The Vertebral Column

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Vertebral Column

It is composed of 33 vertebrae;
  7 cervical,
  12 thoracic,
  5 lumbar,
  5 sacral,
  4 coccygeal separated from each other by intervertebral discs.
Structure of a Typical Vertebrae

1- Vertebral Body
2-Vertebral arch; composed of two pedicle and two lamina
3-Vertebral Foramen between Body and arch transmits spinal cord
4- Intervertebral foramen transmit the spinal nerves
5- Processes it has seven processes
   2 Transverse
   2 Superior articular
   2 Inferior articular
   1 Spine
### Comparison between vertebrae

<table>
<thead>
<tr>
<th></th>
<th>Cervical</th>
<th>Thoracic</th>
<th>Lumbar</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Body</strong></td>
<td>Small - oval</td>
<td>Moderate - round</td>
<td>Large - kidney shape</td>
</tr>
<tr>
<td><strong>Foramen</strong></td>
<td>Large triangular</td>
<td>Small round</td>
<td>Large triangular</td>
</tr>
<tr>
<td><strong>Arch</strong></td>
<td>- Short bifid transverse process with a foramen. - Short bifid spine</td>
<td>- Thick large transverse process</td>
<td>- Thin short transverse process. - Short, broad, horizontal spine.</td>
</tr>
</tbody>
</table>
The body is small & oval.

The foramen is large triangular.

The transverse processes are short, bifid with a foramen (foramen transversarium) which transmit vertebral artery and vein.

The spine is short & bifid.

**7th cervical vertebra (vertebra prominens)**

It has the longest spinous process, the process is not bifid. The transverse process...
TYPICAL THORACIC VERTEBRA

• The body is moderately sized & heart shaped.
• The foramen is small rounded.
• The transverse processes are large with impression for the rib & directed posterolaterally.
• The spine is large & long.
Typical thoracic vertebrae
The body is large kidney shaped.
The foramen is large triangular.
The transverse process is thin & directed laterally.
The spine is short, thick & broad.
The 5 sacral vertebrae join to form one mass known as the sacrum.

- It is roughly triangular with a base above & apex below & has 4 Anterior & 4 posterior sacral foramina

- The coccygeal segments join to form one mass known as the coccyx.
Joints of the Vertebral Column

The vertebrae articulate with each other by cartilaginous joints between their bodies and by synovial joints between their articular processes.

**Intervertebral Disc**
- Act as shock absorbers.
- Their elasticity allows the rigid vertebrae to move one on the other.
- Their elasticity is gradually lost with advancing age

**Type** : Secondary cartilaginous
Structure:
The upper and lower surfaces of the bodies of vertebrae are covered by thin plates of hyaline cartilage. Between the plates of hyaline cartilage is an intervertebral disc of fibrocartilage.
Each intervertebral disc consists of:
1- **Peripheral part**, the anulus fibrosus: is composed of concentric layers of fibrocartilage.
2- **Central part**, the nucleus pulposus: is an ovoid mass of gelatinous material contains amount of water, a small number of collagen fibers, and a few cartilage cells. It is normally under pressure and situated slightly nearer to the posterior than to the anterior margin of the disc.
Ligaments of Intervertebral joints

The anterior and posterior longitudinal ligaments run down the anterior and posterior surfaces of the bodies of vertebrae from the skull to the sacrum. The anterior ligament is wide and is strongly attached to the front and sides of the vertebral bodies and to the intervertebral discs. The posterior ligament is weak and narrow and is attached to the posterior borders of the discs.
**Intervertebral disc Herniation**
Leads to compression of spinal nerves and neurological manifestations. Sensory like numbness pain or sensory loss or Motors as muscle weakness.

**Intervertebral disc Degeneration**
As effect of ageing and disc degeneration thus limiting the ability of the disc to absorb shock.
**Type**: Plane synovial joints

**Articular surfaces**: between the superior and inferior articular processes of adjacent vertebrae. The articular facets are covered with hyaline cartilage, and the joints are surrounded by a capsular ligament.

**Ligaments**

1. **Supraspinous ligament**: Between the tips of adjacent spines.
2. **Interspinous ligament**: Connects adjacent spines.
3. **Intertransverse ligaments**: Between adjacent transverse processes.
4. **Ligamentum flavum**: Connects the laminae of adjacent vertebrae.
5-**Ligamentum nuchae**:
In the cervical region, the supraspinous and interspinous ligaments are greatly thickened to form the strong ligamentum nuchae. It is a triangular, the base of the triangle is attached to the external occipital protuberance. The apex is attached to the tip of the spinous process of 7th cervical vertebra.
In the fetus, the vertebral column has one continuous anterior concavity.

After birth, when the child becomes able to raise his head the cervical part of the vertebral column becomes convex anteriorly (cervical Lordosis).

Toward the end of the first year, when the child begins to stand upright, the lumbar part of the vertebral column becomes convex anteriorly (lumbar Lordosis).
1-Kyphosis: is increase in the sagittal curvature present in the thoracic part of the vertebral column.
Causes: by muscular weakness or by structural changes in the vertebral bodies or by intervertebral discs

Types:
1- Acute angular kyphosis: due to Crush fractures or tuberculous destruction of the vertebral bodies

2- Senile kyphosis: due to osteoporosis and or degeneration of the intervertebral discs involving the cervical, thoracic, and lumbar regions of the column.

3- Round-shouldered: due to weak muscle tone with long hours of study or work over a low desk can lead to a gently curved kyphosis of the upper thoracic region
What Causes Rounded Shoulders?

Stouching for a prolonged period of time, especially if it has formed into a habit, is the main cause for rounded shoulders.
Abnormal Curves of the Vertebral Column

(a) Scoliosis

(b) Kyphosis
Lordosis is an exaggeration in the sagittal curvature present in the lumbar region.

**Causes:**
- An increase in the weight of the abdominal contents, as with the gravid uterus or a large ovarian tumor
- Disease of the vertebral column such as spondylolisthesis

Scoliosis is a lateral deviation of the vertebral column. This is most commonly found in the thoracic region.

**Causes:**
- Paralysis of muscles caused by poliomyelitis.
- Congenital hemivertebra
Dislocations of the Vertebral Column

- Dislocations without fracture occur only in the cervical region.
- Dislocations commonly occur between the 4th and 5th or 5th and 6th cervical vertebrae.
- Dislocations with fracture occur in thoracic and lumbar regions.
- Unilateral dislocations cause spinal nerve injury producing severe pain.
- Bilateral dislocations cause spinal cord injury.
- Bilateral upper cervical dislocations cause death due to injury of phrenic nerves C3 to 5 leads to diaphragm paralysis.
Atlas and axis
**Atlas**: is the 1\textsuperscript{st} cervical vertebra. It is ring-shaped and has two lateral masses connected by an anterior arch and a posterior arch. Each lateral mass articulates above with an occipital condyle of the skull and below with the superior articular process of axis vertebra.

**Axis**: is the 2\textsuperscript{nd} cervical vertebra & is characterized by the large tooth-like dens (odontoid process), which extends superiorly from the vertebral body.
Articular Surface:
Occipital condyles, above and the superior articular surface of the atlas vertebra below.

Type: Synovial condylar joints

Ligaments
**Anterior atlanto-occipital membrane:** connects the anterior arch of the atlas to the anterior margin of the foramen magnum.
**Posterior atlanto-occipital membrane:** connects the posterior arch of the atlas to the posterior margin of the foramen magnum.

Movements
They allow extension, forward and lateral flexion.
Anterior atlantoöccipital membrane and atlantoaxial ligament

Posterior atlantoöccipital membrane and atlantoaxial ligament.
A. The Median atlanto-axial Joint:

**Articular Surface:** between the odontoid process and the anterior arch of the atlas

**Type:** Pivot synovial joint

**Ligaments**

1. **Apical ligament:** connects the apex of the odontoid process to the anterior margin of foramen magnum.
2. **Alar ligaments:** connect the odontoid process to the occipital condyles.
3-Cruciate ligament:
It consists of a transverse and a vertical parts.
  The transverse part is attached to the lateral mass of the atlas.
  The vertical part runs from the body of the axis to cranial aspect of occipital bone

Movement: Rotation
Apical Ligament
B. The Lateral atlanto-axial Joints:

**Articular Surface:**
Inferior atlantal and the superior axial articular facets

**Type:**
plane synovial joint
Sacroiliac Joint

- **Type:** plane synovial joint
- **Articular surfaces:** between sacral and iliac auricular surfaces.
- **Ligaments:**
  - The ventral sacroiliac ligament
  - The interosseous sacroiliac ligaments
  - The dorsal sacroiliac ligament.
- **Functions:**
  - It transmits the body weight from lumbar spine to the hip bones.
Development of Vertebral column

Stage 1

Stage of formation of mesenchymal vertebral column

Time of development: 4\textsuperscript{th} week
Development of the Vertebræ and Intervertebral Discs

The paraxial mesoderm separates into blocks of tissue, called somites. There are 44 pairs of somites adjacent to the notochord.

Frontal view
Development of the Vertebrae and Intervertebral Discs

Each somite divides into three regions: dermatome, sclerotome, and myotome.
Differentiation of sclerotomic segments

- Each segments differentiated into
  - Cephalic part (less condensed or light)
  - Caudal part (more condensed or dark)
- The caudal condensed part of each sceleretome fuses with the cranial light part of the sceleretome below it forming a mesenchymal centrum (future vertebral body).
- Cells from that centrum migrate dorsally to surround and fuse behind the neural tube, forming the vertebral or neural arch (future pedicles, laminae and spinous process).

- At the junction of the vertebral body and vertebral arch, the following processes project laterally.
  - Two (right and left) costal processes.
  - Two (right and left) primitive transverse processes lie dorsal to the costal processes.
II. Cartilaginous stage:

In the 6th week of development, the mesenchymal vertebrae are chondrofied, so that a mesenchymal vertebral column is transformed into a cartilaginous one.

III. Bony stage

By the 8th week of development, three primary centers appear which transform each vertebra into a bony structure.
Fate of the notochord:

The notochord has the following fate:

• In the region of the vertebral bodies, it degenerates completely.

• In the intervertebral regions, it forms the nucleus pulposus of each intervertebral disc while the annulus fibrosus of each disc is derived from the scleretomic mesenchyme,
Congenital anomalies
Spina bifida

**Cause**: incomplete fusion of halves of the vertebral arches resulting in midline defect usually in lumbosacral region
**Hemivertebra**

**Cause:** failure of one of the chondrofication center to appear so failure of half of vertebra to form

**Feature:** defective vertebra produce scoliosis (lateral curvature)
Congenital kyphosis
Thank You