Occipital transtentorial/falcine approach, a “cross-court” trajectory to accessing contralateral posterior thalamic lesions: case report

Kenichiro Iwami, MD, PhD, Masazumi Fujii, MD, PhD, and Kiyoshi Saito, MD, PhD

Department of Neurosurgery, Fukushima Medical University, School of Medicine, Fukushima City, Japan

Surgical treatment of lesions in the posterior thalamus, especially those extending laterally, is technically challenging because of a deep surgical field, narrow operative corridor, and the surrounding critical neurovascular structures. The authors describe an occipital transtentorial/falcine approach (OTFA) that was successfully used in the treatment of a cavernous malformation (CM) extending laterally from thalamus to midbrain. A 40-year-old man complained of progressive right hemiparesis and numbness. Radiological evaluation revealed a large CM in the left thalamus, surfacing on the pulvinar thalami, and extending 4 cm laterally from the midline. In addition to the usual procedures of a right-sided occipital transtentorial approach, the authors incised the falx cerebri to expand the operative corridor to the left thalamus. They achieved generous exposure of the left thalamus through a “cross-court” oblique trajectory while avoiding excessive retraction on the occipital lobe. The CM was completely removed, and no newly developed or worsening deficits were detected postoperatively. To better understand the OTFA and its application, the authors performed a cadaveric dissection. The OTFA provides increased exposure of the posterior thalamus without cortical incision and facilitates lateral access to this area through the “cross-court” operative corridor. This approach adds to the armamentarium for neurosurgeons treating thalamic lesions.

https://thejns.org/doi/abs/10.3171/2016.7.JNS16681

KEY WORDS occipital transtentorial approach; falx cerebri; contralateral; thalamus; cavernous malformation; surgical technique
Recently, Rangel-Castilla and Spetzler reported different surgical approaches to TCMs according to the location of each lesion, including the occipital transtentorial approach (OTA), supracerebellar infratentorial approach (SCITA), transcortical-transventricular approach, and transcallosal approach. Each approach has unique advantages and disadvantages.

Many neurosurgeons use the OTA for exposing the posterior incisural space due to their familiarity with this technique, an improved view of the ipsilateral half of the quadrigeminal region, and a better working angle, compared with the SCITA. However, certain limitations of the OTA are unavoidable. First, medial visualization is limited by the falx cerebri (falx); therefore, the contralateral thalamic region is difficult to access. Second, excess retraction of the occipital lobe carries a risk of postoperative visual field disturbance. Thus, it is difficult to access lesions on the ipsilateral pulvinar thalami, especially those extending laterally, unless a cortical incision is made within the precuneus, and the lesions are approached via the lateral ventricle. Finally, special attention is required to preserve the deep venous system, including the great vein of Galen (galenic system).

The occipital transtentorial/falcine approach (OTFA) is a modified OTA, during which the falx is transected to expand the operative corridor medially, providing access to the contralateral thalamus. We report the case of a patient harboring a TCM and describe the technical nuances of using the OTFA, supplemented with intraoperative images, illustrations, and a cadaveric study.

Case Report
Clinical History
A 40-year-old man complained of right hemiparesis and numbness. Radiological evaluation using MRI revealed a left TCM with a diameter of 1 cm (Fig. 1A). Eighteen days after the diagnosis, he presented with a sudden worsening of his previous symptoms and a marked enlargement of the lesion with a diameter of 4 cm (Fig. 1B–D). The lesion's superficial location on the pulvinar thalami was thought to be best approached from the posteromedial direction based on the 2-point method.

Since carotid and vertebral artery angiography showed an absence of blood flow in the inferior sagittal sinus (ISS), ligation and transection of the ISS was thought to be tolerable in this patient (Fig. 1E). We selected an OTFA, a modified OTA, in which the falx is additionally transected to expand the operative corridor medially to access the contralateral thalamus in a “cross-court” manner.

Operation
The patient was placed in a modified Concorde position, with his head in a neutral position and his upper body elevated approximately 15° above the horizontal axis. This neutral head position permits intuitive aware-

![Fig. 1. A–D: Contrast-enhanced T1-weighted MR images. Axial view obtained at the patient's initial visit (A). Axial (B), coronal (C), and sagittal (D) images obtained at the patient's second visit. E: Lateral late venous phase image of the common carotid angiography. The ISS was not visualized. F: Postoperative contrast-enhanced axial T1-weighted MR image showing complete removal of the CM.](image-url)
ness of the midline at all times, facilitating the orientation of the surgical field and, thus, safer manipulation of the brain tissue when accessing deep-seated lesions. A U-shaped skin incision, inferiorly based, was created, and an occipital bone flap was removed over the superior sagittal sinus (SSS) and right transverse sinus. After the X-shaped dural incision, an external ventricular drain was placed to deflate the ventricle and minimize hemispheric retraction. After sectioning the right tentorium parallel to the straight sinus (Fig. 2A), the falx was also divided parallel to—and 1 cm above—the straight sinus, in a posterior-to-anterior direction (Figs. 2B and 3A). The ISS was coagulated and transected with the falx 1 cm anterior to the great vein of Galen (Fig. 2C and 3A and B). The mobilized straight sinus was retracted superiorly and inferiorly to expose the left thalamus, with careful attention not to damage the galenic system. Superior retraction of the straight sinus facilitated exposure of the more caudal side of the left thalamus, providing an adequate corridor for resection of the CM (Figs. 2D and 3).

Through this “cross-court” oblique trajectory, the superficial part of the TCM on the left pulvinar thalami was exposed, and the TCM was completely removed, while avoiding excessive retraction on the right occipital lobe (Figs. 1F and 2E). This trajectory allowed sufficient access to the lateral margin of the tumor capsule (Fig. 2F).

Postoperative Clinical Course
No newly developed or worsening deficits were found.

Cadaveric Dissection
To study the efficacy of the OTFA, we performed a cadaveric dissection in an adult cadaveric brain specimen using 4× to 20× magnification (Fig. 4). All procedures were performed in the same operative setting as described above. The skin incision, right craniotomy, and

FIG. 2. Intraoperative microscopic photographs. A: The right tentorium was divided parallel to the straight sinus. Medial visualization was limited by the straight sinus and falx. B: The falx was also divided parallel to—and 1 cm away from—the straight sinus, in a posterior-to-anterior direction. C: The inferior sagittal sinus was coagulated and transected 1 cm anterior to the great vein of Galen (white arrowhead). D: The mobilized straight sinus was retracted superiorly to provide an operative corridor to the left thalamus. E: Through the “cross-court” oblique trajectory, the cavernous malformation was exposed and circumferentially dissected. F: The “cross-court” oblique trajectory allowed sufficient access to the lateral margin of the tumor capsule. For all panels, the black arrowheads indicate the straight sinus and black arrows indicate the precentral cerebellar vein. P = pulvinar thalami. Figure is available in color online only.

FIG. 3. Diagrams depicting the occipital transtentorial/falcine approach. A: Cutting the tentorium 1 cm lateral and parallel to the straight sinus (green dotted line). Additional incision within the falx, 1 cm above and parallel to the straight sinus (red dotted line). Ligation and transection of the ISS (red double line). PCV = precentral cerebellar vein; SS = straight sinus; TS = transverse sinus. B: After sectioning the right tentorium, falx, and ISS, the straight sinus is mobilized. The asterisk indicates the left tentorium. C: By retracting the straight sinus superiorly (green arrow), the inferior thalamic lesion can be exposed (tentorial route, red arrow). D: By retracting the straight sinus inferiorly (green arrow), the superior thalamic lesion can be exposed (falcine route, red arrow). Figure is available in color online only.
dural opening were made in the same way and to the same extent as the surgery performed in the TCM patient. Figure 4A indicates the cadaver's head position and operative field of view. The right occipital lobe was retracted to expose the falx and right tentorium (Fig. 4B). By retracting the divided tentorium, the midbrain was exposed, but the left thalamus still could not be observed (Fig. 4C). The falx was also divided parallel to—and 1 cm above—the straight sinus. The ISS was transected with the falx to mobilize the straight sinus. The mobilized straight sinus could be retracted both superiorly and inferiorly, providing a tentorial or falcine route, respectively, to the left thalamus. The tentorial route exposes the dorsal midbrain (Fig. 4E). The falcine route exposes the contralateral splenium and occipital lobe (F). Black arrowheads indicate the straight sinus (C–F). M = midbrain; SP = splenium. Figure is available in color online only.

Choosing the appropriate approach begins with a careful analysis of the TCM's location. Taking the surrounding vital structures into consideration, an ideal entry point and direction of approach are chosen based on the 2-point method. An assessment of the patient’s general condition and a knowledge of the advantages and limitations of each surgical approach should also guide the surgeon's decision.

For posterior thalamic lesions, there are several favorable approaches, such as transcortical-transventricular approaches, the transcallosal-transventricular approach, SCITA, and OTA. The transcortical-transventricular approaches require a cortical incision in either the superior parietal lobule or the precuneus, which increases the risk of postoperative deficits and seizure. Moreover, too deep of an incision of the thalamus might be necessary when the tumor is not close to the ventricular surface within the surgical trajectory. Thus, these approaches should only be used for thalamic lesions that extend up to the ventricular surface.

The SCITA is also a suitable approach to posterior thalamic lesions, since it allows wide exposure to the dorsal portion of the midbrain. To expose the pulvinar thalami, the SCITA is performed through a contralateral parame-dian suboccipital craniotomy to avoid obstruction by the vermis. During the SCITA, the galenic system is generally above the surgical field and thus easily preserved, compared with the OTA and OTFA. Although the SCITA can be performed in the Concorde position, it is usually performed in the sitting position, and precautionary measures should be taken to prevent the risk of an air embolism from the surgical site during surgery. Therefore, this

**Discussion**

It has been reported that deep-seated CMs have higher bleeding and rebleeding rates compared with superficial CMs. TCMs are relatively rare lesions that can cause severe neurological deficits. Due to their deep location, the surgical approach selected is directly associated with new or worsening postoperative neurological deficits in TCM patients.
approach must be performed by a team of neurosurgeons and anesthesiologists who are experienced in this particular approach. In patients with a steeply inclined tentorium, the operative field may be restricted. In some cases, bridging veins over the cerebellar surface can significantly obstruct the surgical corridor.

We currently prefer the OTA to manage posterior incisural space lesions, because the working distance is shorter, and it can be performed in the Concorde position, requiring less concern for air embolism, compared with the SCITA. Moreover, the OTA is applicable to numerous areas, such as the pineal body, posterior third ventricle, superior surface of the cerebellum, and dorsal midbrain. In patients with a steeply angled tentorium, the OTA is more favorable than the SCITA. Major disadvantages of the OTA are that the surgical view is obstructed by the galenic system and that the medial and contralateral surgical fields are restricted by the falx. The OTA also carries a risk of postoperative visual field defects. Using the OTA to access the ipsilateral thalamus would create a narrow working angle and require increased retraction of the occipital lobe. In 2002, Kawashima et al. performed a cadaveric study and proposed a new approach, which they named the occipital bitranstentorial/falcine approach.13 They incised the falx and made a bilateral cut to the tentorium to expand the medial surgical field. This would provide an excellent approach to the contralateral posterior incisural space through 2 surgical windows among the incision of the falx and bilateral incisions of the tentorium. However, to access the lateral portion of the contralateral thalamus, the straight sinus would still need to be mobilized. Moreover, the process of cutting the tentorium bilaterally forces surgeons to manipulate both hemispheres of the occipital lobe, which may lead to severe postoperative visual field defects or cortical blindness.

In the OTFA, the unilateral tentorial incision, as well as the falx and ISS incisions, is made to mobilize the straight sinus and expose the contralateral thalamus. Based on the location of the thalamic lesions, we can use either the tentorial or falcine route (Fig. 4C and D). The tentorial route allows additional access to the contralateral dorsal midbrain and an inferior half of the pulvinar thalami, while the falcine route allows additional access to the contralateral splenium, the occipital lobe, and the superior half of the pulvinar thalami. It is also noteworthy that the tentorial route provides an undivided operative field in the region of the posterior incisural space, adding to the conventional occipital transtentorial approach. In the reported case, the cavernous malformation extended from thalamus to midbrain and the tentorial route provided more adequate exposure of the cavernous malformation for resection. Thus, we removed it only via the “tentorial route.” Large thalamic tumors should be removed using both routes. This “cross-court” trajectory minimizes the degree of hemispheric retraction. We have attempted to describe this principle in Fig. 5.

A major disadvantage of the OTFA is that it requires transection of both the falx and ISS. The ISS has the potential to receive blood flow from the corpus callosum and the medial cerebral hemispheres.14 To our knowledge, there have been only 2 case reports of isolated ISS thrombosis.

One demonstrated bilateral venous infarction at the posterior cingulate cortices, and the other demonstrated corpus callosum hematoma.7,8 Thus, transection of the ISS may lead to postoperative venous congestion in those drainage areas. Moreover, special attention must be paid to preserve the galenic system and to prevent straight sinus occlusion during straight sinus retraction. Although transection of the falx and ISS is presumed safe and commonly performed during contralateral interhemispheric approaches,13 the venous drainage pattern must be evaluated preoperatively. The OTFA should only be applied to patients in whom transection of the ISS will be well tolerated. At this time, we require that the absence of venous flow in the ISS be confirmed using preoperative imaging studies, prior to implementing the OTFA. In a study using MR venography, Ayanzen et al. reported that the ISS was only seen in 52% of all cases, while the SSS and straight sinus were observed in every case.2 Thus, it is estimated that the OTFA can be safely used in a relatively large number of patients. For the meticulous evaluation of ISS, we recommend digital subtraction angiography, which provides detailed and dynamic images of the cerebral vasculature. It is useful not only for the evaluation of normal anatomy, but also for the detection of anomalies, which might impact the safety and utilization of OTFA. The degree of the development of vascular channels in the tentorium and falx is highly variable.4,21 The well-developed vascular channels might function as a collateral draining route. Ryu reported that the falcine sinus was present in 12 of 586 patients (2.1%), a relatively high incidence.18 Fluorescein angiography may also be useful during intraoperative venous flow assessment in the ISS, falx, and tentorium.
Conclusions

Based on this case study, the OTFA to the posterior thalamic region is a reasonable alternative to currently implemented approaches. This modification to the OTA expands the medial operative field to expose the contralateral thalamus. This new approach should be incorporated into the neurosurgeon’s armamentarium to treat thalamic lesions.

Acknowledgments

We thank Hiroyuki Yaginuma, MD, PhD, Department of Neuroanatomy and Embryology, for constant support.

References


Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions

Conception and design: Iwami. Acquisition of data: Iwami, Fujii. Analysis and interpretation of data: Iwami, Fujii. Drafting the article: Iwami, Fujii. Critically revising the article: all authors. Reviewed submitted version of manuscript: Iwami, Fujii. Approved the final version of the manuscript on behalf of all authors: Iwami. Study supervision: Saito.

Correspondence

Kenichiro Iwami, Department of Neurosurgery, Fukushima Medical University, School of Medicine, 1 Hikarigaoka, Fukushima City 960-1295, Japan. email: iwamins@gmail.com.