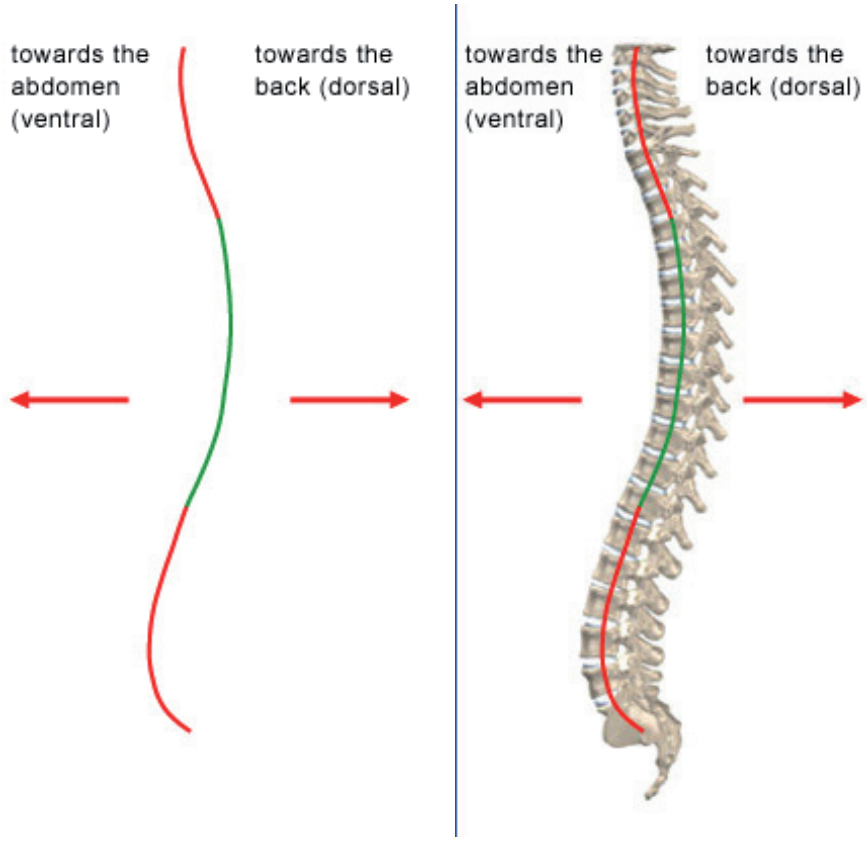
Forms of the spinal column

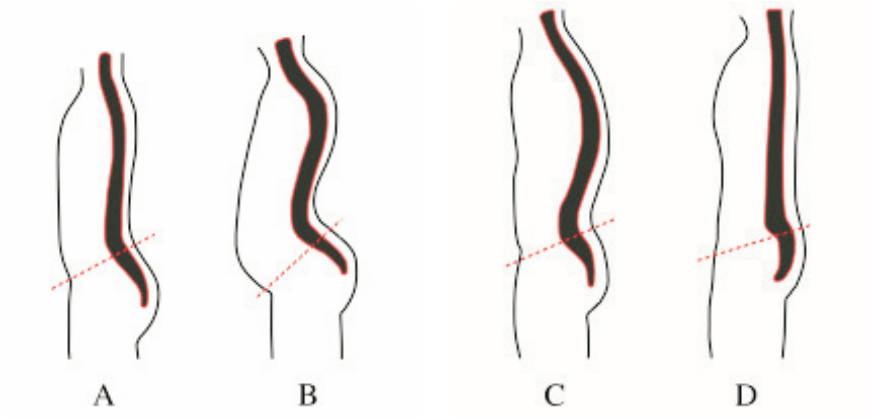
Human spinal posture is highly individual, though the overall impression is that of a person standing upright. Posture depends primarily on the genetically determined basic structure of the individual's spinal column. Numerous variations are possible as the result of different factors, such as muscle and bone development, the ligamentous apparatus, muscle tone and psychological influences.

The normal posture (A) of the spinal column as seen from the side (sagittal plane) is characterized by the typical formation of two different "types of curves." Lordosis is where the spine curves towards the front or abdomen (ventral curvature) as seen in the sagittal plane, where the convex curvature extends forward (ventrally) and the concave curvature backward (dorsally). The physiological curvature of the cervical and lumbar spine segments constitutes a lordosis. The thoracic spine shows a corresponding kyphosis in the sagittal profile, i.e. a dorsal curvature or curve towards the back.

• kyphosis - lordosis



• Postural forms and pelvic inclination

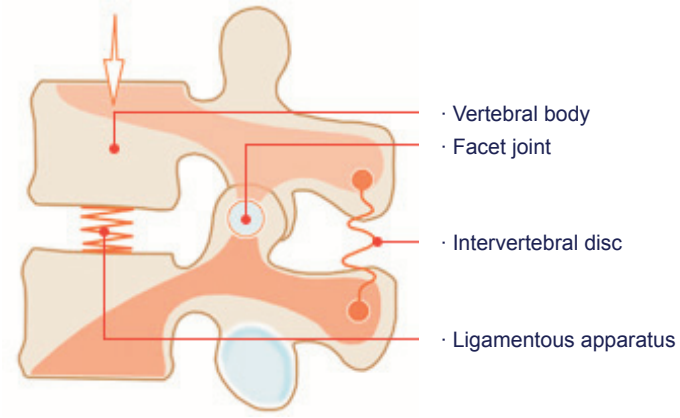


The lordotic curved back (B) is characterized by a more pronounced curvature in both thoracic kyphosis and lumbar lordosis, causing the pelvis to incline forward, the abdomen to bulge and the thorax to appear flattened.
The humpback (C) is characterized by a highly pronounced thoracic kyphosis, whereby the curvature of the thoracic spine may extend all the way down to the lumbar spine.
The flat back (D) is characterized by a pronounced flattening of the kyphotic and lordotic curves.

The mobile segment

The spinal column performs a variety of mechanical functions, the most important of which are the absorption, dampening, and transmission of pressure and impact loads as well as the absorption and delimitation of movements.
The smallest functional element of the spinal column is also known as a mobile segment.
A mobile segment consists of two neighboring vertebrae, the intervertebral disc between then, the facet joints and the ligamentous apparatus.
The intervertebral disc is fused to the base and upper plates of the vertebra and the anterior longitudinal ligament, so that it imparts stability to the spinal column. The deformability of the spongy center of the disc gives the mobile segment a measure of elasticity and freedom of movement. The intervertebral disc and ligamentous apparatus are in functional balance, known as discoligamentous stability.
The intervertebral, or facet, joints function in this model as the center of rotation between the vertebral bodies as the ventral column and the dorsal column with the transverse and spinous processes, ligamentous apparatus and deep muscles of the back.
As the spinal column ages, this sensitive system of spinal column balance may develop serious imbalances, which may in turn result in a variety of degenerative spinal column diseases.

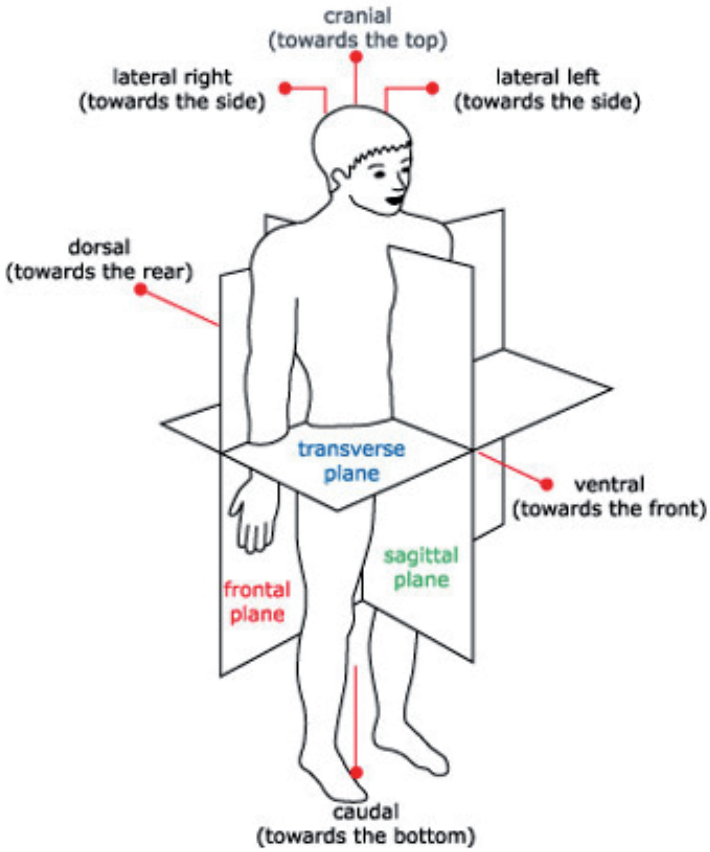
• A mobile segment acc. to Junghanns, the smallest unit of the spinal column.



Biomechanics of the spinal column segments

Taken as a whole, the spinal column is a system that elastically absorbs the deforming forces applied to it. In the field of biomechanics, deformation is the term used to describe spatial changes in body structures due to applied forces. Elasticity is defined as the ability of a structure to reverse such a deformation without any outside help.
The following illustration shows the main geometric terms used to describe the planes of the body and directions of motion.
The following planes and directions are defined when referring to the body:
· Frontal plane, conceived as dividing the human body into front and back halves
· Sagittal plane, conceived as dividing the body into left and right halves
· Transverse (cross-sectional) plane, conceived as a division into upper and lower parts, frequently called the horizontal plane.
· Lateral: towards the side (right or left)
· Ventral: towards the front or abdomen
· Dorsal: towards the rear or back
· Cranial: towards the top or head
· Caudal: towards the tail end or feet

• Terms from the geometry of the body

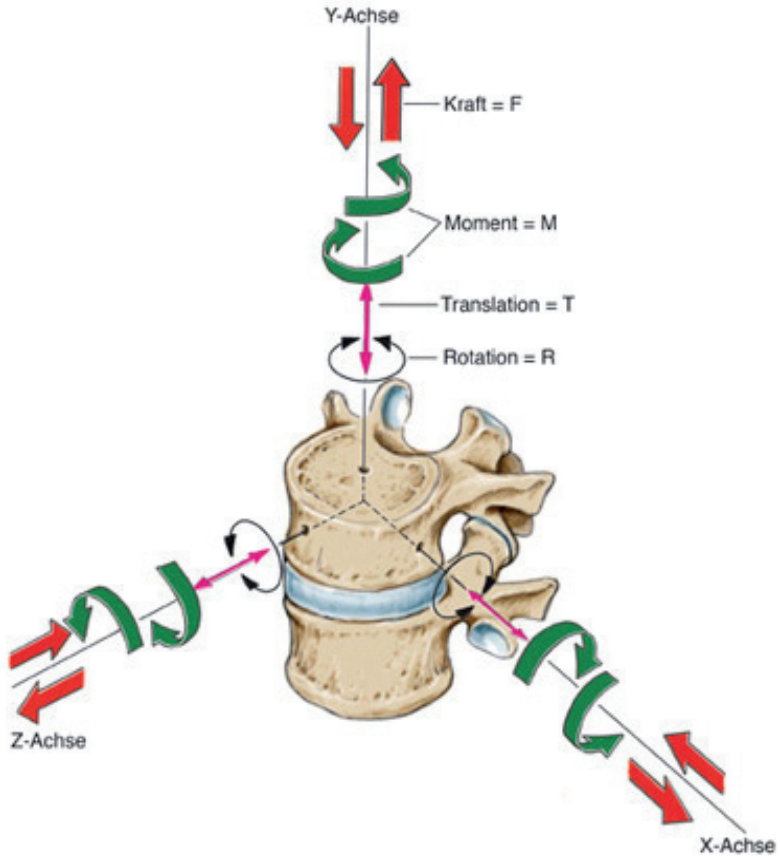


12 three-dimensional directions of movement are possible in a mobile segment within the planes of the body. They are as follows:

· Tension and compression
· Lateral shift to right or left
· Sagittal shift to front or back
· Flexion and extension
· Torsion (rotation) to the right or left
· Lateral inclination to the right or left

In this model, flexion and extension are realized in the X axis, lateral inclination in the Z axis and lateral rotation in the Y axis.

• Forces and movements of the mobile segment in three-dimensional space acc. to White et al.1990



The load bearing capacity, elasticity, flexibility and freedom of movement of the spinal column segments presuppose intact and healthy mobile segments including the vertebral body, intervertebral disc, facet joints, ligamentous apparatus and deep autochthonous back muscles.

Within this complex interplay of individual elements, the back muscles play an active role in the so-called “tension band“ system that can be understood as a complex system of tensed belts that make it possible for humans to walk upright. Disturbances of this complex harmony in the interplay of the individual components, for example caused by the aging process with attendant wear of the spinal column, can lead to significant changes in a mobile segment, which can then potentially lead to number of degenerative spinal column diseases.

Cervical spine

The special structures of the cervical spine give the head its wide range of mobility. In biomechanical terms, the cervical spine is divided into three sections:

· The upper cervical spine (C0-C2) with the atlantooccipital (C0-C1) and atlantoaxial (C1-C2) joints that are connected to the occipital bone of the skull.
· The central cervical spine C2-C5
· The lower cervical spine C5-Th1

The atlantooccipital joint is mainly responsible for flexion and extension, the atlantoaxial joint for rotation (torsion). The cervical spine segment C2/C3 assumes a considerable share of lateral movement in this region.

Thoracic spine

The thoracic spine is the part of the spinal column with the lowest degree of mobility in the frontal and sagittal planes, since the ribs of the thorax are solidly connected by joints to the thoracic vertebrae and the sternum.

Lumbar spine

The lumbar spine, taken as a whole, has a maximum mobility of 60°-70° in flexion and up to 30° in extension. Lateral inclination to the right and left is possible up to 30°. The rotation range of the individual mobile segments in the lumbar spine is limited to only 2°.

The lower lumbar spine and in particular the transition to the sacrum (lumbosacral transition) can be termed a weak point in spinal column statics, since the 5th lumbar vertebra shows a tendency to shift forward in response to changes in the lumbosacral angle. A healthy lumbar spine is able to absorb the shearing, torsion and compression forces applied to it through the interplay of the intact components of the mobile segments. The fact that the lumbar spine is subject to considerable static loads makes it particularly susceptible to the development of degenerative conditions.