Moyamoya Disease in a 20-Year-Old Male: A Case Report

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Statement of Contribution

Bibek Shrestha played a central role in the research, contributing to the conceptualization, data curation, formal analysis, and methodology. He was responsible for project administration and took the lead in writing the original draft, as well as in the review, editing, and visualization processes. Dhiraj Adhikari contributed significantly by providing resources, supervision, and validation, while also assisting with conceptualization, investigations, and data curation. Bikram Gajurel, Anish Shrestha, Prakash Subedi and Rebicca Pradhan

were involved in the supervision, validation, and investigation phases of the project, ensuring the study's accuracy and credibility. Dijesh Maskey and Pragya Bhandari contributed resources, validation, and investigative efforts to further strengthen the study.

S. N	Name	Contribution
1	Bibek Shrestha	Conceptualization, data curation, formal analysis, methodology, project administration, original
2	Dhiraj Adhikari	Resources, supervision, validation, conceptualization, investigations, and data curation
3	Bikram Gajurel	Supervision, validation, and investigations.
4	Dijesh Maskey	Resources, validation, and investigations.
5	Anish Shrestha	Supervision, validation, and investigations.
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Disclosure

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Conflict of interest

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

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ABSTRACT

Moyamoya disease (MMD) is a rare, progressive cerebrovascular disorder characterized by the narrowing of the internal carotid arteries, leading to ischemic events. This case describes a 20-year-old male who presented with left-sided weakness, slurred speech, and right-sided facial deviation. His symptoms started with a right-sided headache and progressed over several days. The patient had a significant history of pulmonary valve stenosis but no history of substance abuse or other vascular risk factors. Neurological examination showed left-sided motor weakness and facial nerve involvement. Imaging studies, including MRI and CT angiograms, revealed infarcts in the right frontoparietal and temporal regions, along with significant narrowing of the internal carotid arteries and the presence of collateral vessels, suggestive of MMD disease. Serological tests ruled out other causes of vasculitis or infectious etiologies. Following the diagnosis, the patient was managed with aspirin, and his symptoms gradually improved. This case underscores the importance of considering MMD disease in young patients presenting with stroke-like symptoms and highlights the role of imaging in its diagnosis.

Key clinical message

Moyamoya disease, though rare, should be considered in young patients presenting with stroke-like symptoms, especially in the absence of traditional risk factors such as smoking, hypertension, or substance abuse. In this case, the diagnosis was confirmed through advanced imaging techniques, which revealed the characteristic narrowing of the internal carotid arteries and the formation of collateral vessels. Early recognition and appropriate medical management with aspirin led to symptomatic improvement. This case emphasizes the need for prompt investigation in young individuals with cerebrovascular events and highlights the critical role of imaging in diagnosing MMD, enabling early intervention to prevent recurrent ischemic events.

Key words

Angiography; cerebrovascular disease; Moyamoya disease; numbness; stroke.

Introduction

Moyamoya disease (MMD) is a rare cause of cerebral vascular ischemia, which is radiologically featured as progressive stenosis of the distal part of the internal carotid artery and the formation of capillary collaterals (1). It can affect any age, children and adults, while ischemic manifestations are more common in pediatric cases, whereas hemorrhagic cases are more common in adults. Diagnosis relies on imaging techniques, which include CT, MRI and angiography (2). The disease can progress from unilateral to bilateral involvement, with specific clinical and genetic factors potentially influencing this progression (3). Intracranial haemorrhage is a significant concern, with about half of the adult-onset MMD patients experiencing it. Cerebral ischemia is the most common manifestation, affecting 73.9% of elderly patients along with speech and cognitive impairment (4,5). Cognitive dysfunction is a significant issue in adult MMD patients, particularly affecting those with difficulty in social independence. A broad range of cognitive functions can be disrupted, including basic abilities and frontal lobe function (6). While the optimal treatment strategy remains debated, personalized selection based on patient characteristics and disease severity is crucial for balancing perioperative risks and long-term benefits in MMD management. MMD treatment primarily involves cerebral revascularization through direct or indirect bypass procedures. Direct bypass, such as superficial temporal artery-middle cerebral artery (STA-MCA) anastomosis, provides higher revascularization rates and potentially better clinical outcomes (7). Herein, we will discuss a 20-year-old male, non-smoker and non-alcohol consumer with a diagnosis of MMD, which is a rare chronic cause of stroke.

Case History/ Examination

A 20-year-old male non-smoker and non-alcohol consumer came to the emergency department with chief complaints of left-sided weakness, slurred speech and right-sided facial deviation for six days. The patient was well six days back when he had a headache in the right temporal region associated with nausea. He had a headache in the right-sided temporal region for six days, which is sharp pain. He gave a 6 out of 10 on the pain analogue scale, which was continuous when he woke up in the morning and wanted to go to the bathroom; however, he could not walk properly. After 1 hour, he fell and could not balance himself on the passage. He first developed weakness in the left lower limb, followed by weakness in the left arm. He also developed slurring of speech, which was understandable, along with facial deviation without drooling of saliva. He has a significant history of pulmonary valve stenosis 12 years back with balloon valvuloplasty. There was no significant drug history, family history or substance abuse history. The patient was conscious and oriented to time, place, and person on examination, and his higher mental function was intact. His blood pressure was 110/70 mmHg, pulse was 89 beats per minute, respiratory rate was 20 per minute, and SPO2 was 97% on the right hand. A neurological examination was done, where Bulk was normal bilaterally, and tone was intact on the upper and lower limbs. Power on the right side was intact, whereas power on the left upper and lower limbs was 4 out of 5. On cranial nerve examination, face deviation was found, and frowning was absent on the left side. His sensory examination revealed decreased sensation to vibration till the umbilicus, whereas position sensation was intact. Waddling gait was present, and Gower's sign was positive. Babinski on the bilateral limbs was down going, and cerebellar examination was normal; however, nystagmus was present. There was no sign of meningeal irritation. During the cardiovascular examination, S1 and S2 heart sounds were heard, and they were expected.

Methods

Based on the history and clinical examinations, stroke due to an embolic event, moyamoya disease as a provisional diagnosis, along with multiple sclerosis and vascular malformation. Since the absence of optic neuritis or specific sensory disturbances further reduces the likelihood of MS, blood investigations and imaging were done to narrow it further. Laboratory tests revealed increased leukocyte count of 13,200/cmm [Normal: 4,000-11,000/cmm] with a neutrophil predominance of 87.2% [Normal: 45-75%], C-reactive protein (CRP) quantitative was positive (+++), ESR (Capillary Photometric) of 17 mm/hr [Normal: 0-15 mm/hr] and haemoglobin level of 13.3 gm% [Normal: 13.5-18.0 gm%]. Laboratory investigation was sent with serum sodium of 138 mEq/l [Normal: 135-146 mEq] and potassium with 3.8 mEq/l [Normal: 3.5-5.2 mEq]. Her biochemical profile includes alanine aminotransferase (ALT) 59 U/L [Normal: 7 to 56 units per litre], aspartate aminotransferase (AST) 7 U/L [Normal: 8 to 33 U/L], triiodothyronine (fT3): 4.21 pmol/L (2.4-6.0), thyroxine (fT4): 16.2 pmol/L (9-19), TSH: 1.26 uIU/ml (0.35-4.94), HDL Cholesterol (Direct): 1.0 mmol/L (0.8-1.6) and LDL Cholesterol (Direct): 3.7 mmol/L (less than 4). Additionally, the serological investigation was sent for HIV, Syphilis, Hepatitis B antigen, Hepatitis C antigen and Lupus, antinuclear antibody (ANA), and IFA human epithelial cell line (HEP-2) endpoint titre and was negative. Normal serological tests rule out other causes of vasculitis. Radiological investigation was conducted, and Magnetic Resonance Imaging of the Brain with magnetic resonance angiogram found T2/FLAIR high signal intensity involving the grey and white matter of the right frontoparietal temporal lobe, as well as the right lentiform nucleus, caudate head, and internal capsule, along with a mass effect. (Figure 1) Fronto-parietal temporal lobe as well as lentiform nucleus, caudate nucleus and internal capsule shows diffuse restriction in DWI. (Figure 2) Magnetic resonance venography suggested the right frontal, parietal, temporal lobe, basal ganglia and internal capsule acute/ subacute infarct, mainly proper middle cerebral artery territory with mass effect with loss of flow void in left transverse sinus in T2 image with loss of flow signal. (Figure 3) CT angiogram of the head and neck was sent for further investigation, which suggested a subacute infarct involving the right frontal, temporal, parietal lobe with mass effect and midline shift, abrupt and smooth long segment narrowing of vertical segment of the bilateral internal carotid artery (left> suitable) through its course

with collateral vessels around a clinoid segment of the bilateral internal carotid artery and bilateral middle cerebral artery territory- features are likely of vasculitis suggested of MMD. Further, echocardiography and electrocardiography were done, and normal findings were revealed.

Conclusion and results

Following the history, examinations, investigations, and diagnosis of MMD. The patient was given IV Normal Saline 3% along with IV Mannitol 200 ml to reduce the swelling in the brain as seen in MRI MRA and MRV finding. (Figure1, 2 and 3) The aetiology was not well understood for so aspirin 150 mg/day was suggested to decrease the embolic events which might even worsen the condition. Following aspirin and weakness and facial deviation subsequently subsided. Follow up was done subsequently, in which the patient's weakness and facial deviation have decreased and patient can walk independently without any support.

Discussion

Moyamoya disease is a progressive cerebrovascular disorder which is characterized by stenosis of internal carotid arteries and its territories, which eventually lead to recurrent stroke episodes (8). In children, ischemic events are more common compared to adults, where adults are more prone to hemorrhagic manifestation (2). Ischemic and hemorrhagic strokes exhibit distinct lesion patterns, with ischemic strokes predominantly affecting the insula, putamen, operculum, and superior temporal cortex. In contrast, hemorrhagic strokes tend to involve more posterior and medial areas (10). Patients typically exhibit neurological deficits, with severity correlating to the extent of brain damage (11). Toh et al. (2023) revealed the prevalence of cognitive impairment in 54.4% of adult patients, including 31.55% with executive dysfunction. However, cognitive impairment had no association with stroke history, age or education level (9). In this case, a 20-year-old patient presented with headache, weakness of upper and lower left limbs, slurring of speech and facial deviation. The exact etiopathogenesis of MMD is still uncertain. However, Diffusion-weighted MRI studies have revealed white matter alterations in watershed regions of children with MMD, even without overt stroke or silent infarction, suggesting ongoing injury due to chronic hypoperfusion (12). In adults, cognitive impairment, particularly in intelligence and arithmetic functions, is associated with white matter changes in specific brain regions, such as the uncinate fasciculus and inferior frontal-occipital fasciculus (13). There is a complex genetic association underlying MMD. Genetic variants in genes like ALPK1 and THBS2 have been linked to susceptibility for both coronary artery disease and ischemic stroke, which may share genetic architecture with MMD (14). Neuroimaging plays a crucial role in diagnosing and assessing. MRI studies reveal white matter alterations in children with MMD, particularly in watershed regions, even without overt stroke or silent infarction (12). Computational fluid dynamics simulations based on phase-contrast MRI data show significant hemodynamic changes in MMD patients, including higher pressure drop differences between internal carotid arteries and increased flow in posterior communicating arteries (15). CT angiography (CTA) findings in MMD reveal significant vascular changes. In MMD patients, the basilar artery tends to move towards the midline and upward, with enlarged posterior circulation vessels compared to healthy controls. The disease progression is characterized by a longitudinal shift of collateral channels from anterior to posterior components, potentially increasing the risk of hemorrhagic stroke in adults (16,17). In our case, MRI angiography and venography were sent and suggested of frontal, parietal, temporal lobe, basal ganglia and internal capsule acute/ subacute infarct, mainly proper middle cerebral artery territory with mass effect. To confirm further, a CT Angiogram was sent and suggested a narrowing of the bilateral internal carotid artery (left> suitable) through its course with collateral vessels around a clinoid segment of the bilateral internal carotid artery and bilateral middle cerebral artery territory- features suggestive of MMD. Treatment modalities for MMD vary depending on the type and patient's age. For adult hemorrhagic MMD, bypass surgery significantly reduces stroke recurrence compared to medical treatment. However, bypass surgery for adult ischemic MMD shows no significant benefit over medical treatment (18). Antiplatelets

have shown effective results in controlling the recurrence of infarcts in the cerebral artery, highlighting the complex role of antiplatelet treatments in cerebrovascular treatment. This case highlights the importance of considering MMD in young patients presenting with stroke-like symptoms, the critical role of imaging in diagnosis, and the potential for recovery with appropriate treatment.

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Images

1. Figure 1: MRI of Brain with MRA showing T2 Flair high signal intensity involving gray and white matter
2. Figure 2: MRI of Brain with MRA showing Diffusion restriction in DWI
3. Figure 3: MRI with MRV Loss of flow void in left transverse sinus in T2 image with loss of flow signal

Declerations

1. Ethics approval and consent to participate: The Institutional Review Board of the Institute of Medicine, Nepal, does not mandate ethical approval for the writing or publication of case reports, and patient consent was obtained. Informed written consent was obtained from the patient before writing this case report.
2. Consent for publication: Informed written consent was obtained from the patient for the publication of this case report in a scientific journal.
3. Availability of data and materials: The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.
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