

Neurosurgical Techniques

A multimodal staged approach for the resection of a Sylvian aqueduct rosette-forming glioneuronal tumor: A case report and literature review

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A B S T R A C T

Background and importance: The rosette-forming glioneuronal tumor (RGNT) is a rare central nervous system tumor which often arises intraventricularly. We report the first surgical case of an RGNT arising from the Sylvian aqueduct treated through a double approach.

Clinical presentation: A 25-year-old female presented with triventricular hydrocephalus on MRI secondary to a 2 cm Sylvian aqueduct mass. Emergent endoscopic third ventriculostomy with biopsy confirmed the diagnosis of RGNT. She was first followed up and due to the rapid tumor's growth a double surgical approach was proposed. The first was a telo-velar approach to the lower third of the aqueduct. The second stage was an endoscopic ultrasound aspirator aided transfrontal transforaminal approach; last postoperative MRI shows a 6 mm residual tumor. Patient leads an active working and social life.

Conclusion: Choosing a two stages approach for this rare and complex Sylvian aqueduct RGNT resulted in a positive clinical and radiological outcome.

1. Introduction

The rosette-forming glioneuronal tumor (RGNT) is a central nervous system lesion that has been considered an independent entity since 2007 and is included as a “neuronal and mixed neuronal-glia tumor” in the World Health Organization (WHO) classification system of 2016. RGNT shows a relatively well-defined tumor parenchyma interface and is composed of biphasic neurocytic and glial components. The tumor can arise in various sites of the brain but an intraventricular origin is most frequent [1]. Only one non-operative case has been previously reported originating from the Sylvian aqueduct [2]. Here, we describe the rare case of RGNT arising in the Sylvian aqueduct in whom we performed a biportal approach. Along with the surgical technique description and the clinical and radiological peculiarities, we also report a detailed literature review on the topic.

2. Clinical presentation

A 25-year-old female came to our attention in January 2012 with a three-month history of blurred vision. The neuro-ophthalmological examination demonstrated papilledema, and an emergent MRI showed a triventricular hydrocephalus due to the presence of a Sylvian aqueduct mass (Fig. 1A and B).

The patient underwent emergent endoscopic third ventriculostomy (ETV) with biopsy. Histology documented a low grade glioneuronal proliferation with immunophenotypic positivity for GFAP and synaptophysins, confirming the diagnosis of a RGNT (Fig. 2). Watchful waiting was then performed to determine the tumor growth rate. At 6 and 12 months, no signal changes or volume increases were detected (Fig. 3). The patient was then lost to follow-up until she returned to our Institution in September 2015. At that time, an MRI performed in another institution demonstrated a clear increase in the tumor volume (Fig. 4).

Considering the fusiform morphology and the complex location of the lesion a biportal-combined approach was planned. In December 2016, the patient underwent the first surgical step through a telo-velar approach to the aqueduct. Postoperatively, the patient suffered intense nausea and occipital headaches for two weeks. A new MRI demonstrated the residue and obstructive hydrocephalus due to basal adhesive meningitis (Fig. 5A and B). The patient underwent placement of a ventriculoperitoneal shunt (VPS). CSF samples excluded bacterial infection. Subsequently, she recovered very well and regained an independent life.

The second surgical step consisted in an endoscopic transfrontal transforaminal approach to the Sylvian aqueduct. The post-operative MRI in May 2017 showed an estimated 6 mm of residual tissue (Fig. 6).

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<https://doi.org/10.1016/j.inat.2018.05.018>

Received 16 February 2018; Received in revised form 22 May 2018; Accepted 28 May 2018

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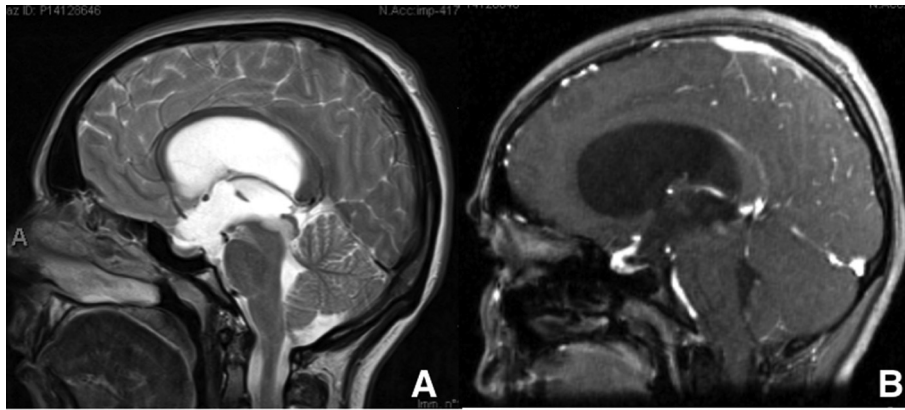


Fig. 1. A) T2 TSE MRI at admission showing a triventricular hydrocephalus associated to a hyperintense mass completely occluding the Sylvian aqueduct. B) Contrast enhanced T1 displays a faint circular spot of gadolinium in the upper pole of the mass.

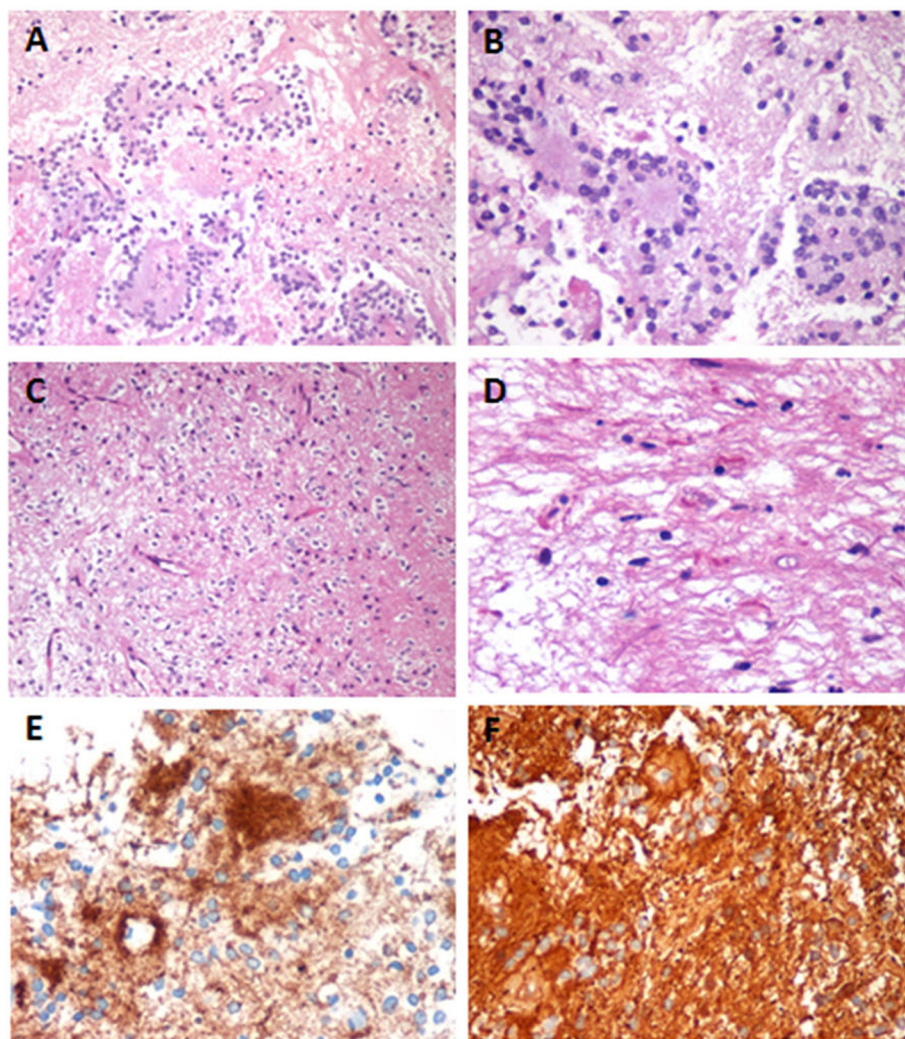


Fig. 2. Histologic features of the Rosette Forming Glioneuronal Tumor of the IV ventricle. At low power magnification the tumor shows typical well-formed rosettes and perivascular pseudo-rosettes (A) composed of cell with neurocytic features and dispersed in a fibrillary background. At higher magnification (B) tumor shows also true rosettes with a neuropil core. Area of rounded oligodendrocyte-like cells (C) and an astrocytic component reminiscent of pilocytic astrocytoma with Rosenthal fibers are also present (D).

A–D, H&E, 20 \times and 40 \times original magnification; E–F, synaptophysin and GFAP immunostaining, 40 \times original magnification.

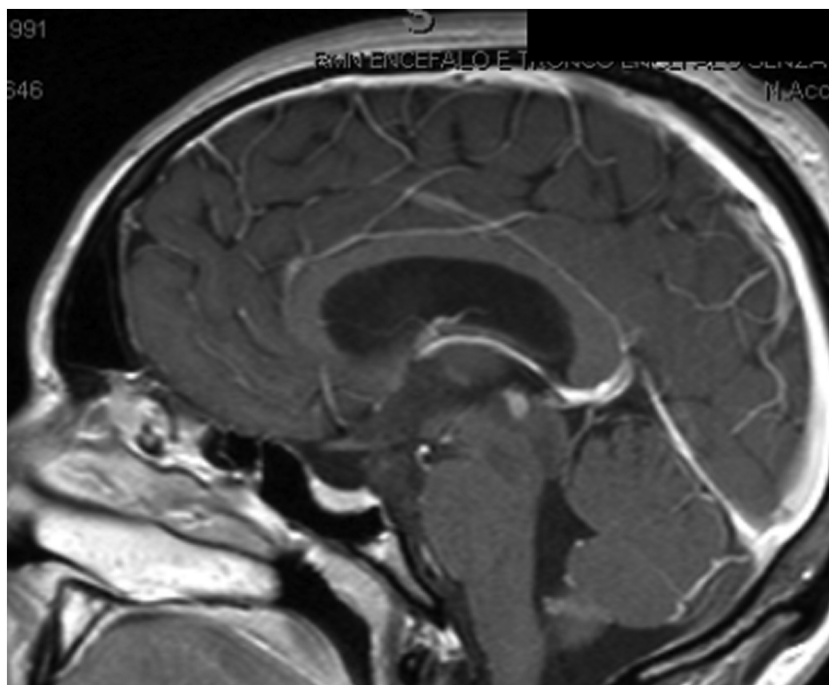


Fig. 3. 12 months postoperative MRI showing stable volume and signal with complete resolution of the hydrocephalus.

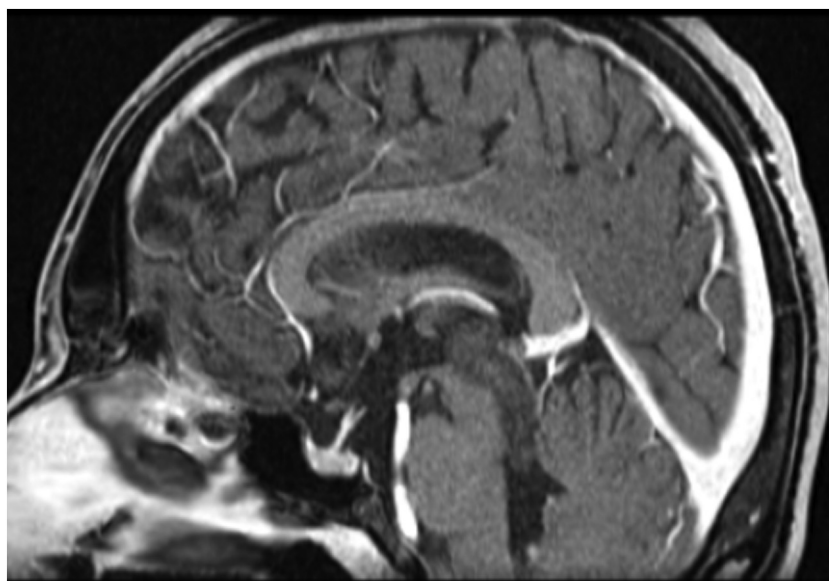


Fig. 4. Three year later MRI demonstrated a more than evident volume increase (from 20 mm to 37 mm in longer diameter). Interestingly contrast enhancement was no longer visible.

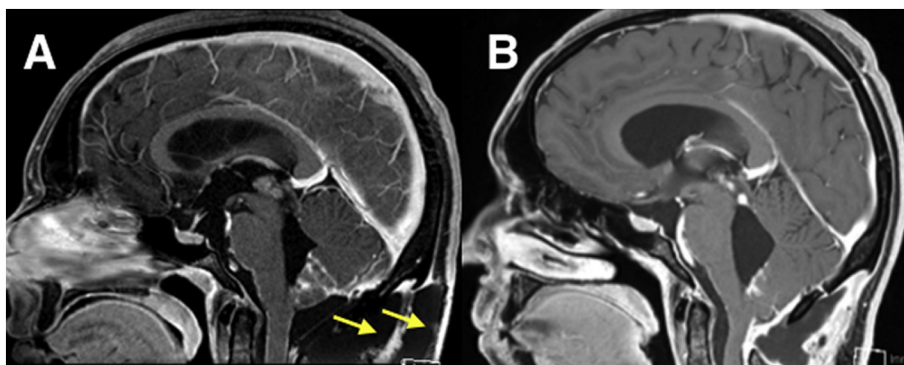


Fig. 5. A) Post contrast T1 MRI showing resection of the inferior half of the tumor. Note the large pseudomeningocele (yellow arrows) and the contrast uptake at the level of the basal cisterns as for an adhesive meningitis. B) Three months MRI control demonstrates the partial resolution of the pseudomeningocele. Of note, the residual tumor displayed modification of contrast uptake. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

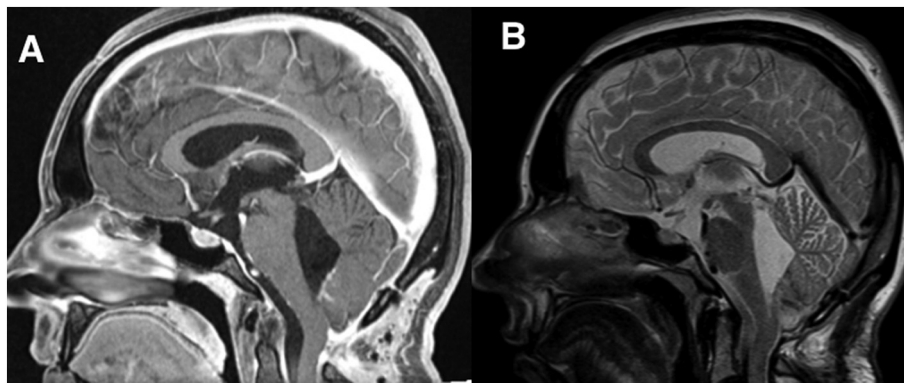


Fig. 6. Post contrast MRI 3 months postoperatively T1-WI with Gadolinium (A) and T2-WI (B). The upper third of the tumor popping up into the third ventricle has been removed. Residue occluding the aqueduct was estimated about 6 mm in maximum diameter.

The patient totally recovered her daily activities life, even though she reports having double vision.

3. Surgical notes (see video for details)

For the telovelar approach, the patient was placed in the prone position with the head flexed in a three pin-headrest. An incision was made in the midline, 2 to 3 cm above the external occipital protuberance, and extending to C3. The occipital bone, the posterior arch of the atlas, the upper cervical lamina and the spinous process of C2 were exposed. Then, a suboccipital craniotomy and a posterior laminectomy of C1 were performed. After wide dissection of the arachnoid of cisterna magna, the tela choroidea was exposed and cut bilaterally; tonsils and vermis were carefully retracted to expose the floor of the fourth ventricle and the caudal part of the tumor arising from the aqueduct. The most exophytic portion was removed with grasping forceps. Using an endoscope-assisted technique and an endoscopic ultrasound aspirator, the most intra-aqueductal part of the tumor corresponding to its inferior third was removed.

For the transfrontal-transforaminal approach, a neuronavigation system was used to access the right lateral ventricle and identify the foramen of Monro through an anterior frontal burr hole. At the most posterior border of the third ventricle, the vegetating mass completely hidden the aqueduct. Resection was pursued by both endoscopic grasping forceps and the ultrasound aspirator. Total tumor resection and aqueductoplasty was tried and ultimately abandoned due to neoplastic infiltration and the tissue's consistency.

4. Discussion

RGNT is a rare central nervous system tumor that was first included as a grade I independent entity by the WHO in 2007. It affects predominantly older children and young adults with a female prevalence. Histologically, this slow-growing lesion is comprised of a glial component, whose morphology similar to a pilocytic astrocytoma, and a neurocytic component, which forms neurocytic rosettes and/or perivascular pseudorosettes. There are cases of mixed RGNT/DNET as well [3]. Molecular aspects of RGNT have been investigated, and genetic mutations in PIK3CA and FGFR1 genes and an association with neurofibromatosis type 1 have been found [4]. Radiologically, these lesions are heterogeneous, showing calcified, nodular and cystic components. They appear hypointense on T1- and iso/hyperintense on T2-weighted MRI sequences; contrast enhancement is variable. Peculiar biological features underlying neuroradiological changes with RGNTs have already been observed by Mattogno et al., who documented spontaneous regression likely due to intervening ischemia [5].

The first of approximately one-hundred cases in the literature, was described by Komori et al. in 1998 [6]. Thirty-four RGNTs originated

from the fourth ventricle and only one from the Sylvian aqueduct and reported only post-mortem information [7]. The current case is, to the best of our knowledge, the only such surgical case [8–56].

In cases of Sylvian aqueduct tumors, the primary goal of surgery is to treat the obstructive hydrocephalus, perform a biopsy or, when feasible, remove the tumor. Different techniques have been used to approach the aqueduct and all depend upon the volume and location of the tumor. The endoscopic transfrontal approach is one technique that has proven to be successful, especially in the case of lesions that extend into the upper part of the aqueduct. This technique presents some disadvantages however, such as the suboptimal trajectory to the aqueduct and the necessity of crossing the frontal cerebral parenchyma [57,58]. In our case, we planned to create a communication through the aqueduct, but we soon realized that penetration through the tumor carried a high risk of causing midbrain damage. An alternative is represented by the trans-fourth ventricle route through a telo-velar approach. This technique favors a straight trajectory to the aqueduct, which lies parallel to the floor of the fourth ventricle, and a direct visualization of lesions located in or extending into the lower part of the aqueduct [59]. The application of endoscope and endoscopic ultrasound aspirator in both surgical procedures speeded up the tumor resection; however, the tightness of the aqueduct and the surrounding critical structures, made too risky to push forward the endoscopic ultrasound aspirator.

5. Conclusions

The RGNT is a rare and distinct tumor of the glioneuronal family, classified as WHO grade I. When symptomatic tumors are located in the Sylvian aqueduct, the optimal therapy should be surgery, but it is important to provide the patient with the best and safest approach. Surgery should not only have the goal of confirming diagnosis and removing as much tumor as possible, but also treating hydrocephalus. Certain locations require carefully planning of the surgical strategy, specifically regarding the route to the tumors that may need to be multiple, as in the current case. To the best of our knowledge, this is the first documented case of resection through a biportal approach, which allowed a positive clinical and radiological outcome.

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.inat.2018.05.018>.

Disclosure

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

Acknowledgements

Nothing to declare.

Conflict of interest

None.

References

- [1] S. Feiden, W. Feiden, WHO classification of tumours of the CNS: revised edition of 2007 with critical comments on the typing and grading of common-type diffuse gliomas, *Pathologie* 29 (6) (2008) 411–421.
- [2] J. Roth, K.L. Chaichana, G. Jallo, G. Miron, G. Cinalli, S. Constantini, True aqueductal tumors: a unique entity, *Acta Neurochir.* 157 (2) (2015) 169–177.
- [3] P.G. Eye, L. Davidson, P.J. Malafronte, S. Cantrell, B.J. Theeler, PIK3CA mutation in a mixed dysembryoplastic neuroepithelial tumor and rosette forming glioneuronal tumor, a case report and literature review, *J. Neurol. Sci.* 373 (2017) 280–284.
- [4] E.P. Sieg, R. Payne, S. Langan, C.S. Specht, Case report: a rosette-forming glioneuronal tumor in the tectal plate in a patient with neurofibromatosis type I, *Cureus* 8 (11) (2016) e857.
- [5] P.P. Mattogno, P. Frassanito, L. Massimi, et al., Spontaneous regression of pineal lesions: ghost tumor or pineal apoplexy? *World Neurosurg.* 88 (2016) 64–69.
- [6] T. Komori, B.W. Scheithauer, D.C. Anthony, et al., Papillary glioneuronal tumor: a new variant of mixed neuronal-glial neoplasm, *Am. J. Surg. Pathol.* 22 (10) (1998) 1171–1183.
- [7] N. Matsumura, Y. Wang, Y. Nakazato, Coexpression of glial and neuronal markers in the neurocytic rosettes of rosette-forming glioneuronal tumors, *Brain Tumor Pathol.* 31 (1) (2014) 17–22.
- [8] H. Cebula, S. Chibbaro, M.N. Santin, S. Kremer, D. Chaussemy, F. Proust, Thalamic rosette-forming a glioneuronal tumor in an elderly patient: case report and literature review, *Neurochirurgie* 62 (1) (2016) 60–63.
- [9] P.A. Beuriat, A. Tauziède-Espariat, M. Pages, P. Varlet, F. Di Rocco, Rosette-forming glioneuronal tumor outside the fourth ventricle: a case-based update, *Childs Nerv. Syst.* 32 (1) (2016) 65–68.
- [10] L.T. Bidinotto, C. Scapulatempo-Neto, A. Mackay, et al., Molecular profiling of a rare rosette-forming glioneuronal tumor arising in the spinal cord, *PLoS One* 10 (9) (2015) e0137690.
- [11] C. Dunham, Uncommon pediatric tumors of the posterior fossa: pathologic and molecular features, *Childs Nerv. Syst.* 31 (10) (2015) 1729–1737.
- [12] M. Nagaiishi, S. Nobusawa, N. Matsumura, et al., SLC44A1-PRKCA fusion in papillary and rosette-forming glioneuronal tumors, *J. Clin. Neurosci.* 23 (2016) 73–75.
- [13] T. Yamamoto, T. Matsubara, K. Satomi, et al., Rosette-forming glioneuronal tumor originating in the hypothalamus, *Brain Tumor Pathol.* 32 (4) (2015) 291–296.
- [14] G. Medhi, C. Prasad, J. Saini, et al., Imaging features of rosette-forming glioneuronal tumors (RGNTs): a series of seven cases, *Eur. Radiol.* 26 (1) (2016) 262–270.
- [15] A.R. Nair, C.V. Gopalakrishnan, T.R. Kapilamoorthy, N. Radhakrishnan, Rosette forming glioneuronal tumor of the fourth ventricle in squash cytology smear, *J. Cytol.* 31 (4) (2014) 215–217.
- [16] K.S. Allinson, D.G. O'Donovan, R. Jena, J.J. Cross, T.S. Santarius, Rosette-forming glioneuronal tumor with dissemination throughout the ventricular system: a case report, *Clin. Neuropathol.* 34 (2) (2015) 64–69.
- [17] A. Schlamann, A.O. von Bueren, C. Hagem, et al., An individual patient data meta-analysis on characteristics and outcome of patients with papillary glioneuronal tumor, rosette glioneuronal tumor with neuropil-like islands and rosette forming glioneuronal tumor of the fourth ventricle, *PLoS One* 9 (7) (2014) e101211.
- [18] S. García Cabezas, R. Serrano Blanch, R. Sanchez-Sanchez, Eito A. Palacios, Rosette-forming glioneuronal tumour (RGNT) of the fourth ventricle: a highly aggressive case, *Brain Tumor Pathol.* 32 (2) (2015) 124–130.
- [19] M. Gessi, Y.A. Moneim, J. Hammes, et al., FGFR1 mutations in rosette-forming glioneuronal tumors of the fourth ventricle, *J. Neuropathol. Exp. Neurol.* 73 (6) (2014) 580–584.
- [20] E. Matyja, W. Grajkowska, P. Kunert, A. Marchel, A peculiar histopathological form of dysembryoplastic neuroepithelial tumor with separated pilocytic astrocytoma and rosette-forming glioneuronal tumor components, *Neuropathology* 34 (5) (2014) 491–498.
- [21] K. Chiba, Y. Aihara, S. Eguchi, M. Tanaka, T. Komori, Y. Okada, Rosette-forming glioneuronal tumor of the fourth ventricle with neurocytoma component, *Childs Nerv. Syst.* 30 (2) (2014) 351–356, <https://doi.org/10.1007/s00381-013-2216-3>.
- [22] F. Thommen, E. Hewer, S.C. Schäfer, E. Vassella, A. Kappeler, I. Vajtai, Rosette-forming glioneuronal tumor of the cerebellum in statu nascendi: an incidentally detected diminutive example indicates derivation from the internal granule cell layer I, *Clin. Neuropathol.* 32 (5) (2013) 370–376.
- [23] J. Zhang, R. Babu, R.E. McLendon, A.H. Friedman, C. Adamson, A comprehensive analysis of 41 patients with rosette-forming glioneuronal tumors of the fourth ventricle, *J. Clin. Neurosci.* 20 (3) (2013) 335–341.
- [24] B.N. Nandeesha, M.S. Chabra, M.K. Babu, A.K. Chand, A rare posterior cranial fossa tumor, *J. Cancer Res. Ther.* 8 (4) (2012) 644–646.
- [25] R. Zanabria Ortiz, J.J. Domínguez Báez, E. Lazo Fernández, Y. Sánchez Medina, L.F. Gómez Peral, P. Pérez del Rosario, Rosette-forming glioneuronal tumor of the fourth ventricle: case report and literature review, *Neurocirugía (Astur.)* 24 (4) (2013) 172–177.
- [26] T. Hakan, F.V. Aker, Rosette-forming glioneuronal tumour of the fourth ventricle: case report and review of the literature, *Folia Neuropathol.* 54 (1) (2016) 80–87.
- [27] M. Kumar, R. Samant, R. Ramakrishnaiah, et al., Rosette-forming glioneuronal tumor of the fourth ventricle, *Radiol. Case Rep.* 8 (1) (2015) 740.
- [28] J. Xu, Y. Yang, Y. Liu, et al., Rosette-forming glioneuronal tumor in the pineal gland and the third ventricle: a case with radiological and clinical implications, *Quant. Imaging Med. Surg.* 2 (3) (2012) 227–231.
- [29] J. Xiong, L. Ding, H. Chen, H. Chen, Y. Wang, Mixed glioneuronal tumor: a dys-embryoplastic neuroepithelial tumor with rosette-forming glioneuronal tumor component, *Neuropathology* 33 (4) (2013) 431–435.
- [30] S. Chakraborti, A. Mahadevan, A. Govindan, et al., Rosette-forming glioneuronal tumor – evidence of stem cell origin with biphenotypic differentiation, *Virchows Arch.* 461 (5) (2012) 581–588.
- [31] M. Gessi, S.R. Lambert, L. Lauriola, A. Waha, V.P. Collins, T. Pietsch, Absence of KIAA1549-BRAF fusion in rosette-forming glioneuronal tumors of the fourth ventricle (RGNT), *J. Neuro-Oncol.* 110 (1) (2012) 21–25.
- [32] S. Kemp, A. Achan, T. Ng, M.A. Dexter, Rosette-forming glioneuronal tumour of the lateral ventricle in a patient with neurofibromatosis 1, *J. Clin. Neurosci.* 19 (8) (2012) 1180–1181.
- [33] C. Hsu, G. Kwan, Q. Lau, S. Bhuta, Rosette-forming glioneuronal tumour: imaging features, histopathological correlation and a comprehensive review of literature, *Br. J. Neurosurg.* 26 (5) (2012) 668–673.
- [34] J. Xiong, Y. Liu, S.G. Chu, et al., Rosette-forming glioneuronal tumor of the septum pellucidum with extension to the supratentorial ventricles: rare case with genetic analysis, *Neuropathology* 32 (3) (2012) 301–305.
- [35] Y. Fushimi, A. Miyasaki, H. Taki, et al., Rosette-forming glioneuronal tumor of the fourth ventricle with bilateral olivary degeneration, *Jpn. J. Radiol.* 29 (6) (2011) 445–448.
- [36] M. Gessi, A. Waha, P. Setty, A. Waha, T. Pietsch, Analysis of KIAA1549-BRAF fusion status in a case of rosette-forming glioneuronal tumor of the fourth ventricle (RGNT), *Neuropathology* 31 (6) (2011) 654–657.
- [37] T.N. Chandrashekar, A. Mahadevan, S. Vani, et al., Pathological spectrum of neuronal/glioneuronal tumors from a tertiary referral neurological institute, *Neuropathology* 32 (1) (2012) 1–12.
- [38] E. Matyja, W. Grajkowska, P. Nauman, A. Ozieblo, W. Bonicki, Rosette-forming glioneuronal tumor of the fourth ventricle with advanced microvascular proliferation – a case report, *Neuropathology* 31 (4) (2011) 427–432.
- [39] O.E. Solis, R.I. Mehta, A. Lai, et al., Rosette-forming glioneuronal tumor: a pineal region case with IDH1 and IDH2 mutation analyses and literature review of 43 cases, *J. Neuro-Oncol.* 102 (3) (2011) 477–484.
- [40] D. Podlesek, K. Geiger, D.J. Hendry, G. Schackert, D. Krex, Rosette-forming glioneuronal tumor of the fourth ventricle in an elderly patient, *J. Neuro-Oncol.* 103 (3) (2011) 727–731.
- [41] S. Ulivieri, G. Oliveri, A. Cerase, C. Miracco, Papillary glioneuronal tumor of the fourth ventricle: case report and review of the literature, *G Chir.* 31 (8–9) (2010) 368–370.
- [42] E. Frydenberg, R. Laherty, M. Rodriguez, M. Ow-Yang, T. Steel, A rosette-forming glioneuronal tumour of the pineal gland, *J. Clin. Neurosci.* 17 (10) (2010) 1326–1328.
- [43] A. Arai, T. Sasayama, M. Tamaki, et al., Rosette-forming glioneuronal tumor of the fourth ventricle – case report, *Neurol. Med. Chir. (Tokyo)* 50 (3) (2010) 224–228.
- [44] S. Luan, D. Zhuang, L. Sun, F.P. Huang, Rosette-forming glioneuronal tumor (RGNT) of the fourth ventricle: case report and review of literature, *Clin. Neurol. Neurosurg.* 112 (4) (2010) 362–364.
- [45] M.N. Shah, J.R. Leonard, A. Perry, Rosette-forming glioneuronal tumors of the posterior fossa, *J. Neurosurg. Pediatr.* 5 (1) (2010) 98–103.
- [46] N. Ghosal, S.V. Furtado, A.S. Hegde, Rosette-forming glioneuronal tumor pineal gland and tectum: an intraoperative diagnosis on smear preparation, *Diagn. Cytopathol.* 38 (8) (2010) 590–593.
- [47] Y. Wang, J. Xiong, S.G. Chu, et al., Rosette-forming glioneuronal tumor: report of an unusual case with intraventricular dissemination, *Acta Neuropathol.* 118 (6) (2009) 813–819.
- [48] J.Q. Lu, B.W. Scheithauer, P. Sharma, et al., Multifocal complex glioneuronal tumor in an elderly man: an autopsy study: case report, *Neurosurgery* 64 (6) (2009) E1193–E1195.
- [49] L. Duan, Y. Zhang, W. Fu, S. Geng, Rosette-forming glioneuronal tumor originating from the spinal cord: report of 2 cases and literature review, *World Neurosurg.* 98 (2017) 875.e1–875.e7, <https://doi.org/10.1016/j.wneu.2016.11.109>.
- [50] F. Marhold, M. Preusser, W. Dietrich, D. Prayer, T. Czech, Clinicoradiological features of rosette-forming glioneuronal tumor (RGNT) of the fourth ventricle: report of four cases and literature review, *J. Neuro-Oncol.* 90 (3) (2008) 301–308.
- [51] I. Vajtai, M. Arnold, A. Kappeler, et al., Rosette-forming glioneuronal tumor of the fourth ventricle: report of two cases with a differential diagnostic overview, *Pathol. Res. Pract.* 203 (8) (2007) 613–619.
- [52] A. Albanese, A. Mangiola, A. Pompucci, et al., Rosette-forming glioneuronal tumour of the fourth ventricle: report of a case with clinical and surgical implications, *J. Neuro-Oncol.* 71 (2) (2005) 195–197.
- [53] M. Preusser, W. Dietrich, T. Czech, D. Prayer, H. Budka, J.A. Hainfellner, Rosette-forming glioneuronal tumor of the fourth ventricle, *Acta Neuropathol.* 106 (5) (2003) 506–508.
- [54] Y. Kitamura, T. Komori, M. Shibuya, et al., Comprehensive genetic characterization of rosette-forming glioneuronal tumors: independent component analysis by tissue microdissection, *Brain Pathol.* (2017), <https://doi.org/10.1111/bpa.12468>.
- [55] F.Y. Lin, K. Bergstrom, R. Person, et al., Integrated tumor and germline whole-exome sequencing identifies mutations in MAPK and PI3K pathway genes in an adolescent with rosette-forming glioneuronal tumor of the fourth ventricle, *Cold Spring Harb. Mol. Case Stud.* 2 (5) (2016) a001057.

- [56] T.K. Maiti, A. Arimappamagan, A. Mahadevan, T.C. Yasha, P. Pandey, V. Santosh, Rare pathologies in the posterior third ventricular region in children: case series and review, *Pediatr. Neurosurg.* 50 (1) (2015) 42–47.
- [57] N. Nathoo, E. Kiratu, N. Dasi, Endoscopic aqueductoplasty and stenting – report of initial experience, *S. Afr. Med. J.* 92 (1) (2002) 51–52.
- [58] M.R. Gaab, H.W. Schroeder, Neuroendoscopic approach to intraventricular lesions, *Neurosurg. Focus.* 6 (4) (1999) e5.
- [59] M.L. Apuzzo, O.K. Chikovani, P.S. Gott, et al., Transcallosal, interformical approaches for lesions affecting the third ventricle: surgical considerations and consequences, *Neurosurgery* 10 (5) (1982) 547–554.