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Transventricular Prefornicеal Approach Combined with Endoscopic Transnasal Surgery for a Giant Pituitary Adenoma: A Case Report and Literature Review

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Abstract

Giant pituitary adenomas carry significant surgical risks when treated with transsphenoidal approaches or the transcranial approach alone. Combined transsphenoidal and transcranial approaches have been reported; however, removing adenomas extending into the third ventricle may still be challenging. We report a case of giant pituitary adenoma expanding into the third ventricle, which was removed using a combined transventricular prefornicеal approach and an endoscopic endonasal transsphenoidal surgery (ETSS). A 41-year-old man with headache, nausea, and a 1-week history of a visual field defect was transferred to our hospital. He had a disturbed left visual acuity, right homonymous hemianopia, and choked disc in both eyes. Preoperative magnetic resonance imaging revealed a giant pituitary adenoma with a maximum diameter of 55 mm extending from the intrasellar to the suprasellar region, thus occupying the entire third ventricle and causing hydrocephalus. The space between the anterior commissure and the fornix was expanded. The foramen of Monro was shifted backward due to compression by the tumor. He underwent maximum surgical resection using a combined transventricular prefornicеal approach and ETSS. Considering technical demands and reliability, the intra- to suprasellar parts were removed by ETSS while the intraventricular part was removed through the prefornicеal approach. The residual tumor in the right cavernous sinus and behind the anterior communicating artery was treated with stereotactic radiotherapy. One year after the operation, the patient leads an independent life. The combined technique of the prefornicеal approach and ETSS provided a direct view of the entire third ventricle and hemostasis in the present case.

Keywords: giant pituitary adenoma, endoscopic transnasal surgery, prefornicеal approach, combined surgery, stereotactic radiotherapy

Introduction

Non-functioning pituitary adenomas with a diameter >40 mm are classified as giant pituitary adenomas.[1–3] Resecting these adenomas by transsphenoidal approaches with or without endoscopy or a transcranial approach alone is challenging due to the risk of critical complications such as postoperative hemorrhage and damage to the surrounding brain structures; thus, the reported mortality rate using these surgical approaches is 3.2–10.6%.[4–6] Recently, a combined transcranial approach and simultaneous endoscopic endonasal transsphenoidal surgery (ETSS) have been proposed for the radical resection of giant pituitary adenomas.

Most of the transcranial approaches used include the pterional and the interhemispheric approaches for the lateral and superior extension, respectively.[7–11] For those adenomas expanding into the third ventricle, there have been a few case reports using transventricular approaches employing transforaminal or transchoroidal techniques[12–15]; however, these approaches may have limitations in removing tumors from the anterior part of the third ventricle.[16]

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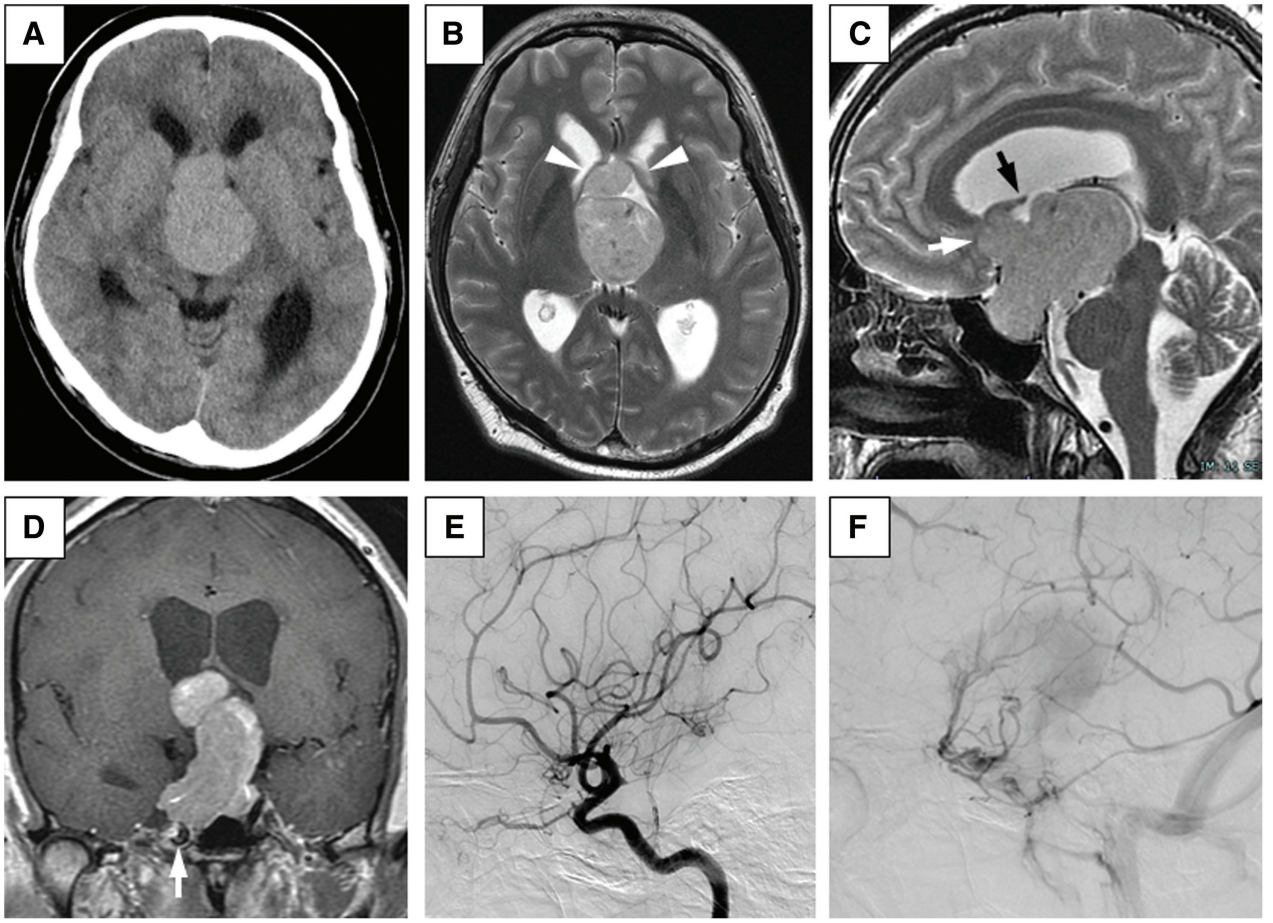

Fig. 1 Presurgical characteristics and location of a giant pituitary adenoma in a 41-year-old patient. (A) Preoperative CT showing a solid tumor filling the third ventricle. (B) The tumor is hyperintense on a T2WI, and the wall of the septum pellucidum in front of the fornix is bilaterally stretched (arrowheads). (C) In the sagittal image, the space between the anterior commissure (white arrow) and the fornix (black arrow) is expanded, and the foramen of Monro is shifted to the back due to compression by the tumor. (D) In the coronal image on Gd-T1WI, the tumor extends to the right cavernous sinus, and the right ICA is shifted (white arrow). (E) Arterial phase of the left internal carotid angiography shows many small arteries feeding the tumor. (F) Venous phase of the angiography reveals the tumor stain. CT: computed tomography, T2WI: T2-weighted MR image, Gd-T1WI: gadolinium-enhanced T1-weighted MRI, ICA: internal carotid artery.

In this paper, we report the case of a giant pituitary adenoma occupying the entire third ventricle that was removed using a combined transventricular preforniceal approach[16] and simultaneous ETSS. The preforniceal approach is reported to be useful for the resection of tumors occupying the anterior third ventricle, but only a few reports exist. Here, we highlight the advantages of the preforniceal approach combined with ETSS for giant pituitary adenoma.

Case Report

The patient was a 41-year-old man who presented with headache, vomiting, and visual dysfunction for one week. He had no notable medical, family, or psychosocial history. Computed tomography (CT) and magnetic resonance imaging (MRI) performed at a local hospital revealed a large brain mass lesion with hydrocephalus. He was transferred to our hospital for further examination and treatment. The procedures performed on the subject were conducted in accordance with the Ethical Guidelines for Medical and Health Research Involving Human Subjects (Provisional Translation as of March 2015) and its later amendments.

Neurologic examinations showed a slight disturbance of consciousness (Glasgow Coma Scale Score 14 = E4 V4 M6), disturbed left visual acuity (0.6 vs. 1.0 in the left vs. right eye), right homonymous hemianopsia, and choked disc in both eyes. CT showed a giant mass occupying the intrasellar and suprasellar regions and the third ventricular space

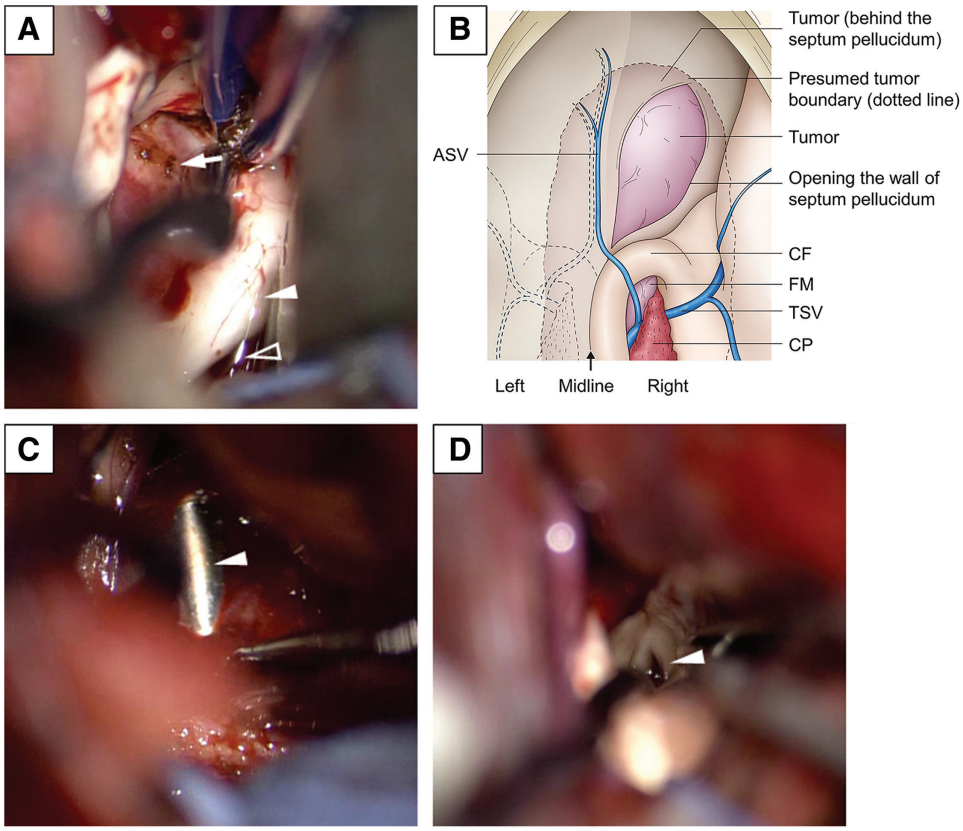

Fig. 2 Intra-operative microscopic view and schema of the transventricular preforniceal approach. (A) The tumor is exposed into the right preforniceal space; the arrow, the solid arrowhead, and the open arrowhead show the tumor, the right column of fornix, and the foramen of Monro, respectively. (B) The schema of intraoperative microscopic view in the right ventricle. Contralateral anatomical structures have been demonstrated with transparent illustration. The wall of septum pellucidum was incised in front of the right column of the fornix, and the tumor was exposed in the back. (C) Tumor resection boundary for the endoscopic transsphenoidal approach. The endoscopic tool (arrowhead) is observed in a microscopic view. (D) Cerebral aqueduct (arrowhead) is revealed after the tumor removal. ASV: anterior septal vein, CF: column of fornix, CP: choroid plexus, FM: foramen of Monro, TSV: thalamostriate vein.

causing hydrocephalus. No calcification or hemorrhage was observed (Fig. 1A). Gadolinium-enhanced T1-weighted MRI (Gd-T1WI) revealed that the tumor, with a maximum diameter of 55 mm, was homogenously enhanced, but the normal pituitary gland was not evident. The tumor was hyperintense on T2-weighted MR images (T2WIs) (Fig. 1B, C), stretching the wall of the septum pellucidum bilaterally in front of the column of fornix (Fig. 1B). The space between the anterior commissure and the fornix was expanded. The foramen of Monro was shifted backward by the tumor (Fig. 1C). The right internal carotid artery (ICA) was compressed and shifted by the tumor in the right cavernous sinus as seen on a coronal plane image by Gd-T1WI (Fig. 1D). Arterial spin labeling suggested a moderately hypervascular lesion. Cerebral angiography showed feeders from the bilateral ICAs (Fig. 1E and 1F).

Serum levels of free thyroxine (T4), follicle-stimulating hormone (FSH), and prolactin were 2.33 ng/mL (0.9–1.7), 243.8 mIU/mL (2.1–18.6), and 39.4 ng/mL (4.3–13.7), respectively. Other pituitary-related hormones were within the normal range.

Since the present case showed the symptoms not only by optic pathway compression but also by intracranial hypertension, a surgical strategy was planned to relieve hydrocephalus in addition to maximum tumor resection. Considering technical demands and our experience in ETSS, we chose a combination of ETSS and transcranial approach so that the intra- and suprasellar part of the tumor could be safely removed with feeder control through ETSS while the intra-third ventricular part could be removed through the transcranial route under direct visualization. Because opening of the cerebral aqueduct was also thought essential to improve hydrocephalus,

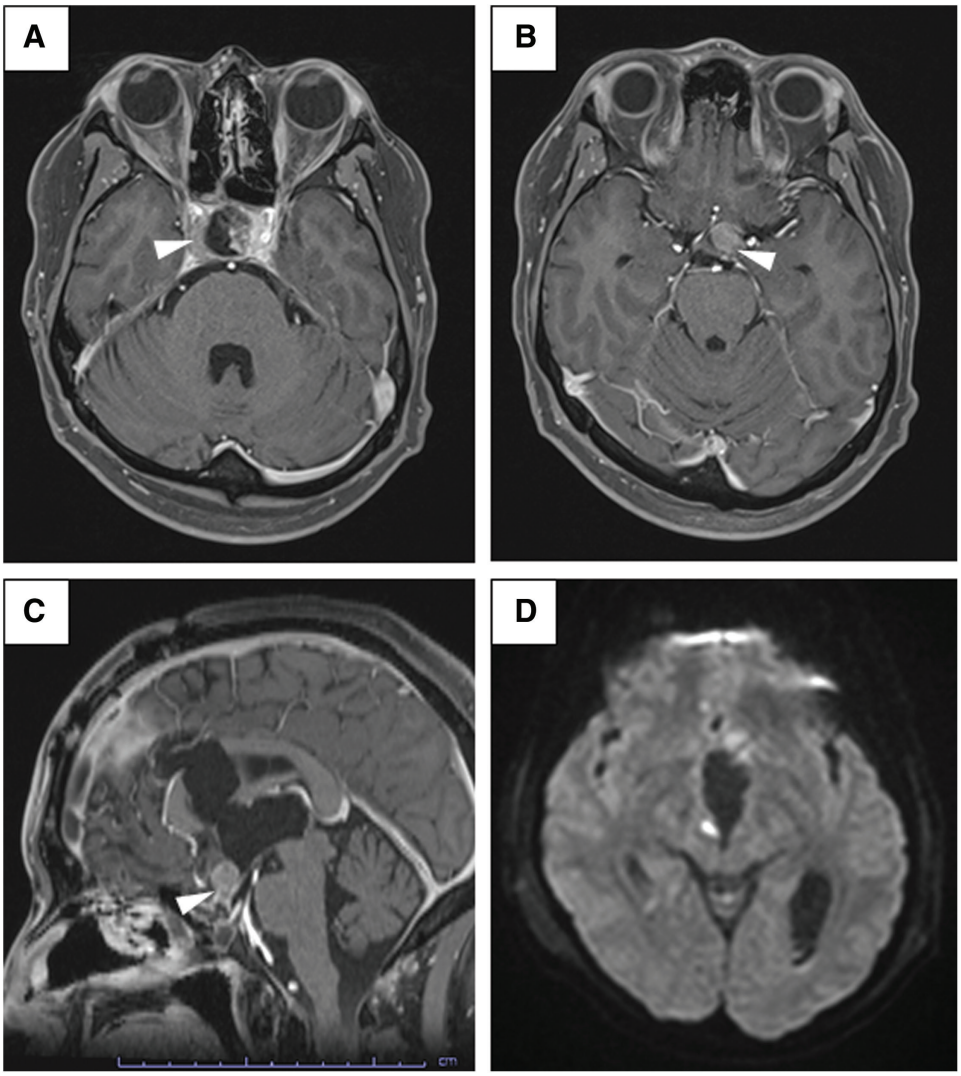

Fig. 3 Postoperative residual tumor characteristics in the 41-year-old patient. (A) Postoperative Gd-T1WI showing the small residual tumor (arrowhead) in the right cavernous sinus and (B and C): behind the AComA; most of the tumor was removed sufficiently. (D) Diffusion-weighted image showing a high-intensity signal around the right midbrain cerebral peduncle, but damage in other brain areas is not observed. Gd-T1WI: gadolinium-enhanced T1-weighted MRI, AComA: anterior communicating artery.

we chose the preforniceal approach as the transcranial route. The preforniceal approach was considered suitable as well in terms of preoperative MRI showing that the tumor stretched the space between the anterior commissure and the fornix.[16]

The patient was placed in the supine position with the vertex moderately elevated so that both the transcranial and the ETSS approaches could be performed simultaneously.

Because the nasal septum deviation was located on the right side, ETSS was performed through the left nasal cavity for extensive opening of the sellae floor. The dura was incised and opened for intracapsular tumor removal. The tumor was soft and could be removed by aspiration.

Simultaneously, right frontal craniotomy was performed, and a 2 cm incision was placed in the corpus callosum to enter the right lateral ventricle. The foramen of Monro and the column of the fornix were identified, and a preforniceal incision was made to enter the septum pellucidum (Fig. 2A and 2B). The tumor was immediately visible through the incision and removed for internal decompression by suction using an ultrasonic aspirator. Bleeding from the tumor was minimal because of the simultaneous tumor removal by ETSS. Tumor resection was continued to reach the sellae diaphragm, also achievable by ETSS (Fig. 2C). Comparing to the intra- and suprasellar component, the intraventricular tumor was partially fibrous.

After internal decompression, the tumor was meticulously dissected from the third ventricle walls for extracapsular removal. The cerebral aqueduct was observed after tumor removal (Fig. 2D). A stiff part of the tumor adhering to the anterior communicating artery (AComA) was difficult to dissect because of a deep and narrow working space and was intentionally left to avoid the risk of injury to the perforating arteries.

A part of the tumor invading the right cavernous sinus also remained at the end of ETSS. The ETSS procedure was followed by hemostasis, fat grafting, fascia grafting on the dura, and coating of the sellae floor with the inferior turbinate flap. The drainage tube was then placed in the right lateral ventricle through the transcranial corridor, followed by the closing of the cranium. The visual evoked potentials of the subject remained within normal levels during the operation.

Postoperative MRI showed that most of the tumor (approximately 94% of the volume) had been removed, except for the residual tumor in the right cavernous sinus and behind the AComA (Fig. 3A–3C). Hyperintense spots on diffusion-weighted images were seen in the right cerebral peduncle (Fig. 3D), corresponding to slight motor weakness in the left cerebral peduncle, which resolved in a week. The patient developed slight disorientation just after the surgery, and his condition eventually improved a month after the surgery (revised Hasegawa's dementia scale score: 25; Mini-Mental State Examination score: 27). His left visual acuity improved to 1.2. The homonymous hemianopsia improved in the left eye but remained the same in the right eye. The choked disc was improved in the both eyes. The decline in the cortisol level and diabetes insipidus were treated by replacement therapy with hydrocortisone and vasopressin, respectively. Histopathologically, the tumor was immunopositive for FSH, coinciding with its elevation in the serum. However, because the patient was clinically asymptomatic in terms of FSH, the tumor was considered a non-functioning pituitary adenoma.

Stereotactic radiotherapy (central dose: 36.0 Gray [Gy]; marginal dose: 32.4 Gy; nine fractions) was performed for the residual tumor five months later. Although the patient had been undergoing hormone replacement therapy, neurological symptoms were not evident one year after his surgery (modified Rankin scale score: 1).

Discussion

We report the case of a giant pituitary adenoma that was removed sufficiently with a combined preforniceal approach and simultaneous ETSS. While ETSS has become the primary option for non-giant pituitary adenoma removal in recent years, Koutourousiou et al. reported that the near-total resection (>90%) of giant pituitary adenomas could be achieved in only 66.7% of the total cases.[5] The tumor characteristics that limit the ETSS efficacy are multilobular extension (especially laterally and superiorly or in either direction), protrusion into the middle fossa, and adhesion to the cerebral vasculatures.[5] These characteristics may be effectively treated by the combination of ETSS with a transcranial approach, but a two-stage surgery has been reported to carry a risk of postoperative hemorrhage.[17,18]

A literature search found more than 90 reported cases who underwent simultaneous, combined surgery in the last 20 years; most of them used the pterional approach for tumors with lateral extension

Table 1 Reported approaches combined with endoscopic ETSS for giant pituitary adenomas extending into the third ventricle

Authors	Combined approaches	Recommended indication	Advantage	Limitations and risk
Greenfield et al.[15] Ojha et al.[14] Romano et al.[13]	Transforaminal[16,25–27]	Anterior-middle TV tumor expanding into the FM	Simple with an existing route	Limited surgical corridor Risk to the fornix and the thalamostriate vein
Yamada et al.[12]	Transchoroidal[16,25–27]	Middle-posterior TV tumor	Critical structures can be left intact	Limited access to anterior TV Risk to ICV
Present case	Preforniceal[16]	Anterior TV tumor expanding between the fornix and the anterior commissure	Wide surgical corridor for large tumors	Limited surgical corridor for small tumors Is a risk to the fornix

ETSS: endonasal transsphenoidal surgery, TV: third ventricle, FM: foramen of Monro, ICV: internal cerebral vein.

and the interhemispheric approach for those with superior extension in the transcranial space. The transventricular approach for the third ventricle has been reported in nine cases.[6–15,19–24] Among them, four cases are described in detail: three transforaminal approaches and one transchoroidal approach (Table 1).[12–15]

Although both the transforaminal and transchoroidal approaches are commonly used for tumors of the third ventricle,[16,25–27] they have limitations in directly observing tumors in the anterior part of the third ventricle.[16] The preforniceal approach that uses the route between the anterior commissure and the fornix is reported to have an advantage in this situation.[16] The resectability of the posterior part of the third ventricle is not well known; however, our previous experience has suggested this possibility for a large tumor occupying the entire third ventricle (data not shown).

In the present case, the preforniceal approach provided easy access to the anterior and posterior parts of the third ventricle and even the cerebral aqueduct by extending the preforniceal corticotomy by a few millimeters along the column of the fornix and retracting the fornix posteriorly.

As shown by intra- and postoperative findings, the limitation of the preforniceal approach may be a narrow working space in the area behind the AComA. An interhemispheric lamina terminalis approach is an appropriate surgical route for the tumor around AComA and the anterior part of the third ventricle, but the accessibility to the superoposterior part is limited.[16,28] Alternatively, a transcranial approach may be performed using an endoscope[13–15] or a port retractor system.[12] The appropriate surgical strategy should be selected on the basis of the aim of surgery, the preoperative radiological findings, and the patient condition.

Conclusion

The transventricular preforniceal approach combined with ETSS was useful to remove a giant pituitary adenoma extending into the entire third ventricle.

Conflicts of Interest Disclosure

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

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