

Lumbar Spine

The lumbar vertebrae are the last five vertebrae of the vertebral column.

They are particularly large and heavy when compared with the vertebrae of the cervical or thoracic spine.

Their bodies are wider transversely than anteroposteriorly.

From the posterior surfaces of the superior articular processes, there are marked enlargements, called the *mammillary process*.

The laminae are shorter vertically than the bodies; this causes a gap between the lamina at each level, which is bridged only by ligaments.

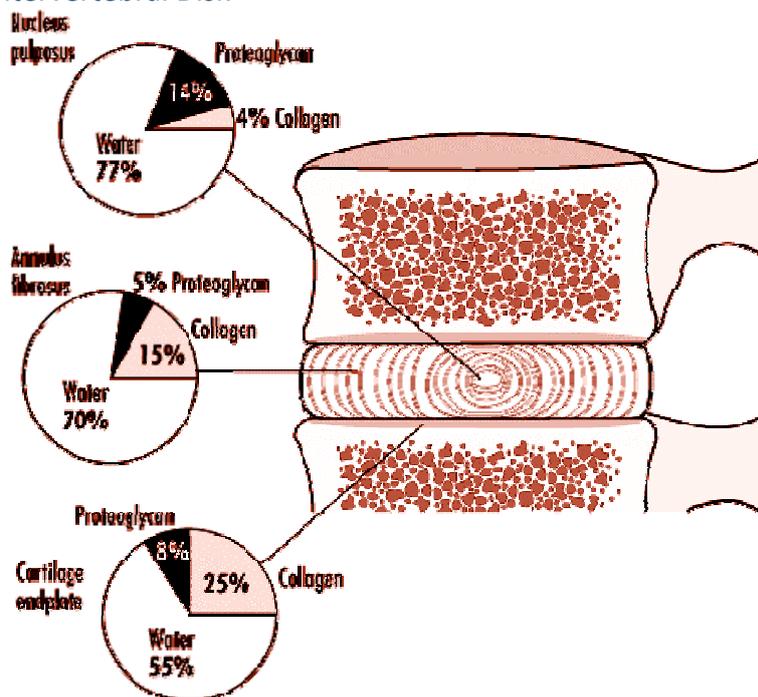
The spinous processes are broader and stronger than those in the thoracic spine; they project in a dorsal direction with little caudad angulation.

The articulations in the lumbar spine are the same three-joint complex. The joints are oriented in a more sagittal plane. This orientation allows the lumbar spine to have relatively more flexion and extension than its thoracic counterpart but significantly less rotation. This joint alignment also allows for lateral flexion in the lumbar spine.

The anterior longitudinal ligament is relatively thicker in the lumbar spine. The ligamentum flavum is much stronger than its thoracic counterpart.

The facet joint capsules of the lumbar spine are thicker and stronger in the lumbar spine, as are the supraspinous and interspinous ligaments.

Intervertebral Disk



It consist of two components: the outer, laminar fibrous container (or annulus), and the inner, semifluid mass (the nucleus pulposus) .

The annulus fibrosus is a concentric series of fibrous lamellae. Its major function is to withstand tension from the torsional stresses of the vertebral column as well as the horizontal extensions of the compressed nucleus that it contains. The annulus is attached to the vertebral body through a blending of the fibers with the vertebral periosteum as well as the longitudinal ligaments.

The nucleus pulposus occupies a concentric position within the confines of the annulus. Its major function is that of a shock absorber. The nucleus pulposus exhibits viscoelastic properties under applied pressure, responding with elastic rebound.

The disks make up about one fourth of the height of the entire spinal column. Moving from cephalad to caudad, the disks become larger in their cross-sectional area as well as thicker when measured from one vertebral end plate to the next.

The blood supply and nutrition of the intervertebral disk is achieved primarily by diffusion from the adjacent vertebral end plates. The annulus is penetrated by capillaries for only a few millimeters.

The disk itself has no direct innervation. Sensory fibers are abundant, however, in the adjacent longitudinal ligaments. The pain attributable to disk disease most likely is carried through those fibers.

Spinal Cord and Cauda Equina

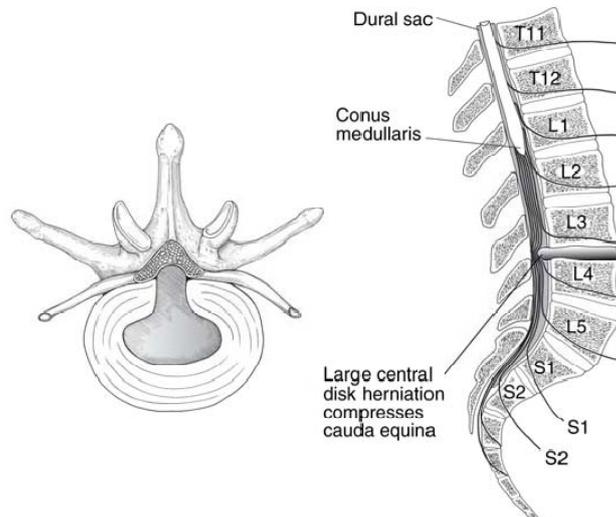
The spinal cord typically ends at the thoracolumbar junction, and caudad to that level is the cauda equina. The cauda equina is merely a collection of nerve roots that are traversing the spinal canal until they exit at their appropriate foramen. This differentiation is important because of the differences in structural anatomy and the responses to injury of the spinal cord and cauda equina.

The thoracic spinal cord is generally wider laterally than it is deep in the anteroposterior direction. The cord is smaller in the thoracic region than its cervical counterpart. The average anteroposterior depth found by Elliot was about 9 mm. An average anteroposterior vertebral canal diameter is 17 mm. The cord occupies about half of the space available within the vertebral column.

The tapered lower end of the spinal cord is the conus medullaris. From this point caudad, only individual nerve roots exist and are grouped together as the cauda equina. These nerve roots pass caudad until they reach the appropriate level, where they pass out through the vertebral foramen.

The response of the spinal cord to injury is different from the response of the cauda equina. The nerve roots in the cauda equina recover from injury in the same fashion as a peripheral nerve. Injury to the spinal cord is generally irreversible, however, and has permanent

consequences. This fact is important when considering injuries of the thoracolumbar spine with associated neurologic deficits.



BIOMECHANICS

The thoracolumbar spine is a complex, three-dimensional structure with coupled motion

Characteristics. The thoracolumbar spine is capable of flexion, extension, lateral flexion, and rotation. The total range of motion is the result of a summation of the limited movements permitted between the individual vertebrae.

The most common movement of the vertebral column is flexion. Flexion requires an anterior compression of the intervertebral disk, along with a gliding separation of the articular facets at the zygapophyseal joint. This movement is limited by the posterior ligamentous complex and the dorsal musculature.

Rotation is related most directly to the thickness of the intervertebral disk. It involves compression of the annulus fibrosus fibers. Rotation also is limited directly by the geometry of the zygapophyseal joints. The disk limits rotation by resistance to compression in the annulus.

The mobility of the thoracolumbar region is not uniform throughout any of its segments. The upper thoracic spine is impaired greatly in its motion by the rib cage. The articular facets in this region are oriented in the frontal plane. The lower thoracic region allows more flexion and extension because the disk and vertebral bodies progressively increase in size. Also, in the lower thoracic spine, the articular facet joints begin to turn more toward the sagittal plane, permitting greater flexion and extension but limiting rotation. The lumbar region is oriented to allow significant amounts of flexion, extension, and lateral flexion. The zygapophyseal joints are oriented in the sagittal plane, however, locking them against rotation.

The lumbosacral joints change their orientation so that they are midrange between frontal and sagittal planes. This alignment allows some rotation; however, this is limited by the iliolumbar ligaments. The essential function of the lumbosacral joints is to buttress the fifth lumbar vertebra in relation to the sacrum.

Each region of the spine has its own characteristic curvature. These curves allow upright posture while maintaining the center of gravity over the major weight-supporting structures of the pelvis and lower limbs. The normal thoracic kyphosis places the thoracic vertebrae posterior to the center of gravity. This kyphosis compensates for the normal cervical lordosis, which allows the head to be held in its erect position. The lumbar lordosis brings the middle of the lumbar spine anterior to the center of gravity, allowing erect posture. The transitional vertebrae between each major spinal segment intersect the center of gravity and appear to be the most unstable regions of the spine. This fact is emphasized by the high incidence of fractures and dislocations in the transitional regions.

The biomechanics of the intervertebral disk emphasize its functional competency. The annulus fibrosis receives most forces transmitted from one vertebral body to the other. It is constructed best to resist tension and shear. This resistance is accomplished by the radial alignment of the progressive lamellae of the annulus. Experimental analysis has shown that different portions of the annulus respond differently to the same degree of tension. It appears that the peripheral annulus has the greatest recovery, whereas the medial sections are more distensible.

The nucleus pulposus is designed best to resist compression forces. It receives primarily vertical forces from the vertebral bodies and redistributes them in a radial fashion to a horizontal plane. The internal pressure of the nucleus distorts the annulus, which, with its resiliency, allows recovery from the pressure.

Torsion is resisted by

- Disc 40%
- Facet 40%
- Ligaments 20%

Denis: Anterior and Middle column bears compressive load.

In lower lumbar spine 20% of compression load by facet joint.

Compressive load on the disc decreases height of the disc by 5%. This increases in tension in the Annulus fibrosus. At pressure of 2000 lb, the end plate fracture.

The intradiscal pressure in the unloaded disc: 10N/Sq.cm

