Typical Cervical Vertebra C3-6

- Small, relatively broad body
- Bifid Spinous Process
- Long and narrow laminae
- Spinal Canal: large, triangular; remarkably consistent dimensions
- Transverse Foramen: vertebral arteries

Typical Cervical Vertebra Anterior

- Superior surface concave transversely, convex A-P
- Uncinate Processes
  - marked bilateral lips; C3-T1
  - Form uncovertebral joints
  - Consider with major limitations in SB
Uncovertebral Joints

- Present between C2-3 to C7-T1
- Fully developed at 18 yrs
- Medial border disc, lateral border ligaments
- Joint surfaces covered with hyaline cartilage
- Enhance stability of cervical spine
- Act as a “rail” to guide flexion/extension
- Limits sidebending
- Frequently affected by arthritic changes

Cervical Transverse Processes

- Transverse Processes run lateral-anterior-inferior
- Form “gutter” through which the nerve root runs
- Transverse Foramen for vertebral artery

Atlas

- No vertebral body
- No spinous process
- Orientation of the articular surface (OA)
- Anterior Tubercle - ALL
- Facet on posterior aspect of Anterior Arch
- Wide transverse processes (up to 90mm)
Vertebral Artery

- Arises from the first part of the subclavian artery and passes upward on the longus colli to enter the foramen transversarium of C6.
- Ascends from C6 to C1. After emerging through the transverse foramen of C2, it winds around the vertebral canal and together with the 1st cervical nerve and vein pierces the posterior atlanto-occipital membrane to enter the cranial foramen through the foramen magnum.
- On the anterior side of the brainstem it joins its fellow to form the basilar artery.
- The vertebral arteries contribute about 11 percent of the total cerebral blood flow, the remaining 89 percent being supplied by the carotid system.


Atlanto Occipital Ligaments

Joint capsule
- Thin and loose

Anterior atlanto occipital membrane
- Connects the anterior part of the foramen magnum to the atlas and C1.
- May provide some A-P stability.

Posterior atlanto occipital membrane
- Connects the posterior ring of C1 to the occiput at the foramen magnum. Broad and thin.
- The anterior and posterior membranes prevent anterior and vertical displacement of C1 and C2.

Ligaments of C1-2

Anterior atlanto axial membrane
- Connects C1 to C2 anteriorly.

Posterior atlanto axial ligament
- Broad thin membrane. Attaches to the posterior ring of the atlas and the axis. The posterior A-O and A-A membrane are anatomically analogous to the yellow ligament.

Ligaments of C1-2

**Cruciate ligament**
- The major portion of this ligament is the transverse ligament.
- Ascending and descending parts, which are triangular shaped.
- Prevents inferior/superior displacement of the transverse ligament.

**Transverse ligament**
- Most important ligament in the upper cervical spine.
- 7-8 mm thick.
- Attaches on the medial surface of the lateral mass of the atlas.

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Ligaments connecting C2 with Occiput

**Tectorial membrane**
- Continuation of PLL.
- Runs from the body of C2 up over the posterior portion of the dens and then makes a 45-degree angle in the anterior direction as it attaches to the anterior edge of the foramen magnum.
- Limits flexion, extension and vertical translation.

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Ligaments connecting C2 with Occiput

**Alar ligaments**
- A pair of ligaments attached to the dorsolateral surfaces of the tip of the dens.
- Primarily limit rotation.
- Highly innervated.
- When affected, able to generate cervicogenic headaches, refers to the eye.
Anterior Longitudinal Ligament

Differences Lumbar vs Cervical:
Thick and well developed in the T- & L-spine, thinner and less developed in the C-spine

Nuchal Ligament

• Distinct band
• Posterior border of occiput attaching to SP’s to C7 (not great attachments in upper cervical)
• Precise Role?
  ➢ Proprioception
  ➢ A-P stability at C1-4

Disc

Not just a smaller version of a lumbar disc
Less soft nuclear material, and the nucleus only really exists until early adulthood

By age 40, the central region of the disc is composed of fibrocartilage
The annulus fibrosis is not a ring like structure of lamellae, but more a discontinuous structure made up of 2 distinct portions
Anterior annulus is crescent shaped, running between the uncinate processes. Well developed and thick at midline
Posterior annulus is small and thin. The posterolateral aspect of the disc lacks annulus fibrosus support
Between 9-14 years of age, horizontal fissures develop in the disc, until they completely transact the posterior 2/3 of the disc
This, in combination with the absence of a substantial posterior annulus, facilitates rotation
- Transitional level = inferior articulation of the upper cervical and superior of the mid cervical
- Common level for dysfunction as has a lot of mobility relative to the mid-cervical (axis of rotation further away from the disc which creates more gliding and less stability)
- Frequently affected mechanically

**Coupling Characteristics Cervical Spine**

- Two or more individual motions are coupled when one motion is always accompanied by another motion. This phenomenon is due to the geometry of the individual vertebrae, the connecting vertebrae and discs, as well as the curvature of the spine
- Sidebending and rotation are coupled opposite for C0-1
- Sidebending and rotation are coupled to the same side for the mid cervical spine

**Occiput-C1**

- The articular surfaces of the occipital condyles are bi-convex
- The superior articular surfaces of C 1 are bi - concave and face superior and medial.
- The long axes of the superior facets of the atlas converge anteriorly.
- The joint has 2 degrees of freedom: flexion/extension in the sagittal plane and sidebending in the frontal plane
- Rotation is conjunct to the opposite side of sidebending.
Arthrokinematics C0-1

- During flexion, both convex occipital condyles glide in the opposite direction of the movement of the occiput (posterior)
- During extension, both occipital condyles glide in the opposite direction of the movement of the occiput (anterior)

Rotation
- Rotation as an active movement does not exist at C0-C1.
- Rotation is conjunct to the opposite side of sidebending.

In right side bending:
- The right C0 moves in medial / inferior / anterior direction.
- The left C0 moves in lateral / posterior / superior direction.
- This creates a conjunct left rotation of occiput on C1.

"MIA has nice LPS."

Arthrokinematics C0-1

C1-2

- Inferior articular facets of C1 are convex.
- Superior articular facets of C2 are convex.
- No sidebending.
- Rotation is the main movement.
A synovial joint is present between the posterior surface of the anterior arch at atlas and the anterior surface of the dens.

There is an articulation between the posterior surface of the dens and the anterior surface of the transverse ligament.

**Arthrokinematics C1-2**

- On right rotation, the right facet of C1 glides in posterior direction
- The left facet glides in anterior direction
- On left rotation, the opposite occurs
- During flexion, both facet surfaces of C1 roll anterior and glide posterior
- The anterior arch of C1 glides in a caudal direction on the anterior surface of the dens
- During extension, the opposite occurs

**Upper Cervical Spine Stability**

- Loose joint capsule to allow large ROM and poor joint congruency
- Stability mostly from the dens and the ring of ligaments located around it
- Ligamentum flavum not present at this level (atlantoaxial membrane)
- Transverse ligament is the most important ligament in the upper C-spine
Arthrokinematics C2-7

• The articular surfaces of the superior articular facet are slightly convex and face cranial and posterior.
• The articular surfaces of the inferior articular facet are slightly concave and face caudal and anterior.
• The facet orientation in the mid cervical spine is approximately 45 degrees to the horizontal.
• C2-7

Flexion: the facets move up and forward.
Extension: the facets move down and back.
Sidebending: during right sidebending, the right facet moves down and back, the left facet up and forward.
Rotation: during right rotation, the right facet moves down and back, the left up and forward.

ROM Cervical Spine

<table>
<thead>
<tr>
<th>Joint</th>
<th>Flexion/Extension</th>
<th>Rotation</th>
<th>Sidebending</th>
</tr>
</thead>
<tbody>
<tr>
<td>C0-C1</td>
<td>Flexion 5 Extension 10</td>
<td>Minimal, conjunct</td>
<td>5</td>
</tr>
<tr>
<td>C1-2</td>
<td>Flexion 5 Extension 10</td>
<td>35-40</td>
<td>0</td>
</tr>
<tr>
<td>C2-7</td>
<td>Flexion 35-40 Extension 55-60</td>
<td>30-35</td>
<td>30-35</td>
</tr>
<tr>
<td>Total Cervical Spine</td>
<td>Flexion 45-50 Extension 76-80</td>
<td>65-75</td>
<td>35-40</td>
</tr>
</tbody>
</table>

Because of the large range and variability in the data presented in the literature, ROM values posted here are compiled from multiple sources.

Use it less as a strict objective number, but more as a useful guideline in appreciating the relative kinematics among the joints in the cervical spine.
Common Cervical Spine
ROM Patterns

• Capsular pattern
• Noncapsular pattern
  – Closing pattern
  – Opening pattern
  – Combination/irregular pattern
  – Discogenic pattern
  – C1-C2 pattern

Capsular Pattern

• Symmetrical limitation of rotation/sidebend
• Little to no limitation of flexion; marked limitation with extension

Closing Pattern

• Pain limitation with extension, ipsilateral rotation/sidebend
• Pain may or may not be associated with peripheralization of symptoms
• Hypothesize to be a dysfunctional closing biomechanic problem involving the ipsilateral facet and/or uncovertebral joint
• In the presence of peripheralization may be related to narrowing of the IVF with nerve root irritation
Opening Pattern

- Painful limitation with flexion, contralateral rotation/sidebend
- Common to have the rotation/sidebend components as the most involved motions
- Hypothesized to be a dysfunctional opening biomechanic involving the contralateral facet and/or uncovertebral joint
- May R/O muscular pattern with resisted movements

References