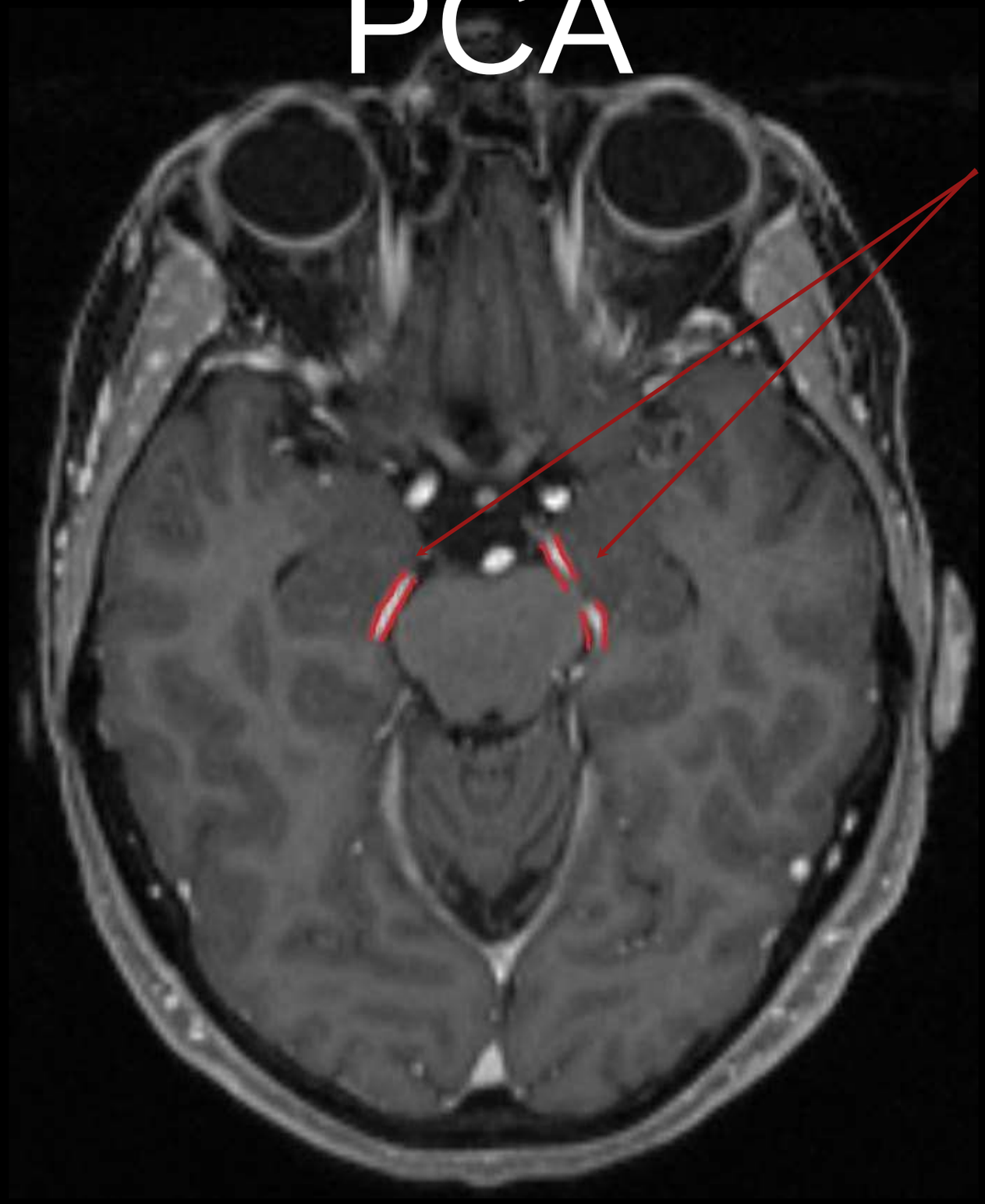
CIRCLE OF WILLIS - PCA



PCA = Posterior Cerebral Artery

Axial

CIRCLE OF WILLIS - PCA



PCA = Posterior Cerebral Artery

Axial

End of module 1

- Introduction to Neuroimaging - DIL part 1
- Basic Brain Anatomy - DIL part 1
- Standardized Approach to Image Interpretation - DIL part 2
- Common Pathology
  - Bleeds (Hemorrhages) - DIL part 3
  - Strokes (Infarcts) DIL part 4
  - Masses (Tumors) part 5