RUPTURED INTRACRANIAL DERMOID CYSTS: CLINICAL, RADIOGRAPHIC, AND SURGICAL FEATURES

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OBJECTIVE: Intracranial dermoid cysts are pathologically characterized by a thick, stratified squamous epithelium cyst wall containing dermal elements. Rupture into the subarachnoid spaces and ventricles is extremely rare. We review the clinical, radiographic, and surgical features of eight ruptured dermoid cysts.

METHODS: We retrospectively evaluated five surgically treated patients with pathologically proven ruptured dermoid cysts. Clinic notes, operative reports, and neuroimaging, including initial computed tomographic and magnetic resonance imaging scans, were reviewed. Imaging was also available on three outside patients reviewed by members of our radiology department.

RESULTS: The most common presentations were headaches (57%) and seizures (42%), followed by hydrocephalus (29%) from intraventricular rupture. These lesions were consistently hypodense on computed tomographic scans and hyperintense on T1-weighted images with minimal to no enhancement after gadolinium administration. Disseminated fat droplets were present in the subarachnoid space in both cerebral hemispheres in all patients, and five patients had intraventricular rupture with fat–fluid levels in the ventricles. Gross to near-total resection of the primary lesion was achieved in all five surgically treated patients treated at our institution. Four patients had remnant tumor capsules adherent to neurovascular structures that were unresectable. Repeat resection was performed for one recurrence; there were no further recurrences during a follow-up period of 2 to 134 months (mean, 65.6 mo). Two patients with preoperative hydrocephalus eventually required ventriculoperitoneal shunting.

CONCLUSION: Ruptured intracranial dermoid cysts represent 0.18% of all central nervous system tumors surgically treated in our institution during a 12-year period. The presence of disseminated fat droplets in the subarachnoid space or ventricles on neuroimaging is diagnostic for a ruptured dermoid cyst. Gross total removal is achievable; however, residual tumor capsules adherent to neurovascular structures should be left behind to minimize complications.

KEY WORDS: Dermoid cyst, Intracranial, Rupture, Tumor

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Dermoid cysts are rare, benign lesions of embryological origin that represent 0.04 to 0.6% of all intracranial tumors (7, 11). They are commonly located in the midline and are found in the posterior fossa or suprasellar, frontobasal, or temporobasal regions (7, 11, 15, 20). They arise from inclusion of ectodermally committed cells at the time of closure of the neural groove between the third and fifth week of embryonic life (18). The cyst wall is characterized by a thick, stratified squamous epithelium capsule that contains dermal elements, including sebaceous glands, sweat glands, and hair follicles (11, 20). Dermoids typically enlarge slowly and accumulate thick, yellowish material that comprises desquamated epithelium, sebaceous gland secretions, fat, oil, and hair (1, 11, 20). The presence of hair follicles and sebaceous and sweat glands in the cyst wall distinguishes dermoid from epidermoid cysts.

Rarely, these lesions may rupture, resulting in dissemination of the intracystic contents into the subarachnoid space and ventricles. It is debatable whether these lesions acutely clinically manifest at the time of rupture or if acute

symptoms present long after a chronic process of dissemination of dermoid contents. We present a series of eight patients presenting with acute symptoms from ruptured intracranial dermoid cysts. Although this is a small series of an extremely rare tumor, our study represents the largest series to date because the vast majority of cases in the literature are presented in individual case reports. In our study, we analyze the clinical, pathological, and neuroimaging features and discuss the surgical management of these lesions.

MATERIALS AND METHODS

Five patients who presented with ruptured dermoid cysts were surgically treated between 1995 and 2007. Their clinic charts, operative reports, and pathology reports were retrospectively reviewed to evaluate the clinical presentation and pathological and surgical manifestations. A neuroimaging analysis was also conducted by review of pre- and postoperative computed tomographic (CT) and magnetic resonance imaging (MRI) scans. All cases were reviewed in accordance with the Health Insurance Portability and Accountability Act regulations. Three additional patients from the radiology archives at our institution were also included in the neuroimaging analysis. Surgical information was not available for review for these three patients; however, information regarding clinical presentation was available for two of these patients.

RESULTS

Five cases of ruptured intracranial dermoid cysts were treated between 1995 and 2007, representing 0.18% (5 of 2707 tumors) of all new central nervous system tumors operated during this 12-year period in our institution. The patients included four men and one woman with a mean age of 38 years (range, 25–57 yr) (*Table 1*). These patients all had histologically confirmed dermoid cysts with radiographic and intraoperative evidence of rupture.

Clinical Presentation

The clinical presentations of seven patients were available for review. Four (57%) patients presented with headache, three (42%) presented with seizures, one (14%) had visual loss from optic chiasm compression, one (14%) presented with facial numbness and diplopia from cavernous sinus compression, and two (29%) presented with hydrocephalus, of whom one had altered level of consciousness from acute ventricular outflow obstruction.

Neuroimaging Features

CT scans were available for review in seven patients and MRI scans were available for review in eight patients (*Figs. 1–5*). The location of the tumor was quite variable. Three

TABLE 1. Clinical, radiographic, and surgical findings of eight patients with ruptured intracranial dermoid cysts[a,b]

Patient no.	Age (yr)/sex	Presentation	Tumor location	CT scan findings	MRI scan findings	Capsule adherence	Follow-up (mo)
1	57/M	Seizure	Right peri-sylvian	Hypodense, calcium	Hyperintense T1, homogeneous, FDS, MCA encasement	Yes (to MCA)	61
2	25/F	HA, visual loss	Suprasellar/ anterior cranial base	—[c]	Hyperintense T1, heterogeneous, FDS	No	15
3	36/M	Hydrocephalus, acute mental status decline	Pineal region with parieto-occipital extension	Hypodense	Hyperintense T1, homogeneous, FDS, IVR, HCP	Yes (to ependyma)	116
4	35/M	HA, hydrocephalus, left facial numbness, diplopia	Left peri-sylvian with suprasellar extension	Hypodense, calcium	Hyperintense T1, homogeneous, FDS, IVR, HCP, ICA encasement	Yes (to ICA, ON)	134
5	37/M	Progressive headaches for 1 year	Right parasellar extending to sylvian fissure	Hypodense	Hyperintense T1, heterogeneous, FDS, IVR	Yes (to MCA, ACA)	2
6	20/M	Seizure	Pineal region with parieto-occipital extension	Hypodense, calcium	Hyperintense T1, heterogeneous, FDS, IVR	—	—
7	36/M	HA, seizure	Left frontal	Hypodense	Hyperintense T1, homogeneous, FDS, IVR	—	—
8	—	—	Petroclival region, brainstem, temporal lobe	Hypodense	Hyperintense T1, heterogeneous, FDS	—	—

[a] CT, computed tomography; MRI, magnetic resonance imaging; FDS, fat droplets in subarachnoid space; MCA, middle cerebral artery; HA, headaches; IVR, intraventricular rupture; HCP, hydrocephalus; ICA, internal carotid artery; ON, optic nerve; ACA, anterior cerebral artery.
[b] Patients 1 through 5 were treated surgically in our institution; Patients 6 through 8 were neuroimaging cases from outside institutions reviewed by members of our radiology department.
[c] Dashes indicate not available for review.

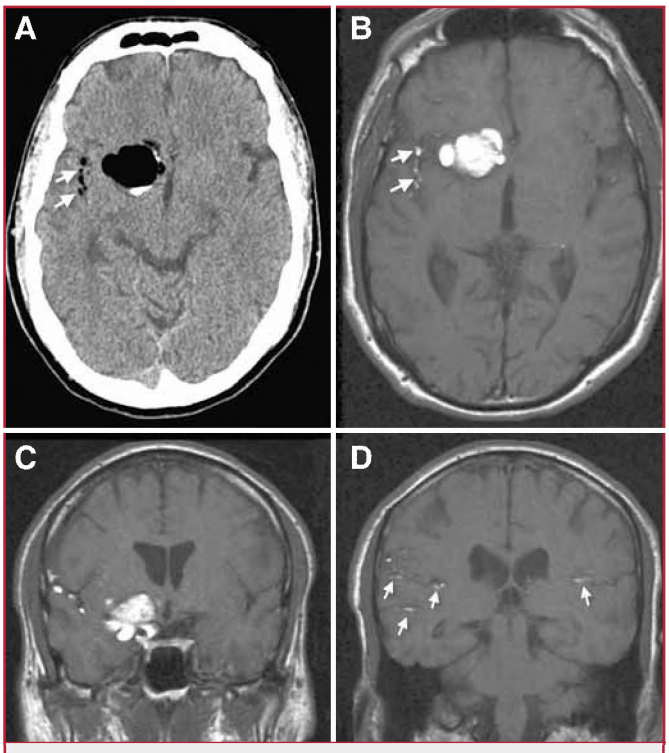

FIGURE 1. *Preoperative computed tomographic (CT) and magnetic resonance imaging (MRI) scans of Patient 1.* **A**, *CT scan showing a hypodense lesion in the right sylvian fissure with an area of calcification in the rim of the lesion. Small droplets of hypodensity in the subarachnoid space are also seen* (white arrows). **B–D**, *axial and coronal T1-weighted MRI scans showing a homogeneously hyperintense lesion consistent with a right peri-sylvian ruptured dermoid tumor with disseminated fat droplets in both sylvian fissures* (white arrows).

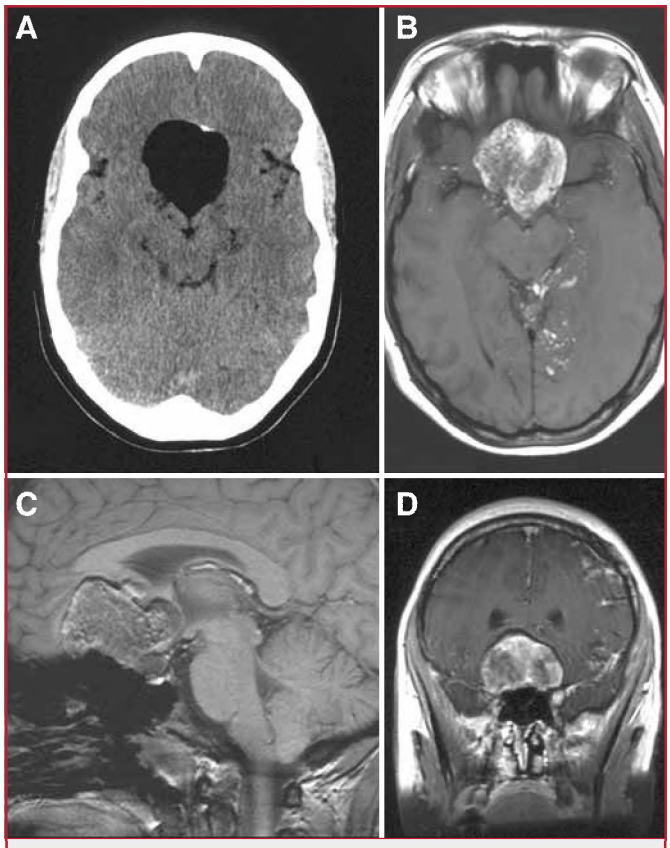

FIGURE 2. *Preoperative CT and MRI scans of Patient 2.* **A**, *CT scan showing a hypodense lesion in the suprasellar region with an area of calcification in the rim of the lesion.* **B–D**, *preoperative MRI scans (***B**, *axial T1-weighted;* **C**, *sagittal T1-weighted;* **D**, *coronal postgadolinium T1-weighted) showing a heterogeneously hyperintense lesion with minimal enhancement occupying the suprasellar and anterior cranial base region. Hyperintense fat droplets are visible throughout the subarachnoid cisterns.*

tumors (38%) were located in the peri-Sylvian region, with one extending into the suprasellar cistern (*Figs. 1* and *4*). One (13%) was primarily in the suprasellar region, involving the tuberculum sellae and planum sphenoidale (*Figs. 2* and *3*). Two (25%) were in the pineal region with extension superolaterally to the parieto-occipital region (*Fig. 5*). One (13%) was in the frontal lobe, and one (13%) was in the petroclival region with significant brainstem and temporal lobe compression.

On CT scans, all patients (100%) had a hypodense lesion with hypodense droplets throughout the subarachnoid spaces. Three patients (43%) had evidence of calcium in the rim of the lesion.

On MRI scans, all patients (100%) had hyperintense lesions on T1-weighted images with minimal to no enhancement after gadolinium administration consistent with fat content within the lesion. Hyperintense fat droplets were also present throughout the subarachnoid spaces in both cerebral hemispheres in all patients (100%). Four patients (50%) had a homogeneous pattern of hyperintensity on T1-weighted images, whereas four (50%) had a heterogeneous pattern of hyperintensity on T1-weighted images. Two patients (25%) exhibited encasement around large arteries (one internal carotid artery [ICA], one middle cerebral artery [MCA]). Five patients (63%) demonstrated evidence of intraventricular rupture (hyperintensity within the ventricles on T1-weighted images) with fat–fluid levels. Two of these patients (25%) had hydrocephalus as revealed by scans that eventually required ventriculoperitoneal shunting. Postoperative MRI scans (*Fig. 4D*) at the time of the most recent follow-up evaluation in the five surgically treated patients demonstrated stable disseminated fat content in the subarachnoid spaces (Patients 1–5) and in the ventricles (Patients 3 and 4).

Surgical Features and Results

Five patients underwent operation for a pathologically proven ruptured dermoid cyst. At surgery, fat droplets within the subarachnoid space were visualized in each patient. These droplets within the subarachnoid cisterns were not surgically removed. The tumor capsules all had an arachnoid plane that was readily dissectible off the surrounding brain. Four patients

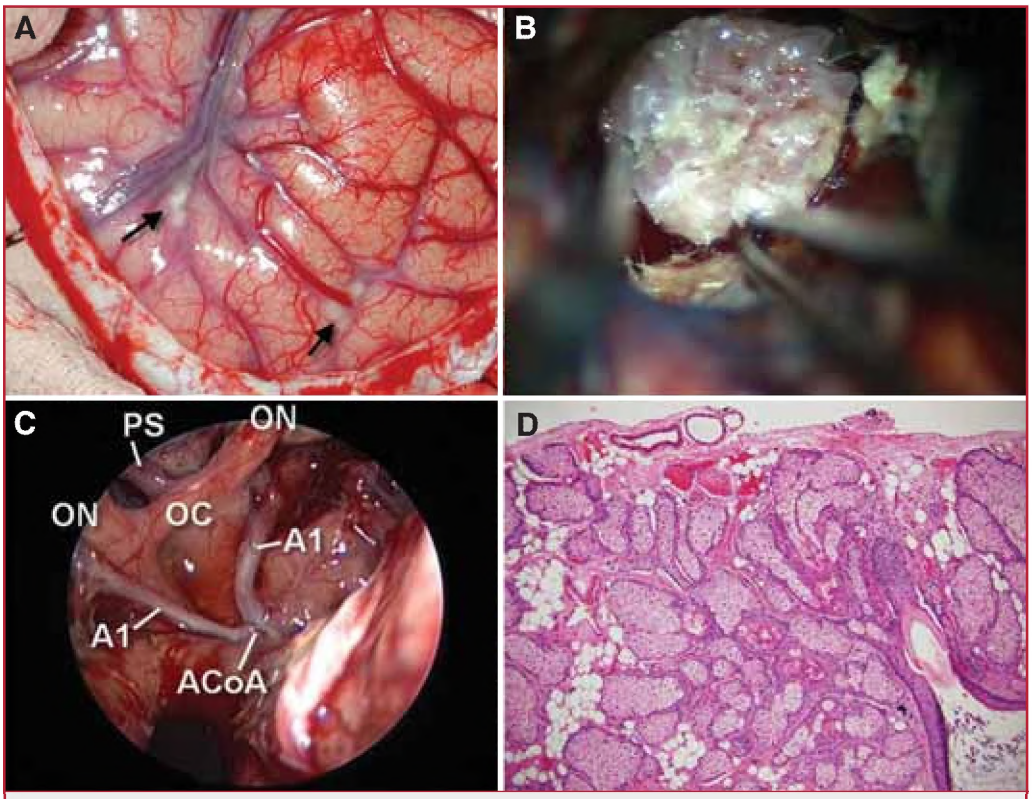

FIGURE 3. *Intraoperative photographs (A–C) and histopathological analysis (D) of Patient 2, who underwent gross total resection of the ruptured dermoid cyst through a pterional approach with endoscopic assistance. A, disseminated fat droplets from the ruptured dermoid are visible in the sylvian fissure and subarachnoid spaces (arrows). B, microscopic view showing removal of cystic contents of the dermoid comprised of fatty debris, desquamated skin, and hair. At the base of the tumor on the planum sphenoidale, a plaque of what appeared to be anatomic skin is shown. C, endoscopic view with a 30-degree angled endoscope showing gross total removal of the tumor with excellent visualization of the anterior communicating artery complex and optic apparatus. ACoA, anterior communicating artery; OC, optic chiasm; ON, optic nerve; PS, pituitary stalk. D, histopathological analysis showing stratified squamous epithelium associated with prominent sebaceous glands, sweat glands, adipose tissue, hair follicles, and rare smooth muscle consistent with a dermoid cyst. The cyst contents contain keratinous debris and hair (hematoxylin and eosin; original magnification, ×200).*

had a small portion of the tumor capsule that was densely adherent to surrounding neurovascular structures (one MCA, one ependyma of ventricle, one ICA and optic nerve, one MCA and anterior cerebral artery). These remnants of tumor capsule were left behind at surgery because of risk of injury to these structures. The contents within the tumor cyst consistently included hair follicles, fat, and sebaceous glands, which were easily removed with suction to allow intracystic debulking and decompression of the cyst. The resection cavities were irrigated with saline, and dispersion of cyst contents was prevented to minimize the risk of chemical meningitis. In two patients, the angled endoscope was used to look around corners and inspect regions hidden from the microscopic view (endoscopic-assisted resection). In both cases, this technique helped achieve a more complete resection.

Not all of the disseminated fat droplets in the subarachnoid space and ventricles can be removed entirely. Therefore, we defined gross total resection as resection of the primary cystic lesion (source of dermoid contents) without removing disseminated droplets. One patient had gross total removal of the tumor, and four had near-total resection of the tumor (patients who had adherent tumor capsules left behind). One patient who had residual tumor experienced a recurrence 5 months later that required a repeat resection. There have been no further recurrences during a follow-up period of 2 to 134 months (mean, 65.6 mo). Two patients who presented with preoperative hydrocephalus eventually required ventriculoperitoneal shunting.

ILLUSTRATIVE CASES

Patient 1

A 57-year-old, right-handed man presented with a new-onset generalized tonicoclonic seizure. No neurological deficits were revealed during clinical examination. A CT scan demonstrated a hypodense lesion, consistent with air or fat, in the right sylvian fissure with an area of calcification within the rim of the lesion (*Fig. 1*). Small droplets of hypodensity in both sylvian fissures were also observed. T1-weighted MRI scans revealed a hyperintense lesion compatible with a right perisylvian dermoid tumor that had ruptured into both sylvian fissures (*Fig. 1*).

The patient was administered anticonvulsant medication and underwent a right pterional frontotemporal craniotomy for resection of the tumor. Intraoperatively, a dermoid tumor consisting of fat, cholesterol, and hair was found adherent to the entire M1 segment of the right MCA. The right optic nerve was elevated and pushed medially by the tumor. The tumor was carefully dissected off the MCA, frontal and temporal lobes, and the optic nerve. A near-total resection of the tumor was performed. A small portion of the tumor, which was very adherent to the perforating vessels at the MCA trifurcation region, was left behind. The resection bed and basal cisterns were irrigated. The fat droplets in the sylvian fissure were left intact.

Pathological examination of the resected material revealed multiple fragments of soft tan-brown tissue with multiple hairs and viscous material consistent with a dermoid cyst. Postoperatively, the patient remained neurologically intact. Postoperative MRI scans showed adequate gross total resection of the dermoid tumor with remaining dermoid droplets in both sylvian fissures. The patient remained stable at the time of his 5-year follow-up examination.

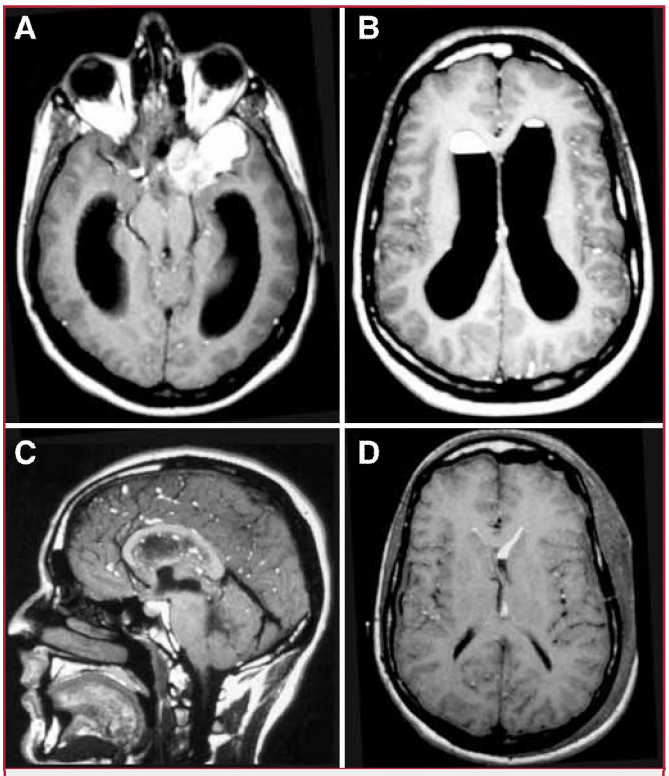

FIGURE 4. *MRI scans of Patient 4. Preoperative T1-weighted MRI scans (**A** and **B**, axial views; **C**, sagittal view) showing a homogeneously hyperintense lesion in the left peri-sylvian region extending into the suprasellar cistern. There are hyperintense disseminated fat droplets throughout the subarachnoid spaces and a fat–fluid level in the lateral ventricles (**B**) with hydrocephalus. The patient underwent near-total resection of the ruptured dermoid and ventriculoperitoneal shunting. **D**, postoperative MRI scan at 11-year follow-up examination showing decreased size in the ventricles with dormant fat content in the ventricles and subarachnoid spaces.*

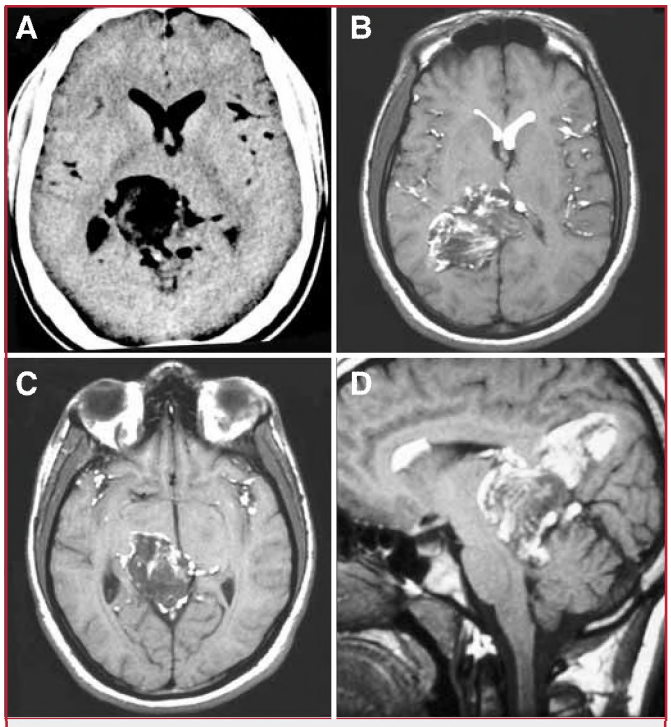

FIGURE 5. *CT (**A**) and MRI (**B–D**) scans of Patient 5. **A**, CT scan showing a hypodense lesion in the pineal region with disseminated hypodense droplets. T1-weighted MRI scans (**B** and **C**, axial views; **D**, sagittal view) showing a heterogeneously hyperintense lesion in the pineal region with extension into the right parieto-occipital region. There are hyperintense fat droplets in the subarachnoid spaces in both cerebral hemispheres and a fat–fluid level in the ventricles consistent with an intraventricular rupture.*

Patient 2

A 25-year-old woman presented with worsening migraine headaches, double vision, and visual difficulty. At examination, her visual acuity was 20/15 in both eyes and visual fields demonstrated bitemporal defects superiorly. A CT scan showed a hypodense lesion in the suprasellar region with an area of calcification in the rim of the lesion (*Fig. 2*). T1-weighted MRI scans demonstrated a suprasellar lesion that extended toward the tuberculum sellae and planum sphenoidale with disseminated fat droplets in the subarachnoid spaces (*Fig. 2*). The tumor was compressing the optic chiasm.

The patient underwent a left pterional frontotemporal craniotomy for removal of the tumor. Intraoperatively, fat droplets were visualized in the subarachnoid space (*Fig. 3*). The cyst contents revealed fatty debris, desquamated skin, and hair. The tumor and cyst capsule were removed entirely. At the base of the tumor on the planum sphenoidale, a plaque of what appeared to be anatomic skin was identified (*Fig. 3*). A 30-degree angled endoscope was placed in the suprasellar cistern, and a small portion of tumor, which was not visible under microscopic view, was visualized underneath the ipsilateral optic nerve and carotid artery. This was subsequently resected to achieve gross total removal of the tumor. The angled endoscope allowed excellent visualization of the suprasellar cistern and anterior communicating artery complex (*Fig. 3*). The resection bed and suprasellar cisterns were irrigated copiously with saline. The disseminated fat droplets in the subarachnoid space from the preoperative cyst rupture were left intact.

Pathological analysis revealed stratified squamous epithelium associated with prominent sebaceous glands, sweat glands, adipose tissue, hair follicles, and rare smooth muscle consistent with a dermoid cyst (*Fig. 3*). The cyst contents contained keratinous debris and hair. Postoperatively, the patient was neurologically intact with improved visual fields. Her examination results remained stable at 1 year of follow-up.

Patient 3

A 36-year-old man presented with acute mental status decline secondary to obstructive hydrocephalus. T1-weighted MRI scans revealed a large pineal region mass with extension into the lateral ventricle. Diffuse disseminated fat droplets were present in the subarachnoid space, and a fat–fluid level was present in the lateral ventricles suggestive of a ruptured dermoid cyst. An external ventricular drain was placed, and the patient made a near-complete recovery with the exception of diplopia.

The patient underwent a left occipital craniotomy for a transcortical intraventricular approach for near-total resection of the intraventricular dermoid cyst. When the lateral ventricle was entered, fat droplets were found mixed with the cerebrospinal fluid. The ventricular surface

and subependymal layer were also studded with fat droplets. There was an area of discoloration of the ependymal layer medially where the tumor was abutting the lateral ventricle. The tumor capsule was entered and fatty droplets, keratin-like material, and hair were encountered. The tumor was debulked internally by removal of the cyst contents. An endoscope was used interchangeably with the microscope to look around corners and guide the tumor resection. A near-gross total resection of the tumor was performed. There was a small residual of tumor capsule adherent to the ependymal surface that was left intact. The resection bed and ventricles were irrigated thoroughly. The disseminated fat droplets in the subarachnoid space were left intact.

Postoperatively, the patient remained neurologically stable. A ventriculoperitoneal shunt was subsequently placed to treat the hydrocephalus. Five months later, the patient presented with recurrence of the tumor in the pineal region. A supracerebellar infratentorial approach was used to achieve gross total resection of the tumor. The patient remained stable without evidence of recurrence 9 years after surgery.

Patient 4

A 35-year-old man presented with progressive headaches, nausea, vomiting, and intermittent left facial numbness and diplopia. The week before admission, he had increased bouts of vomiting and dizziness. Results of his neurological examination were normal with the exception of mild meningismus and papilledema.

A CT scan revealed a hypodense lesion in the left peri-sylvian region with a small rim of calcium and significant hydrocephalus. Hypodense droplets were also appreciated in the subarachnoid space in both cerebral hemispheres. The lesion was hyperintense on T1-weighted MRI scans (*Fig. 4*). There was high signal intensity within the ventricles with a fluid–fluid level on T1-weighted images consistent with an intraventricular rupture of a left peri-sylvian dermoid cyst. There was also significant hydrocephalus.

The patient initially underwent ventriculoperitoneal shunt placement for his hydrocephalus. He then underwent a pterional craniotomy for resection of the dermoid cyst. After the sylvian fissure was opened widely, a large inferotemporal mass was discovered and carefully dissected off the frontal and temporal lobes and the MCA and ICA. A remnant of the tumor capsule that was very adherent to the optic nerve and ICA near the terminal bifurcation could not be removed safely and therefore was left behind. A large amount of hair follicles, greasy gelatinous material, calcium, and fat was observed within the tumor capsule. The wound was copiously irrigated with saline solution buffered with hydrocortisone to prevent chemical meningitis. The disseminated fat droplets in the subarachnoid space and ventricles were left intact.

Postoperatively, the patient remained neurologically intact. He had no evidence of recurrence at the time of his 11-year follow-up examination. The fat droplets within the ventricles and subarachnoid spaces remained dormant as documented by follow-up images (*Fig. 4*).

DISCUSSION

Clinical Features

Rupture of intracranial dermoid cysts is a rare phenomenon. Approximately 51 cases have been described in the literature (6, 18). The rupture is usually spontaneous, but it has also been reported after closed-head trauma (16). The dissemination of intracystic contents after surgical removal of dermoid cysts has also been described (4). Although the exact mechanism of rupture is unknown, Stendel et al. (18) hypothesized that glandular secretions, possibly increased by age-dependent hormonal changes, may lead to rapid enlargement and rupture of these cysts.

When dermoid cysts spontaneously rupture into the subarachnoid space or ventricular system, patients can present with a variety of symptoms, including headache, seizures, hemiparesis, aseptic meningitis, hydrocephalus, vasospasm, cerebral ischemia, fat embolism, and visual deficit (1, 4, 10, 12, 14, 15, 18, 19, 21). It is postulated that the presence of lipid contents in the subarachnoid space causes chemical irritation of the adjacent neurovascular structures. In one study by El-Bahy et al. (6), headache was the most common symptom (32.6%), followed by seizures (26.5%), cerebral ischemia with sensory or motor deficit (16.3%), and aseptic meningitis (8.2%). In patients with unruptured dermoid cysts, the signs or symptoms result from compression of adjacent neurovascular structures; however, because these are slow-growing tumors, some may reach large sizes without causing neurological signs or symptoms (15, 20).

Neuroimaging

On CT scans, dermoid cysts can have mixed densities. The fatty portion of the tumor appears hypodense and areas of calcification are hyperdense (*Figs. 1* and *2*). Fat droplets in the subarachnoid space or ventricles are hypodense. Hydrocephalus may be present if there is rupture into the ventricular system and a fat–fluid level may be present.

On MRI scans, the lesions usually appear hyperintense on T1-weighted images consistent with fat content; however, some may appear more heterogeneous (*Fig. 5*) with minimal enhancement because of the presence of calcifications, hair, epithelial debris, and sebaceous secretion. Disseminated lipid droplets in the subarachnoid cisterns or ventricles appear hyperintense on T1-weighted images and are sensitive for the diagnosis of a ruptured dermoid cyst (11, 14, 17). A fat–fluid level may also be present in patients with intraventricular rupture (*Figs. 4* and *5*). Chemical-shift MRI scans provide excellent contrast between the subarachnoid lipids and the adjacent normal brain with good spatial resolution.

Surgical Management

We recommend surgical resection in patients with large symptomatic lesions to relieve mass effect that has resulted in neurological deficit. In our series of five patients who underwent surgical resection, three had neurological compromise from mass effect (one had visual decline from suprasellar compression, one had diplopia and facial numbness from cavernous sinus compression, and one had hydrocephalus from brainstem compression). The remaining two patients did not have a preoperative neurological deficit at the time of presentation (one had seizures, one had progressive headaches). Although headaches and seizures are not always reversible with surgery, surgical removal was considered in these patients because the lesions were of significant size. In patients with smaller asymptomatic lesions or merely headache, close observation with serial imaging would be a reasonable, accept-

able option. If the tumor demonstrates interval growth, surgical removal should be considered.

The goal of treatment in patients with dermoid cysts involves complete surgical removal of the primary tumor capsule and intracystic contents. Because the dissemination of fat droplets is usually extensive bilaterally, it is usually not possible nor is it necessary to remove the disseminated fat droplets. Because of its ability to display the extensiveness of the lesion and the involvement with the local neurovascular anatomy, MRI is useful in developing an effective surgical approach and in determining whether or not radical resection is achievable (4, 17, 20). Surgical management of dermoid cysts involves incising the capsule, removing cyst contents for internal debulking and decompression, and microsurgically dissecting the capsule from adherent or adjacent neurovascular structures (11, 20). Ideally, a plane of dissection can be developed between the capsule and overlying arachnoid, but the dermoid capsules commonly have a dense adherence to the brain parenchyma and vasculature (11, 20). Dermoids are more likely than epidermoids to exhibit adherent involvement of the arachnoid, which makes the development of a surgical plane and dissection difficult (20). If the tumor capsule is strongly adherent to surrounding neurovascular structures, subtotal resection should be considered, leaving the adherent portion intact to avoid vascular complications (1, 3, 4, 20). Four patients in our series had residual tumor capsules adherent to neighboring neurovascular structures. In Patient 1, the dermoid cyst capsule was readily dissected off of the M1 segment of the MCA and frontal lobe; however, a portion of the capsule that was adherent to the perforating vessels at the MCA trifurcation was left behind. In a report by Yaşargil et al. (20), the authors chose not to radically dissect a capsule involving the aqueduct of Sylvius. They achieved radical resection of seven out of eight dermoid tumors.

Unlike in epidermoid tumors, the recurrence rate after subtotal resection of a dermoid cyst is extremely low (8, 11, 20) with only two cases reported previously (2, 8); we report an additional case of recurrence after subtotal resection (Patient 3). Therefore, the benefits of obtaining complete resection must be considered against the risks of causing neurological injury.

The dissemination of lipid droplets in the subarachnoid space from spontaneous cyst rupture can be diffuse and widespread, and it is not practical to remove all of these droplets. Intraventricular or subarachnoid fat does not seem to be resorbed and has been demonstrated to persist for years after the time of rupture (4, 9, 13). Long-term monitoring with serial MRI scans and clinical examinations of patients with extensive disseminated fat particles has not demonstrated progression or movement of the fat or new neurological deterioration, which is consistent with our experience (4, 9, 13, 19).

During cyst decompression and removal, leakage of intracystic contents into the subarachnoid spaces should be avoided. This can be facilitated by minimizing the opening of the cyst wall for internal debulking and protecting the surrounding neurovascular structures with cottonoid patties. Extensive irrigation of the resection bed and subarachnoid cisterns is recommended to minimize the risk of postoperative aseptic meningitis (1, 3, 4, 18, 20). Some authors have suggested the use of irrigation of the operative field with hydrocortisone to wash out the tumor debris and avoid postoperative fat dissemination and aseptic meningitis (4). If the patient develops postoperative meningitis, it is usually transient, self-limited, and responsive to systemic dexamethasone therapy (3, 4, 11, 20). Delayed ischemic deficit from vasospasm has been reported after resection of a ruptured dermoid (5). Copious irrigation of the subarachnoid spaces may lower the concentration of dermoid byproducts and the potential risk of delayed cerebral ischemic deficit (5).

CONCLUSION

Ruptured intracranial dermoid cysts represent only 0.18% of all central nervous system tumors operated on during a 12-year period at our institution. Patients commonly present with headaches, seizures, and symptoms related to mass effect. The neuroimaging features are quite characteristic, and the presence of disseminated fat droplets in the subarachnoid space or ventricles on neuroimaging scans is diagnostic for a ruptured dermoid cyst. Gross total removal is achievable in most cases; however, residual tumor capsules adherent to neurovascular structures should be left behind to minimize the risk of complications.

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COMMENTS

The authors have carefully documented four patients with ruptured intracranial dermoid tumors who underwent definitive surgery. They have added three other patients who had imaging only. These lesions have an unmistakable imaging pattern, making the preoperative diagnosis almost certain. I agree with the authors that the goal should be complete removal of the primary lesion but not at the expense of damage to surrounding structures. I have followed several patients such as these and have never seen a recurrent rupture. This study emphasizes the need to perform computed tomographic as well as magnetic resonance imaging (MRI) scans when this diagnosis is a possibility.

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Although "benign," dermoid cysts often present challenges in terms of surgical management. Cyst rupture is usually symptomatic and can be visualized on contemporary computed tomographic and MRI scans. As the authors indicate, complete resection is often hampered by adherence of the cyst capsule to important neurovascular structures, and recurrence can occur in short order after incomplete resection. The lack of literature on the use of stereotactic radiosurgery for these lesions suggests that it is probably ineffective, rendering dermoid cysts squarely in the open surgical realm.

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The authors present a series of seven patients with an exceedingly rare entity: rupture of intracranial dermoid cysts. Considering the fact that to date 51 cases have been published, the current analysis is highly valuable.

The authors are to be commended for the detailed and precise description of the clinical, radiological, and surgical features. The figures and the intraoperative images are of very good quality and could be used as a reference on the topic.

Two aspects, discussed by the authors, have to be underlined. We completely agree that dermoid cysts have a very low recurrence rate and are less likely to recur than epidermoid cysts. Respectively, if a part of the capsule is strongly adherent to a neural or vascular structure, subtotal removal is the best decision so as not to create a new neurological deficit.

It is known that the spillage of the contents of a dermoid cyst into the subarachnoid space or intraventricularly might lead to chemical aseptic meningitis, hydrocephalus, seizures, cerebral vasospasm, and/or fibrosis around the cranial nerves and spinal nerve roots (2, 3). During surgical removal of a dermoid cyst, continuous irrigation of the operative field should be performed to avoid these complications. Interestingly, the current study demonstrates that although disseminated fat drops remained intact over a mean follow-up of 80 months, no long-term neurological disturbances were registered. Nevertheless, owing to the risk of both recurrence and/or late neurological deterioration, we recommend regular follow-up with serial MRI scans and neurological examinations (1).

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1. Carvalho GA, Cervio A, Matthies C, Samii M: Subarachnoid fat dissemination after resection of a cerebellopontine angle dysontogenic cyst: Case report and review of the literature. **Neurosurgery** 47:760–764, 2000.
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This is the largest series on ruptured intracranial dermoid cysts in the literature. The information in this well-written and well-analyzed series will be useful for any reader if they encounter this rare lesion. These hyperintense lesions show minimal or no enhancement after gadolinium administration on T1-weighted MRI scans, consistent with their high fat content. Interestingly, hyperintense fat droplets were also present throughout the subarachnoid spaces in all the patients in this series, raising the question of why these lesions may become symptomatic in a delayed fashion. The take-home message for us is that a complete resection without chasing fat droplets can result in a good long-term outcome without recurrence. Additionally, the authors wisely advise a conservative approach when peeling these benign lesions off vessels and cranial nerves.

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