Clinical note

Treatment of cystic craniopharyngioma with $^{90}$Y-Colloid. Four clinical cases


Keywords: Cystic craniopharyngioma, Yttrium-90 colloid, Intracavitary irradiation, Guided radiotherapy

Abstract

Craniopharyngioma is a histologically benign and frequently cystic intracranial tumor. It may present aggressive behavior due to compression from nearby structures. Its therapeutic management is complicated because although surgery is the usual treatment of choice, it is not exempt of high morbidity and mortality and frequent tumor recurrence. In craniopharyngiomas with a significant cystic component, internal irradiation with radioactive isotopes is a therapeutic alternative to conventional treatments.

We present the cases of four patients with cystic craniopharyngiomas who were treated with intracystic administration of $^{90}$Y-colloid, and their evolution after the treatment.

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Introduction

Craniopharyngioma is a usually suprasellar intracranial tumor derived from embryonary cells of the pharyngeal Rathke pouch. Despite being histologically benign and of slow growth, it usually presents aggressive local behavior. This type of tumor is frequently cystic containing fluid and causing space-occupying symptomatology, with endocrine disorders and visual alterations being the most common manifestations.

Craniopharyngiomas are relatively infrequent tumors which present 2 peaks of incidence: one during infancy and the other in adulthood around the 5th decade of life. The diagnosis and characterization of the lesion are carried out by imaging studies, mainly magnetic resonance (MR), showing a variable appearance based on the proportion of solid and cystic component as well as possible calcifications. Although the treatment of choice in most cases is surgery, followed or not by radiotherapy, in craniopharyngiomas presenting an important cystic component in which complete resection is difficult, internal irradiation of the tumor with radioisotopes is a useful option for improving symptoms and represents an alternative to conventional treatments, despite not being exempt of secondary effects, mainly visual deterioration. This type of treatment produces fibrosis of the cystic wall and a reduction in fluid production and, thus, slower growth and collapse of the cyst.

We present the cases of 4 patients treated with a $^{90}$Y-Colloid, $\beta$ emitter with a mean energy of 0.93 MeV, soft tissue penetration of 3.6 mm and a period of semidesintegration of 64 h. All the patients had had recent imaging tests specifying the dimensions of the cyst. Calculation of the dose to inject was performed using the formula described by Backlund considering the volume of the cyst and applying a dosimetric factor of correction for sphericity to achieve a dose of 200 Gy distributed uniformly throughout the wall of the cyst (Table 1; Fig. 1). The injection was made in the operating room by an expert neurosurgeon, with stereotaxic puncture in 3 cases and using an intrathecal access device in the remaining case (Ommaya reservoir).

Clinical cases

Clinical case 1

The first case was a 61-year-old female with a history of headache, polyuria, amenorrhea and incomplete bitemporal...
hemianopsia. In an initial MR study a predominantly cystic suprasellar tumor of 35 mm in diameter was observed with pointed calcifications in the capsule which distorted the optic system and partially occupied the third ventricle, suggestive of craniopharyngioma. The initial treatment was craniotomy and resection of the lesion. Four months later, on clinical and radiological evidence of lesion persistence, treatment with 192.4 MBq (5.2 mCi) of $^{90}$Y was administered, presenting clear improvement in the visual fields one month after the intervention.

Clinical case 2

A 55-year-old woman with a history of reduction in visual acuity, left lateropulsion on walking, alteration of superior functions (apathy and alteration of memory), reduction in strength in the left hemibody, urinary incontinence and hypersomnia. The MR study showed a suprasellar tumor compressing the mesencephalon, the right optic nerve and the chiasm as well as the floor of the diencephalon, the third ventricle and the right thalamic nucleus, being predominantly cystic and approximately 30 mm in diameter, suggestive of craniopharyngioma. Treatment with 129.5 MBq (3.5 mCi) of $^{90}$Y was decided upon, resulting in marked improvement in the long tracts, the superior functions, sonnolence and hemiparesis 3 weeks after the intervention.

Clinical case 3

A 33-year-old male showed a reduction in visual acuity and a posterior cortisol deficit, being diagnosed with a suprasellar lesion with compression of the chiasm and the right optic nerve by MR. The patient underwent 2 surgical interventions performing evacuation of the cyst. Posteriorly, an Ommaya reservoir was placed due to the need for periodic emptying of the cystic content (every 12 d). At 22 months after diagnosis the patient was treated with $^{90}$Y through the intracranial reservoir, injecting 293.78 MBq (7.94 mCi). Following treatment a reduction in cystic volume from 17 cm$^3$ to 9.4 cm$^3$ was observed by computed tomography (CT), decreasing the periodicity of intracystic emptying to 3.5 months. Clinically, the patient referred progressive loss of binocular vision and diplopia.

Clinical case 4

A 23-year-old male was diagnosed with cystic craniopharyngioma at 5 years of age on presentation of anterior and posterior panhypopituitarism, undergoing radical resection of the suprasellar and subtetrochiasmatic craniopharyngioma. Posteriorly, the patient received radiotherapy treatment and underwent 2 other interventions, the last at 22 years of age. Eight months after this surgery the control MR showed images of cyst remnants with adhesion to the optic chiasm and the hypophyseal stem and marked growth of the cystic cranial portion with respect to the previous imaging study (Fig. 2A–C). Treatment with $^{90}$Y was decided upon by stereotactic puncture, injecting a total dose of 125.8 MBq (3.4 mCi). In the CT performed 9 months after treatment, a marked reduction in the cyst was observed in size (Fig. 2D), with the patient remaining asymptomatic and with good control of hypophysial function.

Discussion

The use of radioactive isotopes for intracavitary treatment of cystic craniopharyngiomas was first employed in the 1950s. The radioisotopes described for this objective are basically the 3 beta radiation emitters: $^{186}$Re, $^{90}$Y and $^{32}$P, with yttrium being the most widely used due to its short period of semidesintegration. Nonetheless, some studies recommend the use of $^{32}$P instead of $^{90}$Y since it presents slightly inferior beta emission energy, has a longer period of semidesintegration and has lesser tissue penetration, producing fewer secondary effects, although it seems that the rate of response with both isotopes is similar. The initial treatment is surgery. However, irradiation with isotopes is indicated in those patients in whom the tumor cannot be completely resected, when 50% or more of the tumor is cystic and when the number of cysts is less than 3 and in the cases of post-treatment recurrence with symptoms due to a large, single cyst.

It seems that intracavitary irradiation of this type of tumor produces less deterioration of hipophysial function and quality of life than other treatments. Nonetheless, the most frequent complication of this therapy is visual deterioration. In the literature reviewed most of the cases with visual deterioration took place in patients with previous optic disease, which may indicate that loss of vision is not only related to the irradiation of the zone but also to other predisposing factors. This may explain the evolution of patient number 3 whose vision worsened following treatment with $^{90}$Y. Frequent transitory paralysis of the cranial par iii has also been described, and it has been speculated that this may be due to an excess of radiation of the anterior optic tract or in the branches of the perforating arteries of the vertebrobasilar system which would produce clinical signs of a paramedian thalamic, peduncular or pontine infarction (paralysis of par iii, absence of oculocephalic reflexes, alterations in memory, etc.).

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**Table 1**

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<th>Formula</th>
<th>Description</th>
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<tr>
<td>$V = 4/3 \pi (abc)$</td>
<td>Calculation of the volume of a spherical cyst.</td>
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<tr>
<td>$f = \frac{100 V}{A}$</td>
<td>Calculation of the dose to be administered.</td>
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Source: Backlund ED.²

a–c = radiuses, in cm, of the cyst in 3 directions of space.

$r$ = radius of a spherical cyst.

$f$ = dosimetric factor obtained empirically depending on cyst volume and which is applicable in ellipsoid and spheroid cysts if the mixture of the colloid injection with the cystic fluid is complete and homogeneous.

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**Fig. 1.** This graph shows the dosimetric factor ($f$) as a function which increases according to the diameter of a spherical cyst which contains a solution of $^{90}$Y. X: diameter of cyst (in mm). Y: value of $f$ based on the diameter of the cyst (in $\mu$Ci/ml).
Fig. 2. Images corresponding to clinical case number 4. A: sagittal cranial CT slice prior to treatment with 90Y in which tridimensional reconstruction of the cyst is observed (blue color). B: with this reconstruction it is possible to make a precise calculation of the volume of the cyst. C: Pretreatment axial CT slice showing a rounded, cystic hypodense lesion in the suprasellar region (arrow) corresponding to the cystic craniopharygioma. D: axial cranial CT slice after intracystic irradiation demonstrating a very significant reduction in cyst volume (arrow).

Julow et al.\textsuperscript{8} presented a series of 60 patients with recurrent cystic craniopharyngioma treated with 90Y followed during 30 years and concluded that it is a useful therapy which induces a long-lasting diminishment in the volume of the cyst, although it does present a number of neurological and vascular complications which the authors attribute to a probable excessive doses of radiation applied to the wall of the cyst.

In the cases presented, the calculation of the dose of 90Y to inject was made based on the desired dose in the cyst wall of 200 Gy since, according to the literature, doses inferior to 100 Gy are associated with early failure and greater cyst recurrence, while doses greater than 400 Gy more probably cause damage derived from the radiation.\textsuperscript{9}

In the 4 patients studied, we observed that this type of therapy with 90Y is useful since it reduces the dimensions of the cyst with a consequent improvement of the symptoms derived from the compression of neighboring structures and because the follow up of the patients treated seems to be favorable.

References