B-Cell Lymphoma Intramedullary Tumor: Case Report and Systematic Review

Daniel Gregório Gonsalves[1] Paulo Eduardo Albuquerque Zito Raffa[1] Gabriela Gerenutti de Sousa[2] Melissa Esposito Gomes Rigueiral[3] Iracema Araújo Estevão[4] Cesar Cozar Pacheco[4] Roger Thomaz Rotta Medeiros[4] Paulo Roberto Franceschini[5] Paulo Henrique Pires de Aguiar[4,6,7]

[1] Graduation Medicine at Faculty of Medicine of Catanduva, Catanduva, São Paulo, Brazil
[2] Graduation Medicine at Pontifical Catholic University of São Paulo, Sorocaba, Brazil
[3] Graduation Medicine at Faculty of Medicine of ABC, Santo André, São Paulo, Brazil
[4] Department of Neurosurgery, Santa Paula Hospital, São Paulo, Brazil
[5] Department of Neurosurgery, University of Caxias do Sul, Rio Grande do Sul, Brazil
[6] Department of Research and Innovation, Laboratory of Cellular and Molecular Biology, Faculty of Medicine of ABC, Santo André, São Paulo, Brazil
[7] Department of Neurology, School of Medicine of Pontifical Catholic University of São Paulo, Sorocaba, São Paulo, Brazil

Address for correspondence Daniel Gregório Gonsalves, Graduation Medicine at Faculty of Medicine of Catanduva, Rua dos Estudantes, 225, Catanduva, São Paulo, Brazil, 15.809-144 (e-mail: danielgregoriogonsalves@gmail.com).

AJNS 2023;18:231–245.

Abstract

Intramedullary tumors represent the major cause of spinal cord injuries, and its symptoms include pain and weakness. Progressive weakness may concomitantly occur in the upper and lower limbs, along with lack of balance, spine tenderness, sensory loss, trophic changes of extremity, hyperreflexia, and clonus. The study protocol was in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines. A systematic search of the MEDLINE electronic database was performed to identify the studies reporting the clinical features of children and adults who presented with an intramedullary lymphoma. Twenty-one studies were included, reporting 25 cases. Manuscripts were excluded if the full-text article was not available, original data were not reported (e.g., review articles), or if the main disease was not intramedullary lymphoma. A structured data extraction form was employed to standardize the identification and retrieval of data from manuscripts. To enlighten the discussion, a case is also presented. An 82-year-old woman with Fitzpatrick skin type II, diagnosed and treated for non-Hodgkin's lymphoma 7 years ago, was admitted with mental confusion and memory loss for the past 2 months—evolving with recurring falls from her own height. One day before admission, she displayed Brown-Séquard syndrome. An expansive lesion from C2 to C4 in the cervical spinal cord was found and a hypersignal spinal cord adjacent was described at the bulb medullary transition to the C6–C7 level. A primary spinal cord tumor was considered, as well as a melanoma metastasis, due to the lesion's flame pattern. The patient presented a partial recovery of symptoms and a reduction of the spinal cord edema after being empirically treated with corticosteroids, but the lesion

Keywords
- spinal cord neoplasms
- lymphoma
- large B cell
- diffuse
- neurosurgery

article published online
June 6, 2023

DOI https://doi.org/10.1055/s-0043-1768574.
ISSN 2248-9614.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

maintained its extent. Subsequently, a large diffuse B-cell lymphoma with non-germinal center was found in open body biopsy, infiltrating neural tissue. The main objective of the present study is to report a surgical case treated for a large diffuse B-cell lymphoma, in addition to presenting the results of a systematic review of primary intramedullary spinal cord lymphoma.

Introduction

Spinal tumors are divided into three groups, which are extradural, intradural–extramedullary, and intramedullary spinal cord tumors (IMSCT). They represent approximately 15% of all central nervous system (CNS) tumors. IMSCT is the most uncommon type of spinal tumor. It originates in the spinal cord itself, causing its invasion and destruction of white and gray matter.[1] However, a spinal cord lesion can also be linked to a lymphoma. Primary intramedullary spinal cord lymphoma (PISCL) is one of the rarest spinal diseases, comprising 1% of all CNS lymphomas. It is characterized by a rapid progression in the first year after diagnosis, followed by a slower one after this period.[2] PISCL is an aggressive condition and can emerge directly from CNS, involving the eye, leptomeninges, brain, and spinal cord.[3] Primary CNS lymphoma (PCNSL) has a high possibility of relapse, with poor long-term survival, even though the assigned treatment has advanced. Currently, the treatment of choice in these cases is optimized therapy with high-dose methotrexate-based chemotherapy.[4]

In Brown-Sequard syndrome, the lesion may be completely transverse, initially presenting with asymmetrical spinal cord signs. When an incomplete spinal cord injury (SCI) occurs, some neurologic function will be retained, and one of the syndromes related to that condition is Brown-Séquard syndrome (BSS). The symptoms of BSS, resulting from spinal cord hemisection, present themselves differently in each hemibody. These are weakness and paralysis on one side and painful and thermal sensory loss on the other, with causes ranging from traumatic to nontraumatic, such as tumors, vertebral disk herniation, and tuberculosis.[5]

Individuals of all ages can be affected by spinal metastases. However, these are more frequently reported in patients between 40 and 70 years of age, with the thoracic spine the most affected site and the highest incidence of neurological deficit, followed by the lumbar and cervical spine.[6]

All these concepts are necessary to understanding the following clinical case, in which an 82-year-old woman displays symptoms analogous to the BSS presentation, secondary to an intramedullary lesion. The aim of this investigation is to discuss this rare presentation and enlighten the diagnosis.

Methods

The study protocol was in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines.

Population: Adults and children, both genders, across the world.

Exposition: Diagnosed primary intramedullary lymphoma.

Comparison: Age, sex, interval of diagnosis, clinical features, diagnosis, localization,treatment, histological type.

Outcomes: Follow-up and mortality outcomes (alive, deceased).

Search Strategy and Data Sources

A systematic search of the MEDLINE electronic database from February 7 to September 31, 2022 was performed using PubMed's MeSH Advanced Search Builder tool. The search commands can be referred to in ►**Appendix 1.**

The search was performed to identify studies reporting clinical features of children and adults who presented with an intramedullary lymphoma. The reference lists of identified studies were examined to identify further reports of interest.

Study Selection

Three reviewers independently screened the titles and abstracts of all citations for eligibility and retrieved those that met the inclusion criteria. If insufficient information was available in the abstract to decide on eligibility, the whole article was retrieved for review. Discrepancies were resolved by consensus and utilization of a fourth reviewer when necessary. Manuscripts reporting information on children and adults, both genders, were included when an intramedullary lymphoma was present and the article dated from the last 5 years. Manuscripts were excluded if the full-text article was not available, original data were not reported (e.g., review articles), or if the main disease was not intramedullary lymphoma.

Data Extraction

A structured data extraction form was employed to standardize the identification and retrieval of data from manuscripts. Data were organized into a standardized table, where each reviewer extracted the following data from the studies: age, sex, interval of symptom onset, clinical presentation, localization, treatment, histological type, follow-up, and outcome. Where manuscripts did not report the information we were evaluating, we displayed the information as not available.

Results

For the systematic literature review, of the 963 articles that were found, we selected those within 5 years of publication

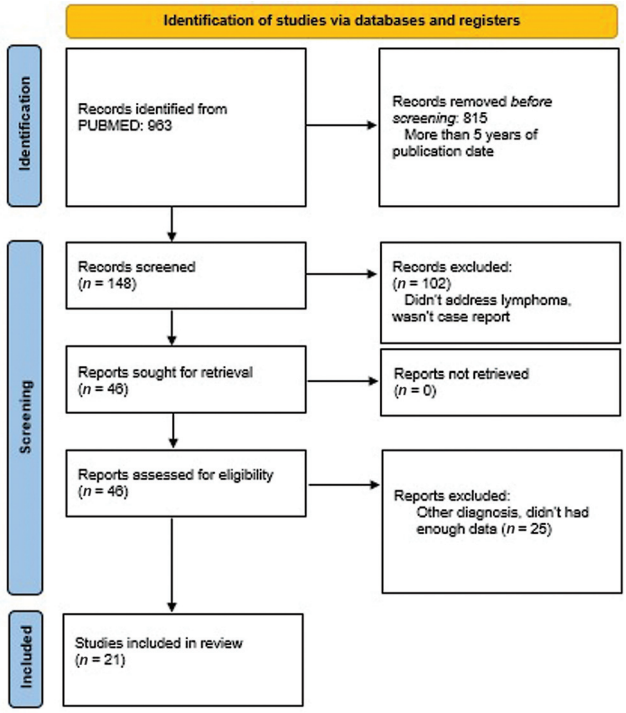

Fig. 1 Flow diagram of the systematic reviews and articles included.

date, excluding those that did not contain articles reporting primary data (e.g., isolated reviews, meta-analyses, or national database projects) and that were not written in English. In all, 148 articles were screened by the reviewers and articles that did not address lymphoma or were not case reports were excluded (102 articles). Then, 46 articles were screened for primary data and full-text information, including 21 studies to the review (►**Fig. 1**).

The 21 selected studies[7–27] that met the eligibility criteria are described in ►**Table 1**, reporting a total of 25 cases (20 male and 5 female patients), in the age range of 15 to 79 years (average: 52.72 years). Only 10 cases reported follow-up as 4 patients were lost to follow-up and 11 studies did not report it. The average follow-up was 1.73 years (range: 2 weeks–6 years). Three patients were deceased at the time of report, 7 did not report the information, and 15 patients were alive (6 free of infection, 1 in remission, 1 with remaining disease, and 7 unknown). In terms of location, 4 lesions were located above the cervical region, 5 cervical, 10 thoracic, 7 lumbar, and 1 cauda equina lesions (discriminated in the table), with individual clinical presentations. The time interval from symptoms onset to diagnosis was clearly informed by 22 patients, ranging from 4 days to 1 year (average: 3.6 months). Diagnosis were diffuse large B-cell lymphoma on 10 cases, CNS lymphoma (2 cases—1 spinal), T-lymphoblastic lymphoma (3 cases—1 with cauda equina involvement), large B-cell lymphoma (2 cases), marginal zone lymphoma (1 case), follicular grade I to II lymphoma (1 case), non-Hodgkin's lymphoma (3 cases—2 primary B cell), anaplastic large cell lymphoma (1 case), primary peripheral gamma delta T-cell lymphoma (1 case), and 1 case of B-lymphoblastic lymphoma.

Performed treatment included surgical resection, partial biopsy, chemotherapy, radiotherapy, biological therapy, and corticosteroids. Tumor resection was done in 13 patients, decompressive laminectomies was done in 9 patients, chemotherapy (CT) in 18 patients, corticosteroids in 6 patients, radiotherapy in 4 patients, and biological drugs in 2 patients. The following symptoms appeared recurrently in the case series and may help suspicion for lymphoma if present: constitutional symptoms, back pain, and lower motor neuron involvement.

Case Description

An 82-year-old old woman, with Fitzpatrick type II skin, diagnosed and treated for non-Hodgkin's lymphoma 7 years ago, was admitted at the hospital with mental confusion and memory loss for the past 2 months, evolving with recurring falls from height in the last month. A day before hospital admission, her condition aggravated, now exhibiting loss of strength and hemiparesis in the right side of the body, associated with superficial hemiparesthesia in the left side, a clinical condition compatible with BSS, characterized by a spinal cord hemisection, which was confirmed by imaging tests. No other neurological findings were noted.

Computed tomography (CT) scan and magnetic resonance imaging (MRI) showed an expansive lesion from C2 to C4 in the cervical spinal cord (►**Fig. 2**). Its dimension was $4.8 \times 0.8 \times 0.7$ cm, homogenous impregnation with gadolinium. There was also a hyperintensity in the spinal cord, from the bulb medullary transition to the C6–C7 level (►**Fig. 2**), possibly corresponding with spinal cord edema. After being evaluated by the hemathology, oncology, neurology, and neurosurgery teams, it was not possible to confirm nor reject recidivated lymphoma, for a primary spinal cord tumor (ependymoma, astrocytoma, hemangioblastoma) was possible, as well as a melanoma metastasis, due to the lesion's flame pattern.

The patient presented a partial recovery of symptoms and a reduction of the spinal cord edema after being empirically treated with corticosteroids, but the lesion maintained its extent (►**Fig. 3**). A frozen section body biopsy was performed, and the surgical material was sent to anatomopathological and immunohistochemical study (►**Table 2**).

A large diffuse B-cell lymphoma with nongerminal center infiltrating neural tissue was found in C2. Therefore, the primary hypothesis was confirmed: lymphoma.

The neurosurgical team performed an excision of the intramedullary cervical lesion (►**Fig. 4**), through a lateral intermediate sulcus approach. The patient was neuromonitored intraoperatively and afterward motor rehabilitation was initiated (►**Fig. 5**). A discreet improvement of muscle strength on the right hemibody was perceived. Vital signs were stable, besides a few hypertension episodes. The next step was urgent radiotherapy, followed by chemotherapy.

Unfortunately, the patient developed sepsis during chemotherapy 2 weeks after surgical resection and succumbed to the disease.

Table 1 Relevant lymphomas cases from the literature in the past 5 years

Title	Year	DOI	Authors	Age/sex	Interval (onset-diagnosis)	Clinical features	Diagnosis	Localization	Treatment	Histological type	Follow-up	Outcome
A conservative approach to the treatment of a rare case of cervical spine double expressor diffuse large B-cell lymphoma: a case report	2022	10.7759/cureus.21208	Chen W, Hika B, Smith CJ, Parrett TJ, Mesfin FB	58/M	1 y	Chronic neck pain and spasm	Diffuse large B-cell lymphoma	Retropharyngeal mass extending through the bilateral neuroforamina, into the epidural space, and involving the posterior elements of the cervical spine at C2–C3 ($1.8 \times 4.7 \times 4.5$ cm)	Posterior decompression and excisional biopsy without resection of the tumor, CT (systemic and intrathecal), RT	Double expressor DLBCL with anaplastic features. Small lymphocytes and large atypical cells with prominent nucleoli and large cytoplasm, positive for CD20, cyclin D1, and Pax5. Ki67 revealed a substantial level of proliferative activity	Not available	Alive
Detection of circulating tumor DNA in cerebrospinal fluid prior to diagnosis of spinal cord lymphoma by flow cytometric and cytologic analyses	2022	10.1007/s00277-021-04686-7	Iriyama C, Murate K, Iba S, Okamoto A, Yamamoto H, Kanbara A, Sato A, Iwata E, Yamada R, Okamoto M, Watanabe H, Mutoh T, Tomita A	62/M	1 mo	Motor/sensory disturbance of the extremities	Central nervous system lymphoma	C5–C7 and Th2–Th3 level	CT (Systemic and intrathecal), RT	Not available	Not available	Alive
A rare entity in the lumbar epidural region: T-cell lymphoblastic lymphoma	2021	10.14444/7165	Erdem MB, Kale A, Yaman ME, Emmez H	38/M	1 mo	Weakness in the lower extremities and newly developed urinary incontinence	T-lymphoblastic lymphoma	L2–L4 levels	L3 total, and L2 and L4 bilateral partial decompressive laminectomies, CT, donor lymphocyte	Lymphoblastic cell infiltration in the bone marrow biopsy, positive for cytoplasmic CD3 expression and TdT	5 mo	Deceased
Primary cauda equina T-cell lymphoblastic lymphoma	2020	10.1016/j.wneu.2020.06.184	De Vries J, Oterdoom MD, Den Dunnen WF, Enting RH, Kloet RW, Roeloffzen WW, Jeltema HR	54/F	8 mo	Progressive back pain radiating to both legs and deteriorating neurologic deficits	Primary cauda equina TLBL (T-cell lymphoblastic lymphoma)	L1–L4 and a central mass at L3–L4	Laminectomy of L3 and L4, Corticosteroids, CT (intrathecal and venous), RT	Small blue round tumor cells in hematoxylin and eosin staining. Microscopic analysis showed a vague, nodular growth pattern. The tumor cells were polymorphic and had hyperchromatic nuclei and a nucleolus in some cells. There was hardly any cytoplasm. Multiple mitotic figures were spotted as well as small, thin-walled vessels. Focal points of necrosis were apparent. The lesion mainly consisted of CD-3-positive cells. Further analysis showed positive results for TdT (terminal deoxynucleotidyl transferase) and for the following clusters of differentiation (CD): CD-1a, CD-99, CD-4, and CD-8. Weakly positive were T-cell markers CD-2, CD-5, and CD-7. The lesion showed a Ki-67 proliferation fraction of 90%. EBV in situ hybridization came out negative. These findings are compatible with T-LBL	6 wk	Deceased

Table 1 (*Continued*)

Title	Year	DOI	Authors	Age/sex	Interval (onset-diagnosis)	Clinical features	Diagnosis	Localization	Treatment	Histological type	Follow-up	Outcome
Primary central nervous system lymphoma mimicking longitudinally extensive transverse myelitis	2020	10.1177/1941874420967560	Natteru PA, Shekhar S, Nair LR, Uschmann H	59/W	4 wk	Progressive tetraparesis and bowel and bladder incontinence	Large B-cell lymphoma	T1–T9 levels	CT, Corticosteroids	Immunohistochemical staining and flow cytometric analysis was positive for CD-20, BCL-6, and MUM-1, and negative for CD-10 and cyclin D1	Not available	Alive
A rare case of primary ventricular lymphoma presented on FDG PET/CT	2020	10.1097/RLU.0000000000002876	Wang D, Su M, Xiao J	51/W	4 mo	Unsteady gait and progressive decline in memory	Diffuse large B-cell lymphoma	Multiple space-occupying lesions in the ventricles	Not available	Diffuse growth pattern of large, dysplastic lymphocytes with vesicular nuclei, positive for CD20 and MUM1 immunostaining. Ki67 demonstrated high proliferative index	Not available	Not available
Primary central nervous system lymphoma with diffuse neurolymphomatosis involving multiple cranial and spinal nerve roots	2020	10.1097/RLU.0000000000003018	Singh SS, Mittal BR, Kumar R, Singh H, Balaini N, Goyal M	23/M	4 mo	Intermittent fever, headache, vomiting, loss of weight and appetite, and progressive weakness of all 4 limbs, which subsequently progressed to quadriplegia associated with urinary incontinence. Evolved with altered sensorium, decreased hearing in both ears, decreased sensation in bilateral upper and lower limbs and trunk, difficulty in swallowing, change in voice, and nasal regurgitation	B-cell non-Hodgkin's lymphoma	Brainstem, cerebellum, spinal cord, cribriform plate, bilateral foramen ovale and foramen rotundum, multiple spinal nerve roots, lateral ventricles, bilateral jugular foramen and carotid canal, bilateral Meckel's cave	Antitubercular therapy, Corticosteroids,	High-grade B-cell non-Hodgkin's lymphoma	Not available	Not available
Primary diffuse large B-Cell non-Hodgkin's lymphoma of the thoracic spine presented initially as an epigastric pain	2020	10.4103/ajns.AJNS_300_19	Fakhouri F, Shoumal N, Obeid B, Alkhoder A	60/M	4 days	Acute nonradiating epigastric pain. Two days later, the pain started to radiate toward the back, and the patient started to suffer from severe thoracic back pain. Four days later, the pain started to radiate toward both lower limbs with subtle beginning of	Large B-cell lymphoma	T6/T7 level	Partial laminectomy with total resection of the extradural mass, CT	Diffuse malignant infiltration of large atypical lymphoid cells, large vesicular nuclei, prominent nucleoli, and coarse chromatin. Numerous mitotic cells were also present, and immune stains were positive for CD20 and leukocyte common antigen	2 y	Alive, free of infection

(*Continued*)

Table 1 (*Continued*)

Title	Year	DOI	Authors	Age/sex	Interval (onset-diagnosis)	Clinical features	Diagnosis	Localization	Treatment	Histological type	Follow-up	Outcome
						the weakness of the lower limbs and progressed within a few hours later to inability to walk, with intact neurological function of the upper extremities						
Hematolymphoid malignancies presenting with spinal epidural mass and spinal cord compression: a case series with rare entities	2019	Not available	Pandey S, Gokden M, Kazemi NJ, Post GR	61/M	3 wk	Lower back and leg pain, numbness, inability to walk, and bladder/bowel incontinence	Diffuse large B-cell lymphoma, not otherwise specified	L1 mass with extension from T12 to L3 with cord compression	Tumor resection	Large neoplastic cells with prominent eosinophilic cytoplasm, irregular nuclei, and frequent mitoses, with scattered eosinophils	Lost to follow-up	Not available
				49/M	2 wk	New back pain, left leg weakness, and numbness	Diffuse large B-cell lymphoma, not otherwise specified	L2 vertebral body pathologic fracture and a left paraspinal mass involving the kidney, psoas muscle aorta and L1–L3 vertebrae	Tumor resection, CT	Large neoplastic cells with prominent eosinophilic cytoplasm, irregular nuclei, and frequent mitoses, with scattered eosinophils	2 wk	Alive with disease
				23/M	1 mo	Progressive back pain and difficulty walking	Diffuse large B-cell lymphoma, not otherwise specified	T7–T8 vertebral body mass with epidural extension at T6–T9	Tumor resection, CT	Large neoplastic cells with prominent eosinophilic cytoplasm, irregular nuclei, and frequent mitoses, with scattered eosinophils	Not available	Alive, free of infection
				55/F	3 mo	Mid-back pain (3 mo), bilateral lower extremity weakness (2 wk), and complete sensorimotor loss (2 d)	Anaplastic large cell lymphoma	T4 vertebral mass with T3–T5 soft-tissue component and cord compression. Additional lesions in T12 vertebra, left ilium, right femur, bilateral pleural effusions, multiple lung nodules, and left frontal extra-axial mass	Tumor resection, CT	Pleomorphic population of highly atypical cells with eosinophil polymorphonuclear leukocytes; positive for CD45, CD5, and CD30	4 y	Alive, in remission
				15/M	1 mo	Back pain, tingling, and numbness of legs	B-lymphoblastic lymphoma	T9 vertebral body mass with epidural extension at T8–T10	Tumor resection, CT	Not available	Not available	Alive, free of infection

Table 1 (*Continued*)

Title	Year	DOI	Authors	Age/sex	Interval (onset-diagnosis)	Clinical features	Diagnosis	Localization	Treatment	Histological type	Follow-up	Outcome
Primary intraspinal non-Hodgkin's lymphoma: case report and review of literature	2019	10.1016/j.jocn.2018.11.046	Beume LA, Wolf K, Urbach H, Klingler JH, Staszewski O, Marks R, Weiller C, Rauer S, Hosp JA	67/F	6 wk	Inability to walk, reduced sensitivity in the lower extremities, and bowel and bladder dysfunction. Severe weakness of the right (MRC muscle scale: 1/5) and left leg (2/5), and loss of sensation below Th6. Deep tendon reflexes of the legs were absent while Babinski's sign was positive on both sides	Primary intraspinal B-cell non-Hodgkin's lymphoma	Upper border of C6: upper border of T12. Intramedullary T3–T9. Retinal infiltration	CT/BT	Pleomorphic partially lymphoid, partially blastic tumor cells with increased mitotic and proliferative activity and immunohistochemical positivity for CD20 and CD79a, with a MIB1 of 90%	Not available	Alive
Primary peripheral gamma delta T-cell lymphoma of the central nervous system: report of a the intramedullary spinal cord and presenting with myelopathy	2019	10.4132/jptm.2018.08.21	Yim J, Song SG, Kim S, Choi JW, Lee KC, Bae JM, Jeon YK	75/W	3.5 mo	Back pain and lower extremity weakness	Primary peripheral gamma-delta T-cell lymphoma	Multiple enhancing intramedullary nodular lesions in the spinal cord at T9–T10, T11, and L5 levels	T11 laminectomy and tumor removal	Diffuse infiltration of monotonous, medium-to-large atypical lymphocytes with round nuclei, condensed chromatin, pale-to-eosinophilic cytoplasm, and small inconspicuous nucleoli. Immunohistochemically, the atypical cells were CD3(+), CD20(−), TCRßF1(−), TCRγ(+), CD30(−), CD4(−), CD8(−), CD10(−), BCL-6(−), MUM1(−), CD56(+), TIA-1(+), granzyme B(focal+), and CD103(+). The Ki-67 index was about 80%	Lost to follow-up	Not available
Spinal primary central nervous system lymphoma: case report and literature review	2018	10.1016/j.jocn.2018.01.034	Li Feng, Dingbang Chen, Hongyan Zhou, Cunzhou Shen, Haiyan Wang, Xunsha Sun, Xiulin Liang, Ling Chen	45/M	1 y	Progressive tremor in the left limbs and slight dysarthria as well as 3-mo history of paraparesis, tinnitus, and insomnia. Severe dysarthria, sialorrhea, incompetent closure of the eyelids, constipation, atrophy in the left limbs, as well as paralysis and numbness in the left lower limb in 2 mo	Spinal primary central nervous system lymphoma	Cerebellum and cauda equine	First tuberculosis was suspected, treatment with isoniazid, rifampicin, pyrazinamide, and ethambutol was performed, in addition to intrathecal injections of isoniazid and dexamethasone	Cytological examination of CSF revealed abundant of lymphocytes with macronucleoli	2 wk	Deceased

(*Continued*)

Table 1 (*Continued*)

Title	Year	DOI	Authors	Age/sex	Interval (onset-diagnosis)	Clinical features	Diagnosis	Localization	Treatment	Histological type	Follow-up	Outcome
Primary spinal lymphoma masquerading as meningioma: preoperative and postoperative magnetic resonance imaging findings	2018	10.1016/j.wneu.2018.04.129	Arslan H, Yavuz A, Aycan A	55/M	Not available	Back pains with the complaints accompanied by increasing weakness in the lower extremities	Diffuse large B-cell non-Hodgkin's lymphoma	Thoracic area, the anterior epidural space and paravertebral area, approximately 55 × 9 mm	Tumor removal	Diffuse large B-cell non-Hodgkin's lymphoma	Not available	Not available
A case report of primary central nervous system lymphoma with intestinal obstruction as the initial symptom	2018	10.1097/MD.0000000000010080	Li X, Qi S, Jiao Y, Gao J, Du H	50/M	8 d	Lack of defecation for 8 d and with symptoms of abdominal distention, intermittently suffered from backache	Diffuse large B-cell lymphoma	Right of centrums of T9–T11	Tumor removal, CT	Immunohistochemical analyses showed the following: AE1/AE3 (−), Bcl-2 (−), Bcl-6 (+), CD10 (−), CD20 (+), CD3 (marginally +), CD30 (Ki-1) (−), CD31 (−), CD34 (−), CD5 (marginally +), HMB45 (−), Ki-67 (index; 40%), Mum-1 (−), and PAX-5 (+)	Lost to follow-up	Alive
Primary cauda equina lymphoma diagnosed by nerve biopsy: a case report and literature review	2018	10.3892/ol.2018.8629	Suzuki K, Yasuda T, Hiraiwa T, Kanamori M, Kimura T, Kawaguchi Y	65/M	5 mo	Gait disturbance due to motor palsy in the bilateral lower extremities, and severe numbness in his left sole	Diffuse large B-cell lymphoma, nongerminal center type	L1–S1	Cauda equina biopsy, CT (intravenous)	Atypical cells with irregular large nuclei and little cytoplasm had infiltrated into the nerve, positive for cluster of differentiation (CD)20, B-cell lymphoma 2 (BCL-2), BCL-6, multiple myeloma oncogene 1 (MUM-1), and negative for CD3, CD5, and CD10	6 y	Alive, free of infection
Wrap-around appearance: underrecognized radiologic feature of spinal lymphoma	2018	10.1016/j.wneu.2018.04.051	Patel M, Wu OC, Kasliwal MK	71/M	Not available	Neck and upper back pain	Non-Hodgkin's lymphoma	T2	T2 laminectomy and decompression, CT	Not available	Not available	Not available
Primary central nervous system lymphoma of T-cell origin: an unusual cause of spinal cord disease	2017	10.1007/s13760-016-0726-y	Sophie Fastré, Frédéric London, Julie Lelotte, Alessandra Camboni, Anne Jeanjean	45/M	Over weeks	Progressive paraparesis and numbness of his lower limbs over weeks, with bladder dysfunction. Generalized hyperreflexia and bilateral extensor plantar response	Lymphoma of T-cell origin	Hypersignal images in the left cerebellum and intramedullary cervical spinal cord with rostral extension to the brainstem	Corticosteroids, CT	Infiltration of cerebellar tissue with histiocytes and lymphocytes. Lymphoma of T-cell origin (strongly positive for CD3, CD2, CD5, and CD4, and weakly positive for CD7)	3 mo	Alive
Non-Hodgkin lymphoma of the cauda equina: a rare entity	2017	10.1080/02688697.2016.1224321	Geevarghese R, Marcus R, Aizpurua M, Al-Sarraj S, Ashkan K	46/M	3 mo	Gradually worsening lower back pain, radiating to both legs (worse on the right) accompanied with paresthesia over the genital areas, lack of sensation on passing urine and stools	Follicular grade I–II lymphoma	L4/L5 to the mid-S2 level	L4–S1 decompression and debulking, corticosteroids, CT, IMB	Positive for CD20 and a low proliferative index (Ki67; 10%)	2.5 y	Alive, free of infection

Table 1 (*Continued*)

Title	Year	DOI	Authors	Age/sex	Interval (onset-diagnosis)	Clinical features	Diagnosis	Localization	Treatment	Histological type	Follow-up	Outcome
Primary spinal marginal zone lymphoma: an unusual cause of spinal cord compression	2017	10.11604/pamj.2017.27.171.11947	Alaya Z, Achour B	67/M	2 mo	Progressive paralysis, concerned with the lower limbs	Marginal zone lymphoma	Extensive posterior epidural tissue process fromT6 to T8 in continuity with left pleural neoplastic thickening through the intervertebral homolateral foramens	Laminectomy with resection of the intraductal lesion, CT	Heterogeneous group of B-cell lymphomas derived from marginal zone cells found in the spleen's white pulp and surrounding germinal centers	Not available	Alive, free of infection
Primary intramedullary malignant lymphoma in the cervical cord with a presyrinx state	2017	10.7759/cureus.2006	Chida K, Sugawara A, Koji T, Beppu T, Mue Y, Sugai T, Ogasawara K	79/M	6 mo	Left hemiparesis with 2/5 in his upper limb and 3/5 in his lower limb and hypoesthesia in his left side from the neck to the foot. The deep tendon reflexes were increased in his left upper limb	Diffuse large B-cell lymphoma	C1–C2	Tumor removal	Diffuse proliferation of large atypical lymphocytes, positive for CD20 and CD79a, and negative for CD3	2 y	Alive
Primary spinal epidural lymphoma as a cause of spontaneous spinal anterior syndrome: a case report and literature review	2017	10.1055/s-0036-1597692	Córdoba-Mosqueda ME, Guerra-Mora JR, Sánchez-Silva MC, Vicuña-González RM, Torre AI	45/M	2 mo	High-intensity thoracic pain limiting his movements; a month later, he was accompanied by decrease in the strength of the left pelvic limb; after 2 mo, he started with weakness of both lower limbs and impaired urinary sphincter control	Diffuse large B-cell lymphoma	T1–T2	Neural decompression by posterior way and biopsy of the extradural spinal lesion, CT, RT	CD20þ, BCL-2þ, CD3þ CD5þ, CD10þ, CD30–, and Ki67 positive in 20% of neoplastic cells	Not available	Not available

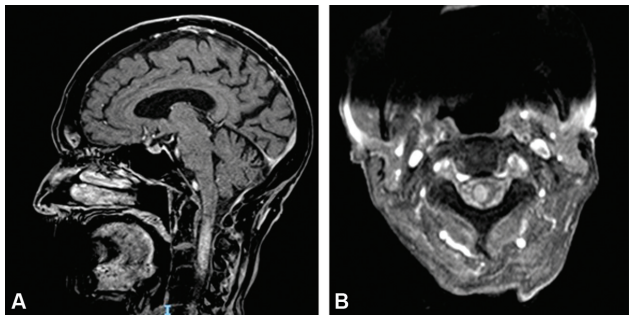

Fig. 2 (**A**) Precorticotherapy sagittal postcontrast magnetic resonance imaging (MRI). (**B**) Precorticotherapy axial T1 postcontrast.

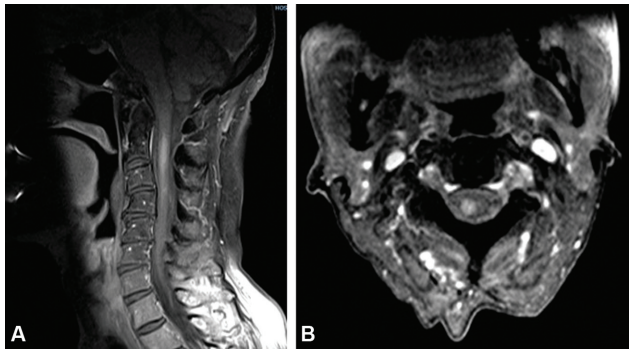

Fig. 3 (**A**) Five days after corticotherapy: sagittal T1 postcontrast magnetic resonance imaging (MRI). (**B**) Five days after corticotherapy: axial T1 postcontrast MRI.

Table 2 Immunohistochemical study

Marker	Result
BCL-2	Negative
Bcl-6	Focal positive
CD3 (Pan T)	Negative
CD10	Negative
CD20 (Pan B)	Positive
CD30	Negative
CD79a	Positive
Cyclin D1	Negative
Ki67	Positive in 90% of the neoplastic cells
MUM-1	Focal positive
Tdt	Negative
C-MYC	Negative

Discussion

Spine tumors can be branched between extradural, intradural extramedullary, and intradural intramedullary, the latter being (IMSCTs) rare neoplasms that can be subdivided into gliomas (ependymomas and astrocytomas) and hemangioblastomas, all of which may be responsible for neurological dysfunction and deterioration.[28] The pathophysiology of these lesions varies: ependymomas are encapsulated tumors, mostly benign; spinal astrocytomas are less aggressive than when developed in the brain, but nerve fiber stretching can cause pain and neurologic defects; hemangioblastomas are highly vascular tumors and can cause mass effect due to capillary hyperpermeability.[29] Also, metastatic intramedullary tumors can occur, usually arising from primary neoplasms such as of the lung and breast.[28] Intramedullary spinal cord metastasis (ISCM) can also be secondary to malignant melanoma, since it can present with paraparesis, quadriparesis, and urinary and/or fecal incontinence, but it is an extremely difficult diagnosis of exclusion.[30]

The primary malignant melanoma is also an intramedullary tumor that can occur in the spinal cord, but it is still little described. It accounts for 1% of all cases of melanoma,

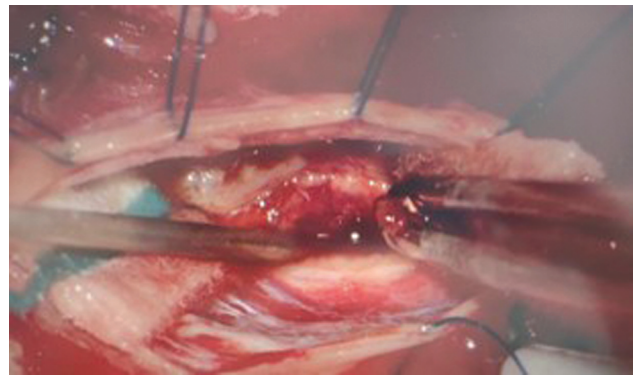

Fig. 4 Postbiopsy axial T1 postcontrast magnetic resonance imaging (MRI).

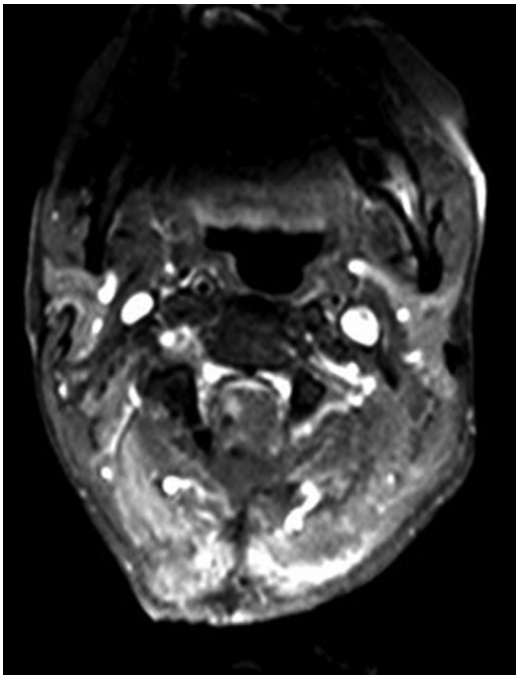

Fig. 5 Tumor resection: intraoperative image.

Table 3 Sensory sensation loss depending on the nerve tract involved (Brown-Séquard syndrome [BSS])

Dorsal columns	Fine touch, vibration, two-point discrimination, and conscious proprioception ipsilaterally affected
Spinothalamic tract	Pain, temperature, and crude touch contralaterally affected
Dorsal and ventral spinocerebellar tracts	Dorsal: ipsilateral dystaxia and involvement Ventral: contralateral dystaxia
Horner's syndrome (lesion at or above T1)	Ptosis, miosis, and anhidrosis (due to ipsilateral loss of sympathetic fibers), facial redness (due to vasodilation)
Corticospinal tracts	At the site of the lesion: ipsilateral loss of movements, presenting flaccid paralysis, lower motor neuron lesion like loss of muscle mass, fasciculations, and decreased power and tone Below the level of lesion: paralysis with hypertonia clasp knife type, hyperreflexia, and positive Babinski's sign

Source: Shams and Arain.[5]

indicating the lesion is extremely unique, with the diagnosis requiring histopathological confirmation and excluding metastatic spread from other areas.[30] This diagnosis was considered especially because of the patient's Fitzpatrick type II classification.

Additionally, the patient also had a medical history of a non-Hodgkin's lymphoma from 7 years ago, which hinted to a possible recidivistic lymphoma. Intramedullary lesions can therefore be subdivided into glial tumors, nonglial tumors such as lymphomas and benign lesions, exemplified by epidermoid cysts, lipomas,[28] and, rarely, abscesses.[31]

Lymphomas develop from progressive mutations in the deoxyribonucleic acid (DNA), namely, amplification, deletion, or chromosomal translocations. Non-Hodgkin's lymphomas arise from mature B lymphocytes and may have small portions of T lymphocytes or natural killer cells. Some subtypes may also be associated with infections, such as Epstein–Barr virus, *Helicobacter pylori*, and hepatitis C virus.[32] Primary central nervous system lymphoma (PCNSL) is an extranodal non-Hodgkin's lymphoma whose known causes can commonly be human immunodeficiency virus (HIV), chronic immunosuppression, and organ transplantation. Studies show that the human T-lymphotropic virus type 1 (HTLV-1) virus can also be associated with the appearance of T-cell lymphomas of the spinal cord. According to Urasaki et al, the virus probably migrates from blood to the parenchyma of the CNS, but does not proliferate. Thus, parainfectious myelitis is believed to occur.[33] However, this disease can develop in immunocompetent patients, as already seen in association with rheumatoid arthritis and systemic lupus erythematosus.[34] These relations could not be found in the patient's history.

The most conclusive sign of intramedullary lesion was the presentation of BSS, which is little described in the literature as a PCNSL manifestation. BSS is a result of hemisection of the spinal cord and manifests with weakness or paralysis and ipsilateral proprioceptive deficits and loss of pain and temperature sensation on the contralateral side of the lesion, indicating a diverse severity.[5] Partial hemisection is more evident and includes nerve tracts in the injured area. Therefore, the sensory sensations affected depend on the site of the lesion (►**Table 3**).

The most common intramedullary location is the cervical cord, as seen in our case, followed by the thoracic, then the lumbar cord.[35] It is common to observe a delay on its diagnosis, due to its rarity, similarity to other causes of myelopathy, and the difficulties in obtaining viable histological samples and pathologic diagnosis.[36] Intramedullary spinal cord lymphoma is very rare. It is seen in less than 1% of primary CNS lymphomas.[37]

Longitudinally extensive transverse myelopathy (LETM) is common and is usually inflammatory, demyelinating, related to connective tissue disease, due to sarcoidosis or paraneoplastic causes,[38] but uncommon on lymphomas. The presentation of LETM may be associated with brain lesions, and other differentials such as neuromyelitis optica (NMO) spectrum disorders are considered, leading to delay in diagnosis and may be fatal if not suspected or detected. Two case series of LETM[39] showed that none of the patients evaluated had lymphoma as diagnosis although our patient and one other reported case presented it.[40]

Even though spinal cord expansion is usually present, some patients may have minimal enlargement.[41] Lesions are generally poorly defined, syringomyelia is rare, hemorrhagic component usually does not appear as a component,[42] and cysts are not usually present.[41] Involvement of the brain is reported, within the brainstem, cerebellum, deep gray matter, or cerebral cortex.[43] Peripheral nerve involvement has been described as well.[44]

Reported signal characteristics include T1: isointense to the spinal cord/T2: hyperintense (contrasts with the characteristic low T2 signal intensity that is seen in intracranial lesions)/T1 C+ (Gd): usually solid and homogeneous enhancement.[45]

The patient evolved with loss of strength and hemiparesis on the right side of the body and superficial hemiparesthesia on the left side, thus suggesting BSS, which was confirmed by imaging tests.

Conclusion

Intramedullary lesions can be related to several pathologies, such as tumors and lymphomas. Even if the etiology is different, most of the time the clinical presentation is similar.

Occurrence of BSS is commonly concurrent to the intramedullary lesions and is valuable evidence of a spinal cord hemisection. Therefore, it is difficult to differentiate the two conditions. In this case, the patient's medical history played a major role in the diagnosis, but the etiology and treatment of the disease could be elucidated only after a biopsy. Thus, it is important to stress the value of surgical procedures to conclude neurological diagnosis.

Funding
None.

Conflict of Interest
None declared.

References

1 Das JM, Hoang S, Mesfin FB. Intramedullary spinal cord tumors. StatPearls; 2022. Accessed August 3, 2022 at: https://www.ncbi.nlm.nih.gov/books/NBK442031/
2 Yang W, Garzon-Muvdi T, Braileanu M, et al. Primary intramedullary spinal cord lymphoma: a population-based study. Neurooncol 2017;19(03):414–421
3 Lv C, Wang J, Zhou M, Xu JY, Chen B, Wan Y. Primary central nervous system lymphoma in the United States, 1975-2017. Ther Adv Hematol 2022;13:20406207211066166
4 Löw S, Han CH, Batchelor TT. Primary central nervous system lymphoma. Ther Adv Neurol Disord 2018;11:1756286418793562
5 Shams S, Arain A. Brown Sequard Syndrome. StatPearls; 2022. Accessed August 3, 2022 at: https://www.ncbi.nlm.nih.gov/books/NBK538135/
6 Aycan A, Celik S, Kuyumcu F, et al. Spinal metastasis of unknown primary accompanied by neurologic deficit or vertebral instability. World Neurosurg 2018;109:e33–e42
7 Chen W, Hika B, Smith CJ, Parrett TJ, Mesfin FB. A conservative approach to the treatment of a rare case of cervical spine double expressor diffuse large B-cell lymphoma: a case report. Cureus 2022;14(01):e21208
8 Iriyama C, Murate K, Iba S, et al. Detection of circulating tumor DNA in cerebrospinal fluid prior to diagnosis of spinal cord lymphoma by flow cytometric and cytologic analyses. Ann Hematol 2022;101(05):1157–1159
9 Erdem MB, Kale A, Yaman ME, Emmez H. A rare entity in the lumbar epidural region: T-cell lymphoblastic lymphoma. Int J Spine Surg 2021;14(s4):S52–S56
10 De Vries J, Oterdoom MD, Den Dunnen WF, et al. Primary cauda equina T-cell lymphoblastic lymphoma. World Neurosurg 2020;142:227–232
11 Natteru PA, Shekhar S, Nair LR, Uschmann H. Primary central nervous system lymphoma mimicking longitudinally extensive transverse myelitis. Neurohospitalist 2021;11(02):170–174
12 Wang D, Su M, Xiao J. A rare case of primary ventricular lymphoma presented on FDG PET/CT. Clin Nucl Med 2020;45(02):156–158
13 Singh SS, Mittal BR, Kumar R, Singh H, Balaini N, Goyal M. Primary central nervous system lymphoma with diffuse neurolymphomatosis involving multiple cranial and spinal nerve roots. Clin Nucl Med 2020;45(06):e285–e287
14 Fakhouri F, Shoumal N, Obeid B, Alkhoder A. Primary diffuse large B-cell non-Hodgkin's lymphoma of the thoracic spine presented initially as an epigastric pain. Asian J Neurosurg 2020;15(01):162–164
15 Pandey S, Gokden M, Kazemi NJ, Post GR. Hematolymphoid malignancies presenting with spinal epidural mass and spinal cord compression: a case series with rare entities. Ann Clin Lab Sci 2019;49(06):818–828
16 Beume LA, Wolf K, Urbach H, et al. Primary intraspinal non-Hodgkin's lymphoma: case report and review of literature. J Clin Neurosci 2019;61:262–264
17 Yim J, Song SG, Kim S, et al. Primary peripheral gamma delta T-cell lymphoma of the central nervous system: Report of a case involving the intramedullary spinal cord and presenting with myelopathy. J Pathol Transl Med 2019;53(01):57–61
18 Feng L, Chen D, Zhou H, et al. Spinal primary central nervous system lymphoma: case report and literature review. J Clin Neurosci 2018;50:16–19
19 Arslan H, Yavuz A, Aycan A. Primary spinal lymphoma masquerading as meningioma: preoperative and postoperative magnetic resonance imaging findings. World Neurosurg 2018;118:86–87
20 Li X, Qi S, Jiao Y, Gao J, Du H. A case report of primary central nervous system lymphoma with intestinal obstruction as the initial symptom. Medicine (Baltimore) 2018;97(10):e0080
21 Suzuki K, Yasuda T, Hiraiwa T, Kanamori M, Kimura T, Kawaguchi Y. Primary cauda equina lymphoma diagnosed by nerve biopsy: a case report and literature review. Oncol Lett 2018;16(01):623–631
22 Patel M, Wu OC, Kasliwal MK. Wrap-around appearance: underrecognized radiologic feature of spinal lymphoma. World Neurosurg 2018;115:157–158
23 Fastré S, London F, Lelotte J, Camboni A, Jeanjean A. Primary central nervous system lymphoma of T-cell origin: an unusual cause of spinal cord disease. Acta Neurol Belg 2017;117(03):765–767
24 Geevarghese R, Marcus R, Aizpurua M, Al-Sarraj S, Ashkan K. Non-Hodgkin lymphoma of the cauda equina: a rare entity. Br J Neurosurg 2017;31(06):734–735
25 Alaya Z, Achour B. Primary spinal marginal zone lymphoma: an unusual cause of spinal cord compression. Pan Afr Med J 2017;27:171
26 Chida K, Sugawara A, Koji T, et al. Primary intramedullary malignant lymphoma in the cervical cord with a presyrinx state. Cureus 2017;9(12):e2006
27 Córdoba-Mosqueda ME, Guerra-Mora JR, Sánchez-Silva MC, Vicuña-González RM, Torre AI. Primary spinal epidural lymphoma as a cause of spontaneous spinal anterior syndrome: a case report and literature review. J Neurol Surg Rep 2017;78(01):e1–e4
28 Samartzis D, Gillis CC, Shih P, O'Toole JE, Fessler RG. Intramedullary spinal cord tumors: part i-epidemiology, pathophysiology, and diagnosis. Global Spine J 2015;5(05):425–435
29 Ogden AT, Francavilla TL. Intramedullary Spinal Cord Tumors. Medscape; 2020. Accessed August 3, 2022 at: https://emedicine.medscape.com/article/251133
30 Tuz Zahra F, Ajmal Z, Qian J, Wrzesinski S. Primary intramedullary spinal melanoma: a rare disease of the spinal cord. Cureus 2021;13(07):e1619
31 Raffa PEAZ, Vencio RCC, Ponce ACC, et al. Spinal intramedullary abscess due to *Candida albicans* in an immunocompetent patient: a rare case report. Surg Neurol Int 2021;12:275
32 Bowzyk Al-Naeeb A, Ajithkumar T, Behan S, Hodson DJ. Non-Hodgkin lymphoma. BMJ 2018;362:k3204
33 Urasaki E, Yamada H, Tokimura T, Yokota A. T-cell type primary spinal intramedullary lymphoma associated with human T-cell lymphotropic virus type I after a renal transplant: case report. Neurosurgery 1996;38(05):1036–1039
34 Mullangi S, Lekkala MR. CNS Lymphoma. StatPearls; 2021. Accessed August 3, 2022 at: https://www.ncbi.nlm.nih.gov/books/NBK563302/
35 Dähnert W. Radiology Review Manual. Nucl Med Commun 2011;32(10):195–196
36 Flanagan EP, O'Neill BP, Porter AB, Lanzino G, Haberman TM, Keegan BM. Primary intramedullary spinal cord lymphoma. Neurology 2011;77(08):784–791
37 Hochberg FH, Miller DC. Primary central nervous system lymphoma. J Neurosurg 1988;68(06):835–853

38 Kitley JL, Leite MI, George JS, Palace JA. The differential diagnosis of longitudinally extensive transverse myelitis. Mult Scler 2012; 18(03):271–285
39 Cobo-Calvo Á, Alentorn A, Mañé Martínez MA, et al. Etiologic spectrum and prognosis of longitudinally extensive transverse myelopathies. Eur Neurol 2014;72(1-2):86–94
40 Elavarasi A, Dash D, Warrier AR, et al. Spinal cord involvement in primary CNS lymphoma. J Clin Neurosci 2018;47: 145–148
41 Fitzsimmons A, Upchurch K, Batchelor T. Clinical features and diagnosis of primary central nervous system lymphoma. Hematol Oncol Clin North Am 2005;19(04):689–703, vii
42 Haque S, Law M, Abrey LE, Young RJ. Imaging of lymphoma of the central nervous system, spine, and orbit. Radiol Clin North Am 2008;46(02):339–361, ix
43 Bekar A, Cordan T, Evrensel T, Tolunay S. A case of primary spinal intramedullary lymphoma. Surg Neurol 2001;55(05):261–264
44 Schwarz S, Zoubaa S, Knauth M, Sommer C, Storch-Hagenlocher B. Intravascular lymphomatosis presenting with a conus medullaris syndrome mimicking disseminated encephalomyelitis. Neuro-oncol 2002;4(03):187–191
45 Iqbal S, Wein S. Lymphoma of the spinal cord. Radiopaedia.Org.; 2012. Accessed March 17, 2023 at: https://doi.org/10.53347/rid-19279

Appendix 1

("lymphoma"[MeSH Terms] OR "lymphoma"[All Fields] OR "lymphomas"[All Fields] OR "lymphoma s"[All Fields] OR ("composite lymphoma"[MeSH Terms] OR ("composite"[All Fields] AND "lymphoma"[All Fields]) OR "composite lymphoma"[All Fields]) OR ("hodgkin disease"[MeSH Terms] OR ("hodgkin"[All Fields] AND "disease"[All Fields]) OR "hodgkin disease"[All Fields]) OR ("lymphoma, non hodgkin"[MeSH Terms] OR ("lymphoma"[All Fields] AND "non hodgkin"[All Fields]) OR "non-hodgkin lymphoma"[All Fields] OR ("lymphoma"[All Fields] AND "non"[All Fields] AND "hodgkin"[All Fields]) OR "lymphoma non hodgkin"[All Fields]) OR ("lymphoma, b cell"[MeSH Terms] OR ("lymphoma"[All Fields] AND "b cell"[All Fields]) OR "b-cell lymphoma"[All Fields] OR "lymphoma b cell"[All Fields]) OR ("lymphoma, follicular"[MeSH Terms] OR ("lymphoma"[All Fields] AND "follicular"[All Fields]) OR "follicular lymphoma"[All Fields] OR ("lymphoma"[All Fields] AND "follicular"[All Fields]) OR "lymphoma follicular"[All Fields]) OR ("lymphoma, large cell, immunoblastic"[MeSH Terms] OR ("lymphoma"[All Fields] AND "large cell"[All Fields] AND "immunoblastic"[All Fields]) OR "immunoblastic large-cell lymphoma"[All Fields] OR ("lymphoma"[All Fields] AND "large"[All Fields] AND "cell"[All Fields] AND "immunoblastic"[All Fields]) OR "lymphoma large cell immunoblastic"[All Fields]) OR ("lymphoma, mantle cell"[MeSH Terms] OR ("lymphoma"[All Fields] AND "mantle cell"[All Fields]) OR "mantle-cell lymphoma"[All Fields] OR ("lymphoma"[All Fields] AND "mantle"[All Fields] AND "cell"[All Fields]) OR "lymphoma mantle cell"[All Fields]) OR ("lymphoma, t cell"[MeSH Terms] OR ("lymphoma"[All Fields] AND "t cell"[All Fields]) OR "t-cell lymphoma"[All Fields] OR "lymphoma t cell"[All Fields]) OR ("lymphoma"[MeSH Terms] OR "lymphoma"[All Fields] OR "lymphomas"[All Fields] OR "lymphoma s"[All Fields]) OR ("lymphoma"[MeSH Terms] OR "lymphoma"[All Fields] OR ("lymphoma"[All Fields] AND "malignant"[All Fields]) OR "lymphoma malignant"[All Fields]) OR ("lymphoma"[MeSH Terms] OR "lymphoma"[All Fields] OR ("lymphomas"[All Fields] AND "malignant"[All Fields]) OR "lymphomas malignant"[All Fields]) OR ("lymphoma"[MeSH Terms] OR "lymphoma"[All Fields] OR ("malignant"[All Fields] AND "lymphoma"[All Fields]) OR "malignant lymphoma"[All Fields]) OR ("lymphoma"[MeSH Terms] OR "lymphoma"[All Fields] OR ("malignant"[All Fields] AND "lymphomas"[All Fields]) OR "malignant lymphomas"[All Fields])) AND ("spinal cord neoplasms"[MeSH Terms] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "spinal cord neoplasms"[All Fields] OR ("spinal cord neoplasms"[MeSH Terms] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "spinal cord neoplasms"[All Fields] OR ("tumors"[All Fields] AND "spinal"[All Fields] AND "cord"[All Fields]) OR "tumors spinal cord"[All Fields]) OR ("spinal cord tumour"[All Fields] OR "spinal cord neoplasms"[MeSH Terms] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "spinal cord neoplasms"[All Fields] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "tumor"[All Fields]) OR "spinal cord tumor"[All Fields]) OR ("spinal cord tumours"[All Fields] OR "spinal cord neoplasms"[MeSH Terms] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "spinal cord neoplasms"[All Fields] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "tumors"[All Fields]) OR "spinal cord tumors"[All Fields]) OR ("spinal cord neoplasms"[MeSH Terms] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "spinal cord neoplasms"[All Fields] OR ("tumor"[All Fields] AND "spinal"[All Fields] AND "cord"[All Fields]) OR "tumor spinal cord"[All Fields]) OR ("spinal cord neoplasms"[MeSH Terms] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "spinal cord neoplasms"[All Fields] OR ("neoplasms"[All Fields] AND "spinal"[All Fields] AND "cord"[All Fields]) OR "neoplasms spinal cord"[All Fields]) OR ("spinal cord neoplasms"[MeSH Terms] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "spinal cord neoplasms"[All Fields] OR ("neoplasm"[All Fields] AND "spinal"[All Fields] AND "cord"[All Fields])) OR ("spinal cord neoplasms"[MeSH Terms] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "spinal cord neoplasms"[All Fields] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasm"[All Fields]) OR "spinal cord neoplasm"[All Fields]) OR ("spinal cord neoplasms"[MeSH Terms] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "spinal cord neoplasms"[All Fields] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields] AND "malignant"[All Fields])) OR ("spinal cord neoplasms"[MeSH Terms] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "spinal cord neoplasms"[All Fields] OR ("intramedullary"[All Fields] AND "spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields] AND "primary"[All Fields])) OR ("spinal cord neoplasms"[MeSH Terms] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "spinal cord neoplasms"[All Fields] OR ("primary"[All Fields] AND "intramedullary"[All Fields] AND "spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "primary intramedullary spinal cord neoplasms"[All Fields]) OR ("spinal cord neoplasms"[MeSH Terms] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "spinal cord neoplasms"[All Fields] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields] AND "primary"[All Fields] AND "intramedullary"[All Fields])) OR ("spinal cord neoplasms"[MeSH Terms] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "spinal cord neoplasms"[All Fields] OR ("primary"[All Fields] AND "spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields] AND "intramedullary"[All Fields]) OR "primary spinal cord neoplasms intramedullary"[All Fields]) OR ("spinal cord neoplasms"[MeSH Terms] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "spinal cord neoplasms"[All Fields] OR ("spinal"[All Fields] AND

"cord"[All Fields] AND "neoplasms"[All Fields] AND "benign"[All Fields])) OR ("spinal cord neoplasms"[MeSH Terms] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "spinal cord neoplasms"[All Fields] OR ("intradural"[All Fields] AND "extramedullary"[All Fields] AND "spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "intradural extramedullary spinal cord neoplasms"[All Fields]) OR ("spinal cord neoplasms"[MeSH Terms] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "spinal cord neoplasms"[All Fields] OR ("intradural"[All Fields] AND "extramedullary"[All Fields] AND "spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "intradural extramedullary spinal cord neoplasms"[All Fields]) OR ("spinal cord neoplasms"[MeSH Terms] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "spinal cord neoplasms"[All Fields] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields] AND "intradural"[All Fields] AND "extramedullary"[All Fields])) OR ("spinal cord neoplasms"[MeSH Terms] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "spinal cord neoplasms"[All Fields] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields] AND "intradural"[All Fields] AND "extramedullary"[All Fields])) OR ("spinal cord neoplasms"[MeSH Terms] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "spinal cord neoplasms"[All Fields] OR ("intramedullary"[All Fields] AND "spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "intramedullary spinal cord neoplasms"[All Fields]) OR ("spinal cord neoplasms"[MeSH Terms] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields]) OR "spinal cord neoplasms"[All Fields] OR ("spinal"[All Fields] AND "cord"[All Fields] AND "neoplasms"[All Fields] AND "intramedullary"[All Fields]) OR "spinal cord neoplasms intramedullary"[All Fields])).

