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ORIGINAL ARTICLE

Approach selection and outcomes of craniopharyngioma resection: a single-institute study

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Abstract
Since there are many approaches for successful craniopharyngioma resection, how to choose a suitable approach remains problematic. The aim of this study was to summarize experience of approach selection and outcomes of craniopharyngioma resection in our institute. The data of 182 primary craniopharyngiomas between January 2013 and June 2019 were retrospectively reviewed. Craniopharyngiomas were classified into intrasellar, intra-suprasellar, suprasellar, and intra-third ventricle types based on the location. The surgical approaches, extent of resection, endocrine and ophthalmological outcomes, and complications were evaluated. Gross total resection (GTR) was achieved in 158 (86.8%) patients, near-total resection (NTR) in 20 (11%), and partial resection (PR) in 4 (2.2%). New-onset hypopituitarism occurred in 90 (49.5%) and new-onset diabetes insipidus in 48 (26.4%). Visual function was improved in 110 of the 182 patients, unchanged in 52, and deteriorated in 20. For intra-suprasellar and suprasellar tumors, patients in the endoscopic endonasal approach (EEA) group had higher GTR rate, lower incidence of new-onset hypopituitarism, and better visual outcome than patients in transcranial approach group, but no significant difference in the incidence of new-onset diabetes insipidus was found. There were no surgery-related deaths, and the common complications included permanent oculomotor nerve palsy, hemorrhage, and cerebrospinal fluid leaks. During the follow-up period, tumor recurrence or regrowth occurred in 6.6% of the cases. Tumor location is key for choosing an optimal surgical approach for craniopharyngioma resection. The EEA should be considered as the first choice for intra-suprasellar and suprasellar craniopharyngiomas to achieve better visual outcomes and fewer pituitary hormonal disorders.

Keywords Craniopharyngioma · Endoscopic endonasal approach · Transcranial approach · Outcome · Classification

Introduction

A craniopharyngioma is a benign tumor arising from the epithelial remnants of Rathke's pouch that is difficult to cure because of the high recurrence rate and subsequent malignant behavior [1]. Maximal safe resection of a craniopharyngioma, while preserving neurological function, is the ultimate goal to achieve the highest rate of recurrence-free survival and preserve quality of life [2–4]. However, a craniopharyngioma is surrounded by critical neurovascular structures, which include the hypothalamus, ophthalmological systems, basilar artery and its branches, internal carotid artery and its branches, and brain stem; thus, complete resection while avoiding neurological injury remains challenging to the neurosurgeon.

Various transcranial approaches (TCA) (i.e., pterional, orbitozygomatic, subfrontal, frontobasal interhemispheric, and transpetrosal) have been applied for craniopharyngioma resection [5–9]. In recent years, with the technological development of endoscopic equipment, such as the advent of high-definition monitors and video cameras, improved illumination and image quality, and intraoperative navigation, more and more craniopharyngiomas have been successfully resected via the endoscopic endonasal approach (EEA) [10–18].

Since there are many approaches for successful craniopharyngioma resection, choosing the most appropriate remains problematic to the neurosurgeon. Some authors have reported their experience with various tailored surgical

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approaches based on anatomical characteristics, such as the relationship between the tumor and the diaphragma sellae, third ventricle, optical chiasm, and pituitary stalk [8, 13, 19]. There is consensus regarding the choice of using the TCA for surgical treatment of intraventricular craniopharyngiomas and the EEA for the intrasellar type [20–23]. However, for the intra-suprasellar and suprasellar types, especially the suprasellar type, there is no consensus on an optimal treatment strategy (EEA or TCA). Therefore, the aim of the present study was to summarize the rationale underlying the choice of the surgical approach for craniopharyngioma resection in our institute.

Materials and methods

The medical records of 182 patients who underwent surgical resection of a primary craniopharyngioma between August 2013 and June 2019 in the Department of Neurosurgery, Beijing Tiantan Hospital, Capital Medical University, were retrospectively reviewed. This group consisted of 82 males and 100 females with a mean age at the time of surgery of 42.3 (range, 4–72) years. The mean follow-up period of this study was 33 (range, 8–78) months.

Surgical strategies based on anatomical subclassification

All craniopharyngiomas were simply classified into the following four subtypes based on the anatomical location for surgical approach selection (Figs. 1a, 2a, 3a, and 4a): intrasellar type (type I, 25 cases), intra-suprasellar type (type II, 68 cases), suprasellar type (type III, 76 cases), and intra-third ventricle type (type IV, 13 cases).

An intrasellar craniopharyngioma is primarily located in the intrasellar region; thus, the EEA was applied for all 25 (100%) patients (Fig. 1b). For the intra-suprasellar type without significant lateral or forward extension (subtype IIa) (Fig. 2b;

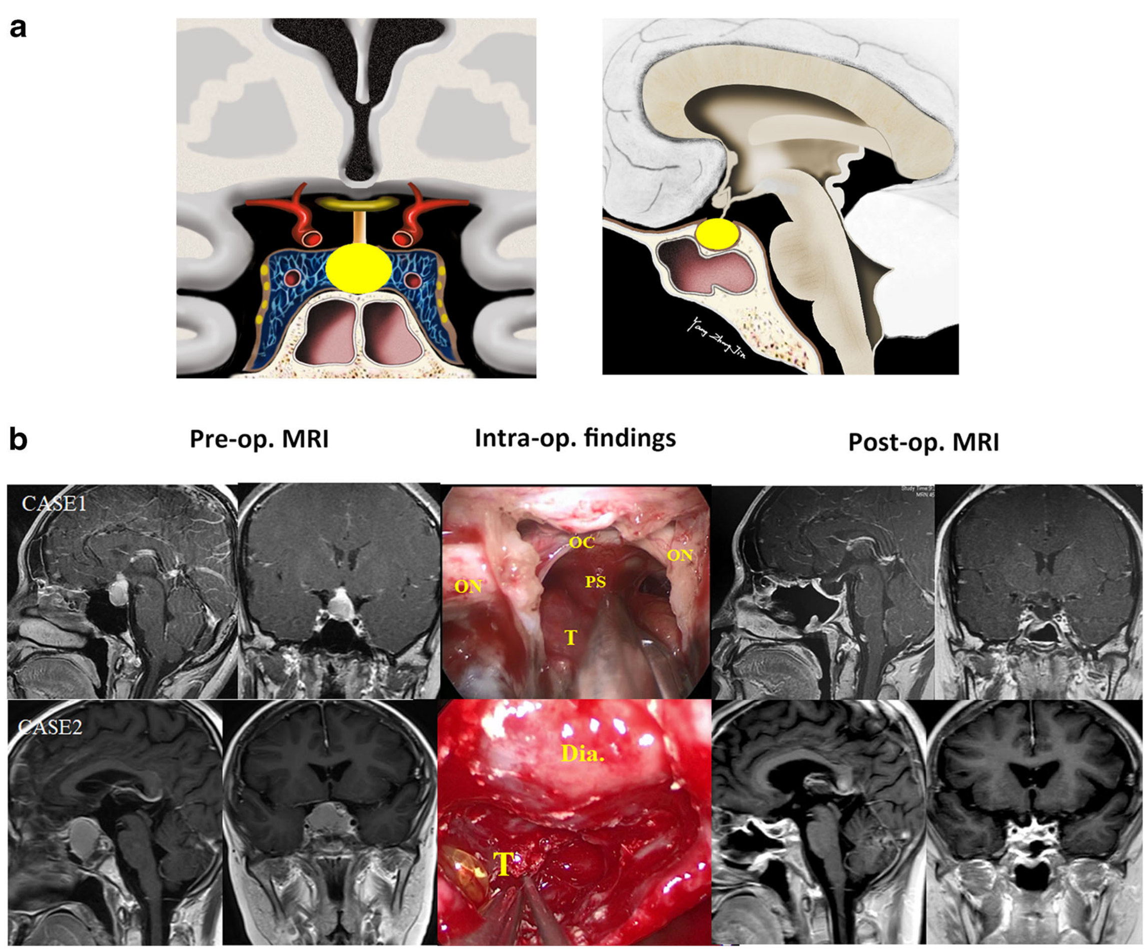

Fig. 1 Schematic diagrams of intrasellar craniopharyngiomas and case illustration. Schematic diagrams of intrasellar craniopharyngiomas in sagittal and coronal images (**a**). Case 1, pre-operative MRI showed the tumor located in the sellar region. Intra-operatively, pituitary stalk was found between the 3rd ventricular floor and normal pituitary tissue. Post-operative sagittal and coronal images showed that the tumor was totally removed through EEA (**b**). Case 2, the tumor was cystic and solid. The solid tumor tissue was removed and normal pituitary tissue was preserved (**b**). OC, optic chiasm; PS, pituitary stalk; ON, optic nerve; T, tumor; Dia., diaphragm sella

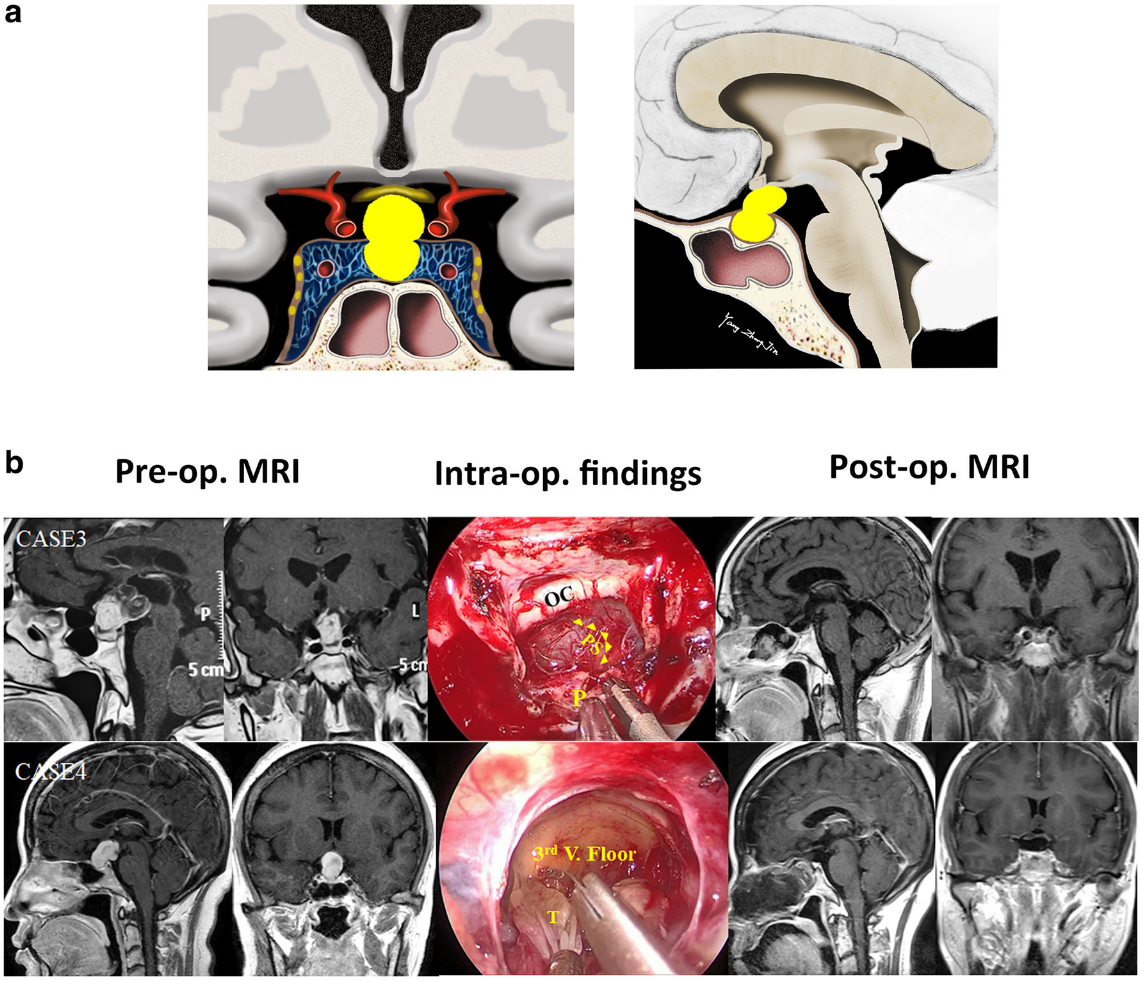

Fig. 2 Schematic diagrams of intra-suprasellar craniopharyngiomas and case illustration. Schematic diagrams of intra-suprasellar craniopharyngiomas in sagittal and coronal images (**a**). Case 3, preoperative images demonstrated that the space between the pituitary gland and the optic chiasm is enough to remove the tumor as well as the fact that it is easy to directly visualize the inferior surfaces of the chiasm though EEA. The pituitary stalk located in the left-posterior part of tumor. Postoperative images showed that the tumor was totally removed via EEA, as it provided a large enough surgical corridor (**b**). Case 4 showed the tumor capsule could be dissected from the hypothalamus using scissors through EEA (**b**). OC, optic chiasm; PS, pituitary stalk; T, tumor; P, pituitary; 3rd V. floor, 3rd ventricular floor

Supplemental Fig. 1 case 9), the EEA was applied in 55 (80.9%) of the 68 patients, whereas the lateral subfrontal approach or pterional approach was used for tumors with lateral extension beyond the carotid bifurcation (subtype IIb; 7/68 [10.3%]; Supplemental Fig. 1 case 10) or those with extreme forward extension when the plane between tumor capsule and normal neurovascular structures was blocked by the frontal lobe (subtype IIc; 6/68 [8.8%]; Supplemental Fig. 1 case11).

For the suprasellar type without significant lateral and retrosellar extension (subtype IIIa, 52/76 [68.4%]; Fig. 3b; Supplemental Fig. 2 cases 12–13), the EEA was selected for 42 patients (42/52, 80.8%) and the lateral subfrontal approach for 10 (10/52, 19.2%). For most cystic tumors with/without solid part adherent to the basal ganglia, EEAs were preferred because the part adherent to basal ganglia could be pushed toward midline after tumor decompression, then the tumor-basal ganglia interface may be found by EEA (case 9 and case 12). However, if the tumor broke the third ventricle floor and extended into the lateral ventricle through Monro's foramen, TCA was preferred. A tumor that was mainly located behind the saddle at 0.5 cm below the dorsum sellae was defined as the retro-saddle type (subtype IIIb; 18/76 [23.7%]; Supplemental Fig. 2 cases 14–15) and the lateral subfrontal approach was preferred for fifteen cases, while the EEA was chosen for the other three cases. In addition, for the suprasellar type with significant lateral extension beyond the carotid bifurcation (subtype IIIc, 6/76 [7.9%]; Supplemental Fig. 2 case 16) with or without retrosellar extension (Supplemental Fig. 2 case 16), the pterional approach was selected for one patient (1/6, 16.7%) and the lateral subfrontal approach for the remaining five (5/6, 83.3%).

For tumors located within the third ventricle, the lateral subfrontal translamina terminalis approach was applied if the tumor was closer to the lamina terminalis and third ventricle

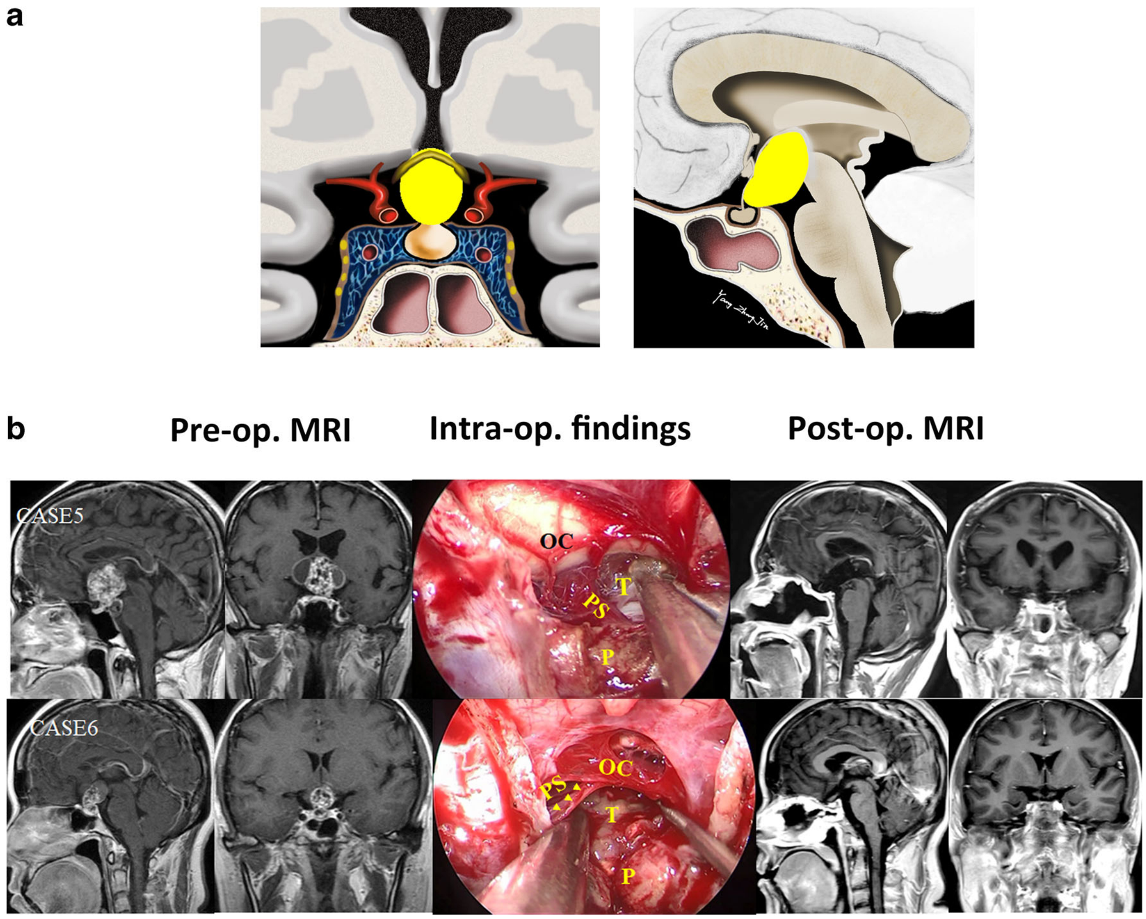

Fig. 3 Schematic diagrams of suprasellar craniopharyngiomas and case illustration. Schematic diagrams of suprasellar craniopharyngiomas in sagittal and coronal images (**a**). Case 5, pre-operative sagittal and coronal images demonstrated a suprasellar type craniopharyngioma. Through EEA, the stalk can be identified clearly and preserved intact during the operation because the tumor is attached along the stalk. Post-operative images showed that the tumor was totally removed (**b**). Case 6, the tumor was all inside the pituitary stalk. To remove the tumor through EEA, the first step was opening the stalk along the vertical axis. The stalk became the wall of the tumor, and it can also be carefully preserved during the tumor resection (**b**). OC, optic chiasm; PS, pituitary stalk; ON, optic nerve; T, tumor; P, pituitary

floor (7/13 [38.5%]; Fig. 4b, case 7) or the transcallosal interforniceal approach if the tumor was closer to the fornix (6/13 [61.5%]; Fig. 4b, case 8).

Regardless of the approach and procedure, the tumor was first debulked to decompress the tumor capsule. Once the tumor was adequately debulked and decompressed, the extracapsular portion of the tumor was dissected away from the optic chiasm, hypothalamus, and surrounding artery system, especially the posterior cerebral artery, via careful microdissection between the tumor capsule and arachnoid plane. The double arachnoid layers, which preserve vital neurovascular structures within the cisterns, were preserved. During dissection of the capsule from the surrounding structures, the small perforating vessels and pituitary stalk were carefully preserved by minimizing the use of bipolar coagulation, protecting the walls of the hypothalamus, sharply dissecting the tumor capsule from the optic chiasm, and gentle manipulation, which are all important factors to ensure quality of life. After the tumor was removed, a tailored biological membrane (Beijing Tianxinfu Medical Applicant Corporation) was placed under the dura to block dura defect. Then, the prepared vascularized nasoseptal flap was placed on the sellar floor to cover the dura defect tightly. Autogenous muscle tissue was used to support the flap and fixed with fibrin glue. Then, an iodoform gauze was used to pack the nasal cavity to support the autogenous muscle tissue for 7 to 10 days (Video 1). After surgery, the patients received lumbar CSF drainage in the post-operative day 1. The duration of lumbar drainage for most patients was 3 to 5 days, and it was withdrawn when the WBC counting, glucose, and lactate of CSF were almost in the normal ranges.

Evaluation of tumor resection and recurrence

The extent of resection was determined by pre- and post-operative volumetric analysis of MR images. Tumor recurrence during the follow-up period was defined as the

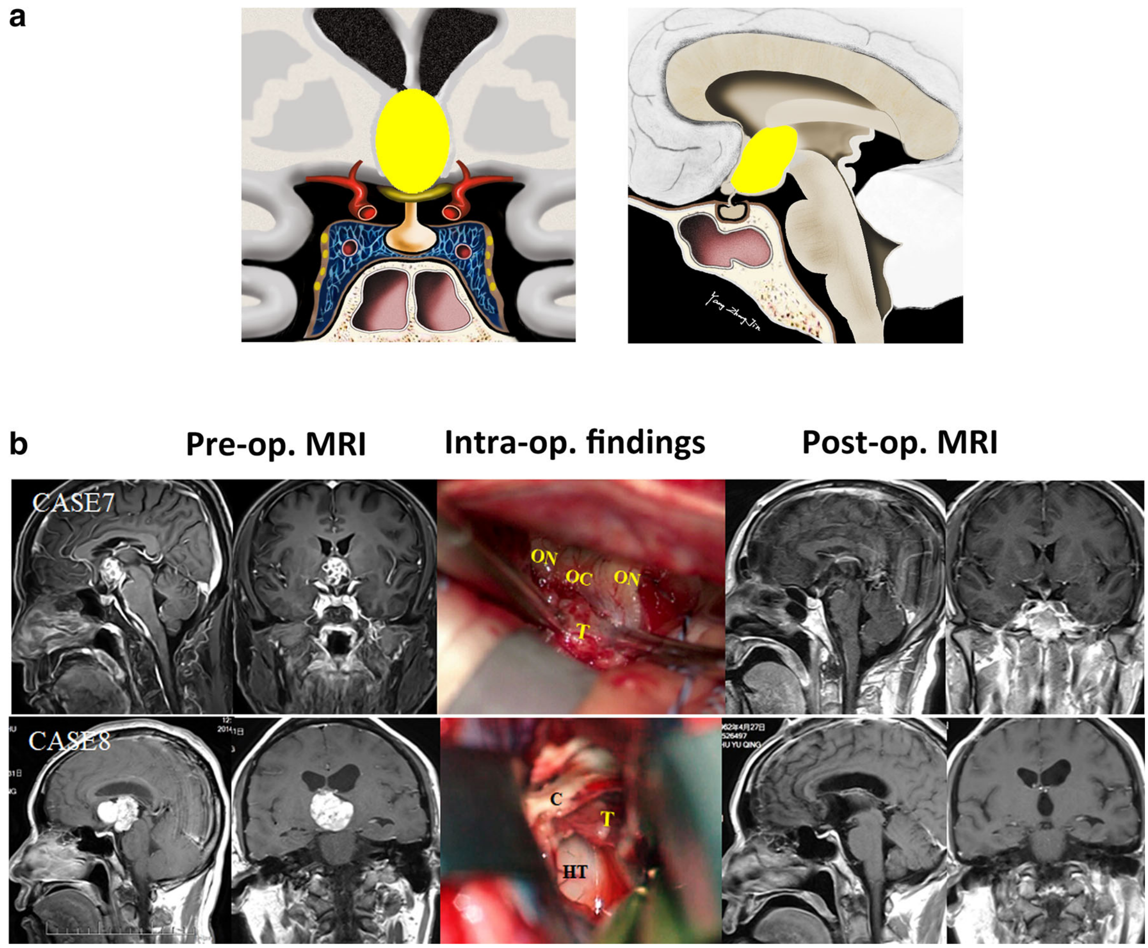

Fig. 4 Schematic diagrams of intra-third ventricular craniopharyngiomas and case illustration. Schematic diagrams of intra-third ventricular craniopharyngiomas in sagittal and coronal images (**a**). For case 7, we chose lateral subfrontal translamina terminalis approach because the tumor is closer to the lamina terminalis and third ventricle floor (**b**). For case 8, we chose transcallosal interforniceal approach because the tumor was closer to the fornix (**b**). OC, optic chiasm; ON, optic nerve; T, tumor; HT, hypothalamus; C, callosum

appearance of new pathological tissue on MR images or the growth of tumor remnants. Follow-up MR imaging was performed at 1 week and 3 months after surgery and then at regular intervals of 6–12 months.

Visual function

Ophthalmological evaluation, including visual acuity and visual field examinations, was performed by an ophthalmologist before and after surgery.

Endocrine status

The endocrine status of all patients was assessed pre- and post-operatively with the use of complete serum pituitary hormone panels. Diabetes insipidus was diagnosed before and after surgery based on sodium levels and the presence of hypotonic polyuria.

Statistical analysis

Unpaired samples were analyzed using the Mann-Whitney U test or Kruskal-Wallis test, while paired samples were assessed using the Wilcoxon t test. Differences correlating to an error of probability (p) < 0.05 were considered statistically significant.

Results

Extent of tumor resection

Among all 182 cases, gross total resection (GTR) was achieved in 158 (86.8%), near-total resection (NTR) in 20 (11%), and partial resection (PR) in 4 (2.2%). Among intra-suprasellar tumors, the GTR rate in the EEA group was significantly higher than that in the TCA group (92.7% [51/55] vs. 61.5% [8/13], respectively). Among suprasellar tumors, the GTR rate was significantly higher in the EEA group than that in the TCA group (91.1% [41/45] vs. 77.4% [24/31], respectively) (Table 1).

Ophthalmological results

Prior to surgery, 168 (92.3%) of 182 patients had visual deficits. After surgery, visual function was improved in 110 (60.4%) patients, remained unchanged in 52 (28.6%), and had somewhat deteriorated in 20 (11.0%) (Table 2).

In general, visual outcomes were better in the EEA group than those in the TCA group ($p < 0.01$). Of the 68 patients with an intra-suprasellar craniopharyngioma, visual improvement was achieved in 41 (60.3%) patients (36 by EEA and 5 by TCA), while there was no change in 20 (29.4%) (16 by EEA and 4 by TCA) and seven (10.3%) experienced some deterioration (3 by EEA and 4 by TCA). As compared with the TCA, visual outcome was better via the EEA ($p < 0.01$). Of the 76 patients with a suprasellar tumor, improvement in visual function was achieved in 46 (60.5%) patients (31 by EEA and 15 by TCA), while there was no change in 19 (10 by EEA and 9 by TCA) and some deterioration in 11 (4 by EEA and 7 by TCA). As compared with the TCA, visual outcomes were better via the EEA in this subtype group ($p < 0.05$).

Endocrine results

Preoperatively, hypopituitarism was diagnosed in 93 (51.1%) of 182 patients and diabetes insipidus in 36 (19.8%). Postoperatively, hypopituitarism occurred in 133 (73.0%) patients and permanent diabetes insipidus in 74 (40.7%). New-onset hypopituitarism was defined as new symptoms of hypopituitarism based on pre-operative status. In addition, new-onset hypopituitarism occurred in 91 (50%) patients and new-onset diabetes insipidus in 48 (26.4%) (Table 3). Among patients with the intra-suprasellar and suprasellar subtypes, new-onset hypopituitarism was more common in the TCA group than that in the EEA group (intra-suprasellar type, 69.2% vs. 32.7%, respectively, $p < 0.05$; suprasellar type, 80.6% vs. 46.7%, respectively, $p < 0.01$). However, among patients with both intra-suprasellar and suprasellar subtypes, no significant difference was found on new-onset diabetes insipidus between the TCA groups and the EEA groups (intra-suprasellar type, 32.3% vs. 24.4%, respectively; suprasellar type, 38.5% vs. 23.6%, respectively).

Complications

No surgery-related death occurred among the 182 patients. Permanent oculomotor nerve palsy was confirmed in one patient who underwent the lateral subfrontal approach. Post-operative hemorrhage occurred in one patient who underwent the lateral subfrontal approach and required complete resection of a hematoma. Post-operative leakage of cerebrospinal fluid (CSF) occurred in three patients in the EEA group, which required repair of the leakage. One patient suffered transient coma for 47 days for a small rupture of a branch of the posterior cerebral artery.

Tumor recurrence

During the follow-up period, tumor recurrence or regrowth occurred in 12 (6.6%) of the 182 patients. Tumor recurrence or regrowth was confirmed in one (4%) of the 25 patients in the intrasellar group, four (5.9%) of 68 in the intra-suprasellar group, six (7.9%) of 76 in the suprasellar group, and one (7.7%) of 13 in the intra-third ventricle group.

Table 1 The extension and prognosis of craniopharyngioma resection

Group (No. of cases)	Cases *n* (%)	GTR *n* (%)	NTR *n* (%)	PR *n* (%)	Recurrence or regrowth *n* (%)
All patients	182	58 (86.8%)	20 (11.0%)	4 (2.2%)	12 (6.6%)
Intrasellar type	25	23 (92%)	2 (8%)	0	1 (4%)
EEA	25	23	2	0	
Intra-supra sellar type	68	59 (86.8%)	8 (11.8%)	1 (1.5%)	4 (5.9%)
TC	13	8	4	1	
EEA	55	51	4	0	
Suprasellar type	76	65 (85.5%)	9 (11.8%)	2 (2.6%)	6 (7.9%)
TC	31	24	6	1	
EEA	45	41	3	1	
Intra-third ventricle type	13	11 (84.6%)	1 (7.7%)	1 (7.7%)	1 (7.7%)
TC	13	11	1	1	

GTR, gross total resection; *NTR*, near-total resection; *PR*, partial resection; *TC*, transcranial approach; *EEA*, endoscopy endonasal approach

Table 2 The ophthalmological outcome of craniopharyngiomas

	Approach (cases)	Pre-op. visual defect	Post-op. visual defect		
			Improved	No change	Worsen
Intrasellar type	EEA(25)	24	21	4	0
Intra-suprasellar type	EEA(55)	52	36	16	3
	TCA(13)	13	5	4	4
Suprasellar type	EEA(45)	43	31	10	4
	TCA(31)	30	15	9	7
Intra-third ventricle type	TCA(13)	6	2	9	2
Total		168	110	52	20

TCA, transcranial approach; *EEA*, endoscopy endonasal approach

Discussion

The anatomical location of a craniopharyngioma is the key for selection of the surgical approach

A craniopharyngioma is classified based on several criteria, including anatomical location of the tumor [19], origin of the tumor [24], and the relationships to the optic chiasm [22], diaphragma sellae [25], third ventricle [26], and infundibulum [13]. Although Kassam et al. proposed a classification system based on the relationship to infundibulum for endoscopic surgery, some Kassam type I and II tumors had extended forward/laterally to a great extent and were, thus, difficult to resect via the EEA. Therefore, craniopharyngiomas were simply classified into the following four subtypes in order to select the optimal surgical approach: intrasellar, intra-suprasellar, suprasellar, and intra-third ventricle.

(1) Intrasellar type: The anatomical relationship between an intrasellar craniopharyngioma and the surrounding structures is similar to that of a pituitary adenoma. The sellar floor is enlarged to provide enough space for tumor resection, and the tumor is usually not adhered to important blood vessels or the hypothalamus because the suprasellar side of the tumor is often covered by an extended diaphragm, thereby rendering these types of tumors ideal candidates for the EEA. Therefore, the EEA was used for all intrasellar cases in this series. In addition, the intrasellar area is a blind spot with the TCA. Thus, the TCA was not recommended for this type.

(2) Intra-suprasellar type: For most patients with an intra-suprasellar craniopharyngioma, the EEA offers three advantages: (1) the space between the pituitary gland and the optic chiasm is sufficient to remove the tumor; (2) it is easy to directly visualize the inferior surfaces of the chiasm and the plane between the tumor and hypothalamus; and (3) there is a lack of neurovascular structures over the ventral aspect of the tumor. However, if the tumor extends laterally beyond the carotid bifurcation, the pterional or lateral subfrontal approach was chosen as there are several corridors that provide access to the tumor via the prechiasmatic, opticocarotid, retrocarotid, and translamina terminalis spaces, especially along the lateral side of the tumor. In addition, if the tumor extends extremely forward and it is difficult to observe the front interface of the tumor via the EEA, the lateral subfrontal approach was chosen. However, there are three blind spots in TCA (the undersurface of the optic chiasm, third ventricle, and intrasellar region) for intra-suprasellar type tumors.

(3) Suprasellar type: In the present series, the EEA was usually employed for suprasellar craniopharyngiomas without

Table 3 The endocrine outcome of craniopharyngiomas

	Approach (cases)	Pre-op. hypopituitarism	Post-op. hypopituitarism	New-onset hypopituitarism	Pre-op. DI	Post-op. DI	New-onset DI
Intrasellar type	EEA (25)	17	23	10	9	14	5
Intra-suprasellar type	EEA (55)	28	35	18	7	16	13
	TC (13)	6	10	9	2	6	5
Suprasellar type	EEA (45)	20	30	21	16	25	11
	TC (31)	15	26	25	2	11	10
Intra-third ventricle type	TC (13)	7	9	7	0	4	4
Total		93	133	90	36	76	48

TC, transcranial approach; *EEA*, endoscopy endonasal approach significant lateral and retrosellar extension. For these tumors, the EEA offers a direct midline trajectory to the retrochiasmatic space, interpeduncular space, and third ventricle from below with excellent direct visualization of the entire surgical field with current endoscopic technology. (1) Direct and sharp extracapsular dissection of the tumor from surrounding critical structures can be performed with direct and excellent visualization of the undersurface of the optic chiasm, third ventricle, and interpeduncular space, which can avoid further damage to critical neurovascular structures by pulling the residual tumor and capsule. (2) The pituitary stalk and small vessels can be identified early and more clearly, as compared with the TCA, which allows for better preservation. (3) For the suprasellar type, the EEA corridor is usually narrower than with the intra-suprasellar type, but a larger space and path can be obtained by tumor decompression and opening of the lamina terminalis.

However, if the tumor had extremely extended to the lateral side, the TCA was chosen because the lateral side of the tumor is a blind spot with the EEA. If the tumor extends extremely to the retrosellar area or is mainly located behind the saddle, the EEA should not be chosen because (1) the procedure requires transposition of the pituitary gland and stalk to expose the tumor, which may result in panhypopituitarism, and (2) with a mass effect on the superior and posterior aspects of the optic chiasm, the corridor between the chiasm and pituitary gland may be insufficient to remove tumors located within the retrochiasmatic space. For such cases, the TCA was applied. During surgery, the translamina terminalis route is an effective choice for the experienced surgeon.

However, the undersurface of the optic chiasm and the upper interface between the tumor and hypothalamus remain a blind spot with this view. During this procedure, the arachnoid membrane around the optic nerves and anterior cerebral artery-anterior communicating artery complex was meticulously dissected, and the artery complex was gently elevated with the frontal lobe to fully expose the lamina terminalis. The tumor can be exposed after opening the lamina terminalis. But the mobilization of the optic nerve may endanger visual function during tumor resection.

Some authors [7] have advocated the transpetrosal approach for resection of craniopharyngiomas located in retrochiasmatic regions because it offers direct visualization of the posterior and inferior surfaces of the chiasm, the floor of the third ventricle, and the hypothalamic tuber cinereum. However, this approach has the disadvantages of prolonged retraction of the temporal lobe, potential injury to the vein of Labbé, and loss of midline orientation. Hence, this approach is only suitable for a recurrent tumor that is located mainly in the retrosellar area because of possible tight adhesions with the surrounding structures and the obfuscated view with the pterional and lateral subfrontal approaches.

(4) Intra-third ventricle type: The EEA is not recommended for this type by most of the authors because of the intact third ventricle floor between the tumor and sellar space [20]. In this series, the transcallosal interforniceal approach was chosen for tumors located closer to the fornix, while the lateral subfrontal translamina terminalis approach was employed for tumors closer to the lamina terminalis and third ventricle floor. The TCA provides an anterior or superior approach for tumor resection, which can protect the intact third ventricle floor from injury. Nonetheless, Forbes et al. recommend the EEA for resection of the intra-third ventricle type as a safe and efficacious operative strategy that should be considered for resection of this challenging subtype [27]. However, the EEA requires opening of the intact floor to reach the tumor, which could increase the risk of injury to the hypothalamus.

The surgical outcome of different surgical approaches is another key factor in the selection of surgical approaches

Compared with previous reports, the results of the present study were satisfactory in regard to the extent of tumor resection, tumor control, surgical complications, visual function, and endocrine status [8, 28–31].

(1) GTR evaluation: The craniopharyngioma radical resection rates are reportedly 40 to 90%, with retrochiasmatic location, larger size, calcification > 10%, extension into the third ventricle, and recurrence reported to be significant prognostic factors that negatively affect the extent of resection. Several studies have reported that the rate of radical resection in repeat surgery is markedly lower than that in primary surgery and that repeat surgery is associated with increased perioperative morbidity and mortality rates [32, 33]. In this series, the GTR rate in the EEA group was significantly higher than that in the TCA group for the intra-suprasellar and suprasellar types because of the ability to avoid blind spots and removal of all residual tumors through the EEA.

(2) Visual function evaluation: In this study, the EEA group had a better visual outcome as compared with the TCA group among patients with the suprasellar and intra-suprasellar types. There are three possible explanations for these results: (1) EEA allows for decompression of the tumor before manipulation of the optic apparatus. In contrast, the majority of TCA require manipulation of the optic apparatus during tumor debulking because resection must be performed between optic nerves. (2) With the EEA, small vessels arising from the internal carotid artery and superior hypophyseal arteries that provide the vascular supply to the optic apparatus are often visualized and can be preserved. (3) Most craniopharyngiomas are tightly adhered to the undersurface of the optic

apparatus. With the EEA, the tumor capsule can be sharply dissected from the optic apparatus under direct vision, which may decrease the risk of retraction-related injury of the optic apparatus, whereas the undersurface of the optic chiasm and optical nerves is a blind spot for TCA.

(3) Endocrine status evaluation: Electrolyte imbalance and decreased thyroid hormone and cortisol secretion were the most common complications after craniopharyngioma resection. In the present study, the rate of post-operative hypopituitarism was lower in the EEA group than that the TCA group. As a possible explanation, (1) the pituitary stalk and small vessels that provide the vascular supply to the stalk can be identified early and more clearly and can be better preserved than with the TCA; (2) through the EEA, sharper dissection of the tumor capsule from the hypothalamus can be performed under direct vision as compared with the TCA.

A major obstacle to successful transsphenoidal tumor resection is post-operative CSF leaks and resulting meningitis. The increased rate is related to resection of a craniopharyngioma, more than other parasellar lesions (such as pituitary adenomas), which involves violation of the arachnoid cisterns and offers entry into the third ventricle. The recent addition of a vascularized nasal septal flap for reconstruction appears to hold tremendous promise [13]. The rate of CSF leakage has markedly decreased over time with advancements in reconstructive techniques and the use of vascularized, nasal septal flaps. In this series, the rate of CSF leakage was 2.4% (3/125) in the EEA group.

Conclusions

Choosing an optimal surgical approach is essential to increase the total resection rate, while reducing the recurrence and mortality rates for the treatment of craniopharyngiomas. The anatomical location of the craniopharyngioma is key when selecting the surgical approach. If possible, the EEA should be considered as the first-line surgical modality for craniopharyngiomas to ensure a higher GTR rate, fewer hormonal disorders, and better visual outcomes.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This retrospective study was approved by the Ethics Committee of Beijing Tiantan Hospital, Capital Medical University (KYSQ 2019-287-01).

Informed consent Informed consent was obtained from all adult participants or the parents of 2 minor participants included in the study.

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