Spine Anatomy

Your back, or spine, is made up of many parts. Your backbone, also called your vertebral column, provides support and protection. It consists of 33 vertebrae (bones). There are disks between each of the vertebrae that act like pads or shock absorbers. Each disk is made up of a tire-like outer band called the fibrous annulus and a gel-like inner substance called the nucleus pulposus. Together, the vertebrae and the discs provide a protective tunnel (the spinal canal) to house the spinal cord and spinal nerves. Nerves run down the center of the vertebral column through the spinal canal exiting at different levels to bring nervous information to muscles, joints and tissues.

The spinal column extends from the skull to the pelvis. The vertebrae are stack on top of each other group into four regions:

- Cervical Spine
- Thoracic Spine
- Lumbar Spine
- Sacral Spine
Your back also has muscles, ligaments, tendons, and blood vessels. Muscles are strands of tissues that act as the source of power for movement. Ligaments are the strong, flexible bands of fibrous tissue that link the bones together, and tendons connect muscles to bones and discs. Blood vessels provide nourishment. These parts work all together to help you move about.

Back pain may be a result of injury to any of these body parts. Injury to the soft tissues (muscles, ligaments, tendons) results in sprains or strains, which are generally not serious. Injury to bones, nerves, or blood vessels may be more serious. The outer layers of disks (annulus fibrosus) can get tears or cracks, allowing nucleus pulposus to bulge out. Any of these injuries can cause inflammation and pain.
Intervertebral Discs

Intervertebral discs make up one fourth of the spinal column's length. There are no discs between the Atlas (C1), Axis (C2), and the Coccyx (tail bone). Discs are not vascularized, nourishment, therefore depend on the end plates to diffuse needed nutrients and oxigen. The cartilaginous layers of the end plates anchor the disk in place.
Intervertebral disks are fibrocartilaginous cushions serving the spine as a shock absorbing system, which protect the vertebrae, brain, and other structures (i.e. nerves). The discs allow some vertebral motion; extension and flexion. Individual disc movement is very limited – however considerable motion is possible when several discs combine forces.

Fibrosus and Nucleus Pulposus: Intervertebral discs are formed of an annulus fibrosus and a nucleus pulposus. The annulus fibrosus is a strong radial tire-like structure made up of lamellae; concentric sheets of collagen fibers connected to the vertebral end plates. The sheets are orientated at various angles. The annulus fibrosus encloses the nucleus pulposus. A rupture of the annulus makes the nucleus pulposus of the disc prone to herniation.

Although both the annulus fibrosus and nucleus pulposus are composed of water, collagen, and proteoglycans (PGs), the amount of fluid (water and PGs) is greatest in the nucleus pulposus. PG molecules are important because they attract and retain water. The nucleus pulposus contains a hydrated gel–like matter that resists compression. The amount of water in the nucleus varies throughout the day depending on activity.

Ligaments

Ligaments are fibrous bands or sheets of connective tissue linking two or more bones,
cartilages, or structures together. One or more ligaments provide stability to a joint during rest and movement. Excessive movements such as hyper–extension or hyper–flexion, may be restricted by ligaments. Further, some ligaments prevent movement in certain directions.

Three of the more important ligaments in the spine are:

- The Ligamentum Flavum, Anterior Longitudinal Ligament and the Posterior Longitudinal Ligament.
- The Ligamentum Flavum forms a cover over the dura mater: a layer of tissue that protects the spinal cord. This ligament connects under the facet joints to create a small curtain over the posterior openings between the vertebrae.
- The Anterior Longitudinal Ligament attaches to the front (anterior) of each vertebra. This ligament runs up and down the spine (vertical or longitudinal).

**The cervical spine**

Seven vertebrae form the cervical spine; the top two vertebrae are called C1 and C2 and the lower cervical region C3 through C7.

![Atlas (C1) and Dens](image)

Atlas (C1) The Atlas is the first cervical vertebrae and therefore abbreviated C1. The vertebra supports the skull. Its appearance is different from the other spinal vertebrae. The atlas is a ring of bone made up of two lateral masses joined at the front and back by the anterior arch and the posterior arch.

Axis (C2) The Axis is the second cervical vertebra or C2. It is a blunt tooth–like process that projects upward. It is also referred to as the ‘dens’ (Latin for ‘tooth’) or odontoid process. The dens provides a type of pivot and collar allowing the head and atlas to rotate around the dens.
C3 to C7: The rest of the cervical spine vertebrae are responsible for much of the flexion and extension motion of the C-spine. Degenerative processes in this segment of the vertebral column are only second to the lumbar spine.

**Thoracic Spine**

Thoracic spine is the second segment of the vertebral column located just under the cervical spine. Thoracic spine holds and joins the rib cage and the organs inside the chest.

Aside for a slight side-to-side movement, the thoracic spine does not have much of a moving range.

Vertebrae in the thoracic spine are named from T1, just under C7, to T12 the lower most vertebrae. Together with the cervical spine, the thoracic spine protects and contains most of
the spinal cord.

1. Vertebral Body
2. Spinous Process
3. Transverse Facet
4. Pedicle
5. Foramen
6. Lamina
7. Superior Facet joint

**Lumbar Spine**

It is in the lumbar spine that pain and related conditions present most frequently. Chronic lumbar spine pain is the most single cause of work leaves and disability. In order to understand back and its different treatment modalities it is paramount to understand spinal anatomy and
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function, lumbar spine in particular.

Lumbar Vertebrae (L1 – L5)

The lumbar vertebrae graduate in size from L1 through L5. These vertebrae bear much of the body's weight and related biomechanical stress. The pedicles are longer and wider than those in the thoracic spine. The spinous processes are horizontal and more squared in shape. The intervertebral foramen (neural passageways) is relatively large but nerve root compression is more common than in the thoracic spine.

**Purpose of the Vertebrae**

Although vertebrae range in size; cervical the smallest, lumbar the largest, vertebral bodies are the weight bearing structures of the spinal column. Upper body weight is distributed through the spine to the sacrum and pelvis. The natural curves in the spine, kyphotic and lordotic, provide resistance and elasticity in distributing body weight and axial loads sustained during movement.

The vertebrae are composed of many elements that are critical to the overall function of the spine, which include the intervertebral discs and facet joints.

**Functions of the Vertebral or Spinal Column Include:**

**Protection**
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- Spinal Cord and Nerve Roots
- Many internal organs

Base for Attachment

- Ligaments
- Tendons
- Muscles

Structural Support

- Head, shoulders, chest
- Connects upper and lower body
- Balance and weight distribution

Flexibility and Mobility

- Flexion (forward bending)
- Extension (backward bending)
- Side bending (left and right)
- Rotation (left and right)
- Combination of above

Other

- Bones produce red blood cells
- Mineral storage

Sacral Spine

The Sacrum is located behind the pelvis. Five bones (abbreviated S1 through S5) fused into a
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triangular shape, form the sacrum. The sacrum fits between the two hipbones connecting the spine to the pelvis. The last lumbar vertebra (L5) articulates (moves) with the sacrum. Immediately below the sacrum are five additional bones, fused together to form the Coccyx (tailbone).

The Normal Spinal Curves

The natural curves in the spine, provide resistance and elasticity as they distribute body weight during movement.

In the womb and for a period of time following birth, a baby’s spine is shaped like the letter C. This curve is termed a primary curve, which is Kyphotic. During the time the baby is learning to lift his head and eventually walk, muscles develop. As muscular strength and ability is gained, the baby’s activity will shift body weight to the spine. Gradually secondary curves develop in the cervical and lumbar regions; Lordotic curves. These curves will continue to develop until growing stops.

Spinal curves are either kyphotic or lordotic. In a normal spine there are four types of spinal curvatures important to balance, flexibility, and stress absorption and distribution.

Nerve Structures of The Spine
Nerves control the body’s functions including the vital organs, sensation, and movement. The nervous system receives information and initiates an appropriate response. It is affected by internal and external factors (i.e. stimulus).

Nerves follow tracts and cross over junctions called Synapses. Simplified, it is a complex communicative process between nerves conducted by chemical and/or electrical changes.

Central Nervous System (CNS)

The Central Nervous System is composed of the brain and spinal cord. The brain has 12 Cranial Nerves. The spinal cord, which originates immediately below the brain stem, extends to the first lumbar vertebra (L1). Beyond L1 the spinal cord becomes the Cauda Equina. The spinal cord provides a means of communication between the brain and peripheral nerves.

Peripheral Nervous System (PNS)

The CNS extends to the Peripheral Nervous System, a system of nerves that branch beyond the spinal cord, brain, and brainstem. The PNS carries information to and from the CNS.

The PNS includes the Somatic Nervous System (SNS) and the Autonomic Nervous System (ANS). The somatic nervous system includes the nerves serving the musculoskeletal system and the skin. It is voluntary and reacts to outside stimuli affecting the body. The autonomic
nervous system is involuntary automatically seeking to maintain homeostasis or normal function.

The ANS is further divided into the Sympathetic Nervous System and the Parasympathetic Nervous System. The sympathetic nervous system is an involuntary system often associated with the flight or fight response. The parasympathetic nervous system is responsible for promoting internal harmony such as regular heartbeat during normal activity.

Just below the last Thoracic (T12) and first Lumbar (L1) vertebra the spinal cord ends at the Conus Medullaris. From this point the spinal nerves, resembling a horse’s tail become known as the Cauda Equina extending to the coccyx. These nerves are suspended (floating) in spinal fluid.

The nerve roots pass out of the spinal canal through the intervertebral foramen, these are small paired tunnel-like structures through which each spinal nerve passes through exiting the spine, branching en two, anterior and posterior nerves. The anterior divisions supply the front of the spine including the limbs. The posterior divisions are distributed to the muscles behind the spine.

**Other Spinal Cord and Nerve Structures**

Cerebrospinal Fluid (CSF) is a clear fluid found in the brain chambers (Ventricles), spinal canal, and spinal cord. This fluid is secreted from the Choroids Plexus, a vascular part in the ventricles of the brain. CSF bathes and circulates among these tissues and acts as a shock absorber to protect against injury. The fluid contains different electrolytes, proteins, and glucose. In an average adult the total volume of CSF is about 150 milliliters.

**Meninges**

Meninges are membranes that cover and protect the brain and spinal cord. There are three primary types:

1. **Dura Mater.** The dura mater, or dura, is the gray outer layer of the spinal cord and nerve roots. It is made of strong connective tissue.
2. **Arachnoid Mater.** The arachnoid mater resembles a loosely woven fabric of arteries and veins. This layer is thinner than the dura mater. The Subarachnoid space is filled with
3. **Pia Mater.** The pia mater is the innermost layer and is a delicate and highly vascular membrane providing blood to the neural structures.