Article

Efficacy of the Craniopharyngioma Resection via Expanded Endoscopic Endonasal Transsphenoidal Approach in the Treatment of Complex Craniopharyngioma and Its Effect on Pituitary Function and Complications of Patients

Ann. Ital. Chir., 2024 95, 2: 192–199
https://doi.org/10.62713/aic.3145

Xiongjian Bu[1]

[1]Neurosurgery, Baoding No.2 Central Hospital, 072750 Baoding, Hebei, China

Background: Surgical resection is the most effective method for craniopharyngioma, with complex operations and a high incidence of complications, especially for complex craniopharyngioma. The study focuses on selecting a proper surgical method to treat complex craniopharyngioma. A clinical study was conducted in this direction to explore the efficacy of expanded endoscopic endonasal transsphenoidal approach (EETS) and transcranial approach (TCA) in the treatment of complex craniopharyngioma and their effects on pituitary function and complications of patients.
Methods: The clinical data of 73 patients with complex craniopharyngioma in Baoding No.2 Central Hospital from December 2017 to December 2022 were retrospectively analyzed. 13 patients who did not meet the admission criteria were excluded, and 60 patients were finally included. The included patients were divided into the TCA and EETS groups according to the treatment method. The surgical conditions, total tumor resection rate, clinical remission rate, and complications of patients in two groups were compared. The pituitary function of all patients, including thyroid stimulating hormone (TSH), adrenocorticotropic hormone (ACTH), and human growth hormone (hGH), was compared.
Results: A total of 60 patients were finally included in the study, including 30 cases in the EETS group and 30 cases in the TCA group. The two groups had no statistical difference in baseline demographic characteristics and pathological types ($p > 0.05$). Compared with the TCA group, the EETS group had less intraoperative blood loss, operation time, tumor resection time, and hospitalization time ($p < 0.001$) and had a significantly higher total tumor resection rate and clinical remission rate ($p < 0.05$). The EETS group had higher ACTH and hGH levels than the TCA group ($p < 0.05$). There was no statistical difference between the two groups incidence of complications and disease recurrence rate ($p > 0.05$).
Conclusion: The craniopharyngioma resection via EETS has a significant therapeutic effect in complex craniopharyngioma with a high total tumor resection rate and clinical remission rate, which can protect the pituitary function of patients and provide more benefits for patients.

Keywords: neuroendoscopy; craniopharyngioma resection via expanded endoscopic endonasal transsphenoidal approach; complex craniopharyngioma; pituitary function

Introduction

Craniopharyngioma is a slow-growing benign tumor of the central nervous system located in the sellar or parasellar region, which can occur from any point of the pituitary-hypothalamic axis and develop along this axis, and the tumor is located from the sella to the third ventricle of the brain [1]. One study from Ramanbhavana *et al*. [2] has shown that craniopharyngioma is more common in young and middle-aged people than in the elderly. The typical symptoms of this disease are headache, vomiting, impaired vision, and polyuria. Severe cases have complications, including intracranial hypertension and hydrocephalus, which seriously threaten their life safety [3].

Correspondence to: Xiongjian Bu, Neurosurgery, Baoding No.2 Central Hospital, 072750, Baoding, Hebei, China (e-mail: 15130357726@163.com).

Surgery is an essential means of treating craniopharyngioma, and the transcranial approach (TCA) has certain limitations. The lower part of the optic lemniscus cannot be fully exposed, and the hypothalamus and the ventral posterior side of the optic chiasm cannot be directly viewed and protected. This surgery makes it hard to confirm whether the tumor is completely removed in direct vision, and the surgery has a poor surgical field, which affects tumor resection and may damage the surrounding tissues [4]. Part of tumors adhere firmly to adjacent structures, so they cannot be removed entirely or cause severe neurological sequelae [5]. The pituitary gland, as an important endocrine organ of the human body, is located in the hypothalamus, whose primary function is to control the secretion of various hormones in the human body. Surgical injury can lead to pituitary dysfunction, resulting in abnormal physiological functions of the body and even causing abnormal hormone secretion [6]. Therefore, more effective surgical methods are needed to improve complex craniopharyngioma treatment efficiency.

With the advancement of medical technology and the continuous development of endoscopic techniques, the expanded endoscopic endonasal transsphenoidal approach (EETS) has obtained clinical attention and has become a key research topic. Because the surgical perspective is the same as the growth direction of the tumor, the tumor can be completely exposed. During the resection, the relationship between the tumor and surrounding tissues can be carefully observed, and there is a clearer degree of adhesion between the tumor and its surrounding blood vessels, nerves, and tissues [7]. This surgery can be performed under the multi-angle mirror, and it can adapt to the anterior skull base, sphenoid platform, tuberculum sellae, optic chiasm, intrasellar, suprasellar, and clivus and other regions of tumor resection to make the total tumor resection easier. There are few clinical studies on the application of EETS in treating complex craniopharyngioma. Therefore, this study explored the efficacy of EETS and TCA in treating complex craniopharyngioma and their effects on pituitary function and complications to provide clinical treatment reference.

Research Subjects and Methods

Experimental Design and Participants

The medical records of patients diagnosed with complex craniopharyngioma in Baoding No.2 Central Hospital from December 2017 to December 2022 were retrospectively analyzed (the technical route is shown in Fig. 1). The surgeon of the selected patients was the same one. Inclusion criteria: (1) According to the diagnostic criteria of craniopharyngioma in the *Common Intracranial Tumors* [8], cystic margin and calcification were detected by CT imaging examination. Magnetic resonance imaging showed that the cyst fluid was cholesterol-like crystals with signal changes. The patients were diagnosed with complex craniopharyngioma by imaging, laboratory, and pathological examination. (2) Patients had no surgical contraindications. (3) Patients aged 11–60 years old. (4) Patients had complete clinical data. (5) Patients didn't have mental illness and could communicate with others normally. Exclusion criteria: (1) Patients didn't have cardiovascular, liver, kidney, or other organic lesions. (2) Patients had other malignant tumors and bleeding tendency. (3) The patients had anesthesia contraindications. (4) Patients exited halfway due to various reasons.

Moral Consideration

This study was approved by the ethics committee of Baoding No.2 Central Hospital. The researchers met the participants and their immediate family members separately and established a harmonious relationship with them. At the same time, researchers explained the research objectives, research steps, the content and steps of data collection, the duration of research, and the protection of the rights of participants. The obtained data did not reveal participants' personal privacy but presented an overall view. When patients participated in the study, the researchers asked the patients' immediate family members to sign the consent for participation. This study conformed to the Declaration of Helsinki.

Therapeutic Scheme

All patients were asked for detailed medical history on admission, especially the initial symptoms and onset time, including visual acuity, menstrual history, and abnormal lactation. Routine examinations were performed on patients before surgery, including hormone levels, blood routine, blood biochemistry, chest X-ray, electrocardiogram, and visual acuity.

The preoperative imaging examinations of 60 patients were retrospectively analyzed. The examination found that 30 patients had simple intrasellar type or cystic and substantial craniopharyngiomas growing into the sphenoid sinus or intrasellar combined with cystic craniopharyngiomas developing to the suprasellar region or preoperative endocrine dysfunction. Such patients received EETS treatment, and the remaining patients received TCA treatment. The imaging examination of the other 30 patients showed the dumbbell-shaped tumor mass on the saddle and in the sella, with a small sellar septum, or suprasellar tumor mass extending to the anterior, middle, and posterior fossa, or the suprasellar craniopharyngioma invading the sella, without reaching the sellar floor (the pituitary was located under the tumor). This type of patient received TCA treatment. The treatment methods of the two groups were as follows:

(1) The TCA group was treated with TCA under general anesthesia and tracheal intubation. According to the actual situation of patients, the approach was selected to open patients' brains layer by layer, enter the cerebral parenchyma, and remove the craniopharyngioma. After surgery, water and electrolyte management was performed on patients, and detection of vital signs, timely review of pituitary hormones, and review of hormone and corresponding hormone supplements were performed [9].

(2) The EETS group received the EETS treatment, and specific methods were as follows. After successful general anesthesia, patients were in a supine position to raise their shoulders properly, and the head was about 25° backward. The nasal cavity, mouth, forehead, and face of patients were disinfected, with the towels routinely disinfected, and the nasal cavity was filled with epinephrine cotton to make the mucosa contract. Nasal cavity phase: The neuroendoscopy entered from the nasal cavity, and the middle turbinate on the patients' right side was removed. The nasal septum mucosa was incised around the aperture of the sphenoidal, and the mucosal flap was stripped and placed in the posterior nasal meatus for skull base reconstruction. Sphenoid sinus phase: Neuroendoscope removed the anterior wall of the

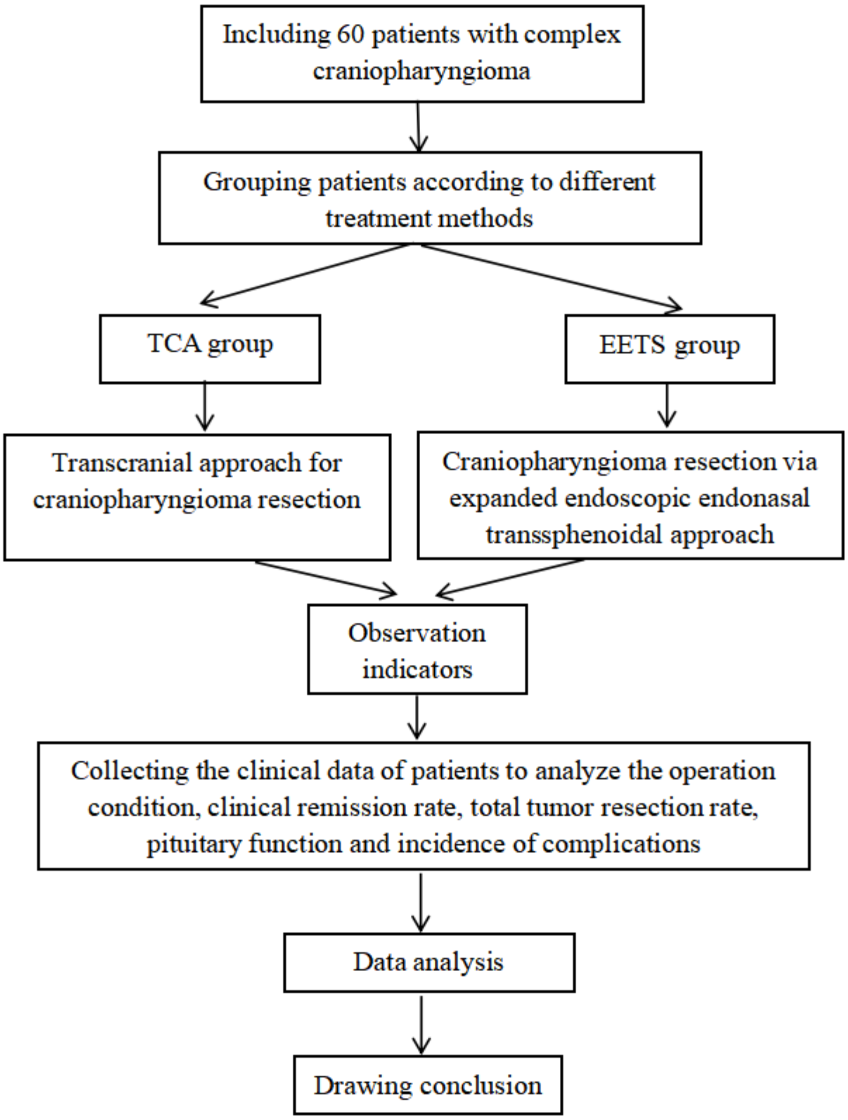

Fig. 1. Technical route. TCA, transcranial approach; EETS, expanded endoscopic endonasal transsphenoidal approach.

sphenoid sinus through the double nasal passages, entering the sphenoid sinus and posterior ethmoid sinus. Then, the sphenoid bone, tuberculum sellae, sellar floor, upper part of clivus, and bilateral and lateral wall of sphenoid sinus were exposed successively. Bone markers such as bilateral optic nerve eminence, internal carotid artery eminence, and medial and lateral optic nerve-internal carotid artery recess were identified, and neuronavigation verified the position of the midline, bilateral internal carotid artery, optic nerve, and upper, lower, left, and right boundaries of tumor. Saddle bottom-dura phase: The bottom of the sella was ground, expanding from the bone window to the tuberculum sellae and sphenoid bone, and bilateral optic nerves entered the medial edge of the optic canal. If necessary, the neuroendoscope expanded anteriorly and posteriorly to the anterior skull base, upper part of the slope, and both sides to the medial margin of the cavernous sinus. The dura mater was cut after electrocoagulation, then the upper boundary of the visual field was exposed to the anterior optic chiasm, and the lower boundary was exposed to the pituitary gland, entering the saddle area and upper saddle. Tumor phase: The arachnoid membrane was opened to detect the tumor, and intratumoral decompression was performed. The adhesion of the tumor with the lower part of the optic chiasm and the lower part of the optic thalamus was separated, and the pituitary stalk and corresponding blood vessels were protected. After tumor resection, the surgical area was rinsed with normal saline. Skull base reconstruction: After the surgery, the skull base was reconstructed with chemical glue, artificial repair material, middle turbinate mucosal flap, and biological glue. The nasal cavity was supported by a water-filled balloon, and the expansion sponge was used to stop bleeding.

Table 1. Comparison of clinical data of patients in both groups [n (%), M (P_{25}, P_{75})/($\bar{x} \pm s$)].

Indicators	TCA group (n = 30)	EETS group (n = 30)	Statistics	*p*
Gender			χ^2 = 0.278	0.598
Male/female	19/11	17/13		
Age [years old, M (P_{25}, P_{75})]	45.00 (25.25, 52.25)	47.00 (31.75, 54.25)	z = 0.414	0.679
BMI [kg/m^2, M (P_{25}, P_{75})]	21.08 (19.97, 22.58)	22.25 (20.52, 23.64)	z = 1.405	0.160
Pathological type			χ^2 = 0.271	0.602
Ameloblastic type	18 (60.00)	16 (53.33)		
Papillomatous type	12 (40.00)	14 (46.67)		
Tumor diameter (cm, $\bar{x} \pm s$)	3.46 ± 0.80	3.21 ± 0.95	t = 1.180	0.247
Residence			χ^2 = 0.268	0.605
City	13 (43.33)	15 (50.00)		
Countryside	17 (56.67)	15 (50.00)		
Tumor location			χ^2 = 0.334	0.846
Intra-suprasellar type	4 (13.33)	3 (10.00)		
On-saddle type	14 (46.67)	13 (43.33)		
Suprasellar three ventricles	12 (40.00)	14 (46.67)		

TCA, transcranial approach; EETS, expanded endoscopic endonasal transsphenoidal approach; BMI, body mass index.

Table 2. Comparison of clinical indicators in both groups [($\bar{x} \pm s$/M (P_{25}, P_{75})].

Groups	Intraoperative blood loss [mL, M (P_{25}, P_{75})]	Operation time (min, $\bar{x} \pm s$)	Tumor resection time (min, $\bar{x} \pm s$)	Hospitalization time [d, M (P_{25}, P_{75})]
TCA group (n = 30)	135.50 (102.75, 149.50)	160.17 ± 16.87	46.97 ± 6.89	18.00 (16.00, 20.25)
EETS group (n = 30)	75.50 (69.50, 85.50)	128.67 ± 12.85	28.30 ± 3.62	12.00 (11.00, 14.00)
Statistics	z = 6.093	t = 8.134	t = 13.134	z = 6.644
p	<0.001	<0.001	<0.001	<0.001

Postoperative management was conducted in two groups of patients. (1) One day after surgery, patients underwent MRI and CT examination to detect blood routine, blood glucose, blood lipid, electrolyte, and liver and kidney function indexes, and their postoperative bleeding was monitored. (2) Record of urine volume. If diabetes insipidus occurs, patients should be treated with pituitrin (batch No.: 220322; manufacturer: Anhui Hongye Pharmaceutical Co., Ltd., Bengbu, China; NMPA approval No.: H34022977; specification: 1 mL: 6 U × 10 pieces/box) and electrolyte management in time. (3) Conventional hormone replacement therapy was performed on patients, and hormone levels were reviewed after surgery.

Observation Indicators

(1) The clinical data of patients in the two groups were compared, including gender, age, body mass index (BMI), pathological type, tumor diameter, residence, and tumor location.

(2) Patients' surgical condition and hospitalization time in both groups were compared, including intraoperative blood loss, operation time, tumor resection time, and hospitalization time.

(3) The clinical remission and total tumor resection rates were compared between the two groups. The evaluation criteria were as follows. Clinical remission rate: The symptoms of patients were significantly improved after three months of follow-up, and the imaging examination showed that the tumor cells were reduced by >20%. Total tumor resection rate: Tumor burden reduction rate (%) = 1 – (postoperative tumor volume/preoperative tumor volume) × 100%. Total resection: tumor burden reduction rate = 1; near total resection: 0.96 ≤ tumor burden reduction rate <1; subtotal resection: 0.9 ≤ tumor burden reduction rate <0.96; partial resection: tumor burden reduction rate <0.9.

(4) The pituitary function of patients in the two groups was compared, including thyroid stimulating hormone (TSH), adrenocorticotropic hormone (ACTH), and human growth hormone (hGH).

(5) The incidence of complications in both groups was compared, including diabetes insipidus, cranial nerve injury, hemiplegia, and epilepsy.

(6) The complex craniopharyngioma postoperative recurrence rate was compared between the two groups. The follow-up time of patients was 12–60 months after surgery.

Statistical Analyses

SPSS software (version: 24.0; manufacturer: International Business Machines Corporation; Armonk, NY, USA) was used for all statistical analyses. The categorical variables

Table 3. Comparison of clinical remission rate and total tumor resection rate between the two groups [n (%)].

Groups	Nearly total resection	Subtotal removal	Partial resection	Cases of total tumor resection	Cases of clinical remission
TCA group (n = 30)	7 (23.33)	5 (16.67)	4 (13.33)	14 (46.67)	18 (60.00)
EETS group (n = 30)	3 (10.00)	2 (6.67)	1 (3.33)	24 (80.00)	26 (86.67)
χ^2				7.117	0.007
p				0.007	0.020

Table 4. Comparison of pituitary function in both groups [($\bar{x} \pm$ s/M (P_{25}, P_{75})].

Projects	Time	TCA group (n = 30)	EETS group (n = 30)	Statistics	p
TSH	Before surgery ($\mu IU/mL$, $\bar{x} \pm$ s)	3.31 $\pm$ 0.78	3.55 $\pm$ 0.77	t = 1.214	0.230
	After surgery [$\mu IU/mL$, M (P_{25}, P_{75})]	0.81 (0.49, 1.43)	1.73 (1.52, 2.56)	z = 4.458	<0.001
ACTH	Before surgery [pmol/L, M (P_{25}, P_{75})]	6.96 (6.21, 7.73)	7.24 (5.91, 8.58)	z = 0.577	0.564
	After surgery (pmol/L, $\bar{x} \pm$ s)	2.74 $\pm$ 0.65	3.37 $\pm$ 0.88	t = 2.750	0.006
hGH	Before surgery [nmol/L, M (P_{25}, P_{75})]	3.18 (2.61, 3.73)	3.11 (2.38, 3.73)	z = 0.518	0.605
	After surgery (nmol/L, $\bar{x} \pm$ s)	0.75 $\pm$ 0.33	1.11 $\pm$ 0.55	t = 3.085	0.003

TSH, thyroid stimulating hormone; ACTH, adrenocorticotropic hormone; hGH, human growth hormone.

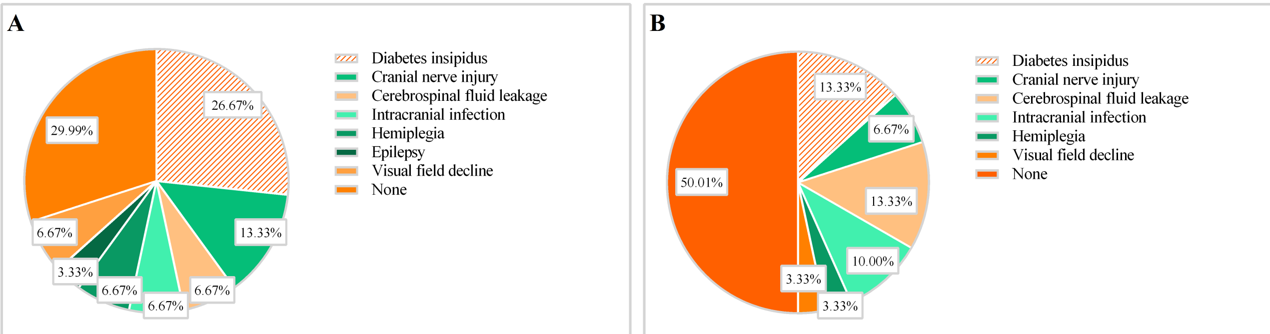

Fig. 2. Comparison of the incidence of postoperative complications in two groups. (A) The incidence of complications in the TCA group; (B) The incidence of complications in the EETS group.

such as gender and pathological type of patients in both groups were detected by χ^2 or Fisher's exact test, indicated by percentage. The continuous variables conforming to the normal distribution were detected by the *t*-test, and those not conforming to the normal distribution were detected by the nonparametric test, indicated by median (25th, 75th). $p < 0.05$ was considered statistically significant. Microsoft Office Word (version: 2006, Microsoft Corporation, Redmond, WA, USA) and the GraphPad Prism (version: 8.0; GraphPad Software; San Diego, CA, USA) were used to draw Figs. 1,2, respectively.

Results

Comparison of Patients' Clinical Data in Both Groups

There was no significant difference in gender, age, BMI, pathological type, tumor diameter, residence, and tumor location between the two groups, and no statistical significance existed in basic information ($p > 0.05$), as shown in Table 1.

Comparison of Clinical Indicators in Both Groups

Compared with the TCA group, the EETS group had less intraoperative blood loss, operation time, tumor resection time, and hospitalization time ($p < 0.001$), as shown in Table 2. The results showed that compared with the craniopharyngioma resection via the TCA approach, the EETS approach had higher surgical efficiency in treating craniopharyngioma.

Comparison of Clinical Remission Rate and Total Tumor Resection Rate between the Two Groups

The EETS group had a significantly higher total tumor resection rate and clinical remission rate than the TCA group ($p < 0.05$), as shown in Table 3. The results showed that the craniopharyngioma resection via EETS could improve the tumor resection rate and disease prognosis.

Comparison of Pituitary Function between the Two Groups

The EETS group had higher TSH values after surgery than the TCA group ($p < 0.001$) and had higher levels of ACTH and hGH than the TCA group ($p < 0.05$), as shown in Table

Table 5. Comparison of the incidence of complications in two groups [n (%)].

Projects	TCA group (n = 30)	EETS group (n = 30)	Statistics	p
Diabetes insipidus	8 (26.67)	4 (13.33)	$\chi^2 = 1.667$	0.197
Cranial nerve injury	4 (13.33)	2 (6.67)	$\chi^2 = 0.741$	0.389
Cerebrospinal fluid leakage	2 (6.67)	4 (13.33)	-	0.671*
Intracranial infection	2 (6.67)	3 (10.00)	-	1.000*
Hemiplegia	2 (6.67)	1 (3.33)	0.351	0.554
Epilepsy	1 (3.33)	0 (0.00)	1.017	0.313
Visual field decline	2 (6.67)	1 (3.33)	0.351	0.554

Notes: *indicated the results of Fisher's exact test and - showed no data.

Table 6. Comparison of recurrence rate of disease in both groups [n (%)].

Groups	Recurrence	Non-recurrence	Recurrence rate	χ^2	p
TCA group (n = 30)	6	24	20.00	0.480	0.488
EETS group (n = 30)	4	26	13.33		

4. The results suggested that craniopharyngioma resection may lead to endocrine disorders and decreased hormone levels. The craniopharyngioma resection via the EETS approach can protect the anterior pituitary lobe and reduce postoperative damage to pituitary function.

Comparison of the Incidence of Complications between the Two Groups

The incidences of cerebrospinal fluid leakage and intracranial infection in the EETS group were 13.33% and 10.00%, respectively, which were higher than 6.67% and 6.67% in the TCA group, and the difference was not statistically significant ($p > 0.05$). TCA surgery enters the skull from above the sellar floor to reach the tumor, and there is no damage to the sellar floor. Therefore, the chance of cerebrospinal fluid leakage after TCA is relatively low. However, EETS surgery requires opening the sellar floor to reach the tumor. Therefore, the incidence of cerebrospinal fluid leakage is relatively high after EETS surgery, which increases the contact between brain tissue and the outside world. External bacteria can easily enter the brain retrogradely, increasing intracranial infection risk. In addition, there was no statistical difference in the incidence of diabetes insipidus, cranial nerve injury, hemiplegia, epilepsy, and decreased visual field between the two groups ($p > 0.05$), as shown in Table 5 and Fig. 2.

Comparison of Recurrence Rate of Disease in Both Groups

There were 6 cases with relapses in the TCA group (20%) and 4 cases in the EETS group (13.33%). No significant difference existed in the recurrence rates between the two groups ($p > 0.05$), as shown in Table 6.

Discussion

In clinical practice, surgical resection is mainly used for the treatment of craniopharyngioma, but this type of surgery is difficult to operate, with high postoperative complications [10,11]. Complex craniopharyngiomas are adjacent to the hypothalamus, pituitary, and pituitary stalk. As an essential endocrine organ of the human body, the pituitary gland is located in the body's hypothalamus, whose primary function is to control the secretion of various hormones. Traditional transcranial surgery makes it easy to damage pituitary function, leading to pituitary dysfunction and causing physiological dysfunction and abnormal hormone secretion [12].

Endoscopic endonasal approach is an innovative technique, which is widely used in skull base surgery [13]. Na *et al.* [14] have shown that EETS can distinctly increase the total resection rate of tumors compared with TCA. Another study indicates that about 64% of patients with craniopharyngioma have postoperative pituitary dysfunction, but craniopharyngioma resection via EETS has certain advantages in protecting endocrine function [15]. The results of this study showed that the EETS group had less intraoperative blood loss, operation time, tumor resection time, and hospitalization time than the TCA group and had a significantly higher total tumor resection rate and clinical remission rate than the TCA group. This is because the craniotomy is disturbed by blood vessels and nerves, and the deep tumors cannot be seen directly, resulting in a weakened therapeutic effect on tumors [16]. Under craniopharyngioma resection via the EETS approach, the surgical perspective is the same as the growth direction of the tumor so that the tumor can be completely exposed. During the resection, surgeons can clearly observe the relationship between the tumor and surrounding tissues, which can improve the tumor resection rate, reduce the damage to the optic nerve bundle, and improve the prognosis of the disease. The above finding is consistent with the research results of Almeida *et al.* [17]. Their study shows that the craniopharyngioma resection via the EETS approach has a higher total resection rate than the craniotomy approach, showing good clinical results.

Guo *et al.* [18] indicate that the risk of pituitary dysfunction after craniopharyngioma resection is high, and pituitary dysfunction is related to the injury of the pituitary stalk. Complex craniopharyngioma is adjacent to the hypothalamus, pituitary gland, and pituitary stalk, and resection of this tumor easily causes pituitary dysfunction, most of which is permanent dysfunction [19]. Therefore, it is necessary to protect the pituitary stalk of patients and avoid its injury during craniopharyngioma resection. This study showed that the EETS group had higher TSH values after surgery than the TCA group, and this group had higher levels of ACTH and hGH than the TCA group. The reason may be as follows. The craniopharyngioma resection via the EETS approach can protect the anterior pituitary [20]. Neuroendoscopic resection of tumors from the pituitary stalk and below the optic chiasm can provide a clear surgical field of vision, help doctors better identify tumors and pituitary and peripheral nerve blood vessels, and reduce postoperative damage of pituitary function. This study found no statistical difference between the EETS and TCA groups by analyzing the incidence of complications and the recurrence rates of disease in both groups. The results may be related to the limitations of this study. EETS must remove the tumor by entering the nasal cavity via the sphenoid sinus, tuberculum sellae, and sphenoid platform to reach the tumor location. In this process, this surgery is easy to cause nasal tissue defects, and cerebrospinal fluid leaks from the defect site after surgery, resulting in cerebrospinal fluid leakage. This study showed that the incidence of cerebrospinal fluid leakage in the EETS and TCA groups was 13.33% and 6.67%, respectively. The results suggest that although EETS improves tumor resection rate and reduces the recurrence rate of the disease, postoperative complications cannot be avoided.

Based on the results of this study, the following two suggestions are proposed.

(1) The craniopharyngioma resection via the EETS approach has a clearer visual field than the TCA approach because the tumor tissue can be observed more completely. This surgery has complicated operations. Thus, preoperative and postoperative preparation and nursing should be done to ensure the clinical efficacy of patients.

(2) Neither EETS nor TCA can eliminate complications. Therefore, medical staff should also pay attention to postoperative monitoring and observe the postoperative recovery of patients so that they can take interventions on time in case of adverse events to minimize the adverse effects on patients.

This study has small sample size, which may lead to biased results, so the sample size should be expanded in future studies to further improve the study's objectivity. This study also did not record and analyze the long-term efficacy of patients, which needs to be further explored in future studies.

Conclusion

According to these results, craniopharyngioma resection via the EETS approach has a significant therapeutic effect in complex craniopharyngioma. This surgery can reduce the impact on patients' pituitary function with certain safety, providing a more evidence-based basis for selecting subsequent clinical treatment options.

Availability of Data and Materials

Data to support the findings of this study are available on reasonable request from the corresponding author.

Author Contributions

XJB designed the research study. XJB performed the research and analyzed the data. The author contributed to editorial changes in the manuscript. The author read and approved the final manuscript. The author has participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

Patients and their families who were informed of this study signed a consent form. This study has been approved by the ethical committee of Baoding No.2 Central Hospital [approval No.: (2022) No.55]. The study follows the Declaration of Helsinki.

Acknowledgment

Not applicable.

Funding

This research was funded by Baoding Science and Technology Plan Project (Efficacy of the Craniopharyngioma Resection via Expanded Endoscopic Endonasal Transsphenoidal Approach in the Treatment of Complex Craniopharyngioma and its Effect on Pituitary Function and Complications of Patients), Grant No. 2241ZF198.

Conflict of Interest

The author declares no conflict of interest.

References

[1] Jazbinšek S, Kolenc D, Bošnjak R, Faganel Kotnik B, Zadravec Zaletel L, Jenko Bizjan B, *et al*. Prevalence of Endocrine and Metabolic Comorbidities in a National Cohort of Patients with Craniopharyngioma. Hormone Research in Pediatrics. 2020; 93: 46–57.

[2] Ramanbhavana VS, Vara Prasad KS. A Case Series of Craniopharyngioma: Epidemiological Study and Management Analysis at Tertiary Care Center. Asian Journal of Neurosurgery. 2019; 14: 1196–1202.

[3] Kiliç M, Can SM, Özdemir B, Tanik C. Management of Craniopharyngioma. The Journal of Craniofacial Surgery. 2019; 30: e178–e183.

[4] Liu J, Wang P, Tang C, Jiang HT, Zhang G, Wu N. Endoscopic endonasal transsphenoidal approach for cran-

iopharyngioma: A case report. Experimental and Therapeutic Medicine. 2023; 25: 114.
[5] Prieto R, Pascual JM, Hofecker V, Winter E, Castro-Dufourny I, Carrasco R, *et al*. Craniopharyngioma adherence: a reappraisal of the evidence. Neurosurgical Review. 2020; 43: 453–472.
[6] Qiao N. Endocrine outcomes of endoscopic versus transcranial resection of craniopharyngiomas: A system review and meta-analysis. Clinical Neurology and Neurosurgery. 2018; 169: 107–115.
[7] Tosaka M, Yamaguchi R, Yamazaki A, Mukada N, Shimauchi-Otaki H, Osawa S, *et al*. Endoscopic Extended Transsphenoidal Approach for Sellar and Suprasellar Xanthogranuloma: Potential Implications for Surgical Strategies in Adult Craniopharyngioma. World Neurosurgery. 2022; 167: e27–e39.
[8] Müller HL. The Diagnosis and Treatment of Craniopharyngioma. Neuroendocrinology. 2020; 110: 753–766.
[9] Rock AK, Dincer A, Carr MT, Opalak CF, Workman KG, Broaddus WC. Outcomes after craniotomy for resection of craniopharyngiomas in adults: analysis of the National Surgical Quality Improvement Program (NSQIP). Journal of Neuro-oncology. 2019; 144: 117–125.
[10] Lei C, Chuzhong L, Chunhui L, Peng Z, Jiwei B, Xinsheng W, *et al*. Approach selection and outcomes of craniopharyngioma resection: a single-institute study. Neurosurgical Review. 2021; 44: 1737–1746.
[11] Tang B, Xie S, Huang G, Wang Z, Yang L, Yang X, *et al*. Clinical features and operative technique of transinfundibular craniopharyngioma. Journal of Neurosurgery. 2019; 1–10.
[12] Figueredo LF, Martínez AL, Suarez-Meade P, Marenco-Hillembrand L, Salazar AF, Pabon D, *et al*. Current Role of Endoscopic Endonasal Approach for Craniopharyngiomas: A 10-Year Systematic Review and Meta-Analysis Comparison with the Open Transcranial Approach. Brain Sciences. 2023; 13: 842.
[13] Li C, Zhu H, Zong X, Wang X, Gui S, Zhao P, *et al*. Application of endoscopic endonasal approach in skull base surgeries: summary of 1886 cases in a single center for 10 consecutive years. Chinese Neurosurgical Journal. 2020; 6: 21.
[14] Na MK, Jang B, Choi KS, Lim TH, Kim W, Cho Y, *et al*. Craniopharyngioma resection by endoscopic endonasal approach versus transcranial approach: A systematic review and meta-analysis of comparative studies. Frontiers in Oncology. 2022; 12: 1058329.
[15] Dho YS, Kim YH, Se YB, Han DH, Kim JH, Park CK, *et al*. Endoscopic endonasal approach for craniopharyngioma: the importance of the relationship between pituitary stalk and tumor. Journal of Neurosurgery. 2018; 129: 611–619.
[16] Aragón-Arreola JF, Marian-Magaña R, Villalobos-Diaz R, López-Valencia G, Jimenez-Molina TM, Moncada-Habib JT, *et al*. Endoscopic Endonasal Approach in Craniopharyngiomas: Representative Cases and Technical Nuances for the Young Neurosurgeon. Brain Sciences. 2023; 13: 735.
[17] Almeida JP, Marenco-Hillembrand L, Moniz-Garcia D, Goyal A, Olomu OU, Quinones-Hinojosa A. Endoscopic Endonasal Approach for Resection of a Recurrent Craniopharyngioma: Techniques to Maximize Surgical Exposure and Extent of Resection. World Neurosurgery. 2023; 180: 66.
[18] Guo Y, Pei L, Li Y, Li C, Gui S, Ni M, *et al*. Characteristics and factors influencing hypothalamic pituitary dysfunction in patients with craniopharyngioma. Frontiers in Endocrinology. 2023; 14: 1180591.
[19] Zhu H, Qiao N, Yang X, Li C, Ma G, Kang J, *et al*. Corrigendum to: “The clinical application of intraoperative visual evoked potential in recurrent craniopharyngiomas resected by extended endoscopic endonasal surgery”, [Clin. Neurol. Neurosurg. 214 (2022) 107149]. Clinical Neurology and Neurosurgery. 2023; 229: 107707
[20] Yu S, Taghvaei M, Reyes M, Collopy S, Piper K, Karsy M, *et al*. Evolution of Surgical Outcomes in Endoscopic Endonasal Resection of Craniopharyngiomas. Journal of Neurological Surgery. Part B, Skull Base. 2022; 84: 375–383.