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A comprehensive review of stroke: Types, epidemiology, pathophysiology, and risk factors

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Abstract

Stroke, a leading cause of adult mortality, is a syndrome characterized by loss of cerebral function due to hypoxic tissue damage. It can be categorized as ischemic or hemorrhagic. Ischemic strokes, accounting for 80-85% of all strokes, are primarily due to cerebral thrombosis or embolism, often from atherosclerosis-induced narrowing of cranial blood vessels. Furthermore, cardioembolism resulting from conditions like atrial fibrillation and myocardial infarction is another source of ischemic stroke. Hemorrhagic strokes, representing 1-7% and 7-27% of all strokes in the form of subarachnoid and intracerebral hemorrhages respectively, disrupt cerebral circulation, causing hypoxic tissue damage.

Nearly 50% of all strokes are thrombotic, resulting from large and small blood vessel occlusions leading to infarction. Embolic strokes occur when clots, often originating from cardiac sources, lodge in brain's blood vessels disrupting cerebral blood flow. Stroke symptoms are dependent on the anatomical location and severity of damage, leading to sudden motor weakness, sensory disturbances, speech disorders, visual or gait abnormalities.

Stroke is a prevalent neurological issue, with approximately 800,000 cases annually in the United States alone. The incidence of stroke, around 160 per 100,000, doubles with every decade after 55. While stroke numbers are growing due to an aging population, mortality rates have decreased due to better management of risk factors and improved acute treatment.

In ischemic stroke, blood flow blockage deprives brain tissue of oxygen and glucose. The ensuing ischemic cascade has been understood better through recent research, uncovering environmental changes involved in its pathophysiology and leading to the concept of a therapeutic time window for early intervention.

Risk factors for stroke encompass non-modifiable aspects (age, gender, race, ethnic origin, and heredity) and modifiable ones (systemic hypertension, smoking, alcoholism, dyslipidemia, obesity, sedentary lifestyle, atrial fibrillation, past heart disease, and transient ischemic attacks). Stroke prevalence in rural areas of developing countries is notably lower than Western countries, likely due to varying socioeconomic factors, ethnic origins, and cultural habits. Understanding these risk factors and the pathophysiology of strokes is crucial for prevention and improved management strategies.

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Introduction

A stroke, or cerebrovascular event, is a clinical syndrome characterized by cerebral function loss due to tissue hypoxia. The World Health Organization (WHO) defines a stroke clinically as "the rapid development of clinical signs and symptoms of a focal neurological disorder lasting more than 24 hours or leading to death with no apparent cause other than a vascular origin". When focal neurological deficits only persist for a short period (usually less than an hour), this is called a transient ischemic attack (TIA). Stroke is the second most common cause of death in the adult population. Strokes are divided into two types according to their pathophysiology: these are ischemic stroke and hemorrhagic stroke (1).

Ischemic stroke

Ischemic strokes are the most common type of stroke and result from cerebral thrombosis or embolism. They are responsible for 80-85% of cerebrovascular accidents (CVA) worldwide. One of the most common causes of ischemic stroke is the narrowing of blood vessels in the head or neck. The narrowing of the vessels primarily results from atherosclerosis and cholesterol accumulation (2). As the narrowing of the vessels progresses, stagnation of blood occurs, leading to the formation of blood clots. These blood clots can block the vessels in the area of formation (thrombosis) or dislodge and become lodged in a distal region (embolism), causing ischemic damage in brain tissues. Another cause of stroke can be cardio embolism, which can result from thrombus formation in the heart chambers. Conditions such as atrial fibrillation, myocardial infarction, valve lesions, or cardiomyopathies can affect thrombus formation in the heart chambers. Some minor causes of ischemic stroke include traumatic injury to blood vessels in the neck and clotting disorders (2,3).

Thrombotic stroke

This is a type of stroke where the underlying pathology is the formation of a thrombus that blocks the blood vessels in cerebral circulation. Nearly 50% of all stroke cases are due to these types of thromboses in blood vessels (4). Thrombosis in cerebral circulation generally occurs in two types of blood vessels - large vessels and small vessels-. Thrombosis occurs in large blood vessels such as the anterior cerebral artery, middle cerebral artery, and posterior cerebral artery, causing infarction over large areas. Thrombosis in small penetrating arteries causes lacunar infarction in different regions of the brain (5).

Embolic stroke

In an embolic stroke, a blood clot originating from other parts of the body reaches the brain's blood vessels. Most often, the blood clot originates from a cardiac source or the carotid artery, and this clot (embolus) passes through the cerebral circulation. Within the cerebral circulation, these clots lodge at a place where the artery narrows or branches, disrupting the blood flow in the brain parenchyma and causing focal deficits or stroke in the form of transient ischemic attacks (6).

Hemorrhagic stroke

Hemorrhagic stroke can be due to a subarachnoid hemorrhage or intracerebral hemorrhage. Subarachnoid hemorrhage constitutes 1-7% of all strokes, and intracerebral hemorrhage makes up 7-27% of all strokes worldwide. Stroke is a heterogeneous syndrome that can originate from any disease process that disrupts cerebral circulation and then causes hypoxic tissue damage (7). The manifestation of a stroke is dependent on the anatomical location and severity of tissue damage. It can cause sudden motor weakness, sensory disturbances, speech disorders or total speech loss, visual or gait abnormalities. Because the cerebral cortex has different areas and functions, it is usually the area provided by the specific vascular region affected. Warning signs of a stroke should be immediately recognized for early medical intervention (7,8).

Epidemiology

Stroke ranks at the top in terms of frequency among neurological diseases in adults. It is known as the most common and serious neurological problem worldwide. Approximately 800,000 stroke cases are reported each year in the United States. About 600,000 of these are the first attack, the remainder being recurrent stroke attacks. Stroke is a challenging disease in terms of both the treatment process and the outcomes, ranking second after heart diseases as a cause of death. Although stroke cases in the US increase with the growth and aging of the population, a general decrease is observed in the mortality rate from stroke. This decline is thought to be related to better management of stroke risk factors and improved medical treatment in the acute phase. Today, the incidence of stroke is around 160 per 100,000. The incidence of stroke is especially age-dependent and doubles in every decade after the age of 55 (8-10).

Pathophysiology

Stroke is a sudden neurological event characterized by the sudden or rapid progression of symptoms and signs concerning specific regions of the brain. In the stroke caused by ischemia, the blood flow to the brain is blocked and the brain tissue is deprived of glucose and oxygen. Ischemic stroke arises from multiple causes and subsequently has sequels. When colonized by rough intima plaque, a thrombus can form in the arteries both outside and inside the skull. When endothelial damage occurs, the collateral clotting system is activated. The collateral system takes over and maintains function. When the collateral system is also endangered, eventually cell death occurs and the situation worsens (11).

In an embolic stroke, a clot from a different source blocks the brain's blood vessels. The micro embolus has many cardiac origin sources, such as patent foramen ovale, atrial fibrillation, and infective endocarditis. Cardioembolic origin accounts for 20% of ischemic strokes. The source of the emboli can be any form such as blood, fat, and air, commonly occurring during surgical procedures. Less common other causes include aortic dissection and coagulopathies, arteritis, infection, and drug use like cocaine. The thrombus or emboli reduce the blood flow to the brain, leading to an ischemic cascade (12).

The brain requires optimal temperature, pH, waste removal, and nutritional balance for its optimal functions. Scientific research conducted in the last thirty years has uncovered the environmental changes involved in the pathophysiology of ischemic stroke. Understanding the ischemic cascade and damage at the cellular level has led to the concept of a therapeutic time window for early intervention. Dead cells are surrounded by a hypo-perfused region known as the penumbra region. In the ischemic cascade, pharmacological and non-pharmacological treatments are used to halt cellular events (13,14).

Risk factors

A careful understanding of risk factors can help prevent the onset of stroke. Age, gender, race, ethnic origin, and heredity are risk factors that cannot be changed. Systemic hypertension, smoking, chronic alcoholism, dyslipidemia, obesity, a sedentary lifestyle, atrial fibrillation, past heart disease, and transient ischemic attacks are potentially treatable/alterable factors in stroke incidence (15). Epidemiological studies related to stroke are much less in developing countries. The prevalence of stroke in rural areas is between 40-270, which is lower compared to Western countries. The cause of variation may stem from socioeconomic factors, ethnic origin, and cultural habits (16).

Conclusions

Stroke is a leading cause of death globally, primarily caused by ischemic events due to blood vessel narrowing or blockage. Understanding risk factors, especially treatable ones like hypertension, smoking, and obesity, can aid prevention. More epidemiological studies are needed, especially in developing countries.

Conflict of interest

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