Craniovertebral Junction Embryology and Anatomy

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CVJ-Embryology
SOMITE - The building block of vertebrae, skeletal muscle and dermis.

SOMITEL - Outer Dermatome
           /               
          /                
        Inner Myotome     Medial Sclerotome
          |                |
          V                V
Vertebra

Diagram:
- SOMITE
  - Outer Dermatome
  - Inner Myotome
  - Medial Sclerotome → Vertebra
<table>
<thead>
<tr>
<th>Sclerotomes</th>
<th>Divisions</th>
<th>Subdivisions</th>
<th>Formations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occipital</td>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>Hypocentrum</td>
<td>Basiocciput</td>
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<td></td>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
<td>Centrum</td>
<td>Exoccipital centers (Jugular tubercles)</td>
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<td></td>
<td>3&lt;sup&gt;rd&lt;/sup&gt;</td>
<td>Neural Arch</td>
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<td>4&lt;sup&gt;th&lt;/sup&gt;</td>
<td>&quot;Proatlas&quot;</td>
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<td></td>
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<td>Hypocentrum</td>
<td>Anterior tubercle clivus</td>
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<td></td>
<td></td>
<td>Centrum</td>
<td>Apical ligament</td>
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<tr>
<td></td>
<td></td>
<td>Neural Arch</td>
<td>Apex of dens</td>
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<tr>
<td>Spinal 1&lt;sup&gt;st&lt;/sup&gt;</td>
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<td>Occipital condyles, third condyle</td>
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<td></td>
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<td>Hypocentrum persists</td>
<td>U-shape of foramen magnum</td>
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<td>Centrum</td>
<td>Alar and cruciate ligaments</td>
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<td>Neural arch</td>
<td>Posterior arch of atlas (C1)</td>
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<tr>
<td>Spinal 2&lt;sup&gt;nd&lt;/sup&gt;</td>
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<td>Lateral atlantal masses</td>
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<td>Hypocentrum</td>
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Diagram: An anatomical diagram illustrating the relationships between the various elements described in the table.
CVJ- Anatomy
• Marginal effect of placement of occipital screws on ROM
• Lateral fixation results in less lateral bending
• Medial fixation results in less rotation

However only small screws can be placed laterally, making the construct less robust.

Anderson et al. Spine; 2006
• Principal stabilizing ligaments of C1 -
  - Transverse atlantal ligament
  - Alar ligaments

• Secondary stabilizing ligaments of CVJ are more elastic & weaker than the primary ligaments.
  - Apical ligament
  - Anterior & posterior A-O membranes
  - Tectorial membrane
  - Ligamentum flavum
  - ALL & PLL
  - Capsular ligaments
CVJ- Muscles
• The capital flexor muscles include the following:
  - Longus capitis
  - Rectus capitis anterior and lateral
  - Suprahyoid and hyoid muscles

• The capital extensor muscles include the following:
  - Splenius capitis
  - Semispinalis capitis
  - Longissimus capitis
  - Obliquus capitis inferior and superior
  - Rectus capitis posterior major and minor

• The cervical flexor muscles include the following:
  - Anterior scalene
  - Middle scalene
  - SCM

• The cervical extensor muscles include the following:
  - Semispinalis cervicis
  - Longissimus cervicis
  - Splenius cervicis
• The muscle groups that laterally flex and rotate the cervical spine include the following:
  - Rectus capitis lateralis
  - Obliquus capitis inferior and superior
  - Intertransversarii
  - Multifidi
  - Iliocostalis cervicis
  - Longus colli
  - Levator scapulae
  - Longissimus capitis
  - Splenius cervicis
  - Splenius capitis
  - SCM
  - Scalene muscles
• Muscles have only a minor role related to CVJ stabilization & do not limit the movements of the joints.

• Their principal function is one of initiating & maintaining movement at the CVJ.
CVJ-Biomechanics
• The structure of CVJ is a compromise between stability and mobility.

• Ligaments and membranes have a primary role in providing stability to the CVJ, because this region lacks intervertebral discs and has horizontally aligned articular facets.

• It ensures a smooth transition between the fixed skull and the highly mobile upper cervical spine, while protecting its valuable contents.
Biomechanics Occ-C1 Articulation

- Primary movement- Flexion & Extension (23to24.5 degrees)
- Flexion: limiting factor- impingement of dens on FM
- Extension: limiting factors- Tectorial membrane
Biomechanics C1-C2 Articulation

• Primary movement- axial rotation
• Axis of rotation- central portion of dens
• C1-C2 rotation negatively coupled to rotation at Oc-C1 rotation
• Axial rotation: limiting factors-
  - C1-C2 articulation
  - I/L transverse ligament
  - C/L alar ligament
  - Capsular ligament
Biomechanics C1-C2 Articulation

• Flexion-extension
• Axis of rotation- midway b/w tip and base of dens near dorsal cortex
• Flexion : limiting factor- transverse ligament
• Extension: limiting factors-
  - C1-C2 articulation
  - Tectorial membrane
Biomechanics C1-C2 Articulation

- Lateral bending- 6.7 degrees
- Limiting factors-
  - Alar ligament
CVJ- Vessels
CVJ-Arterial relationships

- Vertebral artery has four segments
  - V3/suboccipital segment
    - Vertical
    - Horizontal
    - Oblique
CVJ-Arterial relationships

- Potential sites of injury to V3 segment:
  1- Medial edge of horizontal V3
  2- Superior edge of horizontal V3
  3- Transition of V2-V3
Thank You