Differential Diagnosis and Surgical Management of Cerebellopontine Angle Cystic Lesions

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ABSTRACT
Cerebellopontine angle (CPA) tumors in adults are mainly benign and extra-axial. Although the most common CPA lesion (vestibular schwannoma) is familiar to most neurosurgeons, cystic lesions of the CPA do pose an important diagnostic challenge demanding a careful consideration of a wide range of differential diagnosis including: epidermoid cysts, arachnoid cysts, schwannomas, meningiomas as well as other rare entities such as vascular and malignant tumoral lesions. The authors present a critical review of the current literature on cystic CPA lesions, providing an overview about possible differentials as well as guidelines for preoperative imaging evaluation of a cystic CPA lesion.

Keywords: Cerebello-pontine angle, epidermoid cysts, arachnoid cysts, cystic schwannomas, cystic meningiomas, differential diagnosis, surgical management.

SUMÁRIO
A maioria dos tumores de ângulo ponto-cerebelar em adultos são benignos e extra-axiais. A lesão mais comum do ângulo ponto-cerebelar (schwannoma vestibular) é familiar à maioria dos neurocirurgiões. Entretanto lesões císticas do ângulo ponto-cerebelar merecem uma análise cuidadosa, levando-se em consideração uma ampla gamada de diagnósticos diferenciais, dentre os quais: cistos epidermóides, cistos aracnóides, neurinomas císticos, meningiomas císticos, bem como outras entidades mais raras como lesões vasculares e tumoriais malignas. Os autores apresentam uma revisão crítica da literatura, proporcionando ao leitor uma visão geral sobre os possíveis diagnósticos diferenciais bem como atuais diretrizes para a avaliação imacenológica de lesões císticas no ângulo ponto-cerebelar.

Palavras-chave: ângulo ponto-cerebelar, cisto epidermóide, cisto aracnóide, neurinoma do acústico, schwannoma vestibular, diagnóstico diferencial, tratamento cirúrgico.
INTRODUCTION

Cerebellopontine angle tumors in adults are mainly benign and extra-axial. Cystic lesions of the CPA often pose as an important challenge to neurosurgeons, demanding a careful pre-operative evaluation about a wide range of possible differential diagnosis, as well as a tailored surgical technique according to each particular lesion.

The possible histopathological diagnosis for a cystic lesion in the CPA is, in order of frequency: epidermoid cyst, arachnoid cyst, cystic schwannoma, cystic meningioma and other rare entities, described in few case reports, such as neurocysticercosis, neurenteric cyst, cavernous malformations as well as malignant tumoral lesions, which may present as cystic heterogeneous masses due to intra-tumoral necrosis.

EPIDERMID CYSTS

Typically epidermoid cysts are extra-axial lesions with the imaging signal similar to the cerebrospinal fluid. These tumors usually show undulating margins, modeling their shape to match with the CPA and insinuating themselves around the nerves and blood vessels in the CPA. A lamellated or onion-skin appearance and small peripheral rim of calcification may be seen in few cases.11

Magnetic resonance imaging (MRI) usually show no enhancement with gadolinium: they are of hypo or iso-intense sign in T1 weighted (T1W) images with iso or high signal intensity on T2W images and FLAIR (Fig. 1).33,34

However, the most striking characteristic, which is very suggestive of epidermoid tumors, is the marked restriction (presenting a bright appearance) at Diffusion-weighted imaging (DWI). The apparent diffusion coefficient (ADC) values of epidermoid tumors are significantly lower than that of CSF, and higher than that of deep white matter.9 There are, however reports of unusual image findings in epidermoid tumors such as hyperdensity in computed tomography (CT) and on T1- and T2-weighted MRI. These late imaging characteristics are thought to be caused by a high protein concentration within the content of the cyst.26

Figure 1. In epidermoid cysts, although MRI sequences may demonstrate an expansive lesion with compression of the cerebellar parenchyma (Patient 1 -A, B and C), the lesion usually spread diffusely through the cisternal spaces. (Patient 2 - D, E and F). These lesions usually are non-enhancing (A and B) and present hype or isointense signal in T2 (C) and FLAIR (D) and a typical pattern of marked restriction in diffusion-weighted sequences (E) with typical low apparent diffusion coefficient (ADC) values (F).

Figure 2. Surgical illustration of a right retrosigmoid approach and intraoperative images demonstrating surgical resection of a cystic lesion of the CPA. Note the white (pearl-like) and non-vascular appearance of the lesion, typical of epidermoid cysts. (Cr: cranial; Ca: Caudal; Lat: lateral; Med: medial).
Surgery is the only definitive treatment for epidermoid cysts. However, the decision to operate should be carefully discussed for each patient, particularly if the patient is asymptomatic. The extent of the lesion at the anterior aspect of the brainstem, and sometimes above the tentorium, the fragile cortex and vessels, and the hazards of postoperative chemical meningitis often make such surgery more challenging. Therefore, in many cases, radical total resection should not be attempted, because the cyst membrane may be very adherent to local structures such as cranial nerves and surrounding skull base vessels (Fig. 2).

**Cystic Schwannomas**

Cystic schwannomas are usually larger and present a shorter time to diagnosis as well as when compared with solid schwannomas. CT scan usually shows a thin rim-enhancement of the cyst wall. Cystic schwannomas tend to have a funnel-shaped appearance in the axial MRI and short-club-shaped configuration on the coronal images. There is strong homogeneous contrast enhancement of the solid components in approximately half of the tumors. Cystic schwannomas can be classified into three groups: type A - large single cysts with a thin tumor wall (the most common presentation); type B - single cysts with a thick tumor wall; type C – multi-cystic tumors (Fig. 3).

**Figure 3.** MRI sequences and 3D-reconstruction of a large (3.6 x 2.0 x 2.3 cm) multi-cystic CPA lesion. The pathological specimen confirmed a vestibular schwannoma with areas of cystic degeneration and necrosis.

The cystic components of vestibular schwannomas are well-correlated with their histological features. Histopathological analysis of the cyst wall reveals the presence of numerous abnormal sinusoid and telangiectasia-like vessels, which may occasionally reveal signs of thrombosis. The vessel walls display endothelial proliferation and are frequently hyalinized. Hemosiderin deposits and hemosiderin-containing phagocytes are also found near these vessels. Myxoid degeneration and necrosis are evident in vast areas. In fact, such degenerative changes appear to be the main cause of formation of the large cysts.

As some series suggest, the surgical outcome of cystic vestibular schwannomas tends to be poorer compared with non-cystic vestibular schwannomas of matching size. There is also evidence that schwannomas may suffer cystic enlargement after undergoing radiosurgery, specially in already large tumors.

In cystic tumors, rapid clinical worsening is common due to sudden expansion of cystic elements. Tighter adherences are found between cystic tumors and surrounding nervous elements (particularly brainstem and possibly facial nerve) when compared to solid lesions. Therefore, a ‘wait-and-see policy’ is usually not recommended to patients with cystic vestibular schwannomas. In relation to the surgical technique, careful sharp dissection to divide the tumor adherences from the nervous tissue must be employed. However, severe complications may be caused by excessive efforts to dissect the tumor from brainstem adherences.

**Arachnoid Cysts**

Although CPA arachnoid cysts represent a small number of total arachnoid cysts, the CPA is the second most common location for arachnoid cysts to occur, secondary only to the sylvian fissure. These congenital lesions are usually found in children who are either asymptomatic or present with subtle signs or symptoms related to compression of adjacent cerebral and neurovascular structures.

Arachnoid cysts are smoothly margined, presenting CSF-like signal intensity in all MRI imaging sequences and do not enhance after contrast administration (Fig. 4). Arachnoid cysts may be much similar to epidermoid cysts in their radiological features, especially in the CPA. It is essential, therefore, to differentiate the two lesions because they may warrant different therapeutic interventions. Both lesions are characteristically well-demarcated and have a homogeneous low-density, similar to cerebrospinal fluid on CT scan, presenting no contrast enhancement. On MRI, both epidermoids and arachnoid cysts appear hypointense on T1-weighted images and hyperintense on T2-weighted images. On FLAIR, however, an arachnoid cyst tends to follow the cerebrospinal fluid intensity, whereas an epidermoid tumor becomes strongly hyperintense. However, a few times, an epidermoid may appear as a low-intensity lesion on FLAIR. This dilemma is solved with the use of echo planar diffusion scanning, in which an epidermoid cyst remains bright, while arachnoid cyst not.
Figure 4. MRI sequences demonstrating a large (5.5 x 4.5 x 4.0) cystic CPA lesion without extension in the internal acoustic canal. The lesion does not present contrast-enhancement nor displaces the VII/VIII nerves, a common finding of arachnoid cysts.

Not all arachnoid cysts require surgical intervention. Patients with asymptomatic cysts should be followed clinically and radiologically with sequential MRI. Indications for operative management include lesions that demonstrate growth, neural compression, hydrocephalus or refractory symptoms that may be related to cysts in this location, such as auditory loss or cerebellar signs.

The definitive treatment for arachnoid cysts still remains craniotomy and microsurgical resection or fenestration of the cyst walls, usually through a retrosigmoid suboccipital approach. More recently, some authors have endoscopic cisternostomy through a single key-hole, as a minimally invasive approach.

An alternative would be the insertion of a cyst-peritoneal shunt, but the high incidence of shunt malfunction demanding a second shunt review operation and the relatively good results using the marsupialization, make it second-line modality of treatment for arachnoid cysts, especially in the CPA.

Cystic Meningiomas

Meningiomas are the second most common tumors of the CPA after vestibular schwannomas, comprising 6 to 15% of cases of CPA lesions. However, cystic meningiomas in the CPA are much rarer. These tumors usually appear oval or hemispheric, with broad dural-based attachments to the tentorium or petrous bone dura. Commonly there is a solid component, which demonstrates marked contrast-enhancement. Usually no extension into the internal auditory canal is noted. The surgical resection of such tumors is in general easier when compared to vestibular schwannomas (unless there is a presence of hard component) and nerve function preservation rates tends to be higher.

Meningiomas of the CPA rarely extend into the internal auditory canal (IAC) or arise from its dural lining (approximately 1.7% of all CPA meningiomas and almost all of them non-cystic). The clinical symptoms of intracanalicular meningiomas are very similar to those of vestibular schwannomas. Most of the patients reported in the literature, at the time of diagnosis present with vestibulocochlear nerve disturbances, such as hearing loss, tinnitus, disequilibrium and vertigo, or facial nerve paralysis. These CPA meningiomas involving the IAC require special surgical management. In most of the patients whose tumor arises from the dura within the IAC, facial and cochlear nerve preservation is much more difficult to be achieved, because of the infiltrative behavior of such lesions.

Rare Lesions

Neurocysticercosis

Although the brain parenchyma is regarded as the most usual site of involvement of neurocysticercosis, certain reports claim that subarachnoid space is main location for such lesions. If the larvae lodge in the meningeal layers, the infestation may involve the subarachnoid space. Such subarachnoid cysts may become multi-loculated, resembling a “cluster of grapes”. This is usually referred as the ‘racemose’ form of neurocysticercosis. Within the subarachnoid space, the CPA and suprasellar cisterns are the most common locations. On MRI, these lesions show the same signal intensity as the CSF on all pulse sequences, with no post-contrast enhancement.

The diffuse infestation observed in some racemose forms can sometimes be difficult to be distinguished from the surrounding CSF space. The clue to the presence of such lesions is the focal widening of the CSF space or secondary inflammatory response in the adjacent parenchyma. Infestation of the subarachnoid space may also result in communicating hydrocephalus due to chronic meningitis. Additionally MRI may show enhancement of the subarachnoid cisterns due to inflammatory response.
It is important to identify cysticercotic cysts and to differentiate them from other tumoral types of CPA cystic lesion\textsuperscript{15}, because the best therapeutic option for most of the patients still remains the pharmacological treatment against the larvae. In most of the cases, especially in subarachnoid infestation, supplementary steroids are recommended to avoid an abrupt immune response. In selected cases, if there is evidence of CSF flow obstruction, surgical removal of the cyst may be indicated.

**Neuroenteric Cysts**

Neurenteric or enterogenous cysts are lesions lined with mucin-secreting and/or ciliated, cuboidal or columnar epithelium, resembling that found in the respiratory and intestinal tract. They result from the inappropriate partitioning of the embryonic notochordal plate and presumptive endoderm during the third week of human development. These lesion have been described with several different terms, including endodermal, foregut, epithelial, bronchogenic, and respiratory cysts.\textsuperscript{7} Most commonly, they are encountered as an intradural extramedullary cyst, especially in the lower cervical and upper thoracic regions and are usually associated with dysraphism.

Neurenteric cysts arising intracranially are rare and to date only 53 cases have been described in the literature, 92% of which were located in the posterior fossa, most of them as solitary lesions. These cysts tend to present a slight male predominance (60% of the cases) as well as a wide range of age of presentation - from birth to 77 years (mean 34 years).\textsuperscript{3} Clinical symptoms are usually non-specific and result from inflammatory response or local mass effect. The most frequent symptoms are headache and gait disturbances. Our literature search yielded only 15 cases of neurenteric cysts located in the CPA.\textsuperscript{1} Similar to other lesions at this location, the reported neurenteric cysts may also present clinically involving cranial nerve deficits.

Surgical resection is the most indicated therapy for most of the lesions. Intra-operatively these tumors are usually found to have a dark-red appearance, containing muddy gelatinous fluid in its multi-cystic compartments. The surrounding dura may be thick and yellowish because of reactive hypervascularization.\textsuperscript{19} Although very rare in this location, this benign developmental lesion should also be considered as a potential differential diagnosis for patients presenting with cystic lesions in the CPA.

**Other lesions**

There have been several isolated case reports of other cystic lesions in the CPA, such as: cavernous malformation\textsuperscript{27,39}, Ependymal cyst\textsuperscript{30} (an uncommon benign lesion originating from embryonic notochordal remnants), as well as other rare malignant tumors – such as anaplastic ganglioglioma\textsuperscript{52}, primary epidermoid carcinoma\textsuperscript{35}, endolymphatic sac tumor\textsuperscript{38}, primary atypical teratoid/rhabdoid tumor\textsuperscript{36}. The cystic appearance of the malignant lesions is thought to be originated from intra-tumoral necrosis leading to cystic degeneration. For most of them, surgical treatment is still the first option of treatment, having the advantage of also providing histological sample for analysis.

**Conclusions**

Although cystic schwannomas are still the most common cystic lesions of the CPA, a careful preoperative analysis is recommended, when evaluating a cystic lesion in the CPA. The wide range of possible differential diagnosis includes: epidermoid cyst, arachnoid cyst, cystic meningioma as well as other rare entities such as neurocysticercosis, neurenteric cysts, and vascular and malignant cystic tumors.

Surgical management is the mainstay treatment for the majority of such lesions, with the theoretical advantage of providing histological sample for confirmation of suspected diagnosis. As we have previously discussed elsewhere, although the classic retrosigmoid route remains the standard surgical approach to CPA lesions, the surgical technique should be tailored to each specific case according to particularities of patient’s anatomy as well as lesion appearance and nature.\textsuperscript{23}

**References**


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