

# Tiny Falx Meningioma Causing Massive Interhemispheric Subdural Hematoma: A Case Report

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Bleeding from meningiomas is well known, but massive subdural hemorrhage from a very small meningioma is rare. A 61-year-old woman presented with a sudden-onset headache and slight right hemiparesis without a history of trauma. Computed tomographic scan showed bilateral acute/subacute interhemispheric subdural hematoma, but contrast-enhanced computed tomography (CT) scan, non-enhanced magnetic resonance imaging (MRI) and digital subtraction angiography failed to detect the cause. The hematoma was conservatively treated. Three weeks later, CT scans showed a vestige of the hematoma along the falx. However, repeated angiogram revealed a tumor stain on the falx supplied by the middle meningeal arteries, leading to the tentative diagnosis of meningioma. The tumor was removed and histologically diagnosed as angiomatous meningioma. It is rare that falx meningioma causes massive interhemispheric subdural hematoma, and the diagnosis of the causative lesion is challenging if tumor is small. We review the literature and discuss the characteristics.

**Keywords:** falx, meningioma, interhemispheric subdural hematoma

## Introduction

Bleeding from meningiomas is relatively rare.<sup>1)</sup> The most common type of bleeding is subarachnoid hemorrhage, followed by intracerebral hemorrhage and intratumoral hemorrhage.<sup>2–4)</sup> Subdural hemorrhage from meningiomas is uncommon, especially along the falx.<sup>5–7)</sup> We here report a rare case of tiny falx meningioma presenting as massive interhemispheric subdural hematoma, initially of unknown origin, and review the literature.

## Case Report

A 61-year-old woman presented with a sudden-onset headache. There was neither episode of trauma before the symptom nor antiplatelet or anticoagulant therapies. On admission, she

was alert and had slight right hemiparesis. Computed tomography (CT) scans suggested bilateral interhemispheric hematoma with mixed high and iso-densities (Figs. 1A and 1B), which was not enhanced with contrast medium (Fig. 1C). Three-dimensional CT angiography showed no abnormal vessels (Fig. 1D). Magnetic resonance imaging revealed that it was mixed acute and subacute subdural hematoma around the falx associated with subarachnoid hemorrhage, and also showed a small old intracerebral hematoma in the left frontal lobe (Figs. 1E–1H). Digital subtraction angiography (DSA) revealed neither a tumor stain nor abnormal intracranial vasculatures, including the venous system (Fig. 2).

Under suspicion of hematoma from vascular anomaly, conservative treatment including blood pressure control and rehabilitation was performed, because the size of hematoma was relatively small and the patient's symptoms were mild. The hematoma decreased gradually. Three weeks later, CT showed only a vestige of the hematoma along the falx (Fig. 3A). Repeated DSA showed a tumor stain on the falx supplied by the right middle meningeal arteries (Figs. 3B and 3C). Magnetic resonance imaging showed a small enhancing tumor with intratumoral hemorrhage on the left side of the falx (Figs. 3D–3F), which was tentatively diagnosed as meningioma. Following the endovascular embolization of the feeding arteries, the tumor was totally removed via a frontal parasagittal craniotomy to prevent rebleeding. In intraoperative findings, the tumor was a thin soft red-colored mass with many small blood vessels on the surface, which was only adhered to the left side of the falx (Fig. 4A). There was old hematoma observed between the tumor and the brain surface. Hematoxylin and eosin staining showed that numerous blood vessels were contained in the tumor (Figs. 4B and 4C). In immunohistochemistry, the intervening tumor cells were positive for epithelial membrane antigen, somatostatin receptor 2A and cytokeratin, while negative for CD34 and signal transducer and activator of transcription 6, leading to the diagnosis of angiomatous meningioma, not solitary fibrous tumor/hemangiopericytoma (Figs. 4D–4H).

The postoperative course was uneventful, and the patient was discharged without neurological deficits. No rebleeding has been observed thereafter.

## Discussion

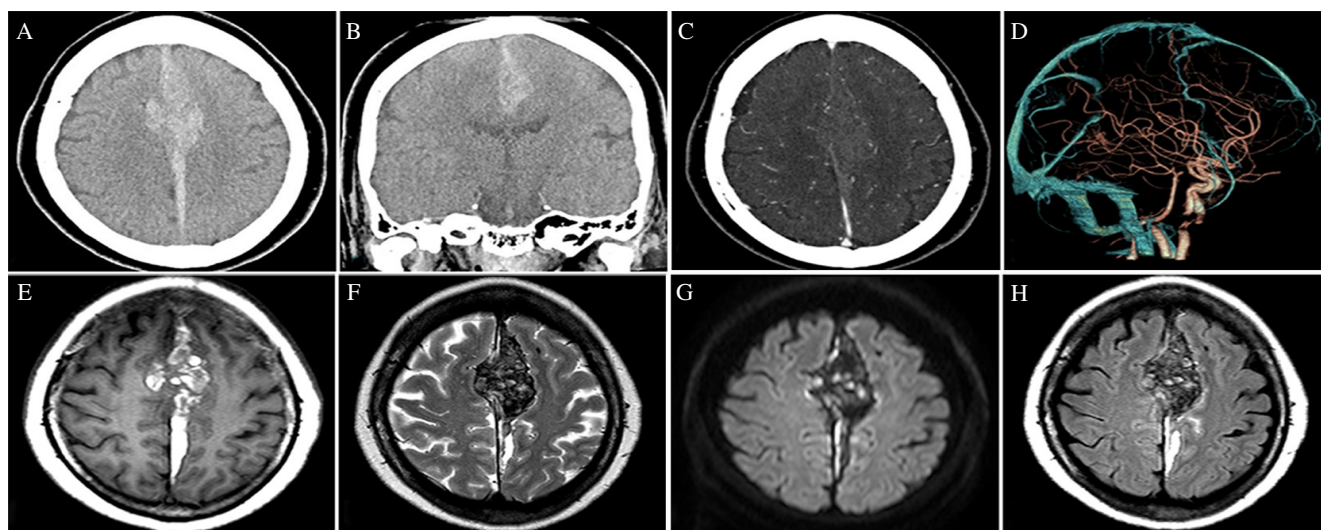
The bleeding from meningiomas is relatively rare, and the reported incidence is about 1.3–2.4% of all meningiomas.<sup>3,4)</sup> Most of hemorrhage from meningiomas presented as

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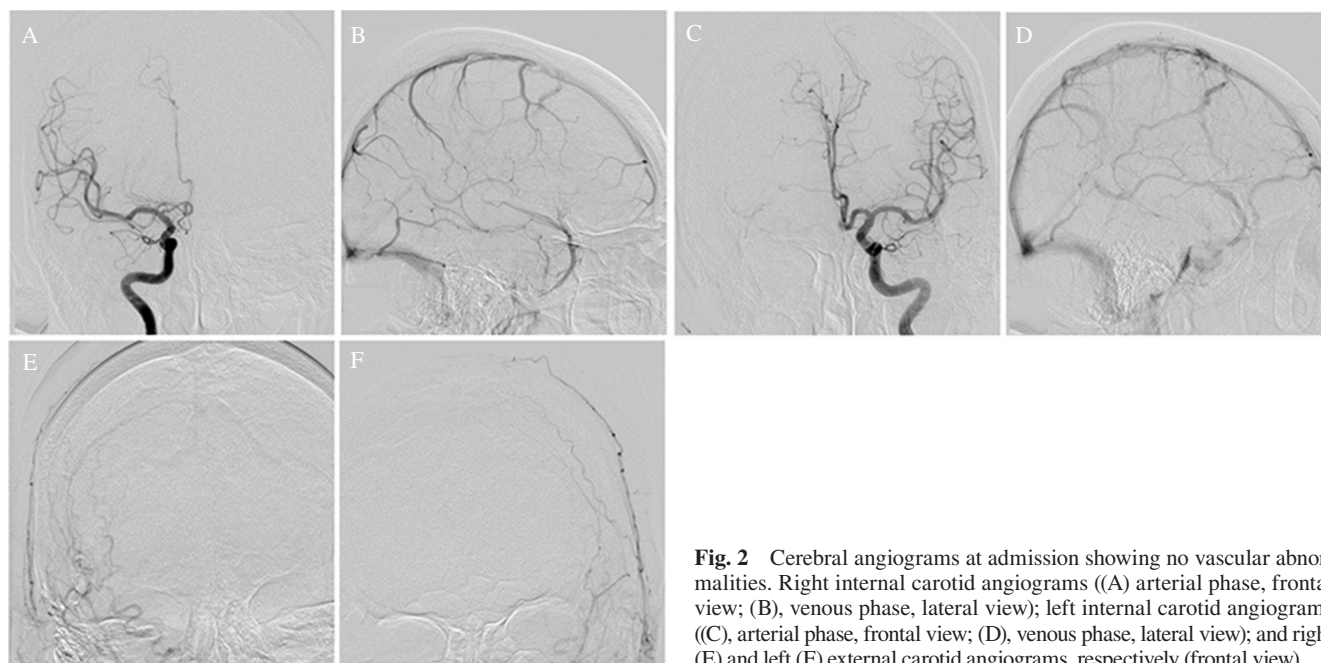
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**Fig. 1** Computed tomographic scans ((A) non-contrast axial view; (B) non-contrast coronal view; (C) contrast-enhanced axial view), 3D CT angiography (D) and axial MR images ((E), T1-weighted image; (F) T2-weighted image; (G) diffusion-weighted image; (H) fluid-attenuated inversion recovery image) at admission. The images (A–B, E–H) show mixed acute and subacute extensive subdural hematoma around the falx bilaterally, which is not enhanced with contrast medium (C), associated with subarachnoid hemorrhage in the convexity of the left parietal lobe (H). A small low intense spot is also shown in the left frontal lobe, which is an incidentally identified cerebral microbleed (E–H).

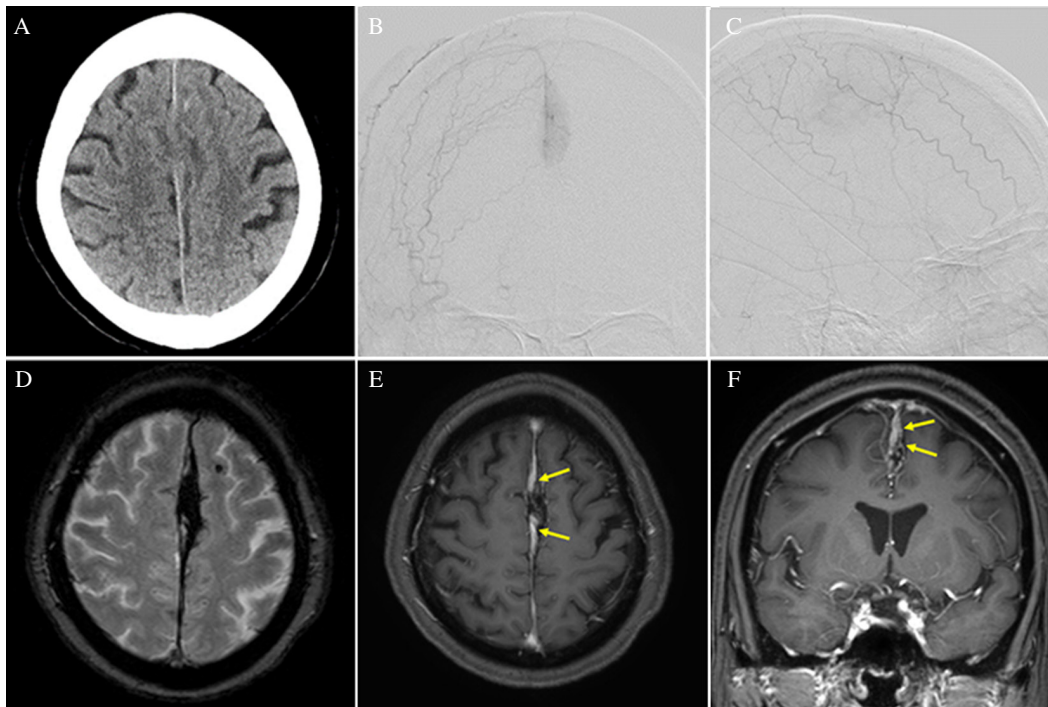


**Fig. 2** Cerebral angiograms at admission showing no vascular abnormalities. Right internal carotid angiograms ((A) arterial phase, frontal view; (B), venous phase, lateral view); left internal carotid angiograms ((C), arterial phase, frontal view; (D), venous phase, lateral view); and right (E) and left (F) external carotid angiograms, respectively (frontal view).

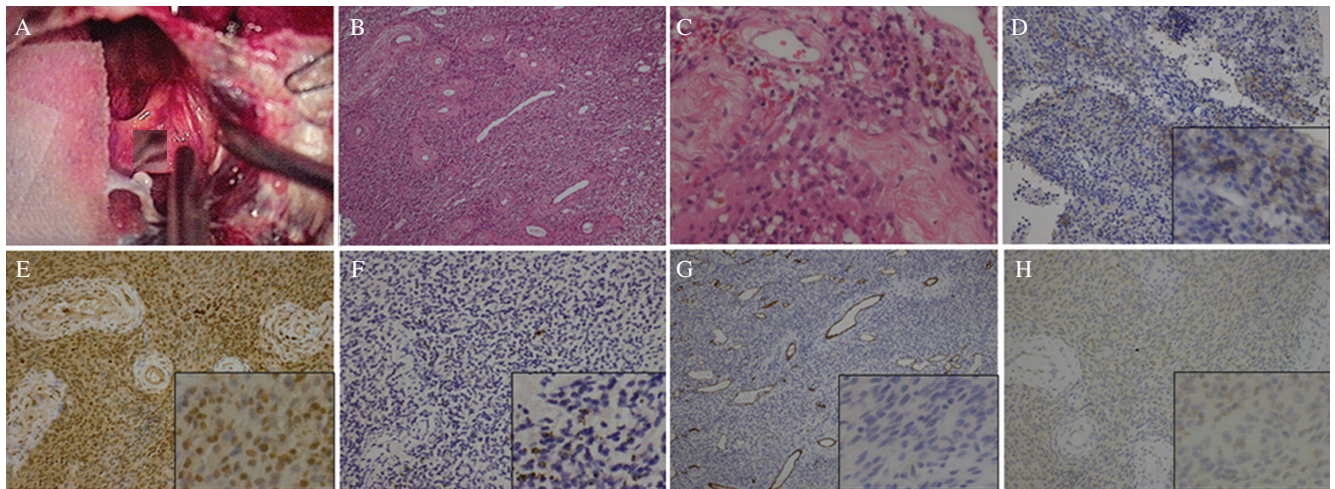
subarachnoid hemorrhage, intracerebral hemorrhage or intratumoral hemorrhage.<sup>2–4</sup> Subdural hemorrhage is uncommon: especially acute or subacute interhemispheric subdural hematoma is rare, and only four cases were reported including our case (Table 1).<sup>7–9</sup> To be associated with interhemispheric subdural hematoma, meningioma should be located in a parasagittal region or on the falx.<sup>7–9</sup> The tumor histology was diverse and a half of cases were accompanied by intratumoral hematoma.<sup>7–9</sup> The surgical outcome was excellent in all cases. The preoperative identification of a previously unsuspected small meningioma with

a nearly complete hemorrhagic transformation may be difficult like in our case. However, non-traumatic interhemispheric subdural hematoma is very rare, and the reported causes have been limited to hemodialysis, anticoagulation and cerebral aneurysmal bleeding.<sup>10–12</sup> A lesson of this case may be to suspect such a meningioma as a cause of interhemispheric subdural hematoma early on, and perform or repeat diagnostic neuroimaging including magnetic resonance imaging (MRI) and cerebral angiography.

In this case, the authors suspected bilateral interhemispheric subdural hematoma by a vascular lesion and emergently



**Fig. 3** Axial computed tomographic scan (A), right external carotid angiograms (B), frontal view (C), lateral view (C), T2-weighted (D), T1-weighted gadolinium-enhanced axial (E) and coronal (F) MR images at 3 weeks after admission. Hematoma along the falx almost disappears (A, D–F), and a small enhancing lesion is shown on the left side of the falx (arrow; E–F). Angiograms reveal a tumor stain on the left side of the falx supplied by the right middle meningeal artery.



**Fig. 4** Intraoperative photograph (A) upper, front side; right, falx side) and pathological findings (B–H). Hematoxylin and eosin staining (B), magnification, ×100; C, ×400) shows numerous blood vessels in the tumor. In immunohistochemistry, the intervening tumor cells are positive for epithelial membrane antigen (D), (×200; inset, ×400), somatostatin receptor 2A (E), (×200; inset, ×400), and cytokeratin (F) (×200; inset, ×400), while negative for CD34 (G), (×100; inset, ×400) and signal transducer and activator of transcription 6 (H), (×200; inset, ×400), leading to the diagnosis of angiomatous meningioma.

**Table 1** Summary of four cases of meningioma presenting as acute interhemispheric subdural hematoma

Author (year)	Patient's age (years), sex	Tumor location	Associated hemorrhage	Histology	Outcome
Renowden and Hourihan (1992) <sup>8)</sup>	41, Female	Parasagittal	None	Meningothelial	CR
Sunada et al. (1998) <sup>9)</sup>	48, Female	Parasagittal	IT	Fibrous	CR
Krishnan et al. (2015) <sup>7)</sup>	62, Male	Falx	None	Fibrous	CR
Present case	61, Female	Falx	IT, SAH	Angiomatous	CR

CR: complete recovery, IT: intratumoral hematoma, SAH: subarachnoid hemorrhage.

performed contrast-enhanced CT scan and DSA, but not gadolinium-enhanced MRI at the first medical examination. The nearby association of small old intracerebral hematoma also suggested the existence of some underlying lesion, but was eventually considered to be an incidental cerebral microbleed. The first DSA failed to reveal a tumor stain possibly due to direct compression and/or locally elevated pressure by massive hematoma. However, we cannot exclude the possibility that gadolinium-enhanced MRIs could reveal the tumor, and therefore should have evaluated gadolinium-enhanced MRIs at admission for this kind of bilateral extensive hematoma. Some neurosurgeons might consider that most of the mass lesion in the initial images were not subdural hematoma, but intratumoral hematoma from the shape; even in retrospective reevaluation; however, it is suggested that most of the mass lesion was subdural hematoma, because the findings of MRIs were consistent with hematoma, most of the mass lesion disappeared within 3 weeks, and intraoperative findings showed a small tumor in addition to old hematoma between the tumor and the brain surface.

There are three reported cases of falx meningioma presenting as acute or subacute subdural hematoma,<sup>5-7</sup> but only one case was associated with interhemispheric subdural hematoma.<sup>7</sup> This means that even falx meningioma tends to cause non-interhemispheric subdural hematoma, although the reason is unknown. On the other hand, three cases of meningiomas associated with acute subdural hematoma could not be detected on admission CT like in our case.<sup>13-15</sup> The common features were small tumor size relative to subdural hematoma, and therefore the tumor was hidden by massive hematoma. The surgical outcome was excellent in all cases. The tumor location was various, and the features suggesting the existence of meningioma such as bony changes, areas of focal cerebral distortion and edema near the clot, as well as differences in densities in various regions of the clot were not apparent, although MRI, especially gadolinium-enhanced MRI, may detect meningioma even in such a case. Notably, in three of four cases including our case, the tumor histology was angio-blastic or angiomatous: the term “angioblastic meningioma” was abandoned and now the tumor may belong to the solitary fibrous tumor/hemangiopericytoma according to WHO 2016 classification.<sup>16,17</sup> Lefranc et al.<sup>14</sup> reported a case of small transitional meningioma that caused recurrent acute subdural hematoma and was diagnosed on MRI after the second evacuation of subdural hematoma. It is suggested that a small meningioma or meningioma-like lesion associated with massive subdural hematoma is prone to rebleed, and thus needs to be evacuated even if the hematoma conservatively disappears like in our case.

The mechanisms of bleeding from intracranial meningiomas are not yet well understood,<sup>1,15</sup> but several hypotheses have been proposed:<sup>3,4,18,19</sup> (1) with tumor growth, feeding vessels are enlarged and expanded, and the vascular walls become thin, weak and easy to rupture; (2) by stretching subdural bridging veins or by pressing and occluding peritumoral veins or the venous sinus with tumor growth, bleeding

occurs; (3) abnormal intratumoral vessels are ruptured; (4) blood vessels are injured by direct invasion of tumor; (5) vasoactive substances are released by tumor; and (6) intratumoral necrosis or infarction causes bleeding. Our case was a very small angiomatous meningioma associated with both subdural hematoma and intratumoral hemorrhage. Angiomatous meningiomas tend to bleed because of its thin-walled vessels and rich vasculature.<sup>2,15</sup> Thus, abnormal intratumoral vessels might be ruptured and cause intratumoral hemorrhage, secondarily leading to subdural hematoma in this case.

## Conclusion

We reported a rare case of very small meningioma presenting as bilateral massive acute/subacute interhemispheric subdural hematoma. The possible association of a small meningioma should be kept in mind when evaluating any case of non-traumatic acute/subacute subdural hematoma.

## Conflicts of Interest Disclosure

The authors declare no conflicts of interest.

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