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Research Article

Posterior Fossa Arachnoid Cysts as Findings in an Ataxia Clinic

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Abstract

Arachnoid cysts are collections of cerebrospinal fluid surrounded by an arachnoid membrane. Most of them are asymptomatic and are detected incidentally on imaging studies. Others reveal themselves with a variety of clinical symptoms depending on their size and location. Although most located in the temporal fossa, cysts can be found in any compartment of the brain or spinal cord. Posterior fossa arachnoid cysts (PFAC) account for 5-48% of all arachnoid cysts. In this case series, we analyze relevant features of 27 PFAC reviewed in an ataxia and other rare diseases clinic.

Keywords: Arachnoid cysts, posterior cranial fossa, magnetic resonance imaging, ataxia, outcome assessment.

Introduction

The first description of arachnoid cysts was made by the English physician Richard Bright in 1827, under the name “serous cysts”. He described two cases, both discovered by autopsy, in his book “Reports of Medical Cases: Selected with a View of Illustrating the Symptoms and Cure of Diseases by a Reference to Morbid Anatomy”. Since then and due to the lack of consensus, these cysts have been variously named as “chronic cystic arachnoiditis”, “cisternal arachnoiditis”, “serous meningitis” among others [1]. Arachnoid cysts (AC) are malformations consisting of collections of cerebrospinal fluid surrounded by arachnoid membranes and located in the subarachnoid space. These malformations are benign, most often congenital, extra-axial and represent 1% of all intracranial lesions [2-4]. By location, they can be classified into two major groups: Supratentorial AC (46-90%) and Infratentorial AC (5- 48%) [5-9]. Supratentorial cysts are most commonly located in the middle fossa (32-60%), while posterior fossa arachnoid cysts (PFAC) are predominantly retro cerebellar (35-85%) [10,11]. AC can be classified as primary (congenital) and secondary [6,12]. The primary ones originate from the separation of arachnoid membranes during embryological development, due to a circumscribed increase in the pulsation of cerebrospinal fluid [7]. Secondary AC are not as common and can develop as a result of head injuries, hemorrhages or infections. Ultrastructural studies have classified them into 3 types: type 1, arachnoid-like morphology; type 2, fibrous morphology, which are thicker walls than normal arachnoids; type 3 of aberrant morphology, which can contain hair cells in its luminal part, and the presence of microvilli and glial cell processes. [13] An ectopic arachnoid plexus has also been found within arachnoid cysts [14]. Different classifications of posterior fossa cysts (PFAC) have been proposed

(Table1). Also, different surgical techniques have been proposed in symptomatic cases (Table 2). Most cases are asymptomatic and are detected incidentally on imaging studies performed for another not associated causes [11,15]. The symptomatology depends on the location of the cysts [16,17]. Headache is the most prevalent clinical manifestation followed by increased intracranial pressure, seizures, hydrocephalus, ataxia or gait instability, hemiparesis, dyskinesias, altered mental status, blurred vision, and hearing loss [5,8,11,18]. In posterior fossa AC, imbalance and dizziness represent cardinal symptoms, in addition to presenting hearing loss or facial palsy [4]. The most relevant imaging study to analyze these cysts is volumetric magnetic resonance imaging, due to its better definition of the posterior fossa, although ultrasound is used in intrauterine screening. In the MRI study well defined lesions are observed, which displace adjacent structures, which do not contain lipidic or protein substances in their interior, and which have the same intensity as the cerebrospinal fluid, in all sequences. They may cause cranial deformities in some cases. AC can be confused with epidermal cysts, but the difference is usually found on diffusion-weighted imaging (DWI) where epidermal cysts appear hyperintense, due to their protein components, also hyperintense on FLAIR, as opposed to arachnoid cysts, which are hypointense on both sequences. Most arachnoid cysts are asymptomatic and have no changes over time, so conservative treatment in these cases is recommended [19]. Few cases have been reported in the literature that have varied in size or even disappeared in subsequent control studies [20-22]. Rare complications have also been reported, such as herniation of the cyst through the foramen magnum, sudden loss of visual acuity, intracystic hemorrhage [23-25], subdural hematomas [26], and intracranial hypertension. It is important to identify complications due to compression, which causes alteration first of the structures adjacent to the cyst, and then of distant structures [27]. Patients who have undergone surgery show improvement in language, motor symptoms and neuropsychological status [28,29]. The risk of recurrence varies according to series and procedures with an average of 30%. After excision of the cyst, and 30-50% after endoscopic procedure. Other post-surgical complications include spasticity, hemiparesis, headache, CSF leakage, hydrocephalus, subdural hygroma [Pradilla], hemorrhage, tonsillar and craniocervical herniation [30,31]. In the case of placing a shunt, it may malfunction or become infected [32] while relatively good results have been described using marsupialization or endoscopic cisternostomy in children with PFAC [33].

Reference	Classifications						
Little JR, et al. 1973 [10]	Cerebellopontine Angle (CPA)	Midnline Inferior	Midline Superior	Hemispheric	Clivus	Tentorial Notch	
Vaquero J, et al. 1981 [34]	Supracerebellar	Retrocerebellar	Laterocerebellar	Clival	Mixed Cysts		
Arai & Sato 1990 [35]	Retrocerebellar (Type A & B)	Type A (Without maldeveloped rhombencephalic roof)	Type B (With maldeveloped rhombencephalic roof)	Hemispheric	CPA		
Al-Holou, 2013 [8]	Retrocerebellar	Supracerebellar	Laterocerebellar	CPA	Quadrigeminal Cistern	Ambient Cistern	Brainstem
de Carvalho, 2014 [7]	Group 1 AC of the CPA	Group 2 AC of the CPA with extension in dorsal surface of the brainstem	Group 3 AC located inside the internal auditory canal	Group 4 AC located in the dorsal part of the cerebellum			

Table 1: Classifications of arachnoid cysts of the posterior fossa.

Authors	Year	Number of cases	Average age	Surgical technique	Results
Pradilla et al. [2]	2007	20	10.9 y	Endoscopic 73%, Open 27%: Craniotomy 5%, Fenestration 11%, Laminectomy 5%	Improvement in symptoms and stable cysts 60%, Complete resolution of symptoms 13%, ongoing symptoms 13%
Tunes et al. [4]	2015	4	42 y	Fenestration by craniotomy (4)	Asymptomatic 3, improvement 1
Al Holou et al. [8]	2013	661	> 19 y	Surgical 24 of 35 symptomatic	Increase in size: 5, reduction in size: 2, worsening of symptoms: 2
Helland et al. [9]	2007	156	39 y	Craniotomy and cystocisternal fenestration 122, shunt 34	Temporal: asymptomatic 50%, improvement 30.6%, equal 12%, worst 7.4%. Frontal: asymptomatic 54.5%, improvement 40.9% worst 4.6%. Posterior fossa:, asymptomatic 5, improvement 5, unchanged 2, worsening in 1
Boutarbouch et al. [5]	2008	32	32 y	Cleavage and marsupialization (17), stereotactic aspiration (4), Endoscopic fenestration (2), cystoperitoneal shunt 3 (2 due to recurrence). Conservative treatment (8)	Improvement 23, unchanged 6, worsening 1. Recurrence: 7.
Ciricillo et al. [15]	1991	40	4.3 y	Craniotomy and fenestration to the space SA (15), Shunt Cystoperitoneal (14), Shunt ventriculoperitoneal (6). Tx conservative (5).	Size reduction 34 of 35. Obliteration:10. Complication by fenestration: 6 of 15. Shunt revision : 9 of 28
Gui et al. [36]	2015	28	5 m- 42 y	Ventricle Endoscopic cystostomy 10, ventriculostomy of the third endoscopic ventricle 28	Total success (symptoms, size, hydrocephalus) in 25, endoscopic reintervention 1, posterior bypass placement 2. Reduction in size 22. Subdural collection 4
Karabatsou et al. [37]	2007	39	15.8 y	Endoscopic: Cystocisternotomy 27, cysto ventriculostomy 22, ventriculostomy of third ventricle 9	Improvement 35, symptoms 3, unchanged 1, slight improvement 1
Kim et al. [38]	1999	7	2- 62 y	Cystocisternotomy 4, cistoventriculostomy 1, ventriculocystostomy 1, ventriculocistocisternotomy 1	Intracisternal bleeding 1, Relief of symptoms 7, reduction of cyst 7
Raffael et al. [39]	1988	31	4.4 y	Craniotomy and Fenestration 29, cystoperitoneal shunt 5	Successful procedures 22 (76%), Subsequent placement of cystoperitoneal shunt 7. Reduction in size 30. 2 of 4 no longer require antiepileptic drugs
Zhang et al. [19]	2012	62	1-13 y	Cystoperitoneal shunt 62	Size reduction 59

Hayashi et al. [40]	1979	12	3 m-19 y	Frontotemporal craniotomy and fenestration 8, shunt VA 1, suboccipital craniotomy 1, cystoperitoneal shunt 1	No intervention 2, Improvement 9, No change 1
Yamakawa et al. [41]	1991	39	30-90 y	Resection 15, shunt 4. Conservative in the others	• Improvement in16 of 21 surgeries
Khan et al. [2]	2013	45	2m- 71 y	Fenestration by craniotomy, shunt, endoscopic fenestration and guided craniotomy	Cysts smaller than 2.50 cm have a better improvement than those who had a cyst larger than 5 cm.
Srinivasan US et al. [11]	2015	26	21-54 y	7 treated surgically	AC can be safely excised with an excellent long-term result except for the ventricular and retroclivial cysts. Midline AC require cystoperitoneal shunting or endoscopic fenestration due to risk of recurrence

Table 2: Surgical approaches to fossa posterior arachnoid cysts and outcome.

Materials and Methods

We present 20 patients with posterior fossa arachnoid cysts diagnosed in the ataxia clinic of a single neurological center, reviewed between 2014 and 2019. The study of this series focuses on the clinical characteristics, surgical indications, evolution of these patients and complementary examinations. For each patient, we collected data including family history, birth complications, head injuries, morbidities, age of onset, current age, surgeries, before performing a complete medical and neurological examination. We define ataxia as the loss of coordination of movements and loss of balance due to dysfunction of the cerebellum or its afferent and efferent pathways. We assessed the degree of ataxia with the SARA scale [42]. In addition, other neurological manifestations were recorded.

Patients

Of 123 patients with sporadic ataxia that we reviewed, 20 have posterior fossa arachnoid cysts evidenced by magnetic resonance imaging or computed tomography. Arachnoid cysts found in regions other than the posterior fossa, cystic lesions such as epidermoid cysts or other tumor lesions were excluded. It is worth mentioning that in all sporadic or recessive cases, the molecular diagnosis of Friedreich's ataxia was performed. If possible and indicated, next-generation sequencing was requested. The morphological evaluation of the cysts was performed retrospectively through 3D magnetic resonance imaging with Carestream Vue Motion software, preferably using the FIESTA sequence. The anteroposterior and major transverse diameters were measured in axial images (d1 and d2) and the height in sagittal sections (H). While in 3 cases voxel-based volumetry was performed, in all cases the following formula was used [43]:

$$Cyst\ volume\ \frac{(\pi)(d1)(d2)(H)}{6}$$

A descriptive analysis of the database was performed and relevant correlations between variables were sought.

Results

The present series is part of a cohort of rare diseases at the ataxia clinic and a protocol approved in 2014 by the 2 institutional committees. All patients are registered, followed, and treated in the institution throughout their condition. Of 123 cases with ataxias with a presumed recessive pattern of inheritance, or sporadic, we found 20 with posterior fossa arachnoid cysts (16.26%). Seven other cases were referred to the clinic after a PFAC was diagnosed.

Clinical Characteristics

The series is composed of 19 men (70.37%) and 8 women (29.63%), with an average age of onset of 17.5 years (SD 15.3), of which the most frequent risk factor was head trauma in 14.8% (n=4). The first clinical manifestation was gait ataxia in 12 (44.44%), followed by ophthalmological alterations and dysarthria both 18.5% (n=5), hearing loss (n=2), rest tremor or other movement disorders (Table 3). Gait ataxia was evident in most of them, but only detectable when performing tandem gait testing in 7 subjects. Dysarthria occurred, in varying degrees, in four cases and 1 case with fluctuating language impairment. Three patients had spastic gait, but in total, 13 had pyramidal signs. Headache affected 44.4% (n=12) of varying intensity, eye pain in one, tremor in 33.3% (n=9) generally of action and cephalic postural type, broad and constant in two cases. Other symptoms found in this series were nystagmus, dizziness, and hearing loss. This last

one was significantly correlated with the youngest age of onset (p=0.02) Some other clinical elements point to a neurodegenerative etiology, such as sialorrhea observed in 4 cases, REM sleep behavior disorder found in 6 subjects and bradykinesia in three. Cognition was affected in nine of these patients, 4 with mild cognitive impairment and 5 with dementia. The most prevalent location of the cysts was cisterna magna (n=20), 5 of a quadrigeminal cistern, 2 cysts of the fourth ventricle, one with extension to quadrigeminal fossa and the other to cisterna magna. Among cisterna magna cysts, 16 present a retrovermian extension, 3 with a right retrocerebellar extension, 4 on the left side and 4 bilateral. The volume of the cysts had a range of 3-94 cm^3, a mean of 17,85 cm3, SD ± 22. Some of them were characterized by the presence of multiple partitions (Fig.1). The volume was not related to the outcome. Many patients have more than 20 years of evolution sometimes characterized by fluctuations. In three cases the SARA scale shows improvement over the years, while most of the subjects show a slow and progressive worsening. Three other patients presented intracranial hypertension that merited urgent surgery. Only one case of quadrigeminal cyst presented a dilation of the supratentorial ventricular system which required a ventriculoperitoneal shunt. Hypoplasia, atrophy, or molding of the cerebellum was generally well tolerated.

Current age, yrs/ sex	Age at onset	Background	Location	Vol. (ml)	First symptom	Cephalalgia	Ataxia (SARA)	MoCA	ICH	Pyramidal syndrome	Outcome
25/F	20	Down Syndrome	RV & RH	6.3	Pseudopapiloedema	no	+		No	No	Stability
31/M	1	Frontotemporal epilepsy	RV & RH	16.5	Seizures	no	Loss of balance, falls, mood changes	29	No	No	Stability
23/M	2	Febrile seizures	RV & RH	23.5	Cephalic and hands tremor/ Nystagmus	+++	+++ (14)	30	+++	Yes	Partial improvement
40/M	6	3 Traumatic head injuries	RV, H & CC	52.27	VA decrease	ocular	+++ (14.5)	30	No	No	Blindness
46/M	8	Slight psychomotor retardation	RV & H	43.18	Dysarthria	++	+++ (14)	27	No	No	Partial improvement
38/M	8	Right palpebral ptosis	RV-RH (L)	3.85	Right palpebral Ptosis	-	++ (10)	23	No	Yes	Negative FRDA and NPC
42/M	8	Brother with similar condition	RV & H	94	Ataxic gait	-	+		No	Yes	Intermittent headache-ARSACS
39/M	9	Brother with similar condition	RV	47.9	Ataxic gait	+	+++ (18)	15	No	Yes	Gait worsening-ARSACS
40/M	14	-	RV, RH (L) & CC	5.8	Ataxic gait/ pes cavus	-	+++ (11)		No	Yes	FRDA excluded
39/F	7	Seizures/ Traumatic head injury	RV, IV, CC, CM	41	Ataxic gait	-	+(28.5)	10	No	Yes	Unverricht-Lundborg disease diagnosed cyst fenestration programmed
32/M	17	Traumatic head injury	RV & CM	3	Scanning speech	+++	++	20	No	Yes	Surgery programmed
30/M	18	-	CM	3	Low amplitude rest tremor	++	++		No	Yes	Under study
25/M	18	Ataxia with spastic paraparesis	RV & RH(L)	27	Toe walking	++	+ spastic gait (8)	24	No	Yes	FRDA excluded
31/M	21	Schwannoma radiosurgery	RV (2 cysts)	3.9	Peripheral facial nerve palsy	-	-		No	No	Stability
32/F	21	-	RV (2 cysts)	3	Ataxic gait	-	+ (20.5)	12	No	Yes	Stability under treatment for SANDO
28/M	23	-	CM	3.24	Falls	-	++	.	No	Yes	Under physical and cognitive therapy
54/M	34	Nasal septum fracture/ obstructive sleep apnea	CM	3	Diplopia	+	+	.	No	No	Spontaneous cyst regressing

57/M	50	-	RV & RH	18.34	Ataxic gait	+	+ (19)	25	No	Yes	-
64/M	57	Alcoholism	IV & CM	27	Dizziness, headache, scanning speech	+	+	25	Yes	-	Total improvement with cysto cisternal derivation
61/M	58	-	RV & IH	4.45	Falls		+	.	No	Yes	Dies by fall
25/F	22	-	Supratentorial, infratentorial & spinal	string of cysts	Headache	+++	-	25	No	No	Only tensional symptoms
14/F	8	Secondary hydrocephalus	CC	3	Intracranial hypertension	++	-	-	Yes	-	Asymptomatic after VP shunt + cystoventricular shunt
42/F	37	Treated for Multiple Sclerosis	CC	3.39	Loss of balance, falls, mood changes	++	+(4)	28	No	No	Asymptomatic
16/M	13	Dominantly-Inherited Spinocerebellar Ataxia	CM& RH (R)	7	Ataxic gait	no	+	27	No	No	SCA2
47/F	33	Dominantly-Inherited Spinocerebellar Ataxia	CM	7	Slow saccades/ muscle cramps	no	+++	MMSE 28	No	No	SCA2
53/F	31	Familial epilepsy	RV	7.5	Myoclonus, ptosis, weakness	+	+	-	-	-	Spontaneous improvement
17/M	12	Huntington Disease	RV	6.02	trunk and extremities dystonia	-	+	No	No	No	disease progression

RV: Retrovermian Cyst; RH: Retrohemispheric Cyst; CC: Quadrigeminal Cistern Cyst (Quadrigeminal Plate Region); IV: Intraventricular Cyst; CM: Cisterna Magna Cyst; R: Right; L: Left; SARA: Scale For The Assessment And Rating Of Ataxia; Moca: Montreal Cognitive Assessment; ICH: Intracranial Hypertension; FRDA: Friedreich Ataxia; NPC: Nieman Pick Type C; SCA2: Spinocerebellar Ataxia Type 2; SANDO: Sensory Ataxic Neuropathy, Dysarthria, Ophthalmoparesis: ARSACS: Autosomal Recessive Spastic Ataxia Of Charlevoix-Saguenay.

Table 3: Clinical characteristics of the series of patients.

Genetics

Most of these patients were analyzed genetically. 15 patients were diagnosed with neurodegenerative diseases of which 14 are genetic, including 9 recessive ataxias or mitochondrial ataxias. Concerning the outcome, one subject died from falling, three subjects undergone surgery by fenestration and showed significant improvement while a fourth patient scheduled for surgery rejected the procedure due to improvement of the symptomatology with valproate, lamotrigine, and folic acid. A case of cyst appearance after a radiosurgery for cerebellopontine angle tumor is debatable since its presence was not detected before surgery. Also, the presence of cysts in hereditary ataxias is still poorly described in the literature.

Discussion

This series of 27 cases of PFAC confirms previously reported clinical findings such as prevalence in males, onset frequently before adulthood, possible lesion history, and most cases with genetic implications. Indeed, about half of the patients present a characteristic pattern of recessive ataxias, which are evaluated for a long time before having a definitive diagnosis in which next generation sequencing is frequently required, such as in two patients with ARSACS and one case of compound heterozygous mitochondrial ataxia. We believe it is very important to investigate all possible causes and, if neurodegenerative, to refer them to a geneticist to order the necessary tests, who will order the necessary tests, plan the follow-up and provide genetic counseling. For the description of these cysts, we have used a customized anatomical classification, as there is currently no consensus for the classification of cysts according to their location, due to their sizes and shapes, which can cover many regions. We also found that most cases are of mixed location. None of the patients had internal table deformity, polycystic kidney disease, glutaric aciduria, and none met the criteria for Dandy-Walker malformation, the main differential diagnosis. AC outside the posterior fossa have been found only in 1 case. We measured the volume of cysts with a relatively simple formula validated in 3 cases by voxel-based morphometry to look for correlations with symptomatology. We did not find this relationship with severity, but the presence of compartments that can expand or cause fluctuations. Surgical indications are controversial, with the presence of intracranial hypertension being the main requirement for surgical approach, while the development of symptoms such as ataxia, headache, dysarthria are relative indications that require weighing the risks and benefits and explain why only 4 surgical procedures were performed in this series. That said, periodic follow-up of these patients becomes mandatory. To re-emphasize the genetic causes, we believe that in dominant diseases such as Huntington disease and SCA2, the most common spinocerebellar ataxia in Mexico, these cysts are extremely rare. It is the apparently neurodegenerative recessive or sporadic forms that we care to diagnose. In the study of Qin et al. [44], 9 out of more than 30,000 genes possibly implicated with the presence of AC were identified. In our series, the definite involvement of genetic variants providing recessive ataxias or other rare diseases associated with AC appears to be in most cases. Knowing whether they are of mitochondrial origin, spastic ataxias or other genetic disorders that can guide medical treatment seems relevant. We therefore recommend next-generation sequencing studies to all patients with arachnoid cysts and apparently recessive ataxia to better understand their etiology.

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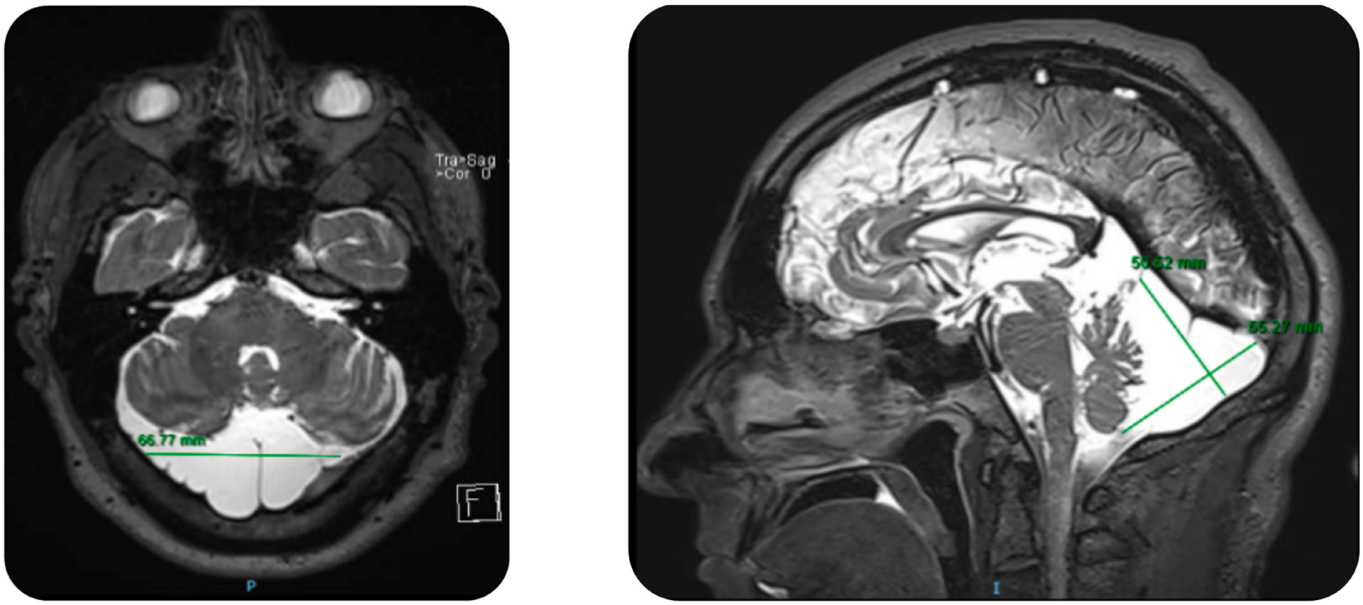

Figure 1. MR imaging of the brain; axial and sagittal image in T2 sequence. A large lobulated and septate retrovermian cyst is observed in one case of ARSACS where measurements were made.