



MOYAMOYA DISEASE: CLINICAL AND ANGIOGRAPHIC FEATURES

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Summary. *This is a retrospective study of 12 adults (8 female, 4 male, mean age 45.3; range 26-63) and two children with moyamoya disease (MD) identified among 3400 diagnostic cerebral angiographies performed in a period of 17 years. Diagnosis of MD was made on the basis of features and progression of angiographic findings. Clinical manifestations and angiographic findings were analysed with a review of the literature. Two children and six adult patients had a clinical feature of ischemic cerebral events. The other adult patients had clinical signs of subarachnoid and/or intracerebral and intraventricular hemorrhage. Cerebral angiography showed a typically fine network of vessels at the base of the brain with a hazy, puff-of-smoke appearance, and development of transdural and leptomeningeal anastomoses in children and 8 adults patients. Four adult patients were in the terminal stage, with complete cerebral supply via vertebrobasilar and external carotid branches. Two of the adult patients had accompanying saccular aneurysms with localisations on basilar and internal carotid bifurcations, of which the latter was bleeding. All angiographic changes were bilateral. Low incidence and adult predominance are characteristic of MD in our population. There was no familial occurrence among our patients. The clinical features of ischemic stroke were present in both children and adults, and intracranial hemorrhage in adults only. A characteristic angiographic feature of moyamoya was found in both children and adults.*

Key words: *Moyamoya disease, incidence, familial occurrence, clinical feature, cerebral angiography, aneurysm*

Introduction

Moyamoya disease (MD) is a bilateral stenocclusive process of the internal carotid artery bifurcation (1,2,3,4). The official criteria established by the Japanese Ministry of Health and Welfare for the diagnosis of MD require bilateral stenocclusive changes verified by conventional angiography (5). Moyamoya is a Japanese word for a "puff" or "cloud of smoke" or "haze", and it has been used to refer to an extensive basal cerebral rete mirabile - a network of small anastomotic vessels at the base of the brain around and distal to the circle of Willis, seen in carotid angiograms, along with segmental stenosis or occlusion of the terminal parts of both internal carotid arteries (6). The disease occurs most frequently in Japanese, Asians and individuals of non-Caucasian origin (7), but it affects many others in the United States, western Europe and Australia (6). The condition was observed mainly in infants, children and adolescents, and seemingly more in females than in males (6,8).

The present study was undertaken to evaluate the incidence, familial occurrence, clinical features and angiographic changes of MD in our population.

Materials and Methods

This is a retrospective study of 12 adult patients (8 female, 4 male, mean age 45.3; range 26-63) and two children (1 female and 1 male, age 7 and 10 years) identified among 3400 diagnostic cerebral angiographies performed in a period of 17 years. Clinical manifestation and angiographic findings were analysed with review of the literature. Diagnosis of MD was made on the basis of features and progression of angiographic findings. All patients were studied by conventional cerebral angiography and visualisation of both carotid and vertebrobasilar circulation. Angiograms were analysed for stenocclusive lesions, moyamoya, collateral vessels and aneurysms.

Results

Cerebral ischemic symptoms with focal hemiparesis cerebral deficit, speech and sensory disturbances were present in children. Six adult patients had a clinical feature of ischemic stroke. The other adults had a clinical signs of subarachnoid and/or intracerebral and intraventricular hemorrhage. There was no familial relationship between patients.

Cerebral angiographies showed a typically fine network of vessels at the base of brain with hazy, puff-of-smoke appearance, and development of transdural and leptomeningeal anastomoses in children and 8 adult patients. Four adult patients were in the terminal stage of the disease with complete cerebral supply via vertebrobasilar and external carotid branches. Two adult patients had accompanying saccular aneurysms with localisations on the basilar and internal carotid bifurcation, of which the latter was bleeding. All angiographic changes were bilateral.

Discussion

MD described in the early 1960 by Takeuchi and Suzuki et al. (9) occurs most frequently in Japanese, but affects other populations as well, both children and adults, and seemingly females more than males (8). MD has a very low incidence in our population. It was diagnosed in 14 patients among 3400 diagnostic cerebral angiographies performed in a period of 17 years. Females were predominantly affected (9 females vs. 5 males).

In Japanese MD was observed mainly in infants, children and adolescents. Nishimoto and Takeuchi reported that more than half of 111 patients in their study were less than 10 years of age, and only 4 were older than 40 years (10). In our group of patients there was a predominance of adults (12 adults vs. 2 children).

The cause of MD remains unknown and theories of inflammatory and immunologic pathophysiological mechanisms remain unproven (11,8). It was reported that basic fibroblast growth factor (bFGF), which is a cytokine with potent angiogenic activity, is present in a very high concentration in the cerebrospinal fluid samples taken from the subarachnoid space of the cerebral cortex in patients with typical MD (1,11,12). There is strong evidence of hereditary factors in the disease, with familial cases reported especially among the Japanese, but also from Europe and in identical twins (8,13).

According to Houkin et al. there is extensive evidence that MD has a tendency to show multifunctional inheritance (14). The frequency of familial occurrence has been estimated at 6% to 16% (1,14). There was no familial occurrence in our group of patients. The frequency depended on the procedures used for screening high-risk individuals who are blood relatives of probands (14,15).

Ischemic cerebral symptoms with recurrent episodes of focal cerebral deficit was a clinical manifestation of MD in children, which is in agreement with reports of other authors (2,16,17,18,19). Clinical features of ischemic stroke were present in 6 adult patients. Clinical signs of subarachnoid and/or intracerebral and intraventricular hemorrhage were present in adult patients only (Fig. 1). Hemorrhages may occur due to several different pathological processes. The mechanism

of hemorrhage is attributed to a breakdown of greatly dilated perforating moyamoya vessels that from the extensive basal collateral network (2,20). Pseudoaneurysm or microaneurysm formations due to weakness of the internal elastic lamina and thinness of the vessel wall have also been described as a source of subarachnoid hemorrhage (21). Pseudoaneurysms can be identified angiographically as discrete vascular dilatations typically arising from the peripheral portions of the perforating and anterior and posterior choroidal arteries in a paraventricular location. Commonly they will be shown to disappear on a follow-up angiography. The source of hemorrhage in one of our patients was saccular aneurysm of the internal carotid bifurcation. Saccular aneurysms also have been demonstrated in association with MD, with a significantly increased proportion on the basilar artery compared with other aneurysm series (22,23,24,25). Aneurysm at the site of the basilar artery bifurcation was present in one of our adult patients. The increased frequency of basilar artery aneurysms has been attributed to hemodynamic factors of increased flow in the posterior circulation in patients with compromised carotid arteries.



Fig. 1. CT in 33-year-old patient with MD revealing intraventricular, intracerebral and subarachnoid hemorrhage caused by rupture of left carotid bifurcation saccular aneurysm.

Angiographic findings in two children from our series were occlusions of the supraclavicular internal carotid arteries with development of a fine network of basal perforating vessels resembling "volcano smoke" - moyamoya vessels and collaterals (Fig. 2). The same



Fig. 2. Left carotid angiogram in 10-year-old boy shows internal carotid occlusion and moyamoya vessels.

angiographic changes were found in eight adult patients (Fig. 3). The basal vascular network is contributed by lenticulostriate, chorioidal, thalamoperforating, premamillary and thalamogeniculate arteries, as well

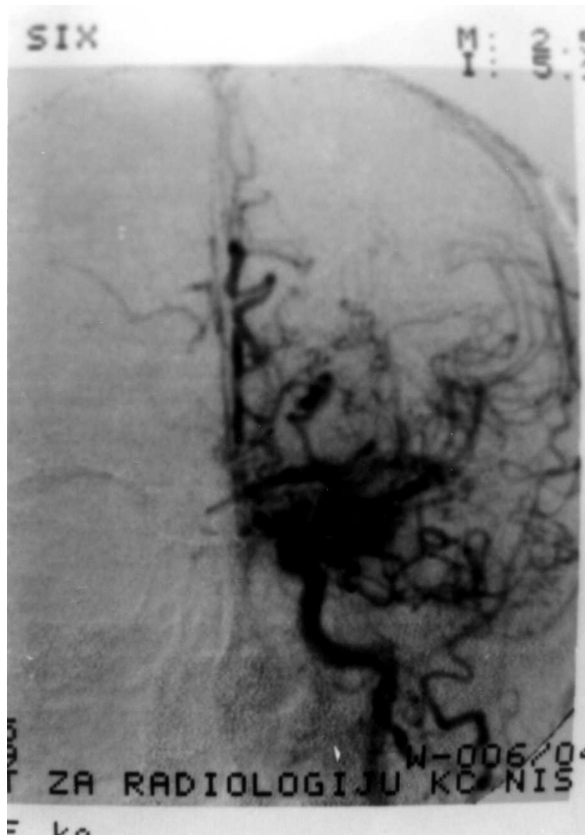


Fig. 3. Left carotid angiogram in 63 year old man with MD, shows occlusion of left internal carotid artery, moyamoya vessels, and ophthalmic, transdural, and leptomeningeal anastomoses with retrogradely filled pericallosal artery.

by to unnamed branches arising directly from the circle of Willis.

Opinions are divided as to whether the basal rete mirabile represents a congenital vascular malformation (i.e. a persistence of the embryonal network) or a rich collateral vascularisation, secondary to a congenital hypoplasia or acquired stenosis or occlusion of the internal carotid arteries in life (6). The volume of basal moyamoya and collaterals depends upon the stage of the disease (17).

With the extension of the occlusive process to the middle and anterior cerebral arteries there is a development of leptomeningeal collaterals. These collaterals were present in almost all of our patients. Also, there was a development of extracranial transdural and transosseous collaterals, including meningeal branches; superficial temporal, occipital, and internal maxillary arteries from the external carotid system; and ethmoidal, recurrent meningeal, and anterior falcine arteries from the ophthalmic circulation.

Four adult patients were in the terminal stage, with complete obliteration of internal carotid arteries with narrow proximal segments (the so-called "pseudohypoplastic appearance") and disappearance of moyamoya. Complete cerebral supply in these patients was via vertebrobasilar circulation and external carotid collaterals (Fig. 4).

All angiographic changes in our adult patients were bilateral. Unilateral changes were present in one child on the initial angiogram. Repeated angiograms 5 years later revealed progression from unilateral to bilateral involvement. Patients who show unilateral changes of MD, particularly children, often exhibit progression to typical bilateral MD during their follow-up period (26). The bilateral lesions are likely to develop within 1 or 2 years in young children with unilateral evidence of MD (27,28,29,30). Houkin et al. reported that unilateral MD differs from typical bilateral MD with respect to

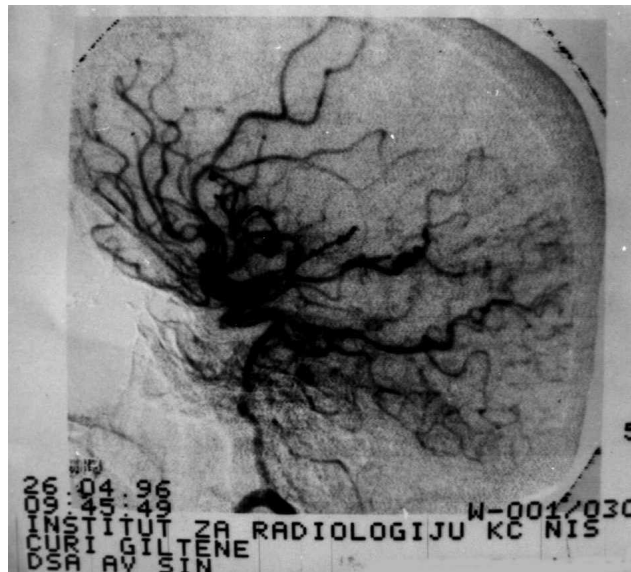


Fig. 4. Left vertebral angiogram in a 26 - year old patient in terminal phase of MD, shows cerebral supply via vertebrobasilar circulation.

longitudinal angiographic changes, level of bFGF in the subarachnoid space, and frequency of familial

occurrence, but these speculations require confirmation (1,15).

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MOYAMOYA OBOLJENJE: KLINIČKE I ANGIOGRAFSKE KARAKTERISTIKE

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Kratak sadržaj: *Retrospektivnom studijom obuhvaćeno je 12 odraslih i dvoje dece obolelih od oboljenja Moyamoya (MD) dijagnostikovanih u periodu od 17 godina. U radu su analizirane kliničke manifestacije i angiografski nalazi u obolelih. Dijagnoza MD postavljena je angiografskim pregledom. Dvoje dece i 6 odraslih bolesnika imalo je kliničku sliku ishemijskih cerebralnih promena. Klinički znaci subarahnoidalne i/ili intracerebralne i intraventricularne hemoragije bili su prisutni u ostalih bolesnika. Cerebralnom angiografijom nađene su stenookluzivne promene unutrašnjih karotidnih arterija i tipična mreža krvnih sudova magličastog izgleda na bazi mozga sa razvojem transduralnih i leptomeningealnih anastomoza u dece i 8 odraslih bolesnika. Četiri odraslih bolesnika bilo je u terminalnom stadijumu bolesti sa okluzijom unutrašnjih karotidnih arterija i kompletnom vaskularizacijom mozga preko vertebrobazilarnog sistema i grana spoljašnjih karotidnih arterija. Dvoje odraslih bolesnika imalo je udružene sakularne aneurizme lokalizovane na bifurkaciji bazilarne i unutrašnje karotidne arterije, Angiografske promene u svih bolesnika bile su obostrane.*

Ključne reči: *Moyamoya oboljenje, incidenca, kliničke karakteristike, cerebralna arteriografija, aneurizma*

Received: June 16, 1997