

Experiences of Bifrontal Interhemispheric Approach in Craniopharyngioma Surgery

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Objective : The purpose of this study is to evaluate the surgical outcomes of bifrontal interhemispheric (BIH) approach and compare them to those of the pterional approach for the treatment of craniopharyngioma.

Methods : Seventeen patients had their first operation for the resection of craniopharyngiomas between 2000 and 2004 at our medical center. Eleven patients who had the pterional approach and 6 with the BIH approach were enrolled. The age range at the time of surgery was 5 to 80 years (mean age 35.6 years old). The presenting symptoms were visual disturbance in 12 patients and signs of increased intracranial pressure in 5 patients.

Results : The tumors were totally removed in 3 (27 %) and subtotally in 8 (73 %) patients with the pterional approach. Total tumor removal was achieved in 5 out of 6 (83%) patients by the BIH approach, except 1 patient with a subchiasmatic lesion. Vision was improved in 4 (36 %) patients treated with the pterional approach and in all patients treated by the BIH approach

Conclusion : The BIH approach for craniopharyngioma surgery may be an effective and safe approach for tumors that extend outside of the sellar-suprasellar region with acceptable outcomes.

KEY WORDS : Craniopharyngioma · Approach · Pterional · Interhemispheric.

Introduction

Although controversy exists regarding the optimum treatment for craniopharyngiomas, all neurosurgeons agree that total removal of the tumor is desirable if it can be done safely^{1,3,4,6}. However, the successful radical excision of a craniopharyngioma remains one of the most difficult procedures even in the era of microsurgery.

Surgeons use a variety of approaches according to the location and size of the tumor as well as surgeon preference. The approaches include transphenoidal (TSA), pterional, transcortical-transventricular, subfrontal, subtemporal, transtemporal, anterior interhemispheric (BIH) and anterior transcallosal approaches, alone or in combination^{7,9,12}.

In our institution, the pterional, transventricular, TSA, or their combined approaches have been preferred approaches, and recently the BIH approach has been used for the removal of a craniopharyngioma. The BIH approach is known to allow for a bilateral, wider operative field; in addition there is a better

midline orientation with views of important neural structures and perforating arteries, without requiring a combination with other approaches. This approach is recommended as a good surgical approach for removal of large suprasellar or retrochiasmatic craniopharyngiomas.

In this report, we evaluated the surgical outcomes of six cases treated by the BIH approach and compare them with those of the pterional approach at our hospital.

Materials and Methods

A total of 25 patients underwent the surgical treatment for a craniopharyngioma by 2 neurosurgeons between 2000 and 2004. Among them, 17 patients had their first operation and six patients had a second or the third operation. Eleven patients underwent a pterional approach and 6 patients a BIH approach for their first surgery and were enrolled in this study. There were 6 female and 11 male patients whose age at the time of surgery was between 5 and 80 years (mean age 35.6 years

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Table 1. Characteristics of 17 patients who underwent pterional and bifrontal interhemispheric(BIH) approach

Characteristics	Pterional (11 patients)	BIH (6 patients)
Age (yrs)		
< 18	3	3
≥ 18	8	3
Tumor size (mm)		
AP	27.5 ± 8.5	29.7 ± 9.5
T	29.5 ± 12.5	25.0 ± 6.4
H	33.9 ± 12.5	22.7 ± 6.6
Location		
intrasellar	0	0
intra- and suprasellar	4	0
suprasellar ± parasellar	7	4
extra- and intraventricular	0	2
Consistency		
solid	3	1
cyst	4	0
mixed	4	5
Calcification		
+	4	1
-	7	5
mean follow-up period (mos)	14.4	31.0

AP : anterior-posterior, T : transverse, H : height

old). The presenting symptoms included visual disturbance in 12 patients and signs of increased intracranial pressure in 5 patients.

Preoperative magnetic resonance images(MRI) were reviewed to evaluate the size, location and consistency of the tumor. Endocrine testing for the assessment of anterior pituitary function was performed before surgery, 1 week and 3 months postoperatively. Endocrine studies included basal serum levels of adrenocorticotropic hormone(ACTH), growth hormone (GH) and thyroid-stimulating hormone(TSH). An endocrinopathy was defined as a necessity of medical treatment at the last follow-up.

Ophthalmological examinations including visual acuity and field evaluation were performed before surgery, immediately after surgery and at 3 months postoperatively. Visual improvement was defined as an improvement in visual acuity or visual field evaluation at 3 months postoperatively. The extent of removal was determined by the neurosurgeon's estimation of residual tumor and postoperative imaging at 3 months.

Statistical Analysis

Statistical analyses were conducted using SPSS 10.0 for Windows (SPSS, Inc., Chicago, IL, USA). Results of tumor size were expressed as means ± standard error of means and analyzed using the Mann-Whitney *U* test. A *p*-value of less than 0.05 was considered statistically significant.

Table 2. Surgical and functional outcomes according to approaches

	Pterional (11 patients)	BIH (6 patients)
Extent of removal		
total	3	5
subtotal	8	1
partial	0	0
Vision		
improved	4	5
unchanged	6	1
worsened	1	0
Endocrinopathy		
DI	1	0
hypothyroidism	3	0
hypopituitarism	1	1

BIH : bifrontal interhemispheric, DI : diabetes insipidus

Results

Patient follow-up continued from 4 to 39 months (mean 18.8 months) (Table 1).

Preoperative MR findings

Tumor size

The mean anterior-posterior diameter of the tumor for the enrolled patients was 29.7 ± 9.5mm (mean ± standard deviation) and larger in the cases treated by the BIH approach. The transverse diameter and height of the tumor were larger in the cases treated by the pterional approach as 29.5 ± 12.5 and 33.9 ± 12.5mm, respectively.

The size of tumors was greater than 25mm in diameter. However, there was no significant difference in tumor volume between the pterional and the BIH group.

Location

For suprasellar lesions, the pterional or the BIH approach was performed. Two tumors extending to intraventricular lesions were resected by the BIH approach.

Consistency

One of 6 patients, who were in the BIH group, had a tumor with calcification. The tumor of the BIH group was predominantly mixed in 5 patients and solid in 1 patient. For the pterional group, the tumor was solid in 3 patients, cystic in 4 patients, and mixed in 4 patients. The presence of calcification was observed in 4 out of 11 patients.

Surgical outcomes

Table 2 summarizes the extent of tumor removal and functional outcome according to approach used.

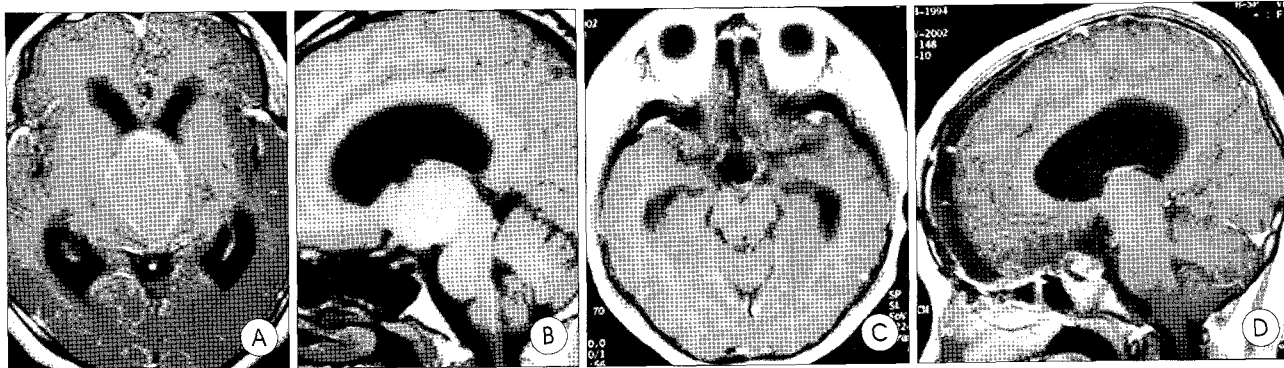


Fig. 1. Axial T1-weighted gadolinium-enhanced magnetic resonance image (A) and sagittal image (B) showing a homogenous sellar and suprasellar mass with the compression of the third ventricle. Postoperatively, total removal of the tumor is shown (C & D).

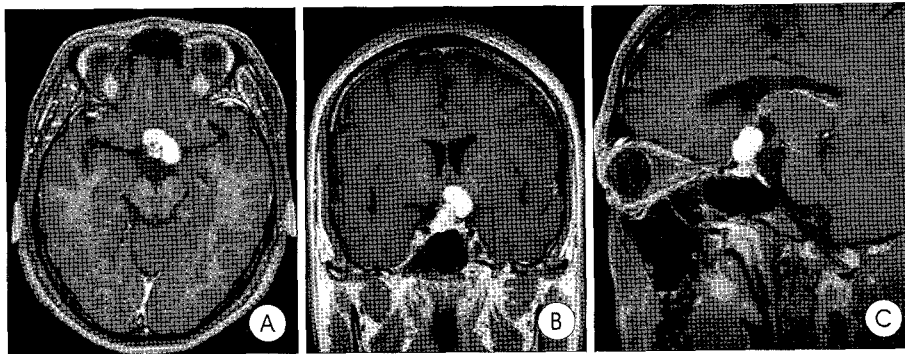


Fig. 2. 1.5mm-thin sliced magnetic resonance images showing a sellar and suprasellar mass (A, B & C). The suprasellar mass upwardly indenting upon the floor of third ventricle.

sellar and suprasellar mass, 40mm in the diameter, with the compression of the third ventricle. The mass abutted on the optic chiasm and was located at the superior portion of the optic chiasm. In addition, the enlargement of the lateral ventricle was noted. Total removal of the tumor was performed via the BIH approach (Fig. 1C, D). Transient diabetes insipidus was occurred immediately after surgery, but was otherwise uneventful. No tumor recurrence was observed on the most recent MRI.

Extent of resection and visual outcomes

Three out of 11 tumors, removed by the pterional approach, were completely removed, and the others were partially resected. Five of the 6 patients who underwent surgery by the BIH approach were totally removed, and the postoperative vision was improved in all patients. Four patients in the pterional group (36%) experienced the visual improvement. However, in 6 patients (54%) the vision was unchanged after surgery and in 1 the vision was worse.

Complications

An endocrinopathy was newly developed in 5 patients in the pterional group (45%), and the medical management was required in all patients during the follow-up period. One patient in the BIH group was diagnosed with panhypopituitarism. The CSF leakage developed in 2 patients in the BIH group, and 1 of them suffered from permanent anosmia.

Illustrative Cases of BIH groups

Case 1

This 16-year old girl was transferred to our emergency department for headache and vomiting. She had been aware of her reduced vision for several years, but this complaint was not reported. A preoperative MRI (Fig. 1 A, B) showed a homogenous

recurrence was observed on the most recent MRI.

Case 2

This 23-year-old man was referred to our hospital for visual disturbance. Preoperatively, the visual acuity of the right eye was 30cm finger count and the left eye was 0.4. In order to define the relationship of the tumor and the optic chiasm, a 1.5mm-thin sliced MRI was performed (Fig. 2). The long diameter of the mass was 25mm, and involved the sellar and suprasellar region. The suprasellar component showed cystic change and upward indentation to the floor of the third ventricle. Subtotal resection was achieved via the BIH approach; vision was unchanged. After surgery, adjuvant radiotherapy was performed.

Discussion

Many improvements in the treatment of craniopharyngiomas have been incorporated into patient management including : hormone replacement therapy, the ability of a surgeon to choose the best possible surgical approach on the basis of MRI studies, and microsurgical techniques. In the past decade, the newly defined goal of total tumor excision has been accomplished for many patients^{2,9,11,17,18}. However, the preferred

approach and the extent of surgery vary according to clinical presentation and surgeon judgment. The selection of the operative approach continues to be discussed without consensus.

The pterional approach has been reported as the most frequently used in several series^{19,20}. Yasargil et al.²⁰ used a pterional approach in 98 of 144 cases (68%), a combined approach in 30 cases (20.8%) and a TSA in 14 cases (9.7%) in his series. The study by Van Effenterre et al.¹⁹ suggests that radical surgery for craniopharyngiomas allows for a good outcome in terms of survival, full recovery, and quality of life for both adults and children. They chose the pterional approach in 112 of 122 cases as the best approach when attempting a total resection; these investigators recommended this approach for all patients with symptomatic craniopharyngiomas in adults and children. However, in their series there were 29 cases with symptomatic tumor recurrence. Fahlbusch et al.⁵ reported on their experience using the pterional and/or combined approach in 70 of 148 cases (47.3%), TSA in 35 (23.6%) and BIH approach in 17 (11.5%).

We agree with Garcia-Uria⁸ and Rougerie¹⁰ and that the TSA is not suitable for radical removal of craniopharyngioma. In contrast to adenomas that are usually soft, craniopharyngiomas are firm, calcified and tend to adhere to adjacent structures. Dissection to the optic pathway and the floor of the third ventricle is difficult and dangerous when the TSA is used. The resection of diaphragma sellae is often necessary to complete tumor removal and may increase the likelihood of CSF leakage. Therefore, it is best reserved for patients with small and cystic intrasellar-infradiaphragmatic tumors.

To date there is no consensus on which is better, the pterional or the BIH approach. Suzuki et al.^{15,16} and Shibuya et al.¹³ have previously described an interhemispheric approach for the treatment of most of craniopharyngiomas. The advantage of this approach is the minimal brain retraction; in addition, the arteries and veins coursing along the exposed dorsal and medial surface of the frontal lobe and over the corpus callosum can be saved. Fahlbusch et al.⁵ recommended a BIH approach if a major intraventricular tumor extension is anticipated; this is because this approach provides excellent midline orientation and the displaced floor of the opened third ventricle is exposed. Shirane et al.¹⁴ modified the traditional interhemispheric approach (bilateral subfrontal and interhemispheric approach) and used the basal interhemispheric approach combined with the translamina terminalis approach, that is, a frontobasal interhemispheric approach, to treat craniopharyngiomas protruding from the sellar-suprasellar region to the ventricle or septum pellucidum.

On occasion we use the frontobasal interhemispheric approach (bilateral subfrontal and interhemispheric approach); this is because it allows us to cut the falx at the lower level and be

able to drain CSF earlier. We remove from the prechiasmatic area and decompress cystic lesions by opening the capsule. Retrochiasmatic exposure is started by creating a midline incision in the lamina terminalis. If the third ventricle is elevated but not invaded by the craniopharyngioma, the thin tissue layer of the distended lamina terminalis is incised without opening the third ventricle. After the craniopharyngioma is exposed, it is debulked within the capsule for decompression so that the capsule can be gently removed from the surrounding structures. Perforating vessels are stripped away and the capsule is bluntly removed from the surrounding reactive gliotic layer or from the arachnoid covers.

Localization of tumor in relation to the optic chiasm is an important factor in removal²⁰. When the tumor is retrochiasmatic, it is not visible in the optic space and more difficult than other types. In this study, the tumor, removed by the BIH approach, included the retrochiasmatic portion and was resected after the opening of lamina terminalis. However, subchiasmatic lesion was a blind portion of the BIH approach. Illustrated case 2 was an example of pitfall in the BIH approach. Even though preoperative MR images showed that the tumor was mainly located in suprasellar lesion, intraoperative findings were quite different and total removal was not achieved due to a blind spot of the subchiasmatic lesion.

Size and consistency of the tumor are known to be associated with the extent of tumor resection. However, some authors reported that the size of the tumor did not interfere with the removal^{1,2,9}. This retrospective study does not show a significant difference in size and consistency between the pterional and BIH group, but suggests that the BIH approach may be useful for resecting large retrochiasmatic and suprasellar craniopharyngiomas. Our patients who underwent total or near-total removal of the tumors had a reasonably low morbidity with no intraoperative or postoperative mortality. Postoperative improvement in visual function was achieved in 5 out of 6 patients with BIH approach and any deterioration was not observed. These results seem to be comparable to those of other series in which the unilateral approach were primarily used^{19,20}.

We suggest that the bilateral median approach may be comparable to unilateral approaches, such as the pterional approach, for the removal of large midline tumors; this is because of the parasagittal alignment of important neural structures and perforators. For the unilateral approaches, important structures on the contralateral side are located in a blind spot behind the tumor, and the ipsilateral perforators located on the side of the approach interfere with tumor dissection. By contrast, bilateral median approaches allow for direct visualization of both sides of these structures. Perforating arteries do not disturb the operative view in the more median route used in the BIH approach.

Conclusion

Our findings suggest that the BIH approach can be effective and safe for craniopharyngiomas extending outside of the sellar-suprasellar region. Via this approach, tumors can be removed without significant sequelae related to the surgical method, due to ease of preservation of the pituitary stalk, hypothalamic structures, and perforating vessels.

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