Intramedullary Spinal Cord Lesion: A Radiological Review.

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Learning objectives

1. To review the different types of intramedullary spinal cord tumors in children and adults.

2. To teach epidemiological, pathophysiological and clinical aspects associated with each tumor.

3. To show the image acquisition protocol of magnetic resonance imaging to perform the diagnosis.

4. To review the magnetic resonance imaging features of the intramedullary spinal cord tumors.
Background

Intramedullary tumors are rare neoplasms, representing about 4-10% of all tumors of the central nervous system. They are 10 times less common than intracranial tumors, although histologically are similar.

Due to its location, these tumors produce severe neurological impairment, poor quality of life and even death. Gliomas represent 80% of all intramedullary tumors and there are divided into 2 groups: astrocytomas and ependymomas. The most common histological type in adults is the ependymoma and in children is the astrocytoma. Hemangioblastoma is the third tumor in frequency of occurrence with a prevalence of 15%. In the remaining 5% are the metastases, primary lymphoma, paragangliomas and primitive neuroectodermal tumors.
INTRODUCTION

Intramedullary tumors are rare neoplasms, representing about 4-10% of all tumors of the central nervous system (CNS) and about 2%-4% of CNS glial tumors [1]. They can potentially lead to severe neurologic deterioration, decreased function, poor quality of life, or even death, and are 10 times less common than intracranial tumors, although histologically are similar.

Intradural intramedullary compartment represents the spinal cord itself, which explains the predominance of glial tumors (90%) located here. Non-glial tumors are much less common (10%).

Gliomas are divided into 2 groups: astrocytomas (60 to 70%) and ependymomas (30 to 40%) [2]. The most common histological type in adults is the ependymoma and in children is the astrocytoma. Hemangioblastoma is the third tumor in frequency of occurrence with a prevalence of 15%. In the remaining 5% are the metastases, primary lymphoma, paragangliomas and primitive neuroectodermal tumors [3][4].

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Preoperative neurologic status and tumor histology are two of the most important variables affecting treatment outcome with these lesions, being the magnetic resonance (MR) imaging the preoperative study of choice to narrow the differential diagnosis and guide surgical resection [5-8] For treatment planning it is crucial to differentiate between non-neoplastic diseases and tumors of the spine.

By making the differential diagnosis, the intramedullary signal changes in the absence of medullary expansion, favor a non-neoplastic, such as degenerative motor neuron
disease (eg., Amyotrophic lateral sclerosis) etiology, inflammatory diseases (eg., polio, chronic demyelination associated with multiple sclerosis), vascular causes (eg., no hemorrhagic infarction spinal cord, amyloid angiopathy) or gliosis (eg., chronic compressive myelopathy).

![Image of consecutive axial T2-weighted MR images showing an abnormal area of high signal intensity (yellow arrow) in the center thoracic spinal cord with progressive expansion due to an intramedullary tumor (Astrocitoma).](image)

**Fig. 3:** Consecutive axial T2-weighted MR images reveal an abnormal area of high signal intensity (yellow arrow) of the center thoracic spinal cord with progressive expansion, due to an intramedullary tumor (Astrocitoma).

**References:** Department of Radiology, Clinical University Hospital Virgen de la Arrixaca, Murcia/Spain 2015.

**EPENDYMOMA**

Ependymomas are the most common intramedullary spinal tumors in adults, constituting up to 60% of all intramedular tumors [1]. These lesions tend to manifest in young adulthood, the average age of onset is around 40 years and there is a slight predominance in males. Spinal ependymomas account for 30% of all CNS ependymomas.

Usually these tumors are solitary, but there may be presence of multiple ependymomas in the spinal cord, often in partnership with other spinal masses (eg., Schwannomas and meningiomas) or in patients with neurofibromatosis type 2 (NF2) [9]. Multiple or isolated ependymomas in the intramedullary space, may also appear as secondary metastases of a primary intracranial or spinal ependymoma.
Fig. 4: Ependimoma of dorsal spine cord. Intraoperative photograph demonstrates a lobulated oval intramedullary mass in the thoracic spine cord.


The primary low-grade ependymomas spine (Grade I and II according to the World Health Organization (WHO), namely the myxopapillary ependymoma and classic ependymoma, respectively, are much more common than high-grade (WHO grade III: anaplastic ependymomas).

CLINICAL PRESENTATION:

Patients present a history of mild and slowly progressive neurological deterioration. The slow tumor growth and the tendency to compress, rather than infiltrate adjacent neural tissue, often leads to delay the primary diagnosis. The mean duration of symptoms is 36 months [10-13].

At the time of diagnosis most patients complain of back pain and segmental sensory and / or motors focal deficits, depending on tumor location. Sensory symptoms are the predominant complaints and are probably due to compression or disruption of spinothalamic tracts. [3]. Dominant motor symptoms are commonly associated with very large ependymomas and the surgical risk is increased. The patient’s preoperative status is the most important predictor of outcome [10-12]. The most common sites of extraspinal metastatic spread are the lungs, retroperitoneum and lymph nodes [14].
MRI FINDINGS:

T1-weighted images: Iso or slightly hyperintense relative to the spinal cord. In rares cases are hyperintense secondary to hemorrhage.

T2-weighted images: Hyperintense relative to the spinal cord.

Cap sign: A hypointense rim at the poles of the tumor (hemosiderin).

Contrast-enhanced T1-weighted images: homogeneous enhancement.

+/- Perilesional edema and probable syringomyelia.

They may have meningeal enhancement.

**Fig. 5:** 10-year-old child with a 6-month history of neck pain and upper and lowe extremity weakness. (A) Sagittal T1-weighted MR image shows an large oval intramedullar mass isointense to slightly hyperintense relative to the spinal cord, from C1 through T1 (arrow). (B) Sagittal T2-weighted MR image reveals an large oval intramedullar mass hyperintense relative to the spinal cord (arrow), and inferior syringohydromyelia. (C) Sagittal fat-suppressed T1-weighted MR image obtained after paramagnetic contrast administration demonstrates a large oval intramedullar well defined mass with moderate heterogeneous enhancement (arrow).

**References:** Department of Radiology, Clinical University Hospital Virgen de la Arrixaca, Murcia/Spain 2015.
Fig. 6: 10-year-old child with a 6-month history of neck pain and upper and lower extremity weakness. Post-biopsy images. (A) Sagittal T2-weighted MRI shows an large oval intramedullar mass, isointense to slightly hyperintense relative to the spinal cord, from C1 through T1 (pink arrow) with a small post-biopsy cavity in the inferior aspect of the tumor (green arrow) and inferior syringohydromyelia. (B) Sagittal fat-suppressed T1-weighted MR image obtained after paramagnetic contrast administration demonstrates a large oval intramedullar well defined mass with moderate heterogeneous enhancement (pink arrow), and a small post-biopsy cavity in the inferior aspect of the tumor (green arrow).

References: Department of Radiology, Clinical University Hospital Virgen de la Arrixaca, Murcia/Spain 2015.
Fig. 7: Ependimoma of cervical spine cord. Intraoperative photograph demonstrates a lobulated oval intramedullary mass in the cervical spine cord. Results of histologic examination revealed ependymoma.

References: Department of Neurosurgery, Clinical University Hospital Virgen de la Arrixaca, Murcia/Spain 2015.

MYXOPAPILLARY EPENDYMOMA

Filum terminale myxopapillary ependymoma is a histological variant that constitutes about 13% of all ependymomas, but over 80% of all ependymomas located in the conus and filum terminale. These tumors are located extramedullary and are predominantly men. The average age at time of presentation is under 35 years.
Fig. 8: Intraoperative photograph demonstrates a lobulated oval intradural mass next to the terminal filum.


CLINICAL PRESENTATION:

It is characterized by back pain with or without sciatica irradiation, which are easily confused with other conditions of back pain, delaying diagnosis for long periods of time [16].

MRI FINDINGS:

Myxopapillary Ependymomas have a nonspecific radiologic appearance, and are typically:

T1-weighted images: Isointense relative to the spinal cord.

T2-weighted images: Hyperintense relative to the spinal cord.

Hyperintense on T1 - and T2-weighted images due to mucin content or hemorrhage.

Contrast-enhanced T1-weighted images: homogeneous enhancement.

Its predilection for the conus medullaris should be suggestive of the diagnosis.
Fig. 9: Myxopapillary ependymoma of the filum terminale in a 42-year-old woman with 18 months history of progressive lower-extremity weakness and numbness. (A) Sagittal T1-weighted MR image shows an intradural oval mass (green arrow) in the L3 level. It presents slightly hyperintense relative to the spinal cord (arrowhead). (B) Sagittal T2-weighted MR image reveals a mass of heterogeneous signal intensity from L3 to L5 (green arrows).

References: Department of Radiology, Clinical University Hospital Virgen de la Arrixaca, Murcia/Spain 2015.
Fig. 10: Myxopapillary ependymoma of the filum terminale in a 42-year-old woman with 18 months history of progressive lower-extremity weakness and numbness. (A) Axial T1-weighted MR image shows a intramedullary oval mass (arrow) slightly hyperintense. (B) Axial T2-weighted MR image reveals a central mass of heterogeneous signal intensity.

References: Department of Radiology, Clinical University Hospital Virgen de la Arrixaca, Murcia/Spain 2015.

The prognosis after surgical treatment will depend on the prior neurological status and especially the size of the tumor. This is the main determinant for total resection.
Fig. 11: Intraoperative photograph demonstrates a lobulated oval intradural mass next to the terminal filum.


SUBEPENDYMOMA

Subependymoma, which is another variant of ependymoma, rarely appears in the spinal cord and have only about 40 cases reported in the literature. It is estimated that by their benign course, 50% are asymptomatic for life and therefore are rather incidentally at autopsy. When they are symptomatic, patients are usually men (2: 1) and with over 40 years of age [1].
**Fig. 12:** Subependymoma Intraoperative photograph. 61-year-old woman with intramedullary lesion at C3-C4.


**CLINICAL PRESENTATION:**

These tumors produce a slowly progressive clinical course with pain as the most common symptom.

**MRI FINDINGS:**

Fusiform dilatation with well-defined borders of the spinal cord.

Eccentric location.

50% show enhancement with defined margins.

MR imaging findings are not sufficiently unique to enable the differentiation of ependymomas from subependymomas.

**ASTROCYTOMA**
Astrocytomas are tumors that arise from astrocytes, and are the most common glial tumors. About one-third of all spinal cord gliomas are astrocytomas.

These tumors are graded on a scale from I to IV (WHO), based on how normal or abnormal the cells look. There are low-grade astrocytomas and high-grade astrocytomas. Low-grade astrocytomas are usually localized and grow slowly. High-grade astrocytomas have a rapid grow and require a different course of treatment. Most astrocytoma tumors in children are low grade. In adults, the majority are high grade. Male patients are more commonly affected [10,12]. The most common site of involvement is the thoracic cord, followed by cervical cord [12,16]. Astrocytomas in the filum terminale are rares and more common in children.

Fig. 13: Astrociroma of the thoracic spine cord. Intraoperative photograph show a lobulated oval intramedullary mass in the thoracic spine cord.

· Pilocytic Astrocytoma *(also called Juvenile Pilocytic Astrocytoma)*. These grade I astrocytomas typically stay in the area where they started and do not spread. They are considered the "most benign" (non-cancerous) of all the astrocytomas. The two others less well known grade I astrocytomas are: cerebellar astrocytoma and desmoplastic infantile astrocytoma.

· Diffuse Astrocytoma *(also called Low-Grade or Astrocytoma Grade II)* Types: Fibrillary, Gemistocytic, Protoplasmic Astrocytoma-These grade II astrocytomas tend to invade surrounding tissue and slow growth.

· Anaplastic Astrocytoma-An anaplastic astrocytoma is a grade III tumor. These rare tumors require more aggressive treatment than benign pilocytic astrocytoma.

· Astrocytoma Grade IV *(also called Glioblastoma, previously named "Glioblastoma Multiforme," "Grade IV Glioblastoma," and "GBM")*- There are two types of astrocytoma grade IV-primary, or *de novo*, and secondary. Primary tumors are very aggressive and the most common form of astrocytoma grade IV. The secondary tumors are those which originate as a lower-grade tumor and develop into a grade IV tumor.

· Subependymal Giant Cell Astrocytoma are ventricular tumors associated with tuberous sclerosis. (ref: american brain tumor association).

**CLINICAL PRESENTATION:**

Headaches, seizures, memory loss, and changes in behavior are the most common early symptoms of astrocytoma. The symptoms are similar to ependymomas, with pain and sensory deficits (53%) and motor dysfunction (41%). Walking abnormalities (27%), torticolis (27%) and scoliosis (24%) are also seen [17].

**MRI FINDINGS:**

T1-weighted images: Expansion of the spinal cord. Usually <4 segments.

+/- Proximal portion slightly hyperintense cystic CSF (hydromyelia)

Solid portion hypointense / isointense.

T2-weighted images: hyperintense lesion.

Contrast-enhanced T1-weighted images: 20-30% do not enhance.

Medium / heavy enhance. Partial> Total.

Heterogeneous / infiltrating> homogeneous / delimited.
The cap sign is not associated with cord astrocytomas [18].

![Fig. 14: Intramedullary Astrocytoma. 18 months-old child with 4 months history of progressive lower-extremity weakness and numbness, and bowel and bladder dysfunction. (A)Consecutive Sagittal T2-weighted MR images show a intramedullary oval mass (arrow), well defined, from T11 to L1, with hyperintense signal relative to the spinal cord. (B) Consecutive axial T2-weighted MR images reveal a central, expansive and well defined mass, with hyperintense signal relative to the spinal cord. References: Department of Radiology, Clinical University Hospital Virgen de la Arrixaca, Murcia/Spain 2015.](image-url)
**Fig. 15:** Intramedullary Astrocytoma. 18 months-old child with 4 months history of progressive lower-extremity weakness and numbness, and bowel and bladder dysfunction. (A) Consecutive Sagittal T1-weighted MR images show a intramedullary oval mass (yellow arrow), well defined, from T11 to L1, with hypointense signal relative to the spinal cord. (B) Consecutive sagittal fat-suppressed T1-weighted MR images obtained after paramagnetic contrast administration demonstrate a well-circumscribed oval mass (arrow) with moderate heterogeneous enhancement from T11 to L1.

**References:** Department of Radiology, Clinical University Hospital Virgen de la Arrixaca, Murcia/Spain 2015.
**Fig. 16**: Intramedulary Astrocytoma in a 33-year-old woman with 12 months history of progressive upper-extremity weakness and numbness. (A) Sagittal and (C) axial T1-weighted MR images show well defined expansive nodular hypointense lesion at C7 level. (B) Sagittal and (D) axial contrast-enhanced sagittal T1-weighted MR images demonstrate an expansive nodular lesion at C7 level with slight enhancement. 

**References**: Department of Radiology, Clinical University Hospital Virgen de la Arrixaca, Murcia/Spain 2015.
Fig. 17: Same patient. Consecutive sagittal (A and B) and axial (C and D) T2-weighted MR images show a nodular central and expansive hyperintense lesion at C7 level.

References: Department of Radiology, Clinical University Hospital Virgen de la Arrixaca, Murcia/Spain 2015.

GANGLIOglioma

Gangliogliomas (GGs) are rare CNS tumors composed of both neuronal (ganglion cells) and glial elements [1]. They occur in young people with a peak age of incidence between 10 and 20 years [9]. Spinal gangliogliomas are rare, comprising 1.1% of all spinal cord
neoplasms [2]. They are more frequent in children, representing 15% of intramedullary neoplasms in the paediatric age [19,20]. There is no gender predilection [21,22].

Almost half of the 27 cases (48%) are within the cervical cord, followed by the thoracic cord (22%). Less commonly, gangliogliomas may involve the conus medullaris or the entire spinal cord [21,22].

Most of these tumors have a benign histology with a favorable prognosis, but in most studies, authors have not stratified patients by tumor location because of small numbers. Rare cases of anaplastic gangliogliomas and malignant transformation have been reported [19-22].

**CLINICAL PRESENTATION:**

They are characterized by slow growth with a long history of scoliosis, walking disturbance, progressive motor weakness of all extremities (progressive myelopathy).

**MRI FINDINGS:**

T1-weighted images: Mixed signal intensity.

Hypo- or hyperintensity due to hemosiderin.

T2-weighted images: Homogeneous in 60%, heterogeneous in 40%

Hypointensity due to hemosiderin

Contrast-enhanced T1-weighted images: Patchy enhancement and cord surface enhancement. No enhancement in 15%.

± mural circumferential or nodular enhancement.

Little edema.
**Fig. 18**: 14-month-old female child with spinal cord ganglioglioma. Sagittal T1 fat-suppressed gadolinium contrast-enhanced MR image of the cervical and thoracic spine shows a long segment enhancing intramedullary lesion (arrows) extending from T1 to T11 with cord expansion and syringomyelia (arrowheads) at the rostral and caudal aspects of the enhancing tumor.

Fig. 19: 14-month-old female child with spinal cord ganglioglioma. Sagittal T2-weighted MR image of the cervical and thoracic spine shows syringomyelia (arrows) rostral to the intramedullary tumor (star). Abnormal hyperintense T2 signal and expansion is noted in the upper cervical spinal cord and brainstem (arrowheads).


HEMANGIOBLASTOMA

Hemangioblastomas are highly vascularized rare benign tumors, classified as grade I by the WHO. Hemangioblastoma of the spinal cord was first described by Schultze in 1912.
with the first successful resection of this type of tumor performed on the same occasion. Its prevalence is 1 - 7.2% of all spinal cord tumors and have no gender predilection [12,23,24]. Hemangioblastoma may occur sporadically or as a component of Von Hippel-Lindau syndrome (VHL). 32% of patients with spinal hemangioblastoma have VHL, the remaining patients have sporadically tumors [1].

The majority of spinal hemangioblastomas originate in the thoracic region, with cervical lesions also common. Lumbar and sacral hemangioblastomas are less common.

Fig. 20: Hemangioblastoma. Intraoperative photograph show a lobulated oval intramedullary mass in the cervical spine cord.

References: McCormick P., M.D., MPH

CLINICAL PRESENTATION:

Multiple hemangioblastomas indicate VHL syndrome. Patients with suspected Hemangioblastoma/VHL, should undergo contrast-enhanced MR imaging of entire neural axis to exclude multiple lesions. The mean of symptoms duration is 38 months and include sensory changes, motor dysfunction and pain. in a few cases, spinal hemangioblastomas can present with subarachnoid hemorrhage or hematomyelia [25-27].
MRI FINDINGS:

Depends on lesion size and the presence of syrinx.

T1-weighted images:

Large: Mixed hypo- or isointense. Lesions # 2.5 cm almost always show enlarged feeding arteries ± draining veins (“flow voids”)

Small: lesions Isointense. Delineated syrinx is present in > 50% and is hypointense.

T2-weighted images:

Large lesions: mixed hyperintensity with flow voids and the hemorrhage is common. They can be extensive with long segment cord edema without syrinx.

Small: uniformly hyperintense. Can be associated with peritumoral edema.

Contrast-enhanced T1-weighted images:

Large: Heterogeneous enhancement. If syrinx is present the wall does not enhance.

Small: Subpial nodule (often near on surface of dorsal cord)

Fig. 21: 21-years-old man with a cervical hemangioblastoma. (A) Sagittal T1-weighted cervical MRI shows a heterogeneous mass from C4 to C6 with a cranial nodular
lesion, together with a large expansive hypointense lesion along the spinal cord. (B) Sagittal T2-weighted cervical MRI show a cranial nodule with hyperintense signal and hypointense area in keeping with hemosiderin, as well as extensive intramedullary oedema. (C) Sagittal T1-weighted post-gadolinium contrast MRI noting an avidly heterogeneously enhancing nodule representing a hemangioblastoma.

**References:** Department of Radiology, Clinical University Hospital Virgen de la Arrixaca, Murcia/Spain 2015.

**PARAGANGLIOMA**

Spinal paragangliomas are rare neuroendocrine tumors of the extra-adrenal paraganglionic system, arising from specialized organelles called paraganglia. Tumors of the carotid body and glomus jugulare constitute more than 90% of reported extra-adrenal PGs. [9]

Lerman et al was first described the spinal paraganglioma of the filum terminale in 1972 [28].

**CLINICAL PRESENTATION:**

A long duration of symptoms is typical, with a mean of 4 years [29]. Filum terminale paragangliomas frequently actively secrete neuropeptides although symptoms associated with them, are usually absent [30].

**MRI FINDINGS:**

MR images typically show a sharply circumscribed, occasionally partly cystic mass that is hypo- or isointense to spinal cord on T1-weighted images, markedly contrast enhancing and hyperintense on T2-weighted images. The presence of serpentine, congested, ectatic vessels and a low signal intensity rim ("cap sign") are considered diagnostically helpful clues.

**METASTASES**

Intramedullary spinal cord metastasis (ISCM) represents 4.2%-8.5% of central nervous system (CNS) and clinically affects only 0.1%-0.4% of all cancer patients. Lung and breast carcinomas are the most frequent sources of ISCM [31-34]. Melanoma, malignant lymphoma, colon carcinoma, ovarian carcinoma, and renal cell carcinomas are other original sites for metastasis to ISCM. They are located in the cervical cord in 45% of cases, in the thoracic cord in 35% of cases and lumbar region in 8% of cases [31-34].
Fig. 22: Spinal metastases of small cell lung cancer in a 71-year-old man with a history of small cell lung cancer that presents paresthesias in upper and lower limbs, with progressive loss of strength. (A and B) Consecutive STIR-weighted MR images demonstrate a well-circumscribed multiples intramedullary oval nodules (green arrows). References: Department of Radiology, Clinical University Hospital Virgen de la Arrixaca, Murcia/Spain 2015.
**Fig. 23:** Same patient. (A and B) Consecutive contrast sagittal T1-weighted MR images show multiple intramedullary nodes and leptomeningeal enhancement (green arrows) with hyperintense signal relative to the spinal cord.

**References:** Department of Radiology, Clinical University Hospital Virgen de la Arrixaca, Murcia/Spain 2015.

**CLINICAL PRESENTATION:**

The metastases most commonly manifest with pain (70% of cases), followed by bowel or bladder dysfunction (60%) and paresthesias (50%) [1]. The patient show a rapid decline in neurologic status, most of them, have symptoms for less than 1 month before diagnosis [31], in contrast to the long duration of symptoms of the primary intramedullary tumors.

**MRI FINDINGS:**

Focal, enhancing cord lesion or lesions with extensive edema and are typically small (< 1.5 cm).
T1- weighted images:
Enlarged cord, associated rarely with syrinx cavity.

If the lesion is secondary to melanoma, it can show high signal (hyperintense) due to degradation products of intralesional hemorrhage or, due to properties to melanin.

T2- weighted images: Focal high signal due to diffuse edema.

Rarely low signal due to hemorrhagic metastasis.

T2* GRE images: Hypointensity due to hemorrhagic components.

Contrast-enhanced T1-weighted images: Focal enhancement.

Rim sign: Intense, thin rim of peripheral enhancement around enhancing lesion

Flame sign: Poorly-defined, flame-shaped region of enhancement at superior/inferior margins
**Fig. 24:** Medulloblastoma metastases in a 18-year-old girl with history 2-week history of progressive right hemiparesis. (A and B) Consecutive sagittal T1-weighted cervical MR images show multiple bulky and metastasis of medulloblastoma in various levels of the spinal cord are observed, present a hypointense signal with respect to spinal cord (blue arrows).

**References:** Department of Radiology, Clinical University Hospital Virgen de la Arrixaca, Murcia/Spain 2015.

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**Fig. 25:** Medulloblastoma metastases in a 18-year-old girl with history 2-week history of progressive right hemiparesis. (A and B) Sagittal T2-weighted cervical MR images show multiple bulky and metastasis of medulloblastoma in various levels of the spinal cord are observed, present a hyperintense signal with respect to spinal cord, and some heterogeneous (blue arrows).

**References:** Department of Radiology, Clinical University Hospital Virgen de la Arrixaca, Murcia/Spain 2015.
Fig. 26: Medulloblastoma metastases in a 18-year-old girl with history 2-week history of progressive right hemiparesis. (A and B) Axial T2-weighted cervical MR images show multiple bulky and metastasis of medulloblastoma in various levels of the spinal cord are observed, present a hyperintense signal with respect to spinal cord (blue arrows).

References: Department of Radiology, Clinical University Hospital Virgen de la Arrixaca, Murcia/Spain 2015.

LYMPHOMA

Primary central nervous system lymphoma is a rare disease. This type of tumour has been given a variety of different names. An intracranial solitary mass lymphoma is much more common than primary spinal lesions [35].

Intramedullary lymphoma is located most commonly in the cervical cord, followed by the thoracic cord and finally the lumbar cord.

MRI FINDINGS:

There are a few reports of MR imaging findings in intramedullary lymphoma due to it is an extremely rare tumor. MR can show an enhancing mass, poorly defined.
**Fig. 1:** Intramedullary Spinal Cord Tumors.

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Fig. 2: Intraoperative photograph demonstrates a intramedullary spinal cord tumor resection.

Fig. 3: Consecutive axial T2-weighted MR images reveal an abnormal area of high signal intensity (yellow arrow) of the center thoracic spinal cord with progressive expansion, due to an intramedullary tumor (Astrocitoma).

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**Fig. 9:** Myxopapillary ependymoma of the filum terminale in a 42-year-old woman with 18 months history of progressive lower-extremity weakness and numbness. (A) Sagittal T1-weighted MR image shows an intradural oval mass (green arrow) in the L3 level. It presents slightly hyperintense relative to the spinal cord (arrowhead). (B) Sagittal T2-weighted MR image reveals a mass of heterogeneous signal intensity from L3 to L5 (green arrows).

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**Fig. 10:** Myxopapillary ependymoma of the filum terminale in a 42-year-old woman with 18 months history of progressive lower-extremity weakness and numbness. (A) Axial T1-weighted MR image shows a intramedullary oval mass (arrow) slightly hyperintense. (B) Axial T2-weighted MR image reveals a central mass of heterogeneous signal intensity.

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Fig. 11: Intraoperative photograph demonstrates a lobulated oval intradural mass next to the terminal filum.

**Fig. 12:** Subependymoma Intraoperative photograph. 61-year-old woman with intramedullary lesion at C3-C4.

**Fig. 13:** Astrocytoma of the thoracic spine cord. Intraoperative photograph shows a lobulated oval intramedullary mass in the thoracic spine cord.

Fig. 14: Intramedullary Astrocytoma. 18 months-old child with 4 months history of progressive lower-extremity weakness and numbness, and bowel and bladder dysfunction. (A) Consecutive Sagittal T2-weighted MR images show a intramedullary oval mass (arrow), well defined, from T11 to L1, with hyperintense signal relative to the spinal cord. (B) Consecutive axial T2-weighted MR images reveal a central, expansive and well defined mass, with hyperintense signal relative to the spinal cord.

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**Fig. 15:** Intramedullary Astrocytoma. 18 months-old child with 4 months history of progressive lower-extremity weakness and numbness, and bowel and bladder dysfunction. (A) Consecutive Sagittal T1-weighted MR images show a intramedullary oval mass (yellow arrow), well defined, from T11 to L1, with hypointense signal relative to the spinal cord. (B) Consecutive sagittal fat-suppressed T1-weighted MR images obtained after paramagnetic contrast administration demonstrate a well-circumscribed oval mass (arrow) with moderate heterogeneous enhancement from T11 to L1.

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**Fig. 16:** Intramedullary Astrocytoma in a 33-year-old woman with 12 months history of progressive upper-extremity weakness and numbness. (A) Sagittal and (C) axial T1-weighted MR images show well defined expansive nodular hypointense lesion at C7.
level. (B) Sagittal and (D) axial contrast-enhanced sagittal T1-weighted MR images demonstrate a expansive nodular lesion at C7 level with slight enhancement.

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Fig. 17: Same patient. Consecutive sagittal(A and B) and axial(C and D) T2-weighted MR images show a nodular central and expansive hyperintense lesion at C7 level.

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**Fig. 18:** 14-month-old female child with spinal cord ganglioglioma. Sagittal T1 fat-suppressed gadolinium contrast-enhanced MR image of the cervical and thoracic spine shows a long segment enhancing intramedullary lesion (arrows) extending from T1 to T11 with cord expansion and syringomyelia (arrowheads) at the rostral and caudal aspects of the enhancing tumor.

Fig. 19: 14-month-old female child with spinal cord ganglioglioma. Sagittal T2-weighted MR image of the cervical and thoracic spine shows syringomyelia (arrows) rostral to the intramedullary tumor (star). Abnormal hyperintense T2 signal and expansion is noted in the upper cervical spinal cord and brainstem (arrowheads).

Fig. 20: Hemangioblastoma. Intraoperative photograph show a lobulated oval intramedullary mass in the cervical spine cord.

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Fig. 21: 21-years-old man with a cervical hemangioblastoma. (A) Sagittal T1-weighted cervical MRI shows a heterogeneous mass from C4 to C6 with a cranial nodular lesion,
together with a large expansive hypointense lesion along the spinal cord. (B) Sagittal T2-weighted cervical MRI show a cranial nodule with hyperintense signal and hypointense area in keeping with hemosiderin, as well as extensive intramedullary oedema. (C) Sagittal T1-weighted post-gadolinium contrast MRI noting an avidly heterogeneously enhancing nodule representing a hemangioblastoma.

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Fig. 22: Spinal metastases of small cell lung cancer in a 71-year-old man with a history of small cell lung cancer that presents paresthesias in upper and lower limbs, with progressive loss of strength. (A and B) Consecutive STIR-weighted MR images demonstrate a well-circumscribed multiples intramedullary oval nodules (green arrows).

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Fig. 23: Same patient. (A and B) Consecutive contrast sagittal T1-weighted MR images show multiple intramedullary nodes and leptomeningeal enhancement (green arrows) with hyperintense signal relative to the spinal cord.

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**Fig. 24:** Medulloblastoma metastases in a 18-year-old girl with history 2-week history of progressive right hemiparesis. (A and B) Consecutive sagittal T1-weighted cervical MR images show multiple bulky and metastasis of medulloblastoma in various levels of the spinal cord are observed, present a hypointense signal with respect to spinal cord (blue arrows).

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**Fig. 25:** Medulloblastoma metastases in a 18-year-old girl with history 2-week history of progressive right hemiparesis. (A and B) Sagittal T2-weighted cervical MR images show multiple bulky and metastasis of medulloblastoma in various levels of the spinal cord are observed, present a hyperintense signal with respect to spinal cord, and some heterogeneous (blue arrows).

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**Fig. 26:** Medulloblastoma metastases in a 18-year-old girl with history 2-week history of progressive right hemiparesis. (A and B) Axial T2-weighted cervical MR images show multiple bulky and metastasis of medulloblastoma in various levels of the spinal cord are observed, present a hyperintense signal with respect to spinal cord (blue arrows).

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Conclusion

The diagnosis of IMSCT is performed using advanced imaging techniques such as MRI, with acquisition protocols and imaging features that must be known by radiologists, because of them it depend their management and subsequent surgical planning.
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References


