Dermoid Cyst of the Prepontine Cistern and Meckel's Cave: Illustrative Case and Systematic Review

Lawrance K. Chung¹ Carlito Lagman¹ Courtney Duong¹ Daniel T. Nagasawa¹ Alexander M. Tucker¹
William H. Yong² Isaac Yang^{1,3,4}

¹ Department of Neurosurgery, David Geffen School of Medicine, University of California, Los Angeles, Los Angeles, California, United States

² Department of Pathology and Laboratory Medicine, David Geffen School of Medicine, University of California, Los Angeles, Los Angeles, California, United States

³ Department of Radiation Oncology, David Geffen School of Medicine, University of California, Los Angeles, Los Angeles, California, United States

⁴ Jonsson Comprehensive Cancer Center, David Geffen School of Medicine, University of California, Los Angeles, Los Angeles, California, United States

Address for correspondence Isaac Yang, MD, Department of Neurosurgery, University of California, Los Angeles, 300 Stein Plaza, Suite 562, 5th Floor Wasserman Building, Los Angeles, CA 90095-1761, United States (e-mail: iyang@mednet.ucla.edu).

J Neurol Surg B 2018;79:139–150.

Abstract

Objective Dermoid cysts are benign, congenital malformations that account for ~0.5% of intracranial neoplasms. The authors describe a 42-year-old female with a prepontine dermoid cyst who underwent apparent gross total resection (GTR) but experienced cyst recurrence. To date, very few cases of prepontine dermoid cysts have been reported. The prevalent region where these cysts are located can be difficult to determine. In addition, the authors systematically review the literature to characterize the clinical presentation, anatomical distribution, and surgical outcomes of intracranial dermoid cysts.

Design Systematic review.

Setting/Participants PubMed, Web of Science, and Scopus databases.

Main Outcome Measures Extent of resection, symptom improvement, and recurrence rates.

Results A total of 69 patients with intracranial dermoid cysts were identified. Three (4.3%) intracranial dermoid cysts were located in the prepontine cistern. The average age of patients was 33.3 years. The most common presenting symptoms were headache (52.2%) and visual disturbances (33.3%). Intracranial dermoid cysts were distributed similarly throughout the anterior, middle, and posterior cranial fossae (29.0%, 36.2%, and 29.0%, respectively). GTR was achieved in 42.0% of cases. Thirty-four (49.3%) patients experienced symptom resolution. Recurrence rate was 5.8% at a mean follow-up of 2.1 years.

Conclusions Intracranial dermoid cysts most often present as headaches and visual disturbances. Intracranial dermoid cysts were found in the anterior, middle, and posterior cranial fossae at similar frequencies but with clear predilections for the Sylvian fissure, sellar region, and cerebellar vermis. Outcomes following surgical excision of intracranial dermoid cysts are generally favorable despite moderate rates of GTR.

Keywords

- dermoid cysts
- intracranial
- prepontine cistern
- systematic review

received

April 5, 2017

accepted after revision

June 10, 2017

published online

August 11, 2017

© 2018 Georg Thieme Verlag KG
Stuttgart · New York

DOI <https://doi.org/10.1055/s-0037-1604332>.
ISSN 2193-6331.

Introduction

Dermoid cysts arise from ectopic epithelium sequestered within the neural tube during embryogenesis.^{1–15} Intracranial dermoid cysts are uncommon and account for ~0.5% of brain tumors.^{1,9,16,17} Intracranial dermoid cysts have been commonly reported near the sella and cerebellar vermis.¹⁸ However, only three cases of prepontine dermoid cysts have been reported to date.^{19–21} The authors herein describe an additional case of a prepontine dermoid cyst arising in a 42-year-old female who underwent apparent gross total resection (GTR) with subsequent cyst recurrence. The prevalent region where these deep-seated cysts are located may be difficult to determine; thus, the appropriate surgical approach is often unclear. Given the rarity of this location, a systematic review was performed to characterize the clinical presentation, anatomical distribution, and surgical outcomes of intracranial dermoid cysts.

Case Illustration

History and Physical

A 42-year-old female with no significant past medical history presented with 4 months of progressive dental paresthesias and lower jaw pain. On examination, she had left-sided facial pain in the distribution of V2 and V3. Her hearing was intact bilaterally with an excellent House–Brackman score.

Imaging

The patient underwent further evaluation with computed tomography (CT) and magnetic resonance imaging (MRI), including diffusion studies. CT revealed a hypodense mass, anterior to the brainstem and that extended into Meckel's cave on the left. T1- and T2-weighted sequences demonstrated a non-enhancing, hyperintense, 3 cm lobulated mass in the prepontine cistern, inferior to the left trigeminal nerve (**Fig. 1**). Initial assessment suggested a dermoid cyst.

Fig. 1 Preoperative imaging for the illustrative case, (A) axial T1-weighted MRI showing a hyperintense mass in the prepontine cistern with extension into Meckel's cave, (B) axial T2-weighted MRI, (C) coronal T1-weighted MRI with contrast, and (D) sagittal T1-weighted MRI. MRI, magnetic resonance imaging.

Fig. 2 Postoperative imaging for the illustrative case, (A) axial T1-weighted MRI demonstrating apparent gross total resection of the previously described preopontine mass, (B) axial T2-weighted MRI, (C) sagittal T1-weighted MRI, and (D) axial DWI. DWI, diffusion-weighted imaging; MRI, Magnetic resonance imaging.

Management and Pathology

Surgical resection was advised, and the patient was placed on gabapentin for symptomatic management. The patient underwent a suboccipital craniotomy (retrosigmoid approach) for resection of the mass. Dissection of several pontomedullary adhesions was performed under the operative microscope. Cerebrospinal fluid drainage and table rotation enabled visualization of the ventral brainstem. The capsule and its cystic contents were fully excised with no remnants visualized intraoperatively. The wound was irrigated with saline until clear, and the incision was closed in standard fashion. Immediate postoperative imaging indicated GTR (►Fig. 2). Final pathological examination showed hair fragments and scaly epithelium within the specimen, consistent with a dermoid cyst (►Fig. 3).

Follow-up

One-year follow-up imaging demonstrated a 9×3 mm recurrent dermoid cyst in the preopontine cistern, (►Fig. 4).

At 4-year follow-up, the mass demonstrated no further growth and the patient reported complete symptom resolution. She continues to be followed with serial imaging to monitor cyst size. Informed consent to publish this case was obtained from the patient at the most recent follow-up visit.

Methods

Data Sources

A comprehensive search of the PubMed, Web of Science, and Scopus databases was independently performed through January 2017 by the first and second authors. Articles related to intracranial dermoid cysts were identified using search terms “dermoid cyst” AND “intracranial.” A second independent query was performed in a similar fashion to identify cases of preopontine dermoid cysts using search terms “dermoid cyst” AND “preopontine.” After removing duplicates, title and abstracts were screened for relevant articles.

Fig. 3 Hematoxylin and eosin stain of the operative specimen showing the presence of (A) hair shafts and (B) keratin debris, which are consistent with a dermoid cyst.

Fig. 4 Postoperative imaging for the illustrative case demonstrating what appears to be a recurrent dermoid cyst in the prepontine cistern, (A) coronal T1-weighted MRI, (B) and (C) sagittal T1-weighted MRI, and (D) axial T2-weighted MRI. MRI, Magnetic resonance imaging.

Fig. 5 Schematic diagrams of the search strategies for (A) intracranial dermoid cysts and (B) prepontine dermoid cysts. *All articles were reviewed regardless of exclusion criteria.

Schematic diagrams of the search strategies are provided in ► **Fig. 5**.

Study Selection

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were adhered to throughout this study. English, full-text case reports and series were included. Non-English, abstract-only text, and review articles were excluded. Studies with insufficient outcomes data or those involving dermoid cysts with extradural components, malignant transformations, sinus tracts, and/or associated with clinical syndromes were eliminated. Studies without mention of histopathological or gross confirmation of the dermoid cyst were further excluded. However, due to the paucity of prepontine dermoid cyst cases, all relevant studies were reviewed independent of the above-mentioned exclusion criteria.

Data Extraction

Patient demographics, presentations, cyst locations, and surgical outcomes were extracted. Symptom presentation was categorized as cognitive/psychiatric, cranial nerve palsy, headache, hydrocephalus (on imaging), nausea/vomiting, motor (motor weakness or cerebellar signs), seizure, visual disturbances (diplopia, decreased acuity, or nystagmus), or other. The included studies are summarized in ► **Table 1**.

Results

A total of 69 patients were identified in 54 studies published between years 1977 and 2016.^{1,4,11,12,18–67} The mean age

was 33.3 years. Males comprised 50.7% of the cases. Headache was the most common presenting symptom (52.2%), followed by visual disturbances (33.3%). Thirty-four (49.3%) patients experienced cyst rupture prior to presentation. Intracranial dermoid cysts were equitably distributed throughout the cranial vault, with 29.0%, 36.2%, and 29.0% located in the anterior, middle, and posterior cranial fossae, respectively. Anterior cranial fossa dermoid cysts were predominately located in the Sylvian fissure, middle cranial fossa dermoid cysts in the sellar region, and posterior cranial fossa dermoid cysts in the cerebellar vermis. The interpeduncular fossa (2.9%) and other locations (2.9%) were also described.

All patients underwent surgical resection. GTR was achieved in 42.0% of cases. Thirty-four (49.3%) patients achieved symptom resolution, while 15 (21.7%) patients experienced only partial symptom improvement. Two (2.9%) patients died of either surgical or post-surgical complications. There were four (5.8%) recurrences at a mean follow-up of 2.1 years. Patient characteristics, management, and outcomes data are detailed in ► **Table 2**.

Discussion

Dermoid cysts are benign, congenital tumors primarily filled with lipid components, desquamated cells, and keratinaceous debris.^{1,4,68,69} These cysts are diagnosed most frequently between the third and fifth decades of life, a finding supported by the cases we reviewed.^{1,10,69,70} We found no sex predominance for intracranial dermoid cysts,

Table 1 Summary of studies included in review

Study and year	Age, years	Sex	Presentation	Rupture	Location	EOR	Outcome	Recurrence	FU, years
Agesio 2013 ²²	52	M	CNP	N	MF	GTR	NR	NR	NR
Aggarwal 2014 ²³	8	F	C/P, HCP, visual	N	PF (fourth ventricle)	GTR	NR	NR	NR
Akdemir 2004 ¹	18	M	CNP, HA, visual	N	MF (sellar)	GTR	Improved	N	0.01
Anand 2014 ²⁴	30	F	HA, Sz	N	AF (Sylvian fissure)	NR	Improved	N	1.00
Berginer 1988 ²⁵	26	M	HCP, Sz, other	N	MF (sellar)	STR	Improved	N	2.00
Bizzozero 1992 ²⁶	20	F	HA, HCP, N/V	N	PF (fourth ventricle)	GTR	Improved	N	1.50
Brown 2001 ²⁷	18	F	C/P, HA, HCP, visual, other	N	PF (cerebellar vermis)	GTR	Partial	N	0.67
Caldarelli 2001 ²⁸	16	F	CNP	N	PF (brainstem)	STR	Improved	N	5.00
Chen 2005 ²⁹	61	F	C/P, CNP, motor	N	AF (Sylvian fissure)	STR	Improved	N	1.00
Ciurea 2005 ³⁰	4	M	CNP, HA, N/V, visual	N	PF (brainstem)	NR	Improved	N	3.00
Detweiler 2009 ³¹	58	M	C/P, visual	Y	AF	GTR	Partial	N	0.67
Ecker 2003 ³²	23	F	HA, N/V, other	Y	AF (Sylvian fissure)	STR	Partial	N	0.58
Eren 2003 ³³	3	M	HA	N	PF (cerebellar vermis)	GTR	NR	NR	NR
Ford 1981 ³⁴	26	M	Motor, N/V, other	Y	AF	NR	Improved	N	0.17
Garces 2016 ¹⁸	61	F	Sz	N	AF (Sylvian fissure)	GTR	Improved	N	2.50
Geyik 2016 ³⁵	12	M	HA, HCP, visual	N	PF (fourth ventricle)	GTR	Partial	N	NR
Hahn 1986 ³⁶	16	F	HA, motor	Y	MF (sellar)	NR	NR	NR	NR
Johnson 2005 ³⁷	42	M	C/P, HA	Y	AF (frontobasal)	STR	Partial	N	0.42
Jyoti Das 2009 ³⁸	48	M	C/P, HA, N/V, other	Y	AF (frontobasal)	NR	NR	NR	NR
Karabulut 2000 ³⁹	26	M	HA, N/V, other	Y	IF	NR	NR	NR	NR
Kim 2008 ⁴⁰	29	M	HA, other	Y	MF (sellar)	GTR	Partial	N	3.00
Klonoff 1990 ⁴¹	43	F	C/P, visual, other	N	MF (sellar)	STR	Partial	N	4.83
Koh 2012 ⁴²	17	F	Other	Y	PF	GTR	NR	NR	NR
Lee 1977 ⁴³	43	F	HA, N/V, Sz	N	AF (frontobasal)	NR	Improved	N	0.17
Li 2011 ⁴	14	M	HA, HCP, motor, other	N	PF (cerebellar vermis)	GTR	NR	NR	NR
Li 2012 ⁴⁴	14	M	Sz	Y	AF (Sylvian fissure)	GTR	Improved	N	0.25
Liu 2008 ⁴⁵	57	M	Sz	Y	AF (Sylvian fissure)	STR	Improved	N	5.00
	25	F	HA, visual	Y	MF (sellar)	GTR	Improved	N	1.00
	36	M	C/P, HCP, visual, other	Y	MF (sellar)	STR*	Partial	Y	9.00
	35	M	CNP, HA, HCP, N/V, visual	Y	AF (Sylvian fissure)	STR	Improved	N	11.0
Luan 2012 ⁴⁶	28	F	Other	N	PF (cerebellar vermis)	GTR	Improved	N	2.50
Mamata 1998 ⁴⁷	63	F	CNP	N	MF (sellar)	NR	NR	NR	NR
Maulsby 1980 ⁶⁷	12	F	HA, visual	Y	PF (cerebellar vermis)	STR	Death	NR	0.02
McCoul 2012 ⁴⁸	50	M	HA	N	MF (sellar)	GTR	Improved	N	3.00
Nakamura 2001 ⁴⁹	15	F	CNP, HA, motor	Y	MF (sellar)	GTR	Improved	N	1.00
Neugroschl 2002 ⁵⁰	73	M	Motor, other	N	PF (cerebellar vermis)	GTR	Partial	N	NR
North 1993 ⁵¹	4	M	Visual	Y	Other	NR	Partial	N	1.00
Orakcioglu 2008 ⁵²	19	M	C/P, HA, Sz	Y	AF (frontobasal)	NR	Partial	N	9.00
	33	M	Sz	Y	Other	STR	Improved	N	1.50
	16	F	HA	Y	MF (sellar)	STR	Improved	N	2.00
	60	M	CNP, HA, N/V, motor, other	N	PF (cerebellar vermis)	GTR	Improved	N	0.25
	56	M	C/P	Y	MF (sellar)	GTR	Improved	N	0.60
	52	M	Sz, visual, other	N	MF	GTR	Improved	N	0.50
Pant 2008 ⁵³	12	F	HA, N/V, Sz	N	PF (cerebellar vermis)	STR	Improved	N	1.00
Park 2012 ⁵⁴	28	F	HA, other	Y	MF (sellar)	STR*	Partial	Y	1.67
Plans 2006 ⁵⁵	53	M	C/P, HCP	Y	PF	NR	Partial	N	0.50
Prahbu 2009 ¹⁹	30	F	CNP, motor	N	PF (prepontine)	NR	Improved	NR	NR
Riordan 2016 ⁵⁶	31	F	CNP	N	MF	GTR	Partial	NR	0.08

Table 1 (Continued)

Study and year	Age, years	Sex	Presentation	Rupture	Location	EOR	Outcome	Recurrence	FU, years
Schneider 2012 ¹¹	14	F	HA, HCP	N	AF	GTR	Improved	N	0.50
	11	M	C/P, HA, other	N	AF (Sylvian fissure)	NR	Improved	N	1.00
Skorvli 2014 ⁵⁷	51	M	HA, visual	Y	AF (Sylvian fissure)	NR	Partial	NR	1.00
Smith 1991 ⁵⁸	23	F	HA, visual	Y	MF (sellar)	NR	NR	N	0.06
	24	F	Visual	Y	MF (sellar)	NR	NR	Y	16.0
	43	M	HA, Sz, visual	Y	MF (sellar)	NR	NR	N	1.00
	35	M	Motor, visual	Y	MF (sellar)	NR	NR	N	0.50
	49	M	Sz	Y	MF (sellar)	NR	NR	N	0.50
	45	F	Sz, other	Y	AF	NR	NR	N	1.00
	80	F	Motor	Y	AF (Sylvian fissure)	NR	Death	NR	0.04
Sood 2014 ⁵⁹	48	M	HA, Sz	Y	AF (frontobasal)	GTR	NR	NR	NR
Stendel 2002 ¹²	16	F	CNP, motor	N	MF (sellar)	GTR	Improved	NR	NR
Sturiale 2009 ⁶⁰	37	F	CNP, other	N	MF	GTR	Improved	N	1.00
Tan 2015 ⁶¹	52	F	HA, visual	N	MF (sellar)	NR	NR	N	0.25
Tanabe 2016 ²⁰	63	F	CNP	N	PF (prepontine)	GTR	Improved	NR	NR
Titlic 2008 ²¹	41	M	HA, N/V, HCP	NR	PF (prepontine)	NR	NR	NR	NR
Tun 2008 ⁶²	41	F	HA, visual	N	IF	STR	Improved	N	1.00
van Calenbergh 2004 ⁶³	4	F	CNP, visual	N	PF (brainstem)	DR*	Improved	Y	3.92
Wani 2016 ⁶⁴	30	M	HCP, motor, visual	Y	PF (cerebellar vermis)	NR	Improved	NR	1.00
Wang 2013 ⁶⁵	59	F	HA, visual	N	MF	GTR	Improved	N	2.00
Yadiz 2015 ⁶⁶	53	M	HA, other	Y	AF (Sylvian fissure)	GTR	Improved	N	0.25

Abbreviations: AF, anterior fossa; C/P, cognitive and/or psychiatric; CNP, cranial nerve palsy; DR, drainage; EOR, extent of resection; F, female; FU, follow-up; GTR, gross total resection; HA, headache; HCP, hydrocephalus; IF, interpeduncular fossa; M, male; MF, middle fossa; N, no; N/V, nausea and/or vomiting; NR, not reported; PF, posterior fossa; STR, subtotal resection; Sz, seizure; Y, yes.

*Patient had reoperation.

an observation first described in an earlier study.¹⁶ These slow-growing cysts have variable clinical manifestations and are commonly treated with surgery.

Theories of Development

Theories regarding the development of dermoid cysts acknowledge the presence of ectopic tissue in the central nervous system. However, iatrogenic dermoid cysts have been reported to arise after procedures that introduce epithelium into areas adjacent to neural tissue (e.g., lumbar puncture or percutaneous aspiration of subdural hematoma).⁸ The most widely supported theory involves ectopic ectoderm inappropriately sequestered in the neural tube during closure between the third and fifth weeks of gestation.^{2,8,10,12–15,32,55,68,69,71} Evidence supporting this theory includes an affinity of dermoid cysts to develop along the midline.^{6,8–12,15,68,69} Dermoid cysts have also been associated with congenital anomalies (e.g., Klippel–Feil syndrome or agenesis of the corpus callosum).^{2,3,13} Others have hypothesized that mesodermal or mesenchymal cells are necessary during the inclusion of the ectoderm.^{2,5,11,12} While not as supported as the *a priori* theory, this mode of development is consistent with laterally positioned (e.g., cerebellopontine angle [CPA] or Sylvian fissure) intracranial dermoid cysts. Lateral and supratentorial dermoid cysts may also represent displaced midline dermoid cysts.¹⁸

Reports of malignant transformation of intracranial dermoid cysts have also been described, though at much lower rates than intracranial epidermoid cysts.^{72–74} Only four cases of malignant transformation of intracranial dermoid cysts have been reported in the literature thus far.^{75–78} These cases were associated with either older age (mean age of 50) or recurrence from incomplete capsule removal during prior surgery.

Clinical Presentation

Headaches, seizures, and symptoms of increased intracranial pressure are most common, but other signs and symptoms may manifest depending on the location of the cyst.^{1,2,6–8,10–14,32,71} The majority of patients have cranial neuropathies that affect extraocular movements or facial sensation. Visual impairment and trigeminal paresthesia/neuralgia were also common in the cases we reviewed. In contrast, cyst rupture often presents as acute or recurrent meningitis.^{4,38–40,54,66,67} Ruptured cysts may also result in unusual presentations, such as hallucinations or cheiro-oral syndrome (thalamic lacunar syndrome resulting in sensory deficits of the fingers and mouth).^{31,49}

Asymptomatic patients have also been described in the literature. These patients are often diagnosed incidentally during routine imaging after trauma.^{46,68} Traumatic rupture of dermoid cysts may also present as an acute onset headache

Table 2 Summary of patients (*n* = 69)

Age, years	
Mean	33.3
Median	30.0
Range	3–80.0
Sex, <i>n</i> (%)	
Male	35 (50.7)
Female	34 (49.3)
Presentation, <i>n</i> (%)	
Headache	36 (52.2)
Visual disturbances	23 (33.3)
Cranial nerve palsy	15 (21.7)
Seizure	14 (20.3)
Hydrocephalus	12 (17.4)
Motor/cerebellar	12 (17.4)
Cognitive/psychiatric	12 (17.4)
Nausea/vomiting	11 (15.9)
Other	20 (29.0)
Rupture, <i>n</i> (%)	
Yes	34 (49.3)
No	34 (49.3)
Not reported	1 (1.4)
Location, <i>n</i> (%)	
Anterior fossa	20 (29.0)
Sylvian fissure	11 (15.9)
Frontobasal	5 (7.2)
Middle fossa	25 (36.2)
Sellar	20 (29.0)
Posterior fossa	20 (29.0)
Cerebellar vermis	9 (13.0)
Fourth ventricle	3 (4.3)
Brainstem	3 (4.3)
Prepontine	3 (4.3)
Interpeduncular fossa	2 (2.9)
Other	2 (2.9)
Extent of resection, <i>n</i> (%)	
Gross total	29 (42.0)
Subtotal	15 (21.7)
Drainage of cyst only	1 (1.4)
Not reported	24 (34.9)
Outcomes, <i>n</i> (%)	
Symptoms improved	34 (49.3)
Symptoms partially improved	15 (21.7)
Death	2 (2.9)
Not reported	18 (26.1)
Recurrence, <i>n</i> (%)	
No	46 (66.7)
Yes	4 (5.8)
Not reported	19 (27.5)

or meningismus.⁵⁴ Patients often remain asymptomatic until spontaneous cyst rupture, or until the mass becomes 3 cm in size.^{1,6,7,10,68} A correlation between intracranial dermoid cyst size and patient age is supported by the literature.^{5,9,10,70} Specifically, patients may not present until the third or fifth decade of life simply because the cyst has not had enough time to reach a size large enough to cause significant mass effect or rupture.^{5,9,10,70}

Radiologic Features

Dermoid cysts appear as non-enhancing heterogeneous masses, a finding that is consistent throughout the literature.^{7,9,11,14,15} The heterogeneity is attributed to the variable secretions and desquamations the cyst may contain.^{1,4,10,13,71} An intensely enhancing dermoid cyst may suggest the presence of malignant transformation.⁷⁷ As dermoid cysts are primarily fat-filled capsules, CT imaging most often displays a sharply defined hypodense mass.^{1,4,7,9–15,71} Punctate hyperdensities may be visualized and are consistent with calcification of cystic components.^{1,4,10,13,71}

Conversely, dermoid cysts appear more variable on MRI. The literature most commonly describes dermoid cysts as displaying T1-hyperintensity and T2-hypointensity.^{4,10,27,52} However, heterogeneous signal intensity on T2-weighted MRI is frequently reported, ranging from hypo- to hyperintense and is attributed to the variable density of the fatty components within the cyst.^{1,9,32} T1-hypointensity and T2-hyperintensity have also been reported in patients with dermoid cysts, particularly in the solid components of these cysts.⁷¹ Linear peripheral enhancement may also be seen with gadolinium administration.²² Rupture of cystic contents produces marked hyperintensity on both T1- and T2-weighted MRI, and often with the tell-tale sign of fat-like droplets in the subarachnoid space or ventricular system.^{1,9,71} This finding may be useful when determining the location of ruptured cystic components for removal.

Dermoid cysts rarely restrict on diffusion-weighted imaging (DWI).⁹ This key feature can be used to differentiate dermoid cysts from epidermoid cysts, which display intense diffusion restriction. However, dermoid cysts may contain thick or solid components that decrease diffusion; thus, mimicking epidermoid cysts.⁷⁹ Diffusion sequences were only present in 10 of the articles we reviewed.^{11,18,19,22,35,37,52,53,59,66} In those cases, DWI displayed minimal to moderate restriction. A diffusion scan for our patient, at recurrence, demonstrated minimal restriction (► Fig. 2D).

Location

Dermoid cysts are commonly found along the midline, a location supported by their theory of development as entrapped ectodermal cells within the growing neural tube.^{28,45} Prior studies have reported an infratentorial predilection, particularly near the cerebellar vermis and the fourth ventricle.^{16,37} Surprisingly, the incidence of supratentorial dermoid cysts has increased in recent decades.^{1,17,80} Supratentorial dermoid cysts are frequently found in the sellar, temporal, and frontobasal regions, and less commonly in the cavernous sinus.²⁸ The intracranial dermoid cysts we

reviewed were almost equally distributed between the anterior, middle, and posterior cranial fossae; however, there was a clear predilection for specific anatomical regions. Supratentorial dermoid cysts were overwhelmingly located in the sellar region and Sylvian fissure, while infratentorial dermoid cysts were predominately located near the cerebellar vermis. Although Sylvian fissure dermoid cysts have been previously reported to be exquisitely rare, our review suggests that Sylvian fissure dermoid cysts may be relatively common.¹⁸

Management

Recurrence following subtotal resection was rare, with very few cases identified in our review of the literature.^{41,63,81,82} Complete resection may not be possible when the capsule is adherent to neurovascular structures or vital areas (e.g., brainstem). GTR may be associated with greater surgical morbidity.¹ Therefore, the goal in surgical decision-making should be safe, maximal resection, rather than complete resection.^{12,13,83}

Surgical approach is dependent on the location of the cyst. Most middle fossa dermoid cysts were resected via a pterional craniotomy.^{11,12,32,69,71} Posterior fossa dermoid cysts were often resected via a suboccipital craniotomy.^{3,4,10} CPA dermoid cysts were also resected via a standard retrosigmoid approach.^{55,84} It must be considered that the chosen trajectory may limit visualization of cystic components, especially those extending into multiple compartments.

The illustrative case herein described highlights the advantages and disadvantages of several approaches to resecting a prepontine dermoid cyst. Intracranial dermoid cysts may be relatively large and involve multiple compartments. In our patient, the dermoid cyst was located in the prepontine cistern and extended into Meckel's cave. It was the senior author's opinion that the bulk of the mass was located near the CPA and, thus, was accessible via a retrosigmoid approach. The retrosigmoid approach allows for maximal exposure of CPA tumors, with direct visualization of cranial nerves V to XI.⁸⁵ However, this approach may not be optimal for tumors extending into the petroclival or anterior brainstem region due to the need for increased cerebellar retraction and a long surgical corridor. For these tumors, an anterior and posterior transpetrosal approach may be required. The combined transpetrosal approach provides optimal exposure to zones I to II of the petroclival region, from the dorsum sellae to the jugular tubercle, with minimal need for brainstem retraction.⁸⁵ This short, flat route to the anterior brainstem comes at the expense of increased temporal bone removal. Another option is an orbitozygomatic approach, particularly for sellar masses that extend laterally into the cavernous sinus or posteriorly into the cerebral peduncle.⁸⁵ However, unfamiliarity with this approach may result in a surgeon favoring a pterional craniotomy.

Medical management may be attempted prior to definitive treatment or in cases not amenable to surgical resection. Of the cases we reviewed, a single patient was managed expectantly, although surgery was eventually performed after serial imaging demonstrated cyst growth in the setting

of worsening symptoms.¹¹ In a single study, carbamazepine was used as the primary treatment in two patients with CPA dermoid cysts presenting as trigeminal neuralgia.⁸⁶ Sustained symptom resolution was achieved in both patients at the last follow-up. However, the literature overwhelmingly supports surgical resection as the first-line treatment.

Pathology

Dermoid cysts are most often reported as capsules filled with either a yellow or white substance, with a wide range of viscosities. Dermal appendages to surrounding structures are not uncommon.^{8,11} In our patient, microdissection was necessary to safely remove as much of the adherent portions as possible. Closer pathological examination reveals a capsule lined with stratified squamous epithelium.^{1,5,7,12,15,69,71} The cystic components contain secretions from sebaceous glands, desquamated material from epithelial cells, keratin, hair follicles, and even teeth, which may explain the common misdiagnosis of teratoma.^{1,4,5,7,9,11,12,15,69,71} Teratomas, by definition, must contain non-cutaneous material and can be ruled out by histopathologic evaluation.¹²

Differential Diagnosis

Although histopathological confirmation remains the gold standard in diagnosing dermoid cysts, imaging modalities may be useful in excluding other differential diagnoses. The spectrum of congenital cystic masses includes epidermoid cysts and teratomas.⁸⁷ Other potential diagnoses may also include arachnoid cysts and cholesterol granulomas.^{9,10,69} Arachnoid cysts may be differentiated from dermoid cysts by the heterogeneous appearance of dermoid cysts on imaging.^{9,14,15} Diffusion scans may be used to differentiate epidermoid cysts by their greater degree of restriction as compared to dermoid cysts.^{9,14,15} Cholesterol granulomas often show greater inflammatory response on pathological evaluation as compared to dermoid cysts.^{9,14,15}

Outcomes

Nine decades ago, postoperative mortality rates for patients with dermoid cysts were as high as 70%.⁸⁸ Advancements in microsurgical techniques now allow for safe, maximal resection. Currently, intracranial dermoid cysts are associated with postoperative mortality rates as low as 5%.⁸⁰ We identified only two deaths among the cases reviewed, with both cases occurring in the 1980s and one attributed to postoperative pulmonary embolism.^{58,67}

Due to the possibility of immunological response from either cyst rupture or surgical removal of dermoid components, patients should be closely monitored for signs and symptoms of aseptic meningitis (Mollaret's meningitis).^{1,3,32} Mollaret's meningitis results from meningeal irritation secondary to invasion of the subarachnoid space by oil droplets from a ruptured dermoid cyst.^{9,12,15,71} None of the cases we identified reported occurrence of this problem as a consequence of surgical resection. However, one patient experienced delayed ischemic injury from arterial vasospasm after

surgery, which was attributed to dermoid material left in the surgical bed.³² Thus, proper irrigation of cystic contents during surgery may reduce morbidity by diluting the concentration of dermoid byproducts.

The size of dermoid cysts is related to the growth of epithelium, as well as, the rate of secretion from the glandular components of the capsule.^{9,11,12,14,71} Of the patients reviewed, only four recurrences were reported.^{45,54,58,63} Three of those recurrences underwent repeat surgery, and all three cases reported favorable outcomes.^{45,54,63} Management of the last recurrence was not described.⁵⁸ Given that the dermoid capsule represents the metabolically active component of the dermoid cyst, recurrence likely occurs in a time-dependent manner.⁸⁹ Although recurrences within a year may be possible, the ectodermal origin of dermoid cysts suggests a slow, linear growth that predisposes individuals to late recurrences.^{1,90} Thus, it is plausible that all subtotally resected dermoid cysts may eventually recur if given enough time. Resection of dermoid cysts in deep-seated areas may be limited by incomplete visualization and, therefore, may lead to residual capsule being left behind and a higher likelihood of recurrence.

Conclusion

Intracranial dermoid cysts have variable clinical manifestations. Headache and visual disturbances are most common. Cranial neuropathies were also common. Intracranial dermoid cysts were distributed similarly among the anterior, middle, and posterior cranial fossae but with clear predilections for the Sylvian fissure, sellar region, and cerebellar vermis, respectively. Surgical decision-making should consider the prevalent region where the cyst is located to achieve a safe, maximal resection. Although rates of GTR were moderate, symptomatic relief after surgery was common, and recurrence was rare.

Conflict of Interest

The authors report no conflicts of interest concerning the materials or methods used in this study or the findings specified in this paper.

Acknowledgments

Lawrance K. Chung was supported by an the American Medical Association (AMA) Foundation Seed Grant, an Alpha Omega Alpha Carolyn L. Kuckein Student Research Fellowship, a Gurtin Skull Base Research Fellowship, and a Tina and Todd Segel Skull Base Fellowship. Carlito Lagman was partially supported by a Gurtin Skull Base Research Fellowship and a Tina and Todd Segel Skull Base Fellowship. Isaac Yang was supported by a Visionary Fund Grant, an Eli and Edythe Broad Center of Regenerative Medicine and Stem Cell Research Scholars in Translational Medicine Program Award, the Jason Dessel Memorial Seed Grant, the Honberger Endowment Brain Tumor Research Seed Grant, and the STOP CANCER Research Career Development Award.

References

- Akdemir G, Dağlioğlu E, Ergünger MF. Dermoid lesion of the cavernous sinus: case report and review of the literature. *Neurosurg Rev* 2004;27(04):294–298
- Brydon HL. Intracranial dermoid cysts with nasal dermal sinuses. *Acta Neurochir (Wien)* 1992;118(3-4):185–188
- Diekmann-Guiroy B, Huang PS. Klippel-Feil syndrome in association with a craniocervical dermoid cyst presenting as aseptic meningitis in an adult: case report. *Neurosurgery* 1989;25(04):652–655
- Li ZJ, Miao YX, Sun P, et al. Unusual CT hyperattenuating dermoid cyst of cerebellum: a new case report and literature review. *Cerebellum* 2011;10(03):536–539
- Linkov G, Kanev PM, Isaacson G. Conservative management of typical pediatric postauricular dermoid cysts. *Int J Pediatr Otorhinolaryngol* 2015;79(11):1810–1813
- Martínez-Lage JF, Ramos J, Puche A, Poza M. Extradural dermoid tumours of the posterior fossa. *Arch Dis Child* 1997;77(05):427–430
- Nagayama M, Shinohara Y, Takeoka T, et al. Intracranial paramedian hourglass-shaped dermoid associated with hereditary steatocystoma multiplex. *Eur Neurol* 1992;32(05):260–263
- Niederhagen B, Reich RH, Zentner J. Temporal dermoid with intracranial extension: report of a case. *J Oral Maxillofac Surg* 1998;56(11):1352–1354
- Osborn AG, Preece MT. Intracranial cysts: radiologic-pathologic correlation and imaging approach. *Radiology* 2006;239(03):650–664
- Sanchez-Mejia RO, Limbo M, Tihan T, Galvez MG, Woodward MV, Gupta N. Intracranial dermoid cyst mimicking hemorrhage. Case report and review of the literature. *J Neurosurg* 2006;105(04):311–314
- Schneider UC, Koch A, Stenzel W, Thomale UW. Intracranial, supratentorial dermoid cysts in paediatric patients—two cases and a review of the literature. *Childs Nerv Syst* 2012;28(02):185–190
- Stendel R, Pietilä TA, Lehmann K, Kurth R, Suess O, Brock M. Ruptured intracranial dermoid cysts. *Surg Neurol* 2002;57(06):391–398, discussion 398
- Turgut M. Klippel-Feil syndrome in association with posterior fossa dermoid tumour. *Acta Neurochir (Wien)* 2009;151(03):269–276
- Warakulle DR, Anslow P. Differential diagnosis of intracranial lesions with high signal on T1 or low signal on T2-weighted MRI. *Clin Radiol* 2003;58(12):922–933
- Zimny A, Zińska L, Bładowska J, Neska-Matuszewska M, Sasiadek M. Intracranial lesions with high signal intensity on T1-weighted MR images - review of pathologies. *Pol J Radiol* 2013;78(04):36–46
- Guidetti B, Gagliardi FM. Epidermoid and dermoid cysts. Clinical evaluation and late surgical results. *J Neurosurg* 1977;47(01):12–18
- Rubin G, Scienza R, Pasqualin A, Rosta L, Da Pian R. Craniocerebral epidermoids and dermoids. A review of 44 cases. *Acta Neurochir (Wien)* 1989;97(1-2):1–16
- Garces J, Mathkour M, Beard B, Sulaiman OA, Ware ML. Insular and sylvian fissure dermoid cyst with giant cell reactivity: case report and review of literature. *World Neurosurg* 2016;93:491.e1–491.e5
- Prabhu K, Daniel RT, Mani S, Chacko AG. Dermoid tumor with diastematomyelia. *Surg Neurol* 2009;72(06):717–721, discussion 721
- Tanabe N, Tomita T, Nagai S, Kuwayama N, Noguchi K, Kuroda S. [Dermoid cyst in Meckel's cave presenting with oculomotor nerve palsy and trigeminal neuralgia: a case report]. *No Shinkei Geka* 2016;44(10):863–867
- Titlic M, Jukic I, Kolic K, Rogosic V, Josipovic-Jelic Z. An acute headache and hydrocephalus caused by the dermoid cyst. *Bratisl Lek Listy (Tlacene Vyd)* 2008;109(12):580–581
- Ageshio N, Shimono T, Goto T, et al. Imaging appearance of petrous apex dermoid cysts containing little or no fat. *Jpn J Radiol* 2013;31(02):133–137
- Aggarwal A, Tewari MK, Radotra B, Gupta V. A case of intrauterine diagnosed posterior fossa dermoid presenting in childhood. *Childs Nerv Syst* 2014;30(02):361–363

- 24 Anand D, Aggarwal S, Soin D, Garg R. Sylvian Fissure Dermoid Cyst - A Rare case. *J Clin Diagn Res* 2014;8(09):RD01-RD02
- 25 Berginer VM, Tiberin P, Hirsch M, Berginer J. Febrile convulsions in an adult as presenting symptom of intracranial dermoid cyst: a case report. *Epilepsy Res* 1988;2(02):141-143
- 26 Bizzozero L, Talamonti G, D'Angelo VA, Casadei GP, Arrigoni GL, Collice M. Dermoid cyst mimicking hematoma in the posterior fossa. *Clin Neurol Neurosurg* 1992;94(01):61-63
- 27 Brown JY, Morokoff AP, Mitchell PJ, Gonzales MF. Unusual imaging appearance of an intracranial dermoid cyst. *AJNR Am J Neuroradiol* 2001;22(10):1970-1972
- 28 Caldarelli M, Colosimo C, Di Rocco C. Intra-axial dermoid/epidermoid tumors of the brainstem in children. *Surg Neurol* 2001;56(02):97-105
- 29 Chen JC, Chen Y, Lin SM, Tseng SH. Sylvian fissure dermoid cyst with intratumoral hemorrhage: case report. *Clin Neurol Neurosurg* 2005;108(01):63-66
- 30 Ciurea AV, Coman T, Tascu A, Ionescu V. Intradural dermoid tumor of the posterior fossa in a child with diastematomia. *Surg Neurol* 2005;63(06):571-575, discussion 575
- 31 Detweiler MB, David E, Arif S. Ruptured intracranial dermoid cyst presenting with neuropsychiatric symptoms: a case report. *South Med J* 2009;102(01):98-100
- 32 Ecker RD, Atkinson JL, Nichols DA. Delayed ischemic deficit after resection of a large intracranial dermoid: case report and review of the literature. *Neurosurgery* 2003;52(03):706-710, discussion 709-710
- 33 Eren S, Erman Z, Kadioğlu HH. An extradural dermoid tumour in the posterior fossa with atypical imaging findings. *Eur J Radiol Extra* 2003;45(02):43-46
- 34 Ford K, Drayer B, Osborne D, Dubois P. Case report. Transient cerebral ischemia as a manifestation of ruptured intracranial dermoid cyst. *J Comput Assist Tomogr* 1981;5(06):895-897
- 35 Geyik AM, Geyik S, Erkuğlu I, Alptekin M, Gezgün I, Dokur M. Multicentric dentigerous dermoid cyst with an unusual location in the central nervous system. *Surg J* 2016;02(02):e1-e4
- 36 Hahn FJ, Ong E, McComb RD, Maw JR, Leibrock LG. MR imaging of ruptured intracranial dermoid. *J Comput Assist Tomogr* 1986;10(05):888-889
- 37 Johnson DG, Stemper SJ, Withers TK. Ruptured "giant" supratentorial dermoid cyst. *J Clin Neurosci* 2005;12(02):198-201
- 38 Jyoti Das C, Tahir M, Debnath J, Shyam Pangtey G. Ruptured intracranial dermoid. *BMJ Case Rep* 2009;2009:bcr2006109835b
- 39 Karabulut N, Oguzkurt L. Tetra-ventricular hydrocephalus due to ruptured intracranial dermoid cyst. *Eur Radiol* 2000;10(11):1810-1811
- 40 Kim IY, Jung S, Jung TY, Kang SS, Kim TS. Traumatic rupture of an intracranial dermoid cyst. *J Clin Neurosci* 2008;15(04):469-471
- 41 Klonoff DC, Kahn DG, Rosenzweig W, Wilson CB. Hyperprolactinemia in a patient with a pituitary and an ovarian dermoid tumor: case report. *Neurosurgery* 1990;26(02):335-339
- 42 Koh YC, Choi JW, Moon WJ, Roh HG, Park HJ. Intracranial dermoid cyst ruptured into the membranous labyrinth causing sudden sensorineural hearing loss: CT and MR imaging findings. *AJNR Am J Neuroradiol* 2012;33(05):E69-E71
- 43 Lee SH, Delgado TE, Buchheit WA. Intracranial dermoid tumor: diagnosis by computed tomography. A case report. *Neurosurgery* 1977;1(03):281-283
- 44 Li Q, You C, Zan X, Chen N, Zhou L, Xu J. Mature cystic teratoma (dermoid cyst) in the sylvian fissure: a case report and review of the literature. *J Child Neurol* 2012;27(02):211-217
- 45 Liu JK, Gottfried ON, Salzman KL, Schmidt RH, Couldwell WT. Ruptured intracranial dermoid cysts: clinical, radiographic, and surgical features. *Neurosurgery* 2008;62(02):377-384, discussion 384
- 46 Luan Y, Wang H, Zhong Y, Bian X, Luo Y, Ge P. Traumatic hemorrhage within a cerebellar dermoid cyst. *Int J Med Sci* 2012;9(01):11-13
- 47 Mamata H, Matsumae M, Yanagimachi N, Matsuyama S, Takamiya Y, Tsugane R. Parasellar dermoid tumor with intra-tumoral hemorrhage. *Eur Radiol* 1998;8(09):1594-1597
- 48 McCool ED, Chow S, Lee DL, Anand VK, Schwartz TH. Endoscopic endonasal approach for resection of ventral skull base keratinaceous cysts. *Int Forum Allergy Rhinol* 2012;2(03):258-263
- 49 Nakamura M, Mizuguchi M, Momoi MY, Chou H, Masuzawa T. Transient cheiro-oral syndrome due to a ruptured intracranial dermoid cyst. *Brain Dev* 2001;23(04):261-263
- 50 Neugroschl C, David P, Sadeghi N, et al. Unusual CT features of dermoid cyst in the posterior fossa. *Eur Radiol* 2002;12(11):2726-2729
- 51 North KN, Antony JH, Johnston IH. Dermoid of cavernous sinus resulting in isolated oculomotor nerve palsy. *Pediatr Neurol* 1993;9(03):221-223
- 52 Orakcioglu B, Halatsch ME, Fortunati M, Unterberg A, Yonekawa Y. Intracranial dermoid cysts: variations of radiological and clinical features. *Acta Neurochir (Wien)* 2008;150(12):1227-1234, discussion 1234
- 53 Pant I, Joshi SC. Cerebellar intra-axial dermoid cyst: a case of unusual location. *Childs Nerv Syst* 2008;24(01):157-159
- 54 Park SK, Cho KG. Recurrent intracranial dermoid cyst after subtotal removal of traumatic rupture. *Clin Neurol Neurosurg* 2012;114(04):421-424
- 55 Plans G, Aparicio A, Majós C. Intracranial dermoid cyst rupture with subarachnoid and intraventricular fat dissemination. *Neurology* 2006;66(12):1937
- 56 Riordan M, Klosterman T, Kellman R, Chin L. Combined transzygomatic and pterional approach for resection of a dermoid cyst of the foramen ovale. *World Neurosurg* 2016;87:661.e1-661.e4
- 57 Skovrlj B, Mascitelli JR, Steinberger JM, Weiss N. Progressive visual loss following rupture of an intracranial dermoid cyst. *J Clin Neurosci* 2014;21(01):159-161
- 58 Smith AS, Benson JE, Blaser SI, Mizushima A, Tarr RW, Bellon EM. Diagnosis of ruptured intracranial dermoid cyst: value MR over CT. *AJNR Am J Neuroradiol* 1991;12(01):175-180
- 59 Sood S, Gupta R. Susceptibility artifacts in ruptured intracranial dermoid cysts: a poorly understood but important phenomenon. *Neuroradiol J* 2014;27(06):677-684
- 60 Sturiale CL, Mangiola A, Pompucci A, D'Ercole M, Di Muro L, Anile C. Interdural giant dermoid cyst of the petrous apex. *J Clin Neurosci* 2009;16(11):1498-1502
- 61 Tan LA, Kasliwal MK, Harbhajanka A, Kellogg RG, Arvanitis LD, Munoz LF. Hyperdense suprasellar mass: an unusual radiological presentation of intracranial dermoid cyst. *J Clin Neurosci* 2015;22(07):1208-1210
- 62 Tun K, Celikmez RC, Okutan O, Gurcan O, Beskonakli E. Dermoid tumour of the lateral wall of the cavernous sinus. *J Clin Neurosci* 2008;15(07):820-823
- 63 van Calenbergh F, Demaerel P, Sciort R, van Gool S. Long-term survival in a child with a brain stem dermoid cyst. *Surg Neurol* 2005;63(03):261-263, discussion 263-264
- 64 Wang X, Yu Y, Zhang X, et al. Unusual imaging appearance of a huge intracranial dermoid cyst located across the anterior and middle skull base. *J Neurol Surg A Cent Eur Neurosurg* 2013;74(Suppl 1):e185-e187
- 65 Wani AA, Raswan US, Malik NK, Ramzan AU. Posterior fossa ruptured dermoid cyst presenting with hydrocephalus. *Neurosciences (Riyadh)* 2016;21(04):358-360
- 66 Yaldiz C, Duransoy YK, Mete M, Şimsek T, İşısağ A, Selçuki M. Dermoid cyst rupture presenting as subarachnoid hemorrhage: report of a rare case. *Neurosurg Q* 2015;25(04):461-464
- 67 Mulsby GO, Sheldon JJ, Leborgne JM, Altman DH. Intracranial dermoid cyst: diagnosis by computerized tomography. *Am J Dis Child* 1980;134(04):420-421
- 68 Amirjamshidi A, Ghodsi M, Edraki K. Teeth in the cerebellopontine angle: an unusual dermoid tumour. *Br J Neurosurg* 1995;9(05):679-682

- 69 Vega RA, Hidlay DT, Tye GW, Fuller CE, Rhodes JL. Intradiploic dermoid cyst of the lateral frontotemporal skull: case report and review of the literature. *Pediatr Neurosurg* 2013;49(04):232–235
- 70 Bellet JS. Developmental anomalies of the skin. *Semin Perinatol* 2013;37(01):20–25
- 71 El-Bahy K, Kotb A, Galal A, El-Hakim A. Ruptured intracranial dermoid cysts. *Acta Neurochir (Wien)* 2006;148(04):457–462
- 72 Nagasawa D, Yew A, Safaee M, et al. Clinical characteristics and diagnostic imaging of epidermoid tumors. *J Clin Neurosci* 2011;18(09):1158–1162
- 73 Nagasawa D, Yew A, Spasic M, Choy W, Gopen Q, Yang I. Survival outcomes for radiotherapy treatment of epidermoid tumors with malignant transformation. *J Clin Neurosci* 2012;19(01):21–26
- 74 Nagasawa DT, Choy W, Spasic M, et al. An analysis of intracranial epidermoid tumors with malignant transformation: treatment and outcomes. *Clin Neurol Neurosurg* 2013;115(07):1071–1078
- 75 Gluszc A. A cancer arising in a dermoid of the brain. A case report. *J Neuropathol Exp Neurol* 1962;21:383–387
- 76 Kobayashi T, Kuchiwaki H, Inao S, Nakashima N. A squamous cell carcinoma originated from intracranial dermoid cyst. *Neurochirurgia (Stuttg)* 1993;36(01):26–29
- 77 Tsugu H, Fukushima T, Hayashi S, Iwaasa M, Matsuda T. Squamous cell carcinoma arising in an intracranial dermoid cyst—case report. *Neurol Med Chir (Tokyo)* 2001;41(04):213–216
- 78 Nishio S, Takeshita I, Morioka T, Fukui M. Primary intracranial squamous cell carcinomas: report of two cases. *Neurosurgery* 1995;37(02):329–332
- 79 Aksoy FG, Aksoy OG, Gomori JM. Klippel-Feil syndrome in association with posterior fossa suboccipital dermoid cyst. *Eur Radiol* 2001;11(01):142–144
- 80 Yaşargil MG, Abernathey CD, Sarioglu AÇ. Microneurosurgical treatment of intracranial dermoid and epidermoid tumors. *Neurosurgery* 1989;24(04):561–567
- 81 Arseni C, Dănăilă L, Constantinescu AI, Carp N, Decu P. Cerebral dermoid tumours. *Neurochirurgia (Stuttg)* 1976;19(03):104–114
- 82 Jamjoom AB, Cummins BH. The diagnosis of ruptured intracranial dermoid cysts. *Br J Neurosurg* 1989;3(05):609–612
- 83 Lunardi P, Missori P. Supratentorial dermoid cysts. *J Neurosurg* 1991;75(02):262–266
- 84 Kang MG, Kim KJ, Seok JI, Lee DK. Intracranial dermoid cyst rupture with midbrain and thalamic infarction. *Neurology* 2009;72(08):769
- 85 Schmidek HH, Sweet WH. *Operative Neurosurgical Techniques: Indications, Methods, and Results*. New York: Grune & Stratton; 1982
- 86 Jamjoom AB, Jamjoom ZA, al-Fehaily M, el-Watidy S, al-Moallem M, Nain-Ur-Rahman. . Trigeminal neuralgia related to cerebello-pontine angle tumors. *Neurosurg Rev* 1996;19(04):237–241
- 87 Smirniotopoulos JG, Chiechi MV. Teratomas, dermoids, and epidermoids of the head and neck. *Radiographics* 1995;15(06):1437–1455
- 88 Bailey P. Cruveilhier's "tumeurs perlées". *Surg Gynecol Obstet* 1920;31:390–401
- 89 Carmel P. *Brain Tumors of Disordered Embryogenesis*. vol 4. 4th ed. Philadelphia: Saunders; 1996
- 90 Alvord EC Jr. Growth rates of epidermoid tumors. *Ann Neurol* 1977;2(05):367–370