

# Coexistence of Chiari 2 Malformation and Moyamoya Syndrome in a 17-Year-Old Girl

## —Case Report—

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### Abstract

**A 17-year-old female with Chiari 2 malformation developed cerebral infarction with angiographically typical bilateral moyamoya vessels manifesting as sudden onset of moderate left hemiparesis. Magnetic resonance imaging revealed multiple infarcts in the right frontal lobe, agenesis of the corpus callosum, upward herniation of the dorsal cerebellum, tectal beak of the midbrain, and downward herniation of the cerebellar vermis. Cerebral angiography demonstrated occlusion of the bilateral internal carotid arteries and basal moyamoya vessels. Single photon emission computed tomography showed significantly reduced regional cerebral blood flow in the right frontoparietal cortex. The cerebral vascular reactivity to acetazolamide was diminished in both cerebral hemispheres. She underwent superficial temporal artery-middle cerebral artery anastomosis combined with encephalo-myo-synangiosis on the right, and on the left 6 months later. Cerebral angiography performed 4 months after the second operation showed good patency of the bypasses and substantial collateral vessels in both cerebral hemispheres. This association may have happened by chance, and a common etiology is uncertain, but a currently undetermined genomic component might have contributed to the disease progression.**

Key words: moyamoya disease, Chiari 2 malformation

### Introduction

Moyamoya disease is characterized by progressive narrowing of the bilateral internal carotid arteries followed by development of basal collateral vessels, and is one of the discrete causes of ischemic stroke.<sup>10,14)</sup> Moyamoya syndrome may include inherited disorders such as Down syndrome,<sup>5)</sup> neurofibromatosis 1,<sup>9)</sup> and protein C deficiency,<sup>7)</sup> as well as other acquired pathological conditions which may be involved in the mechanisms causing such moyamoya phenomena.<sup>1-3)</sup> Autoimmune mechanisms such as Grave's disease,<sup>3)</sup> Behcet's disease,<sup>6)</sup> and antiphospholipid syndrome<sup>1)</sup> may also be involved in the development of moyamoya syndrome, although cross-reactivity of autoantibodies to cerebral vessels has not yet been clearly demonstrated. Genetic factors may also contribute as the possi-

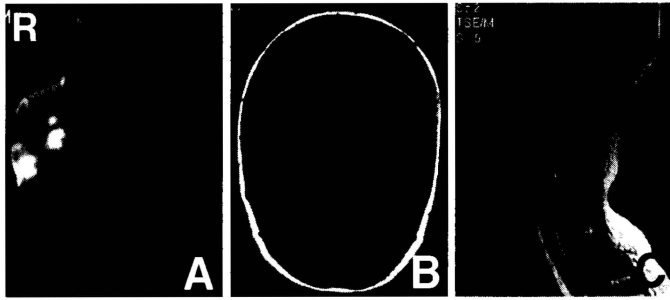
ble locations of genes for familial moyamoya disease have been demonstrated.<sup>4,10,14)</sup> However, only a few congenital diseases associated with moyamoya syndrome, such as neurofibromatosis 1,<sup>14)</sup> Fanconi anemia,<sup>2)</sup> and Marfan syndrome,<sup>2)</sup> are known to have genetic locations close to the ones for familial moyamoya disease. In addition, clear pathogenetic links remain to be identified. Therefore, most congenital disorders, including Down syndrome,<sup>5)</sup> the most frequently reported disorder, may be only associated with moyamoya syndrome.

Here we describe a unique case of moyamoya syndrome associated with Chiari 2 malformation, a congenital central nervous system (CNS) anomaly complex.<sup>12,13)</sup>

### Case Report

A 17-year-old female suddenly developed moderate left hemiparesis, and was admitted to our hospital. She was found at birth to have Chiari 2 malforma-

Received December 19, 2007; Accepted September 5, 2008

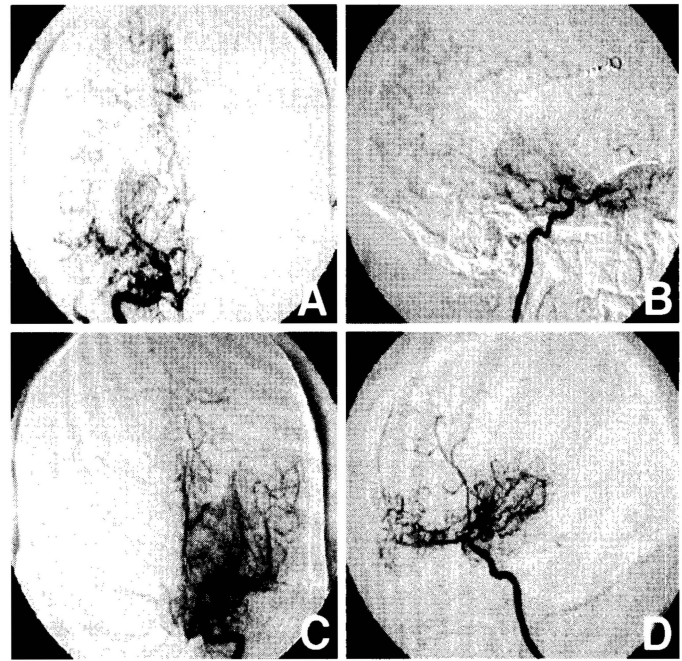


**Fig. 1** A: Diffusion-weighted magnetic resonance (MR) image showing multiple infarcts in the right frontal lobe and image distortion around the right ventricular catheter. B: Fluid-attenuated inversion recovery MR image showing agenesis of the corpus callosum. C: Sagittal T<sub>2</sub>-weighted MR image demonstrating upward herniation of the dorsal cerebellum, tectal beak of the midbrain, elongation of the fourth ventricle, and downward herniation of the cerebellar vermis.

tion including lumbar myelomeningocele and hydrocephalus. She underwent closure of the lumbar myelomeningocele, ventriculoperitoneal shunt placement, and foramen magnum decompression. She went to school with urinary incontinence, thus requiring self-removal of urine. She had not undergone magnetic resonance (MR) imaging or other type of vascular imaging of the brain until the present ischemic episode. Her family history did not include any cases of cerebrovascular diseases, neurodegenerative diseases, or autoimmune diseases.

On admission, diffusion-weighted MR imaging revealed multiple infarcts in the right frontal lobe (Fig. 1A). Fluid-attenuated inversion recovery MR imaging demonstrated agenesis of the corpus callosum (Fig. 1B). Sagittal T<sub>2</sub>-weighted MR imaging showed upward herniation of the dorsal cerebellum, tectal beak of the midbrain, and downward herniation of the cerebellar vermis (Fig. 1C). Cerebral angiography demonstrated occlusion of the bilateral internal carotid arteries and basal moyamoya vessels, consistent with primary moyamoya disease (Fig. 2). Single photon emission computed tomography using N-isopropyl-4 iodoamphetamine showed significantly reduced regional cerebral blood flow in the right frontoparietal cortex. The cerebral vascular reactivity to acetazolamide was diminished in both cerebral hemispheres. Laboratory examinations including endocrinological, autoimmune, and prothrombotic studies were normal.

Following administration of aspirin for 3 weeks, the patient underwent superficial temporal artery-



**Fig. 2** Right (A, B) and left (C, D) internal carotid angiograms, anteroposterior (A, C) and lateral views (B, D), revealing occlusion of the bilateral internal carotid arteries, typical moyamoya collateral vessels, and transdural anastomoses, more advanced in the right hemisphere (stage 4) than in the left (stage 3).

middle cerebral artery anastomosis combined with encephalo-myo-synangiosis on the right. Her postoperative course was uneventful, and she was able to walk. She has not experienced any further ischemic episodes, and underwent the same surgery on the left 6 months after the first operation. Cerebral angiography performed 4 months after the second operation showed good patency of the bypasses and substantial collateral vessels in both cerebral hemispheres.

## Discussion

Chiari 2 malformation is defined as a CNS anomaly complex including hindbrain herniation, myelodysplasia, hydrocephalus, and other craniovertebral disorders.<sup>12,13)</sup> A molecular genetic cause of pathogenesis has been proposed,<sup>11)</sup> but cerebrovascular involvement is rarely reported.<sup>12)</sup> The concentration of basic fibroblast growth factor, one of the possible mediators of angiogenesis, is increased in the cerebrospinal fluid of patients with moyamoya disease and other congenital CNS disorders such as Chiari 1 malformation and tethered spinal cord,<sup>8)</sup> but little is known about any possible common etiology between these conditions.

The present case of moyamoya syndrome associated with Chiari 2 malformation had a clinical manifestation and angiographic findings similar to cases of primary moyamoya disease. The patient had no exclusive history, and the involvement of prothrombotic disorders or autoimmune mechanisms seems unlikely. This combination may have occurred by chance, but the involvement of some currently undetermined genomic component may have been involved in the disease progression. The clinical course of moyamoya syndrome depends on the associated disorders, so understanding of the underlying mechanisms is important.

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