I_ _NEUROSURGERY INITIATIVE

SPINAL TUMORS

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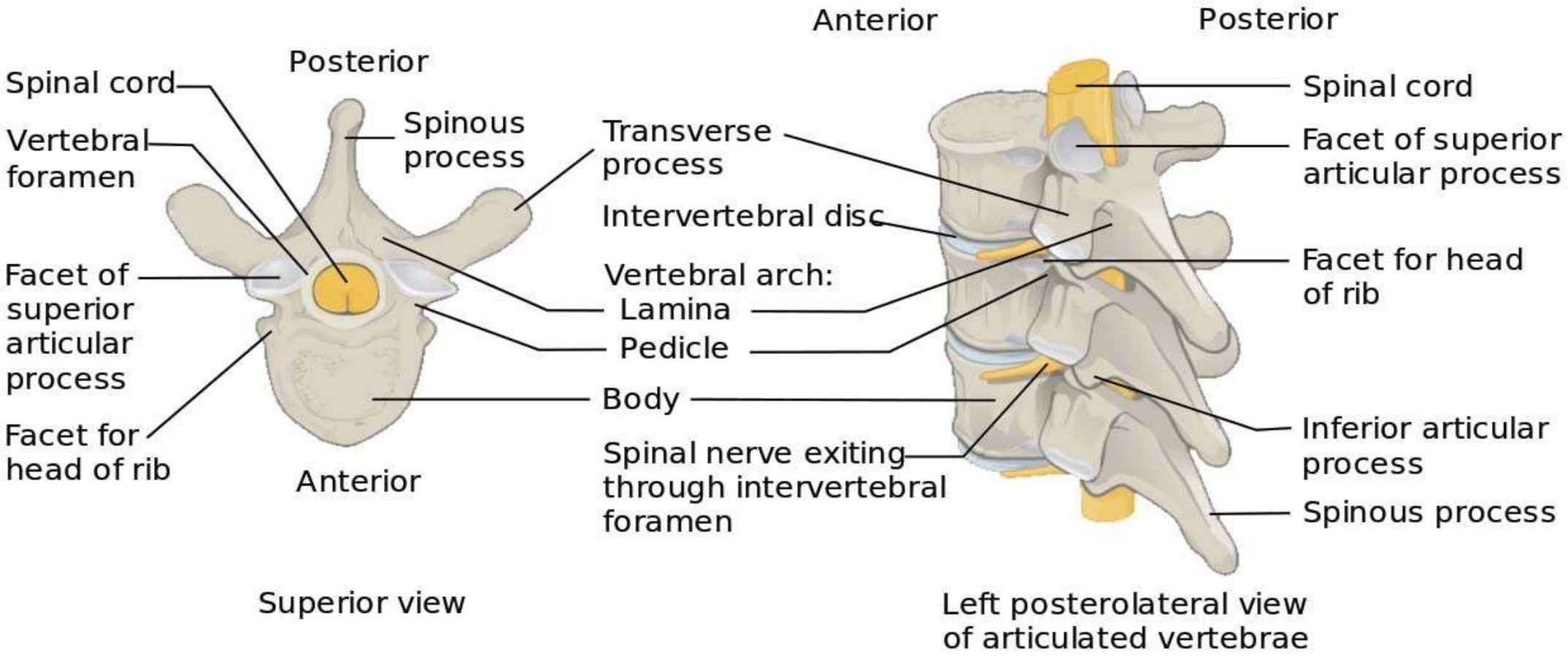
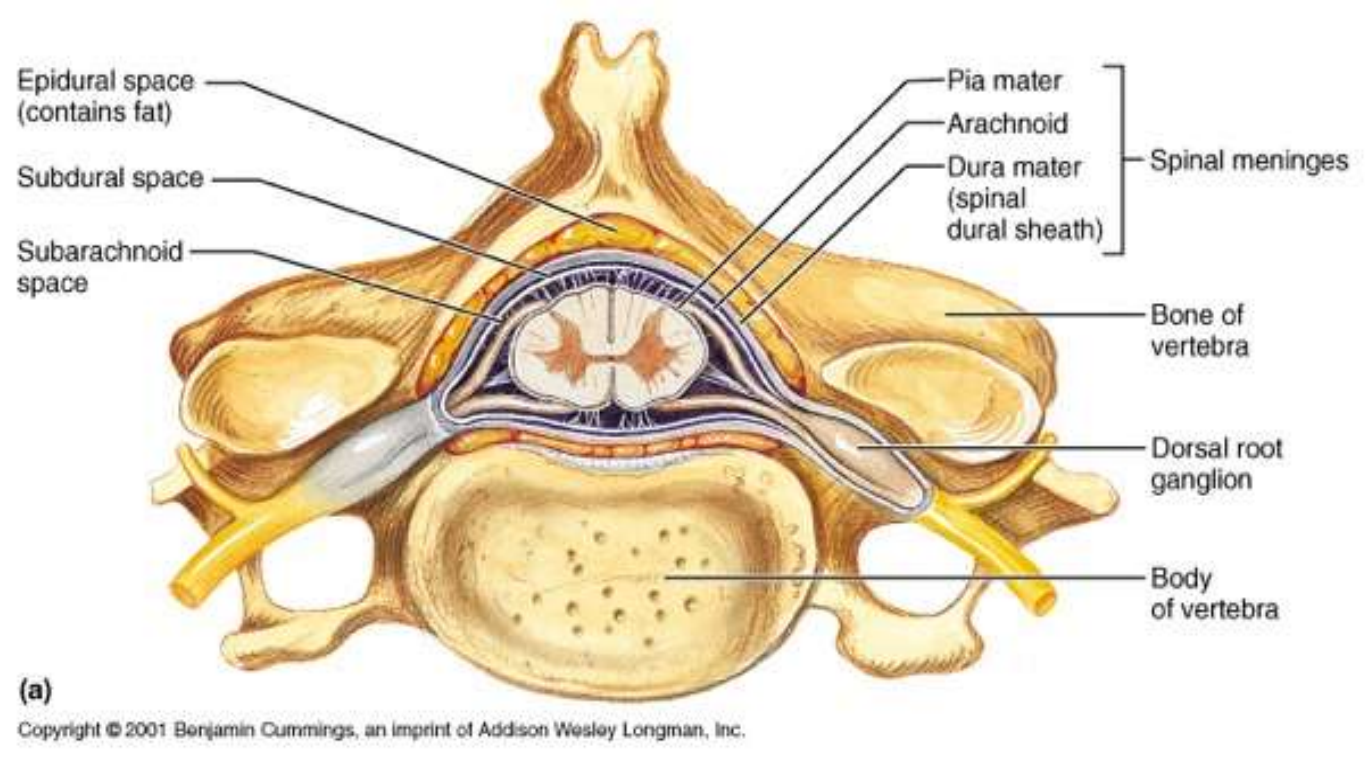
Prelude

- The spinal cord is made of 29 vertebrae, 7 cervical, 12 thoracic, 5 lumbar, 5 sacral (fused) and 4 coccygeal (fused).
- The spinal cord ins not straight. It has a cervical and lumbar lordosis
- Generally the vertebra is made of body, pedicle, laminae and spinous process.
- Generally a standard vertebra has 6 articulations, 4 through facets and 2 through intervertebral discs.
- Each vertebra has two foramina above it and two below it for the exciting nerve roots.
- The ALL and PLL stretch infront of the bodies and posterior to them.
- The vertebrae are also held to each other by other ligaments of which we have; supraspinous, interspinous and ligamentum flavum.

Vertebral Column



Standard Cervical Vertebral Anatomy



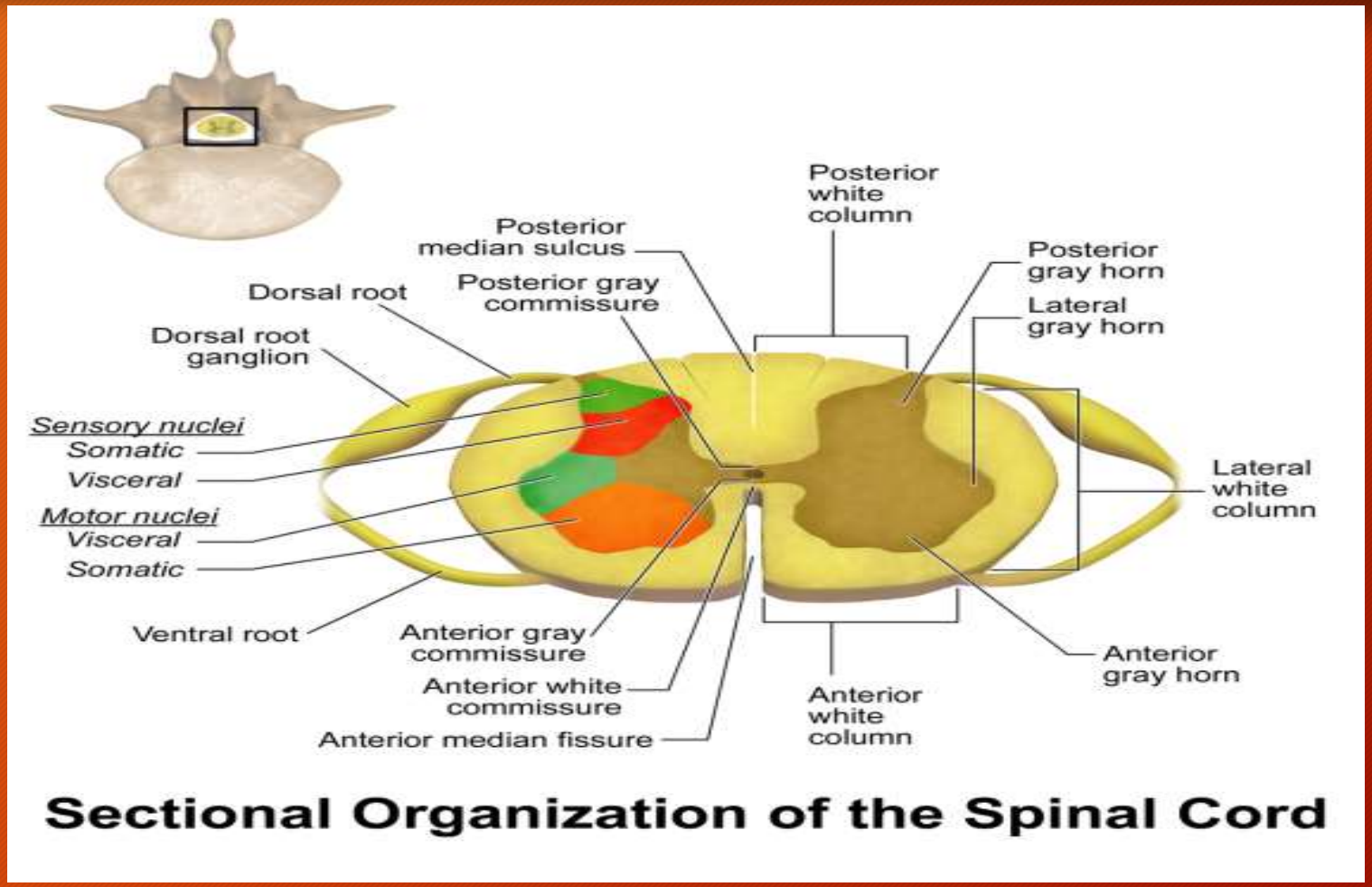
Blood Supply of the Spinal Cord

- **The anterior spinal artery** is formed by the union of two branches one from each vertebral artery and descends almost along the anterior median fissure.
- **Each posterior spinal artery** arises from the posterior inferior cerebellar artery (PICA), which is a branch of the vertebral artery. Each artery descends just lateral to the posterior median sulcus on each side near the area of entry of the posterior root into the cord
- Other vessels supply the cord, they are called the **segmental spinal arteries**, which arise from lumbar arteries in the abdomen, posterior intercostal arteries in the thorax and vertebral arteries in the neck. The largest of these segmental intramedullary arteries is called **Adamkiewicz artery**, usually arising on the left side of the lower thoracic region.

Venous Drainage of the Spinal Cord

- The spinal cord is drained by a massive network of veins taking its blood to the major venous systems of the body like the azygos system in the thorax, the deep cervical veins and also intracranial veins. The plexus is called **Batson's plexus of veins**. There are longitudinal veins running along the cord. One vein along the anterior fissure, one vein along the posterior median sulcus, and a pair of veins on each side of the cord anteriorly and posteriorly just at were the roots enter and exit the cord.

Sectional Organization of the Spinal Cord



Acute and Chronic Cord Compression

- Compression could be acute or chronic.
- The acute compression (e.g. when a vertebra which has been destroyed by a metastatic tumor collapses) will lead to immediate paralysis below the level of the compression. If this compression is not relieved within a short period of time the neurological damage most likely will be permanent.
- In contradiction to this, if a limb has been weak due to chronic compression even for a long period of time; removal of the compression is expected to be followed by recovery

Acute Cord Compression

- ***Acute compression*** from a lesion outside the cord leads to FLACCID paralysis and sensory loss BELOW THE LEVEL of the compression with absent reflexes and a mute plantar response.

Chronic Cord Compression

- ***Chronic compression*** produces signs of motor and sensory loss and an upper motor lesion BELOW THE LEVEL of compression, so that there is SPASTICITY and exaggerated reflexes and a Babinski response.

Clinical Presentation

Spinal tumors present clinically through:

- **Pain**
- **Neurological deficits:**
  - **Motor**.
  - **Sensory.**
  - **Autonomic dysfunction**

Types of Pain

There are different types of pain associated with different types of tumors.

- Metastases involving the **vertebrae** and compressing the cord will cause severe pain, which is usually nocturnal. The tumor tends to swell during the night due to the fall of cortisol levels and the increase and retention of CO2.
- Whereas, tumors abutting on **nerve roots** will produce electrical pain radiating along the course of the involved root.
- Pain from **cord** lesions is dull aching.

Investigations

PLAIN X-RAYS:

- These are very important tools in the diagnosis and should be performed in every case. They may help in confirming the level of the pathology and/or indicate the type of pathology. The following are some of the changes the may be detected:
- A collapsed vertebra (metastatic lesion or osteoporosis).
- An osteolytic or osteoblastic lesion in a body or lamina or pedicle (metastatic lesion)
- A scalloped vertebral body (indicate long standing pressure)
- A widened intervertebral foramen (neurofibroma)
- A widened canal, as indicated by increased inter-pedicular distance (long standing pressure).
- An abnormal calcification.
- Scoliosis.
- Paravertebral mass shadows

PLAIN X-RAYS

Straightening of the cervical spine

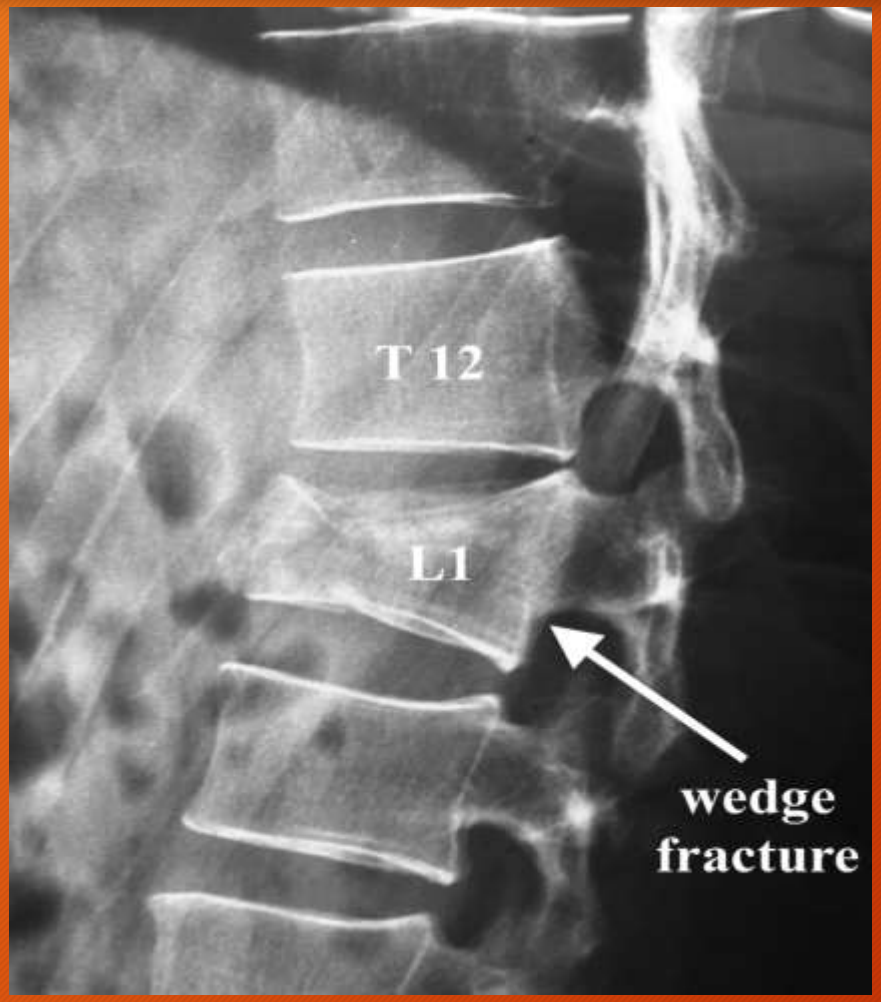
PLAIN X-RAYS

Vertebral destruction

PLAIN X-RAYS

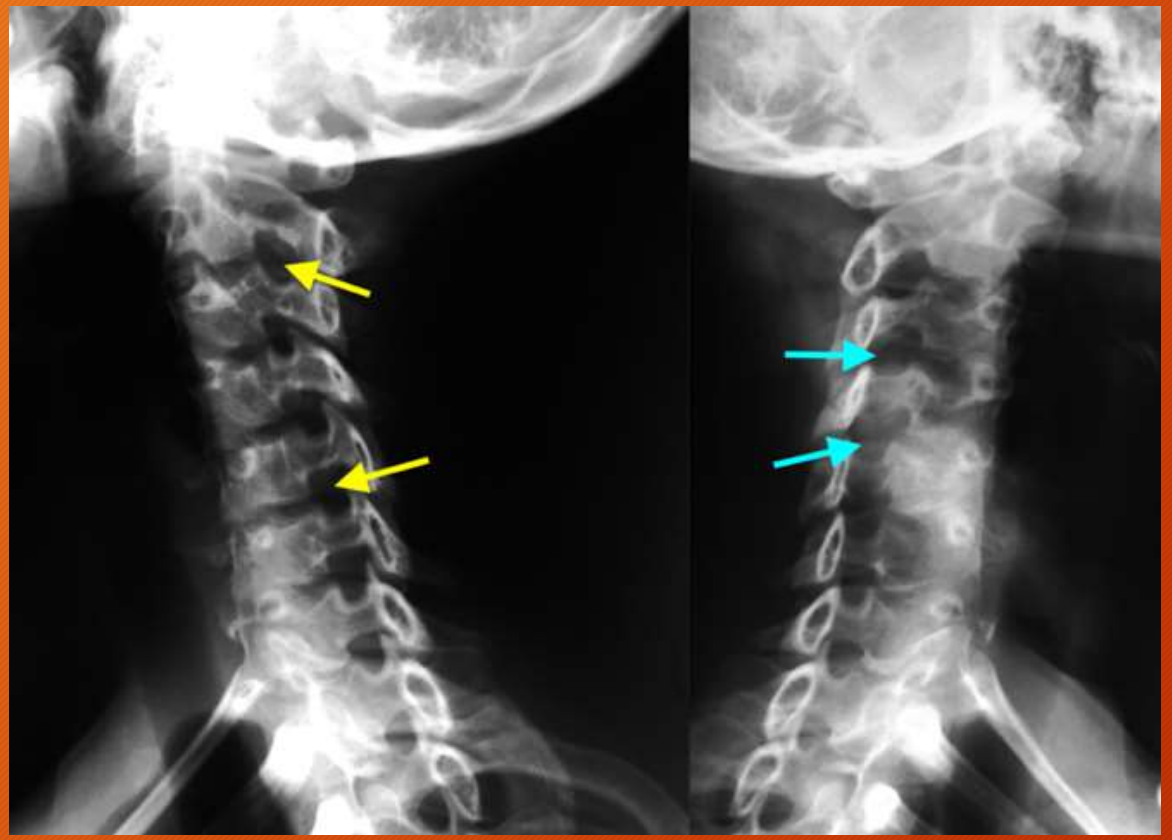
Scalloped Vertebrae

PLAIN X-RAYS



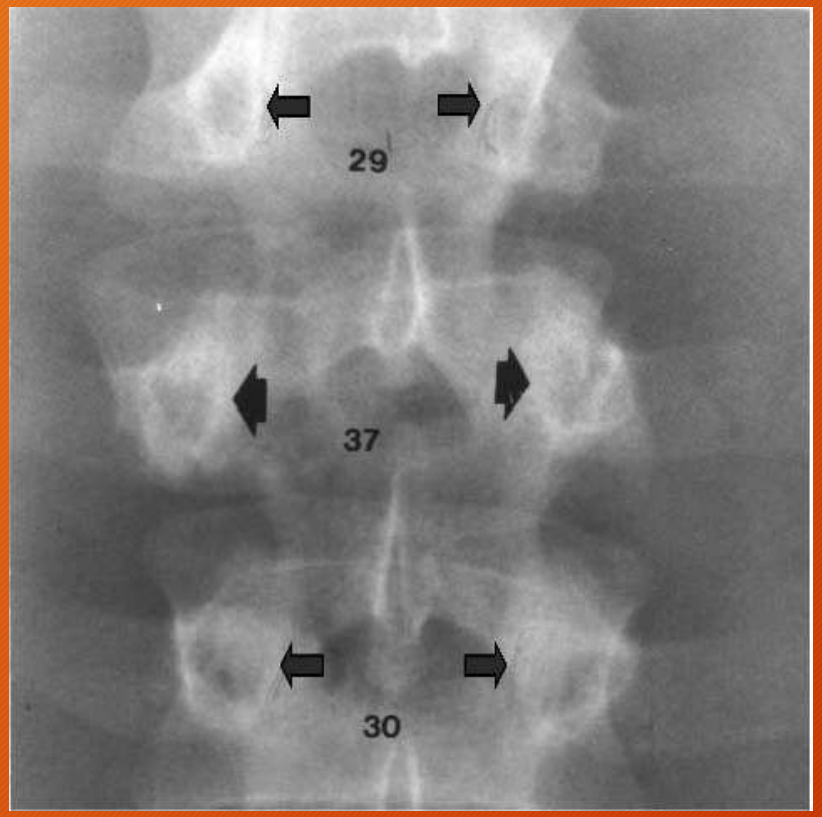
Collapsed Vertebra

PLAIN X-RAYS



Wide Intervertebral Foramina

PLAIN X-RAYS

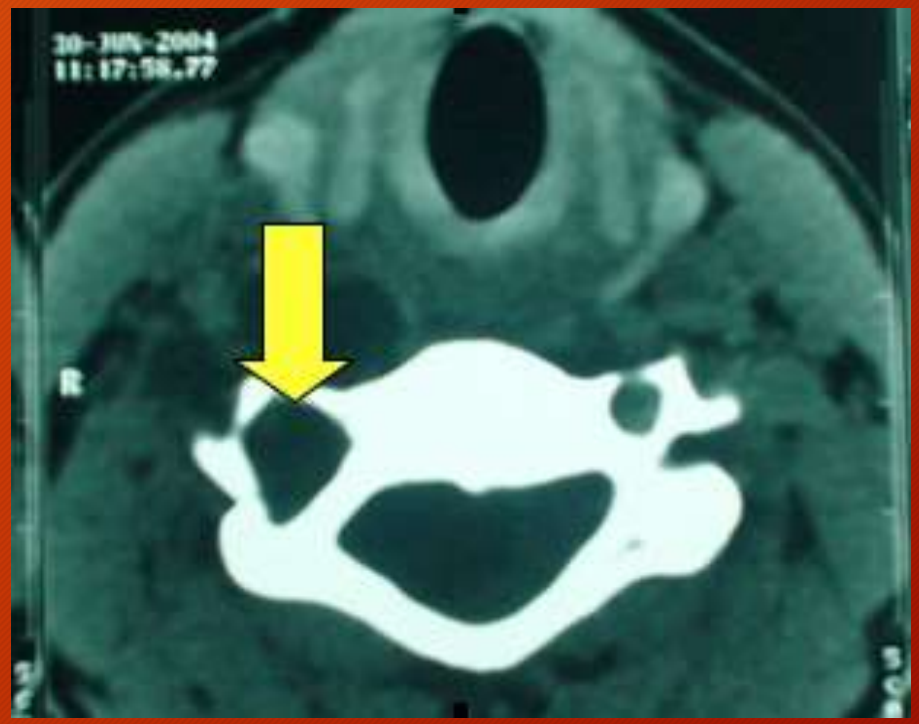


Increased interpedicular distance (IPD)

Investigations

COMPUTERIZED TOMOGRAPHY

This is of value to demonstrate erosion of bone in case of destructive lesions. It may also show widening of the vertebral, canal or foramina. Scalloping and calcifications are well demonstrated by this method. It is not helpful in soft tissue diagnosis.



Wide foramen transversarium

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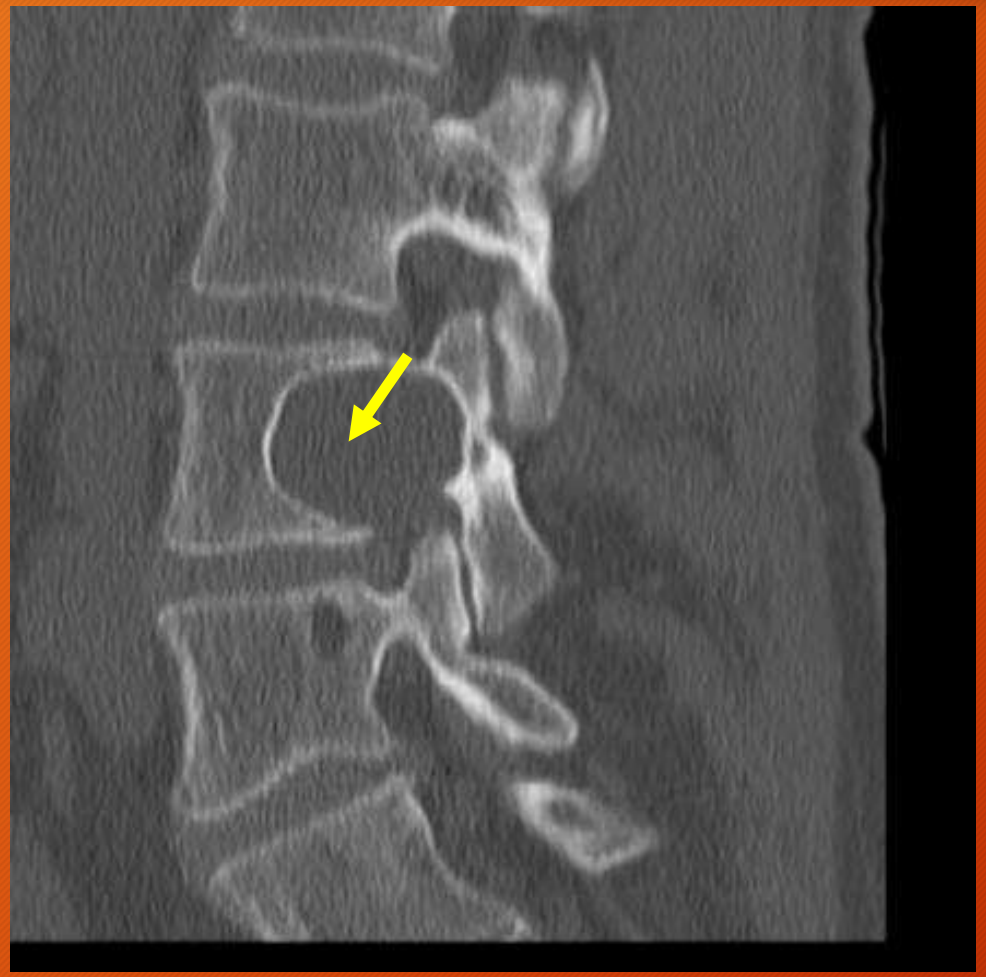

Scalloped Vertebra

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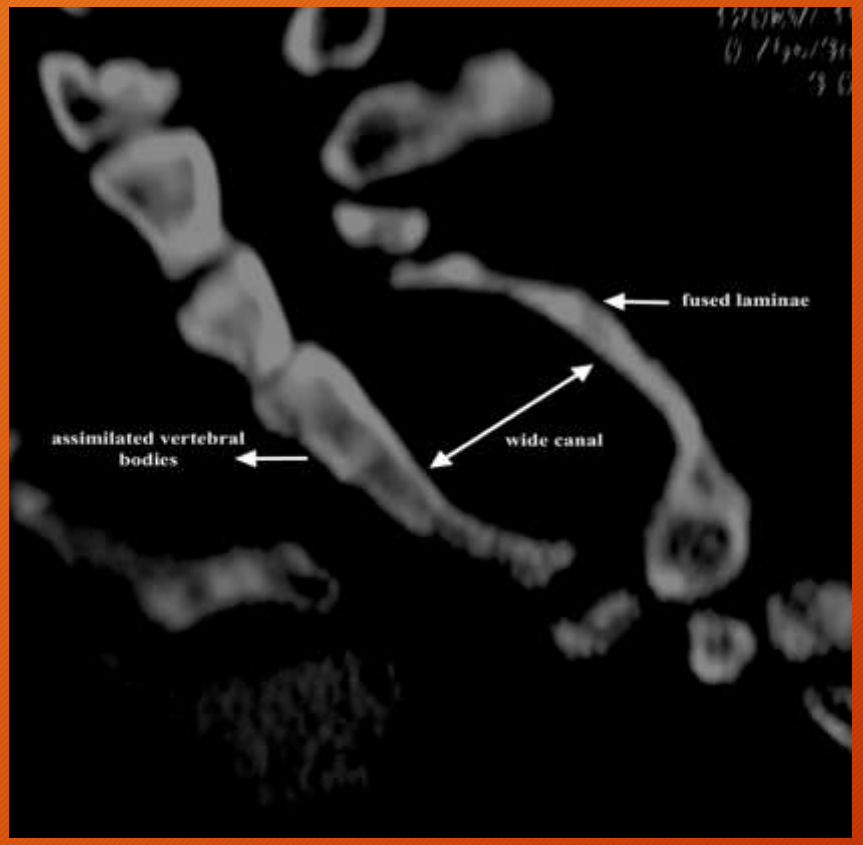

Wide Vertebral Canal

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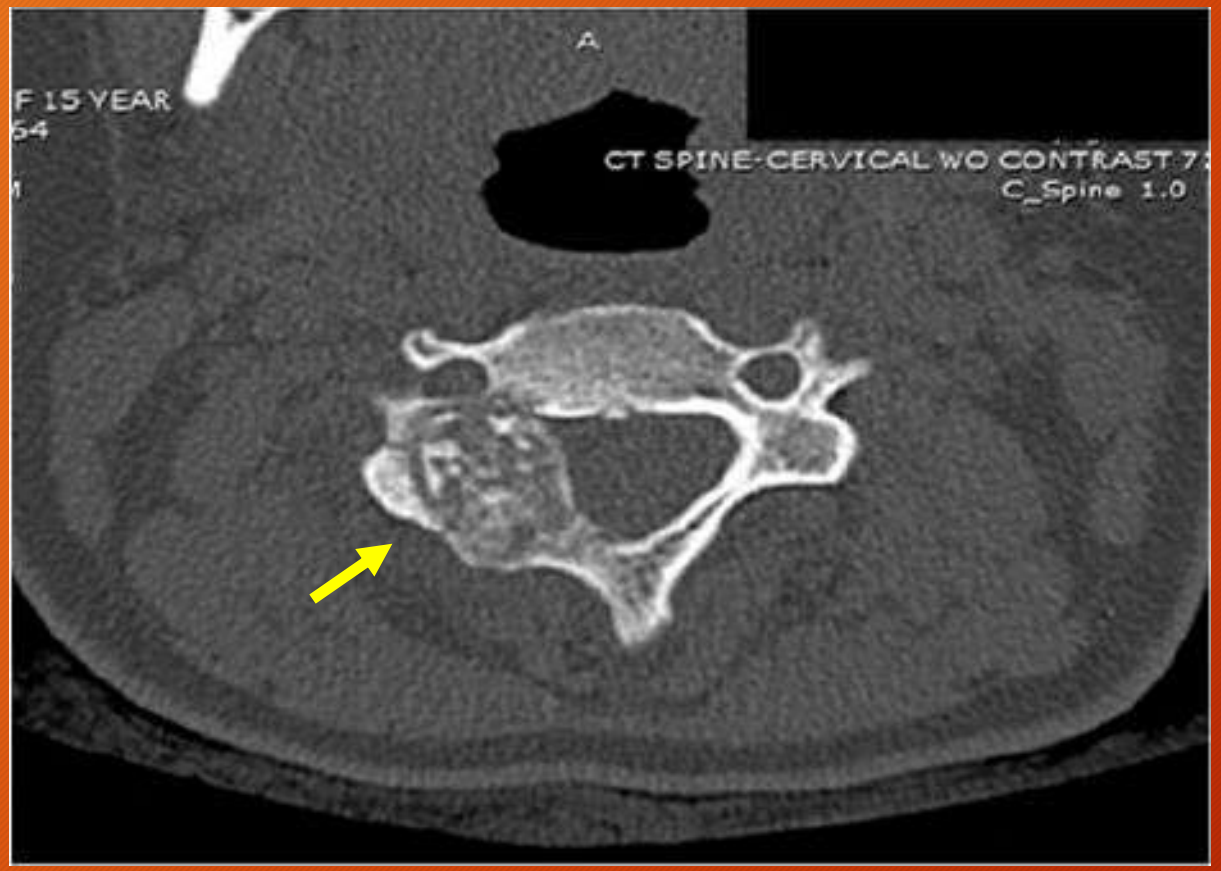


Destroyed Lamina by tumor which encroaches on the foramen transversarium

Investigations

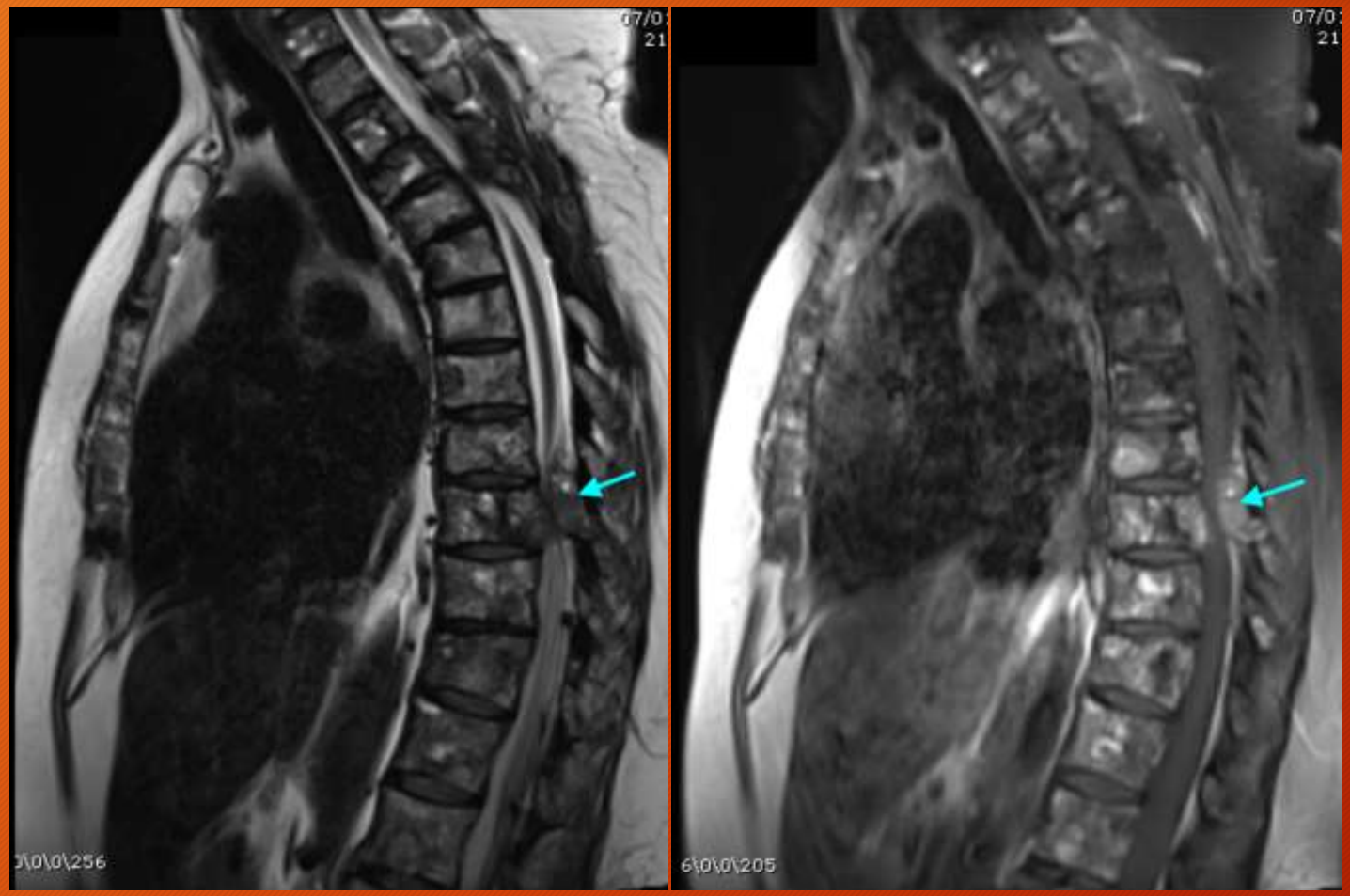
MAGNETIC RESONANCE IMAGING

- This is the investigation of choice in demonstrating spinal tumors. In many cases it is also helpful in giving an idea about the pathology of many tumors. Sagittal and axial views in both T1 and T2 weighted formats are routine. Other views could be requested as required including coronal views (MRI myelogram), or other formats for specific pathology like fat suppression

MAGNETIC RESONANCE IMAGING

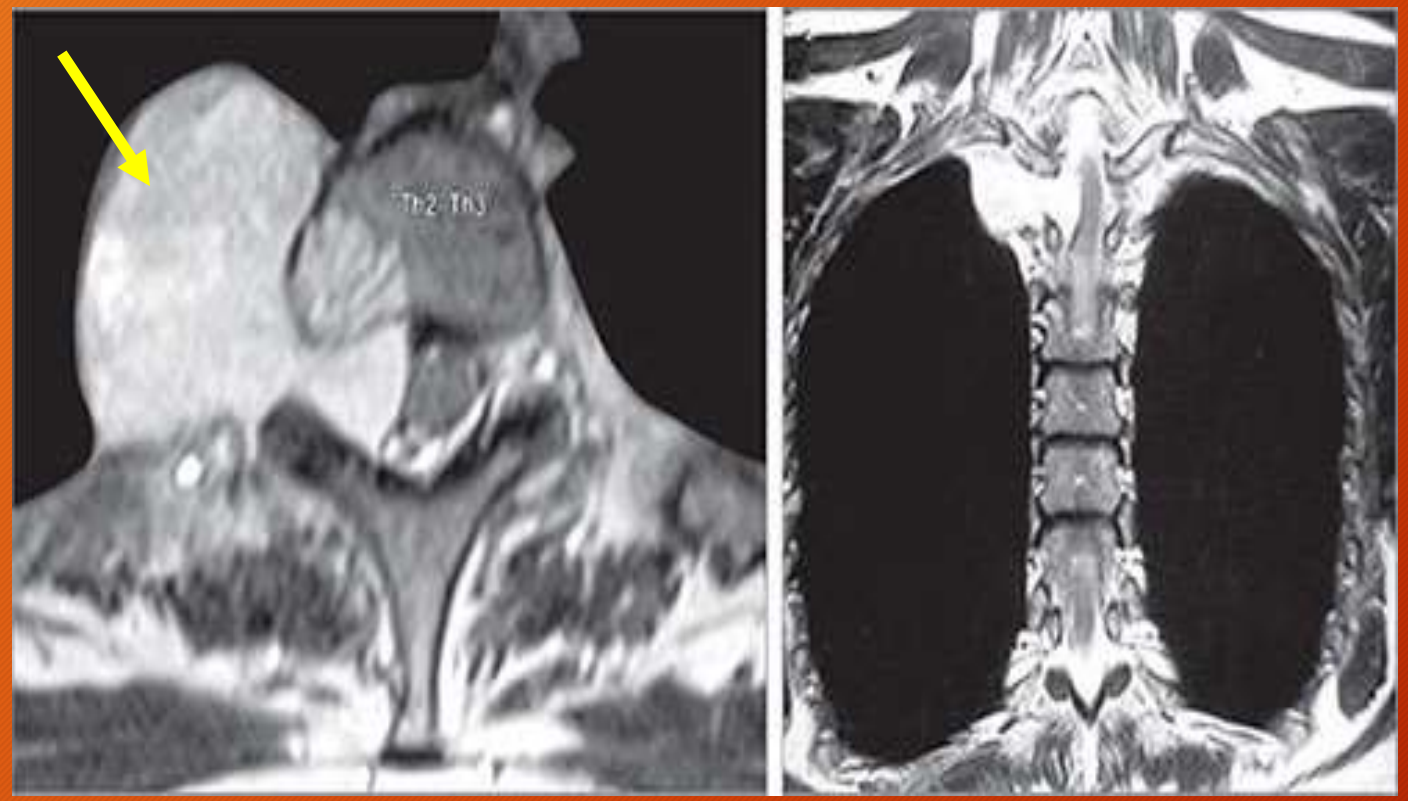
Metastatic lesions

MAGNETIC RESONANCE IMAGING



MRI of the Cervico thoracic spine T2 weighted on the left, and T1 with Gadolinium on the right showing a metastatic tumor causing spinal cord compression

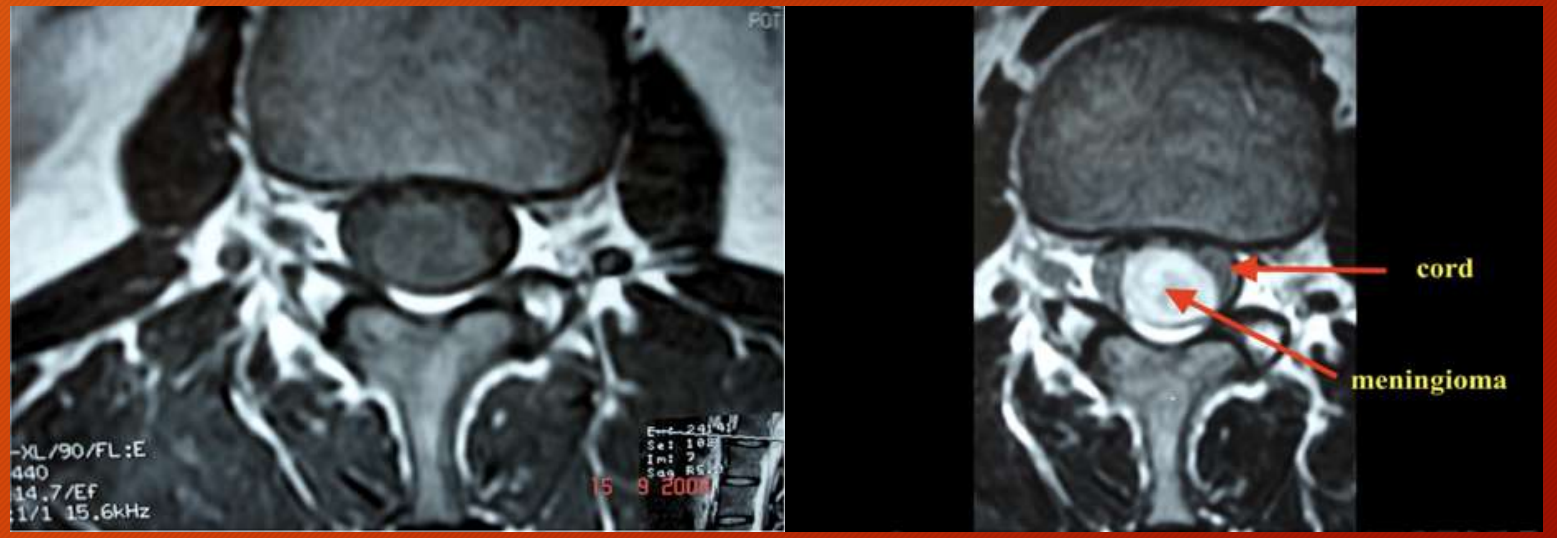
MAGNETIC RESONANCE IMAGING



MRI showing a dumb bell tumor extending through the intervertebral foramen into the chest, and compressing the spinal cord.

MAGNETIC RESONANCE IMAGING

Figure (191): A T2 sagittal MRI showing a spinal **intramedullary ependymoma** (white arrows) which is sausage like. Note the CSF cap on top of the tumor (black arrow) which is a dilatation of the central canal, usually there is another one at the lower end.



MRI of a spinal cord tumor (meningioma). On the left a T1 weighted sequence showing the tumor as an isointense mass displacing the cord anteriorly and to the sides, and on the right T1 after Gadolinium showing the excellent enhancement of the tumor.

MAGNETIC RESONANCE IMAGING

Figure (192a): A T2 sagittal MRI showing **syringomyelia** (white arrow) opposite T1 and T2 vertebrae. Note the pointed appearance at the top end of the syrinx which is the central canal returning to normal.

Figure (190a): A T1 sagittal MRI without contrast showing an **intradural meningioma.**

Figure (190b): A T1 sagittal MRI with contrast showing an **intradural meningioma**, note the increased intensity with Gadolinium.

Images from my book Introduction To Neuroimaging

Classification of Spinal Tumors

- These tumors could be classified **anatomically** into:
- **Extradural** which form about 60% of the total. They occur outside the dura; in the extradural space or vertebral body.
- Most of these tumors are metastatic which start primarily in a pedicle of a vertebra, having arrived via the blood stream. But some are primary malignant and some are benign, but they are uncommon.
- **Intradural** which form about 40% of the total, these could be either:
  - ***Extramedullary*** are those which arise from the roots or coverings (meninges) and form around **35%**, or,
  - ***Intramedullary***, arise from the cord itself and form around 5%.

Extradural Tumors

MALIGNANT

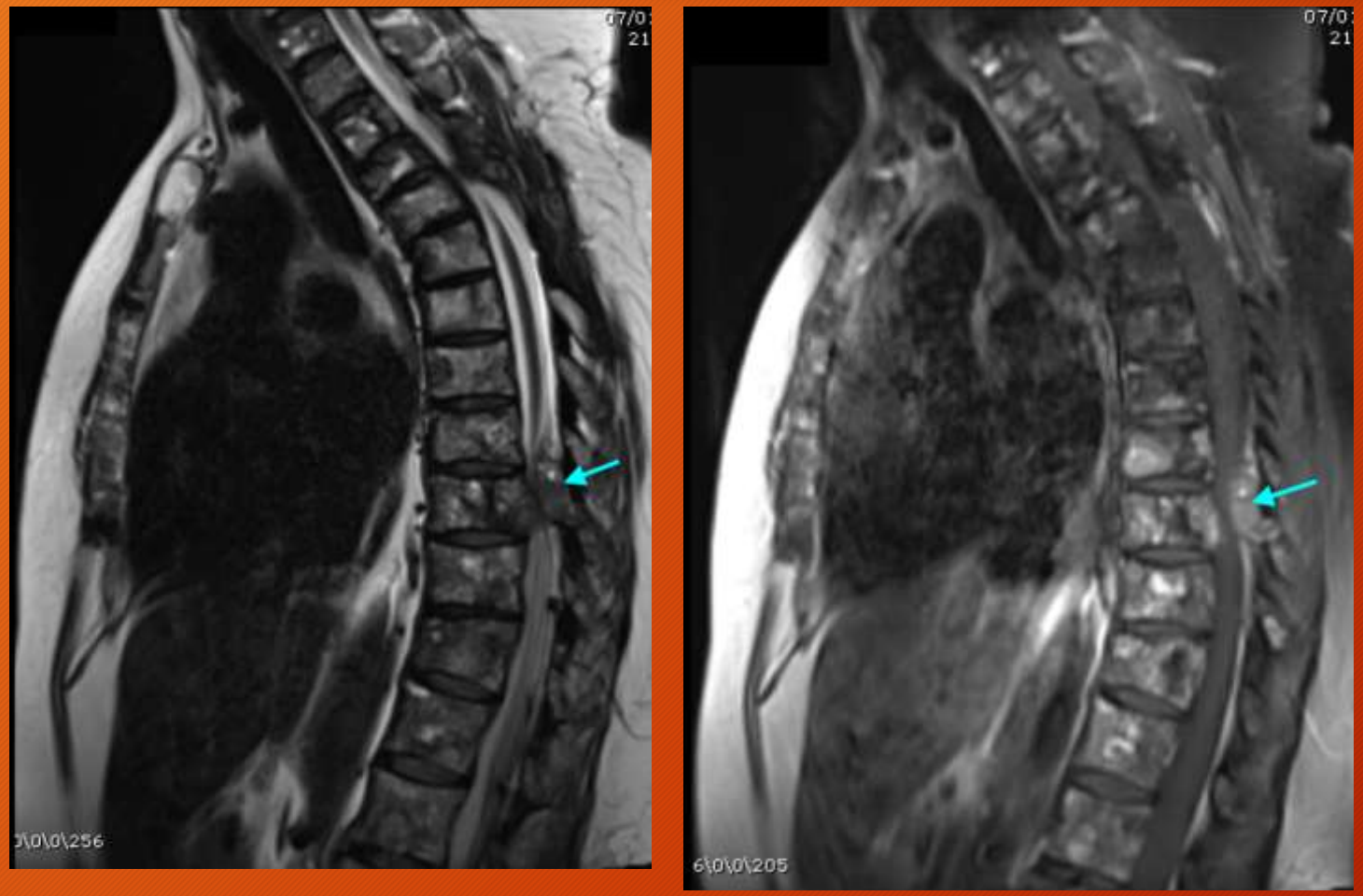
- These tumors form about 60% of all spinal tumors, and occur mainly in older people. They are mostly metastatic tumors with their primary somewhere else in the body.
- They have in most cases started in a part of the vertebra (body, pedicle) and extended into the extradural space compressing the cord or roots.
- These tumors arise from primary tumors of the breast, lung, kidney and prostate. Also multiple myeloma and lymphoma. Most of these metastatic tumors are osteolytic in nature, but some like the prostate, are osteoblastic. Both types may show abnormality on plain x-rays.
- In children they could be sarcomas and neuroblastomas

Extradural Tumors

MALIGNANT

- There route of spread is usually hematogenous mainly to thoracic vertebra, However, metastases from the prostate spread via the veins to get access to Batson's plexus, therefore most of its metastases are in the lumbar vertebrae.
- They may arise in the pedicle, lamina or vertebral body. From there the grow to compress the dura and its contents.

Extradural Metastases



T2 thoracic MRI showing compression of the cord, and T1 MRI with contract showing hyperintense lesion in the vertebra and around the dura

Extradural Metastases

Extradural Tumors

BENIGN

- These tumors occur in the extradural space, either in the bone as in hemangioma or in the nerves as they course through the epidural space; nerve sheath tumors (NST) like schwannomas and neurofibromas, or from the dura (meningioma). Other tumors which occur in this space are lipomas, however they form a smaller portion of all spinal tumors.

Intradural Tumors

EXTRAMEDULLARY

- They are slowly growing tumors hence they lead in addition to the compression, to changes in the adjacent bone.
- They could be either:
  - Meningiomas
  - Nerve Sheath Tumors

Intradural Tumors

EXTRAMEDULLARY

- They are slowly growing tumors hence they lead in addition to the compression to changes in the adjacent bone.
- They could be either:
  - Meningiomas
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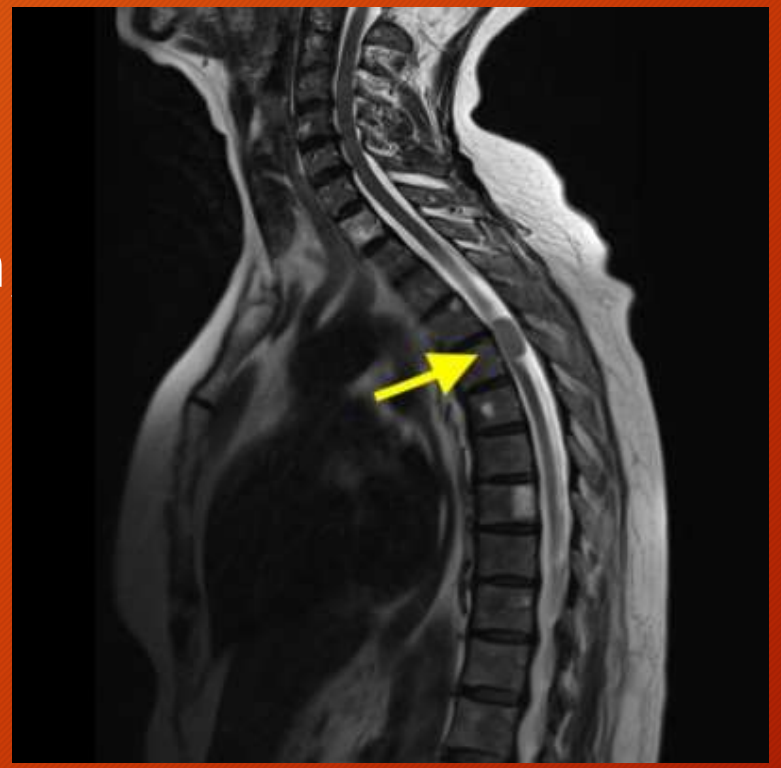


Meningioma

- Occur in middle-aged or elderly
- Marked female predominance
- Could be extradural or intradural extramedullary
- Commonly intradurally in the thoracic region
- causes marked compression

- Tumor grows extremely slowly, there is usually long history of ill-defined back pain, usually thoracic and very slowly progressive paralysis.
- X-ray: erosion of pedicles. No hyperostosis
- Diagnosis: MRI with IV contrast

Meningioma

Figure (190a): A T1 sagittal MRI without contrast showing an **intradural meningioma.**

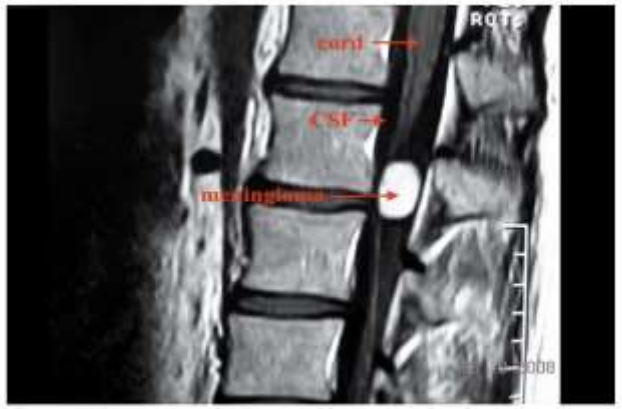


Figure (190b): A T1 sagittal MRI with contrast showing an **intradural meningioma**, note the increased intensity with Gadolinium.

T1 and T1 with contrast spinal MRI sagittal and transverse cuts showing a hyperintense lesion which is an intradural meningioma

Nerve Sheath Tumors

- Most common intradural tumor
- May occur at any site.
- Arise from posterior nerve root
- Present as slowly growing tumor with cord compression.
- May be a Schwannoma or a neurofibroma
- Most common presentation is pain in radicular distribution.
- May be multiple.
- In cervical area there is long standing neurological involvement of the cervical nerve root before features of cord compression
- If the cord is affected then some degree of **Brown-Séquard** syndrome is present.
- May extend through intervertebral foramen: "Dumb-bell" appearance
- X-ray: bone erosions & enlargement of intervertebral foramen
- Diagnosis by MRI

Nerve Sheath Tumors

Nerve Sheath Tumors

Neurofibromatosis 1

Intradural Tumors

INTRAMEDULLARY

- Uncommon.
- Usually present in 2nd or 4th decades.
- They are mostly benign.
- They could be either:
  - Astrocytomas
  - Ependymomas

- Diagnosis by MRI which shows expansion of cord by enhancing mass

Ependymoma

- 60% of intrinsic spinal tumor.
- Mainly in adults.
- Half of the cases arises from filum terminale and cause compression of cauda equina.
- The rest are mainly cervical and present with cord compression.

- They are pathologically four types
- They are considered benign and the most common is the myxopapillary variety occurring in the filum terminale.

Ependymoma

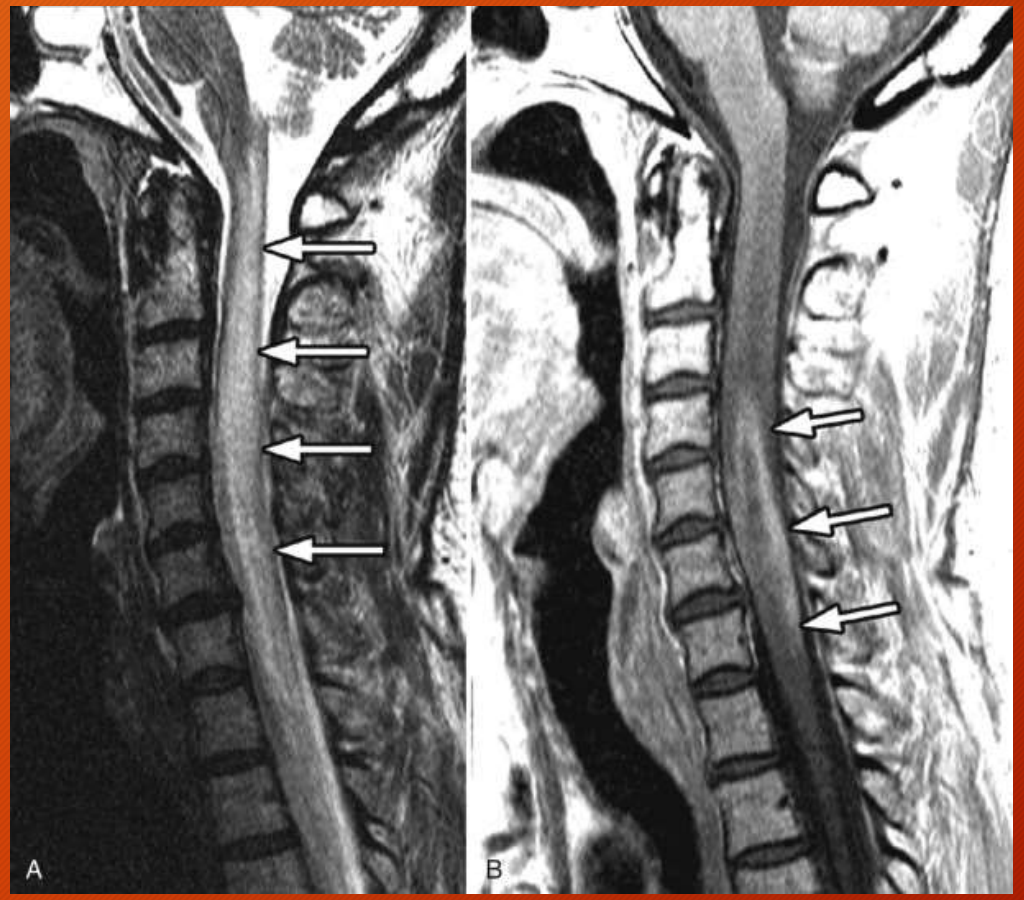
Figure (191): A T2 sagittal MRI showing a spinal **intramedullary ependymoma** (white arrows) which is sausage like. Note the CSF cap on top of the tumor (black arrow) which is a dilatation of the central canal, usually there is another one at the lower end.

A T1 and T2 MRI of the cervical region showing a sausage like mass within the cord, The mass is hypointense on T1 and hyperintense on T2

Astrocytoma

- 6-8% of spinal tumors.
- Usually present in 2nd to 3rd decades (CHILDREN).
- Most commonly benign
- Arise from glial cells and stretch the spinal cord tissue and infiltrates it
- Diagnosis by MRI where they appear as slightly intense tumor which acquire a high signal on contrast injection

Astrocytoma



MRI of the cervical region showing intra medullary mass on T1, T1 with contrast And T2

Management

- Spinal cord tumors are usually treated by surgery aiming for excision and/or relief of compression. Excision can be achieved in most benign tumors; however, some tumors are difficult to excise completely and therefore are usually debulked. In metastatic tumors, the aim of surgery is usually decompression.

Management

- **Metastases**: If situated posterior or postero-lateral to the cord, a decompressive laminectomy followed by radiotherapy (RT) is the usual course of action. However, if situated anterior to the cord then an anterior approach with corpectomy and fusion should be performed, to be followed by RT. Lymphomas respond well to steroids.

Management

- **Meningiomas, Schwannomas and Neurofibromas** are usually treated with excision via a laminectomy. The dural attachment in meningiomas must be removed to prevent regrowth of the tumor.
- Schwannomas can be shaved off nerve roots.
- Neurofibromas are difficult to excise completely, so the course of action depends on whether the nerve root could be sacrificed or not. If so the tumor can be removed with its nerve root, otherwise a partial resection is the only course of action. Since the tumor grows slowly a second operation could be done after many years. Dumb-bell tumors require 2 stage operations. There is no place for RT in these types of tumors except in rare cases of pathological change.

EXCISION OF SPINAL MENINGIOMA

EXCISION OF SPINAL SCHWANNOMA

Management

- **Ependymomas and Astrocytomas** are dealt with surgically via a laminectomy and myelotomy. Cord ependymomas could be shelled out, especially if associated with a syrinx. Filum terminale ependymomas are removed with the filum itself, which should be sectioned from the top end first to avoid retraction of the tumor and the cord upwards. There is usually no need for RT, but there may be a place in some types of astrocytoma.
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Prognostic Factors

- Ambulatory status of the patient
- Age of patient
- Duration of symptoms and compression
- Histopathology of the tumor