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Case Report

Acute subdural hematoma caused by hemorrhagic falx meningioma: A case report and review of the literature ☆

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ABSTRACT

We herein report a case of acute subdural hematoma caused by hemorrhagic falx meningioma. The patient was a 64-year-old woman with no significant medical history or prior history of trauma. She experienced a sudden onset of headache and weakness in her extremities. Computed tomography (CT) scan and magnetic resonance imaging (MRI) showed a mass lesion with intratumoral hemorrhage or faint calcification along the left side of the fronto-parietal cerebral falx. There was also a linear lesion at the left side of the falx, suggesting acute subdural hematoma. MRI was performed again on the eleventh day. On precontrast T1-weighted images, intratumoral hemorrhage and widespread left subdural hematoma were shown as high intensity. On postcontrast T1-weighted images, the tumor showed heterogeneous enhancement with a dural tail sign on the falx, indicative of a falx meningioma. She underwent surgical resection, and the histological subtype was transitional meningioma. Nine cases of hemorrhagic falx meningioma associated with acute subdural hematoma have been reported. If not limited to the site of occurrence, there have been 59 reported cases overall. In our investigation, the incidence of hemorrhage is higher in the convexity and lower in the skull base. It is higher for fibrous, angiomatous, and metaplastic subtypes and lower for meningothelial subtype. The location and histological subtype might

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be risk factors for meningioma associated with subdural hematoma. Further accumulation of cases will be necessary to establish the cause of bleeding.

Introduction

Meningiomas tend to occur in middle-aged to elderly women (median age 55.7-58 years, female:male ratio 2.4-2.8:1) [1,2]. They are classified into 3 grades based on the malignancy of the histological subtype by the World Health Organization. The 70%-95% of meningiomas are classified as WHO grade 1 [2]. Meningiomas are the most common brain tumor; however, those accompanied by bleeding are relatively rare [2,3]. Hemorrhagic meningioma with subdural hematoma is even more rare [3]. Hemorrhagic falx meningiomas associated with acute subdural hematoma have been reported in 8 cases [4–11]. We present here a ninth case.

Case report

A 64-year-old woman was transported to previous hospital after getting a headache and weakness in her limbs. She had no history of trauma or significant medical history, including hypertension. She did not take any anticoagulant or antiplatelet drugs. Computed tomography (CT) scan showed a mixed high and low-density mass lesion along the left side of the fronto-parietal cerebral falx, suggesting a hemorrhagic or calcified brain tumor. There was also a high-density linear lesion at the left side of the falx, suggesting an acute subdural hematoma (Fig. 1). Subsequently, she underwent magnetic resonance imaging (MRI) using a 3-Tesla scanner

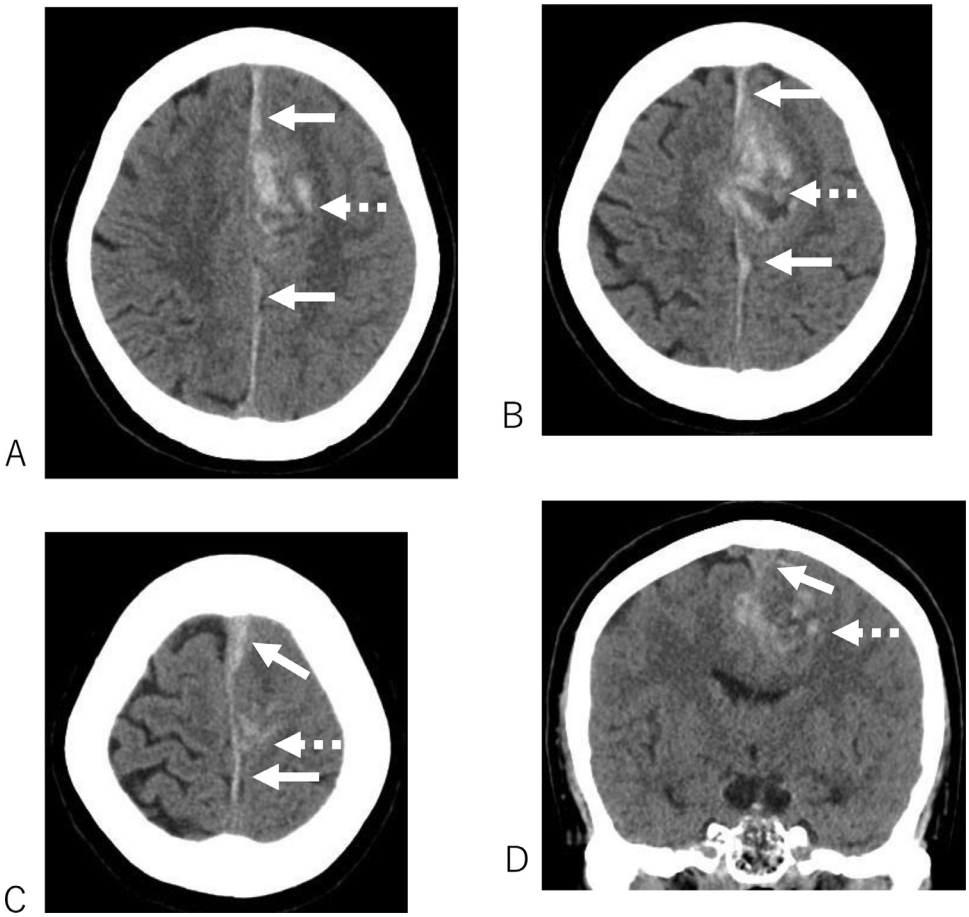

Fig. 1 – (A-C) Axial and (D) coronal computed tomography images without contrast media obtained on an emergency basis show a mixed high and low-density mass lesion along the left side of the fronto-parietal cerebral falx, suggesting a hemorrhagic or calcified brain tumor (*dotted arrows*). There is also a high-density linear lesion at the left side of the falx, suggesting an acute subdural hematoma (*arrows*).

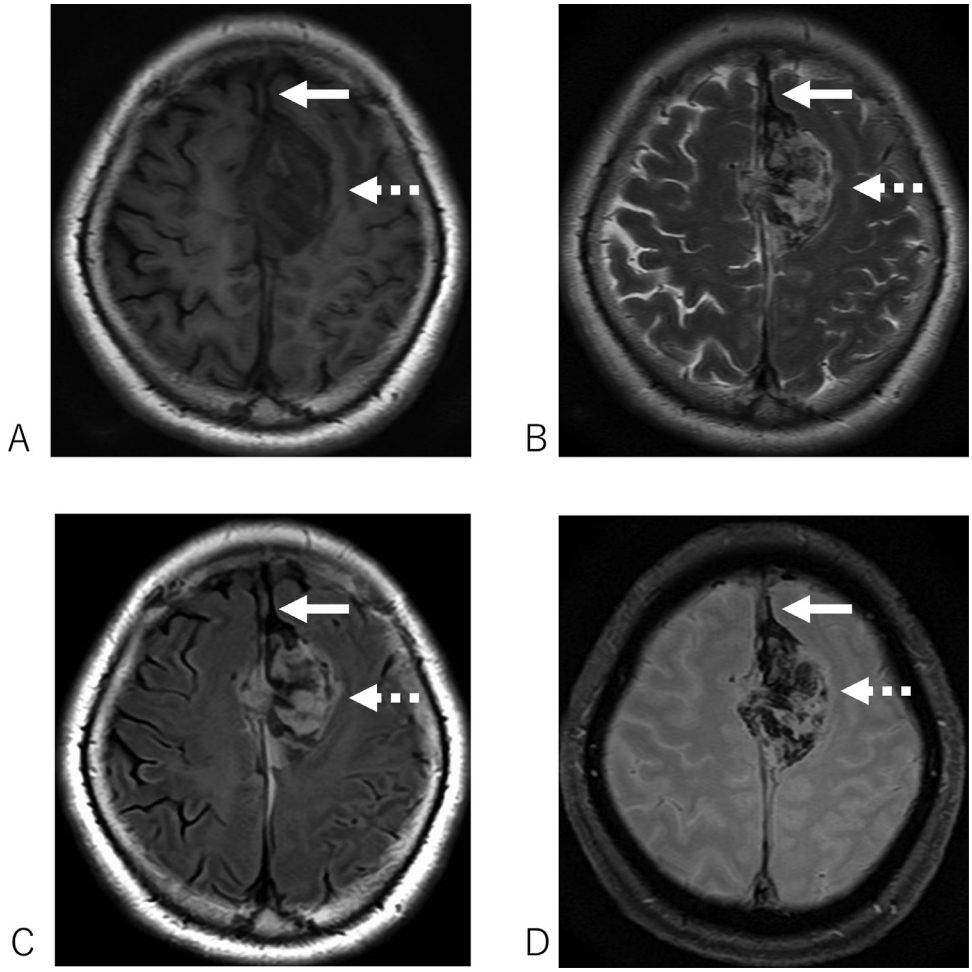

Fig. 2 – Subsequently performed initial magnetic resonance imaging (MRI) obtained using a 3.0 Tesla scanner. (A) T1-weighted image shows a mixed low and isointense mass lesion (*dotted arrow*). The acute subdural hematoma is isointense (*arrow*). (B) T2-weighted, (C) fluid attenuated inversion recovery (FLAIR), and (D) T2*-weighted images show a mixed high and low-intensity mass lesion (*dotted arrows*). The acute subdural hematoma is low intensity because of deoxyhemoglobin (*arrows*). The low-intensity components of the mass can be regarded as intratumoral chronic hemorrhage or faint calcification.

(Vantage Galan, Canon Medical Systems, Otawara, Japan). T1-weighted images showed a mixed low and isointense mass lesion, measuring 5.0 × 3.6 × 4.0 cm in size. The acute subdural hematoma was isointense (Fig. 2A). T2-weighted, fluid attenuated inversion recovery (FLAIR), and T2*-weighted images showed a mixed high and low-intensity mass lesion. The acute subdural hematoma was low intensity because of deoxyhemoglobin. The low-intensity components of the mass could be regarded as intratumoral chronic hemorrhage or faint calcification. Mild edema was also observed around the mass (Fig. 2B-D). She was admitted to the hospital for further investigation and treatment. The level of consciousness was clear, and no other symptoms were observed. On the fourth day of admission, a gradual onset of right lower limb paralysis was observed. MRI was performed again, but no significant changes were observed compared to the previous examination.

She was transferred to our university hospital for surgery. On the eleventh day of onset, contrast-enhanced MRI was performed. The 7.5 mL of gadobutrol (Gadovist; Bayer Schering Pharma AG, Berlin, Germany) was injected. Used machine was a 1.5-Tesla scanner (Achieva Nova Dual; Philips Medical Systems, Best, Netherlands). Precontrast T1-weighted images showed high-intensity punctate areas in the anterior part of the tumor. The widespread left acute subdural hematoma was also high-intense. These high-intensity signals could be regarded as methemoglobin (Fig. 3A-D). T2-weighted and FLAIR images showed a high-intensity component in the tumor. The acute subdural hematoma was also high intense. The high intensity was due to extracellular methemoglobin (Fig. 3E, F). On postcontrast T1-weighted images, the tumor showed heterogeneous enhancement with a dural tail sign, indicative of falx meningioma. A portion of it extended beyond the falx to the contralateral side (Fig. 3G, H). She underwent middle meningeal artery embolization and craniotomy for tumor resection. The meningioma had strong bleeding tendencies, since the tumor was found to be vascularized by numerous branches from the anterior cerebral arteries. A significant

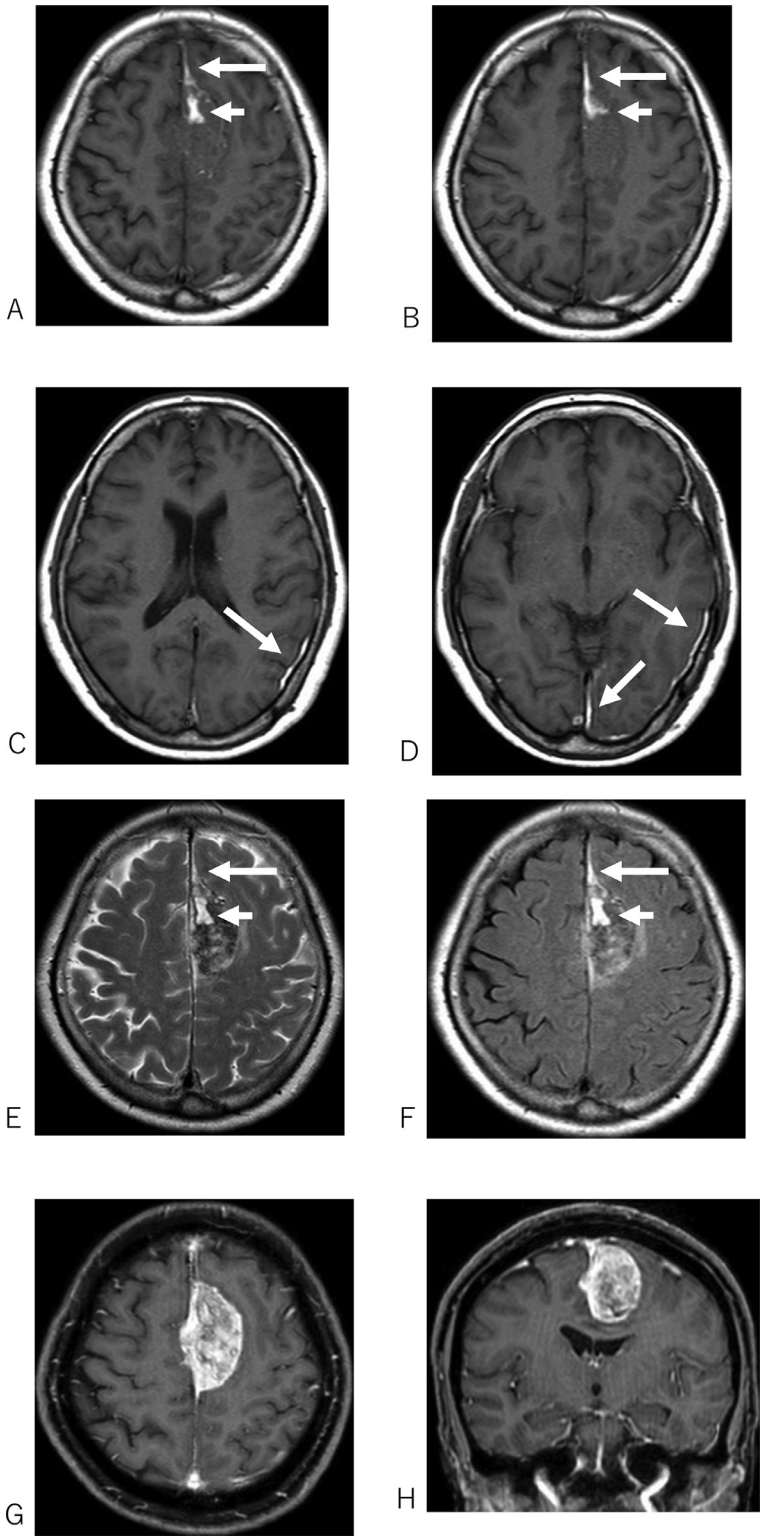

Fig. 3 – Follow-up MRI 10 days after Fig. 2 obtained using a 1.5 Tesla scanner. (A-D) On precontrast T1-weighted images, high-intensity punctate areas are identified in the anterior part of the tumor (*short arrows*). The widespread left acute subdural hematoma is high intense (*long arrows*). These high-intensity signals can be regarded as methemoglobin. (E) T2-weighted and (F) FLAIR images show a high-intensity component in the tumor (*short arrows*). The acute subdural hematoma is also high intense (*long arrows*). The high intensity is due to extracellular methemoglobin. (G, H) On postcontrast T1-weighted axial and coronal images, the tumor shows heterogeneous enhancement with a dural tail sign, indicative of a falx meningioma.

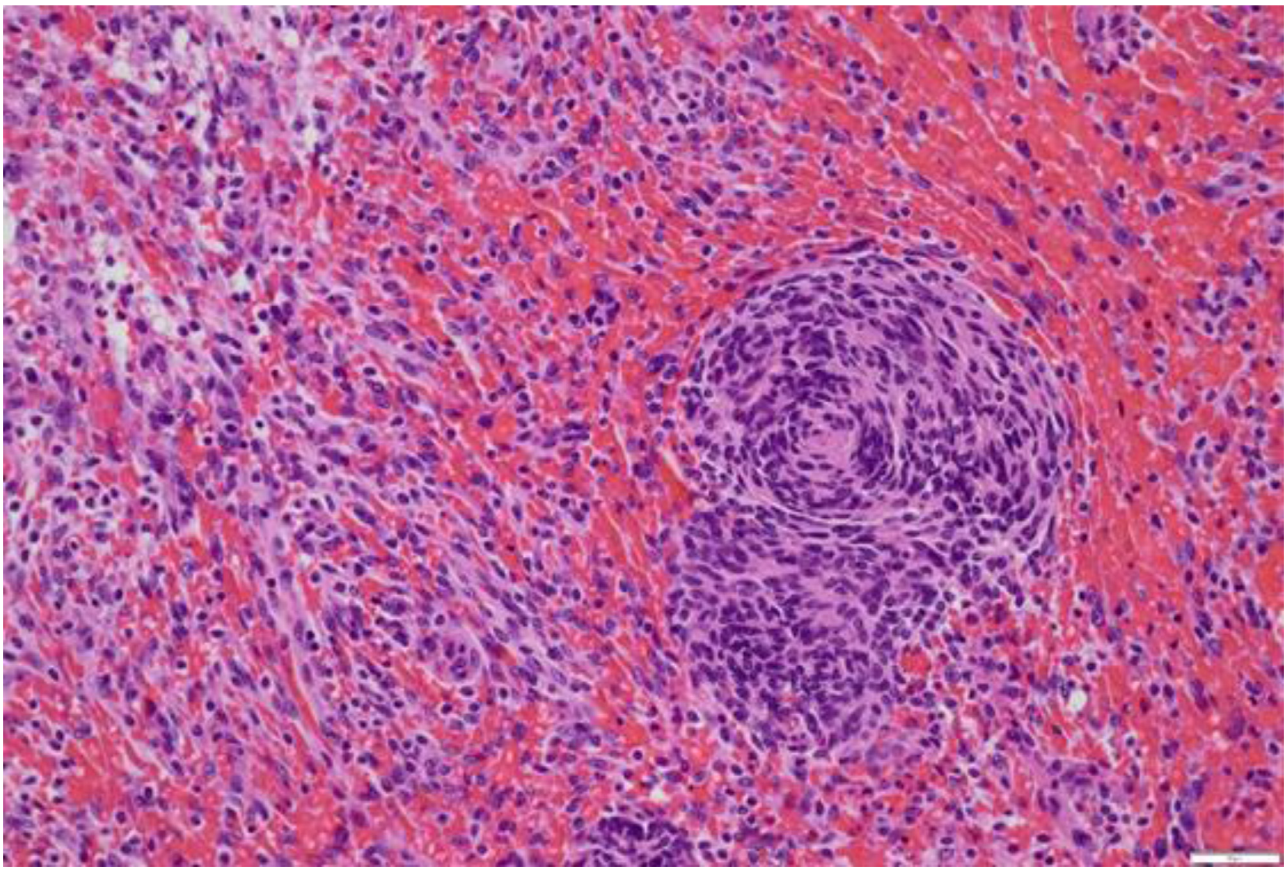

Fig. 4 – Hematoxylin and eosin staining shows meningioma with frequent whorl formation. In addition, hemorrhage is observed in the meningioma, indicative of a hemorrhagic meningioma. Original magnification × 200.

portion of the tumor and the subdural hematoma was successfully removed.

The pathological examination revealed spindle-shaped tumor cells showing whorl frequent formation with hemorrhage, indicative of a hemorrhagic meningioma (Fig. 4). The Ki-67 labeling index was 0.8%, suggesting a benign tumor. Other immunohistochemical staining indicated positive SSTR2a, negative EMA, and focal PgR positivity. Consequently, the diagnosis was transitional meningioma, central nervous system World Health Organization grade 1 [12].

Postoperatively, she exhibited only slight muscle weakness in the right upper and lower extremities, with no adverse events such as disturbance of consciousness or seizures. The overall condition remained stable, and she was discharged on the 22nd postoperative day. Since discharge, no new adverse events have been observed.

Discussion

Bleeding from brain tumors is often associated with brain metastasis, oligodendrogliomas, and glioblastomas. Hemorrhage from benign tumors is not commonly observed, except for pituitary adenoma [8,13]. Meningiomas with hemorrhagic manifestations are also infrequent, representing 1.3%-2.4% [14–16]. Furthermore, among hemorrhagic meningiomas, the presence of subdural hematoma is observed in only a mere 18% [16]. Hemorrhagic falx meningiomas associated with acute subdural hematoma have been reported in 9 cases including the present case in relevant English-language literature (Table 1) [4–11]. Among them, 7 cases are female, with the median age of 64 (range: 61-78) years. The histological subtypes include 4 cases of transitional, followed by 2 cases of meningothelial, 1 case of angiomatous and fibrous.

Table 1 – Reported cases of acute subdural hematoma caused by hemorrhagic falx meningioma in relevant English-language literature.

Authors (Year)	Age/sex	Histology	Outcome
Okuno et al. [4]	78/F	Transitional	MD
Goyal et al. [5]	66/F	Transitional	GR
Dallocchio et al. [6]	73/F	Meningothelial	MD
Worm et al. [7]	64/M	NA	MD
Krishnan et al. [8]	62/M	Fibrous	GR
Suzuki et al. [9]	61/F	Angiomatous	GR
Matsuoka et al. [10]	61/F	Transitional	GR
Oyamada et al. [11]	77/F	Meningothelial	SD
Present case (2024)	64/F	Transitional	GR

GR: good recovery, MD: moderate disability, NA: not applicable, SD: severe disability.

Table 2 – Comparison between meningioma with subdural hematoma and those without bleeding.

	Meningioma without bleeding	Meningioma with subdural hematoma	with OR (95% CI)	*P* value[b]
N (*n*%)	826	59		
Median age	58 (7-88)	62 (4 m-85 y)		
Sex				
Female	585 (71%)	33 (56%)	0.52 (0.30-0.93)	.019
Male	241 (29%)	26 (44%)		
Location				
Skull base	404 (49%)	6 (10%)	0.12 (0.041-0.28)	< .001
Convexity	303 (37%)	41 (69%)	3.93 (2.16-7.40)	< .001
Falx/parasagittal	109 (13%)	11 (19%)	1.51 (0.68-3.06)	.24
Intraventricular	10 (1%)	0 (0%)	0 (0-6.34)	1
Tentorium	0 (0%)	1 (2%)	Inf (0.36-Inf)	.067
Histology				
Meningothelial	465 (56%)	22 (37%)	0.50 (0.27-0.89)	.016
Transitional	181 (22%)	13 (22%)	1.08 (0.52-2.10)	.87
Fibrous	46 (6%)	9 (15%)	3.24 (1.31-7.25)	.006
Secretory	21 (3%)	0 (0%)	0 (0-2.85)	.64
Angiomatous	9 (1%)	6(7)[a] (12%)	12.88 (3.90-40.77)	< .001
Microcystic	4 (1%)	1(2)[a] (3%)	7.56 (0.67-54.20)	.0505
Metaplastic	1 (0.1%)	2 (3%)	30.18 (1.55-1778.30)	.011
Grade 2	76 (9%)	1 (2%)	0.18 (0.004-1.07)	.081
Grade 3	7 (1%)	0 (0%)	0 (0-10.40)	0
Unknown/not stated	16 (2%)	4 (7%)		

[a] Angiomatous/microcystic subtype.
[b] Statistical software R.

We compare meningiomas with subdural hematoma to those without bleeding (Table 2) [3–11,13,15–57]. In cases of meningiomas with subdural hematoma, the median age is 62 (range: 4 m-85 y) years. The tendency to occur in middle-aged to elderly females is similar to meningiomas without bleeding. The proportion of females is 56% (female 33:male 26), and the gender difference is less pronounced compared to meningiomas without bleeding. The occurrence at the skull base is significantly lower, while it is significantly higher at the convexity. One of the risk factors for traumatic acute subdural hematoma in the elderly is cerebral atrophy. Cerebral atrophy may lead to elongation of bridging veins, making them susceptible to rupture from minor trauma [58]. Regardless of the presence of cerebral atrophy, it is presumed that bridging veins might be mechanically elongated and disrupted by convexity meningiomas. As for the histological subtype, meningothelial subtype is significantly less common, while fibrous, angiomatous, and metaplastic subtypes are significantly more prevalent. Considering that angiomatous subtype is highly vascular, it is speculated that even with minor trauma, there is a high likelihood of vessels being damaged. Fibrous subtype has been reported to have a high risk of bleeding in other studies [59]. However, the exact cause remains unclear along with metaplastic subtype. Although there are no Grade 3 cases in this study, malignant meningiomas are also reported to be relatively prone to bleeding [60].

The exact cause of hemorrhage remains unclear, but several hypotheses have been proposed [15]: (1) tumor growth leads to the enlargement and expansion of feeder's vessels, resulting in fragility of their walls [29], (2) tumor growth leads to the stretching of bridging veins [23], (3) abnormal tumor blood vessels rupture [18,21], (4) especially in malignant meningiomas, the tumor infiltrates directly into the blood vessels [16,38], (5) vasoactive substances are released from mast cells within the tumor [33], and (6) intratumoral necrosis and infarction due to rapid growth of the meningioma render them vulnerable in response to blood pressure fluctuations [51]. In addition to hypertension, anticoagulant therapy is also a risk factor for tumor bleeding [61]. There are few reported cases of bleeding in meningiomas triggered by trauma [36].

In this case, she had no history of trauma and other risk factors for bleeding. In the surgery, there were no obvious ruptured veins or abnormal tumor vessels. Modifications through embolization intervention made it unclear whether there was necrosis or infarction prior to treatment. Given the presence of numerous feeder vessels from the anterior cerebral artery system, it is reasonable to speculate that the tumor growth led to the rupture of thin and fragile feeder vessels at the anterior part, resulting in acute subdural hematoma.

Conclusion

We encountered a case of hemorrhagic meningioma accompanied by acute subdural hematoma. There are multiple hypotheses regarding the cause of hemorrhage. In this case, we have an assumption that the tumor growth led to the rupture of fragile tumor vessels at the anterior part of the tumor, and the bleeding flowed into the subdural space.

In this study, it is found that the location and the histological subtype such as convexity meningioma and fibrous, angiomatous, metaplastic meningiomas might be risk factors for meningioma associated with subdural hematoma. Further

accumulation of cases will be necessary to establish the more robust cause of bleeding.

Patient consent

Informed consent was obtained from the patient for publication of the case report.

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