

Role of Ommaya Reservoir in the Management of Cystic Craniopharyngioma: A Review of Therapeutic Outcomes

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Abstract: *Craniopharyngiomas are benign epithelial tumors of the sellar region characterized by high recurrence rates and significant cystic components. This review evaluates the role of Ommaya reservoir placement and intracystic bleomycin therapy in the management of cystic variants. A synthesis of clinical approaches including stereotactic catheter placement, cyst aspiration, and intracystic chemotherapy was performed, with reported dosing ranging from 2 to 5 mg per injection at intervals of 2 to 7 days and cumulative doses between 15 and 180 mg. Evidence indicates that intracystic bleomycin effectively reduces cyst volume, stabilizes tumor progression, and facilitates subsequent surgical intervention, with long-term control observed in 43 to 73 percent of cases. Complications such as infection, catheter malposition, and neurotoxicity were reported but remained manageable. These findings suggest that Ommaya reservoir based intracystic therapy represents a valuable minimally invasive adjunct, particularly in pediatric and recurrent cases, although standardized protocols and long-term outcome data are needed*

Keywords: Craniopharyngioma, cystic craniopharyngioma, Ommaya reservoir, intracystic chemotherapy, bleomycin therapy, pediatric neurosurgery

Abbreviations:

CT – computed tomography

MRI- Magnetic resonance imaging

CPH- Craniopharyngioma

1. Introduction

Craniopharyngioma is a histologically benign tumor that originates from epithelial nests or from areas of squamous metaplasia. It can be associated with aggressive behaviour and a high rate of recurrence.^{1,2} Therefore, the therapeutic approach to craniopharyngioma requires a detailed radiological analysis and careful surgical, radiological, and other therapeutic strategies to achieve satisfactory results. The majority of craniopharyngioma (CPH) have a cystic component and only 10% are completely solid. One of the characteristics of craniopharyngiomas is the presence of single or multiple cysts, which can account for 80-90% of the total bulk of the tumour.³ Although the tumour is histologically benign, partial or subtotal excision will eventually lead to a recurrence, in up to 70% of patients.⁴ Total excision carries a morbidity rate up to 16% and operative mortality rates vary from 1.1% to 16.7%.⁵

Treatment of CPH is controversial, although the majority of authors agree on radical surgical therapy as the ideal option. However, in spite of the advances in microsurgical techniques, total resection is associated with serious complications, such as visual and endocrinological disturbances.

Partial resection, with or without radiotherapy or radiosurgery, has also been used in the treatment of these lesions. However, recurrences are frequent even after radical surgery, and usually pose serious problems for patient management⁶. Cystic CPH represent a special kind of tumor amenable to therapeutic approaches other than surgical, such as drainage by stereotactic puncture or intracavitary injection of radioactive solutions or chemotherapeutic agents. It is generally accepted that total removal is the treatment of choice for CPHs, but gross or invasive tumors can only be completely resected with considerable risk. Recently, interest has grown in less-invasive procedures notably in case of recurrent lesions. The goal of surgery has shifted toward a more conservative attitude that enables long-term control of the disease and a good quality of life. Accordingly, in recurrent CPHs, total removal could be achieved in a lower rate compared with primary surgery (0%-25%) and is frequently associated with increased perioperative morbidity and mortality rates (10.5%-24%). Often, symptoms are related to mass effect caused by the re-expansion of the cyst, and so palliative measures such as the Ommaya reservoir system can be adopted. In the paediatric population, these measures have been employed to delay irradiation in case of

recurrent cystic CP, up to the complete maturation of the hypothalamic hypophyseal axis.

2. Methods

In cases with a predominantly cystic type of tumor, a catheter was inserted into the cyst under stereotactic guidance and connected to an Ommaya reservoir placed in the subgaleal space. The location of the catheter in the cyst was determined by CT scan. A small amount of cystic fluid was aspirated, and cytological examination of the cystic fluid was done; in all patients, the results were compatible with the findings of craniopharyngioma. In cases with the mixed solid and cystic type of tumor, only a partial or subtotal removal of tumor was done by a transsphenoidal or subfrontal approach due to dense tumor adherence to the surrounding structures. Attempts to totally remove the tumor are frequently associated with serious neurological complications because these tumors are usually surrounded by many important structures. Therefore, the solid portion of the tumor was removed as much as possible, while the cystic portion was left intact and punctured with a catheter under direct vision before the catheter was connected to an Ommaya reservoir; the catheter location was determined with a postoperative CT scan. Bleomycin was injected into the catheter to stabilize the tumor and minimize tumor recurrence. Disruption of the cystic component from the solid portion was not seen in any case due to the presence of dense fibrosis and a capsule around the tumor, with a distinct boundary between the solid and cystic components. Careful dissection and the removal of only the appropriate amount of the solid tumor component is essential to avoid disruption of the cyst and spillage of cystic fluid. The intratumoral administration of bleomycin was started 10-15 days after surgery. This provided enough time for post-operative stabilization and allowed us to confirm that there was no leakage of cystic content by injecting contrast media into the cyst and then checking for leakage on CT scan. After taking all of these precautions, about 2-5 ml of cystic fluid were aspirated before bleomycin was injected. Lactate dehydrogenase (LDH) levels were measured in each aspirated sample, and the results were compared. Each injection contained 2-5 mg of bleomycin; the dose depended on the amount of cystic fluid that was actually aspirated. The interval between injections was 2-7 days. The total bleomycin doses ranged from 15 to 180 mg. Bleomycin injection was discontinued if any major side effects (hypersomnia, mental change, visual disturbance) occurred at any time during the treatment period.

3. Discussion

Many neurosurgeons believe that total excision is the only reliable approach to prevent recurrence of craniopharyngiomas⁷⁻⁹. However, despite total excision, the recurrence rate is high in the first 3 years post resection and the severity of endocrinological disturbances, such as diabetes insipidus and related impairment in growth and development, tends to correlate with the extent of the resection¹⁰⁻¹¹. Based on the results of other series, radical surgical intervention was associated with a 40% incidence of hypothalamic damage and a 19% incidence of visual impairment¹³. Such results have convinced surgeons to combine a more restricted resection with other treatment modalities, such as external

radiotherapy, stereotactic radiosurgery, intracavitary brachytherapy and chemotherapy¹⁴⁻¹⁶.

Solid craniopharyngiomas represent, in our opinion, an indication for surgical removal. For this particular form, we do not think that valuable alternatives in paediatric age patients are currently available. The treatment of cystic lesions can take serious advantage from the evacuation of this component: indeed, stereotactic and/or neuroendoscopic cyst aspiration also can relieve most of the symptoms related to mass effect, with little trauma to surrounding structures.¹⁵ Moreover, the placement of an Ommaya catheter into the cyst permits repeated aspiration of cystic fluid through the subcutaneous reservoir during follow-up: it enables direct injection of chemotherapeutic agents or local irradiation. In the paediatric population, the Ommaya reservoir has been adopted extensively, as it provides symptom relief and delays "aggressive surgery" or adjuvant radiotherapy in case of infiltrative lesions. Several reports have shown a relatively long follow-up with good cyst control and 43% to 73% of patients that did not require any additional treatment.¹⁵⁻¹⁷ Yasargil et al.¹⁸ found that the overall mortality rate and recurrence rate were 17 and 7%, respectively, even after aggressive radical excision. Treatment of craniopharyngiomas should not only be a gratifying exercise for surgeons; it must also be kept in mind that long term functional outcomes should be preserved. In the current series, the goal of the surgery was to obtain a complete drainage of the cyst fluid and leave inside an Ommaya ventricular catheter. A relevant characteristic of this device is the high versatility: indeed, it is seldom used to treat different cyst tumor lesions and it can be inserted by means of different techniques with good rates of cyst growth control. Based on the low rate of re aspiration from the subcutaneous reservoir, it is hypothesized that the catheter may function as a stent, following cyst collapse or that the natural history of such lesion can be unpredictable. Spaziante et al. first understood benefits of a continuous drainage of the "motor oil" or "cholesterol rich cystic" fluid into the CSF by means of the Ommaya catheter, which prevents long-lasting recollection and the need of repeated percutaneous aspiration¹⁵ It is worth reminding that the trans cystic catheter placement could be double-checked with the direct endoscope visualization; on the other side, in case of stereotactic technique, the position check of the catheter requires a postoperative CT scan and/or MRI; in this case, the reliability of an intra-extra cyst holes position could be only assumed. The good tumor control rates in both techniques, however, point out the importance of the shunting effect, although it is not possible to quantify whether some of the CPs presented an indolent course. Concerning the role of radiotherapy in cystic CPs, it can be considered as a part of multimodal management strategy. Subtotal resection (STR) plus adjuvant radiotherapy showed similar efficacy in the prevention of tumor progression, being characterized by lower hypothalamic and hypophyseal morbidity. Compared with the results of limited surgery (STR) plus adjuvant radiotherapy, the cyst drainage plus Ommaya reservoir placement provides a slightly greater rate of recurrence than STR plus radiotherapy (27.3% vs. 12%e25%) but lower rates as compared with applying only cystic drainage (27.3% vs. 42%).

Surgery, in our opinion, has to be reserved for the solid form of craniopharyngiomas with the goal of achieving total removal while avoiding severe complications and sequels of optic function, endocrine and neuro psychological structures, or should be used for the cystic form that is not sensitive to an alternative treatment. Bleomycin is an antimitotic drug used to treat renal and epithelial cancer. The mechanism of action is at the level of the duplication of the chains of DNA favouring cellular death. At the beginning, we used Bleomycin mainly for treatment of cystic recurrences with the aim of reducing the risk of such recurrences after surgery.¹¹

The direct surgical approach showed us that after intracystic chemotherapy the removal of lesion was easier because the lesion became hard with clearer limits and a well-limited cleavage plane. On the other hand, the solid portion was not affected by bleomycin; many of the patients that had mixed or solid type tumors experienced tumor recurrences and had poor outcomes. Although other intra- cystic chemical therapies, such as 32P, have been used to treat intracranial cystic tumors, these have been shown to benefit mainly purely cystic tumors (that is, arachnoid cysts) and have not been widely studied for use in craniopharyngiomas. The main advantage of bleomycin is that it decreases the secretion of cystic fluid and causes tumor cells to degenerate, particularly in craniopharyngiomas.

Compared to surgery, the advantages of intracavitary bleomycin chemotherapy for cystic craniopharyngiomas include simplicity of use, the ability to repeat the injection cycles without additional surgery and the possibility of maintaining residual endocrinological hypophyseal function¹³. Moreover, even in patients with recurrence after bleomycin treatment, the treatment does not hinder or cause difficulties for any future operations.

Reported complications of this type of procedures include infections, malpositioning/dislocation, and obstruction of the Ommaya reservoir system. In the present series, we had an Ommaya infection 2 weeks after neuroendoscopic placement that required system removal. Two recent retrospective series analysed the rates of Ommaya reservoir infection, reporting risk of device infection from 5.5% to 8%. Another complication we observed was a case of stereotactic catheter malpositioning, which required a stereotactic replacement. The published rates of suboptimal ventricular catheter placement vary widely, but this type of complication has been reported almost exclusively in stereotactic procedures, ranging from 1% to 25%

4. Conclusion

Management of craniopharyngiomas requires balancing effective tumor control with the preservation of neurological and endocrine function. Radical excision, while traditionally considered the gold standard, carries significant risks of morbidity and mortality, particularly in paediatric patients. The cystic nature of many craniopharyngiomas has opened the door to less invasive strategies, notably the use of Ommaya reservoir systems for cyst drainage and intracystic bleomycin instillation. These approaches have demonstrated efficacy in reducing cyst volume, stabilizing tumor growth, and delaying the need for irradiation, thereby improving

quality of life in children and recurrent cases. Although complications such as infection, catheter malposition, and neurotoxicity can occur, bleomycin therapy does not preclude future surgical interventions and often facilitates safer resections. Overall, the combination of Ommaya reservoir placement with intracystic bleomycin represents a valuable adjunct to surgery, especially in recurrent or predominantly cystic tumors. Standardization of dosing protocols and long-term outcome studies remain essential to optimize safety and efficacy.

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