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Case Report

Moyamoya syndrome presenting in an adult with Down syndrome: A case report with a literature review [☆]

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ABSTRACT

Moyamoya disease is an unusual occlusive cerebrovascular condition commonly seen in children, marked by stenosis of the internal carotid artery and circle of Willis, causing cerebral ischemia. Moyamoya syndrome is a Moyamoya-like arteriopathy with risk factors including autoimmune disorders, thyroid disease, sickle cell disease, or Down syndrome. Trisomy 21 is a genetic disorder consistent with specific physical and behavioral characteristics, with intellectual impairment. We describe a rare case of Moyamoya syndrome manifesting as ischemic stroke in an adult with Down syndrome

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Introduction

Moyamoya disease (MMD) is an unusual occlusive cerebrovascular condition commonly seen in children, marked by stenosis of the internal carotid artery and circle of Willis, causing cerebral ischemia. The disease usually causes blockage of both internal carotid arteries, while angiographic investigations have shown that unilateral involvement occurs in 20% of patients. Basal and leptomeningeal collateral vessels are

generally created around the stenotic artery [1]. Moyamoya is a Japanese word that refers to anything foggy, like cigarette smoke. Takeuchi and Shimizu were the first to report the syndrome in Japan in 1957, while Suzuki and Takaku described it more precisely in 1969 [2].

Moyamoya syndrome (MMS) is a Moyamoya-like arteriopathy with risk factors including autoimmune disorders, thyroid disease, sickle cell disease, or Down syndrome (DS) [3]. DS is a genetic disorder consistent with specific physical and behavioral characteristics, with intellectual impairment. It is linked

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Fig. 1 – Cranial computed tomography imaging showing hypodensity in the territory of the middle cerebral artery (A), (B).

to variable vascular abnormalities like MMS [4]. We describe a rare case of MMS manifesting as ischemic stroke in an adult with DS.

Case report

A 32-year-old woman with DS was admitted 2 days after sudden transient dizziness, left-sided weakness with left facial numbness. She had no history of cardiac, endocrine, or gastrointestinal complications. Although the patient had a mild mental impairment, she was self-sufficient in her everyday tasks. Physical examination revealed typical trisomy 21 characteristics.

The patient was aware and afebrile. A neurological examination revealed left hemiparesis with a rating of 3/5 on the Medical Research Council scale. Deep tendon reflexes were brisk on the left side with a Babinski sign. There was left-sided tactile hypoaesthesia with no motor coordination disorder. A cranial nerve examination revealed dysarthria with left central facial palsy. The examination of extra neurological systems was normal.

Cranial computed tomography imaging showed hypodensity in the territory of the middle cerebral artery (Fig. 1). Cranial magnetic resonance imaging revealed on diffusion, fluid-attenuated inversion recovery, and T2 weighted sequences high signal intensity interesting the right frontoparietal lobes referring to an acute ischemic lesion (Fig. 2). Magnetic resonance angiography showed severe stenosis of the M1 of the right middle cerebral artery associated with mild dilatation of lenticulostriate arteries and new arterial network (Fig. 3).

Paraclinical tests were unremarkable (complete blood count, hepatic and renal tests, prothrombotic tests, glycosylated hemoglobin, hemoglobin electrophoresis, homocysteine, autoantibody tests, and thyroid tests). Electrocardiogram, transesophageal echocardiography, and Doppler ultrasonography of the cervical arteries were normal. A cerebrospinal fluid examination was normal. The diagnosis of unilateral MMS causing acute ischemic stroke was

made based on the imaging findings and the normality of paraclinical testing.

The patient was treated with aspirin and physiotherapy. Two months after her admission, a clinical examination revealed resolution of the facial palsy and dysarthria with moderate residual left hemiparesis.

Discussion

Cerebrovascular events in children and adolescents are uncommon. Individuals with DS have a higher risk of ischemic stroke, usually secondary to thromboembolism caused by an underlying cardiac malformation. Obstruction of cerebral arteries is linked to high susceptibility to bacterial infections such infectious endocarditis and meningitis [5].

Pearson et al. [5] examined 37 children with DS and discovered anomalies that were indicative of MMS in seven of them. MMS is 3 times more frequent among people with DS than in the general population. This association was first described in 1977. Since that, more than 25 clinical cases have been reported, mostly in young patients.

Various hypotheses about the mechanism of MMD in association with DS have been suggested. People with DS are generally exposed to vascular disease. This is observed in conditions such as aberrant nailbed capillary structure, retinal vessel anomalies, congenital heart disease, and primary intimal fibroplasia [6].

The prevalence of circle of Willis anomalies in patients with DS has been observed to be greater than in those with isolated congenital cardiac disease [5]. Vascular dysplasia can be caused by a structural defect that contributes to the genesis of MMD. Concerning the genetic basis of DS, various proteins encoded on chromosome 21 have been linked to an elevated risk of vascular disease, including the α -chains of collagen type VI, cystathionine β -synthase, and interferon- γ receptor [6].

The participation of autoimmunity in the pathophysiology of MMD is also suggested, given the increase in autoimmune

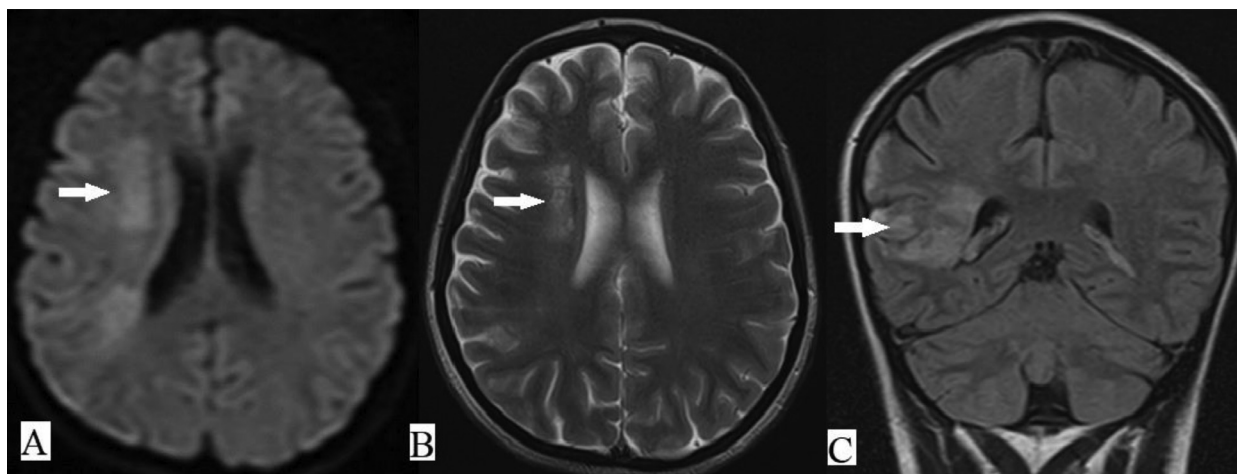


Fig. 2 – Cranial magnetic resonance imaging demonstrating on diffusion (A), T2 weighted (B) and coronal fluid-attenuated inversion recovery (C) sequences hyper-signal intensity involving the right frontoparietal lobes.

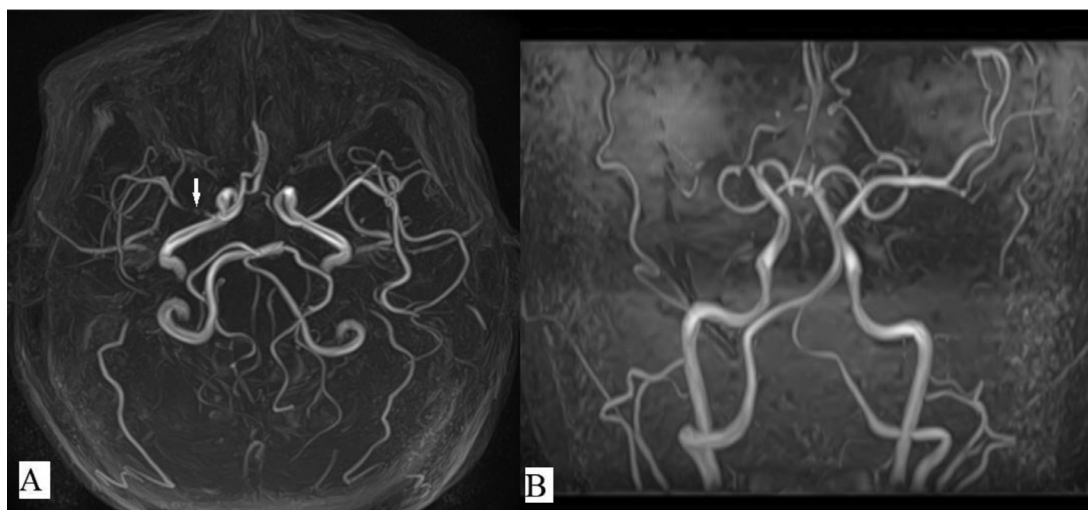


Fig. 3 – Magnetic resonance angiography showing severe stenosis of the M1 of the right middle cerebral artery (A) with mild dilatation of lenticulostriate arteries and new arterial network (B).

diseases such as autoimmune thyroid disorders in DS. MMD has also been related to antiphospholipid antibodies, exposing individuals to vascular thrombosis [7].

Eighty percent of the 26 documented individuals with DS and MMD had a cerebral infarction, 19% had a transient ischemic stroke, and five percent had an intracranial hemorrhage. The age of 6 years was the average age of onset, with hemiplegia as the most common presentation [6].

For the diagnosis of MMD, 3 criteria must be met: (1) stenosis of the distal segment of internal carotid artery, the proximal segment of anterior cerebral artery and middle cerebral artery, (2) abnormal arterial network near the stenosis, (3) exclusion of other conditions such as sickle cell disease, meningitis, or radiation therapy [8]. Angiographic investigations have revealed that 20% of individuals had unilateral radiological characteristics of MMS. Magnetic resonance angiography, which was recently developed, offers a noninvasive alternative to traditional angiography [9].

The management of patients with MMS is still debatable, with many points of view. Some authors recommend simply medicinal therapy with aspirin, while others support surgical therapy. Long-term anticoagulants are not indicated for MMS patients due to the risk of bleeding. Surgical approaches to revascularize regions of cerebral ischemia have been proposed, but the outcomes have been disappointing [10]. According to a recent study, pial synangiosis may be an effective treatment option for patients with DS [11].

Conclusion

The association between MMS and DS is not well established. Although the rarity of MMS as an etiology of stroke, physicians should be conscious of the nonembolic cause of cerebrovascular accidents in patients with DS. A magnetic resonance an-

giography must be included in the evaluation. To establish the underlying reason for the greater prevalence of MMD in trisomy 21 patients, more sophisticated imaging, immunological testing, or epigenetic study is necessary. It is important to understand the relationship between MMD and stroke in a patient with DS to make an accurate diagnosis and develop an effective care plan.

Patient consent

I qualify as the corresponding author to this manuscript warrant that I have informed the patient of this scientific manuscript and I confirm that I obtained his written and informed consent for the publication of this article.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.radcr.2022.05.006](https://doi.org/10.1016/j.radcr.2022.05.006).

REFERENCES

- [1] Smith ER, Scott RM. Progression of disease in unilateral moyamoya syndrome. *Neurosurg Focus* 2008;24:E17. doi:[10.3171/FOC/2008/24/2/E17](https://doi.org/10.3171/FOC/2008/24/2/E17).
- [2] Suzuki J, Takaku A. Cerebrovascular “moyamoya” disease. Disease showing abnormal net-like vessels in base of brain. *Arch Neurol* 1969;20:288–99. doi:[10.1001/archneur.1969.00480090076012](https://doi.org/10.1001/archneur.1969.00480090076012).
- [3] Scott RM, Smith ER. Moyamoya disease and moyamoya syndrome. *N Engl J Med* 2009;360:1226–37. doi:[10.1056/NEJMra0804622](https://doi.org/10.1056/NEJMra0804622).
- [4] Tavares Bello C, Barreiros C, Gil I, Vasconcelos C. Down syndrome and Moyamoya disease: an unusual cause of stroke. *BMJ Case Rep* 2017;219894. doi:[10.1136/bcr-2017-219894](https://doi.org/10.1136/bcr-2017-219894).
- [5] Pearson E, Lenn NJ, Cail WS. Moyamoya and other causes of stroke in patients with Down syndrome. *Pediatr Neurol* 1985;1:174–9. doi:[10.1016/0887-8994\(85\)90060-8](https://doi.org/10.1016/0887-8994(85)90060-8).
- [6] Dai AI, Shaikh ZA, Cohen ME. Early-onset Moyamoya syndrome in a patient with Down syndrome: case report and review of the literature. *J Child Neurol* 2000;15:696–9. doi:[10.1177/088307380001501012](https://doi.org/10.1177/088307380001501012).
- [7] Del-Rio Camacho G, Orozco AL, Pérez-Higueras A, Camino López M, Al-Assir I, Ruiz-Moreno M. Moyamoya disease and sagittal sinus thrombosis in a child with Down's syndrome. *Pediatr Radiol* 2001;31:125–8. doi:[10.1007/s002470000313](https://doi.org/10.1007/s002470000313).
- [8] Olds MV, Griebel RW, Hoffman HJ, Craven M, Chuang S, Schutz H. The surgical treatment of childhood moyamoya disease. *J Neurosurg* 1987;66:675–80. doi:[10.3171/jns.1987.66.5.0675](https://doi.org/10.3171/jns.1987.66.5.0675).
- [9] Ganesan V, Savvy L, Chong WK, Kirkham FJ. Conventional cerebral angiography in children with ischemic stroke. *Pediatr Neurol* 1999;20:38–42. doi:[10.1016/s0887-8994\(98\)00112-x](https://doi.org/10.1016/s0887-8994(98)00112-x).
- [10] Matsushima T, Inoue T, Suzuki SO, Fujii K, Fukui M, Hasuo K. Surgical treatment of moyamoya disease in pediatric patients—comparison between the results of indirect and direct revascularization procedures. *Neurosurgery* 1992;31:401–5. doi:[10.1227/00006123-199209000-00003](https://doi.org/10.1227/00006123-199209000-00003).
- [11] See AP, Ropper AE, Underberg DL, Robertson RL, Scott RM, Smith ER. Down syndrome and moyamoya: clinical presentation and surgical management. *J Neurosurg Pediatr* 2015;16:58–63. doi:[10.3171/2014.12.PEDS14563](https://doi.org/10.3171/2014.12.PEDS14563).