The spine

Surgical & Clinical Anatomy Kinematics Biomechanical principles

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Clinical Anatomy

Anatomic Fact

Clinical Application



Anatomical alignment of vertebral column

Vertebral Column



Thoracic kyphosis is 20-45 deg.
Lumbar lordosis is 20-60 deg.
Cervical spine is highly mobile.

Anatomical alignment of vertebral column

Saggital balance: C7 plumb line cross @ the middle or posterior part of the L5-S1 disc



Spinal deformities

- Scoliosis coronal.
- Hyperkyphosis/hypokyphosis sagittal.



Basic Osseous Anatomy Lumbar Spine

Key Words

- Body
- Pedicle
- Lamina
- Articular proc.
- Transverse proc.
- Spinous proc.
- Spinal canal

Lumbar Vertebrae [L2] Superior View



Basic Osseous Anatomy Lumbar Spine

Key Words

- (Intervertebral) Foramen
- Facet joint
- (Intervertebral)
 Disc



Radiographic Anatomy Lumbar Spine

Key Words

- Body
- Pedicle
- Lamina
- Articular proc.
- Transverse proc.
- Spinous proc.
- Pars
- Foramen
- Disc





Basic Osseous Anatomy Lumbar Spine

Pars interarticularis

Lumbar Vertebrae [L3-L4] - Assembled Posterior View





Pars interarticularis defect = Spondylolysis



Disc & Facet joint





Separate lecture

Basic Osseous Anatomy Thoracic Spine

Key Words

- Transverse
 costal facet
- Inf. & sup. costal demi facet
- Pedicle



Radiographic Anatomy Thoracic Spine

Key Words

- Transverse costal facet
- Inf. & sup. costal demi facet
 - Pedicle



Pedicle Screws

Instrument for reduction & stabilization of the spine during spinal fusion



Basic Osseous Anatomy Cervical Spine CO-C2

Cervical Vertebrae [C1-C4], Assembled Posterosuperior View







Basic Osseous Anatomy Cervical Spine C3-C7

Key Words

- Intervertebral foramen
- Vertebral foramen
- Facet joint
- Uncinate process & the oncovertebral joint of Luschka





Radiographic Anatomy Cervical Spine

Key Words

- (Intervertebral) Foramen
- Facet joint
- Uncinate
 process & the
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Spinal Motion Segment

The Spinal Motion Segment is the functional unit of the spine.

- 2 vertebra
- Joints
- Ligaments & joint capsules

Motion & Stability

Spinal Motion Segment 7 spinal ligaments – from C1 to sacrum





Traumatic injury to the Spinal Motion Segment

Chance fracture



Spinal Motion Segment Lumbar spine - 3 joints





SPINAL STENOSIS

Canal measures less than 10 mm





Spinal Motion Segment Thoracic spine — costovertebral articulation

- CostotransverseCostocorporeal
- Less motionHigh stability





Thoracic spine – less motion

 Only 1% of intervertebral disc herniation occur at the T - spine

Spinal Motion Segment Cervical spine - 5 joints

1 x Disc
2 x facet joints
2 x Luschka joints

Cervical Vertebrae [C3-C5], Assembled Anterior View



Oncovertebral joint of Luschka & Cervical Spinal Stenosis



Vascular Anatomy of the Spine

Key words
Intercostal A. (segmental A.)
Ant. Radicular A.
Post. Radicular A.
Ant. Spinal A.



Vascular Anatomy of the Spine

Anterior spinal A.
Adamkiewicz's A. arises from intercostal A. of T8 to L2 (LT>RT)
Vascular supply to T spine is sparse.



Spinal cord infarct

- Ligation of Adamkiewicz's A. during surgery
- T spine is "at risk" for vascular injuries



Vascular Anatomy of the Spine C - spine

Vertebral arteries Origin: subclavian A. Supply: Basilar A. Ant. Spinal A. Spinal A. (enter foramina)



Vascular Anatomy of the Spine

Epidural venous plexus



The spinal cord is shorter than the spinal column.





Variations in the conus medullaris location

Topography of spinal cord termination

Subjects	T12–L1 disc	Center of L1	L1–L2 disc	Center of L2	L2-L3 disc
Adult Europeans (%)	16	44	20	16	4
Adult Africans (%)	8	8	52	24	8
Total (%)	12	26	36	20	6
Children		4	5	6	





Cauda Equina & Lumbosacral nerve roots



Most disc herniations will compress the transversing N. root.











 The intradural arrangement of nerve roots at the cauda equina

The study of motion



2 types of motion exist: Translations & rotations = 6 deg. of freedom.



The Instantaneous axes of rotation
Different for T, L & C spinal segments
Different under changing loads



Mechanism of traumatic Injury

Instantaneous Axis of Rotation (IAR) dictates the pattern of deformation of a motion segment when a force vector is applied.



The Spinal Motion Segments exhibit a "Coupled Motion" pattern. (d/t facet orientation)



Cervical Facet Dislocation

The mechanism of traumatic unilateral facet dislocation is related to the coupled motion exhibited by the cervical spine



Motion preserving implants Total Disc Replacement (TDR)





Facet joint orientation
Motion pattern
Coupling
biomechanics



- C spine has the overall greatest ROM
- Rotation is limited in L – spine

 Note: the number of segments!

Predisposition for fracture @ the T-L junction

Change in stiffness.
Change in range of motion.
Change in sagittal alignment.
An almost 90 degrees change in the orientation of the facets at the T-L junction.

Bending forward is a 2 part motion:

 L-spine flexion
 Hip flexion



Spinal Fusion



Biomechanics is the science of the action of forces on the living body.



The biomechanical functions of the spine

 Transfer weight of head limbs & trunk to the pelvis

Allows motion

Protects the spinal cord

Bone
Joint
Ligaments
Muscles and nerves

Biomechanics The physical properties of the Spinal Motion Segment

Key words

- Stress-strain curve
- Biphasic behavior
- Neutral zoneElastic zone



Biomechanics L – spine in flexion and extension Motion & Stability



Degeneration of the spinal motion segment

Less total range of motion
Proportionally larger Neutral Zone



The intradiscal pressure



The intradiscal pressure Clinical applications (A.L. Nachemson 1976)



Biomechanics The intradiscal pressure Clinical applications





The intradiscal pressure Clinical applications



Conclusions Anatomy

- Sagittal and coronal alignment.
- Basic anatomy: Pedicle, "pars", "facet", "foramen", Luschka.
- The motion segment: 3 L joints, 5 C joints, T costovertebral articulation, 7 ligaments.
- Vascular anatomy: Adamkiewicz's A.
- Conus medullaris & anatomical relationships of the nerve roots.

Conclusions kinematics

Instantaneous axes of rotation.
Coupled Motion.
Facet joint orientation.
range of motion in C, T & L spine.
Bending forward is a 2 part motion

Conclusions Biomechanics

Stress-strain curve.
Biphasic behavior.
Motion & Stability.
The intradiscal pressure.