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Case Report

Rosai-Dorfman disease mimicking images of meningiomas: Two case reports and literature review

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ABSTRACT

Background: Rosai-Dorfman disease (RDD) is a rare non-Langerhans cell histiocytic proliferative disorder classically as a massive cervical lymphadenopathy. However, over the years, extranodal locations were confirmed with the central nervous system involvement in less than 5% of cases, which is marked as a significant differential diagnosis of meningiomas, with which they are widely confused due to the similarity of their radiological images.

Case Description: We report a 37-year-old man and 45-year-old man who were diagnosed with intracranial RDD but whose radiological images mimic meningiomas, requiring anatomopathological and tumor's immunohistochemistry for definitive diagnosis. Moreover, a review of 184 publications with 285 cases of intracranial involvement of this disease was also performed, comparing these findings with those brought in the previous studies.

Conclusion: Intracranial Rosai-Dorfman tumors should always be remembered as differential diagnosis of meningiomas since they are similar radiologically and macroscopically. Once remembered and diagnosed, the lesion must be treated following the same pattern of resection done in meningiomas and, treatment's differences will not occur in the surgical excision technique, but in complementary chemotherapy implementation, radiotherapy, and even with radiosurgery aid, depending on the case. Thus, it is possible to obtain better results than with just the isolated surgical procedure.

Keywords: Central nervous system, Histiocytosis, Magnetic resonance imaging, Meningioma, Rosai-Dorfman disease

INTRODUCTION

Rosai-Dorfman disease (RDD) is a rare non-Langerhans cell histiocytosis characterized by accumulation of activated histiocytes in the affected tissues. Widely heterogeneous and with a variety of clinical phenotypes, it may be present from the isolated form to the form in association with other diseases such as autoimmune,[49,197] hereditary,[125,131,211] or malignant.[6,69,112,116,136] Its importance is marked as a significant differential diagnosis of meningiomas, with which they are widely confused due to the similarity of their radiological images, being differentiated by surgically resected tissue histopathological analysis.[63,132,148,180]

His first description dates back to 1965 by a French pathologist - Pierre Paul Louis Lucien Destombes,[40] and 4 years later was exhaustively studied by Rosai and Dorfman, who analyzed 34 cases of the same disease under the name of sinus histiocytosis with massive lymphadenopathy.[155] Classically, RDD presents as a bilateral cervical lymphadenopathy, but in 43% of patients the disease presents as an extranodal location.[49] It is important to point out that RDD is a rare disease, with prevalence of approximately 1:200,000 people,[122] with involvement of the central nervous system (CNS) occurring in less than 5% of cases of RDD and, within this portion, approximately 75% present themselves as intracranial lesions and 25% as spinal lesions.[14] As for the age group, nodal RDD is more frequently observed in children and young adults (mean age 20.6 years), being more present in men (male/female ratio 1.4:1).[99,105,149] However, when intracranial RDD is involved, the age group most affected changes, generally affecting adult men in the fourth and fifth decades of life (mean age 39.5 years).[27,63]

In intracranial RDD, the most involved structures are the suprasellar region, cerebral convexity, parasagittal region, cavernous sinus, and petroclival region,[99,149] with infratentorial parenchymal lesions being the most frequent,[198] while supratentorial, intraventricular, and multifocal lesions are observed with significantly lower frequency.[130,148] Radiologically, intracranial RDD is commonly confused with meningioma[63,132,148,180] and requires tumor histopathology and immunohistochemistry for its definitive diagnosis. In anatomopathological examination of the lesions, histiocytes with large and discolored cytoplasm with large hypochromatic nucleus and prominent nucleolus are present.[40] Emperipolesis is a useful finding, although not necessary for diagnosis.[42] In immunohistochemical examination, histiocytes are positive for S-100 and CD-68 protein and negative for CD1a[27,99,156] and moreover for symptoms, usual presentations of intracranial RDD include seizures, headache, cranial nerve deficits, hemiparesis, and dysphasia,[87] usually evolving over weeks or months.[161]

The present study reports two cases of RDD with intracranial involvement, one of them with follow-up of more than 15 years. A review of 184 publications with 285 cases of RDD with CNS involvement (CNS-RDD) was also performed, comparing these findings with those brought in the previous studies. For identifying the studies, the MeSH tool from PubMed database was used, using the keywords "Histiocytosis, Sinus" restrict to MeSH Major Topic (entry terms: histiocytoses, Sinus; Sinus Histiocytoses; Sinus Histiocytosis; RDD; Disease, Rosai-Dorfman; RDD; Sinus Histiocytosis with Massive Lymphadenopathy; Destombes-Rosai-Dorfman Syndrome; Destombes Rosai Dorfman Syndrome; and Syndrome, Destombes-Rosai-Dorfman) and the keyword "Central Nervous System;" no filter was used for languages, date of publication or type of study. In addition, manual searches were performed based on the studies found by the initial electronic search. All articles including new cases of the disease and containing basic information (sex, age, location of the pathology, and if there was isolated involvement of the CNS) were included in the study.

CASES REPORTS

First case report

Male patient, 37 years old, presented 4 years before with painless left supraclavicular adenomegaly, with progressive increase followed by intense pain in the left clavicle after physical activity. Imaging examinations demonstrated the presence of bone infiltration, supraclavicular and infraclavicular adenomegaly, as well as lesions in the orbit and cranial cap. Biopsy of supraclavicular lymph node confirmed lymphadenitis with massive sinus histiocytosis compatible with RDD, with immunohistochemical examination demonstrating CD68 and S100 positive and CD30 and CD1a negative. The patient initially presented an excellent response with corticoids using, noting significant regression of adenomegaly, and general improvement of symptoms. In the last year, however, he began to refer to migratory arthralgia with an increase in cervical adenomegalies, requiring the continuous use of corticoids and increased doses in exacerbations, and he presented with pulsatile headache which was often disabling. A skull MRI was performed which revealed an expansive lesion in the left frontal region [Figure 1], requiring hospitalization, and use of prophylactic anticonvulsant. A microsurgery was performed for total resection of the brain tumor [Figure 2], which in the anatomopathological examination showed proliferation of histiocytes of ample cytoplasm and vesicular nuclei with prominent nucleoli, forming aggregates surrounded by lymphoplasmocytic infiltrate and with emperipolesis. The immunohistochemical examination demonstrated histiocytes positive for S-100 and CD-68 protein and negative for CD1a, thus confirming the diagnosis of RDD. A panel of mutations for solid tumors was also performed by Next-Generation Sequencing, with no relevant changes in the areas of interest of the analyzed genes. The patient was discharged 3 days later, remaining in follow-up until now well and without recurrence.

Second case report

Male patient, 45 years old, receives specialized neurological care with convergent strabismus and complaint of diplopia, headache, ringing in the left ear and hypoacusis for 6 months. A gadolinium-contrasted MRI examination was requested, which demonstrated a lesion in the petroclival region invading the cavernous sinus with extension into the posterior fossa, with contrast uptake compatible with

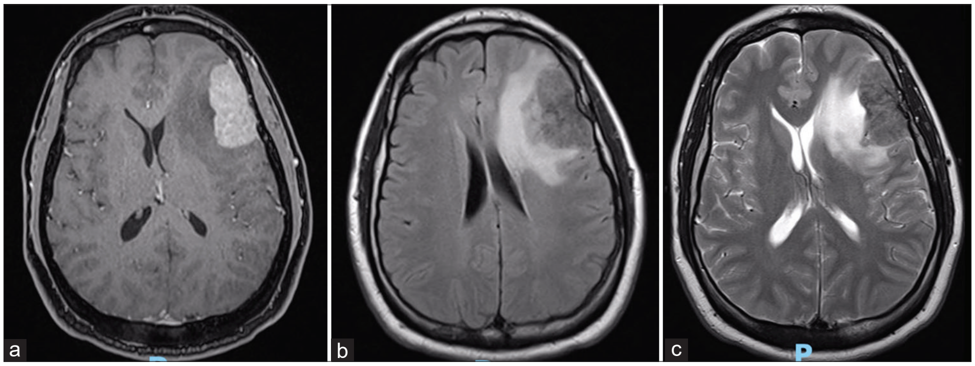

Figure 1: Magnetic resonance imaging showing expansive lesion in the left frontal region with left to right mass effect and surrounding edema. (a) Axial gadolinium-enhanced image. (b) Axial FLAIR. (c) Axial T2-weighted.

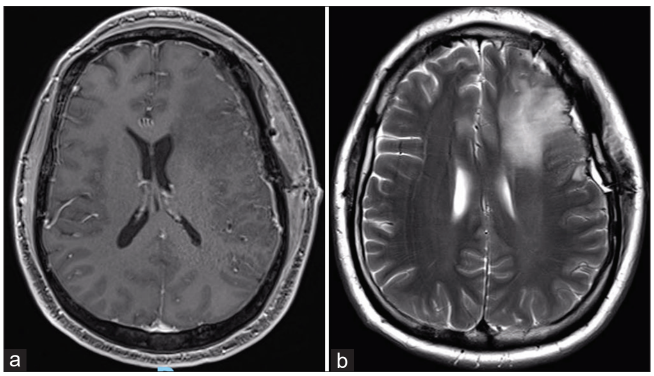

Figure 2: Magnetic resonance imaging at the post operated showed total resection of the left frontal tumor associated with edema, determining deletion of the local cortical grooves, compression of the frontal horn of the left lateral ventricle and contralateral midline deviation. (a) Axial gadolinium-enhanced image. (b) Axial T2-weighted.

meningioma. MRI also showed that the lesion reached the cervical region, descending through the petroclival portion, and bordering the clivus [Figure 3]. The patient was then submitted to a combined subtemporal and presigmoid route for partial resection – leaving only part of the lesion in the middle fossa [Figure 4] – of the possible meningioma, which after anatomopathological analysis was concluded it was not a meningioma but a case of RDD. Then, continuous chemotherapy treatment with CHOP (cyclophosphamide, doxorubicin, vincristine, and prednisone) and radiotherapy in specialized oncology services was started for 2 years and submitted to several sections throughout this period. The patient was operated on with tumor partial resection in 2005, remaining in follow-up until now without recurrence.

DISCUSSION

According to 285 RDD literature reviewed cases [1–5,7,9,10,12–24,26–39,41,44-48,50-54,56-68,70,72-96,98,99,102-111,113-115,117-123,126-129,130,132-135,137-142,144,146-148,150-154,157-161,163-175,177,178,181-185,187-191,193-196,198,200,202-210,212-215,217-221] added two newly cases presented in this study [Tables 1 and 2], we obtained a male/female ratio of 1.9:1 and a mean of 38.51 years and a median of 38 years of age, with 50% of patients aged between 26 and 53 years. The exclusively intracranial involvement was present in 77% (*n* = 221) of RDD cases, with a mean age of 39.5 years, while the exclusively spinal involvement was present in only 14% (*n* = 40) of them and with a mean age of 36.4 years. The mean age values obtained are quite close to the mean of 39.5 years described in the previous studies,[27,63] mainly in cases with exclusive intracranial involvement. However, the 1.9:1 male/female ratio obtained in our review was much more remarkable in the prevalence of men than the 1.4:1 in the previous studies.[99,105,149]

On the other hand, comparing the frequencies of intracranial or spinal involvement according to the systemic or non-systemic involvement of the disease, RDD with isolated CNS involvement, reported in 77% (*n* = 221) of all cases of CNS-RDD, showed that 84% (*n* = 186) of isolated cases of the CNS had exclusively intracranial involvement and only 10% (*n* = 23) had exclusively spinal involvement. As for systemics CNS-RDD cases, the exclusively intracranial involvement occurred in 56% (*n* = 37) of the cases, while the exclusively spinal involvement was present in 26% (*n* = 17) of them. Therefore, it should be noted that comparing RDD with isolated CNS involvement, systemic CNS-RDD has a lower prevalence of exclusively intracranial involvement and a greater involvement of the spinal cord; in 26% (*n* = 17) of the cases with systemic presentation there was exclusive involvement of the spinal and in approximately 18% (*n* = 12) of the cases there was intracranial and spinal involvement. Thus, it is interesting to note that when RDD has systemic involvement, spinal cord involvement is more frequent than in relation to RDD with exclusive CNS involvement, which may have different explanations, such as perhaps because of systemic disease focus origin, usually sinus and with massive lymphadenopathy in the region, be closer to the spinal cord, this will somehow facilitate the disease spread to this nearest neural structure. This would mean that, once systemic RDD

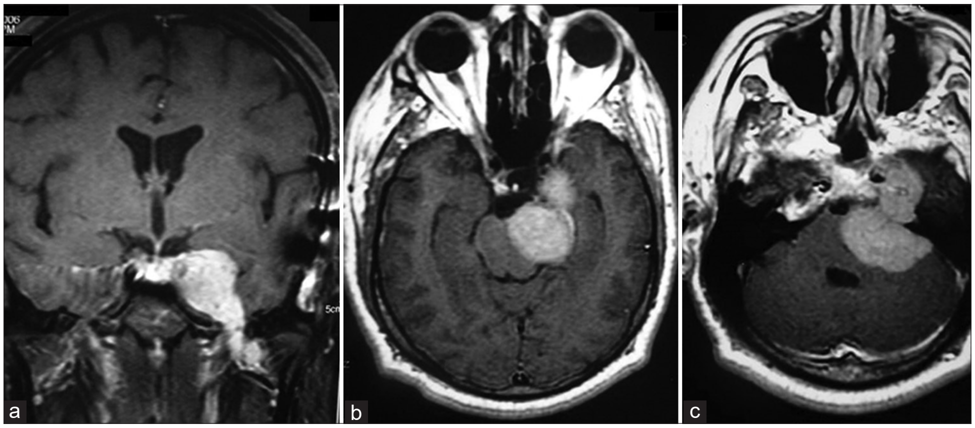

Figure 3: Magnetic resonance imaging preoperated showing expansive lesion in the left petroclival region with left to right mass effect, invading the cavernous sinus with extension into the posterior fossa and reach the cervical region, descending through the petroclival portion, bordering the clivus. Lesion with contrast enhances compatible with meningioma. (a) Coronal gadolinium-enhanced image (GEI). (b and c) Axial GEI.

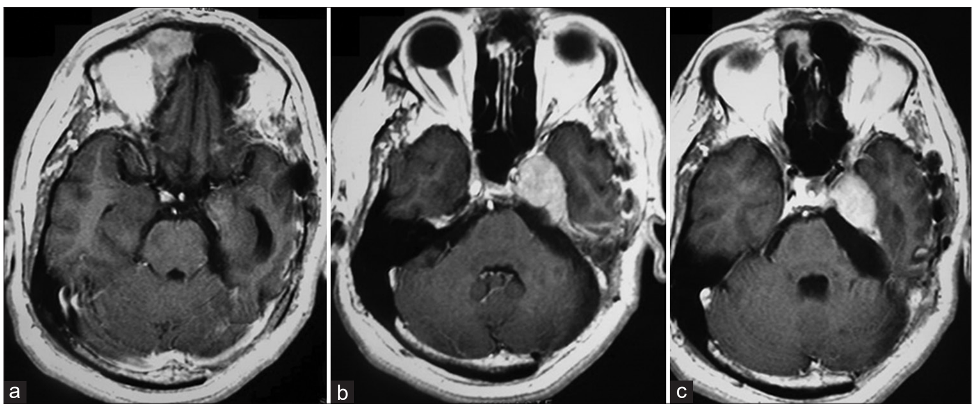

Figure 4: (a-c) Magnetic resonance imaging at the post operated showed parcial resection of the left petroclival tumor with remaining lesion in the middle fossa. Axial gadolinium-enhanced image.

Table 1: Characteristics of CNS-RDD cases according to present and previous reports from references.[1-5,7,9,10,12-24,26-39,41,44-48,50-54,56-68,70,72-96,98,99,102-111,113-115,117-123,126-129,130,132-135,137-142,144,146-148,150-154,157-161,163-1-75,177,178,181-185,187-191,193-196,198,200,202-210,212-215,217-221]

Characteristic	RDD with isolated CNS involvement (*n*=221)	Systemic RDD with CNS involvement (*n*=66)	Total RDD with CNS involvement (*n*=287)
Age – yr			
Mean	38.93	37.11	38.51
Range	1–79	3–78	1–79
Sex			
Female	74	25	99
Male	147	41	188
Location			
Intracranial	186	37	223
Spine	23	17	40
Intracranial and spine	12	12	24

RDD: Rosai-Dorfman disease, CNS: Central nervous system

was present, it could spread more easily to any location in the CNS, without maintaining the preferential intracranial involvement of CNS exclusive cases.

The typical radiological findings of intracranial RDD show dural-based, extra-axial, well-circumscribed masses mimicking meningioma with MRI usually reveals multiple well-defined, dural-based or intraventricular, extra-axial masses with possible perilesional cerebral edema.[80] Intracranial RDD CT typically presents homogeneous hyperdense or isodense masses, but MRI is currently the optimal diagnostic modality for evaluating lesions. On T1-weighted images, the lesions usually appear as isointense or hyperintense masses with clear borders relative to the peripheral brain parenchyma[56,150,187,196,201] and possible perilesional cerebral edema hypo or isointense.[80] While on T2-weighted images, the lesions usually appear as isointense masses with possible intralesional hypointense foci,[56,150,187,196,201] although studies have described rather low signal intensity on in this type of image.[7,87,196] On the other hand, meningiomas on T2-weighted MR images show low to high signal

Table 2: Central nervous system involvement in 287 cases of Rosai-Dorfman disease.[1-5,7,9,10,12-24,26-39,41,44-48,50-54,56-68,70,72-96,98,99,102-111,113-115,117-123,126-129,130,132-135,137-142,144,146-148,150-154,157-161,163-175,177,178,181-185,187-191,193-196,198,200,202-210,212-215,217-221]

Case. No.	Authors	Sex	Age (years)	Location	Exact location
1	Our study - case 1	Male	37	Intracranial	[L] frontal
2	Our study - case 2	Male	41	Intracranial and spine	Petroclival, cavernous sinus, posterior fossa and cervical region
3	Abdel-Razek *et al.*, 2013	Male	43	Intracranial	[R] and [L] frontal, falx cerebri, anterior clinoid process and [R] petrous bone
4	Abdel-Razek *et al.*, 2013	Female	38	Intracranial	[R] parietal parasagittal
5	Adeleye *et al.*, 2010	Male	61	Intracranial	[L] tentorial dural and supra/infratentorial compartments
6	Adeleye *et al.*, 2010	Male	38	Intracranial	Tuberculum sella dural, [R] parietal and [L] foramen magnum
7	Agnoletto *et al.*, 2019	Male	46	Intracranial	[R] cerebellar hemisphere
8	Alimli *et al.*, 2016	Male	1	Intracranial	[L] parieto-occipital
9	Amagasa *et al.*, 2001	Male	42	Intracranial	Pituitary fossa
10	Andriko *et al.*, 2001	Male	51	Spine	Spinal canal, thoracic epidural
11	Andriko *et al.*, 2001	Male	50	Intracranial	Base of skull, [L] petroclinoid ligament
12	Andriko *et al.*, 2001	Male	42	Spine	Spinal canal, epidural space, T6–T8
13	Andriko *et al.*, 2001	Male	22	Intracranial	[L] fronto-temporal and [R] parietal
14	Andriko *et al.*, 2001	Female	63	Intracranial	[R] frontal
15	Andriko *et al.*, 2001	Female	25	Intracranial	Falx cerebri and sagittal sinus
16	Andriko *et al.*, 2001	Female	31	Intracranial	Falx cerebri
17	Andriko *et al.*, 2001	Male	35	Spine	Spinal cord, intramedullary, T4–T5
18	Andriko *et al.*, 2001	Male	62	Intracranial	[R] parasellar
19	Andriko *et al.*, 2001	Female	43	Intracranial	[R] parietal
20	Andriko *et al.*, 2001	Male	24	Intracranial	[L] occipital dura
21	Antuña Ramos *et al.*, 2012	Female	10	Intracranial and spine	[R] frontal, [L] middle cerebellar peduncle, [R] ventral pons and spinal cord, intramedullary, T9-T10
22	Arnao *et al.*, 2016	Male	70	Intracranial	[L] fronto-parietal-temporal
23	Kumar *et al.*, 2014	Male	43	Intracranial	[R] fronto-temporal
24	Asai *et al.*, 1988	Male	39	Intracranial	[L] occipital subarachnoid space
25	Baassiri *et al.*, 2020	Male	54	Intracranial and spine	Foramen magnum, the base of the odontoid process, [L] anterolateral to the spinal cord and medullary spinal junction surrounding the [L] vertebral artery
26	Battal *et al.*, 2017	Male	18	Intracranial	[R] and [L] choroid plexus of ventricular atria, tentorial dural, falx cerebri and planum sphenoidale dural
27	Bernard *et al.*, 1999	Female	10	Spine	Spinal, epidural and subdural, L3-L5
28	Beros *et al.*, 2011	Male	41	Intracranial	[R] cerebellar hemisphere
29	Bertero *et al.*, 2018	Female	68	Intracranial	[L] temporal
30	Lima *et al.*, 2019	Female	60	Intracranial	[L] parietal
31	Bhandari *et al.*, 2006	Female	23	Spine	Intradural extramedullary space, C3-C4 to C5-C6, T1-T2 to T4 and T5
32	Bhat *et al.*, 2015	Male	38	Intracranial	[L] parietal convexity
33	Bhattacharjee *et al.*, 1992	Male	78	Intracranial	Suprasellar and planum sphenoidale
34	Bing *et al.*, 2009	Female	32	Intracranial	[L] parieto-occipital
35	Boissaud-Cooke *et al.*, 2020	Male	52	Intracranial	[R] frontal
36	Brandsma *et al.*, 2003	Female	36	Intracranial	[L] cerebellopontine angle, [R] and [L] supratentorial parasellar extension
37	Brandsma *et al.*, 2003	Male	41	Intracranial	[R] occipital
38	Brandsma *et al.*, 2003	Female	33	Intracranial and spine	Infratentorial, [R] and [L] internal auditory meatus and ganglion Gasseri, and cervical spinal cord
39	Breiner *et al.*, 2013	Female	63	Intracranial	[R] and [L] periventricular white matter and corpus callosum
40	Buchino *et al.*, 1982	Male	13	Intracranial and spine	Base of skull and spinal cord, C6-T12
41	Camp *et al.*, 2012	Female	31	Intracranial	[L] frontal, [R] parietal and [R] frontal white matter
42	Cao *et al.*, 2011	Male	35	Intracranial	Tentorial dural in the [R] trigone and [R] lateral ventricle

(Contd...)

Table 2: *(Continued)*

Case. No.	Authors	Sex	Age (years)	Location	Exact location
43	Carey and Case, 1987	Male	35	Intracranial	Parasagittal crossing the midline
44	Castellano-Sanchez and Brat, 2003	Female	37	Intracranial	[L] parietal
45	Catalucci *et al.*, 2012	Male	57	Intracranial	Anterior, middle and posterior cranial fossa
46	Cavuoto *et al.*, 2011	Male	25	Intracranial	Pons, cerebral and cerebellar peduncles, [L] temporal, [L] frontal, [L] globus pallidus, [L] optic nerve, optic chiasm and proximal optic tracts
47	Chan *et al.*, 1985	Female	7	Spine	Spinal cord, C5-C6
48	Chen, 2003	Male	70	Intracranial	[R] parietal and suprasellar
49	Chen, 2003	Male	62	Spine	Sacral canal
50	Chivukula *et al.*, 2014	Female	66	Intracranial	Hypothalamus
51	Clark and Berry, 1996	Female	38	Intracranial	[L] parietal
52	Cooper and Jenrette, 2012	Male	6	Intracranial and spine	[L] temporal, diffuse meningeal infiltration and spine
53	Cunliffe *et al.*, 2009	Male	33	Intracranial	Skull base, with involvement of the sella and suprasella cistern
54	Deodhare *et al.*, 1998	Male	41	Intracranial	[L] parieto-occipital
55	Deodhare *et al.*, 1998	Male	38	Intracranial	[L] parieto-occipital
56	Deshayes *et al.*, 2013	Female	51	Intracranial	Floor of the third ventricle
57	Di Rocco *et al.*, 2007	Female	13	Intracranial	[L] frontal
58	Dran *et al.*, 2008	Male	17	Spine	Spine, intradural extramedullary space, T1-T4
59	El Majdoub *et al.*, 2009	Female	10	Intracranial	[L] white matter and basal ganglia
60	El Molla *et al.*, 2014	Male	76	Spine	Spinal cord, intramedullary, C2-C3
61	Forest *et al.*, 2014	Male	41	Intracranial	Frontal and temporal dural-based
62	Forest *et al.*, 2014	Female	35	Intracranial	Orbitary and optic pathways
63	Forest *et al.*, 2014	Male	38	Intracranial	Multiple dural-based lesions
64	Fortea *et al.*, 2008	Female	53	Intracranial	[L] occipital cortex and cerebellar hemispheres
65	Foucar *et al.*, 1982	Male	21	Intracranial	[L] cerebellopontine angle, epidural
66	Foucar *et al.*, 1982	Female	59	Spine	Spinal, T8
67	Foucar *et al.*, 1982	Male	53	Spine	Spinal, epidural, C7-T3
68	Foucar *et al.*, 1982	Female	12	Spine	Spinal, epidural, C2, C5-T2
69	Foucar *et al.*, 1982	Male	4	Spine	Spinal, subdural
70	Foucar *et al.*, 1982	Female	55	Intracranial	Frontal, epidural
71	Foucar *et al.*, 1982	Female	28	Intracranial	[L] parietal, epidural
72	Foucar *et al.*, 1982	Female	11	Spine	Spinal, epidural: T3-T9, L5-S1
73	Franco-Paredes and Martin, 2002	Female	57	Intracranial	Diffuse leptomeningeal
74	Friedman *et al.*, 1984	Male	32	Intracranial	Supracellar
75	Fukushima *et al.*, 2011	Female	33	Intracranial	Cavernous sinus
76	Gaetani *et al.*, 2000	Female	67	Intracranial	Cerebellar, Intracerebellar
77	Geara *et al.*, 2004	Male	3	Intracranial	[L] cerebellar hemisphere, tentorium, fourth ventricle, trigeminal nerves at their origins from the pons, choroid plexus in the [R] and [L] trigone
78	Ghosal *et al.*, 2007	Male	26	Intracranial	[R] parietal convexity
79	Gies *et al.*, 2005	Female	40	Intracranial	[L] parietal
80	Griffiths *et al.*, 2004	Male	9	Intracranial	[R] frontal
81	Gui *et al.*, 2014	Male	60	Intracranial	Corpus callosum
82	Gui *et al.*, 2014	Female	54	Intracranial	[L] frontal and parietal
83	Gupta *et al.*, 2015	Female	20	Intracranial	[L] and [R] bulky intraconal
84	Gupta *et al.*, 2006	Male	15	Intracranial	Parasellar and petroclival
85	Gupta *et al.*, 2011	Male	14	Intracranial	[L] skull base
86	Haas *et al.*, 1978	Female	12	Spine	Epidural, C2 and C5-T2
87	Hadjipanayis *et al.*, 2003	Male	52	Intracranial	[L] cavernous sinus and petroclival
88	Halelfadl *et al.*, 2007	Female	65	Intracranial	[L] temporal convexit

(Contd...)

Table 2: *(Continued)*

Case. No.	Authors	Sex	Age (years)	Location	Exact location
89	Hargett and Bassett, 2005	Female	29	Spine	Spinal cord, T5-T9
90	Hashimoto *et al.*, 2014	Male	53	Intracranial	[R] frontotemporal and sphenoid wing
91	Hinduja *et al.*, 2009	Male	42	Intracranial	[L] orbital apex, middle cranial fossa and cavernous sinus
92	Hollowell *et al.*, 2000	Male	78	Spine	Spinal cord, C4-C8
93	Hong Cheng *et al.*, 2017	Male	64	Intracranial	[R] frontal
94	Hong *et al.*, 2016	Female	59	Intracranial	Intraparenchymal cerebellar
95	Huang *et al.*, 1998	Male	38	Intracranial	Parietal, dural-based
96	Huang *et al.*, 2016	Male	55	Spine	Spine, epidural, T1-T9
97	Huang *et al.*, 2016	Male	40	Spine	Spine, epidural, C3-C6
98	Huang *et al.*, 2016	Female	14	Spine	Spine, intervertebral foramen, S1-S2
99	Huang *et al.*, 2016	Male	43	Spine	Spine, epidural, C5-C6
100	Idir *et al.*, 2011	Female	28	Intracranial	[L] frontal
101	Imada *et al.*, 2015	Female	68	Intracranial	Brainstem
102	Jayaram *et al.*, 2020	Male	24	Spine	Intraspinal, epidural, C7-T4
103	Jiang and Jiang, 2018	Male	39	Intracranial	[R] fronto-parietal and [L] frontal meningeal
104	Jiang and Jiang, 2018	Male	53	Intracranial	[L] parietal, temporal and occipital meningeal
105	Jiang and Jiang, 2018	Female	9	Intracranial	[R] parietal meningeal
106	Johnston *et al.*, 2009	Male	14	Intracranial	[R] cerebellum
107	Jones and Rueda-Pedraza, 1997	Male	34	Spine	Intramedullary spinal cord
108	Joshi *et al.*, 2019	Male	58	Intracranial	[L] medial occipito-parietal
109	Joshi *et al.*, 2019	Female	42	Intracranial	[R] parietal dural-based
110	Joshi *et al.*, 2019	Male	40	Intracranial	[R] parietal dural based
111	Joshi *et al.*, 2019	Male	46	Intracranial	[R] parietal dural based
112	Joshi *et al.*, 2019	Male	36	Spine	Spinal column
113	Joubert *et al.*, 2013	Male	38	Intracranial	Frontal falx cerebri, lateral ventricles and [L] and [R] tentorium cerebelli
114	Jurić *et al.*, 2003	Male	39	Intracranial	[R] temporal
115	Kaminsky *et al.*, 2005	Male	32	Intracranial	Petroclival, cavernous sinuses, suprasellar and anterior cranial fossa
116	Kattner *et al.*, 2000	Male	33	Intracranial	[R] parasagittal
117	Katz *et al.*, 1993	Male	20	Intracranial	Foramen magnun, posterior fossa and cervical Region
118	Kayali *et al.*, 2004	Male	31	Intracranial	[L] temporal
119	Kelly *et al.*, 1999	Female	45	Intracranial and spine	[L] cavernous sinus, posterior pituitary gland, optic chiasma, third ventricle and spinal cord, T2
120	Kessler *et al.*, 1976	Male	53	Spine	Spinal Cord, C7-T3
121	Kidd *et al.*, 2006	Female	37	Intracranial and spine	Anterior cranial fossa, [R] cerebellopontine angle, clivus and spinal cord, C5
122	Kidd *et al.*, 2006	Male	68	Intracranial	Suprasellar region and [R] parasellar region
123	Kim *et al.*, 2011	Male	39	Intracranial and spine	[R] frontal, temporal, cerebellopontine angle. [L] clinoidal, petroclival. [R] [L] Meckel's Cave
124	Kim *et al.*, 1995	Male	50	Intracranial	[R] parietal convexity
125	Kitai *et al.*, 2001	Male	36	Intracranial	[L] occipital convexity
126	Kitai *et al.*, 2001	Female	42	Intracranial	[R] frontal base
127	Kitai *et al.*, 1996	Male	25	Intracranial	Tentorium
128	Kong *et al.*, 2019	Male	10	Intracranial	Posterior pituitary
129	Konishi *et al.*, 2003	Female	68	Intracranial	[L] frontal region
130	Krishnamoorthy *et al.*, 2011	Male	51	Intracranial	[R] frontal region
131	Kumar *et al.*, 2008	Male	45	Intracranial	[L] parietal and temporal convexity
132	Lauwers *et al.*, 2000	Female	28	Intracranial	Central nervous system, meninges
133	Le Guenno *et al.*, 2012	Male	57	Intracranial	[L] frontotemporal
134	Leung *et al.*, 2003	Male	35	Intracranial	[L] parietal convexity and [R] tentorium

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Table 2: *(Continued)*

Case. No.	Authors	Sex	Age (years)	Location	Exact location
135	Li *et al.*, 2012	Male	40	Intracranial	[R] parietal
136	Löhr *et al.*, 1995	Female	40	Spine	Cervical region
137	Lopez and Estes, 1989	Male	35	Intracranial	[L] cavernous sinus and Meckel's cave, [L] cerebellopontine angle cistern. Internal auditory canal, middle cranial fossa.
138	Lou *et al.*, 2012	Male	27	Intracranial	Suprasellar and intrasellar region
139	Lou *et al.*, 2012	Male	29	Intracranial	Suprasellar and intrasellar region
140	Lou *et al.*, 2012	Female	26	Intracranial	Suprasellar region
141	Lou *et al.*, 2012	Male	14	Intracranial	Suprasellar region
142	Lou *et al.*, 2012	Female	22	Intracranial	Suprasellar region, midbrain and cerebellum
143	Lu *et al.*, 2012	Female	48	Intracranial	[L] frontal area
144	Lu and Guo, 2010	Male	34	Intracranial	[L] frontal lobe and corona radiata
145	Lüdemann *et al.*, 2015	Male	2	Intracranial	[R] and [L] frontal lobe, [L] ventricule
146	Lungren *et al.*, 2009	Female	2	Intracranial	Frontal convexity and parafalcine region
147	Luo *et al.*, 2017	Male	41	Intracranial	Fourth ventricle, [R] and [L] posterior horn of lateral ventricles, [L] parasellar and cerebellopontine angle
148	Luo *et al.*, 2017	Female	31	Intracranial	Cavernous sinus, foramen magnum, [R] parasellar, [R] and [L] sphenoidal crest and fronto-parietal meningeal
149	Luo *et al.*, 2017	Female	73	Intracranial	[L] posterior cranial fossa
150	Lutterbach *et al.*, 2003	Female	60	Intracranial	[L] hemisphere
151	Maiti *et al.*, 2011	Female	19	Spine	Extradural lesion, C3-C6
152	McPherson *et al.*, 2006	Male	53	Intracranial	Skull base, planum sphenoidale and tuberculum sella
153	Kim *et al.*, 2011	Male	39	Intracranial and spine	[R] frontal, temporal, and cerebellopontine angle. [L] clinoidal and petroclival. [R] and [L] Meckel's cave
154	Miletic *et al.*, 2008	Female	8	Intracranial	[L] occipital horn of lateral ventricle. [R] and [L] frontal periventricular
155	Mir *et al.*, 1985	Male	33	Intracranial	Suprasellar
156	Mirra *et al.*, 1983	Female	11	Intracranial	[R] frontal area
157	Mirra *et al.*, 1983	Female	38	Spine	Spinal cord, C7
158	Morandi *et al.*, 2000	Female	22	Intracranial	Fourth ventricle
159	Nalini *et al.*, 2012	Male	18	Intracranial and spine	[R] and [L] Parasellar region. Tuberculum sella, planum sphenoidale, tentorium, clivus and cervical spinal canal
160	Nassif and Boulos, 2015	Male	42	Intracranial	N/A
161	Natarajan *et al.*, 2000	Female	45	Intracranial	[R] frontal lobe
162	Ng and Poon, 1995	Male	22	Intracranial	Posterior pituitary
163	Olsen *et al.*, 1988	Male	69	Intracranial	[L] temporal lobe
164	Osenbach, 1996	Male	35	Spine	Spinal cord, T4-T5
165	Mahzoni *et al.*, 2012	Male	33	Intracranial	[L] parietal region
166	Panicker *et al.*, 1996	Female	58	Intracranial	Middle cranial fossa, dural-based
167	Parmar *et al.*, 2013	Female	64	Intracranial and spine	Planum sphenoidale, clivus, [L] temporal lobe and spine, C5-C6 level
168	Patwardhan and Goel, 2018	Female	40	Intracranial	Occipital horn of the lateral ventricle
169	Petzold *et al.*, 2001	Male	47	Intracranial	Cerebellopontine angle, foramen magnum, chiasmatic cistern, planum sphenoidale and [R] parafalcine region
170	Prayson and Rowe, 2014	Male	29	Intracranial	[R] posterior parietal convexity
171	Purav *et al.*, 2005	Male	18	Intracranial and spine	[L] Meckel's cave and spine, C2-C3 level
172	Purav *et al.*, 2005	Male	23	Intracranial	[L] parietal
173	Purav *et al.*, 2005	Male	31	Intracranial	[L] parietal
174	Purav *et al.*, 2005	Male	37	Intracranial	[R] parieto-ccipital
175	Purav *et al.*, 2005	Male	37	Intracranial	[L] parietal
176	Purav *et al.*, 2005	Male	39	Intracranial	[L] frontal
177	Purav *et al.*, 2005	Male	50	Intracranial	Multiple intraparenchymal
178	Purav *et al.*, 2005	Female	51	Intracranial	[L] frontal convexity

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Table 2: *(Continued)*

Case. No.	Authors	Sex	Age (years)	Location	Exact location
179	Purav *et al.*, 2005	Male	56	Intracranial	[R] parietal parasagittal
180	Purav *et al.*, 2005	Female	60	Intracranial	[R] parietal convexity
181	Qin *et al.*, 2019	Male	43	Intracranial and spine	Frontal falx, parietal falx, tentorium cerebelli and spinal, T3
182	Raslan *et al.*, 2011	Male	50	Intracranial and spine	Skull base, convexit and spinal, meningeal
183	Raslan *et al.*, 2011	Male	54	Intracranial and spine	Sellar and suprasellar, [R] and [L] cerebellopontine angle, and cervical canal, epidural
184	Raslan *et al.*, 2011	Female	50	Intracranial	Pituitary
185	Raslan *et al.*, 2011	Female	57	Spine	Spinal, meningeal, T9
186	Resnick *et al.*, 1996	Male	38	Intracranial	[L] cerebellopontine angle
187	Richardson *et al.*, 2018	Female	64	Intracranial	[R] and [L] cerebellar hemispheres, basal ganglia, and corpus callosum
188	Rocha-Maguey *et al.*, 2016	Female	27	Spine	Spinal cord, intramedullary, C7-T1
189	Rotondo *et al.*, 2010	Female	63	Intracranial	spread to the pars tuberalis, the lower portion of the pituitary stalk and to the adjacent dura
190	Russo *et al.*, 2009	Male	72	Intracranial	Pituitary
191	Russo *et al.*, 2009	Male	57	Intracranial	[R] and [L] frontal
192	Said *et al.*, 2011	Male	74	Intracranial	[R] temporal
193	Sakai *et al.*, 1998	Male	60	Intracranial	[L] cerebellopontine angle, [R] temporal fossa and convexity, [R] and [L] frontal convexity
194	Sandoval-Sus *et al.*, 2014	Female	32	Intracranial	Extraaxial brainstem
195	Sandoval-Sus *et al.*, 2014	Male	51	Intracranial	Extraaxial brainstem
196	Sandoval-Sus *et al.*, 2014	Male	53	Intracranial and spine	Extraaxial brainstem and spinal, extramedullary and intramedullary
197	Sandoval-Sus *et al.*, 2014	Male	18	Intracranial and spine	Extraaxial brainstem and spinal, extramedullary
198	Sandoval-Sus *et al.*, 2014	Male	38	Intracranial	Extraaxial brainstem and cerebral
199	Sandoval-Sus *et al.*, 2014	Male	60	Intracranial	Extraaxial cerebral
200	Sato *et al.*, 2003	Female	59	Intracranial and spine	Suprasellar region, [R] temporal convexity, [L] frontal convexity and cerebello-pontine angle, and spine, C5 level
201	Schmidt *et al.*, 2004	Male	4	Intracranial and spine	[R] and [L] retro-orbita and spine, epidural, L1-S2
202	Scumpia *et al.*, 2009	Male	22	Intracranial	[R] middle cranial fossa
203	Seyednejad *et al.*, 2007	Female	43	Intracranial	Anterior and posterior cranial fossa, and spine, C5–C6 level
204	Shah *et al.*, 2020	Female	63	Intracranial	Cavernous sinus and superior orbital fissure
205	Shaver *et al.*, 1993	Male	5	Intracranial	[L] cavernous sinus, with extension over the tentorial margin into the posterior fossa
206	Shuangshoti *et al.*, 1999	Female	55	Intracranial	[R] fronto-parietal
207	Siadati *et al.*, 2001	Female	48	Intracranial	[L] parieto-occipital
208	Simos *et al.*, 1998	Male	62	Intracranial	[L] paiental, with base of attachment along the falx
209	Siu *et al.*, 2015	Male	60	Intracranial	[L] anterior cranial fossa
210	Song *et al.*, 1989	Male	30	Intracranial	Frontal, middle and posterior fossa
211	Sundaram *et al.*, 2005	Male	35	Intracranial	Dural-based lesions
212	Sundaram *et al.*, 2005	Male	35	Intracranial	Dural-based lesions
213	Sundaram *et al.*, 2005	Female	35	Intracranial	Dural-based lesions
214	Symss *et al.*, 2010	Male	21	Intracranial	Infratentorial, extending on both sides along the tentorium, up to the cavernous sinuses
215	Symss *et al.*, 2010	Male	35	Intracranial	[R] and [L] frontal dural based lesion with involvement of the falx
216	Symss *et al.*, 2010	Female	17	Intracranial	Suprasellar region
217	Tan *et al.*, 2018	Male	66	Intracranial	[L] temporal

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Table 2: *(Continued)*

Case. No.	Authors	Sex	Age (years)	Location	Exact location
218	Tanboon *et al.*, 2003	Male	22	Intracranial	Sellar region
219	Tauziede-Espariat *et al.*, 2015	Female	35	Intracranial	[R] and [L] parieto-occipital leptomeningeal
220	Tavangar *et al.*, 2006	Male	79	Intracranial	[L] parasagittal region
221	Theeler *et al.*, 2008	Female	56	Intracranial	[R] fronto-parietal convexity
222	Tian *et al.*, 2015	Male	6	Intracranial	Frontal falx cerebri, lateral ventricles and both sides of the tentorium
223	Tian *et al.*, 2015	Male	17	Intracranial	Falx cerebri and midline in both parietal lobes
224	Tian *et al.*, 2015	Male	26	Intracranial	[R] middle and posterior fossa
225	Tian *et al.*, 2015	Female	49	Intracranial	Falx cerebri and midline in both parietal lobes
226	Tian *et al.*, 2015	Male	68	Intracranial	[R] frontal
227	Tian *et al.*, 2015	Male	7	Intracranial	Multiple intracranial lesions
228	Tian *et al.*, 2015	Male	40	Spine	Spine, C3-C5, C6 level
229	Tian *et al.*, 2015	Male	43	Spine	Spine, C5-C6 level
230	Toh *et al.*, 2005	Female	60	Intracranial	[R] occipital lobe and the [R] cerebellar hemisphere
231	Toh *et al.*, 2005	Male	59	Intracranial	[R] and [L] frontal lobe with a base of attachment along the falx
232	Tomio *et al.*, 2012	Male	53	Intracranial	[R] parietal convexity
233	Triana-Pérez *et al.*, 2011	Male	40	Intracranial	[R] parieto-occipital extending into the posterior fossa
234	Tripathi *et al.*, 2017	Female	7	Intracranial and spine	[R] and [L] third, fifth, sixth, seventh and eighth cranial nerves, and cauda equina nerve roots and conus
235	Trudel, 1984	Male	28	Intracranial	[L] middle cranial fossa
236	Tu *et al.*, 2017	Male	41	Spine	Spine, T2-T3 level with dura tail sign
237	Tubbs *et al.*, 2005	Male	13	Spine	Craniocervical junction
238	Türe *et al.*, 2004	Male	29	Intracranial	[R] cavernous sinus, reaching the rostrum along the interhemispheric fissure
239	Udono *et al.*, 1999	Male	67	Intracranial	[R] frontal
240	Varan *et al.*, 2015	Male	5	Intracranial	Pontomesencephalic junction
241	Walker *et al.*, 2011	Female	54	Intracranial	Multiple dural-based lesions
242	Wang *et al.*, 2001	Female	19	Intracranial	Infratemporal fossae
243	Wang *et al.*, 2001	Male	38	Intracranial and spine	[R] frontal and [R] temporal
244	Wang *et al.*, 2010	Male	22	Intracranial	[L] parietal
245	Wang *et al.*, 2010	Female	40	Intracranial	[L] middle fossa
246	Wang *et al.*, 2010	Male	38	Intracranial	[L] petrous orbit
247	Wang *et al.*, 2010	Male	47	Intracranial	[L] petrous region
248	Wang *et al.*, 2010	Male	58	Spine	Spine, T8-T10 level
249	Wang *et al.*, 2010	Male	26	Intracranial	[R] occipital
250	Warrier *et al.*, 2012	Male	6	Intracranial and spine	Meningeal infiltrate to the cortex and spine
251	Wen *et al.*, 2019	Female	54	Intracranial	[R] frontal
252	Wen *et al.*, 2019	Male	40	Intracranial	[L] occipital
253	Wen *et al.*, 2019	Male	54	Intracranial	Falx cerebri
254	Woodcock *et al.*, 1999	Female	15	Intracranial	Pituitary infundibulum and around optic chiasm and lamina terminalis
255	Wrzolek and Zagzag, 2002	Male	38	Intracranial	[L] frontal
256	Wrzolek and Zagzag, 2002	Female	69	Intracranial	[L] tentorial
257	Wu and Xu, 2014	Male	43	Spine	Spine, C5-C6 level
258	Wu *et al.*, 2001	Male	35	Intracranial	[L] temporal and [L] occipital
259	XiaoWen *et al.*, 2010	Male	38	Intracranial and spine	Skull base, supra-sellar region, basal cistern, tentorium, bilateral cavernous sinuses, cerebral convexities, optic nerves and chiasm, and cervical intra-spinal canal
260	Yang *et al.*, 2017	Female	14	Intracranial	Petroclival, [L] cavernous sinus

(Contd...)

Table 2: *(Continued)*

Case. No.	Authors	Sex	Age (years)	Location	Exact location
261	Yao *et al*., 2013	Female	12	Spine	Spine, C4-C5 level
262	Yetiser *et al*., 2004	Male	7	Intracranial	[R] parietal convexity near to interhemispheric fissure
263	Yetiser *et al*., 2004	Male	6	Intracranial	Occipital region
264	Z'Graggen *et al*., 2006	Male	35	Intracranial	[L] cerebral convexity, including the falx cerebri and superior sagital sinus
265	Zhang *et al*., 2010	Male	27	Intracranial	Sellar region
266	Zhang *et al*., 2010	Female	38	Intracranial	Pituitary fossa with a suprasellar extension on the sagittal
267	Zhang *et al*., 2010	Female	26	Intracranial	Pituitary fossa with a suprasellar extension on the sagittal
268	Zhang *et al*., 2010	Male	30	Intracranial	Anterior cranial fossa
269	Zhang *et al*., 2018	Female	43	Intracranial	[R] and [L] fronto-parietal and tentorium
270	Zhang *et al*., 2018	Male	16	Intracranial	[L] temporal fossa
271	Zhu *et al*., 2013	Male	54	Intracranial	Cerebral subdura
272	Zhu *et al*., 2013	Male	60	Intracranial	Cerebral subdura
273	Zhu *et al*., 2013	Male	4	Intracranial	Cerebral parenchyma
274	Zhu *et al*., 2013	Female	26	Intracranial	Saddle area
275	Zhu *et al*., 2013	Male	38	Intracranial	Saddle area
276	Zhu *et al*., 2013	Male	27	Intracranial	Saddle area
277	Zhu *et al*., 2013	Male	53	Spine	Spinal subdura
278	Zhu *et al*., 2012	Male	25	Intracranial	[L] frontal, attaching to falx cerebri
279	Zhu *et al*., 2012	Female	38	Intracranial	[L] temporal, attaching to dura
280	Zhu *et al*., 2012	Male	46	Intracranial	[L] temporal, attaching to dura
281	Zhu *et al*., 2012	Male	26	Intracranial	[L] occipital, attaching to dura
282	Zhu *et al*., 2012	Male	41	Intracranial	[R] temporal, attaching to dura
283	Zhu *et al*., 2012	Male	40	Intracranial	[R] parasellar, attaching to dura
284	Zhu *et al*., 2012	Male	68	Intracranial	[R] frontal, attaching to sagittal sinus and falx cerebri
285	Zhu *et al*., 2012	Male	35	Intracranial	[R] occipital, attaching to [R] tentorium cerebelli
286	Zhu *et al*., 2012	Male	58	Spine	Spinal canal, attaching to spinal meninges, T8-T10
287	Zhu *et al*., 2012	Male	47	Intracranial	[L] parietal, attaching to dura and falx cerebri

R: Right, L: Left, N/A: Not available

intensity, varying this according to the histological subtype, and on angiograms are commonly seen as hypervascular lesions,[25] whereas in RDD this results are variable.[76,96] On RDD, in addition, on contrast-enhanced T1-weighted images with gadolinium, the lesions are markedly enhanced, homogeneously or inhomogeneously, and the dural tail sign can commonly be found.[1,47,56,94,150,184,187,196,201] Recently, new MRI sequences have been recommended for the diagnosis of RDD, such as diffusion tensor imaging (DTI), susceptibility-weighted imaging, and perfusion-weighted imaging,[71,77] in addition, the use of 18F-FDG PET/CT has been described to diagnose relapsed intracranial RDD of the hypothalamus in a patient.[39] MRI spectroscopy meningiomas have been shown to have elevated Cho and decreased NAA, which is also seen in many other neoplastic processes, decrease in Cr and prominent Ala, much more so than in other neoplastic processes and is considered a spectroscopic signature for meningiomas.[176] On the other hand, in RDD lesions, spectroscopy generally shows elevated lipid and N-acetyl aspartate peaks, suggestive of granulomatous inflammatory pathology, and a raised choline peak.[199] Furthermore, perfusion MRI imaging can provide useful information on meningioma vascularity which is not available from conventional MRI. Measurement of maximal rCBV and corresponding rMTE values in the peritumoral edema is useful in the preoperative differentiation between benign and malignant meningiomas[216] and the relatively low rCBV perfusion values in CNS-RDD.[199] Regarding to the neuroimaging, the best diagnostic clues for diagnosing CNS-RDD appear to be represented by hypo-isointensity in the T2-weighted sequences and the relatively low rCBV perfusion values, likely due to abundant fibrous tissue; however, these findings are not specific and not always present, and the final diagnosis is often still histological.[199] Therefore, preoperative radiological findings using current MRI sequences are difficult to distinguish between meningiomas and RDD; however, it has already been described that the absence of hyperostosis, bony erosion, or calcification – characteristically absent in the RDD[177] – should suggest RDD as a differential diagnosis of meningiomas.[150]

As for the two reported cases of RDD, they were very similar to the expected age group and sex grouping, according to the literature and our review. As for the location of the lesion, which can happen in many regions, including the supratentorial region, where meningiomas occur and in which one of them mimics, the two cases presented in this study are very representative, especially the second one, since at first moment it was thought that it was one of those. Furthermore, the involvement reaching the cervical portion of the second case is compatible with a higher prevalence location of spinal cord injuries according to previous studies.[101] Regarding its severity, although the involvement of CNS is often progressive and fatal, patients undergoing surgical resection have favorable prognosis in many cases.[180] However, surgical resection without complementary or additional therapy is frequently associated with recurrences of the disease[47] and should be associated with complementary or adjuvant treatments. As examples of these, chemotherapy and radiotherapy, which were very successful in the present case, may be indicated and instituted as several authors suggest,[8,9,43,55,97,124,145,153,162,179,186] especially when radical surgical resection of the tumor is not possible – which would be the best approach as several authors defend.[70,151,165] Treatment of resectable intracranial RDD and high risk by means of radiosurgery may also be a therapeutic option to be instituted,[45] obtaining very favorable results when combined with neurosurgical excision.[65,163,201] Furthermore, possibly promising, the use of Brachytherapy, a special way of applying radiation, may be a possible option to be analyzed, having already well documented therapeutic results in the treatment of other pathologies such as gliomas and some extracranial solid tumors.[11,100,143,192,222] Alternatively, the use of glucocorticoids has also shown quite beneficial effects on the regression and resolution of multiple and isolated intracranial lesions[47,126,217] and should be considered as an effective option in the treatment of RDD in certain cases where surgical resection is not applicable.

More importantly, surgical resection should follow the same pattern as meningiomas, since the texture of both is very similar, and it is extremely unlikely that with only radiological images the two pathologies can be differentiated before neurosurgical removal for anatomopathological analysis. At present, the best treatment for intracranial RDD involves surgical excision,[201] as employed in the two cases reported here.

CONCLUSION

Thus, we conclude that intracranial Rosai-Dorfman tumors should always be remembered as differential diagnosis of meningiomas, since they are similar radiologically and macroscopically. Once remembered and diagnosed, the lesion must be treated following the same pattern of resection done in meningiomas and, treatment's differences will not occur in the surgical excision technique, but in complementary chemotherapy implementation, radiotherapy, and even with radiosurgery aid, depending on the case. Thus, it is possible to obtain better results than with just the isolated surgical procedure.

Declaration of patient consent

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

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Abdel-Razek M, Matter GA, Azab WA, Katchy KC, Mallik AA. Isolated intracranial Rosai-Dorfman disease: Report of two cases and a review of the literature. Turk Neurosurg 2013;23:509-13.
2. Adeleye AO, Amir G, Fraifeld S, Shoshan Y, Umansky F, Spektor S. Diagnosis and management of Rosai-Dorfman disease involving the central nervous system. Neurol Res 2010;32:572-8.
3. Agnoletto GJ, Bit-Ivan EN, Hanel RA, Sauvageau E. All that glitters is not gold: Rosai-Dorfman as a single cerebellar necrotic lesion. BMJ Case Rep 2019;12:e228483.
4. Alimli AG, Oztunali C, Boyunaga OL, Pamukcuoglu S, Okur A, Borcek AO. MRI and CT findings of isolated intracranial Rosai-Dorfman disease in a child. Neuroradiol J 2016;29:146-9.
5. Amagasa M, Yuda F, Kojima H, Noshita N, Sato S. Natural course of lymphocytic infundibuloneurohypophysitis. Clin Neuropathol 2001;20:229-32.
6. Ambati S, Chamyan G, Restrepo R, Escalon E, Fort J, Pefkarou A, *et al*. Rosai-Dorfman disease following bone marrow transplantation for pre-B cell acute lymphoblastic leukemia. Pediatr Blood Cancer 2008;51:433-5.
7. Andriko JA, Morrison A, Colegial CH, Davis BJ, Jones RV. Rosai-Dorfman disease isolated to the central nervous system: A report of 11 cases. Mod Pathol 2001;14:172-8.
8. Aouba A, Terrier B, Vasiliu V, Candon S, Brousse N, Varet B, *et al*. Dramatic clinical efficacy of cladribine in Rosai-Dorfman disease and evolution of the cytokine profile: Towards a new therapeutic approach. Haematologica 2006;91:ECR52-2.
9. Arnao V, Riolo M, Savettieri G, Aridon P. Mercaptopurine treatment in an adult man with orbital and intracranial Rosai-Dorfman disease. Case Rep Neurol Med 2016;2016:1030478.
10. Asai A, Matsutani M, Kohno T, Fujimaki T, Tanaka H, Kawaguchi K, *et al*. Leptomeningeal and orbital benign lymphophagocytic histiocytosis. Case report. J Neurosurg 1988;69:610-2.
11. Ayukawa F, Shibuya H, Yoshimura R, Watanabe H, Miura M. Curative brachytherapy for recurrent/residual tongue cancer.

Strahlenther Onkol 2007;183:133-7.
12. Baassiri W, Moussalem CK, Massaad E, Zeidan YH, Darwish H. Craniocervical Rosai-Dorfman disease involving the vertebral artery: Case report and literature review. World Neurosurg 2020;133:69-73.
13. Battal B, Hamcan S, Balyemez U, Akgun V. Choroid plexus involvement in Rosai-Dorfman disease. Neurol India 2017;65:222-3.
14. Bernard F, Sarran N, Serre I, Baldet P, Callamand P, Margueritte G, *et al*. Sinus histiocytosis (Destombes-Rosai-Dorfman disease) revealed by paraplegia. Arch Pédiatr 1999;6:173-7.
15. Beros V, Houra K, Rotim K, Zivkovic DJ, Cupic H, Kosec A. Isolated cerebellar intraparenchymal Rosai-Dorfman disease--case report and review of literature. Br J Neurosurg 2011;25:292-6.
16. Bertero L, Zenga F, Maletta F, Senetta R, Cassoni P. A 68-year-old woman with a left orbital and temporal mass. Brain Pathol 2018;28:133-4.
17. Bhandari A, Patel PR, Patel MP. Extranodal Rosai-Dorfman disease with multiple spinal lesions: A rare presentation. Surg Neurol 2006;65:308-11.
18. Bhat A, Kupanur SS, Geethamani V. Isolated intracranial rosai-dorfman disease involving the meninges: Report of a rare case. Turk Neurosurg 2015;25:186-9.
19. Bhattacharjee MB, Wroe SJ, Harding BN, Powell M. Sinus histiocytosis with massive lymphadenopathy--isolated suprasellar involvement. J Neurol Neurosurg Psychiatry 1992;55:156-8.
20. Bing F, Brion JP, Grand S, Pasquier B, Lebas JF. Tumor arising in the periventricular region. Neuropathology 2009;29:101-3.
21. Boissaud-Cooke MA, Bhatt K, Hilton DA, Muquit S. Isolated intracranial Rosai-Dorfman disease: Case report and review of the literature. World Neurosurg 2020;137:239-42.
22. Brandsma D, Jansen GH, Spliet W, Van Nielen K, Taphoorn MJ. The diagnostic difficulties of meningeal and intracerebral plasma cell granulomas--presentation of three cases. J Neurol 2003;250:1302-6.
23. Breiner A, Dubinski W, Gray B, Munoz DG. A 63 year old woman with white matter lesions and pachymeningeal inflammation. Brain Pathol 2013;23:225-8.
24. Buchino JJ, Byrd RP, Kmetz DR. Disseminated sinus histiocytosis with massive lymphadenopathy: Its pathologic aspects. Arch Pathol Lab Med 1982;106:13-6.
25. Burger PC, Scheithauer BW. Atlas of tumor pathology. In: Tumors of the Central Nervous System. Washington, DC: Armed Forces Institute of Pathology; 1994. p. 259-86.
26. Camp SJ, Roncaroli F, Apostolopoulos V, Weatherall M, Lim S, Nandi D. Intracerebral multifocal Rosai-Dorfman disease. J Clin Neurosci 2012;19:1308-10.
27. Cao XY, Luan SH, Bao WM, Shen C, Yang BJ. Solitary intracranial Rosai-Dorfman disease: Case report and literature review. J Int Med Res 2011;39:2045-50.
28. Carey MP, Case CP. Sinus histiocytosis with massive lymphadenopathy presenting as a meningioma. Neuropathol Appl Neurobiol 1987;13:391-8.
29. Castellano-Sanchez AA, Brat DJ. May 2003: 57-year-old-woman with acute loss of strength in her right upper extremity and slurred speech. Brain Pathol 2003;13:641-2.
30. Catalucci A, Lanni G, Ventura L, Ricci A, Galzio RJ, Gallucci M. A rare case of intracranial rosai-dorfman disease mimicking multiple meningiomas. A case report and review of the literature. Neuroradiol J 2012;25:569-74.
31. Cavuoto K, Galor A, Dubovy SR, Gregori N, McCarthy M. Subconjunctival masses associated with central nervous system rosai-dorfman disease. Cornea 2011;30:237-40.
32. Chan KW, Chow YY, Ghadially FN, Stansfeld AG, Woo CH. Rosai-Dorfman disease presenting as spinal tumor. A case report with ultrastructural and immunohistochemical studies. J Bone Joint Surg Am 1985;67:1427-31.
33. Chen KT. Crush cytology of Rosai-Dorfman disease of the central nervous system. A report of 2 cases. Acta Cytol 2003;47:1111-5.
34. Chivukula S, Clark K, Murdoch G, Engh J. A singular case of intracranial sinus histiocytosis without massive lymphadenopathy: Isolated Rosai-Dorfman disease of the hypothalamus. J Neurol Surg Part A Cent Eur Neurosurg 2014;76:244-8.
35. Clark WC, Berry AD 3rd. Extranodal sinus histiocytosis with massive lymphadenopathy: Isolated central nervous system involvement mimicking meningioma. South Med J 1996;89:621-3.
36. Cooper SL, Jenrette JM. Rosai-Dorfman disease: Management of CNS and systemic involvement. Clin Adv Hematol Oncol 2012;10:199-202.
37. Cunliffe CH, Fischer I, Monoky D, Law M, Revercomb C, Elrich S, *et al*. Intracranial lesions mimicking neoplasms. Arch Pathol Lab Med 2009;133:101-23.
38. Deodhare SS, Ang LC, Bilbao JM. Isolated intracranial involvement in Rosai-Dorfman disease: A report of two cases and review of the literature. Arch Pathol Lab Med 1998;122:161-5.
39. Deshayes E, Le Berre JP, Jouanneau E, Vasiljevic A, Raverot G, Seve P. 18F-FDG PET/CT findings in a patient with isolated intracranial Rosai-Dorfman disease. Clin Nucl Med 2013;38:e50-52.
40. Destombes P. Adenitis with lipid excess, in children or young adults, seen in the Antilles and in Mali. (4 cases). Bull Soc Pathol Exot Filiales 1965;58:1169-75.
41. Di Rocco F, Garnett MR, Puget S, Pueyerredon F, Roujeau T, Jaubert F, *et al*. Cerebral localization of Rosai-Dorfman disease in a child. Case report. J Neurosurg 2007;107:147-51.
42. Diamond EL, Dagna L, Hyman DM, Cavalli G, Janku F, Estrada-Veras J, *et al*. Consensus guidelines for the diagnosis and clinical management of Erdheim-Chester disease. Blood 2014;124:483-92.
43. Diamond EL, Durham BH, Dogan A, Hyman DM, Rampal RK, Ulaner G, *et al*. Phase 2 trial of single-agent cobimetinib for adults with BRAF V600-mutant and wild-type histiocytic disorders. Blood 2017;130:257.
44. Dran G, Rasendrarijao D, Vandenbos F, Paquis P. Rosai-Dorfman disease causing spinal cord compression. Neurosurgery 2008;62:E977-8.
45. El Majdoub F, Brunn A, Berthold F, Sturm V, Maarouf M. Stereotactic interstitial radiosurgery for intracranial Rosai-Dorfman disease. A novel therapeutic approach. Strahlenther

Onkol 2009;185:109-12.
46. El Molla M, Mahasneh T, Holmes SE, Al-Khawaja D. Rare presentation of Rosai-Dorfman disease mimicking a cervical intramedullary spinal cord tumor. World Neurosurg 2014;81:442.e7-9.
47. Forest F, N'guyen AT, Fesselet J, Metellus P, Bouvier C, de Paula AM, *et al*. Meningeal Rosai-Dorfman disease mimicking meningioma. Ann Hematol 2014;93:937-40.
48. Fortea J, Compta Y, Valldeoriola F, Tolosa E, Rey MJ, Gastón F, *et al*. Fatal worsening of late-onset cerebellar ataxia with neuronal intranuclear inclusions due to superimposed meningeal Rosai-Dorfman disease. Mov Disord 2008;23:1488-90.
49. Foucar E, Rosai J, Dorfman R. Sinus histiocytosis with massive lymphadenopathy (Rosai-Dorfman disease): Review of the entity. Semin Diagn Pathol 1990;7:19-73.
50. Foucar E, Rosai J, Dorfman RF, Brynes RK. The neurologic manifestations of sinus histiocytosis with massive lymphadenopathy. Neurology 1982;32:365-72.
51. Franco-Paredes C, Martin K. Extranodal Rosai-Dorfman disease involving the meninges. South Med J 2002;95:1101-2.
52. Friedman MJ, Rossoff LJ, Aftalion B, Khan A, Decker R, Steinberg H. Sinus histiocytosis presenting as a mediastinal mass. Chest 1984;86:266-7.
53. Fukushima T, Yachi K, Ogino A, Ohta T, Watanabe T, Yoshino A, *et al*. Isolated intracranial Rosai-Dorfman disease without dural attachment--case report. Neurol Med Chir (Tokyo) 2011;51:136-40.
54. Gaetani P, Tancioni F, Di Rocco M, Rodriguez y Baena R. Isolated cerebellar involvement in Rosai-Dorfman disease: Case report. Neurosurgery 2000;46:479-81.
55. Garces S, Medeiros LJ, Patel KP, Li S, Pina-Oviedo S, Li J, *et al*. Mutually exclusive recurrent KRAS and MAP2K1 mutations in Rosai-Dorfman disease. Mod Pathol 2017;30:1367-77.
56. Geara AR, Ayoubi MA, Achram MC, Chamseddine NM. Rosai-Dorfman disease mimicking neurofibromatosis: Case presentation and review of the literature. Clin Radiol 2004;59:625-30.
57. Ghosal N, Murthy G, Visvanathan K, Sridhar M, Hegde AS. Isolated intracranial Rosai Dorfman disease masquerading as meningioma: A case report. Indian J Pathol Microbiol 2007;50:382-4.
58. Gies U, Gruia D, Lassmann H, Bergmann M. A case of rapidly progressive Rosai-Dorfman disease restricted to the central nervous system. Zentralbl Neurochir 2005;66:142-6.
59. Griffiths SJ, Tang W, Parameswaran R, Kelsey A, West CG. Isolated intracranial Rosai-Dorfman disease mimicking meningioma in a child. Br J Neurosurg 2004;18:293-7.
60. Gui Q, Li F, Song X. Intracranial Rosai-Dorfman disease: A report of seven cases with review of literature. Austin J Clin Pathol 2014;1:1013.
61. Gupta A, Farzal Z, Pandey A. An unusual cause of proptosis. BMJ Case Rep 2015;2015:bcr2015211741.
62. Gupta DK, Suri A, Mahapatra AK, Mehta VS, Garg A, Sarkar C, *et al*. Intracranial Rosai-Dorfman disease in a child mimicking bilateral giant petroclival meningiomas: A case report and review of literature. Child's Nerv Syst 2006;22:1194-200.
63. Gupta K, Bagdi N, Sunitha P, Ghosal N. Isolated intracranial Rosai-Dorfman disease mimicking meningioma in a child: A case report and review of the literature. Br J Radiol 2011;84:e138-41.
64. Haas RJ, Helmig MS, Prechtel K. Sinus histiocytosis with massive lymphadenopathy and paraparesis: Remission with chemotherapy. A case report. Cancer 1978;42:77-80.
65. Hadjipanayis CG, Bejjani G, Wiley C, Hasegawa T, Maddock M, Kondziolka D. Intracranial Rosai-Dorfman disease treated with microsurgical resection and stereotactic radiosurgery. Case report. J Neurosurg 2003;98:165-8.
66. Halelfadl S, Bougrine M, Fadli M, Elkettani F, Bellakhdar F. Rosai-Dorfman disease mimicking meningioma. Pan Arab J Neurosurg 2007;11:89-94.
67. Hargett C, Bassett T. Atypical presentation of sinus histiocytosis with massive lymphadenopathy as an epidural spinal cord tumor: A case presentation and literature review. J Spinal Disord Tech 2005;18:193-6.
68. Hashimoto K, Kariya S, Onoda T, Ooue T, Yamashita Y, Naka K, *et al*. Rosai-Dorfman disease with extranodal involvement. Laryngoscope 2014;124:701-4.
69. Hassani J, Porubsky C, Berman C, Zager J, Messina J, Henderson-Jackson E. Intraperitoneal Rosai-Dorfman disease associated with clear cell sarcoma: First case report. Pathology 2016;48:742-4.
70. Hinduja A, Aguilar LG, Steineke T, Nochlin D, Landolfi JC. Rosai-Dorfman disease manifesting as intracranial and intraorbital lesion. J Neurooncol 2009;92:117-20.
71. Hingwala D, Neelima R, Kesavadas C, Thomas B, Kapilamoorthy TR, Radhakrishnan VV. Advanced MRI in Rosai-Dorfman disease: Correlation with histopathology. J Neuroradiol 2011;38:113-7.
72. Hollowell JP, Wolfla CE, Shah NC, Mark LP, Whittaker MH. Rosai-Dorman disease causing cervical myelopathy. Spine (Phila Pa 1976) 2000;25:1453-6.
73. Hong Cheng SK, Tang YL, Prashanth RJ, Chuah KL. Extradural Brain Mass in a 64-Year-Old Man. Brain Pathol 2017;27:115-6.
74. Hong CS, Starke RM, Hays MA, Mandell JW, Schiff D, Asthagiri AR. Redefining the prevalence of dural involvement in Rosai-Dorfman disease of the central nervous system. World Neurosurg 2016;90:702.e13-20.
75. Huang BY, Zhang H, Zong WJ, Sun YH. Rosai-Dorfman disease of rare isolated spinal involvement: Report of 4 cases and literature review. World Neurosurg 2016;85:367.e11-6.
76. Huang HY, Huang CC, Lui CC, Chen HJ, Chen WJ. Isolated intracranial Rosai-Dorfman disease: Case report and literature review. Pathol Int 1998;48:396-402.
77. Idir I, Cuvinciuc V, Uro-Coste E, Penna M, Boetto S, Cognard C, *et al*. MR perfusion of intracranial Rosai-Dorfman disease mimicking meningioma. J Neuroradiol 2011;38:133-4.
78. Imada H, Sakatani T, Sawada M, Matsuura T, Fukushima N, Nakano I. A lethal intracranial Rosai-Dorfman disease of the brainstem diagnosed at autopsy. Pathol Int 2015;65:549-53.
79. Jayaram A, Al Maslamani NJ, Rahiman NAPA, Negi VC. Rosai-Dorfman disease with paravertebral and epidural thoracic spine involvement: A case report and literature review. Radiol Case Rep 2020;15:484-8.
80. Jiang Y, Jiang S. Intracranial meningeal Rosai-Dorfman disease mimicking multiple meningiomas: 3 Case reports and a literature review. World Neurosurg 2018;120:382-90.

81. Johnston JM, Limbrick DD, Ray WZ, Brown S, Shimony J, Park TS. Isolated cerebellar Rosai-Dorfman granuloma mimicking Lhermitte-Duclos disease: Case report. J Neurosurg Pediatr 2009;4:118-20.
82. Jones MP, Rueda-Pedraza ME. Extranodal sinus histiocytosis with massive lymphadenopathy presenting as an intramedullary spinal cord tumor: A case report. Am J Hematol 1997;54:253-7.
83. Joshi SS, Joshi S, Muzumdar G, Turel KE, Shah RM, Ammbulkar I, *et al*. Cranio-spinal Rosai Dorfman disease: Case series and literature review. Br J Neurosurg 2019;33:176-83.
84. Joubert C, Dagain A, Faivre A, Nguyen AT, Fesselet J, Figarella-Branger D. Intracranial Rosai-Dorfman disease mimicking multiple meningiomas. Rev Med Brux 2013;34:112-4.
85. Jurić G, Jakić-Razumović J, Rotim K, Zarković K. Extranodal sinus histiocytosis (Rosai-Dorfman disease) of the brain parenchyma. Acta Neurochir (Wien) 2003;145:145-9.
86. Kaminsky J, Koerbel A, Mittelbronn M, Beschorner R, Ernemann U, Tatagiba M. Rosai-Dorfman disease involving the cranial base, paranasal sinuses and spinal cord. Clin Neuropathol 2005;24:194-200.
87. Kattner KA, Stroink AR, Roth TC, Lee JM. Rosai-Dorfman disease mimicking parasagittal meningioma: Case presentation and review of literature. Surg Neurol 2000;53:452-7.
88. Katz DS, Poe LB, Corona RJJ. Sinus histiocytosis with massive lymphadenopathy: A case of simultaneous upper respiratory tract and CNS disease without lymphadenopathy. AJNR Am J Neuroradiol 1993;14:219-22.
89. Kayali H, Onguru O, Erdogan E, Sirin S, Timurkaynak E. Isolated intracranial Rosai-Dorfman disease mimicking meningioma. Clin Neuropathol 2004;23:204-8.
90. Kelly WF, Bradey N, Scoones D. Rosai-Dorfman disease presenting as a pituitary tumour. Clin Endocrinol (Oxf) 1999;50:133-7.
91. Kessler E, Srulijes C, Toledo E, Shalit M. Sinus histiocytosis with massive lymphadenopathy and spinal epidural involvement: A case report and review of the literature. Cancer 1976;38:1614-8.
92. Kidd DP, Revesz T, Miller NR. Rosai-Dorfman disease presenting with widespread intracranial and spinal cord involvement. Neurology 2006;67:1551-5.
93. Kim GG, Friedel ME, Eloy JA, Jyung RW, Liu JK. Extensive multifocal Rosai-Dorfman disease involving the central nervous system and paranasal sinuses. Laryngoscope 2011;121:S234-4.
94. Kim M, Provias J, Bernstein M. Rosai-Dorfman disease mimicking multiple meningioma: Case report. Neurosurgery 1995;36:1185-7.
95. Kitai R, Llena J, Hirano A, Ido K, Sato K, Kubota T. Meningeal Rosai-Dorfman disease: Report of three cases and literature review. Brain Tumor Pathol 2001;18:49-54.
96. Kitai R, Sato K, Kubota T, Kabuto M, Kawano H, Kobayashi H, *et al*. Meningeal sinus histiocytosis mimicking lymphoplasmacyte-rich meningioma. Case report. J Neurosurg 1996;84:1051-4.
97. Konca C, Özkurt ZN, Deger M, Akı Z, Yağcı M. Extranodal multifocal Rosai-Dorfman disease: Response to 2-chlorodeoxyadenosine treatment. Int J Hematol 2009;89:58-62.
98. Kong Z, Wang Y, Ma W, Cheng X. FDG PET/CT image for a Rosai-Dorfman disease with pituitary and bone involvement in a pediatric patient. Clin Nucl Med 2019;44:873-5.
99. Konishi E, Ibayashi N, Yamamoto S, Scheithauer BW. Isolated intracranial Rosai-Dorfman disease (sinus histiocytosis with massive lymphadenopathy). Am J Neuroradiol 2003;24:515-8.
100. Koot RW, Maarouf M, Hulshof MC, Voges J, Treuer H, Koedooder C, *et al*. Brachytherapy: Results of two different therapy strategies for patients with primary glioblastoma multiforme. Cancer 2000;88:2796-802.
101. Kozak B, Talbott J, Uzelac A, Rehani B. Rosai-Dorfman disease isolated to the thoracic epidural spine. J Radiol Case Rep 2015;9:6-16.
102. Krishnamoorthy V, Parmar CF, Panikar D. Isolated intracranial Rosai Dorfman disease. Neurol India 2011;59:443-6.
103. Kumar KK, Menon G, Nair S, Radhakrishnan VV. Rosai-Dorfman disease mimicking chronic subdural hematoma. J Clin Neurosci 2008;15:1293-5.
104. Kumar YA, Peng PY, Chen XC. Intracranial rosai-dorfman disease. Case Rep Radiol 2014;2014:724379.
105. Kutlubay Z, Bairamov O, Sevim A, Demirkesen C, Mat MC. Rosai-Dorfman disease: A case report with nodal and cutaneous involvement and review of the literature. Am J Dermatopathol 2014;36:353-7.
106. Lauwers GY, Perez-Atayde A, Dorfman RF, Rosai J. The digestive system manifestations of Rosai-Dorfman disease (sinus histiocytosis with massive lymphadenopathy): Review of 11 cases. Hum Pathol 2000;31:380-5.
107. Le Guenno G, Galicier L, Uro-Coste E, Petitcolin V, Rieu V, Ruivard M. Successful treatment with azathioprine of relapsing Rosai-Dorfman disease of the central nervous system. J Neurosurg 2012;117:486-9.
108. Leung JL, Cheung JY, Tan TC, Tang KW, Chan CM, Ho LC, *et al*. Carotid artery occlusion in a patient with intracranial Rosai-Dorfman disease. J Hong Kong Coll Radiol 2003;6:211-3.
109. Li Y, Sun H, Zhang Y, Liu W. Isolated intracranial Rosai-Dorfman disease presenting as mental deterioration. Clin Neurol Neurosurg 2012;114:1070-3.
110. Lima LB, Sobreira-Neto MA, Braga-Neto P, Nóbrega PR. Isolated central nervous system Rosai-Dorfman disease and breast cancer: An unusual presentation. Int J Neurosci 2019;129:393-6.
111. Löhr HF, Gödderz W, Wölfe T, Heike M, Knuth A, Meyer zum Büschenfelde KH, *et al*. Long-term survival in a patient with Rosai-Dorfman disease treated with interferon-alpha. Eur J Cancer 1995;31A:2427-8.
112. Long E, Lassalle S, Cheikh-Rouhou R, Hofman V, Lacour JP, Hofman P. Intestinal occlusion caused by Rosai-Dorfman disease mimicking colonic diverticulitis. Pathol Res Pract 2007;203:233-7.
113. Lopez P, Estes ML. Immunohistochemical characterization of the histiocytes in sinus histiocytosis with massive lymphadenopathy: Analysis of an extranodal case. Hum Pathol 1989;20:711-5.
114. Lou X, Chen Z, Wang F, Ma L. MR findings of Rosai-Dorfman disease in sellar and suprasellar region. Eur J Radiol 2012;81:1231-7.
115. Lu CH, Chang KC, Lee EJ, Chuang MT, Chang RS. Intracranial

Rosai-Dorfman disease with unusual transcranial extension. J Neuroimaging 2012;22:312-5.
116. Lu D, Estalilla OC, Manning JT, Medeiros LJ. Sinus histiocytosis with massive lymphadenopathy and malignant lymphoma involving the same lymph node: A report of four cases and review of the literature. Mod Pathol 2000;13:414-9.
117. Lu M, Guo DY. Leptomeningeal Rosai-Dorfman disease. J Neuroradiol 2010;37:196-7.
118. Lüdemann W, Banan R, Samii A, Koutzoglou M, Di Rocco C. Cerebral Rosai-Dorfman disease. Childs Nerv Syst 2015;31:529-32.
119. Lungren MP, Petrella JR, Cummings TJ, Grant GA. Isolated intracranial Rosai-Dorfman disease in a child. Am J Neuroradiol 2009;30:E148-9.
120. Luo Z, Zhang Y, Zhao P, Lu H, Yang K, Zhang Y, *et al*. Characteristics of Rosai-Dorfman disease primarily involved in the central nervous system: 3 Case reports and review of literature. World Neurosurg 2017;97:58-63.
121. Lutterbach J, Henne K, Pagenstecher A, Böhm J. Lung cancer and Rosai-Dorfman's disease. A clinicopathological study. Strahlenther Onkol 2003;179:486-92.
122. Mahzoni P, Zavareh MH, Bagheri M, Hani N, Moqtader B. Intracranial Rosai-Dorfman disease. J Res Med Sci 2012;17:304-7.
123. Maiti TK, Gangadharan J, Mahadevan A, Arivazhagan A, Chandramouli BA, Shankar SK. Rosai-Dorfman disease presenting as cervical extradural lesion: A case report with review of literature. Neurol India 2011;59:438-42.
124. Maklad AM, Bayoumi Y, Tunio M, Alshakweer W, Dahar MA, Akbar SA. Steroid-resistant extranodal rosai-dorfman disease of cheek mass and ptosis treated with radiation therapy. Case Rep Hematol 2013;2013:428297.
125. Maric I, Pittaluga S, Dale JK, Niemela JE, Delsol G, Diment J, *et al*. Histologic features of sinus histiocytosis with massive lymphadenopathy in patients with autoimmune lymphoproliferative syndrome. Am J Surg Pathol 2005;29:903-11.
126. McPherson CM, Brown J, Kim AW, Demonte F. Regression of intracranial Rosai-Dorfman disease following corticosteroid therapy: Case report. J Neurosurg 2006;104:840-4.
127. Miletic H, Röhling R, Stenzel W, Deckert M, Benz-Bohm G, Berthold F, *et al*. 8-year-old child with a lesion in the left nucleus lentiformis. Brain Pathol 2008;18:598-601.
128. Mir R, Aftalion B, Kahn LB. Sinus histiocytosis with massive lymphadenopathy and unusual extranodal manifestations. Arch Pathol Lab Med 1985;109:867-70.
129. Mirra SS, Tindall SC, Check IJ, Brynes RK, Moore WW. Inflammatory meningeal masses of unexplained origin. An ultrastructural and immunological study. J Neuropathol Exp Neurol 1983;42:453-68.
130. Morandi X, Godey B, Riffaud L, Heresbach N, Brassier G. Isolated Rosai-Dorfman disease of the fourth ventricle. Case illustration. J Neurosurg 2000;92:890.
131. Morgan N V, Morris MR, Cangul H, Gleeson D, Straatman-Iwanowska A, Davies N, *et al*. Mutations in SLC29A3, encoding an equilibrative nucleoside transporter ENT3, cause a familial histiocytosis syndrome (Faisalabad histiocytosis) and familial Rosai-Dorfman disease. PLoS Genet 2010;6:e1000833.
132. Nalini A, Jitender S, Anantaram G, Santosh V. Rosai Dorfman disease: Case with extensive dural involvement and cerebrospinal fluid pleocytosis. J Neurol Sci 2012;314:152-4.
133. Nassif S, Boulos F. Extranodal (dural) Rosai-Dorfman disease radiologically and histologically mimicking meningioma: A case report. Anal Quant Cytopathol Histopathol 2015;37:144-6.
134. Natarajan S, Post KD, Strauchen J, Morgello S. Primary intracerebral rosai-dorfman disease: A case report. J Neurooncol 2000;47:73-7.
135. Ng HK, Poon WS. Sinus histiocytosis with massive lymphadenopathy localized to the sella. Br J Neurosurg 1995;9:551-5.
136. O'Malley DP, Duong A, Barry TS, Chen S, Hibbard MK, Ferry JA, *et al*. Co-occurrence of Langerhans cell histiocytosis and Rosai-Dorfman disease: Possible relationship of two histiocytic disorders in rare cases. Mod Pathol 2010;23:1616-23.
137. Olsen EA, Crawford JR, Vollmer RT. Sinus histiocytosis with massive lymphadenopathy. Case report and review of a multisystemic disease with cutaneous infiltrates. J Am Acad Dermatol 1988;18:1322-32.
138. Osenbach RK. Isolated extranodal sinus histiocytosis presenting as an intramedullary spinal cord tumor with paraplegia. Case report. J Neurosurg 1996;85:692-6.
139. Panicker NK, Sabhikhi AK, Rai R. Rosai-Dorfman disease presenting as a meningioma. Indian J Cancer 1996;33:192-4.
140. Parmar V, Seward C, Huho A, Qian J, Gandhi R, Pilitsis JG. Rosai-Dorfman disease presenting as cervical radiculopathy. Clin Neurol Neurosurg 2013;115:808-10.
141. Patwardhan PP, Goel NA. Isolated intraventricular Rosai-Dorfman disease. Asian J Neurosurg 2018;13:1285-7.
142. Petzold A, Thom M, Powell M, Plant GT. Relapsing intracranial Rosai-Dorfman disease. J Neurol Neurosurg Psychiatry 2001;71:538-41.
143. Pinkawa M, Fischedick K, Piroth MD, Gagel B, Borchers H, Jakse G, *et al*. Health-related quality of life after permanent interstitial brachytherapy for prostate cancer: Correlation with postimplant CT scan parameters. Strahlenther Onkol 2006;182:660-5.
144. Prayson RA, Rowe JJ. Dural-based Rosai-Dorfman disease: Differential diagnostic considerations. J Clin Neurosci 2014;21:1872-3.
145. Pulsoni A, Anghel G, Falcucci P, Matera R, Pescarmona E, Ribersani M, *et al*. Treatment of sinus histiocytosis with massive lymphadenopathy (Rosai-Dorfman disease): Report of a case and literature review. Am J Hematol 2002;69:67-71.
146. Purav P, Ganapathy K, Mallikarjuna VS, Annapurneswari S, Kalyanaraman S, Reginald J, *et al*. Rosai-Dorfman disease of the central nervous system. J Clin Neurosci 2005;12:656-9.
147. Qin G, Ye J, Lan S, Liang Y, Xu P, Tang X, *et al*. Rosai-Dorfman disease with spinal and multiple intracranial involvement: A case report and literature review. Br J Neurosurg 2019;18:1-5.
148. Ramos AA, Vega MA, Alles JV, Garcia MJ, Martínez AM. Multiple involvement of the central nervous system in Rosai-Dorfman disease. Pediatr Neurol 2012;46:54-6.
149. Raslan O, Ketonen LM, Fuller GN, Schellingerhout D. Intracranial Rosai-Dorfman disease with relapsing spinal lesions. J Clin Oncol 2008;26:3087-9.
150. Raslan OA, Schellingerhout D, Fuller GN, Ketonen LM. Rosai-

Dorfman disease in neuroradiology: Imaging findings in a series of 10 patients. AJR Am J Roentgenol 2011;196:W187-93.
151. Resnick DK, Johnson BL, Lovely TJ. Rosai-Dorfman disease presenting with multiple orbital and intracranial masses. Acta Neuropathol 1996;91:554-7.
152. Richardson TE, Wachsmann M, Oliver D, Abedin Z, Ye D, Burns DK, *et al*. BRAF mutation leading to central nervous system rosai-dorfman disease. Ann Neurol 2018;84:147-52.
153. Rivera D, Pérez-Castillo M, Fernández B, Stoeter P. Long-term follow-up in two cases of intracranial Rosai-Dorfman Disease complicated by incomplete resection and recurrence. Surg Neurol Int 2014;5:30.
154. Rocha-Maguey J, Felix-Torrontegui JA, Cabrera-López M, Gutiérrez-Castro M, Montante-Montes de Oca D. A new case of cervical intramedullary sinus histiocytosis causing paraplegia and review of the literature. Surg Neurol Int 2016;7:9.
155. Rosai J, Dorfman RF. Sinus histiocytosis with massive lymphadenopathy. A newly recognized benign clinicopathological entity. Arch Pathol 1969;87:63-70.
156. Rosai J. Rosai and Ackerman's Surgical Pathology. 10th ed. New York: Elsevier Health Sciences; 2011.
157. Rotondo F, Munoz DG, Hegele RG, Gray B, Khatun N, Bonert M, *et al*. Rosai-Dorfman disease involving the neurohypophysis. Pituitary 2010;13:256-9.
158. Russo N, Giangaspero F, Beccaglia MR, Santoro A. Intracranial dural histiocytosis. Br J Neurosurg 2009;23:449-54.
159. Said R, Abi-Fadel F, Talwar J, Attallah JP, Dilawari A. Intracranial rosai-dorfman: A clinical challenge. Neurologist 2011;17:117-9.
160. Sakai K, Koike G, Seguchi K, Nakazato Y. Sinus histiocytosis with massive lymphadenopathy: A case of multiple dural involvement. Brain Tumor Pathol 1998;15:63-9.
161. Sandoval-Sus JD, Sandoval-Leon AC, Chapman JR, Velazquez-Vega J, Borja MJ, Rosenberg S, *et al*. Rosai-Dorfman disease of the central nervous system: Report of 6 cases and review of the literature. Medicine (Baltimore) 2014;93:165-75.
162. Sasaki K, Pemmaraju N, Westin JR, Wang WL, Khoury JD, Podoloff DA, *et al*. A single case of rosai-dorfman disease marked by pathologic fractures, kidney failure, and liver cirrhosis treated with single-agent cladribine. Front Oncol 2014;4:297.
163. Sato A, Sakurada K, Sonoda Y, Saito S, Kayama T, Jokura H, *et al*. Rosai-Dorfman disease presenting with multiple intracranial and intraspinal masses: A case report. No Shinkei Geka 2003;31:1199-204.
164. Schmidt S, Eich G, Hanquinet S, Tschäppeler H, Waibel P, Gudinchet F. Extra-osseous involvement of Langerhans' cell histiocytosis in children. Pediatr Radiol 2004;34:313-21.
165. Scumpia AJ, Frederic J-A, Cohen AJ, Bania M, Hameed A, Xiao PQ. Isolated intracranial Rosai-Dorfman disease with orbital extension. J Clin Neurosci 2009;16:1108-9.
166. Seyednejad F, Tubbs RS, Shoja MM, Daghigi MH, Oakes WJ. Presumed recurrence of intracranial Rosai-Dorfman disease as a cervical spine tumor. Acta Neurochir (Wien) 2007;149:425-7.
167. Shah V, Mohyeldin A, London NR, Fritz J, Prevedello DM, Carrau RL, *et al*. When a meningioma isn't: Endoscopic endonasal orbital decompression and biopsy of skull base Rosai-Dorfman disease treated previously with empiric radiation therapy. World Neurosurg 2020;135:141-5.
168. Shaver EG, Rebsamen SL, Yachnis AT, Sutton LN. Isolated extranodal intracranial sinus histiocytosis in a 5-year-old boy. Case report. J Neurosurg 1993;79:769-73.
169. Shuangshoti SS, Navalitloha Y, Sukpanichnant S, Unhasuta C, Shuangshoti S. Central nervous system involvement in Rosai-Dorfman disease: Report of a case with a review of the literature. Neuropathology 1999;19:341-6.
170. Siadati A, Powell SZ, Shahab I, Valadka AB, Parker JR. Pathologic quiz case: A 48 year-old woman with a dural-based intracranial tumor. Arch Pathol Lab Med 2001;125:1115-6.
171. Simos M, Dimitrios P, Philip T. A new clinical entity mimicking meningioma diagnosed pathologically as rosai-dorfman disease. Skull Base Surg 1998;8:87-92.
172. Siu RCH, Tan IL, Davidson AS, Robertson A, Fraser CL. Clinical Reasoning: Compressive optic neuropathy secondary to intracranial Rosai-Dorfman disease. Neurology 2015;85:e89-92.
173. Song SK, Schwartz IS, Strauchen JA, Huang YP, Sachdev V, Daftary DR, *et al*. Meningeal nodules with features of extranodal sinus histiocytosis with massive lymphadenopathy. Am J Surg Pathol 1989;13:406-12.
174. Sundaram C, Uppin SG, Prasad BC, Sahu BP, Devi MU, Prasad VS, *et al*. Isolated Rosai Dorfman disease of the central nervous system presenting as dural-based and intraparenchymal lesions. Clin Neuropathol 2005;24:112-7.
175. Symss NP, Cugati G, Vasudevan MC, Ramamurthi R, Pande A. Intracranial Rosai Dorfman disease: Report of three cases and literature review. Asian J Neurosurg 2010;5:19-30.
176. Tamrazi B, Shiroishi MS, Liu CS. Advanced imaging of intracranial meningiomas. Neurosurg Clin 2016;27:137-43.
177. Tan S, Ruan L, Jin K, Wang F, Mou J, Huang H, *et al*. Systemic Rosai-Dorfman disease with central nervous system involvement. Int J Neurosci 2018;128:192-7.
178. Tanboon J, Chaipipat M, Wattanasirmkit V, Wongtabtim W, Shuangshoti S, Bunyaratavej K. Squash cytology of Rosai-Dorfman disease in the sellar region. Acta Cytol 2003;47:1143-4.
179. Tasso M, Esquembre C, Blanco E, Moscardo C, Niveiro M, Paya A. Sinus histiocytosis with massive lymphadenopathy (Rosai-Dorfman disease) treated with 2-chlorodeoxyadenosine. Pediatr Blood Cancer 2006;47:612-5.
180. Taufiq M, Khair A, Begum F, Akhter S, Shamim Farooq M, Kamal M. Isolated intracranial Rosai-Dorfman disease. Case Rep Neurol Med 2016;2016:1972594.
181. Tauziede-Espariat A, Polivka M, Chabriat H, Bouazza S, Sene D, Adle-Biassette H. A case report of meningeal Rosai-Dorfman disease associated with IgG4-related disease. Clin Neuropathol 2015;34:343-9.
182. Tavangar SM, Mahta A, Haghpanah V, Larijani B. Extranodal Rosai-Dorfman disease involving the meninges in a 79-year-old man. Ann Saudi Med 2006;26:474-6.
183. Theeler BJ, Keylock JB, Yoest SM. Teaching NeuroImage: Isolated intracranial Rosai-Dorfman disease mimicking a meningioma. Neurology 2008;70:e42.
184. Tian Y, Wang J, Ge J zhao, Ma Z, Ge M. Intracranial Rosai-Dorfman disease mimicking multiple meningiomas in a child: A case report and review of the literature. Child's Nerv Syst 2015;31:317-23.

185. Tian Y, Wang J, Li M, Lin S, Wang G, Wu Z, *et al*. Rosai-Dorfman disease involving the central nervous system: Seven cases from one institute. Acta Neurochir (Wien) 2015;157:1565-71.
186. Toguri D, Louie A V, Rizkalla K, Franklin J, Rodrigues G, Venkatesan V. Radiotherapy for steroid-resistant laryngeal Rosai-Dorfman disease. Curr Oncol 2011;18:e158-62.
187. Toh CH, Chen YL, Wong HF, Wei KC, Ng SH, Wan YL. Rosai-Dorfman disease with dural sinus invasion. Report of two cases. J Neurosurg 2005;102:550-4.
188. Tomio R, Katayama M, Takenaka N, Imanishi T. Complications of surgical treatment of Rosai-Dorfman disease: A case report and review. Surg Neurol Int 2012;3:1.
189. Triana-Pérez AB, Sánchez-Medina Y, Rosario PD, Millán-Corada AM, Gómez-Perals LF, Domínguez-Báez JJ. Enfermedad de Rosai-Dorfman intracraneal: Presentación de un caso y revisión de la literatura. Neurocirugia 2011;22:255-60.
190. Tripathi R, Serajee F, Jiang H, Huq AH. Novel presentation of Rosai-Dorfman histiocytosis with a prolonged course of cranial and peripheral neuropathies. Pediatr Neurol 2017;71:70-2.
191. Trudel M. Dural involvement in sinus histiocytosis with massive lymphadenopathy. Case report. J Neurosurg 1984;60:850-2.
192. Tselis N, Kolotas C, Birn G, Röddiger S, Filipowicz I, Kontova M, *et al*. CT-guided interstitial HDR brachytherapy for recurrent glioblastoma multiforme. Long-term results. Strahlenther Onkol 2007;183:563-70.
193. Tu J, Li WT, Yang C. Rosai-Dorfman disease of the subdural spine with a long segment lesion: A case report and literature review. J Int Med Res 2017;45:875-81.
194. Tubbs RS, Kelly DR, Mroczek-Musulman EC, Hammers YA, Berkow RL, Oakes WJ, *et al*. Spinal cord compression as a result of Rosai-Dorfman disease of the upper cervical spine in a child. Childs Nerv Syst 2005;21:951-4.
195. Türe U, Seker A, Bozkurt SU, Uneri C, Sav A, Pamir MN. Giant intracranial Rosai-Dorfman disease. J Clin Neurosci 2004;11:563-6.
196. Udono H, Fukuyama K, Okamoto H, Tabuchi K. Rosai-Dorfman disease presenting multiple intracranial lesions with unique findings on magnetic resonance imaging. Case report. J Neurosurg 1999;91:335-9.
197. Vaiselbuh SR, Bryceson YT, Allen CE, Whitlock JA, Abla O. Updates on histiocytic disorders. Pediatr Blood Cancer 2014;61:1329-35.
198. Varan A, Şen H, Akalan N, Oğuz KK, Sağlam A, Akyüz C. Pontine Rosai-Dorfman disease in a child. Childs Nerv Syst 2015;31:971-5.
199. Varrassi M, Corridore A, Tommasino E, Giorgia S, Bruno F, Di Sibio A, *et al*. MR imaging of cerebral involvement of Rosai-Dorfman disease: A single-centre experience with review of the literature. Radiol Med 2021;126:89-98.
200. Walker RN, Nickles TP, Lountzis NI, Jacobs DL, Nawaz NK. Rosai-Dorfman disease with massive intracranial involvement: Asymmetric response to conservative therapy. J Neuroimaging 2011;21:194-6.
201. Wang C, Kuang P, Xu F, Hu L. Intracranial Rosai-Dorfman disease with the petroclival and parasellar involvement mimicking multiple meningiomas: A case report and review of literature. Medicine (Baltimore) 2019;98:e15548.
202. Wang E, Anzai Y, Paulino A, Wong J. Rosai-Dorfman disease presenting with isolated bilateral orbital masses: report of two cases. AJNR Am J Neuroradiol 2001;22:1386-8.
203. Wang Y, Gao X, Tang W, Jiang C. Rosai-Dorfman disease isolated to the central nervous system: A report of six cases. Neuropathology 2010;30:154-8.
204. Warrier R, Chauhan A, Jewan Y, Bansal S, Craver R. Rosai-Dorfman disease with central nervous system involvement. Clin Adv Hematol Oncol 2012;10:196-8.
205. Wen JH, Wang C, Jin YY, Xu D, Jiang B, He XJ, *et al*. Radiological and clinical findings of isolated meningeal Rosai-Dorfman disease of the central nervous system. Medicine (Baltimore) 2019;98:e15365.
206. Woodcock RJ, Mandell JW, Lipper MH. Sinus histiocytosis (Rosai-Dorfman disease) of the suprasellar region: MR imaging findings--a case report. Radiology 1999;213:808-10.
207. Wrzolek MA, Zagzag D. May 2002: 38-year-old man and 69-year-old woman with dural based masses. Brain Pathol 2002;12:517-8.
208. Wu L, Xu Y. Rosai-Dorfman disease: A rare lesion with dura tail sign mimicking spinal meningioma. Spine J 2014;14:3058-9.
209. Wu M, Anderson AE, Kahn LB. A report of intracranial Rosai-Dorfman disease with literature review. Ann Diagn Pathol 2001;5:96-102.
210. XiaoWen D, XueBin X, YuQing Y, Ting L. Intracranial Rosai-Dorfman disease: Case report and literature review. Eur J Radiol Extra 2010;76:e75-8.
211. Xie Y, Pittaluga S, Price S, Raffeld M, Hahn J, Jaffe ES, *et al*. Bone marrow findings in autoimmune lymphoproliferative syndrome with germline FAS mutation. Haematologica 2017;102:364-72.
212. Yang X, Liu J, Ren Y, Richard SA, Zhang Y. Isolated intracranial Rosai-Dorfman disease mimicking petroclival meningioma in a child. Medicine (Baltimore) 2017;96:e8754.
213. Yao K, Li TF, Zhu MW, Duan ZJ, Hu ZL, Bian Y, *et al*. An intramedullary cervical cord lesion in a 12-year-old girl. Neuropathology 2013;33:582-5.
214. Yetiser S, Cekin E, Tosun F, Yildirim A. Rosai-Dorfman disease associated with neurosensorial hearing loss in two siblings. Int J Pediatr Otorhinolaryngol 2004;68:1095-100.
215. Z'Graggen WJ, Sturzenegger M, Mariani L, Keserue B, Kappeler A, Vajtai I. Isolated Rosai-Dorfman disease of intracranial meninges. Pathol Res Pract 2006;202:165-70.
216. Zhang H, Rödiger LA, Shen T, Miao J, Oudkerk M. Perfusion MR imaging for differentiation of benign and malignant meningiomas. Neuroradiology 2008;50:525-30.
217. Zhang JT, Tian HJ, Lang SY, Wang XQ. Primary intracerebral Rosai-Dorfman disease. J Clin Neurosci 2010;17:1286-8.
218. Zhang S, Huang J, Chen Y. Primary isolated intracranial Rosai-Dorfman disease: Report of a rare case and review of the literature. Neurol Neurochir Pol 2018;52:390-3.
219. Zhang TT, Fu YJ, Piao YS, Liu GZ, Wang LM, Chen SY, *et al*. 43 year old woman with left arm paralysis. Brain Pathol 2018;28:1021-2.

220. Zhu F, Zhang J, Xing X, Wang D, Zhu R, Zhang Q, *et al*. Rosai-Dorfman disease: A retrospective analysis of 13 cases. Am J Med Sci 2013;345:200-10.
221. Zhu H, Qiu LH, Dou YF, Wu JS, Zhong P, Jiang CC, *et al*. Imaging characteristics of Rosai-Dorfman disease in the central nervous system. Eur J Radiol 2012;81:1265-72.
222. Ziemlewski A, Zienkiewicz J, Serkies K, Badzio A. Preliminary report of pulsed dose rate brachytherapy in head-and-neck cancer. Strahlenther Onkol 2007;183:512-6.

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