Lectures of Human Anatomy

Vertebral Column-I

By

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VERTEBRAL (SPINAL) COLUMN

Introduction

It is a part of the axial skeleton. It extends from the skull to pelvis where it transmits body weight to the two lower limbs. Therefore, the size of vertebrae increases gradually till reaches the 1st sacral vertebra where the body weight is transmitted to hip bones. From the 1st sacral vertebra, the size diminishes again to reach tip of coccyx.

Structure of the Vertebral Column

It is formed of: I. Vertebrae, & II. Inter-vertebral discs.

I. Vertebrae: Their number is 33 vertebrae.

Structure (or Parts) of the Vertebra

- The vertebra is formed of two main parts; a body and an arch with a foramen in-between of them called "vertebral foramen". The vertebral foramina of the vertebrae together form the vertebral canal, enclosing the spinal cord.
- The arch carries many processes, including:-
  1. One spine, directed posteriorly.
  2. Two transverse processes.
  3. Two superior articular processes.
  4. Two inferior articular processes.
- The arch itself is divided into 2 halves by the attachment of the spine.
- Each half is then subdivided by the transverse process into 2 parts:-
  1. Anterior part, attached to the body of the vertebra, called pedicle.
  2. Posterior part, in-between the transverse process and spine, called lamina.
N.B.: The spines of vertebrae can be felt along the midline of the back.

II. Inter-vertebral disc:
- **Structure:** It is a fibro-cartilage, found between the bodies of the vertebrae (so it represents a secondary cartilaginous joint).
  Each disc is formed of two portions:
  - **Nucleus pulposus:** is the central gelatinous part.
  - **Annulus fibrosus:** is the peripheral part. It is formed of fibro-cartilaginous tissue, of which collagen fibers are arranged in concentric manner. It is attached to the anterior and posterior ligaments of the vertebral column.
- **Function:** The discs act as a buffer between the vertebrae to neutralize the shocks applied to the vertebral column.
- They represent about 20% (or 1/5th) of the total length of the vertebral column.
  (N.B.: There is no inter-vertebral disc between the first and the second cervical vertebrae) or in sacrum or coccyx.

Classification of Vertebrae
The vertebrae are arranged into 5 regions, as follows:
- "7" cervical vertebrae.
- "12" thoracic vertebrae.
- "5" lumbar vertebrae.
- "5" sacral vertebrae, fused together to form "one bone called; "sacrum"."
• "4" coccygeal vertebrae, fused together to form "one bone called; "coccyx" (tailbone).

Vertebral Column (posterior view)

I. Cervical Vertebrae

Characters of typical cervical vertebrae (3rd to 6th), include:
1. They are the smallest and lightest vertebrae.
2. Body of vertebra is small in size and the transverse diameter is larger than the antero-posterior one.
3. Vertebral foramen is wide and triangular.
4. Spine is short and bifid.
5. Transverse processes are bifid and each one show a foramen called foramen transversarium, for passage of vertebral vessels and sympathetic nerve fibers.
6. Facet on the superior articular process is directed superiorly and posteriorly, while that of the inferior articular process is directed inferiorly and anteriorly.

N.B.: Once you see these foramina, the vertebra is then a cervical in type.

Typical cervical vertebra (upper surface)
Atypical Cervical Vertebrae

1. **1st Cervical Vertebra** (called *atlas*): has no body and no spine. The upper surface contains large oval depression for articulations with the occipital condyles of skull. The joints between it and skull, called *atlanto-occipital joints* allow us to express 'yes'.

2. **2nd Cervical Vertebra** (called *axis*): has dens (called odontoid process). This process represents the body of 1<sup>st</sup> vertebra, fused with the body of 2<sup>nd</sup> vertebra. It acts as a pivot for rotation of the skull and the first vertebra. The joints between it and the 1<sup>st</sup> cervical vertebra called *atlanto-axial joints* allow us to express 'no'.

3. **7th Cervical Vertebra**: It resembles the typical vertebra, except it has long tapering spinous process.

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Photographs of upper surfaces of vertebrae, showing: Differences between Seventh cervical vertebra (A) and First thoracic vertebra (B)
II. **Thoracic Vertebrae**

Characters of typical thoracic vertebrae (2nd to 8th), include:

1. They are larger in size than the cervical vertebrae.
2. The body is heart-shaped and carries 2 demi-facets; superior and inferior for articulation with heads of ribs.
3. Vertebral foramen is small and circular.
4. Transverse process is directed postero-laterally and has an articular surface for articulation with the tubercle of the corresponding rib.
5. Spine is long, tapering and directed postero-inferiorly.
6. Superior articular process is directed backwards and the inferior process is directed anteriorly.

![Typical thoracic vertebra: A) Upper surface, B) Lateral Surface](image)

**Photograph showing: Articulated typical thoracic vertebrae**

**Photograph showing: Typical thoracic vertebra (Side view)**

### Atypical thoracic vertebrae:

1. **1st thoracic vertebra:** is similar to 7th cervical vertebra in shape of body and spine, but it has transverse process like that of typical thoracic vertebrae. In addition, each side of the body has one complete facet for articulation with the head of corresponding rib and an inferior demi-facet for articulation with the upper part of head of 2nd rib.
2. **9th thoracic vertebra**: Side of body has a semicircular upper facet for articulation with head of the corresponding rib.

3. **10th thoracic vertebra**: Side of body has a complete facet for articulation with head of the corresponding rib.

4. **11th thoracic vertebra**: Side of body has a complete facet for articulation with head of the corresponding rib. Transverse process is small and has no costal facet.

5. **12th thoracic vertebra**: is similar to 1st lumbar vertebra but the side of body has a complete facet for articulation with head of the corresponding rib. Inferior articular process is directed laterally.

III. **Lumbar Vertebrae**

**Characters of typical lumbar vertebrae (1st to 4th)**, include:
- Body is large, massive and kidney-shaped.
- Spine is quadri-angular and horizontal.
- Articular processes lie in sagittal plane.

**Atypical lumbar vertebra (5th)**: is characterized by transverse process which is massive, encroaching on the body of the vertebra.

IV. **Sacro**

It is the posterior bone of the pelvic cavity. It is formed of five sacral vertebrae fused together.

**Shape**: It is a triangular or wedge in shape, with the base above and its apex below. It is slightly concave anteriorly.
- The anterior upper border of the body of first sacral (S1) vertebra projects inwards. It is called **sacral promontory**.
Identification of the promontory is important in gynecological examination of the pelvis and at laparotomy. The lateral mass on each side is a fan-shaped, called *ala of sacrum*. The superior articular process of S1 vertebra carries articular facet directed posteriorly.

- The sacral foramina form together the *sacral canal*.
- The lower opening of sacral canal is called *sacral hiatus*, that represents a route for caudal anesthesia. It is surrounded on either sides by sacral cornua, that are of great importance for identification of sacral hiatus on the body surface. They are felt above the natal cleft.
- The anterior surface is smooth and concave. It has four pair of *anterior sacral foramina*.
- The posterior surface is irregular and convex. It has four pair of *posterior sacral foramina*.
- The lateral surface shows articular surface, called *auricular surface* for articulation with the hip bone at sacro-iliac joint.

**Sex differences:** The sex differences arise from the general rule that the female pelvis is more wider and shorter than that of males. Moreover, the musculo-skeletal system (joints and muscles) is usually smaller in females than in males.

<table>
<thead>
<tr>
<th></th>
<th>Male sacrum</th>
<th>Female sacrum</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length and width</strong></td>
<td>It is longer and narrower</td>
<td>It is shorter and wider</td>
</tr>
<tr>
<td><strong>Curvature of bone</strong></td>
<td>It shows a gentle and uniform curvature</td>
<td>It descends nearly straight in its upper part, while the lower part turns forwards.</td>
</tr>
<tr>
<td><strong>Upper surface</strong></td>
<td>Body is wider than the ala</td>
<td>Body is narrower or equal to ala.</td>
</tr>
<tr>
<td><strong>Auricular surface</strong></td>
<td>Longer</td>
<td>Shorter</td>
</tr>
<tr>
<td></td>
<td>- Opposite more than two vertebrae (half or three vertebrae).</td>
<td>- Opposite only to 2 vertebrae.</td>
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Structures passing through it:
- **Sacral canal:**
  1. Five pairs of sacral nerves.
  2. One pair of coccygeal nerves.
  3. Filum terminale, that represents an extension from the tube of pia matter that ends with the end of spinal cord at lower border of L1 vertebra.
  4. Tube of arachnoid and dura matter. It contains CSF in the subarachnoid space and it ends opposite the S2 vertebra.

- **Sacral hiatus:**
  1. One pair of sacral (5th) nerves.
  2. One pair of coccygeal nerves.
  3. Filum terminale. It ends through blending with periosteum at the back of periosteum.

- **Anterior sacral foramina:**
  1. Anterior rami of the 1st four sacral nerves "exit".
  2. Lateral sacral arteries "entrance".

- **Posterior sacral foramina:**
  1. Posterior rami of the 1st four sacral nerves "exit".
  2. Lateral sacral arteries "exit".

**Articulations of Sacrum:**
1. Body articulates with the body of 5th lumbar vertebra at the *intervertebral disc* "secondary cartilaginous joint".
2. Auricular surface articulates with the iliac bone (of hip bone) to form *sacro-iliac joint* "synovial joint".
3. Facet on the articular process articulates with that on the inferior articular process of 5th lumbar vertebra "synovial joint".
4. Apex articulates with the base of coccyx at the *sacroccocygeal joint*. It is a symphysis between the 2 bones, allowing a sight flexion and extension.

**V. Coccyx**
This is a small triangular bone formed of 4 rudimentary vertebrae, fused together. Its base articulates with the apex of sacrum. Its apex is directed downwards, beneath the skin of natal cleft.
Structures Connecting the Vertebrae

A) **Ligaments:**
   1. **Anterior longitudinal ligament:** --- in front the bodies of vertebrae.
   2. **Posterior longitudinal ligament:** --- behind the bodies of vertebrae (within the vertebral canal).
   3. **Supra-spinous ligament:**------ between the tips of spines.
   4. **Inter-spinous ligament:**--------- between the spines.
   5. **Inter-transverse ligament:**---- between the transverse processes.
   6. **Pair of ligamenta flava:**------- between the laminae.

B) **Joints:**
   1. **Inter-vertebral disc** *(secondary cartilaginous joint)*;---- between the bodies of vertebrae.
   2. **Two synovial joints**;---- between the articular processes.

*Diagram showing Sites of Ligaments Connecting the Vertebrae*