

# Remote Supratentorial Hemorrhage following Supratentorial Craniotomy: A Case Report

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Intracranial hemorrhage (ICH) in regions remote from the initial intracranial operation site is rare. The mechanism of ICH following cranial surgery remains unclear, although several theories have been proposed. Most of the reports describe cerebellar hemorrhages after supratentorial procedures or supratentorial hemorrhages after infratentorial procedures. Remote supratentorial hemorrhage (RSH) following supratentorial surgery is extremely rare. We report a case of postoperative RSH occurring away from the surgical site. A 62-year-old woman underwent a right occipital lobectomy to resect lung carcinoma metastases. The patient developed a postoperative consciousness disturbance, and a brain computed tomography (CT) scan revealed an ICH in the left frontal region. The patient underwent ICH evacuation, but remained severely disabled. It is necessary to be aware that this complication is possible after craniotomy.

**Keywords:** remote site hemorrhage, craniotomy, postoperative hemorrhage

## Introduction

Postoperative hemorrhages usually occur at the site of the operation, and bleeding in regions remote from the initial intracranial surgery site is a rare but a serious complication.<sup>1,2)</sup> The exact etiological factors remain unclear, but reviews and reports speculate about the effects of hypertension, coagulopathy, cerebrospinal fluid (CSF) drainage, head position, and pathological abnormalities.<sup>1–5)</sup> The mechanism of postoperative hemorrhage is thought to be multifocal. CSF loss and sitting position were primary considerations in previous cases,<sup>2,5–7)</sup> and most of the reports described cerebellar hemorrhages following supratentorial procedures or supratentorial hemorrhages following infratentorial procedures.<sup>2,3)</sup>

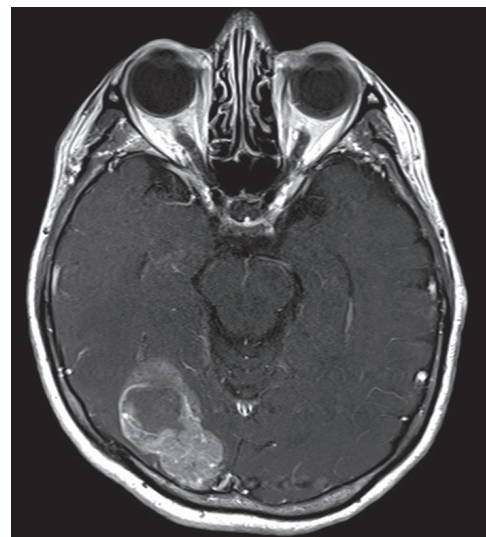
Conversely, the incidence of remote supratentorial hemorrhage (RSH) as a complication of supratentorial surgery is extremely rare.<sup>2)</sup> In this case report, we describe a case of RSH secondary to supratentorial craniotomy.

## Case Report

A 62-year-old woman underwent a right occipital lobectomy to resect cancer that had metastasized to the brain. The patient had a history of primary lung adenocarcinoma

and had undergone gross total resection 7 years earlier. She had remained in complete remission for more than 5 years, but follow-up laboratory examination showed increased serum tumor marker levels, and whole-body computed tomography (CT) scan revealed a brain mass. She was admitted to our hospital, and brain magnetic resonance imaging (MRI) revealed a right occipital metastatic tumor (Fig. 1). The patient underwent surgery to resect the mass, and the surgical pathological report was lung adenocarcinoma. She received postoperative radiotherapy.

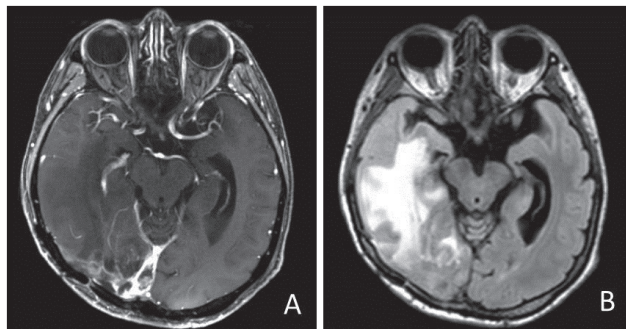
Two years later, the patient presented with headache and gait disturbance. Her lungs were clear, but brain MRI revealed a disseminated recurrence in the right occipital region (Fig. 2). Left homonymous hemianopsia had already been noted, and an occipital lobectomy was performed in the prone position. The deep venous system and sinus vessels around the tumor were not injured during the operation. The ventricle was not breached during surgery. The patient regained consciousness soon after surgery. Three hours later, the patient complained of a progressive headache and developed consciousness disturbance. Follow-up CT showed a left frontal intracranial hemorrhage (ICH) away from the operation site (Fig. 3). Immediate revision surgery was performed to evacuate the hematoma, and intraoperative findings did not reveal injury or apparent dissemination on the surface of the



**Fig. 1** T<sub>1</sub>-weighted magnetic resonance imaging showing a strong enhanced mass in the right occipital lobe.

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**Fig. 2** A: T<sub>1</sub>-weighted magnetic resonance imaging (MRI) showing disseminated lesions. B: Fluid-attenuated inversion recovery (FLAIR) MRI revealing extensive peritumoral edema in the right temporal and occipital lobes.



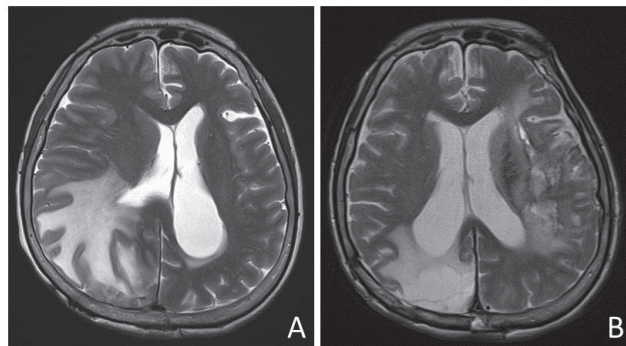
**Fig. 3** Postoperative computed tomography showing an acute hemorrhage in the left frontal intraparenchyma.

brain. Postoperative MRI revealed a decrease in the degree of brain edema and an improvement in the midline shift (Fig. 4).

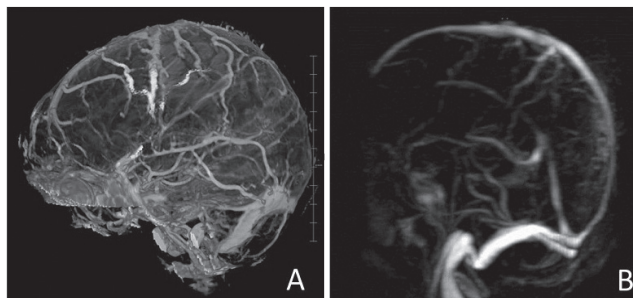
The patient had no history of arterial hypertension, and her blood pressure was stable during the perioperative period. She was not treated with anticoagulants, and her laboratory findings including the coagulation parameters were normal. Preoperative MRI revealed no frontal lobe abnormalities and preoperative MR venography (MRV) revealed no sinus vessel obstruction. However, postoperative MRV revealed the left frontal cortical veins were poorly depicted (Fig. 5). The patient gradually recovered but remained severely disabled; she was discharged with total aphasia and right hemiparesis.

### Discussion

Most postoperative ICHs develop near the surgery site and are usually attributed to inadequate intraoperative hemostasis.<sup>1)</sup> However, remote ICH is a rare complication that should be distinguished from iatrogenic ICH.<sup>2)</sup> Remote cerebellar hemorrhage following supratentorial craniotomy is the most commonly described remote hemorrhage pattern,<sup>3)</sup> with



**Fig. 4** A: Preoperative T<sub>2</sub>-weighted magnetic resonance imaging (MRI) showing massive brain edema with a midline shift. B: T<sub>2</sub>-weighted MRI performed a month after surgery revealing a decrease in the degree of brain edema and an improvement in the midline shift. It also showed removal of the hematoma in the left frontal lobe.



**Fig. 5** A: Preoperative magnetic resonance venography (MRV) three-dimensional reconstruction (left lateral view) revealing normal venous drainage. B: Follow-up MRV (left lateral view) taken a month after surgery poorly showing the left frontal veins draining into the superior sagittal sinus.

an incidence rate of 0.08%–0.6%.<sup>4,7)</sup> Supratentorial hemorrhages after infratentorial craniotomy has an incidence rate of 0.06%.<sup>1)</sup> Most of these supratentorial hemorrhages occur in patients who undergo surgery in a sitting position.<sup>2)</sup>

Conversely, there are few reports of supratentorial hemorrhages following supratentorial craniotomy. In a case series of remote ICHs, the reported RSH incidence after supratentorial surgery was approximately 16%.<sup>2)</sup>

The etiology of RSH still remains unclear. Possible influences include arterial hypertension, coagulation disorders, CSF overdrainage, disturbances of venous drainage due to head position, and vascular lesions.<sup>1–5)</sup> Recent reports suggested that RSH is not related to hypertension or coagulopathy.<sup>6,8)</sup>

CSF loss is strongly related to the occurrence of remote cerebellar hemorrhages.<sup>5–7)</sup> The cerebellum might be anatomically susceptible to decreased intracranial pressure (ICP).<sup>7)</sup> Mechanical shifting of the cerebellum caused by intraoperative CSF aspiration stretches the superior vermal vein and its tributaries, which can result in vessel tearing.<sup>4,5)</sup> Cerebellar sagging due to CSF hypovolemia can cause transient occlusion of the superior bridging veins and consequent hemorrhagic venous infarction.<sup>3)</sup>

Most supratentorial hemorrhages occur after infratentorial craniotomy performed in the sitting position. It is possible that surgical position can exacerbate the effects of CSF loss and brain displacement, and cortical veins may be stretched or obstructed in their course to the adjacent sinus.<sup>2,5)</sup> Alternatively, the sitting position might reduce arterial blood flow in the main vessels, resulting in cerebral ischemia. In another study, hyperperfusion caused an ICH when the patient was placed in a supine position from the sitting position.<sup>9)</sup>

Increased preoperative ICP and rapid surgical decompression were also suggested as possible mechanisms. Sudden changes in intracranial dynamics can alter cerebral blood flow, and when combined with dysautoregulation, parenchymal vessels damage can result in cerebral bleeding.<sup>10)</sup> A rapid ICP decrease during surgery can contribute to compensatory acute engorgement of the venous sinuses. A critical increase in transmural venous pressure might result in ICH in the setting of venous congestion.<sup>11)</sup>

In the present case, there was no significant increase in blood pressure. Laboratory data, including coagulation parameters, were normal. The operation was finished uneventfully without venous injury, excessive CSF aspiration, or excessive head rotation. During the surgery, the head was placed in the prone position with the vertex down. Postoperative MRV image did not show the left frontal cortical veins clearly.

Because hemorrhage occurred immediately after surgery, we consider it to be a complication associated with surgery instead of idiopathic ICH. Although the cause is difficult to identify, the left frontal cortical veins are poorly depicted on images, as shown in Fig. 5. During surgery, the head was not excessively rotated. However, it was positioned with the vertex down. The positioning of the head may have caused venous drainage impairment.

We speculate that, in addition to the possible occurrence of venous drainage impairment in association with the vertex-down position, a rapid decrease in ICP due to occipital lobectomy and the shift in the position of the brain due to a postural change from a prone position to a supine position induced venous drainage impairment, ultimately causing ICH.

On the basis of the findings in our case and previous reports, the possibility of ICH caused by venous infarction is considered. In our case, the possible causes may include rapid changes in the head presentation and ICP, as well as postural change. During surgery, it may be useful to keep the

head above the heart, to avoid excessive drainage of cerebrospinal fluid, and to avoid rapid postural changes.

## Conclusion

RSH following supratentorial surgery is an extremely rare complication, and the underlying mechanism remains unclear.

However, sudden changes due to tumor resection and subsequent intracranial hypotension following lobectomy may have been a contributing factor in the present case. Although remote cerebral hemorrhages are rare, it is necessary for clinicians to be aware of the possibility and ensure their prompt detection.

A detailed postoperative neurological examination is the best way to minimize the risk of hazardous sequelae and ensure prompt treatment to avoid adverse outcomes.

## Conflicts of Interest Disclosure

The authors declare that they have no conflicts of interest.

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