

*Review Article*

## Advances in Management of Cerebral Vascular Disease

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### Abstract

*Cerebral vascular disease occurs at the arteries of brain due to the less supply of blood. Stroke is mostly caused by cerebral vascular disease and it is also a common cause of vascular dementia due to reduced oxygen supply and blood flow to the brain. In industrialized countries, neurologic disability is most frequently caused by cerebrovascular disease. Individuals with cardiovascular disease, diabetes and high blood pressure etc are at higher possibility for cerebral vascular disease. After malignancy and heart disease, cerebral vascular disease is the third leading of death and estimated that an average 500,000 new stroke occurred in each year. Advance techniques such as carotid endarterectomy, magnetic resonance imaging, angiography and single photon emission computed tomography etc are used for management of cerebral vascular disease.*

**Keywords:** Cerebrovascular disease, Stroke, Radioisotopes, Imaging

### Introduction:

Cerebral vascular disease is a group of brain diseases. It is the disease of blood vessels that supply blood to brain. The cerebral vascular disease mostly occurred when pathological changes occur in blood vessel e.g. Embolus (occlusion of lumen) and any lesion that change the viscosity of blood and also increased the permeability of the walls of blood vessels. Cerebrovascular disease initially affects those persons that have a ischemia heart disease, elder, smoker and also have a history of diabetes (Nor et al., 2005). The cerebral vascular disease results may include such as hemorrhage stroke, ischemia and other blood vessel problems.

### Types of Cerebrovascular Diseases

Cerebral vascular disease may be divided into three different types (1) Ischemic stroke is occurred due to blockage of arteries due to deposition of fatty, so clot formation in the arteries of brain which is called as plaque. It is further classified into two types (2) Cerebral Embolism in which clot breaks into pieces and through blood stream reach the brain (3) Cerebral thrombus occurred when a clot stay in place in the brain.

### Transient Ischemic Attack (TIA):

It is short-term cerebral vascular disease and there is no permanent damage in the artery only a small temporary blockage occurred in the artery.

### Hemorrhagic Stroke:

When it is occurred then bleeding start in the brain due to weakening and bursting of small blood vessel in the brain (Deb et al., 2010). So, brain cells start to damage after the bursting of

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blood vessels. It may be classified (1) Intracerebral Hemorrhage when spreading of blood in the surrounding brain tissue occurred due to bursting of an artery in the brain than this hemorrhage occurred (2) Subarachnoid Hemorrhage occurred when blood reach in the space present between the skull and brain (Lees et al., 2006).

### Major risk factors

Following are the risk factor that causes cardiovascular disease such as: Hypertension ( Systolic or diastolic) , Smoking, Atrial Fibrillation, Myocardial Infarction, Hyperlipidemia, Congestive Heart Failure, Diabetes , Acute Alcohol abuse, TIA >70% occlusion of the carotid arteries, Oral contraceptives when combined with smoking in women, Hypercoagulopathy, High RBC count and Hemoglobinopathy, Age, Gender, Race, Prior Stroke, and Heredity (Hill, 2005) .

The Cerebral vascular diseases are managed by following methods such as:

**Single photon emission computed tomography (SPECT, or less commonly, SPET)** is a nuclear medicine tomographic method which used gamma rays. In this technique, radionuclide such as gamma-emitting radioisotope injected into the patient bloodstream. Radioisotope of gallium (III) which have certain chemical properties such as readily dissolved ion and concentrated in such part of body where disease is present (Westover et al., 2007, Cantu et al., 2003). This technique is usually performed to determine blood flow to area where seizure originated. It is used to see the pattern of blood flow in the veins and arteries of

brain. It is performed between seizure or during seizures and also used to diagnose ischemic area of brain, stroke, tumor etc. Due to its sensitivity, it is used to detect reduced blood flow to injury site as compare to other techniques. It is three-dimensional technique and provide useful information about internal organ of body such as infection imaging, (Ezekowitz et al., 2003) brain imaging and tumor imaging.

### Functional brain imaging

In Functional brain imaging, we mostly used gamma-emitting tracer such as  $^{99m}\text{Tc}$ -HMPAO (hexamethylpropylene amine oxime).  $^{99m}\text{Tc}$  is a metastable nuclear isomer, which can be detected by a gamma camera due to emission of gamma rays (Ederle and Brown, 2006). When HMPAO attached with  $^{99m}\text{Tc}$ , it is taken up by brain tissue in such a way that is proportional to blood flow in brain and then nuclear gamma camera is assessed with brain blood flow. The  $^{99m}\text{Tc}$ -HMPAO tracer (as well as the same  $^{99m}\text{Tc}$ -EC tracer) is used to detect brain metabolism regionally, (Rosen and Lenkinski, 2007) in an attempt to diagnose and differentiate the different harmful pathologies of demantia and also provide useful information about local brain injury from different processes and brain glucose metabloism.

### Magnetic resonance imaging (MRI), OR Nuclear magnetic resonance imaging (NMRI),

This medical imaging technique (Allen et al., 2000) used to seen the limited function of body and internal structure. It is painless technique, we arranged the magnetization of some atoms in the body with the help of magnetic field and then change systemically magnetization arrangement by radiofrequency field. Rotating magnetic field is procedure by nuclei and detect by scanner (Sandu

et al., 2009) .Then image of scan area of body is formed.

## **SPECIALIZED MRI SCANS**

### **Functional MRI (fMRI)**

In this technique we measured signal change, when neural activity changed in the brain. The MRI signal changed due to increased neural activity (Paciaroni and Bogouslavsky, 2010, Elliott and Smith, 2010) and this process is known as blood-oxygen-level dependent (BOLD) effect. It scanned the brain at rapid rate but low resolution.

The primary form of fMRI uses the blood-oxygen-level-dependent (BOLD) contrast, discovered by Seiji Ogawa. This is a type of specialized brain and body scan used to map neural activity in the brain or spinal cord of humans or other animals by imaging the change in blood flow (hemodynamic response) related to energy use by brain cells. Since the early 1990s, fMRI has come to dominate brain mapping research because it does not require people to undergo shots, surgery, or to ingest substances, or be exposed to radiation. Another method of obtaining contrast is arterial spin labeling.

The procedure is similar to MRI but uses the change in magnetization between oxygen-rich and oxygen-poor blood as its basic measure. This measure is frequently corrupted by noise from various sources and hence statistical procedures are used to extract the underlying signal. The resulting brain activation can be presented graphically by color-coding the strength of activation across the brain or the specific region studied. The technique can localize activity to

within millimeters but, using standard techniques, no better than within a window of a few seconds (Sims and Muyderman, 2009, Kidwell and Warach, 2003).

fMRI is used both in the research world, and to a lesser extent, in the clinical world. It can also be combined and complemented with other measures of brain physiology such as EEG and NIRS. Newer methods which improve both spatial and time resolution are being researched, and these largely use biomarkers other than the BOLD signal. Some companies have developed commercial products such as lie detectors based on fMRI techniques, but the research is not believed to be ripe enough for widespread commercialization.

### **Diffusion MRI**

It determined the movement of water molecules in biological tissues (Stam, 2005). Naturally, in isotropic medium water molecules move randomly according to Brownian motion. Reynold's number is low in biological tissue so flow is laminar and movement of molecule will be anisotropic e.g. Inside the axon there is low chance of crossing the myelin membrane of neuron. So they move along axis of the neural fiber (Guercini et al., 2008).

### **Duplex ultrasound**

Duplex ultrasound is recently discovered technique which is noninvasive screening of carotid bifurcation disease because it is cheap, accurate and easily available. It can provide an image of the vessels lumen, ocular ischemia, morphology of the vessels wall and associated plaque, degree of stenosis etc. It does not constantly differentiate tight stenosis from

occlusion and distal or proximal carotid circulation. This advance technology used to differentiate tight extra cranial carotid stenosis from occlusion and also provide pathological, pathological and anatomical information about the ischemic lesions and intracranial circulation with safety and reproducible accuracy.

### **Transcranial Doppler imaging**

In 1982, Transcranial Doppler (TCD) technique is used for examination of intracranial arteries that was first introduced by Aaslid and colleagues. It is used to measure the velocity of blood flow in vessels of brain. It helped in the diagnosis of vasospasm stenosis from a subarachnoid hemorrhage, (Bamford, 2000) emboli, and other dysfunctions. It is mostly fast and inexpensive technique in growing population in the United States. Its result is better when used in combination with other tests e.g. CT-Scan, MRI etc. A recent advance in Doppler imaging is the ability to provide a three-dimensional projection (3D Doppler) of the intracranial arteries that enable them to improved detection and evaluation of stenoses involving the circle of Willis and also improved characterization of intracranial aneurysms (Beckett et al., 2008). In 1990, the American Academy of Neurology suggested that Transcranial (TCD) has established value in the treatment of patients with subarachnoid hemorrhage, intracranial stenosis, collaterals and brain death.

### **Carotid Endarterectomy (CEA)**

The carotid artery is the large vertical artery that is red in color. The arch of the aorta that supplied blood to the subclavian artery (common carotid

artery). The common carotid artery divided itself into two arteries one is the internal carotid artery and other is external carotid artery (O'Regan et al., 2008 ). Plaque formation occurred in one of the artery. So, in case of carotid endarterectomy we cut the artery, than open the artery and remove the plaque and take the section of carotid artery with plaque. The direction of blood flows from the common carotid artery and then next to internal carotid artery and external carotid artery. The atherosclerotic plaque is the dark color mass which present in the internal carotid artery (left), which would be removed with the help of this technique. Endarterectomy is the removal material the inside of an artery. The plaque can make in the inner surface of the artery, and cause narrowing of the artery. Pieces of plaque, called emboli, can move towards brain through the internal carotid artery, where it blocks circulation, and can cause death of the brain tissue. The first symptom appeared due to plaque are temporary or transitory stroke, known as transient ischemic attacks (TIAs). According to definition, TIAs remain less than 24 hours, after 24 hours they are called strokes. Symptoms stenosis has a higher chance of stroke within the next two days (Algra et al., 2007). The National Institute for Health and Clinical Excellence (NICE) suggested that patient with moderate to severe (50-99% blockage) stenosis and symptoms should have "immediate" endarterectomy within 2 weeks.

### **Recent medical management for the types of cerebral vascular disease:**

#### **For Transient Ischemic Attacks**

The first transient ischemic treatment is done with aspirin, than second with clopidogrel and third with ticlopidine. If TIA is frequent occurred

after aspirin treatment, then combination of dipyridamole and aspirin is required. The common cause of TIAs is embolization of brain and atrial fibrillation visualized by electrocardiogram (ECG). Ultrasound (TCD) scan shows carotid stenosis, because TIAs mostly affect supply of carotid stenosis. Surgery is the technique by which we opened the artery and remove the plaque after anesthesia (Bartolucci and Howard, 2006, Ringleb et al., 2008). But this process causes complication such as stroke. Stroke is usually happened during surgery or after the procedure. Now ACE inhibitors are also used to treat frequent attack.

### Surgical Interventions

#### Carotid Endarterectomy (CEA)

1. surgical removal of the atheromatous plaque
2. reserved for patients with an ulcerated lesion or clot that occludes > 70% of blood flow in the carotid artery (Fairhead et al., 2005)
3. may decrease risk of stroke by 60% over the two years following the procedure
4. vertebral endarterectomy no longer used

### Endovascular procedures

#### Balloon Angioplasty

1. consists of placing a small deflated balloon in the stenosed vessel
2. the balloon is then inflated pressing the atheromatous plaque against the wall
3. has a risk of dislodging emboli that can be carried to the brain or retina

#### Stent Placement

1. experimental procedure
2. consists of placing a stainless steel coil into the vessel which then sticks to wall of artery

### Computed Tomography (CT scan):

It is used to explain the presence of blood in subarachnoid space. CT is preferred for the early identification of hemorrhage in patients who are being considered for thrombolytic therapy. CT is also useful for ruling out other lesions that (Yadav et al., 2004) may mimic stroke, such as a tumor. CT produces good contrast between high-attenuation (bright) blood and low-attenuation (dark) cerebrospinal fluid. CT is also widely available on an emergency basis, and there are fewer contraindications to its use than with MRI.

### Conclusion:

Cerebral vascular disease is a group of brain abnormalities. It occurred due to dysfunctioning and various pathological processes occur in the blood vessels. So, we can manage it by using different technique such as Carotid Endarterectomy, SPET, angiography and MRI.

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