

Definitions

annulus fibrosis - tough, fibrous rings surrounding nucleus pulposus of discs

arachnoid - middle layer of the membranes which cover the brain and spinal cord

atlas - first cervical vertebra unique for having no body, allows head to move forward and backward

axis - second cervical vertebra forming a pivotal joint with the atlas, allows side to side movements of head

cauda equina - collection of nerves which branch from the lumbar and sacral levels of the spinal cord and must run a distance in the vertebral column before they can exit

central canal - very center of the spinal cord, so named because it starts as a hollow tube which closes in most people as they age

cerebral spinal fluid (CSF) - clear liquid in the brain and spinal cord, acts as a shock absorber

cervical - upper part of the spine, the neck area

coccygeal - lowest region of spine containing 4 fused vertebrae to form the coccyx or tailbone

choroid plexus - lines the walls of the lateral ventricles of the brain and roof of the third and fourth ventricles, produces CSF

discs - parts of the spine which separate and cushion vertebral bodies

dorsal nerve root - one of two nerve fiber bundles of a spinal nerve that carries sensory information to the central nervous system

dura - thick, outer covering of the brain and spinal cord

epidural cavity - the space between the walls of the vertebral canal and the dura

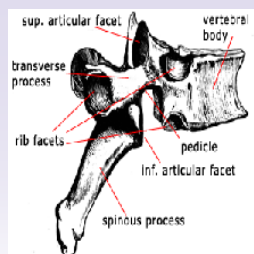
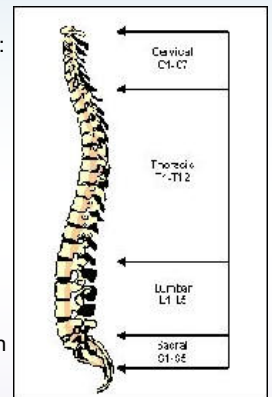
fasciculi (or tracts) - related

The Nuts & Bolts Of Spinal Anatomy

September 4, 2004 - When dealing with a Chiari or syringomyelia diagnosis, patients may find themselves getting a quick neuroanatomy lesson from a neurosurgeon with the aid of an anatomical model. His precise surgeon's fingers might push down into the space at the base of the model's skull, mimicking the cerebellar tonsils crowding into the spinal canal. Taking this brief introduction further and gaining a basic knowledge of spinal anatomy is helpful to anyone interested in developing a deeper understanding of Chiari malformation and syringomyelia. What are the spinal cord and vertebral column and how do they serve as the main pathway of communication between the brain and the rest of the body?

The spine is a strong, flexible, and sensuously curved column composed of thirty-three bones called vertebrae. These vertebrae are grouped into five regions: cervical, thoracic, lumbar, sacral, and coccygeal. (right.) The top of the spine is made of seven vertebrae that form the cervical spine. Just below are the twelve thoracic vertebrae, then the five in the lumbar, five in the sacral, and four in the coccygeal. Whereas the vertebrae in the top three regions are called true or movable vertebrae, those of the sacral and coccygeal are referred to as false, or fixed, vertebrae because they are fused in the adult to form two bones, the sacrum and the coccyx.

With the exception of the first two cervical vertebrae which have special features, all of the true or movable vertebrae have certain characteristics in common. Each of these vertebrae has two parts, the body and the vertebral arch which come together to form an opening for the spinal cord to pass through, known as the vertebral foramen. The body is the largest part of the vertebra and is positioned along the front side of the body. When the vertebrae are joined together, the bodies form a strong pillar of support for the head and torso while maintaining flexibility and protecting the spinal cord. The vertebral arch includes pedicles, laminae, the spinous process, and the two transverse processes. The spinous process juts out the farthest and can be felt by running a hand along the outside of the back. The vertebral arch is important for the attachment of muscles and ligaments responsible for giving the spine its integrity as a mobile structure.



The bodies of the vertebrae are separated by discs which absorb shock and act as spacers keeping the bones apart. Each disc contains a central core of gel-like substance, nucleus pulposus, encircled by a series of fibrous rings, the annulus fibrosis. The central position of the gelatinous cores, together with the ligaments, holds the vertebrae in alignment. When properly aligned, the vertebral column acts as a central axis for the body. A healthy spine seen from a side view will have four curves. (left.) These include the two inward-moving curves of the cervical and lumbar spine and the two outward curves of the thoracic and sacral spine. The curves provide shock absorption and give support to the structures above them. For example, the inward curvature of the cervical spine provides support for the head. Without this inward curve the downward pull of gravity through the top of the head causes muscles to tense as they must work harder to carry the weight of the head. A healthy spine does not exhibit pronounced lateral curves. Abnormal lateral curves are known as scoliosis, one of the most common symptoms of Chiari and syringomyelia in children.

Of particular significance to Chiari patients are the first two vertebrae at the top of the cervical spine, the atlas and the axis. The first cervical vertebra carries the weight of the head and is named the atlas after the mythological Greek figure, Atlas, who was sentenced to carry the weight of the Earth on his shoulders. This vertebra does not have a body. The atlas is ring-like with two bulky lateral masses that support the head which moves forward and backwards on this vertebra. The lateral masses both have a large, oval, concave area. These are the cup-like superior facets which articulate with the occipital bone of the skull. Typically, the opening of the spinal canal through the atlas is quite roomy. However, in Chiari patients this space is often crowded with the cerebellar tonsils causing compression of the spinal cord. The second vertebra is called the axis and forms the pivot upon which the atlas, carrying the weight of the head, rotates.

The vertebral column encloses the elongated, cylinder-shaped spinal cord. The spinal cord exits the brain and extends downward through the center of the vertebral column to the level of the second lumbar vertebra where the cauda equina, or horse's tail of nerves continues down through the lower part of the spine.

Nerves of the spinal cord are bundled so that related types of nerve fibers run together in fasciculi or tracts. These include descending tracts of motor nerves that transmit impulses to muscles from the brain and stimulate movement. The ascending tracts of sensory nerves carry messages to the brain about sensations,

bundles of nerve fibers in the spinal cord which transmit motor and sensory signals to and from the brain

laminae - 2 broad plates which form the back part of the vertebral arch

lumbar - lower part of the spine

meninges - the three membranes that cover the brain and spinal cord

nucleus pulposus - gel-like substance found in the central core of each disc of a healthy spine

pedicles - 2 short, thick parts of vertebral arch which joins with the vertebral body

pia mater - membrane which adheres to the surface of the spinal cord

sacral - region of spine containing 5 vertebrae united to form the sacrum

spinal nerves - 31 pairs of nerves which branch off from the spinal cord and exit through openings between vertebrae

spinous process - part of the vertebral arch which juts out and serves for the attachment of ligaments and muscles

subarachnoid space (SAS) - the space between the arachnoid and the pia mater containing cerebrospinal fluid

superior facets - 2 large oval, cup-like areas of the atlas which articulate with the occipital bone of the skull

thoracic - middle part of the spine, the chest area

transverse processes - 2 projections one at either side of the vertebral arch which serve for attachment of ligaments and muscles

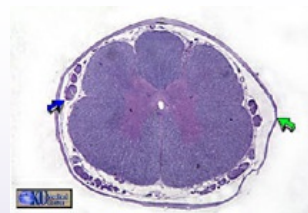
ventral nerve root - the other nerve fiber bundle of a spinal nerve, consisting of motor fibers, that branches off from the spinal cord

vertebrae - 33 bones which form the flexible spinal column

vertebral arch - part of vertebra which joins with body of a vertebra

including pain. Compression of the spinal cord can therefore produce motor and sensory symptoms such as pain and neurological deficits depending upon which nerve fibers are under pressure.

A cross-section view of the spinal cord reveals both white matter, containing the tracts, and grey matter containing nerve cells. (right.) The white matter surrounds the inner butterfly-shaped grey matter which contains a tiny space in the center, the central canal. The central canal of the spinal cord runs the length of the cord and contains cerebral spinal fluid. Exiting the spinal cord through small openings between the vertebrae are thirty-one pairs of spinal nerves. Each spinal nerve has a dorsal and ventral nerve root which attach to the cord. All communication between the brain and the body is transmitted through these nerves.



The spinal cord does not completely fill the space inside the vertebral column. Instead it is encircled by three protective membranes, or meninges, which are called the pia mater, the arachnoid, and the dura mater. The pia mater adheres to the surface of the cord. The subarachnoid space, filled with cerebral spinal fluid, lies between the pia mater and the arachnoid and goes around the spinal cord and brain. The arachnoid lines the inside of the dura mater, the outermost membrane which continues with the brain. The epidural cavity is the space between the dura mater and the vertebrae.

Cerebral spinal fluid (CSF) is produced in the choroid plexus of the brain and then moves along slowly with each heartbeat, circulating through the ventricles of the brain and then throughout the subarachnoid space of the spinal cord and brain. Bathing and nourishing the nervous system, CSF also cushions the brain and spinal cord. Produced at a rate of .35ml/minute, the total volume of CSF is replaced two or three times in a twenty-four hour period. The CSF is absorbed into the intracranial venous system. CSF disturbances, along with direct compression of nerve tissue, may manifest as Chiari symptoms. Sometimes CSF is squeezed downward, forced into the spinal cord itself where this fluid does not belong, creating the long blister-like syrinx of syringomyelia [Ed Note: the actual mechanism underlying syrinx formation is not well understood]. Occasionally, the syrinx will form in the central canal of the cord, causing a dilation of the canal known as hydromyelia. The combination of both of these is sometimes termed syringohydromyelia.

Through a deeper understanding of the spine and its role in Chiari and syringomyelia, patients can hope to gain additional insight helpful in making well-informed decisions regarding the treatment and management of these conditions. Focusing on spinal curvatures and alignment by improving posture, taking time out throughout the day for gentle stretches, and not sitting for prolonged periods of time are small adjustments which may help improve quality of life. Something as simple as making a conscious effort to avoid hunching, so common in pain sufferers, may help to provide some relief and allow better functioning of the nervous system.

--Kathryn Quintana

Sources For This Article:

- Emory University web site: On-line anatomy manual
- Farhi, Donna. *Yoga, body, Mind & Spirit*. New York: Henry Holt & Company, 2000.
- Gray, Henry. *Anatomy of the Human Body*. Philadelphia: Lea & Febiger, 1918; Bartleby.com, 2000.
- Milhorat TH, et al. *Neurosurgery*. 1999 May; 44(5):1005-17.
- www.neurosurgerytoday.org Chiari Type I Malformation, June 2001.
- University of Manitoba web site: Online Neuroanatomy Tutorial

to enclose spinal cord

vertebral body - largest part of a vertebra, when joined in a column the bodies form strong support

vertebral foramen - opening in spinal column through which spinal cord passes

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