

Leukomalacia With Ruptured Saccular Aneurysm

Iftekhar Ahmed, MD, Joanna Sher, MD

• A 42-year-old woman with a ruptured saccular aneurysm of the internal carotid artery developed large areas of cerebral leukomalacia, resulting in hemiparesis and an obtunded mental state. A significant factor in the development of the white matter lesions was episodic hypotension, leading to reduced cerebral blood flow in a patient whose cerebral circulation was already compromised by vasospasm secondary to the subarachnoid hemorrhage. This case illustrates yet another clinical situation associated with the development of white matter necrosis.

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Leukomalacia, or necrosis localized to the white matter of the central nervous system, is a relatively unusual lesion that has been described in cases of congestive heart failure and drug addiction coma^{1,2} as well as in carbon monoxide intoxication and severe hypoxia.³⁻⁵ Focal neurological deficit may occur as a result.^{2,3} The roles of hypoxemia, acidosis, and hypotension have been stressed as important in the pathogenesis.⁶ Destructive lesions of white matter are also known to occur as a result of local vascular disease with severe cerebral arteriolar sclerosis (Bingswanger's subcortical encephalopathy) and with vasculitis associated with bacterial meningitis.⁷

This report describes yet another group of clinical circumstances result-

ing in large areas of white matter necrosis, ie, ruptured saccular aneurysm of an artery of the circle of Willis with associated vasospasm and hypotension.

REPORT OF A CASE

A 42-year-old woman was hospitalized with complaints of severe generalized headaches and mental confusion for one day. There was a history of hypertension of several years' duration. The patient had had diabetes mellitus for 16 years. Blood pressure was 200/100 mm Hg; pulse rate, 92 beats per minute; temperature, 37 °C; and respirations, 25/min. The patient was alert but disoriented for time, place, and person.

She responded to questions and was slightly restless. No focal neurological findings were demonstrable, except for nuchal rigidity. A lumbar puncture showed grossly bloody cerebrospinal fluid. Arterial blood gas values at this time were as follows: pH, 7.30; Po₂, 55 mm Hg; Pco₂, 46 mm Hg. The patient was treated with methyl dopa, hydralazine, hydrochlorothiazide (Hydrodiuril), and aminocaproic acid. During the first few days after admission, the patient's BUN level rose to 35 mg/dl and creatinine value to 4.6 mg/dl. On the fourth day, periods of hypotension with blood pressure as low as 80 mm Hg systolic were recorded on several occasions. Neurological examination at this time disclosed a left-sided weakness of the body, left central facial paresis, and papilledema. Decreased mental alertness was noted. Corticosteroids were added to the regimen. The next day, a cerebral angiogram showed an aneurysm of the right internal carotid artery at the level of the origin of the posterior communicating artery, measuring 6 × 4 mm. The patient's general condition continued to deteriorate. It was difficult to control her diabetes because of stress and corticosteroid therapy. Two days before her death, she had a large melanotic bowel



Section of cingulate gyri, corpus callosum, and periventricular white matter, showing well-circumscribed areas of leukomalacia (Weil, × 4).

movement that was guaiac positive, and became hypotensive with a systolic blood pressure of 70 to 80 mm Hg. Despite treatment with isoproterenol, she remained hypotensive. Neurological examination at this time disclosed coma with left-sided weakness. On doll's eye maneuver, the eyes did not pass to the left of midline. Arterial blood gas values were as follows: pH, 7.28; Po₂, 52 mm Hg; Pco₂, 48 mm Hg. The hemoglobin level dropped from 13.2 to 10 g/dl. She developed cardiorespiratory arrest and died.

At autopsy, a chronic duodenal ulcer was found, surrounded by a few adherent small blood clots. The heart was enlarged due to moderate left ventricular hypertrophy. Examination of the brain disclosed extensive subarachnoid hemorrhage over the base of the brain. There was a 4-mm ruptured saccular aneurysm of the right internal carotid artery adjacent to the origin of the posterior communicating artery. Cross sections of the cerebral hemispheres showed many well-demarcated areas of softening in the frontal and parie-

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From the Department of Pathology, Downstate Medical Center, Brooklyn, NY.

Reprint requests to Department of Pathology, Downstate Medical Center, Brooklyn, NY 11203 (Dr Sher).

tal white matter, bilaterally, measuring up to 3 cm in greatest diameter (Figure). There were similar white matter lesions in the right optic radiation adjacent to the lateral ventricle. Microscopically, the leukomalacic areas appeared pale staining and necrotic, with edematous borders. Acute inflammatory infiltrates were present, surrounding many of the small blood vessels within the necrotic areas. Microglial cells were not prominent. Only rare macrophages were noted in a few foci at the edges of the lesions.

COMMENT

Most commonly, the cerebral lesions associated with ruptured saccular aneurysms are infarctions of the cortex and basal ganglia. In a series of 159 cases reported by Crompton,⁸ necrosis of white matter was found only as a part of areas of encephalomalacia that were primarily cortical. Isolated areas of leukomalacia in such cases are apparently rare.

In general, leukomalacia is an uncommon lesion, known to occur in some cases of congestive heart failure and in coma associated with excessive ingestion of drugs such as heroin and barbiturates. Carbon monoxide intoxication is known to produce leukomalacia. Such white matter lesions in carbon monoxide intoxication are attributed to the anoxia, edema, and local hemodynamic changes in the white matter, as well as to disturbed glycogen metabolism.⁹⁻¹¹ In some cases, acidosis and hypoxia have been thought to act synergistically in the production of white matter edema and subsequent necrosis.^{6,12} Hypotension, resulting in reduced cerebral blood flow, and associated hypoxemia, were found to be the common clinical features in three cases reported by Ginsberg et al.¹ Similarly, in the case reported by DeReuck and Schaumburg,² there was decreased cerebral

blood flow secondary to an acute decrement in cardiac output, in a patient with a cerebral circulation already compromised by arteriosclerosis.

In our case, the large areas of leukomalacia apparently resulted from the reduced cerebral blood flow during the hypotensive episodes in a patient whose cerebral circulation was already compromised by vasospasm secondary to subarachnoid hemorrhage. Changes in her cardiovascular status may have been secondary to the subarachnoid hemorrhage. The effects of subarachnoid hemorrhage on the cardiovascular system have been well described^{13,14} and are attributed to the altered autonomic tone to the heart.^{15,16} The acidosis, which was verified several times during her hospital course, may have acted as a contributing factor.

DeReuck and Schaumburg^{2,17} described three different vascular arrangements supplying the periventricular regions, all of which are in arterial end zones. The arterial supply of the white matter surrounding the anterior horns and bodies of the lateral ventricles is provided by long perforating branches of leptomeningeal vessels that turn away from the ventricular wall in a "ventriculofugal" pattern. The significance of this pattern of vascular supply is that the last white matter area to receive the arterial flow is therefore at a short distance from the ventricular wall. By contrast, a "ventriculopetal" pattern is found in the anterior corpus callosum and brain stem, whereas a combination of both types is seen in areas adjacent to the choroid plexus. The pattern of lesions noted in our case, with frequent sparing of a rim of white matter immediately adjacent to the ventricle, is consistent with these observations.

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