

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).

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.

Surgery

Accurate surgery in this region is dependant upon knowing the relationships between the bone, the discs, the vertebral artery, the spinal cord and the nerve roots. For example, decompressive procedures such as anterior discectomy can be performed without damaging **vertebral vessels**, whilst foraminotomy allows relief of nerve root compression without destabilizing the spine. Similarly, an understanding of the lateral masses (the regions of the superior and inferior articular facets) allows them to be used as fixation points for posterior spinal fixation.