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Arterial Blood supply of Brain and Anatomical basis of Strokes: A Review literature

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Abstract: Although the human brain makes up only 2 per cent of total body weight, it receives 15 to 20 per cent of cardiac output and accounts for 20 per cent of total body oxygen consumption under normal conditions. Cessation of blood flow results in rapid depletion of energy reserves which can produce ischemic neurological symptoms within seconds. A stroke occurs when the blood supply to part of your brain is interrupted or reduced, preventing brain tissue from getting oxygen and nutrients. Brain cells begin to die in minutes. A stroke is a medical emergency, and prompt treatment is crucial. Early action can reduce brain damage and other complications. The good news is that many Patients die of stroke now than in the past. Effective treatments can also help prevent disability from stroke. In this paper the author describe in details the arterial part of the brain circulation as well as the clinical signs and symptoms in the cases Strokes.

Keywords: Strokes, Sign Symptom of strokes, Anatomy of Artery, Complication of Strokes

1. Introduction of Blood supply of Brain and strokes.

Cerebral circulation is the movement of blood through a network of cerebral arteries and veins supplying the brain. The rate of cerebral blood flow in an adult human is typically 750 milliliters per minute, about15% of cardiac output. Arteries deliver oxygenated blood, glucose and other nutrients to the brain. Veins carry "used or spent" blood back to the heart, to remove carbon dioxide, lactic acid, and other metabolic products. Because the brain would quickly suffer damage from any stoppage in blood supply, the cerebral circulatory system has safeguards including auto regulation of the blood vessels. The failure of these safeguards may result in a stroke. The volume of bl ood in circulation is called the cerebral blood flow. Sudden intense accelerations change the gravitational forces perceived by bodies and can severely impair cerebral circulation and normal functions to the point of becoming serious life-threatening conditions. The following description is based on idealized human

cerebral circulation. The pattern of circulation and its nomenclature vary between organisms. Blood supply to the brain is normally divided into anterior and posterior segments, relating to the different arteries that supply the brain. The two main pairs of arteries are the Internal carotid arteries (supply the anterior brain) and vertebral arteries (supplying the brainstem and posterior brain). The anterior and posterior cerebral circulations are interconnected via bilateral posterior communicating arteries. They are part of the Circle of Willis, which provides backup circulation to the brain. In case one of the supply arteries is occluded, the Circle of Willis provides interconnections between the anterior and the posterior cerebral circulation along the floor of the cerebral vault, providing blood to tissues that would otherwise become ischemic.

2. Definition of Strokes:

A **stroke** is a medical condition in which poor blood flow to the brain causes cell death. There are two main types of stroke: ischemic, due to lack of blood flow, and hemorrhagic, due to bleeding. Both cause parts of the brain to stop functioning properly. Signs and symptoms of a stroke may include an inability to move or feel on one side of the body, problems understanding or speaking, dizziness, or loss of vision to one side. Signs and symptoms often appear soon after the stroke has occurred. If symptoms last less than one or two hours, the stroke is a transient ischemic attack (TIA), also called a mini-stroke. A hemorrhagic stroke may also be associated with a severe headache. The symptoms of a stroke can be permanent. Long-term complications may include pneumonia and loss of bladder control. The main risk factor for stroke is high blood pressure. Other risk factors include tobacco smoking, obesity, high blood cholesterol, diabetes mellitus, a previous TIA, end-stage kidney disease, and atrial fibrillation. An ischemic stroke is typically caused by blockage of a blood vessel, though there are also less common causes. A hemorrhagic stroke is caused by either bleeding directly into the brain or into the space between the brain's membranes. Bleeding may occur due to a ruptured brain aneurysm. Diagnosis is typically based on a physical exam and supported by medical imaging such as a CT scan or MRI scan. A CT scan can rule out bleeding, but may not necessarily rule out ischemia, which early on typically does not show up on a CT scan. Other tests such as an electrocardiogram (ECG) and blood tests are done to determine risk factors and rule out other possible causes. Low blood sugar may cause similar symptoms.

3. Arterial Blood Supply of the Brain

The arterial blood supply of the brain is derived from the vertebral artery and internal carotid artery (ICA). The vertebral arteries supply blood to the ‘posterior circulation’ and the carotid arteries supply blood to the ‘anterior circulation’. However, these 2 important sources of blood are directly connected (think of this as nature’s ‘back up system’, should one of the systems fail). The connection of the vertebral and carotid circulations is via the Circle of Willis**.**

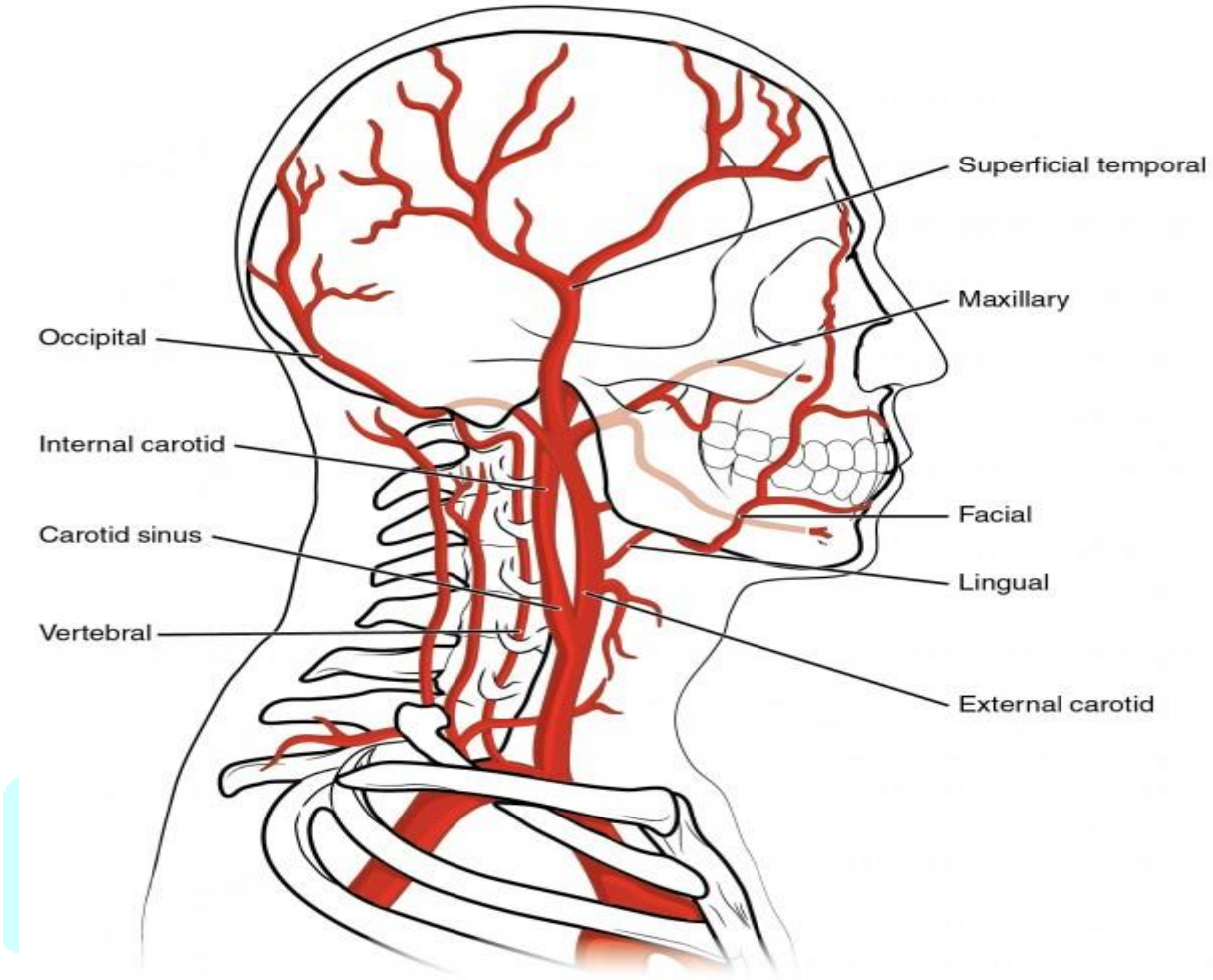


Image: Arteries Supplying the Head and Neck.

4. Anatomy of the internal carotid artery (anterior circulation)

The common carotid artery divides at the level of the 4th cervical vertebra (C4) to form the ICA and external carotid artery. This site is referred to as the carotid bifurcation and contains the carotid body, which contains chemoreceptors that detect changes in the oxygen concentration and the pH-value of blood circulating through the carotid arteries. The external carotid artery divides into 8 major branches. The internal carotid artery (ICA), on the other hand, has no branches in the cervical region. The ICA is divided into several segments including pars cervicalis (cervical segment), pars petrosa (petrous segment), pars cavernosa (cavernous segment), and pars cerebralis (cerebral segment). Each of these segments, with the exception of the pars cerebralis, has numerous branches. The intracranial portion of the ICA is further divided into 5 segments (C1–C5), terms that are used in clinical practice. The direct continuations of the ICA are the middle cerebral artery (MCA) and anterior cerebral artery (ACA). The ACA is the smaller of the 2 and supplies the medial portion of the hemispheres to the parietal lobe. The ICA supplies the frontal, parietal and the temporal lobes, as well as the diencephalon. The ophthalmic artery is a branch of the ICA and supplies the eyes and parts of the paranasal sinus.

5. Vertebrobasilar circulation (posterior circulation)

The vertebral arteries arise from the subclavian arteries and proceed through the transverse foramina of the cervical vertebrae at the levels of C1 through C6. Subsequently, at the level of the foramen magnum, the vertebral arteries pierce the posterior atlantooccipital ligament, dura mater, and arachnoid membrane, reaching the subarachnoidal space. The vertebral artery then gives rise to the posterior inferior cerebellar artery, the largest branch of the vertebral artery and 1 of 3 arteries that supply the cerebellum. Another branch of the vertebral artery is the single anterior spinal artery, which is supplied by both vertebral arteries. In the region of the pons, both vertebral arteries merge to form the single basilar artery. Unlike the vertebral arteries, the basilar artery is an unpaired artery, which means that occlusion of the basilar artery can lead to devastating clinical consequences. For example, occlusion of the distal part of the basilar artery can result in infarction of the pons and the clinical picture of a 'locked-in syndrome'. The basilar artery proceeds along the ventral surface of the pons. Along its course, the basilar artery gives rise to the anterior inferior cerebellar artery (AICA), the pontine perforators, as well as the superior cerebellar artery (SCA). Another possible branch of the basilar artery is the labyrinthine artery, which supplies the inner ear. However, the labyrinthine artery may also arise from the AICA.

6. Posterior cerebral artery

At the transition of the pons to the mesencephalon, the basilar artery bifurcates into the paired posterior cerebral arteries, 1 of the 3 major arteries that supply the brain. There are several branches of the Posterior Cerebral Artery. The posterior communicating artery connects the Posterior Cerebral Artery (and therefore the posterior circulation) to the ICA. Other important branches of the Posterior Cerebral Artery include the following: anterior and posterior temporal arteries (supply the temporal lobe), medial and lateral occipital arteries (supply the occipital lobe), calcarine artery (supplies the visual cortex), and medial and lateral posterior choroidal arteries. The Posterior Cerebral Artery can also be divided into 4 segments P1–P4, which are useful for describing the precise localization of a vascular lesion.

7. Anatomy of the circle of Willis

The circle of Willis is a circulatory anastomosis between the vascular territory of the carotid arteries, known as the 'anterior circulation' and the vascular territory of the vertebrobasilar circulation, also known as the 'posterior circulation'. The anterior and posterior circulations are connected at the base of the skull via the paired anterior communicating arteries and posterior communicating arteries. Therefore, if one part of the cerebral circulation is occluded, the circle of Willis allows collateral supply via an alternate vascular route. The anterior and posterior communicating arteries are also clinically important because they are a frequent site for intracranial aneurysms (pathologic vascular dilatations), which can result in a subarachnoid hemorrhage if the aneurysm ruptures. It is important to note that there are many normal anatomical variations to the circle of Willis.

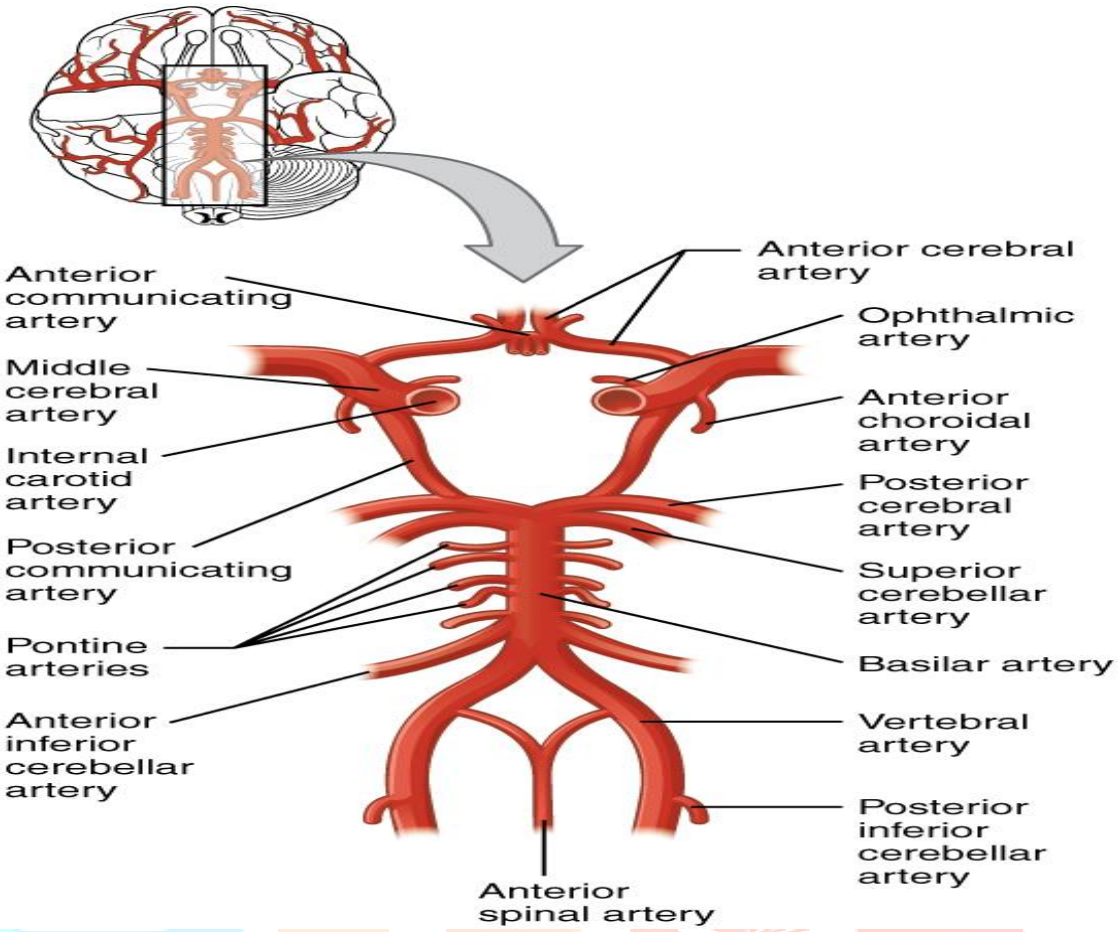
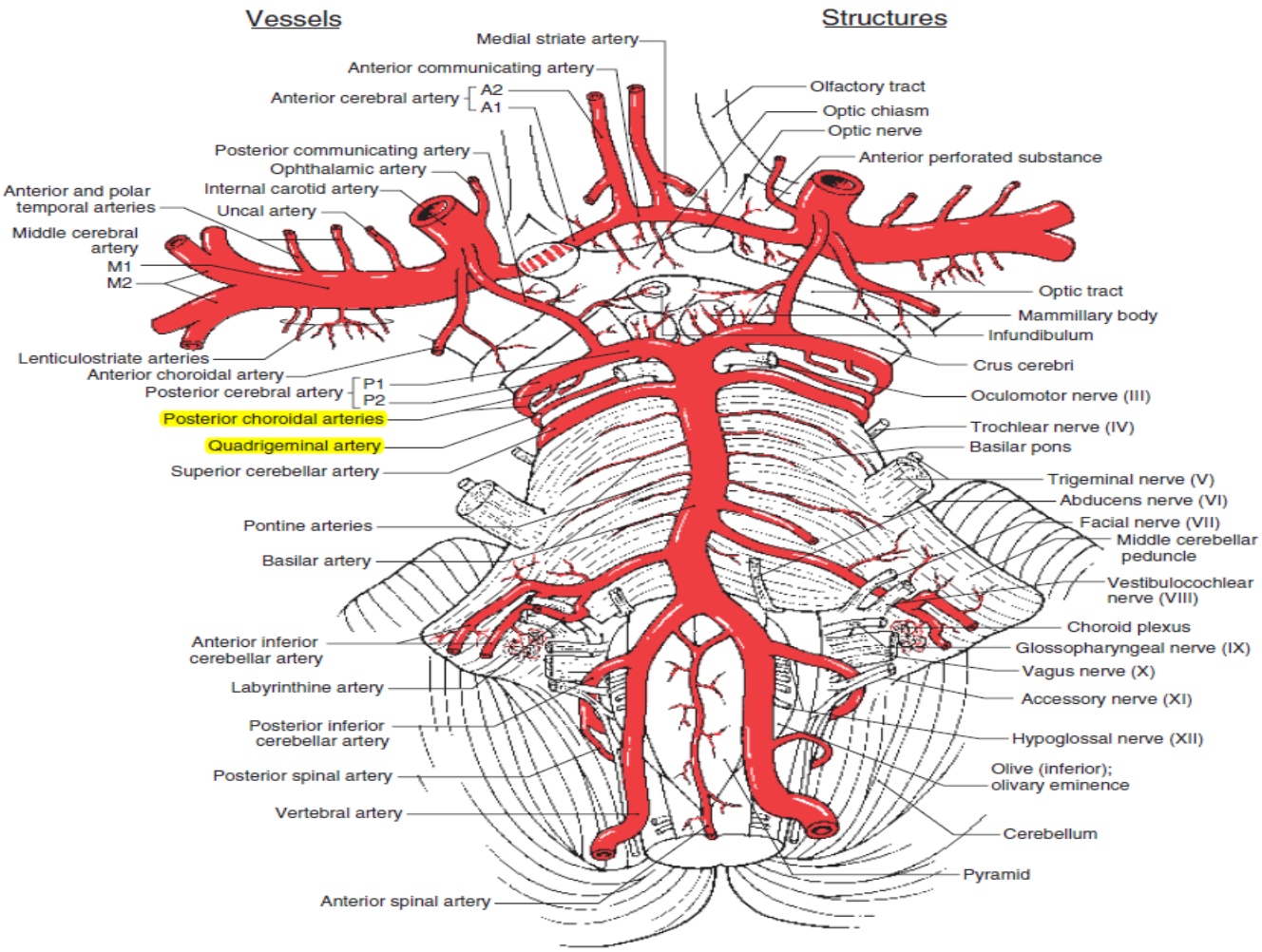


Image: Circle of Willis.

8. Vascular anatomy of the brain

The MCA supplies a large part of the lateral aspect of the hemispheres, including Broca's area and Wernicke's areas—the primary motor and sensory language centers respectively. The occipital lobe is supplied by the Posterior Cerebral Artery and includes the visual cortex. The frontal lobes, the medial portion of the hemispheres, and the superior portion of the parietal lobes are supplied primarily by the ACA. For a detailed view of the vascular supply and corresponding anatomy, please review the image.

9. Arterial supply of the brain stem and cerebellum



The brain stem and cerebellum are supplied by the basilar artery and cerebellar arteries or branches of these vessels. The branches are differentiated into medial, mediolateral, and lateral portions, based on their localization and which anatomical territory they supply. The medulla, which follows the brain stem, is supplied, among others, by the anterior spinal artery, a branch of the vertebral artery. The cerebellum is supplied by the AICA (anterior inferior cerebellar artery), posterior inferior cerebellar artery (PICA), and superior cerebellar artery (SCA). The AICA is the first branch of the basilar artery. The PICA is a branch of the vertebral artery. The SCA is the final and largest branch of the basilar artery before it splits into the paired Posterior Cerebral Artery s.

Table: Aortic Arch, Bifurcation, and Cerebral Circulation

Vessel	Description
Subclavian Artery	The right subclavian artery arises from the brachiocephalic artery and the left subclavian artery from the aortic arch; they proceed to the chest wall, vertebras and thyrocervical parts; supply blood to the arms, chest, shoulders, back and the central nervous system.
Vertebral Artery	Branch of the subclavian artery, which proceeds through the vertebral foramen and the foramen magnum into the brain; connects to the internal carotid artery to form the Circle of Willis; supplies blood to the brain and the medulla.
Common Carotid Artery	The right common carotid originates from the brachiocephalic artery, the left common carotid artery from the aortic arch; each artery divides into the external and internal carotid arteries; supplies the respective sides of head and neck.
External carotid Artery	Branch of the common carotid artery; supplies blood to numerous facial structures, mandibula, neck, esophagus, and larynx.
Internal carotid artery	Branch of the common carotid artery; starts with the carotid sinus nerve; passes through the carotid canal of the temporal bone at the cranial base; connects to the branches of the vertebral artery to form the Circle of Willis.Supplies blood to the brain.
Circle of Willis	An anastomosis at the cranial base, which ensures a continuous blood supply; formed by the branches of the internal carotid and vertebral arteries; supplies blood to the brain.
Anterior Cerebral Artery	Branch of the internal carotid artery; supplies blood to the frontal lobe of the cerebrum.
Middle Cerebral Artery	Another branch of the internal carotid artery. Supplies blood to the temporal lobe and the parietal lobe of the cerebrum.
Ophthalmic Artery	Branch of the internal carotid artery; supplies blood to the eyes.
Anterior Communicating Artery	Anastomosis of the right and left internal carotid arteries; supplies blood to the brain.
Posterior Communicating Artery	Branch of the posterior cerebral artery, which is part of the posterior portion of the circle of Willis. Supplies blood to the brain.
Posterior Cerebral Artery	Branch of the basilar artery, which forms parts of the posterior segment of the circle of Willis. Supplies blood to the posterior part of the cerebrum and brain stem.

Basilar Artery	Formed by the fusion of both vertebral arteries. Branches reach into the cerebellum, brain stem, and posterior brain arteries; primary blood supply of the brain stem

10.Stroke syndromes

Stroke occurs when there is a disruption of cerebral blood flow and is associated with ischemia in the associated brain tissue. This can occur due to occlusion of a cerebral vessel (**ischemic stroke)** or due to the rupture of a cerebral blood vessel (**hemorrhagic stroke**). The clinical symptoms and signs of a stroke depend on which blood vessel and corresponding brain tissue are affected.

The classical clinical presentation of stroke in the ACA vascular territory includes hemiparesis (i.e. weakness), which involves the legs more than the arms and is always contralateral to the vascular lesion. This is because the anterior cerebral artery supplies the frontal, prefrontal, and supplementary motor cortexes as well as part of the primary motor and sensory cortex. Additionally, occlusion of the ACA can lead to bladder dysfunction. Review of the homunculus may help clarify these. When the MCA territory is affected by as stroke, the classical clinical presentation includes contralateral hemiparesis (weakness), as well as sensory deficits. Aphasia (the inability to speak), may also occur when the dominant hemisphere for language is affected (which is the left hemisphere for most right-handed people and many left-handed people). Since the Posterior Cerebral Artery supplies the visual cortex, strokes in this vascular territory will typically result in visual disorders, e.g. in the form of **hemianopsia**. If the vascular supply to the thalamus is also affected, clinical findings can include sensory deficits (numbness) in the contralateral face, arm, and leg.

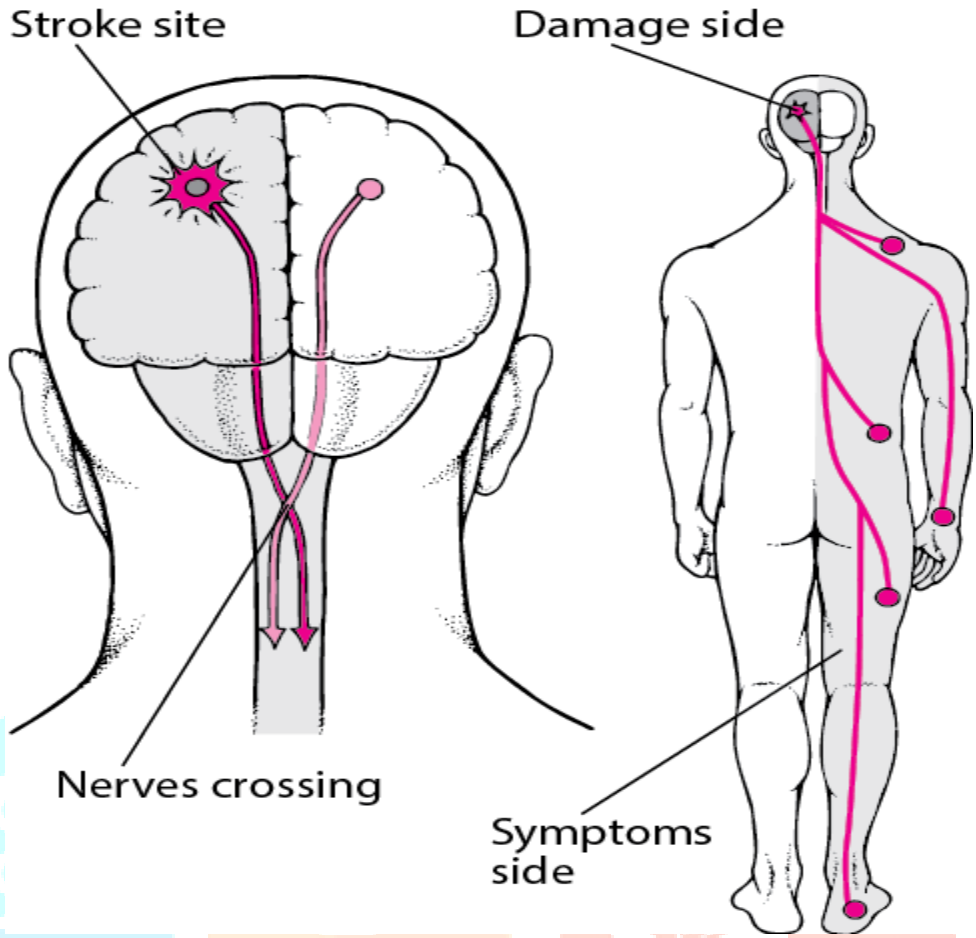


Image: Stroke side.

11. Symptoms of Stroke.

If you or someone you're with may be having a stroke, pay particular attention to the time the symptoms began. Some treatment options are most effective when given soon after a stroke begins.

Signs and symptoms of stroke include:

A. **Trouble speaking and understanding what others are saying.** You may experience confusion, slur your words or have difficulty understanding speech.

B. **Paralysis or numbness of the face, arm or leg.** You may develop sudden numbness, weakness or paralysis in your face, arm or leg. This often affects just one side of your body. Try to raise both your arms over your head at the same time. If one arm begins to fall, you may be having a stroke. Also, one side of your mouth may droop when you try to smile.

C. **Problems seeing in one or both eyes.** You may suddenly have blurred or blackened vision in one or both eyes, and you may see double.

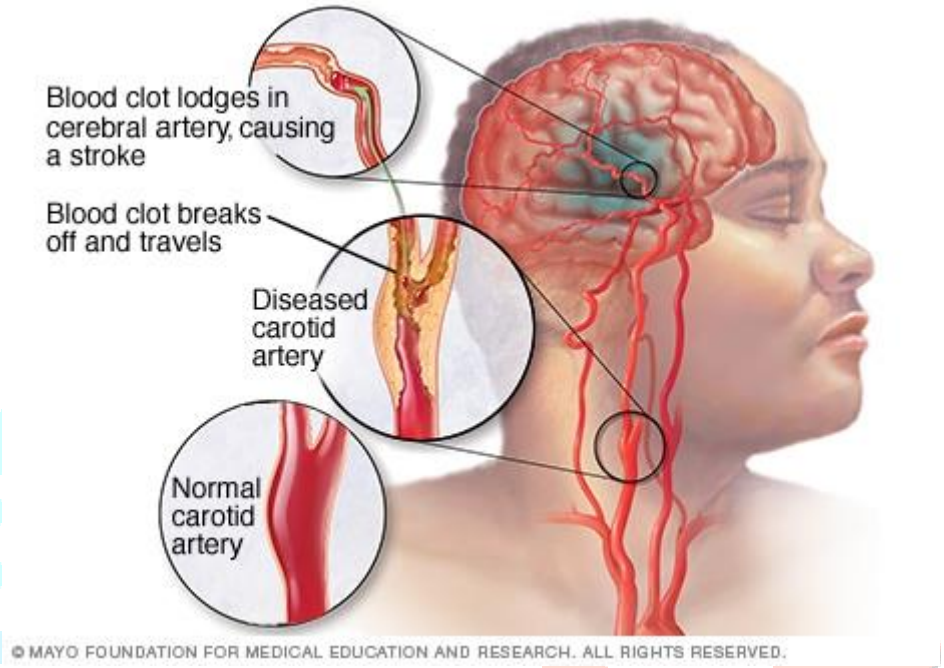
D. **Headache.** A sudden, severe headache, which may be accompanied by vomiting, dizziness or altered consciousness, may indicate that you're having a stroke.

E. **Trouble walking.** You may stumble or lose your balance. You may also have sudden dizziness or a loss of coordination.

12.Causes of Strokes

There are two main causes of stroke: a blocked artery (ischemic stroke) or leaking or bursting of a blood vessel (hemorrhagic stroke). Some people may have only a temporary disruption of blood flow to the brain, known as a transient ischemic attack (TIA), that doesn't cause lasting symptoms.

I. Ischemic stroke



Ischemic stroke Open pop-up dialog box

This is the most common type of stroke. It happens when the brain's blood vessels become narrowed or blocked, causing severely reduced blood flow (ischemia). Blocked or narrowed blood vessels are caused by fatty deposits that build up in blood vessels or by blood clots or other debris that travel through your bloodstream and lodge in the blood vessels in your brain. Some initial research shows that COVID-19 infection may be a possible cause of ischemic stroke, but more study is needed.

II. Hemorrhagic stroke

Hemorrhagic stroke occurs when a blood vessel in your brain leaks or ruptures. Brain hemorrhages can result from many conditions that affect your blood vessels. Factors related to hemorrhagic stroke include:

A. Uncontrolled high blood pressure

B. Overtreatment with blood thinners (anticoagulants)

C. Bulges at weak spots in your blood vessel walls (aneurysms)

D. Trauma (such as a car accident)

E. Protein deposits in blood vessel walls that lead to weakness in the vessel wall (cerebral amyloid angiopathy)

F. Ischemic stroke leading to hemorrhage

Transient ischemic attack (TIA)

A transient ischemic attack (TIA) — sometimes known as a mini-stroke — is a temporary period of symptoms similar to those you'd have in a stroke. A TIA doesn't cause permanent damage. They're caused by a temporary decrease in blood supply to part of your brain, which may last as little as five minutes. Like an ischemic stroke, a TIA occurs when a clot or debris reduces or blocks blood flow to part of your nervous system. Seek emergency care even if you think you've had a TIA because your symptoms got better. It's not possible to tell if you're having a stroke or TIA based only on your symptoms. If you've had a TIA, it means you may have a partially blocked or narrowed artery leading to your brain. Having a TIA increases your risk of having a full-blown stroke later.

13.Risk factors of Stroke.

Many factors can increase your stroke risk. Potentially treatable stroke risk factors include:

I. Lifestyle risk factors

A. Being overweight or obese

B. Physical inactivity

C. Heavy or binge drinking

D. Use of illegal drugs such as cocaine and methamphetamine

II. Medical risk factors

A. High blood pressure

B. Cigarette smoking or secondhand smoke exposure

C. High cholesterol

D. Diabetes

E. Obstructive sleep apnea

F. Cardiovascular disease, including heart failure, heart defects, heart infection or abnormal heart rhythm, such as atrial fibrillation

G. Personal or family history of stroke, heart attack or transient ischemic attack

Other factors associated with a higher risk of stroke include:

A. **Age** — People age 55 or older have a higher risk of stroke than do younger people.

B. **Race** — African Patients have a higher risk of stroke than do people of other races.

C. **Sex** — Men have a higher risk of stroke than women. Women are usually older when they have strokes, and they're more likely to die of strokes than are men.

D. **Hormones** — Use of birth control pills or hormone therapies that include estrogen increases risk.

14.Complications of Stroke.

A stroke can sometimes cause temporary or permanent disabilities, depending on how long the brain lacks blood flow and which part was affected. Complications may include:

A. **Paralysis or loss of muscle movement.** You may become paralyzed on one side of your body, or lose control of certain muscles, such as those on one side of your face or one arm.

B. **Difficulty talking or swallowing.** A stroke might affect control of the muscles in your mouth and throat, making it difficult for you to talk clearly, swallow or eat. You also may have difficulty with language, including speaking or understanding speech, reading, or writing.

C. **Memory loss or thinking difficulties.** Many people who have had strokes experience some memory loss. Others may have difficulty thinking, reasoning, making judgments and understanding concepts.

D. **Emotional problems.** People who have had strokes may have more difficulty controlling their emotions, or they may develop depression.

E. **Pain.** Pain, numbness or other unusual sensations may occur in the parts of the body affected by stroke. For example, if a stroke causes you to lose feeling in your left arm, you may develop an uncomfortable tingling sensation in that arm.

F. **Changes in behavior and self-care ability.** People who have had strokes may become more withdrawn. They may need help with grooming and daily chores.

Conclusion:

The good knowledge of both the characteristics of blood flow and the anatomical variations in blood supply to the brain as well as the specific ischemic signs and symptoms is necessitated in the clinical practice. The preoperative screening for considerable variations can provide best functional survival in patients who are suitable for vascular surgery. Cerebrovascular disease, or stroke, occurs as a result of vascular compromise or hemorrhage and is one of the most frequent sources of neurologic disability. Because the cerebral vessels each tend to irrigate specific territories in the brain, their occlusion results in highly stereotyped syndromes that, even prior to imaging studies, can suggest the site of the vascular lesion. Nearly half of the admissions to many busy neurologic services are because of strokes. Cerebrovascular disease is the third most common cause of death in industrialized societies. Because thrombolysis if accomplished in the initial hours after a stroke occurs can sometimes restore blood flow and improve clinical status, early recognition and treatment of stroke are essential. In this article we mention the sign symptom, of strokes along-with risk factor and complication.

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