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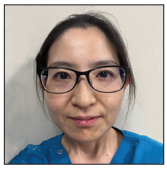
Case Report

Fatal ruptured occult arteriovenous malformation in a young adult: An autopsy case report

Makiko Oomori[1], Sayaka Ito[2], Kazushi Higuchi[3]

[1]Department of Residency, Japanese Red Cross Nagahama Hospital, Nagahama, [2]Department of Neurosurgery, Kohka Public Hospital, Kohka, [3]Department of Neurosurgery, Japanese Red Cross Nagahama Hospital, Nagahama, Japan.

E-mail: Makiko Oomori - makiko.v3v.915@gmail.com; *Sayaka Ito - sayakaito518@gmail.com; Kazushi Higuchi - kazu-higuchi@kzh.biglobe.ne.jp



***Corresponding author:**
Sayaka Ito,
Department of Neurosurgery,
Kohka Public Hospital, Kohka,
Japan.

sayakaito518@gmail.com

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ABSTRACT

Background: Brain arteriovenous malformations (AVMs) are congenital developmental disorders with unclear causative factors and pathogenic mechanisms. Various epigenetic factors may influence the development and rupture of AVMs. Ruptured AVMs may lead to poor outcomes. Therefore, the risk factors of AVM rupture and treatment strategies for unruptured AVMs should be explored. Herein, we report a case of a fatal ruptured AVM diagnosed by radiological and autopsy findings and review the literature regarding AVM treatment.

Case Description: A 46-year-old man was brought to the hospital with sudden loss of consciousness while sitting on the edge of the bathtub. On examination, he was unconscious with poor breathing efforts. He was intubated and a brain CT scan was performed, which showed an intracerebral hemorrhage (ICH) adjacent to the right trigone with massive intraventricular hemorrhage (IVH) and subarachnoid hemorrhage (SAH). Contrast-enhanced CT scan showed abnormal vessels adjacent to the hematoma. He was diagnosed with ICH associated with IVH and SAH caused by a ruptured abnormal vascular lesion. He underwent external ventricular drainage to control the intracranial pressure. He remained unconscious and died 16 h after hospital admission. Autopsy was performed to identify the cause of ICH. Pathological sections showed a mass of blood vessels, measuring 20 × 10 × 10 mm in size, within the hematoma with a single drainer connecting to the transverse sinus. These blood vessels had variable size, shape, and wall thickness on microscopy. Some vessels had abnormal thickened walls with discontinuous elastic fibers. Based on the radiological and autopsy findings, an ICH secondary to Spetzler-Martin Grade I AVM was confirmed.

Conclusion: If the cause of ICH cannot be determined during a patient's life, autopsy may be performed to determine the pathophysiology of occult vascular lesions, including AVMs. Patients with AVMs may have moderate or no symptoms before and after rupture. Because deep AVMs fed by posterior circulation have high risk of bleeding, surgical intervention should be considered for these patients to prevent a poor outcome. Low-grade and paraventricular AVMs in a young adult may be successfully treated with multimodal surgery.

Keywords: Diagnostic imaging, Endovascular procedures, Hemorrhagic stroke, Intracranial arteriovenous malformation, Microsurgery

INTRODUCTION

Brain arteriovenous malformations (AVMs) are congenital developmental disorders with unclear causative factors and pathogenic mechanisms. Recently, various epigenetic factors have been identified to influence the development and rupture of AVMs.[9,34] Ruptured AVMs may present with severe clinical manifestations. Therefore, the risk factors of AVM rupture and treatment

strategies for unruptured AVMs should be explored. Herein, we report a case of fatal ruptured AVM diagnosed by radiological and autopsy findings and review the literature regarding AVM treatment.

CASE DESCRIPTION

A 46-year-old healthy man was brought to our hospital by ambulance because of sudden loss of consciousness while sitting on the edge of the bathtub. He had no known diseases or history of head trauma. On admission, he was comatose (Glasgow Coma Scale score: 4) with 2 mm round isocoric pupils. He was immediately intubated in the emergency room because of severely suppressed breathing. After achieving hemodynamic stability by administering catecholamine, a brain CT scan was performed, which showed an intracerebral hemorrhage (ICH) adjacent to the right trigone with massive intraventricular hemorrhage (IVH) and subarachnoid hemorrhage (SAH) [Figures 1a and b]. A contrast-enhanced CT scan was performed to investigate the cause of ICH, which showed abnormal vessels adjacent to the hematoma [Figure 1c]. An abnormal vessel originated from the right posterior cerebral artery and connected to the hematoma, indicating that the vessel was an artery. Another abnormal vessel originated from the hematoma and connected to the right transverse sinus, indicating that the vessel was a vein. Therefore, the patient was diagnosed with ICH, IVH, and SAH caused by a rupture of the abnormal vascular lesion which was suspicious of AVM or pial arteriovenous fistula. The increased intracranial pressure (ICP) was not controlled by conservative management and required the insertion of an external ventricular drain. The patient remained comatose and died 16 h after admission. Autopsy was performed 70 min after his death to identify the cause of ICH. During autopsy, the unfixed brain weighed 1610 g, indicating slight brain edema. SAH was observed along the brain surface. Sections of the fixed brain showed a hematoma in the right parahippocampal area although close to the right trigonum [Figure 2a], with blood extending into the entire ventricular system. A mass of blood vessels (20 × 10 × 10 mm in size) was seen within the hematoma [Figure 2b]. The vascular mass had a single feeding artery originating from the right posterior cerebral artery and a single draining vein with drainage into the right transverse sinus. On microscopy, small blood vessels in the vascular mass had variable size, shape, and wall thickness [Figure 2c]. Thin-walled vessels had the appearance of veins but the presence of elastic fibers confirmed that they were arteries. Some vessels had abnormal, partially thickened walls with discontinuous elastic fibers [Figure 2d] and medial smooth muscle. There were no aneurysms or varices within the lesion. No thrombotic or calcified changes were found within the lesion. Based on the radiological and autopsy findings, an ICH secondary to Spetzler-Martin Grade I AVM (with <3 cm nidus, found in noneloquent area associated with superficial draining system) was confirmed.

DISCUSSION

Diagnosis of occult AVM

Angiographically occult vascular malformations are a group of intracranial vascular malformations that cannot be visualized by serial cerebral angiography.[16,22,40] More than half of angiographically occult vascular malformations are AVMs.[31,40] Neuroimaging may fail to detect AVMs in up to 10% of cases.[22] MRI can detect angiographically occult lesions with high accuracy.[16,22] However, in life-threatening situations, contrast-enhanced CT scan is mostly performed because of its speed and convenience. The use of MRI in life-threatening situations is difficult because of limited availability, long time duration required for the examination, and difficulties encountered in the management of unstable patients during MRI.[7,22,40]

Our patient had elevated ICP and was hemodynamically unstable; therefore, MRI could not be performed and contrast-enhanced CT scan was performed in the emergency room. Further investigations in our patient, with an MRI or digital subtraction angiography, may have detected the occult AVM.

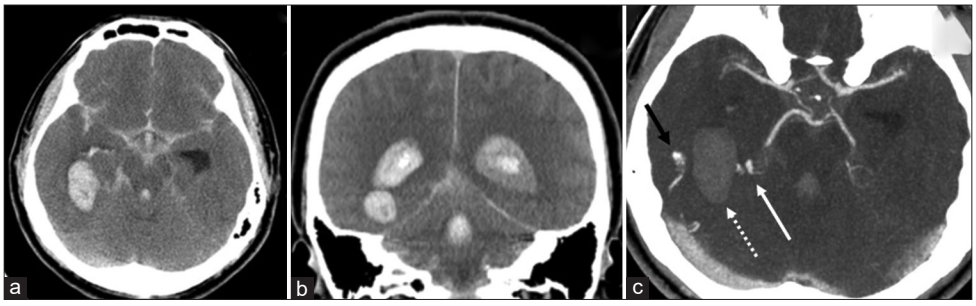

Figure 1: Brain CT of the patient. Noncontrast CT scan (a: axial and b: coronal views) showing hematoma adjacent to the right trigone, intraventricular hemorrhage, diffuse subarachnoid hemorrhage, edematous brain, and hydrocephalus. Contrast-enhanced CT scan in the axial view (c) showing abnormal vasculature with an artery originating from the right posterior cerebral artery (white arrow), vein draining into the right transverse sinus (black arrow), and hematoma (dotted arrow).

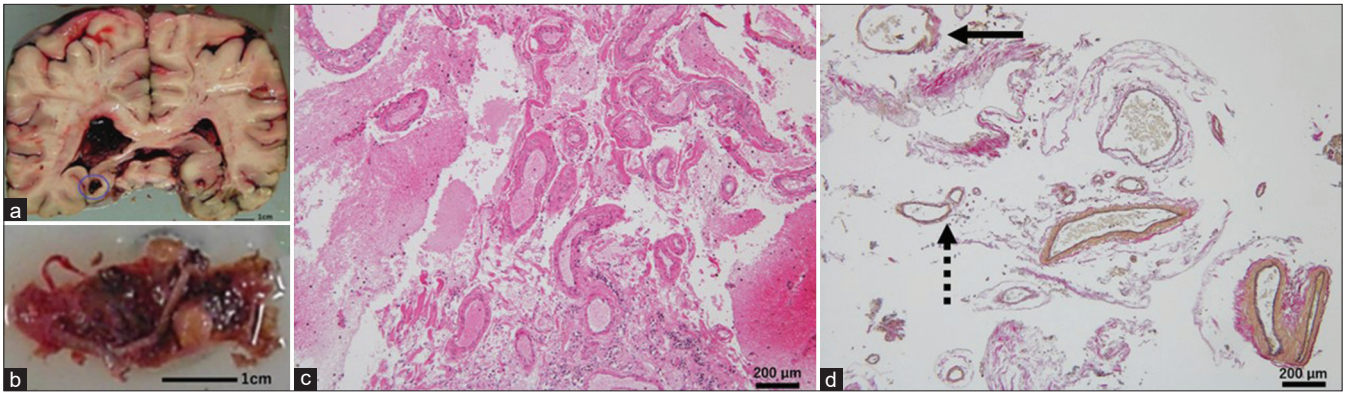

Figure 2: Pathological findings of the patient. A coronal section of the fixed brain (a) showing subarachnoid hemorrhage at the brain surface and hematoma in the right parahippocampal area although close to the right trigonum (encircled in a), with blood extending into the lateral ventricles. A 20 × 10 × 10 mm mass of blood vessels (b). Staining with hematoxylin and eosin (c) and Elastica van Gieson (d) showing small blood vessels with variable size, shape, and wall thickness. Thin-walled vessels had the appearance similar to veins but contained elastic fibers, which confirmed that they were arteries (dotted arrow in d). Some vessels showed abnormal partially thickened walls with discontinuous elastic fibers (arrow in d).

Occult AVMs may present with subclinical recent or old hemorrhage.[31] After hemorrhage, some AVMs may have poor blood flow because the hematoma compresses or destroys the AVM,[11,22] causes thrombosis of the AVM,[6,11] and/or leads to vasospasm of AVM-related vessels.[11,22] Pathohistological examinations of occult AVMs have showed thrombosis, fibrosis, and calcification of the AVM, suggestive of subclinical bleeding.[6,31]

Histopathological examination of the lesion in our patient showed findings typical of AVMs, that is, many vessels with variable size, shape, and wall thickness, and discontinuous elastic fibers and medial smooth muscle. Compression of the AVM by the hematoma may explain why the AVM was occult. The autopsy of our patient confirmed the diagnosis of occult ruptured AVM with massive IVH and SAH.

Surgical interventions for AVM: microsurgery, endovascular embolization, and radiosurgery

Ruptured AVMs have high morbidity and mortality. The risk factors for AVM rupture are deep location,[4,12,33,36] including paraventricular region[3,10,18,20,36] and basal ganglia,[36,37,42] previous hemorrhage,[21,28,33] deep venous drainage,[12,37] feeding by a perforating artery or vertebrobasilar system,[37] intranidal aneurysm(s),[12,37] younger age,[4,13,36] and smaller AVM size.[1,4,39,42] The AVM in our patient had a feeder from the vertebrobasilar system and was located in the paraventricular region, which were risk factors for rupture.

Up to 30% of AVMs are located in the paraventricular region.[3,20,39] Almost 70–90% of paraventricular AVMs present with hemorrhage, which frequently causes severe clinical symptoms.[18,20] Paraventricular AVMs have a high risk of hemorrhage because the paraventricular region has incomplete parenchymal embrace; therefore, the AVMs may be vulnerable to pulsatile changes in the cerebrospinal fluid and blood pressures.[38] Hemorrhagic paraventricular AVMs may be associated with IVH,[18] which leads to increased morbidity and mortality rates.[3]

The AVM in our patient was located adjacent to the right trigone, where the pulsatile stress may have predisposed to the hemorrhage. Because of the massive IVH at the initial presentation, our patient did not survive.

In 1961, Margolis *et al.* reported four patients with ruptured AVMs diagnosed by autopsy. These patients died due to complications of the initial hemorrhage.[19] Thereafter, with advancements in neuroimaging, surgical techniques, and interventional devices, outcomes of surgically treated AVMs have improved. Thus, surgical intervention is routinely used for patients with AVM.[29]

A randomized trial of unruptured brain arteriovenous malformations (ARUBA) was the first randomized and controlled trial to compare medical and surgical treatments for AVM. The surgical interventions included microsurgery, endovascular embolization, and radiosurgery. The trial showed that medical treatment was superior to surgical treatment for preventing stroke and death over follow-up periods of 33 months and 5 years.[23,24] ARUBA had numerous limitations in terms of the study design, progression, data analysis, and results. Although ARUBA demonstrated the risks of interventional treatment of unruptured AVMs, medical treatment or observation should not be used for all unruptured AVMs.[2,8]

Studies with similar participants and primary endpoints to ARUBA showed that microsurgery is safe and effective for low-grade AVMs with a high cure rate and immediate results;[7,14,30,41] radiosurgery is useful for lesions that are small, deep, inaccessible, and/or located in eloquent areas;[5,15,26,35]

and endovascular embolization can safely reduce the blood flow of an AVM before microsurgery (i.e., multimodal surgery).[17,25,27,32] The outcomes of surgical interventions in these studies were similar to or better than the medical arm of ARUBA. Understanding the precise angioarchitecture of AVMs and characteristics of treatment modalities can help identify optimal patients for surgical treatment.

In summary, our patient was a 46-year-old adult with a 2 cm sized paraventricular AVM fed by a branch of posterior cerebral artery. The AVM had multiple risk factors for rupture. Unfortunately, the patient presented with massive IVH and did not survive. Patients with AVMs similar to our patient may have moderate or no symptoms before or after rupture. Because these AVMs have high risk of bleeding, surgical intervention should be considered. Low-grade and deep AVMs fed by branch(es) of vertebrobasilar system may be treated by radiosurgery or endovascular embolization with or without microsurgery. Although our patient did not survive, the future patients may be saved.

CONCLUSION

We reported the radiological and autopsy findings of a paraventricular occult AVM with fatal hemorrhage at presentation. If the cause of ICH cannot be determined during a patient's life, autopsy may be performed. Such investigations may help to determine the pathophysiology of AVMs. Paraventricular AVMs, such as that found in our patient, in a young adult may be successfully treated with multimodal surgery. It is necessary to develop better treatment strategies for patients with AVMs.

Ethics approval and consent to participate

Not applicable.

Availability of data and materials

The data that support the findings of this case are available on reasonable request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Declaration of patient consent

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

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Nil.

Conflicts of interest

There are no conflicts of interest.

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