

Endodermal Cysts of the Central Nervous System: Review of the Literature and a Case Report

Abstract

Context: Endodermal cysts are rare benign developmental cysts lined by mucin-secreting and/or ciliated, cuboidal, or columnar epithelium of probably endodermal origin. **Aims:** Endodermal cysts are rarely intracranial, frequently located in the posterior fossa. Supratentorial location is the most infrequent and only few cases are reported in the literature, included our case. **Settings and Design:** The authors report a case of intracranial supratentorial endodermal cyst with a review of the literature. **Subjects and Methods:** A 40-year-old woman was admitted to our department because of progressive gait disorder for 3 months due to right brachial and crural motor deficit associated to right crural sensory disorder (tactile hypesthesia) and right Babinski response at neurological examination due to an endodermal cyst located in the left frontoparietal convexity. **Discussion** Total resection of endodermal cysts is recommended, despite their location and adhesion to the surrounding structures, due to its high risk of recurrence. Fenestration of the cystic content into the subarachnoid cistern may cause obstructive hydrocephalus or chemical meningism. **Results:** Although rare, surgeons should be aware that these lesions must be differentiated clinically, radiologically, and histologically from other supratentorial cystic lesions.

Keywords: Central nervous system, endodermal cyst, enterogenous cyst, epithelial cyst, neurenteric cyst, neuroenteric cyst, supratentorial extra-axial cystic lesion

Introduction

Endodermal cysts are rare developmental cysts lined by mucin-secreting and/or ciliated, cuboidal, or columnar epithelium similar to the respiratory and the intestinal ones. Although the first case reported in literature by Puusepp^[1] dates back to 1934, there has been some controversy in literature regarding their nomenclature also due to the unclear pathogenesis. Historically, they were referred to as “teratomatous,” “intestinome,” neurenteric, gastrocytoma, and enterogenous cysts. Other terms frequently used in literature are enteric, bronchogenic, or respiratory cysts.^[1-5]

Endodermal cysts are usually found in the mediastinum,^[6] but they can also rarely occur in any region of the central nervous system, constituting about 0.01% of CNS tumors. They are more common in the lower cervical and upper thoracic spine (0.3%–1.3% of all spinal canal tumors) where they are often associated with dysraphism syndromes,^[7] regarding

the intracranial site (0.15%–0.35% of all intracranial tumors).^[8]

Intracranial endodermal cysts are very uncommon, and in the majority of the cases, they are found in the posterior fossa near the midline, anterior to the brainstem, or within the fourth ventricle. Supratentorial location is the most infrequent among these developmental cysts; to our knowledge, only 66 intracranial supratentorial endodermal cysts cases were reported in the literature, including our case.^[9-60]

The authors present a complete and concise review of the world’s literature about clinical, radiological, histological features and treatment’s aspect of intracranial supratentorial endodermal cysts, including our case report.

Subjects and Methods

Review of literature

We performed a review of the current literature using the National Library of Medicine and National Institutes of

**Fotios Kalfas¹,
Claudia Scudieri^{2,3}**

¹Department of Neurosurgery Padua University Hospital, Padua, ²Department of Neurosurgery and Gamma Knife Radiosurgery, IRCCS San Raffaele Scientific Institute, Vita-Salute University, Milan, ³Department of Neurological Surgery, Galliera Hospitals, Genova, Italy

Address for correspondence:

Dr. Fotios Kalfas,
Department of Neurosurgery
Padua University Hospital,
Padua, Italy.
E-mail: fkalfas@tiscali.it
Dr. Claudia Scudieri,
Department of Neurosurgery
and Gamma Knife Radiosurgery,
IRCCS San Raffaele Scientific
Institute, Vita-Salute University,
Milan, Italy.
E-mail: claudiascudieri@gmail.com

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: Kalfas F, Scudieri C. Endodermal cysts of the central nervous system: Review of the literature and a case report. Asian J Neurosurg 2020;15:989-96.

Submitted: 28-Oct-2019 **Revised:** 30-Mar-2020
Accepted: 13-Aug-2020 **Published:** 21-Dec-2020

Access this article online

Website: www.asianjns.org

DOI: 10.4103/ajns.AJNS_322_19

Quick Response Code:



Health based on the keywords: “neuroenteric cyst,” “endodermal cyst,” “enterogenous cyst,” “neurenteric cyst,” “epithelial cyst,” “enterogenic,” “foregut,” “respiratory,” and “broncho-genic cyst.” Only reports in English were considered; spinal and infratentorial endodermal cysts were excluded because of their different pathogenesis.

Only 66 intracranial supratentorial endodermal cysts cases were reported in the literature, including our case.^[9-60]

Case report

A 40-year-old woman was admitted our department of neurological surgery because of progressive gait disorder for 3 months due to the right brachial and crural motor deficit associated to right crural sensory disorder (tactile hypesthesia) and right Babinski response at neurological examination. Four years before, the patient underwent magnetic resonance imaging (MRI) examination with incidental diagnosis of nonenhancing extra-axial cystic lesion in the left frontoparietal convexity, hypointense on T1-weighted, and hyperintense on T2-weighted sequences with no contrast enhancement after Gadolinium administration [Figure 1]. The lesion was initially considered to be arachnoid cysts. Due to the absence of signs and symptoms at the neurological examination, the patient underwent clinic-neuroradiological follow-up.

At admission, Brain MRI scans with and without contrast scans showed an increase in volume of the cyst lesion (the maximum diameter was 7 cm vs. 5 cm in the previous radiological examination) with a mass effect on the surrounding structures [Figure 2].

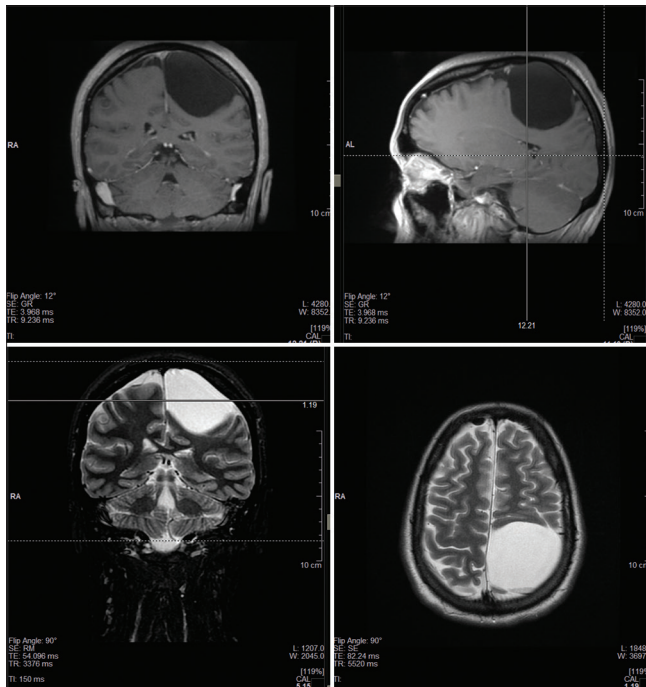


Figure 1: Preoperative magnetic resonance imaging examination shows a nonenhancing extra-axial cystic lesion in left frontoparietal convexity, hypointense on T1-weighted, and hyperintense on T2-weighted sequences

The patient underwent a left parietal craniotomy; the extra-axial nature of the cyst was confirmed. Macroscopically, the lesion consisted of a thin cyst membrane adherent to the dura mater and to the falx cerebri containing a creamy fluid.

The cyst wall was dissected from the underlying brain parenchyma allowing for complete and excision. Postoperative computerized tomography (CT) and MRI scans were uneventful [Figure 3].

All tissues were subsequently fixed in formalin and processed for paraffin sections. Microscopic examination revealed that the cyst wall was lined with a columnar epithelium with a brush border in some areas stain positive with Alcian blue. The cells of the cyst were immunopositive for the epithelial marker cytokeratin 7 and epithelial membrane antigen. Immunostaining for glial fibrillary acidic protein, carcinoembryonic antigen, and S-100 protein was negative. The overall features of the specimen were diagnostic of type A endodermal cyst [Figure 4].

Postoperatively, the patient developed recurrent partial motor/sensory seizures treated with anticonvulsant medication. At 1-month follow-up evaluation, her partial seizures did not recur with anticonvulsant medication, and on neurological examination, the motor/sensory disorders improved.

Results

The patient's features of our literature's review are shown in Table 1.

In our review of literature, the main age at diagnosis was 42 years (range: 0–78 years) with a slight male preponderance (47% females vs. 53% males).

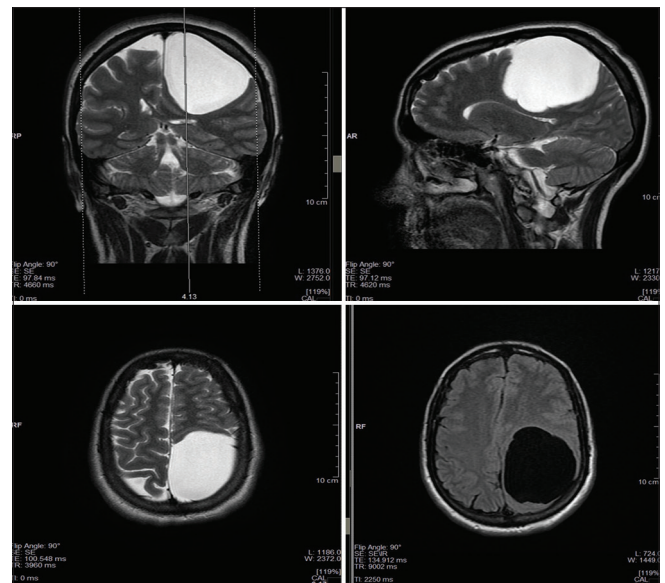


Figure 2: Preoperative magnetic resonance imaging scans show an increase in volume of the cyst lesion

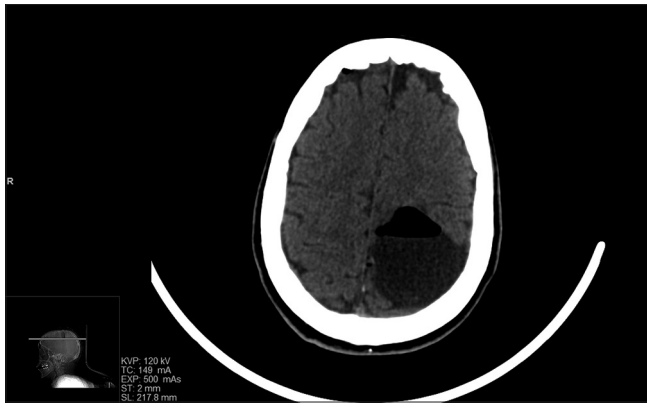


Figure 3: Postoperative computerized tomography scans show a left parietal craniotomy and the complete dissection of the cyst wall from the underlying brain parenchyma

Laterally located endodermal cysts were reported in 47 patients (71%) in contrast to only 16 patients (24%) with midline endodermal cysts. In three cases, we did not find any further information about cysts location. In those laterally located, 28 cases were found in the frontal lobe, 4 cases in the parietal lobe, 5 in the temporal lobe, 10 in the frontoparietal lobe, 1 in the parieto-occipital lobe, and 1 in the parietotemporal one. Twenty-two cases were found on the left side and 23 cases on the right side without any significant side preponderance. Two cases were found of bilaterally location. The main symptoms at the diagnosis were headache observed in 25 patients (38%) and seizures observed in 22 cases (33%). Other symptoms commonly reported are motor/sensory deficit in case of frontoparietal localization, visual loss, hypopituitarism, and cranial nerve palsy commonly related to the suprasellar/parasellar location. Behavior changes and memory loss are frequent in case of involvement of the frontal lobe. One case in the pediatric age was characterized by macrocrania. In a limited number of cases, the clinical symptoms at the moment of the diagnosis were vomiting and other symptoms related to increased intracranial pressure.

All patients underwent surgical treatment and complete excision was achieved in 23 of them. Seven patients underwent cyst recurrence; all of them were related to incomplete excision. Eleven patients experienced postoperative seizures probably related to the chemical irritation due to fluid leakage after incomplete excision or during surgery.

To prevent this complication, we suggest an aspirating cyst's fluid with a needle prior to incise the cyst's wall and protect the subarachnoid space with cotton and warm irrigation.

The most common histological group, following the Wilkins and Odom classification, was Type A with 41 cases (62%); only sixteen cases were Type B (24%). In three cases, malignant transformation was diagnosed, and in only one case, mucinous carcinoma was found. In five cases, we did not find any further information about histological features.

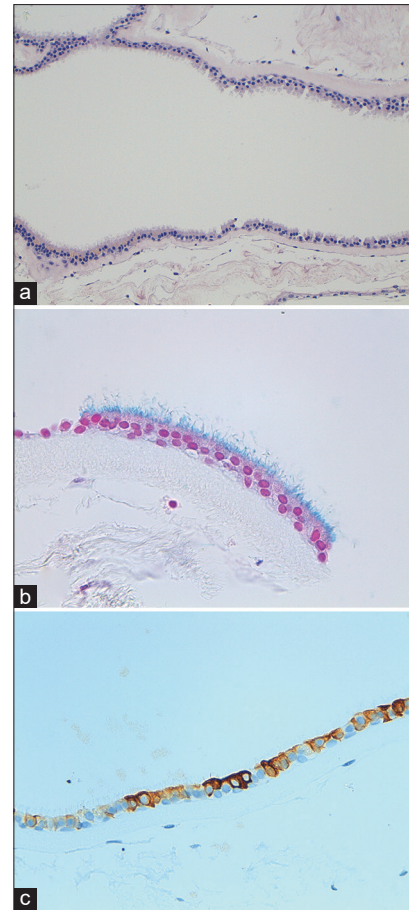


Figure 4: The histological features of the cyst. Hematoxylin and eosin stain revealed that the cyst wall was lined with a columnar epithelium (a) with brush border in some areas stain positive with Alcian blue (b). The cells of the cyst were immunopositive for the epithelial marker cytokeratin 7 (c). The overall features of the specimen were diagnostic of Type A endodermal cyst according to Wilkins and Odom classification ($\times 100$)

Discussion

Definition, histopathology, classification, and pathogenesis

Endodermal cysts are fluid-filled cysts lined by columnar or cuboidal ciliated and/or goblet cell epithelium, such as the gastrointestinal one.^[61] Their macroscopic appearance varies from yellow or white, thin-walled cysts containing a gelatinous transparent or creamy fluid produced by the epithelium cells. The latter lie on a basement membrane and stain positive with periodic acid–Shiff and Alcian blue. In recent years, immunohistochemistry (IHC) has gained an important role in the diagnosis. Characteristic findings are positivity for cytokeratin, epithelial membrane antigen, and carcinoembryonic antigen, like the embryonic gastrointestinal tract suggesting an endodermal origin of the cysts. They are generally immunonegative for neuronal and ectodermal markers such as neuron-specific enolase, synaptophysin, glial fibrillary acidic protein, and S-100. However, some lesions can include structures derived from mesoderm or neuroectoderm.^[62]

Even though this lesion has always been considered histologically benign, malignant transformation is extremely rare but possible, as only eight cases have been reported in the literature. *De novo* carcinomas have been described in six reports which were either focally infiltrative, low-grade adenocarcinoma, or carcinoma *in situ*. Only two cases revealed a malignant transformation during recurrence, probably related to chronic inflammation due to repeated cyst rupture or subtotal resection of the cyst wall that may result in dysplasia and could help to malignant transformation. KRAS mutation may play an oncogenic role.^[20,37,54,63-67] As reported by Taek *et al.*^[54] in case of malignant transformation in mucin-producing adenocarcinoma, there could be a serum CEA and CA-125 elevations, like other tumors of epithelial origin including lung, ovary, breast, and colorectum that could be helpful

Table 1: Endodermal cysts of the central nervous system: Epidemiology, location and clinical features, histological characteristics, and surgical outcome

Features	Total number and %
Epidemiology	
Median age (age range), years	42 (0–78)
Male	35 (53)
Female	31 (47)
Location	
Lateral	47 (71)
Left	22
Right	23
Bilaterally	2
Midline	16 (24)
Not specified	3 (5)
Surgical outcome	
Incomplete excision	18 (27)
Complete excision	23 (35)
Not indicated	25 (38)
Histological classification	
A	41 (62)
B	16 (24)
Not indicated	5 (8)
A plus malignant transformation	3 (5)
Mucinous carcinoma	1 (1)
Clinical symptoms	
Headache	25 (38)
Seizures	22 (33)
Visual loss	8 (12)
Gait disturbance/dizziness	8 (12)
Motor deficit	6
Numbness/paraesthesia	5
Memory loss	5
Behavior changes	4
Incidental	3
Hypopituitarism	3
Cranial nerve palsy	3
Intracranial pressure/vomiting	3
Macrocrania	1

also to detect malignant transformation during the follow-up in patients with partially resected endodermal cysts.

Actually, there is not a classification for intracranial endodermal cysts, so the intraspinal classification one is commonly used.

The classification proposed by Wilkins and Odom^[68] in 1976, based on the histological features, identifies three types of endodermal cysts as reported in Table 2.

Despite the many theories proposed to explain the true etiology and the embryological origin of the endodermal cysts, their pathogenesis and the presence of an endodermal lesion within neuroectodermal tissue are still unclear.

One of the theories proposed is based on the failing dissolution of the neuroenteric canal, a transient connection between the primitive neural tube (ectoderm) and the enteric tube (endoderm) which split apart during the notochord formation during the third week of embryogenesis. In this way, some endodermal cells can be incorporated in the neuroectodermal tissue.^[69] Since the most cranial extension of the notochord is located at the level of clivus, this theory can easily explain the genesis of the endodermal cysts which lie in the posterior fossa or in the spinal canal but not the intracranial supratentorial ones.

Graziani *et al.*^[17] proposed another theory to explain the pathogenesis of the supratentorial endodermal cysts, suggesting an origin from remnants of Seessel's pouch, a transient endodermal outpouch. This theory suggests a common origin of colloid cysts and Rathke's cyst explaining their common immunohistochemistry and can justify the supratentorial endodermal cysts located in the midline (parasellar, retrosellar, and suprasellar); however, it does not explain the genesis of the laterally located supratentorial ones.

Mittal *et al.*^[46] during the following years suggested an origin from remnants of endodermal cells that undergo an

Table 2: Histological classification of endodermal cysts of the central nervous system by Wilkins and Odom

Type	Description
Type A	Single layer or pseudostratified cuboidal or columnar, ciliated or not epithelial cells on a basement membrane overlying fibroconnective tissue mimicking the respiratory or gastrointestinal epithelium
Type B	Cysts are richer in connective tissue and contain in addition glands producing mucinous or serous fluid. These cysts may be composed of other tissues including smooth muscle, striated muscle, fat, cartilage, bone, elastic fibers, lymphoid tissue, nerve fibers, and ganglion cells
Type C	In addition to the findings in Type B, may be associated with glial elements such as ependymal cells of the wall

anomalous migration from the neurenteric canal into the ectoderm, justifying the birth of laterally located cysts.

Considering all the above-mentioned hypothesis, we are in full agreement with other authors^[17,28,46,69] who consider the suprasellar and parasellar cysts embryologically different from the supratentorial non-midline cysts, probably does not exist a single common cause to explain the pathogenesis of all supratentorial endodermal cysts and all hypothesis could be considered valid.

Radiological features and differential diagnosis

CT scans show a low-density area with no contrast enhancement. MRI remains the imaging modality of choice. Endodermal cysts are well-demarcated lesions that displace but do not infiltrate the adjacent neurovascular structures. On MRI, they are hyperintense on both T1 and T2W sequences but may appear hypointense. This variability in signal intensities is due to the difference in concentration of mucoid material, cholesterol, and protein content within the lesion. Most of the cysts do not enhance following contrast administration.^[28] In our case, MRI examination showed a nonenhancing extra-axial cystic lesion in the left frontoparietal convexity, hypointense on T1-weighted, and hyperintense on T2-weighted sequences with no contrast enhancement after Gadolinium administration; the cystic lesion appeared as low-density well-circumscribed area [Figures 1 and 2].

MR spectroscopy can add more information; it can help in presurgical diagnosis and in the differential diagnosis from other lesions by having large N-acetylaspartate (NAA) like peak at 2 ppm chemical shift.^[70,71] Endodermal cysts are lined by pseudostratified columnar epithelium and mucin-secreting goblet cells. A large peak at 2 ppm in MR spectroscopy may be due to mucinous content of these cysts. The differential diagnosis for intracranial endodermal cyst includes epidermoid cyst, dermoid cyst, arachnoid cyst, other endodermal cysts (Rathke and colloid cyst), and very rarely ecchordosis physaliphora if retroclival in location.

Arachnoid cysts follow cerebrospinal fluid (CSF) intensity in all sequences. Dermoids usually demonstrate the heterogeneous signal intensity and most have intralésional fat component that gets suppressed on fat-saturated images. Ecchordosis physaliphora is an ectopic notochordal remnant, typically located in the intradural prepontine area that appears hyperintense on both T1 and T2. Stalk connecting to the clivus and bone erosion is the key imaging feature of this lesion.^[72] Rathke and colloid cysts can be excluded by their typical location. Colloid cysts, Rathke's cleft cyst, and endodermal cysts are endodermal inclusion cysts that have been named according to their locations.^[17] White epidermoid may be difficult to distinguish as it is T1 hyperintense; however, epidermoids show striking restriction of diffusion on DWI that is usually not seen in the endodermal cyst.^[73,74]

Clinical symptoms and management

The principal clinical symptoms are related mainly to the local mass effect, so they vary depending on the cyst's location.

Supratentorial endodermal cysts are usually larger in size at the moment of the diagnosis and present later in life than those in the posterior fossa or in the spinal canal. This is likely due to the slow-growing nature of these cysts and the ability to accommodate growth of the cysts in the supratentorial compartment, regarding the smaller volumes of the posterior fossa and spinal canal and the lower tolerance of local mass effect.

In supratentorial endodermal cysts, clinical features are related to the raising intracranial pressure. Patients commonly present with headache, nausea, and vomiting; they may also present focal or generalized seizures or motor/sensory deficit. In case of intraventricular cysts, isn't rare to objectify signs and symptoms related to hydrocephalus.^[75] Our patient presented at admission to our department right brachial and crural motor deficit associated to right crural sensory disorder (tactile hypesthesia) and right Babinski response at neurological examination due to the local mass effect to the pre- and postcentral gyri.

Clinical symptoms tend to fluctuate as a result of cyst enlargement due to the active secretion of mucus by the goblets cells followed by spontaneous cyst rupture into the subarachnoid space.^[76] Most cases of endodermal cysts have a long history and slow progression. Several mechanisms are proposed to explain the growth of cysts, including secretion from the epithelial cells of the cyst, differences in osmotic pressure, and the existence of a one-way valve.^[77,78] In some cases, sudden onset of the symptoms can be due to intracystic hemorrhage. In literature only five cases are reported of spontaneous intracystic hemorrhage.^[44,56,79-81] Of all the reported cases, one showed hemorrhage in the subarachnoid space and four showed intracystic bleeding. Histological examination of the cyst wall found rich blood vessels, which were thought to be the cause of intracystic hemorrhage. Subarachnoid hemorrhage could be associated with the rupture of cyst surface vessels. Both inflammation and leakage of cystic contents could cause the rupture of cyst wall vessels. In these cases, the hemorrhage confused imaging presentation, leading to misdiagnosis.

Fluctuating clinical course or postoperative meningism can also be uncommonly due to chronic, recurrent, aseptic meningitis with polymorphonuclear pleocytosis and negative CSF cultures also known as Mollaret meningitis probably related to subarachnoid leakage of cystic fluid^[82] confirmed by the elevated CSF protein content. In these cases, repeated lumbar punctures can relieve symptoms. To prevent this complication, the cystic fluid could be aspirated prior to incision of the cyst's wall.

The consensus for the treatment of symptomatic endodermal cysts is complete resection. Partial resection should be avoided because of the high risk of recurrence. Complete resection, however, might be more difficult primarily due to the possible adhesions to important vascular/neural structures. In case of recurrence, reoperation is indicated for symptomatic recurrence. In our case, the cyst wall was dissected from the underlying brain parenchyma obtaining maximal safe resection.

Partial resection resulted in the rapid overlapping of the remaining cystic wall. Recognizing and electrocoagulating the remaining cystic wall is important in preventing recurrence after subtotal resection in preventing recurrence after subtotal resection. Besides, fenestration of the cystic content into the subarachnoid cistern may cause obstructive hydrocephalus due to its protein-rich content as in our case which macroscopically appeared as milky, creamy fluid. Both the mechanisms can result in early recurrence.^[83] Hence, clinical or radiological follow-up is recommended for early detection of recurrence.

Chen *et al.*^[53] analyzed some factors correlated with recurrence. In their analysis, limited by the small number of cases, genders, locations of cysts, and ciliated cells noted in pathologic examinations made no contribution to predicting recurrence. In the recurrence group, mucin-secreting cells were found in 66.6% of cases.

Conclusion

Endodermal cysts are rare developmental cysts histologically considered benign, even though malignant transformation is possible, which should be considered in the differential diagnosis with the other cystic lesions of the central nervous system. The definitive diagnosis should be obtained with the help of histology and IHC.

The principal clinical features are highly variable and related mainly to the local mass effect. The aim of treatment of symptomatic endodermal cysts is complete resection due to the high risk of recurrence in case of partial resection. In case of incomplete excision, clinical–radiological follow-up is mandatory for the high risk of cyst recurrence and neoplastic degeneration.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the legal guardian has given his consent for images and other clinical information to be reported in the journal. The guardian understands that names and initials will not be published and due efforts will be made to conceal identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Puusepp M. Rare variety of sudural teratoma of the cervical region (intestine): Quadriplegia, eradication and complete healing. *Rev Neurol (Paris)* 1934;2:879-86.
2. Kubie LS, Fulton JF. A clinical and pathological study of two teratomatous cysts of the spinal cord, containing mucinous and ciliated cells. *Surg Gynecol Obstet* 1928;47:297-311.
3. Holcomb GW Jr., Matson DD. Thoracic neurenteric cyst. *Surgery* 1954;35:115-21.
4. Knight G, Griffiths T, Williams I. Gastrocystoma of the spinal cord. *Br J Surg* 1955;42:635-8.
5. Scoville WB, Manlapaz JS, Otis RD, Cabieses F. Intraspinal enterogenous cyst. *J Neurosurg* 1963;20:704-6.
6. Jeung MY, Gasser B, Gangi A, Bogorin A, Charneau D, Wihlm JM, *et al.* Imaging of cystic masses of the mediastinum. *Radiographics* 2002;22S79-93.
7. Kumar R, Jain R, Rao KM, Hussain N. Intraspinal neurenteric cysts – Report of three paediatric cases. *Childs Nerv Syst* 2001;17:584-8.
8. Chen CT, Lee CY, Lee ST, Chang CN, Wei KC, Wu CT. Neurenteric cysts: risk factors and management of recurrence. *Acta Neurochir (Wien)* 2016;158(7):1325-31. doi: 10.1007/s00701-016-2828-y. Epub 2016. PMID: 27169426.
9. List CF, Williams JR. Subdural epithelial cyst in the interhemispheric fissure. Report of a case, with some remarks concerning the classification of intracranial and thalial cysts. *J Neurosurg* 1961;18:690-3.
10. Vuia O. Congenital intracerebral epithelial cysts. *Neurochirurgia (Stuttg)* 1976;19:219-26.
11. Palma L, Celli P. Suprasellar epithelial cyst. Case report. *J Neurosurg* 1983;58:763-5.
12. Campbell DA, Varma TR. An extraventricular colloid cyst: Case report. *Br J Neurosurg* 1991;5:519-22.
13. Dauch WA, Hellwig D, Rossberg C, Lütcke A, Mennel HD. Epithelial cyst of the central nervous system. A rare abnormality. *Neurochirurgia (Stuttg)* 1991;34:111-5.
14. Scaravilli F, Lidov H, Spalton DJ, Symon L. Neuroenteric cyst of the optic nerve: Case report with immunohistochemical study. *J Neurol Neurosurg Psychiatry* 1992;55:1197-9.
15. Harrison MJ, Morgello S, Post KD. Epithelial cystic lesions of the sellar and parasellar region: A continuum of ectodermal derivatives? *J Neurosurg* 1994;80:1018-25.
16. Leventer DB, Merriam JC, Defendini R, Behrens MM, Housepian EM, LeQuerica S, *et al.* Enterogenous cyst of the orbital apex and superior orbital fissure. *Ophthalmology* 1994;101:1614-21.
17. Graziani N, Dufour H, Figarella-Branger D, Donnet A, Bouillot P, Grisoli F. Do the suprasellar neurenteric cyst, the Rathke cleft cyst and the colloid cyst constitute a same entity? *Acta Neurochir (Wien)* 1995;133:174-80.
18. Bavetta S, El-Shunnar K, Hamlyn PJ. Neurenteric cyst of the anterior cranial fossa. *Br J Neurosurg* 1996;10:225-7.
19. Büttner A, Winkler PA, Weis S. Endodermal cyst of the third ventricle: Case report. *Neurosurgery* 1997;40:832-5.
20. Ho LC, Olivi A, Cho CH, Burger PC, Simeone F, Tihan T. Well-differentiated papillary adenocarcinoma arising in a supratentorial enterogenous cyst: Case report. *Neurosurgery* 1998;43:1474-7.

21. Asamoto S, Sugiyama H, Doi H, Hino K, Ida M, Takahashi M, *et al.* A case of neuroaxis endodermal cyst. No To Shinkei 1999;51:520-3.
22. Sampath S, Yasha TC, Shetty S, Chandramouli BA. Parasellar neurenteric cyst: Unusual site and histology: Case report Neurosurgery 1999;44:1335-7.
23. Cheng JS, Cusick JF, Ho KC, Ulmer JL. Lateral supratentorial endo- dermal cyst: Case report and review of literature. Neurosurgery 2002;51:493-9.
24. Christov C, Chrétien F, Brugieres P, Djindjian M. Giant supra- tentorial enterogenous cyst: Report of a case, literature review, and discussion of pa
25. Tan GS, Hortobágyi T, Al-Sarraj S, Connor SE. Intracranial laterally based supratentorial neurenteric cyst. Br J Radiol 2004;77:963-5.
26. Kachur E, Ang LC, Megyesi JF. Intraparenchymal supratentorial neurenteric cyst. Can J Neurol Sci 2004;31:412-6.
27. Stubenvoll F, Beschorner R, Danz S, Freudenstein D. Fronto-laterally located supratentorial bronchogenic cyst: Case report and review of the literature. Clin Neuropathol 2006;25:123-7.
28. Preece MT, Osborn AG, Chin SS, Smirniotopoulos JG. Intracranial neurenteric cysts: Imaging and pathology spectrum. AJNR Am J Neuroradiol 2006;27:1211-6.
29. Okunaga T, Tsutsumi K, Hayashi T, Nagata I. Endodermal cyst of the oculomotor nerve: Case report. Neurosurgery 2006;58:E994.
30. Neckrysh S, Valyi-Nagy T, Charbel FT. Neuroenteric cyst of the anterior cranial fossa: Case report and review of the literature. Surg Neurol 2006;65:174-7.
31. Miyagi A, Katayama Y. Neurenteric cyst arising in the high convexity parietal lesion: Case report. Neurosurgery 2007;60:E203-4.
32. Takumi I, Mori O, Mizutani N, Akimoto M, Kobayashi S, Teramoto A. Expansile neurenteric cyst arising in the frontal lobe associated with status epilepticus: Report of a case and discussion of epileptogenesis. Brain Tumor Pathol 2008;25:97-101.
33. Marchionni M, Smith C, Eljamel MS. Intracranial enterogenous cyst extending into both supratentorial and infratentorial compartments: Case report and review of the literature. Skull Base 2008;18:213-6.
34. Basheer N, Kasliwal MK, Suri A, Sharma MC, Arora A, Sharma BS. Lateral extradural, supratentorial neurenteric cyst. J Clin Neurosci 2010;17:639-41.
35. Keiner D, Gaab MR, Ostertag H, Sommer C, Oertel J. Brain abscess formation within an endodermal cyst of the frontal lobe: Case report. Minim Invasive Neurosurg 2009;52:242-5.
36. Garbizu JM, Mateo-Sierra O, Iza B, Ruiz-Juretschke F, Pérez-Calvo JM. Supratentorial endodermal cyst. Case report. Neurocirugia (Astur) 2009;20:367-71.
37. Dunham CP, Curry B, Hamilton M. Malignant transformation of an intraaxial-supratentorial neurenteric cyst – Case report and review of the literature. Clin Neuropathol 2009;28:460-6.
38. Reddy RS, Vijayasaradhi M, Uppin MS, Challa S. A rare case of extradural neurenteric cyst with supratentorial and infratentorial extension. Acta Neurochir (Wien) 2010;152:1957-9.
39. Krishnamurthy G, Roopesh Kumar VR, Rajeswaran R, Rao S. Supratentorial enterogenous cyst: A report of two cases and review of literature. Neurol India 2010;58:774-7.
40. Jhavar SS, Nadkarni T, Goel A. Intraparenchymal temporal neurenteric cyst. J Clin Neurosci 2011;18:415-7.
41. Little MW, Guilfoyle MR, Bulters DO, Scoffings DJ, O'Donovan DG, Kirkpatrick PJ. Neurenteric cyst of the anterior cranial fossa: Case report and literature review. Acta Neurochir (Wien) 2011;153:1519-25.
42. Gauden AJ, Khurana VG, Tsui AE, Kaye AH. Intracranial neuroenteric cysts: A concise review including an illustrative patient. J Clin Neurosci 2012;19:352-9.
43. Natrella F, Mariottini A, Rocchi R, Miracco C. Supratentorial neurenteric cyst associated with a intraparenchymal subependymoma. BMJ Case Rep. 2012;2012:bcr0120125566. Published 2012 Aug 13. doi:10.1136/bcr.01.2012.5566.
44. Kitamura Y, Sasaki H, Hashiguchi A, Momoshima S, Shidoh S, Yoshida K. Supratentorial neurenteric cyst with spontaneous repetitive intracystic hemorrhage mimicking brain abscess: A case report. Neurosurg Rev 2014;37:153-9.
45. Caruso R, Artico M, Colonnese C, Marrocco L, Wierzbicki V. Supratentorial endodermal cysts: Review of literature and case report. J Neurol Surg A Cent Eur Neurosurg 2013;74:378-87.
46. Mittal S, Petrecca K, Sabbagh AJ, Rayes M, Melançon D, Guiot MC, *et al.* Supratentorial neurenteric cysts-A fascinating entity of uncertain embryopathogenesis. Clin Neurol Neurosurg 2010;112:89-97.
47. Arabi M, Ibrahim M, Camelo-Piragua S, Shah G. Supratentorial neurenteric cyst mimicking hydatid cyst: A case report and literature review. Avicenna J Med 2013;3:73-80.
48. Salvetti DJ, Williams BJ, Posthumus JS, Shaffrey ME. Enterogenous cyst of the third ventricle. J Clin Neurosci 2014;21:161-3.
49. Junaid M, Kalsoom A, Khalid M, Bukhari SS. Giant supratentorial neurenteric cyst. J Coll Physicians Surg Pak 2014;24 Suppl 3:S214-5.
50. Janczar K, Tybor K, Papierz W. Supratentorial neurenteric cyst—a case report. Neurol Neurochir Pol 2014;48:219-22.
51. Chakraborty S, Priamo F, Loven T, Li J, Insinga S, Schulder M. Supratentorial Neurenteric Cysts: Case Series and Review of Pathology, Imaging, and Clinical Management. World Neurosurg. 2016;85:143-152. doi:10.1016/j.wneu.2015.08.057.
52. Rangarajan V, Mahore A, Patil MK, Shendarkar AD. Supratentorial endodermal cysts-Report of two cases. Asian J Neurosurg 2016;11:310.
53. Chen CT, Lee CY, Lee ST, Chang CN, Wei KC, Wu CT. Neurenteric cysts: Risk factors and management of recurrence. Acta Neurochir 2016;158:1325-31.
54. Rim HT, Song JH, Kim ES, Kwon MJ. Mucinous adenocarcinoma arising from a residual supratentorial neurenteric cyst and expressing mutated KRAS: a case report. Hum Pathol. 2016 Dec;58:146-151. doi: 10.1016/j.humpath.2016.05.027. Epub 2016 Aug 26. PMID: 27569299.
55. Lopez-Gonzalez MA, Dolan E. Endodermal cyst in pineal region: Rare location. Surg Neurol Int. 2016 May 6;7(Suppl 11):S279-81. doi: 10.4103/2152-7806.181984. PMID: 27217965; PMCID: PMC4866050.
56. Bao XJ, Li XY, Wang QP, Ren XY, Liang ZY, Ma WB, *et al.* Intraparenchymal endodermal cyst with spontaneous intracystic hemorrhage in the temporal lobe of an adult. Medicine 2016;95:e4968.
57. Góes P, Vaz-Guimaraes F, Suriano IC, Araújo S, Zymberg ST. Supratentorial neurenteric cyst: Analysis of 45 cases in the literature. Interdiscipl Neurosurg Adv Techn Case Manage 11 (2018) 57-64 [doi: 10.1016/j.inat. 2017.08.008].
58. MacMahon P, Iacob S, Bach SE, Elwood ET, Lin JJ, Avellino AM. Neurosurgical management of a rare congenital supratentorial neurenteric cyst with associated nasal dermal sinus: case report, Journal of Neurosurgery: Pediatrics PED, 2017;20:521-5.
59. Kim JH, Wang KC, Phi JH, Park SH, Cheon JE, Kim SK.

- Intracranial neurenteric cyst arising at the suprasellar cistern with extension to middle cranial fossa. *Childs Nerv Syst* 2018;34:2491-2495. doi: 10.1007/s00381-018-3892-9. Epub 2018 Jul 6. PMID: 29980836.
60. Nunes Dias L, Puerta Roldán P, Guillén Quesada A, Suñol Capella M, Hinojosa J. Supratentorial neuroenteric cyst in children: a case report and brief literature review. *Childs Nerv Syst* 2019;35:2227-31. doi: 10.1007/s00381-019-04190-4. Epub 2019 May 11. PMID: 31079180.
 61. Burger PC, Scheithauer BW. *AFIP Atlas of Tumor Pathology, Series 4*. Washington, DC: Armed Forces Institute of Pathology; 2007.
 62. Emerson RE, Azzarelli B. Enterogenous cysts of the spinal canal and cerebellopontine angle. *Appl Immunohistochem Mol Morphol* 2004;12:230-3.
 63. Sahara Y, Nagasaka T, Takayasu M, Takagi T, Hata N, Yoshida J. Recurrence of a neurenteric cyst with malignant transformation in the foramen magnum after total resection. Case report. *J Neurosurg* 2001;95:341-5.
 64. Monaco R, Boscaio A, Di Blasi A, D'Antonio A, Profeta G, De Falco R, *et al.* Intraepithelial carcinoma arising in an endodermal cyst of the posterior fossa. *Neuropathology* 2003;23:219-24.
 65. Gessi M, Legnani FG, Maderna E, Casali C, Solero CL, Pollo B, *et al.* Mucinous low-grade adenocarcinoma arising in an intracranial enterogenous cyst: Case report. *Neurosurgery* 2008;62:E972-3.
 66. Wang W, Piao YS, Gui QP, Zhang XH, Lu DH. Cerebellopontine angle neurenteric cyst with focal malignant features. *Neuropathology* 2009;29:91-5.
 67. Okabe H, Katsura K, Yamano T, Tenjin H, Nakahara Y, Ishida M, *et al.* Mucinous adenocarcinoma arising from supratentorial intramedullary neuroenteric cyst with broncho-pulmonary differentiation. *Neuropathology* 2014;34:420-4.
 68. Wilkins RH, Odom GL. Tumors of the spine and spinal cord, part 2. In: Vinken PJ, Bruyn GW, editors. *Handbook of Clinical Neurology*. Amsterdam; 1976. p. 55-102.
 69. Christov C, Chrétien F, Brugieres P, Djindjian M. Giant supratentorial enterogenous cyst: Report of a case, literature review, and discussion of pathogenesis. *Neurosurgery* 2004;54:759-63.
 70. Andre E, Xu M, Yang D, Siow JK, Yeo TT, Xu Y, *et al.* MR spectroscopy in sinus mucocoele: N-acetyl mimics of brain N-acetylaspartate. *AJNR Am J Neuroradiol* 2006;27:2210-3.
 71. Periakaruppan A, Kesavadas C, Radhakrishnan VV, Thomas B, Rao RM. Unique MR spectroscopic finding in colloid-like cyst. *Neuroradiology* 2008;50:137-44.
 72. Mehnert F, Beschoner R, Küker W, Hahn U, Nägele T. Retroclival ecchordosis physaliphora: MR imaging and review of the literature. *AJNR Am J Neuroradiol* 2004;25:1851-5.
 73. Inoue T, Kawahara N, Shibahara J, Masumoto T, Usami K, Kirino T. Extradural neurenteric cyst of the cerebellopontine angle. Case report. *J Neurosurg* 2004;100:1091-3.
 74. Ochi M, Hayashi K, Hayashi T, Morikawa M, Ogino A, Hashmi R, *et al.* Unusual CT and MR appearance of an epidermoid tumor of the cerebellopontine angle. *AJNR Am J Neuroradiol* 1998;19:1113-5.
 75. Vlaho S, Gebhardt B, Gerlach R, Weidauer S, Kieslich M. Cyst of the third ventricle as an unusual cause of acquired hydrocephalus. *Pediatr Neurol* 2003;28:225-7.
 76. Pianetti Filho G, Fonseca LF. High medular compression cause by neurenteric cyst. Report of a case. *Arq Neuropsiquiatr* 1993;51:253-7.
 77. Inoue T, Matsushima T, Fukui M, Iwaki T, Takeshita I, Kuromatsu C. Immunohistochemical study of intracranial cysts. *Neurosurgery* 1988;23:576-81.
 78. Ito S, Fujiwara S, Mizoi K, Namiki T, Yosimoto T. Enterogenous cyst at the cerebellopontine angle: Case report. *Surg Neurol* 1992;37:366-70.
 79. Khalatbari MR, Moharamzad Y. Spontaneous hemorrhage into a neurenteric cyst of the cerebellar vermis. *Neuropediatrics* 2011;42:116-8.
 80. Malcolm GP, Symon L, Kendall B, Pires M. Intracranial neurenteric cysts. Report of two cases. *J Neurosurg* 1991;75:115-20.
 81. Scarone P, Boissonnet H, Heran F, Gray F, Robert G. Neurenteric cyst of the posterior fossa. Case report and review of the literature. *Neurochirurgie* 2009;55:45-52.
 82. Weiss MA, Gebarski SS, McKeever PE. Foramen magnum neurenteric cyst causing Mollaret meningitis: MR findings. *AJNR* 1996;17:386-8.
 83. Yang T, Wu L, Fang J, Yang C, Deng X, Xu Y. Clinical presentation and surgical outcomes of intramedullary neurenteric cysts. *J Neurosurg Spine* 2015;23:99-110.