Hypertension and Vascular Dementia*†

LYNN A. PETTY, M.S.,† JOHN R. PARKER, M.S.,‡
and JOSEPH C. PARKER, Jr., M.D.

University of Missouri-Kansas City,
Truman Medical Center
Department of Pathology,
Kansas City, MO 64108

ABSTRACT

Postmortem surveys on patients treated for chronic hypertension often fail to demonstrate significant vessel changes. Nevertheless, hypertensive alterations in the brain can include infarcts and hemorrhages. Autopsies in a primary care hospital have shown that hypertension can affect arteries, arterioles, and capillaries in various patterns and degrees in the brain. These vascular lesions may be associated with large and small infarcts and hemorrhages in isolated or diffuse patterns. Widespread cerebral edema can occur with rapidly progressive hypertension. Atherosclerosis, arterial and arteriolar fibrinoid necrosis, and micro-aneurysms may be observed. Chronic hypertensive encephalopathy causes vascular dementia and can be associated with subcortical arterial and arteriolar leukoencephalopathy, leukoaraiosis and/or Binswanger’s disease. Epidemiologic evaluations based on complete autopsy studies need to be correlated with compliance of therapy, appropriate diagnosis of hypertension, and its long-term effects on the nervous system. Although persistent poorly controlled hypertension is known to damage the brain both acutely and chronically, the effects of intermittent hypertension remain to be defined.

Hypertensive Strokes

Hypertension is a common diagnosis and affects at least 60 million Americans.¹² Despite the advances in diagnosis and treatment of hypertension, postmortem changes consistent with hypertension continue to be seen. Hypertension can cause various changes in arterial vessels, depending on their size and the duration of the elevated blood pressure. In larger arteries, hypertrophy of smooth muscle and damaged elastic fibers with eventual fibrous replacement of their walls leads to rigidity and dilatation. In smaller arteries, intimal thickening may be present. Arterioles may display lipohyalinosis.⁴

Acute hypertensive cerebral changes include encephalopathy, fibrinoid arterial necrosis, and intraparenchymal hem-
Acute encephalopathy has been attributed to excessive vasodilation and alteration of the blood-brain barrier. Location of the intracerebral hemorrhage suggests hypertension when it occurs in the basal ganglia and thalamus. Widespread small hemorrhages in the brain can also be seen in a hypertensive patient.

Chronic hypertensive changes in the brain include lipohyalinosis and Charcot-Bouchard aneurysms which are one to three mm aneurysms commonly seen in patients who are over 50 years old. The aneurysms may rupture with sudden increased pressure leading to intracerebral bleedings. Chronic hypertensive changes are also associated with infarcts induced by intimal arterial thickening with subsequent decreased blood flow to the supplied parenchyma.

Although the brain receives 14 percent of the cardiac output, it requires 23 percent of the oxygen supply to function. Therefore, small changes in hemodynamics may lead to ischemia and eventual infarction. This delicate balance indicates that even normal fluctuations in blood pressure could lead to ischemia. The boundary zones or watershed areas are especially susceptible to infarction owing to hypoperfusion. Basal ganglia, internal capsules, pons, and areas supplied by the middle cerebral arteries are major sites of infarction associated with hypertension.

Infarcts occur primarily either by increased atheroma formation to the point of occlusion or by embolization from distant sites. Their extent depends on the rate of vascular occlusion, available collaterals, and site of occlusion. Their location and diffuseness correlate with clinical manifestations including dementia. Ten to 20 percent of all dementias are considered to be due to a hypertensive hematoma.
vascular problem. Alzheimer’s disease, on the other hand, accounts for 55 percent of all demented patients. Another 20 percent are mixed dementias with both Alzheimer’s disease and vascular dementia. The following patient illustrates this mixed type of dementia.

Case History

L.C., an 86-year-old black male, was admitted to Truman Medical Center-West complaining of increasing shortness of breath and sharp chest pain for several days. Additionally, he experienced episodes of blurred vision, brief episodes of impaired consciousness, and disorientation to time and place. He had a history of hypertension, congestive heart failure, and atherosclerosis and had bilateral carotid endarterectomies two years earlier. On this terminal admission, a head computer tomography (CT) scan showed moderate cortical atrophy. The patient had ischemic changes by electrocardiogram (EKG). Subsequently, he developed abdominal pain and a mesenteric angiogram suggested a probable complete occlusion of the superior mesenteric artery. Exploratory laparotomy revealed no blood clot in this vessel. The patient became hypotensive post-operatively and required vasopressor therapy. His hospital course was complicated by blood-tinged sputum consistent with acute pulmonary edema induced by fluid maintenance therapy and blood transfusion. He deteriorated steadily and expired nine days after admission.

Postmortem examination revealed severe coronary atherosclerosis with complete occlusion of the left circumflex artery and 50 percent occlusions of the left anterior descending and right coronary arteries. He had cardiomegaly (600 grams) with left ventricular hypertrophy, calcific aortic stenosis, and severe generalized atherosclerosis. Severe pulmonary edema and pleural effusions were seen. Other findings included acute and chronic passive congestion of the liver and kidneys, congestive splenomegaly, and acute renal tubular necrosis.

The fresh brain weighed 1,080 grams. Widened cerebral sulci and atrophic gyri were noted. The circle of Willis had marked atherosclerosis. Sections of the brain failed to show lateral ventricular dilatation; however, barreling of the third ventricle was present. The cerebellum was normal except for a 0.5 cm ischemic cystic lesion in the right superior lobe. Microscopy showed prominent neurofibrillary tangles and neuritic plaques in the frontal and temporal cortices consistent with Alzheimer’s disease. Diffuse atherosclerosis of the cerebral vessels with subcortical leukoencephalopathy was seen. Neuronal loss was noticeable in the basal ganglia and occipital and parietal cortices.

![Figure 2. This CT scan from a 47-year-old woman with rapidly progressive hypertension and dementia demonstrates severe leukoaraiosis, mild ventriculomegaly, and slight cortical atrophy consistent with Binswanger’s disease.](image-url)
Vascular Dementia

Vascular dementia comprises six entities which include multi-infarct dementia, lacunar dementia, cerebral amyloid angiopathy (figure 1), white matter lesions with infarcts, single infarct dementia, and Binswanger's subcortical leukoencephalopathy (figures 2 and 3).\(^3\) Multi-infarct dementia is the most common vascular dementia and typically results from bilateral large infarcts involving the anterior circulation. Although infarcts occur in non-demented patients, these rarely exceed a volume of 50 ml. In multi-infarct dementias, 90 percent of the infarcts are bilateral and involve a volume greater than 100 ml.\(^4\) Multi-infarct dementia usually presents with focal features such as dysarthria, dysphagia, and hemianopia. A CT scan with cerebral atrophy and ventricular dilatation is consistent with the diagnosis.

In contrast, lacunae, which are small 0.5 to 1.5 cm cavities, occur mainly in hypertensive patients and are seen in the diencephalon.\(^4\) They may be asymptomatic in 30 percent of patients.\(^3\) Lacunae may develop from small infarcts, small bleeds, increased vascular tortuosity, or some combination of these disorders. The increased tortuosity may lead to ischemia and eventual infarction.\(^4\) Some

![Figure 3](image_url)
lacunae, too small to be observed on a CT scan, can be found with magnetic resonance imaging (MRI).³

Amyloid may be found in the media and adventitia of arteries and arterioles of older individuals. This amyloid angiopathy occurs in 81 percent of patients with Alzheimer’s disease.⁴,⁶ Scheibel et al⁹ report a refractile material in capillaries of patients with Alzheimer’s disease that was histochemically amyloid and found outside the brain.⁹,¹⁴ This suggests systemic amyloid may occur in Alzheimer’s disease.⁶

In 1894, Binswanger described eight cases of subcortical leukoencephalopathy with atrophy of the white matter and ventricular enlargement.¹ Currently, neuroimaging diagnoses of Binswanger’s disease have increased, in spite of better control of hypertension.⁵ Clinically, the diagnosis of Binswanger’s disease may present as a distinct syndrome in a demented patient with diffuse bilateral leukoaraiosis and uncontrollable hypertension.⁵,¹³

Hachinski et al⁵ has proposed the term leukoaraiosis for hypodense lesions in the subcortical white matter on computerized tomography (figure 2). Leukoaraiosis leads to dementia by interrupting subcortical pathways, short association fibers, and thalamocortical and corticostriate pathways and appears in 8.6 percent of non-demented individuals increasing with age.¹⁰ Its significance is still not clear. Steingart et al¹⁰ compared cognitive and neurologic function in asymptomatic patients with leukoaraiosis on a CT scan. Those with leukoaraiosis scored significantly lower than controls on psychometric tests and had an increased incidence of abnormal gait and diminished limb power. These patients also displayed rooting and palommental reflexes. Steingart et al¹¹ simultaneously compared cognitive and neurologic findings in demented patients with leukoaraiosis which revealed significantly lower mean scores on psychometric tests. Leukoaraiosis has been associated with hypertension, age, extensor planter response, and decreased power in limbs.¹⁰,¹¹ Inzitari et al⁷ discovered a correlation between elevated mean systolic blood pressure and leukoaraiosis. Patients with leukoaraiosis had a four-time greater incidence of stroke than control patients.

Alzheimer’s disease may be a capillary dementia, and, in combination with stroke, could lead to a mixed dementia.⁹ In an individual with both features, the cause may be almost impossible to determine. A threshold amount of both lesions may be necessary for dementia.¹³ Treatable causes of dementia should always be excluded. Bradshaw et al² discovered that 10 percent of patients with only dementia had an underlying treatable disorder and suggested a CT be included in the initial evaluation.² Steingart et al¹⁰ developed ischemic scores that included nocturnal confusion, fluctuation of symptoms, fluctuation of personality, history of stroke, and focal neural signs and symptoms to determine objectively if a dementia was vascular or idiopathic (Alzheimer’s disease). A score of seven or greater indicated a high possibility of multiinfarct dementia, and a score less than four suggested Alzheimer’s disease.

Even though no treatment for vascular dementia is available, Nayler⁵ demonstrated decreased strokes, morbidity and mortality, and systolic blood pressure in stroke-prone rats on a high cholesterol diet treated with five mg per kg of amloidipine. This long acting calcium channel blocker decreased atherosclerosis in the thoracic aorta of rabbits on a high cholesterol diet. Further studies to evaluate the effects of intermittent hypertension on stroke and dementia are required to determine possible prevention with anti-hypertensive agents.
References


