Structure and Function of the Vertebral Column

Posture
Vertebral Alignment
Does it really matter? Yes it does!

Postural Curves
The vertebral column has a series of counterbalancing curves

Convex & Concave curves
- the reference point is the posterior aspect
- Cervical Lordosis
- Thoracic Kyphosis
- Lumbar Lordosis
Postural Curves

Cervical
- Anterior
  - Convex
  - Concave
- Posterior
  - Convex
  - Concave

Thoracic
- Anterior
  - Concave
  - Convex
- Posterior
  - Convex
  - Concave

Lumbar
- Anterior
  - Convex
  - Concave
- Posterior
  - Concave

Standing Posture

Standing Posture

Lateral view
Alignment should be through:
- the earlobe
- the acromion process
- Anterior vertebral bodies
- Greater trochanter
- Posterior to the patella
- Ant. to the lat. Malleolus

This woman has severe osteoporosis. How has it affected her posture?

Standing Posture

Anterior view
- Shoulders level
- Sternum centered and in midline
- Hips level
- Knees level
- Feet slight outward toeing
Standing Posture

Posterior view
- Scapula & Shoulders level
- Spinous processes centered and in midline
- PSIS & Hips level
- Knees level, not bowed or knock kneed?
- Ankles straight?

Sitting Posture
- Maintain vertebral curves with feet flat on floor, low back supported
- Avoid slouching (forward head, rounded shoulders, decreased lumbar lordosis)

Cervical Spine Assessment
Kyphosis
Increased flexion in the thoracic spine, forward head posture in the cervical spine

The Vertebral Column

Osteology of the Cervical Spine & Trunk
They say “you need to have a good head on your shoulders,” but really, you need to have it on your atlas!

Parts of a Vertebra
- Body
- Neural Arch
- Vertebral Foramen
- Pedicle
- Lamina
- Transverse Process
- Articular Process
- Spinous Process

Atlas: Caudal aspect
Typical Cervical Vertebrae

Examples of Vertebrae

Sacrum & Coccyx
Posterior Aspect
Sacro-Iliac joints
Sacrum & Coccyx

**Anterior Aspect**

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**Sacrum & Coccyx**

**Lateral Aspect**

Sacro Iliac Joint

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**Intervertebral Discs**

- Between each vertebrae: beginning between C2 and C3
- 23 total
- Functions:
  - Shock absorption
  - Maintain flexibility of the vertebral column
  - 25% of the length of the vertebral column

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Lippert pg 214
**Intervertebral Discs**

*Annulus Fibrosus*
- Outer portion
  - Concentric fibrocartilage rings
  - Contain the nucleus pulposus

*Nucleus Pulposis*
- Gelatinous substance
  - High water content
  - 70-90% at birth
  - Serving as a hydraulic shock absorber
  - Less than 70% at 60 years of age

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**Joints of the Vertebral Column**

*Atlanto-occipital joint*
- Articulation between the Condyles of the occiput & superior articular processes of the atlas
- Supports the weight of the head

*Atlanto-axial joint*
- Synovial joint
  - Articulation between the Odontoid process (dens) of the Axis & and anterior arch of the atlas
The joints between C2 through S1 are consistent throughout:
- Weight-bearing joints
- Synovial joints
- Capsular ligaments
  - Occur anteriorly between vertebral bodies
  - Posterior joints bilaterally known as facet joints

**Atlantoaxial Joint**

![Atlantoaxial Joint Image]

**Joints of the Vertebral Column**

The joints between C2 through S1 are consistent throughout:
- Weight-bearing joints
- Synovial joints
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  - Occur anteriorly between vertebral bodies
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**Ligaments of the Vertebral Column**

**Anterior longitudinal ligament**

Attaches the bodies of the vertebrae on the anterior surface.
- Prevents excessive hyperextension.
- Thin superiorly and thick inferiorly to fuse the sacrum.
- Found in the thoracic and lumbar regions deep to the aorta.
Ligaments of the Vertebral Column

Posterior longitudinal ligament
Attaches to the bodies of the vertebrae on the posterior surfaces inside the vertebral foramen
Prevents excessive flexion
Thick superiorly to help support the skull and thin inferiorly
Contributes to instability and increased disk injury in the lumbar region.

Ligaments of the Vertebral Column

Supraspinal ligament
Extends from the 7th cervical vertebra distally to the sacrum posteriorly along the tips of the spinous processes

Interspinous ligament
Attaches successive spinous processes

Nuchal ligament
Interspinous ligament in the cervical spine

Ligaments of the Vertebral Column

Ligamentum Flavum
Connects adjacent laminae on the anterior surface
We just looked at lots of ligaments. Why do you think that there are so many in the vertebral column?

Joint Motion of the Vertebral Column

- Atlanto-occipital joint
  - Flexion and extension
- Atlantoaxial joint
  - Rotation and some lateral flexion
- Cervical spine
  - Flexion, extension, rotation, lateral flexion, retraction, protraction
- Trunk
  - Flexion, extension, rotation, lateral flexion

Pelvic Tilt

The position of the pelvis affects the position of the lumbar spine...

Anterior Pelvic Tilt

Posterior Pelvic Tilt
**Sacrolilac Joint**
The joint between the sacrum and the ilium where a small amount of motion may take place. If one ilium is rotated forward on the sacrum, back pain may result and the patient may appear to have a functionally longer leg on that side.

**Scoliosis**
Lateral Curvature of the spine
What internal organs become affected if the curvature is severe?
How is the stability of the spine affected?

**Spondylolysthesis**
Anterior displacement of one vertebra over another
Myology of the Neck

- Anterior
  - SCM
  - Scalenes (3)

- Posterior
  - Erector spinae group (3)

Sternocleidomastoid

<table>
<thead>
<tr>
<th>Origin</th>
<th>Insertion</th>
<th>Innervation</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sternal head: superior aspect of the manubrium of the sternum</td>
<td>Mastoid process of the temporal bone</td>
<td>Spinal accessory n. (cranial n. XI)</td>
<td>Bilateral: Flexion of the head &amp; neck</td>
</tr>
<tr>
<td>Clavicular head: medial 1/3 of the clavicle</td>
<td></td>
<td></td>
<td>Unilateral: Contra lateral rotation of the head and neck</td>
</tr>
</tbody>
</table>

Bilateral: Flexion of the head & neck
Unilateral: Contra lateral rotation of the head and neck
**Scalenes**

| Origin | Ant. Scalene: transverse processes of C3-C7  
| Middle Scalene: transverse processes of C2-C7  
| Posterior Scalene: transverse processes of C3-C7 |
| Insertion | Ant. Scalene: 1st rib  
| Middle Scalene: 1st rib  
| Posterior Scalene: external surface of the 2nd rib |
| Innervation | Ventral rami (C3-C7) |
| Action | Bilateral: flexion of the neck, assist with inspiration by elevating ribs 1&2  
| Unilateral: lateral flexion |

**Myology of the Trunk**

- **Anterior**  
  - Rectus abdominis  
  - External oblique  
  - Internal oblique  
  - Transverse abdominis  
  - Iliopsoas
- **Posterior**  
  - Erector spinae (3)
- **Lateral**  
  - Quadratus lumborum

**Rectus Abdominis**

| Origin | Crest of the pubis |
| Insertion | Xiphoid process and cartilages of ribs 5-7 |
| Innervation | Intercostal n. (T7-T12) |
| Action | Flexion of the trunk, posterior pelvic tilt, increases intra-abdominal and intrathoracic pressure |
| "tidbits" | pregnancy? tendinous inscriptions? |
### External Oblique

<table>
<thead>
<tr>
<th>Origin</th>
<th>Lateral side of ribs 4-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insertion</td>
<td>Iliac crest and linea alba</td>
</tr>
<tr>
<td>Innervation</td>
<td>Intercostal nerves (T8-T12)</td>
</tr>
<tr>
<td>Action</td>
<td><strong>Bilateral:</strong> Flexion of the trunk, posterior pelvic tilt, increased intra-abdominal and intra-thoracic pressure  <strong>Unilateral:</strong> Rotation of the trunk to the contralateral side, lateral flexion of the trunk</td>
</tr>
</tbody>
</table>

### Internal Oblique

<table>
<thead>
<tr>
<th>Origin</th>
<th>Iliac crest, inguinal ligament &amp; thoracolumbar fascia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insertion</td>
<td>Ribs 9-12, linea alba</td>
</tr>
<tr>
<td>Innervation</td>
<td>Intercostal n. (T8-T12)</td>
</tr>
<tr>
<td>Action</td>
<td><strong>Bilateral:</strong> flexion of the trunk, posterior pelvic tilt, increases intra-abdominal and intra-thoracic pressure  <strong>Unilateral:</strong> lateral flexion of the trunk to the ipsilateral side</td>
</tr>
</tbody>
</table>

### Transverse Abdominis

<table>
<thead>
<tr>
<th>Origin</th>
<th>Iliac crest, thoracolumbar fascia cartilages of ribs 6-12, &amp; inguinal ligament</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insertion</td>
<td>Linea alba</td>
</tr>
<tr>
<td>Innervation</td>
<td>Intercostal n. (T7-T12)</td>
</tr>
<tr>
<td>Action</td>
<td>Increases intra-abdominal pressure, increases tension in thoracolumbar fascia</td>
</tr>
</tbody>
</table>
**Iliopsoas**

<table>
<thead>
<tr>
<th>Origin</th>
<th>Psoas Major: transverse processes of T12-L5 Iliacus: Iliac fossa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insertion</td>
<td>Lesser trochanter of the femur</td>
</tr>
<tr>
<td>Innervation</td>
<td>Femoral n.</td>
</tr>
<tr>
<td>Action</td>
<td>Hip flexion, trunk flexion, anterior pelvic tilt</td>
</tr>
</tbody>
</table>

**Quadratus Lumborum**

<table>
<thead>
<tr>
<th>Origin</th>
<th>Crest of the ilium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insertion</td>
<td>Transverse processes of L1-L4 &amp; 12th rib</td>
</tr>
<tr>
<td>Innervation</td>
<td>Ventral rami (T12-L3)</td>
</tr>
<tr>
<td>Action</td>
<td><strong>Bilateral:</strong> extension of the lumbar region <strong>Unilateral:</strong> lateral flexion of the trunk</td>
</tr>
</tbody>
</table>

**What can you identify?**
What can you identify?

Erector Spinae
Large vertically oriented muscles on both sides of the spinous processes (about one hand’s width laterally)
- Extend and stabilize the entire vertebral column and craniocervical region

Iliocostalis

<table>
<thead>
<tr>
<th>Inferior</th>
<th>Superior</th>
<th>Innervation</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lumborum: common</td>
<td>Lumborum: angle of</td>
<td>Dorsal rami of adjacent spinal n.</td>
<td>Bilateral: extension</td>
</tr>
<tr>
<td>tendon</td>
<td>ribs 6-12</td>
<td></td>
<td>Unilateral: lateral flexion</td>
</tr>
<tr>
<td>Thoracic: angle of</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ribs 3-7</td>
<td>Thoracic: angle of</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cervicis: transverse processes of C4-C6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Innervation: Dorsal rami of adjacent spinal n.
### Longissimus

| Inferior | Thoracic: common tendon  
| Cervical: transverse processes of T1-T4  
| Cephalic: Transverse processes of T1-T5 & near facet joints C3-C7 |
| Superior | Thoracic: transverse processes of T1-T12  
| Cervical: Transverse processes of C2-C6  
| Cephalic: mastoid process of temporal bone |

**Innervation**  
- **Bilateral:** extension  
- **Unilateral:** lateral flexion  

**Action**  
Dorsal rami of adjacent spinal n.

### Spinalis

| Inferior | Thoracic: common tendon  
| Cervical: ligamentum nuchae and spinous processes C7-T1  
| Cephalic: Blends with semispinalis capitis |
| Superior | Thoracic: Spinous processes of T1-T6  
| Cervical: Pinous process of C2  
| Cephalic: Blends with semispinalis capitis |

**Innervation**  
- **Bilateral:** extension  

**Action**  
Dorsal rami of adjacent spinal n.

### Erector Spinae Muscles

- Images of the muscles shown.
1. Were there so many muscles that compressed the abdomen?
2. Are lower back injuries so common?
3. Do so many people have such poor posture if we have so many muscles to help keep our body upright?

• How would you isometrically strengthen the neck muscles (all planes)?
• How would you stretch the R trunk lateral flexors?
• How would you strengthen the trunk extensors?
• How would you strengthen the trunk flexors?