CALCARINE FISSURE

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CALCARINE FISSURE

Primary Disciplinary Field(s): Neuroanatomy, **Neuroscience**, **Ophthalmology**

1. Core Definition and Nomenclature

The **Calcarine Fissure** (or **Calcarine Sulcus**) is a prominent and deep anatomical feature located on the **medial surface** of the **occipital lobe** of the human cerebrum. Its name derives from the Latin word *calcar*, meaning "spur," referencing the spur-like projection it creates on the medial wall of the posterior horn of the lateral ventricle, known as the **calcar avis**. This fissure is one of the most critical landmarks in the posterior brain, fundamentally delineating the location of the primary visual processing center.

Functionally, the existence and depth of the calcarine fissure are directly related to the density of neural tissue required for processing visual information. It essentially doubles the surface area of the cerebral cortex available for the **primary visual cortex** (V1), allowing a vast expanse of gray matter to be tucked into the limited space of the occipital pole. The consistent presence and morphology of this sulcus across individuals underscore its evolutionary and functional importance in primate vision.

Nomenclature often alternates between *fissure* and *sulcus*. While technically a **sulcus** (a groove), due to its depth and persistence, it is frequently referred to as a **fissure**. It is also sometimes referred to historically as the **Calcarine Area**, particularly when describing the cortical tissue immediately surrounding it, though this term is less common in modern neuroanatomical descriptions which favor V1 or Area 17 based on cytoarchitecture.

2. Detailed Anatomical Structure and Course

The course of the **Calcarine Fissure** is generally horizontal, commencing near the posterior pole of the **occipital lobe** and extending anteriorly toward the center of the brain. Its total length can vary but typically spans several centimeters, tracing a clear path across the cerebral hemisphere's medial wall.

The fissure is characterized by two distinct segments, delineated by their junction with another major sulcus. The posterior segment, often referred to as the post-calcarine sulcus, is the longer portion and travels from the very tip (pole) of the occipital lobe anteriorly. The crucial anterior segment begins where the calcarine fissure intersects with the deep, vertically running **parieto-occipital sulcus**. This intersection marks a key boundary: anteriorly, the fissure continues its course, terminating close to the splenium of the **corpus callosum**, sometimes merging with the hippocampal sulcus or the medial temporal lobe structures.

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The tissue situated immediately above the calcarine fissure is called the **cuneus** (wedge), which processes the inferior visual field quadrant. The tissue located below the calcarine fissure is termed the **lingual gyrus** (lingual area), which processes the superior visual field quadrant. This specific anatomical arrangement dictates the functional organization of primary vision, making the fissure a critical dividing line for retinotopic organization.

3. Relationship with the Primary Visual Cortex (V1)

The most profound significance of the **Calcarine Fissure** lies in its intimate association with the **primary visual cortex** (V1), also known as Brodmann Area 17. V1 is the first cortical area that receives visual information relayed from the lateral geniculate nucleus (LGN) via the **optic radiation**.

The majority of V1 cortex is buried within the walls of the calcarine fissure, rather than lying exposed on the surface of the cuneus and lingual gyrus. This burial maximizes the cortical area dedicated to vision. Specifically, the banks of the fissure are lined with the characteristic six layers of the V1 cortex, which contains the prominent line of Gennari (a dense band of myelinated fibers visible to the naked eye), a definitive histological marker of Area 17.

This functional relationship means that any pathology or damage directly affecting the calcarine fissure--such as hemorrhage, ischemic stroke, or trauma--will result in severe and specific visual field deficits, collectively known as **hemianopia** or **quadrantanopia**, depending on the extent and location of the lesion relative to the fissure.

4. Functional Organization: Retinotopic Mapping

The visual information mapped onto the **Calcarine Fissure** follows a precise and highly conserved **retinotopic organization**, meaning that neighboring points in the visual field are processed by neighboring neurons in the cortex. The fissure serves as the central dividing line for this mapping.

Upper and Lower Visual Fields: The superior bank (cuneus) of the fissure processes information originating from the **inferior half** of the visual field, while the inferior bank (lingual gyrus) processes information from the **superior half** of the visual field. The foveal representation (central vision) is located near the very posterior tip of the fissure, often extending onto the exposed surface of the occipital pole.

Medial and Lateral Visual Fields: Due to the decussation (crossing) of visual fibers at the optic chiasm, the right calcarine fissure processes information from the entire left visual field, and the left calcarine fissure processes the right visual field.

Peripheral to Central Mapping: Visual representation follows an anterior-to-posterior gradient. The most anterior portions of the fissure process the peripheral extremes of the visual field, while moving posteriorly, the cortical representation becomes progressively dedicated to the central,

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foveal vision. The disproportionate amount of cortex dedicated to the fovea (**cortical magnification**) is concentrated at the posterior end of the fissure.

This precise mapping allows neuroscientists and clinicians to accurately predict the location and extent of brain damage based on the patient's visual field loss, solidifying the calcarine fissure as the functional epicenter of primary visual processing.

5. Vascular Supply and Clinical Pathology

The vascular integrity of the **Calcarine Fissure** is critical, as its blood supply is relatively specialized, making it vulnerable to certain types of cerebrovascular events. The primary supply comes from branches of the **Posterior Cerebral Artery** (PCA). Specifically, the calcarine branch of the PCA feeds the cortex lining the sulcus.

Occlusion of the PCA, or one of its calcarine branches, is a common cause of posterior circulation stroke. Because the PCA supplies V1, a stroke affecting this artery typically results in a contralateral **homonymous hemianopia** (loss of vision in the corresponding half of the visual field in both eyes). A key clinical observation related to PCA strokes is **macular sparing**. In many cases, central (macular) vision is preserved, even when peripheral vision is lost. This phenomenon is often attributed to the macula's representation at the occipital pole potentially receiving dual blood supply from both the PCA and branches of the Middle Cerebral Artery (MCA), offering collateral circulation protection.

The clinical correlation between the location of the lesion along the fissure and the specific visual deficit is highly reliable. For instance, damage limited to the superior bank of the right calcarine fissure (cuneus) leads to a left inferior homonymous quadrantanopia.

6. Developmental Neuroanatomy

The formation of the **Calcarine Fissure** is a key event in fetal brain development, reflecting the rapid expansion of the occipital cortex necessary for visual function. Cortical folding begins early in gestation, and the calcarine fissure is one of the earliest and most consistently formed primary sulci, typically becoming visible around the fifth or sixth month of gestation.

The process of **gyrification**, or the folding of the cortex, is driven by differential growth rates between layers and is influenced by axonal tension and radial unit hypothesis. The deep infolding of the calcarine fissure ensures that the dense array of neurons constituting V1 is accommodated efficiently. Disruptions during this critical developmental phase can lead to anatomical anomalies, such as shallow sulci or variations in the position of V1, which may correlate with subtle or significant visual processing deficits later in life.

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Studies in comparative neuroanatomy show that the calcarine fissure is highly pronounced in primates, reflecting the high reliance on sophisticated visual processing in these species. Its depth and complexity are correlated with the acuity and dominance of vision in the animal's sensory profile.

7. Key Concepts and Associated Structures

Lingual Gyrus (H5/H6): The inferior bank of the calcarine fissure, associated functionally with V1 processing of the superior visual field and also involved in recognition of words and memory.
Cuneus: The superior bank of the calcarine fissure, associated with V1 processing of the inferior visual field.
Parieto-Occipital Sulcus: The vertical fissure that intersects the calcarine fissure, serving as the arbitrary anatomical boundary between the parietal lobe and the occipital lobe.
Calcar Avis: An internal ridge or prominence visible on the medial wall of the posterior horn of the lateral ventricle, formed by the deep inward projection of the calcarine fissure tissue.
Striate Cortex: Another term for V1, derived from the visible line of Gennari, emphasizing its characteristic striped appearance under microscopic examination.

Further Reading

Calcarine sulcus (Wikipedia)
The Visual Cortex and V1 Anatomy
Neuroanatomy Online: The Occipital Lobe

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