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CASE REPORT

# A Case of Spinal Cavernous Hemangioma with Rapidly Worsening Neurological Symptoms after COVID-19 Infection

**Nobuyuki Arai, MD [a] Hiromasa Abe, MD [a] Takashi Hiraoka, MD [a] and Kozo Hanayama, MD [a]**

**Background**: COVID-19 can cause respiratory symptoms, as well as various complications and sequelae. This report describes a patient with worsening neurological symptoms caused by a spinal cavernous hemangioma after infection with COVID-19. Cavernous hemangioma usually occurs in the upper part of the brain (70%–90%) and rarely occurs in the spinal cord (5%–7%). Approximately 65% of cases of intramedullary spinal cavernous hemangioma present with neurological symptoms, and more than half of these cases show a slow worsening of symptoms. This is a rare case of intramedullary spinal cavernous hemangioma with cysto-rectal involvement in which neurological symptoms rapidly worsened following COVID-19 infection. **Case**: A woman in her 30s was admitted to the hospital because of the sudden onset of muscle weakness in both lower limbs and cysto-rectal disturbances after COVID-19 infection. She was diagnosed with a hemorrhage from a spinal cord tumor and underwent emergency resection. The pathological diagnosis was a spinal cavernous hemangioma. At first, she had a spinal cord injury (third thoracic vertebrae; American Spinal Injury Association Impairment Scale, C; Frankel classification, B; with cysto-rectal impairment), but 2 months later, she started walking with knee–ankle–foot orthoses and parallel bars. After 3 months, she could move independently around the ward using a wheelchair. Upon discharge, the patient could walk with ankle–foot orthoses and Lofstrand crutches. **Discussion**: COVID-19 is associated with various extrapulmonary manifestations and may increase the risk of hemorrhage in cases of intramedullary spinal cavernous hemangioma.

**Key Words:** COVID-19 infection; hemorrhage risk; intramedullary; neurological symptoms; spinal cavernous hemangioma

## INTRODUCTION

In cases of coronavirus disease (COVID-19), although treatment of respiratory symptoms is the primary objective, the virus may also cause unexpected complications and sequelae that pose major challenges to treatment.[1)] Numerous non-pulmonary symptoms have been reported, including cardiovascular symptoms such as myocarditis and coronary artery disease, gastrointestinal symptoms such as diarrhea and vomiting, renal symptoms such as acute renal failure, neurological symptoms of stroke, brain hemorrhage, and taste disorder.[2–10)] In patients with COVID-19, uncontrolled cytokine release, endothelial disruption, and upregulation of procoagulant activity may be compounded by hypoxia, resulting in a positive thromboinflammatory feedback loop that culminates in thrombosis and hemorrhage.[11)] Shkoukani et al.[12)] reported that COVID-19 may increase the incidence of hemorrhage in cavernous hemangiomas.

In general, cavernous hemangiomas most commonly occur on the upper part of the brain (70%–90%) and rarely occur in the spinal cord (5%–7%).[13)] Ungeheuer et al.[14)] reported that approximately 65% of cases of intramedullary spinal cavernous hemangiomas present with neurological symptoms, with progressive and slow worsening of neuroglial symptoms in more than half of these cases, but that a rapid onset associated with cavernoma hemorrhage may also be observed. The

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[a] Department of Rehabilitation Medicine, Kawasaki Medical School, Kurashiki, Japan
Correspondence: Nobuyuki Arai, MD, 577 Matsushima, Kurashiki, Okayama 701-0192, Japan, E-mail: dodobiyan@med.kawasaki-m.ac.jp

risk of hemorrhage for those with a cavernous malformation is estimated at 2.5% annually. Gross et al.[15] reviewed 27 series of 352 patients and reported an annual bleeding rate of approximately 2.1%, with rapid worsening of symptoms in 30% of cases and cysto-rectal involvement in 11% of cases. Badhiwala et al.[16] reviewed 40 series of 632 patients and reported an annual bleeding rate of approximately 2.5%, rapid worsening of symptoms in 45%, and cysto-rectal disturbances in 0.5% of patients.

In 2009, Papageorgiou et al.[17] reported a 67-year-old woman with right lower extremity monoparesis that deteriorated rapidly because of an intramedullary spinal cavernous hemangioma. In 2018, Oh et al.[18] reported good outcomes with early training for a 79-year-old patient conservatively treated for intraspinal hemorrhage likely caused by an intramedullary spinal cavernous hemangioma. More recently, Fredrickson et al.[19] reported the case of 56-year-old patient with paraplegia caused by intramedullary spinal cavernous hemangioma. They reported good outcomes with functional restoration training.[19] Bleeding that is thought to cause acute neurological symptoms is generally caused by anticoagulant therapies such as warfarin or heparin, congenital or acquired bleeding disorders, primary or metastatic spinal cord tumors, or delayed complications of spinal irradiation.[14]

We performed functional recovery training on a patient with an intramedullary spinal cavernous hemangioma who had trouble moving her right lower extremity after a COVID-19 infection, followed by a rapid worsening of neurological symptoms. The patient underwent emergency excision and remained with incomplete paraplegia. This is a very rare case of intramedullary spinal cavernous hemangioma with vesicoureteral involvement that rapidly worsened the neurological symptoms after COVID-19 infection. After the nature of the study was explained, the patient provided written informed consent to publish this case report.

## CASE

A woman in her 30s, without comorbidities or a history of postoperative ovarian cyst or left patellar fracture, could independently perform activities of daily living before symptom onset. After testing positive for COVID-19, the patient recuperated at home. Two days later, her fever subsided; however, she developed weakness and sensory numbness in her right lower extremity. A few days later, she experienced trouble with defecation and urinary incontinence. Facing trouble moving her right lower limb, she was admitted to our hospital. On admission, the patient had a body temperature of 36.8 °C, blood pressure of 113/65 mmHg, heart rate of 71/min, and SpO2 of 99%. No obvious abnormality was noted in neurological findings. Muscle strength was assessed using the manual muscle test (MMT): both upper limbs, 5; hip flexion (right/left), 2+/5; knee extension (right/left), 2−/5; ankle dorsiflexion (right/left), 1/5; phalangeal joint extension (right/left), 2/5; and ankle plantarflexion (right/left), 2/5. In the sensory system, temperature sensation was deactivated on the left side below the fourth thoracic vertebrae (Th4), position sensation was deactivated bilaterally below Th4, tactile sensation was blunted on the right side below Th3, and hyperalgesia was observed on the right side below Th4. Vibratory sensation was decreased in the right lower limb: (right/left) 0/12 s. Dysuria was also noted. Voluntary anal contractions similar to deep anal pressures were noted. Blood tests, spinal fluid analyses, and imaging were also performed. Blood and spinal fluid tests revealed no apparent infectious or inflammatory diseases. Magnetic resonance imaging (MRI) of the head showed ectopic gray matter along the walls of both lateral ventricles, and MRI imaging of the spinal cord showed an enlarged thoracic spinal cord at the level of Th2 to Th6, abnormally high signal areas within the spinal cord, and edematous changes in the spine above Th2 and below Th6. The thoracic spinal cord lesion was spindle-shaped and showed the same signal intensity as the spinal cord on T1-weighted images and a slightly lower signal on T2-weighted images. A faint contrast effect and hemosiderin deposition were noted (**Fig. 1**). Based on blood tests and imaging studies, spinal cavernous hemangioma and ependymoma were suspected. Surgery was scheduled for 2 weeks later. However, the following day, muscle weakness and sensory deficits worsened in the right lower extremity, muscle weakness appeared in the left lower extremity, and blunting of warm, superficial, and deep sensations appeared on the left side below Th3. On the same day, blood tests showed elevated white blood cell count and elevated C-reactive protein, and computed tomography of the chest revealed a ground-glass shadow in the left lower lobe; remdesivir + tazobactam/piperacillin administration was initiated for pneumonia associated with COVID-19 infection. Emergency tumor resection was performed the following day. At the time of surgery, blood clots were found in the dura mater, and the resected tumor was diagnosed as a spinal cavernous hemangioma based on the pathological findings (**Fig. 2**). Two weeks after the surgery, the patient was transferred to the recovery ward. At the time of transfer, there were no obvious abnormalities in neurological findings. The following muscle strength data (MMT) were recorded: upper

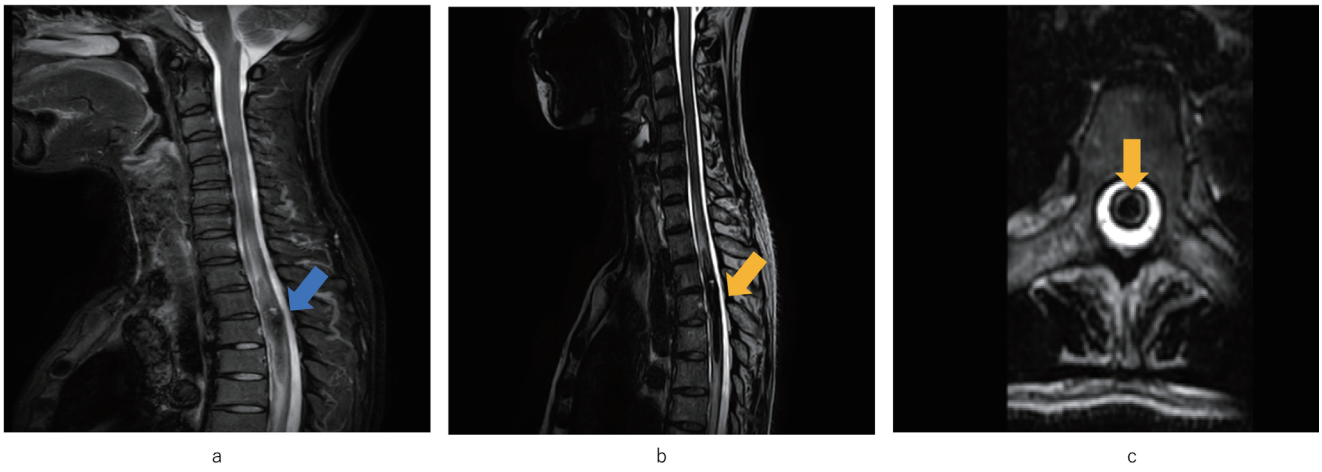


**Fig. 1.** MRI findings on admission. (a) The thoracic spinal cord was spindle-shaped and enlarged at the level of Th2 to Th6 (arrow), with abnormal high-signal areas in the spinal cord and edematous changes in the spine above and below it. The thoracic spinal cord lesion was spindle-shaped, with equal signal to the spinal cord on the T1-weighted image. (b) T2-weighted image showed slightly lower signal in the level of Th2 to Th6 level (arrow). (c) T2-weighted image showed a faint contrast effect and hemosiderin deposition (arrow).

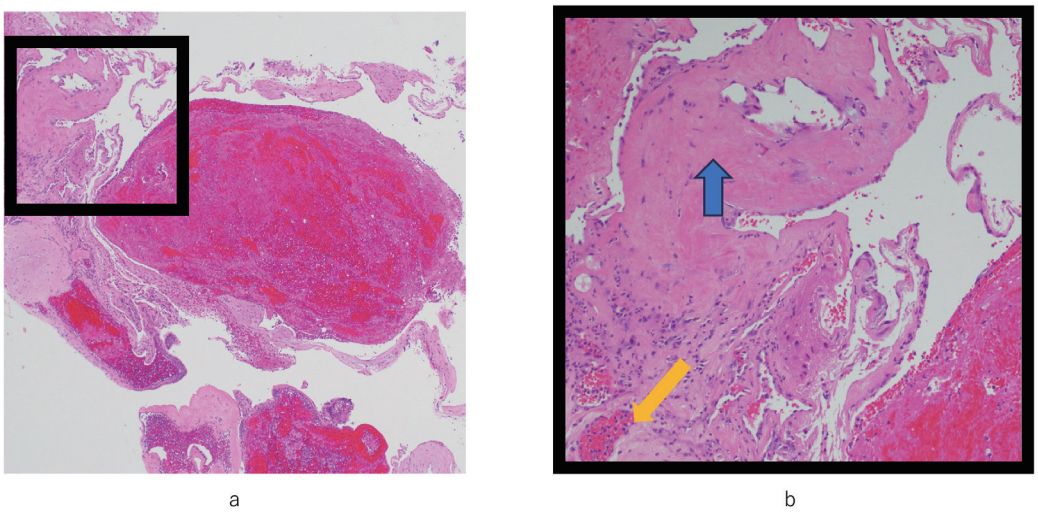


**Fig. 2.** Pathological findings of resected tumor. (a) Tissue sample consisting of large and small blood vessels and containing peripheral blood clots (magnification ×). (b) Magnified (10×) inset of (a) showing vascularization of the wall. Blood vessels (arrow) indicate a cavernous hemangioma. Thrombus is seen in the micro vessels (arrow).

limbs, 5; hip flexion (right/left), 1/2; knee extension (right/left), 1/2; ankle dorsiflexion (right/left), 1/2; phalangeal joint extension (right/left), 1/2; and ankle plantarflexion (right/left), 1/2. The following sensory observations were recorded: temperature sense was deactivated on the left side below Th4, position sensation was deactivated on the right side below Th3, tactile sensation was dulled on the right side below Th3, and hyperalgesia was observed on the right side below Th4. Vibration sensation was reduced in the right lower limb: (right/left) 0/3 s. Residual dysuria, voluntary anal contraction, and deep anal pressure were also noted. The patient had a spinal cord injury: level of injury, Th3; American Spinal Injury Association Impairment Scale, C; Frankel classification, B; with cysto-rectal impairment. Each day was divided

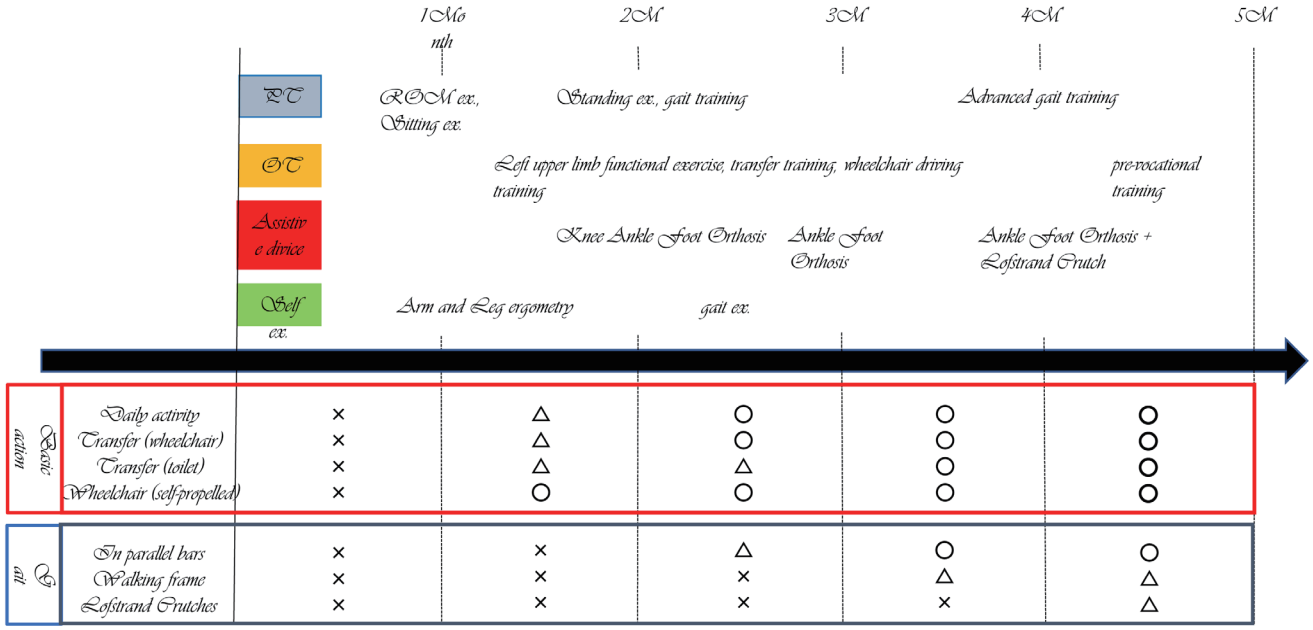


**Fig. 3.** Chart showing changes in patient abilities over the duration of treatment. Upper chart shows progress in the training content; lower chart shows progress of the patient's abilities. Crosses, unable to perform; circles, usually able to perform; triangles, able to perform. ROM, range of motion; ex., exercise.

into morning and afternoon sessions for a total of 2–3 h of physical and occupational therapy (**Fig. 3**). The training was conducted according to the Japanese Rehabilitation Society Clinical Practice Guidelines,[20] and no specific criteria were established for discontinuation. Two months later, the patient began gait training using knee–ankle–foot orthoses and became independent in self-care, including changing clothes and urination. At 3 months after surgery, the patient could walk using an ankle–foot orthoses and could move independently around the ward while using a wheelchair. At the time of discharge (5 months), the patient could independently perform activities of daily living in a wheelchair and was able to walk up steps and over short distances using an ankle–foot orthoses and Lofstrand crutches (**Fig. 3**). Progress in muscle strength improvement is shown in **Table 1**.

## DISCUSSION

### Pathophysiology

MRI findings of cavernous hemangiomas are characterized by the presence or absence of hemorrhage and vary according to the course of the disease; however, there is no contrast effect.[21] A collection of dilated vascular cavities with sinusoidal structures and no elastic fibers or smooth muscles in the vessel walls characterize the pathology.[22] This case was diagnosed as cavernous hemangioma based on imaging and pathological findings. In a previous report, the neuropathic picture of intramedullary spinal cavernous hemangioma was reported to be transverse or of Brown–Séquard type.[23] Although cavernous hemangiomas occur within the medulla, there seems to be no clear trend in their sign of origin. This case started with sensory and motor deficits on the right side that gradually progressed to sensory and motor deficits on the left side. These symptoms indicate that the cavernous hemangioma originated from a branch of the right posterior spinal artery or a perforating branch of the soft membrane artery plexus.

### COVID-19 Infection and Bleeding

Shkoukani et al.[12] reported that COVID-19 may increase the incidence of hemorrhage in cavernous hemangiomas. However, the underlying mechanisms remain unclear. It is widely known that COVID-19 infection causes abnormalities in the coagulation–fibrinolysis system. In 2022, Onishi et al.[24] reported that a characteristic of coagulation and fibrinolysis abnormalities in COVID-19 infection is that, unlike other coagulation and fibrinolysis abnormalities such as disseminated intravascular coagulation, hypercoagulation leads to hyperfibrinolysis and bleeding approximately 7 days after hypercoagulation, and bleeding occurs more frequently

**Table 1** . Post-hospitalization course of lower limb muscle strength

| Movement | Muscle strength (right/left) | | | | |
|---|---|---|---|---|---|
| | At time of hospitalization | Immediately before surgery | Immediately after surgery | When changing department | At discharge |
| Hip flexion | 2+/5 | 0/1 | 0/0 | 1/2 | 3/4 |
| Knee extension | 2−/5 | 0/1 | 0/0 | 1/2 | 3/4 |
| Ankle dorsiflexion | 1/5 | 0/1 | 0/0 | 1/2 | 3/5 |
| Phalangeal joint extension | 2/5 | 0/2 | 0/1 | 1/2 | 3/4 |
| Ankle plantarflexion | 2/5 | 0/1 | 0/0 | 1/2 | 3/4 |

Muscle strength assessed by MMT.

in patients with moderate or more severe coagulation and fibrinolysis. Given the moderate severity of the patient's condition and the timing of paralysis progression, we considered that abnormalities in the coagulation and fibrinolysis systems caused by COVID-19 infection led to bleeding from the cavernous hemangioma, exacerbating neurological symptoms.

## Functional Prognosis and Rehabilitation

Steiger et al.[25] reported the postoperative course of removal of 20 symptomatic spinal cavernous hemangiomas experienced between 1994 and 2009, with only 3 of the 20 patients worsening by one Frankel classification and 10 improving by one classification. The present case improved from Frankel classification B to Frankel classification C, similar to previous reports, and regardless of whether COVID-19 infection was the cause, the functional prognosis was not significantly different from that of the usual postoperative course of intraspinal cavernous hemangiomas. However, the annual rebleeding rate of cavernous hemangiomas is as high as 10%, approximately six times that of the initial hemorrhage, and some reports state that neurological symptoms associated with rebleeding should be monitored as late as 6 months.[13,14] In addition, the sequelae of COVID-19 (e.g., fatigue, shortness of breath, memory impairment, and taste disorder) should be monitored for 6 months after the onset of the disease.[26] We recommended that the present case be followed closely for at least 6 months. The effect of COVID-19 on this rare cavernous hemangioma is unknown, and we considered functional improvement to be the most important goal for rehabilitation. Therefore, training was performed in the same manner as that for general spinal cord injuries but with increased attention on the effects of blood pressure on the cavernous hemangioma. No special criteria were established for discontinuation of training. Nevertheless, various sequelae are known to occur after COVID-19. For example, if there were cardiovascular sequelae, active training may have been difficult, and the functional prognosis may have been different. In designing training programs for patients with sequelae, consideration should be given to establish criteria for discontinuation of training.

## CONCLUSION

We encountered a case of an intramedullary spinal cavernous hemangioma that developed neurological symptoms after COVID-19 infection, necessitating surgical intervention. Rapid changes in neurological symptoms after COVID-19 infection and surgery are rare. The rapid deterioration of neurological symptoms following COVID-19 infection is associated with a wide variety of extrapulmonary manifestations. COVID-19 may be a hemorrhagic risk factor in cases of intramedullary intraspinal cavernous hemangioma. However, we applied the same training standards as those used for postoperative cases of intramedullary spinal cavernous hemangiomas without major problems, and function improved to the degree expected in these cases. In the future, it may be useful to focus on the exacerbation of neurological symptoms caused by bleeding in cases of COVID-19 infection with intramedullary cavernous hemangioma.

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## CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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