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Case Report

A Purely Endoscopic and Simultaneous Transsphenoidal and Transcranial Keyhole Approach for Giant Pituitary Adenoma Resection: A Technical Case Report

Kazuhito Takeuchi,[1] Tetsuya Nagatani,[2] Tadashi Watanabe,[2] Eriko Okumura,[1] Yusuke Sato,[1] and Toshihiko Wakabayashi[1]

A combined transsphenoidal-transcranial approach for the resection of pituitary adenomas has previously been reported. While this approach is useful for specific types of pituitary adenomas, it is an invasive technique. To reduce the invasiveness of this approach, we adopted the keyhole concept for pituitary adenoma resection. A 23-year-old man presented at a local hospital with a 6-month history of bilateral hemianopia. Magnetic resonance imaging revealed a large pituitary adenoma extending from the sella turcica toward the right frontal lobe. Endoscopic transsphenoidal surgery was planned at a local hospital; however, the operation was abandoned at the start of the resection because of the firm and fibrous nature of the tumor. The patient was subsequently referred to our hospital for additional surgery. The tumor was removed purely endoscopically via a transsphenoidal and transcranial route. Keyhole craniotomy, 3 cm in diameter, was performed, and a tubular retractor was used to achieve a wider surgical corridor; this enabled better visualization and dissection from the surrounding brain and provided enough room for the use of surgical instruments under endoscopic view. The tumor was successfully removed without complication. This is the first case report to describe the resection of a giant pituitary adenoma using a purely endoscopic and simultaneous transsphenoidal and transcranial keyhole approach.

Keywords: transsphenoidal surgery, pituitary adenoma, keyhole surgery, combined surgery, endoscopic surgery

Introduction

Transsphenoidal surgery is generally considered the first-line treatment for pituitary adenomas, except for those with specific anatomical and histopathological features.[1–3] While this technique is regarded as safe and effective, it is challenging to remove giant pituitary adenomas using this technique alone, especially tumors that have a fibrous component, dumbbell shape, and show extreme invasion toward the cranial side.[1,3,4] Staged transsphenoidal and transsphenoidal-transcranial approaches have been used for the resection of such giant tumors.[3,5,6] However, while effective, they require multiple surgical strategies under general anesthesia and therefore pose a risk of postoperative hemorrhage from residual parts of the resected tumors.[1)]

A combined simultaneous transsphenoidal and transcranial approach has also been reported.[1,3,4,7] This approach provides wide tumor visualization, good orientation, less possibility of postoperative hemorrhage, and a greater extent of resection without the need for additional surgery. However, it is a highly invasive procedure for the patient. Alternatively, the keyhole concept provides a minimally invasive strategy for the removal of brain tumors.[8,9] This concept is based on the idea that traditional self-retaining retractors may not achieve an appropriate surgical corridor for deep-seated brain tumors.[10,11] Instead, tubular retractors may be more useful for making long surgical corridors and are expected to cause minimal damage to the white matter.[10,11] Therefore, to reduce the invasiveness of the combined transsphenoidal-transcranial approach for the resection of giant fibrous pituitary adenomas, we adopted the keyhole concept using a newly invented tubular retractor. Here, we describe this novel technique through a case report.

Case Report

A 23-year-old man with a history of relapsing ulcerative colitis presented at a local hospital with bilateral hemianopia that had persisted for 6 months. Magnetic resonance imaging (MRI) revealed a sellar and suprasellar mass lesion. Endoscopic transsphenoidal surgery was planned; however, the operation was abandoned at the start of the resection because of the firm and fibrous nature of the tumor. The postoperative pathological diagnosis was a pituitary adenoma. Following the operation, the patient's visual disturbance did not improve, and he was subsequently referred to our institution for additional treatment.

On admission, the patient showed bilateral temporal hemianopia but no hormonal deficit. Contrast-enhanced MRI revealed a large pituitary adenoma extending from the sella turcica toward the right frontal lobe (Fig. 1). Computed tomography (CT) angiography revealed a cavernous aneurysm of the left internal carotid artery, which was attached to the bottom of the tumor (Fig. 2).

Additional surgical resection was considered. The transsphenoidal-transsylvian approach was initially considered;

[1]Department of Neurosurgery, Nagoya University Graduate School of Medicine, Nagoya, Aichi
[2]Department of Neurosurgery, Japanese Red Cross Nagoya Daini Hospital, Nagoya, Aichi

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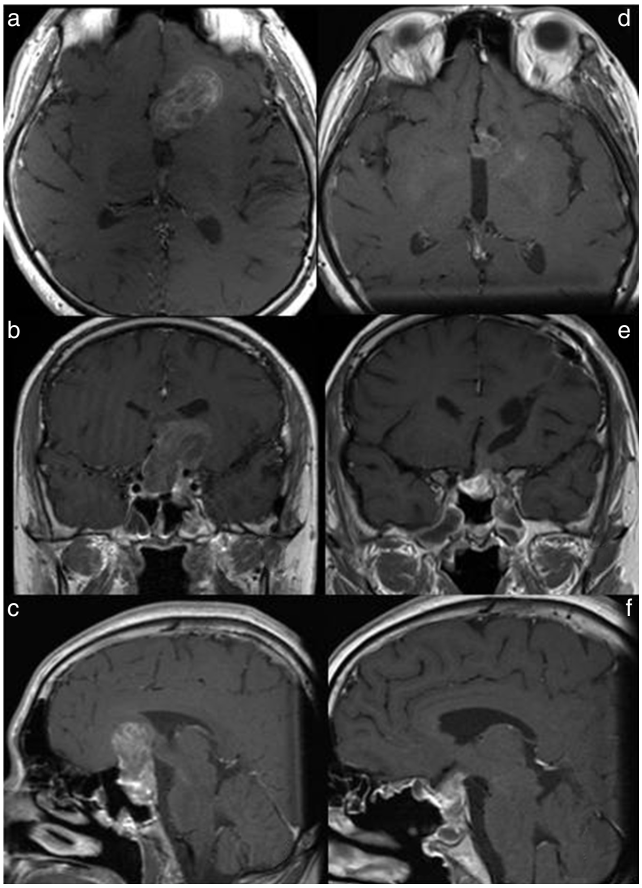

Fig. 1 a–c: Pre- and postoperative MRI scans. Maximum diameter of the tumor was 47 mm on preoperative MRI. d–f: The tumor was buried inside the frontal lobe. The tumor was sub-totally removed. MRI: magnetic resonance imaging.

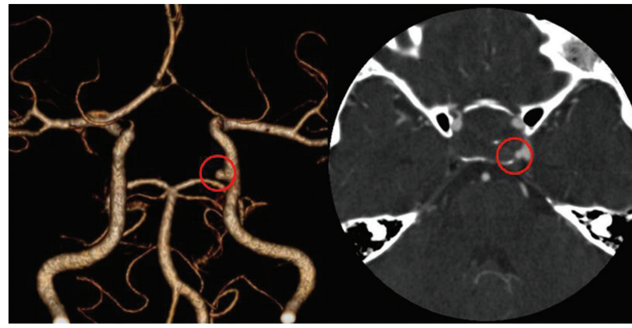

Fig. 2 Three-dimensional computed tomography angiography. Images show a small aneurysm (circle) of the patient's left internal carotid artery.

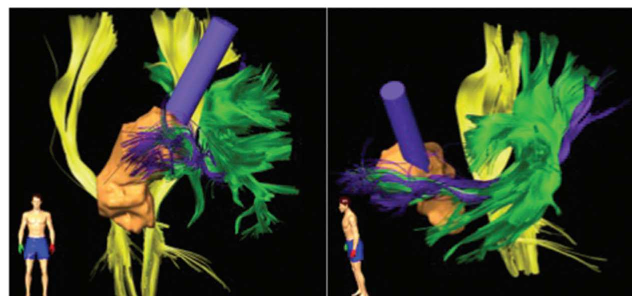


Fig. 3 Surgical planning with diffusion tensor image fiber tracking. The bilateral pyramidal fiber tract, left superior longitudinal fasciculus, and left inferior fronto-occipital fasciculus are shown in yellow, green, and purple, respectively. The tumor is shown in orange. The proposed surgical corridor is indicated as a purple rod and is planned such that the tracts could be avoided.

however, because the tumor was strongly buried in the cranial side, we were afraid of the potential for retraction injury to the brain and postoperative hemorrhage from the residual tumor on the top of the tumor bed. Although the transcortical route can be a cause of postoperative seizure, it provides a full view of a tumor that is buried in the brain.

A simultaneous combined endoscopic endonasal transsphenoidal and endoscopic keyhole transcortical approach was planned. The surgical corridor of the transcortical route was determined with the diffusion tensor image (DTI) to minimize the risk of injury of subcortical fibers (Fig. 3). Surgery was carried out successfully without any complication and the patient's visual disturbance improved. Postoperative MRI revealed a small tumor remnant in the left side of the sellar region and post-chiasmatic area (Fig. 1). Subtotal tumor removal was achieved. The patient was discharged on postoperative day 10 with no neurological sequelae and endocrinological deficit.

Surgical Technique

I. Setting for the operation

The patient was placed in the supine position on the operating table under general anesthesia, and his head was fixed with a Sugita head frame. The tumor was simultaneously approached via transcranial keyhole and transsphenoidal routes using two endoscope-holder devices (EndoArm; Olympus Co., Tokyo) that were operated by two teams. The keyhole team stood at the head end of the patient, while the transsphenoidal team stood at the right side of the patient. The monitors for the endoscopic and navigation systems were placed on the left side for both surgeons (Fig. 4).

II. Transsphenoidal surgery

The tumor below the optic nerve was mostly removed by the transsphenoidal team. The transsphenoidal approach was performed in a paraseptal fashion, and a pedicled nasoseptal flap was created. Although the sphenoid sinus was already open, the window was widened to enable manipulation of all aspects of the sella. The bone window of the sella floor was completely opened to expose the intact dura matter, but the bone of the tuberculum sella was not removed. The tumor was firm and could not be

Fig. 4 Scene in the operating room for the combined surgery. Two endoscopes were used as visualizing tools. The transcranial and transsphenoidal teams face each other while removing the tumor.

sucked out, and the tumor capsule inside the sella was not detectable. Curettage, cutting with scissors, and microdebrider were used as internal tumor debulking to remove the tumor. Almost the entire tumor inside the sella was removed; however, a small tumor remnant was left behind since the tumor in the left side of the intrasellar area was very firm and, thus, there was a risk of aneurysmal rupture. After removal of the tumor from inside the sella, the tumor in the suprasellar area was removed. In this area, the transcranial-keyhole team was already trying to remove the same part of the tumor.

III. Transcranial-keyhole surgery

The tumor above the optic nerve was mostly removed by the keyhole team. The keyhole team made an 8-cm incision in the skin along the hairline, followed by a left frontal area craniotomy 3 cm in diameter. A thin transparency sheath was inserted toward the tumor using 2.7-mm endoscopic viewing and navigation guidance to make the trajectory without opening the lateral ventricle. The trajectory was dilated with another transparency sheath of 10-mm diameter (Neuroport; Olympus Co., Shinjuku, Tokyo). The tumor capsule was detected at the tip of the sheath. It was difficult to remove the tumor through this narrow corridor since the tumor capsule and the tumor itself were firm and fibrous; thus, we used the ViewSite tubular retractor (Vycor Medical Inc., Boca Raton, Florida, USA) to create a wider surgical corridor. Internal tumor debulking was performed with scissors and a curette under endoscopic viewing prior to dissection of the tumor capsule from the surrounding normal brain. After sufficient debulking, dissection and removal of the capsule became easy. Tilting the tubular retractor to expose the margins of the tumor capsule was an important maneuver to facilitate dissection.

IV. Removal of the tumor in the suprasellar area

The critical region of the current surgery was the suprasellar area, because of the associated vital structures such as the optic nerve, anterior cerebral arteries, and other perforating arteries surrounded by the tumor. In this technique, both teams could attack the tumor simultaneously in concert, and alert each other with respect to caution regarding the vital structures, which could not be seen from both sides. The tumor was grasped and retracted by one team and dissected and cut by another team. This maneuver made it easy to remove the tumor in this vital area. The tumor had tightly adhered to the bilateral anterior cerebral artery and the optic nerve; therefore, the tumor capsule around this portion was not removed.

V. Reconstruction of the sellar floor

After removal of the tumor, corticospinal fluid (CSF) and irrigation fluid ran off from the cranial side toward the nasal cavity. Irrigation of fluid from the cranial side of the surgical corridor was very useful for washing the surgical cavity and the corridor; however, a watertight seal between the cranial area and the nasal cavity was needed to prevent postoperative CSF leakage. The sellar floor was mainly reconstructed by the transsphenoidal team. The rectus abdominis fascia lata and subcutaneous fat were harvested from the right lower abdomen. The fascia lata was laid under the suprasellar area to form the inner layer and stitched twice to the dura matter with 6-0 prolene. A fat graft was inserted into the sella, and then the dura matter of the sellar floor was sutured with 6-0 prolene. A nasoseptal flap was overlaid and sealed with fibrin glue.[12] After the reconstruction, the keyhole team filled up the surgical corridor on the cranial side with water to confirm that there was no CSF leakage from the sella toward the sphenoid sinus. The total operation time was 354 min, and total blood loss was 180 ml.

Discussion

Transsphenoidal surgery is a first-line treatment for pituitary adenomas[1–3]; however, it is occasionally difficult to remove tumors using this approach alone, especially tumors that have a fibrous component, dumbbell shape, and show extreme invasion toward the cranial side.[1–4] Various modifications of transsphenoidal surgery that overcome these challenges have been reported.[3,5,6,13] For example, extended transsphenoidal surgery can be used to directly approach the suprasellar area without brain retraction and expose the suprasellar component of the tumor as well as the optic nerves and the anterior cerebral arteries.[14] However, removing a tumor with a large suprasellar component and/or lateral extension is still challenging using this approach. Staged transsphenoidal-transcranial surgery can remove these tumors; however, this technique carries the risk of postoperative hemorrhage from the residual tumor.

A combined transsphenoidal-transcranial approach has also been reported as a safe and effective alternative technique for the resection of these difficult tumors.[1,7,15] This approach provides excellent exposure of the tumor and surrounding vital structures via multiple surgical corridors, permits corroborative removal of the tumor and a greater removal rate in a single operation, and reduces the risk of postoperative hemorrhage. However, the combined transsphenoidal-transcranial approach is relatively highly invasive, and some patients are not physically healthy enough to withstand the surgery.

Keyhole surgery uses a more precise surgical route to reduce morbidity and the invasiveness of surgery through minimizing the skin incision, and thus exposure of the normal brain tissue.[8,9] Recent technological advancement in navigation systems and neuroendoscopes has made it possible to directly approach deep-seated brain tumors. Kassam et al. used a purely endoscopic approach with a transparent sheath, 11.5 cm in diameter, to resect an intraparenchymal brain tumor. They reported that tumor removal was feasible and achievable with an acceptable level of complication.[12]

In this case, the patient's tumor was believed to be firm and fibrous and was strongly buried in the frontal lobe, which prevented its removal from the transsylvian approach. The transsylvian approach could induce retraction injury of the frontal base, and it seemed difficult to bring the entire tumor into view in this corridor because it was buried deep in the frontal lobe. The transcortical route can easily access the complete tumor above the sella without strong retraction of the trajectory. However, the transcortical route has some problems. In particular, there is a potential concern of trajectory injury that can induce a neurological deficit. Postoperative seizure is also a concern after this approach; however, the true incidence of cortical incision-related postoperative epilepsy is difficult to determine because there are many factors that can contribute to a seizure disorder.[16–18] Although these problems cannot be discounted, recent imaging technologies and surgical instruments can reduce their likelihood. In particular, planning the surgical corridor with DTI fiber tracking can minimize the risk of neurological deficits that are induced by trajectory injury.[10,19] Furthermore, linear cortical incision can reduce the risk of postoperative seizure, and use of a tubular retractor system also contributes to minimizing the cortical incision and reduces the risk of trajectory injury by distribution of forces on the surrounding white matter.[10,12,17,20]

We used a ViewSite tubular retractor that was 17 mm in width and 7 cm in length. This retractor is made of transparent plastic and is available in four different widths (12 mm, 17 mm, 21 mm, and 28 mm) and three different lengths (3 cm, 5 cm, and 7 cm). It was invented for microscopic surgery, but the design is also suitable for endoscopic surgery. The ellipsoidal shape makes it easy to simultaneously manipulate the endoscope and any other surgical instrument. Furthermore, the endoscope provides a bright surgical field in deep-seated areas.

Combining these keyhole techniques with the transsphenoidal-transcranial approach, we reduced the invasiveness of the surgery and achieved excellent tumor removal at the same time. While combined transsphenoidal surgery is an excellent alternative for some types of pituitary adenomas, this approach can also be considered for giant pituitary adenomas, especially those buried deep in the brain.

Conclusion

Successful resection of a giant pituitary adenoma was performed without complication using a purely endoscopic combined simultaneous transsphenoidal and transcranial keyhole approach, which was less invasive than the traditional combined method. The ViewSite tubular retractor proved to be a useful tool for this surgery, even though the tumor was very firm and fibrous. This is a useful surgical approach for the resection of some pituitary adenomas, especially those buried deep in the brain.

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Conflicts of Interest Disclosure

The authors declare no conflict of interest.

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Corresponding author:
Kazuhito Takeuchi, MD, Department of Neurosurgery, Nagoya University, Graduate School of Medicine, 65 Tsurumai-cho, Showa-ku, Nagoya, Aichi 466-8550, Japan.
✉ mail@wajit.com