Lumbosacral Joint
Anatomy of the posterior elements, particularly at S1, is important. The sacrum forms the supporting structure of the lumbar spine, as well as being the junction between the spine and the pelvis. The L5/S1 junction is particularly prone to disc prolapse (Slide 1 and Slide 2) and degenerative changes.

Transitional Vertebrae
Transitional vertebrae can occur at any of the junctions, but are particularly common at the lumbo-sacral region. The transition can be 'complete' but is more commonly partial. Transitional vertebrae are relevant clinically because they can 'protect' the last disc. However, some can cause back pain in their own right. They can also cause some confusion when performing surgery in this region.

Sacro-Iliac Joint
The sacro-iliac joint is very difficult to stress so that pain in the sacro -iliac joint can be differentiated from other causes of low back pain. The clinical tests of sacro-iliac joint pain are neither sensitive nor specific. Bone scans and computerized tomography can help to localize abnormalities to the sacro-iliac joints. The only real way to confirm sacro-iliac joint pain is with the use of local anesthetic injections under radiographic control. Corticosteroids can also be injected simultaneously as a therapeutic maneuver. In any case of sacro-iliac abnormality without preceding trauma, further investigation is necessary to diagnose/exclude any spondyloarthropathies. If sacro-iliac pain is diagnosed and does not respond to conservative measures, local fusion can be attempted.

Sacro-iliac sprain can be diagnosed using 'Gaenslen's test'. The diagnosis is made by hyper-flexing the hip on the unaffected hip and therefore locking the pelvis and hyper-extending the hip on the affected side. Pain indicates the presence of a sacro-iliac strain. It can take up to six weeks to recover.

Sacral Fractures
As the sacrum forms part of the pelvis as well as part of the spine, its integrity is important for stability.

Fractures (Slide 1, Slide 2 and Slide 3) of the sacrum are frequently accompanied by other pelvic injuries and are frequently missed on initial X-ray assessment. Some of the complications of these fractures are related to the structures adjacent to the bone, namely: blood loss from retroperitoneal vessels, especially veins; and neural injuries to the cauda equina, sacral plexus or the sciatic nerve.

Tumors
Primary spinal tumors may result from primary tumors of bone (Slide 1 and Slide 2), spinal cord and nerve roots, or the meninges. The vertebral column may also be involved with secondary disease via local spread from paraspinous soft tissues, or distant spread via metastatic disease (Slide 1 and Slide 2).

Location
The majority of malignant tumors, both primary and metastatic, will originate anteriorly and involve the vertebral body and possibly one or both pedicles. Strictly posterior localization, even when more than one level is involved, is far more typical of benign lesions.

Tumors have a tendency to be located in certain parts of the vertebrae:

-Vertebral body: chordoma (Slide 1 and Slide 2), giant cell tumor, hemangioma, eosinophilic granuloma, metastatic disease and multiple myeloma
-Posterior elements: aneurysmal bone cyst (Slide 1 and Slide 2), osteoblastoma, osteoid osteoma and osteochondroma
-Adjacent vertebrae: aneurysmal bone cyst, chondrosarcoma and chordoma
-Multiple vertebrae: eosinophilic granuloma, metastases and myeloma

Imaging
Plain radiographs
If a spinal tumor is suspected, antero-posterior (AP) and lateral radiographs should be obtained to evaluate spinal alignment, bony integrity and soft-tissue contours. Indirect evidence of mass lesions

can be inferred from these studies. Destructive lesions of bone are not usually detectable on plain films until 30-50% of trabecular bone has been destroyed. An important initial clue on an AP view is the ”winking owl“ sign, which indicates unilateral pedicle destruction. Vertebral body collapse may also be seen on plain films. Of patients suffering from symptomatic spine metastases, 85% of cases of epidural compressions, 94% of breast tumors, 74% of lung tumors and 40% of lymphoma will have plain film evidence of tumor. Normal radiographs do not exclude the presence of neoplastic spinal disease or epidural compression. Finally, the physician must not forget to obtain postero-anterior (PA) and lateral chest radiographs to check for the presence of either primary or metastatic disease of the lungs and mediastinum.

Radionuclide Studies
Technetium bone scans are an effective screening tool for spinal neoplasms; they demonstrate osteoblastic activity and provide a panoramic skeletal survey for areas of bone injury and repair. They can locate isolated occult lesions and disclose patterns of widespread metastatic disease. If there are multiple lesions, a bone scan can indicate the most convenient biopsy site. However, technetium bone scans cannot distinguish areas of destruction due to tumors from those due to infections or fractures and there is a high false-negative rate in the presence of multiple myeloma. False-negative scans may also occur in cases of chemotherapy-induced osteoblastic suppression, hypernephroma and naso-pharyngeal, lung and breast carcinoma. Nonetheless, the bone scan in combination with screening laboratory studies and physical examination helps to identify approximately 95% of spinal tumors early in their course. Patients who test negative, up to this point, can be reassured that it is unlikely that they have a spinal neoplasm. However, these individuals should be followed up clinically to see if any indication for further evaluation evolves.

Magnetic Resonance Imaging
Magnetic resonance imaging (MRI) is the primary imaging modality for anatomic definition of spinal tumors. MRI readily defines the relationship of the osseous lesion to the spinal cord, meninges and paravertebral tissues and is a sensitive tool for identifying marrow changes caused by primary or metastatic disease. Another major advantage of MRI is that it easily identifies multifocal metastases and multiple levels of epidural compression in sagittal plane images. MRI may also help to distinguish between tumor and infection; in tumor cases, the disc-space is not usually involved. MRI may also be useful when attempting to differentiate between benign and pathologic compression fractures of the vertebral bodies. Typically, pathologic (non-osteoporotic) fractures have low signal intensity on T1-weighted images and high signal intensity on T2-weighted images, although this is not always the case. In contrast, the majority of benign vertebral fractures demonstrate normal marrow signals on both T1- and T2-weighted images. Furthermore, fat suppression MRI pulse sequences may help to distinguish between tumor and other tissues.

Initially, conventional MRI should be performed, although gadolinium-enhanced studies may help to reveal epidural lesions and intradural or extramedullary tumors, locate foci of tumor activity for biopsies and further delineate known areas of spinal cord compression as well as evaluate tumor response to therapeutic intervention.

Computed Tomography
Spinal computed tomography (CT) scans, with or without intrathecal contrast, remain an important part of the evaluation and treatment of spinal neoplasia, especially in those lesions that are bone forming. The unique ability of CT scans to image bone detail makes it of great importance in assessing the surgical field and helping to plan surgery.

Angiography
Angiography may be indicated for:

1. Preoperative embolization of vascular tumors or the use of embolization as treatment.
2. Identification of the vascular supply of a tumor or of its effect on the local vasculature.
3. Identification of the artery of Adamkiewicz or of the vascular supply to the neural elements in the region.

4. Trial occlusion of a vertebral artery in a patient with a cervical tumor that may involve the vertebral artery.

Neoplastic disease of the spine may arise from local lesions developing within or adjacent to the spinal column, or from distant malignancies spreading to the spine or paraspinous tissues by hematogenous or lymphatic routes.

Local involvement of the spine may result from primary tumors of bone, primary lesions arising in the spinal cord or its coverings or continuous spread of tumors of the paraspinous soft tissues or lymphatics. Regional or distant spread of metastatic disease to the spine may occur with almost any of the solid tumors of the body, with osseous malignancies of the appendicular skeleton and with systemic lymphoreticular malignancies such as multiple myeloma and lymphoma.

Spondylolisthesis
This is a descriptive term to describe subluxation between vertebrae. Unlike other orthopedic descriptions, it is the proximal part that is described with respect to the distal. Thus antero- and retro-listhesis describe forward and backward subluxation of the upper vertebrae with respect to the lower respectively. Moreover, lateral subluxation may also occur. However, the most common use of 'Spondylolisthesis' describes a forward slip of the upper vertebra on the lower. The most common level involved is L5/S1.

Spondylolisthesis can be described according to what levels are involved, the direction of displacement and the degree (i.e., grade 1, grade 2, grade 3 and grade 4) and also the etiology of the listhesis.

There are two classifications commonly used: Wiltse, Newman and McNab (1976) described five types of spondylolisthesis based on the pathology and anatomical location. Unfortunately, this gives no guidance to natural history or treatment needed. Marchetti and Bartolozzi (1982, 1994) described a system based on the etiology and supplemented with guidance to natural history.

The pars interarticularis plays an important part in intervertebral stability. It forms part of the 'hook' that enables the upper vertebra to remain in position.
As can be seen by the classification schemes, pathology leading to pars disruption (spondylolysis, Slide 1 and Slide 2) is one of the common causes of spondylolisthesis.

Degenerative Spondylolisthesis
Degenerative spondylolisthesis usually occurs at the L4/L5 level and is primarily due to wear and tear at the discs and facet joints. The pars remains in continuity. Presentation is that of back pain as well as lumbar stenosis.

Imaging
Plain X-Ray (Static)
When spondylolysis or spondylolisthesis is clinically suspected, standing PA and lateral radiographs of the lumbar spine with a cone-down lateral view of L3 to the sacrum are indicated. In most cases, the pars interarticularis defect can be seen on spot lateral views as a radiolucent band just beneath the pedicles. If the defect is not visualized by lateral film and the condition is suspected, the oblique view may be helpful. On this view, one can see what has been described as a Scotty dog (Slide 1 and Slide 2) with a broken neck or wearing a collar.

Plain X-Ray (Dynamic)
Because a spinal motion segment is considered mechanically unstable when it exhibits increased or abnormal motion, the radiographic analysis of lumbar spine dynamics is fundamental. In order to maximize the degree of slip for static radiographs, they should be obtained in the static position. However, in patients with unstable spondylolisthesis, to maximize the chances of detecting maximum abnormal translatory motion, flexion and extension radiographs should be taken in the lateral decubitus position.

Computed Tomography
CT, when performed with a reverse gantry angle and thin sections, is the investigation of choice for identifying radiographically occult lyses. CT is very sensitive in diagnosis of the pars defect, especially in thin sclerotic lesions.

Magnetic Resonance Imaging
Recently, appearances of normal pars interarticularis and of pars defects on MRI have been reported. Although pars defects can clearly be identified, the normal pars can either be missed or appear hypo-intense if the scan plane passes predominantly through the medial or lateral cortex of the pars. This may make exclusion of a pars defect difficult on MRI. Conversely, if the scan plane passes directly through the pars, a defect can be excluded if continuous medullary bone can be followed from the pedicle through the pars into the lamina. According to the MRI findings the pars interarticularis are graded as:

Type 1 = normal pars
Type 2 = sclerotic pars, where the pars appear hypo-intense if the scan plane was predominantly through the cortex of the pars.
Type 3 = when the pars could not be assessed at all.
Type 4 = when the pars are clearly demonstrated and a defect is felt to be present.

For a defect to be diagnosed, a double hypo-intense line had to be present crossing the pars.