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Case Report

Dural composite hemangioendothelioma: The first intracranial case

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ABSTRACT

Background: Composite hemangioendothelioma (CHE) is a rare, locally aggressive neoplasm of intermediate malignant potential. It is composed of a mixture of vascular tumors with a predilection for the dermis and subcutis of the extremities.

Case Description: In this report, we describe a 41-year-old man who presented with a 2-month history of headache, dizziness, and intermittent seizures. Magnetic resonance imaging showed a hemorrhagic, multilobulated, and dural-based mass with extension into the calvarium. The mass measured 10.3 × 4.8 × 4 cm along the interhemispheric fissure and encased the superior sagittal sinus. Excision was performed, and histopathologic examination revealed a heterogeneous mixture of vascular components consisting of epithelioid hemangioendothelioma, retiform hemangioendothelioma, and hemangioma. This is the first report of a primary intracranial CHE.

Conclusion: The spectrum of mesenchymal neoplasms within the cranium expands to encompass CHE.

Keywords: Dura, Epithelioid hemangioendothelioma, Falx cerebri, Retiform hemangioendothelioma, Vascular neoplasm

INTRODUCTION

Hemangioendotheliomas are vascular neoplasms that exhibit an intermediate level of malignancy and display histopathological characteristics that fall between those of a hemangioma and an angiosarcoma. They are located predominantly in the skin and subcutaneous tissue of the distal extremities. Although they can be locally aggressive, they rarely metastasize. They encompass a diverse spectrum of histologic types, including epithelioid hemangioendothelioma (EHE), retiform hemangioendothelioma (RHE), papillary intralymphatic angioendothelioma, pseudomyogenic hemangioendothelioma, kaposiform hemangioendothelioma (KHE), and composite hemangioendothelioma (CHE).[96]

CHE refers to a rare neoplasm of intermediate malignant potential composed of two or more of the following tumors: EHE, RHE, papillary intralymphatic angioendothelioma, KHE, and

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angiosarcoma. Well-differentiated vascular lesions, such as hemangiomas and arteriovenous malformations, may also be found in CHE. Very few cases of CHE have been described in the literature, and they usually involve the skin or soft tissue.[96] Here, we present the first case report of an intracranial primary CHE arising along the falx cerebri with infiltration into the calvarium. It is crucial to report this locally aggressive neoplasm due to its clinical presentation and radiographic similarity to other neoplasms such as meningioma. In this report, we also provide reviews of published CHE cases and primary intracranial hemangioendothelioma cases.

CASE HISTORY

The patient is a 41-year-old right-handed man who presented to an ophthalmologist with diplopia for the prior two months. He had also been experiencing intractable headaches, dizziness, and intermittent seizures manifesting as shaking of his right leg, with each episode lasting 2–3 min. These symptoms had steadily progressed, prompting him to seek medical consultation. He denied any previous similar episodes or any significant medical history. Although there was full vision of the left eye, there was right nasal hemianopsia with superior field cuts. He was sent to the emergency department for evaluation of bilateral papilledema.

A baseline head computed tomography (CT) scan showed a lobulated hyperdense soft-tissue mass along the interhemispheric fissure and superior sagittal sinus (SSS) [Figures 1a and b]. Mass effect was noted on both parietal lobes with mild inferior tentorial herniation. Vasogenic edema surrounded the mass in the posterior left parietal lobe, and permeative lytic involvement of the parietal calvarium was also noted. The SSS was fully encased within the mass. Magnetic resonance imaging (MRI) of the brain with and without gadolinium demonstrated a large, hemorrhagic, and multilobulated enhancing mass measuring 10.3 × 4.8 × 4 cm (anteroposterior × transverse × craniocaudal dimensions) along the interhemispheric fissure encasing the SSS with possible sinus occlusion [Figures 1c and d]. There was biparietal calvarium involvement, including the inner and outer tables extending into the subgaleal soft tissues [Figure 1e].

The patient was sent for a formal angiography procedure after identifying possible SSS occlusion on MRI. There was a postangiography procedure diagnosis of partial occlusion of the posterior second third of the SSS with collateral drainage primarily to the left side through cortical veins (not shown). Artery embolization was not feasible, given the location of the neoplasm relative to the SSS. Based on the clinical presentation and neuroimaging, the decision was made to take the patient for a bilateral frontoparietal craniectomy for tumor resection. Gross appearance during surgery revealed a hard, fibrous mass with marked vascularity (not shown). The neoplasm seemed to originate from dura overlying the SSS, tracking along the interhemispheric fissure and extending to the surrounding cranium (not shown). Creating planes among the mass and parenchyma was difficult due to the adherent nature of the neoplasm. Gross total resection was limited by the location of the neoplasm involving a substantial part of the SSS and the anterior paracentral lobule. Once larger portions of neoplasm located away from eloquent areas were excised, careful attention was turned to debulking the remaining neoplasm with the use of the Cavitron Ultrasonic Surgical Aspirator. The patient experienced an uncomplicated 2-week postoperative course before being sent to inpatient rehabilitation and then Gamma Knife radiotherapy for residual tumor.

Pathology

Histopathological examination of the neoplasm showed an admixture of different components with focal infiltration into the dura and bone. Approximately 30% of the neoplasm had abundant eosinophilic cytoplasm, nuclear atypia, and intracytoplasmic vacuoles with occasional hyalinized stroma, consistent with EHE [Figure 2a]. Many areas of the neoplasm (approximately 50%) consisted of long, branching, and thin-walled blood vessels with monomorphic cells that protruded into the lumen, occasionally forming a hobnail pattern consistent with RHE [Figure 2b]. In focal areas (approximately 20% of the examined neoplasm), markedly dilated thin-walled vascular channels were lined by bland, oval nuclei [Figure 2c]. No angiosarcoma-like areas or KHE -like areas were identified. Many of the tumor cells were strongly positive for CD31 [Figure 2d] and ERG [Figure 2e] by immunohistochemistry. Mitotic figures were rarely seen (not shown). No necrosis was evident (not shown). The Ki-67 proliferation index was variably mildly elevated [Figure 2f].

DISCUSSION

Here, we present the first case report of a primary intracranial CHE in a 41-year-old man who presented with headache, dizziness, and seizures. On initial presentation and baseline CT and MRI [Figure 1], the preoperative planning was anticipatory for meningioma arising from the falx cerebri and invading the calvarium. The intraoperative findings seemed to be incongruent with that of a meningioma, given the high vascularity and adherent nature of the neoplasm. Histopathologic examination of the resected mass revealed a heterogeneous mixture of vascular lesions, including RHE (major component), EHE, and hemangioma. The expression of the vascular endothelial cell markers CD31 and ERG further supported the diagnosis of CHE [Figure 2]. This patient prompted us to review published intracranial hemangioendothelioma cases, which revealed that EHE is by far the most common hemangioendothelioma. Our report widens the spectrum of primary vascular tumors arising in the central nervous system.

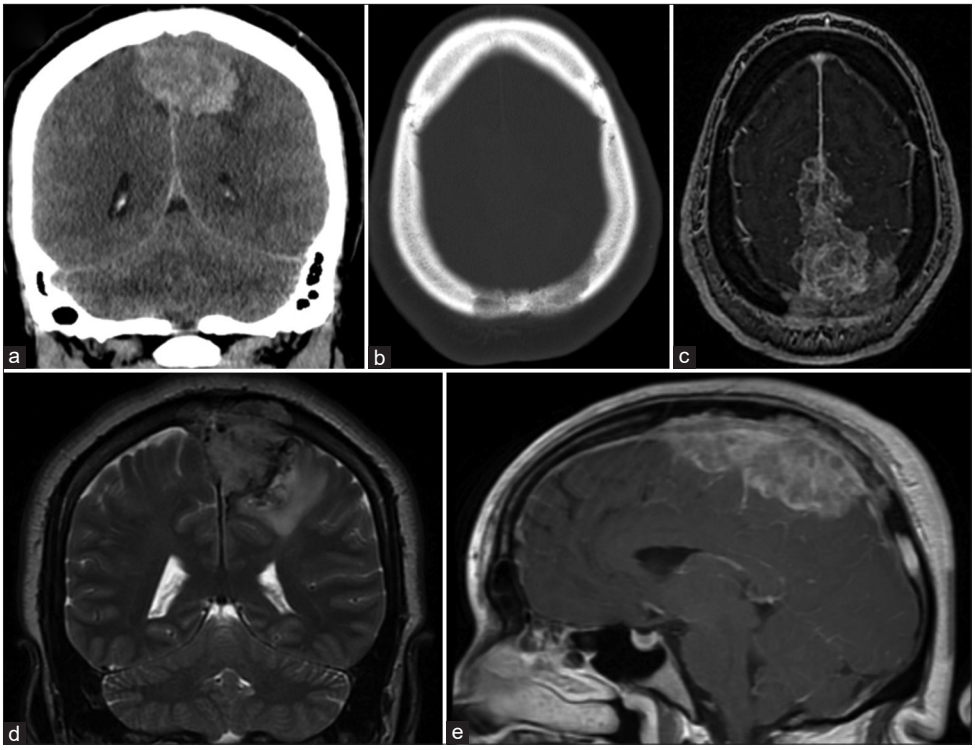

Figure 1: Baseline noncontrast computed tomography and magnetic resonance imaging (MRI) images of the brain. (a) Coronal view shows an interhemispheric mass with left-sided mass effect. (b) Axial view using bone window reveals lytic involvement of calvarium. (c) Axial T2-weighted MRI shows superior sagittal sinus involvement. (d) Coronal T2-weighted MRI reveals tumor extension through the calvarium. (e) Sagittal T1-weighted MRI post-gadolinium shows tumor enhancement.

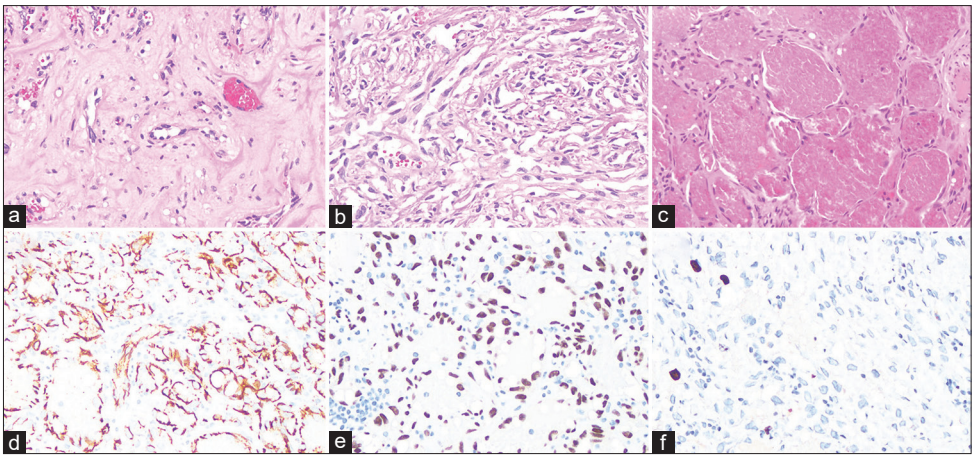

Figure 2: Histologic features of the intracranial composite hemangioendothelioma. (a) Hematoxylin and eosin (H&E)-stained section shows an area of epithelioid hemangioendothelioma, with cells containing intracytoplasmic vacuoles embedded in a hyaline stromal matrix. (b) H&E-stained section shows an area of retiform hemangioendothelioma, with abundant arborizing vascular channels. (c) H&E-stained section shows an area of hemangioma, with dilated vascular channels lined by oval nuclei without atypia. (d) An anti-CD31 antibody reveals abundant endothelial cells in this neoplasm. (e) An anti-ERG antibody confirms the abundant endothelial cells in this neoplasm. (f) The Ki-67 proliferation index is low, with up to 3.6% of cells labeled with this antibody.

First described in 2000, CHE is a rare, intermediate grade slowly growing vascular lesion that usually presents as an erythematous nodule in the dermis or subcutaneous tissue of the extremities. Less than 100 cases have been reported in the literature [Table 1].[4,5,8,11-13,15,18-21,25,28,31,32,36,39,41,46,48-52,55,56,58,60,61,69,74,75,77,80,81,87,88,90,91,93,100,102,103] Two patients with primary spinal CHE have been reported.[58,60] The reported median age at diagnosis is 42.5 years, which is nearly identical to our patient's age. Risk factors for CHE include Maffucci syndrome, lymphedema, and a history of radiation therapy. There are varying combinations of vascular components, including hemangioma, arteriovenous malformation, EHE, RHE, papillary intralymphatic angioendothelioma, KHE,

Table 1: Summary of reported composite hemangioendothelioma.

Reference	Age/sex	Location	Treatment	Outcome
Nayler *et al*., 2000	42/M	Dorsum foot	Excision	No recurrence (1 yr)
Nayler *et al*., 2000	27/F	Dorsum foot	Excision	Multiple recurrences over 4 yr; below knee amputation; no recurrence (6 yr)
Nayler *et al*., 2000	21/M	Index finger	Excision	No recurrence (13 yr)
Nayler *et al*., 2000	70/M	Tongue	Excision	Metastasis to submandibular node (9 yr); recurrence in tongue (10 yr); metastasis to thigh (11 yr)
Nayler *et al*., 2000	44/M	Finger	Excision	No recurrence (2 yr)
Nayler *et al*., 2000	31/F	Dorsum foot	Excision	Not reported
Nayler *et al*., 2000	71/F	Dorsum foot	Excision	Not reported
Nayler *et al*., 2000	35/M	Dorsum hand	Excision	Recurrence over 4 yr
Reis-Filho *et al*., 2002	23/F	Forearm and hand	Below-elbow amputation	No recurrence (7 yr)
Sapunar *et al*., 2003	43/M	Toe	Excision, radiotherapy	Not reported
Biagioli *et al*., 2005	46/F	Big toe	Wide excision	Recurrence (within 1 yr); complete excision; recurrence (18 mo); excision; no recurrence (1 yr)
Tronnier *et al*., 2006	73/F	Foot	Excision of three tumors (one not removed)	Recurrence of two tumors (20 mo)
Fukunaga *et al*., 2007	39/F	Ankle, foot	Partial excision	Alive with disease (39 mo)
Fukunaga *et al*., 2007	44/M	Mandibular vestibule	Excision	No recurrence (13 mo)
Fukunaga *et al*., 2007	75/F	Thigh	Excision	Recurrence (27 mo)
Fukunaga *et al*., 2007	37/F	Upper arm	Partial excision	Multiple recurrences (>10 excisions)
Fukunaga *et al*., 2007	22/F	Foot	Partial excision	Not reported
Fasolis *et al*., 2008	38/M	Cheek mucosa	Wide excision	No recurrence (3 yr)
Requena *et al*., 2008	60/M	Leg and foot	Excision	Local recurrence and lymph node metastasis (a few mo); lymphadenectomy; interferon-alpha2a and melphalan; alive with disease (1 yr)
Tejera-Vaquerizo *et al*., 2008	23/F	Back	Biopsy and wide excision	No recurrence (30 mo)
Utas *et al*., 2008	62/F	Forearm, hand	Interferon-alpha2b	No recurrence
Aydingöz *et al*., 2009	48/F	Thigh	Excision and lymph node dissection	Multiple local recurrence (mo); multiple excisions; lymph node metastasis (2 yr); lymphadenectomy; broad excision; chemotherapy and radiotherapy; no recurrence (2 yr)
Cakir *et al*., 2009	50/F	Mediastinum	Total sternotomy and mass resection	No recurrence (13 mo)
Tsai *et al*., 2011	23/F	Foot	Wide excision	No recurrence (7 mo)
Tsai *et al*., 2011	15/F	Hypopharynx	Excision	No recurrence (18 mo)
Tsai *et al*., 2011	49/F	Hypopharynx	Excision	No recurrence (10 mo)
Tsai *et al*., 2011	8/M	Elbow	Excision	No recurrence (48 mo)
Chen *et al*., 2012	46/F	Neck	Wide excision	Not reported
Yoda and Ohashi, 2012	67/F	Spleen	Splenectomy, paclitaxel	Multiple liver nodules at initial presentation
Liau *et al*., 2013	24/F	Scalp	Wide excision	No recurrence (1 yr)
McNab *et al*., 2013	66/M	Knee and lower leg	Biopsy, taxol	Increased pain at tumor site (3 mo)
Tateishi *et al*., 2013	34/F	Nose	Biopsy, radiation	No recurrence (9 mo)
Zhang *et al*., 2013	32/F	Kidney	Nephrectomy	No recurrence (11 mo)
Mahmoudizad *et al*., 2014	68/M	Scalp and neck	Radiation	Not reported

(Contd...)

Table 1: *(Continued)*.

Reference	Age/sex	Location	Treatment	Outcome
Stojsic *et al*., 2014	58/M	Gluteal region	Excision	No recurrence (3 mo)
Leen *et al*., 2015	43/M	Submandibular region	Biopsy, excision with neck dissection	No recurrence (6 mo)
Bhat, 2016	31/M	Upper back	Wide excision	No recurrence (5 mo)
Perry *et al*., 2017	47/M	Wrist	Not reported	Recurrence; metastases to liver, lung, and humerus. Died of disease
Perry *et al*., 2017	48/F	Ankle	Not reported	Recurrence; alive without disease
Perry *et al*., 2017	36/F	Periaortic	Not reported	Metastasis to sacrum; alive with disease
Perry *et al*., 2017	48/F	Vertebral	Not reported	Metastasis to lung; alive with disease
Perry *et al*., 2017	27/M	Pulmonary vein	Not reported	Metastasis to brain; alive with disease
Perry *et al*., 2017	14/F	Ear	Not reported	Not reported
Perry *et al*., 2017	55/F	Hip	Not reported	No recurrence
Perry *et al*., 2017	55/M	Liver	Not reported	No recurrence
Perry *et al*., 2017	15/M	Foot	Not reported	No recurrence
Perry *et al*., 2017	59/F	Cheek	Not reported	Not reported
Perry *et al*., 2017	9/M	Finger	Not reported	Not reported
Rokni *et al*., 2017	78/F	Left forehead and right cheek and eyelid	Biopsy, excision, and thalidomide	Not reported
Cheuk *et al*., 2020	53/F	Paravertebral	Excision	Not reported
Chin *et al*., 2020	67/F	Forearm	Excision	No recurrence (4 mo)
Gok *et al*., 2020	54/M	Paravertebral	Excision	No recurrence (1 yr)
Langguth *et al*., 2020	50/F	Pericardium	Excision	Not reported
Antonescu *et al*., 2020	42/F	Finger	Not reported	Not reported
Antonescu *et al*., 2020	9/F	Foot	Not reported	Not reported
Antonescu *et al*., 2020	9/F	Heel	Not reported	Not reported
Antonescu *et al*., 2020	7/F	Finger	Not reported	Not reported
Antonescu *et al*., 2020	37/M	Pancreas, liver and lung	Not reported	Not reported
Antonescu *et al*., 2020	19/M	Hand	Not reported	Not reported
Antonescu *et al*., 2020	56/F	Forearm	Not reported	Not reported
Antonescu *et al*., 2020	24/F	Scalp	Not reported	Not reported
Antonescu *et al*., 2020	36/F	Scalp	Not reported	Not reported
Antonescu *et al*., 2020	35/M	Heel	Not reported	Not reported
Antonescu *et al*., 2020	12/M	Shoulder	Not reported	Not reported
Antonescu *et al*., 2020	68/F	Buttock	Not reported	Not reported
Li *et al*., 2021	65/M	Spleen	Partial excision	Alive with disease (6 mo)
Miyamoto *et al*., 2021	71/M	Posterior chest wall	Excision	No recurrence (12 mo)
Dermawan, 2022	70/M	Lower nasopharynx, cervical lymph nodes	Neck dissection	Local recurrence and mild hilar lymphadenopathy (2 mo); radiation therapy, ipilimumab + nivolumab, followed by thalidomide. Alive with disease (1 yr)
Dermawan, 2022	71/F	Neck lymph node	Neck lymph node dissection	No recurrence (3 mo)
Han, 2022	38/F	Stomach	Biopsy, wedge resection	No recurrence (18 mo)
Koutlas *et al*., 2022	21/F	Mandibular vestibule	Biopsy	No recurrence (24 mo)
Zhang *et al*., 2022	46/M	Heart	Excision	No recurrence (6 mo)
Nakamura *et al*., 2022	80/F	Cervical spine	Partial excision	No recurrence (21 mo)
Balko *et al*., 2023	49/M	Leg and gluteal area	Biopsy, excision	No recurrence (2 yr)
Bui and Balzer, 2023	40s/M	Penis	Excision	Recurrence and partial penectomy (7 yr); recurrence and excisional biopsy (2 yr); radiation; no recurrence (5 yr)
Huang *et al*., 2023	9 mo/F	Liver	Resection	Not reported
Jones *et al*., 2023	55/F	Thigh	Biopsy, wide excision	No recurrence (1.5 yr)
Linos *et al*., 2024	35/F	Brachial plexus	Excision	No recurrence (4 mo)
Linos *et al*., 2024	24/M	Plantar foot	Excision	No recurrence (4 mo)
Linos *et al*., 2024	80/F	Mediastinum	Excision	Recurrence (40 mo)
Linos *et al*., 2024	38/M	Abdominal wall	Excision	Not reported

F: Female, M: Male, wk: Weeks, mo: Months, yr: Years

and angiosarcoma. As in our patient, the predominant components have been reported to be RHE and EHE.[31,61]

In comparison to conventional angiosarcoma, most CHEs exhibit less aggressive behavior. However, adjuvant therapy may be warranted in cases of subtotal resection, given the rate of local recurrence and malignant potential.[96] A subtotal resection or biopsy may also not provide an accurate, full representation of the entire neoplasm. Therefore, it is likely that CHE is under-reported in the literature.

Since EHE is a common component of CHE,[31,61] it is an important entity in the differential diagnosis. EHE typically originates outside the neuraxis, involving skin, soft tissue, solid organs, and bones. This vascular neoplasm of intermediate malignant potential is often arranged in clusters and cords embedded in a myxo hyaline stromal matrix. The tumor cells are epithelioid and have characteristic intracytoplasmic vacuoles that represent immature vascular lumina. Immunohistochemical analysis reveals the expression of endothelial differentiation markers such as CD31, ERG, CD34, and FLI1.[96] A review of the literature revealed 61 cases of primary intracranial EHE [Table 2].[2,3,6,7,9,10,16,18,23,26,27,29,30,33,35,38,40,43,45,47,53,54,57,59,62-68,70-73,76,79,82-86,89,92,94,95,98,99,101,104,105] There is a wide age range (31 weeks gestation-74 years of age), with a slight male predilection (31:30). Parajón *et al*. and Murali *et al*. published case reports with reviews of reported intracranial EHEs.[59,67] Their work showed a 24% (8/34) recurrence rate, with three cases having subtotal resections. In a follow-up period ranging from 4 weeks to 11 years, five patients were represented with neoplasms affecting extracranial sites.

The other common component in CHE, seen in our patient's tumor, is RHE.[31,61] Like EHE, RHE occurs primarily in young and middle-aged adults and demonstrates a tendency for frequent local recurrence and rare metastasis. The clinical manifestation of RHE often presents as a solitary reddish lesion in the dermis or subcutis of the extremities. Histopathological examination reveals a distinctive pattern characterized by arborizing blood vessels that resemble the rete testis. These blood vessels are lined by relatively uniform endothelial cells that may exhibit a hobnail pattern. While endothelial cell markers are expressed, lymphatic markers such as podoplanin/D2-40 are negative.[96] A review of the literature revealed five cases of reported primary intracranial RHE [Table 3].[1,34,44,89] There is a wide age range (1–62 years of age), with a slight female predilection (3:2). Four of the five cases showed tumors originating in bone.

Table 2: Summary of reported primary intracranial epithelioid hemangioendothelioma.

Reference	Age/sex	Location	Extent of resection	Adjuvant	Outcome
Rath *et al*., 1970	45/M	Frontotemporal	Subtotal	Radiation	Tumor free (2 yr)
Pearl *et al*., 1980	36/M	Frontoparietal	Biopsy	Radiation	Decrease in size
Pearl *et al*., 1980	73/M	Suprasellar	Subtotal	Radiation	Tumor stable
Pearl *et al*., 1980	74/M	Temporal	Not reported	None	Not reported
Llena *et al*., 1984	2 wk/M	Temporo-occipital	Gross total	None	Death
Kepes *et al*., 1986	58/M	Extradural temporal	Not reported	Not reported	Liver metastasis (2 yr)
Kepes *et al*., 1986	74/M	Temporal	Not reported	Not reported	Not reported
Taratuto *et al*., 1988	4/M	Parietal	Subtotal	None	Tumor stable (1 yr)
Chow *et al*., 1992	4 mo/M	Frontoparietal	Subtotal	None	Tumor stable (2.5 yr)
Drut *et al*., 1993	31 wk/M	Tentorium	None (autopsy)	None	Abortion
Hurley *et al*., 1994	23/F	Parietal	Gross total	None	Tumor free (4 yr)
Nora and Scheithauer, 1996	28/F	Frontal	Gross total	None	Tumor free (2.5 yr)
Nora and Scheithauer, 1996	62/M	Frontal	Gross total	None	Tumor free (1 yr)
Puca *et al*., 1996	27/M	Temporal	Gross total	Radiation	Tumor free (1.5 yr)
Chen *et al*., 1997	7/F	Gasserian ganglion	Gross total	None	Tumor free (5 yr)
Chen *et al*., 1997	3 mo/M	Cervicomedullary	Subtotal	IFN-α	Tumor decreased (4 yr)
Tammam *et al*., 1997	4/M	Cerebellopontine angle	Subtotal	Radiation	Alive at 2 mo
Aznar *et al*., 1998	5 mo/M	Frontotemporal	Gross total	None	Not reported
Aznar *et al*., 1998	20/M	Temporal	Gross total	None	Tumor free (1 yr)
Fryer *et al*., 1998	61/M	Frontoparietal	Gross total	Radiation	Death (1 yr)
Phookan *et al*., 1998	36/F	Cavernous sinus	Gross total	None	Tumor free (4 mo)
Rushing *et al*., 1998	38/F	Clivus	Biopsy	None	Not reported
Golash *et al*., 1999	33/M	Frontal	Gross total	None	Tumor free (2 mo)
Palmieri *et al*., 2000	20/F	Bilateral parietal	Gross total	IFN-α	Tumor free (2.5 yr)
Tancredi *et al*., 2000	20/F	Bilateral frontal	Gross total	IFN-α	Tumor free (3 yr)

(Contd...)

Table 2: *(Continued).*

Reference	Age/sex	Location	Extent of resection	Adjuvant	Outcome
Chan *et al.*, 2001	20/M	Frontal	Gross total	None	Tumor free (2 yr)
Hodaie *et al.*, 2001	4 mo/M	Temporal	Gross total	None	Tumor free (1 yr)
Koh and Yoo, 2001	26/F	Sphenoid	Subtotal	Erythropoietin	Not reported
Venizelos and Paradinas, 2002	11 mo/M	Parieto-temporo -occipital	Subtotal	None	Local recurrence (6 mo); no additional recurrence at 30 mo.
Watanabe *et al.*, 2003	55/F	Petroclival	Subtotal	Gamma Knife	Tumor stable (1 yr)
Baehring *et al.*, 2004	49/F	Suprasellar	Subtotal	None	Tumor stable (6 mo)
Hamlat *et al.*, 2004	53/M	Suprasellar	Biopsy	IFN, radiation	Tumor decreased (21 mo)
Kubota *et al.*, 2004	24/F	Parieto-occipital	Gross total (2 surgeries)	Radiation, vascular embolization	Tumor free (9 yr)
Fernandes *et al.*, 2006	27/M	Temporal with extracranial extension	Subtotal	None	Death (8 mo)
Yeo *et al.*, 2007	55/M	Frontal	Gross total	Not reported	Not reported
Murali *et al.*, 2008	15/F	Fronto-temporo-parietal	Gross total	Radiation	Death (1 mo)
Parajon and Vaquero, 2008	58/M	Sphenoid wing	Gross total	None	Tumor free (1 yr)
Sumrall *et al.*, 2010	31/F	Multifocal, including bilateral occipital	Gross total (largest)	Radiation, chemotherapy	Tumor stable (11 yr)
Zhang *et al.*, 2010	57/F	Temporal tentorium	Subtotal	Radiation	Tumor decreased (2 mo)
Ma *et al.*, 2011	58/F	Clivus	Subtotal	Radiation	No recurrence or metastasis (6 mo)
Ahmed *et al.*, 2012	42/F	Sella/suprasellar involving sphenoid sinus, sphenoid bone and clivus	Not reported	Not reported	Not reported
Aniba *et al.*, 2012	3/F	Intraorbital, extending to temporal fossa, ethmoid bone, nasal fossa, maxillary and cavernous sinuses	Subtotal	None	Death (10 wk)
Rocha Oliveira *et al.*, 2012	37/F	Paracentral lobule	Gross total	Sunitinib	Tumor free (14 mo)
Zheng *et al.*, 2012	25/M	Temporal bone	Gross total	None	Tumor free (5 mo)
Zheng *et al.*, 2012	44/F	Petroclival	Subtotal	Radiation	Tumor stable (1.5 yr)
Drazin *et al.*, 2013	62/M	Mastoid/posterior fossa	Gross total	Radiation after recurrence	Recurrence (15 mo); no recurrence (8 yr)
Zheng *et al.*, 2013	38/F	Meninges with occipitoparietal bone involved	Not reported	None	Local recurrence (1 mo)
Medina *et al.*, 2015	52/M	Temporal bone, posterior fossa	None	Radiation, chemotherapy	Multiple bone metastases, death
Pacheco *et al.*, 2015	37/F	Sphenoid	Not reported	Not reported	Not reported
Raheja *et al.*, 2015	20/M	Sphenopetroclival region with extension into temporal lobe	Subtotal	IFN, radiation	Tumor stable (6 mo)
Tsuchiya *et al.*, 2015	24/F	Multifocal intra-axial lesions in bilateral cerebrum and cerebellum	Biopsy	Radiation	Death (4 mo)
Barger *et al.*, 2016	45/F	Suprasellar	Subtotal	None	Not reported
Tian *et al.*, 2016	56/F	Parietal bone	Not reported	Not reported	Not reported
Tian *et al.*, 2016	51/F	Tentorium cerebelli	Not reported	Not reported	Not reported
Tian *et al.*, 2016	57/F	Temporal bone	Not reported	Not reported	Not reported
Tian *et al.*, 2016	13/F	Cerebral falx	Not reported	Not reported	Not reported

(Contd...)

Table 2: *(Continued).*

Reference	Age/sex	Location	Extent of resection	Adjuvant	Outcome
Batista *et al.*, 2018	58/F	Cavernous and sphenoid sinus	Subtotal	Radiotherapy	No recurrence (2 yr)
Omerhodžić *et al.*, 2018	34/M	Cerebellum	Gross total	None	No recurrence (2 yr)
Süß *et al.*, 2018	55/M	Parieto-occipital meninges	Not reported	Not reported	Not reported
Yamamoto *et al.*, 2018	53/F	Frontal	Gross total	None	No recurrence (3 yr 7 mo)
Ooi *et al.*, 2019	11/F	Parieto-temporo-occipital	Subtotal	None	Tumor stable (3 yr)

F: Female, M: Male, wk: Weeks, mo: Months, yr: Years, IFN: Interferon

Table 3: Summary of reported primary intracranial retiform hemangioendothelioma.

Reference	Age/sex	Location	Extent of resection	Adjuvant	Outcome
Aditya *et al.*, 2003	36/M	Parietal bone	Not reported	Not reported	Not reported
Kim *et al.*, 2016	13/M	Sphenoid bone with extension into cavernous sinus, orbital apex, and retro-nasal area	Subtotal	None	No recurrence (8 yr)
Tian *et al.*, 2016	62/F	Frontal bone	Not reported	Not reported	Not reported
Tian *et al.*, 2016	33/F	Cavernous sinus	Not reported	Not reported	Not reported
Gündoğan *et al.*, 2020	1/F	Temporal bone	Biopsy	Propranolol, prednisolone, vincristine, sirolimus	Stable disease (4 mo)

F: Female; M: Male; mo: Months, yr: Years

Table 4: Summary of reported primary intracranial kaposiform hemangioendothelioma.

Reference	Age/sex	Location	Extent of resection	Adjuvant	Outcome
Hardisson *et al.*, 2002	27/M	External auditory canal	Biopsy	Radiation	Alive (5 yr)
Chang *et al.*, 2006	6 mo/M	Internal auditory canal	Subtotal	IFN, prednisolone	Not reported
Cho *et al.*, 2009	13 mo/M	Tentorium cerebelli	Subtotal	IFN-α, prednisolone	Local recurrence (3 mo), subtotal resection, metastases (right orbit, suprasellar region), death (15 mo).
Tian *et al.*, 2016	34/M	Tentorium cerebelli	Not reported	Not reported	Not reported
Das *et al.*, 2021	21 mo/M	Temporal bone	Subtotal	IFN-α, prednisolone	Death (6 mo)
Cai *et al.*, 2022	2 mo/M	Frontal lobe	Gross total	Not reported	No recurrence (1 yr)
Jung *et al.*, 2023	14/M	Sphenoid bone with dural extension	Not reported	Sirolimus	Tumor size decreased (8 mo)

F: Female, M: Male, wk: Weeks, Mo: Months, Yr: Years, IFN-α: Interferon alpha

No recurrence was seen in the two cases with reported outcomes.

Other hemangioendotheliomas may occur within the cranium. Single cases of intracranial pseudomyogenic hemangioendothelioma[97] and papillary intralymphatic angioendothelioma[78] have been reported. More common is intracranial KHE, seen exclusively in young males and often associated with dura [Table 4].[14,17,22,24,37,42,89] KHE usually presents in children with the Kasabach-Merritt phenomenon as an infiltrative mass containing capillaries in the skin or deep soft tissues. The neoplasm is composed of nodules of spindle-shaped endothelial cells forming slit-like spaces and epithelioid nodules of pericytes containing fibrin thrombi. Areas of fibrosis and abnormal lymphatic spaces may be seen

at the periphery of the lesion.[96] While KHE has recently been reported within a CHE,[60] no histologic evidence of KHE was identified in our patient's neoplasm.

CONCLUSION

We present the clinicopathologic features of a primary intracranial CHE in an adult man. The large hemorrhagic mass appeared to originate from the falx cerebri and infiltrate the overlying calvarium. Histopathologic examination of the resected neoplasm revealed a mixture of EHE, RHE, and hemangioma. Primary intracranial CHE has not been previously reported in the literature. Based on a review of published composite hemangioendotheliomas elsewhere in the body, this neoplasm should be managed with aggressive surgical resection when possible.

Ethical approval

All procedures performed in this study involving human participants were in accordance with the ethical standards of the Research Committee of University of Helsinki and with the 1964 Declaration of Helsinki and its amendments or comparable ethical standards.

Declaration of patient consent

Patient's consent was not required as as patient's identity is not disclosed or compromised.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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