

RAD 420

Radiographs of the Spine

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Introduction

- ❑ The bones of the spine or vertebral column are frequent targets of imaging evaluation especially X-ray.
- ❑ The bones of the spine may show manifestation of almost any disease that occurs elsewhere in the skeleton.
- ❑ Plain X-rays are the basic means of investigation.
- ❑ but computed tomography and MRI are increasingly being used as well. They are used for investigations requiring high resolution images.

Radiographic Anatomy of the Spine



❑ The bones of the spine are 33 articular bones. It is not easy to demonstrate all of them same time. They are demonstrated in segments according to their anatomical locations. They are:

- Cervical vertebrae – 7
- Thoracic (dorsal) vertebrae – 12
- Lumbar vertebrae – 5
- Sacral vertebrae – 5
- Coccyx vertebrae – 4

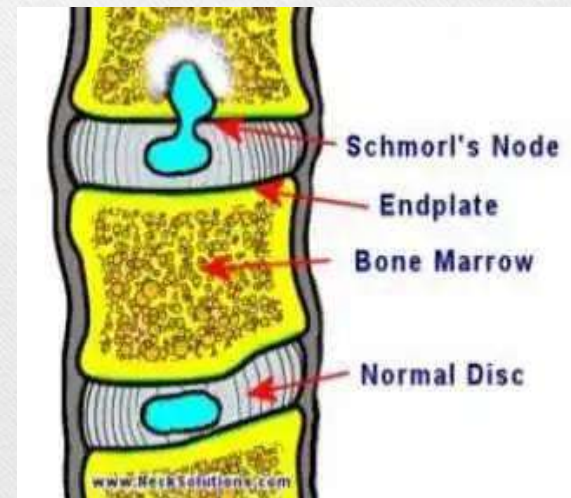
❑ **TOTAL = 33** vertebrae in normal subjects

Radiographic Anatomy of the Spine

- ❑ The detailed structure of the vertebrae in the cervical, thoracic and lumbar regions differs but the general structure is similar.
- ❑ In the lateral view the vertebral bodies are approximately rectangular in shape. There may be shallow indentations on the upper and lower surface due to protrusion of disc material into the vertebral end plates. These indentations are known as *Schmorl's* nodes and are **often** of no clinical significance.

Schmorl's nodes

- ❑ **Schmorl nodes**, also known as **intravertebral disc herniations**, are the protrusions of the cartilage of the intervertebral disc through the vertebral body endplate and into the adjacent vertebra (**see illustration**). The protrusions may contact the marrow of the vertebra, leading to inflammation.
- ❑ It is named after **Christian Georg Schmorl**, a German pathologist who first described them in 1927.
- ❑ Quiescent Schmorl nodes are found in around 75% of autopsies, at all ages, and more frequently in males.
- ❑ Chronic Schmorl nodes are usually asymptomatic.
- ❑ Acute Schmorl nodes, in contrast, are uncommon and are associated with inflammation and symptoms.



Schmorl's nodes

- ❑ In acute stage, Schmorl nodes are difficult to detect on plain radiograph due to sclerosis around the margin of the herniation not having had time to develop.
- ❑ They appear as small nodular lucent lesions involving the inferior endplate of lower thoracic and lumbar vertebral bodies (**see radiograph**). Involvement of both the inferior and the superior endplates is not uncommon. A sclerotic margin may be present.
- ❑ Schmorl nodes are better identified on CT images, showing the same pattern observed on radiographs.
- ❑ **Differential diagnosis**
 - For chronic Schmorl nodes, there are few differentials. For acute Schmorl nodes consider:
 - ✓ **Spondylodiscitis Vs infection:** acute Schmorl nodes will have more focal endplate changes, no fever, and no epidural or prevertebral phlegmonous changes
 - ✓ Malignancy



The typical vertebra



An Axial CT image of a lumbar vertebra.

B = Body

P = Pedicle

Lm = Lateral mass

T = Transverse process

L = Lamina

S = Spinous process

The typical vertebra

- ❑ The vertebra is a short bone that has a rough typical shape, with some variations in different segments. The typical vertebra has a body anteriorly and a neural arch posteriorly.
- **VERTEBRAL BODY:** The anterior part of the vertebra is reel-like in shape, and its size increases cranio-caudally.
- **NEURAL ARCH:** Complex bony structure composed of multiple parts, contributing to the creation of the spinal canal. It is composed of:
 - ✓ **Pedicles:** Two short, bony projections that extend from the posterior edge of the vertebral body
 - ✓ **Lateral Masses:** Two structures formed by the union of the superior and inferior articular processes. On the superior and the inferior aspects lie the inferior articular process and superior articular process.
 - ✓ **Laminae:** Two flat, thin plates of bone that join posteriorly at the midline to complete the neural arch.
 - ✓ **Spinous Process:** Prominent, posteriorly-directed projection arising at the junction of the laminae.
 - ✓ **Transverse Processes:** Lateral bony extensions arising from the junction of the pedicles and laminae.

Signs of Abnormality of the Spine

- ❑ **Vertebral body collapse:** A collapsed vertebral body is one which has lost height. Collapse of vertebral body is best assessed on lateral radiograph and very difficult to assess at computed tomography. If there is collapse it is good to assess adjacent disc to see it is narrowed and to check if the pedicle has been destroyed.



Signs of Abnormality of the Spine

- ❑ **Disc space narrowing:** The intervertebral discs are radiolucent on plain films as they are composed of fibrous tissue and cartilage. Normally the disc spaces are the same height at all levels in the cervical and thoracic spine. In the lumbar spine, the disc spaces increase slightly in height going down the spine except for the disc space at L5/S1 junction which is usually narrower than the one above it (between L4 and L5). Disc space narrowing is a feature of degenerative disease of the spine and disc space infection.

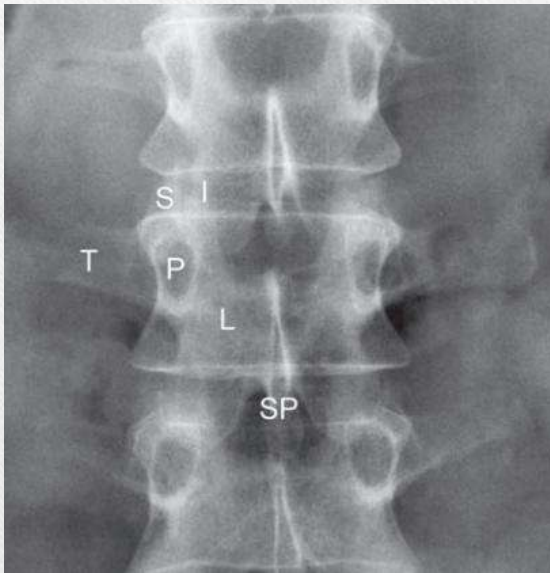


Signs of Abnormality of the Spine

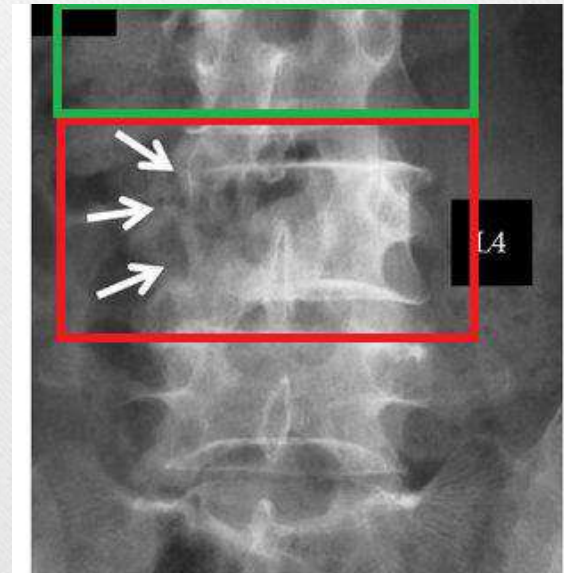
- ❑ **Destruction of the pedicles:** On plain films the pedicles are best assessed in the frontal view, except in the cervical spine where oblique views are necessary.
- The pedicles are also well demonstrated at computed tomography.
- Destruction of one or more pedicles is a sign of spinal metastases.
- Flattening and widening of the interpedicular distance occurs in tumors arising from the neural canal such as neurofibroma or meningioma.

Signs of Abnormality of the Spine

Normal Pedicles

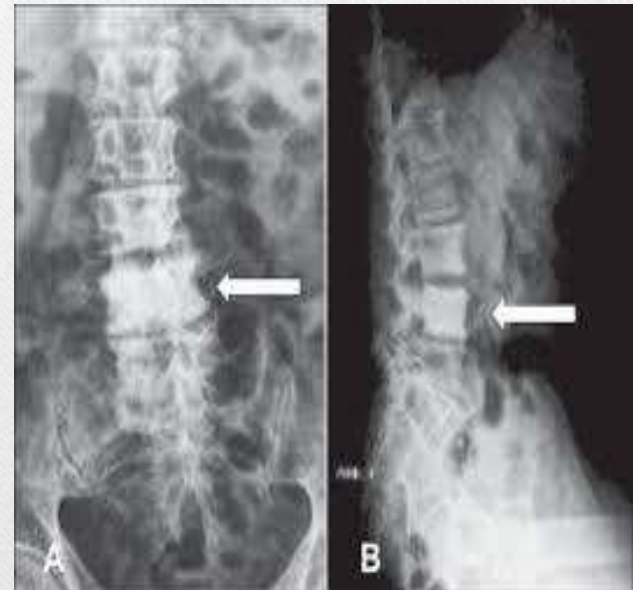


Destroyed Pedicle



Signs of Abnormality of the Spine

- ❑ The **dense vertebra sign**: Sclerosis may be part of a generalized process involving many bones. Common causes of sclerotic vertebra are:
 - Metastases, especially from primary tumours of prostate or breast.
 - Malignant lymphoma.
 - Paget's disease.
 - Haemangioma.



Signs of Abnormality of the Spine

- ❑ The **lytic vertebra sign**: This may also be part of a widespread process or may be confined to one vertebra.

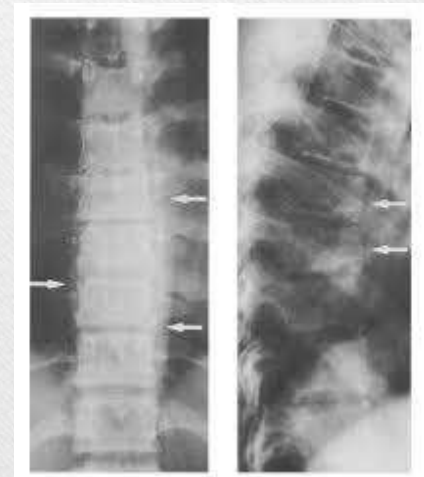
Common causes of lytic vertebra are:

- Metastases, particularly from primary tumours of the lungs or kidneys.
- Myeloma.
- Malignant lymphoma.
- Infection.



Signs of Abnormality of the Spine

- ❑ **Paravertebral shadow:** Paravertebral soft tissue shadow is a sign of abnormality in the spine. Soft tissue swelling is easy to recognize on plain films in the thoracic region where the soft tissue adjacent to the spine is fusiform in shape but more difficult in the lumbar region. In the cervical region anterior soft tissue swelling causes a forward displacement of the pharyngeal air shadow. At computed tomography paravertebral soft tissue shadow is recognized at all levels.
- ❑ Causes of paravertebral soft tissue swelling include:
 - Infection.
 - Malignant neoplasms.
 - Haematomas following trauma.



Spondylosis

- ❑ Spondylosis is a degenerative disc disease characterized by:
 - There may be herniation of the degenerate disc.
 - Degenerate disc stimulate osteophytosis (the so called osteophytic lippings).
 - Soft tissue swelling.
 - Affects lower cervical and lower lumbar spines mostly.
 - Disc space narrowing.



Ankylosing spondylitis

- ❑ Radiographic features are
 - Fuzziness of sacroiliac joints.
 - Later, there is erosion of sacroiliac joints.
 - In late stages, fusion of the sacroiliac joint spaces and calcification of spinal ligaments and formation of vertically oriented bony bridges between vertebral bodies.
 - The whole spine may become fused into a solid bone. This appearance is called *bamboo spine*.



Infection

❑ Radiographic features are:

- Destruction of the intervertebral discs and adjacent vertebral bodies.
- Disc space narrowing with erosion of adjoining surfaces of vertebral bodies.
- Collapse of vertebral bodies resulting in sharp angulation known as gibbus.
- Paravertebral abscess may result.
- If the infecting organism is *Staphylococcus aureus*, there are sclerotic bony changes.
- In tuberculous infection, there are lytic bony changes.
- Fusion of vertebral bodies when healing occurs.
- There may be calcification of the tuberculous paravertebral abscess.

Spondylolisthesis

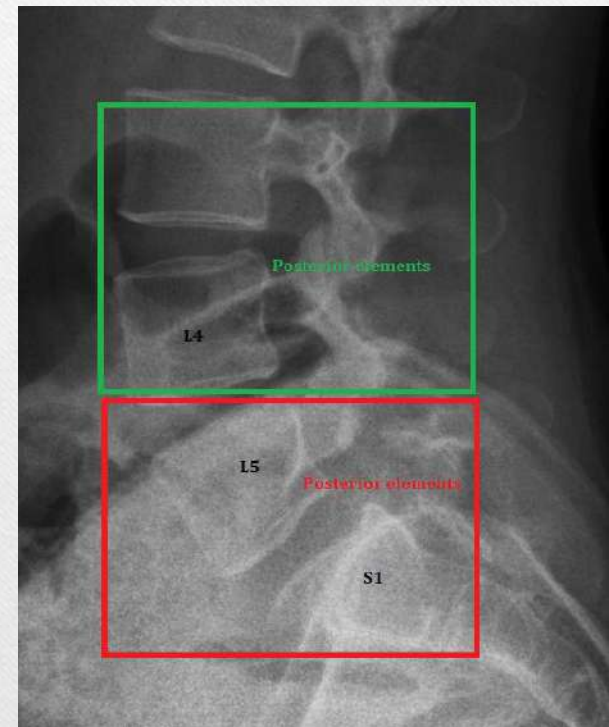
❑ Radiographic features are:

- Forward slip of over a vertebral body over the one below it (**see the red box in the radiograph**).
- It usually affects the lumbar spine most, especially at the L4/L5 and L5/S1 junctions.
- This forward slip is best demonstrated in the lateral view of the involved segment of the spine.



Spondylolysis

- ❑ Spondylolysis is **a stress fracture through the pars interarticularis of the lumbar vertebrae** (compare the posterior elements in the **red box** [abnormal] with **green box** [normal]). The **pars interarticularis** is a thin bone segment joining two vertebrae. It is the most likely area to be affected by repetitive stress.
- ❑ It is found in one out of every 20 people.
- ❑ Defect in the pars interarticularis is usually due to trauma but there is no forward slip of one vertebra on another.
- ❑ Untreated cases progress to spondylolisthesis.



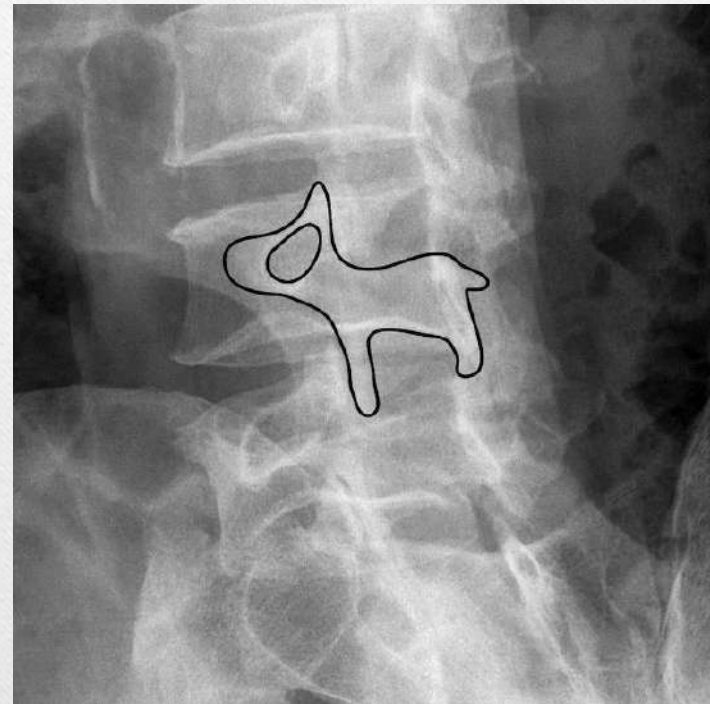
Scottie dog sign (spine)

- ❑ **Scottie dog sign** (often seen misspelt as Scotty) refers to the normal appearance of the lumbar spine when seen on oblique radiographic projection.
- ❑ On oblique projections, the posterior elements of the vertebra form the shape of a Scottie dog



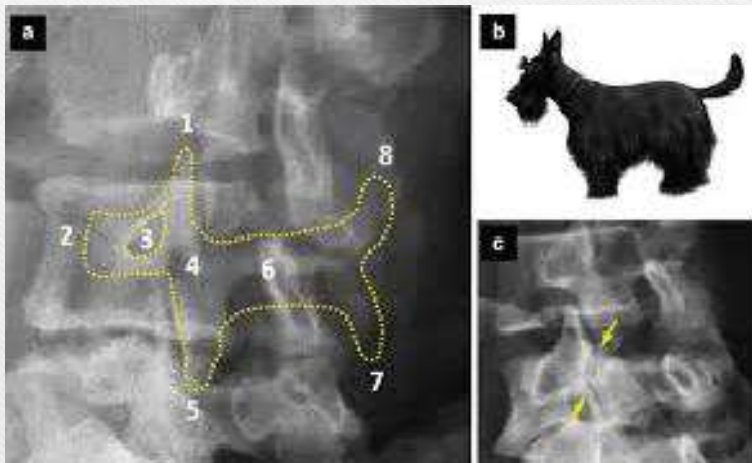
Scottie dog sign (spine)

- ❑ On oblique views, the posterior elements of the vertebra form the figure of a Scottie dog with:
 - the **transverse process** being the nose
 - the **pedicle** forming the eye
 - the **inferior articular facet** being the front leg
 - the **superior articular facet** representing the ear
 - the pars interarticularis (the portion of the lamina that lies between the facets) equivalent to the neck of the dog

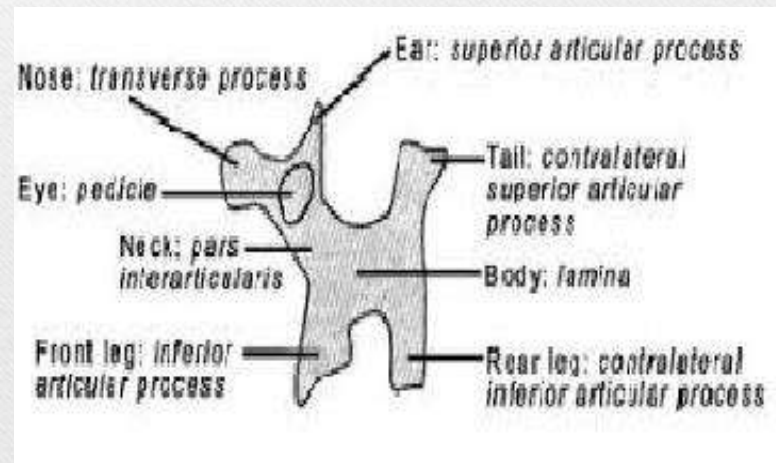


Scottie dog sign (spine)

On a Radiograph



Drawn Illustration



Metastases and multiple myeloma

- ❑ The radiographic features are:
 - Multiple myeloma gives rise to lytic lesions in the vertebral bodies.
 - There may be vertebral body collapse with metastases.
 - Metastases often involve both pedicles and vertebral bodies.



Possible Faults and Limitations in Spinal Radiographs

❑ Cervical Spine:

- Closed mouth in the views of odontoid peg to be demonstrated. Open mouth projection is needed for demonstration of the odontoid peg but in case the patient is unconscious, a translucent block should be put in the patient's mouth to keep it open. This may limit the anatomical structures demonstrated. The limitation may also be seen in patients with added severe maxillofacial injury.
- The tongue can cast soft tissue shadow on the bony structures and cause them to be obscured. This can be prevented by making the patient to continuously say *aaaaaaabbbbbb* in a drawl during exposure.
- Inadequate extension of the neck can cause the upper part of the cervical spine to be obscured. The base of the skull can likewise obscure C1 and C2 vertebral bodies.
- In case of injury to C1, there is usually difficulty in maneuvering the neck and tomography should be used inevitably.

Possible Faults and Limitations in Spinal Radiographs

❑ Thoracic Spine:

- T1-T4 segment is usually superimposed on the trachea in anteroposterior view. This can be a source of confusion for a novice in plane x-ray interpretation.
- T5-T8 segment is usually superimposed on the dense heart shadow in anteroposterior view. In the upper part of the abdomen, the IVC and aorta also superimpose on the vertebrae. To overcome this superimposition of structures, high KV should be used to burn off these soft tissue structures.
- There may be motional blurring if breath holding technique is used during exposure.
- The shoulder is thick and usually obscures the upper thoracic spine segment in the lateral view.
- There may inappropriately ambitious coning which could lead to anatomical cut-off.

Possible Faults and Limitations in Spinal Radiographs

- **Lumbar Spine:**
- If the shoulder is thrown forward the normal lumbar lordosis will be lost but flexing the knee preserves the curve but decreases its extent. A radiograph obtained with the shoulder thrown forward is inappropriate.
- The L5/S1 junction (disc space) is usually foreshortened in anteroposterior view because it is projected by oblique rays coming to it. So coned down view is usually necessary to assess L5/S1 joint space.

End

**Thank you for
listening**