MIDDLE CEREBRAL ARTERY

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November 3, 2025

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Primary Disciplinary Field(s): Neuroanatomy, Neurology, Neurosurgery, Radiology

1. Core Definition and Function

The Middle Cerebral Artery (MCA) is recognized as the largest and most clinically significant of the three major paired arteries that supply the cerebrum. Originating as a terminal branch of the Internal Carotid Artery (ICA), the MCA plays a critical role in providing oxygenated blood to the vast majority of the lateral surface of the cerebral hemispheres, including crucial regions responsible for motor function, sensation, speech, and auditory processing. Its anatomical trajectory and extensive branching pattern make it particularly vulnerable to thrombotic or embolic events, leading to the most frequent and impactful type of ischemic stroke syndrome.

Functionally, the integrity of the MCA is paramount for higher-order cognitive and sensorimotor processes. It supplies the primary motor and somatosensory cortices corresponding to the upper limb and face, as well as the language centers, namely Broca's Area (speech production) and Wernicke's Area (language comprehension) in the dominant hemisphere. A fundamental distinction must be drawn between the deep, penetrating branches of the MCA--the lenticulostriate arteries--which nourish the basal ganglia and internal capsule, and its superficial, cortical branches, which irrigate the cerebral mantle. This dual supply system explains the varied and complex clinical presentations associated with occlusions at different points along the artery's course.

2. Anatomical Course and Segmentation

The MCA follows a complex anatomical path, typically described in four distinct segments, designated M1 through M4, based on its relationship to surrounding bony and dural structures, particularly the Sylvian fissure (lateral sulcus). The understanding of these segments is crucial for both neurosurgical planning and the interpretation of radiological imaging, as the location of an occlusion dictates the predictable pattern of neurological deficit.

The initial segment, known as the **M1 segment** or the sphenoidal segment, begins immediately after the bifurcation of the ICA. This horizontal segment courses laterally within the cisterns adjacent to the sphenoid bone. It is during this short but vital stretch that the MCA gives rise to the deep, penetrating lenticulostriate arteries. The M1 segment terminates as the artery reaches the depth of the Sylvian fissure. Due to its proximal location, occlusion of the M1 segment results in the most devastating clinical syndrome, often affecting both deep (subcortical) and superficial (cortical) territories.

The **M2 segment**, or the insular segment, is characterized by its winding path over the insula, deep within the lateral sulcus. Here, the main trunk of the MCA begins to branch extensively, forming a complex network--the Sylvian cistern network--before emerging onto the cortical surface. These branches are generally categorized into superior and inferior trunks, which will ultimately supply the upper and lower halves of the MCA territory, respectively. The **M3 segment**, the opercular segment, consists of the branches that loop around the opercula (frontal, parietal, and temporal) to reach the superficial surface. Finally, the **M4 segment**, or the cortical segment, encompasses the terminal branches that spread out over the convexities of the cerebrum, providing the final blood supply to the cortical gyri.

3. Key Branches: Lenticulostriate Arteries

The lenticulostriate arteries represent the critical deep arterial supply arising directly from the proximal M1 segment of the MCA. These small, penetrating vessels ascend sharply to vascularize the basal ganglia (specifically the putamen and globus pallidus), the head and body of the caudate nucleus, and the crucial internal capsule. The internal capsule contains nearly all descending motor fibers (corticospinal tract) and ascending sensory fibers, condensing the entire body's motor and sensory representation into a very small area.

The clinical significance of the lenticulostriate arteries is immense. Because they are tiny, end-arteries (meaning they have little to no collateral circulation), they are highly susceptible to damage caused by chronic hypertension. High blood pressure causes hypertrophy and lipohyalinosis of these vessel walls, leading to small vessel occlusion, resulting in lacunar infarcts. Occlusion of a lenticulostriate artery results in a classic **pure motor stroke** or **pure sensory stroke**, where the deficit is often disproportionately severe given the minute size of the affected area, due to the high concentration of critical pathways within the internal capsule.

4. Cortical Territories Supplied

The cortical branches (M4 segment) of the MCA fan out across the lateral convexity of the hemisphere, supplying an expansive and functionally diverse territory. Understanding the distribution of these branches is essential for predicting the clinical manifestations following a cortical stroke. The cortical supply is typically divided along the Sylvian fissure into superior and inferior division territories.

Superior Division Territory: This division typically supplies the lateral aspects of the frontal and parietal lobes. Functionally, this includes the primary motor cortex and somatosensory cortex corresponding to the face and upper extremity (the lateral portion of the homunculus), Broca's area (in the dominant hemisphere), and the frontal eye fields. Infarction here typically causes contralateral hemiparesis and sensory loss predominantly affecting the face and arm, alongside expressive aphasia if the dominant hemisphere is involved.

Inferior Division Territory: This division extends to the lateral temporal and lower parietal lobes.

Key structures supplied include Wernicke's area (in the dominant hemisphere), the superior temporal gyrus, and parts of the angular and supramarginal gyri. Occlusion in this territory is less likely to cause severe motor deficits but frequently results in receptive aphasia (inability to understand language) and significant visual field deficits, often presenting as a contralateral superior homonymous quadrantanopia (pie in the sky defect).

Parieto-Occipital Supply: While the posterior cerebral artery (PCA) primarily supplies the visual cortex, the terminal branches of the MCA contribute to the lateral parietal-occipital region, influencing visuospatial processing and potentially contributing to visual deficits such as hemineglect.

5. Clinical Relevance: Ischemic Stroke Syndromes

The Middle Cerebral Artery is the site of occlusion in approximately 90% of all cerebral infarctions, establishing MCA stroke as the single most common type of ischemic stroke. The severity and specific symptomatology depend entirely on the site of occlusion--whether it is proximal (M1) or distal (M2/M3/M4)--and whether collateral circulation is sufficient to maintain perfusion to certain areas.

A complete **M1 occlusion** is the most catastrophic event, leading to the infarction of the entire MCA territory (both deep and superficial). Clinically, this manifests as a dense contralateral hemiplegia (paralysis of the arm, face, and leg), severe hemianesthesia (sensory loss), and severe global aphasia if the dominant hemisphere is affected, or profound hemineglect and anosognosia if the non-dominant hemisphere is affected. Furthermore, the massive size of the infarct often leads to severe cerebral edema, resulting in increased intracranial pressure, which carries a high risk of herniation and death.

Conversely, a distal occlusion, such as in a single cortical branch (M4), results in a more restricted, localized deficit--a partial MCA syndrome. For example, an isolated superior division stroke might cause motor symptoms and expressive aphasia, while sparing language comprehension. Understanding these distinct syndromes is crucial for neurologists, particularly when determining eligibility for acute interventions such as intravenous thrombolysis or endovascular thrombectomy.

6. Aphasias and Hemineglect

The MCA's supply to the language centers is the foundation for the understanding of distinct aphasia syndromes. Damage to the dominant hemisphere's superior division, specifically involving **Broca's Area** (located in the inferior frontal gyrus), causes **expressive aphasia**. Patients with expressive aphasia understand language well but struggle to produce coherent speech, often speaking haltingly and using telegraphic language. The deficit is typically accompanied by right-sided hemiparesis.

Damage to the inferior division, impacting **Wernicke's Area** (located in the posterior superior temporal gyrus), results in **receptive aphasia**. These patients produce fluent, often nonsensical speech (word salad) but have severely impaired comprehension. They are unaware of their language deficit. If the damage extends to the arcuate fasciculus, the fiber tract connecting these two areas, a **conduction aphasia** results, characterized by intact comprehension and fluency but poor repetition.

When the non-dominant hemisphere (typically the right) is affected by an MCA stroke, the resulting cognitive deficit is often **hemineglect** (also called spatial neglect). This complex syndrome involves a failure to report, respond to, or orient toward novel stimuli presented to the side of space opposite the lesion (the contralateral side), despite having intact sensory and motor capacity. Patients with severe right MCA strokes may ignore the entire left side of their world, failing to eat food on the left side of a plate or shave the left side of their face. This is often associated with **anosognosia**, a lack of awareness or denial of the profound neurological deficit.

7. Diagnostic Imaging Techniques

Accurate and rapid localization of an MCA occlusion is paramount in acute stroke management, where time-sensitive intervention can preserve viable brain tissue (the penumbra). Several advanced neuroimaging techniques are routinely employed to visualize the MCA and assess the extent of ischemic damage.

Computed Tomography (CT) Scanning is the primary initial diagnostic tool. Non-contrast CT is used primarily to exclude hemorrhagic stroke, which would contraindicate thrombolysis. A subtle but important sign of proximal M1 occlusion on CT is the **hyperdense MCA sign**, indicating a clot within the vessel lumen. Following this, CT angiography (CTA) is performed, which uses iodine contrast to clearly map the cerebral vasculature, definitively identifying the exact location of the occlusion and aiding in surgical planning for thrombectomy.

Magnetic Resonance Imaging (MRI), particularly Diffusion-Weighted Imaging (DWI) sequences, is the most sensitive method for detecting early ischemic changes, often within minutes of symptom onset. Magnetic Resonance Angiography (MRA) serves a similar purpose to CTA, providing detailed vascular mapping without the use of ionizing radiation. Additionally, **Perfusion Imaging (CTP or MRP)** is used to differentiate the irreversibly damaged core infarct from the salvageable ischemic penumbra, guiding the clinical decision to proceed with advanced reperfusion therapies.

8. Further Reading

Wikipedia: Middle Cerebral Artery
National Center for Biotechnology Information (NCBI): Anatomy, Head and Neck, Middle Cerebral

Artery
American Heart Association/American Stroke Association Guidelines for Acute Ischemic Stroke