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Imaging of Intramedullary Spinal Cord Lesions on MRI

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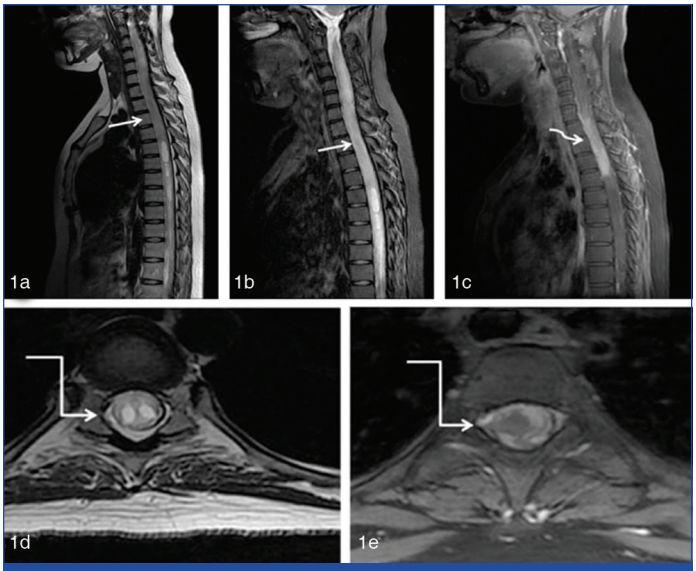
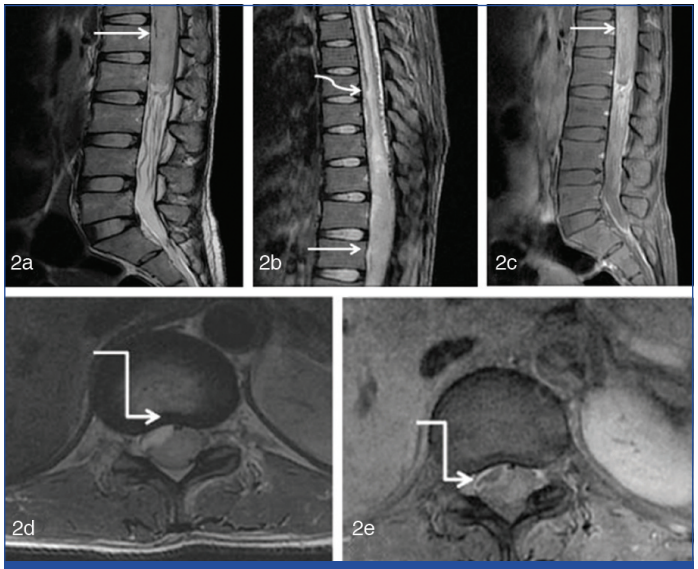
Lesions originating from parenchyma of the spinal cord present with a myriad of symptoms and signs more commonly via direct compression, followed by infiltration into the spinal parenchyma. Pain can be radicular, posterior midline, dull and aching. Rare presentations include paravertebral tightness/stiffness, and syringomyelia. Deficits were most commonly motor, followed by, sensory or bladder dysfunction [1].

Astrocytomas are second most common intramedullary tumours, and most common among paediatric age group. They are neoplasms of astrocytic origin and infiltrate into the surrounding spinal cord tissue, ill-defined margins, lack well defined capsule or cleavage plane, making them prone for incomplete resection and recurrence. They present with long multi-segment, eccentric and holocord involvement. They are associated with neurofibromatosis and cyst formation. Tumoural cysts are usually intra substance and reflect necrosis, haemorrhage, or degeneration that shows in-homogeneous signal intensity and peripheral contrast enhancement on MRI [Table/Fig-1(a-e),2(a-e)]. Canal widening with kyphoscoliosis is more frequently encountered in paediatric age group. On Magnetic Resonance Imaging (MRI), they appear to expand the cord and are hypo to isointense on T1 weighted images, hyper intense on T2 and Short Tau Inversion Recovery (STIR) images, with varying degrees of patchy enhancement [1,2].

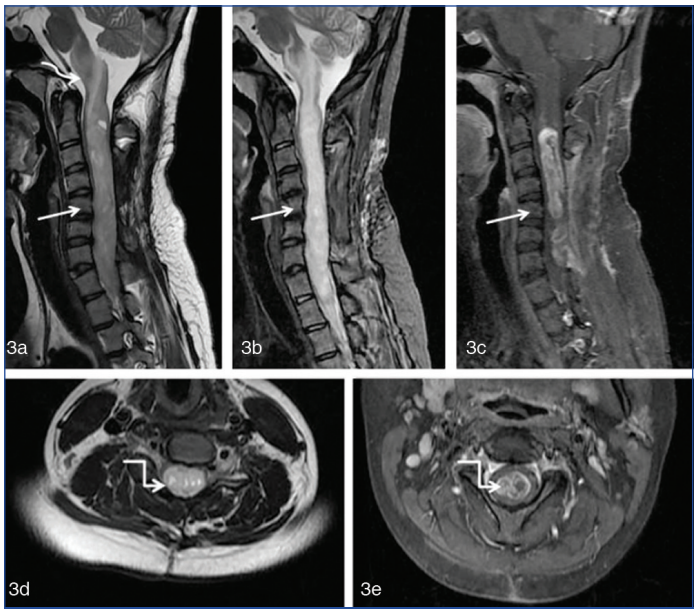
Ependymomas are most common intramedullary tumours in adults, with predilection in cervico-thoracic segments. However, myxopapillary variant of ependymomas tends to occur more commonly in filumterminale and conusmedullaris. They are known to arise from ependymal lining of cord with central location, and extend peripherally as they grow. Rare variant of extramedullary ependymoma can initially be intramedullary and become eventually exophytic, growing out of the medulla. Ependymomas have well defined margins, and compress the cord [1,2]. Traversing vessels at the junction,get stretched and eventually bleed; giving the "cap sign" [Table/Fig-3(a-e),4(a-e)]. Non enhancing non tumoural (polar)



[Table/Fig-1]: Proven case of Astrocytoma in 22-year-old female. Sagittal Short Tau Inversion Recovery (STIR); a), T2; b) postcontrast T1 images (c) images show poorly marginated intramedullary hyperintense lesion, causing cord enlargement (white arrow) and moderate homogeneous postcontrast enhancement (curved white arrow). Axial T2; d) and postcontrast T1; e) images at caudal aspect of the lesion shows enhancing irregular shaped tumoural cysts (white elbow arrow connector).

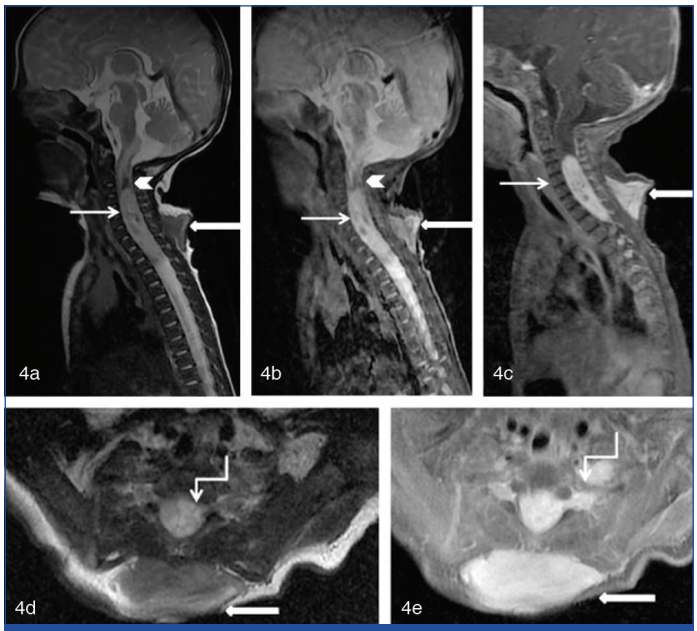


[Table/Fig-2]: Known case of astrocytoma in 26-year-old women. Sagittal T2; a), STIR; b) postcontrast T1; c) images show diffuse hyperintense intramedullary lesion (white arrow) with long segment syrinx along cranial aspect (curved white arrow). Axial T2 and postcontrast T1; d&e) confirm the above findings with peripherally enhancing cyst along right anterior aspect (elbow arrow connector).



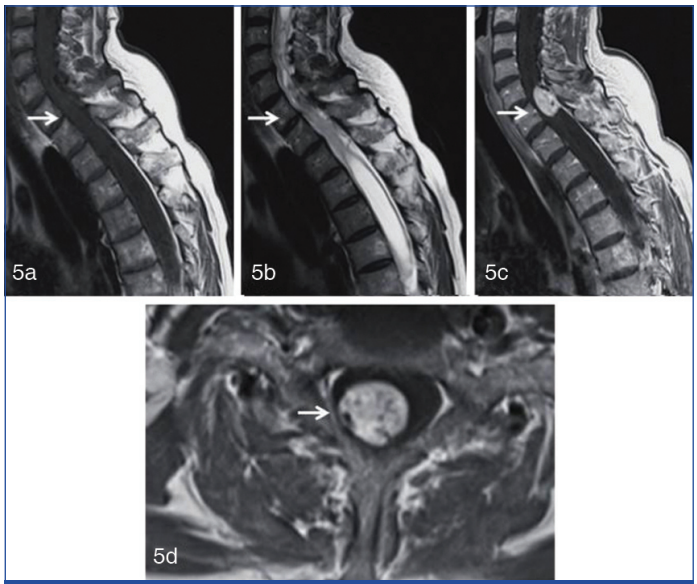
[Table/Fig-3]: Known case of ependymoma in 18-year-old female. Sagittal T2; a) STIR; b) postcontrast T1; c) images show heterogeneous hyperintense intramedullary lesion with small intra lesional cysts (white arrow). Cranially it is reaching upto medulla (curved white arrow). Axial T2 and postcontrast T1; d&e) confirm the above findings with non enhancing cysts (white elbow arrow connector).

cysts are commonly associated with ependymoma, and show Cerebrospinal Fluid (CSF) signal extends beyond the cranial or caudal pole of the neoplasm. Presence of syringohydromyeliais seen more consistently with ependymoma, than astrocytoma. Most of the ependymomas were T1 iso to hypointense, with hyperintensity on T2 and STIR images, and homogenous intense enhancement with persistent hypointense "cap sign". Ependymomas tend to occur commonly in association with Neurofibromatosis 2 [2,3].



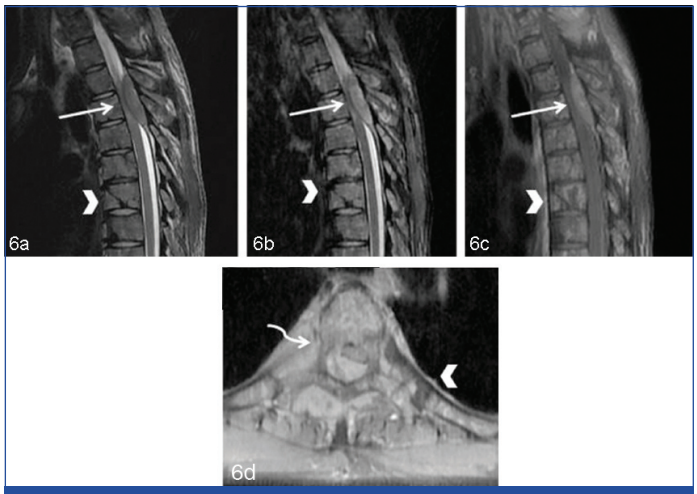
[Table/Fig-4]: Histopatholic proven case of ependymoma in 5-year-old child. Sagittal T2; a), and STIR; b) postcontrast T1; c) images show heterogeneously enhancing lesion in cervical cord (white arrow). T2 hypointense rim noted along caudalaspect, giving "cap sign" (white arrow head). Axial T2 and postcontrast T1; d&e) confirm the above findings with extension along nerve roots (white elbow arrow connector). Adjacent soft tissue overlying cervical cord shows lesion in subcutaneous plane (no communication with spinal cord). Well-defined heterogeneous hyperintense mass in subcutaneous plane, not getting supressed on STIR and showing homogenous postcontrast enhancement, likely low flow vascular malformation (thick white arrow).

Haemangioblastomas are benign tumours of vascular origin, and show short segment involvement with prominent flow voids, usually extending along pial surface [Table/Fig-5]. They have cystic component with enhancing highly vascular nodular component. They have surrounding oedema, syrinx and association with Van HippelLindau disease. Enlarged spinal arteries may be seen, and they should be differentiated from vascular malformation [4].

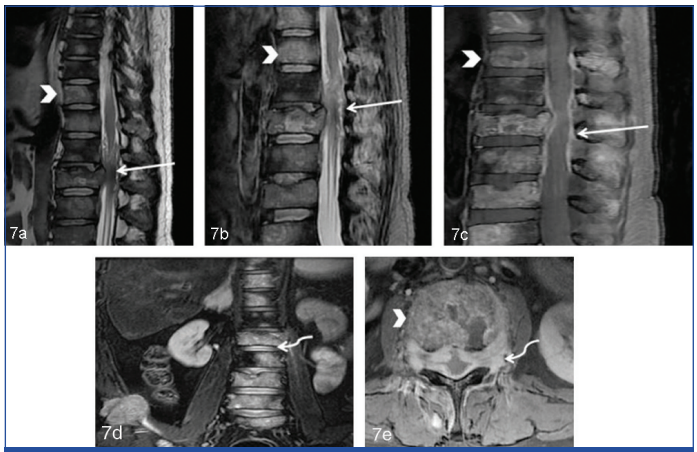


[Table/Fig-5]: Diffuse enlargement of the spinal cord noted in known case of haemangioblastoma. Sagittal T1; a), T2; b), Postcontrast T1; c) and axial; d) postcontrast T1 extensive oedema and multiple cyst formation can be seen extending up to the level of the apex. Tumour at the C7 level shows intense post contrast enhancement (white arrow). Flow voids can be observed within it.

Intramedullary spinal cord metastases are comparatively rare, especially in absence of known primary malignancy. Drop metastasis with CSF dissemination through the spinal cord, central canal or contiguous spread from carcinomatous meningitis [Table/Fig-6(a-d),7(a-e)]. Most common route of spread through haematogenous dissemination leading to arterial embolisation (most common primaries include carcinoma lung). Other routes include retrograde spread through Batson's spinal venous plexus; metastatic perineural spread to the spinal cord, CSF dissemination through drop metastasis or intraspinal through perineural sheaths. Cystic change/ haemorrhage are seen rarely. They show postcontrast enhancement with extensive disproportionate oedema (extensive T2 hyper intensity, which can be on average multifold larger than that of the enhancing portion of the lesion) [3]. Postcontrast complete or partial rim enhancement along margins is noted.Another rarer proposed route of spread is via penetrating vessels within the Virchow-Robin spaces penetration of the spinal cord parenchyma.



[Table/Fig-6]: Multiple vertebral body and rib metastasis (white arrowhead) in known case of carcinoma oropharynx. Sagittal T2; a), and STIR; b) postcontrast T1; c) images show moderately enhancing heterogeneous hyperintense lesion in posterior epidural space, compressing and effacing dorsal thecal sac and displacing cord anteriorly (predominantly on left-side) with myelomalacic changes (white arrow). Axial postcontrast T1; d) confirms above findings (curved white arrow) with rib involvement.

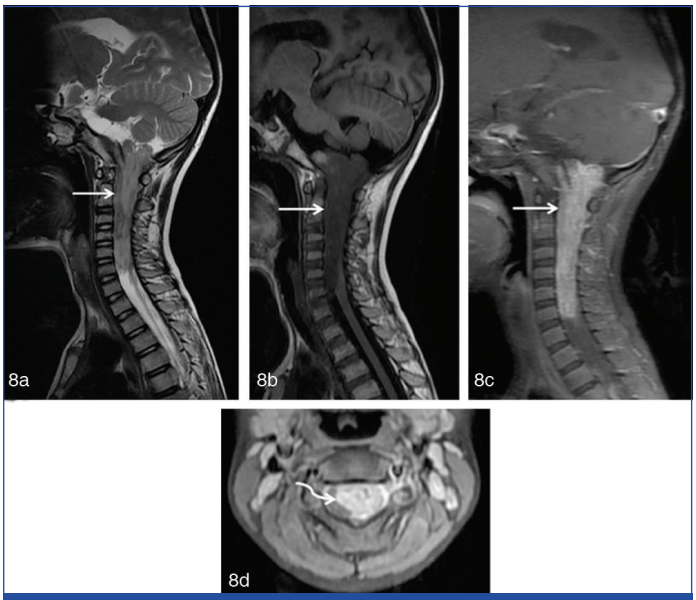


[Table/Fig-7]: Multiple vertebral body and pelvic bone metastasis (white arrowhead) in case of carcinoma lung. Sagittal T2; a), STIR; b) and postcontrast T1; c) images show heterogeneous hyperintense lesion with moderate enhancement, extending along exiting nerve root foramina (white arrow). Coronal STIR; d) and Axial postcontrast T1; e) Zoomed in image confirms above findings with dural enhancement (curved white arrow).

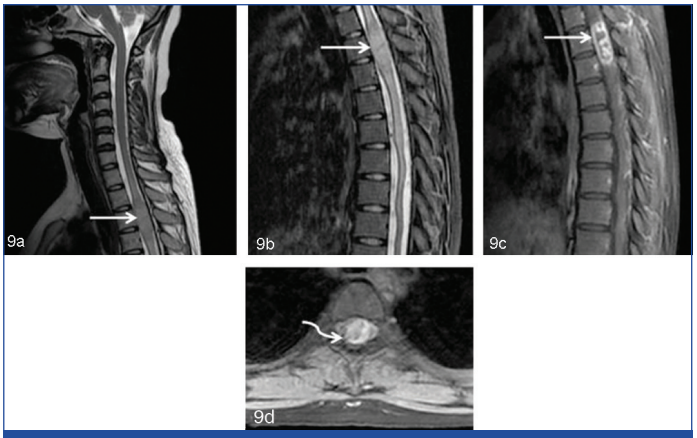
Rare subtype of exophytic ependymoma [Table/Fig-8(a-d)] has similar features as ependymoma, with additional exophytic soft tissue component.

Infective granulomas present with fusiform cord swelling with ill-defined iso to hyperintensity on T1WI [Table/Fig-9(a-d)]. Surrounding oedema maybe present with T2 hypointense area. Adjacent disc, soft tissue may show enhancement, depending on involvement.Varying amount of caseous necrosis and liquefaction present as central

hyperintensities. An iso-hypointense rim, showing enhancement was seen surrounding a hyperintense centre [4]. [Table/Fig-10] describes the radiological findings of all the nine cases.



[Table/Fig-8]: Shows case of Ependymoma (exophytic type Sagittal T2; a), and T1; b) postcontrast T1; c) images show heterogeneously enhancing intradural, extramedullary lesion in cervical cord (white arrow), extending from medulla to C7 vertebral level, effacing cisterna magna with ependymal enhancement. Axial T1 postcontrast; d) confirm the above findings with thinning of adjacent cord with intramedullary ring enhancing lesions. Dural enhancement is extending along exiting nerve roots (curved white arrow). Histopathology confirmed diagnosis of Ependymoma (Exophytic subtype).



[Table/Fig-9]: Tuberculoma in 14-year-old female. Sagittal T2; a), STIR; b) postcontrast T1; c) images show T2/STIR isointense lesion with heterogeneous postcontrast enhancement in cervico-dorsal cord (white arrow). Cord is expanded in involved segment, with thinning and oedema of adjacent cord. Axial T1 postcontrast; d) confirm the above findings with intramedullary ring enhancing lesions (curved white arrow).

Malignant intramedullary spinal tumours may escape early diagnosis, as patients bearing these lesions may be initially asymptomatic. With use of MRI; T1, T2 and STIR weighted images should be accessed, in atleast two different imaging planes with large field-of-view, to allow visualisation of the entire cord, and demarcate location and extent of these tumours. Haemorrhagic components should be assessed on Gradient echo images. Postcontrast images demonstrate solid enhancing tumour components and helps in differentiating tumour cysts from peritumoural cysts [5].

S. No.	Cases	Clinical findings	Radiological findings
1	Astrocytoma	Paraparesis with radicular pain radiating to bilateral upper limbs.	Poorly marginated intramedullary hyperintense lesion, with cord expansion and moderate homogeneous postcontrast enhancement with enhancing irregular shaped tumoural cysts along caudal aspect.
2	Astrocytoma	Quadriparesis with poorly localised posterior midline pain.	Diffuse hyperintense intramedullary lesion with long segment syrinx along cranial aspect. Lesion shows postcontrast enhancement with peripherally enhancing cyst along right anterior aspect
3	Ependymoma	Quadriplegia with loss of reflexes and dull aching pain in neck,arms and back.	Heterogeneous hyperintense intramedullary lesion with small intra lesion cysts. Cranially it is reaching upto medulla, with associated non enhancing cysts.
4	Ependymoma	Progressive paravertebral pain, radiating to bilateral upper limbs.	Heterogeneously enhancing lesion in cervical cord with T2 hypointense rim noted along caudal aspect, giving “cap sign” Associated extension along nerve roots. Incidental adjacent Well-defined heterogeneous hyperintense soft tissue overlying cervical cord shows lesion in subcutaneous plane (no communication with spinal cord), not getting supressed on STIR and showing homogenous postcontrast enhancement, likely low flow vascular malformation.
5	Haemangioblastoma	Dull aching pain, increasing in recumbent position.	Diffuse enlargement of the spinal cord with postcontrast T1 extensive oedema and multiple cysts. Tumour at the C7 level shows intense postcontrast enhancement with significant flow voids can be observed within it.
6	Intramedullary spinal cord metastases	Paraesthesia with posterior midline dull aching pain.	Multiple vertebral body and rib metastasis in known case of carcinoma oropharynx. Moderately enhancing heterogeneous hyperintense lesion in posterior epidural space, compressing and effacing dorsal thecal sac and displacing cord anteriorly (predominantly on left-side) with myelomalacic changes.
7	Intramedullary spinal cord metastases	Radiculopathy with paravertebral stiffness.	Multiple vertebral body and pelvic bone metastasis in case of Carcinoma Lung. Multiple heterogeneously hyperintense lesions with moderate enhancement, extending along exiting nerve root foramina with dural enhancement.
8	Ependymoma (Exophytic subtype)	Generalised myelopathy with upper cranial nerve involvement atrophy of ipsilateral tongue, sternocleidomastoid and trapezius muscles	Heterogeneously enhancing intradural lesion in cervical cord with parenchymal extension from medulla to C7 vertebral level, effacing cisterna magna with ependymal enhancement. It has exophytic extra medullary component. Thinning of adjacent cord noted with intramedullary ring enhancing lesions. Dural enhancement is extending along exiting nerve roots.
9	Infective granulomas (Tuberculoma)	Chronic dull aching pain with nerve root compression symptoms	T2/STIR isointense lesion with heterogeneous postcontrast enhancement in cervico-dorsal cord, with associated Cord expansion in involved segment. Associated thinning and oedema of adjacent cord is noted with intramedullary ring enhancing lesions.

[Table/Fig-10]: Clinical and radiological findings of the cases.

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