Management of craniopharyngiomas

Craniofaringiomas. Análise crítica da literatura

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ABSTRACT

The authors reviewed the literature about the management of craniopharyngiomas and about the main complications of surgical treatment. The different approaches and the prognosis are also critically discussed.

Keywords: craniopharyngioma - hypopituitarism - diabetes insipidus - pituitary stalk – surgical approach.

RESUMO

Os autores fazem uma revisão estruturada da literatura sobre o manejo dos craniofaringiomas e sobre as principais complicações do tratamento cirúrgico. As diferentes vias de acesso são discutidas, bem como o prognóstico.

Palavras-chave: craniofaringioma, hipopituitarismo, diabetis insipidus, haste hipofisária.

INTRODUCTION

Craniopharyngiomas are benign tumors originated from squamous epithelial remnants of Rathke’s pouch. They can arise from the nasopharynx wall to the tuber cinereum and may develop within the sphenoid bone, the sella, or the suprasellar region, and may extend into anterior and middle cranial fossa.

Craniopharyngiomas may be localized purely intrasellar craniofaringiomas (4%), intra and suprasellar (21%) and suprasellar lesions, which occasionally extend into the third ventricle (75%).

20. Regarding to suprasellar lesions, the majority are placed in infundibulum what may lead to visual impairment due its correlation to optic chiasm. Usually, these tumors are retrochiasmatic in the setting of the so-called pre-fixed chiasm, but they can occur as prechiasmatic lesions between the two optic nerves.

PATHOLOGY

Histologically, craniofaringiomas are classified into two major types:
- Adamantinomatous - typically found in the pediatric age. It consists of calcifications and usually have both cystic and solid components. Calcification is commonly seen and may occur in nearly 60% of cases.
- Papillary - often a solid tumor, and more common in adults than in children.

Fig. 1. (A) CT (axial view) - a cystic craniofaringioma in a child with endocrinological symptoms. (B) MRI (coronal view) - cystic craniofaringioma in a child with endocrinological symptoms.
Clinical Findings

Epidemiological studies have demonstrated that craniopharyngiomas correspond to approximately 2 - 4.5% of intracranial tumors. They have a bimodal age distribution with peaks at ages 5 to 14 and later in life at ages 50 to 74 years-old. There is no clear gender preference for these tumors and no underlying genetic susceptibility has been discovered. Craniopharyngiomas account for 10% of pediatric brain tumors, with 100 new cases annually in the United States and is the most common suprasellar tumor in the pediatric age.

Symptoms are present due to three different physiopathological aspects:
- Endocrine problems.
- Mass effect
- Cognitive dysfunction.

Endocrine symptoms are diabetes insipidus (15%), dysfunction of the anterior pituitary gland, which in children produces growth and sexual retardation and in adults produces secondary gonadal failure with low gonadotropin output.

Mass effect may cause headache, which may also accompany obstructive hydrocephalus seen in those patients who have obstruction of the third ventricle and subsequent increased intracranial pressure. Symptoms of high intracranial pressure is usual in children and significantly less common in adults. Visual impairment may be caused by mass effect.

Cognitive dysfunction is characteristic of elderly patients with craniopharyngiomas and is probably related to a combination of endocrinopathy, direct effect on the structures of the region of the hypothalamus and repetition meningitis due to cholesterol crystals in the cyst of craniopharyngiomas.

Classification

Classifications of the growth patterns of craniopharyngiomas have been suggested by a few investigators. Among these, a suggestion made by Hoffman is both simple and applicable in most cases, and useful for surgical planning. According to his description

(1)- sellar type - are confined to the sella turcica or only protrude a short distance above the level of the diaphragm sellae.

(2)- prechiasmatic type - grow forward, pushing the chiasm and the horizontal portions of the anterior cerebral arteries upward and backward (postfixed chiasm)

(3)- retrochiasmatic type grow backward into the third ventricle and push the chiasm forward against the tuberculum sellae (prefixed chiasm)

(4)- giant type grow in various directions, including the posterior cranial fossa.

Diagnosis

Bitemporal hemianopsia, which is characteristic of chiasmal lesions may be detected in visual field examination. The visual acuity should be documented and may often be affected if there is direct pressure on the optic nerves. The optic fundi need to be evaluated for the presence of optic atrophy and in children for papilledema.

Children need to be evaluated with regard to growth and sexual development with periodic measurements of height and weight and Tanner staging as they approach puberty.

Micropenis may be found in male child patients. The most prominent secondary effects include growth retardation and gonadal failure producing sexual retardation. Secondary effects following surgery include what is commonly termed hypothalamic obesity, which occurs in as many as 30% of postoperative patients. Clinical workup revealed diabetes insipidus in 16.1% of the patients with no prior surgery. Secondary adrenal failure (ACTH deficiency) and secondary hypothyroidism are observed in 31.5% and 24.5% of patients, respectively. Secondary hypogonadism, which may be found in 77.4% of cases, is by far a more frequent finding. Hypothalamohypophysial disconnection with consecutive hyperprolactinemia may be present in 41.3% of patients at initial presentation.

Laboratory diagnosis consists of serum electrolytes and water balance and the measurement of anterior pituitary hormonal function including evaluation of growth hormone, IGF-1, TSH, free thyroxin, cortisol, FSH, LH, testosterone/estradiol and prolactin.

Neuroimaging is the most accurate exam for diagnosis. MRI scan is the gold standard for demonstrating the anatomy and the pathology, and CT scan is often helpful for detecting calcifications. These imaging studies also provide an assessment of the relationship of the tumor to the optic chiasm and the third ventricle and permit the identification of hydrocephalus.

Other laboratory diagnostic procedures include a formal neuro-ophthalmologic consultation and visual field testing and neuropsychological cognitive evaluation.
The differential diagnosis includes Rathke’s cleft cyst, pituitary adenoma, astrocytoma of the hypothalamus or optic chiasm and suprasellar arachnoid cyst, epidermoid tumors, lymphoma, breast metastasis.

### TREATMENT

#### CONSERVATIVE
The various categories of treatment include conservative management with observation and careful monitoring, medical therapy with replacement of hormone deficiencies.

#### SURGICAL
Some craniopharyngiomas even exhibit fingerlike attachments to critical structures such as the hypothalamus, optic nerves, pituitary stalk, and basal cebrovascularula . Dissection is further complicated due to the tumors’ propensity to cause an intense gliosis and dense arachnoid adhesions to the surrounding brain parenchyma and neurovascular structures. Complete microsurgical resection of the tumor appears to offer the most favorable patient outcome.

The operative strategies depend largely on the size, location, and extent of tumor, and additional factors may be the cystic or solid type and is it first or second surgery. There are 3 critical sites in craniopharyngioma surgery that all approaches should respect avoiding additional damages: pituitary stalk, hypothalamus and perforating arteries.

Growth pattern is closely correlated to the origin of the tumor, whether it is above or below the diaphragm sellae. In craniopharyngiomas with prechiasmatic growth, the major portion of the tumor should be resected by gentle traction. These tumors are candidates for the transsphenoidal approach if the sphenoid sinus is pneumatized. Craniopharyngiomas with retrochiasmatic growth, which are not covered by diaphragm sellae and contact brain tissue directly, are easily torn by traction and the craniopharyngioma-gial interface should be carefully dissected under direct vision through craniotomy.

Surgical treatment with craniotomy (figures 2a, 2b) has been the standard for many years. It is indicated for suprasellar tumors and allows for visualization of the optic nerves, the optic chiasm, and the relationship of the tumor to these structures and the carotid arteries and the IIIrd cranial nerve. For small tumors predominantly in the sella, the transsphenoidal approach is of choice (Figures 3a, 3b, 3c).

However, if it is located in infundibulum, the pterional approach (figures 4a, 4b) or subfrontal and even small orbitofrontal craniotomies (endoscopic or microscoic assisted) can be used successfully. Exclusively small intraventricular lesions can be reached through the lamina terminalis or transventricular (trans-callosal or the transventricular approaches).

Fig. 2. Bifrontal craniotomy: In A, a cystic craniopharyngioma with cholesterol fluid. In B: cyst is drained in order to facilitate the microsurgical approach.

Fig. 3. (A) MRI (sagital view) - solid craniopharyngioma with suprasellar extension. (B) Transphenoidal access using endoscope may be useful to completely resect the tumor. (C) MRI (sagital view) - complete resection of the tumor by means of transphenoidal approach with endoscope.

Fig. 4. (A) – MRI ( coronal view ) - a cystic solid craniopharyngioma. (B) Female patient undergone a pterional approach, with removal of the entire tumor.

The main types of approaches for big tumors are pterional, subfrontal transbasal, extended pterional, bifrontal, orbitozygomatic, temporopolar, fronto orbitozygomatic, modified osteoplastic frontoorbitozygomatic craniotomy for children, fronto orbitozygomatic temporopolar. For giant tumors, combined skull base approaches may be useful, taking into consideration the position in relation to optic chiasm (retrochiasmatic, chiasmatic, prechiasmatic).

Currently, the bifrontal approach is rarely performed. The classic technique was previously described and attention should be taken to symmetrical dissection of the both olfactory nerves.
opening of interhemispheric cistern and gently retracting the frontal lobes. Access is obtained through the optic chiasmatic cistern and both carotid optic cisterns. After shrinking the capsule with bipolar or draining the cyst, dissection is performed in the outer limits of capsule: the tumor is taken in piece meal or it is removed “en bloc” by gentle traction.

The pterional approach should be performed in the side of higher visual deficit or in the side where the tumor is more pronounced. The Sylvian cistern is fundamental in this approach and the cerebrospinal fluid (CSF) should be drained till complete relaxation of brain: it facilitates the removal of tumor between the ipsilateral carotid-optic space and optic-chiasmatic space. If the tumor is retrochiasmatic with posterior extension, an extended pterional approach or a temporo polar approach may be performed, with gaining of more posterior space.

The subfrontal transbasal approach is our preferred one, as for many authors: with a right sided frontobasal craniotomy, we may access the tumor in the subfrontal region, with dissection of the ipsilateral olfactory nerve. If the bigger expansion of tumor is placed in the left side, a left sided craniotomy is performed. After CSF drainage, the frontal lobe may be elevated with retractors and the tumor be removed between the carotid artery and optic nerve or between the two optic nerves.

Radical removal of retrochiasmatic craniopharyngiomas with posterior hypotalamic expansion has generally been accepted to be one of the most difficult operations. Transpetrosal-transstentorial approach was proposed by Hakuba to treat those tumors. The principal advantage of this technique is that it allows to visualize and preserve the hypothalamus, even in cases where it is remarkably displaced upwards, allowing also to directly visualize and preserve the third ventricle walls (in cases of the intraventricular extension of the tumor) and the inferior surface of the optic chiasm and nerves. Some tumors that invade the IIIrd ventricle can be removed in this fashion and using a midline approach for midline tumors is often appropriate.

Transsphenoidal surgery is indicated particularly in cases that present with an enlarged sella where the assumption can be made that the origin of the tumor may be below the diaphragm. Small tumors can be removed completely using a transsphenoidal approach.

The transsphenoidal extended skull base approach (TESBA) can be utilized for dealing with tumors with significant intracranial extension, providing that the axis of the tumor is appropriately along the path of surgery using the transsphenoidal route and the removal of the tuberculum sella and the planum sphenoidale in order to obtain access to the retrochiasmatic space.

Endoscopic exploration after lesion evacuation is generally easier and of greater efficacy when the residual cystic cavity is larger as opposed to smaller. The use of angled endoscopes is optimal in larger residual cavities. Early descent of the suprasellar cistern, bleeding inside the residual cyst cavity, and a small sella are the most common causes preventing thorough exploration of the residual cavity after its evacuation. Endoscopic exploration of the sellar cavity during transsphenoidal surgery offers both general and specific advantages in the treatment of craniopharyngiomas and a variety of different cystic sellar lesions (including cystic adenomas, Rathke’s cleft cysts, and arachnoid cysts).

Total resection is still believed to give patients the greatest chance of having an independent and productive life, free from recurrences.

**Postoperative complications**

**Endocrinological**

The rate of new adrenal and thyroid failure postoperatively is less pronounced. The percentage of hypogonadism increases slightly postsurgery. Improvement or complete recovery of preoperative anterior pituitary deficits is relatively rare.

Growth hormone deficiency may be observed in 72% of patients in the primary surgery group who are assessed preoperatively by means of an insulin tolerance test. Similarly, 73.9% of children are GH-deficient. However, short stature is found in only 46.7% of the children at initial presentation. Short stature is observed in 13.3% of the adult patients at the time of diagnosis.

Diabetes insipidus is the most common postoperative deficiency in both the transcranial and transsphenoidal groups. In the case of primary surgery (surgery as initial therapy), the overall percentage of patients with diabetes insipidus increases from 16.1% preoperatively to 59.4% postoperatively. Landolt and Zachmann observed a relatively low incidence of new postoperative diabetes insipidus, but a high risk of postoperative anterior pituitary failure after transsphenoidal surgery.

**Radiation therapy**

Total resection is often impossible, either by craniotomy or by transsphenoidal approach, and in those cases subtotal resection followed by one or another form of radiation therapy is useful. Fractionated radiation therapy clearly delays
recurrence and Gamma Knife radiosurgery (GK) in suitable cases has beneficial effects on residual tumor.

Kobayashi et al evaluated 107 patients with craniopharyngiomas who were submitted to GK after surgery. They found changes in neurological and pituitary–hypothalamic symptoms as overall improvement which was demonstrated in 17 (18.7%), no change in 59 (64.8%), and deterioration in 15 (16.5%). The outcome was documented in 93 cases: excellent in 42, good in 23, fair in seven, poor in three, and dead in 18 patients.

Radiation therapy is associated with some small risk of complications with regard to damage to the optic nerves, the hypothalamus, and to cognitive function. Radiation therapy should be avoided in the immature brain, particularly in children that are younger than 9 years-old.

**Intracavitary Therapy**

Most cases of craniopharyngioma have a cystic element, so reduction of the cyst volume is often desirable. This can be achieved through various methods of aspiration, shunt systems, and introduction of chemotherapeutic elements. An Ommaya reservoir system is commonly used for drainage of the cystic elements: it is placed during open surgery or by stereotactic access (figures 5a, 5b).

In primary or recurrent cystic tumors, intracavitary surgical therapy can be done using stereotactic techniques and the installation of radioactive isotopes into the cyst cavity, or the installation of a chemotherapeutic agent Bleomycin and currently alpha interferon INF α can be considered. Yttrium-90 intracavitary irradiation may be used stereotactically applied (STAIR) in craniopharyngioma cysts, with a 50% decrease in cyst volume maybe apparent two or four months later, a 70% decrease in cyst volume between the 5th and 6th months and an 80% reduction by the 7th and 8th months.

**References**


