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Endoscopic Occipital Transtentorial Transrecess Approach for Third Ventricle Lesions

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Abstract

OBJECTIVE: The endoscopic occipital transtentorial approach is a common route for treating pineal region lesions, but there have been few reports on strictly intra-third ventricular lesions. Using transrecess corridor during this approach can access the third ventricle. This article will describe the surgical techniques and anatomical features of endoscopic occipital transtentorial transrecess approach (EOTT-TR).

METHODS: Ten consecutive patients harboring intra-third ventricular lesions were included.

All patients were operated with EOTT via the transrecess corridor. The clinical outcomes and endoscopic surgical procedure were analyzed.

RESULTS: EOTT-TR was used in 3 patients with intra-third ventricle craniopharyngiomas, 2 patients with low-grade and 2 patients with high-grade thalamus gliomas, 3 patients with cavernous malformation in the thalamus. Gross-total resection was achieved in 6 of 10 patients. Transient diplopia and upward gaze dysfunction occurred in four patients. No other newly neurological deficits were found in all patients.

CONCLUSIONS: The EOTT-TR approach is a feasible approach for handling third ventricle lesions from posterior-superior view. EOTT-TR approach can expose the entire view of the third ventricle, particularly offering advantages in exposing the anterior-inferior part of the third ventricle, especially the floor of the third ventricle.

Introduction

The surgical access to the third ventricle, particularly through a posterior approach, presents a significant challenge due to the intricate anatomy and the critical neurovascular structures involved [1]. Since most tumors originating from the pineal gland tend to enlarge and protrude into the posterior part of the third ventricle and quadrigeminal cistern, tumor resection naturally exposes the third ventricle. Therefore, in the context of surgical approaches, this region is collectively referred to as the pineal and posterior third ventricle area [2]. Two primary approaches have been established for this purpose: the supracerebellar infratentorial approach (SCITA) and the occipital transtentorial approach (OTTA) [3].

For lesions confined to the posterior third ventricle or medial thalamus that do not extend into the quadrigeminal cistern, the traditional approaches may typically include interhemispheric transcallosal or trans-frontal cortical approaches (via the forniceal or choroidal fissures) [4]. However, the posterior transcallosal or transfrontal cortical approach was more suitable for the posterosuperior region of thalamus, which required considerable splenial resection and retraction, and incision of callosal fibers originating from the splenium. Forward exposure requires longer incision or more retracting of the corpus callosum [5].

This has led us to explore whether we can bypass the obstruction created by the pineal gland. The superior and inferior stalks of the pineal gland are connected to the habenula and the posterior commissure, respectively, forming the supra-pineal recess and the pineal recess [6-7]. The approach through this recess displaces the pineal gland, providing a feasible pathway to access the third ventricle.

In prior work, we described the surgical techniques for addressing intraventricular lesions via the E-SCITA through the pineal recess [8]. However, this approach provides limited exposure of the anterior-inferior part of the third ventricle during our clinical practice. Our subsequent anatomical and preliminary clinical studies show that endoscopic occipital transtentorial transrecess approach (EOTT-TR approach) offers advantages for exposing this region [9]. This study primarily aims to explore the anatomical characteristics and clinical surgical experiences of accessing the third ventricle by transposition the pineal gland through the pineal recess from EOTTA.

Operative Technique and Methods

Written informed consent was obtained from all patients, and the study protocol was approved by the Ethics Committee of Zhongshan Hospital of Fudan University. The study was conducted in accordance with the Declaration of Helsinki. The clinical data of patients were retrospectively analyzed, focusing on the surgical techniques and clinical outcomes. Patients were placed in the left lateral-prone position. The upper body and head were elevated 30°, and the head was placed in 3-pin fixation and turned approximately 15°to the right side to allow gravity to retract the ipsilateral parieto-occipital lobe. An incision was made parallel to the midline, 1 cm beside the midline in the occipital region, with a length of approximately 7cm above the transverse sinus. The bone window is located 1 cm superior to the transverse sinus and 1 cm inferior to the lambdoid suture, with a vertical diameter of 4 cm. The horizontal bone window crossing the superior sagittal sinus was created, with a diameter of 4 cm (Figure 1).

Endoscopic Procedure

The endoscope (0°, Hopkins II, 0° TIPCAM 1S 3D, STORZ, Germany) was fixed to a pneumatic holder (Mitaka, Japan) so that the procedure could be performed bimanually.

Tentorial Incision

The dural flap was turned toward the midline. The endoscope is placed in the posterior interhemispheric space, and cerebrospinal fluid was released from the cisterna quadrigeminalis. After the intracranial pressure decreases, an artificial dura mater was applied to cover the medial surface of the occipital lobe, which was retracted laterally by gravity to expose the straight sinus and tentorium. Using navigator to identify the straight sinus. Then incise the front tentorium 1 cm lateral to straight sinus, extending to its free edge. Sutures are used to suspend the tentorium on both sides, with one side of the suture fixed to the falx cerebri and the other side of the suture capable of fixing the artificial dura mater on the medial surface of the occipital lobe.

Opening of Quadrigeminal Cistern and Exposing the Pineal Gland

Opening the arachnoid membrane covering quadrigeminal cistern. And the arachnoid membranes connecting the basal vein (BV) and the precentral cerebellar vein (PCV) are further dissected, then we can expose the pineal gland above the venous gap. There are several pineal veins wrapped around the surface of the gland (Figure 1,2)

Opening the Pineal-Recess and up-transposition of the Pineal Gland

After electrocoagulation and transection of the pineal vein, the inferior lamina of the stalk from the posterior commissure was dissected to open the pineal recess beneath the pineal gland. Then, upward transposition of the pineal gland can create EOTT-TR approach to the third ventricle (Figure 1,2).

Exposing and Resecting the Tumor

Tumors originating from the right thalamus or located on the right walls of the third ventricle are clearly exposed. The contralateral left EOTTA provides better exposure for tumors originating from the lateral walls of the third ventricle. If the tumor is in the left thalamus, adequate exposure can be achieved via the right OTTA-TR corridor, with careful protection of the BV to avoid instrument (bipolar forceps) contact or injury (Right-handed surgeons). Depending on the nature of the tumor, it is removed either en bloc after dissection or piecemeal. The tumor cavity is meticulously hemostatized.

Exploring the Third Ventricle

Finally, the blood clots that have flowed into the lateral ventricles and the anterior part of the third ventricle during the operation are aspirated. If the patient had significant hydrocephalus preoperatively, a third ventriculostomy can be performed via the EOTT-TR approach to expose and open the tuber cinereum floor or the lamina terminalis of the third ventricle (Figure 1).

Results

EOTT-TR approach was used in 3 patients with intra-third ventricle craniopharyngiomas, 2 patients with low-grade thalamus glioma, 2 patients with high-grade thalamus glioma and 3 patients with cavernous malformation in the thalamus. The third ventricle is divided into anterior and posterior parts by the foramen of Monro: Among the cases, 6 cases were in the posterior part of the third ventricle, and 4 cases spanned both the anterior and posterior regions. Except for three cases with tumors originating from the left lateral wall of the third ventricle, which were approached via a right-sided, all other tumors located in the midline region or the right lateral wall of the third ventricle were accessed through a left-sided approach. Gross-total resection was achieved in 6 of 10 patients, the remaining four patients underwent subtotal resection (Table 1).

Transient diplopia and upward gaze dysfunction occurred in four patients. Diabetes insipidus was found in three patients with craniopharyngiomas, and recover was achieved in one patient in the three months

follow-up. Hormone replacement therapy was sustained for other craniopharyngiomas. No visual impairment was observed in all craniopharyngiomas. No other newly neurological deficits were occurred in all patients.

Discussion

The third ventricle is deep-seated and surrounded by critical structures, making surgical access challenging. The surgical approaches to the third ventricle can be divided into anterior and posterior routes based on the boundary of foramen of Monro. Anterior approaches include endoscopic transnasal trans-lamina terminalis or trans-tuber cinereum approaches, anterior interhemispheric or lateral pterional trans-lamina terminalis approaches, and anterior interhemispheric transcallosal or trans-middle frontal gyrus transforaminal approaches, sometimes combined with a transchoroidal approach. Posterior approaches include posterior interhemispheric transcallosal transchoroidal or transfoniceal approaches, and approaches targeting the pineal region, such as the supracerebellar infratentorial approach (SCITA) and the occipital transtentorial approach (OTTA), combined with pineal gland transposition to access the third ventricle [9]. Previously, we reported the use of the SCITA to displace the pineal gland via the pineal recess for treating third ventricle and pulvinar thalamus lesions [8]. This article primarily summarizes our clinical experience and technical details of using the OTTA to displace the pineal gland via the pineal recess for managing both anterior and posterior third ventricle lesions.

The OTTA initially developed from Poppen's procedure in 1966[10,11] and further refined by Jamieson in 1971[12], has become a widely adopted technique for addressing pineal region tumors. Despite its enduring utilization, the OTTA is not without its limitations. These include the necessity for a relatively large bone opening, difficulties in orientation due to the approach's oblique trajectory, a risk of retraction injury to the occipital lobe, and blind spots at the ipsilateral wall and roof of the third ventricle. These limitations have been reported to be mitigated by the endoscopic approach, the selection of the incision and bone window for the endoscopic OTTA(EOTTA) via the posterior interhemispheric approach divides into high and low-level [13,14,15]. The high EOTTA emphasizes the exposure of the direction of the cerebellar-mesencephalic fissure including dorsal lower midbrain, upper fourth ventricle, and anterosuperior cerebellum. In contrast, the low-level approach focuses on exposing the lesions in the pineal gland region toward the third ventricle. The choice of bone window in this group is beneficial for exposing the anterior third ventricle from the pineal region. Additionally, the design of the bone window at a not too low position avoids the risk of damage of the transverse sinus and significant visual field damage caused by excessive retraction in the occipital polar region and emphasizes the lateral retraction of the occipital lobe's medial surface rather than the bottom surface, and also avoids injury to the bridging veins at the base of the occipital lobe. The patient positioning employed during the surgery facilitated cerebrospinal fluid drainage, allowing for gravitational descent of the occipital lobe to create a surgical corridor.

However, previous reports about OTTA primarily focused on pineal region lesions extending into the third ventricle, where the removal of the pineal lesions facilitated the third ventricle exposure. In purely third ventricle cases where the pineal gland remains intact, it must be transposed to expose the third ventricle, a challenge addressed in our earlier reports using the endoscopic SCITA [8]. SCITA provides an inferosuperior perspective, which is suboptimal for exposing the anterior third ventricle and its more inferior portions. It poses difficulties in exposing the floor of the anterior third ventricle [16,21]. Additionally, the lateral upward perspective of the EPM-SCITA offers advantages in exposing the contralateral third ventricle wall, but is limited in exposing the ipsilateral third ventricle wall [16]. However, EOTT-TR approach which is much closer to the midline provides symmetrical exposure of the lateral third ventricle wall on both sides. In addition, EOTT-TR approach is a posterior-superior to anterior-inferior exposure perspective [9,21,22]. This perspective is more favorable for exposing the anterior floor of the third ventricle which cannot be reached from SCITA.

Therefore, this advantage provides us with an anatomical basis for the treatment of strictly third ventricle craniopharyngiomas that originate from the floor of third ventricle region. Previous literature reports that the intraventricular boundaries of the third ventricle craniopharyngiomas are mostly free, while adhesions exist at the origin of the floor of third ventricle [17]. The dissection of craniopharyngiomas starting from the posterior part can achieve efficient and safe boundary dissection and tumor debulking.

Due to the typical location of the suprapineal recess, which a space located between the upper surface of the pineal gland and the lower layer of tela choroidea in the roof of the third ventricle [18], previous literature has reported the use of the suprapineal recess approach via SCITA [7], moving the pineal gland serially downward to enter the third ventricle and expose the thalamus. However, the pineal veins which surrounding the pineal gland, draining from below to the great vein of Galen [19]. Thus, detaching and moving the pineal stalk downward from habenular commissure carries the risk of damaging the surrounding pineal veins and stretching the Galen vein. Furthermore, when performing the suprapineal recess approach, there is a significant risk of causing the pineal gland to become detached and dislodged. In contrast, accessing the surgical field inferior to the pineal gland allows the gland to be preserved in its superior-most position, thereby not impeding the surgical procedure. Therefore, the transrecess approach, which moves the pineal gland upward from the posterior commissure, is more in line with anatomical and physiological principles.

Besides, EOTTA and PM-SCITA begin to dissect the arachnoid from the thinnest layer of arachnoid at the lateral side of the quadrigeminal cistern [20]. Both approaches separating the arachnoid membrane between the basilar vein (BA) and the precentral cerebellar vein (PCV) to expose the pineal gland. However, due to the return angle relationship between the Galen vein and its tributary veins, compared to PM-SCITA, EOTTA has a smaller operating space in the venous gap between BV and PCV, and it causes greater interference to BV. Therefore, during the EOTT-TR approach procedure, more careful handling is required. And right-handed surgeons can avoid more BV injury by using a left-sided EOTT-TR approach. Additionally, the superior colliculi must be meticulously preserved to prevent diplopia and vertical gaze

palsy in EOTT-TR approach. EOTT-TR approach allows for endoscopic third ventriculostomy (ETV), performing the fenestration through the lamina terminalis and tuber cinereum helps mitigate the risk of previously potential obstructive hydrocephalus resulting from post-surgical adhesions [16].

Conclusion

EOTTA-TR approach is a feasible approach for handling third ventricle lesions from posterior-superior view. EOTTA-TR approach exposes the entire view of the third ventricle, particularly offering advantages in exposing the anterior-inferior part of the third ventricle, especially the floor of the third ventricle.

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Zhongshan Hospital of Fudan University and was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all individual participants included in this study.

Consent for publication

Written informed consent for publication of clinical data and images was obtained from all patients.

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Conflict of interest

The authors declare that they have no conflict of interest.

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Table

Table 1 is available in the Supplementary Files section.

Figures

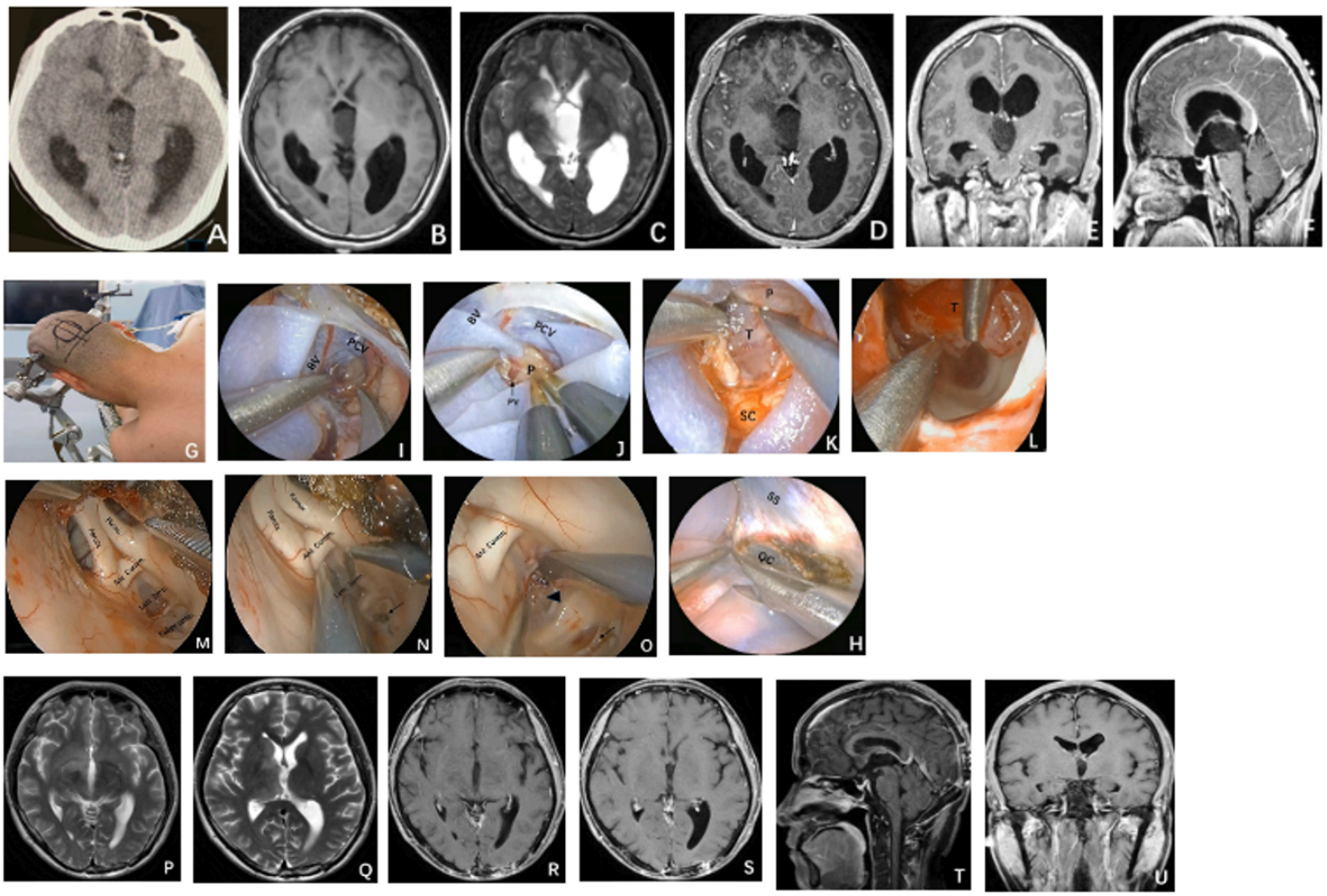


Figure 1

Typical case of the left EOTT-TR approach. A-F: A diffuse midline glioma (DMG) in the third ventricle is visible on the preoperative CT (A), and MRI (B-F). G: The patient position and operative incision and bone window. H-O: Endoscopic views of the EOTT-TR approach during the operation. Incision the tentorium

(H); Dissection of quadrigeminal cistern (I); The pineal gland was exposed by dissecting the arachnoid membranes in the quadrigeminal cistern between the BV and the PCV (J). The pineal gland was up transposition to gain access through the pineal recess to the third ventricle (K). K-L: The DMG was exposed (K) and removed (L). M-O: EOTT-TR approach provides sufficient exposure of the anterior part especially the floor of the of the third ventricle and ETV was performed. Angled bipolar coagulation creates fenestration at the tuber cinereum (long arrow) and the lamina terminalis (triangular arrow); the ACA is visible after lamina terminalis fenestration (N and O). P-U: Postoperative MRIs show that the tumor was totally removed. EOTT-TR: endoscopic occipital transtentorial transrecess. Ant. Comm.: anterior commissure; BV: basal vein; Lam. Term.: lamina terminalis; P: pineal gland; PCV: precentral cerebellar vein; PV: pineal vein; QC: quadrigeminal cistern; SC: superior colliculus; SS: straight sinus; SSS: superior sagittal sinus. T: tumor; TS: transverse sinus; Tuber ciner.: tuber cinereum.

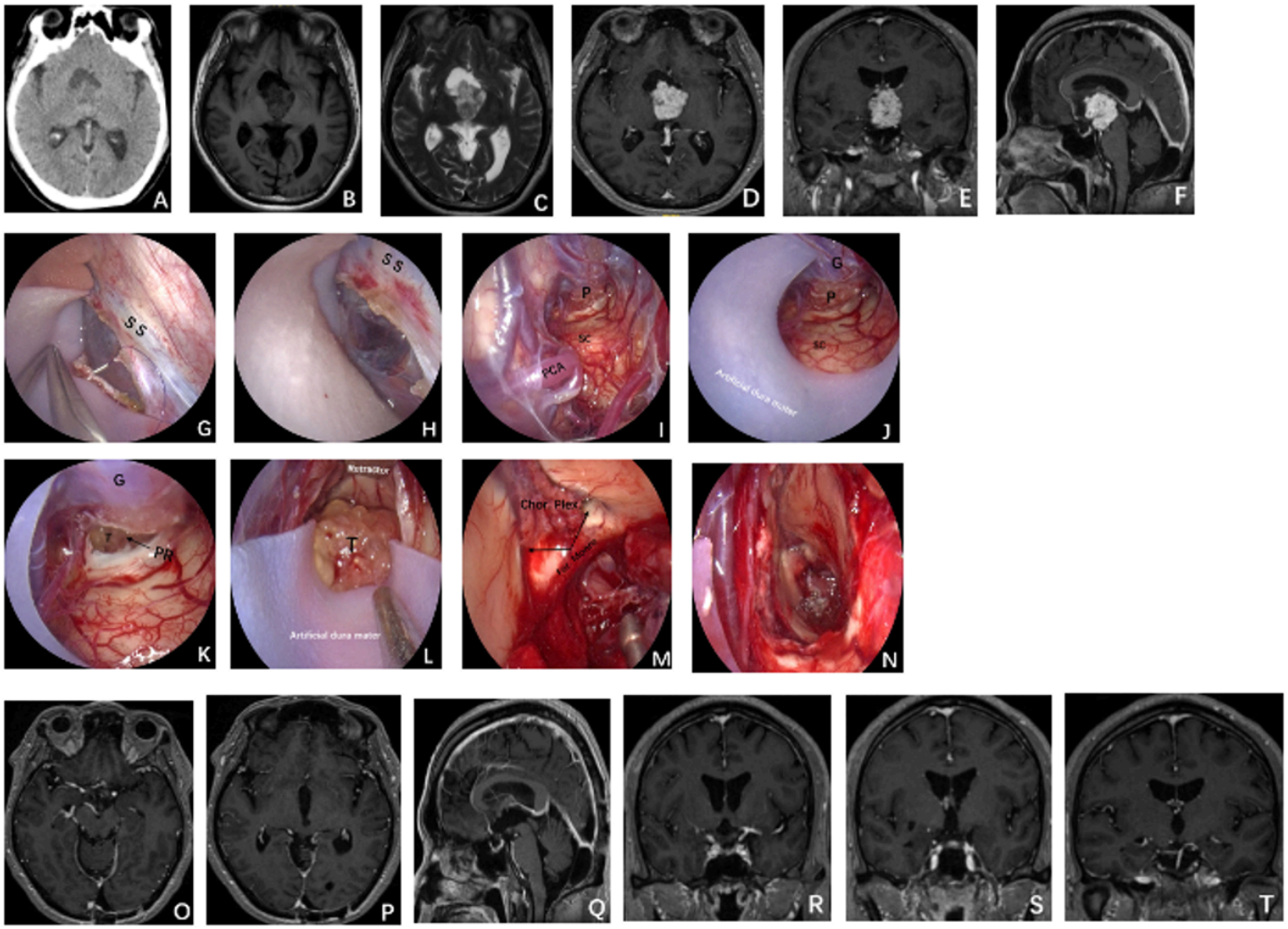


Figure 2

Left EOTT-TR approach is applied for another case of craniopharyngioma. The preoperative CT (A) and MRIs (B-F) show that a big suprasellar craniopharyngioma was occupied the anterior and posterior parts of the third ventricle. The cystic part is located on the right side of the anterior third ventricle. Endoscopic

views (G-N) of this approach during the operation. G-H: Dissection of the quadrigeminal cistern after the incision of tentorium; I-J: Dissect and confirm the location of the pineal gland and the pineal recess below it. K: Up-transposition the pineal gland and enlarge the pineal recess to expose the tumor in the third ventricle. L-M: Debulking the tumor and dissecting the boundary at the adherent area in the anterior part of the third ventricle. N: View of the third ventricle after totally resection of the tumor from EOTT-TR approach. O-T: Postoperative 3 months MRIs show the tumor was totally removed. Chor. Plex: choroid plexus; For. Monro: foramen of Monro; G: vein of Galen; P: pineal gland; PCA: posterior cerebral artery; PR: pineal recess; SC: superior colliculus; SS: Straight sinus; T: tumor.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- TableOTTTR.xlsx
- SupplementaryVideo1EOTTTRProcedure..mp4