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Review Article

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The Anterior Interhemispheric Transcallosal Approach in Craniopharyngiomas

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Abstract

Objective: *Craniopharyngioma is a type of embryo-epithelium tumor which originates from the remnant tissue of Rathke's pouch, and the tumor mostly grows in saddle. These tumors are associated with significant morbidity and mortality, primarily from their anatomic proximity to many critical neurological and vascular structures. This study aimed to summarize the clinical experiences and postoperative effects of the transcallosal approach for craniopharyngiomas.*

Methods: *A retrospective analysis was performed on 14 consecutive patients with craniopharyngioma who underwent surgical resection via anterior transcallosal route at the department of Neurosurgery of Cherchell Hospital between January 2015 and June 2020. All patients had thorough preoperative and postoperative ophthalmological and endocrine evaluations. The follow-up period ranged from 10 to 36 months.*

Results: *Gross total resection was achieved in eight patients (57%) in this series. Six patients (43%) with preoperative visual impairment experienced significant visual improvement. The overall recurrence rate was 36%.*

Conclusion: *The interhemispheric transcallosal approach can be used alone for purely intraventricular craniopharyngiomas, or they can be used in combination with other anterolateral and midline transcranial approaches to respect the intra and extra ventricular portions of the tumor.*

Keywords: craniopharyngioma, third ventricle, transcallosal approach.

Introduction

Craniopharyngioma is a type of embryo-epithelium tumor which originates from the remnant tissue of Rathke's pouch, and the tumor mostly grows in saddle. During growth, the tumor usually influences important tissue structures such as hypothalamus, visual pathway, stalk hypophysial and internal carotid. Besides, tumor removal may cause many complications, with low total removal and high recurrence rates. Thus, the resection of craniopharyngioma has always been a changeable operation in neurosurgery. With the application of microsurgical treatments, the transcranial approaches have been considered as safe and effective treatments for craniopharygioma. In order to preserve the quality of life and long term of tumor control and survival, surgical approaches selection must be based on careful preoperative evaluation, especially the anatomic location of the tumor. The commonly used transcranial routes include midline anterior, rontolateral approaches, transsphenoidal interphemispheric, unilateral subfrontal/bifrontal transbasal and transventricular approaches as the transcallosal or transfrontal route [1].

The transcallosal approach is typically used for craniopharyngiomas either within the third ventricle or with a significant third ventricular component. The purpose of the present study was to evaluate long-term follow-up results in a consecutive series of 14 consecutive patients treated microsurgically for craniopharyngioma using the transcallosal route in the department of Neurosurgery of Cherchell Hospital.

Materials and Methods

Preoperative evaluation: Before microsurgery, all patients underwent magnetic resonance imaging (MRI) plain and enhanced scan, and also computed tomography (CT). Four cases were diagnosed with definite calcification during the CT detection. Most tumors were in the saddle, growing along the midline, compressing optic nerve and optic chiasma, growing up into the third ventricle. Supratentorial ventriculomegaly could be observed in patients with

obstruction of interventricular foramen. Around six patients presented moderate to severe hydrocephalus. The maximum diameter of tumor was 2.5 to 7.8cm. Of all the cases, three cases were cystic, seven cases were solid cystic and the rest were parenchymatous.

The obvious reinforcement of cystic wall and parenchymatous part was observed through enhanced scanning. In six cases, the tumor bodies were completely in the third ventricle. Before the microsurgery, the patients went for routine examination of visual acuity and visual field to make clear the existence and extent of the vision and field damages. All the patients underwent comprehensively preoperative endocrine examination related to pituitary and hypothalamus, including checks for blood prolactin, thyroid hormones, gonadal hormones, growth hormone, adrenocorticotropic hormone, cortisol etc. There were two cases of cortisol decline and five cases of thyroid function decline in the laboratory preoperative examination.

Results

1. Patient characteristics: Among the 14 patients, there were eight males and six females. All the patients ranged from 3 to 56 years with a mean age of 21.6years. The course of disease was from 21 days to 12 months with an average duration of 7.3 months. Admission symptoms: headache (90%), impaired vision (45%), defect of visual field (40%), diabetes insipidus (35%).

2. Surgical technique: After induction of general anesthesia, the patient is placed in the supine position, with the head fixed in a Mayfield 3-pin head-holder. The head is then rotated 30 degrees to the side contralateral to the tumor. The head of the bed is elevated approximately 20 degrees.

The transcallosal approach offers midline access so that both walls of the third ventricle are identified. The patient is positioned supine, and a head frame maintains the head in the midline with a degree of flexion to aid venous return. The craniotomy is fashioned to primarily be right sided, anterior to the motor strip (no more than 2cm behind the coronal suture) with the left edge extending beyond the sagittal sinus to prevent craniotomy-induced injury. Careful stripping of dura from the bone flap should be conducted in this region with preparation to prevent air embolism or manage significant hemorrhage in the event of sinus breach. The dura is opened as a flap with caution given to any large cortical veins entering the superior sagittal sinus. These veins have been shown to predominate in the region 2 cm posterior to the coronal suture and should be mobilized rather than coagulated. In the interhemispheric-transcallosal route, retraction is preferred on the right side to facilitate gentle dissection down to the corpus callosum and to avoid the potential for retractor-induced sinus thrombosis. The arachnoid membranes over the interhemispheric fissure are very easy to dissect. Distinguishing the cingulate gyrus from the corpus callosum may require tracing of the callosomarginal arteries to their origin anterior to the corpus callosum.

The pericallosal arteries are identified and separated to create a safe working corridor to the corpus callosum between the two vessels. Colostomy is performed 1-2 cm behind the tip of the genu and should not be larger than 2.5 cm to prevent the occurrence of a disconnection disorder. Entry into the third ventricle may take the interforniceal, transforaminal or subchoroidal routes. On entering the lateral ventricle, to determine lateralization, the posterolateral to anteromedial trajectory of the choroidal fissure is sought. Fenestration and partial resection of the septum pellucid allows access to both lateral ventricles. Tumor debulking is performed in a piecemeal fashion once the tumor capsule is entered. Aspiration of any cystic components may help decompress the tumor and increase operative space. The aqueduct of Sylvius should be protected from haemorrhage by the placement of patties. Preservation of the ventricular walls, floor and infundibulum are paramount to prevent severe morbidity and therefore residual tumor attached to the floor of the third ventricle is probable. This adherent portion is thought to be the origin of the tumor. Once tumor resection is complete, irrigation and haemostasis are essential and the placement of an external ventricular drain is strongly recommended.

3. Postoperative treatments and follow-up: The electrolyte levels and 24hours quantity of the electrolyte were routinely monitored after operation. Within postoperative 24hours, the intracranial CT was rechecked to gain acquaintance of intracranial situation, and the endocrine hormone level was also reviewed. In the early postoperative time, patients were given cortisol and thyroid hormone to supplement or replace the treatments, desmopressin to control diabetes insipidus and redress water-electrolyte disorder in time. A postoperative review within one month was performed for all the patients with diabetes insipidus. The cranial MRI, endocrine, visual acuity and visual field were rechecked one to three months after surgery. And if residual tumors were found in the cranial MRI, patients would be instructed to undergo radiotherapy or radiosurgery; thereafter patients were reviewed every six months with MRI to observe the changes of tumor. Patients with no residual tumor were followed up every eight to twelve months.

4. Results: Transcallosal approach was used in the all of the cases. In this study, there were no cases died during operations. The extents of tumor resection were determined by intraoperative judgments and postoperative iconography. There were eight cases (57%) experiencing total tumor removal, four cases (29%) undergoing subtotal resection, and two cases (14%) suffering partial removal. The postoperative hospitalization was three to seven days with an average of 5.9 days.

5. Complications: In our study most of the patients had limited complications. Five (36%) cases had diabetes insipidus, including four (29%) cases of temporary insipidus (urine volume returned to normal level in one to three weeks) and one (7%) case of persistent insipidus. Within one month after surgery, six cases (43%) showed visual improvement, five cases (36%) had no visual change and three cases (21%) appeared visual deterioration. One patient presented with intracranial hematoma. This patient suffered reoperation to remove hematoma and then recovered. Thyroid function decreased in four (29%) cases and cortisol declined in three (21%) cases, which needed hormone for replacement therapy. Specific complications related to the transcallosal approach include seizures, venous infarct, impairment of short term memory and even transient mutism. Hemiparesis can arise as a consequence of venous infarction, retraction oedema and prolonged pericallosal artery retraction although this may be transitory. Memory

impairment is more common in this kind of procedure due to forniceal injury. The patients in our series did not experienced any one of these complications.

6. Follow up: The follow up ranged from 10 to 36 months with an average of 22 months. In this period, tumor recurrence occurred in five cases (36%), including one case with reoperation and four cases sended to adjuvant radiotherapy.

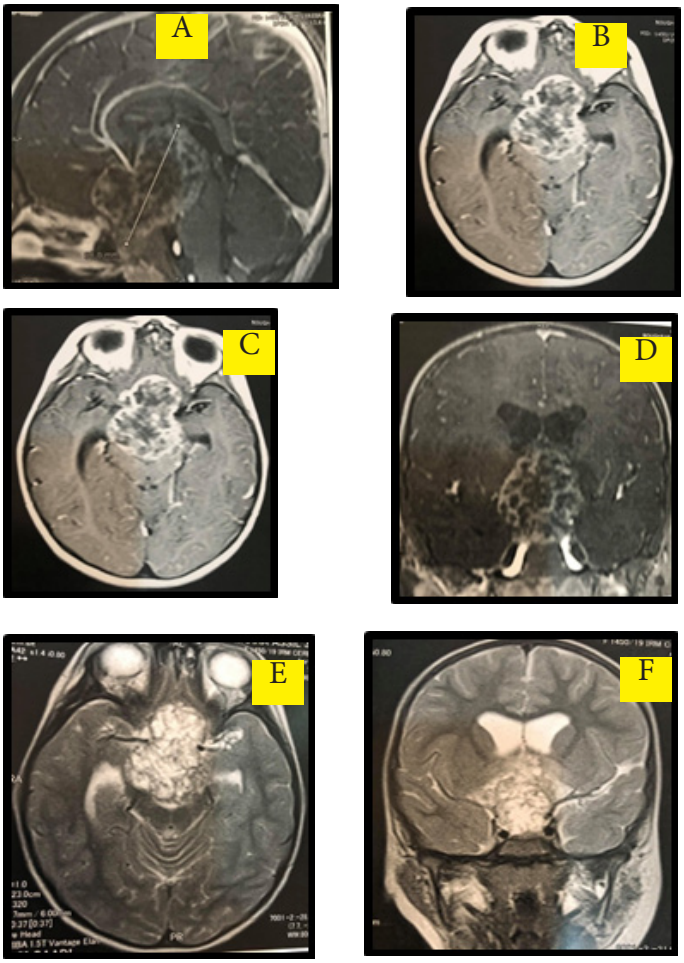
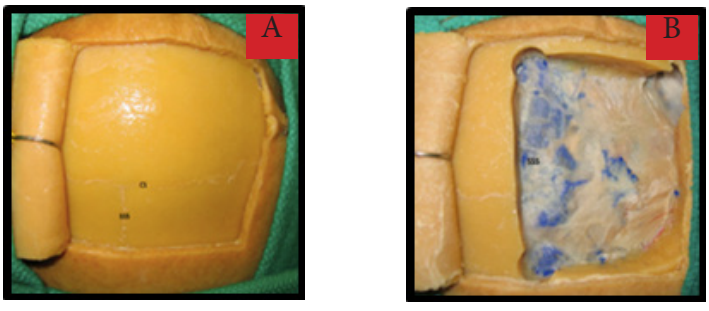


Figure 1: (A) preoperative mire showed a huge craniopharyngioma that protruding into the third ventricle. a, b, c: t1 enhancing sagittal, axial and coronal ; d, e : t2 axial and coronal.



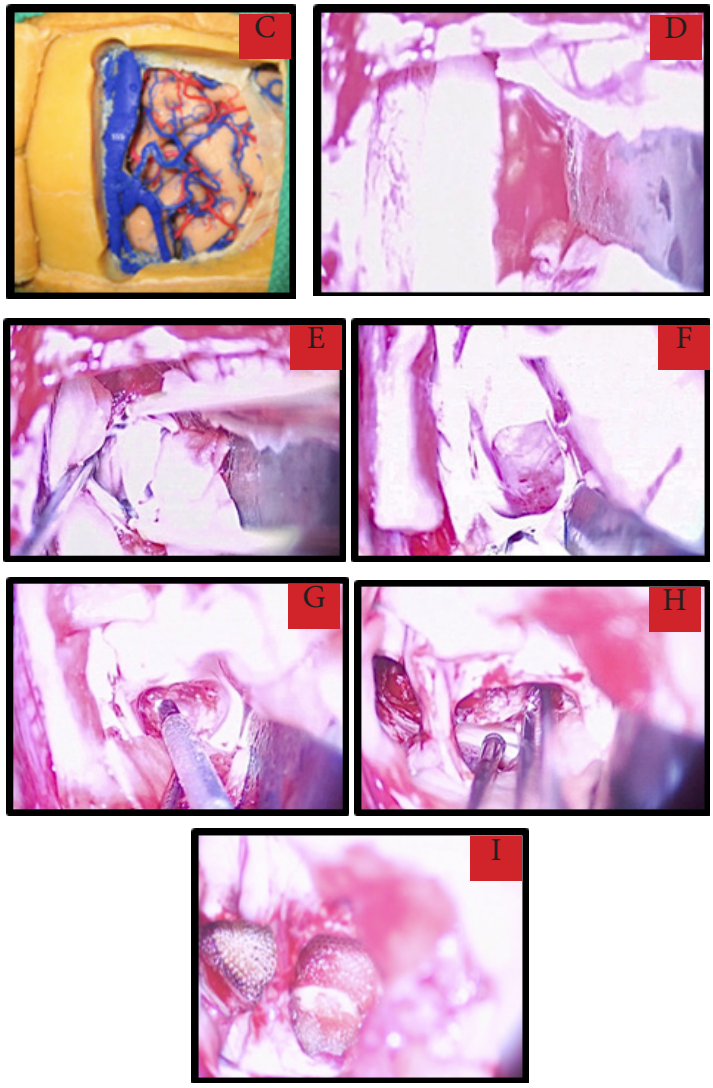


Figure 2: Different steps in the interhemispheric anterior transcallosal approach performing by the senior author. A, B, C: craniotomy and dural opening. D, E: anterior colostomy. F: entering the third ventricle through the interventricular foramen. G, H, I: tumor resection in piecemeal fashion. CC : corpus callosum. Tr: tumor

Discussion

Craniopharyngiomas are epithelial tumors, which are derived from Rathke's pouch and develop in the course of the craniopharyngeal canal. They account for one to 4% of all primary intracranial tumors, and 5 to 10% in children [1]. According to the literature, there is a bimodal age distribution with two peaks in children aged 0 to 19 years and in adults aged 40 to 79 years with a uniform distribution between the two genders [2, 3]. There are two main histological types of craniopharyngiomas, the adamantine type is more common in children and the papillary type is found almost exclusively in adults. The craniopharyngioma is considered grade I tumor according to WHO classification 2016 [4].

Their diameter varies from 2 to 4 cm, but can be significantly greater. They often have irregular contours with a cystic component (46 to 64%) [34]. The adamantine type is frequently calcified. Craniopharyngiomas from the pituitary stalk tend to extend mainly to the sellar region and then develop towards the parasellar region. On the other hand, tumors from tuber cinereum extend mainly upwards towards the hypothalamus and back into the third ventricle. Several topographical classifications have been developed for the group of craniopharyngiomas placed behind the chiasm, which usually involve the third ventricle area (classically considered as retrochiasmatic tumours). Some of the most remarkable ones are reported by Yasargil et al. Sami et al. And others [21,23].

All sharing the common feature of taking into account the relationships between the tumor and the third ventricle margins. Yasargil et al. found seven craniopharyngiomas with a pure third ventricle location among his 162 surgical operated cases. In comparison with the high prevalence of visual and endocrine disturbances usually observed in suprasellar craniopharyngiomas (between 70 and 90% of cases, both in adults and children), and their low prevalence of psychiatric symptoms (less than 15%), intraventricular craniopharyngiomas have a much lower frequency of endocrine (27%) and visual (28%) disturbances and a higher presence of psychiatric abnormalities (40%) and memory dysfunction (33%).

These differences must be related to the different position of the tumor, which is located above the suprasellar area and involves the third ventricle floor, including the mamillary bodies, and the hypothalamus [9,11,12]. Resection remains the mainstay of treatment for craniopharyngiomas with the goal of radical resection, if safely possible, to minimize the rate of recurrence. With the application of microsurgical treatments, the transcranial approaches have been considered as safe and effective treatments for craniopharygioma, but the surgery is quite difficult especially when the tumor had a large size. Therefore, one of the major challenges for neurosurgeon is how to achieve the maximal resection of these tumors with few postoperative complications. There are several transcranial routes that can be used for craniopharygioma and they can be broadly classified as midline anterior (trans sphenoidal, interhemispheric and unilateral subfrontal/bifrontal transbasal) or frontolateral (pterional-frontotemporal and modified orbitozygomatic) [23,24]. Other approaches have been described such as the posterior transpetrosal approach. Transcallosal approach is mostly used to deal with saddle tumor which has intruded into the third ventricle, lateral ventricle and septum pellucidum [5,6,8]. For tumors with lateral and third ventricular extension, the interhemispheric transcallosal trajectory can be further extended inferiorly using other approaches like transchoroidal, subchoroidal or interforniceal approach, which provides a safe, wide corridor into the third ventricle.

The transcallosal approach has several important advantages. It does not require cortical incision, and is feasible when ventricular enlargement is not great. The transcallosal approach requires minimal retraction upon the brain and provides easy access to both lateral ventricles and foramina of Monro. It also provides an outlet for the escape of cerebrospinal fluid from the lateral ventricles to the subarachnoid space [15,20]. As one would expect, the chief limitation of any intraventricular approach is access to the anterior suprasellar space. Transcallosal approach has difficulty in removing the craniopharyngioma which locates in the saddle or beneath the optic cross at saddle back. These techniques are largely reserved for purely third ventricular craniopharyngiomas, or tumors whose extension predominantly expands along a superior-inferior trajectory centered about the anterior third ventricle. Additionally, the risks of forniceal injury, pericallosal artery injury, venous infarct (injury to internal cerebral veins or bridging veins), and postoperative seizures, although frequently overstated, remain important considerations.

In their series, Feng et al. find that epileptic seizure occurred in seven patients (6.4%) and the symptoms were controlled through expectant treatment. One month after surgery, improved or unchanged vision was observed in 109 cases (92.4%), deteriorated vision was shown in nine patients (7.6%), with two of the nine cases going blind [25]. After the surgery, there were also two cases of cerebral infarction and nine cases of hemorrhage and tumidness of the right frontal lobe (three with frontal lobe contusion, and six with frontal lobe hematoma), and four of the nine cases received evacuation of hematoma for right frontal lobe in endoscope and had good recovery after surgery, the other 5 cases received conservative treatments (one patient discharging from hospital had grade 3 left limb myodynamia).

Long et al. emphasized that it is an advantageous approach for tumors located within the third ventricle or lateral ventricles and is particularly appropriate for craniopharyngiomas within the third ventricle [20]. Such tumors, by virtue of their large size and intimate relationship to the optic chiasm, circle of Willis, and hypothalamus, have been virtually impossible to remove by standard techniques.

Behari et al [11]. concluded that Intraventricular craniopharyngiomas occur in an older population and present mainly with raised intracranial pressure. Visual and endocrinologic imbalances are much less in these lesions compared to the suprasellar craniopharyngiomas. They mainly attach to the third ventricular floor. The surgical approaches to the third ventricle, along with radiotherapy and hormone supplementation, were successful in the management of these rare tumors.

In summary, the interhemispheric transcallosal approach can be used alone for purely intraventricular craniopharyngiomas, or they can be used in combination with other anterolateral and midline transcranial approaches to resect the intra and extraventricular portions of the tumor. When the tumor grows up higher than the monro foramen plane or into the lateral ventricle, craniopharyngioma can be removed through the transcallosal lateral ventricle-monro foramen.

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