Transverse Sinus-Tentorium Splitting Approach for Pineal Region Tumors

—Case Report—

Hiroichi BECK and Eiji MORIYAMA

Department of Neurosurgery, Fukuyama National Hospital, Fukuyama, Hiroshima

Abstract

A 15-year-old boy with a large pineal region mass was admitted to our institute. The tentative diagnosis was mixed germ cell tumor. Tumor resection was carried out via a transverse sinus-tentorium splitting approach. The tumor tissue was completely resected, and no operative complication other than transient vertical gaze paresis was noted. The histological diagnosis was mixed germ cell tumor composed of mature and immature teratoma, germinoma, and embryonal carcinoma. After three courses of chemotherapy, the patient underwent external irradiation. He remained asymptomatic with no signs of recurrence 42 months after the surgery. The combination of the infratentorial supracerebellar approach and the occipital transtentorial approach provides excellent views and work space above and below the tentorial notch. Transverse sinus section is not mandatory for this approach, but sectioning of the unilateral transverse sinus and the tentorium along the rectal sinus allows retraction of the falx and the underlying brain to the opposite side. Thus, a much wider horizontal and vertical projection is obtained. This approach enables safer and more extensive tumor removal for large pineal region tumors.

Key words: pineal region tumor, surgical approach, transverse sinus-tentorium splitting approach, combined approach

Introduction

Removal of the pineal region tumors is associated with high mortality and morbidity. Pineal region tumors can be resected through the infratentorial supracerebellar approach or the occipital transtentorial approach, with reasonably low morbidity and mortality.^{5,9,13,15,19} However, these approaches have limitations when dealing with large tumors. These two approaches can be combined by sectioning the transverse sinus and the tentorium to achieve safer and more extensive tumor removal.^{1,7,10,17,18,20,21} We report a successful removal of large pineal region tumor by splitting the transverse sinus-tentorium complex.

Case Report

A 15-year-old boy was admitted to our institute because of persistent headache. Magnetic resonance (MR) imaging showed a pineal region mass of 4×3

$\times 3$ cm and hydrocephalus (Fig. 1). The tentative diagnosis was mixed germ cell tumor based on the heterogeneous MR appearance before and after administration of contrast medium. Elevation of serum alpha-fetoprotein level suggested the presence of a

Fig. 1 Preoperative T₁-weighted magnetic resonance images with gadolinium revealing a pineal region mass with multiple components. left: Axial view, right: sagittal view.

malignant component, such as endodermal sinus tumor.

Cerebral angiography showed asymmetrical transverse sinuses. The left transverse sinus between the torcular herophili and the junction with the vein of Labbé was very hypoplastic. The left transverse sinus distal to the vein of Labbé was normal and the left superior petrosal sinus drained into this portion. The supratentorial cortical veins, the superior sagittal sinus, and the galenic systems were well visualized, and the majority of contrast medium drained into the well-developed right transverse sinus through the torcular herophili (Fig. 2 left).

The patient was placed in the Concorde position under general anesthesia. This prone position lifts the patient's head higher than the level of the heart with the head tilted to the right, away from the surgeon.⁶⁾ Bilateral combined occipital and suboccipital craniotomies around the torcular herophili were performed (Fig. 2 right).

The suboccipital dura was opened in a triangular shape with the transverse sinus as the base. The occipital sinus was divided after ligation. The occipital dura was then opened just superior to the transverse sinus. A 20-gauge Teflon cannula attached to a water-filled tube was inserted into the transverse sinus just lateral to the torcular herophili. Test occlusion of the sinus lateral to the needle was continued

for 5 minutes. The venous pressure was 5 cmH₂O before the occlusion. No rise of venous pressure or brain swelling was noted. The transverse sinus was ligated and sectioned 1.5 cm lateral to the torcular herophili, then the tentorium was cut along the line parallel to the straight sinus toward the tentorial notch area.

After splitting the left transverse sinus-tentorium complex, the left occipital lobe was gently retracted laterally. The right occipital lobe was retracted to the opposite side with the overlying falx, and the cerebellum was retracted caudally. Consequently, the quadrigeminal region was widely exposed, and the tumor together with the displaced galenic venous system came into the operative field. The tumor tissue extending into the third ventricle was also well visualized (Fig. 3). The tumor was completely resected easily, and the direction of the microscope could be changed freely. After tumor removal, the tentorium was approximated with a dura substitute sheet (GORE-TEX® PATCH, preclude dura substitute; W.L. GORE & Associates, Inc., Flagstaff, Ariz., U.S.A.), but the transverse sinus was not re-sutured because of the gap between the cut ends. The histological diagnosis was mixed germ cell tumor composed of mature and immature teratoma, germinoma, and embryonal carcinoma.

Postoperatively, mild vertical gaze paresis was ob-

Fig. 2 left: Schematic drawing of the venous drainage in this patient. The medial half of the left transverse sinus (TS) was hypoplastic. A large tentorial sinus drained into the left TS at its midpoint. The left TS distal to the junction with a large vein of Labbé (LV) was normal. The occipital sinus (OS) drained into the torcular herophili. right: Schematic drawings of the surgical approach. The scalp incision is indicated by the solid line, and the craniotomy opening by the broken line (upper). Dural incisions are shown by the small broken line and the site of sinus section by the double solid line (lower). ISS: inferior sagittal sinus, SPS: superior petrosal sinus, SSS: superior sagittal sinus.

Fig. 3 Schematic drawings of the operative images in the axial plane, showing the effect of left transverse sinus section on the tumor (T) exposure. *left:* The falx cerebri at the midline obstruct the view in the routine right occipital transtentorial approach (broken line with open arrowhead). *center:* Sectioning of the left transverse sinus allows the falx and the underlying brain to be moved to the opposite side (closed arrowheads). Angled projection from the right then provides a more extended view on the left side (solid line with closed arrowhead). *right:* The anterior end of the falx can also be moved to the right, enabling wider exposure on the right side (solid line with closed arrowhead).

Fig. 4 Postoperative T₁-weighted magnetic resonance images with gadolinium 6 months after surgery showing absence of residual or relapsed tumor. *left:* Axial view, *right:* sagittal view.

served, but this resolved in a few months. Postoperative MR imaging showed no residual tumor (Fig. 4). After three courses of chemotherapy consisting of ifosfamide, cisplatin, and etoposide, the patient underwent whole brain external irradiation of 30 Gy with local boost of 20 Gy. He remained asymptomatic 42 months after the surgery. Follow-up MR imaging found no signs of local tumor recurrence or in-

trathecal seeding.

Discussion

Histological verification is critical for the management of pineal region lesions.^{9,16)} Open surgery has several advantages over stereotactic biopsy. First, sampling error is reduced with open procedures because a large quantity of tumor tissue can be obtained. This is especially important when dealing with germ cell tumors, which often have multiple components. Second, complete resection or at least radical debulking is sometimes possible even for malignant tumors, and this facilitates the effect of adjuvant therapy. Therefore, every effort should be made to remove the tumor extensively or completely. On the other hand, damage to the normal brain should be minimized.

The infratentorial supracerebellar approach cannot easily reach large pineal region tumors extending anteriorly into the third ventricle and above the deep venous complex.^{12,15,16)} The occipital transtentorial approach is suitable for the latter tumors because of the higher projection in the sagittal plane.^{5,13,15,16)} However, the occipital transtentorial approach lacks the midline trajectory because the anatomical midline is blocked by the superior sagit-

tal sinus and the falx. Thus, a large tumor expanding to the opposite side or anterior third ventricle cannot be easily reached. Another disadvantage is the potential risk of occipital lobe injury by prolonged retraction.^{13,15,16)}

The combination of these two approaches provides excellent views above and below the tentorial notch.^{10,17,18,20,21)} Sectioning of the transverse sinus might not be necessary to obtain a wide projection in the sagittal plane.^{10,20)} We believe the wider lateral projection obtained by splitting the transverse sinus and the tentorium is an additional attractive feature of this approach (Fig. 3). Retraction of the contralateral occipital lobe with the overlying falx provides much greater exposure of the quadrigeminal region. The falx acts as a natural barrier protecting the underlying brain during the retraction. The tumor can be reached along the midline or along the line angled to the opposite side. The wide, unhindered exposure minimizes retraction of the ipsilateral occipital lobe.

The tumor in our patient could have been totally removed through only the infratentorial supracerebellar approach or occipital transtentorial approach, but our prime concern was the prevention of brain injury during the prolonged retraction. Preoperative angiography showed the left transverse sinus was hypoplastic and encouraged us to split the transverse sinus-tentorium complex from the beginning of the operation. Our operative technique resembles to those used previously.^{17,18,21)} A small difference is that our craniotomy was located more to the left, on the side of the hypoplastic transverse sinus (Fig. 2 right). The venous channels around the torcular herophili show wide variation and complexity, so caution is essential in sectioning the transverse sinus.^{1-4,8,11,14)}

Sectioning the hypoplastic transverse sinus after uneventful test occlusion seems to be a safe procedure. The patient position and the type of anesthesia influence the venous pressure, but the change rather than the absolute value during the test occlusion is critical. The absence of brain swelling increases the safety of the procedure.^{14,17,18,21)} We believe that reconstruction of the sectioned sinus, which is technically difficult and time consuming, is not necessary. Permanent obliteration of the transverse sinus should have no harmful effects on brain that can tolerate temporary interruption during the operation, that is of several hours duration. No significant complication was reported in a larger series in association with the permanent obliteration of the unilateral transverse sinus.^{17,18,21)} On the other hand, reconstruction of the cerebellar tentorium with a dura substitute is advisable. This procedure is easy

to perform and might prevent vertical displacement of critical structures such as the brainstem and the deep venous systems.

The combined infratentorial and supratentorial approach without transverse sinus section is a valid approach for pineal region tumors.²⁰⁾ Transverse sinus section is a useful option for selected patients with large pineal region tumors, which enables safer and more extensive tumor removal. Detailed analysis of the preoperative angiography and intraoperative test occlusion is imperative.

References

- 1) Beck H, Moriyama E, Iseda K, Saitoh N: [Transverse sinus-tent splitting approach for pineal region tumor], in: *Proceedings of the 57th Annual Meeting of The Japan Neurosurgical Society*. Sapporo, Hokkaido University, 1998, p 38 (abstract) [Jpn]
- 2) Bisaria KK: Anatomic variations of venous sinuses in the region of the torcular Herophili. *J Neurosurg* 62: 90-95, 1985
- 3) Durgun B, Ilglt ET, Çizmeli MO, Atasever A: Evaluation by angiography of the lateral dominance of the drainage of the dural venous sinuses. *Surg Radiol Anat* 15: 125-130, 1993
- 4) Hacker H: Normal supratentorial veins and dural sinuses, in Newton TH, Potts DG (eds): *Radiology of the Skull and Brain*. St Louis, The CV Mosby, 1974, pp 1851-1902
- 5) Jamieson KG: Excision of pineal tumors. *J Neurosurg* 35: 550-553, 1971
- 6) Kobayashi S, Sugita K, Tanaka Y, Kyoshima K: Infratentorial approach to the pineal region in the prone position: Concorde position. Technical note. *J Neurosurg* 58: 141-143, 1983
- 7) Matsumura H, Makita Y, Someda K, Kondo A: Arteriovenous malformations in the posterior fossa. *J Neurosurg* 47: 50-55, 1977
- 8) Matsushima T, Suzuki SO, Fukui M, Rhoton AL Jr, de Oliveira E, Ono M: Microsurgical anatomy of the tentorial sinuses. *J Neurosurg* 71: 923-928, 1989
- 9) Matsutani M, Sano K, Takakura K, Fujimaki T, Nakamura O, Funata N, Seto T: Primary intracranial germ cell tumors: a clinical analysis of 153 histologically verified cases. *J Neurosurg* 86: 446-455, 1997
- 10) Meyer FB: Occipital approach and combined occipital-suboccipital approach, in: *Atlas of Neurosurgery. Basic Approaches to Cranial and Vascular Procedures*. Philadelphia, Churchill Livingstone, 1999, pp 163-184
- 11) Muthukumar N, Palaniappan P: Tentorial venous sinuses: an anatomic study. *Neurosurgery* 42: 363-371, 1998
- 12) Nagao S, Kuyama H, Murota T, Suga M, Tanimoto T, Kawauchi M, Nishimoto A: [Surgical approaches to pineal tumors: complications and outcome]. *Neurol Med Chir (Tokyo)* 28: 779-785, 1988 [Jpn, with Eng ab-

- stract)
- 13) Nazzaro JM, Shults WT, Neuwelt EA: Neuro-ophthalmological function of patients with pineal region tumors approached transtentorially in the semisitting position. *J Neurosurg* 76: 746-751, 1992
 - 14) Potthoff PC: Transsinus approach. *J Neurosurg* 89: 1073-1074, 1998
 - 15) Reid WS, Clark WK: Comparison of the infratentorial and transtentorial approaches to the pineal region. *Neurosurgery* 3: 1-8, 1978
 - 16) Sano K: Alternate surgical approach to pineal region neoplasms, in Schmidek HH, Sweet WH (eds): *Operative Neurosurgical Techniques*, ed 3, vol 1. Philadelphia, WB Sanders, 1996, pp 743-754
 - 17) Sekhar LN, Goel A: Combined supratentorial and infratentorial approach to large pineal-region meningioma. *Surg Neurol* 37: 197-201, 1992
 - 18) Sekhar LN, Tzortzidis F: Approaches to the pineal region, in Sekhar LN, Oliveira E (eds): *Cranial Microsurgery. Approaches and Techniques*. New York, Thieme, 1999, pp 330-342
 - 19) Stein BM: The infratentorial supracerebellar approach to pineal lesions. *J Neurosurg* 35: 197-202, 1971
 - 20) Tamaki N, Yin D: Combined infratentorial and supratentorial transtentorial approach to pineal region tumors: A technical note. *Neurosurgery Quarterly* 9: 236-240, 1999
 - 21) Ziyal IM, Sekhar LN, Salas E, Olan WJ: Combined supra/infratentorial-transsinus approach to large pineal region tumors. *J Neurosurg* 88: 1050-1057, 1998

Address reprint requests to: H. Beck, M.D., Department of Neurosurgery, Fukuyama National Hospital, 4-14-17 Okinogami-cho, Fukuyama, Hiroshima 720-8520, Japan.