ScientificScholar®
Knowledge is power
Publisher of Scientific Journals

www.surgicalneurologyint.com

Surgical Neurology International

Editor-in-Chief: Nancy E. Epstein, MD, Professor of Clinical Neurosurgery, School of Medicine, State U. of NY at Stony Brook.

SNI: Infection

Editor
Ali Akhaddar, MD, IFAANS
Avicenne Military Hospital, Marrakech, Morocco

SNI
Open Access

Case Report

Early recanalization and vasospasm after endovascular treatment in a case of ruptured vertebral artery dissecting aneurysm associated with COVID-19

Yukihiko Nakamura[1], Chihiro Takashima[1], Takahisa Nonaka[1], Taku Ohkubo[1], Takayuki Kawano[1], Akira Okura[1], Daisuke Kondou[2], Kazutaka Sonoda[2], Masaru Hirohata[3], Motohiro Morioka[3]

Departments of [1]Neurosurgery and [2]Neurology, Saiseikai Fukuoka General Hospital, Fukuoka, [3]Department of Neurosurgery, Kurume University School of Medicine, Kurume, Japan.

E-mail: *Yukihiko Nakamura - yukihiko911@gmail.com; Chihiro Takashima - takashima_chihiro@kurume-u.ac.jp; Takahisa Nonaka - takahisa5620@gmail.com; Taku Ohkubo - ohkubo_taku@med.kurume-u.ac.jp; Takayuki Kawano - kawano-t@saiseikai-hp.chuo.fukuoka.jp; Akira Okura - ookura@saiseikai-hp.chuo.fukuoka.jp; Daisuke Kondou - kon.neuro86@gmail.com; Kazutaka Sonoda - kazutaka.sonoda@gmail.com; Masaru Hirohata - hiroha@med.kurume-u.ac.jp; Motohiro Morioka - mmorioka@med.kurume-u.ac.jp

***Corresponding author:**
Yukihiko Nakamura,
Department of Neurosurgery,
Saiseikai Fukuoka General Hospital, Fukuoka, Japan.

yukihiko911@gmail.com

Received: 17 June 2023
Accepted: 25 August 2023
Published: 08 September 2023

DOI
10.25259/SNI_517_2023

Quick Response Code:

ABSTRACT

Background: The coronavirus disease 2019 (COVID-19) pandemic has caused significant structural changes in acute care hospitals. COVID-19-associated stroke has gained attention, with abnormal coagulation and vascular endothelial damage being recognized. While ischemic cases are commonly reported, hemorrhagic cases have also been reported. This report presents a case of ruptured vertebral artery dissection aneurysm associated with COVID-19, resulting in subarachnoid hemorrhage (SAH). The treatment course, challenges in managing cerebral vasospasm, and early recanalization achieved through endovascular therapy are described.

Case Description: A 67-year-old male patient was brought to our hospital for emergency treatment of impaired consciousness that occurred while recovering from COVID-19. He underwent endovascular internal trapping using coils, and although the rupture did not recur, he required long-term tracheal management, which resulted in a cerebral infarction caused by cerebral vasospasm. In addition, early recanalization was seen, which required retreatment.

Conclusion: This case highlights the challenges in managing COVID-19-associated SAH and emphasizes the need for infection control measures and proper postoperative care. Establishing protocols for detecting and managing cerebral vasospasm is essential.

Keywords: Coronavirus disease 2019, Delayed cerebral infarction, Endovascular internal trapping, Vasospasm, Vertebral artery dissecting aneurysm

INTRODUCTION

The unprecedented COVID-19 (coronavirus disease 2019) pandemic has brought significant changes to the structure of acute care hospitals. COVID-19-associated stroke has gained attention in recent years.[3] Abnormal coagulation and vascular endothelial damage associated with the infection have also been recognized.[5] While ischemic cases are frequently reported, hemorrhagic cases have also been documented.[19] In this report, we present a case of ruptured

vertebral artery (VA) dissection associated with COVID-19, leading to subarachnoid hemorrhage (SAH), and describe the treatment course and the challenges encountered in managing cerebral vasospasm, as well as the early recanalization achieved through endovascular therapy.

CASE DESCRIPTION

A 67-year-old male, cab driver. Past History: None noted.

On the 3rd day of COVID-19 onset, he did not answer his family's phone calls, and when the hotel staff checked on him, they found that he had collapsed in his room and was rushed to the hospital. Neurological findings: Glasgow Coma Score: 9 (E2V3M4) with no apparent paralysis. Imaging findings: Computed tomography (CT) scanning revealed SAH, intraventricular hemorrhage, and hydrocephalus [Figure 1a]. CT angiography (CTA) revealed a spindle-shaped dilatation of the left VA, and the posterior inferior cerebellar artery (PICA) was branched proximally [Figure 1b]. A simple chest CT revealed multiple frosted shadows in the peripheral areas of both lungs [Figure 1c].

Treatment plan

The diagnosis of SAH (Hunt and Kosnik: grade 4, world federation of neurosurgical societies (WFNS): grade 4) due to a ruptured vertebral artery dissecting aneurysm was determined to be the PICA distal-type, and the development of a contralateral VA was sufficient flow and endovascular internal trapping was planned.

Endovascular treatment was performed with the minimum required number of surgeons and medical staff under full personal protective equipment (full-PPE) in the angio (ANGIO) suite with a negative-pressure ventilation system. Under general anesthesia, both femoral arteries were punctured and a 5Fr Guiding sheath was placed in the right VA, and a 4Fr catheter was placed in the left VA to control digital subtraction angiography (DSA). DSA revealed that the aneurysm was PICA distal-type with a dome measuring 12.6 mm × 6 mm [Figure 2a]. The left VA was well-developed, and a branch of the anterior spinal artery was observed. We planned internal trapping of the right VA using the double catheter technique. Thirty platinum coils were used for the occlusion of the right VA. Flow arrest was observed and the procedure was terminated [Figure 2b]. Blood flow from the contralateral left VA was sufficient and retrograde flow to the ipsilateral VA [Figure 2c].

Postoperatively, the patient was managed as in the case of a normal severe SAH, including strict fluid management, blood pressure maintenance, and the administration of fasudil hydrochloride and sodium ozagrel natrium (nimodipine is not applicable in our country). The only deviation from regular treatment, considering the risk of secondary infection due to extubation, is that we continued to manage the patient by intubation. We performed neurological examinations and found no paralysis or sensory disturbance every few hours. Furthermore, the patients have undergone transcranial Doppler (TCD) examinations every day, which revealed results that were not significantly elevated (mean flow velocity was 50–80 cm/s). The patient was extubated 10 days after hospitalization, following two consecutive negative COVID – polymerase chain reaction (PCR) results. At that time, motor aphasia was observed, and CT revealed a focal cerebral infarction in the left frontal lobe [Figure 3a] that was thought to be caused by cerebral vasospasm at the distal middle cerebral artery (MCA) [Figure 3b]. On the 30th day, the aneurysm was recanalized [Figure 3c]. The recanalization segment showed an aneurysmal-like dilatation [Figure 3d], and coil embolization using nine coils was performed with a focus on the dilated area, achieving re-occlusion [Figure 3e].

A ventriculoperitoneal shunt was also performed for the complication of hydrocephalus. The patient was transferred to a different hospital for rehabilitation on the 50th day, and his symptoms gradually recovered, with mild motor aphasia persisting at 1 year after onset and the modified Rankin Scale 1.

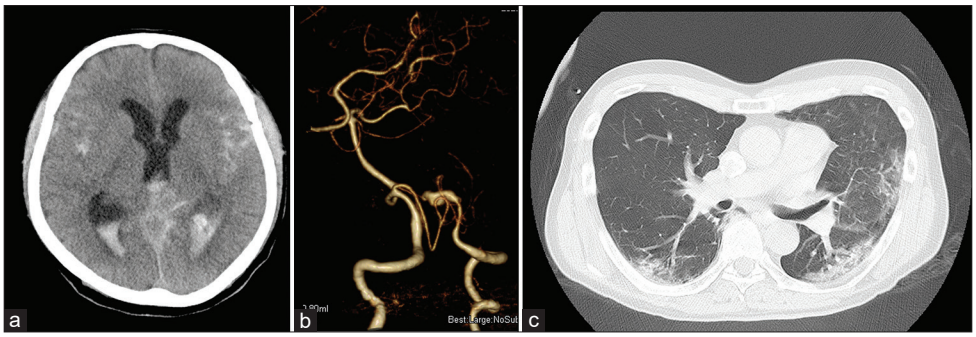

Figure 1: Computed tomography (CT) and three-dimensional CT angiogram on admission after COVID-19 onset day 3 (a) diffuse subarachnoid hemorrhage with intraventricular hemorrhage and hydrocephalus. (b) Pearls and strings are seen in the left vertebral artery. (c) Chest CT shows multiple frosted shadows are seen in the bilateral lung fields.

Figure 2: Digital subtraction angiography of the right vertebral artery (VA) (a and b) and left VA (c) (a) right vertebral artery dissecting aneurysm (VAG), lateral view. The aneurysm was present just after the posterior inferior cerebellar artery (PICA) branch. (b) Right VAG, lateral view. Flow arrest was seen in the right VA while the PICA was preserved. (c) Left VAG, frontal view. After internal trapping, the left VA was perfused sufficiently, retrograde flow to the right VA, and a branch of the anterior spinal artery was observed.

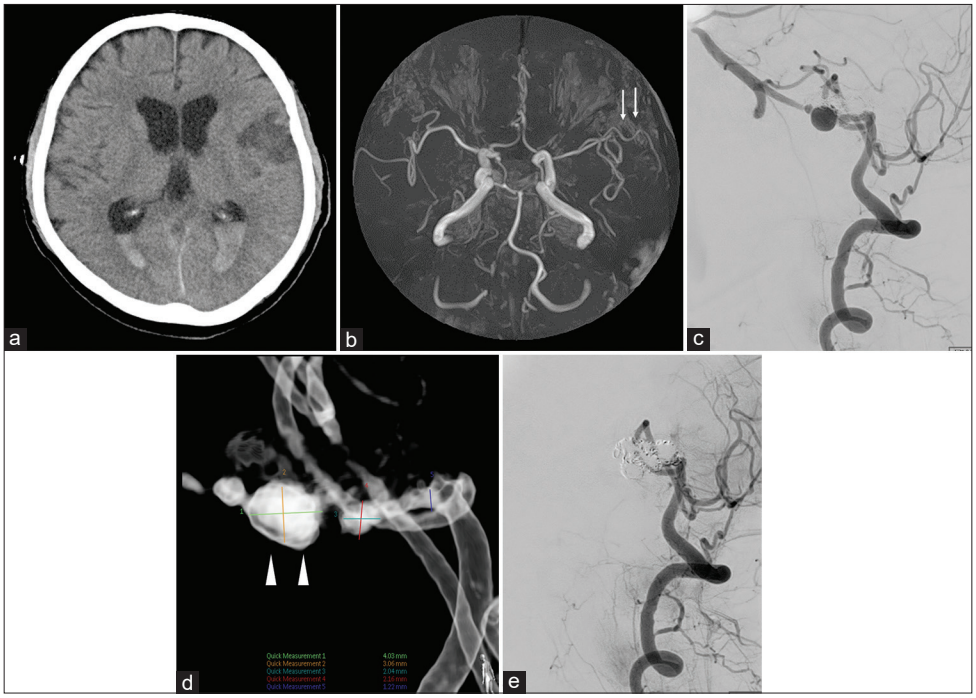

Figure 3: Computed tomography (a) and magnetic resonance angiography (MRA) (b) on the 10 days after hospitalization. Digital subtraction angiography of the right vertebral artery (VA) on the 30 days after hospitalization (c-e). (a) Part of the left frontal lobe showed a low-intensity zone. (b) MRA showing mild stenosis of the left distal middle cerebral artery (white arrow). (c) Right vertebral angiography (VAG), lateral view. Recanalization is seen in the right VA. (d) Right VAG, lateral view. An aneurysm-like dilation (white arrowhead) is seen at the lower part of the coil mass. (e) Right VAG, lateral view. After re-embolized, flow arrest was seen in the right VA while the posterior inferior cerebellar artery (PICA) was preserved.

DISCUSSION

The association between COVID-19 and stroke has attracted attention in recent times.[3] The pathogenesis of COVID-19-related stroke is currently known to be a complex blend of (1) pro-thrombotic, (2) vascular endothelial damage, (3) systemic inflammation, and (4) myocardial damage.[11] Clinically, ischemic stroke is frequently reported, and management criteria are urgently needed in the US.[7]

The risk of developing SAH is currently unknown and considered controversial;[12] however, it is associated with

prolonged hospitalization and a poor prognosis.[14] There are scattered reports of arterial dissection, including ruptured VA dissecting aneurysms.[16] Dodd *et al*. reported ten cases of SAH associated with COVID-19.[2] In this study, four of ten patients had dissecting aneurysms, and such a high frequency suggests that COVID-19 and arterial dissections are potentially related. Otherwise, ischemia-associated dissection of the internal carotid artery has been reported.[10,18] As mentioned above, the presence of the COVID-19 infection suggests that vascular fragility caused by endothelial damage may contribute to the development of cerebral artery dissection. Due to the limited number of reported cases, further research is needed to prove this hypothesis.

Otherwise, to consider the importance of the management of COVID-19-associated SAH, a report on the management of aneurysmal SAH under COVID-19 prevalence has been published.[13] Standard precautions should be taken from the time of the initial response, and tracheal intubation should be considered at an early stage to prevent oxygenation and viral spread. Endovascular treatment, which requires an ANGIO room with negative-pressure ventilation, is recommended as the last resort on the day of surgery. It should be performed under full PPE with minimal staff. Standard precautions for the prevention of delayed cerebral ischemia (DCI) are the same as for standard treatment but in high-grade SAH with WFNS grade 4.5, continued intubation is recommended, and the patient should be sedated to avoid hypotension. In this case, multiple COVID-PCRs were performed; however, because it took 10 days for the patient to become negative, extubation was delayed, and there was no opportunity for adequate neurological examination, especially in speech. Although TCD is recommended for monitoring,[9] it may not be able to detect peripheral MCA vasospasm. Sadahiro *et al*. reported that peripheral MCA spasms do not increase the flow velocity but rather decrease it.[15] A similar phenomenon could occur in this case. CTA or angiogram is recommended on days 6–8, and this case should have been examined with proper precautions against infection as a DCI high-risk case. Patients with COVID-19-associated SAH may be resistant to standard DCI treatment due to hypoxia and respiratory failure. In addition, thrombosis and renal dysfunction are likely to complicate the treatment of COVID-19, and careful and case-specific drug administration is necessary. In COVID-19-associated SAH, the delay in the detection of cerebral vasospasm, as in the present case, may occur due to inadequate human resources and examination systems. It is necessary to establish initial responses, DCI prevention, and examination criteria per the resources of each institution.

In the present case, the patient developed recurrence after internal trapping and similar cases of recurrence have been reported in the past.[8,17] Sawada *et al*.[17] suggested two possible mechanisms for the rare recanalization. First, it is possible that they occluded the false lumen along with the aneurysm. A typical double lumen with dissections could not be adequately depicted on the initial angiograms due to compression of the true lumen. Therefore, it may have placed the microcatheter into the false lumen and occluded it during the initial procedure. Several months later, the compressed true lumen may have gradually re-expanded and recanalized during the healing process. Second, there is a possibility that an insufficient number of coils were used during the initial treatment, which may have contributed to the possibility of recanalization. In our case, the possibility of occlusion within the false lumen or insufficient coil embolization seems most plausible. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)-related arterial dissections have been postulated to occur due to excessive local or systemic inflammatory reactions, leading to the rupture of the intima and internal elastic lamina.[1,6]

During the acute phase in the COVID-19-associated vasculopathies, infection by SARS-CoV-2 seems to have specific direct and indirect effects on the endothelium, immune, and coagulation systems, thus promoting endothelial dysfunction, immunothrombosis, and formation of neutrophil extracellular traps.[4] These pathological conditions suggest a potential association with recurrence; however, it is important to note that this case represents the first reported instance of recanalization following the treatment of a COVID-19-associated dissection, and without pathological evidence, these remain speculative hypotheses.

CONCLUSION

We experienced a case of a ruptured VA dissecting aneurysm associated with COVID-19. Thorough infection control measures are essential from the initial stages to the postoperative term. Postoperative management alone may be insufficient. It is necessary to consider the establishment of a preventive and examination system for cerebral vasospasm and keep in mind the possibility of recurrence.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The author(s) confirms that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

REFERENCES

1. Bond KM, Krings T, Lanzino G, Brinjikji W. Intracranial dissections: A pictorial review of pathophysiology, imaging features, and natural history. J Neuroradiol 2021;48:176-88.
2. Dodd WS, Jabbour PM, Sweid A, Tjoumakaris S, Gooch MR, Al Saiegh F, *et al.* Aneurysmal subarachnoid hemorrhage in patients with coronavirus disease 2019 (COVID-19): A case series. World Neurosurg 2021;153:e259-64.
3. Ellul MA, Benjamin L, Singh B, Lant S, Michael BD, Easton A, *et al.* Neurological associations of COVID-19. Lancet Neurol 2020;19:767-83.
4. Greistorfer T, Jud P. Pathophysiological aspects of COVID-19-associated vasculopathic diseases. Thromb Haemost 2023.Doi: 10.1055/s-0043-1768969.
5. Hess DC, Eldahshan W, Rutkowski E. COVID-19-related stroke. Transl Stroke Res 2020;11:322-5.
6. Humayun L, Smith C, Li W, Zhang YS, Park C, Feng W, *et al.* SARS-CoV-2-related vascular injury: Mechanisms, imaging and models. Microphysiol Syst 2021;5:1.
7. Khosravani H, Rajendram P, Notario L, Chapman MG, Menon BK. Protected code stroke: Hyperacute stroke management during the coronavirus disease 2019 (COVID-19) pandemic. Stroke 2020;51:1891-5.
8. Kikuchi Y, Sugiu K, Tokunaga K, Nishida A, Nishimura T, Date I. Case of a ruptured vertebral artery dissecting aneurysm recanalized after internal trapping. No Shinkei Geka 2007;35:813-9.
9. Mastantuono JM, Combescure C, Elia N, Tramèr MR, Lysakowski C. Transcranial Doppler in the diagnosis of cerebral vasospasm: An updated meta-analysis. Crit Care Med 2018;46:1665-72.
10. Morassi M, Bigni B, Cobelli M, Giudice L, Bnà C, Vogrig A. Bilateral carotid artery dissection in a SARS-CoV-2 infected patient: Causality or coincidence? J Neurol 2020;267:2812-4.
11. Nannoni S, de Groot R, Bell S, Markus HS. Stroke in COVID-19: A systematic review and meta-analysis. Int J Stroke 2021;16:137-49.
12. Nguyen TN, Haussen DC, Qureshi MM, Yamagami H, Fujinaka T, Mansour OY, *et al.* Decline in subarachnoid haemorrhage volumes associated with the first wave of the COVID-19 pandemic. Stroke Vasc Neurol 2021;6:542-52.
13. Nguyen TN, Jadhav AP, Dasenbrock HH, Nogueira RG, Abdalkader M, Ma A, *et al.* Subarachnoid hemorrhage guidance in the era of the COVID-19 pandemic - An opinion to mitigate exposure and conserve personal protective equipment. J Stroke Cerebrovasc Dis 2020;29:105010.
14. Ravindra VM, Grandhi R, Delic A, Hohmann S, Shippey E, Tirschwell D, *et al.* Impact of COVID-19 on the hospitalization, treatment, and outcomes of intracerebral and subarachnoid hemorrhage in the United States. PLoS One 2021;16:e0248728.
15. Sadahiro H, Shirao S, Yoneda H, Ishihara H, Oku T, Inamura A, *et al.* Decreased flow velocity with transcranial color-coded duplex sonography correlates with delayed cerebral ischemia due to peripheral vasospasm of the middle cerebral artery. J Stroke Cerebrovasc Dis 2016;25:2352-9.
16. Sato T, Miura Y, Yasuda R, Toma N, Suzuki H. Vertebral artery dissecting aneurysm rupture under severe COVID-19. Brain Hemorrhages 2022;3:210-3.
17. Sawada M, Kaku Y, Yoshimura S, Kawaguchi M, Matsuhisa T, Hirata T, *et al.* Antegrade recanalization of a completely embolized vertebral artery after endovascular treatment of a ruptured intracranial dissecting aneurysm. Report of two cases. J Neurosurg 2005;102:161-6.
18. Yamada T, Kato T, Ishiguro M, Shirakami S, Imai S. Stent placement for ischemic intracranial carotid artery dissection in a patient with COVID-19. No Kekkannai Chiryo (NKC) 2022;7:13-9.
19. You Y, Niu Y, Sun F, Zhang J, Huang S, Ding P, *et al.* Impact of COVID-19 pandemic on haemorrhagic stroke admissions: A systematic review and meta-analysis. BMJ Open 2021;11:e050559.

How to cite this article: Nakamura Y, Takashima C, Nonaka T, Ohkubo T, Kawano T, Okura A, *et al.* Early recanalization and vasospasm after endovascular treatment in a case of ruptured vertebral artery dissecting aneurysm associated with COVID-19. Surg Neurol Int 2023;14:324.