Sellar Atypical Teratoid/Rhabdoid Tumor Presenting with Subarachnoid and Intraventricular Hemorrhage

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■ BACKGROUND: **Atypical teratoid/rhabdoid tumors (ATRT) are uncommon malignancies of the central nervous system and are often difficult to distinguish radiographically and pathologically from other common tumors. We present the first case of sellar ATRT presenting with subarachnoid hemorrhage (SAH) and intraventricular hemorrhage (IVH).**

■ CASE DESCRIPTION: **A 62-year-old woman, who had presented with symptoms of headache, diabetes insipidus, hypothyroidism, and seizures, was found to have a sellar tumor with hemorrhagic transformation. Surgical resection was performed. The pathological examination findings were consistent with ATRT. Despite early surgical intervention, she later died before starting craniospinal radiotherapy and chemotherapy.**

■ CONCLUSION: **To the best of our knowledge, although known to present with intratumoral hemorrhage, to date, no cases of sellar ATRT have presented with SAH or IVH have been reported. Considering our finding that ATRT can present with SAH and IVH, establishing the correct diagnosis using radiographic imaging, gender, pathological findings, and molecular markers is paramount for speedy treatment and management.**

INTRODUCTION

Atypical teratoid/rhabdoid tumors (ATRT) of the central nervous system (CNS) are commonly occurring aggressive tumors in children aged <3 years.[1] However, in adults, the lifetime risk has been estimated at <1/1,000,000.[2] On microscopy, the tumors will appear to have features derived from both the ectoderm and the mesoderm cell layers. ATRT is diagnosed by identifying the molecular inactivation of either *INI1/SMARCB1* or *BRG1/SMARCA4* chromatin remodeling complex genes.[3]

Unlike childhood ATRT, for which the evidence has been conflicting regarding the most common CNS sites,[4] midline structures such as the pineal and pituitary glands have tended to be the common sites of adult ATRT.[5] Furthermore, although adult ATRT involving the cerebral hemispheres or the cerebellum has been reported in both sexes, to date, sellar ATRT has only been reported in women. Additionally, although intratumoral hemorrhage is a known imaging feature seen in both adult and pediatric ATRT, to the best of our knowledge, subarachnoid hemorrhage (SAH) and/or intraventricular hemorrhage (IVH) at presentation have not been previously reported.[6,7]

In childhood ATRT, the median age at diagnosis has been 1.2–3.3 years, with a slightly increased prevalence in boys.[5] In children aged <6 months of age, ATRT has been the most common malignant CNS tumor.[8] The median survival has been estimated to be ~1 year, although the range has varied from 9 months to 10.6 years.[9,10] An estimated 20% of cases will have disseminated disease at the diagnosis.[11] Thus, the diagnostic workup should include cerebrospinal fluid analysis, magnetic resonance imaging of the brain and spine, and renal ultrasonography to assess for renal rhabdoid tumors.[12,13] On histological examination, ATRT will consist of a mixture of neuroectodermal and rhabdoid cells which, using histological findings alone, will make it difficult to distinguish from medulloblastoma, 1 of the main tumors that should be included in the differential diagnosis.[4]

Although the prognosis is bleak, treatment should include surgery and chemoradiotherapy. Unlike childhood ATRT, the

Key words
- ATRT
- Atypical teratoid/rhabdoid tumors
- Intraventricular hemorrhage
- Leptomeningeal carcinomatosis
- Leptomeningeal spread
- Sellar ATRT
- Subarachnoid hemorrhage

Abbreviations and Acronyms
ATRT: Atypical teratoid/rhabdoid tumor
CNS: Central nervous system
CT: Computed tomography
IVH: Intraventricular hemorrhage
SAH: Subarachnoid hemorrhage

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number of cases in adults has been much smaller. The prognosis for patients with adult ATRT is more optimistic, with the increased survival in adults and older children (age, >3 years) hypothesized to be related to the use of multimodal therapy.[14] Adult ATRT can be further divided into sellar and nonsellar ATRT. Sellar ATRT is a much smaller subset of adult ATRT, with 17 cases reported (Table 1). To date, sellar ATRT has only been reported in females.

The presence of SAH and IVH has been reported in patients with pituitary apoplexy and is caused by pituitary adenoma or even a Rathke cleft cyst.[29] More rarely, craniopharyngiomas, metastatic cancers, and undifferentiated sarcomas have been reported to cause SAH and IVH in a limited number of cases.[30] Finally, to the best of our knowledge, no other cases of ATRT presenting with SAH and IVH have been reported.

CASE DESCRIPTION

A 62-year-old, right-handed white woman with no significant medical history had presented to an outside hospital with complaints of frontal headache, nausea, and double vision. The headaches had been progressive in severity over several months and were no longer amenable to over-the-counter sinus medications. Additional medical history provided by her husband included the presence of polydipsia for the previous 2 months, with her water intake increasing from 3–4 bottles/day to 15–20 bottles/day with associated polyuria, with frequent urination every hour. She also reported sudden hearing loss on the right side that had been present for 1 week before presentation.

The initial imaging study demonstrated a hyperdense sellar mass with suprasellar extension, which, at first, was concerning for a craniopharyngioma or pituitary macroadenoma (Figure 1). In addition, a small amount of IVH was noted (Figure 1). The

Table 1. Previous Cases of Reported Sellar Atypical Teratoid/Rhabdoid Tumor

Investigator	Age (years)	Sex	Treatment	Outcome
Kuge et al.,[15] 2000	32	F	Resection	Spinal dissemination
Raisanen et al.,[16] 2005	20	F	Resection, chemotherapy, RT	Local recurrence; alive 28 months after resection
Raisanen et al.,[16] 2005	31	F	Resection, RT	Brain stem dissemination; died 9 months after resection
Arita et al.,[17] 2008	56	F	Resection, RT	Brainstem + spinal cord dissemination; died 23 months after diagnosis
Las et al.,[18] 2010	46	F	NR	NR
Schneiderhan et al.,[19] 2011	57	F	Resection	Recurrence, treated by chemotherapy and RT; alive 6 months after resection
Schneiderhan et al.[19] 2011	61	F	Resection	Recurrence, treated by second resection; died 3 months after second resection
Moretti et al.,[20] 2013	60	F	Resection, RT	Lung metastasis; died 30 months after resection
Park et al.,[21] 2014	42	F	Resection, chemotherapy, RT	Alive at 2 years
Shitara et al.,[22] 2014	44	F	Partial resection, steroids, RT	Dissemination to cerebellum, spinal cord and lung; died 17 months after resection
Biswas et al.,[23] 2015	48	F	Resection	Recurrence, followed by second resection, chemotherapy, and RT; leptomeningeal disease; died 6 weeks after resection
Nobusawa et al.,[24] 2016	69	F	Resection, chemotherapy, RT	Alive at 2 years
Almalki et al.,[25] 2017	36	F	Resection, chemotherapy, RT	Alive at 3 years
Barresi et al.,[26] 2017	59	F	Incomplete resection, RT	Died 2 months after resection
Nakata et al.,[27] 2017	21	F	Resection, chemotherapy, RT	NR
Nakata et al.,[27] 2017	26	F	Resection, chemotherapy, RT	NR
Nishikawa et al.,[28] 2018	42	F	Resection, chemotherapy, RT	Hydrocephalus; died 11 months after resection
Present patient	62	F	Resection	Rapid deterioration and hydrocephalus; died <2 months after resection

F, female; RT, radiotherapy.

laboratory test results revealed the presence of diabetes insipidus and hypothyroidism, and she, subsequently, started desmopressin and levothyroxine. Several days after her admission, her clinical condition worsened, she developed a seizure and a sixth nerve palsy and was transferred to our hospital for escalation of care.

On arrival, she was found to have left lateral gaze palsy and sensorineural hearing loss on the right side but was otherwise intact. The formal ophthalmological examination revealed significantly decreased acuity in the left eye with relative afferent pupillary defect and a partial abducens nerve palsy. The left eye showed evidence of lagophthalmos. Formal Humphrey visual fields showed severely affected fields in the left eye and significant field loss inferiorly more than superiorly and more temporally than nasally in the right eye. The nerve margins were blurred in both eyes, and optical coherence tomography demonstrated mildly supranormal peak inferiorly in the right eye.

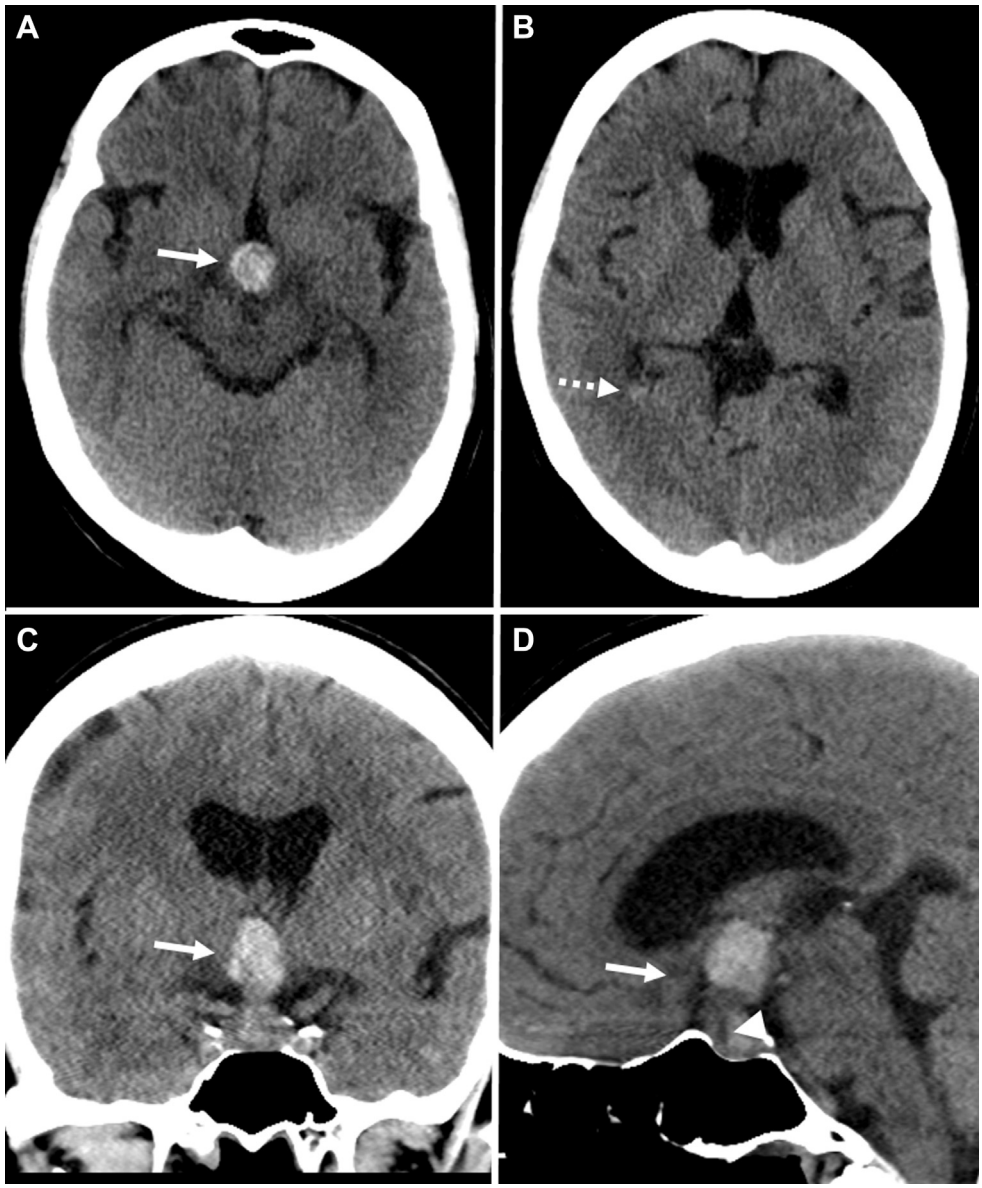

Figure 1. (**A**, **C**, and **D**) Non–contrast-enhanced computed tomography scan of the head showing a hyperdense sellar and suprasellar mass (*solid arrows*). (**B**) A small amount of intraventricular hemorrhage was noted within the occipital horn of the right lateral ventricle (*dotted arrow*). (**D**) In addition, a blood-fluid level is evident in the sellar component (*arrowhead*).

At that time, magnetic resonance imaging was repeated, again demonstrating a sellar and suprasellar mass (Figure 2). It was difficult to discern whether these represented a single lesion with 2 components or 2 separate lesions. Contrast-enhanced magnetic resonance images demonstrated some leptomeningeal enhancement. The sellar component of the lesion demonstrated a small internal blood fluid level. The mass resulted in compression of the optic chiasm, with significant edema within the optic chiasm and optic tracts. The radiographic differential diagnosis was narrowed down to metastasis, lymphoma, or, possibly, germinoma, given the presumed multiplicity. Atypical pituitary macroadenoma and craniopharyngioma were also considered. Computed tomography (CT) angiography was obtained given the evidence of SAH and IVH; however, the results were negative, attributing those findings to hemorrhage from the tumor.

A plan was coordinated with the endoscopic otolaryngology team for transsphenoidal resection. However, the patient became acutely decompensated on hospital day 4. She was confused and had experienced another seizure, despite having been on antiepileptic therapy. An immediate head CT scan showed interval rupture of the suprasellar component, with moderate amounts of hemorrhage within the interpeduncular cistern and extension into the lateral, third, and fourth ventricle with mass effect and edema involving the cerebral peduncle and midbrain (Figure 3). Obstructive hydrocephalus was also present, with diffuse dilatation of the bilateral lateral and third ventricles. She was taken to the operating room emergently for resection of the mass using a transcranial right subfrontal approach and external ventricular drain placement (Figure 4). The pathological examination revealed a malignant epithelioid neoplasm consistent with sellar atypical teratoid/rhabdoid tumor (SMARCB1/INI1-deficient suprasellar tumor; Figure 5).

The patient was eventually discharged to rehabilitation but presented again with a progressively worsening mental status. A CT scan of the head revealed hydrocephalus, and a ventriculoperitoneal shunt was placed. Despite aggressive interventions, the patient died <2 months after the initial diagnosis.

DISCUSSION

To the best of our knowledge, we report the first case of a sellar ATRT presenting with SAH and IVH. Consistent with the reported

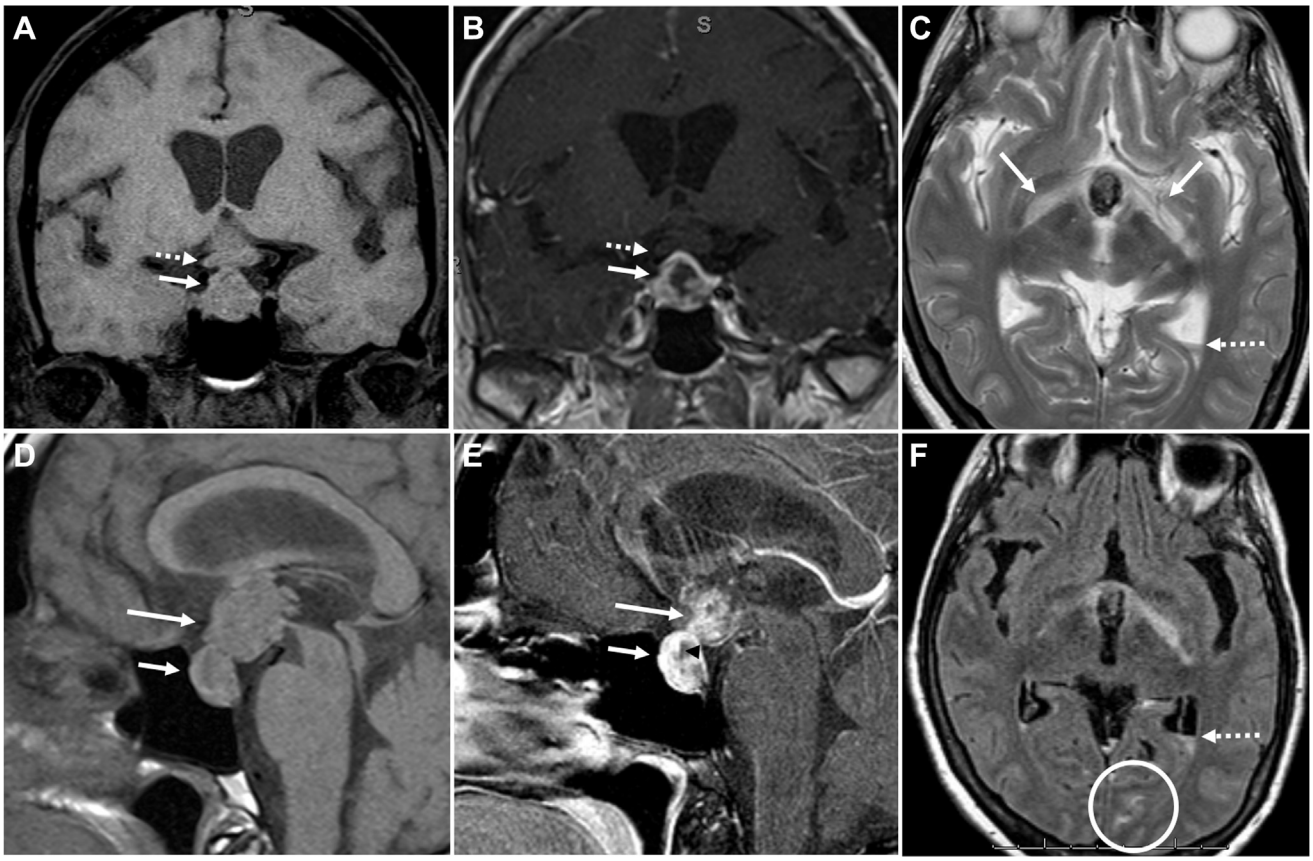

Figure 2. Magnetic resonance imaging studies of the brain and sella. Coronal and sagittal T1-weighted sequences (**A, D**) before and (**B, E**) after the administration of intravenous contrast demonstrating a T1-weighted isointense and heterogeneously enhancing sellar mass (*short white arrow*) with either a separate lesion or a second suprasellar component (*long white arrow*). Note the mass effect on the optic chiasm (*dotted arrow*) and blood-fluid level in the sellar lesion (*black arrowhead*). Axial (**C**) T2-weighted and (**F**) fluid-attenuated inversion recovery sequences showing marked edema along the optic tracts (*arrows*) with evidence for intraventricular hemorrhage (*dotted arrow*) and subarachnoid hemorrhage (*circle*).

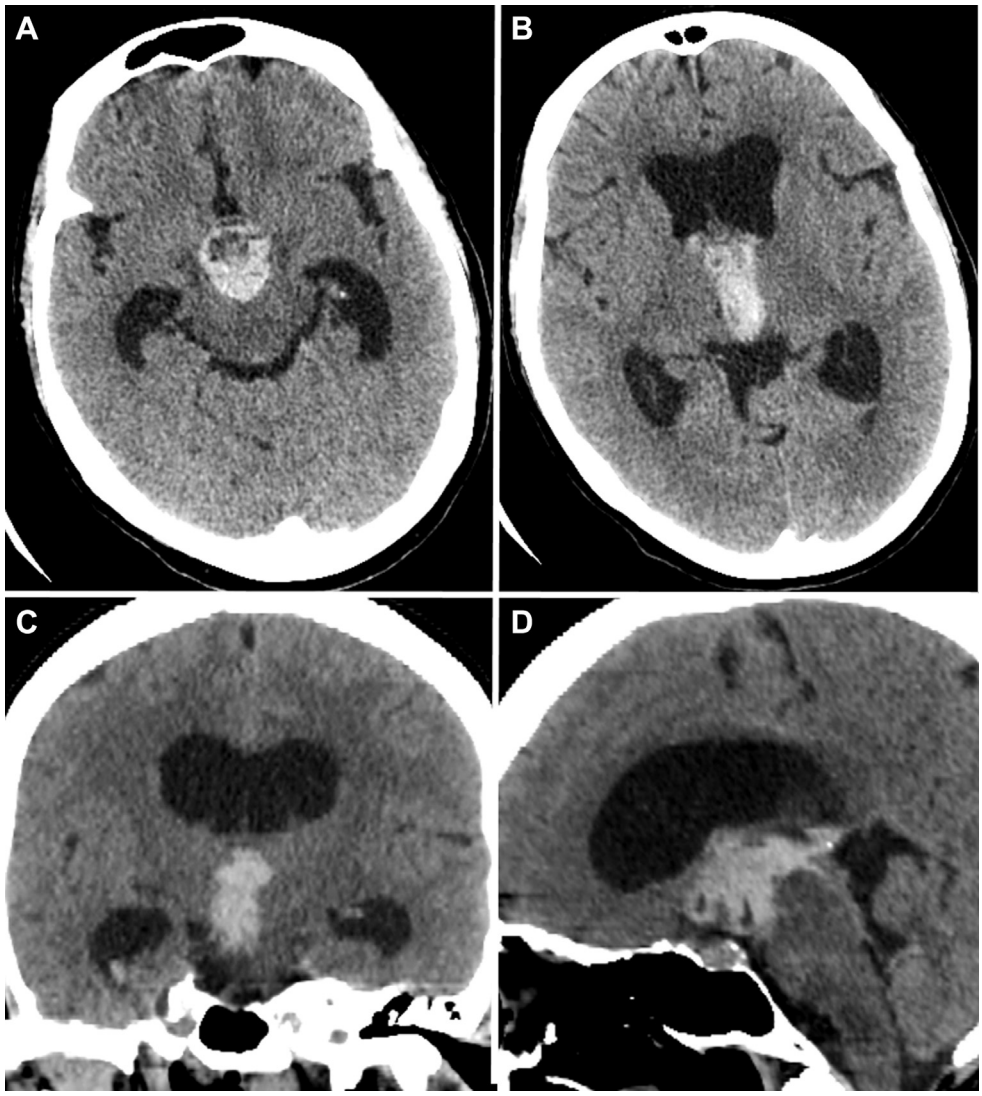

Figure 3. (**A**, **B**) Non–contrast-enhanced computed tomography scan of the head again demonstrating the mass but with interval rupture and hemorrhage. (**C**, **D**) The hemorrhage appears to extend into the interpeduncular cisterns and third ventricle with early signs of obstructive hydrocephalus.

data, our case of sellar ATRT was in a woman. However, owing to the rapid progression, we were unable to provide craniospinal radiotherapy or chemotherapy. The protocols for adult ATRT have recently been developed and are similar to the treatment protocols used for childhood ATRT.

Although the prognosis for childhood ATRT is bleak, treatment should include surgery and chemoradiotherapy. Surgical resection provides an opportunity to place a ventriculoperitoneal shunt and a reservoir for delivery of chemotherapy. The extent of surgical resection on survival has not produced consistent results[4] and requires further investigation. Adjuvant chemotherapy is a critical component of ATRT management, and 2 protocols have served as guides to treatment in the reported data: Children's Cancer Group 9921 and Intergroup Rhabdomyosarcoma III regimen 36. Children's Cancer Group 9921 uses a 4-drug combination, with a 42% overall response rate.[31] Intergroup Rhabdomyosarcoma III regimen 36, originally developed for rhabdomyosarcoma, consists of 7 chemotherapeutic agents plus 3 intrathecal drugs.[32] More details on the various combinations of chemotherapy agents, based on these protocols, have been previously reported.[4] Finally, radiotherapy has also been used to control both primary ATRT and disseminated disease, although the use of radiotherapy has been limited in children aged <3 years.

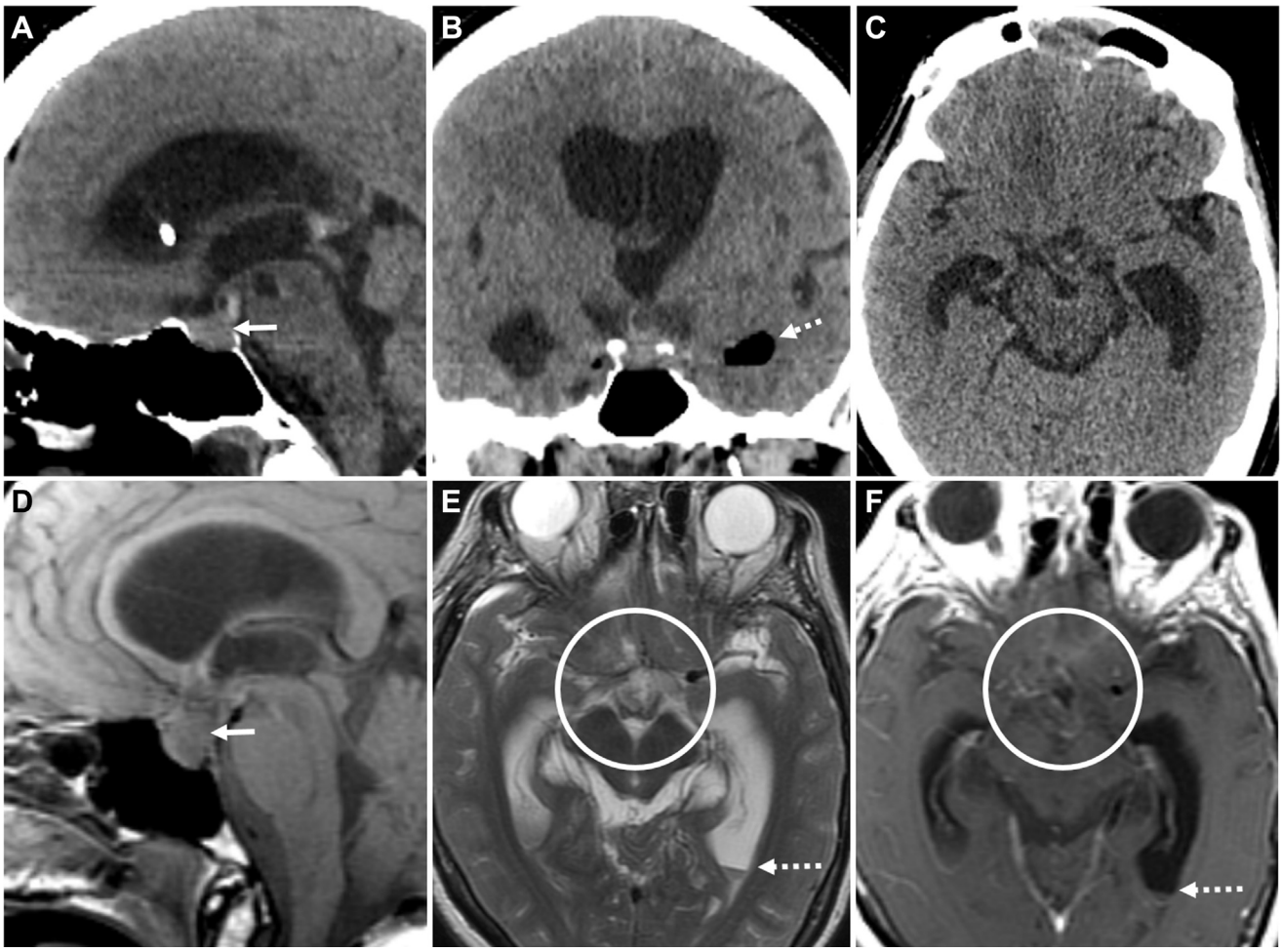

Figure 4. (**A**–**C**) Postoperative computed tomography scan of the head demonstrating interval debulking of the suprasellar component of the hemorrhagic lesion with a small amount of residual soft tissue within the sella (*arrow*). Postoperative changes, including frontal craniotomy and intraventricular air (*dotted arrow*), are noted. (**D**–**F**) Postoperative magnetic resonance imaging studies of the brain also showing a small residual sellar component (*arrow*) with debulking of the suprasellar component (*circles*) and residual intraventricular hemorrhage (*dotted arrows*).

Details on the dose range, fractionation schemes, and other factors have been previously reported.[4] This intense multimodal treatment has been reported to increase overall survival in children aged >3 years.[14,33]

Recently, a multimodal treatment protocol, the Medical University of Vienna ATRT protocol, has been proposed. The protocol consists of 37 weeks of chemotherapy, including vincristine, methotrexate, ifosfamide, cisplatin, etoposide, cyclophosphamide, doxorubicin, thiotepa, and carboplatin. Some of these agents can also be delivered intrathecally. Chemotherapy was followed by 3-dimensional conformal radiotherapy during weeks 37–43, with 1.8 Gy/fraction to a total of 54 Gy.[34]

As previously stated, sellar ATRT has only been reported in females. Unlike other female cancers, such as breast and endometrial cancer, the age at diagnosis has not been skewed toward older patients, suggesting that sellar ATRT might not be related to the lifetime exposure to hormones.[27] Sellar ATRT is not the only cancer, in a nonsexual organ, that has demonstrated a female preponderance. Nakata et al.[27] noted that a similar pattern can be observed in mucinous cystic neoplasms of the pancreas and retroperitoneal and mesenteric mixed epithelial stromal tumors of the kidney, which have also demonstrated a female preponderance and occur in non–sex-related organs. Although the number of cases reported was small, Nakata et al.[27] reported that sellar ATRT demonstrates a vascular pattern different from that of nonsellar ATRT and have suggested that sellar ATRT might represent a distinct genetic and histopathological variant of adult ATRT with a different demographic profile.

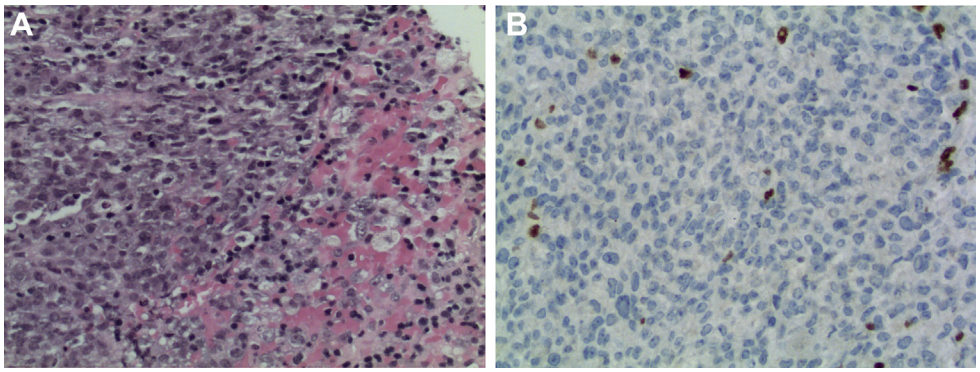

Figure 5. (**A**) Microscopic image showing a malignant neoplasm arranged in sheets and nests in collagenous stroma and associated with pools of extravasated blood. The neoplastic cells were round to oval with eosinophilic to clear cytoplasm and large nuclei with vesicular chromatin, prominent eosinophilic nucleoli, and irregular nuclear contours. The neoplastic cells had the following immunophenotype: positive cytokeratin, positive epithelial membrane antigen, positive smooth muscle actin, and positive CD34 (images not shown). (**B**) Of note, no nuclear expression was found of INI1 (SMARCB1) in the tumor cells.

CONCLUSION

According to previous research, the histopathological pattern of sellar ATRT, in particular, their vascularity, appears to be different from ATRT found in different locations, suggesting a different and distinct variant. To date, a small number of cases of sellar ATRT have been reported; however, all were found in females. We present the first case of a patient with sellar ATRT presenting with SAH and IVH. We suggest that for female patients with a sellar mass and hemorrhage, ATRT should be included in the differential diagnosis, with aggressive diagnosis and treatment warranted. The diagnosis of ATRT has been typically delayed by the rarity and difficulty in achieving the appropriate diagnosis, especially in the adult population.

REFERENCES

1. Rorke LB, Packer R, Biegel J. Central nervous system atypical teratoid/rhabdoid tumors of infancy and childhood. *J Neurooncol*. 1995;24:21-28.
2. Woehrer A, Slavc I, Waldhoer T, Heinzl H, Zielonke N, Czech T, et al. Incidence of atypical teratoid/rhabdoid tumors in children: a population-based study by the Austrian Brain Tumor Registry, 1996-2006. *Cancer*. 2010;116:5725-5732.
3. World Health Organization. In: Louis DN, Ohgaki H, Wiestler OD, Cavenee WK, eds. *WHO Classification of Tumours of the Central Nervous System*. Revised 4th ed. Lyon: International Agency for Research on Cancer; 2016.
4. Biswas A, Kashyap L, Kakkar A, Sarkar C, Julka PK. Atypical teratoid/rhabdoid tumors: challenges and search for solutions. *Cancer Manag Res*. 2016;8:115-125.
5. Dardis C, Yeo J, Milton K, Ashby LS, Smith KA, Mehta S, et al. Atypical teratoid rhabdoid tumor: two case reports and an analysis of adult cases with implications for pathophysiology and treatment. *Front Neurol*. 2017;8:247.
6. Meyers SP, Khademian ZP, Biegel JA, Chuang SH, Korones DN, Zimmerman RA. Primary intracranial atypical teratoid/rhabdoid tumors of infancy and childhood: MRI features and patient outcomes. *AJNR Am J Neuroradiol*. 2006;27:962-971.
7. Han L, Qiu Y, Xie C, Zhang J, Lv X, Xiong W, et al. Atypical teratoid/rhabdoid tumors in adult patients: CT and MR imaging features. *AJNR Am J Neuroradiol*. 2011;32:103-108.
8. Frühwald MC, Biegel JA, Bourdeaut F, Roberts CWM, Chi SN. Atypical teratoid/rhabdoid tumors-current concepts, advances in biology, and potential future therapies. *Neuro-oncology*. 2016;18:764-778.
9. Dufour C, Beaugrand A, Le Deley MC, Bourdeaut F, André N, Leblond P, et al. Clinicopathologic prognostic factors in childhood atypical teratoid and rhabdoid tumor of the central nervous system: a multicenter study. *Cancer*. 2012;118:3812-3821.
10. von Hoff K, Hinkes B, Dannenmann-Stern E, von Bueren AO, Warmuth-Metz M, Soersensen N, et al. Frequency, risk-factors and survival of children with atypical teratoid rhabdoid tumors (AT/RT) of the CNS diagnosed between 1988 and 2004, and registered to the German HIT database. *Pediatr Blood Cancer*. 2011;57:978-985.
11. Hilden JM, Meerbaum S, Burger P, Finlay J, Janss A, Scheithhauer BW, et al. Central nervous system atypical teratoid/rhabdoid tumor: results of therapy in children enrolled in a registry. *J Clin Oncol*. 2004;22:2877-2884.
12. Biswas A, Julka PK, Bakhshi S, Suri A, Rath GK. Intracranial atypical teratoid rhabdoid tumor: current management and a single institute experience of 15 patients from north India. *Acta Neurochir (Wien)*. 2015;157:589-596.
13. Sredni ST, Tomita T. Rhabdoid tumor predisposition syndrome. *Pediatr Dev Pathol*. 2015;18:49-58.
14. Tekautz TM, Fuller CE, Blaney S, Fouladi M, Broniscer A, Merchant TE, et al. Atypical teratoid/rhabdoid tumors (ATRT): improved survival in children 3 years of age and older with radiation therapy and high-dose alkylator-based chemotherapy. *J Clin Oncol*. 2005;23:1491-1499.
15. Kuge A, Kayama T, Tsuchiya D, Kawakami K, Saito S, Nakazato Y, et al. [Suprasellar primary malignant rhabdoid tumor in an adult: a case report]. *No Shinkei Geka*. 2000;28:351-358.
16. Raisanen J, Biegel JA, Hatanpaa KJ, Judkins A, White CL, Perry A. Chromosome 22q deletions in atypical teratoid/rhabdoid tumors in adults. *Brain Pathol*. 2005;15:23-28.
17. Arita K, Sugiyama K, Sano T, Oka H. Atypical teratoid/rhabdoid tumour in sella turcica in an adult. *Acta Neurochir (Wien)*. 2008;150:491-495 [discussion: 496].
18. Las Heras F, Pritzker KPH. Adult variant of atypical teratoid/rhabdoid tumor: immunohistochemical and ultrastructural confirmation of a rare

tumor in the sella tursica. *Pathol Res Pract*. 2010; 206:788-791.

19. Schneiderhan TM, Beseoglu K, Bergmann M, Neubauer U, Macht S, Hänggi D, et al. Sellar atypical teratoid/rhabdoid tumours in adults. *Neuropathol Appl Neurobiol*. 2011;37:326-329.

20. Moretti C, Lupoi D, Spasaro F, Chioma L, Di Giacinto P, Colicchia M, et al. Sella turcica atypical teratoid/rhabdoid tumor complicated with lung metastasis in an adult female. *Clin Med Insights Case Rep*. 2013;6:177-182.

21. Park HG, Yoon JH, Kim SH, Cho KH, Park HJ, Kim SH, et al. Adult-onset sellar and suprasellar atypical teratoid rhabdoid tumor treated with a multimodal approach: a case report. *Brain Tumor Res Treat*. 2014;2:108-113.

22. Shitara S, Akiyama Y. Atypical teratoid/rhabdoid tumor in sellar turcica in an adult: a case report and review of the literature. *Surg Neurol Int*. 2014;5:75.

23. Biswas S, Wood M, Joshi A, Bown N, Strain L, Martinsson T, et al. Exome sequencing of an adult pituitary atypical teratoid rhabdoid tumor. *Front Oncol*. 2015;5:236.

24. Nobusawa S, Nakata S, Hirato J, Kawashima T, Sato K, Fujimaki H, et al. Atypical teratoid/rhabdoid tumor in the sella turcica of an elderly female with a distinct vascular pattern and genetic alterations. *Virchows Arch*. 2016;469:711-715.

25. Almalki MH, Alrogi A, Al-Rabie A, Al-Dandan S, Altwairgi A, Orz Y. Atypical teratoid/rhabdoid tumor of the sellar region in an adult with long survival: case report and review of the literature. *J Clin Med Res*. 2017;9:216-220.

26. Barresi V, Lionti S, Raso A, Esposito F, Cannavò S, Angileri FF. Pituitary atypical teratoid rhabdoid tumor in a patient with prolactinoma: a unique description. *Neuropathology*. 2018;38: 260-267.

27. Nakata S, Nobusawa S, Hirose T, Ito S, Inoshita N, Ichi S, et al. Sellar atypical teratoid/rhabdoid tumor (AT/RT): a clinicopathologically and genetically distinct variant of AT/RT. *Am J Surg Pathol*. 2017;41:932-940.

28. Nishikawa A, Ogiwara T, Nagm A, Sano K, Okada M, Chiba A, et al. Atypical teratoid/rhabdoid tumor of the sellar region in adult women: is it a sex-related disease? *J Clin Neurosci*. 2018;49:16-21.

29. Singh TD, Valizadeh N, Meyer FB, Atkinson JLD, Erickson D, Rabinstein AA. Management and outcomes of pituitary apoplexy. *J Neurosurg*. 2015; 122:1450-1457.

30. Ganaha T, Inamasu J, Oheda M, Hasegawa M, Hirose Y, Abe M. Subarachnoid hemorrhage caused by an undifferentiated sarcoma of the sellar region. *Surg Neurol Int*. 2016;7(suppl 16): S459-S462.

31. Geyer JR, Sposto R, Jennings M, Boyett JM, Axtell RA, Breiger D, et al. Multiagent chemotherapy and deferred radiotherapy in infants with malignant brain tumors: a report from the Children's Cancer Group. *J Clin Oncol*. 2005;23: 7621-7631.

32. Crist W, Gehan EA, Ragab AH, Dickman PS, Donaldson SS, Fryer C, et al. The Third Intergroup Rhabdomyosarcoma Study. *J Clin Oncol*. 1995;13: 610-630.

33. Chi SN, Zimmerman MA, Yao X, Cohen KJ, Burger P, Biegel JA, et al. Intensive multimodality treatment for children with newly diagnosed CNS atypical teratoid rhabdoid tumor. *J Clin Oncol*. 2009;27:385-389.

34. Slavc I, Chocholous M, Leiss U, Haberler C, Peyri A, Azizi AA, et al. Atypical teratoid rhabdoid tumor: improved long-term survival with an intensive multimodal therapy and delayed radiotherapy. The Medical University of Vienna Experience 1992-2012. *Cancer Med*. 2014;3:91-100.

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