BASILAR ARTERY

Authored by
mohammad looti

November 5, 2025

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Primary Disciplinary Field(s): Anatomy, Neurology, Cardiovascular Medicine

1. Core Definition

The **basilar artery** (BA) is a crucial unpaired midline blood vessel situated within the cranium, specifically along the ventral surface of the pons. It constitutes a principal component of the posterior circulation system, often referred to collectively as the **vertebrobasilar system**, which bears the exclusive responsibility for supplying oxygenated blood to essential neural structures. These structures include the brainstem (midbrain, pons, and medulla), the cerebellum, and significant portions of the posterior cerebrum, particularly the occipital lobes and medial temporal lobes. The artery's location and distribution are vital for sustaining functions such as consciousness, motor control, sensory relay, and autonomic regulation, making its hemodynamic integrity indispensable to neurological function. Dysfunction or acute occlusion of this vessel typically leads to rapid and catastrophic neurological deficits due to widespread ischemia in the fundamental areas it serves.

As confirmed by anatomical observation, the basilar artery originates precisely at the junction where the two vertebral arteries unite. This confluence usually occurs near the pontomedullary sulcus, marking a critical transition point from the spinal circulation derived from the neck into the specialized cerebral circulation. The artery then ascends superiorly along the clivus, embedded within the subarachnoid space and resting upon the central groove of the pons, before terminating in a significant bifurcation that forms the posterior components of the Circle of Willis.

2. Anatomy and Origin

The formation of the basilar artery is a distinct and highly critical event in cerebral vascular anatomy. The left and right vertebral arteries, having ascended through the transverse foramina of the cervical spine and traversed the foramen magnum, converge intracranially. This fusion point, typically located at the inferior border of the pons, is where the singular **basilar artery** officially begins. The artery then proceeds cephalad, maintaining a strict midline position within the basilar sulcus, a shallow indentation formed on the anterior (ventral) surface of the pons. Its path is characterized by a relatively short segment, generally measuring between 2.5 and 3.5 centimeters in length in a healthy adult, extending until it reaches the superior border of the pons.

The anatomical placement of the basilar artery is significant because it directly juxtaposes the brainstem, which houses numerous vital nuclei and fiber tracts. The artery is situated within the cisterna pontis, protected by the arachnoid and immersed in cerebrospinal fluid (CSF). The close adherence of the artery to the ventral brainstem means that vascular diseases, such as the elongation or tortuosity associated with severe hypertension (dolichoectasia), can exert chronic pressure on adjacent structures, leading to neurological signs. Furthermore, the basilar artery lies near the roots of several critical cranial nerves, including the abducens nerve (CN VI), the facial nerve (CN VII), and the vestibulocochlear nerve (CN VIII), which explains why pathologies affecting the basilar artery often involve simultaneous cranial nerve dysfunction.

3. Course and Relationship to Cranial Structures

The course of the basilar artery is fundamentally tied to the topography of the brainstem. As it ascends, it passes the origins of its major side branches and smaller perforating arteries, which penetrate the pontine tissue directly. Its upward trajectory culminates at the interpeduncular fossa, situated at the level of the midbrain. Here, the artery undergoes its terminal bifurcation, splitting into the paired **Posterior Cerebral Arteries** (PCAs). This bifurcation site, often referred to as the basilar tip, is one of the most clinically relevant points, as it is a common location for aneurysm formation.

The relationship between the basilar artery and the oculomotor nerve (CN III) is particularly important. CN III emerges from the midbrain close to the basilar tip; consequently, pathologies such as tip aneurysms or compression from adjacent vessels can lead to an isolated third nerve palsy, characterized by specific eye movement limitations and pupil dilation. The artery's location, running parallel to the ascending reticular activating system (RAS) pathways, ensures that vascular compromises anywhere along its length can jeopardize consciousness and the state of arousal, leading quickly to profound somnolence or coma.

4. Major Branches and Anastomoses

The basilar artery is responsible for feeding a complex vascular network via its numerous paired branches, which are typically symmetrical, although variations exist. These branches are generally categorized into three types: the pontine perforators, the named cerebellar arteries, and the terminal branches.

The **Pontine Perforating Arteries** are a series of small vessels that originate directly from the ventral surface of the basilar trunk. They penetrate the pons, supplying the deep nuclei and vital tracts, including the corticospinal and corticobulbar pathways. Occlusion of these very small, delicate end-arteries is a common cause of lacunar strokes, which can result in pure motor or pure sensory deficits, depending on the precise location of the infarct.

The major named branches, typically arising segmentally from inferior to superior, are the lifeblood of the cerebellum and associated brainstem structures:

Anterior Inferior Cerebellar Arteries (AICA): Usually the first pair of major branches, they supply

the anterior and inferior aspects of the cerebellum, often giving rise to the **Labyrinthine Arteries**, which supply the inner ear, making them crucial for hearing and balance functions.
Superior Cerebellar Arteries (SCA): The highest pair of major side branches, originating just before the terminal bifurcation. They course posteriorly to supply the superior cerebellar hemispheres and the dorsal aspects of the midbrain, including the superior cerebellar peduncles.

The terminal branches are the paired **Posterior Cerebral Arteries** (PCAs), which mark the end of the basilar artery. The PCAs form the posterior corners of the Circle of Willis, connecting anteriorly to the internal carotid circulation via the posterior communicating arteries. This anastomosis is crucial, as it provides a pathway for collateral blood flow from the anterior circulation to compensate for decreased flow in the basilar system, though this compensation is often insufficient during acute, large-vessel occlusion.

5. Functional Significance: The Vertebrobasilar System

The functional importance of the basilar artery lies in its role as the central conduit of the posterior circulation. Unlike the anterior circulation, which primarily services the cerebral hemispheres responsible for complex cognition, the vertebrobasilar system is tasked with perfusing structures essential for fundamental survival and coordination. These functions include maintaining the respiratory rhythm and cardiac output (mediated by the medulla), regulating consciousness (via the Reticular Activating System in the brainstem), and ensuring smooth, coordinated movement (via the cerebellum and its connections).

Due to the extraordinarily high concentration of descending motor tracts (pyramidal tracts) and ascending sensory pathways packed closely together within the brainstem, even small ischemic lesions fed by the basilar artery's perforating branches can produce profound, multisystem deficits. Because the basilar artery supplies the pontine region where motor signals cross the midline or are highly concentrated, bilateral occlusion often results in complete quadriparesis or quadriplegia. The integrity of flow through the basilar artery is therefore a direct determinant of basic life support and neurological command.

6. Clinical Relevance: Basilar Artery Stroke Syndromes

Acute occlusion or high-grade stenosis of the basilar artery (BAO) represents one of the most devastating cerebrovascular events, carrying a historically high mortality and morbidity rate. The clinical presentation is highly variable, depending on the level of occlusion (proximal, middle, or distal) and the extent of collateral flow. Symptoms often include sudden onset of vertigo, diplopia (double vision), dysphagia (difficulty swallowing), facial weakness, and profound ataxia (lack of coordination).

A specific and catastrophic outcome of severe ventral pontine infarction due to BAO is **Locked-in**

Syndrome (LIS). In LIS, the patient suffers near-total paralysis (quadriplegia and aphonia) due to the destruction of the descending motor pathways within the pons, but the reticular formation and consciousness centers remain intact. This results in a state where the patient is fully aware and cognitively preserved yet completely unable to move or speak, communicating only through vertical eye movements controlled by structures spared in the midbrain. LIS serves as a powerful demonstration of the concentrated criticality of the structures perfused by the basilar artery.

7. Pathophysiology and Aneurysms

The basilar artery is highly susceptible to both atherosclerosis and aneurysm formation. Atherosclerotic plaques, typically driven by systemic risk factors like severe, untreated **hypertension**, diabetes mellitus, and hypercholesterolemia, frequently develop at the origins of the vertebral arteries or along the basilar trunk itself. Progressive stenosis (narrowing) limits flow, predisposing the patient to posterior circulation TIAs or thrombotic strokes. Chronic hypertension also contributes to basilar artery dolichoectasia--a condition where the artery becomes elongated, dilated, and highly tortuous--which can physically compress adjacent cranial nerves or brainstem structures, leading to compression syndromes.

Basilar artery aneurysms are complex and particularly dangerous. The basilar artery, particularly its terminal bifurcation (the basilar tip), is a common location for saccular aneurysms. Due to their location deep within the skull base, these aneurysms pose significant surgical challenges. Rupture of a basilar artery aneurysm leads to a severe **subarachnoid hemorrhage**, often with blood filling the interpeduncular and pontine cisterns. Such hemorrhages are associated with high initial mortality and significant risk of subsequent complications, including hydrocephalus and vasospasm, demanding immediate neurosurgical or neurointerventional management.

8. Diagnostic Techniques

Accurate diagnosis of basilar artery pathology is essential for timely intervention. Initial imaging often involves Computed Tomography (CT) scanning, primarily to exclude intracranial hemorrhage, although CT sensitivity for early ischemic stroke in the posterior fossa is limited. Definitive diagnosis of acute basilar artery stroke relies on Magnetic Resonance Imaging (MRI), specifically using Diffusion-Weighted Imaging (DWI) sequences, which can visualize acute cellular changes indicative of infarction in the brainstem and cerebellum with high accuracy.

For detailed visualization of the vessel lumen, dedicated angiographic techniques are mandatory. Magnetic Resonance Angiography (MRA) and Computed Tomography Angiography (CTA) are non-invasive methods that reliably depict the basilar artery, assess the degree of stenosis, identify occlusions, and characterize aneurysms. The highly detailed **Digital Subtraction Angiography** (DSA), while invasive, remains the gold standard for intricate vascular analysis, often employed during pre-procedural planning or when navigating the artery for endovascular thrombectomy or aneurysm treatment.

9. Treatment Modalities

Acute basilar artery occlusion requires immediate, time-sensitive treatment aimed at rapid recanalization (restoration of flow). Treatment protocols often involve intravenous thrombolysis (IV tPA) if the patient meets strict criteria and presents within the therapeutic window. However, the definitive modern treatment for large vessel occlusion in the basilar artery is **endovascular thrombectomy**.

In thrombectomy, specialized neurointerventionalists utilize catheters, wires, and mechanical retrieval devices (such as stent retrievers) to physically grasp and remove the obstructing thrombus from the basilar artery. Timely and successful recanalization of the basilar artery dramatically improves clinical outcomes, significantly reducing the morbidity and mortality rates associated with BAO. The success of this highly technical procedure is critically dependent upon institutional readiness and rapid patient transfer, reinforcing the artery's status as a top neurological emergency.

10. Further Reading

Basilar Artery (Wikipedia)
Anatomy, Head and Neck, Basilar Artery (StatPearls)
Basilar Artery Occlusion Stroke: Diagnosis, Management, and Outcomes (Stroke Journal)
Vertebrobasilar System Anatomy and Clinical Relevance (Seminars in Interventional Radiology)