**Title Page**

**Type: Case Report**

# **A Rare Presentation of Moyamoya Disease with Intraventricular Hemorrhage in an 8-Year-Old: A Case Report**

# **AUTHORSHIP**

1. Vivek Karn, Department of Pediatrics, Tribhuvan University Teaching Hospital, Kathmandu Nepal,

Email: drvivekkarn@gmail.com

1. Bibek Shrestha, Maharajgunj Medical Campus, Tribhuvan University, Institute of Medicine,

Email: [shresthabibek85iom@gmail.com](mailto:shresthabibek85iom@gmail.com)

1. Macchindra Lammichhane, Department of Pediatrics, Tribhuvan University Teaching Hospital, Institute of Medicine

Email: lamichhanemachhindra@gmail.com

1. Radha Chaudhary, Department of Pediatrics, Tribhuvan University Teaching Hospital, Institute of Medicine

Email: chaudharyradha21@gmail.com

1. Priyesh Shrestha, Department of Radiology, Tribhuvan University Teaching Hospital, Kathmandu Nepal,

Email: [priyeshshrestha7@gmail.com](mailto:priyeshshrestha7@gmail.com)

1. Pradeep Gupta, Department of Pediatrics, Tribhuvan University Teaching Hospital, Institute of Medicine

Email: drpradeepgupta87@gmail.com

1. Nabin Dhakal, Maharajgunj Medical Campus, Tribhuvan University, Institute of Medicine,

Email: nawveen27@gmail.com

# **STATEMENT OF CONTRIBUTION**

The authors collectively contributed to this project with distinct roles and expertise. Vivek Karn played a central role in conceptualization, data curation, formal analysis, methodology, project administration, original writing, review, editing, and visualization. Bibek Shrestha, Macchindra Lamichhane, Radha Chaudhary , Priyesh Shrestha, Pradeep gupta and Nabin dhakal both contributed to supervision, validation, and investigations. Each author's contribution was integral to the project's success, ensuring the accuracy and reliability of the findings presented in this work.

# **DISCLOSURE**

None

# **DATA AVAILABILITY STATEMENT**

None

# **FUNDING STATEMENT**

None

# **CONFLICT OF INTEREST**

None

# **PATIENT CONSENT STATEMENT**

Written informed consent was obtained from the patient’s guardian for publication of this case report and accompanying images, complying with the requirements as mentioned in Wiley’s CCR Consent Form.

**Manuscript**

**Type: Case Report**

# **A Rare Presentation of Moyamoya Disease with Intraventricular Hemorrhage in an 8-Year-Old: A Case Report**

# **Key Clinical Message**

This case report highlights the rare presentation of Moyamoya disease with intraventricular hemorrhage in an 8-year-old child, emphasizing its diagnostic and management challenges. While Moyamoya typically presents with ischemic symptoms in children, this case underscores the importance of considering hemorrhagic events as a possible manifestation, even in pediatric patients. The diagnosis was established through clinical evaluation and advanced imaging, which revealed arterial occlusion and collateral vessel formation. The patient’s management involved prompt external ventricular drain placement to address elevated intracranial pressure and hydrocephalus, alongside seizure control and infection prevention measures. The case underscores the critical role of radiological evaluation and surgical interventions in managing rare complications of Moyamoya disease. It calls attention to the need for heightened awareness of atypical presentations and the potential benefits of early intervention in improving outcomes for pediatric patients with this progressive cerebrovascular disorder.

# **Key Words**

Cerebrovascular Disorders; Collateral Circulation; Hydrocephalus; Intraventricular Hemorrhage; Moyamoya Disease.

# **Introduction**

Moyamoya disease is a rare, progressive cerebrovascular disorder characterized by stenosis or occlusion of the internal carotid arteries and their major branches, leading to the formation of a network of abnormal collateral vessels known as "moyamoya vessels". While the disease predominantly presents with ischemic symptoms in children, it can also manifest as hemorrhagic events, particularly in adults. [2] Despite extensive research, its etiology remains unclear, with various hypotheses proposed including genetic abnormalities, infection, and autoimmune disorders. The "double hit hypothesis" proposes that multiple factors contribute to Moyamoya development. [3] Recent studies suggest a complex interplay of factors in Moyamoya disease pathogenesis, including aberrant angiogenesis, inflammation, and endothelial progenitor cell dysfunction. [4] It impacts cognitive function and quality of life, particularly in pediatric patients. [5] Surgical revascularization is the primary treatment, with a combination of direct and indirect bypass techniques showing benefit. [6]

Herein, we present a case of an 8-year-old child presenting with intraventricular hemorrhage poses unique diagnostic challenges and management considerations, as this presentation is atypical for pediatric moyamoya disease. [7]

# **CASE HISTORY/ EXAMINATION**

An 8-year-old female presented to the emergency department with chief complaints of headache and loss of consciousness, persisting for one day. The patient was in her usual state of health until she developed a sudden onset headache, initially localized to the occipital region and later generalized. This was accompanied by multiple episodes of non-bilious, non-projectile vomiting containing recently ingested food particles. After the headache, the child experienced a gradual loss of muscle tone, progressing to a transient loss of consciousness. This was followed by episodes of an increased tone in both upper and lower limbs, accompanied by bowel and bladder incontinence. These episodes of increased tone lasted approximately 30–40 seconds, followed by brief periods of loss of consciousness. Each episode was succeeded by a regain of consciousness lasting about two minutes. During these inter-episodic periods of regained consciousness, the patient reported a persistent headache.

There was no history of head trauma, previous episodes of headache, medication use, fever, or abnormal or altered behavior. The patient’s developmental milestones were reported as normal, with no history of similar episodes in the past. There was no significant neurological or cardiovascular history associated with the patient. On physical examination, there was no pallor, icterus, clubbing, cyanosis, or signs of dehydration. Vital signs were stable. Pupils were equal in size (3 mm bilaterally) and sluggishly reactive to light. The Glasgow Coma Scale (GCS) score was 4/15, with components E1, V1, and M2. The gag reflex was intact, and there were no meningeal signs. Neurological examination revealed decreased tone in both the upper and lower limbs bilaterally. Deep tendon reflexes were absent in all four limbs, and plantar reflexes were unresponsive. On respiratory examination, bilateral breath sounds were audible, with symmetrical chest movements. Cardiovascular examination showed palpable peripheral pulses and normal heart sounds.

# **METHODS**

Based on the patient's history and clinical examination, the differential diagnoses included structural brain lesions, epileptic seizures, inflammatory conditions such as meningitis and encephalitis, metabolic abnormalities, acute disseminated encephalomyelitis (ADEM), and vascular disorders such as Moyamoya disease. Subsequent blood investigations revealed normal levels of electrolytes, metabolites (including glucose and lactate), acid-base status, and blood gas values. A computed tomography (CT) scan of the head demonstrated intraventricular hemorrhage accompanied by elevated intracranial pressure. Magnetic Resonance imaging (MRI) with angiography was done following T2 weighted axial, which revealed T2 high intensity area in right periventricular white area and left centrum semiovale and non-visualization of right middle cerebral artery and proximal A1 segment of right anterior cerebral artery with paucity of cortical vessels on the ipsilateral side. (Figure 1) This case was diagnosed as Moyamoya disease based on the clinical history of sudden headache, neurological deficits, and seizures, alongside imaging findings of non-visualization of the right middle cerebral artery, proximal A1 segment of the right anterior cerebral artery, and paucity of cortical vessels, indicative of vascular occlusion and collateral formation. The absence of fever, infection, trauma, or diffuse inflammatory changes on imaging excludes differentials like meningitis, encephalitis, and ADEM. Structural brain lesions were ruled out by normal imaging findings apart from the hemorrhage, further confirming Moyamoya disease as the underlying pathology.

# **CONCLUSION AND RESULTS**

To address the elevated intracranial pressure and hydrocephalus, the patient underwent external ventricular drain placement. The procedure involved making a 3 cm incision at the left Kocher’s point, followed by the creation of a burr hole at the same location. Ventriculostomy was successfully performed on the first attempt. The cerebrospinal fluid (CSF) was found to be turbid and under high pressure. The EVD was tunneled 5 cm from the ventriculostomy site and securely anchored in place. Postoperatively, the patient was managed with intravenous Vancomycin and Meropenem. Following the insertion of EVD, the CT Brain was done and showed resolved intraventricular hemorrhage. (Figure 2) On the 15th postoperative day, the EVD was removed. At follow-up, the patient showed significant improvement, with no fever, vomiting, or headache, and normal higher mental functions, muscle tone, and reflexes. For seizure management, the patient received intravenous Levetiracetam 300 mg twice daily. Other medications included intravenous Vancomycin 500 mg four times daily, suppository Paracetamol 300 mg, intravenous Fentanyl 10 mcg once daily, and intravenous Ceftriaxone 1 gram twice daily.

# **Discussion**

Moyamoya disease is a rare and progressive cerebrovascular disorder marked by the narrowing or occlusion of internal carotid arteries and their primary branches, leading to the formation of abnormal collateral vessels. [1,2] It primarily affects East Asian populations, with a higher prevalence in Korea and Japan compared to Western countries. The disease exhibits two incidence peaks: around age 10 and 30-45 years, with later onset in women. Children typically present with ischemic symptoms, while adults more often experience intracranial hemorrhage. Genetic studies have identified RNF213 as a susceptibility gene for moyamoya disease, with the p.R4810K variant common in East Asian patients. [8] This variant was found in 56% of Asian-descent Moya moya patients in a diverse U.S. population, while other RNF213 variants were identified in non-Asian patients. [9] Moyamoya is a rare cerebrovascular disorder with an incidence of 0.35-0.94 per 100,000 population, it primarily affects Asian populations but is also reported in other parts of the world. [10] Common symptoms include transient ischemic attacks, strokes, headaches, seizures, and sensorimotor paralysis. Herein the patient presented with the complaints of unconsciousness, and the seizure attacks. In children, moyamoya disease is often associated with other congenital conditions, such as neurofibromatosis type 1 and Down syndrome, which may complicate the diagnostic process. [11] The presence of intraventricular hemorrhage in a pediatric patient raises concerns about potential underlying vascular malformations or secondary moyamoya syndrome, which can occur in conjunction with other systemic conditions. [12]

Radiological diagnosis plays a crucial role in screening, evaluating vascular changes, and clinical follow-up. Magnetic Resonance Imaging (MRI) and MR angiography are considered the most reliable non-invasive methods for visualizing primary findings, such as arterial occlusion and collateral formation, as well as secondary findings like cerebral infarction and hemorrhage. Computed Tomography (CT) with contrast enhancement can reveal tortuous vessels in the basal ganglia, corresponding to collaterals seen on angiography. CT angiography is also valuable in diagnosing vascular changes. [13] Here, MR angiogram was done which showed high intensity area in right periventricular white area and left centrum semiovale and non-visualization of right middle cerebral artery and proximal A1 segment of right anterior cerebral artery with paucity of cortical vessels on the ipsilateral side and confirmed the diagnosis of Moyasmoya disease as a primary diagnosis. Moyamoya disease can lead to refractory high intracranial pressure, particularly following intraventricular hemorrhage, requiring aggressive management such as ventricular drainage, barbiturates, and hypothermia. High intracranial pressure is a critical concern, often requiring aggressive interventions such as ventricular drainage, barbiturates, and hypothermia [14] While traditionally, experts advised against evacuating intraventricular hemorrhage (IVH) in the acute phase, recent cases suggest that early surgical removal of severe IVH casting may be beneficial in managing critical ICP and improving outcomes. [15] In this case, decrease the elevated intracranial pressure and hydrocephalus, the patient underwent external ventricular drain placement. Along with raised ICP, seizures are a known complication, with 9-19% of pediatric moyamoya patients developing epilepsy. Seizures can be the presenting symptom, especially in younger patients, and may occur even without radiographic evidence of ischemia. [16]

This case highlights the rare presentation of Moyamoya disease with IVH in a pediatric patient. It underscores the importance of recognizing atypical clinical manifestations such as hemorrhagic events in children, despite ischemic presentations being more common in this age group. Further studies are needed to establish screening protocols for high-risk pediatric populations, especially those with genetic predispositions or associated syndromes like Down syndrome and neurofibromatosis type 1. Identifying biomarkers that could predict hemorrhagic presentations in pediatric Moyamoya disease would aid early detection.

# **Figures**

1. Magnetic Resonance imaging with angiography following T2 weighted axial: which revealed T2 high intensity area in right periventricular white area and left centrum semiovale and non-visualization of right middle cerebral artery and proximal A1 segment of right anterior cerebral artery with paucity of cortical vessels on the ipsilateral side.
2. CT Brain: showing resolved intraventricular hemorrhage with external ventricular drain placement.

# **References**

1. Hyakuna, N., Muramatsu, H., Higa, T., Chinen, Y., Wang, X., & Kojima, S. (2014). Germline mutation of CBL is associated with Moyamoya disease in a child with juvenile myelomonocytic leukemia and Noonan Syndrome‐Like disorder. Pediatric Blood & Cancer, 62(3), 542–544. https://doi.org/10.1002/pbc.25271
2. Kayal, A., Borah, P., Sharma, V., Basumatary, L., Das, M., & Goswami, M. (2014). Varied presentations of moyamoya disease in a tertiary care hospital of north-east India. Annals of Indian Academy of Neurology, 17(3), 317. https://doi.org/10.4103/0972-2327.138518
3. Houkin, K., Ito, M., Sugiyama, T., Shichinohe, H., Nakayama, N., Kazumata, K., & Kuroda, S. (2012). Review of past research and current concepts on the etiology of Moyamoya disease. Neurologia Medico-chirurgica, 52(5), 267–277. https://doi.org/10.2176/nmc.52.267
4. Dorschel, K. B., & Wanebo, J. E. (2023). Physiological and pathophysiological mechanisms of the molecular and cellular biology of angiogenesis and inflammation in moyamoya angiopathy and related vascular diseases. Frontiers in Neurology, 14. https://doi.org/10.3389/fneur.2023.661611
5. Weinberg, D. G., Rahme, R. J., Aoun, S. G., Batjer, H. H., & Bendok, B. R. (2011). Moyamoya disease: functional and neurocognitive outcomes in the pediatric and adult populations. Neurosurgical FOCUS, 30(6), E21. https://doi.org/10.3171/2011.3.focus1150
6. Joshi, S. B., Sharma, R., Manjunath, N., Dhanakshirur, R. R., Ganesh, V., Jain, S., Raheja, A., Devrajan, L. J., Nehra, A., & Suri, A. (2024). Functional and neuropsychological outcome after surgical treatment of Moyamoya disease. World Neurosurgery, 185, e397–e406. https://doi.org/10.1016/j.wneu.2024.02.038
7. Farah, G. (2014). Clinical and angiographic findings in Moya Moya. American Journal of Case Reports, 15, 147–151. https://doi.org/10.12659/ajcr.890222
8. Kim, J. S. (2016). Moyamoya Disease: Epidemiology, clinical features, and diagnosis. Journal of Stroke, 18(1), 2–11. https://doi.org/10.5853/jos.2015.01627
9. Koizumi, A., Kobayashi, H., Hitomi, T., Harada, K. H., Habu, T., & Youssefian, S. (2015). A new horizon of moyamoya disease and associated health risks explored through RNF213. Environmental Health and Preventive Medicine, 21(2), 55–70. https://doi.org/10.1007/s12199-015-0498-7
10. Tharayil, A. M., Ganaw, A. E. A., Shaikh, N., Prabhakaran, S. M., Chanda, A. H., Praveen, S., Choran, A. K., & Haq, Q. Z. U. (2019). Moyamoya disease: a rare vascular disease of the CNS. In IntechOpen eBooks. https://doi.org/10.5772/intechopen.88770
11. Kayal, A., Borah, P., Sharma, V., Basumatary, L., Das, M., & Goswami, M. (2014b). Varied presentations of moyamoya disease in a tertiary care hospital of north-east India. Annals of Indian Academy of Neurology, 17(3), 317. https://doi.org/10.4103/0972-2327.138518
12. Akimoto, T., Suenaga, J., Hayashi, T., Hirokawa, D., Ito, S., Sato, H., & Yamamoto, T. (2022). Moyamoya Syndrome in a Patient with Williams Syndrome: A Case Report. Pediatric Neurosurgery, 57(5), 365–370. https://doi.org/10.1159/000525229
13. Moyamoya disease: Diagnostic imaging. (2011, January 1). PubMed. https://pubmed.ncbi.nlm.nih.gov/22802820/
14. Montiel, V., Grandin, C., Goffette, P., Fomekong, E., & Hantson, P. (2009). Refractory High Intracranial Pressure following Intraventricular Hemorrhage due to Moyamoya Disease in a Pregnant Caucasian Woman. Case Reports in Neurology, 1(1), 1–7. https://doi.org/10.1159/000205406
15. Goto, Y., Oka, H., & Hino, A. (2020). Managing intervention for severe intraventricular hemorrhage casting in moyamoya disease: Report of two cases. International Journal of Surgery Case Reports, 73, 271–276. https://doi.org/10.1016/j.ijscr.2020.07.021
16. Penn, R., Harrar, D., & Sun, L. R. (2022). Seizures, Epilepsy, and Electroencephalography Findings in Pediatric Moyamoya Arteriopathy: A Scoping review. Pediatric Neurology, 142, 95-103.e2. https://doi.org/10.1016/j.pediatrneurol.2022.11.016