

# Primary Spinal Neurocytoma Involving the Medulla Oblongata: Two Case Reports and a Literature Review

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## Abstract

Central neurocytoma is a rare neuroectodermal tumor found in young adults. These tumors are generally located in the lateral or third ventricles. Extraventricular neurocytoma in the spinal cord is extremely rare. We report on two patients with primary spinal neurocytomas who presented with progressive numbness and weakness in the limbs. Both patients had intramedullary masses between the medulla and the upper thoracic levels. The clinical, radiological, surgical, and pathological features of this abnormality are discussed, and all 20 reported cases were reviewed. In conclusion, neurocytoma should be included in the differential diagnosis of a spinal intramedullary tumor, and subtotal resection is acceptable for a relatively favorable prognosis if gross total removal is unachievable. The efficacy of adjuvant radiochemotherapy to control tumor recurrence is unknown.

Key words: neurocytoma, spinal cord, extraventricular, medulla oblongata, magnetic resonance imaging

## Introduction

Central neurocytoma (CN) is a rare tumor that is typically located in the supratentorial ventricular system near the foramen of Monro. It was first described by Hassoun et al. in 1982 and accounts for only 0.1–0.5% of all primary intracranial tumors.<sup>1)</sup> Primary tumors with the morphological and histological features of CN have been described at extraventricular sites, including the cerebral parenchyma, thalamus, cerebellum and spinal cord.<sup>2,3)</sup> Spinal neurocytoma (SN) is extremely rare, and SNs, which usually mimic common intraspinal tumors, are generally found in intramedullary locations. Therefore, it may be difficult to make a correct preoperative diagnosis. This report details the cases of two patients who were admitted to our department between 2008 and 2010 with intramedullary SNs located between the medulla and the upper thoracic levels. Their clinical data were retrospectively evaluated, and a review of all other known cases in the English literature was performed.

## Case Report

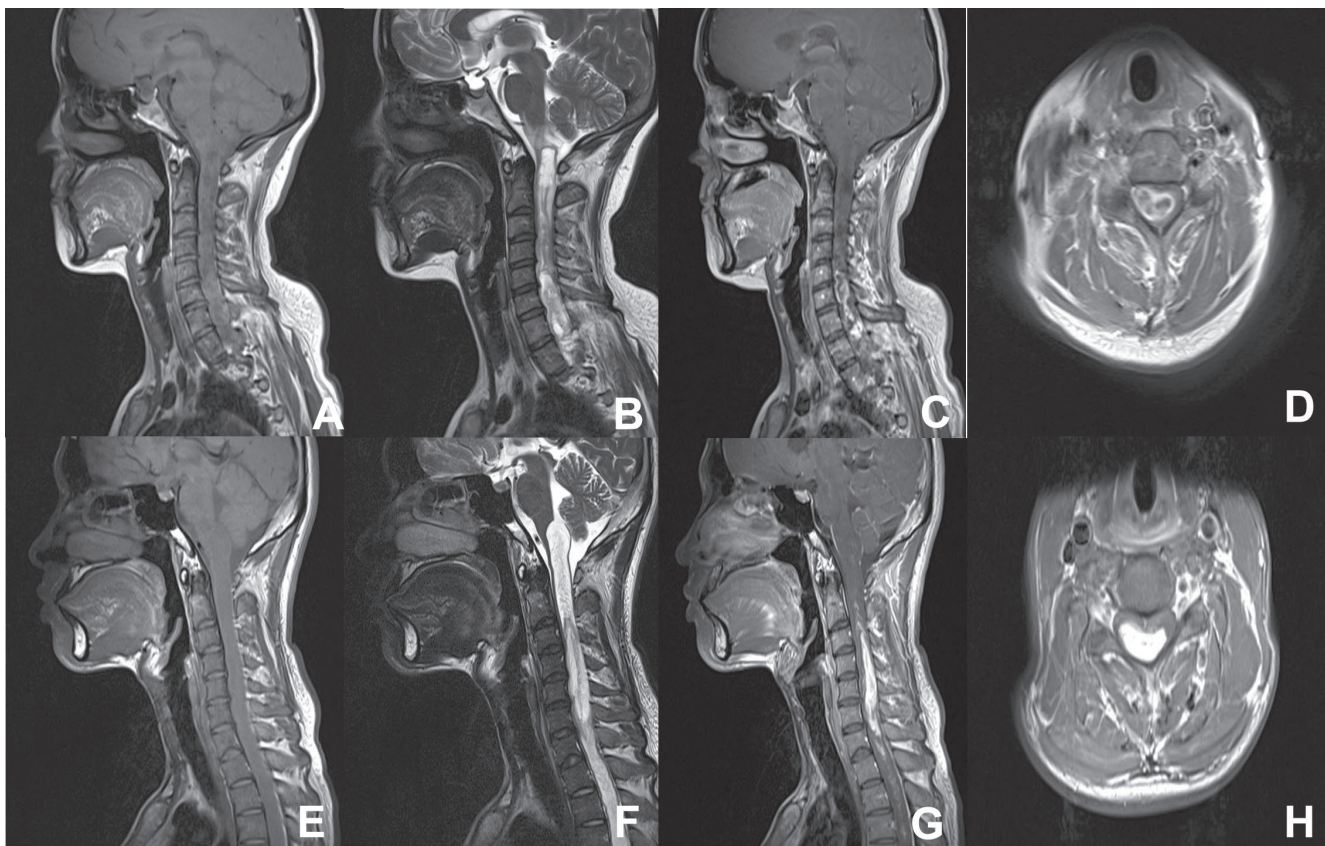
### I. Case 1

A 48-year-old female presented to our outpatient clinic

with an 8-year history of intermittent pain in her right lower limb. She had developed progressive worsening numbness of both the upper and lower limbs for the previous 5 years. She reported experiencing no bowel or bladder symptoms. A neurological examination revealed that muscle tone was increased in the right lower limb, and the muscle power was Grade 4/5 (classified by the Medical Research Council grading system). Deep and superficial sensations in her right leg and superficial sensation in her left arm were reduced. Her right lower limb also showed amyotrophy, increased deep tendon reflexes, and a positive Babinski sign.

Preoperative magnetic resonance imaging (MRI) of the patient's cervical spine demonstrated an intramedullary lesion in the medulla to T1 spinal segments (Fig. 1A–D). The tumor appeared to be composed of multiple irregular nodules that were iso-/hypointense on T<sub>1</sub>-weighted images and mixed hyperintense on T<sub>2</sub>-weighted images. A contrast-enhanced MRI of the lesion showed heterogeneous enhancement after gadolinium administration. Abnormal flow void signals and associated syringomyelia were not observed. According to the location and MRI features of the tumor, the differential diagnosis included ependymoma and astrocytoma.

The patient underwent a C1 to T2 laminectomy using a posterior approach. The dura was tense, and a longitudinal incision was made in its center. The spinal cord was



**Fig. 1** Case 1. A preoperative magnetic resonance imaging (MRI) showing a medulla-T1 intramedullary mass with iso-/hypointensity on the sagittal T<sub>1</sub>-weighted image (A), mixed hyperintensity on the sagittal T<sub>2</sub>-weighted image (B), and heterogeneous enhancement on the sagittal (C) and axial (D) T<sub>1</sub>-weighted images with gadolinium. Case 2. A preoperative MRI showing a medulla-T4 ill-defined intramedullary mass with iso-/hypo-intensity on the sagittal T<sub>1</sub>-weighted image (E), hyperintensity on the sagittal T<sub>2</sub>-weighted image (F), and heterogeneous enhancement at the C3–C7 levels and linear enhancement on the surface of the cerebellum, brainstem, and spinal cord on the sagittal (G) and axial (H) T<sub>1</sub>-weighted images with gadolinium.

swollen and thickened. The intraoperative findings showed that the tumor had incomplete capsule and was red-grayish in color, soft, and moderately vascular. Because of the tumor's adhesion to the spinal cord and its ill-defined margins with the medulla, *en bloc* resection would have been difficult to achieve. For this reason, the intramedullary tumor was subtotally removed under spinal evoked-potential monitoring based on the need to protect the patient's spinal functions.

A histopathological examination revealed that the tumor was composed of areas of delicate fibrillary neuropils and sheets of uniform, small, round cells with finely speckled vesicular nuclei. Most cells showed clear perinuclear halos and appeared to form honeycomb structures that resembled those seen in oligodendrogliomas (Fig. 2A–C). Mitosis, necrosis, and vascular proliferation were absent. The immunohistochemical examinations revealed that the tumor cells were positive for synaptophysin (Syn), neuron-specific enolase (NSE), and S-100 but negative for glial fibrillary acidic protein, chromogranin, neuro-

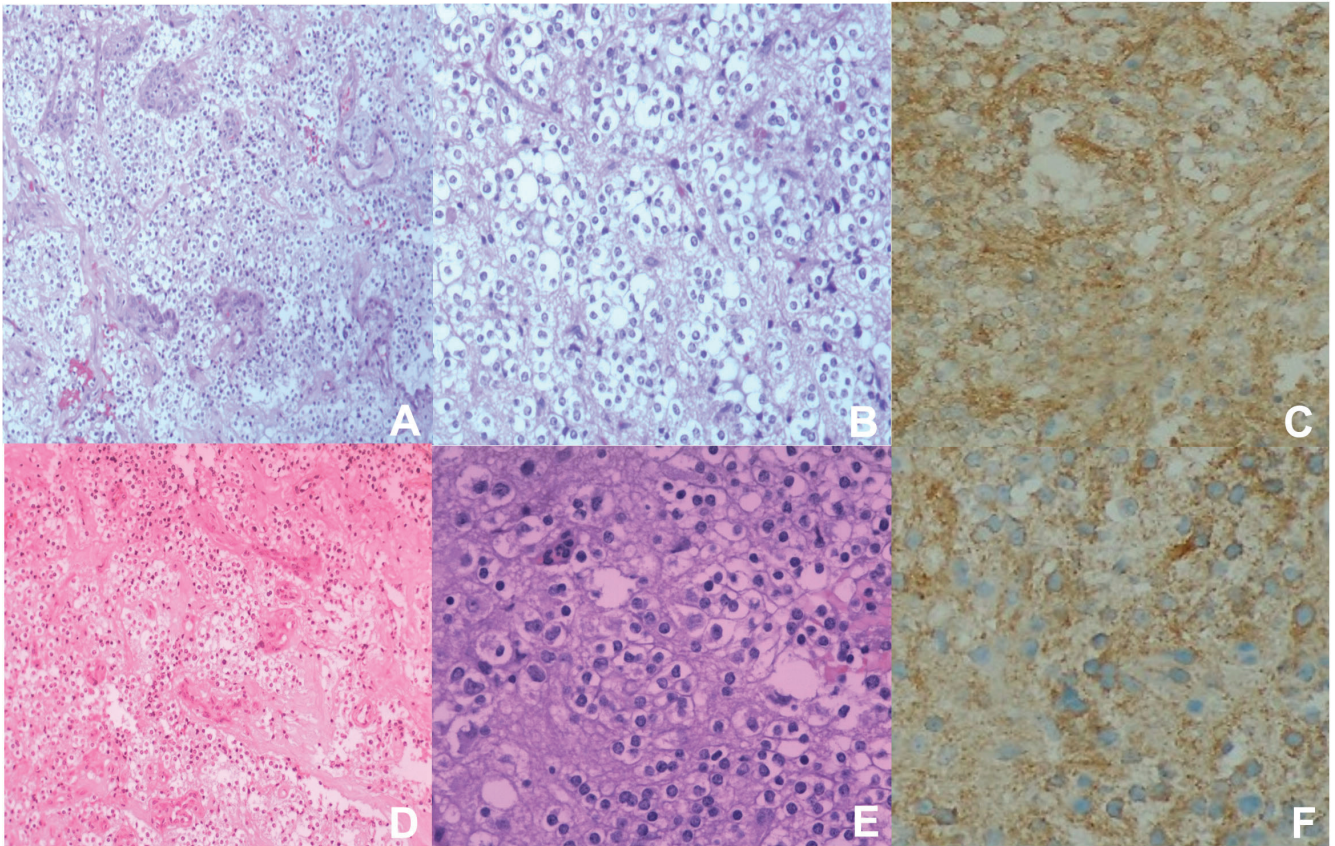
filament, and epithelial membrane antigen. In particular, cytoplasmic positivity for Syn and nuclear positivity for NeuN was observed in the tumor cells (Fig. 3). All the findings were consistent with a diagnosis of extraventricular neurocytoma (EVN).

In the immediate postoperative period, the weakness in the patient's right lower limb worsened (muscle power of Grade 2/5) but improved to a satisfactory level within 6 months postoperatively. At the 18-month follow-up MRI examination, no tumor recurrence or regrowth was found.

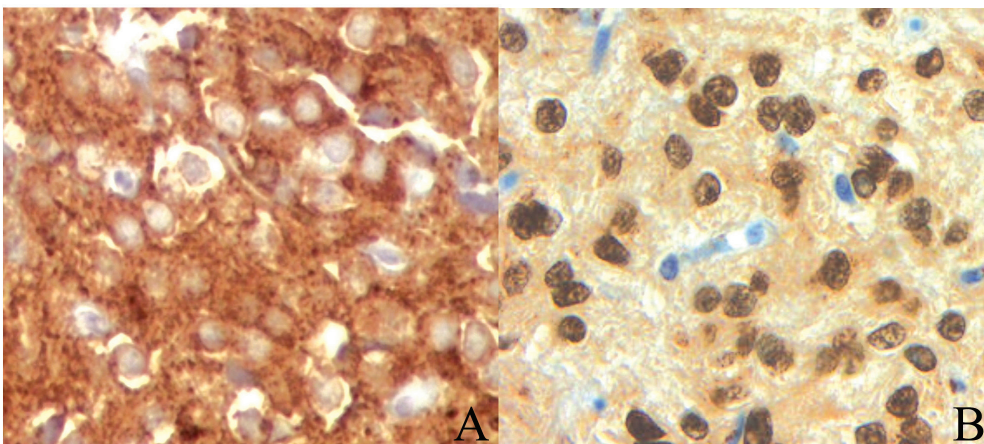
## II. Case 2

A 26-year-old male presented with progressive increasing numbness and weakness in his right upper and lower limbs over the previous 9 months. He had noticed weakness in his left upper limb for 5 months. The bilateral weakness spread slowly upward, beginning from the distal limbs. A neurological examination revealed that muscle power was Grade 4/5 in his right side and left upper limb. Sensations to pinpricks and light touch on





**Fig. 2** Photomicrographs of the surgical specimens in Case 1 (A–C) and Case 2 (D–F) illustrating sheets of uniform small round cells with finely speckled vesicular nuclei, clear perinuclear halos in areas of delicate fibrillary neuropils (A, D: hematoxylin-eosin stain, original magnification  $\times 100$ ; B, E: hematoxylin-eosin stain, original magnification  $\times 200$ ), and strong positivity for synaptophysin (C: original magnification  $\times 100$ ; F: original magnification  $\times 200$ ).



**Fig. 3** Photomicrographs of the surgical specimens in Case 1 showing cytoplasmic positivity for synaptophysin (A) and nuclear positivity for NeuN (B) in the tumor cells (original magnification  $\times 400$ ).

the right foot were decreased, and joint position sense in the lower limbs was poor. Amyotrophy was noted in the right leg. A spinal examination was unremarkable, with no local tenderness or deformity.

A preoperative MRI of the cervical spine showed an ill-defined intramedullary lesion in the medulla to T4 spinal

segments (Fig. 1E–H). The mass was iso-/hypointense on T<sub>1</sub>-weighted images and hyperintense on T<sub>2</sub>-weighted images. The T<sub>1</sub>-weighted imaging with gadolinium showed heterogeneous enhancement at the C3–C7 levels and linear enhancement at the surface of the cerebellum, brainstem, and spinal cord. The preoperative differential diagnosis

included ependymoma, astrocytoma, and metastasis.

A total C3–C7 laminectomy using a high-speed drill revealed a dark grayish, soft, ill-defined, extremely vascular tumor. Because of adhesions to the spinal cord and the high degree of vascularity, the tumor was subtotally removed. A retention suture was performed using an artificial dural patch, and no vertebral lamina reduction was performed for decompression.

The histopathological findings showed the typical morphological features of CN: round tumor cells with perinuclear halos mimicking the appearance of oligodendrogloma cells. The diagnosis was confirmed by immunostaining (Fig. 2D–F).

The postoperative course was uneventful, and the patient's sensory deficits were apparently relieved. Because of the risk of tumor recurrence and metastasis, further treatment was strongly recommended. However, the patient refused to undergo adjuvant radiotherapy and chemotherapy. He left the hospital 2 weeks after surgery. Gradual improvement in limb strength was noted during the follow-up examinations. A 2-year postoperative MRI showed that the tumor had not recurred or metastasized.

## Discussion

Since Coca et al. described the first case in 1994, only 18 cases of primary SN have been reported in the English literature.<sup>2,4–16</sup> Table 1 summarizes the clinical features of previous cases and our two patients. Of the 20 reported patients, 14 were male and 6 were female. Compared with CNs and other EVNs, in which gender predominance is not evident, the male/female ratio of primary SNs (2.3:1) suggests a strong male predilection. The mean age at presentation is 33.7 years, which is similar to that of other EVNs. The tumors tend to arise from the cervical and thoracic spinal regions. Two cases involved the medulla oblongata, and two tumors were located in the lumbar segment. In the previous cases, all the lesions were intramedullary, including one with an extramedullary component.

The signs and symptoms of SNs are consistent with those of other common intramedullary spinal tumors. The clinical presentations of SNs include somatic pain, numbness, progressive or sudden weakness in the limbs, and incomplete voiding when the conus medullaris is involved. The symptoms usually evolve over a period of months to years. Regardless of the duration, rapid deterioration occurred in a few cases, most likely caused by venous thrombosis and tumor hemorrhage.

The MRI features of primary SNs are variable and could be misleading, as shown in the previously reported cases. All the cases involved intramedullary tumors; associated syringomyelia could be found, but this finding was uncommon. The signals of primary SNs ranged from

iso- to hypointensity on T<sub>1</sub>-weighted images and iso- to hyperintensity on T<sub>2</sub>-weighted images. The lesions could show homo- or heterogeneous enhancement after gadolinium administration and some had poorly defined tumor margins. These features were similar to those of spinal cord ependymomas and astrocytomas. In our two cases, variations in the preoperative MRI findings led to difficulties with the diagnosis. Both lesions involved the medulla. Thus, a definitive diagnosis of primary SN was difficult based on MRI alone, and a complete histopathological examination was required to differentiate between other common intramedullary tumors, such as ependymomas, astrocytomas, and oligodendroglomas in particular.

The histogenesis of CN is poorly understood, but some theories have been proposed. CN may originate from cells that are committed to a neuronal phenotype or from bipotential progenitor cells in the periventricular matrix.<sup>12</sup> The differential diagnosis for SN typically includes other intramedullary tumors, particularly ependymoma and oligodendrogloma. Neurocytomas have a fine neuropil-like fibrillary matrix instead of the coarser glial fibrillary matrix of ependymomas. Cells of ependymomas exhibit more angulated nuclei and are negative for Syn. Neurocytoma cells show clear perinuclear halos that resemble oligodendroglomas. Thus, immunohistochemistry is often a necessary adjunct for the differential diagnosis. Strong and diffuse immunostaining for Syn has been recognized as the most suitable and reliable diagnostic marker. The nuclear positivity for NeuN favors diagnosing SN over oligodendrogloma, although the latter can also occasionally express neuronal markers. In the literature, SNs have reportedly expressed some other neuronal markers, including NSE, neuron-associated class III beta-tubulin, and microtubule-associated protein 2.<sup>3</sup> However, chromogranin and neurofilament proteins are generally absent.

Because of the benign nature and well differentiation of this tumor, complete resection is advised to ensure a relatively favorable prognosis. However, because of the ill-defined margins or dense adhesions to the neural tissue, subtotal removal has to be performed to avoid unacceptable postoperative complications. In the literature, 19 patients underwent surgery, and gross total resection was achieved in eight cases (42.1%), subtotal resection in 10 cases (52.6%), and biopsy sampling in one case (5.3%). The medulla was involved in our present cases, and the patients showed good results, although only subtotal removal was possible. Thus, based on the need to protect neurological functions, aggressive attempts to attain gross total removal were unnecessary.

Radiotherapy is considered beneficial for preventing tumor recurrence, particularly when total removal cannot be achieved. However, only five patients underwent postoperative radiotherapy, and two experienced tumor



**Table 1** Summary of previously reported cases of primary spinal neurocytoma

Author (Year)	Age (yrs)/ gender	Tumor location	MRI findings			Treatment	Follow-up
			T <sub>1</sub> WI	T <sub>2</sub> WI	+GA		
Coca et al. (1994) <sup>4)</sup>	67/M	T11–T12 IM	NA	NA	NA	GTR	30 mos no rec.
Tatter et al. (1994) <sup>5)</sup>	65/M	C2–C6 IM	Homo iso	NA	NA	Biopsy + RT	10 yrs no rec.
	49/M	C3–C4 IM	Iso	Iso	Homo	STR+RT; GTR	30 mos rec. + 30 mos no rec.
Stapleton et al. (1997) <sup>6)</sup>	12/M	C4–T1 IM	NA	NA	Heter	GTR	24 mos no rec.
Stephan et al. (1999) <sup>7)</sup>	46/F	T12–L1 IM	Slight hypo	Slight hypo	Homo	GTR	12 mos no rec.
Martin et al. (2002) <sup>8)</sup>	50/M	T2–T5 IM	Irregular iso	Irregular iso	Heter	STR; GTR	24 mos no rec.
Baehring et al. (2005) <sup>9)</sup>	13/M	T6–T10 IM	NA	NA	Heter	NA	NA
Sharma et al. (2005) <sup>10)</sup>	24/M	C5–T1 IM	Iso	Hyper	Homo	GTR; RT + CT	10 mos rec. + 24 mos diss.
Singh et al. (2007) <sup>11)</sup>	8/M	T2–T8 IM	Hypo	Markedly hyper	Heter	STR	3 mos no rec.
Gokhan et al. (2008) <sup>12)</sup>	49/F	C3–C6 IM	NA	Homo iso	NA	STR	NA
Polli et al. (2009) <sup>13)</sup>	6/M	C1–C7 IM	NA	NA	NA	STR	23 yrs no rec.
	15/M	C1–T11 IM	NA	NA	Heter	STR	24 mos died no rec.
	37/F	T12–L1 IM	NA	NA	Heter	STR	15 mos rec. + 12 mos no rec.
Marucci et al. (2009) <sup>14)</sup>	51/M	T10–T11 IM	Hyper	NA	Homo	GTR	12 mos no rec.
Tsai et al. (2011) <sup>15)</sup>	54/F	T3–T5 IM, EM	Iso	NA	Homo	GTR	6 mos no rec.
Agarwal et al. (2011) <sup>2)</sup>	16/M	NA	Iso	Hyper	Homo	STR + RT	6 mos no rec.
	25/M	NA	Iso	Hyper	Homo	STR + RT	6 mos no rec.
Gepp et al. (2012) <sup>16)</sup>	15/F	NA, IM	NA	NA	NA	STR	NA
Present cases	48/F	Medulla-T1 IM	Iso/hypo	Mixed hyper	Heter	STR	18 mos no rec.
	26/M	Medulla-T4 IM	Iso/hypo	Hyper	Heter	STR	2 yrs no rec.

CT: chemotherapy, diss.: dissemination, EM: extramedullary, F: female, +GA: after gadolinium administration, GTR: gross total resection, Heter: heterogeneous, Homo: homogenous, Hyper: hyperintensity, Hypo: hypointensity, IM: intramedullary, Iso: isointensity, M: male, mos: months, MRI: magnetic resonance imaging, NA: not available, rec.: recurrence, RT: radiotherapy, STR: subtotal resection, WI: weighted image, yrs: years.

recurrence in long-term follow-up evaluations. Compared to other cases in which only surgery was performed, the efficacy of adjuvant radiation therapy for controlling tumor recurrence was limited. It is difficult to comment on the role of chemotherapy because only one reported case used this therapy.

The postoperative course ranged from 3 months to 23 years. Good outcomes were obtained after surgery in 14 of 17 cases with follow-up evaluations. Tumor recurrence was rare, and only three recurrence cases were noted. Therefore, even when only subtotal resection was performed, most patients had a good prognosis because SNs usually grow slowly and have a low proliferation level. Because of the likelihood of long-term recurrence (more than 10 months), careful consecutive follow-up evaluations after initial treatment are essential.

## Conflicts of Interest Disclosure

The authors have reported no conflicts of interest.

## References

- 1) Hassoun J, Gambarelli D, Grisoli F, Pellet W, Salamon G, Pellissier JF, Toga M: Central neurocytoma. An electron-microscopic study of two cases. *Acta Neuropathol* 56: 151–156, 1982
- 2) Agarwal S, Sharma MC, Sarkar C, Suri V, Jain A, Sharma MS, Ailawadhi P, Garg A, Mallick S: Extraventricular neurocytomas: a morphological and histogenetic consideration. A study of six cases. *Pathology* 43: 327–334, 2011
- 3) Choudhari KA, Kaliaperumal C, Jain A, Sarkar C, Soo MY, Rades D, Singh J: Central neurocytoma: a multi-disciplinary review. *Br J Neurosurg* 23: 585–595, 2009

- 4) Coca S, Moreno M, Martos JA, Rodriguez J, Barcena A, Vaquero J: Neurocytoma of spinal cord. *Acta Neuropathol* 87: 537–540, 1994
- 5) Tatter SB, Borges LF, Louis DN: Central neurocytomas of the cervical spinal cord. Report of two cases. *J Neurosurg* 81: 288–293, 1994
- 6) Stapleton SR, David KM, Harkness WF, Harding BN: Central neurocytoma of the cervical spinal cord. *J Neurol Neurosurg Psychiatry* 63: 119, 1997
- 7) Stephan CL, Kepes JJ, Arnold P, Green KD, Chamberlin F: Neurocytoma of the cauda equina. Case report. *J Neurosurg* 90(2 Suppl): 247–251, 1999
- 8) Martin AJ, Sharr MM, Teddy PJ, Gardner BP, Robinson SF: Neurocytoma of the thoracic spinal cord. *Acta Neurochir (Wien)* 144: 823–828, 2002
- 9) Baehring J, Ogle E, Sze G, Duncan C, Bannykh S: Ganglioneurocytoma of the spinal cord. *J Neurooncol* 71: 149, 2005
- 10) Sharma S, Sarkar C, Gaikwad S, Suri A, Sharma MC: Primary neurocytoma of the spinal cord: a case report and review of literature. *J Neurooncol* 74: 47–52, 2005
- 11) Singh A, Chand K, Singh H, Sarkar C, Sharma MC: Atypical neurocytoma of the spinal cord in a young child. *Childs Nerv Syst* 23: 207–211, 2007
- 12) Gokhan GA, Gurer IE, Akyuz M, Tuncer R: A case of extraventricular neurocytoma of the spinal cord. *Neuropathology* 28: 322–325, 2008
- 13) Polli FM, Salvati M, Miscusi M, Delfini R, Giangaspero F: Neurocytoma of the spinal cord: report of three cases and review of the literature. *Acta Neurochir (Wien)* 151: 569–574; discussion 574, 2009
- 14) Marucci G, Barbanera A, Serchi E, Andreoli A: Ganglioneurocytoma of the spinal cord: report of a case and review of literature. *Eur Spine J* 18(Suppl 2): 183–185, 2009
- 15) Tsai CY, Tsai TH, Lin CH, Cheng YH, Lieu AS: Unusual exophytic neurocytoma of thoracic spine mimicking meningioma: a case report and review of the literature. *Eur Spine J* 20(Suppl 2): S239–S242, 2011
- 16) Gepp Rde A, Sacco RC, Brandão IC, Braga da Silveira E, Monteiro Júnior A: Central neurocytoma of spinal cord. *Arq Neuropsiquiatr* 70: 234–235, 2012

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