Vertebral Column
The normal vertebral column is made up of 29 vertebrae (7 cervical, 12 thoracic, 5 lumbar and 5 sacral) and the coccyx. Anteriorly, the vertebrae are connected via secondary cartilaginous joints, which form the intervertebral discs. Posteriorly, the neural arch has paired synovial joints, known as facets or zygapophyseal joints.

Contours of the Spine
The overall contour of the spine in the coronal plane is straight. However, in the sagittal plane the contour changes with development. At birth, there is a kyphotic posture to the whole spine (primary curves). With development of the erect posture, lordotic (secondary) curves develop in the cervical and lumbar spines.

Overall, spine alignment is altered in many conditions. Scoliosis (Slide 1 and Slide 2), which is a descriptive term for lateral curvature, is usually accompanied by rotational abnormality as well. This can be due to congenital deformity (Slide 1 and Slide 2), degeneration or associated with numerous neuro-muscular conditions. The most common type, however, is idiopathic.

One way to quantify the degree of curvature is to use the Cobb Measurement Method. The curvature is measured by drawing a line along the upper and lower end plates of the respective upper and lower vertebrae that are most tilted. The angle between these lines is then measured, usually by drawing additional lines at perpendicular angles to the end-plates .

Sagittal plane alignment can also be altered by disease and injury. This is manifested clinically with abnormal kyphosis (Slide 1, Slide 2, Slide 3 and Slide 4) or lordosis (Slide 1, Slide 2 and Slide 3).

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.

Osteoporosis

Osteoporosis is a metabolic bone disorder characterized by decreased amounts of normal-quality bone resulting in an increased susceptibility to fracture.

Although most commonly found in post-menopausal females (Slide 1 and Slide 2), it can also be secondary to immobilization as well as a number of underlying conditions, e.g. steroid use, alcoholism and malignancy.

Imaging

Changes in Vertebral Body Shape

The normal vertebral body has essentially parallel end-plates, although there may be slight end-plate concavity with 1-2mm of central depression. In the thoracic spine, the anterior height of the vertebral body may be 1-2mm less than the posterior. This does not imply collapse and may be seen in contiguous vertebral bodies.

Osteoporosis may result in vertebral compression, which can be acutely painful or pass unnoticed by the patient. Wedging usually affects the upper end-plate more than the lower, so that the difference in height between anterior and posterior surfaces of the vertebral bodies is over 2mm. The radionuclide bone scan shows marked focal increase in uptake. Significant collapse results in flattening of the vertebral body, which usually does not expand significantly. Expansion in collapse is a feature of Paget’s disease and occasionally of primary and secondary bone tumors. In most cases, a collapsed osteoporotic vertebra is said to implode. Callus formation is not usually seen in collapsed osteoporotic vertebrae but is seen in patients with Cushing’s disease. Collapse in osteoporosis is not generalized throughout the spine and it is unusual to find many vertebral bodies affected by collapse in contiguity.

‘Codfish’ vertebrae resemble fish vertebrae in shape, with deep, smooth, biconcave end-plate depressions. This feature is seen in any condition associated with bone softening, including osteomalacia. In osteoporosis, the depressions may be more marked on the upper end-plates and affected bodies are not always contiguous. In osteomalacia, the change is seen more diffusely throughout the spine.

In young adults, a codfish type vertebral body may be seen, where the upper and lower end-plates show smooth depressions slightly posterior to the coronal mid-plane. This change lies around the discal nucleus, as can be seen at discotomy and MRI and usually occurs in the lumbar spine, where the discs are largest.

Osteoporotic patients form less new bone as part of a degenerative process and are probably more susceptible to vertebral collapse than those who have normal mineralization or are hyperostotic, as in diffuse idiopathic skeletal hyperostosis.